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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

REPORT OF PROGRESS

OF THE

DIVISION OF HYDROGRAPHY

FOR

THE CALENDAR YEARS 1893 AND 1894

BY

FREDERICK HAYNES NEWELL
TOPOGRAPHER IN CHARGE

WASHINGTON
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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., May 20, 1895.

SIR: I have the honor to transmit herewith a manuscript entitled "Report of progress of the Division of Hydrography for the calendar years 1893 and 1894," and to request that it be published as a bulletin of the Survey.

Very respectfully, yours,

F. H. NEWELL,
Topographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

REPORT OF PROGRESS OF THE DIVISION OF HYDROGRAPHY FOR 1893 AND 1894.

By F. H. Newell.

INTRODUCTION.

This bulletin contains the results of observations and measurements made by the Division of Hydrography during the calendar years 1893 and 1894, together with similar facts obtained by persons or officials cooperating with the Survey or conducting related lines of investigation. It has not been customary to publish results until the computations have been fully worked up and the matter has been put into the most concise form possible for insertion in one of the papers accompanying the Annual Report; but experience has shown the desirability of printing at as early date as possible much of the original data regarding the location of the river stations and daily observations, as these are becoming to be matters of importance to individuals and communities in different parts of the country. In the past all facts of this kind have been furnished by letter to persons requesting them, but a time has been reached when it seems economical and advisable to present these matters in form accessible to all persons. It is proposed, therefore, to publish in bulletin form, without illustrations, the data obtained during each field season, reserving the more condensed general statements and the results of final computations, as before, for the Annual Report of the Survey, wherein they will be presented, as far as possible, graphically, by means of maps and diagrams. In one of the annual reports succeeding this bulletin will be given a resume of some of the data herewith presented. This will be the sixth paper of the series.[1]

The field seasons for the years 1893 and 1894 marked the time of greatest depression for the Division of Hydrography and the beginning of a period of renewed activity. During 1893 and the earlier

[1] The five preceding papers are as follows: Hydrographic Work: First Annual Report of the Irrigation Survey, being Part II of the Tenth Annual Report of the United States Geological Survey, pp. 78-90. Hydrography: Second Annual Report of the Irrigation Survey, being Part II of the Eleventh Annual Report of the United States Geological Survey, pp. 1-110. Hydrography of the Arid Regions: Third Annual Report of the Irrigation Survey, being Part II of the Twelfth Annual Report of the United States Geological Survey. pp. 213-361. Water Supply for Irrigation: Thirteenth Annual Report of the United States Geological Survey, Part III, pp. 1-99. Results of Stream Measurements: Fourteenth Annual Report of the United States Geological Survey, Part II, pp. 89-155.

months of the following year the allotments for stream measurements barely sufficed to continue the reading and recording of heights of rivers at a number of the stations previously established, and were not large enough to maintain field work, nor to replace river gages as these were washed out, nor to verify the rating tables constructed for various localities. Many stations, therefore, for which excellent rating tables had been prepared during 1889, 1890, and succeeding years had to be abandoned for one cause or another, and in the case of others the change of shape of river channel and the altered relation of gage height to discharge rendered of doubtful value the computations of daily flow. In August of 1894, however, the work was again taken up with vigor, owing to favorable action by Congress. New stations were established, and many old ones of value were inspected and renewed.

In this connection it will be proper to cite the laws under which this investigation is being conducted, or which bear directly upon its operations, and to give a short resume of the existing legislation.

LEGISLATION.

In 1887 the Director of the Geological Survey was called upon by Congress to consider the question of Federal recognition of the irrigation subject. A resolution was introduced and passed directing the Secretary of the Interior, by means of the Director of the Geological Survey, to make an investigation of that portion of the arid region of the United States where agriculture is carried on by means of irrigation. The resolution reads as follows:

Whereas a large portion of the unoccupied public lands of the United States is located within what is known as the arid region and now utilized only for grazing purposes, but much of which, by means of irrigation, may be rendered as fertile and productive as any land in the world, capable of supporting a large population thereby adding to the national wealth and prosperity;

Whereas all the water flowing during the summer months in many of the streams of the Rocky Mountains, upon which chiefly the husbandman of the plains and the mountain valleys chiefly depends for moisture for his crops, has been appropriated and is used for the irrigation of lands contiguous thereto, whereby a comparatively small area has been reclaimed; and

Whereas there are many natural depressions near the sources and along the courses of these streams which may be converted into reservoirs for the storage of the surplus water which during the winter and spring seasons flows through the streams; from which reservoirs the water there stored can be drawn and conducted through properly constructed canals, at the proper season, thus bringing large areas of land into cultivation, and making desirable much of the public land for which there is now no demand; therefore be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior by means of the Director of the Geological Survey be, and he is hereby, directed to make an examination of that portion of the arid regions of the United States where agriculture is carried on by means of irrigation, as to the natural advantages for the storage of water for irrigating purposes with the practicability of constructing reservoirs, together with the capacity of the streams and the cost of construction and capacity of reservoirs, and such other facts as bear on the question of storage of water for irrigating pur-

poses; and that he be further directed to report to Congress as soon as practicable the result of such investigation. . (Joint resolution approved March 20, 1888; Statutes at Large, vol. 25, p. 618.)

This was followed by the passage of an act containing an appropriation of $100,000 for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation. This act is as follows:

For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps, including the pay of employees in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of one hundred thousand dollars or so much thereof as may be necessary. And the Director of the Geological Survey under the supervision of the Secretary of the Interior shall make a report to Congress on the first Monday in December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs and an itemized account of the expenditures under this appropriation. And all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches or canals for irrigation purposes and all the lands made susceptible of irrigation by such reservoirs, ditches or canals are from this time henceforth hereby reserved from sale as the property of the United States, and shall not be subject after the passage of this act, to entry, settlement or occupation until further provided by law:

Provided, That the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by this provision to settlement under the homestead laws. (Sundry civil act approved October 2, 1888; Statutes at Large, vol. 25, p. 526.)

In the following year $250,000 was appropriated for continuing this work. (Sundry civil act approved March 2, 1889.)

A portion of the law passed October 7, 1888, was repealed by the following provision in the sundry civil act approved August 30, 1890, and no appropriation was made for irrigation work as such:

And so much of the act of October 2, 1888, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30th, 1889, and for other purposes," as provides for the withdrawal of the public lands from entry, occupation and settlement, is hereby repealed, and all entries made or claims initiated in good faith and valid but for said act, shall be recognized and may be perfected in the same manner as if said law had not been enacted, except that reservoir sites heretofore located or selected shall remain segregated and reserved from entry or settlement as provided by said act until otherwise provided by law, and reservoir sites hereafter located or selected on public lands shall in like manner be reserved from the date of the location or selection thereof.

No person who shall after the passage of this act, enter upon any of the public lands with a view to occupation, entry or settlement under any of the land laws shall be permitted to acquire title to more than three hundred and twenty acres in the aggregate, under all of said laws, but this limitation shall not operate to curtail the right of any person who has heretofore made entry or settlement on the public lands, or whose occupation, entry or settlement, is validated by this act: Provided,

That in all patents for lands hereafter taken up under any of the land laws of the United States or on entries or claims validated by this act west of the one hundredth meridian, it shall be expressed that there is reserved from the lands in said patent described, a right of way thereon for ditches or canals constructed by the authority of the United States. (Sundry civil act approved August 30, 1890; Statutes at Large, vol. 26, p. 391.)

From this it appears that the portion of the original law approved October 2, 1888, which affected the withdrawal of the public lands from entry, occupation, and settlement was repealed, but that the remaining portions of the law were unaffected by the act of repeal, and there is still on the statute books authority for making an examination of the arid region of the United States, for ascertaining the capacity of the streams, and "for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps."

In the repealing act it was specifically provided that the reservoir sites shall remain segregated, and in an act entitled "An act to repeal timber-culture laws, and for other purposes," approved March 3, 1891, it is provided:

That reservoir sites located or selected and to be located and selected under the provisions of "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and eighty-nine, and for other purposes," and amendments thereto, shall be restricted to and shall contain only so much land as is actually necessary for the construction and maintenance of reservoirs; excluding so far as practicable lands occupied by actual settlers at the date of the location of said reservoirs. (Statutes at Large, vol. 26, p. 1101.)

Under the various laws above cited, systematic measurements of the streams of the arid regions were begun as part of the irrigation survey, and were continued after August 30, 1890, as incidental to the topographic surveys and selection of reservoir sites, the amounts allotted to this work being, however, as previously stated, barely sufficient to preserve from loss the valuable data already obtained and to continue to completion series of measurements for which by far the greater part of the necessary expenditures had been incurred. The publication and diffusion of the information relating to streams of the West, even though fragmentary, brought emphatically to public attention the necessity of such work and of obtaining more detailed facts concerning the water resources of all parts of the country. As a result of this general appreciation, Congress, by act of August 18, 1894, made a specific appropriation for this class of work, as follows:

For gaging 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, twelve thousand five hundred dollars. (Digest of Appropriations for 1895, p. 270.)

A further appropriation by act approved March 2, 1895, will make available on July 1, 1895, an additional sum for continuing this work until June 30, 1896. This bulletin, as relating to the field work for

the years 1893 and 1894, covers the results obtained under the small allotments previously made and the inception of the work under the specific appropriation of August 18, 1894.

A general summary of the more important results obtained in previous years may be found in the Tenth to the Fourteenth Annual Reports of the Director of this Survey (see footnote on p. 9), and in a monograph upon Agriculture by Irrigation, published as one of the volumes of the Eleventh Census of the United States, in which the figures obtained by the enumerators of the Eleventh Census and facts gathered on schedules and suitable blanks by extensive correspondence were elaborated and supplemented by the field information and experience acquired by the members of the Division of Hydrography of this Survey.

FIELD WORK IN 1893 AND 1894.

The field work of this division for the year 1893 and for the first half of 1894 was carried on by Mr. F. H. Newell. It consisted of inspection of river stations, verification of rating tables by measurements of discharge, and examination of local conditions influencing water supply. In the fall of 1894 Mr. Arthur P. Davis took up the work. He established new river stations, and the investigation was extended generally. Prof. Robert Hay was also employed temporarily to make an investigation of the so-called "underflow" and subsurface waters of the area extending from the North Platte River southerly along the one hundred and second meridian, across a portion of Kansas and into eastern Colorado and western Kansas. His conclusions and generalizations have been prepared for publication in a paper accompanying the Sixteenth Annual Report of the Director, while the somewhat detailed data upon which many of his conclusions are based are given herewith, as part of this bulletin, in order that they may be accessible to the relatively limited number of persons who will care to utilize them.

The results of the river work are shown in connection with the descriptions of the stations, and are summarized briefly in the list of discharge measurements. In the descriptions of these stations the geographic order employed in former reports is adhered to. The Upper Missouri and its tributaries are taken up first; then the Platte, Arkansas, Rio Grande, and Colorado basins; next the great interior basin, of which the streams tributary to the lakes or sinks in Nevada, and to Great Salt Lake and Sevier Lake in Utah, are parts; then the Snake and its tributaries, and the other rivers forming portions of the Columbia River system; then the Sacramento, San Joaquin, and creeks of southern California; and lastly the data obtained concerning streams in the Mississippi Valley and along the Atlantic watershed.

The methods of river measurement are described in the Fourteenth Annual Report, Part II, pages 96–101, where are given also a number of illustrations of the current meters and self-recording devices used in river work.

UPPER MISSOURI BASIN IN MONTANA.

The river stations on the West Gallatin and Madison rivers, described in former reports, have been abandoned, owing to the difficulty and expense of reaching them. Other stations have been established lower down on the rivers, near the junction of the Gallatin, Madison, and Jefferson, but above the point where they unite to form the Missouri. On the Missouri itself, near Townsend, a number of discharge measurements have been made at the place where the record of height is being kept by the Missouri River Commission, in order to furnish material for computing the total run-off from this drainage area.

SPANISH CREEK STATION, ON WEST GALLATIN RIVER.

This station was established August 17, 1889, by Mr. J. B. Williams. It is located on the West Gallatin River, about 20 miles southwesterly from Bozeman, Mont., on what is known as Lemon's ranch, about one-half mile above the point where the river emerges from its narrow valley in the mountains. The locality chosen is above the heads of all canals, so that the total flow of the river is obtained. The bed of the river is rocky and not liable to change; the banks are high and steep; the stream is of nearly uniform width, and has a straight course both above and below the station. The section is in every respect suitable, with the possible exception that the bottom is perhaps too rough and rocky, in low water giving rise to riffles. The velocity is also somewhat great for accurate results with the ordinary current meters. During 1889 only two measurements were obtained, these being at about the same stage. In 1890 seven current-meter observations were had, and in 1891 another was obtained. These furnished material for a rating table which has proved to be fairly applicable during the year 1893.

On June 14, 1893, the old river gage was washed away by flood, and was reestablished on August 22, by Mr. F. H. Newell. On the same day a measurement of the river was made at the iron bridge below the mouth of the canyon, showing that for a height of 2.15 feet on the rod the river was flowing at the rate of 818 second-feet. This did not include the quantity flowing in the high-line canal taking water from the right bank of the river. Observations were begun on August 22, 1893, and continued throughout the year, and until June 22, 1894, when, owing to a sudden rise of the river, the gage was again washed out, together with the large tree to which it was attached and the bench marks on the bank of the stream. It not being advisable at that time to relocate the gage, the station was abandoned. At about that time observations of river height were begun at the head of the West Gallatin Canal, which takes water out on the left-hand or west side of the river, near the iron bridge, a short distance from the mouth of the canyon. These were begun on May 27 and continued to June 30, 1894, a time not sufficiently long to justify rating the station.

The estimates of discharge have already been published for the year 1893, but owing to the uncertainty as to the exact position of the river rod after the ice went out it has not been considered advisable to attempt to apply the former rating table showing the relation between gage height and discharge for the period from January 1 to June 30. The figures of height indicate, however, that the river continued at its low stage of probably between 300 and 400 second-feet until about the first week in April, when a slight rise took place, followed by the gradual increase of volume during the latter part of April and early May, the spring flood beginning a few weeks earlier than in the preceding year. In the latter part of May and early June the flood reached its greatest intensity, being in volume probably over 7,000 cubic feet per second. By the middle of the latter month it had fallen to less than 2,000 second-feet, the gradual fall being interrupted by a sudden flood on April 23, which washed out the river rod and with it the old tree upon the bank. This flood, therefore, must have been of unusual intensity, as the banks at this point are high, firm, and covered with heavy timber.

Rating table for the West Gallatin River at Spanish Creek station, Montana.

[Applicable for 1893 and, with doubtful accuracy, for the spring of 1894.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	.....	3.00	1,480	5.00	3,580	7.00	5,900
1.10	.....	3.10	1,570	5.10	3,690	7.10	6,030
1.20	.....	3.20	1,660	5.20	3,800	7.20	6,160
1.30	.....	3.30	1,760	5.30	3,910	7.30	6,290
1.40	280	3.40	1,860	5.40	4,020	7.40	6,410
1.50	320	3.50	1,960	5.50	4,130	7.50	6,540
1.60	370	3.60	2,060	5.60	4,280	7.60	6,670
1.70	430	3.70	2,165	5.70	4,350	7.70	6,800
1.80	500	3.80	2,270	5.80	4,460	7.80	6,930
1.90	570	3.90	2,375	5.90	4,570	7.90	7,060
2.00	650	4.00	2,480	6.00	4,690	8.00	.....
2.10	730	4.10	2,590	6.10	4,810	8.10	.....
2.20	810	4.20	2,700	6.20	4,930	8.20	.....
2.30	890	4.30	2,810	6.30	5,000	8.30	.....
2.40	970	4.40	2,920	6.40	5,170	8.40	.....
2.50	1,050	4.50	3,030	6.50	5,290	8.50	.....
2.60	1,130	4.60	3,140	6.60	5,440	8.60	.....
2.70	1,210	4.70	3,250	6.70	5,530	8.70	.....
2.80	1,300	4.80	3,360	6.80	5,650	8.80	.....
2.90	1,390	4.90	3,470	6.90	5,770	8.90	.....

Daily gage height of West Gallatin River at Spanish Creek station for 1893.

Day.	Jan.	Mar.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	.....	1.70	1.80	3.35	.....	1.90	1.90	1.90	1.70
2	1.80	.....	1.70	1.80	3.55	.....	1.90	2.00	1.90	1.70
3	1.80	.....	1.70	1.80	3.50	.....	1.90	1.95	1.90	1.70
4	1.80	.....	1.70	1.80	3.50	.....	1.90	1.90	1.90	1.70
5	1.80	.....	1.70	1.80	3.50	.....	1.90	1.90	1.80	1.70
6	1.80	.....	1.70	1.80	3.80	.....	1.90	1 90	1.80	1.70
7	1.80	.....	1.70	1.85	4.50	.....	1.90	1.90	1.80	1.70
8	1.80	.....	1.70	2.05	4.70	.....	2.00	2.00	1.80	1.70
9	1.80	.....	1.70	2.30	4.80	.....	1.90	2.00	1.70	1.70
10	1.80	.....	1.70	2.60	5.10	.....	1.90	2.10	1.70	1.70
11	1.80	.....	1.70	2.50	6.50	.....	1.90	2.05	1.70	1.70
12	1.80	.....	1.70	2.75	7.00	.....	1.90	2.00	1.70	1.70
13	1.80	.....	1.70	3.00	6.90	.....	1.90	2.00	1.70	1.70
14	1.80	.....	1.70	3.20	6.50	.....	1.90	1.90	1.70	1.70
15	1.80	.....	1.70	3.50	(a)	.....	1.90	1.90	1.70	1.70
16	1.80	.....	1.70	4.20	.....	.....	1.95	1.90	1.70	1.70
17	1.80	.....	1.80	4.80	.....	.....	2.00	1.90	1.70	1.60
18	1.70	.....	1.80	4.70	.....	.....	2.00	1.90	1.70	1.60
19	1.70	1.70	1.80	3.90	.....	.....	2.00	1.90	1.70	1.60
20	1.70	1.70	1.80	3.55	.....	.....	2.00	1.90	1.70	1.60
21	1.70	1.70	1.80	3.35	.....	.....	2.00	1.90	1.70	1.60
22	1.70	1.60	1.80	3.20	.....	2.10	1.90	1.90	1.70	1.60
23	1.70	1.60	1.80	3.20	.....	2.10	1.90	1.80	1.70	1 60
24	1.70	1.60	1.80	2.95	.....	2.05	1.90	1.80	1.70	1 60
25	1.70	1.60	1.80	2.85	.....	2.00	1.90	1.80	1.70	1.60
26	1.70	1.60	1.80	2.80	.....	1.90	1.90	1.80	1.70	1.60
27	1.70	1.60	1.80	2.80	.....	1.90	1.90	1.80	1.70	1.60
28	1.70	1.60	1.80	2.85	.....	1.90	1.90	1.80	1.70	1.60
29	1.70	1.70	1.80	2.95	.....	1.90	1.90	1.80	1.70	1.60
30	1.70	1.70	1.80	3.10	.....	1.90	1.90	1.85	.....	1.60
31	1.70	1.70	.....	3.15	.....	1.90	.....	1.90	.....	1.60

a Washout.

Daily gage height of West Gallatin River at Spanish Creek station for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.60	1.50	1.50	1.60	2.50	7.40	17	1.50	.....	1.70	1.60	4.00	3.20
2	1.60	1.50	1.50	1.60	2.50	7.70	18	1.50	.....	1.40	1.60	4.00	3.10
3	1.60	1.50	1.50	1.60	2.30	7.30	19	1.50	.....	1.40	1.60	4.30	3.30
4	1.60	1.50	1.40	1.50	2.20	7.30	20	1.50	.....	1.40	1.90	4.90	3.40
5	1.60	1.50	1.40	1.50	2.40	7.00	21	1.50	.....	1.40	2.00	4.90	3.60
6	1.60	1.50	1.40	1.60	2.30	6.80	22	1.50	.....	1.40	2.30	5.00	3.80
7	1.50	1.50	1.40	1.60	2.50	6.40	23	1.50	.....	1.40	2.00	4.70	4.00
8	1.50	1.50	1.40	1.60	2.80	6.20	24	1.50	.....	1.40	2.50	5.30	.....
9	1.50	1.50	1.40	1.70	3.50	6.00	25	1.50	1.6	1.40	2.60	5.50	.....
10	1.50	1.50	1.40	1.90	3.20	5.00	26	1.50	1.6	1.40	2.20	5.70	.....
11	1.50	.....	1.40	1.90	3.20	4.20	27	1.50	1.6	1.50	2.00	5.80	.....
12	1.50	.....	1.40	1.70	2.40	4.10	28	1.50	1.6	1.60	2.10	6.40	.....
13	1.50	.....	1.50	1.60	3.70	3.80	29	1.50	.....	1.60	2.20	6.80	.....
14	1.50	.....	1.60	1.70	4.40	3.20	30	1.50	.....	1.50	2.80	6.90	.....
15	1.50	.....	1.60	1.80	4.30	3.00	31	1.50	.....	1.50	.....	7.00	.....
16	1.50	.....	1.70	1.70	4.00	3.00							

LOGAN STATION, ON GALLATIN RIVER.

This station was established on August 24, 1893, by Mr. F. H. Newell, at the railroad pump house immediately below the Northern Pacific main line bridge crossing Gallatin River at Logan, Mont. The gage was a vertical rod fastened to the cribwork box sunk in the river for the protection of the inlet pipe of the pump. The reading on that date was 0.50, the high water of spring being estimated to be about 4.25 of the gage. The bench marks consist of nails driven into the angle of the pier of the bridge facing the gage, these being placed at the elevation of the 7, 8, 9, and 10 foot marks, and designated by correspond-

ing figures. At the bridge itself measurements of volume can not well be made, as the stream is divided into four channels, being very swift under two of these, and obstructed by piles, snags, and sand under the others. Above the bridge, however, is a broad, straight course, where measurements can be made by means of a boat and cable. Record of the heights of the river was kept at this locality from September 3, 1893, to June 9, 1894, the river being frozen from January 21, 1894, until March 10, 1894, at which time the ice disappeared from the river. The gage rod was finally washed out, together with the crib to which it was attached, no discharge measurements having been made while it was in place.

On November 16, 1894, a new gage was established by Mr. Arthur P. Davis under the northeast corner of the Northern Pacific bridge above mentioned. This gage consisted of timbers partly inclined and partly vertical, the lower inclined portion being graduated from 0.60 feet up to 7.10 feet, and the vertical portion from 7 feet up to 12.10 feet. Bench mark No. 1 is on the head of a bridge spike, in the top of the pile stump to which the lower end of the inclined gage is fastened. It is 0.38 feet below the 2-foot mark on the gage. Bench mark No. 2 is the head of a bridge spike driven horizontally into the first pier east of the river. It is driven into the north end, and is marked "B. M." It is 7.32 feet above the 2-foot mark on the gage. The measurements were made by means of a cable across the river 100 yards above the bridge.

A discharge measurement, made on November 17, when the water stood at the height of 1.11 feet on the gage, showed a volume of 772 second-feet. The width of the stream was 146 feet; the mean depth, 2.9 feet; the maximum depth, 4.6 feet; the mean velocity, 1.82 feet, and the maximum, 2.26 feet. The cross section is excellently adapted to measurements of discharge, having a good gravel bottom. A record of river height was begun on December 16, 1894, and the river was reported as frozen on December 23.

The above figures give the total outflow from the drainage basin of the Gallatin, as the river empties into the Missouri a few miles below. The total area drained is approximately 1,620 square miles, including the Gallatin Valley and the surrounding mountain slopes. Thus the quantity of water discharged at this time represents the amount flowing to waste during the fall, and probably during the winter months. For comparison with this it may be noted that at the gaging station on the West Gallatin, below the mouth of Spanish Creek, the area drained was 850 square miles, and the average flow for November for five years preceding was 490 second-feet.

Daily gage height of Gallatin River at Logan station for 1893.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	0.50	0.60	0.30	12	0.40	0.80	0.70	0.60	23	0.60	0.70	0.50	0.50
2	.....	.65	.60	.30	13	.40	.70	.70	.60	24	.60	.70	.40	.50
3	0.40	.80	.75	.30	14	.40	.70	.65	.60	25	.50	.70	.40	.40
4	.40	.90	.80	.40	15	.40	.80	.60	.60	26	.50	.70	.30	.40
5	.40	1.00	.70	.40	16	.40	.70	.60	.50	27	.40	.70	.30	.40
6	.40	.85	.70	.50	17	.50	.70	.60	.50	28	.40	.70	.30	.40
7	.40	.65	.70	.50	18	.50	.70	.50	.50	29	.40	.70	.30	.40
8	.40	.60	.70	.60	19	.50	.80	.50	.50	30	.50	.70	.30	.40
9	.40	.80	.70	.60	20	.50	.80	.50	.50	31	.....	.70	.....	.40
10	.40	.90	.70	.60	21	.60	.70	.50	.50					
11	.40	.90	.70	.60	22	.60	.70	.50	.50					

Daily gage height of Gallatin River at Logan station for 1894.

Day.	Jan.	Mar.	Apr.	May.	June.	Dec.	Day.	Jan.	Mar.	Apr.	May	June.	Dec.
1	0.40	.....	1.30	1.60	.....	.....	17	0.40	0.60	0.90	3.20	.....	1.30
2	.40	.....	1.00	1.50	.....	.....	18	.40	.50	.90	3.80	.....	1.30
3	.40	.....	.90	1.50	5.60	.....	19	.40	.50	1.10	3.50	.....	1.30
4	.40	.....	.90	1.40	5.60	.....	20	.40	.60	1.10	3.30	.....	1.20
5	.40	.....	.90	1.40	5.80	.....	21	(*a*)	.70	1.10	3.60	.....	1.20
6	.40	.....	.....	1.60	6.00	.....	22	.....	.80	1.20	3.90	.....	1.20
7	.40	.....	.....	1.60	6.00	.....	23	.....	.70	1.40	3.50	.....	(*b*)
8	.40	.....	1.30	1.70	6.00	.....	24	.....	.60	1.80	3.90	.....	.....
9	.40	.....	1.00	1.80	6.00	.....	25	.....	.60	1.90	4.10	.....	.....
10	.40	.....	.90	1.90	.....	.....	26	.....	.60	1.90	4.50	.....	.....
11	.40	0.80	.90	2.00	.....	.....	27	.....	.60	2.00	.....	.....	.....
12	.40	.80	.90	2.00	.....	.....	28	.....	.90	2.00	.....	.....	.....
13	.40	.80	.80	1.90	.....	.....	29	.....	2.50	1.90	.....	.....	.....
14	.40	.90	.70	2.00	.....	.....	30	.....	2.20	1.80	.....	.....	.....
15	.40	.90	.90	2.00	.....	.....	31	.....	1.40	.....	.....	.....	.....
16	.40	.70	.90	2.50	.....	1.30							

a River frozen January 21 to March 10.
b River frozen December 23 to 31.

RED BLUFF STATION, ON MADISON RIVER.

This station was established on April 4, 1890, by Mr. J. B. Williams, who at that time stated that the station is near the mouth of the canyon which separates the upper and lower Madison valleys. The locality is about 4 miles from the town of Red Bluff, Mont., and is about 1½ miles below Hot Spring Creek, a small stream discharging at that time about 5 second-feet. It was at what was then known as Hayward bridge, 1 mile below the new iron bridge, and could be reached by stage from Bozeman, a distance of 30 miles.

The river at the station has a swift current and a rocky bed, with a high bank on the left side and a low one on the right. The gage established by Mr. Williams was inclined for a space of 5 feet vertically, and above this point was attached to a vertical post. Except at times of unusually high water, the river does not rise more than 4 feet. The bench mark is on the top of a flat rock on the left bank of the river, 50 feet above the section, and is marked "B. M." Its elevation above zero of the gage is 17.64 feet. The river is measured from a box suspended on a five-eighths-inch wire cable. The total width of the river is 280 feet. The discharge is unusually constant, owing, presumably, to the

fact that a large proportion of its water comes from the hot springs in the Yellowstone National Park.

Observations begun on April 4, 1890, were continued uninterruptedly through succeeding years, being taken on alternate days in 1894, and finally discontinued at the end of November, owing to lack of funds. The rating table as given below was constructed from gagings made during 1890 and verified in subsequent years. It is believed to be fairly applicable for 1893, but doubtful for 1894. On August 23, 1893, the river was measured from the new iron bridge, about a mile above the station, and the discharge was estimated to be 1,189 second-feet.

Computations of discharge have been made up to the end of June, 1893, and published in the preceding report, but the measurements made since that time indicate such a change in the rating table that computations of discharge can not be made with any considerable degree of confidence until the position of the gage rod has been verified and further check measurements had. This river, as above stated, is notable for the slight changes occurring from week to week in volume, especially during the fall and winter. Its floods come with extraordinary regularity, and the steady flow is hardly disturbed by storms. The flood of 1894 began, as usual, in the latter part of May, reaching a maximum probably of less than 2,500 second-feet, and fell off in the latter part of July to the ordinary fall and winter flow of 1,000 to 1,200 second-feet.

Rating table for Madison River, near Red Bluff, Montana.

[Applicable for 1893, and with less accuracy for later dates.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	.....	2	1,640	3.00	3,780	4.00	6,180
1.10	.....	2.10	1,790	3.10	4,020	4.10	6,420
1.20	910	2.20	1,960	3.20	4,260	4.20	.....
1.30	990	2.30	2,150	3.30	4,500	4.30	.....
1.40	1,070	2.40	2,360	3.40	4,740	4.40	.....
1.50	1,155	2.50	2,580	3.50	4,980	4.50	.....
1.60	1,240	2.60	2,820	3.60	5,220	4.60	.....
1.70	1,330	2.70	3,060	3.70	5,460	4.70	.....
1.80	1,420	2.80	3,300	3.80	5,700	4.80	.....
1.90	1,520	2.90	3,540	3.90	5,940	4.90	.....

Daily gage height of Madison River at Red Bluff station, Montana, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.50	1.40	1.60	1.40	1.95	2.30	1.50	2.00	2.10	1.70	1.85
2	1.75	1.55	1.40	1.60	1.40	1.95	2.20	1.60	2.00	2.10	1.70	1.80
3	1.70	1.60	1.40	1.55	1.50	1.95	2.15	1.60	2.05	2.05	1.65	1.85
4	1.65	1.60	1.40	1.50	1.50	1.95	2.10	1.60	2.05	2.05	1.70	1.85
5	1.60	1.60	1.40	1.45	1.55	2	2.05	1.60	2.10	2.00	1.70	1.80
6	1.60	1.70	1.40	1.40	1.50	2.10	2.00	1.70	2.10	2.00	1.70	1.80
7	1.65	2.00	1.40	1.40	1.55	2.10	2.00	1.80	2.05	2.00	1.70	1.75
8	1.65	2.00	1.40	1.40	1.60	2.15	2.00	1.85	2.05	2.00	1.75	1.75
9	1.65	2.20	1.40	1.40	1.70	2.20	2.00	1.90	2.00	1.90	1.75	1.70
10	1.60	2.20	1.40	1.35	1.70	2.25	1.90	1.90	2.00	1.90	1.75	1.70
11	1.60	2.20	1.40	1.35	1.80	2.30	1.85	2.00	2.00	1.90	1.75	1.70
12	1.60	2.00	1.40	1.40	1.80	2.40	1.80	2.00	2.00	1.85	1.75	1.70
13	1.65	1.90	1.45	1.45	1.80	2.45	1.75	2.00	2.00	1.85	1.75	1.70
14	1.65	1.70	1.45	1.40	1.75	2.50	1.75	2.05	2.05	1.80	1.80	1.75
15	1.65	1.60	1.45	1.30	1.70	2.60	1.70	2.10	2.05	1.80	1.75	1.70
16	1.60	1.50	1.40	1.25	1.75	2.60	1.70	2.10	2.05	1.80	1.80	1.75
17	1.60	1.50	1.35	1.20	1.70	2.70	1.60	2.00	2.00	1.80	1.80	1.75
18	1.55	1.40	1.35	1.20	1.70	2.70	1.60	2.00	2.00	1.80	1.85	1.75
19	1.50	1.40	1.35	1.20	1.70	2.70	1.60	2.05	2.00	1.80	1.85	1.70
20	1.50	1.35	1.40	1.20	1.70	2.65	1.50	2.10	1.90	1.80	1.85	1.75
21	1.50	1.35	1.40	1.20	1.70	2.70	1.50	2.10	1.95	1.80	1.85	1.80
22	1.50	1.35	1.35	1.20	1.75	2.75	1.50	2.10	2.00	1.80	1.80	1.80
23	1.50	1.40	1.40	1.20	1.75	2.70	1.40	2.10	2.05	1.75	1.80	1.75
24	1.50	1.40	1.45	1.20	1.75	2.70	1.40	2.05	2.05	1.75	1.85	1.75
25	1.55	1.35	1.45	1.25	1.75	2.65	1.40	2.05	2.05	1.80	1.85	1.75
26	1.60	1.35	1.40	1.25	1.80	2.60	1.45	2.05	2.10	1.80	1.85	1.75
27	1.55	1.35	1.40	1.25	1.80	2.50	1.45	2.00	2.10	1.70	1.85	1.75
28	1.50	1.40	1.40	1.30	1.80	2.45	1.40	2.00	2.10	1.70	1.85	1.70
29	1.50	.....	1.50	1.30	1.85	2.40	1.40	2.00	2.10	1.75	1.80	1.75
30	1.50	.....	1.50	1.30	1.85	2.40	1.45	2.00	2.10	1.75	1.80	1.70
31	1.50	.....	1.55	.....	1.90	.....	1.45	2.05	.....	1.70	.....	1.70

Daily gage height of Madison River at Red Bluff station, Montana, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.70	.....	.....	1.65	1.65	.....	2.10	.....	.....	.....	1.70
2	.....	1.55	1.60	.....	.....	2.25	.....	1.50	1.55	1.65	.....
3	1.70	.....	.....	1.65	1.65	2.20	2.00	.....	.....	.....	1.70
4	.....	1.50	1.60	.....	.....	2.20	.....	1.50	1.50	1.60	.....
5	1.70	.....	.....	1.70	1.60	2.20	2.00	.....	.....	.....	1.70
6	.....	1.50	1.65	.....	.....	.....	.....	1.50	1.50	1.60	.....
7	1.75	.....	.....	1.70	1.65	2.30	1.90	.....	.....	.....	1.70
8	.....	1.50	1.65	.....	.....	.....	.....	1.50	1.50	1.50	.....
9	1.75	.....	.....	1.70	1.65	.....	1.90	.....	.....	.....	1.75
10	.....	1.50	1.65	.....	.....	2.30	.....	1.55	1.55	1.50	.....
11	1.80	.....	.....	1.75	1.65	.....	1.90	.....	.....	.....	1.75
12	.....	1.50	1.70	.....	.....	2.35	.....	1.50	1.60	1.50	.....
13	1.85	.....	.....	1.75	1.70	.....	1.95	.....	.....	.....	1.70
14	.....	1.55	1.75	.....	.....	2.30	.....	1.50	1.60	1.55	.....
15	1.85	.....	.....	1.70	1.75	.....	1.95	.....	.....	.....	1.70
16	.....	1.50	1.75	.....	.....	2.25	.....	1.50	1.65	1.60	.....
17	1.85	.....	.....	1.65	1.80	.....	1.90	.....	.....	.....	1.75
18	.....	1.60	1.75	.....	.....	2.20	.....	1.50	1.60	1.65	.....
19	1.80	.....	.....	1.65	1.80	.....	1.90	.....	.....	.....	1.70
20	.....	1.65	1.65	.....	.....	2.20	.....	1.50	1.65	1.65	.....
21	1.75	.....	.....	1.65	1.90	.....	1.80	.....	.....	.....	1.75
22	.....	1.65	1.70	.....	.....	2.15	.....	1.55	1.60	1.65	.....
23	1.70	.....	.....	1.75	1.95	.....	1.75	.....	.....	.....	1.75
24	.....	1.70	1.75	.....	.....	2.10	.....	1.50	1.60	1.70	.....
25	1.70	.....	.....	1.70	2.00	.....	1.70	.....	.....	.....	1.80
26	.....	1.70	1.70	.....	.....	2.10	.....	1.50	1.65	1.70	.....
27	1.65	.....	.....	1.70	2.10	.....	1.70	.....	.....	.....	1.85
28	.....	1.65	1.65	.....	.....	2.00	.....	1.45	1.70	1.70	.....
29	1.60	.....	.....	1.70	2.20	.....	1.65	.....	.....	.....	1.80
30	.....	.....	1.60	.....	.....	2.10	.....	1.45	1.70	1.70	.....
31	1.60	.....	.....	.....	2.20	.....	1.60	.....	.....	.....	.....

THREE FORKS STATION, ON MADISON RIVER.

This station was established August 24, 1893, by Mr. F. H. Newell, at the bridge of the Northern Pacific Railroad Company crossing Madison River about a half mile east of the railroad station of Three Forks. The gage was inclined, the zero being 14.11 feet below the top

of the rail on the east end of the bridge. When put in place the reading was 0.30, the measured discharge being 1,251 second-feet. Readings were begun on September 3, 1893, and continued throughout the year and until July 7, 1894, except during the months of January, February, and March, when the gage was obstructed by ice. Readings were again begun on October 21 by a new observer. On November 24 Mr. Arthur P. Davis inspected the station and made a gaging, the discharge being 1,494 second-feet for height of 0.57 foot. This locality is not favorable for obtaining the total discharge of Madison River, as a notable portion of the water finds an outlet through smaller channels crossing the low ground in various directions. At the time of the first measurement, that of August 24, 1893, 55 second-feet were discharging through various sloughs, and this amount should be added to the discharge as measured at the station. The drainage area, as measured from the Montana map, is 2,420 square miles.

Daily gage height of Madison River at Three Forks station, Montana, for 1893.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	0.40	0.30	0.30	12	0.20	0.40	0.20	0.10	23	0.30	0.30	Ice.	.....
2	.....	.30	.30	.30	13	.20	.30	.20	.10	24	.20	.30	Ice.	.....
3	0.20	.30	.20	.10	14	.20	.30	.20	.10	25	.20	.30	Ice.	.....
4	.20	.30	.20	.....	15	.20	.30	.20	.20	26	.20	.30	0.20	.....
5	.20	.30	.20	.10	16	.20	.30	.20	.20	27	.20	.30	.30	.....
6	.20	.30	.20	.10	17	.20	.30	.20	.....	28	.20	.30	.30	.....
7	.20	.30	.20	.....	18	.20	.30	.20	.....	29	.30	.30	.30	.....
8	.20	.30	.20	.....	19	.20	.30	Ice.	.....	30	.40	.30	.30	.....
9	.20	.30	.20	.10	20	.30	.30	.....	.....	31	.....	.30	.....	.....
10	.20	.30	.20	.10	21	.30	.30	.20	.....					
11	.20	.30	.20	.10	22	.30	.30	.20	.....					

Daily gage height of Madison River at Three Forks station, Montana, for 1894.

Day.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	.....	0.60	0.70	2.80	1.80	.....	0.50	0.50
2	.....	1.00	.70	2.80	1.70	.....	.50	.50
3	.....	.70	.60	2.80	1.60	.....	.50	.50
4	.....	.30	.50	2.80	1.60	.....	.50	.50
5	.....	.60	.50	2.70	1.60	.....	.50	.50
6	.....	.60	.60	2.70	1.60	.....	.50	.50
7	.....	.50	.60	2.70	1.60	.....	.50	.50
8	.....	.50	.80	2.70	.....	.....	.50	.50
9	.....	.50	1.00	2.60	.....	.....	.50	.50
10	.....	.50	1.00	2.40	.....	.....	.50	.50
11	.....	.50	1.00	2.20	.....	.....	.50	.50
12	.....	.40	1.00	2.00	.....	.....	.50	.50
13	.....	.10	1.20	1.80	.....	.....	.50	.50
14	.....	.20	1.40	1.80	.....	.....	.50	.50
15	.....	.30	1.60	1.70	.....	.....	.50	.50
16	.....	.30	1.80	1.60	.....	.....	.50	.50
17	.....	[a]2.20	.30	1.80	1.30	.....	.50	2.80
18	.....	.....	.30	1.80	1.20	.....	.50	2.80
19	.....	.....	.30	1.70	1.70	.....	.50	1.60
20	.....	.....	.30	1.70	1.70	.....	.50	.50
21	.....	.....	.40	1.80	1.70	1.00	.50	.50
22	.....	.....	.40	1.90	1.80	1.00	.50	.50
23	.....	.....	.60	2.00	1.80	1.00	.50	.50
24	.....	.....	.80	2.10	1.80	1.00	.50	.50
25	.....	.....	.80	2.20	1.80	1.00	.50	.50
26	.....	.....	.80	2.20	1.80	1.00	.50	.50
27	.....	.....	.80	2.40	1.80	1.10	.50	.50
28	.....	.70	.80	2.50	1.80	.70	.50	.50
29	.....	.50	.90	2.60	1.80	.50	.50	.50
30	.....	1.30	.70	2.70	1.80	.50	.50	.75
31	.....	1.00	.....	2.70	.....	.50	.....	1.02

[a] No reading until March 17 on account of ice.

SAPPINGTON STATION, ON JEFFRSON RIVER.

The gage at this point is located under the northeast corner of the Northern Pacific Railroad bridge across Jefferson River, at Sappington. It was established November 13, 1894, by Mr. Arthur P. Davis. At that time the height of water was 1.08 feet. Observations of river height were begun on that date, but as the water froze around the gage during December, the later observations have relatively little value. The gage is partly inclined and partly vertical, the lower portion being graduated from 0.40 to 5 feet. The vertical portion is spiked to the bridge pier, and is graduated from 5 to 11 feet. Bench mark No. 1 is the head of a railroad spike driven into the top of the pile stump to which the lower end of the gage is spiked. It is 0.66 foot above the 1-foot mark of the gage. Bench mark No. 2 is the head of an 8-inch wire nail driven horizontally into the north end of the lower west cross timber of the east abutment. It is 7.76 feet above the 1-foot mark on the gage. Measurements are made by means of a cable stretched across the river 100 yards above the bridge. The channel is of coarse gravel, well adapted for measurements. A measurement made on November 14, 1894, showed a total discharge of 1,952 second-feet, the stream being 265 feet wide and having a mean depth of 2.76 feet; maximum depth, 3.40 feet; mean velocity, 2.67 feet per second; maximum velocity, 3.74 feet per second. The drainage area above this point is estimated to be 8,270 square miles.

A measurement of Jefferson River was made on August 24, 1893, when the water stood exactly 12 feet below the lower edge of the horizontal iron bars on the east end of the bridge near Three Forks. The discharge at that time was 808 second-feet. The section, however, is not favorable for measurement, owing to the dead water in the broad, obstructed channel, and no station was established until November 13, 1894, when, after a search along the river, the above-described location at Sappington was chosen, 15 miles west of Three Forks.

TOWNSEND STATION, ON MISSOURI RIVER.

This station was established in 1891 by the Missouri River Commission, and readings have been made continuously since that time by an observer employed by the Commission. The locality is 2,504 miles above the mouth of the river. The following description of the gage, its location, and bench marks is from Lieut. J. C. Sanford, secretary of the Missouri River Commission:

A standard wire cable gage was erected by the Missouri River Commission October 1, 1891, on a county road bridge, located about 300 feet below the Northern Pacific Railroad bridge across the Missouri River near Townsend, Mont. Its zero is set at an approximate elevation of 3,700 feet above sea level as determined from a primary line of levels, run under the direction of the Commission in 1890, from Three Forks to Fort Benton, Mont., and starting from a bench mark of the Northern Pacific Railroad at Gallatin, Mont. (See Annual Report of Chief of Engineers, 1891.)

Reference bench mark is B. M. 10 (Townsend), described as "located on the right bank of the Missouri River, about one-half mile north of Townsend Railroad station, about one-half mile from river measured in a perpendicular direction to track, and about three-quarters mile south of railroad bridge over the Missouri River. It is about 60 feet west of a point on the track, 30 feet north of railroad bridge No. 392, and about 7 feet west of railroad fence. Compass reading to milepost 1121 is 318°. Marked by stone and pipe; elevation, 3,795.991 feet. This elevation is erroneous, but is the elevation from which the gage is set.

The tabulated records of the Townsend gage are reductions to the St. Louis directrix datum obtained by subtracting 400.063 feet from the daily means of the gage readings. The gage reads from 3,785 to 3,799 feet.

Lieutenant Sanford states that since the establishment of the gage level lines have been completed connecting all of the upper river gages with the datum of the Missouri River Commission. Precise levels have been run up to Sioux City, Iowa, and above that checked Y lines have been run under the direction of Capt. H. F. Hodges, Corps of Engineers, United States Army, and of the Missouri River Commission. The elevations of the zeros of the other Montana gages read during 1890 are as follows:

Elevations of river gages in Montana.

Locality.	Above mouth.	Elevation of gage zero.
	Miles.	*Feet.*
Great Falls	2,333.3	2,897.165
Craig	2,415.7	3,028.575
Stubbs Ferry	2,463.8	3,207.674
Toston	2,519.8	3,477.230
Gallahers Ferry	2,546.4	3,613.069
Gallatin Ferry	2,546.7	3,614.783

Measurements of discharge at this point were made on August 25, 1893, by Mr. F. H. Newell, when for a gage height of 3,788.75 feet there was found to be a discharge of 3,008 second-feet. The volumes of the three large rivers forming the Missouri, as measured during preceding days, were as follows: Jefferson, 808 second-feet; Madison, 1,251 second-feet; West Gallatin, 818 second-feet; various sloughs, 55 second-feet; making an aggregate of 2,932 second-feet. A second measurement, made November 18, 1894, by Mr. Arthur P. Davis, showed for a height of water of 3,789 feet on the gage a discharge of 3,766 second-feet. The total width of the stream was 425 feet; the mean depth, 3.63 feet; the maximum, 7.50 feet; the mean velocity, 2.44 feet; the maximum velocity 4.68 feet. The stream is divided into four channels by the three bridge piers; otherwise the conditions are favorable for accurate measurement.

These quantities above given represent the discharge for the greater part of the last half of the year, the water rarely falling below 3,788.5. The area drained at this point is approximately 15,000 square miles, comprising, as above stated, the inflow from the Gallatin, the Madison, and the Jefferson rivers. This gage at Townsend is the highest of a

series of twenty or more gages maintained permanently by the Missouri River Commission. Descriptions of these gages are given in the annual report of the Missouri River Commission, contained in the Annual Report of the Chief of Engineers, United States Army; that for 1891, on page 3819; for 1892, on page 3271, and for 1893, on page 2316. The distance of this point above Sioux City is 1,703 miles, and above Fort Benton, the next gage below maintained by the Corps of Engineers, 219 miles. In the report of the Chief of Engineers, United States Army, for 1893, page 2320, it is stated that there is under way an "examination of Missouri River from Three Forks to Canyon Ferry, Mont., with a view of determining at what points, if any, use might be made of water power for manufacturing and other purposes without unreasonably impairing the navigability. This part of the river was surveyed and mapped in 1890 under the direction of the Missouri River Commission. For the present work it is proposed to examine the maps of this survey and select such points as seem suitable to personally examine the localities, and by additional field work to get the necessary data for a report."

The gaging station on the upper Missouri River in the vicinity of Craig, referred to in previous reports, was abandoned in June, 1892, owing to the expense of maintenance and the fact that the Missouri River Commission had a gage at Townsend, Mont.

Daily gage height of Missouri River at Townsend station, Montana, for 1891.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1....	88.3	88.5	88.6	12.....	88.5	88.5	88.2	23.....	88.5	88.7	88.4
2....	88.3	88.5	88.6	13.....	88.5	88.4	88.3	24.....	88.6	88.5	a89.7
3....	88.4	88.5	88.6	14.....	88.6	88.4	88.4	25.....	88.6	88.6	89.7
4....	88.4	88.5	88.5	15.....	88.6	88.3	88.4	26.....	88.6	88.7	89.7
5....	88.4	88.5	88.4	16.....	88.6	88.2	88.4	27.....	88.6	88.7	89.7
6....	88.4	88.6	88.2	17.....	88.6	88.2	88.4	28.....	88.6	88.7	90.2
7....	88.4	88.6	88.2	18.....	88.6	88.2	88.4	29.....	88.5	88.6	90.4
8....	88.5	88.6	88.2	19.....	88.6	88.5	88.4	30.....	88.5	88.6	90.4
9....	88.5	88.5	88.2	20.....	88.6	88.9	88.6	31.....	88.5	.....	90.6
10....	88.5	88.5	88.2	21.....	88.5	89	88.6				
11....	88.5	88.5	88.2	22.....	88.5	89	88.5				

a Ice readings after December 24.

Daily gage height of Missouri River at Townsend station, Montana, for 1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 90.7	90.6	88.6	88.5	88.7	92.6	94.1	88.9	88.5	88.4	88.7	88.7
2	90.7	90.6	88 6	88.5	88.7	92.3	93.9	88.8	88.5	88.4	88.7	88.8
3	90.7	90.6	88.6	88.5	88.7	92.2	93.7	88.8	88.5	88.6	88.7	88.8
4	90.7	90.6	88.6	88.5	88.7	92.0	93.6	88.7	88.5	88.5	88.7	88.8
5	90.7	90.6	88.6	88.5	88.7	91.8	93.2	88.7	88.5	88.5	88.7	88.7
6	90.6	90.6	88.6	88.4	88.7	91.6	92.9	88.7	88.5	88.5	88.7	88.6
7	90.6	90.6	88.7	88.4	88.7	91.6	92.8	88.7	88.5	88.5	88.7	88.4
8	90.6	90.6	88.7	88.4	88.7	92.0	92.6	88.7	88.5	88.4	88.7	88.3
9	90.5	90.6	88.7	88.4	88.7	92.2	92.4	88.7	88.4	88.4	88.7	88.3
10	90.5	90.6	88.6	88.4	88.8	92.6	92.0	88.7	88.4	88.5	88.7	88.2
11	90.4	90.6	88.6	88.5	89.0	93.0	91.8	88.7	88.4	88.6	88.7	88.2
12	90.2	90.6	88.6	88.6	89.0	93.5	91.7	88.7	88.4	88.6	88.7	88.2
13	90.1	90.6	88.7	88.6	89.1	93.6	91.6	88.7	88.3	88.7	88.7	88.2
14	90.1	90.6	88.7	88.7	89.2	93.6	91.4	88.7	88.3	88.7	88.7	88.2
15	90.3	90.7	88.7	88.7	89.4	93.6	91.1	88.7	88.3	88.7	88.7	88.3
16	90.4	90.7	88.6	88.7	89.5	93.6	91.0	88.6	88.3	88.7	88.7	88.4
17	90.4	90.8	88.6	88.7	89.6	93.7	90.7	88.5	88.3	88.7	88.7	88.6
18	90.4	90.8	88.6	88.8	89.8	93.8	90.5	88.4	88.3	88.7	88 7	88.6
19	90.4	90.8	88.6	88.8	90.1	94.2	90.2	88.4	88.3	88.7	88.7	88.7
20	90.4	90.8	88.6	88.8	90.2	94.7	90.0	88.4	88.3	88.7	88.7	88.8
21	90.4	90.8	88.6	88.7	90.2	95.0	89.9	88.4	88.3	88.7	88.7	89.6
22	90.4	90.7	88.6	88.7	90.4	95.1	89.7	88.4	88.4	88.7	88.7	b 90.4
23	90.4	90.7	88.6	88.7	90.5	95.0	89.7	88.4	88.4	88.7	88.8	90.4
24	90.4	89.9	88.6	88.6	91.0	94.7	89.5	88.4	88.4	88.7	88.8	90.4
25	90.5	88.7	88.5	88.6	91.4	94.4	89.4	88.4	88.3	88.7	88.8	90.4
26	90.5	88.6	88.5	88.7	91.8	94.2	89.3	88.5	88.3	88.7	88.6	90.4
27	90.6	88.5	88.5	88.7	92.3	94.1	89.2	88.5	88.3	88.7	88.6	90.4
28	90.6	88.6	88.5	88.7	92.6	93.8	89.1	88.5	88.4	88.7	88.4	90.5
29	90.6	88.6	88.5	88.7	93.0	93.7	89.1	88.5	88.4	88.7	88.4	90.5
30	90.6	.....	88.5	88.7	92.8	94.4	89.0	88.5	88.4	88.7	88.6	90.7
31	90.6	.....	88.5	.....	92.7	.....	88.9	88.5	.....	88.7	.....	90.7

a Ice readings to February 23. b Ice readings after December 22.

Daily gage height of Missouri River at Townsend station, Montana, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 90.8	91.2	91.3	90.0	89.0	91.0	91.2	89.0	88.5	89.1	89.0	88.8
2	91.0	91.2	91.3	89.6	89.0	91.1	91.1	89.0	88.4	89.1	89.0	88.8
3	91.2	91.2	91.3	89.5	89.2	91.2	91.1	88.9	88.4	89.1	89.0	88.8
4	91.4	91.2	91.3	89.4	89.2	91.4	91.0	88.8	88.4	89.1	89.0	88.8
5	91.4	31.2	91.5	89.2	89.3	91.4	91.0	88.8	88.4	89.1	89.0	88.8
6	91.4	91.3	91.5	89.2	89.3	91.4	90.9	88.7	88.4	89.0	89.0	88.8
7	91.4	91.4	91.6	89.1	89.3	91.4	90.9	88.7	88.4	89.0	89.0	88.8
8	91.4	91.4	91.6	89.1	89.5	91.8	90.6	88 6	88.6	89.0	89.0	88.8
9	91.4	91.5	91.7	89.1	89.7	92.2	90.5	88.6	88.6	89.0	89.0	88.8
10	91.4	91.5	91.8	89.1	90.1	92.5	90.3	88.5	88.5	89.0	89.0	88.8
11	91.4	91.5	91.9	89.0	90.2	92.9	90.3	88.5	88.6	89.0	89.0	88.8
12	91.4	91.5	92.0	88.8	90.4	93.4	90.2	88.5	88.6	89.0	89.0	88.7
13	91.4	91.5	92.0	88.7	90.4	94.1	90.2	88.5	88.6	89.0	89.0	88.7
14	91.4	91.5	92.0	88.7	90.7	94.5	90.2	88.5	88.6	89.0	89.0	88.7
15	91.4	91.5	92.0	88.7	90.9	94.4	90.1	88.5	88.6	89.0	88.8	88.7
16	91.4	91.5	92.0	88.7	91.4	93.9	90.0	88.5	88.6	89.0	88.6	88.7
17	91.4	91.5	92.0	88.6	91.6	93.7	89.8	88.5	88.6	89.0	88.5	88.7
18	91.4	91.5	92.0	88.6	92.4	93.4	89.7	88.5	88.6	89.0	88.5	88.7
19	91.5	91.5	92.0	88.6	92.7	93.4	89.6	88.5	88.7	89.0	88.5	88.7
20	91.5	91.5	92.0	88.6	92.5	93.5	89.5	88.5	88.7	89.0	88.5	88.7
21	91.5	91.5	88.8	88.6	92.3	93.2	89.5	88.5	88.8	89.0	88.6	88.7
22	91.5	91.5	88.6	88.6	92.0	93.0	89.4	88.5	88.8	89.0	88.6	88.7
23	91.5	91.5	88.6	88.6	91.9	92.7	89.2	88.6	88.8	89.0	88.6	88.6
24	91.5	91.5	88.7	88.6	91.7	92.5	89.2	88.6	88.8	89.0	88.7	88.6
25	91.4	91.5	88.8	88.7	91.5	92.5	89.2	88.7	88.8	89.0	88.8	88.5
26	91.4	91.5	88.8	88.7	91.1	92.4	89.2	88.6	88.8	89.0	88.8	88.5
27	91.4	91.4	89.1	88.8	90.9	92.2	89.1	88.6	88.9	89.0	88.8	88.5
28	91.4	91.3	89.3	88.9	90.8	92.0	89.1	88.6	89.1	89.0	88.8	88.4
29	91.4	.....	89.7	89.0	90.5	91.8	89.0	88.6	89.1	89.0	88.8	88.3
30	91.3	.....	89.8	89.0	90.6	91.4	89 0	88.5	89.1	89.0	88.6	88.4
31	91.3	.....	89.8	.....	90.8	.....	89.0	88.5	.....	89.0	.....	88.5

a Ice readings to March 20.

Daily gage height of Missouri River at Townsend station, Montana, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	88.4	91.0	91.0	89.7	91.2	95.4	92.4	89.5	88.8	89.0	89.1	89.0
2	88.4	91.0	91.0	89.6	91.1	95.5	92.3	89.4	88.8	89.1	89.1	88.9
3	88.6	91.0	91.0	89.7	91.0	95.7	92.2	89.4	88.8	89.1	89.1	88.8
4	90.1	91.0	91.0	89.7	90.7	95.7	92.2	89.4	88.8	89.1	89.1	88.8
5	a91.4	91.0	91.0	89.7	90.5	95.7	92.2	89.4	88.7	89.0	89.1	88.7
6	91.4	91.0	91.0	89.7	90.6	95.6	92.1	89.4	88.9	89.0	89.1	88.8
7	91.4	91.0	91.0	89.7	90.7	95.6	92.0	89.4	89.0	89.1	89.1	88.8
8	91.5	91.0	91.0	89.6	90.9	95.5	91.9	89.4	89.1	89.1	89.0	88.8
9	91.6	91.0	91.0	89.5	91.2	95.4	91.7	89.4	89.0	89.1	89.0	88.7
10	91.9	91.0	91.0	89.7	91.3	95.1	91.6	89.4	89.0	89.1	89.0	88.7
11	92.2	91.0	91.0	89.7	91.5	94.8	91.4	89.4	89.0	89.1	89.0	88.7
12	92.2	91.0	91.2	89.7	91.7	94.5	91.4	89.4	89.0	89.1	89.1	88.7
13	92.2	91.0	91.3	89.7	91.7	93.9	91.5	89.4	89.0	89.1	89.1	88.6
14	92.2	91.0	91.6	89.7	91.7	93.6	91.4	89.3	89.0	89.1	89.1	88.5
15	92.1	91.0	91.9	89.7	92.1	93.2	91.2	89.2	89.0	89.1	89.1	88.5
16	91.8	91.0	92.2	89.6	92.8	92.8	91.0	89.2	89.0	89.1	89.0	88.6
17	91.7	91.0	92.4	89.5	92.9	92.6	90.9	89.1	89.0	89.1	89.0	88.6
18	91.5	91.0	92.4	89.4	92.8	92.6	90.7	89.1	89.0	89.1	88.9	88.7
19	91.4	90.4	92.4	89.6	92.8	92.7	90.7	89.1	89.0	89.1	89.0	88.7
20	91.4	90.6	92.4	89.7	92.9	92.8	90.5	89.1	89.0	89.1	89.0	88.7
21	91.3	90.4	91.2	89.8	93.2	92.7	90.4	89.1	89.0	89.1	89.0	88.8
22	91.2	90.4	89.5	90.1	93.6	92.6	90.2	89.0	89.0	89.1	89.0	88.8
23	91.0	90.4	89.5	90.6	93.8	92.7	90.1	89.0	88.9	89.1	89.0	88.8
24	91.0	90.4	89.7	91.2	94.2	92.7	89.9	88.9	88.9	89.1	89.0	88.8
25	91.0	90.4	89.7	91.7	94.2	92.7	89.8	88.8	88.9	89.1	89.0	88.8
26	91.0	90.5	89.7	91.8	94.4	92.7	89.8	88.8	88.9	89.1	89.0	88.8
27	91.0	90.7	89.7	92.0	94.6	92.7	89.8	88.8	88.9	89.1	89.0	b89.3
28	91.0	90.8	89.7	92.0	94.7	92.7	89.9	88.8	88.9	89.1	89.0	89.3
29	91.0	.....	89.7	91.7	95.0	92.5	89.9	88.8	88.9	89.1	89.0	89.3
30	91.0	.....	89.7	91.5	95.1	92.4	89.7	88.8	89.0	89.1	89.0	89.3
31	91.0	.....	89.7	.....	95.3	.....	89.6	88.8	.....	89.2	.....	89.8

a Ice readings from January 5 to March 21. *b* Ice readings after December 27.

YELLOWSTONE BASIN, IN WYOMING AND MONTANA.

The river stations upon the Yellowstone, maintained for a number of years at points below Yellowstone National Park, have been abandoned, owing to expense of maintenance and difficulty of access. Measurements of tributaries in Wyoming have been made by Prof. Elwood Mead, State engineer, and by others, the results being shown in the list of gagings on pages 29, 31.

HORR STATION, ON YELLOWSTONE RIVER, MONTANA.

This locality was chosen on August 12, 1889, by Mr. J. B. Williams, at Bowers Ferry, near the small town of Horr, on the Park Branch of the Northern Pacific Railroad. The section is well adapted for discharge measurements, the river being of nearly uniform width above and below the station, and with moderately high banks over which the river does not flow in high water. The bed is composed of coarse gravel and small bowlders, and is not liable to change in ordinary floods. Readings were continued at this point until November 30, 1889, when, on account of the change of the position of the ferry, a new locality one-fourth of a mile farther downstream was selected. At this second point the river is 150 feet wide.

The gage is inclined and securely fastened by braces. It is about 60 feet long, with nearly uniform inclination at an angle of 12° to the horizontal. The bench mark is on the stump of a tree 10 inches in

diameter, sawed off about 3 feet above the ground, marked "B. M." on top. It is very nearly in line with the extended cross section on the right bank of the river, and about 50 feet above the upper end of the gage. The elevation of the bench mark above zero is 11.55 feet. Observations at this point were continued until November 4, 1893, except at times when ice in the river prevented accurate readings. From the discharge measurements made during 1890 and 1891 a rating table was constructed which is probably applicable to these readings for 1893, and is therefore given below:

Rating table for Yellowstone River at Horr station, Montana.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	650	3.00	2,890	5.00	6,270	7.00	9,760
1.10	710	3.10	3,060	5.10	6,440	7.10	9,930
1.20	780	3.20	3,230	5.20	6,600	7.20	10,110
1.30	850	3.30	3,400	5.30	6,770	7.30	10,290
1.40	920	3.40	3,570	5.40	6,940	7.40	10,460
1.50	1,000	3.50	3,740	5.50	7,110	7.50	10,640
1.60	1,080	3.60	3,910	5.60	7,290	7.60	10,810
1.70	1,160	3.70	4,080	5.70	7,480	7.70	10,980
1.80	1,250	3.80	4,240	5.80	7,660	7.80	11,150
1.90	1,340	3.90	4,410	5.90	7,840	7.90	11,320
2.00	1,440	4.00	4,580	6.00	8,010	8.00	11,490
2.10	1,550	4.10	4,750	6.10	8,190	8.10	11,660
2.20	1,670	4.20	4,920	6.20	8,360	8.20	11,830
2.30	1,790	4.30	5,090	6.30	8,540	8.30	12,000
2.40	1,920	4.40	5,260	6.40	8,720	8.40	12,170
2.50	2,060	4.50	5,430	6.50	8,890	8.50	12,340
2.60	2,210	4.60	5,600	6.60	9,060	8.60	12,520
2.70	2,370	4.70	5,760	6.70	9,230	8.70	12,690
2.80	2,540	4.80	5,930	6.80	9,410	8.80	12,860
2.90	2,720	4.90	6,100	6.90	9,590	8.90	13,040

Daily gauge height of Yellowstone River at Horr station, Montana, for 1893.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.00	4.35	6.75	4.45	2.65	2.40	2.00
2	.....	1.10	4.50	6.85	4.35	2.60	2.45	2.00
3	.....	1.20	4.50	6.90	4.25	2.50	2.50	2.00
4	.....	1.20	4.30	6.90	4.15	2.40	2.45	2.00
5	.....	1.15	4.35	6.55	4.10	2.45	2.40	.....
6	.....	1.20	4.95	6.40	4.05	2.55	2.35	.....
7	.....	1.30	5.55	6.20	3.95	2.60	2.30	.....
8	.....	1.40	6.60	6.10	3.90	2.70	2.25	.....
9	.....	1.85	6.75	6.10	3.85	2.80	2.20	.....
10	.....	2.25	7.60	6.20	3.80	2.75	2.15	.....
11	.....	2.10	8.50	6.25	3.75	2.65	2.20	.....
12	.....	2.50	9.10	5.90	3.70	2.60	2.15	.....
13	.....	3.30	9.20	5.85	3.60	2.55	2.20	.....
14	.....	3.75	7.50	5.80	3.55	2.50	2.10	.....
15	.....	4.35	7.00	5.75	3.45	2.50	2.15	.....
16	1.10	4.80	7.50	5.60	3.35	2.50	2.10	.....
17	.95	5.80	7.90	5.50	3.30	2.50	2.10	.....
18	1.10	6.35	8.50	5.50	3.30	2.50	2.15	.....
19	1.15	5.20	8.40	5.40	3.35	2.40	2.10	.....
20	1.10	4.25	8.20	5.30	3.30	2.50	2.10	.....
21	.90	4.00	7.40	5.30	3.30	2.60	2.10	.....
22	.90	3.80	7.45	5.20	3.30	2.50	2.00	.....
23	1.10	3.75	7.40	5.10	3.30	2.50	2.00	.....
24	1.10	3.50	7.15	4.95	3.25	2.40	2.10	.....
25	1.15	3.45	7.25	4.90	3.15	2.40	2.00	.....
26	1.10	3.25	7.30	4.70	3.05	2.35	2.00	.....
27	.90	3.10	7.20	4.60	3.00	2.40	2.00	.....
28	.90	3.20	7.15	4.75	2.95	2.50	2.00	.....
29	.95	3.55	7.00	4.65	2.90	2.40	2.00	.....
30	.95	3.80	6.80	4.65	2.85	2.40	2.00	.....
31	.....	3.90	.....	4.50	2.75	.....	2.00	.....

PLATTE BASIN, IN WYOMING, COLORADO, AND NEBRASKA.

This basin has been described quite fully in the Thirteenth Annual Report of the Survey, Part III, Irrigation, pages 73–91. Measurements have been made on the headwaters of this river, mainly by Prof. Elwood Mead, State engineer of Wyoming; and in Colorado, by the State engineer, and by Prof. L. G. Carpenter, meteorologist and irrigation engineer of the State experiment station at the State Agricultural College. In 1894 work was begun in Nebraska by cooperation with Mr. O. V. P. Stout, professor of civil engineering at the University of Nebraska, and a number of stations were established, as shown by the following descriptions.

WOODS LANDING STATION, ON LARAMIE RIVER, WYOMING.

The station at Woods Landing was established in December, 1888, by Prof. Elwood Mead, observations being continued during the months from April to September, inclusive, in 1889, 1890, and 1891.[1] Below this point a large number of ditches divert the water of Laramie River, so that during the irrigating season very little crosses the Laramie plains or reaches Laramie. The report of the State engineer shows that fifty-three ditches have filed claims to water, the total area described as under these ditches being 150,000 acres. A few measurements have been made of the amount of water passing Laramie. One of these on September 27, 1894, gave 27 second-feet. Beyond this point the river flows in a northerly direction for about 50 miles, and then turns easterly through the Laramie Hills. Near this point are the head works of the Wyoming Development Company's irrigation system, which divert water by means of a stone dam. The canal heading at this point passes through a tunnel 3,100 feet in length, and finally empties into Bluegrass and Sybille creeks, whence the water is again diverted for use in the vicinity of Wheatland. The amount of water which passes this stone dam or returns below to the river by seepage has been measured at the railroad crossing at Uva.

UVA STATION, ON LARAMIE RIVER, WYOMING.

Measurements of river flow were made at the railroad crossing at Uva, Wyo., on June 6, 1894, showing a discharge of 1,845 second-feet, and again on October 24, 1894, giving only 14 second-feet. At about this latter date a gage rod was established at this point and observations were begun. The gage is vertical, and is nailed to the center pier of the railroad bridge at Uva. At a distance of about 25 miles below this

[1] See Twelfth Annual Report United States Geological Survey, Part II, Irrigation, p. 239; Thirteenth Annual Report United States Geological Survey, Part III, Irrigation, pp. 79 and 80; First Biennial Report of the State Engineer to the Governor of Wyoming, 1891 and 1892, Cheyenne, Wyo., 1892, Appendix, pp. xviii and xx; Second Biennial Report of the State Engineer to the Governor of Wyoming, 1893 and 1894, Cheyenne, Wyo., 1894, p. 135.

point Laramie River discharges into the North Platte, Fort Laramie being situated at the junction. Here a float measurement on August 20, 1894, showed a discharge of 51 second-feet, and on October 7, 1894, 23 second-feet.

DOUGLAS STATION, ON NORTH PLATTE RIVER, WYOMING.

Results of occasional measurements of the higher tributaries of North Platte River are given in the Thirteenth Annual Report of the United States Geological Survey, Part III, Irrigation, page 78. The highest permanent station, however, is at Douglas, Wyo., established by the State engineer in 1891. Above this place, on the north side of the river, are extensive tracts of land which can possibly be reclaimed, though at heavy expense, by canals heading 70 miles or more west of Douglas. Records at Douglas have been kept for portions of four years. The results for 1894, as computed by the State engineer of Wyoming, are shown in the following table:

Daily gage height and discharge of North Platte River at Douglas Station, Wyo., for 1894.

Day.	May.		June.		July.		August.		September.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
		Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1	7.8	4,600	10.3	11,052	7.7	4,380	5.8	1,000	5.2	790
2	7.8	4,600	10.5	11,668	7.6	4,157	5.8	1,000	5.2	790
3	8.0	5,044	10.6	11,977	7.4	3,718	5.8	1,000	5.2	790
4	8.2	5,488	10.8	12,596	7.3	3,500	5.7	960	5.2	790
5	8.3	5,710	10.9	12,907	7.3	3,500	5.7	960	5.2	790
6	8.6	6,377	10.8	12,596	7.6	4,157	5.6	920	5.1	765
7	8.6	6,377	10.8	12,596	7.6	4,157	5.6	920	5.1	765
8	8.8	6,823	10.9	12,907	7.6	4,157	5.6	920	5.1	765
9	8.9	7,076	11.0	13,218	7.5	3,937	5.8	1,000	5.1	765
10	9.3	8,092	10.8	12,596	7.3	3,500	5.7	960	5.1	765
11	9.4	8,346	10.5	11,668	7.2	3,283	5.6	920	5.2	790
12	9.7	9,212	10.0	10,131	7.0	2,850	5.6	920	5.2	790
13	10.0	10,131	9.5	8,600	7.0	2,850	5.5	883	5.1	765
14	10.0	10,131	9.1	7,584	6.8	2,423	5.4	850	5.2	790
15	10.0	10,131	9.1	7,584	6.8	2,423	5.3	815	5.4	850
16	10.1	10,438	9.0	7,330	6.7	2,211	5.5	883	5.4	850
17	10.3	11,052	9.1	7,584	6.6	2,000	5.5	883	5.4	850
18	10.5	11,668	9.1	7,584	6.6	2,000	5.4	850	5.3	815
19	10.3	11,052	9.0	7,330	6.7	2,211	5.4	850	5.3	815
20	10.0	10,131	8.8	6,823	6.7	2,211	5.4	850	5.3	815
21	9.7	9,212	8.7	6,600	6.7	2,211	5.4	850	5.2	790
22	9.6	8,906	8.5	6,154	6.7	2,211	5.3	815	5.2	790
23	9.8	9,518	8.4	5,932	6.7	2,211	5.3	815	5.2	790
24	9.9	9,824	8.3	5,710	6.6	2,000	5.3	815	5.2	790
25	9.9	9,824	8.2	5,488	6.4	1,620	5.3	815	5.2	790
26	9.8	9,518	8.0	5,044	6.2	1,345	5.3	815	5.2	790
27	9.8	9,518	8.0	5,044	6.2	1,345	5.3	815	5.1	765
28	9.8	9,518	7.9	4,822	6.2	1,345	5.3	815	5.1	765
29	9.8	9,518	7.8	4,600	6.0	1,145	5.2	790	5.2	790
30	10.0	10,131	7.7	4,380	5.9	1,070	5.2	790	5.2	790
31	10.2	10,745	.....	.....	5.8	1,000	5.2	790	.....	.....

ORIN STATION, ON NORTH PLATTE RIVER.

About 25 miles below Douglas the North Platte River is crossed by the Cheyenne and Northern Railroad, which joins the Fremont, Elkhorn and Missouri Valley Railroad at Orin Junction. At this railroad bridge a number of measurements have been made, and observations of river height were begun on November 1, 1894. The gage at this

point is vertical, and is nailed to the central pier of the railroad bridge. A measurement on May 8, 1894, gave a discharge of 6,823 second-feet; one on June 7, 12,596 second-feet, and one on August 15, only 816. second-feet. Below this point the river continues for many miles in a narrow canyon, in which it receives little water from lateral streams.

Near Fort Laramie a float gaging made by Mr. John Hunton, November 7, 1894, gave a computed discharge of 636 second-feet. From Fort Laramie east to the Nebraska line comparatively little water is diverted from the river. However, favorable conditions are reported[1] for taking out water to cover the lands along the river, especially on the south side, to the relatively low area known as "Goshen Hole." The altitude here is less than that of any other valley in the State, excepting in the extreme northern part, east of Big Horn range, near the Montana line.

In the extreme eastern part of Wyoming and in western Nebraska a considerable amount of water is delivered from the North Platte River for irrigation, as mentioned in a preceding report.[2] The area of land under these canals is being extended year by year, and the settlement of the country is progressing rapidly. Measurements of the river have been made at various points, but no permanent station has been established above the town of North Platte, which is at the junction of this river with the South Platte. Measurements at Camp Clarke have been given in preceding reports. A float measurement on July 26, 1894, gave an approximate discharge of 1,900 second-feet, and one at Gering on July 28, 1894, about 2,500 second-feet. On October 11, 1894, a gaging at the river bridge, almost due north from the town of Ogallala, showed a discharge of 609 second-feet.

NORTH PLATTE STATION, ON NORTH PLATTE RIVER, NEBRASKA.

A gaging station was established at North Platte and readings of river height were begun in the winter of 1894–95. A measurement on October 5, 1894, at the wagon bridge north of town gave a total discharge of 620 second-feet. A second measurement on November 6 at the same point gave 1,227 second-feet. Both of these were made by Mr. Charles P. Ross by means of electric current meters.

FORT COLLINS STATION, ON CACHE LA POUDRE RIVER, COLORADO.

One of the longest records, and probably the best of any small stream in the West, is that being maintained on the Cache la Poudre at a point about 15 miles above Fort Collins. This station was established in 1888 by Prof. L. G. Carpenter, meteorologist and irrigation engineer at the Colorado State Agricultural College. The work has been carried on under the immediate direction of Professor Carpenter, who has done everything in his power to make the results accurate and

[1] Elwood Mead, Biennial Report of State Engineer, 1894, p. 131.

[2] Thirteenth Annual Report United States Geological Survey, Part III, Irrigation, p. 81.

of scientific value. Various forms of self-recording nilometer have been used at this point, and an apparatus has finally been installed by which the height of water at the river station is recorded by electrical devices at the Agricultural College at Fort Collins. The results of computations of daily discharge for 1893 and 1894, as published in the annual report of the State engineer, are given in the following table.

Besides the computations of daily discharge at this point, a series of measurements have been made along Cache la Poudre Creek and South Platte River to determine the amount of water taken from these streams and the quantity flowing in the channel at various points, and as a result the amount which enters the river by means of percolation or seepage. The results obtained are of the highest value, showing, as they do, that these streams, and inferentially others of this class, receive large quantities of water during and after the irrigating season by the soaking of the ground and a gradual return to the drainage lines.

Daily mean discharge of Cache la Poudre River for 1893 and 1894.

[Second-feet.]

	1893.				1894.						
Day.	May.	June.	July.	Aug.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	.....	1,144	336	.....	2,652	1,109	479	171	144	79
2	.....	.....	1,038	343	492	2,820	1,082	494	182	158	91
3	.....	.....	996	321	481	3,046	1,109	512	178	135	96
4	.....	1,230	997	282	483	3,206	1,273	440	179	141	.....
5	.....	1,108	947	256	572	3,461	1,234	379	161	118	.....
6	.....	1,041	795	251	663	3,672	1,158	396	152	146	.....
7	.....	1,197	840	251	793	3,514	1,078	513	140	151	91
8	.....	1,767	833	293	1,057	2,782	956	487	227	143	95
9	.....	2,198	744	327	1,299	2,094	925	477	296	128	96
10	.....	2,667	693	298	1,208	1,908	925	464	281	131	93
11	217	2,912	663	.....	1,246	2,067	923	427	276	120	89
12	344	2,949	678	.....	1,321	2,236	936	393	246	107	94
13	278	2,252	661	.....	1,453	2,346	1,177	362	219	99	85
14	308	.....	602	.....	1,538	2,291	878	365	178	94	80
15	.....	.....	608	.....	1,829	2,104	982	369	165	93	85
16	.....	.....	576	.....	1,838	2,027	899	347	155	93	77
17	.....	.....	526	.....	1,355	1,791	782	319	157	93	42
18	.....	2,386	511	.....	1,315	1,915	817	298	152	93	116
19	.....	2,483	476	239	1,697	1,717	820	295	146	89	150
20	.....	2,427	454	189	1,842	1,586	728	282	135	97	146
21	1,047	2,274	401	226	2,051	1,452	696	278	118	82	115
22	1,043	1,905	384	218	1,779	1,458	647	271	113	85	107
23	920	1,758	359	248	1,585	1,427	602	274	108	87	*b* 60
24	841	1,616	348	219	1,302	1,375	567	240	105	84	*b* 57
25	870	1,422	353	191	1,483	1,250	561	229	108	84	103
26	974	1,354	444	161	*a* 1,650	1,216	567	212	107	84	90
27	876	1,246	463	155	1,817	1,228	553	204	101	78	92
28	812	1,244	406	158	1,984	1,120	522	179	99	74	91
29	878	1,177	383	158	2,151	1,065	497	182	132	71	89
30	1,107	1,132	354	141	2,318	1,067	461	165	145	71	93
31	929	.....	343	151	2,485	.....	444	162	.....	78	.....

a Interpolated from May 26 to June 1. *b* Float stopped by ice.

The lower South Platte in its course through northeastern Colorado is utilized to such an extent for irrigation that the channel becomes dry during the great part of the year. No measurements as yet have been made of the quantity flowing into Nebraska. The sandy channel and lowlands adjacent to this are saturated with water, and although it may not be feasible to bring this out by gravity methods for supply-

ing irrigating ditches, yet it has been demonstrated to be possible to pump what appears to be practically an inexhaustible supply.

The main Platte River, formed by the junction of the North and South branches, flows easterly through Nebraska, only a small proportion of its water being diverted for irrigation and water power. The channel is extremely wide, and during the hotter part of the summer the water is divided and subdivided into numerous small rivulets in the broad, sandy plain. Many of these gradually disappear by evaporation or by percolation into the sands, and thus at points along the river the channel is sometimes almost completely dry, as was the case during the fall of 1894. On August 14, 1894, the discharge of the river at Fremont was 1,420 second-feet; on September 17 there was no water passing Columbus, Nebr., nor on October 6. On that date water was found at a depth of 3 feet 8 inches below the surface of the sand in the bed of the river.[1] No systematic measurements of this river have been made on account of the difficulty of ascertaining the amount of water in its broad, shallow channel, and the expense of maintaining observations.

COLUMBUS STATION, ON LOUP RIVER.

This station is located just above the iron bridge of the Union Pa cific Railway. The observer is M. Savage, bridge watchman. The distance of the observer's house from the gaging station is about a half mile; from the bridge, 50 yards. The gage is of oak, 3 inches by 6 inches, 12 feet long, fastened by lag screws to a pile which forms part of the training works above the bridge. The rod is vertical.

There is an island at the bend, about 1,000 feet above the bridge. The training works cause the current to set from the shore. In high water the flood passes through willows and underbrush on the opposite side. The 12-foot mark on the rod is 7 feet below a point 2 feet east of the third panel point of the north truss of the east span, counting the end of the span as the first panel point. All levels are taken from the top of the bottom chord. This is not a good location, but after considerable search it seemed to be the best available. Observations were begun October 13, 1894, the water standing then at 4.70 feet on gage, not varying greatly from this during the remainder of the year.

KANSAS BASIN, IN NEBRASKA.

The Kansas River is formed by the union of a number of streams rising in the plains region not far from the boundary between Colorado, Nebraska, and Kansas. The most northerly of its branches is the Republican River, which, rising in Colorado, flows as a small stream through the southwestern portion of Nebraska, and continues easterly north of the State line for over half the distance of this boundary.

[1] O. V. P. Stout, Bulletin of the Agricultural Experiment Station of Nebraska, vol. 7, p. 156.

Measurements of some of the more important of the headwaters of Republican River have been made, the principal of these being the North and South Forks, near Benkelman, and of the Frenchman River at Palisade. Other stations on the tributaries of Kansas River will be established in Kansas, in order to obtain the discharge from the Solomon, Saline, Smoky Hill, as well as of the Republican near its mouth.

BENKELMAN STATION, ON NORTH FORK OF REPUBLICAN RIVER.

This station is on the left bank of the stream, about one-third of a mile southeast of the house of Mr. L. Morse, a farmer, who serves as observer, and about 2 miles west of Benkelman. The gage consists of an oak stick 2 inches wide by 6 inches deep and 10 feet long. It is inclined 30° to the horizontal, footmarks being 2 feet apart along the rod. It rests directly on beveled blocks, which in turn are supported by 6 by 8 inch cross-ties, well bedded, tamped, and covered. Lag screws are put through the rod, block, and into the ties. The channel at this point consists of loose sand and is nearly straight. The 5-foot mark on the rod is 1.62 feet above the top of the oak stake, about 5 feet southeast of the corner post of the fence around Morse's Grove.

Observations at this point were begun on November 4, 1894, and continued throughout the year. A measurement made by Prof. O. V. P. Stout, December 9, 1894, when the water stood at a height of 1.74 feet, showed a discharge of about 75 second-feet. The height of water was fairly constant.

BENKELMAN STATION, ON SOUTH FORK OF REPUBLICAN RIVER.

This station is located about one-fifth of a mile west of the road running south from Benkelman and close beside the road which runs west from the south-bound road just after crossing North Fork, on the left bank of the river. The observer is Mr. Joseph L. Wright, jr. The distance of the observer's house from the gaging station is about 1 mile. The gage is of the same character as that on the North Fork of Republican River, except that the rod is 12 feet long. The channel is sandy and straight, but only about 150 yards below a bend. The 6-foot mark on the rod is 0.11 foot higher than the top of the oak stake by the fence post north and east of the road.

PALISADE STATION, ON FRENCHMAN RIVER.

Observations of river height are taken immediately above the bridge of the Burlington and Missouri River Railroad, about three-fourths of a mile above the railroad station at Palisade, Nebr. The observer is Mr. J. M. Reed, a farmer living at a distance of about 75 yards from the gage. This consists of an oak stick, 2 by 4 inches and about 14 feet long. One end is buried in the sand, and the other is fastened by lag screws to two 6 by 8 inch cross-ties about 5 feet long, each bedded

and covered. This rod is in a small recess of the bank, and is inclined at an angle of about 30° to the horizontal, the footmarks being 2 feet apart along the rod. The 7-foot mark on the rod is 0.89 foot below the top of the screw thread on the bottom of the east side of the north pile of the second bent from Palisade. The channel is of loose sand, nearly straight at this locality. Measurements of discharge are made about 25 feet above the gage. One of these on December 28, 1894, gave for a height of 1.87 feet a discharge of 116 second-feet. Observations were begun on October 14, 1894, and were continued throughout the year.

ARKANSAS BASIN, IN COLORADO.

A large number of discharge measurements have been made at various points upon this stream and its tributaries, and a few of the stations established in 1889 have been maintained with a fair degree of continuity. It has been the intention to make a thorough study of this river, since it involves many problems of great importance, some of them interstate in character, and affords unusual facilities in the way of storage for the conservation of the waters of floods which will result in increased development of irrigation below. The highest station—that at Hayden—is primarily for the purpose of obtaining the quantity of water which might be held by storage in Twin Lakes or other reservoir sites, while measurements at Canyon City give the total flow of the stream at the point where the river is most regular in its behavior and least likely to be affected by cloud-bursts. Measurements at Pueblo, La Junta, and at Holly, near the State line, give, of course, results as affected by diversions at points above.

HAYDEN STATION, ON ARKANSAS RIVER.

This station is located at bridge 203A, on the Denver and Rio Grande Railway, 1¼ miles from Hayden section house. The observer is Mr. J. Burns, section foreman at Hayden. The distance of the observer's house from the gaging station is 1¼ miles. The gage is of pine or spruce bridge timber, 16 feet long. One end rests on the bottom. It is inclined 2.5 to 1, making the distance between the footmarks 2.5 feet. The gage is fastened to the wooden revetment at the north end of the bridge with a seven-eighths-inch bolt and five 10-inch bridge spikes. It will stay as long as the revetment stands. The character of the channel is coarse gravel. The top of the revetment timber at the south end of the revetment is on a level with the point 6.04 feet of the gauge. The measurements of discharge were made 14 feet south of the north end of bridge 203A. This is a reasonably good location.

A measurement made September 24, 1894, by Mr. Arthur P. Davis, showed a mean velocity of 1.93 feet and discharge of 114 second-feet; a second measurement October 16 gave 91 second-feet.

CANYON STATION, ON ARKANSAS RIVER.

Observations at this point were begun on April 17, 1889, the station being established here by Mr. Robert Robertson. The record has been maintained since that time, with occasional breaks due to absence or change of observer. This locality is at the Hot Springs Hotel, 1½ miles west of Canyon, Colo., and at the mouth of the Grand Canyon of the Colorado. Two ditches are taken out, one on each side, about this point, but these are easily accessible, and their average discharge is relatively small, except in times of low water. This site was used in 1888 for the same purpose by the State engineer of Colorado, and is highly favorable for obtaining accurate measurement. The channel of the river is straight for several hundred yards, both above and below, and the current, though swift, is not too great at high water nor too sluggish at low stages for satisfactory results. The banks on both sides are high and are not overflowed. The cross section is regular and has not been subject to notable changes, except on the right bank, near the gage, where a sand bar has formed at times of low water.

The gage rod established by Mr. Robertson was of 2 by 6 inch timber, inclined, and attached to the crib of an old bridge on the south or right-hand side of the river, almost directly in front of the hotel. There were two bench marks: No. 1, on the top of a log of the crib; elevation, 10.01 feet above the datum. No. 2, in the cleft of a red bowlder at the foot of a charred stump 50 feet down stream and on the same side of the river; elevation, 9.60 feet. On April 13, 1891, the station was inspected by Mr. Frank Tweedy, and a third bench mark was established, this being a bedded rock 40 feet from the north end of the cable, toward Hot Springs Hotel and 10 feet from the river bank. It is marked "B. M. No. 3, U. S. G. S.," and is 15.98 feet above the zero of the gage. The present observer is Dr. J. L. Prentiss.

The measurements were at first made from a car suspended from a cable stretched across the river, the bridge from which measurements were originally made by the State engineer having been destroyed. Later a new suspension bridge was constructed in front of the hotel, necessitating the removal and replacement of the gage, and subsequent measurements were made from this bridge, which, having a clear span, offers no obstruction to the current. Discharge measurements were made by Mr. F. H. Newell in 1893 and 1894, and by Mr. Arthur P. Davis in the fall of 1894. From these the following provisional rating table was constructed as being applicable to the river heights obtained after the spring flood of 1893.

On May 1, 1889, a station 35 miles below Canyon was established at a point where the river flows through a small box canyon about one-half mile long, with almost vertical walls from 20 to 30 feet high. The channel is straight and the river can not overflow. In low stages, however, the bottom silts, forming sand bars, and in high stages the

volume, being confined, acquires a velocity so great that measurements are made with difficulty. A number of small streams flow in between this station and that at Canyon. These are too small to be measured individually, and it was to determine their aggregate value that this station was established. Observations were continued during the summer of 1889, but the locality was abandoned at the end of August.

Rating table for Arkansas River at Canyon, Colorado, based on gagings No. 23 to 28, used after July 1, 1893.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
2.00	130	2.80	510	3.60	1,180	4.30	2,050
2.10	160	2.90	580	3.70	1,290	4.40	2,190
2.20	200	3.00	650	3.80	1,410	4.50	2,315
2.30	245	3.10	730	3.90	1,530	4.60	2,445
2.40	290	3.20	810	4.00	1,650	4.70	2,585
2.50	340	3.30	900	4.10	1,780	4.80	2,735
2.60	390	3.40	990	4.20	1,910	4.90	2,990
2.70	450	3.50	1,080				

Daily gage height of Arkansas River at Canyon, Colorado, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Dec.
1	2.15	2.20	2.20	2.75	2.40	4.10	4.65	3.10	3.05	.....
2	2.35	2.35	2.30	2.40	2.20	4.20	4.85	4.05	3.10	.....
3	2.35	2.10	2.50	2.30	2.30	4.30	4.50	2.85	3.10	2.90
4	2.30	2.10	2.20	2.50	2.25	4.20	4.40	2.25	3.20	2.90
5	2.25	2.20	2.20	2.40	2.25	4.25	4.20	2.20	3.20	2.86
6	2.20	2.20	2.30	2.35	2.15	4.20	4.05	2.90	3.10	2.90
7	2.25	2.20	2.35	2.40	2.40	4.45	3.90	3.00	3.00	2.70
8	2.20	2.20	2.40	2.25	2.40	4.55	3.70	3.30	2.95	2.60
9	2.15	2.20	2.40	2.20	2.65	4.90	3.65	3.15	2.90	2.60
10	2.20	2.40	2.35	2.30	2.25	4.65	3.60	3.00	2.90	2.60
11	2.25	2.25	2.25	2.20	2.65	4.90	3.60	2.90	2.75	2.60
12	2.15	2.20	2.40	2.30	2.25	5.10	3.30	2.85	2.75	2.60
13	2.15	2.30	2.25	2.35	2.40	4.90	3.35	2.75	2.75	2.60
14	2.25	2.45	2.15	2.20	3.20	4.95	3.25	2.65	2.70	2.60
15	2.25	2.15	2.30	2.20	3.40	5.45	3.25	2.60	2.70	2.60
16	2.25	2.25	2.20	2.25	3.20	5.60	3.65	2.70	2.65	2.60
17	2.20	2.30	2.20	2.25	3.30	5.95	3.25	2.75	2.65	2.60
18	2.20	2.30	2.25	2.30	4.20	6.00	3.20	2.90	2.65	2.60
19	2.15	2.30	2.20	2.25	4.90	5.90	3.25	3.00	2.55	2.60
20	2.05	2.25	2.35	2.30	5.10	5.80	3.20	2.90	2.50	2.70
21	2.15	2.25	2.30	2.25	5.00	5.80	3.10	2.90	2.50	2.70
22	2.10	2.30	2.30	2.20	4.85	5.30	3.00	2.90	2.45	2.60
23	2.05	2.30	2.20	2.15	4.50	5.40	2.80	2.85	2.45	2.60
24	2.20	2.25	2.30	2.20	4.30	5.00	2.75	2.85	2.45	2.70
25	2.20	2.15	2.25	2.50	4.10	5.35	2.65	2.80	2.40	2.80
26	2.10	2.35	2.25	2.30	4.20	5.15	2.70	2.75	2.40	2.70
27	2.15	2.35	2.25	2.45	4.30	5.10	2.45	2.75	2.40	2.60
28	2.35	2.30	2.20	2.35	4.20	4.90	2.40	2.75	2.45	2.60
29	2.20	.....	2.25	2.20	4.90	4.85	2.70	2.75	2.45	2.60
30	2.20	.....	2.30	2.65	4.50	4.60	2.60	2.80	2.40	2.60
31	2.30	.....	2.90	.....	4.30	.....	2.70	2.80	.....	2.60

Daily gage height of Arkansas River at Canyon, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.80	2.80	2.60	3.50	5.20	3.70	3.10	3	2.60	2.30	2.30
2	2.80	2.70	2.90	2.60	3.60	4.80	3.70	3.20	2.90	2.60	2.30	2.30
3	2.70	2.60	2.80	2.60	3.50	4.90	3.70	3.10	2.90	2.50	2.30	2.40
4	2.90	2.60	2.80	2.70	3.50	5.10	3.90	3.00	2.80	2.50	2.30	2.40
5	2.60	2.60	2.70	2.80	3.40	5.30	4.40	3.20	2.90	2.50	2.40	2.40
6	2.70	2.60	2.70	2.80	3.50	5.80	4.40	3.10	2.90	2.50	2.30	2.30
7	2.60	2.70	2.80	2.90	3.60	5.70	4.50	3.00	2.90	2.70	2.40	2.30
8	2.60	2.70	2.80	2.80	3.70	5.80	4.00	2.90	3.00	2.50	2.30	2.40
9	2.60	2.70	2.90	2.80	3.80	5.30	3.90	3.20	3.00	2.50	2.30	2.50
10	2.60	2.60	3.00	2.80	3.90	4.90	3.80	3.10	3.10	2.40	2.30	2.50
11	2.60	2.60	2.90	2.70	4.00	4.70	3.70	3.00	3.10	2.40	2.30	2.40
12	2.60	2.60	3.00	2.70	4.10	4.60	3.60	3.00	3.20	2.40	2.40	2.40
13	2.60	2.60	3.00	2.70	4.20	4.70	3.60	3.10	3.10	2.40	2.30	2.40
14	2.80	2.70	3.10	2.80	4.30	4.80	3.90	3.10	3.10	2.40	2.30	2.40
15	2.70	2.60	3.20	2.90	4.30	4.90	4.00	3.00	3.00	2.40	2.30	2.40
16	2.60	2.60	3.00	3.00	4.20	4.90	4.00	3.00	3.00	2.40	2.30	2.40
17	2.60	2.60	2.90	3.10	4.10	4.80	4.00	3.00	2.90	2.40	2.40	2.30
18	2.60	2.60	2.80	2.90	4.00	4.80	3.90	3.10	2.80	2.30	2.40	2.30
19	2.70	2.60	2.90	2.70	3.90	4.80	4.00	3.10	2.70	2.40	2.30	2.30
20	2.80	2.60	2.80	2.80	4.50	4.70	4.00	3.00	2.70	2.30	2.30	2.30
21	2.80	2.60	2.70	2.90	4.70	4.60	4.00	3.20	2.70	2.30	2.30	2.30
22	2.80	2.70	2.60	3.00	4.90	4.40	4.00	3.10	2.60	2.30	2.40	2.30
23	2.90	2.80	2.60	3.10	4.70	4.40	3.70	3.10	2.60	2.30	2.30	2.30
24	2.90	2.60	2.60	3.20	4.60	4.30	3.50	3.10	2.60	2.30	2.30	2.30
25	2.80	2.60	2.50	3.30	4.40	4.20	3.40	3.20	2.60	2.30	2.40	2.30
26	2.70	2.70	2.60	3.40	4.50	4.10	3.30	3.10	2.60	2.30	2.40	2.40
27	2.60	2.70	2.60	3.40	4.50	4.00	3.30	3.00	2.60	2.30	2.40	2.40
28	2.60	2.80	2.60	3.40	4.60	4.00	3.30	3.00	2.70	2.40	2.40	2.30
29	2.60	.....	2.50	3.40	4.80	3.80	3.20	3.10	2.70	2.30	2.30	2.30
30	2.60	.....	2.50	3.50	5.10	3.70	3.10	3.10	2.70	2.30	2.30	2.30
31	2.70	.....	2.50	.....	5.80	.....	3.10	3.00	.....	2.30	.....	2.30

LA JUNTA STATION, ON ARKANSAS RIVER.

The gage at this station was established by Mr. F. H. Newell on September 27, 1893, on the left or south bank of the river, near the city pumping station. At this point the banks are steep, being at the outside of one of the curves of the river, while on the other they are somewhat low and shelving. The gage is of oak, 10 feet long, 6 inches wide, 3 inches thick, inclined, 1 foot vertical equaling 1.38 feet on the gage. The upper end is bolted to a cottonwood tree, and the lower end to an oak cross-tie loaded with rock. The gage reads to 6.60 feet, and is notched for each tenth of a foot on the edge, and besides the painted figures is further marked by tacks driven into the oak, the number of tacks indicating the number of feet. A bench mark is painted on the northwest corner of the pump house, about 0.3 foot above the ground, the horizontal line being 11 feet above the datum of the gage. The water at that time stood at 0.45 foot, and the discharge as measured at the wagon bridge below town was 24 second-feet.

Records of height of water were maintained from December 5, 1893, through that and the succeeding year. On May 21, 1894, a measurement was made at the wagon bridge, showing a discharge of 157 second-feet. A few days later occurred one of the heaviest floods of the year, followed by a second flood a week later. At the time of the first flood a number of measurements were made at La Junta and at the railroad crossing at Nepesta, 36 miles above. The storm began on Wednesday evening, May 30, 1894, causing the river to rise rapidly that night, and on May

31 it had flooded the bottoms and washed out the approaches to nearly all of the bridges below Canyon. On June 1, at 4 p. m., a measurement by Mr. F. H. Newell at the wagon bridge at Nepesta showed a discharge of 12,000 second-feet. At that time the water had receded 4 feet below the highest flood mark on the bridge. The maximum surface velocity was 6.7 feet per second, and the mean velocity 4 feet per second. On June 2 the water had fallen 5.3 feet below high-water mark, and had a maximum surface velocity of 5.6 feet per second. The measurement was made while the water was falling rapidly, and the discharge is placed in round numbers at 8,000 second-feet. From a comparison of these measurements with such facts as could be obtained on the ground, an inspection of the flooded area, and the statements of men who were watching the river, the conclusion was reached that about 30,000 second-feet passed the Atchison, Topeka and Santa Fe Railroad bridge at the top of the flood of May 31. This quantity would probably have been larger if the pile bridge with the driftwood against it had not prevented the free flowing of the stream.

The first flood was followed by one a week later of about the same violence. On June 7, 1894, at 9 a. m., the measured discharge at the wagon bridge at La Junta at the time the water was falling from this second flood was 15,000 second-feet. The maximum surface velocity was 6 feet per second, and the height of water on the gage was 7.8 feet. The next day, June 8, the water stood at 6.4 feet on the gage, and the measured discharge was 9,500 second-feet. From these measurements and an examination of flood marks the conclusion was reached that the maximum amount passing the bridge at the time of this flood was 20,000 second-feet, the bridges and approaches holding back the water.

The La Junta station was inspected on October 5, 1894, by Mr. Arthur P. Davis, and a measurement was made, showing that the river was discharging 55 second-feet for a gage height of 0.4. At this part of its course the relation of gage height to discharge, especially during the low stages of the river, is constantly varying, owing to silting and scouring of the muddy channel. It is possible, however, that estimates of a fair degree of reliability can be made by making frequent measurements of discharge.

Daily gage height of Arkansas River at La Junta, Colorado, for 1894.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.00	0.45	0.50	0.30	0.40	17	2.25	0.80	1.55	0.30	1.30	0.30
2	1.60	.90	.50	.50	.30	.....	18	2.00	.60	1.50	.30	1.30	.30
3	1.60	3.20	.50	.50	.30	.....	19	2.05	.60	1.50	.30	1.40	.30
4	1.55	5.00	.40	.35	.30	.....	20	2.50	.60	1.40	.30	1.30	.30
5	2.55	2.90	.40	.30	.30	.....	21	2.70	.60	1.40	.30	1.30	.30
6	.....	1.90	.40	.30	.30	.....	22	2.50	.50	1.30	.25	1.20	.30
7	4.50	1.60	.40	.30	.30	.....	23	2.25	.50	1.20	.20	1.25	.30
8	3.90	.....	.40	.40	.30	.....	24	1.90	1.60	1.00	.20	1.10	.30
9	2.90	.....	.35	.35	.30	.30	25	1.70	1.30	.90	.20	1.00	1.00
10	2.60	1.70	.40	.35	.30	.30	26	1.50	1.00	.75	.25	1.00	1.70
11	2.30	1.50	(a)	.30	.30	.30	27	1.50	.60	.65	.20	.90	1.50
12	2.10	1.20	3.00	.30	.30	.30	28	1.50	.50	.55	.30	.90	1.50
13	1.90	.95	2.00	.30	.30	.30	29	1.30	.50	.50	.30	.90	1.30
14	1.70	.90	1.60	.30	.30	.30	30	1.10	.50	.50	.30	.90	1.20
15	1.90	.70	1.60	.30	1.30	.30	31	1.10	.50	.....	.30	.....	1.20
16	2.10	.60	1.60	.30	1.20	.30							

a Washout.

HOLLY STATION, ON ARKANSAS RIVER.

A gage was established at this point by Mr. F. H. Newell on September 26, 1893, on the north side of the west end of bridge No. 362 of the Atchison, Topeka and Santa Fe Railroad Company, 0.9 mile east of the railroad station of Byron. At that time there was no water in the river. The gage consists of an oak plank 16 feet long, 6 inches wide, and 2 inches thick, placed edgewise and inclined at a low angle. The upper end was fastened to an old pile, and the lower end to one of the new supports of the bridge. The edge of the plank is marked to vertical feet and tenths, the inclination being such that 1 foot vertical equals 4.87 feet along the gage rod. Each tenth of a foot vertical is marked by a notch and figures from 0.2 foot up to 3.2 feet, the marking being continued on the vertical pile up to 5.5 feet. The top of the rail is 8.89 feet above the datum of this gage. Besides having painted figures, the height is indicated by tacks driven into the wood. During repairs upon this bridge this gage was transferred and replaced, its position not being verified.

Observations were begun on December 4, 1893, and continued through 1894. On April 15 the observer reported that the river was dry, all of the water being used at points above for irrigation purposes. The river remained dry until the latter part of May, and on June 1 rose 3.5 feet, reaching a height of 4.6 feet on June 3. From this time the water gradually fell off to the first week in July, rising on July 7 to 2.6 feet. On August 25 the channel was again dry, a small amount of water coming down during the next week, following a heavy rain. It was practically dry until September 11, the water rising to a height of 4 feet on September 12, and falling again rapidly, being reported dry on September 23. On October 19 the gage was moved into the main channel; it was again moved on November 26. The following table gives the readings at this point as reported, but from them it is not possible to distinguish the times when the water was actually flowing

in the stream, as the observer did not record the fact as to whether the water around the gage was in motion or was merely standing in large pools in the river channel:

Daily gage height of Arkansas River at Byron, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	1.30	1.40	0.30	.....	3.50	1.10	0.50	0.00	0.00	0.90	0.20
2	.95	1.30	1.60	.30	.....	4.50	1.00	.40	0.00	0.00	.90	.20
3	.95	1.30	1.40	.30	.....	4.60	.90	.40	0.00	0.00	.90	.20
4	1.00	1.30	1.00	.30	.....	3.50	.80	.30	0.00	0.00	.90	.20
5	1.00	1.30	.90	.30	.....	2.80	1.30	2.00	0.00	0.00	.90	.20
6	1.05	1.30	.90	.20	.....	2.70	1.50	1.60	0.00	0.00	.90	.20
7	1.20	1.30	.90	.20	.....	2.50	2.60	.60	0.00	0.00	.80	.20
8	1.20	1.40	.60	.20	.....	4.20	2.60	.50	0.00	0.00	.80	.20
9	1.20	1.40	.40	.20	.....	3.00	2.60	.40	0.00	0.00	.80	.20
10	1.20	1.40	.40	.20	.....	2.80	2.40	.20	0.60	0.00	.80	.20
11	1.20	1.40	.60	.20	.....	2.50	2.30	.20	3.80	0.00	.80	.20
12	1.20	1.40	.60	.20	.....	2.40	2.20	.50	4.00	0.00	.80	.20
13	1.20	1.40	.60	.20	.....	2.10	2.10	.50	1.80	0.00	.80	.20
14	1.20	1.40	.60	.30	.....	2.00	2.00	.40	1.00	0.00	.80	.20
15	1.20	1.50	.50	.30	.....	2.00	1.70	.40	.80	0.00	.80	.20
16	1.20	1.60	.50	.30	.....	2.00	1.40	.40	.60	0.00	.80	.20
17	1.20	1.60	.40	.30	.....	2.00	1.10	.30	.50	0.00	.90	.20
18	1.30	1.60	.30	.20	.....	1.90	.80	.30	.30	0.00	1.00	.20
19	1.30	1.60	.30	.20	.....	1.90	.80	.20	.30	1.00	1.10	.20
20	1.30	1.60	.30	.20	.....	1.80	.80	.20	.30	1.00	1.20	.20
21	1.30	1.60	.20	(a)	.....	1.80	.70	.10	.30	1.00	1.20	.20
22	1.20	1.60	.20	.....	.....	1.70	.70	0.00	.20	1.00	1.20	.20
23	1.20	1.60	.60	.....	.....	1.60	.60	0.00	0.00	1.00	1.20	.20
24	1.20	1.60	.40	.....	.....	1.60	.50	0.00	0 00	1.00	1.20	.20
25	1.20	1.40	.60	.....	.....	1.40	.50	0.00	0.00	.90	1.20	.20
26	1.00	1.40	.50	.....	.....	1.30	.50	.50	0.00	.90	.20	.20
27	1.00	1.40	.40	.....	80	1.20	.50	.40	0.00	.90	.20	.20
28	1.00	1.50	.40	.....	40	1.20	.40	.30	0.00	.90	.20	.20
29	1.30	.....	.40	.....	30	1.20	.40	.10	0.00	.90	.20	.20
30	1.30	.....	.30	.....	30	1.20	.30	0.00	0.00	.90	.20	.30
31	1.30	.....	.30	.....	60	.....	.30	0.00	.....	.90	.....	.30

a River dry from April 21 to May 27 because of water being used for irrigation.

CANADIAN BASIN, IN NEW MEXICO.

Few if any measurements have been made in this important basin, which drains the northeastern corner of New Mexico. There is, however, a demand for information pertaining to the headwaters of this stream and applicable to the tributaries at points where their waters may be utilized. A station has therefore been established on Mora River, at Watrous, a point where measurements can be conducted with the least expense.

WATROUS STATION, ON MORA RIVER.

This station is located at the Atchison, Topeka and Santa Fe Railroad bridge, 1½ miles east of Watrous, N. Mex. The observer is Mr. Frank Flaiz, section foreman at Watrous. The station was established by Mr. Arthur P. Davis on October 4, 1894. The gage is fastened to the oak timber of a retaining wall, just north of the east end of the bridge. The observer's house is distant from the gaging station about 1½ miles. The gage, of pine timber, is vertical, spiked and bolted to the oak retaining wall, painted white, and graduated black. The character of the channel is shifting. The point 12.62 of the gage is level with the top of the east abutment of the bridge.

RIO GRANDE BASIN, IN COLORADO, NEW MEXICO, AND TEXAS.

This drainage basin has been described in some detail in the Twelfth Annual Report, Part II, Irrigation, pages 240–290. A number of the river stations located in 1889 have been maintained, while others have been established during 1894. The problems along this river are largely interstate or international in character, the development of agriculture by irrigation in Colorado tending to reduce the amount of water available in New Mexico, and the increased use in New Mexico and Colorado apparently resulting in a diminished flow at points where irrigating canals in Texas and in the Republic of Mexico have been accustomed to take their supply. Records of river flow have been maintained under difficulties, the principal of which was the lack of funds sufficient to induce observers to continue unbroken series of readings, and because of the impossibility of inspecting the gages and making check measurements at necessary times.

DEL NORTE STATION, ON THE RIO GRANDE.

Measurements and observations were first begun in the vicinity of Del Norte in 1889, by Mr. George T. Quinby. The object of the measurements was to obtain the flow of the river before water was diverted for the agricultural region of the San Luis Valley, and, by a comparison of this with the figures obtained at Embudo, to acquire data as to the effect of the numerous ditches taking out water between the two points. The river 25 miles above Del Norte flows out of the canyon at Wagon Wheel Gap. Little water, however, is diverted until the edge of the San Luis Valley is reached, the largest canal heading near the town of Del Norte. During freshets the river divides into a number of channels, making it difficult to obtain measurements near town. In order to avoid the expense of establishing a station during time of high water, the first measurements—those about June 1—were made from several bridges crossing the numerous branches. The results were not wholly satisfactory, and on June 25 a station was established above the branches. Later a locality about 2 miles farther up was chosen. Observations at this point were kept continuously from September, 1889.

The station is above all the irrigating ditches of importance. The river flows in one channel, about 175 feet wide and of very regular section. The banks on each side are steep, and the water is reported never to overflow. The course of the stream is straight for several hundred yards both above and below the section. An inclined gage is set, at an angle of about 30° to the horizontal, on the left bank, and is referred to bench marks. As noted on October 10, 1891, No. 1 is a large nail in the root of a tree 15 feet northwest of the end of the cable on left bank of river. Bench mark No. 2 is a large nail in the

root of a tree 25 feet southwest of the end of the inclined gage. Both bench marks are 7.54 feet above the datum of the gage.

The station is equipped with a flatboat, 4 feet wide and 14 feet long, attached by rope and tackle to a five-eighths-inch wire cable fastened to a large cottonwood tree on the left bank, and to a sand anchor on the right bank. The inclined gage is 2 inches by 6 inches. On March 9, 1890, the gage was carried away by the ice, and was replaced on March 22. A self-recording nilometer was erected at this station, but after trial it was found that better results could be obtained by daily readings.

Daily gage height of Rio Grande at Del Norte, Colorado, for 1893.

Day	Jan.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.15	1.80	2.80	4.40	2.45	2.00	1.80	1.75	1.55	1.85
2	3.10	1.85	2.75	4.50	2.30	2.10	1.85	1.70	.....	.....
3	3.10	1.90	2.70	4.50	2.25	2.10	1.85	1.70	1.55	1.50
4	3.10	2.05	2.65	4.60	2.15	2.00	1.80	1.70	.....	.....
5	3.10	2.20	2.60	4.40	2.10	1.80	1.70	.....	1.50	2.00
6	3.10	2.15	2.60	4.20	2.10	1.80	1.70	1.65	.....	.....
7	3.05	2.10	2.70	4.20	2.05	1.75	1.70	.....	1.45	2.20
8	3.05	2.05	2.70	4.50	2.00	1.80	1.65	1.60	.....	.....
9	3.00	2.05	2.80	4.50	2.00	1.80	1.60	.....	1.45	2.55
10	3.00	2.05	2.85	4.50	1.90	1.75	1.60	1.60	.....	.....
11	2.95	2.10	3.00	4.40	1.95	1.70	1.60	.....	1.50	2.60
12	2.90	2.05	3.35	4.30	2.05	1.70	1.55	1.55	.....	.....
13	2.90	2.00	3.80	4.20	2.20	1.65	1.55	.....	1.55	2.50
14	2.90	1.95	3.90	3.90	2.10	1.65	1.50	1.60	.....	.....
15	2.90	1.90	3.95	3.80	2.00	1.70	1.50	.....	1.60	2.50
16	2.95	1.95	4.20	3.70	1.90	1.75	1.50	1.55	.....	.....
17	2.95	2.00	4.40	3.60	1.85	1.75	1.60	.....	1.60	2.50
18	2.90	2.10	4.90	3.50	1.80	1.75	1.70	1.60	.....	.....
19	2.90	2.15	4.90	3.40	1.90	1.80	1.65	.....	1.55	2.55
20	2.85	2.10	4.85	3.30	1.75	1.80	1.65	1.55	.....	.....
21	2.85	2.10	4.85	3.15	1.75	1.85	1.60	.....	1.60	2.50
22	2.80	2.20	4.75	3.00	1.70	1.85	1.60	1.55	.....	.....
23	2.80	2.25	4.85	3.00	1.70	1.80	1.60	.....	1.65	2.55
24	2.80	2.40	4.80	2.90	1.80	1.75	1.55	1.60	.....	.....
25	2.80	2.65	4.65	2.80	1.85	1.70	1.60	.....	2.00	2.70
26	2.85	2.80	4.40	2.75	1.90	1.65	1.60	1.60	.....	.....
27	2.90	2.90	4.25	2.70	1.90	1.60	1.65	.....	2.10	2.80
28	2.95	2.95	4.20	2.60	1.90	1.80	1.70	1.55	.....	.....
29	3.00	3.05	4.10	2.50	1.80	1.80	1.75	.....	2.05	2.75
30	2.95	3.00	4.25	2.50	1.80	1.75	1.70	1.60	.....	.....
31	2.90	.....	4.35	.....	1.95	1.80	.....	.....	.....	2.70

Daily gage height of Rio Grande at Del Norte, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.05	3.05			3.50	1.70		1.70	1.75		
2	2.85			2.05	3.10			1.65			1.60	1.44
3		3.05	3.10			3.40	1.70		1.75	1.85		
4	2.90			2.00	3.30			1.60			1.60	1.46
5		3.00	3.10			3.30	1.70		1.70	1.80		
6	2.95			2.10	3.85			1.60			1.60	1.52
7		3.00	3.00			3.30	1.70		1.70	1.80		
8	3.05			2.20	3.85			1.55			1.60	1.58
9		2.95	3.00			3.10	1.70		1.80	1.75		
10	3.10			2.10	3.95			1.60			1.60	1.60
11		3.00	2.95			2.90	1.70		1.90	1.70		
12	3.15			2.15	4.20			1.60			1.60	1.58
13		3.00	2.90			2.78	1.60		1.75	1.65		
14	3.00			2.25	4.40			1.65			1.55	1.54
15		3.00	3.05			2.60	1.55		1.70	1.60		
16	3.05			2.30	3.90			1.70			1.50	1.58
17		2.95	3.15			2.40	1.65		1.65	1.60		
18	3.00			2.25	4.10			1.75			1.50	1.62
19		2.90	2.95			2.30	1.90		1.60	1.65		
20	3.05			2.50	4.60			1.80			1.45	1.68
21		2.95	2.70			2.30	1.85		1.60	1.70		
22	3.00			2.70	4.10			1.95			1.45	1.72
23		3.00	2.25			2.10	1.80		1.55	1.65		
24	2.95			2.95	3.50			2.00			1.50	1.76
25		3.00	2.15			2.00	1.75		1.55	1.65		
26	2.95			3.25	3.30			1.95			1.45	1.80
27		3.00	2.10			1.95	1.65		1.50	1.60		
28	3.00			3.60	3.40			1.80			1.40	2.02
29			2.00			1.85	1.60		1.70	1.65		
30	3.00			3.05	3.50			1.80			1.40	2.18
31			2.05				1.60			1.60		

ALAMOSA STATION, ON THE RIO GRANDE.

This station is located at bridge 249A of the Denver and Rio Grande Railroad, about one-half mile east of Alamosa, Colo. The observer is Mr. E. L. McKinnon, foreman of section 11. The gage is a 2 by 6 inch plank, painted white, and graduated in black to tenths from a foot to 11.3 feet. It is spiked to the west side of the third pier from the east end on the north side of the bridge. The point 11.25 of the scale is level with the top of the pier.

EMBUDO STATION, ON THE RIO GRANDE.

Embudo is a railroad station on the Denver and Rio Grande Railroad, in Rio Arriba County. The station is in a narrow canyon above the head of the valley in which Espanola and other towns are located, and in which the river Chama joins the Rio Grande. In November, 1888, an examination was made along the main stream for the purpose of selecting a point at which the total discharge of the Rio Grande entering New Mexico could be ascertained. Coming from Colorado southward, this is the first point at which the railroad reaches the river, and for this reason it was finally determined to establish a river station here. Measurements were begun at the rocky narrows, about a mile above the railroad station, but in the spring of 1889 the observations were transferred to a point directly behind the railroad station, for convenience of the observer and consequent reduction of expense.

The inclined gage, constructed at that time, is made of scantling, 4 by 4 inches, spiked to posts set firmly in the ground. It is on the right-hand side of the river, at a place where the slopes are very gentle, and therefore is of considerable length in order to reach out to the low-water channel. It is graduated from about 7.30 feet, the low-water mark, up to 16 feet. The point 3.50 would correspond approximately to the deepest part of the section. The gage is about 75 feet above the cable and is in three parts, with different slopes. The cable is five-eighths-inch wire, with nineteen steel strands. It is fastened to a cedar tree on the left-hand side and to sand anchors on the right. Measurements were originally made from a boat held by traveling pulleys running on the cable. The boat being washed away by flood, later measurements were made from a box suspended from the cable.

Bench mark No. 1 is on a rock near the end of the cable, on the left-hand bank, marked "B. M." with white paint. It is 20.66 feet above zero of the gage. Bench mark No. 2 is on a rock about 100 feet above the cable, on the left bank of the river, and is marked "B. M." with white paint. It is 18.79 feet above datum. Bench mark No. 3 is a notch cut in the southeast corner of the station house, about 2 feet above the level of the platform, and is 30.48 feet above datum.

Observations at this point were maintained for a number of years. In 1893 the record is deficient from November 4 to December 4, and in 1894 no reports were received from March 1 to September 15. The station was inspected September 30, 1894, by Mr. Arthur P. Davis, who at that time made a measurement of discharge, showing that for a height of 7.7 feet the river was carrying 284 second-feet. On the next day a flood occurred, and measurements were attempted, although the height of water was fluctuating considerably. The computed discharge was 1,138 second-feet. The changes in the channel at this point are not great, but are sufficient to vitiate the rating table formerly used, and therefore computations of discharge have not been made pending construction of a better rating table.

Daily gage height of Rio Grande at Embudo, New Mexico, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.90	8.15	8.05	8.75	10.65	11.50	8.25	7.70	7.90	8.20	8.00	.....
2	7.90	8.15	8.05	8.85	10.55	11.60	8.15	8.50	7.80	8.15	8.00	.....
3	8.00	8.15	8.20	9.10	10.20	11.60	8.00	8.50	7.75	8.20	7.95	.....
4	8.00	8.05	8.30	9.25	10.00	11.60	7.85	7.80	8.00	8.20	7.95	8.02
5	8.00	8.15	8.30	9.35	9.90	11.60	7.75	7.75	7.90	8.20	.....	8.01
6	8.00	8.25	8.25	9.45	10.00	11.60	7.70	7.60	7.80	8.15	.....	7.98
7	8.05	8.20	8.30	9.60	10.15	11.50	7.60	7.55	7.85	8.20	.....	7.98
8	8.05	8.15	8.30	9.70	10.05	11.30	7.60	7.60	7.85	8.10	.....	8.01
9	8.00	8.20	8.35	9.75	9.90	11.30	7.60	7.65	7.80	8.05	.....	8.00
10	8.05	8.25	8.40	9.65	9.75	11.50	7.55	7.55	7.80	8.10	.....	7.98
11	8.00	8.30	8.25	9.60	9.65	11.60	9.30	7.50	7.80	8.05	.....	7.97
12	8.00	8.20	8.15	9.50	9.70	11.60	7.70	7.45	7.75	8.00	.....	7.97
13	7.95	8.30	8.20	9.45	10.25	11.50	7.50	7.40	7.70	8.00	.....	7.95
14	7.90	8.30	8.20	9.30	11.05	11.20	7.45	7.40	7.75	8.05	.....	7.98
15	7.95	8.10	8.40	9.20	11.65	11.10	7.40	7.40	7.70	8.05	.....	8.00
16	8.00	8.05	8.25	9.10	11.70	10.90	7.40	7.40	7.70	8.00	.....	7.96
17	8.00	8.15	8.20	9.05	11.75	10.60	7.35	7.40	7.75	8.00	.....	7.95
18	7.95	8.20	8.25	9.00	11.90	10.40	7.35	7.50	7.95	8.00	.....	7.94
19	7.90	8.25	8.35	9.10	12.40	10.30	7.35	7.45	7.85	8.00	.....	7.92
20	7.85	8.25	8.40	9.20	12.65	10.10	7.30	7.70	7.85	8.00	.....	7.93
21	7.90	8.25	8.55	9.45	12.60	9.90	7.35	7.65	7.85	8.00	.....	7.93
22	8.05	8.25	8.70	9.55	12.45	9.75	7.50	7.70	7.80	8.00	.....	7.95
23	7.95	8.20	8.70	9.60	12.20	9.60	7.40	7.60	7.80	8.05	.....	7.94
24	7.95	8.20	8.70	9.85	11.85	9.40	7.45	7.55	7.80	8.00	.....	7.95
25	7.95	8.10	8.65	10.40	11.55	9.15	7.50	7.60	7.80	8.00	.....	7.95
26	8.00	8.20	8.50	10.55	11.40	8.95	7.55	7.60	7.80	8.00	.....	7.95
27	8.00	8.20	8.40	10.55	11.40	8.80	7.80	7.70	8.15	8.00	.....	7.94
28	8.00	8.00	8.40	10.40	11.50	8.70	7.50	8.20	8.25	8.00	.....	7.95
29	8.00	.....	8.40	10.30	11.35	8.60	7.40	7.80	8.25	8.00	.....	7.94
30	8.00	.....	8.55	10.35	11.30	8.45	7.45	7.85	8.20	8.00	.....	7.95
31	8.05	.....	8.65	.....	11.35	.....	7.60	8.05	.....	8.00	.....	7.92

Daily gage height of Rio Grande at Embudo, N. Mex., for 1894.

Day.	Jan.	Feb.	Sept.	Oct.	Nov.	Dec.	Day.	Jan.	Feb.	Sept.	Oct.	Nov.	Dec.
1	7.95	7.95	.....	9.55	7.08	8.00	17	7.95	8.00	7.10	7.08	8.00	8.00
2	7.95	7.95	.....	8.08	7.08	8.00	18	7.95	8.00	7.10	7.08	8.00	7.09
3	7.95	7.95	.....	8.05	7.08	8.00	19	7.95	8.00	7.10	7.09	8.00	8.02
4	8.00	7.95	.....	8.03	7.08	7.09	20	7.95	8.05	7.10	.....	7.09	8.01
5	7.95	7.95	.....	8.02	7.08	7.09	21	7.95	8.00	7.10	7.08	7.09	8.00
6	7.95	7.95	.....	8.01	7.08	8.00	22	7.95	8.00	7.10	7.08	7.09	8.01
7	7.95	7.95	.....	8.00	7.08	7.09	23	7.95	8.00	.....	7.09	8.00	8.01
8	7.95	7.95	.....	7.09	7.09	7.09	24	7.95	8.00	.....	8.03	8.00	8.03
9	7.95	7.95	.....	7.09	7.08	7.09	25	7.95	8.00	.....	8.04	8.00	8.01
10	7.90	7.95	.....	7.08	7.08	7.09	26	7.95	8.00	.....	8.04	7.09	8.00
11	7.90	7.90	.....	7.08	7.09	7.09	27	8.00	8.00	.....	7.08	7.09	7.09
12	7.90	7.90	.....	7.08	7.09	8.00	28	8.00	8.00	.....	7.08	7.09	7.09
13	7.90	7.95	.....	7.08	7.09	8.00	29	7.95	.....	.....	7.08	8.00	7.09
14	7.90	8.00	.....	7.08	7.09	8.00	30	7.95	.....	7.10	7.08	8.00	7.09
15	7.90	8.00	.....	7.08	7.09	8.01	31	7.95	.....	.....	7.08	.....	7.09
16	7.90	8.00	7.10	7.08	7.09	8.01							

WATER TANK STATION, ON THE RIO GRANDE.

This station is located about one-fourth of a mile above Water Tank, a section on the Santa Fe Southern Railroad, below Espanola. It was established by Messrs. Arthur P. Davis and P. E. Harroun on February 1, 1895. The observer is Mr. Thomas Dupre, section foreman, whose house is distant from the gaging station about one-fourth of a mile. The inclined portion of the gage is marked from 3.5 feet to 10.6 feet; the vertical portion from 10.6 feet to 16 feet. The inclined part of the gage is braced with wood and anchored with stones. The

upper part is set in the ground, leaning against a huge bowlder, and is held in that position by wire, well tightened. The highest point of the bowlder is marked with a black cross, and is 6.815 feet above the 11-foot mark. Measurement was made from gaging box suspended from cable placed across just above the gage. The channel is sandy and shifting.

SAN MARCIAL STATION, ON THE RIO GRANDE.

This station is located about one-half mile south of San Marcial, N. Mex., at the bridge of the Atchison, Topeka and Santa Fe Railroad. It was established by Mr. Arthur P. Davis on January 29, 1895. The observer is Mr. Bert Halseth, San Marcial, N. Mex., whose house is about one-half mile distant. The gage is of hard pine timber, 9 by 5 inches by 25 feet, anchored and bolted to the east end of the second pier from the south. It is inclined and painted white. The distance between the footmarks is 1.6 feet. The 13-foot mark is level with the extension of the pier, to which the gage is anchored. The 15-foot mark is level with the top of the capstone on which the bridge truss rests. The shifting channel is of sand and mud. Measurements were made from the same bridge. On August 8, 1889, a station was established near San Marcial, and a measurement was made which gave a discharge of 19 second-feet. Soon after this date, however, the river gage was destroyed and the locality was abandoned until 1895.

EL PASO STATION, ON THE RIO GRANDE.

This station is located at the pump house of the smelting works near the station "Town," on the Atchison, Topeka and Santa Fe Railroad, 1½ miles above Old Fort Bliss. It was established on January 24, 1895, by Mr. Arthur P. Davis. The observer is Mr. C. T. Pelham, of El Paso, Tex. The distance from the gage to the pump house is about 50 feet. The gage is of 4 by 6 inch timber, inclined, bolted to solid rock; is 24 feet long, and is continued upward on a 2 by 4 inch by 12-foot piece. The distance between the footmarks is 2.9 feet. The bench mark is an iron core in the center of the masonry monument that marks the corner of the smelter company's land, on a rock knoll just above the gage. It is 8.04 feet above the 11-foot mark on the gage. Measurement was made from a cable just below the gage.

The first river station on the Rio Grande near El Paso was at Old Fort Bliss, about 1,500 feet above the Mexican dam. Observations and measurements were made here from May 10, 1889, until the end of June, 1893, except at times when the river was dry. Later, during a sudden flood, the gage was deeply buried in mud, and on the abandonment of Old Fort Bliss the river rods and equipment were stolen, necessitating

the refurnishing of a new station. The following rating table and list of discharges apply to the old station:

Rating table for Rio Grande at El Paso, Texas.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
4.00	25	6.00	770	8.00	6,060	10.00	11,780
4.10	30	6.10	890	8.10	6,345	10.10	12,070
4.20	35	6.20	1,040	8.20	6,630	10.20	12,360
4.30	40	6.30	1,240	8.30	6,915	10.30	12,650
4.40	45	6.40	1,500	8.40	7,200	10.40	12,950
4.50	50	6.50	1,785	8.50	7,485	10.50	13,250
4.60	57	6.60	2,070	8.60	7,770	10.60	13,550
4.70	66	6.70	2,355	8.70	8,055	10.70	13,850
4.80	80	6.80	2,640	8.80	8,340	10.80	14,150
4.90	96	6.90	2,925	8.90	8,625	10.90	14,450
5.00	116	7.00	3,210	9.00	8,910	11.00	14,750
5.10	140	7.10	3,495	9.10	9,195	11.10	15,050
5.20	170	7.20	3,780	9.20	9,480	11.20	15,360
5.30	210	7.30	4,065	9.30	9,765	11.30	15,670
5.40	260	7.40	4,350	9.40	10,050	11.40	15,980
5.50	320	7.50	4,635	9.50	10,335	11.50	16,300
5.60	390	7.60	4,920	9.60	10,620	11.60	16,620
5.70	470	7.70	5,205	9.70	10,910	11.70	.....
5.80	560	7.80	5,490	9.80	11,200	11.80	.....
5.90	660	7.90	5,775	9.90	11,490	11.90	.....

Daily gage height of Rio Grande at El Paso, Texas, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1.....	5.00	4.95	5.05	.....	6.80	5.90	17.....	5.05	5.20	.....	7.05	7.30	5.10
2.....	.....	4.90	5.05	.....	6.60	5.90	18.....	5.05	5.30	.....	7.00	8.15	5.10
3.....	.....	5.10	5.05	.....	6.90	5.80	19.....	5.05	5.55	.....	6.00	8.10	5.00
4.....	5.05	4.90	5.00	.....	7.40	5.80	20.....	5.05	5.50	.....	5.80	8.10	4.75
5.....	5.15	4.80	5.05	.....	8.10	5.65	21.....	5.05	5.40	.....	5.60	8.10	4.70
6.....	5.05	4.80	5.00	.....	7.85	5.60	22.....	5.05	5.20	.....	5.40	7.95	4.65
7.....	5.04	4.70	4.90	.....	7.25	5.55	23.....	5.00	5.15	.....	5.05	7.95	4.50
8.....	5.05	4.65	.....	.....	6.80	5.50	24.....	5.10	5.10	.....	4.85	8.00	4.25
9.....	5.10	4.65	.....	.....	6.75	5.60	25.....	5.10	5.10	.....	6.10	8.20	4.20
10.....	5.05	5.05	.....	.....	6.80	5.55	26.....	5.20	5.05	.....	6.10	7.90	4.20
11.....	5.10	5.10	.....	.....	6.95	5.50	27.....	5.20	5.00	.....	6.00	7.10	4.05
12.....	5.05	5.05	.....	.....	6.95	5.45	28.....	5.25	5.05	.....	6.30	6.90	4.05
13.....	5.10	4.95	.....	5.70	6.40	5.20	29.....	5.20	.....	.....	6.95	6.60	4.00
14.....	5.10	5.00	.....	5.80	6.35	5.20	30.....	5.10	.....	.....	7.00	6.35	3.90
15.....	5.00	5.15	.....	6.10	5.90	5.05	31.....	5.05	.....	.....	.....	6.05	.....
16.....	5.10	5.25	.....	7.10	6.00	5.10							

COLORADO BASIN, IN COLORADO, UTAH, AND ARIZONA.

The system of great rivers which drains the interior of the continent and discharges through the Colorado into the Gulf of California is one of the most interesting and at the same time one of the least apparent value to the needs of mankind. As a whole the basin is characterized by deep gorges and stupendous canyons, in whose narrow bottoms the streams glide swiftly to the sea. The possible water power is very great, but its probable utilization at present is little short of chimerical. Although a considerable amount of water is discharged from the basin and flows near lands possessing great fertility, yet a relatively small amount can be diverted for irrigation of the soil, owing to the depths to which the flowing waters have cut the channel. It is only near the headwaters that the streams can be utilized to water agricultural lands.

Series of measurements have been begun on some of the more important tributaries, viz, at Grand Junction, Colo.; at Blake and Helper, Utah; at Arizona Dam, above Phœnix, Ariz., and on the main Colorado itself at Yuma, these being mainly for the purpose of obtaining data of general value rather than of local application in questions of immediate water supply.

GRAND JUNCTION STATION, ON GUNNISON RIVER.

This station is located at the pump house of the Denver and Rio Grande Railroad, 1 mile from town, beyond the railroad bridge across Grand River. It was established on October 19, 1894, by Mr. Arthur P. Davis. The observer is Mr. Frank Adair, engineer at the pump house. The gage is of pine timber, vertical, 5 by 5 inches, fastened to bolts set in the stone wall of the pump house. It is painted white and black. The discharge on October 18, 1894, for a height of 1.25 feet was 748 second-feet.

GRAND JUNCTION STATION, ON GRAND RIVER.

This station is located at the north end of the wagon bridge across Grand River at Grand Junction, on the west side of the first abutment. It was established by Mr. Arthur P. Davis, on October 18, 1894. The observer is Mr. B. W. Vedder, engineer of the city waterworks. The station is distant from the pump house about 300 feet. The gage is vertical, of 4 by 6 inch pine timber, and is fastened to bolts set in the stone abutment. The timber and gage are painted white and graduated in black. The point 11.95 of the gage is level with the sandstone coping on which the bridge truss rests. Measurements made from the wagon bridge on October 18, 1894, gave for a height of 0.6 feet a discharge of 1,585 second-feet.

BLAKE STATION, ON GREEN RIVER.

This station is located one-half mile east of Blake, Utah, at the bridge of the Rio Grande Western Railroad, northeast corner, middle pier. It was established on October 20, 1894, by Mr. Arthur P. Davis. The observer is Mr. Frank Jacobs, engineer at the pump house. The station is distant from the pump house about 100 feet. The gage is vertical, of pine timber, 8 by 8 inches by 24 feet, fastened to bolts set in the stone pier and bolted to the iron tension piece. The scale is nailed to a timber. The 18-foot mark on gage is 3 feet below the top of the pier. The river was measured October 21, 1894, from the ferry just above the bridge, showing for a height of 1.98 feet a discharge of 3,035 second-feet.

HELPER STATION, ON PRICE RIVER.

This station is located at the wagon bridge, 1 mile west of Helper, Utah, 50 yards south of the railroad track. It was established by Mr. Arthur P. Davis on October 23, 1894. The observer is Mr. Patrick

Liston, section foreman. The distance of the gaging station from the section house is 1 mile. The gage, of oak timber, is vertical, and is spiked to the north abutment on the west side of the bridge. It is painted white and black. The channel is rocky. The point 7.63 of the gage is level with the top timber of the abutment. The current-meter measurements are taken from the same bridge. The discharge on October 22, 1894, was 34 second-feet.

ARIZONA DAM, ON SALT RIVER.

Computations of the discharge of Salt River for a number of years have been made, based upon measurements of water entering the Arizona Canal and flowing over the dam at its head. This dam, about 30 miles east of Phœnix, Ariz., is described and figured in the Thirteenth Annual Report of the Survey, Part III, Irrigation, pages 221–224. The results of the estimates prepared by Mr. Samuel Davidson and his successors have been given in annual reports of the Survey, but those for 1893 and 1894, if prepared, have not been given out by the company.

A number of attempts have been made by this Survey to obtain accurate measurements of the flow of the Gila River and its tributaries, but owing to the unsettled condition of the country and the difficulty and expense of transportation it has been found impracticable to continue the work, since with the amount available far larger results could be obtained elsewhere. On May 11, 1889, Mr. W. A. Farish, assistant hydrographer, was sent to Arizona to establish a gaging station, and he continued in charge of this work until the end of August, 1890. During that time he placed a number of rain gages, which were, on September 24, 1890, transferred to the Signal Service, and later passed into the charge of the Weather Bureau. He also began observations of evaporation at Tempe, Yuma, and other localities. A reconnaissance was made for the purpose of selecting favorable points for measuring the rivers, but no place suitable for continuous measurements was found on Salt River below the junction with the Verde. About one-half mile above the junction of these two streams there were found localities where work might be done, but unfortunately it was almost impossible to secure a person to make observations of river height. In July, 1889, a station was located on the Salt above the mouth of the Verde, about 2 miles from the Arizona Canal.

An examination of Verde River was made in August, up to Fort McDowell, but no suitable cross section was found. At McDowell the river is almost 1,000 feet wide. The bed is sandy, and is divided into a number of channels or sloughs. About 12 miles above the fort the river emerges from a box canyon, but no person was found in that locality to make observations of river height. The section selected, near the mouth of the Verde River, appeared to be the only feasible locality, and gave fair results up to 4-foot rise of the water. At this stage the stream overflowed into back channels.

On August 26, 1889, measurements were begun on the Gila River about 18 miles above Florence, at a point where the river is confined between steep banks. At that time all of the rivers were low, but subject to fluctuations following rainfall upon the mountains. An examination was made of the Gila below the junction of the Salt as far as the Bend. The bed throughout continued of the same sandy character as above the junction, the water running in sloughs, forming innumerable sand bars in low water, and in time of flood spreading out to a width of from 1,000 to 3,000 feet.

Difficulty was experienced in obtaining observers at the points named, as the persons living sufficiently near to take observations were careless or neglected to make frequent readings of the gage. After a few months' experience it was decided that the only way by which accurate results could be obtained was to go into the mountains, locate stations near the lower end of suitable canyons, and employ a man to stay at the selected points. Later an attempt was made to establish a station below the junction of the Salt and Verde, about 1½ miles below Arizona Dam and 400 yards above the Highland Canal. The river banks at this point are about 13 feet above low water, and the channel during high water is 585 feet wide. On November 25 the attempt was made to put a cable across the river. Supports were built, and on December 4 the cable was about in place, when a sudden flood in the river, coming without warning, swept away the steel cable and supports and buried them under vast quantities of drift. Sudden storms of this character, known locally as "cloudbursts," are not unusual in this part of the country, and the streams are at all times liable to these fluctuations, rendering it impossible to make measurements from boats, as the current at such times is very rapid and large numbers of tree trunks and pieces of heavy drift wood are brought down.

In January, 1890, a river station was established on Gila River at Buttes, 15 miles above Florence, and attempts made to secure an accurate series of measurements. From observations taken at this point the mean daily discharge of the river was computed from August 26, 1889, to August 30, 1890. Occasional readings at a later date enabled computations to be made in December, 1890, and in January and February, 1891. From this camp on the Gila River, above Florence, measurements were made of the discharge of San Pedro River near Dudleyville, and of other streams.

At intervals during succeeding years Mr. Farish made a number of measurements of streams in Arizona, and he reports that during the summer of 1893 a series of observations were made on the Salt and Verde rivers. These measurements extend from May to September.

Daily mean gage height and discharge of the Verde River for 1893.

Day.	May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
		Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1			3.60		3.40	115	3.80	
2			3.60		3.45	122	4.40	
3			3.60		3.45	122	4.00	
4			3.60		3.45	125	4.40	
5			3.60	225	3.45	129	4.00	
6			3.55	192	3.45	118	3.90	
7			3.50	167	3.50	131	4.50	
8			3.50	164	3.50	129	4.00	
9			3.50	159	3.50	127	3.90	
10			3.50	150	3.50	115	3.85	
11			3.55	171	3.50	133	3.80	
12			3.50	138	3.45	126	3.70	
13			3.50	146	3.55	167	3.70	
14			3.50	144	3.55	167	4.10	
15			3.50	167	3.50	121	4.00	
16			3.50	184	3.50	141	4.55	
17			3.50	169	3.50	141	5.50	
18			3.50	186	3.90	260	5.20	
19			3.45	147	4.40	288	5.20	
20			3.45	145	(a)		5.15	
21			3.45	158	3.80	271	5.00	
22			3.45	153	4.10		5.50	
23	3.70		3.45	135	3.80		5.20	
24	3.60		3.50	146	4.10			
25	3.60	243	3.50	154	6.30			
26	3.65	234	3.50	159	5.40			
27	3.60	212	3.50	162	4.70			
28	3.60		3.45	154	4.40			
29	3.60	217	3.45	145	4.10			
30	3.60		3.40	132	4.00			
31	3.60				3.85			

a Gage slipped.

YUMA STATION, ON COLORADO RIVER.

This station is located at the Southern Pacific Railroad bridge across the Colorado River at Yuma, Ariz. Records have been kept here since April, 1878. The locality was examined by Mr. Arthur P. Davis on January 17, 1895. The observer is the bridge watchman at Yuma. The gaging station is about 700 feet distant from the watchman's house. The gage is fastened to a tall pile about 100 feet east of the north end of the bridge. It is vertical, is divided into feet and inches from about 15 feet up, and at low water is dry, so that another gage, for low water, is placed on the west end of the southern pier, and can be read from the bank. Measurements of discharge were made from the same bridge. This is a fairly good cross section ordinarily, but at the time visited, on the above-named date, was broken up with false work for repairs then in progress. The computed discharge was 9,737 second-feet.

Daily gage height of Colorado River at Yuma, Arizona, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17.00	16.58	16.42	18.33	19.42	22.83	20.25	19.42	19.00	18.42	18.75	18.50
2	16.83	16.67	16.75	18.25	19.58	22.75	20.33	19.42	19.08	18.42	18.75	18.50
3	16.67	16.67	16.92	18.00	19.67	22.83	20.25	19.42	19.16	18.33	18.75	18.58
4	16.50	16.58	17.00	17.92	20.75	22.83	20.25	19.33	19.42	18.33	18.83	18.58
5	16.42	16.58	17.00	17.92	20.92	23.00	20.08	19.33	19.42	18.25	18.83	18.58
6	16.42	16.58	17.08	17.92	21.00	23.00	20.00	19.25	19.25	18.33	19.16	18.67
7	16.42	16.83	17.00	18.00	21.00	23.08	19.83	19.25	18.92	18.33	19.16	18.67
8	16.58	17.00	17.16	18.00	20.92	23.16	19.83	19.33	18.67	18.33	19.08	18.67
9	16.92	17.00	17.25	18.08	20.67	23.16	19.67	19.25	18.67	18.33	19.08	18.67
10	17.00	17.00	17.08	18.06	20.50	23.25	19.67	19.33	18.67	18.50	19.00	18.67
11	17.08	17.00	16.92	18.16	20.33	23.25	19.67	19.33	18.50	18.50	18.83	18.67
12	16.83	16.92	17.00	18.33	20.50	23.33	19.67	19.33	18.67	18.42	18.83	18.67
13	16.92	16.92	16.92	18.50	20.83	23.58	19.83	19.25	18.08	18.50	18.75	18.67
14	16.83	16.83	16.92	18.42	21.50	23.67	20.25	19.33	18.67	18.67	18.58	18.83
15	16.58	16.83	16.92	18.33	21.08	23.67	20.16	19.25	18.58	18.67	18.58	18.83
16	16.42	16.75	16.92	18.00	22.42	23.33	19.83	19.42	18.67	18.58	18.58	18.83
17	16.25	16.92	17.00	18.00	22.50	23.00	19.67	19.16	18.50	18.58	18.58	18.92
18	16.16	16.83	16.92	18.00	22.58	22.67	19.75	19.25	18.42	18.58	18.50	18.83
19	16.00	16.83	17.25	18.00	22.75	22.25	19.75	19.25	18.67	18.58	18.50	18.92
20	15.92	16.75	17.42	18.33	23.08	22.16	19.50	19.16	18.67	18.50	18.58	18.83
21	15.83	16.83	17.33	18.25	23.25	21.83	19.42	19.00	18.50	18.67	18.58	18.75
22	15.83	16.83	17.25	18.16	23.42	21.67	19.33	19.00	18.50	18.67	18.58	18.67
23	15.83	16.83	17.25	18.16	23.33	21.50	19.33	18.83	18.67	18.67	18.50	18.67
24	15.83	16.75	17.25	18.50	23.16	21.16	19.50	18.83	18.58	18.58	18.58	18.75
25	15.92	16.67	17.58	18.83	23.00	21.00	19.67	18.75	18.58	18.67	18.67	18.75
26	16.00	16.58	18.42	19.08	23.08	20.75	19.67	18.75	18.50	18.67	18.58	18.67
27	16.25	16.58	18.33	19.50	23.16	20.58	19.50	18.75	18.42	18.75	18.58	19.08
28	16.33	16.50	18.16	19.33	23.33	20.50	19.58	18.92	18.42	18.75	18.50	19.00
29	16.42	.....	18.08	19.42	23.42	20.25	19.67	19.00	18.42	18.75	18.50	18.92
30	16.58	.....	18.16	19.33	23.16	20.16	19.50	19.16	18.33	18.75	18.50	18.80
31	16.58	.....	18.33	.....	23.08	.....	19.42	19.25	.....	18.75	.....	.....

INTERIOR BASIN, IN NEVADA, UTAH, AND IDAHO.

This great basin includes an area of 216,872 square miles, mainly in the State of Nevada, extending southerly into California, easterly into Utah, and northerly into Idaho and Oregon. The principal rivers are upon the east, in Utah, draining the Wasatch Mountains, and ultimately losing their waters in the Great Salt Lake. On the west are the rivers flowing down the steep easterly slope of the high Sierra Nevada, and in the center of the basin is the Humboldt. In the past a considerable number of measurements have been made upon the rivers of Utah and Nevada, and during 1893 and 1894 a few of the river stations previously established were maintained and others were located. In the following pages figures and descriptions are given briefly for the station at Golconda, on the Humboldt; at Battle Creek and Collinston, on the Bear, and at Uintah, Provo, and Leamington, in Utah.

GOLCONDA STATION, ON HUMBOLDT RIVER.

This station is located near Golconda, Humboldt County, Nev., being distant from the home of the observer, Mr. L. Dutertre about $1\frac{3}{4}$ miles. The gage is a pine board, inclined, firmly spiked to posts driven well into the bank, and graduated to feet and tenths. The river channel is through earth; the banks are steep and moderately stable, and the channel is almost straight for 400 or 500 feet. The bed of the channel is of sand and gravel. There are two bench marks on the west side

of the river. One is on a hub 2 by 4 inches, about 20 feet from the gage. This hub is flush with the surface of the ground, is driven 2.5 feet, and is 10.55 feet above zero of the gage. The second is on a heavy spike driven into the side of an 8 by 8 inch post, to which the west end of the heavy wire across the river is fastened. This post is set 3.5 feet in the ground. The elevation of this bench mark is 13.70 feet above zero of the gage.

BATTLE CREEK STATION, ON BEAR RIVER.

Measurements of Bear River were begun at this place on October 11, 1889, a station being established by Mr. T. M. Bannon near the point where the Utah and Northern Railroad formerly crossed the river and turned northwesterly on the way to Pocatello, Idaho. This locality is below the canyons and above Cache Valley, being about 10 miles north of the Utah-Idaho boundary. The name is from that of a small creek which enters Bear River from the right-hand side. Computations of discharge at this point give the quantity of water coming from Idaho into Utah through Bear River, this being available for use at points below. No canals are taken from the river itself for a considerable distance above, though the waters of several of the tributaries are diverted in southern Idaho.

A number of discharge measurements were made during 1890 and 1891, furnishing data for a rating curve for this station as given below. This has not been verified for 1893 and 1894, so that its applicability is in doubt. The bench marks as originally established are as follows: No. 1 is on the west end of cap of first bent of piling of approach on west side of river, and is 10.54 feet above zero of gage. No. 2 is on the southeast corner of the house of Mr. John Murdoch, the observer, about 1½ feet from the ground, on the fourth log. It is 10.95 feet above zero. The gage is nailed to one of the bridge piers, and the cable is 200 feet west.

On April 29, 1891, Mr. Frank Tweedy established a new bench mark in the forks of a double lone cottonwood tree on the north side of the river, about 100 feet from the bank of the river, and 200 feet above the railroad bridge. This is 8.90 feet above zero of gage.

The station was inspected on October 29, 1894, by Mr. Arthur P. Davis. He found the cable too slack for use in measuring and the tag wire missing. The latter he replaced by using 250 feet of barbed wire, and after tightening up the cable made a discharge measurement from a suspended box, obtaining for a height of 1.90 feet a quantity of 980 second-feet.

Rating table for Bear River at Battle Creek, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	350	2.10	1,420	3.20	2,870	4.30	5,030
1.10	430	2.20	1,540	3.30	3,030	4.40	5,260
1.20	510	2.30	1,660	3.40	3,200	4.50	5,500
1.30	600	2.40	1,780	3.50	3,380	4.60	5,740
1.40	690	2.50	1,910	3.60	3,570	4.70	5,980
1.50	780	2.60	2,040	3.70	3,760	4.80	6,230
1.60	880	2.70	2,170	3.80	3,960	4.90	6,480
1.70	980	2.80	2,300	3.90	4,160	5.00	6,730
1.80	1,090	2.90	2,440	4.00	4,370		
1.90	1,200	3.00	2,580	4.10	4,590		
2.00	1,310	3.10	2,720	4.20	4,810		

Daily gage height of Bear River at Battle Creek, Idaho, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	1.70	1.50	2.10	3.10	3.60	3.10	1.60	1.40	1.40	1.60	1.80
2	1.60	1.70	1.50	2.20	3.10	3.60	3.00	1.50	1.40	1.40	1.60	1.80
3	1.60	1.70	1.50	2.20	3.20	3.60	3.00	1.50	1.40	1.40	1.60	.....
4	1.60	1.70	1.50	2.30	3.20	3.70	2.90	1.50	1.40	1.40	1.60	.....
5	1.60	1.70	1.50	2.40	3.20	3.70	2.80	1.50	1.40	1.40	1.60	.....
6	1.60	1.70	1.50	2.45	3.20	3.70	2.70	1.50	1.40	1.40	1.60	.....
7	1.60	1.70	1.50	2.50	3.20	3.70	2.70	1.50	1.40	1.40	1.60	.....
8	1.60	1.70	1.50	2.50	3.25	3.80	2.60	1.50	1.40	1.40	1.60	.....
9	1.60	1.70	1.50	2.50	3.30	3.80	2.50	1.50	1.40	1.40	1.60	.....
10	1.60	1.70	1.50	2.50	3.30	3.80	2.50	1.50	1.40	1.40	1.60	1.80
11	1.60	1.70	1.50	2.60	3.30	3.80	2.40	1.50	1.40	1.40	1.60	1.80
12	1.60	1.70	1.50	2.60	3.40	3.80	2.30	1.50	1.40	1.40	1.60	1.70
13	1.60	1.60	1.50	2.60	3.40	3.70	2.30	1.50	1.40	1.40	1.60	1.70
14	1.60	1.60	1.50	2.60	3.40	3.70	2.20	1.50	1.40	1.40	1.60	1.70
15	1.60	1.50	1.50	2.60	3.40	3.60	2.20	1.50	1.40	1.40	1.60	1.70
16	1.60	1.50	1.50	2.60	3.50	3.60	2.10	1.50	1.40	1.40	1.60	1.70
17	1.60	1.50	1.50	2.60	3.50	3.60	2.10	1.50	1.40	1.50	1.60	1.70
18	1.60	1.50	1.50	2.60	3.60	3.60	2.00	1.50	1.40	1.50	1.60	1.70
19	1.60	1.50	1.50	2.70	3.70	3.60	2.00	1.50	1.40	1.50	1.60	1.70
20	1.60	1.50	1.50	2.80	3.70	3.60	1.90	1.50	1.40	1.50	1.60	1.70
21	1.60	1.50	1.50	2.85	3.70	3.60	1.90	1.50	1.40	1.50	1.60	1.70
22	1.60	1.50	1.50	2.90	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
23	1.70	1.50	1.60	2.90	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
24	1.70	1.50	1.60	3.00	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
25	1.70	1.50	1.60	3.00	3.80	3.50	1.70	1.50	1.40	1.50	1.60	1.70
26	1.70	1.50	1.60	3.00	3.80	3.40	1.70	1.50	1.40	1.50	1.60	1.70
27	1.70	1.50	1.70	3.00	3.80	3.40	1.70	1.50	1.40	1.50	1.60	1.70
28	1.70	1.50	1.90	3.10	3.80	3.30	1.60	1.40	1.40	1.50	1.70	1.70
29	1.70	.....	1.90	3.10	3.80	3.20	1.60	1.40	1.40	1.50	1.70	1.70
30	1.70	.....	2.00	3.10	3.70	3.20	1.60	1.40	1.40	1.50	1.70	1.70
31	1.70	.....	2.00	.....	3.70	.....	1.60	1.40	.....	1.60	.....	1.70

Daily gage height of Bear River at Battle Creek, Idaho, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	*a* 1.70	1.70	2.80	3.90	5.50	3.30	2.10	1.80	2.00	1.90	1.80
2	1.70	1.70	1.80	3.10	3.90	5.50	3.20	2.00	1.80	2.00	1.90	1.80
3	1.70	1.70	1.80	3.40	3.90	5.50	3.10	2.00	1.80	2.00	1.90	1.70
4	1.70	1.70	1.80	3.70	4.00	5.50	3.00	2.00	1.90	2.00	1.90	1.70
5	1.70	1.70	1.80	3.90	4.00	5.50	2.90	2.00	1.90	2.00	1.90	1.70
6	1.70	1.70	1.90	4.10	4.10	5.40	2.80	2.00	2.00	2.00	1.90	1.70
7	1.70	1.70	1.90	4.40	4.10	5.40	2.70	2.00	2.10	2.00	1.90	1.70
8	1.70	1.70	1.90	4.40	4.20	5.40	2.70	2.00	2.10	2.00	1.90	1.70
9	1.70	1.70	1.90	4.40	4.20	5.40	2.70	2.00	2.10	2.00	1.90	1.70
10	1.70	1.70	1.90	4.20	4.30	5.40	2.70	1.90	2.10	2.00	1.90	1.70
11	1.70	1.70	1.90	4.00	4.40	5.33	2.60	1.90	2.00	2.00	1.90	1.70
12	1.70	1.70	2.00	3.80	4.50	5.33	2.60	1.90	2.00	1.90	1.90	1.70
13	1.70	1.70	2.10	3.50	4.50	5.20	2.60	1.90	2.00	1.90	1.80	1.70
14	1.70	1.70	2.10	3.50	4.50	5.10	2.60	1.90	2.00	1.90	1.80	1.70
15	1.70	1.70	2.10	3.50	4.60	5.00	2.60	1.80	2.00	1.90	1.80	1.70
16	1.70	1.70	2.00	3.50	4.60	4.90	2.50	1.80	2.00	1.90	1.80	1.70
17	1.70	1.70	2.00	3.50	4.70	4.80	2.50	1.80	2.00	1.90	1.80	1.70
18	1.70	1.70	2.00	3.50	4.70	4.70	2.50	1.80	2.00	1.90	1.80	1.70
19	1.70	1.70	2.10	3.50	4.80	4.60	2.50	1.80	2.00	1.90	1.80	1.70
20	1.70	1.70	2.10	3.50	4.90	4.40	2.40	1.80	2.00	1.90	1.80	1.70
21	1.70	1.70	2.20	3.60	4.90	4.30	2.40	1.80	2.00	1.90	1.88	1.70
22	1.70	1.70	2.10	3.60	5.00	4.20	2.40	1.80	2.00	1.90	1.80	1.70
23	1.70	1.70	2.00	3.60	5.10	4.10	2.30	1.80	2.00	1.90	1.80	1.70
24	1.70	1.70	1.90	3.70	5.20	4.00	2.30	1.80	2.00	1.90	1.80	1.70
25	1.70	1.70	2.00	3.70	5.30	3.90	2.30	1.80	2.00	1.90	1.80	1.70
26	1.70	1.70	2.10	3.80	5.30	3.80	2.30	1.80	2.00	1.90	1.80	1.70
27	1.70	1.70	2.20	3.80	5.30	3.75	2.20	1.80	2.00	1.90	1.80	1.70
28	1.70	1.70	2.30	3.80	5.30	3.65	2.20	1.80	2.00	1.90	1.80	1.70
29	1.70	.....	2.40	3.80	5.40	3.50	2.20	1.80	2.00	1.90	1.80	1.70
30	1.70	.....	2.50	3.80	5.40	3.35	2.10	1.80	2.00	1.90	1.80	1.70
31	1.70	.....	2.60	.....	5.50	.....	2.10	1.80	.....	1.90	.....	1.70

a Frozen.

COLLINSTON STATION, ON BEAR RIVER.

This station is situated at the lower end of the canyon below the Cache Valley, Utah, and about 7 miles from the railroad station of Collinston, on the Utah and Northern Railroad. It was established in July, 1889, by Mr. T. M. Bannon, the object being to obtain the total amount of water available for use in the irrigation of the extensive tracts of land lying to the north and northwest of Great Salt Lake. The locality is a short distance below the headworks of the Bear River Canal, the observations being kept by the watchman employed by that company. As originally established the inclined gage was referred to bench marks, one of these being on a telegraph pole 50 feet north of the cable and consisting of a staple driven into the pole. This is 8.84 feet above the zero of the gage. A second bench mark is on a stake driven into the ground directly back of the anchor on the cable on the west side and surrounded by rocks. It is 12.77 feet above zero of the gage.

This station was inspected on October 6, 1894, by Prof. Samuel Fortier, who reports that the old bench marks had been removed. He established two new bench marks. One consists of two nails in a notch on the northeast corner of the house, in the corner boards, about 2.3 feet above the ground. The elevation of this point was 7.24 feet above the 5-foot mark of the gage. No. 2 is on a nail in an oak stake 2 by 3 inches, placed 20 feet west of the 8-foot mark of the gage

and 20 feet north of the cable. The elevation is 2.35 feet above the 5-foot mark of the gage. The gage was found to be apparently solid, but it was evident that the ice around the lower portion had lifted that end, necessitating a correction in the original markings. The changes at this point due to ice in the river necessitate the construction of a different form of gage in order to give comparable readings. The following table gives the heights of river as reported by the observer:

Daily gage height of Bear River at Collinston, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.10	1.90	3.50	4.10	4.90	4.05	1.90	1.60	1.90	2.10	2.40
2	2.05	2.15	1.90	3.55	4.10	4.85	4.00	1.90	1.60	1.90	2.10	2.40
3	2.00	2.10	1.80	3.80	4.20	4.80	3.90	2.00	1.60	1.90	2.20	2.40
4	2.10	2.00	1.80	3.90	4.20	4.90	3.80	2.00	1.60	2.00	2.20	2.40
5	2.10	2.25	1.90	4.00	4.40	4.70	3.70	1.90	1.60	2.00	2.20	2.30
6	2.10	2.15	1.90	4.20	4.30	4.60	3.60	1.90	1.60	2.00	2.20	2.30
7	2.10	2.20	1.80	4.20	4.30	4.50	3.50	1.80	1.70	1.90	2.20	2.20
8	2.10	2.30	1.70	4.10	4.30	4.60	3.50	1.80	1.70	1.90	2.10	2.20
9	2.00	2.20	1.70	3.90	4.40	4.60	3.30	1.80	1.70	1.90	2.10	2.20
10	2.00	2.20	1.80	3.90	4.40	4.70	3.10	1.70	1.70	1.90	2.10	2.20
11	2.10	2.00	1.80	4.10	4.50	4.90	3.00	1.70	1.70	2.00	2.10	2.20
12	2.10	1.90	1.80	4.20	4.70	4.90	2.90	1.60	1.70	2.00	2.10	2.30
13	2.00	1.90	1.90	4.30	4.80	5.00	2.80	1.60	1.70	2.00	2.00	2.30
14	2.00	1.85	1.90	4.30	4.90	5.00	2.70	1.60	1.70	2.00	2.00	2.30
15	2.00	1.80	2.00	4.30	5.15	5.10	2.70	1.70	1.70	2.00	2.00	2.30
16	2.00	1.80	2.00	4.15	5.25	5.10	2.60	1.70	1.70	1.90	2.00	2.30
17	2.00	1.90	2.10	4.00	5.40	5.00	2.60	1.70	1.70	1.90	2.00	2.30
18	2.00	1.80	2.20	3.85	5.55	5.05	2.50	1.70	1.70	2.00	2.00	2.20
19	2.10	1.70	2.20	3.80	5.75	5.10	2.50	1.60	1.70	2.00	2.00	2.10
20	2.10	1.70	2.30	3.80	5.95	5.00	2.40	1.60	1.70	2.00	2.00	2.10
21	2.10	1.70	2.40	3.70	6.00	4.90	2.40	1.60	1.70	2.00	2.00	2.10
22	2.00	1.80	2.50	3.70	6.05	4.80	2.40	1.70	1.70	2.00	2.00	2.00
23	2.00	1.80	2.60	3.75	5.95	4.70	2.30	1.70	1.80	2.00	2.00	2.00
24	2.00	1.80	2.70	3.75	5.80	4.60	2.30	1.70	1.80	2.00	2.00	1.90
25	2.00	1.90	2.80	4.00	5.55	4.60	2.30	1.60	1.80	2.00	2.00	1.90
26	2.10	1.90	2.90	4.10	5.40	4.50	2.20	1.60	1.80	2.00	2.10	1.80
27	2.10	1.90	3.00	4.15	5.20	4.40	2.20	1.60	1.80	2.10	2.10	1.80
28	2.10	1.80	3.10	4.30	4.75	4.30	2.10	1.70	1.80	2.10	2.20	1.80
29	2.05	.....	3.20	4.25	4.65	4.20	2.10	1.60	1.90	2.10	2.30	1.80
30	2.10	.....	3.30	4.15	4.60	4.10	2.00	1.60	1.90	2.10	2.30	1.80
31	2.00	.....	3.40	.....	4.60	.....	2.00	1.60	.....	2.10	.....	1.80

Daily gage height of Bear River at Collinston, Utah, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	1.90	1.90	5.00	5.40	6.90	4.50	2.00	1.80	2.10	2.10	2.00
2	1.70	1.90	1.80	4.90	5.50	6.90	4.30	2.00	1.70	2.10	2.10	2.00
3	1.70	1.80	1.80	5.00	5.40	7.00	4.00	2.00	1.80	2.20	2.10	2.00
4	1.70	1.90	1.90	5.00	5.30	7.00	3.90	1.90	1.80	2.20	2.00	2.00
5	1.70	1.90	1.90	5.10	5.30	7.00	3.70	2.00	1.80	2.20	2.00	2.00
6	1.70	1.90	1.80	5.20	5.20	6.90	3.60	2.00	1.90	2.10	2.00	2.00
7	1.80	1.90	1.80	5.30	5.20	6.80	3.60	2.00	1.90	2.20	1.90	2.00
8	1.70	1.90	1.90	5.30	5.30	6.80	3.50	1.90	1.90	2.20	1.90	2.00
9	1.70	1.80	1.90	5.30	5.50	6.70	3.50	1.90	1.80	2.20	1.90	.....
10	1.70	1.80	1.90	5.40	5.60	6.60	3.40	1.90	2.00	2.20	1.90	.....
11	1.80	1.80	2.00	5.40	5.70	6.50	3.30	1.90	2.00	2.10	2.00	.....
12	1.80	1.80	2.20	5.30	5.80	6.40	3.30	1.70	2.00	2.10	2.00	.....
13	1.80	1.90	2.40	5.30	5.80	6.20	3.20	1.70	1.90	2.10	2.00	.....
14	1.90	1.90	2.50	5.20	5.90	6.20	3.00	1.70	1.90	2.10	2.00	.....
15	1.90	1.80	2.70	5.30	6.00	6.10	3.00	1.70	1.80	2.10	2.00	.....
16	1.90	1.90	2.70	5.20	6.10	6.00	3.00	1.60	1.90	2.10	2.00	2.00
17	1.80	1.90	2.80	5.20	6.30	.....	2.90	1.60	1.90	2.00	1.90	2.00
18	1.80	1.80	2.80	5.00	6.30	5.80	2.80	1.60	2.00	2.00	1.90	2.00
19	1.90	1.80	2.90	4.80	6.40	5.70	2.70	1.60	2.00	2.00	1.90	2.00
20	1.90	1.90	3.00	4.70	6.20	5.50	2.60	1.60	2.10	2.10	1.90	1.90
21	1.90	1.80	3.10	4.60	6.10	5.40	2.50	1.60	2.20	2.10	1.90	1.90
22	1.90	1.80	3.10	4.70	6.20	5.20	2.60	1.60	2.30	2.10	1.90	1.90
23	1.80	1.80	3.10	4.80	6.40	5.10	2.60	1.60	2.20	2.10	1.90	2.00
24	1.80	1.80	3.00	4.90	6.40	4.90	2.50	1.60	2.20	2.10	1.90	2.00
25	1.80	1.80	3.40	4.90	6.50	4.80	2.40	1.60	2.10	2.00	1.90	2.00
26	1.90	1.80	3.60	5.00	6.50	4.70	2.40	1.60	2.10	2.00	1.90	2.00
27	1.90	1.90	3.80	5.10	6.50	4.60	2.30	1.70	2.00	2.00	1.90	2.10
28	1.90	1.90	4.00	5.30	6.60	4.60	2.20	1.60	2.00	2.00	1.90	2.10
29	1.80	.....	4.30	5.40	6.70	4.60	2.10	1.70	2.00	2.00	2.00	2.10
30	1.80	.....	4.60	5.50	6.80	4.40	2.10	1.70	2.00	2.00	2.00	2.00
31	1.80	.....	4.80	.....	6.90	.....	2.10	1.70	.....	2.00	.....	2.00

UINTA STATION, ON WEBER RIVER.

This station is near Devils Gate, on the Union Pacific Railroad, in Weber Canyon, about 12 miles east of Ogden City. The nearest railroad station is Uinta, about 3 miles below Devils Gate. The locality is highly favorable for stream measurements, the channel of the river being straight for a short distance both above and below the section at which observations are made. The banks are perpendicular on both sides. The bottom is gravelly and does not change appreciably. The section is 110 feet wide, 0.7 to 0.9 foot deep in low water with a velocity of from 1.5 to 2 feet per second in low water, and from 8 to 10 feet per second during flood. This station is above the head of the canals diverting water to cover the land south and west of Ogden. The first measurements were made August 12, 1889, the station being established in October following. Observations were maintained until the end of 1893, when they were discontinued for lack of funds. On July 20, 1894, they were taken up again by Prof. Samuel Fortier and continued through that year. The station was refitted in October, 1894, and measurements made for the purpose of constructing a rating table.

Rating table of Weber River at Devils Gate, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	240	2.40	1,220	3.80	2,520	5.20	4,040
1.10	290	2.50	1,310	3.90	2,620	5.30	4,160
1.20	340	2.60	1,400	4.00	2,720	5.40	4,280
1.30	395	2.70	1,490	4.10	2,825	5.50	4,405
1.40	450	2.80	1,580	4.20	2,930	5.60	4,530
1.50	520	2.90	1,670	4.30	3,035	5.70	4,655
1.60	590	3.00	1,760	4.40	3,140	5.80	4,780
1.70	665	3.10	1,850	4.50	3,250	5.90	4,905
1.80	740	3.20	1,940	4.60	3,360	6.00	5,030
1.90	815	3.30	2,035	4.70	3,470	6.10	5,755
2.00	890	3.40	2,130	4.80	3,580	6.20	5,280
2.10	970	3.50	2,225	4.90	3,690	6.30	5,405
2.20	1,050	3.60	2,320	5.00	3,800	6.40	5,530
2.30	1,135	3.70	2,420	5.10	3,920		

Daily gage height of Weber River above Uinta, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	0.90	0.90	3.50	3.50	5.00	2.30	0.30	0.20	0.20	0.40	2.00
2	1.40	.90	.90	3.80	3.50	5.20	2.00	.20	.20	.30	.40	2.00
3	1.30	.90	.90	4.00	3.60	5.00	1.80	.20	.20	.40	.40	1.60
4	1.20	.90	.90	4.20	3.70	5.00	1.60	.20	.20	.40	.40	1.20
5	1.10	.90	.90	4.00	3.80	4.80	1.40	.20	.20	.40	.40	1.00
6	1.10	.90	.90	3.60	3.80	4.60	1.00	.10	.20	.40	.40	.90
7	1.10	.90	.90	3.20	4.00	4.40	1.00	.10	.20	.40	.40	.90
8	1.10	.90	.90	2.80	4.20	4.60	.90	.10	.20	.40	.40	.90
9	1.10	.90	.90	2.00	4.40	4.80	1.00	.....	.20	.40	.40	.90
10	1.00	.90	.90	1.80	4.80	5.00	1.20	.....	.20	.40	.40	.80
11	1.00	.90	.90	1.50	5.00	5.50	1.40	.....	.20	.40	.40	.70
12	1.00	.90	1.00	1.00	5.20	5.40	1.40	.....	.20	.40	.40	.70
13	1.00	.90	1.20	1.00	5.20	5.50	1.40	.....	.20	.40	.40	.70
14	1.00	.90	1.40	1.00	6.00	5.40	1.40	.....	.20	.40	.40	.70
15	1.00	.90	1.80	1.00	6.80	5.60	1.30	.....	.20	.40	.40	.70
16	1.00	.90	1.90	1.40	7.50	5.00	1.20	.....	.20	.40	.40	.70
17	1.00	.90	1.90	1.60	7.80	4.40	1.00	.....	.20	.40	.40	.70
18	1.00	.90	2.00	2.00	7.20	4.20	.90	.10	.20	.40	.40	.70
19	1.00	.90	2.10	2.10	6.40	4.00	.80	.10	.20	.40	.40	.60
20	.90	.90	2.40	2.30	5.70	3.80	.70	.....	.20	.40	.40	.50
21	.90	.90	2.40	2.50	5.40	3.60	.50	.....	.20	.40	.50	.50
22	.90	.90	2.60	2.70	5.00	3.40	.40	.10	.20	.40	.60	.50
23	.90	.90	2.60	2.90	4.80	3.30	.50	.20	.20	.40	.70	.50
24	.90	.90	2.80	3.60	4.60	3.10	.50	.20	.20	.40	.80	.50
25	.90	.90	2.90	4.00	4.20	2.90	.50	.10	.20	.40	.80	.50
26	.90	.90	3.00	4.50	4.10	2.80	.40	.10	.20	.40	1.00	.50
27	.90	.90	3.20	4.00	4.00	2.50	.40	.20	.20	.40	1.00	.50
28	.90	.90	3.40	3.60	4.20	2.40	.40	.20	.20	.40	1.00	.50
29	.90	.....	3.40	3.40	4.40	2.40	.40	.20	.20	.40	1.00	.50
30	.90	.....	3.40	3.40	4.60	2.30	.30	.20	.20	.40	1.80	.50
31	.90	.....	3.50	.....	4.80	.....	.30	.20	.....	.40	.....	.50

Daily gage height of Weber River at Devils Gate, above Uinta, Utah, for 1894.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.50	0.80	1.10	1.00	0.90	17	.....	0.40	1.10	1.00	1.00	1.00
2	.....	.50	1.20	1.20	1.00	1.00	18	.....	.40	1.20	1.00	1.00	1.00
3	.....	.50	1.20	1.20	1.10	1.00	19	.....	.50	1.10	1.00	1.00	1.00
4	.....	.50	1.20	1.20	1.10	.80	20	1.10	.60	1.10	1.00	.90	1.00
5	.....	.40	1.20	1.20	1.00	.80	21	1.00	.60	1.00	1.10	.90	1.00
6	.....	.50	1.20	1.10	1.00	.80	22	.90	.70	1.00	1.10	.90	1.00
7	.....	.50	1.10	1.10	1.10	.80	23	.90	.80	1.00	1.10	.90	1.00
8	.....	.50	1.10	1.10	1.10	.80	24	.90	.80	1.00	1.00	.90	1.00
9	.....	.50	1.10	1.10	1.00	.80	25	.90	.80	.90	1.00	1.00	1.00
10	.....	.50	1.20	1.10	1.00	.90	26	.90	.80	.90	1.10	1.00	1.00
11	.....	.50	1.10	1.00	1.00	.90	27	.80	.80	.90	1.10	1.00	1.00
12	.....	.40	1.10	1.00	1.00	.90	28	.80	.80	1.00	1.20	1.00	1.00
13	.....	.40	1.20	1.00	1.00	.80	29	.70	.80	1.00	1.10	1.00	1.00
14	.....	.40	1.20	1.00	1.00	.90	30	.70	.80	1.00	1.10	1.00	1.00
15	.....	.50	1.10	1.00	.90	.90	31	.60	.80	.....	1.10	.....	1.00
16	.....	.50	1.00	1.00	1.00	.90							

PROVO STATION, ON PROVO RIVER.

The Provo River, rising in the Wasatch Mountains, southeasterly from Salt Lake City, Utah, flows westerly through open valleys, and finally cuts a deep canyon, discharging upon the lands east of Utah Lake. Near and below the mouth of the canyon its waters are diverted by numerous canals on both sides of the stream. A gaging station was established in the canyon above the heads of these canals, at a point about 6 miles from Provo City, observations being begun on July 27, 1889. The channel at this point is nearly straight for several hundred feet; the bottom of the river is rocky and does not appear to change. The bank on the north side is sufficiently high to confine all of the waters, but on the south side a rise of 2 feet above low water causes the stream to spread over a rocky bar. Measurements can be made with great accuracy during low water, but at times of flood the results are not so good. The station is equipped with a cable, tag wire, and boat, from which measurements are made. The gage is inclined. The bench mark is on a stone firmly bedded in a bank near the wagon road, about 100 feet southwest of the gage. It is marked "B. M." in black paint, and is 6.95 feet above the zero of the gage. This station was inspected on October 24 by Mr. Arthur P. Davis, who found for a gage height of 4.38 a discharge of 338 second-feet. The observer lives at some distance from this point, and there are some doubts whether his readings of heights are entirely reliable. They are given as reported, together with the rating table constructed from measurements made in preceding years.

Rating table of Provo River at Provo, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
3.70	144	4.70	564	5.70	1,316	6.70	2,100
3.80	154	4.80	630	5.80	1,394	6.80	2,180
3.90	174	4.90	700	5.90	1,470	6.90	2,260
4.00	200	5.00	774	6.00	1,550	7.00	2,340
4.10	240	5.10	851	6.10	1,626	7.10	2,420
4.20	280	5.20	928	6.20	1,704	7.20	2,500
4.30	330	5.30	1,006	6.30	1,780	7.30	2,580
4.40	380	5.40	1,084	6.40	1,860	7.40	2,660
4.50	440	5.50	1,160	6.50	1,940		
4.60	500	5.60	1,240	6.60	2,020		

Daily gage height of Provo River above Provo, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.20	4.10	4.20	5.20	4.70	5.80	5.00	4.20	4.10	4.20	4.40	4.40
2	4.20	4.10	4.20	5.00	4.70	6.10	5.30	4.20	4.10	4.20	4.40	4.40
3	4.20	4.10	4.20	5.20	4.70	6.30	5.20	4.20	4.10	4.20	4.40	4.50
4	4.20	4.10	4.20	5.20	4.70	6.30	4.90	4.20	4.10	4.20	4.40	4.50
5	4.20	4.10	4.20	5.20	4.70	6.40	4.80	4.20	4.10	4.20	4.40	4.50
6	4.20	4.10	4.20	5.10	4.80	6.60	4.70	4.20	4.10	4.20	4.40	4.50
7	4.20	4.20	4.20	5.10	5.00	6.70	4.60	4.20	4.10	4.20	4.40	4.50
8	4.20	4.20	4.20	5.00	5.10	6.80	4.40	4.10	4.10	4.20	4.40	4.50
9	4.20	4.20	4.20	4.90	5.20	6.80	4.30	4.10	4.10	4.30	4.40	4.50
10	4.10	4.20	4.20	4.80	5.30	6.90	4.30	4.10	4.10	4.30	4.40	4.50
11	4.10	4.20	4.20	4.70	5.40	6.80	4.30	4.10	4.10	4.30	4.40	4.50
12	4.10	4.20	4.20	4.70	5.40	6.60	4.30	4.10	4.10	4.30	4.40	4.50
13	4.10	4.20	4.20	4.60	5.50	6.40	4.30	4.10	4.10	4.40	4.40	4.50
14	4.10	4.20	4.20	4.50	5.80	6.40	4.30	4.10	4.10	4.40	4.40	4.50
15	4.10	4.20	4.20	4.40	6.00	6.50	4.30	4.10	4.10	4.40	4.40	4.40
16	4.10	4.20	4.20	4.50	6.40	6.40	4.30	4.10	4.10	4.40	4.40	4.40
17	4.10	4.20	4.20	4.50	6.70	6.30	4.30	4.10	4.20	4.40	4.40	4.40
18	4.10	4.20	4.20	4.50	7.00	6.10	4.20	4.10	4.20	4.40	4.40	4.40
19	4.10	4.20	4.20	4.50	6.70	5.90	4.20	4.10	4.20	4.40	4.40	4.40
20	4.10	4.20	4.20	4.50	6.60	5.70	4.20	4.10	4.20	4.40	4.40	4.40
21	4.10	4.20	4.30	4.40	6.10	5.70	4.20	4.10	4.20	4.40	4.40	4.40
22	4.10	4.20	4.30	4.40	5.90	5.50	4.20	4.10	4.20	4.40	4.40	4.40
23	4.10	4.20	4.40	4.50	5.80	5.50	4.20	4.10	4.20	4.40	4.40	4.50
24	4.10	4.20	4.40	4.80	5.70	5.40	4.20	4.10	4.20	4.40	4.40	4.50
25	4.10	4.20	4.30	4.90	5.60	5.40	4.20	4.10	4.20	4.40	4.40	4.50
26	4.10	4.20	4.40	5.20	5.50	5.40	4.20	4.10	4.20	4.40	4.40	4.50
27	4.10	4.20	4.60	5.10	5.50	5.20	4.20	4.10	4.20	4.40	4.50	4.50
28	4.10	4.20	4.60	5.00	5.60	5.20	4.20	4.10	4.20	4.40	4.50	4.40
29	4.10	.....	4.60	4.70	5.70	5.00	4.20	4.10	4.20	4.40	4.50	4.40
30	4.10	.....	4.90	4.70	5.70	5.00	4.20	4.10	4.20	4.40	4.50	4.40
31	4.10	.....	5.00	.....	5.80	.....	4.20	4.10	.....	4.40	.....	4.40

Daily gage height of Provo River above Provo, Utah, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	4.40	4.50	4.70	5.30	6.50	4.50	4.10	4.10	.....	4.50	4.30
2	4.40	4.40	4.50	4.70	5.20	6.50	4.50	4.10	4.40	.....	4.40	4.30
3	4.40	4.40	4.50	4.70	5.10	.....	4.30	4.10	4.40	.....	4.40	4.30
4	4.40	4.40	4.50	4.70	5.10	.....	4.30	4.10	4.40	.....	4.40	4.30
5	4.40	4.40	4.50	4.70	5.10	.....	4.50	4.10	4.40	.....	4.40	4.30
6	4.40	4.40	4.50	4.70	5.10	.....	4.40	4.10	4.50	.....	4.40	4.30
7	4.40	4.40	4.50	4.70	5.20	.....	4.50	4.10	4.50	.....	4.40	4.30
8	4.40	4.40	4.50	4.60	5.40	.....	4.30	4.10	4.50	.....	4.40	4.30
9	4.40	4.40	4.50	4.60	5.50	.....	4.30	4.10	4.50	.....	4.40	4.30
10	4.40	4.40	4.50	4.70	5.60	5.90	4.30	4.10	4.50	.....	4.40	4.30
11	4.40	4.40	4.50	4.70	5.60	5.90	4.30	4.10	4.60	.....	4.40	4.30
12	4.40	4.40	4.50	4.80	5.80	5.80	4.30	4.10	4.60	.....	4.40	4.30
13	4.40	4.40	4.50	4.90	5.90	5.60	4.30	4.10	4.50	.....	4.40	4.40
14	4.40	4.40	4.50	4.90	6.20	5.60	4.20	4.10	4.50	.....	4.40	4.40
15	4.40	4.40	4.60	4.80	6.40	5.30	4.30	4.10	4.50	.....	4.40	4.40
16	4.40	4.40	4.60	4.80	6.40	5.30	4.20	4.10	.....	.....	4.40	4.40
17	4.40	4.40	4.60	4.70	6.40	5.30	4.20	4.10	.....	.....	4.40	4.40
18	4.40	4.40	4.60	4.70	6.20	4.90	4.20	.....	.....	.....	4.40	4.40
19	4.40	4.40	4.60	4.70	6.10	4.90	4.20	.....	.....	.....	4.40	4.40
20	4.40	4.40	4.60	4.70	6.20	4.80	4.20	.....	.....	.....	4.40	4.40
21	4.40	4.40	4.60	4.80	6.10	4.80	4.20	.....	.....	.....	4.40	4.50
22	4.40	4.40	4.60	4.90	6.10	4.60	4.10	4.10	.....	.....	4.40	4.50
23	4.40	4.40	4.60	5.00	6.00	4.50	4.10	.....	.....	.....	4.30	4.50
24	4.40	4.50	4.60	5.00	6.00	4.60	4.10	.....	.....	.....	4.30	4.40
25	4.40	4.50	4.60	5.10	6.10	4.60	4.10	.....	.....	4.40	4.30	4.20
26	4.40	4.50	4.60	5.30	6.20	4.50	4.10	4.10	.....	4.40	4.30	4.20
27	4.40	4.50	4.60	5.40	6.20	4.50	4.10	4.20	.....	4.50	4.30	4.10
28	4.40	4.50	4.70	5.40	6.30	4.50	4.10	4.30	.....	4.50	4.30	4.10
29	4.40	.....	4.80	5.40	6.40	4.50	4.10	4.20	.....	4.40	4.30	4.20
30	4.40	.....	4.80	5.30	6.40	4.40	4.10	4.20	.....	4.40	4.30	4.20
31	4.40	.....	4.70	.....	6.40	.....	4.10	4.10	.....	4.40	.....	4.20

LEAMINGTON STATION, ON SEVIER RIVER, UTAH.

Measurements of the Sevier River were begun on August 23, 1889, by Mr. T. M. Bannon, near the settlement of Leamington, on the Union Pacific Railroad. This place is in the gorge below the broad valley

in which Richfield and other towns are located, and above the plain whose lowest part is occupied by Sevier Lake. The quantities of water passing this point represent the drainage and excess from irrigated lands farther upstream, and show the amount available for use in developing the fertile lands above Sevier Lake. The gage was located back of the house of C. Overson, 1 mile from the Leamington depot. Observations of river height were continued from August 23, 1889, to December 31, 1893. The rating table given below was constructed from the gagings made during 1890 and 1891, and has not been verified for later dates.

Rating table of Sevier River at Leamington, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
2.00	40	3.20	321	4.40	813	5.60	1,304	6.80	1,796
2.10	48	3.30	362	4.50	854	5.70	1,345	6.90	1,837
2.20	60	3.40	403	4.60	895	5.80	1,386	7.00	1,878
2.30	80	3.50	444	4.70	935	5.90	1,427	7.10	1,919
2.40	100	3.60	485	4.80	976	6.00	1,468	7.20	1,960
2.50	120	3.70	526	4.90	1,017	6.10	1,509	7.30	2,001
2.60	140	3.80	567	5.00	1,058	6.20	1,550	7.40	2,042
2.70	160	3.90	608	5.10	1,099	6.30	1,591	7.50	2,083
2.80	185	4.00	649	5.20	1,140	6.40	1,632	7.60	2,124
2.90	210	4.10	690	5.30	1,181	6.50	1,673	7.70	2,165
3.00	245	4.20	731	5.40	1,222	6.60	1,714	7.80	2,206
3.10	280	4.30	772	5.50	1,263	6.70	1,755	7.90	2,247
								8.00	2,288

Daily gage height of Sevier River at Leamington, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	4.80	5.60	3.90	4.60	3.10	4.80	2.40	2.00	3.30	2.00	2.40	2.40
2.....	4.80	4.00	3.90	4.30	3.00	4.70	2.40	1.90	3.40	2.00	2.40	2.40
3.....	4.80	4.00	4.00	4.20	3.00	4.70	2.40	1.90	3.40	2.00	2.40	2.30
4.....	4.80	4.00	4.00	4.10	3.20	4.50	2.40	2.00	3.40	2.00	2.30	2.30
5.....	4.90	3.90	3.80	4.10	3.30	4.50	2.40	2.00	3.40	2.00	2.30	2.30
6.....	4.90	3.90	3.60	4.10	3.40	4.30	2.40	1.90	3.40	1.90	2.30	2.30
7.....	4.90	3.80	3.40	4.10	3.50	4.10	2.30	2.00	3.40	1.90	2.40	2.30
8.....	4.80	3.80	3.20	4.10	3.70	3.90	2.30	2.00	3.30	1.90	2.40	2.30
9.....	4.70	3.90	3.00	4.00	4.00	3.90	2.30	2.20	3.30	1.90	2.40	2.30
10.....	4.70	3.90	3.00	4.00	4.00	3.90	2.30	2.20	3.40	1.90	2.40	2.30
11.....	4.70	3.90	3.00	4.00	4.00	3.80	2.30	3.60	3.40	2.00	2.30	2.30
12.....	4.40	4.00	3.00	4.00	4.20	3.80	2.30	3.00	3.40	2.00	2.30	2.40
13.....	4.40	4.00	3.00	4.10	4.20	3.70	2.30	3.00	3.40	2.00	2.30	2.40
14.....	4.40	4.00	3.00	4.10	4.30	3.70	2.30	3.10	3.40	2.00	2.30	2.40
15.....	4.40	3.90	3.00	4.10	4.60	3.50	2.30	3.20	3.40	2.00	2.30	2.30
16.....	4.30	3.90	3.00	4.10	4.60	3.40	2.10	3.20	3.40	2.20	2.30	3.30
17.....	4.30	3.90	3.00	4.00	4.70	3.40	2.10	3.30	3.10	2.30	2.30	2.30
18.....	4.30	3.90	3.00	4.00	4.80	3.40	2.10	3.40	3.00	2.30	2.30	2.30
19.....	4.20	3.80	3.40	4.00	5.00	3.30	2.10	3.40	2.90	2.30	2.30	2.40
20.....	4.00	3.80	3.80	4.00	5.00	3.20	2.00	3.40	2.90	2.30	2.30	2.50
21.....	3.90	3.80	4.60	4.10	5.00	3.20	2.00	3.50	2.70	2.30	2.20	2.50
22.....	3.90	3.90	4.80	4.10	5.00	3.20	2.00	3.60	2.70	2.20	2.20	2.50
23.....	3.80	3.80	5.00	4.10	5.00	3.20	2.10	3.70	2.70	2.20	2.20	2.50
24.....	3.90	3.90	4.90	4.10	5.00	3.20	2.10	3.80	2.40	2.20	2.20	2.60
25.....	3.90	3.80	4.80	4.00	5.00	2.50	2.10	3.70	2.50	2.20	2.20	2.60
26.....	3.80	3.80	4.70	3.90	4.90	2.50	4.90	3.60	2.10	2.20	2.30	2.60
27.....	3.70	3.90	4.80	3.60	4.80	2.50	5.60	3.50	2.00	2.20	2.30	2.60
28.....	3.80	3.90	4.90	3.40	4.80	2.50	3.50	3.40	2.00	2.20	2.40	2.60
29.....	3.90	.....	4.90	3.10	4.80	2.50	3.00	3.20	2.00	2.30	2.40	2.60
30.....	4.60	.....	4.80	3.10	4.80	2.50	2.00	3.10	2.00	2.30	2.40	2.60
31.....	5.60	.....	4.70	.....	4.80	.....	2.00	3.20	.....	2.40	.....	2.60

COLUMBIA BASIN, IN IDAHO, OREGON, AND WASHINGTON.

This great drainage basin includes, with its large tributary, the Snake, an area of 191,813 square miles, of which 108,680 square miles are tributary to Snake River, 59,040 square miles in Montana, Idaho, and Washington to the Columbia, and 24,093 square miles to the Columbia from the State of Oregon. It is obviously impossible to attack all of the problems of water supply in this great basin, comprising many thousand square miles of rich agricultural land, though arid, and innumerable localities favorable for the development of water power. A beginning, however, has been made, and stations were maintained for a longer or shorter time during 1893 and 1894 at Chase's ranch on the Teton; at Idaho Falls, Boise, Payette, and Weiser, Idaho; also at Nyssa, Vale, and Pendleton, Oreg., and at North Yakima, Yakima, Toppenish, and Satas, Wash.

CHASE STATION, ON TETON RIVER.

The point at which measurements of Teton River have been made is at Chase's ranch, near the mouth of the river canyon, about 3 miles from the town of Wilford. The nearest railroad station is Market Lake, on the Utah and Northern Railroad, 40 miles distant. The point at which measurements are made is about one-half mile above the highest canal, and is above all irrigating ditches. The station is equipped with a half-inch steel cable, having a clear stretch of 160 feet, and which is about 12 feet above low water. The tag wire marking the section is 15 feet below the cable. The gage is constructed of a piece of 2 by 4 inch timber, 18 feet long. It is inclined at an angle of about 25° to the horizon, and the top of the graduation is about 2 feet above the high-water marks on the banks. It is securely fastened by braces on each side. The zero of the gage is referred to a bench mark on a live stump about 40 feet north of the gage. This bench mark is 2.20 feet above the 5-foot mark on the gage. The station was established by Mr. L. D. Hopson, and readings were begun on April 4, 1890. Observations were finally discontinued on October 11, 1893, owing to the expense of reaching the point and the necessity of verifying the rating table.

Rating table of Teton River at Chase's ranch, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.40	425	2.80	1,070	4.20	2,360	5.60	4,065
1.50	450	2.90	1,140	4.30	2,475	5.70	4,190
1.60	475	3.00	1,215	4.40	2,590	5.80	4,315
1.70	510	3.10	1,295	4.50	2,710	5.90	4,445
1.80	545	3.20	1,375	4.60	2,830	6.00	4,575
1.90	585	3.30	1,455	4.70	2,950	6.10	4,710
2.00	625	3.40	1,545	4.80	3,070	6.20	4,850
2.10	670	3.50	1,635	4.90	3,190	6.30	4,990
2.20	720	3.60	1,725	5.00	3,315	6.40	5,130
2.30	770	3.70	1,825	5.10	3,440	6.50	5,270
2.40	820	3.80	1,925	5.20	3,565	6.60	5,410
2.50	875	3.90	2,025	5.30	3,690	6.70	5,550
2.60	935	4.00	2,135	5.40	3,815	6.80	5,690
2.70	1,000	4.10	2,245	5.50	3,940	6.90	5,830

Daily gage height of Teton River at Chase's ranch, Idaho, for 1893.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.40	2.50	4.00	4.70	2.90	1.90	1.80
2	.....	1.50	2.60	4.30	4.60	2.90	1.90	1.80
3	.....	1.50	2.70	3.90	4.50	2.90	1.80	1.80
4	.....	1.50	2.80	3.60	4.40	2.80	1.80	1.80
5	.....	1.60	2.90	3.90	4.30	2.80	1.80	1.80
6	.....	1.70	3.00	4.20	4.20	2.70	1.80	1.80
7	.....	1.80	3.10	4.80	4.10	2.70	1.80	1.80
8	.....	1.80	3.20	5.00	4.00	2.60	2.00	1.80
9	.....	1.90	3.30	5.40	3.80	2.60	2.00	1.80
10	.....	1.80	3.40	5.90	3.70	2.50	1.90	1.80
11	.....	1.70	3.50	6.20	3.70	2.40	1.80	1.80
12	.....	1.90	3.60	6.60	3.60	2.40	1.80	.....
13	.....	2.00	3.70	6.90	3.60	2.30	1.80	.....
14	.....	2.00	3.80	6.80	3.60	2.30	1.80	.....
15	.....	2.10	3.90	6.70	3.50	2.30	1.80	.....
16	.....	2.20	4.00	6.50	3.50	2.20	1.80	.....
17	.....	2.20	4.20	6.40	3.50	2.20	1.70	.....
18	.....	2.30	4.40	6.20	3.50	2.20	1.70	.....
19	1.40	2.20	4.10	6.10	3.40	2.10	1.70	.....
20	1.40	2.10	3.50	6.00	3.30	2.10	1.70	.....
21	1.40	2.20	3.20	5.90	3.30	2.10	1.70	.....
22	1.40	2.20	3.10	5.70	3.20	2.10	1.70	.....
23	1.40	2.20	2.80	5.60	3.20	2.10	1.70	.....
24	1.40	2.30	2.50	5.40	3.20	2.00	1.70	.....
25	1.40	2.20	2.10	5.30	3.10	2.00	1.60	.....
26	1.40	2.10	2.20	5.20	3.10	2.00	1.60	.....
27	1.40	2.00	2.30	5.10	3.10	2.00	1.60	.....
28	1.40	2.20	2.50	5.00	3.00	1.90	1.60	.....
29	1.40	2.30	2.60	4.90	3.00	1.90	1.60	.....
30	1.40	2.40	3.00	4.80	3.00	1.90	1.60	.....
31	1.40	.....	3.50	.....	3.00	1.90	.....	.....

IDAHO FALLS STATION, ON SNAKE RIVER.

This station is situated about 2 miles below the town of Idaho Falls, formerly known as "Eagle Rock." At the town the river flows through a narrow gorge in the lava, forming whirlpools, and having a velocity so great that current-meter measurements can not be made. Below the railroad bridge, however, it begins to widen, and finally spreads over a broad, gravelly channel, being confined by high banks on both sides. Accurate measurements can be made in low water, and fair results can probably be obtained during flood by means of suitable apparatus. The gage is on the right-hand side of the left bank of the stream, and is a short distance below the house of Mr. E. J. Wilson. It has an inclination of about 30°, and the graduation extends up to 12.5 feet. It is made of 2 by 4 inch scantling, nailed to stakes firmly driven into the river bed and bank. The bench mark is a spike driven into a large cedar tree, formerly used as one of the supports of the cable. The 2.3 mark of the gage is 9.60 feet below this bench mark.

This station was established by Mr. L. D. Hopson and readings begun on July 1, 1889. It was inspected by Mr. Arthur P. Davis on October 3, 1894, but measurements of discharge could not be made until a cable was placed in position. A measurement was made at the wagon bridge at Blackfoot, but the conditions there are not favorable for accurate results. The main current is diagonal to the direction of the channel, and there are numerous small eddies and points where the water is apparently still. Four large piers obstruct the channel, thus complicating the measurements. The maximum velocity was found to be about 6 feet per second, and the depth, 12 feet. The total discharge at this point on November 1, 1894, was estimated to be 8,040 second-feet. The following rating table was constructed from measurements made during preceding years, but has not been verified by recent measurements.

Rating table of Snake River at Idaho Falls, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	1,500	3.00	5,100	5.00	11,450	7.00	21,500	9.00	37,900
1.10	1,600	3.10	5,375	5.10	11,875	7.10	22,150	9.10	38,900
1.20	1,700	3.20	5,650	5.20	12,300	7.20	22,800	9.20	40,000
1.30	1,825	3.30	5,950	5.30	12,750	7.30	23,500	9.30	41,100
1.40	1,950	3.40	6,250	5.40	13,200	7.40	24,200	9.40	42,200
1.50	2,100	3.50	6,550	5.50	13,650	7.50	24,925	9.50	43,300
1.60	2,250	3.60	6,850	5.60	14,100	7.60	25,650	9.60	44,400
1.70	2,400	3.70	7,150	5.70	14,550	7.70	26,425	9.70	45,500
1.80	2,550	3.80	7,450	5.80	15,000	7.80	27,200	9.80	46,600
1.90	2,725	3.90	7,750	5.90	15,450	7.90	28,000	9.90	47,700
2.00	2,900	4.00	8,050	6.00	15,900	8.00	28,800	10.00	48,800
2.10	3,100	4.10	8,350	6.10	16,400	8.10	29,675	10.10	49,900
2.20	3,300	4.20	8,650	6.20	16,900	8.20	30,550	10.20	51,000
2.30	3,500	4.30	8,975	6.30	17,450	8.30	31,425	10.30	52,100
2.40	3,700	4.40	9,300	6.40	18,000	8.40	32,300	10.40	53,200
2.50	3,900	4.50	9,650	6.50	18,575	8.50	33,225	10.50	54,300
2.60	4,100	4.60	10,000	6.60	19,150	8.60	34,150	10.60	55,400
2.70	4,350	4.70	10,350	6.70	19,725	8.70	35,075	10.70	56,500
2.80	4,600	4.80	10,700	6.80	20,300	8.80	36,000	10.80	57,600
2.90	4,850	4.90	11,075	6.90	20,900	8.90	36,950	10.90	58,700

Daily gage height of Snake River at Idaho Falls, Idaho, for 1893.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.60	6.10	7.60	3.70	2.30	2.30	2.30	2.30
2	.....	2.70	6.40	7.30	3.70	2.30	2.30	2.30	2.35
3	.....	2.70	6.80	7.10	3.50	2.30	2.30	2.30	2.40
4	.....	2.85	7.00	7.10	3.40	2.30	2.30	2.30	2.40
5	.....	2.90	6.80	7.10	3.40	2.30	2.30	2.30	2.40
6	.....	3.00	6.80	7.10	3.30	2.30	2.30	2.30	2.50
7	.....	3.05	7.00	7.00	3.20	2.30	2.30	2.30	2.50
8	.....	3.25	7.30	6.60	3.10	2.30	2.30	2.30	2.50
9	.....	3.60	7.60	6.30	3.00	2.30	2.30	2.30	2.50
10	.....	4.15	7.80	6.00	3.00	2.30	2.30	2.30	2.50
11	.....	4.45	8.30	6.00	2.90	2.30	2.30	2.30	2.40
12	.....	4.50	8.70	6.00	2.80	2.30	2.30	2.30	2.40
13	.....	4.65	9.30	6.00	2.80	2.30	2.30	2.30	2.40
14	.....	5.10	9.60	5.80	2.80	2.30	2.30	2.30	2.30
15	.....	5.60	9.50	5.60	2.80	2.30	2.30	2.30	2.30
16	.....	6.15	9.20	5.40	2.70	2.30	2.30	2.30	2.30
17	.....	6.80	8.90	5.30	2.70	2.30	2.30	2.30	2.30
18	.....	7.70	9.00	5.10	2.60	2.30	2.30	2.30	2.30
19	.....	8.15	9.30	5.00	2.60	2.30	2.30	2.30	2.40
20	.....	7.80	9.50	4.90	2.60	2.30	2.30	2.30	2.40
21	.....	7.15	9.50	4.80	2.60	2.30	2.30	2.30	2.40
22	.....	6.60	9.30	4.60	2.60	2.30	2.30	2.30	2.40
23	2.50	6.30	8.90	4.60	2.60	2.30	2.30	2.30	2.40
24	2.50	6.30	8.70	4.50	2.50	2.30	2.30	2.30	.....
25	2.50	6.30	8.40	4.50	2.50	2.30	2.30	2.30	.....
26	2.60	6.00	8.10	4.40	2.50	2.30	2.30	2.30	.....
27	2.60	5.80	7.90	4.30	2.40	2.30	2.30	2.30	.....
28	2.60	5.60	7.80	4.20	2.40	2.30	2.30	2.30	.....
29	2.60	5.50	7.80	4.00	2.40	2.30	2.30	2.30	.....
30	2.60	5.85	7.70	3.90	2.40	2.30	2.30	2.30	.....
31	.....	6.00	.....	3.80	2.30	.....	2.30	.....	.....

Daily gage height of Snake River at Idaho Falls, Idaho, for 1894.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Nov.	Dec.
1	2.70	5.10	12.00	9.00	5.20	3.60	3.20	2.70
2	2.70	5.30	12.00	8.90	5.00	3.60	3.20	2.70
3	2.70	5.20	(a)	8.90	4.90	3.60	3.20	2.60
4	2.70	5.10	.....	8.80	4.90	3.60	3.10	2.50
5	2.50	5.20	.....	8.70	4.90	3.60	3.10	2.50
6	2.50	5.30	.....	8.70	4.80	3.50	3.00	2.60
7	2.50	6.00	.....	8.70	4.70	3.50	3.00	2.70
8	2.50	6.70	.....	8.50	4.70	3.60	3.00	2.70
9	2.60	7.30	.....	8.50	4.60	3.70	3.00	2.50
10	2.70	7.70	11.60	8.50	4.60	3.60	2.95	2.50
11	2.70	7.80	11.40	8.50	4.50	3.60	2.90	2.50
12	2.80	7.90	11.20	8.40	4.40	3.60	2.90	2.50
13	2.90	8.20	10.70	8.30	4.30	3.50	2.90	2.50
14	2.90	8.90	10.40	8.10	4.30	3.50	2.90	2.50
15	2.90	9.40	10.00	7.90	4.20	3.40	2.90	2.50
16	3.00	9.50	9.60	7.60	4.20	3.40	2.80	2.40
17	3.10	9.70	9.50	7.50	4.10	3.40	2.90	2.40
18	3.10	9.30	9.50	7.40	4.10	3.40	2.80	2.40
19	3.20	9.10	9.60	7.20	4.00	3.40	2.80	2.40
20	3.20	9.40	9.60	7.10	4.00	3.40	2.80	2.50
21	3.30	9.90	9.70	6.90	4.00	3.30	2.80	2.50
22	3.30	10.20	9.50	6.80	3.90	3.30	2.80	2.50
23	3.50	10.30	9.50	6.60	3.90	3.30	2.75	2.40
24	4.10	10.40	9.50	6.40	3.80	3.30	2.70	2.40
25	4.50	10.60	9.50	6.20	3.80	3.30	2.70	2.40
26	4.90	10.70	9.40	6.00	3.70	3.30	2.80	2.40
27	5.00	10.90	9.30	5.90	3.60	3.30	2.80	2.40
28	5.10	11.20	9.20	5.70	3.60	3.30	2.80	2.30
29	5.00	11.40	9.10	5.40	3.50	3.30	2.80	2.30
30	4.90	11.50	9.00	5.30	3.50	.....	2.80	.....
31	.....	12.00	.....	5.20	3.50	.....	.....	.....

a Under water June 3 to 9.

BOISE STATION, ON BOISE RIVER.

This station is located 8 miles from Boise, Idaho, in front of Mrs. McNell's house. It was established on December 15, 1894, by Messrs. Arthur P. Davis and V. C. Tompkins. The observer is Mr. B. Cronin, Boise, Idaho. The station is distant from the observer's house about 150 yards. The gage is in two sections; the lower part is of 2 by 6 inch plank, inclined, and marked from 1 foot to 7.5 feet; the upper part is a 4 by 4 inch timber, placed vertically, and marked from 7.5 to 12 feet, both portions painted white. The channel is gravelly. The bench mark is a bridge spike driven into a cottonwood tree 20 feet from gage and 20 feet from river. It is 3.4 feet above 8-foot mark on the gage. Measurements are made from a cable just below the gage.

PAYETTE STATION, ON PAYETTE RIVER.

This station is located at the highway bridge, one-half mile south of Payette, Idaho. It was established on December 7, 1894, by Messrs. Arthur P. Davis and V. C. Tompkins. The observer is Mr. Murray Mott, the town marshal at Payette. The station is distant from the observer's house about one-half mile. The gage is vertical, of pine plank, spiked to a wooden pier, graduated from 0 to 12.5 feet. It is easily read from the bridge. The character of the channel is sandy and shifting. The point 12.5 on the gage is level with the top of the pier, on which is the mark "B. M." Measurements of discharge were made from the same bridge. On the date above given the height was 1.3 feet and the discharge was 1,603 second-feet.

WEISER STATION, ON WEISER RIVER.

This station is located about 10 miles from Weiser, Idaho, just above the ford, on the right bank of the Weiser River. It was established on December 6, 1894, by Mr. Arthur P. Davis. The observer is Mr. J. W. Lane, whose house is about one-fourth of a mile distant from the station. The gage is partly inclined and partly vertical. The inclined portion is graduated from 0.8 to 5.8 feet; the vertical portion, from 6 feet to 10 feet. The marking is with nails and tacks. Bench Mark No. 1 is the highest point of a solid rock 40 feet southwest of the south anchorage or dead man, and is 14.54 feet above the 5-foot mark on the gage. Bench Mark No. 2 is the highest point of a solid rock 60 feet southwest of the dead man, and is 20.16 above the 5-foot mark on the gage. The channel is gravelly. The measurement on December 6, 1894, when the water was at 0.9 foot, gave a discharge of 277 second-feet.

NYSSA STATION, ON OWYHEE RIVER.

This station is located about 20 feet above the new county bridge across the Owyhee River, 1½ miles from Owyhee, Oreg., and one-half mile from the house of the observer, Mr. D. T. Rigsby, near which the former station was located. It was established on December 8, 1894,

by Messrs. Arthur P. Davis and V. C. Tompkins. The gage is inclined, of 5 by 5 inch timber, marked from 1 foot to 13 feet. The distance between footmarks on the lower half is 2.77 feet. The bench mark consists of a spike driven in a large stump about 20 feet from the left bank of the river and 300 feet below the gage. It is the same bench mark formerly used, and is 4.35 feet above the 11-foot mark. The channel is sandy and shifting. The measurement on December 8, 1894, made from the bridge, showed for a height of 1.4 feet a discharge of 307 second-feet. The following tables give the ratings for the old station and the readings of river height for 1893, the applicability of the rating table being somewhat doubtful.

Rating table of Owyhee River at Rigsby's, Oregon.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	130	2.80	1,200	4.60	3,910	6.40	7,800
1.10	150	2.90	1,320	4.70	4,080	6.50	8,120
1.20	170	3.00	1,440	4.80	4,250	6.60	8,450
1.30	200	3.10	1,570	4.90	4,420	6.70	8,800
1.40	240	3.20	1,700	5.00	4,600	6.80	9,200
1.50	280	3.30	1.850	5.10	4,780	6.90	9,600
1.60	320	3.40	2,000	5.20	4,960	7.00	10,000
1.70	360	3.50	2,150	5.30	5,150	7.10	10,400
1.80	400	3.60	2,300	5.40	5,350	7.20	10,800
1.90	450	3.70	2,450	5.50	5,560	7.30	11,200
2.00	500	3.80	2,600	5.60	5,770	7.40	11,600
2.10	560	3.90	2,750	5.70	6,000	7.50	12,000
2.20	630	4.00	2,900	5.80	6,230	7.60	12,400
2.30	700	4.10	3,060	5.90	6,460	7.70	12,800
2.40	800	4.20	3,230	6.00	6,700	7.80	13,200
2.50	900	4.30	3,400	6.10	6,950	7.90	13,600
2.60	1,000	4.40	3,570	6.20	7,220		
2.70	1,100	4.50	3,740	6.30	7,500		

Daily gage height of Owyhee River at Rigsby's, Oregon, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.40	2.50	2.80	5.90	6.85	3.50	2.90	2.70	2.40	2.60	2.60	2.90
2.....	2.40	2.50	2.80	6.05	7.00	3.40	2.80	2.70	2.40	2.60	2.60	2.90
3.....	2.40	2.50	2.80	6.20	7.55	3.40	2.80	2.70	2.60	2.60	2.60	3.10
4.....	2.40	2.50	2.80	6.45	7.85	3.25	2.80	2.70	2.60	2.60	2.60	3.50
5.....	2.40	2.60	2.90	6.75	8.05	3.20	2.80	2.70	2.60	2.60	2.60	3.70
6.....	2.40	2.60	2.90	6.80	8.20	3.20	2.80	2.60	2.60	2.60	2.60	4.00
7.....	2.40	2.60	2.90	6.90	8.00	3.20	2.80	2.60	2.60	2.60	2.70	4.10
8.....	2.40	2.60	2.90	7.05	8.00	3.20	2.80	2.60	2.60	2.60	2.80	4.10
9.....	2.40	2.60	2.90	7.10	7.55	3.20	2.80	2.60	2.60	2.60	2.80	4.00
10.....	2.40	2.60	2.90	7.00	7.00	3.20	2.80	2.60	2.60	2.60	2.90	3.80
11.....	2.40	2.60	2.90	7.00	6.90	3.00	2.80	2.60	2.60	2.60	2.90	3.60
12.....	2.40	2.60	3.05	6.80	6.85	3.00	2.80	2.60	2.60	2.60	3.00	3.40
13.....	2.40	2.60	3.25	6.60	6.50	3.00	2.80	2.50	2.60	2.60	3.10	3.30
14.....	2.40	2.60	3.40	6.50	6.40	3.00	2.80	2.50	2.60	2.60	3.10	3.20
15.....	2.40	2.60	3.55	6.40	6 10	3.00	2.80	2.50	2.60	2.60	3.20	3.00
16.....	2.40	2.60	3.70	6.00	5.00	3.00	2.80	2.50	2.60	2.60	3.20	3.00
17.....	2.40	2.60	3.85	5.50	4.85	3.00	2.80	2.50	2.60	2.60	3.20	2.90
18.....	2.40	2.60	4.00	5.00	4.40	3.00	2.80	2.50	2.60	2.60	3.20	2.90
19.....	2.40	2.70	4.50	4.40	4.40	3.00	2.80	2.50	2.60	2.60	3.10	2.80
20.....	2.40	2.70	4.60	4.00	4.25	3.00	2.80	2.40	2.60	2.60	3.10	2.80
21.....	2.40	2.70	4.70	3.90	4.00	3.00	2.80	2.40	2.60	2.60	3.00	2.70
22.....	2.40	2.70	4.80	3.80	3.85	3.00	2.80	2.40	2.60	2.60	3.00	2.80
23.....	2.40	2.70	4.80	4.20	3.80	3.00	2.80	2.40	2.60	2.60	3.00	3.00
24.....	2.40	2.70	4.80	4.55	3.80	3.00	2.80	2.40	2.50	2.60	3.00	3.10
25.....	2.40	2.70	4.80	4.80	3.80	2.90	2.80	2.40	2.50	2.60	3.20	3.00
26.....	2.40	2.80	5.10	5.30	3.70	2.90	2.80	2.40	2.50	2.60	3.10	2.90
27.....	2.40	2.80	5.40	5.55	3.85	2.90	2.80	2.40	2.50	2.60	3.10	2.80
28.....	2.40	2.80	5.50	5.65	3.50	2.90	2 80	2.40	2.50	2.60	3.00	2.80
29.....	2.50	.....	5.50	5.90	3.50	2.90	2.80	2.40	2.50	2.60	3.00	2.80
30.....	2.50	.....	5.60	6.65	3.50	2.90	2.70	2.40	2.50	2.60	2.90	2.90
31.....	2.50	.....	5.80	.....	3.50	.....	2.70	2.40	.....	2.60	.....	2.90

VALE STATION, ON MALHEUR RIVER.

This station is located on the left bank of the Malheur River, about 150 feet below the junction with Bully Creek and 50 feet above the iron bridge now in construction. It was established by Messrs. Arthur P. Davis and V. C. Tompkins on December 10, 1894. The observer is Mr. E. R. Murray, postmaster, Vale, Oreg. The station is distant from the observer's house about one-fourth of a mile. The gage is inclined, and is in two parts. The lower part is graduated from 1.6 to 9.1 feet, the distance between the footmarks being 1.95 feet. The upper part is graduated from 9.1 to 11.7 feet, the distance between the footmarks being 3 feet. The channel is composed of earth and sand, and is shifting. The bench mark is on a flat rock, nearly buried, above the right bank of the river, 50 feet southeast of south abutment of new bridge, and is 1.32 feet above the 11-foot mark on the gage. In future, measurements are to be made from the bridge. On December 10, 1894, the height was 1.9 feet and discharge 128 second-feet.

PENDLETON STATION, ON UMATILLA RIVER.

A station was established at Pendleton, Oreg., in January, 1891, by Mr. A. L. Adams, chief engineer of the Umatilla Irrigation Company, of Oregon. The section selected was at the point of crossing of the Main street bridge, the gage rod being placed on the central pier of the bridge. A record of the height of the stream was kept at short intervals for a period of over two years, daily readings being made at times when there were decided changes in the height of the stream. When, however, owing to absence of precipitation or to lack of change in the weather affecting the snow in the mountains, the river did not rise or fall notably, no readings were taken, the condition of the stream being watched carefully and observations taken only when necessary.

During this period measurements of discharge by means of floats were made by Mr. Adams, from which a rating table was constructed and the record of gage-height readings utilized in preparing a table of monthly discharges. These as computed extend from February, 1891, to July, 1892.

Table of monthly discharges of Umatilla River at Pendleton, Oregon.

[Total drainage area, 640 square miles.]

Month.	Discharge.			
	Maximum.	Minimum.	Mean.	Total for month.
1891.	*Sec. feet.*	*Sec. feet.*	*Sec. feet.*	*Acre feet.*
January				
February	320	140	180	9,997
March	2,250	140	1,050	64,562
April	2,250	770	1,430	85,091
May	520	140	408	25,087
June	370	140	202	12,020
July	770	60	300	18,446
August	60	60	60	3,689
September	55	35	45	2,678
October	65	35	50	3,074
November	580	60	172	10,235
December	520	410	510	31,359
1892.				
January	830	470	587	36,093
February	2,030	630	1,120	62,202
March	2,800	1,000	1,753	107,788
April	3,870	1,000	1,706	101,514
May	3,250	920	2,090	128,509
June	920	125	455	27,074
July	125	45	74	4,550

On January 9, 1893, Mr. William P. Trowbridge, jr., inspected this station and made a measurement of the discharge at that time, and also made arrangements for the continued reading of the river gage. Owing, however, to uncertainty as to paying necessary expenses, the records were not continued for a time sufficiently long to be of value. Mr. Trowbridge states that the bridge over the stream affords an excellent opportunity for measurements by means of current meters, as the stream at this point is narrow and is confined between a high clay and gravel bank on the north side and an embankment or levee on the south side. The latter was constructed by the town of Pendleton to prevent inundations, which have occurred at times of flood. The section here is good, as the bottom of the river is covered with pebbles and gravel, and apparently is not liable to change. At a point about 60 feet from the south bank of the stream the bridge is supported by a tubular iron pier consisting of two cement-filled iron pipes of a diameter of about 30 inches. This pier offers an obstruction, but as the sidewalk of the bridge projects considerably upstream the meters can be used to advantage. A measurement made on January 14, 1893, gave a discharge of 239 second-feet for a gage height of 1.53. The area of section was 126 square feet, the maximum velocity 3.07 feet per second, and the mean velocity 1.90 feet per second.

At that time a report upon the Umatilla River, its tributaries, and the diversion of water for power and irrigation was made by Mr. Trowbridge. The following extracts from this unpublished report give the principal facts, the maps and illustrations being omitted:

Umatilla River heads in the Blue Mountains, in the northeastern part of the State of Oregon, and flows in a westerly direction into the Columbia River. The moun-

tains from which this stream draws its supply are from 4,000 to 7,000 feet in height, and are covered with a heavy growth of timber. The principal tributaries are Meacham Creek, which has its head a little to the south of the main stream and flows in a general northerly direction, emptying into the Umatilla at a point about 65 or 70 miles from its mouth; Wild Horse Creek, rising a little to the north of the main stream and flowing in a general westerly direction, emptying into the Umatilla near Pendleton; McKaye Creek, which rises still farther to the south of Meacham Creek, flows in a general northerly direction, and empties into the Umatilla 3 miles below Pendleton; Birch Creek, which runs parallel to McKaye Creek; and Butter Creek, which empties into the Umatilla at a point about 12 miles from its mouth. Of the above-named tributaries Meacham Creek is the largest. A considerable volume of water flows from this stream. Wild Horse Creek carries but little water at the present season (January, 1893), but is in volume about sufficient for the watering of stock. McKaye Creek is a stream of considerable importance. Its drainage area is estimated to be about 200 square miles in extent. At a point about 20 miles from its mouth the stream divides into the north and south forks. This whole stream is perennial in its flow, but at a point about 10 or 12 miles from its mouth it disappears in the sands and gravel of the bottom during a large portion of the year. During the high-water season there is a large body of water flowing its entire length, and above the point of disappearance there is a good stream flowing the year around. Birch Creek and Butter Creek are streams of the same character, though much smaller.

The total drainage area of the Umatilla River is estimated to be about 320 square miles. The available records show that the year 1891, excepting the month just following the irrigating season, had less rainfall than any year since 1874, which had but slightly less. During 1891 the total discharge from the watershed, as computed from the record of the gagings, was 302,000 acre-feet, being equivalent to about 18 inches of run-off from the efficient portion of the drainage area.

As is usually the case in most districts where irrigation is a necessity and the water supply is far less than the demand, the appropriations of the waters of the Umatilla River filed by the various companies and individuals far exceed the possible supply from the river.

The oldest water right on the Umatilla River is believed to be that of Mr. W. S. Byers, of Pendleton, dating back to the year 1870, renewed in 1874, or rather filed upon again. In the year 1883, fearful that the establishment of the line of the Umatilla Indian Reservation might affect his former claims, Mr. Byers again filed, being assured that his diversion of water was outside of the established reservation line. He claims the amount required for the development of power sufficient to run his flouring mill in the town of Pendleton. This mill has a capacity of 500 barrels of flour daily.

Water is diverted from the Umatilla River about 1¼ miles above Byers's mill, and is brought through a natural channel of the river for a short distance; thence through a ditch to a point on the bluff opposite the mill, distant about 1,200 feet. The ditch is 10 feet wide on the bottom and 22 feet wide on top, with an average depth of 3 feet. From the terminus of the ditch line the water is carried through a wooden pipe of a diameter of 7 feet 2 inches, made of 5-inch staves 2.5 inches thick. From the head of the ditch, or rather from the point of diversion to the point where the water is applied for power, is a fall of 18 feet.

The discharge from the wooden pipe—that is, the total water power—can not be estimated, as the pipe is cross braced in the inside in such a manner that nothing can be known. The water is distributed to two turbine wheels of the Victor pattern. One is a 20-inch wheel of a calculated horsepower of 100; the other is a 30-inch wheel of 156 horsepower. The waste and overflow from the distributing box at the end of the ditch is carried off through the town in an open channel. The tail-water from the mill is carried through a stone aqueduct 8 feet high to the river, distant about 1,200 feet.

During the low-water stage of the Umatilla River there are times when the mill can not run its full capacity on account of the shortage of water. It is then customary to run one turbine, and let the water in the ditch back up and accumulate for a head; then the other wheel is put in operation. Each wheel has certain duties, and at these times each branch of the work of milling is taken up separately. During this period the mill utilizes all the water of the river. The period varies during different years, and usually commences July 1. This water right is considered very valuable and is not contested. The water could be utilized to good advantage to the town of Pendleton for power in connection with the lighting of the town by electricity.

THE UMATILLA IRRIGATION COMPANY OF OREGON.

On the north and west of the town of Pendleton, Oreg., between the Umatilla and Columbia rivers, is an immense body of agricultural land, which has been settled upon for a number of years and cultivated. Wheat was the principal crop, and an excellent yield has been had; but, on account of the scarcity of rainfall, crops have failed in recent years, and most of the farms have been abandoned. This, of course, has been a great loss to the town of Pendleton. Efforts to reclaim the district were made in the year 1890, and as a result the Umatilla Irrigation Company was incorporated in that year.

The line of the proposed canal commenced in and ran through a portion of the Umatilla Indian Reservation, and the sanction of the United States Government was necessary. Steps were taken to get the desired authority, the outcome being the passage of a bill by Congress, in February, 1891, allowing the company to proceed with its work of reclamation, the consent of the Indians being required. This consent was obtained, and the Indians were compensated in the sum of $1,955. The land to be reclaimed lies on a plateau whose average elevation above sea level in 1,400 feet. The elevation of the river at Pendleton is about 1,070 feet, while the fall of the Umatilla River between Gibbon, at the mouth of Meacham Creek, and Pendleton averages about 32 feet per mile.

The lands slope from the mountains to the Columbia River, and are all capable of being irrigated. The actual amount of land to be irrigated, however, depends entirely upon the available supply of water. The company has contracted to supply 1,500 acres of good land with water for irrigation purposes at the rate of $3 per acre per annum for a period of thirty years, the amount of water to be delivered to be 1 acre-foot between March 1 and July 1. The contract provides for the delivery of water to the land free of cost at the expiration of the thirty-year period, the payment of the annual pro rata expense of the cost of maintenance being the only provision. The contracts are a mortgage upon the land and a first lien upon the crops irrigated.

The company proposes to divert water from the Umatilla River at a point about 18 miles above Pendleton by means of a crib diverting dam extending across the stream. The location of the diversion is on the NW. ¼ sec. 3, T. 2 N., R. 35 E., Willamette meridian. The water is to be carried down the side hill of the canyon in a box flume 6 by 8 feet, with a grade of 1 foot in 500 feet. In all, there are to be 4.5 miles of this fluming. From the end of this flume the water is carried through an ordinary side-hill canal. At a point about 9¾ miles from its head the water is brought to the hilltop and leaves the canyon. From this point it is carried in a general northerly direction toward the town of Adams, on Wild Horse Creek. The canal crosses Wild Horse Creek by means of a flume 40 feet high, and from thence is carried in a westerly direction, following the general contour of the country until it reaches a point opposite the town of Pendleton and distant about 2 miles from it. Here the location survey ends. From the head to this point the canal is 49 miles in length. The canal is designed for a capacity of 560 second-feet, and is to be 28 feet wide on the bottom; maximum depth, 7.5 feet; side slopes, 1 to 1; uniform grade

of 1 foot in 5,000 in earth, and 1 foot in 12,500 in loose rock. From the end of the location work it is proposed to run two branch lines covering the land in question. The estimated cost of the system when finished is $400,000.

UMATILLA IMPROVEMENT COMPANY.

This company was formed for the purpose of reclaiming certain lands lying between the Umatilla and Columbia rivers. The company constructed 1 or 2 miles of their canal, diverting water at a point just below Echo, on the Umatilla River. For reasons not stated, this project was abandoned, and the company lost its rights, these being acquired by the Columbia Valley Land and Irrigation Company.

COLUMBIA VALLEY LAND IRRIGATION COMPANY.

This company was incorporated for the purpose of reclaiming certain lands lying in the same position as the lands proposed to be irrigated by the Umatilla Improvement Company. They further proposed to irrigate a large tract of land lying south of the Columbia River, known as prairie land. The river at this point makes a bend to the south, and the force of the current is directed against the bank where the diversion takes place. No diverting dam is necessary, it being assumed that it is possible to drain the river during the low stages by opening the gates to their fullest extent.

The head gate of this canal is of cement and is furnished with fall brakes for the gates. There are six of these gates, each being 3 feet in width. The front of the gate is protected by rods running out in a slanting position, the rods preventing the accumulation of débris against the gates.

From the point of diversion to Butter Creek, a distance of 6 miles, following the bluff line, a canal is in operation whose dimensions are as follows: Bottom width, 28 feet; top width, 48 feet; maximum depth, 5 feet; grade, 1.52 feet per mile. In running this line the old works of the Umatilla Improvement Company were disregarded entirely. The capacity of the canal is 500 second-feet. The company claims 8,000 miner's inches under 6-inch pressure.

This canal, which is finished and in operation as far as Butter Creek, covers completely a fine tract of land between the bluff and the Umatilla River and Butter Creek. This land has a gentle slope toward the river, and by reason of its slope is finely adapted for the distribution of water. The land in question is known as the Umatilla Meadows, and has an area of 15,000 acres. This is all good, irrigable land. The soil is well adapted to the raising of crops of all descriptions. Although water has been running in the canal for a considerable time, there has been but little used for irrigation except in one or two instances. The coming season, however, a large body of land will be reclaimed.

There is a large tract of land lying west of Butter Creek and south of the Columbia River which the company proposes to reclaim by crossing Butter Creek by means of a flume 800 feet in length, continuing from the point where the present canal ends. It was thought advisable to cross the creek rather than follow up the creek and cross on grade. Butter Creek at certain periods contains considerable water, and this water can be turned into the main canal below the flume with less danger to the canal than if there were a grade crossing.

The canal line from Butter Creek follows the general contour of the country for a distance of 11 miles (location survey), and empties into a natural reservoir whose area is about 200 acres, capable of holding 71,000,000 cubic feet of water. This reservoir is 17 miles from the head of the canal. A slight outlay will be necessary to furnish suitable gates at the western end of the reservoir, as the main canal is carried on for 3 or 4 miles beyond this point. Actual surveys have shown the presence of six natural reservoirs lying in the tract under the ditch, and the slope of the land is such that ditches from the main canal can be constructed connecting it with these different reservoirs, thus enabling an immense amount of water to be

stored during the high-water stage of the Umatilla River and Butter Creek. The proposed canal is to be the same in description as the existing work, following the same gradient, etc.

THE BLUE MOUNTAIN IRRIGATION AND IMPROVEMENT COMPANY.

In the SW. ¼ sec. 1, T. 1 S., R. 33 E., Willamette meridian, the north and south forks of McKaye Creek join and flow in a westerly direction as the main stream of McKaye Creek. At a point about 7 miles below this junction the creek turns to the north and flows in a direction a little west of north, and empties into the Umatilla River 3 miles below Pendleton. From the high bend of the creek to the Umatilla River McKaye Creek runs about parallel to the course of Birch Creek. These two streams are separated from each other by a narrow ridge or bench containing about 12,000 acres of irrigable land. To the east of McKaye Creek, below the bend of the creek, and lying between McKaye Creek and the line of the diminished reserve of the Umatilla Reservation, is another body of fine irrigable land, containing in all about 18,000 acres. To the east of this body of land lies the Umatilla Reservation, containing many thousands of acres of fine land, which is at the present time cultivated by the Indians in wheat and other cereals.

McKaye Creek, from the junction, runs through a narrow valley, almost a canyon, with hills on each side. In its course from the junction of the north and south forks there is a fall of about 47 feet. This part of the stream is perennial in its flow, and carries a considerable amount of water.

The Blue Mountain Irrigation and Improvement Company propose to utilize the waters of McKaye Creek for the purpose of irrigating the lands described above. They have secured by act of Congress the right to divert the waters of this stream which run upon the diminished Umatilla Reserve, which act also gives them the right of way across a certain part of the reservation. Their project is to impound, by means of a dam and reservoir, the flood waters of this stream and conduct them through a canal and a branch canal upon the lands in question.

By constructing a dam across the main stream just below the forks it is possible to back the waters of the stream up for a considerable distance. A dam 60 feet high, with a height of 54 feet for the wasteweir, would back the water for a distance of 1½ miles up the forks. The proposed dam site is a natural one. On one side (the south) a perpendicular ledge of rock juts out into the water. On the north side there is a more gradual slope away from the river. It is proposed to make the wasteweir on top of this ledge, and to tunnel through it below for the outlet of the water to the canal. The capacity of the reservoir is estimated to be 1,700,000,000 gallons.

It is proposed to carry the water from this reservoir onto the lands to be irrigated by means of a canal of the following dimensions: For the first 7 miles the canal is to be 10 feet wide on the bottom, 18 feet on top, with average depth of 3 feet 6 inches, and the excessively large grade of 5 feet to the mile. The canal, after leaving the reservoir, winds its way down toward the bend of the stream below. The water is then carried up onto the narrow bench between Birch Creek and McKaye Creek, where the line follows down the crest of the ridge, and is to be utilized in covering the land between the two creeks. At a point 7 miles below the dam site it is proposed to cross McKaye Creek by means of an inverted syphon 3,200 feet in length, with a fall of 20 feet in that distance, and to run a branch line of the canal down on the north and east side of McKaye Creek, covering within the diminished reserve between the reserve line and McKaye Creek about 18,000 acres.

NORTH YAKIMA STATION, ON NACHES RIVER.

This station was established August 14, 1893, by Mr. F. H. Newell, at a point a few hundred yards above the mouth of the Naches River, near the bridge of the Northern Pacific Railroad. The vertical gage

was nailed to the crib work on the right-hand side of the river, above the railroad bridge, and can be read easily from the track. The 12-foot mark is 9.97 feet below the top of the rail on the bridge, the gage being about 60 feet easterly from the rail. The top of the iron pier, on the southeast end of the county bridge, is 5.87 feet above this 12-foot mark. Measurements were made from the county bridge. The locality is, however, not favorable for the purpose, as the water is very swift, and is broken by the piers of the bridge. The discharge on August 14, 1893, was ascertained to be 1,193 second-feet, the reading on the gage being 1 foot. The station was inspected by Mr. Arthur P. Davis on November 21, 1894. At this time he made measurements of discharge at Nelson's bridge, about 4 miles above. The measured discharge was 1,196 second-feet and the maximum velocity 4.58 feet per second. This locality is not considered good for measurements at high water.

Daily gage height of Naches River above North Yakima, Washington, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.60	3.50	3.10	.....	4.80	7.30	.....	3.80	2.20
2	3.60	3.50	3.00	4.10	4.60	7.30	5.20	3.70	.....
3	3.60	3.50	2.90	4.40	4.60	.....	5.30	3.60	2.40
4	3.60	.....	.....	4.20	4.40	7.90	5.50	3.60	2.40
5	3.60	3.40	2.90	4.30	4.40	6.60	5.60	.....	2.30
6	3.60	3.40	2.90	3.90	4.40	6.40	5.70	3.40	2.30
7	.....	3.40	2.90	4.80	4.40	6.40	5.80	3.20	2.20
8	3.20	3.30	2.90	.....	4.40	6.30	.....	3.10	2.20
9	3.20	3.30	2.80	4.60	4.40	6.20	5.20	2.90	.....
10	3.60	3.30	2.80	4.70	4.40	.....	5.20	2.80	.....
11	3.50	.....	.....	5.30	4.40	5.30	5.10	2.80	.....
12	3.50	.....	2.80	5.30	4.40	5.20	5.10	.....	.....
13	4.40	.....	2.80	5.10	.....	5.10	4.80	2.90	.....
14	.....	.....	2.80	5.10	4.60	5.10	4.80	2.80	.....
15	6.60	.....	2.80	.....	4.60	5.20	.....	2.80	.....
16	5.60	.....	2.80	4.70	4.60	5.70	4.90	2.80	.....
17	5.20	.....	2.90	4.40	4.30	.....	4.90	2.70	.....
18	4.80	.....	.....	4.40	4.40	5.40	4.80	2.70	.....
19	4.80	2.90	2.90	4.40	4.80	5.60	4.80	.....	.....
20	4.80	2.90	2.80	4.90	.....	5.90	4.60	2.70	.....
21	.....	2.90	2.80	5.70	6.10	5.80	4.60	2.70	.....
22	4.20	2.90	2.80	.....	6.10	5.80	.....	2.60	.....
23	4.20	2.90	2.80	5.80	6.40	5.70	4.60	2.60	.....
24	4.20	2.90	3.10	5.90	7.20	.....	4.60	2.60	.....
25	4.10	.....	.....	5.90	7.70	5.40	4.50	2.60	.....
26	4.10	2.90	3.40	6.70	7.90	5.40	4.30	.....	.....
27	4.10	2.90	3.70	6.80	.....	5.30	4.20	2.40	.....
28	.....	3.10	4.10	6.10	7.40	5.30	3.90	2.40	.....
29	3.60	.....	5.40	.....	6.80	5.20	.....	2.30	.....
30	3.60	.....	4.10	5.10	6.60	5.20	3.90	2.30	.....
31	3.60	.....	4.90	.....	6.90	.....	3.80	2.20	.....

TOPPENISH STATION, ON TOPPENISH CREEK.

This station is located about 4 miles south of Toppenish station, at the crossing of the Northern Pacific Railroad. It was established on November 24, 1894, by Messrs. Samuel Storrow and Arthur P. Davis. The observer is the section foreman at Toppenish. The station is distant from the section house at Toppenish about 4 miles. The gage is of 2 by 6 inch scantling, painted white, graduated in black, and spiked to a pile and sleeper of the railroad bridge. Bench marks are to be established by Mr. Storrow. Measurements of discharge were made 80 yards above the bridge.

SATAS STATION, ON SATAS RIVER.

This station is located at the crossings of the Northern Pacific Railroad north of Satas station. There are two of these crossings at low water, three at high water, and seven at extreme floods. Gages were placed on the first three mentioned on November 24, 1894, by Messrs. Samuel Storrow and Arthur P. Davis. The observer is Mr. A. L. Williams, section foreman. These gages are distant from the observer's house 200 to 2,000 yards. They are marked with notches, nails, and black paint on a vertical pile. All can be read from the bridge. These gages are considered temporary. Mr. Storrow will place painted gages at all seven of the bridges and make connection with bench marks. Measurements of discharge were made on the two channels carrying water, at points a few hundred yards above the crossings.

SACRAMENTO BASIN, CALIFORNIA.

This basin includes the northern part of the Great Valley of California, and is drained by the largest rivers of the State. The problems of water supply and of water control are of the most varied character, on account of the peculiar topography and the character of the industries concerned. The rivers, rising in the high mountains, discharge enormous volumes of water, especially in times of flood, and descending rapidly from the mountains, they have great possibilities in the way of power. This power is utilized to a small extent for manufacturing, and in the past was largely employed in hydraulic mining. The débris resulting from these operations, swept down by floods, accumulated in the lower valleys, choked the waterways, or was carried over the low-lying farm lands. As a result, the aid of legislation was invoked, and further dumping of mining débris into the streams was prohibited, which resulted in the practical cessation of hydraulic mining. Many of the flumes and ditches erected for this purpose have of late years been utilized for irrigation, especially in fruit culture, and questions are arising continually concerning the amount of water flowing in the streams and its possible storage and utilization on a larger scale for irrigation works or power plants.

In the lower part of the valley of the Sacramento, and in the central portion, where the waters of the San Joaquin and its tributaries are received, other problems of the reclamation of swamp areas are brought prominently to the attention of the people of California. The State engineer and various commissions have collected data upon the subject, and during 1894 the commissioner of public works began a further examination, including surveys and measurements of volumes. The data thus obtained have not been published in full, those published relating mainly to flood volumes of the larger streams. At higher points a few measurements have been made by this Survey for the purpose of obtaining general information applicable to the smaller rivers. There are given herewith descriptions of stations at Red Bluff and Tehama, on the Sacramento River, and the heights of water

observed at these points by the Weather Bureau and the Central Pacific Railroad Company, respectively.

RED BLUFF STATION, ON SACRAMENTO RIVER.

This station is located at the northeast corner of the wagon bridge just east of the town. It was established and is read by the Weather Bureau. The station is distant one-fourth of a mile from the observer's office in town. The gage is a painted pine plank, placed vertically, fastened to a sycamore tree 20 or 30 feet from the bridge. The channel is sandy and shifting in character. Measurements of discharge were made from the same bridge, but the current is very swift and is badly broken by the piers, introducing a probable error in the measurements of, say, 20 per cent. About 9 miles above Red Bluff the river is in a broad, uniform channel, and has a slow velocity even at high stages, owing to the contraction in the canyon a short distance below. The ferryboat is large and the bow extends several feet beyond the water line, resulting in favorable conditions for discharge measurements. It was agreed between Mr. Lippincott and the county supervisors that if the Geological Survey would place a gage at this point, the ferryman, who is paid by the county, would be instructed to report regularly the height of water. Below the canyon, and above both Red Bluff and Tehama in times of high water, the river leaves its banks, and thus the total amount of water is not shown by the gages. At Tehama the river channel is broken by the bridge piers, but not as badly as at Red Bluff. No canals of importance are taken out above the ferry just mentioned.

Daily gage height of Sacramento River at Red Bluff, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Dec.
1	9.30	4.40	4.30	12.50	6.40	4.90	2.20	1.60	1.30	6.40
2	8.70	4.00	4.20	13.00	6.60	4.80	2.20	1.50	1.30	7.50
3	6.30	6.60	4.40	12.60	6.80	4.80	2.10	1.50	1.30	5.10
4	5.80	12.50	4.40	11.20	6.90	4.80	2.00	1.50	1.30	4.00
5	6.30	10.40	6.00	12.00	6.80	4.60	2.00	1.50	1.20	3.30
6	5.90	7.00	5.10	21.40	6.50	4.80	2.00	1.50	1.20	2.80
7	5.20	5.80	4.80	16.80	6.50	4.70	2.00	1.50	1.20	2.60
8	4.80	7.50	11.20	15.00	7.00	4.60	2.00	1.40	1.20	2.40
9	4.60	7.00	9.60	11.90	7.10	4.60	2.00	1.40	1.20	2.30
10	4.50	6.70	7.20	11.90	7.90	4.40	2.00	1.40	1.40	2.20
11	4.40	6.60	18.60	10.40	7.60	4.40	2.00	1.40	1.60	2.10
12	4.40	10.80	11.00	9.80	7.60	4.40	2.00	1.40	1.80	2.00
13	3.90	10.20	8.40	9.00	7.90	4.20	2.00	1.40	1.60	1.80
14	4.00	7.20	7.40	8.30	7.90	4.10	2.00	1.40	1.00	2.80
15	5.20	6.80	7.00	9.80	7.60	3.80	2.00	1.40	1.00	3.70
16	7.10	6.40	8.30	7.60	7.70	3.50	2.00	1.40	1.00	3.40
17	5.70	6.20	9.30	7.40	8.50	3.30	2.00	1.30	1.00	3.00
18	5.00	5.50	13.20	6.90	8.00	3.20	1.80	1.30	1.00	2.50
19	4.60	5.30	13.20	6.60	7.10	3.00	1.80	1.30	1.00	2.00
20	4.30	5.00	11.50	6.50	6.70	3.00	1.80	1.30	1.00	1.80
21	4.00	4.80	16.50	6.50	6.20	2.90	1.80	1.30	1.00	2.50
22	3.80	4.80	13.00	7.00	6.20	2.80	1.80	1.30	1.00	5.60
23	3.50	4.70	11.00	8.50	6.00	2.60	1.80	1.30	1.00	5.00
24	3.50	4.60	10.80	8.20	6.00	2.60	1.80	1.30	.90	5.30
25	3.60	4.50	9.70	7.70	5.80	2.60	1.70	1.30	.90	5.40
26	4.80	4.40	9.20	7.30	5.60	2.50	1.70	1.30	.90	4.10
27	11.90	4.40	9.40	7.10	5.30	2.40	1.60	1.30	.80	3.40
28	5.50	4.40	9.50	7.20	5.10	2.40	1.60	1.30	.80	3.10
29	5.80	.....	9.90	6.80	5.00	2.40	1.60	1.30	.80	2.80
30	5.50	.....	10.50	6.70	4.90	2.30	1.60	1.30	.80	2.50
31	5.10	.....	13.00	.....	4.90	.....	1.60	1.30	.....	2.30

Daily gage height of Sacramento River at Red Bluff, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	5.80	5.30	10.40	4.50	3.80	1.80	1.00	0.70	1.40	1.00	1.20
2	3.50	5.30	7.50	10.00	4.40	3.60	1.80	1.00	.70	1.00	1.00	1.00
3	3.00	4.90	6.50	9.40	4.20	3.70	1.70	1.00	.70	.70	.80	1.20
4	2.50	4.50	5.90	8.90	4.10	4.00	1.70	.90	.70	.70	.80	1.40
5	2.40	5.40	5.50	8.30	4.00	5.70	1.70	.90	.70	.70	.80	1.80
6	2.30	6.40	7.00	7.80	4.00	4.80	1.60	.90	.70	.70	1.00	5.20
7	2.20	5.40	6.00	7.40	4.50	4.30	1.60	.90	.70	.70	1.00	5.00
8	2.10	6.50	7.30	7.20	4.60	4.00	1.50	.80	.70	.70	1.00	9.50
9	2.00	5.90	7.00	7.00	4.50	3.80	1.50	.80	.70	.70	1.00	7.60
10	1.90	5.70	7.80	6.80	4.20	3.60	1.40	.80	.70	.70	1.00	6.40
11	1.90	5.50	7.00	7.00	4.10	3.50	1.40	.80	.70	.70	1.00	3.60
12	1.90	5.20	6.40	6.80	4.00	3.30	1.40	.80	.70	.70	.90	3.00
13	1.80	5.00	6.00	6.30	4.00	3.20	1.40	.80	.70	.70	.90	3.00
14	6.70	4.00	5.80	6.00	4.50	3.10	1.40	.80	.70	.70	.90	2.60
15	25.00	4.80	6.50	5.70	5.30	3.00	1.30	.80	.70	.70	.90	2.40
16	17.60	4.40	7.30	5.50	4.50	2.90	1.30	.80	.70	.70	.90	2.70
17	10.90	4.00	9.40	5.20	4.10	3.00	1.30	.70	.70	.70	.90	3.80
18	9.00	5.80	8.80	5.00	3.90	2.90	1.30	.70	.70	.80	.90	5.60
19	7.60	11.20	8.40	4.90	4.00	2.80	1.30	.70	.70	.90	.90	11.40
20	10.40	13.00	7.30	5.00	4.00	2.70	1.30	.70	.70	1.00	.90	11.30
21	9.20	8.80	6.80	5.00	3.90	2.60	1.30	.70	.70	1.10	.90	21.50
22	10.90	7.00	6.30	5.00	3.80	2.30	1.30	.70	.70	1.40	.90	15.30
23	10.20	6.00	6.00	5.10	3.70	2.30	1.30	.70	.60	1.90	.90	10.30
24	9.20	5.40	5.60	4.90	3.70	3.30	1.20	.70	.60	6.50	.90	6.70
25	8.10	5.00	5.20	4.80	3.60	2.20	1.10	.70	.60	3.40	.90	5.70
26	7.40	4.80	5.60	5.10	4.00	2.10	1.10	.70	.70	2.20	1.00	5.20
27	6.80	4.80	6.10	5.40	4.20	2.10	1.10	.70	.70	1.70	1.50	4.10
28	6.40	5.00	6.60	4.80	4.00	2.00	1.00	.70	.70	1.50	2.50	3.80
29	6.40	.....	7.20	4.60	3.70	2.00	1.00	.70	.70	1.30	2.40	4.80
30	7.20	.....	8.40	4.50	3.60	2.00	1.00	.70	1.20	1.20	2.00	6.60
31	6.40	.....	9.50	.....	3.60	.....	1.00	.70	.....	1.00	.....	7.40

Daily gage height of Sacramento River at Tehama Bridge, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.00	15.00	14.00	20.50	16.50	15.67	13.67	12.83	12.50	12.50	12.50	16.50
2	18.00	15.00	14.00	20.50	16.50	15.67	13.67	12.83	12.50	12.50	12.50	16.50
3	17.00	16.00	14.00	20.50	17.00	15.50	13.67	12.83	12.50	12.50	12.50	15.50
4	16.50	20.00	14.67	19.00	17.00	15.50	13.67	12.83	12.50	12.50	12.50	14.75
5	16.50	18.00	17.00	20.00	17.00	15.50	13.67	12.67	12.50	12.50	12.50	14.33
6	16.00	17.00	16.00	29.00	17.00	15.50	13.67	12.67	12.50	12.50	12.50	14.00
7	16.00	17.00	16.00	26.00	17.50	15.50	13.67	12.67	12.50	12.50	12.50	13.75
8	15.50	18.00	19.00	23.00	18.25	15.00	13.50	12.67	12.50	12.50	12.50	13.50
9	15.00	17.00	18.00	21.00	18.00	15.00	13.50	12.67	12.50	12.50	12.50	13.50
10	14.75	16.00	17.00	20.00	17.67	15.00	13.50	12.50	12.75	13.00	12.50	13.25
11	14.50	16.00	27.00	19.00	17.67	14.67	13.50	12.50	13.75	12.75	12.50	13.00
12	14.25	18.50	21.00	19.00	18.00	14.33	13.50	12.50	13.50	12.75	12.50	13.00
13	14.25	17.00	19.00	18.00	18.00	14.33	13.33	12.50	13.33	12.75	12.50	13.00
14	14.00	17.00	18.00	17.50	18.00	14.33	13.33	12.50	13.00	12.75	12.50	13.83
15	14.00	16.00	17.00	17.00	17.67	14.33	13.33	12.50	13.00	12.75	12.50	13.83
16	16.50	16.00	19.00	17.00	18.33	14.33	13.33	12.50	12.75	12.75	12.50	13.50
17	15.25	15.50	19.00	17.00	18.33	14.33	13.33	12.50	12.75	12.75	12.50	13.00
18	14.00	15.50	21.00	16.50	17.50	14.33	13.33	12.50	12.75	12.75	12.50	13.00
19	14.75	15.50	22.00	16.50	17.00	14.33	13.33	12.50	12.75	12.75	12.50	13.00
20	14.50	15.00	20.00	16.50	17.00	14.33	13.33	12.50	12.75	12.50	12.50	13.00
21	14.50	15.00	23.00	16.50	16.67	14.00	13.00	12.50	12.75	12.50	12.50	14.00
22	14.25	15.00	21.00	17.00	16.50	14.00	13.00	12.50	12.75	12.50	12.50	15.50
23	14.25	15.00	20.00	18.00	16.50	14.00	13.00	12.50	12.75	12.50	12.50	15.50
24	14.25	14.67	19.00	18.00	16.00	14.00	13.00	12.50	12.75	12.50	12.75	15.50
25	13.00	14.67	19.00	18.00	15.75	13.83	13.00	12.50	12.75	12.50	12.75	16.00
26	13.50	14.67	18.00	17.00	15.50	13.83	13.00	12.50	12.75	12.50	13.50	14.50
27	19.00	14.50	18.00	17.50	15.25	13.83	13.00	12.50	12.75	12.50	16.00	14.25
28	16.00	14.50	18.50	17.50	15.25	13.67	13.00	12.50	12.75	12.50	17.50	14.00
29	16.00	.....	19.00	17.00	15.67	13.67	13.00	12.50	12.75	12.50	15.00	14.00
30	16.00	.....	20.00	17.00	15.67	13.67	13.00	12.50	12.75	12.50	16.00	14.00
31	16.00	.....	20.00	.....	15.67	.....	13.00	12.50	.....	12.50	.....	14.00

Daily gage height of Sacramento River at Tehama Bridge, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.00	.....	3.58	7.00	3.33	3.00	1.33	0.17	0.17	0.75	0.83	1.00
2	14.50	.....	5.33	6.83	3.33	3.00	1.25	.17	.17	.50	.83	.83
3	14.50	.....	4.50	6.33	3.17	3.00	1.25	.17	.17	.42	.50	.75
4	14.00	.....	4.08	6.08	3.08	3.25	1.17	.17	.17	.33	.50	.75
5	13.75	.....	3.83	5.75	3.00	4.00	1.17	.17	.17	.33	.58	1.17
6	13.65	.....	4.92	5.42	3.00	3.50	1.17	.17	.17	.25	.58	3.92
7	13.00	.....	4.08	5.08	3.00	3.17	1.08	.17	.17	.25	.58	2.75
8	13.00	.....	4.50	5.00	3.08	3.08	1.00	.17	.17	.25	.58	6.42
9	13.00	.....	5.58	4.92	3.33	2.92	.92	.17	.17	.25	.50	6.83
10	12.75	.....	5.42	4.83	3.17	2.83	.92	.17	.17	.25	.50	4.58
11	12.75	.....	4.33	5.00	3.08	2.75	.92	.17	.17	.25	.50	3.08
12	12.75	.....	4.42	4.83	3.08	2.67	.83	.17	.17	.25	.42	2.92
13	12.75	.....	4.33	4.42	3.00	2.67	.83	.17	.17	.25	.42	2.25
14	16.00	.....	4.42	4.33	3.08	2.50	.75	.17	.17	.25	.42	1.75
15	20.00	.....	4.50	4.25	3.92	2.42	.75	.17	.17	.25	.50	1.75
16	23.00	.....	5.08	4.00	3.42	2.50	.75	.17	.17	.25	.50	1.75
17	20.00	.....	6.25	3.92	3.08	2.50	.75	.17	.17	.25	.50	2.08
18	18.50	.....	5.92	3.67	3.00	2.58	.75	.17	.17	.33	.50	6.00
19	17.00	.....	5.75	3.58	3.00	2.50	.75	.17	.17	.58	.50	9.00
20	21.00	.....	5.00	3.67	3.08	2.25	.67	.17	.17	.92	.42	8.42
21	19.00	.....	4.75	3.58	3.00	2.08	.67	.17	.17	2.42	.42	15.67
22	19.50	.....	4.33	3.50	2.92	1.83	.58	.17	.17	1.42	.42	11.92
23	19.50	.....	4.08	3.67	2.92	1.67	.58	.17	.17	1.17	.42	7.42
24	18.50	.....	3.92	3.58	2.92	1.67	.58	.17	.17	4.33	.50	5.25
25	17.33	3.83	3.83	3.58	2.92	1.67	.50	.17	.17	2.33	.50	4.17
26	16.50	3.50	4.00	3.67	2.92	1.50	.50	.17	.17	1.58	.50	3.42
27	16.75	3.42	4.17	4.00	3.08	1.50	.42	.17	.17	1.33	.42	2.92
28	16.50	3.58	4.50	3.42	3.17	1.50	.33	.17	.17	.92	1.50	2.83
29	16.00	.....	5.00	3.33	2.92	1.42	.25	.17	.17	.83	1.58	3.75
30	16.50	.....	5.50	3.33	2.92	1.42	.25	.17	.75	.75	.83	5.25
31	16.00	.....	6.42	.....	2.92	.....	.17	.17	.....	.67	.....	5.08

SAN JOAQUIN BASIN, CALIFORNIA.

This great river basin, occupying the southern part of the Great Valley of California, is drained by some of the most notable rivers of California, important from the standpoint both of irrigation and of water power. These streams, rising in the high Sierras, flow westerly and, leaving their narrow canyons, enter upon the broad valley, where, with lessened descent, each builds for itself a delta, over which the stream from time to time shifts its channel or subdivides into numerous sloughs. The railroads and principal towns of the valley are well out from the foothills, so that the principal bridges are at points below the mouths of the canyons and the headworks of the important irrigating canals. In order to obtain the full discharge of the streams it is essential to go back from the railroads up into the canyons, where the rivers flow in a single channel between well-defined banks.

The Southern Pacific Railroad Company has maintained at its bridge crossings series of readings of river height extending over a number of years, and although the river sections at these bridges are not always favorable for discharge measurements, and the full flow of the river, especially in low water, does not pass under the bridge, yet in taking up work in this part of the country it was deemed desirable to attempt to utilize these long records of river height by making series of measurements by which they might be interpreted into quantities. As the work expands the attempt will be made to establish stations higher up on the river at more suitable localities; but as this involves considerable expense, both in time and for transportation, the development must proceed slowly.

The principal stations on the San Joaquin and its tributaries in operation in 1894 were at Bakersfield, Kern County; Kingsburg, Tulare County; Herndon, Fresno County; Modesto, Stanislaus County, and Lodi, San Joaquin County.

TEJON STATION, ON TEJON HOUSE CREEK.

Tejon House Creek rises in the mountains at the southern or upper end of the San Joaquin Valley, south of Tehachapi Pass, and flows in a general westerly and southwesterly direction, the waters being finally lost in the gravels of the open valley, or, in time of flood, passing out upon the plain, flow into the marshes about Kern Lake.

Measurements of this creek were made during 1894 by Mr. J. B. Lippincott, near the Tejon ranch house. The drainage basin above this point is estimated to be about 17 square miles. It rises in altitude from 1,400 feet at the ranch house, 2 miles below the mouth of the canyon, to 9,214 feet on Tehachapi Mountain. The average rainfall at Fort Tejon, whose elevation is 2,300 feet, is 18 inches, and at the ranch house, 12 inches. The underlying rocks of the catchment basin are granitic, and the soils mainly clays, the conditions being such as to produce a considerable run-off. The following are the results of measurements made by Mr. Lippincott during 1894:

	Second-feet.
January 10	60
January 21	60
March 4	80
June 24	6.5
September 5	.9

The gage at this point is read by Mr. R. M. Pogson, agent of the Tejon ranches, Bakersfield, Cal. These observations are made as often as convenient, and cover all decided changes in the amount of water.

The next stream of considerable size to the north is Caliente Creek, along whose course the Southern Pacific Railroad follows from Tehachapi Pass down into the San Joaquin Valley. This stream fluctuates widely, and it has not been deemed practicable to establish a station on it. The State engineer of California attempted to make a series of measurements, but was compelled to abandon the project, although estimates of its discharge were prepared covering the period from November, 1878, to October, 1894. The stream near the railroad station of Caliente is dry for the greater part of the year. The drainage basin above this point is largely covered with sandy soil, gently undulating, and not favorable for a large run-off, the discharge taking place mainly in time of flood.

BAKERSFIELD STATION, ON KERN RIVER.

Measurements of the discharge of Kern River above the head of the canals have been made for a number of years under the direction of Mr. Walter James, chief engineer of the Kern County Land Company,

for the purpose of obtaining the information necessary to the operation of the great system of canals irrigating the Kern delta. Data are not at hand giving the daily height of water or the relation of height to discharge, but the following figures given by Mr. James show the total flow of the river upon the days named:

Flow of Kern River at Bakersfield, California, in 1893.

	Second-feet.
April 19	2,058
April 21	2,223
May 22	4,776
June 6	5,547
June 13	5,619
June 14	5,068
June 20	4,899
June 24	4,142
July 7	3,821
September 29	486
October 24	519
November 7	519
November 20	467

KINGSBURG STATION, ON KINGS RIVER.

This station is located at the Southern Pacific Railroad bridge, 1 mile south of Kingsburg, Cal. The station is an old one, and was examined by Mr. Arthur P. Davis on January 10, 1895. The observer is Mr. Alf. Thompson, watchman. It is distant about 500 feet from the watchman's house. The gage is a vertical plank, fastened to a bridge pier, painted white, and divided into feet and inches. Measurement of discharge was made from the watchman's boat, suspended from the wagon bridge, about 200 feet below the railroad bridge. The channel is too badly broken up for gaging from either bridge. Above this bridge the following canals are taken out:

Name of canal.	Capacity.
	Second-feet.
Fresno	1,500
Seventy-six	600
Fowler Switch	600
Kingsburg	600
Total	3,300

Daily gage height of Kings River at Kingsburg, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.50	7.50	4.50	6.50	5.00	10.33	9.33	4.17	2.33	2.33	2.67	2.33
2	4.33	6.33	4.42	6.67	5.25	10.92	9.50	4.17	2.25	2.50	2.58	2.17
3	4.08	5.83	4.33	6.33	5.33	11.67	9.50	4.17	2.17	2.33	2.58	2.17
4	4.17	5.50	4.17	6.25	6.00	12.08	9.08	4.17	2.50	2.25	2.58	2.17
5	3.83	6.25	4.75	6.17	6.83	12.33	8.83	4.08	3.33	2.33	2.67	2.17
6	3.83	6.00	4.83	6.17	6.83	12.08	8.50	4.00	2.83	2.25	2.92	2.08
7	3.83	5.33	4.58	6.08	7.33	11.92	8.33	4.00	2.58	2.25	2.75	2.08
8	3.75	5.17	4.33	5.50	7.92	11.50	8.17	3.75	2.50	2.17	2.67	2.08
9	3.67	9.83	6.17	5.08	7.75	11.58	8.50	3.75	2.50	2.17	2.92	2.08
10	3.83	11.50	5.25	5.17	8.75	11.75	8.00	3.50	2.50	2.17	2.50	2.08
11	3.83	8.17	4.83	5.25	9.33	12.00	7.17	3.33	2.33	2.25	2.00	2.08
12	4.00	7.00	5.83	5.00	9.92	11.83	6.83	3.42	2.25	2.25	2.00	2.08
13	3.67	6.83	5.75	4.83	10.25	10.42	6.67	3.33	2.17	2.25	2.00	2.08
14	3.67	6.17	5.25	4.67	10.75	9.75	6.33	3.42	2.08	2.25	1.92	2.08
15	3.33	6.08	5.67	5.00	11.00	10.00	5.75	3.42	2.08	2.25	1.92	2.08
16	3.17	5.67	5.67	5.00	10.83	10.50	6.08	3.17	2.08	2.25	1.92	2.08
17	5.00	5.58	5.33	5.00	10.58	10.67	6.08	3.00	2.08	2.25	1.92	2.08
18	4.33	5.42	5.08	5.08	9.58	10.75	6.17	2.83	2.50	2.25	1.92	2.08
19	4.00	5.25	5.00	5.17	8.83	10.17	6.00	2.83	2.50	2.33	1.92	2.08
20	3.58	5.25	6.17	5.25	8.75	9.75	6.00	2.67	2.58	2.50	2.25	2.08
21	3.50	5.25	11.75	5.75	8.58	9.58	6.00	2.58	2.67	2.50	2.33	.....
22	3.25	5.17	8.33	5.83	8.58	9.75	6.00	2.42	2.67	2.50	2.50	2.08
23	3.92	5.17	7.17	6.00	9.00	9.50	5.67	2.33	3.67	2.42	2.33	2.17
24	3.83	5.17	6.25	5.58	9.75	9.17	5.67	2.33	2.50	2.42	2.00	3.50
25	3.83	5.00	6.00	5.17	9.25	9.17	5.67	2.25	2.50	2.33	2.08	3.25
26	3.83	5.08	6.42	5.00	8.75	9.08	5.75	2.25	2.50	2.33	2.17	3.17
27	4.00	5.00	6.58	5.00	8.83	9.00	5.75	2.25	2.42	2.33	2.33	2.67
28	6.25	4.00	6.75	5.33	9.08	9.00	5.00	2.42	2.42	2.67	2.25	2.58
29	5.00	.....	6.92	5.00	9.50	8.92	4.33	2.42	2.33	2.50	2.33	2.58
30	4.75	.....	6.75	4.67	9.75	9.00	4.25	2.50	2.25	2.67	2.58	2.50
31	11.25	.....	6.50	.....	10.08	.....	4.17	2.50	.....	2.58	.....	2.50

Daily gage height of Kings River at Kingsburg, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.00	3.25	4.83	5.25	6.83	2.33	2.75	2.75	2.67	2.92	3.25
2	2.50	1.92	3.33	5.08	5.42	6.25	2.33	2.67	2.50	3.33	2.92	3.17
3	3.33	1.92	4.08	5.42	5.58	5.83	5.00	2.67	2.33	3.25	2.92	3.08
4	3.17	1.92	4.17	5.42	5.83	5.92	4.75	2.67	2.25	3.58	2.92	3.00
5	2.83	1.92	2.92	5.42	6.75	6.00	4.58	2.67	2.17	4.00	2.92	3.00
6	2.50	1.92	2.83	5.33	7.00	6.00	4.58	2.67	2.17	4.17	2.87	3.17
7	2.50	1.92	3.00	5.42	7.83	5.75	4.42	2.50	2.17	4.12	2.83	4.25
8	2.25	1.92	2.83	5.67	8.67	5.25	4.50	2.42	2.17	4.00	2.83	4.75
9	2.00	2.00	2.58	5.92	9.00	5.08	4.33	2.42	2.12	3.75	2.75	4.92
10	1.92	2.67	2.75	6.08	9.00	5.25	3.83	2.33	2.12	3.67	2.67	4.58
11	1.92	4.33	2.83	6.58	8.75	5.25	3.58	2.33	2.08	3.58	2.62	4.83
12	1.83	4.00	2.83	6.33	8.42	5.08	3.75	2.25	2.00	3.50	2.62	4.58
13	1.92	3.83	3.25	6.00	7.50	4.75	3.25	2.25	2.00	3.33	2.67	4.33
14	1.92	3.58	3.58	5.92	7.25	4.50	3.00	2.17	2.00	3.25	2.75	4.33
15	1.92	3.33	3.83	6.25	7.42	4.58	2.83	2.17	2.00	3.17	2.75	4.42
16	3.00	2.75	4.00	5.83	6.92	4.75	2.50	2.17	2.96	3.08	2.58	4.33
17	4.67	4.50	4.83	5.58	6.92	4.75	2.50	2.17	1.96	2.92	2.33	4.33
18	4.00	3.50	4.75	5.00	6.50	4.75	2.50	2.12	1.96	2.67	2.58	4.17
19	4.17	3.08	4.33	5.00	6.17	4.75	2.25	2.12	1.92	2.67	2.58	4.17
20	3.92	3.33	4.58	5.33	6.07	4.58	2.58	2.08	1.00	2.92	2.58	5.92
21	3.83	5.92	3.92	5.50	6.00	4.33	2.67	2.08	2.08	3.00	2.67	6.08
22	4.33	5.83	3.75	5.58	5.83	4.33	2.67	2.08	2.17	3.25	2.67	5.17
23	3.00	4.58	3.50	5.50	6.17	4.50	2.75	2.08	2.33	3.33	2.67	5.17
24	2.50	4.00	3.08	5.17	7.17	4.33	2.67	2.08	2.33	3.50	2.75	5.17
25	2.25	3.58	3.33	5.42	8.00	4.42	5.83	2.08	2.25	3.42	2.75	4.67
26	2.17	3.33	3.83	6.00	7.75	4.33	2.92	2.00	2.29	3.50	2.75	4.33
27	2.08	3.17	4.33	5.67	6.83	4.25	3.00	2.00	2.33	3.33	2.92	4.33
28	2.00	3.08	4.58	5.25	6.42	4.08	2.92	2.00	2.42	3.17	2.92	4.83
29	2.00	.....	4.58	4.92	6.17	4.17	2.83	2.00	2.42	3.17	2.96	5.17
30	1.92	.....	4.83	4.83	6.17	4.25	2.83	2.17	2.58	3.08	2.96	6.33
31	1.92	.....	4.83	.....	7.00	.....	2.75	2.83	.....	3.00	.....	5.67

HERNDON STATION, ON SAN JOAQUIN RIVER.

The gage at this station is located on the northeast corner of the middle pier of the Southern Pacific Railroad bridge, 1 mile north of Herndon, Cal. The station is an old one, and was examined by Mr.

Arthur P. Davis on January 9, 1895. The observer is Mr. George G. Nelson, Borden, Madera County, Cal. The station is distant from the observer's house about 500 feet. The gage is a vertical plank fastened to the bridge pier. It can be read from the bridge. A measurement of discharge made from the wagon bridge, about 800 feet above, gave on the date above named a total flow of 1,995 second-feet.

Daily gage height of San Joaquin River at upper crossing, Herndon, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	6.50	3.58	6.83	5.67	7.75	8.00	4.83	3.67	2.08	1.67	2.33
2	3.17	5.33	3.58	6.58	5.83	9.00	8.25	5.00	3.58	2.08	1.67	2.33
3	3.00	5.00	3.50	6.33	5.75	10.50	8.42	5.00	3.58	2.25	1.67	2.33
4	2.83	4.50	3.67	6.00	5.92	11.33	8.50	5.00	3.50	2.17	1.58	2.33
5	2.58	6.92	3.67	6.20	6.33	11.50	8.17	5.00	3.50	2.00	1.58	2.25
6	2.42	5.00	3.83	6.50	6.50	11.42	7.75	5.00	3.50	2.00	1.50	2.33
7	2.33	4.50	4.00	6.17	6.75	11.25	7.25	5.00	3.58	1.83	1.50	2.17
8	2.00	4.42	4.00	5.83	7.33	10.50	7.00	5.00	3.58	1.75	1.50	2.17
9	2.00	8.50	5.25	5.25	7.67	10.67	7.50	4.92	3.50	1.75	1.50	2.17
10	2.00	7.83	4.42	5.33	8.00	10.50	7.58	4.83	3.42	1.67	1.50	2.17
11	2.17	6.50	4.58	5.08	8.67	10.75	7.33	4.67	3.42	1.67	1.50	2.17
12	2.33	6.00	5.50	5.00	9.33	10.33	7.00	4.50	3.33	1.58	1.50	2.00
13	2.33	5.67	5.00	5.00	9.50	10.00	6.67	4.25	3.33	1.92	1.42	2.00
14	2.17	5.17	4.50	5.25	10.33	9.50	6.25	2.17	3.17	2.00	1.42	2.00
15	2.00	4.83	5.17	5.25	10.50	9.17	6.00	4.00	3.17	2.00	1.42	2.00
16	2.00	4.58	4.83	5.08	10.25	9.00	6.00	4.00	3.00	1.92	1.42	2.00
17	4.50	4.58	4.50	5.00	10.00	8.83	5.83	4.17	3.00	1.92	1.33	2.00
18	3.50	4.50	4.33	4.83	9.75	8.50	6.25	4.17	2.83	1.83	1.33	2.00
19	3.25	4.50	4.33	5.00	8.50	8.42	6.50	4.00	2.75	1.83	1.33	2.58
20	3.17	4.33	8.50	5.33	8.17	8.17	6.67	4.00	2.75	1.83	1.33	2.50
21	3.00	4.25	12.00	5.42	7.75	8.00	6.50	4.00	2.67	1.75	1.33	2.50
22	2.75	4.25	8.00	6.00	8.00	8.00	6.25	3.83	2.58	1.75	1.33	2.50
23	3.00	4.00	6.50	6.67	8.17	8.17	6.00	3.75	2.58	1.75	1.33	2.50
24	2.50	4.00	6.00	6.17	8.50	8.33	6.00	3.75	2.50	1.67	1.33	3.00
25	2.50	4.08	5.50	6.00	8.17	8.00	6.17	3.58	2.50	1.67	1.33	2.75
26	2.42	4.00	5.67	5.75	8.00	7.83	6.00	3.83	2.33	1.67	1.83	2.50
27	3.50	3.83	6.83	5.67	7.75	7.67	6.00	3.75	2.33	1.83	2.17	2.67
28	5.50	3.67	6.58	5.50	7.83	7.42	6.17	3.75	2.25	1.75	2.50	2.67
29	4.00	.....	6.83	5.17	8.00	7.50	5.83	3.67	2.25	1.75	2.83	2.50
30	4.17	.....	6.67	5.00	8.17	7.67	5.50	3.75	2.08	1.67	2.50	2.33
31	9.00	.....	6.75	.....	8.00	.....	5.00	3.75	.....	1.75	.....	2.33

Daily gage height of San Joaquin River at upper crossing, Herndon, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	6.67	2.83	4.83	4.42	6.50	4.50	3.25	3.33	2.17	3.00	2.58
2	2.58	6.58	3.33	5.00	4.75	6.17	4.50	3.17	3.17	2.42	2.92	2.42
3	3.00	6.50	3.83	5.17	5.00	5.83	4.42	3.33	3.17	2.50	2.92	2.42
4	2.83	6.50	3.50	5.00	5.58	5.67	4.42	3.33	3.17	2.50	2.83	2.42
5	2.75	6.42	3.33	5.00	6.33	5.50	4.42	3.42	3.08	2.58	2.83	2.50
6	2.75	6.42	3.33	5.08	6.58	5.50	4.50	3.33	3.08	2.83	2.67	2.67
7	2.58	6.42	3.25	5.00	7.00	5.17	4.50	3.33	3.00	3.00	2.67	2.92
8	2.58	6.46	3.25	5.33	7.50	4.83	4.42	3.25	3.00	3.00	2.67	3.33
9	2.50	8.25	3.08	5.50	8.58	4.83	4.42	3.25	3.00	3.00	2.58	3.75
10	2.50	12.50	5.50	6.00	8.50	5.00	4.33	3.17	3.00	2.75	2.50	3.33
11	2.50	12.00	3.33	6.83	8.00	5.00	4.33	3.17	2.83	2.67	2.50	3.00
12	2.50	10.33	3.33	6.25	7.67	5.00	4.33	3.08	2.83	2.50	2.50	2.83
13	2.50	9.08	4.00	5.83	7.50	4.50	4.17	2.83	2.75	2.50	2.50	2.83
14	2.33	8.67	4.25	5.50	7.00	6.50	4.17	2.75	2.67	2.50	2.50	2.75
15	2.33	8.08	4.00	5.33	6.75	4.42	4.17	2.58	2.67	2.42	2.42	2.67
16	3.50	9.00	4.17	5.08	6.50	5.00	4.25	2.67	2.58	2.25	2.42	2.83
17	3.17	9.25	4.50	5.00	6.42	5.25	4.00	2.67	2.58	2.25	2.42	2.83
18	3.00	12.00	4.33	5.00	6.17	5.50	3.92	2.58	2.58	2.25	2.42	3.00
19	2.75	15.67	4.33	4.83	6.00	5.42	3.83	2.58	2.58	2.17	2.42	3.17
20	2.75	17.33	4.17	5.00	5.75	5.17	3.83	2.50	2.50	2.17	2.42	5.50
21	2.83	17.00	3.83	5.33	5.50	5.00	3.75	2.50	2.50	2.58	2.42	5.00
22	2.58	16.33	3.75	5.25	5.33	4.83	3.75	2.50	2.42	2.92	2.42	4.83
23	3.33	15.67	3.42	5.17	5.50	4.50	3.58	2.50	2.42	3.00	2.42	4.92
24	3.33	15.00	3.50	5.00	6.50	4.50	3.50	2.50	2.33	3.33	2.33	4.50
25	3.17	14.67	3.50	4.83	6.67	4.42	3.42	2.50	2.17	3.42	2.33	3.75
26	3.17	13.00	3.58	5.58	7.00	4.83	3.42	2.50	2.08	3.50	2.33	3.50
27	3.00	13.00	4.00	5.00	7.17	5.00	3.33	2.50	2.00	3.50	2.33	3.33
28	3.00	12.67	4.50	4.92	6.00	5.25	3.42	2.58	2.00	3.42	2.50	4.00
29	3.00	.....	4.74	5.00	5.75	5.17	3.42	3.75	2.00	3.25	2.50	4.50
30	2.92	.....	4.83	4.58	5.83	4.67	3.42	4.33	2.00	3.17	2.58	5.75
31	2.92	.....	5.00	.....	6.50	.....	3.25	3.83	.....	3.00	.....	4.00

MODESTO STATION, ON TUOLUMNE RIVER.

Observations of river height at the railroad bridge crossing Tuolumne River, 1 mile south of Modesto, have been kept by the Southern Pacific Railroad Company for a number of years. On November 12, 1889, William P. Trowbridge, jr., hydrographer of the Irrigation Survey, under instructions from William Ham. Hall, supervising engineer, began a series of measurements at this point, both for the purpose of determining the flow of the stream and for experimentally ascertaining the best methods and apparatus for making velocity measurements upon rivers of this class. In this work he was delayed by the unfavorable weather then prevailing, rain continuing from November 17 to January 1, 1890, with hardly a break, much of the time being accompanied by violent winds. The first work was to place in position a permanent gage, this being attached to the central pier of the railroad bridge. Under orders from William Hood, chief engineer of the Southern Pacific Company, the railroad employees furnished a well-painted gage and secured it in position, under Mr. Trowbridge's supervision. The bridge tender, G. G. Nelson, was also instructed to furnish daily readings of the height of water, copies of his observations being sent to the railroad office and to Mr. Hall.

A one-half-inch cable was stretched across the river at a point about 200 feet above the bridge, this being a distance sufficiently great to be removed from the influence of the bridge piers. At this point the stream is about 220 feet wide, and has an average depth of from 5 to 7 feet at ordinary stages, and from this up to 20 feet in times of flood. A small topographic map was then made of the vicinity, by means of transit and stadia, and cross sections were run at various distances above and below the station in order to furnish data for the study of the stream bed in that vicinity. Longitudinal sections were also run, and bench marks placed at intervals of 500 feet for a distance of 1,000 feet above and below the section. Small temporary gages were placed at the extreme ends of this line for the purpose of obtaining the slope of the river at its various stages, by means of simultaneous gage readings. All bench marks were referred to the plane of the zero mark of the gage on the bridge, this being the reference plane for all work at this locality. This zero mark was referred to the railroad track.

A light, safe catamaran was constructed, capable of being taken apart and shipped to any point, and from this velocity measurements were made. It was determined, however, that the method of obtaining velocity measurements from shore, or the cable and traveling apparatus, should be tried experimentally. This, as devised by Mr. Hall and put into operation by Mr. Trowbridge, consists of two cables stretched across the stream; from one of these—the lower—the meter is suspended by suitable cords and pulleys, and held from being swept downstream by a stay line which runs to the upper cable. A brief descrip-

tion of this method is given in the Eleventh Annual Report of the United States Geological Survey, Part II, Irrigation, pages 16 to 18. It was reported that a number of complete measurements were made, but the results of these were not forwarded to the Washington office. These measurements were necessarily made rapidly, as the river is subject to sudden rises on account of the warm rains falling on the snow in the mountains. Velocity observations were taken at every 20 feet across the river, and at intervals of 2 feet in the vertical, the meter being usually run for two minutes for each observation. Work at this point was continued until February 2, 1890.

This station was inspected on January 8, 1895, by Mr. Arthur P. Davis, who at that time made a measurement of discharge, showing that for a height of 7.7 feet the river was flowing at the rate of 3,003 second-feet. He states that the gage consists of a vertical plank passing from the south side of the middle pier of the railroad bridge, and divided into feet and halves. It can be easily read from the south shore or from the wagon bridge, 200 feet to the west. The river measurement was made from the wagon bridge just below the railroad bridge. At that point the channel is sandy, but favorable for measurements at low water and at medium high stages. In extreme flood, however, the river leaves its banks. Mr. J. B. Lippincott states that the old gage on the Tuolumne was set in 1872 by A. P. Guppy and J. T. Reed. The new gage, now standing in the river, set in 1889 by William P. Trowbridge, jr., reads 1 foot higher than the old gage; that is to say, 2 feet on the old gage would read 3 feet on the new.

Tuolumne River, during the spring floods, has a daily variation, due to the melting of snow in the mountains. The low stage is at about 9 a. m., and the high at about 3 p. m. J. T. Reed, the present observer, records the height of water about 3 p. m.

The velocity of the river at this point is largely controlled by the height of the San Joaquin, into which it empties. When the latter is low, and local rains occur in the Tuolumne, the velocity is relatively high; that is to say, with the same height of gage different velocities may be observed.

Daily gage height of Tuolumne River at Modesto, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.17	12.00	7.00	10.33	8.33	14.67	13.92	7.42	4.92	2.67	1.75	5.50
2	7.83	9.08	6.75	10.50	8.67	15.75	13.50	7.33	4.75	2.58	1.75	6.42
3	7.67	9.00	6.75	10.33	9.25	16.92	14.33	7.33	4.58	2.58	1.67	5.58
4	7.50	8.17	6.67	10.17	10.17	17.58	14.42	7.33	4.50	2.50	1.67	5.92
5	7.25	13.98	6.75	9 83	10.50	17.83	13.92	7.17	4.33	2.50	1.67	4.58
6	7.17	10.08	6.67	12.17	10.00	18.08	13.42	6.92	4.08	2.50	1.67	4.33
7	7.08	7.00	6.42	10.42	10.58	17.92	12.33	6.75	4.00	2.42	1.75	4.17
8	6.83	8.00	6.00	9.58	10.75	17.58	11.75	6.58	3.92	2.42	1.83	3.92
9	6.58	19.08	6.17	9.08	11.83	16.67	12.25	6.33	3.92	2.33	2.17	3.43
10	6.50	16.00	5.83	8.75	12.67	17.00	12.58	6.17	3.83	2.33	2.08	3.17
11	6.33	11.00	5.75	8.67	14.17	17.42	12.50	6.00	3.75	2.33	2.00	3.08
12	6.17	10.00	10.75	8.25	15.25	17.83	11.58	5.92	3.50	2.33	2.00	3.00
13	6.00	10.08	7.75	8.08	15.75	18.00	16.92	5.83	3.33	2.42	2.17	3.17
14	5.33	9.08	6.83	8.00	16.58	16.17	10.50	5.75	3.17	2.42	2.00	3.42
15	5.58	.....	13.50	7.92	16.42	14.08	10.17	5.58	3.17	2.33	1.83	3.08
16	6.50	.....	9.83	8.33	16.58	14.33	10.33	5.50	3.08	2.33	1.75	2.92
17	10.58	7.83	8.17	8.75	15.17	15.58	10.58	5.42	3.08	2.33	1.75	3.00
18	7.83	7.67	6.83	8.50	15.00	15.75	10.50	5.25	3.00	2.25	1.67	3.00
19	6.67	7.50	7.83	8.58	13.42	15.17	10.33	5.08	3.00	2.25	1.67	2.92
20	6.50	7.50	10.83	8.75	12.25	14.33	10.42	5.00	3.08	2.25	1.58	2.83
21	6.33	7.42	22.83	9.00	10.00	13.58	10.17	4.92	3.00	2.17	1.50	2.83
22	6.08	7.33	15.83	9.67	10.50	13.67	9.92	4.83	2.92	2.17	1.50	2.67
23	6.00	7.33	11.75	11.58	11.67	14.58	9.75	4.83	2.83	2.17	1.42	2.67
24	6.00	7.25	9.75	10.42	13.42	13.50	9.58	4.75	2.92	2.17	1.33	3.50
25	5.08	7.25	8.50	9.17	12.50	13.08	9.42	4.67	2.83	2.08	1.50	3.67
26	6.17	7.25	9.00	8.75	11.42	13.67	9.58	4.83	2.83	2.00	1.67	3.33
27	7.08	7.25	9.17	8.75	10.92	13.83	9.00	5.25	2.75	2.00	2.08	3.67
28	9.00	7.17	9.75	8.92	11.08	13.58	8.83	5.42	2.75	2.00	2.75	3.92
29	7.08	.....	10.67	8.75	12.25	13.67	8.58	5.25	2.67	1.83	7.50	3.83
30	7.08	.....	11.33	8.17	13.42	13.08	7.75	5.17	2.67	1.83	6.08	3.75
31	18.00	.....	10.42	.....	14.00	.....	7.58	4.92	.....	1.83	.....	3.58

Daily gage height of Tuolumne River at Modesto, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.83	5.33	7.07	8.33	8.92	15.50	10.67	4.92	3.83	1.50	3.25	1.83
2	3.92	5.33	7.25	8.58	9.67	13.83	10.42	4.83	3.33	1.58	3.08	1.75
3	4.68	5.17	7.33	9.25	9.58	13.33	9.67	4.75	3.25	1.67	3.00	1.58
4	4.75	5.17	6.67	9.08	9.83	13.50	9.83	4.67	3.17	1.67	2.75	1.58
5	4.50	5.33	6.50	9.25	10.83	11.75	9.92	4.58	3.00	1.75	2.67	1.75
6	4.50	5.00	6.42	9.58	12.17	11.83	9.25	4.50	2.83	1.83	2.50	1.83
7	4.08	5.00	6.50	10.25	13.83	10.83	9.17	4.42	2.75	1.75	2.50	3.50
8	4.17	5.00	6.42	10.58	14.67	9.83	9.00	4.25	2.67	1.83	2.42	4.58
9	4.17	4.92	6.25	10.92	15.75	9.67	8.50	4.00	2.50	1.83	2.33	6.00
10	4.08	15.50	6.33	11.83	16.17	9.75	8.50	3.92	2.33	1.92	2.33	6.58
11	4.00	6.92	6.50	13.08	15.83	10.08	8.25	3.75	2.17	1.58	2.25	5.83
12	4.00	5.92	6.42	11.58	16.67	9.50	8.08	3.67	2.08	1.58	2.08	5.33
13	4.25	5.75	7.08	10.92	15.17	8.67	7.83	3.58	2.00	1.58	2.00	4.42
14	4.42	5.50	7.42	11.08	14.25	8.67	7.50	3.58	2.00	1.58	1.92	4.08
15	4.58	5.42	7.50	11.50	14.83	9.67	7.42	3.42	1.92	1.50	1.92	3.75
16	14.42	6.58	7.50	10.50	12.33	10.08	7.17	3.25	1.92	1.67	1.83	3.42
17	7.50	5.00	8.83	9.42	11.17	11.25	6.92	3.17	1.83	1.67	1.75	3.33
18	6.00	5.67	7.75	8.67	11.08	11.83	6.75	3.17	1.75	1.58	1.75	3.50
19	6.25	7.58	7.50	8.83	11.92	11.92	6.50	3.08	1.67	1.58	1.67	6.42
20	5.58	21.83	7.42	10.33	11.33	9.83	6.42	3.08	1.67	1.50	1.58	17.50
21	16.17	23.00	6.83	11.33	10.67	9.92	6.00	3.00	1.58	2.50	1.58	7.08
22	7.42	10.83	6.50	11.17	10.50	10.17	5.92	3.00	1.58	3.50	1.58	15.17
23	6.58	9.58	6.33	10.75	10.58	9.83	5.92	2.92	1.50	4.75	1.50	11.83
24	6.33	7.67	6.33	10.50	12.67	10.50	5.67	2.92	1.50	4.17	1.50	7.67
25	5.83	7.33	6.50	9.75	14.00	10.67	5.58	2.83	1.42	5.67	1.50	7.33
26	5.50	7.17	6.83	11.17	15.08	10.58	5.50	2.83	1.42	5.25	1.50	6.17
27	5.42	6.92	7.50	10.08	14.00	10.17	5.42	2.75	1.33	5.17	1.50	5.75
28	5.42	6.92	7.50	8.75	13.17	10.33	5.50	2.75	1.33	4.58	1.42	10.75
29	5.17	.....	7.92	10.17	11.17	9.83	5.25	2.92	1.25	4.50	1.42	9.33
30	5.25	.....	8.50	8.17	11.42	10.42	5.08	4.08	1.58	3.92	1.75	8.25
31	5.33	.....	8.67	.....	13.75	.....	4.92	3.83	.....	3.50	.....	6.92

LODI STATION, ON MOKELUMNE RIVER.

This station is located 1 mile north of Lodi, at the railroad bridge of the Southern Pacific Company. This station is an old one, and was examined on January 6, 1895, by Mr. Arthur P. Davis. The observer is the bridge watchman. The gaging station is distant from the watchman's house about 600 feet. The gage is a vertical plank fastened to the south side of the middle pier and divided into feet and inches. It can be read from the bank at low water and from the bridge at all times. Gaging was made by lowering the meter through openings in the railroad bridge. The channel is very unfavorable for gaging. When the water is at the 8-foot mark, the current is broken and not at right angles to the bridge. About one-half mile above the railroad bridge is a wagon bridge which has no piers in the river and offers more favorable conditions for gaging.

Daily gage height of Mokelumne River at Lodi, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.00	16.00	8.00	14.17	12.00	15.50	13.00	10.67	10.00	7.83	7.00	7.50
2	8.50	14.33	8.00	14.00	12.50	15.83	13.50	10.75	9.83	7.67	5.50	7.67
3	8.50	13.00	8.00	13.50	12.50	11 33	13.83	10.50	10.00	7.58	4.83	8.00
4	8.50	12.50	8.00	13.00	13.00	16.17	13.83	10.50	10.00	7.50	4.83	6.50
5	8.50	12.00	8.83	12.67	13.50	16.50	13.50	10.50	10.17	7.50	4 83	6.00
6	8.50	12.00	7.83	12.33	13.33	16.50	13.00	10.50	10.17	7.50	4.83	5.83
7	8.50	11.17	7.83	12.08	13.42	16.33	12.67	10.50	10.25	7.42	4.83	5.50
8	8.50	10.00	7.83	11.83	13.58	16.17	12.50	10.50	10.33	7.33	4.83	5.50
9	8.50	13.42	7.83	11.50	14.00	16.33	12.33	10.50	10.50	7.33	4.83	5.50
10	8.50	15.33	7.83	11.33	14.50	16.50	12.00	10.50	10.50	7.42	4.83	5.50
11	8.50	14.00	10.50	11.00	15.00	16.25	11.83	10.50	10.33	7.50	4.83	5.50
12	8.50	12.33	8.00	11.00	15.50	16.33	11.00	10.50	10.50	7.50	4.83	5.50
13	8.50	12.00	8.00	10.50	16.00	16.25	11.50	10.50	10.50	7.83	4.83	5.50
14	8.50	11.17	10.00	10.33	16.50	15.33	11.58	10.50	10.50	8.00	4.83	5.50
15	8.58	10.00	9.00	10.17	17.00	14.17	11.67	10.50	10.50	8.00	4.83	5.50
16	11.00	10.00	10.00	10.00	16.50	14.83	11.50	10.50	10.25	7.50	4.83	5.50
17	12.00	10.00	9.00	10.00	16.67	14.83	11.33	10.50	10.17	8.00	6 33	5.50
18	9.50	9.50	11.00	10.00	16.50	15.00	10.83	10.50	10.17	8:17	7.00	5.50
19	8.50	9.00	13.00	10.33	15.33	15.33	10.83	10.50	10.00	8.17	7.33	5.50
20	8.50	9.00	19.58	10.67	14.17	15.00	10.58	10.50	9.83	8.17	7.33	5.50
21	8.50	8.83	7.00	11.00	14.00	14.83	10.83	10.50	9.50	8.17	7.00	5.50
22	8.33	8.83	15.50	12.00	13.50	14.50	11.67	10.50	9.50	8.17	6.17	5.83
23	8.17	8.83	14.50	13.00	12.83	14.33	10.83	10.50	9.50	8.17	5.83	6.00
24	8.00	8.67	13.00	14.00	13.33	14.42	10.00	10.33	9.83	8.25	5.83	6.50
25	8.00	8.67	13.33	13.50	14.50	14.42	9.25	10.25	9.50	8.25	6.00	7.00
26	8.83	8.50	12.00	12.33	14.33	14.33	9.50	10.33	9.33	8.25	7.50	7.00
27	12.00	8.33	12.50	12.00	13.50	14.33	10.50	8.50	8.25	7.83	10.50	6.00
28	11.33	8.33	12.00	13.00	14.00	14.00	10.83	9.00	8.17	7.75	8.00	5.83
29	10.50	.....	13.00	12.50	13.83	13.50	10.17	9.33	8.17	8.00	7.83	5.83
30	10.00	.....	13.50	12.00	14.33	13.33	10.33	10.00	8.08	8.17	7.50	5.50
31	10.00	.....	14.33	.....	14.58	.....	10.50	9.50	.....	8.00	.....	5.50

Daily gage height of Mokelumne River at Lodi, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	5.50	6.17	8.17	10.33	13.25	15.83	11.50	10.17	10.00	8.50	5.33	5.42
2.....	5.50	6.33	8.17	11.50	13.00	15.00	11.42	10.33	9.83	9.00	5.25	5.42
3.....	6.50	6.33	8.17	11.00	13.25	14.50	11.33	10.33	9.83	9.33	5.25	5.25
4.....	7.00	6.17	8.92	11.50	13.17	14.33	11.33	10.42	9.92	8.50	5.42	5.25
5.....	7.00	6.17	8.25	12.50	13.25	13.33	11.42	10.42	10.00	6.83	5.33	5.17
6.....	7.00	6.33	8.25	12.75	14.08	13.00	11.50	10.42	10.17	6.75	5.17	5.33
7.....	5.50	6.33	8.25	12.83	15.08	12.33	11.50	10.33	10.00	6.50	5.00	6.50
8.....	5.50	6.25	8.25	13.00	15.00	12.25	11.33	10.25	9.67	6.50	5.17	7.00
9.....	5.50	6.25	8.25	14.00	16.08	13.00	11.33	10.17	10.00	6.50	5.25	7.17
10.....	5.50	9.50	8.33	14.08	16.00	12.50	11.42	10.17	9.50	6.67	5.25	6.50
11.....	5.50	7.17	7.92	14.83	16.08	12.00	11.33	9.83	9.50	6.58	5.25	6.33
12.....	5.50	7.00	7.67	15.50	16.00	11.00	10.92	9.75	9.00	6.50	5.25	6.00
13.....	6.00	7.00	7.50	14.50	16.17	12.50	10.67	9.75	8.83	6.50	5.25	6.00
14.....	6.50	6.67	8.00	13.75	16.50	12.33	10.50	9.50	8.67	6.67	5.25	5.83
15.....	7.00	6.50	9.33	14.25	15.83	13.42	7.33	9.33	8.50	7.00	5.17	5.50
16.....	12.00	6.50	9.33	14.00	14.50	13.83	9.67	9.25	8.50	7.33	5.17	5.33
17.....	11.00	7.00	10.00	13.50	13.33	14.33	10.50	9.25	8.33	8.00	5.08	5.33
18.....	8.00	9.00	11.00	12.50	14.17	14.50	10.50	9.00	8.33	8.00	5.08	9.00
19.....	7.50	15.00	10.00	12.75	13.33	13.83	10.50	9.25	8.25	8.00	5.17	9.00
20.....	7.00	16.00	9.00	13.25	13.50	13.33	10.50	9.17	8.17	8.00	5.17	12.50
21.....	12.00	11.00	9.00	13.83	13.25	13.17	10.50	9.00	8.00	5.00	5.25	9.00
22.....	9.00	9.50	8.50	14.50	12.67	12.83	10.50	8.83	7.83	6.00	5.17	10.00
23.....	7.50	9.00	8.33	15.00	13.50	13.25	10.50	9.00	7.83	6.17	5.17	11.00
24.....	7.00	8.00	8.00	14.92	14.00	13.00	10.42	9.25	7.75	6.35	5.25	8.50
25.....	8.00	7.67	8.33	13.92	15.83	12.50	10.50	9.50	7.75	6.50	5.25	8.33
26.....	7.00	8.00	9.00	14.00	15.67	12.42	10.50	9.67	7.58	6.33	5.17	7.50
27.....	6.33	8.17	9.50	13.92	16.00	12.17	10.17	9.58	7.75	6.50	5.17	7.17
28.....	6.00	8.17	10.00	13.82	15.50	12.00	10.50	9.50	7.83	6.50	5.17	6.50
29.....	6.00	.....	10.50	12.00	14.83	11.50	10.25	9.33	7.75	5.83	5.42	6.33
30.....	6.00	.....	10.83	11.83	14.50	11.33	10.33	9.67	8.25	6.50	5.50	7.25
31.....	6.00	.....	11.00	.....	15.50	.....	10.50	9.83	.....	5.33	.....	7.50

SOUTHERN CALIFORNIA STREAMS.

The sources of the water supply of southern California are so widely scattered, and the streams themselves are often so small and difficult of access at points where measurements can be made, that, owing to expense, no systematic work has been done. The State engineer of California made a number of measurements at intervals, but, so far as can be ascertained, the results, though mentioned in reports, have not been prepared for publication. A preliminary reconnaissance was made in the fall of 1894 by this Survey, and a number of points were selected where measurements might be carried on, but the work has not advanced to a stage permitting of the publication of data, and these will be deferred until the next report.

POTOMAC BASIN, IN MARYLAND, VIRGINIA, AND WEST VIRGINIA.

A study of the Potomac River was begun in 1891, the field work being carried on by Mr. Cyrus C. Babb. Observations of river height were first made at Chain Bridge, about 3 miles above the city of Washington, and at later times reconnaissance and discharge measurements were made on some of the higher branches in order to obtain data of run-off from the catchment areas of different character under similar climatic conditions. In the fall of 1894 the matter was given more careful attention, and preparations were made for a thorough series of measurements during the succeeding year.

SPRINGFIELD STATION, ON SOUTH BRANCH OF POTOMAC.

Measurements of the South Branch of the Potomac are made at a point about 2 miles above Springfield, W. Va. Observations were begun on June 3, 1894, and continued until October 20, and were resumed in the succeeding year. Heights of water were measured by a wire gage, which is read by being drawn up along a scale divided into feet and tenths, attached to the guard rail of the bridge on the lower side. The channel is rocky and gravelly and is well adapted to discharge measurements, which are made from the bridge.

Daily gage height of South Branch River at Springfield, West Virginia, in 1894.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	4.1	4.2	3.7	3.6	17	4.65	.....	3.5	3.6	4.3
2	.....	4.1	4.1	3.7	5.1	18	4.9	.....	3.5	4.6	4.2
3	5.4	4.1	3.8	3.6	4.8	19	5.2	.....	3.8	6.7	4.1
4	5.2	4.0	3.8	3.6	4.5	20	4.65	.....	3.7	6.1	4.1
5	5.1	4.0	3.7	3.6	4.3	21	4.6	.....	3.7	5.0	.....
6	5.0	4.0	3.6	3.6	4.1	22	4.5	3.6	3.65	4.6	.....
7	5.5	4.0	3.5	3.5	4.0	23	.....	4.0	3.6	4.1	.....
8	6.4	4.0	3.5	4.0	3.9	24	4.4	4.0	3.6	4.1	.....
9	6.0	4.0	3.5	4.0	3.9	25	4.4	3.9	3.6	4.0	.....
10	5.7	3.9	3.5	3.9	3.8	26	4.3	3.8	3.6	3.9	.....
11	5.3	3.8	3.5	3.8	5.2	27	4.4	3.8	3.6	3.9	.....
12	5.1	3.8	3.5	3.8	5.1	28	4.4	3.8	3.6	3.7	.....
13	4.9	3.8	4.0	3.7	4.8	29	4.25	3.8	3.7	3.6	.....
14	4.85	3.7	3.8	3.7	4.6	30	4.2	3.7	3.7	3.6	.....
15	4.8	.....	3.7	3.6	4.5	31	.....	4.8	3.7	.....	.....
16	4.8	.....	3.6	3.6	4.4						

CUMBERLAND STATION, ON POTOMAC RIVER.

Observations of river height are taken at the West Virginia Central Railroad bridge, Cumberland, Md., about 200 yards below the dam on the Potomac. They were begun on June 11, 1894, and continued throughout that year. The gage is a vertical rod 10 feet long, bolted to the east end of the abutment of head gates above the dam. The channel consists of loose rocks and is not liable to change. The discharge measurements are made from the bridge.

Daily gage height of Potomac River at Cumberland, Maryland., in 1894.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.11	3.0	0.7	1.7	3.5	3.0	17	3.3	2.4	2.8	1.7	2.9	3.0	3.2
2	.....	2.11	3.0	.5	3.0	3.5	3.1	18	3.3	2.3	2.7	2.9	2.9	3.0	3.1
3	.....	2.11	3.1	.6	2.8	3.3	3.1	19	3.3	2.1	2.7	2.9	2.8	2.3	3.1
4	.....	2.10	3.1	.6	2.7	3.0	3.3	20	3.2	2.0	2.0	3.1	2.8	2.3	3.0
5	.....	2.10	2.9	.5	2.5	2.9	3.2	21	3.1	1.9	1.9	3.2	2.7	3.1	3.0
6	.....	2.10	2.8	1.0	2.3	3.0	3.2	22	3.1	1.5	1.9	3.2	2.7	3.0	3.0
7	.....	2.10	2.8	1.0	1.7	3.0	3.1	23	3.4	2.0	2.5	2.9	2.7	3.0	2.9
8	.....	2.10	2.6	1.1	1.6	3.0	3.1	24	3.4	3.0	3.0	2.9	2.2	3.0	3.1
9	.....	2.10	2.5	1.1	1.5	3.1	3.0	25	3.3	3.0	2.8	2.8	1.9	3.2	3.1
10	.....	2.10	2.1	1.1	1.9	3.1	3.0	26	3.3	2.9	2.5	2.7	1.8	3.1	3.0
11	3.5	2.09	2.0	1.0	2.0	3.2	3.2	27	3.3	2.9	1.9	2.7	1.7	3.0	3.0
12	3.4	2.08	2.1	1.0	3.0	3.1	3.4	28	3.3	2.8	1.8	2.5	1.7	3.0	3.1
13	3.4	2.8	2.0	1.2	2.9	3.1	4.1	29	3.2	2.7	1.3	2.0	1.7	3.0	3.1
14	3.3	2.7	3.0	1.2	2.9	3.1	4.7	30	3.0	2.8	1.0	1.8	1.7	3.0	3.1
15	3.3	2.6	3.0	1.3	2.9	3.0	3.3	31	.....	2.9	.9	.....	2.0	.....	3.1
16	3.3	2.5	2.9	1.4	2.9	3.0	3.2								

MILLVILLE STATION, ON THE SHENANDOAH RIVER.

This station is on the Shenandoah River, at Millville, W. Va., 4 miles above Harpers Ferry. The gage consists of a vertical board nailed to the projecting trunk of a tree and firmly fastened by cross braces. The bench mark consists of a notch cut in the tree opposite the 8-foot mark of the gage. The channel is rocky and not liable to change. Measurements are made from a small box, or car, 2 feet wide, 3.5 feet long, and 3 feet high, suspended from a 1¼-inch cable which has been erected by private parties for use of a ferry.

POINT OF ROCKS STATION, ON POTOMAC RIVER.

This station is at the toll bridge over the Potomac River near Point of Rocks, Md. It is equipped with a wire gage, which is read from the bridge floor, measurements of discharge being made from this bridge.

CHAIN BRIDGE STATION, ON POTOMAC RIVER.

Readings of river height at this point were begun on May 4, 1891, and continued until the end of 1893, when they were discontinued, owing to the difficulty of obtaining an observer. They were taken up again on December 18, 1894. The height of water is measured by means of a wire gage having a horizontal scale which reads from 10 to 30 feet. On March 20, 1895, this was supplemented by a cylindrical nilometer. Measurements of discharge are made from the bridge, but have not been wholly satisfactory, owing to the great velocity at times of high water. Computations of discharge of the river, based upon measurements at this point and upon a record kept at Great Falls, have been published in the Fourteenth Annual Report of this Survey, Part II, pages 135–137, giving the monthly flow from 1886 to 1893, inclusive.

LIST OF DISCHARGE MEASUREMENTS OF VARIOUS STREAMS IN THE UNITED STATES.

The following list gives, in brief, the results of individual stream measurements made at various stations established by this Survey, and at other points where it has been ascertained that such work has been carried on. For convenience of reference these are arranged in chronologic order. Many of them have been discussed more fully under the descriptions of the different river stations. In nearly all instances these measurements were made by means of current meters, by which the velocity of various portions of the current was ascertained, the meter being placed at regular intervals across the stream and near the surface, bottom, and in intermediate positions. The depth of the stream having been ascertained by sounding line or pole, and the width measured directly, the discharge for each portion was computed and the results were summed up as shown in the table. This list gives the

name of the stream, the locality or river station at which the measurements were made, and the name of the hydrographer or engineer under whose immediate direction the work was done. There is also given, wherever it can be obtained, an estimate of the drainage area in square miles above the point where these measurements were made. This estimate has in general been prepared by means of planimeter measurements of the best accessible maps, the outline of the drainage area being sketched according to the topographic features. Next to the right of this is given the height of water at the time of the measurement on the arbitrary gage established at the regular river stations; also the mean velocity, obtained by dividing the total computed discharge of the area by the cross section of the river at the point where the measurements were made. The discharge is given in units of cubic feet per second (now commonly employed), briefly designated, for convenience, second-feet.

List of discharge measurements of various streams in the United States.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1893.				*Sq. m.*	*Feet.*		*Sec. feet.*
Jan. 14	Umatilla	Pendleton, Oreg	W. P. Trowbridge	640	1.54		239
June 10	Shell Creek	Sheridan road, Wyo.	E. Mead				1
10	Clear Creek	Above Buffalo, Wyo.	do				304
12	do	do	do				652
14	Piney Creek	Sheridan road, Wyo.	do				975
14	Fullerton Creek	do	do				
14	Rock Creek	Road crossing, Wyo.	do				87
16	Clear Creek	Above Buffalo, Wyo.	do				178
22	do	do	do		4.494		134
July 6	Bear Gulch Creek	Above Kearney, Wyo	M. C. McFarlane				2
17	Clear Creek	Above Buffalo, Wyo.	E. Mead			2.32	37
18	Powder River	Old stage crossing	M. C. McFarlane				66
24	Sundance Creek	Near Sundance, Wyo.	E. Mead				1
26	Sand Creek	Near Beulah, Wyo	do				55
Aug. 14	Yakima	Union Gap, Wash	F. H. Newell		.90	3.09	2,963
14	Naches	North Yakima, Wash	do		1.00	3.76	1,193
16	Katchess Lake	Outlet, Wash	do			2.58	211
22	West Gallatin	Above Salesville, Mont.	do	850	2.15	3.35	818
23	Madison	Near Red Bluff, Mont.	do	2,085	2.10	3.28	1,189
24	Jefferson	Three Forks, Mont.	do	9,400		1.83	808
24	Madison	do	do	2,285	.30	2.15	1,251
25	Missouri	Townsend, Mont.	do	15,000	88.75		3,008
Sept. 2	Bear	Collinston, Utah	do	6,000	1.70	1.40	715
10	St. Charles	Below Beulah, Colo	do				4
22	Arkansas	Canyon, Colo	do	3,060	2.45	2.26	291
26	Yakima	Yakima, Wash	S. Storrow		.25		1,186
27	Arkansas	La Junta, Colo	F. H. Newell	12,200	.45	1.14	24
27	do	Holly, Colo	do			0	0
1894.							
Jan. 10	Tejon House Cr	Kern County, Cal	J. B. Lippincott				60
21	do	do	do				60
Mar. 4	do	do	do				80
Apr. 24	Arkansas	Pueblo, Colo	P. J. Preston	4,600			332
May 8	North Platte	Orin Junction, Wyo.	E. Mead				6,823
15	Arkansas	Canyon, Colo	F. H. Newell	3,060	4.20	7.27	2,395
18	South side ditch	do	do			1.88	32
18	North side ditch	do	do			2.45	27
18	Arkansas	do	do	3.060	3.80	6.68	1,940
21	Little Laramie	So. Fork, Wyo.	Luke Voorhees			3.57	69
21	Henry Canal	La Junta, Colo	F. H. Newell			3.08	620
21	Arkansas	do	do	12,200	1.20	1.57	157
21	Otero Canal	do	do			1.00	5
24	Potomac	Cumberland, Md	C. C. Babb	891			3,037
28	Rocky Ford ditch	Rocky Ford, Colo	F. H. Newell			2.22	71
28	Laguna ditch	do	do			2.83	187
28	Catlin ditch	do	do			2.41	104
28	Otero	do	do			1.70	136
28	High Line Canal	do	do			2.12	115
29	Vroomans	do	do			1.25	10

List of discharge measurements of various streams in the United States—Continued.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1894.				*Sq. m.*	*Feet.*		*Sec. feet.*
May 29	Rocky Ford ditch.	Rocky Ford, Colo	F. H. Newall....	.....	.....	2.68	110
29	Otero ditch	Apishapa flume, Colo.	.....do	.....	.....	1.66	141
29	Catlin ditch	Near head, Colo	.....do	.....	.....	2.76	290
29	Oxford ditch.....	.....do.....	.....do	.....	.....	4.83	174
29	High Line.....	.....do.....	.....do	.....	.....	2.87	365
31	Potomac.....	Springfield, W. Va ...	R. H. Chapman.	1,443	4.70	2.02	1,074
June 1	Fosdicks ditch....	Near head, Colo	F. H. Newell....	.....	.....	2.06	70
1	Arkansas.....	Nepesta, Colo	.....do	.....	.....	4.00	12,000
2	.....do	.....do.....	.....do	.....	.....	3.90	8,000
6	Laramie River....	Uva bridge, Wyo.....	E. Mead.....	.....	.....	.....	1,845
7	Arkansas.....	La Junta, Colo.....	F. H. Newell....	12,200	7.80	3.33	15,000
7	North Platte.....	Orin Junction, Wyo..	E. Mead.....	.....	.....	.....	12,596
8	Arkansas.....	La Junta, Colo	F. H. Newell....	12,200	6.40	3.06	9,500
13	Rio Grande.....	Del Norte, Colo	.....do	1,400	2.68	.....	968
14	Little Goose Cr...	Sheridan Co., Wyo ...	M. C. McFarlane	.....	.....	.....	105
14	Wolf Creek.....	Canyon Bridge, Wyo.	.....do	.....	.....	.....	63
18	Arkansas.....	Canyon, Colo.....	F. H. Newell....	3,060	4.80	.....	2,387
20	Big Goose Creek..	Sheridan, Wyo.....	M. C. McFarlane	.....	.....	.....	463
24	Tejon House Cr ..	Kern County, Cal....	J. B. Lippincott.	.....	.....	.....	7
25	Shell Creek.....	Shell post-office, Wyo.	E. Mead	.....	.....	5.21	569
26	Big Horn.....	Lovell's Ferry, Wyo .	.....do	.....	.....	.....	26,010
July 2	Stinking Water...	Marquette's, Wyo.....	.....do	.....	.....	.....	4,623
2	Potomac.....	Harpers Ferry, W. Va	C. C. Babb	6,354	2,52	.....	1,223
6	Shenandoah	.....do.....	.....do	3,009	.....	.....	1,218
12	Gray Bull.....	Meeteetse, Wyo.....	E. Mead	.....	.....	.....	1,209
15	Wind.....	Merritts, Wyo	.....do	.....	.....	7.35	6,209
17	Big Popo Agie....	25 miles below Lander, Wyo.	M. C. McFarlane	.....	.....	.....	624
18	Little Popo Agie.	Below Youngs, Wyo .	.....do	.....	.....	.....	91
20	Big Sandy.....	Lander Cut-off trail ..	.....do	.....	.....	2.30	148
20	Weber.....	Uinta, Utah.....	S. Fortier.....	.....	1.10	2.84	396
21	New Fork.....	4 miles above forks ..	M. C. McFarlane	.....	.....	.....	2,055
21	Green	Above New Fork	.....do	.....	.....	.....	2,427
21	Potomac.....	Chain Bridge, D. C...	C. C. Babb	11,043	.....	.....	1,781
23	North Piney Cr ..	Uinta Co., Wyo.....	M. C. McFarlane	.....	.....	.....	285
23	Middle Piney.....	North Branch, Wyo ..	.....do	.....	.....	.....	255
23	Middle Piney.....	Uinta Co., Wyo	.....do	.....	.....	.....	93
23	Middle Piney.....	In canyon, Wyo.....	.....do	.....	.....	.....	140
26	North Platte.....	Camp Clarke, Nebr ..	O. V. P. Stout ...	.....	.....	.....	1,900
26	Pumpkin Seed Cr.	Cary's, Cheyenne Co .	.....do	.....	.....	.....	17
28	North Platte.....	Gering, Nebr.....	.....do	.....	.....	.....	2,450
30	Strawberry Creek.	In canyon, Wyo.....	M. C. McFarlane	.....	.....	6.85	195
31	Loup.....	Columbus, Nebr.....	O. V. P. Stout ...	.....	.....	.....	1,475
Aug. 4	Salt.....	In pass, Wyo.....	M. C. McFarlane	.....	.....	.....	628
4	Willow Creek.....	Near mouth, Wyo.....	.....do	.....	.....	.....	104
7	Frenchman.....	Palisade, Nebr	O. V. P. Stout...	.....	.....	.....	94
7	Republican.....	Culbertson, Nebr.....	.....do	.....	.....	0	0
10	Swift Creek.....	Afton Bridge, Wyo...	M. C. McFarlane	.....	.....	.....	155
13	Stump Creek	Above Auburn, Wyo.	.....do	.....	.....	.....	67
14	Platte.....	Fremont, Nebr.....	O. V. P. Stout...	.....	.....	.....	1,420
15	Elkhorn	Waterloo, Nebr.....	.....do	.....	.....	.....	280
15	Weber.....	Uintah, Utah.....	S. Fortier.....	.....	.50	1.73	141
17	Crow Creek.....	At bridge, Wyo.....	M. C. McFarlane	.....	.....	.....	77
19	Loup.....	S. 13, T. 7 N., Wyo., R. 2 W.	L. F. Gottschalk	.....	.....	.....	1,335
20	Laramie	Near Laramie, Wyo ..	John Hunton...	.....	.....	1.38	51
21	Dry Creek.....	Near Afton, Wyo	M. C. McFarlane	.....	.....	.....	56
22	Dismal.....	Near Dunning, Nebr.	G. H. Lawrence.	.....	.....	.....	435
25	Middle Loup.....	Gates, Nebr.....	.....do	.....	.....	.....	850
25	Cottonwood Cr ...	So. of Afton, Wyo....	M. C. McFarlane	.....	.....	.....	79
	Platte	Fremont, Nebr.....	A. Rosewater...	.....	.....	.....	1,209
	Elkhorn	Arlington, Nebr.....	.....do	.....	.....	.....	214
Sept. 5	Tejon House Cr...	Kern County, Cal	J. B. Lippincott.	.....	.....	.....	1
10	South Loup.....	Georgetown, Nebr....	G. H. Lawrence.	.....	.....	.....	68
15	Cedar.....	Fullerton, Nebr.....	O. V. P. Stout...	.....	.....	.....	210
16	Loup.....	.....do.....	.....do	.....	.....	.....	1,704
17	Beaver Creek.....	Genoa, Nebr.....	.....do	.....	.....	.....	71
17	Platte.....	Columbus, Nebr.....	.....do	.....	.....	0	0
19	Weber.....	Pueblo, Colo.....	A. P. Davis.....	1,600	.35	.....	378
20	.....do	Canyon, Colo.....	.....do	1,600	.....	.....	395
20	South side ditch..	.....do.....	.....do	.....	.....	.....	33
20	North side ditch..	.....do.....	.....do	.....	.....	.....	22
23	Lake Creek.....	Twin Lakes, Colo....	.....do	102	.....	.....	43
24	Arkansas.....	Hayden, Colo.....	.....do	.....	1.20	.....	114
27	Rio Grande.....	Del Norte, Colo.....	.....do	1,400	1.52	.....	267
27	Laramie.....	Laramie, Wyo.....	W. M. Gilcrest..	.....	.....	.....	27
28	Rio Grande.....	Alamosa, Colo.....	A. P. Davis.....	.....	.....	1.01	11
28	Laramie	Wood's Landing, Wyo	W. M. Gilcrest..	.....	.....	.....	57
30	Rio Grande.....	Embudo, N. Mex.....	A. P. Davis.....	7,000	7.70	1.50	284

List of discharge measurements of various streams in the United States—Continued.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1894.				*Sq. m.*	*Feet.*		*Sec. feet.*
Oct. 1	Rio Grande	Embudo, N. Mex	A. P. Davis	7,000		3.25	1,138
3	North Platte	Uva Junction, Wyo.	F. H. Newell				
4	Mora	Watrous, N. Mex	A. P. Davis		1.68		35
5	North Platte	North Platte, Nebr.	Chas. P. Ross				620
5	Arkansas	La Junta, Colo	A. P. Davis	12,200	.40		55
6	Bear	Collinston, Utah	S. Fortier	6,600	2.01		1,800
6	Platte	Columbus, Nebr	O. V. P. Stout			0	0
7	Laramie	Near Fort Laramie	John Hunton			1.89	23
11	North Platte	Ogallala, Nebr	F. H. Newell				609
13	Arkansas	Pueblo, Colo	A. P. Davis	4,600	.39		370
15	do	Canyon, Colo	do	3,060	2.40		319
15	South side ditch	do	do				33
15	North side ditch	do	do				27
16	Arkansas	Hayden, Colo	do		1.24		91
17	Gunnison	Grand Junction, Colo.	do		1.25	.48	748
18	Grand	do	do		.60	1.10	1,585
21	Green	Blake, Utah	do		1.98	1.83	3,035
22	Pine	Helper, Utah	do		2.05		34
24	Humboldt	Golconda, Nev	L. H. Taylor		1.30	1.29	57
24	Provo	Provo, Utah	A. P. Davis	640	4.38		338
24	Laramie	Uva, Wyo	W. M. Gilcrest			2.06	14
26	North Platte	Orin Junction, Wyo.	do			1.42	502
27	Red River	Fargo, N. Dak	F. H. Newell				190
29	Bear	Battle Creek, Utah	A. P. Davis	4,500	1.90	2.12	980
30	St. Louis	Cloquet, Minn	F. H. Newell				6,067
Nov. 1	Snake	Blackfoot, Idaho	A. P. Davis	10,500		1.90	8,040
2	North Loup	Moulton, Nebr	G. H. Lawrence				460
3	Laramie	Wood's Landing	W. M. Gilcrest			1.47	80
4	Madison	Three Forks, Mont.	A. P. Davis	2,285	.57	1.99	1,494
6	North Platte	North Platte, Nebr.	Chas. P. Ross				1,960
7	do	Near Fort Laramie	John Hunton			2.23	630
13	Barton Spring	Austin, Tex	F. H. Newell				17
14	San Marcos	San Marcos, Tex	do				150
14	Jefferson	Sappington, Mont.	A. P. Davis	8,270	1.08	2.76	1,952
17	Gallatin	Logan, Mont	do		1.11	1.82	772
18	Missouri	Townsend, Mont	do	15,000	89.00	2.44	3,766
21	Naches	Nelson Bridge, Wash.	do		2.50	2.44	1,196
24	Toppenish	R. I. R. crossing, Wash.	do		3.40	2.4	49
24	Satas	North Branch, Wash.	do		2.00	3.00	27
25	Yakima	Union Gap, Wash	do			5.74	5,926
30	Bear	Battle Creek, Utah	S. Fortier	4,500	1.80		957
30	do	do	do	4,500	1.80		1,030
Dec. 4	Humboldt	Golconda, Nev	L. H. Taylor		2.00	1.31	114
6	Weiser	Weiser Canyon, Idaho	A. P. Davis	1,670	.90	1.10	277
7	Payette	Payette, Idaho	do		1.30	2.56	1,603
8	Frenchman	Palisade, Nebr	O. V. P. Stout		1.87	1.41	116
8	Owyhee	County bridge, Oreg.	A. P. Davis	9,875	1.40	1.47	307
9	Republican	Benkleman, Nebr	O. V. P. Stout		1.74	2.31	75
10	Malheur	Vale, Oreg	A. P. Davis	9,900	1.90	2.00	128
20	Sacramento	Red Bluff, Cal	do		10.70	8.60	a 45,000
22	Bear	Collinston, Utah	S. Fortier	6,000	1.80		957
24	Provo	Provo, Utah	do	640	4.40		390

a Approximate.

WELL RECORDS IN NEBRASKA, COLORADO, AND KANSAS.

The following well records were collected by Prof. Robert Hay in the course of his field work, while making a study of the water supply of a portion of the Great Plains. His conclusions are given in a paper accompanying the Sixteenth Annual Report of the Director, but it has not been practicable, for want of space, to give there the details concerning the different wells examined; and, on the other hand, these have been found to possess so many items of value that their publication seems desirable in order that they may be accessible to those particularly interested in the subject. These details are therefore published in this place.

The region examined by Professor Hay extends in a strip about 30 miles wide from the North Platte River along and near the one hundred and second meridian, this being at about the position of the eastern boundary of Colorado, and thus including portions of western Nebraska, eastern Colorado, and western Kansas. His reconnaissance extended as far south as the South Fork of Smoky Hill River, thus covering a strip of country about 170 miles in length. This area may be considered as typical of many thousand square miles of the Great Plains, and the conclusions drawn by Professor Hay have value to the inhabitants of a great part of the States named.

In the following list the wells have been arranged in alphabetical order by counties within each State in which they occur, and again in alphabetical order by post-offices within each county. The tabular statement embodies such facts as could be best expressed by one or two figures. The serial numbers in the first column of the table refer to details which could not well be expressed in tabular form, and which, for economy of space, have been placed after the table. Thus, to get the complete statement for any one well, reference should be made first to the table and then to the statement at the end of the table which has the same number.

The table gives first the arbitrary number; next, the post-office address of the owner of the well, this being presumably the nearest town; next, the name of the owner of the well, and to the right of this the location according to township, range, and section. All of the Land Office subdivisions in this part of the country are referred to the sixth principal meridian, this being understood in all cases. The townships are all north and the ranges west, the initials N. and W. at the top of the column expressing this fact. In the next column is given the year in which the well was completed, this indicating, presumably, the length of time during which the well has been used. The diameter of the well is, for uniformity, given in inches, the dug wells—those of 4 or 5 feet across—being noted as 48 or 60 inches in diameter. The adjacent columns give the total depth of the well in feet, this being the extreme distance from the surface of the ground to the bottom of the well. The depth of water is the height above the bottom at which the water usually stands. The cost of well usually includes all of the necessary expenses, except possibly the labor contributed by the owner himself in making preparations and in general oversight. Cost of machinery includes pump and suction pipe, windmill, or other device for raising the water.

Of the whole number of wells reported, Professor Hay states that 69 are used for irrigation, of which 22 are in Nebraska, 17 in Colorado, and 30 in Kansas. The number put to this use is being constantly increased, and the summer of 1895 will find them running up into the hundreds. This enumeration does not by any means include all of the wells in the district examined, but simply gives those visited by Professor Hay or

concerning which definite information was obtained. They may be regarded as typical, and the information concerning them so complete that the addition of facts relating to others would be of little value.

There is no longer doubt as to the feasibility of irrigating from 1 to 10 acres by water pumped from such wells, and the cost of so doing becomes a serious matter only when the wells approach or exceed 200 feet in depth. In this relation wells under 50 or 60 feet deep may be considered shallow wells, those up to 125 feet may be regarded as of moderate depth, and only those exceeding 180 feet need be considered as deep wells. The cost of well sinking and of pumping machinery is much less than it was when the earlier wells here enumerated were put down, and with improved methods and greater knowledge of conditions this is constantly decreasing, being least at the present time. The volume of underground water is best illustrated by considering the wells grouped together, as at the towns of Goodland, Cheyenne Wells, Sharon Springs, Kanorado, Haigler, St. Francis, Benkelman, Imperial, Lamar, Big Springs, Julesburg, Ogallala, Grant, etc. In general it may be said that the source of the water is from the local rainfall, a portion of this being absorbed by the previous strata, especially that designated in Professor Hay's paper as Tertiary grit. Artesian flows, or those in which the water rises and overflows the surface, have not been found; or at least not in sufficient quantity for the necessities of the plains; but, on the other hand, wells of the character of those here enumerated, especially those penetrating the Tertiary grit, hold a supply sufficiently great to bring under cultivation considerable areas, if suitable pumping machinery is employed. The intelligent, well-directed efforts of the settlers are being rewarded by success, and the results achieved within this area should serve as a stimulus to the undertaking of similar work in other parts of the country.

Data relating to wells in Nebraska.

CHASE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
			N.	W.			In.	Feet.	Feet.		
1	Champion	C. W. Armstrong	5	40	....	1888	36	64	6	$30.00	$35.00
2	.....do.....	G. W. Getzendaner	6	39	32	1889	8	82	7	41.00	84.00
3	.....do.....	J. S. Bell	6	39	23	1889	10	31	10	16.00	75.00
4	.....do.....	Champion (precinct)	6	39	21	1894	3	217	.....	.....	.....
5	.....do.....	Jesse Long	5	41	8	1891	8	32	16	12.00	2.00
6	Dewitt	George Hunt	....	....	....	1888	12	70	7	.....	.....
7	Imperial	H. H. Grosbach	6	38	4	1888	48	104	12	50.00	140.00
8	.....do.....	.....do.....	6	38	4	1890	6	112	24	50.00	100.00
9	.....do.....	Thomas Mercier	6	38	4	1890	12	123	36	50.00	175.00
10	.....do.....	James Burke	6	38	9	1886	18	100	4	35.00	123.00
11	.....do.....	B. and M. R. R. R.	....	....	....	1892	4	137	8	.....	.....
12	.....do.....	C. E. Williams	7	40	9	1886	12	54	9	25.00	.....
13	Lamar	Mrs. G. Hasier	6	39	10	1893	8	101	11	25.00	75.00
14	.....do.....	Edward Bussel	6	40	18	1889	30	23	3	15.00	.....
15	.....do.....	John Morss	7	41	16	1889	8	65	7	.....	.....
16	.....do.....	Town well	7	41	16	1888	10	90	30	90.00	30.00
17	.....do.....	Public well	7	41	16	1888	42	65	5	65.00	30.00
18	.....do.....	Mr. May (tenant)	7	41	15	1890	42	60	6	30.00	35.00
19	.....do.....	Harry Wilson	7	41	31	1887	42	31	7	5.00	.....
20	.....do.....	Fremont Young	....	....	....	1888	42	26	7	5.00	110.00
21	.....do.....	A. E. McCall	8	41	35	1892	10	84	23	25.00	35.00
22	.....do.....	Frank Burney	7	41	23	1886	10	66	8	30.00	61.00
23	.....do.....	John Morss	7	41	29	1885	8	67	14	35.00	75.00
24	.....do.....	John Kingrick	7	41	28	1889	42	62	8	25.00	.....
25	.....do.....	E. P. Huffman	7	41	33	1887	48	18	4	5.00	5.00
26	.....do.....	J. H. Blanke	7	41	33	1893	8	30	9	5.00	5.00
27	.....do.....	J. W. Toothacre	6	41	21	1893	36	39	9	15.00	12.00
28	.....do.....	Miss A. C. Blake	6	41	20	1892	42	62	8	25.00	60.00
29	Venango	W. E. Howell	....	....	....	1886	.....	108	6	100.00	.....
30	.....do.....	Hugh Rowley	8	41	15	1889	12	124	15	65.00	90.00
31	.....do.....	John Wietjes	8	41	10	1892	12	130	15	40.00	.....
32	.....do.....	W. Meyer	8	41	18	1891	8	132	16	50.00	72.00
33	.....do.....	.....	5	41	8	.....	.....	22	10	.....	.....

DEUEL COUNTY.

34	Big Spring	Frank Dorn	13	41	30	1893	6	100	5	$100.00	$100.00
35	.....do.....	Alex. Morrison	....	....	....	1888	72	24	4	10.00	75.00
36	.....do.....	U. P. R. R	13	42	36	1891	144	14	7	.....	.....
37	.....do.....	Walter Kimball	12	42	2	1884	2½	15	8	.....	150.00
38	.....do.....	F. L. Miller	13	41	31	1894	3½	15	7	5.00	.....
39	.....do.....	J. E. Stenvall	14	42	32	1892	3½	236	19	236.00	80.00
40	.....do.....	E. A. Phelps	13	41	6	1887	7	205	6	160.00	125.00
41	.....do.....	W. H. Gilliard	14	42	20	1887	2	247	30	250.00	120.00
42	.....do.....	Ernest Johnson	13	42	18	1892	6	277	127	277.00	110.00
43	.....do.....	A. Zimmerman	13	43	24	1890	7	132	9	132.00	135.00
44	.....do.....	Mrs. M. E. Steward	13	42	14	1893	8	153	.....	153.00	80.00
45	.....do.....	E. A. Phelps	13	41	30	1894	1½	18	3	5.00	55.00
46	Chappell	H. D. Hostetter	13	44	20	1888	7	168	.....	.....	.....
47	Day	William Lador	15	42	34	1894	3½	304	9	350.00	60.00
48	.....do.....	A. D. Remington	14	42	13	1892	3½	330	100	165.00	335.00
49	.....do.....	G. C. Manser	14	42	24	1894	4½	274	24	250.00	150.00
50	Julesburg	W. F. Stafford	12	42	18	1890	4	20	8	5.00	100.00
51	.....do.....	Geo. Kalb	13	44	12	1893	5	225	21	.....	.....
52	.....do.....	Swan Johnson	13	44	14	1893	5½	218	21	145.00	110.00
53	.....do.....	Swan Friskopp	13	43	20	1893	7	180	.....	153.00	105.00
54	.....do.....	Thos. Bell	13	43	10	1893	6	197	20	197.00	120.00
55	.....do.....	S. Adams	15	42	36	1893	6	363	11	360.00	170.00

Data relating to wells in Nebraska—Continued.

DUNDY COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T. N.	R. W.	S.					Well.	Machinery.
							In.	*Feet.*	*Feet.*		
56	Benkelman	School district well	....	....	....	1892	12	38	7	$16.00	$6.00
57	.....do	J. S. West	1	37	18	1893	12	112	13	40.00	85.00
58	.....do	Jos. Robidoux	....	....	....	1888	.....	41	15	.....	.....
59	.....do	.....do	....	....	....	1886	6	76	10	20.00	85.00
60	.....do	.....do	1	37	18	1888	1¼	25	17	.....	.....
61	.....do	David & Larimore	1	37	17	1885	2	24	12	25.00	60.00
62	Champion	J. U. Deselms	4	41	7	1893	12	37	22	25.00	90.00
63	Haigler	Frank Smith	1	40	23	1894	7	20	11	8.00	75.00
64	.....do	W. H. Sullivan	1	41	28	1894	42	50	26	15.00	85.00
65	.....do	Mr. Southlean	1	40	21	1895	42	10	4	.....	.....
66	.....do	W. R. Way	1	40	30	1885	12	45	13	25.00	.....
67	.....do	J. C. McPherson	....	....	....	1894	6	62	30	25.00	60.00
68	.....do	Town of Haigler	1	41	34	1888	6	62	32	20.00	65.00
69	.....do	H. R. Calkins	1	41	10	1889	.....	48	4	10.00	.....
70	Lamont	M. N. Palmer	....	....	....	1893	*a* 48	10	3	5.00	60.00
71	.....do	W. H. Griffiths	3	41	29	1893	48	42	27	10.00	87.00
72	.....do	R. F. Little	3	41	5	1894	42	18	2	10.00	.....

a Inches, square.

KEITH COUNTY.

73	Big Spring	Henry Butz	14	41	22	1889	3	344	8	$296.00	$200.00
74	.....do	A. Sunderman	13	41	32	1894	2	292	60	190.00	110.00
75	.....do	E. E. Leech	13	41	22	1890	*a* 48	32	17	50.00	150.00
76	.....do	.....do	13	41	22	1894	.....	10	5	100.00	900.00
77	Brule	Jas. Scott	13	40	15	1892	.....	15	5	.....	.....
78	.....do	Ed. Cooney	....	....	....	1884	6	44	10	30.00	100.00
79	Day	Henry Brawz	14	40	18	1893	3	421	18	*b* 484.00	.....
80	.....do	M. S. Collins	15	41	10	1889	1⅓	22	5	.....	6.00
81	.....do	Thos. Clark	14	41	2	1892	2	402	35	500.00	120.00
82	Ogallala	F. P. Dickinson	15	39	36	1889	2	16	6	.....	7.50
83	.....do	A. Phelps	13	38	6	1885	8	16	3	15.00	6.00
84	.....do	U. P. R. R	13	38	6	.....	144	12	4	.....	.....
85	.....do	Jesse Campbell	13	39	7	1890	10	48	15	15.00	40.00
86	.....do	E. M. Searle	13	39	10	1886	1¼	30	6	.....	60.00
87	.....do	Jacob Nostrum	....	....	....	1886	3	190	10	220.00	9.00
88	.....do	J. H. Cameron	13	39	22	1889	12	47	6	10.00	75.00
89	.....do	John Felt	12	40	12	1892	2	225	10	196.00	66.00

b Well and machinery.

PERKINS COUNTY.

90	Big Spring	G. W. Stocking	12	41	24	1887	*a* 48	.....	.....	$400.00	$100.00
91	Brandon	D. Mohnssen	....	....	....	1885	2	195	5	.....	.....
92	.....do	J. C. Leonardson	....	....	....	1892	8	.....	.....	.....	.....
93	.....do	Town of Brandon	....	....	....	.....	.....	164	14	.....	.....
94	.....do	G. Whitford	....	....	....	1893	4	172	22	176.00	56.00
95	Brule	B. F. Woodall	12	40	19	.....	2	210	14	267.00	75.00
96	Grant	B. and M. R. R. R	10	39	13	1887	9	200	40	.....	.....
97	.....do	Jno. M. Mills	9	38	9	1886	12	138	24	140.00	300.00
98	Ogallala	Chas. Roesler	12	39	14	1887	2	214	32	300.00	120.00
99	Venango	D. R. Bivens	9	41	7	1892	10	185	15	.....	.....
100	.....do	Town of Venango	9	41	7	1888	8	190	40	120.00	125.00
101	.....do	J. C. Davidson	9	41	34	1891	7	154	27	63.00	40.00
102	.....do	Harvey Scott	....	....	....	1889	8	195	15	120.00	125.00
103	.....	.....	9	41	30	1886	4	160	18	.....	.....

a Inches, square.

No. 1.—Dug well; 336 gallons an hour; can be easily lowered, but the original level is restored in half an hour; water raised by wind pump with 10-foot wheel and 1.25-inch pipe; is used for domestic purposes, for 50 head of stock, and irrigated half an acre last year, to be increased to an acre this year. Strata passed through: Yellow sandy soil; magnesia at 5 feet; water in gravel and hard rock. The water level is about the same as that at Champion, in the valley of the Frenchman.

No. 2.—Drilled well; water level does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 10-foot wheel and 1.25-inch pipe; is used for domestic purposes and 50 head of stock. Strata passed through: Soil, 3 feet; magnesia, the top sandy; hard ledge 20 feet down; water in gravel.

No. 3.—Bored well; does not vary; water rose about a foot in the well; about 20 barrels per hour; can not be easily lowered; quality of water, soft; water is raised by wind pump with 8-foot wheel and 1.25-inch pipe; is used for house and at times for 125 head of stock. Strata passed through: Soil, 5 feet; sand, 16 feet; water gravel, 10 feet.

No. 4.—Bored well. Strata passed through as follows:

	Feet.
Soil	4
Sand	8
Magnesia (water from 26 to 52 feet)	40
Gray rock and clay	60
Gravel with water	27
Red clay with hard streaks	20
Gravel, sand, and water	12
Clay	6
Sand, gravel, and water	38

No. 5.—Bored well. The second vein, at 30 feet, rose to the upper one, at 16 feet. The depth of water does not vary; can be easily lowered, but not exhausted; the quality of the water is not very hard; the water is raised by windlass; is used for domestic supply and for 9 head of stock. Strata passed through: Sand, magnesia (blue), 12 or 14 feet; quicksand with water; red magnesia, red clay, green magnesia, water in magnesia.

No. 6.—Bored well; can not be easily lowered; the quality of the water is hard; the water is raised by wind pump; is used for house and for many head of stock. The strata passed through are the same as in the other wells about Lamar.

No. 7.—Dug well. The quantity of water which can be obtained from the well has not been tested; can not be easily lowered; quality of the water, not very soft; water is raised by wind engine; is used for a livery barn. Strata passed through: Plains marl, not thick; magnesia with gravel at water. Temperature, 55° F.

No. 8.—Bored well; water does not vary; 5 gallons per minute; can not be easily lowered; quality of water, soft; water is raised by wind pump; is used for domestic purposes and for irrigating a garden. Strata passed through: Magnesia reached at 6 feet from surface; a red clay was passed through in the magnesia and gravel below. This well is about 1,100 feet from No. 1, and has the same temperature.

No. 9.—Drilled well, dug part of the way; water rose a few feet at first; 600 gallons per hour; can not be lowered; water raised by wind pump with 12-foot wheel; is used for domestic purposes and for subirrigation of 4 acres. Strata passed through: Magnesia reached 7 feet from surface; a hard ledge passed through above the water, which is in gravel. This well is 2,000 feet from No. 8, and farther from No. 7.

No. 10.—Dug and drilled well; flow slightly decreased by being partly filled; 240 gallons per hour; can be lowered slightly; quality of water, hard; water raised by wind pump with 12-foot wheel. The water is used for domestic purposes, for 25 head of stock, and irrigates nearly a quarter of an acre. Strata passed through: Magnesia reached at about 20 feet; water was in coarse gravel. This well is nearly as far from No. 7 as No. 9, but in the opposite direction.

No. 11.—Drilled well; 45,000 gallons in 18 hours; can not be lowered; quality of water, hard; water raised by steam pump. Strata passed through: Struck magnesia at 16 feet; a vein of water was reached at 100 feet, which is shut off; hard rock below that to the water used. This well is between wells Nos. 8 and 10.

No. 12.—Bored well; 7 barrels per hour; can not be easily lowered; water raised by buckets and windlass; is used for domestic purposes and for 25 head of stock. Strata passed through: Yellow subsoil, 4 feet; magnesia; water in 9 feet of gravel and sticky rock at bottom; had not reached second sheet.

No. 13.—Drilled well; water rose a few feet in the well; can not be lowered; water raised by wind pump with 8-foot wheel and 1.25-inch pipe; is used for domestic purposes and for 20 head of stock. Strata passed through: Soil, 10 feet; then magnesia; 6 inches of hard rock above the water, which is in gravel. Temperature, 55.5° F.

No. 14.—Dug well; varies with the height of the neighboring mill pond; can be easily lowered; quality of water, medium hard; water raised by means of rope and buckets. Strata passed through: All in the magnesia. This well, with Nos. 3 and 4, is in the valley of the Frenchman.

No. 15.—Dug and bored well; can be easily lowered; quality of water, medium hard; temperature, 52° F.; water raised by hand pump; is used for a livery barn. Strata passed through: Magnesia reached at 6 feet; water is in gravel. This well is in the town of Lamar. Four other wells near by do not influence one another.

No. 16.—Bored well; can be easily lowered; water raised by hand pump; is used for domestic purposes and for stock. This is the public town well. Strata passed through: Soil, 5 feet; hardpan, 8 feet; magnesia, 2 feet; sandy gravel, 45 feet; gravel and sand, 30 feet, with water. This well is 350 feet south from No. 15, and the same distance north from No. 17.

No. 17.—Dug well; quality of water, not very hard; water used constantly by the public. Strata passed through: Magnesia at surface, 5 feet; sand and gravel, 60 feet.

No. 18.—Dug well; can not be easily lowered; quality of water, rather hard; water raised by hand force pump; is used for house and for 50 to 60 head of stock. Strata passed through: Soil, sandy loam, 5 feet; sand and hardpan, 13 feet; magnesia, 3 feet; sand and gravel, 39 feet. The hardpan here described is a dark-lavender clay, containing fine sand, but impervious to water.

No. 19.—Dug well; can not be easily lowered; water raised by means of pulley and buckets; is used for domestic purposes and for stock. Strata passed through: Loamy soil, 5 feet; cohesive sand, 26 feet; no magnesia. This well is south of the Frenchman, approaching the sand hills. The water was struck suddenly.

No. 20.—Dug well; can not be easily lowered; water raised by wind pump; has been used for supplying from 300 to 600 head of cattle ever since made. Strata passed through: Loam and sand.

No. 21.—Bored well; water rose 1 foot; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of cattle. Strata passed through: Soil, 1 foot; magnesia, 1 foot; red clay; sand with water.

No. 22.—Bored well; depth of water does not vary; 24,000 gallons per day; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating one-third of an acre. Tank, 40 by 20 by 1 feet. Strata passed through: Soil, 2.5 feet; magnesia; dry gravel, magnesia; gravel with water. In a well southeast of same section water was struck at from 60 to 82 feet.

No. 23.—Bored well. The water was found at the bottom, and it rose 14 feet. Depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 1 foot; magnesia; rock (at 50 feet); gravel and sand.

No. 24.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating 1 acre. Strata passed through: Soil, magnesia, gravel. A well 1 mile east has about the same depth and similar conditions.

No. 25.—Dug well; rises with the Frenchman River, which is within 50 feet; can be easily lowered by the pump; water raised by hand pump; is used for domestic supply and for 50 head of stock. Strata passed through: Black muck and gravel at bottom. This well is on the Frenchman bottom, the river at this point being only a few rods wide, though somewhat wider above.

No. 26.—Bored well; can be easily lowered by rapid pumping; quality of water, medium soft; water raised by hand pump; is used for domestic supply. Strata passed through: Gravel. There are magnesia bluffs close to, but the formations are variable here. This well is 1¼ miles east by south from No. 25. A short distance south (across the Frenchman) is a schoolhouse well, 54 feet deep, on the magnesia bluffs. The pools in the river bed here are the first permanent water of the Frenchman. (See Follett's sections, Fifty-second Congress, first session, Senate Ex. Doc. 41.)

No. 27.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for 14 head of stock. Strata passed through: Soil, a few inches; sandy loam, 4 feet; magnesia. Water in a sandy formation. There was a little seep of water at 16 feet. This well is on the north edge of the sand hills.

No. 28.—Dug well; depth of water does not vary; can be emptied in two hours, but is replenished to a depth of 3 feet in an hour; quality of water, not very soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 55 head of stock, and irrigates a small area. Strata passed through: Soil and sand, 20 feet; magnesia to near the water; hard just above the water; water in greenish magnesia. Wells in the neighboring quarter section have water at about the same level and similar conditions. This well is in the sand hills.

No. 29.—Well originally dug, now tubed. The depth of the water does not vary, though, having caved in, the water is not as abundant as formerly. Can not be easily lowered; quality of water, soft; water raised by windlass; is used for domestic supply and for 10 head of stock. Strata passed through: Gravel and sand, with a little rock near the bottom. A well 1 mile south is 98 feet deep.

No. 30.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 2 feet; magnesia; rock and gravel. There is some plains marl soil in the neighborhood.

No. 31.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by hand buckets and horse; is used for domestic supply and for 16 head of stock. Strata passed through: Soil, 3 feet; sandy clay; rock to bottom. The magnesia shows 10 rods away, but is not in the well. A well on the southwest quarter of this section has a wind mill, and the water is abundant at the same depth.

No. 32.—Bored well; depth of water does not vary; 7½ barrels per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 3 feet; sand, light with magnesia (plains marl?), 40 feet; gravel, 73 feet; rock, 4 feet; gravel with water to bottom.

No. 33.—Dug well; depth of water does not vary; 22 barrels per hour; water raised by wind pump with 8-foot wheel. Strata passed through: This only reached first vein of water in quicksand, as at No. 5, which is in the same quarter section. A well 8½ miles northeast towards Champion is 50 feet deep.

No. 34.—Drilled well; depth of water does not vary; can be exhausted by pumping in 24 hours, but the water level is restored in a few hours; quality of water, not

very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for a little irrigation. Strata passed through: Soil, 3 feet; magnesia; rock; gravel.

No. 35.—Dug well; depth of water does not vary; can not be lowered by the pump running all day; quality of water, soft; water raised by wind pump with 12-foot wheel and 4-inch cylinder; is used for domestic supply and for 600 head of cattle. Strata passed through: Magnesia and gravel.

No. 36.—Dug well; depth of water does not vary; pumping 500 gallons per minute can not lower it; quality of water, soft; water raised by wind pump with 26-foot wheel; is used for railway purposes. Strata passed through: River alluvia. The water is partly supplied by the overflow seepage from the "Big Spring," which is about 30 rods north and 20 feet higher.

No. 37.—Dug four feet, driven well below; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump, geared with 12-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating half an acre. Strata passed through: River alluvia. The June freshet—the so-called "Coxey flood"—wet by percolation all the hay land between this well and the river, which is to the north of it about 100 rods.

No. 38.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, rather hard and alkaline; water raised by hand pump; is used for domestic supply and for 25 head of stock. Strata: River alluvia; clay at bottom. This is the South Platte bottom, on the south side of the river.

No. 39.—Drilled well; water rose 9 feet above where it was first struck; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata: Soil, 2 or 3 feet; magnesia; sand and gravel.

No. 40.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 10 to 15 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 10 feet; gravel to bottom This is well No. 3 of Mr. Follett's Big Spring line. (Fifty-first Congress, first session, Senate Ex. Doc. 41, Appendix V.)

No. 41.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 200 head of stock. Strata: As usual on the plateau.

No. 42.—Drilled well; water was reached at bottom of well, but rose to 127 feet; depth of water does not vary; half tank (10 feet by 20 feet) in half a day; can be lowered with one-half day's pumping, but is restored in a few hours; water raised by wind pump with 12-foot wheel; is used for domestic supply and for stock. Strata passed through: One foot of soil, limestone, and some clay; water in gravel.

No. 43.—Drilled well; depth of water does not vary; sometimes there is 13 feet of water, but the depth never falls below 9 feet; 975 gallons in 2 hours' pumping; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating one-quarter of an acre. Tank, 30 feet in diameter. Strata passed through: Soil, 8 feet; magnesia, 2 or 3 feet; sand and gravel, 10 feet; cement gravel, about 20 feet; yellow clay, 11 feet; sand and gravel to water, and a lime rock in the water.

No. 44.—Drilled well; water rose a little when first struck; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for over 50 head of stock. Strata passed through: Soil, 2 or 3 feet; magnesia, 4 or 5 feet; gravel all the way to water, with red sand.

No. 45.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for a hotel and for domestic supply. Strata passed through: Gravel, black soil, 2 feet; magnesia and gravel.

No. 46.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 12-foot wheel; is used for domestic supply. Strata passed through: As usual in this district. The magnesia outcrops a mile north at the surface.

No. 47.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 3 feet, yellow clay, 39 feet; gravel, 25 feet; hard rock, 50 feet; gravel, 15 feet; a little magnesia and gravel to water. This well is also on a plateau, near the top of the bluffs overlooking the North Platte.

No. 48.—Drilled well; depth of water does not vary; 200 barrels per day; can not be easily lowered; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 200 head of stock. Temperature, 54° F. Strata passed through: Soil, 8 feet; yellowish clay, 88 feet; sand and gravel with water; clay, magnesia, and gravel; a little rock; magnesia at 300 feet. There was also a sheet of water at 90 feet.

No. 49.—Drilled well; water rose about 18 feet; depth of water does not vary; 200 gallons per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 20 feet; sand and clay, 35 feet (these are the plains marls); magnesia, gravel, and sand to bottom. Drill went 80 feet below the water in reddish, soft magnesia, but struck no more water.

No. 50.—Dug and driven well; water rose slightly; depth of water varies with the height of the river to the extent of 2 or 3 feet; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply. This well, with three others, waters between 100 and 200 head of stock and irrigates 7 or 8 acres, all of them discharging into a tank three-quarters of an acre in area. Strata passed through: Soil; sand; clay, 2 feet above the water. Temperature, 52° F.

No. 51.—Drilled well; water rose 13 feet when struck; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: As usual on this plateau.

No. 52.—Drilled well; water rose 13 feet; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock.

No. 53.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water not very hard; water raised by wind pump; is used for domestic supply and for stock. Much sand caved in while drilling.

No. 54.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 45 head of stock all summer. Strata passed through: Mostly gravel.

No. 55.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 3,000 head of sheep. Strata: Soil, 11 feet; sand and magnesia.

No. 56.—Bored well; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for a schoolhouse. Strata passed through: Soil, 1 foot; sand, or sandy soil, 30 feet; quicksand and pebbles, 8 feet; blue shale at bottom.

No. 57.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for irrigating a number of trees. Strata passed through: Soil, 1 foot; sand all the way down. This is 75 feet above the railway on

the bottom, being in the highest part of the town. It appears that the sand-hill region has here encroached upon the river bottom.

No. 58.—Dug 26 feet, drilled 15 feet; depth of water does not vary; 4 barrels per hour can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 5 head of stock. Strata passed through: Sand; gravel; sand. This well is in the town. There are about 50 wells in the town of Benkelman.

No. 59.—Bored well; depth of water does not vary; water can be obtained from the well for whole days and nights in succession; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for irrigating a garden and an orchard. There is no record of the strata. The well is in the town, but on the slope above the bottom.

No. 60.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for the customers of a large general store. River alluvia (sand).

No. 61.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for livery barn and for 400 head of stock. Strata passed through: Probably all river alluvia, being in the lower part of the town, on Republican bottom. There are several wells near at this level, but none farther out on the bottom.

No. 62.—Bored well; first water was struck at 15 feet, and rose 1 foot; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 480 head of cattle; tank kept full all the time. Strata passed through: Sand, 16 feet; quicksand, 8 feet; magnesia, 13 feet.

No. 63.—Bored well; depth of water does not vary; 16 gallons per minute; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 8-foot geared wheel; is used for 80 head of stock and for irrigating half an acre. Strata passed through: Soil and sand, 9 feet; coarse gravel, 11 feet. There are several wells on the river bottom of similar depth and material, confined to a strip of the North Fork Republican Valley one-half mile wide. A similar strip on each side of the valley slope has wells about 60 feet deep, as at Haigler.

No. 64.—Dug and drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard and alkaline; water raised by wind pump with 9-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating a small area. Strata: Soil; yellow sandy loam; clay and gravel.

No. 65.—Dug well; depth of water does not vary; water raised by means of rope and buckets; is used for domestic supply. Strata passed through: Soil; sand and clay; gravel with water. This well is on Republican bottom.

No. 66.—Bored well; depth of water does not vary; can be easily lowered at times, owing to a defect in tubing; quality of water, medium soft; water raised by means of pulley and buckets; is used for domestic supply and for 15 head of stock. Strata passed through: Soil, 3 feet; yellow clay, with streak of sand in middle, 29 feet; coarse sand, with water, to bottom. This well is on the second slope of the North Fork Republican, 3 miles east of Haigler.

No. 67.—Drilled well; depth of water does not vary; 10,000 gallons per day; can not be easily lowered; quality of water, hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, and has irrigated one-eighth of an acre. Strata passed through: Soil, 1½ feet; yellow clay, 30 feet; sticky yellow clay, with water, 20 feet; quicksand, 3 feet; sandy clay, 7 feet. A well three blocks west is 78 feet deep. After passing through the same formations, gravel was reached at 75 feet, water being struck at the same level as in No. 67, the well referred to having 48 feet of water.

No. 68.—Dug and bored well; depth of water does not vary; can not be easily lowered. There are two sheets of water, the upper being hard and the lower

soft. Water raised by wind pump with 12-foot wheel; is used for public purposes, including irrigation of trees on both sides of a street. Strata passed through: Yellow clay, 32 feet; sticky yellow clay, with water, 20 feet; fine quicksand, 3 feet; sandy soil, 7 feet. There are 4 wells in the town of Haigler, all of which are used for irrigating small areas.

No. 69.—Dug well; depth of water does not vary; can not be easily lowered; water raised by means of pulley and buckets; is used for domestic supply and for 30 head of stock. Strata passed through: Sand; magnesia, coarse sand, and gravel with water.

No. 70.—Dug well; depth of water does not vary. During October, 1894, however, which was extremely dry, the depth of the water seemed to decrease. It is apparently increasing at the present time; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 200 head of stock. Strata passed through: Magnesia; soil; quicksand.

No. 71.—Dug and driven well; depth of water does not vary; 300 barrels in one day; can be lowered slightly, and then keeps its level; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 400 head of stock. Strata passed through: Sand, 10 feet; magnesia and rock; yellow clay and gravel.

No. 72.—Dug well; depth of water varies about a foot from dry years to wet; can not be easily lowered; quality of water, not very hard; water raised by means of pulley and buckets; is used for domestic supply and for 30 head of stock. Strata passed through: All sand.

No. 73.—Drilled well; depth of water does not vary; 200 gallons per hour; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 75 head of stock. Strata passed through: Soil, 5 feet; yellow clay, 90 feet; magnesia, red clay, and gravel to bottom; no hard rock.

No. 74.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 150 head of stock. Strata passed through: Soil with gravel, 3 feet; yellow clay, 40 feet; gravel; rock and gravel to bottom.

No. 75.—Dug well. There are two sheets of water, the lower sheet rising to the upper one. The depth of the water does not vary, except that it rises to the extent of 18 inches when the river, which is 60 rods distant, is at flood; 65 gallons per minute; can not be easily lowered; water raised by wind pump with 14-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating 1 acre. Strata passed through: Soil, 2½ feet; fine quicksand and magnesia, 12½ feet; quicksand with water, 6 inches; coarse gravel, 1½ feet; clay, 8½ feet; and gravel to the water, which is in quicksand at bottom.

No. 76.—Dug well; depth of water varies with the height of the river; 6 cubic feet per second; quality of water, hard; water raised by steam centrifugal pump; is used for irrigation. Strata passed through: River alluvia, with a bed of clay at the bottom, which is 8 feet thick. This is a trench, rather than a well, and was not completed at the time of the writer's visit. The remarkable manner in which this trench was affected by the "Coxey" flood is given in the paper in the Sixteenth Annual Report of the United States Geological Survey.

No. 77.—Driven well; depth of the water varies with the height of the river; can not be easily lowered; water raised by steam pump; is used for domestic supply and for a small number of cattle. Strata passed through: River alluvia. This well is on the South Platte bottom, and there are a number of wells about the village of Brule with plenty of water.

No. 78.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump; is used for domestic

supply, for 140 head of stock, and is capable of watering 500 head. Strata passed through: Sand and gravel. This well is three-quarters of a mile from the river and was not affected by the June freshet.

No. 79.—Drilled well. This is not a successful well because of the sand drawing in and hindering the supply of water. Water raised by wind pump with 14-foot wheel. Strata passed through: Soil, 4 feet; yellow clay (the plains marl), and the usual magnesia and gravel of this plateau. The marl is about 100 feet.

No. 80.—Driven well; depth of water varies with the height of the river, which is 40 rods distant; water can be obtained from the well all day and night; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for domestic supply. Strata passed through: River alluvia.

No. 81.—Drilled well. Broken casing and bad workmanship have rendered this well useless. Depth of water does not vary; could not be easily lowered; quality of water, medium hard; water raised by wind pump with 14-foot wheel. Strata passed through: Soil, 4 feet; yellow, limy, or gray, soil (the marl), 120 feet; white magnesia, yellow magnesia, gravel, and coarse sand with the water. This well is within 40 rods of the top of the plains marl bluffs, whose precipitous fronts begin the descent to the North Platte, the bed of which is over 500 feet below.

No. 82.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by hand pump; is used for domestic supply and for 25 head of cattle. Strata passed through: River alluvia. This well is on the North Platte bottom.

No. 83.—Bored well; depth of water does not vary; 10 gallons per minute; can be lowered by rapid pumping; quality of water, hard; water raised by hand pump with 3-inch cylinder; is used for domestic supply, and has irrigated a city block 250 feet square. Strata passed through: River alluvia. This well seems to have been affected by the freshet in the river last June, as the water is raised with less difficulty than formerly.

No. 84.—Dug well; slightly lowers with pumping, and varies with the water in the South Platte, from which it is distant between 60 and 70 rods; 6,000 gallons per hour for 6 hours can be obtained from the well, this filling the tank, and at the same time lowering the well; quality of water, not very hard; slightly alkaline; water raised by steam pump; is used for railway purposes. Strata passed through: Sandy alluvia.

No. 85.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 2 feet; fine yellow sand (plains marl), 18 feet; water in gravel. This well is on the second slope to the river, which is three-quarters of a mile to the north.

No. 86.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; water used for domestic supply and for 200 head of stock. Strata passed through: River alluvia. This well is near the river. A water hole one-quarter of a mile north of the well had water by percolation after the June freshet.

No. 87.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for stock. Strata passed through: Soil, 3 feet; sand; magnesia; gravel rock, 2 feet; gravel with water.

No. 88.—Bored well; depth of water does not vary; 75 to 100 barrels per day; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 3 feet; fine magnesia sand (plains marl?), 5 feet; clay and sand, 4 feet; gravel and sand, 35 feet.

No. 89.—Tubular well; depth of water does not vary; 20 barrels in 4 hours; can not be easily lowered; quality of water, soft; water raised by wind pump with

10-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating about one-half an acre. Strata passed through: Soil, 1½ feet; reddish yellow clay, 1½ feet; magnesia, sand, and gravel to water.

No. 90.—Dug well; depth of water does not vary; 1 barrel in 15 minutes; can not be easily lowered; quality of water, not very hard; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 2 feet; magnesia; water in sand.

No. 91.—Bored well; depth of water does not vary; 30 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by wind pump.

No. 92.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; is used for domestic supply, for 15 head of stock, and for irrigating a small garden. Strata passed through: Magnesia near top, and water in gravel.

No. 93.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for the stock of all the district.

No. 94.—Bored well; depth of water does not vary; 20 barrels per day; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 14 feet; sand and gravel to water; some hard streaks and some claylike soapstone.

No. 95.—Drilled well; depth of water does not vary; 1 barrel in 25 minutes; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; light-yellow clay, 80 feet; gravel, magnesia, and gravel to water.

No. 96.—Dug 160 feet; drilled 40 feet more; rose slightly when water was struck; steam pump exhausts the well every day, but it is speedily replenished; depth of water does not vary; 36,000 gallons per day; can be easily lowered; quality of water, not very hard; water raised by steam pump; is used for railway purposes and for supplying the town of Grant. Strata passed through: Soil, 18 inches; magnesia, gravel, and sand, with cemented gravel 6 inches above the water.

No. 97.—Dug 110 feet; bored 28 feet. This well flowed at the surface 10 barrels in 1887, again a month later, and again six months afterwards; depth of water does not vary; with the mill running constantly, the water can not be easily lowered; quality of water, rather harder than when the well was first dug; water raised by wind pump; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 18 inches; sand, 2 feet; joint clay, 2 feet; magnesia, 2 feet; gravel, 22 feet; magnesia rock, 5 feet; red clay, 6 feet; gravel, 6 feet; red clay, 8 feet; gravel to water, with some hard rock.

No. 98.—Dug 184 feet; drilled 30 feet; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 40 head of stock. Strata passed through: Sand most of the depth.

No. 99.—Bored well; depth of water does not vary; water obtained from the well day and night; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for livery barn, and for neighborhood stock. Strata passed through: Soil, a few feet; a little white magnesia; water in hard magnesia.

No. 100.—Bored well; water rose a little when first struck; depth of water does not vary at different times of the year; can not be easily lowered; quality of water, hard; water raised by wind pump; is used by the public. Strata passed through: Soil, 4 feet; magnesia, 10 feet; red-clay soil, 30 feet; hard-rock shale (clay?); gravel with water.

No. 101.—Bored well; has risen 13 feet; can not be easily lowered; quality of water, not very soft; water raised by wind pump; is used for domestic supply and

for 100 head of stock daily. Strata passed through: Soil, 20 feet; clay and gravel; streaks of black or brown dirt; no magnesia; water in gravel.

No. 102.—Depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Same as in Venango well.

No. 103.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water soft; water raised by wind pump. Strata passed through: Soil, 1 foot; magnesia, a few feet; gravel.

Data relating to wells in Colorado.

ARAPAHOE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery
			S.	*W.*			*In.*	*Feet.*	*Feet.*		
1	Idalia	E. M. Thurber	4	44	16	1888	7	206	12	$115.00	$120.00
2	do	H. H. Fisher	4	44	22	1887	36	194	2	110.00	110.00
3	do	J. S. McClellan	4	44	1	.....	.....	203	7	.....	.....
4	do	J. H. Cupp	3	44	26	1892	6	235	14	85.00	95.00
5	do	Jno. Gerber	3	44	33	1892	5	225	10	90.00	105.00
6	Jaqua, Kans.	Geo. Hadley	5	42	10	1880	.....	18	8	.....	.....
7	Lansing	C. C. Kirkland	4	44	6	1892	6	189	16	72.00	125.00
8	do	F. A. Greatsinger	3	43	35	1891	6	224	4	100.00	140.00
9	do	C. J. Shoemaker	3	42	34	1893	6	213	8	85.00	105.00
10	do	S. A. Briniker	3	42	17	.....	.....	216	10	.....	.....
11	Logan	Henry Nichols	3	43	33	1892	6	200	8	80.00	.....
12	Seebarsee	J. H. Rosenkrans	1	42	2	1882	36	18	4	10.00	10.00
13	Wray	David Foreman	1	44	8	.....	.....	250	20	.....	.....
14	.....	Jno. Ramsey	4	44	9	1893	5	215	15	85.00	125.00

CHEYENNE COUNTY.

15	Cheyenne Wells	School district, city of Cheyenne Wells.	14	44	21	1893	*a* 42	265	18	.....	.....
16	do	School district No. 6	14	44	7	1890	36	181	4	$300.00	$100.00
17	do	Ella B. Williams	13	44	28	.....	.....	20	5	.....	.....
18	do	E. L. Parker	13	44	26	1890	12	15	2	10.00	50.00
19	do	U. P. R. R	....	....	....	1882	10	257	25	.....	.....

a Inches square.

KIT CARSON COUNTY.

							°				
			N.	*W.*							
20	Ashland	Wm. M. Long	6	42	3	1888	6	150	12	$60.00	$108.00
21	do	.....	6	42	3	1894	6	207	16	80.00	125.00
22	do	.....	6	42	34	1893	5½	172	12	65.00	95.00
23	Burlington	E. W. Cain	9	42	31	1893	.....	130	4	.....	75.00
24	do	Dana Shaw	9	43	35	1888	6	164	14	37.00	70.00
25	do	S. J. Jones	9	43	33	1892	8	150	10	100.00	100.00
26	do	Wm. Penfold	9	43	31	.....	.....	150	10	.....	.....
27	do	Wm. Boyles	9	44	12	1891	8	148	24	55.00	85.00
28	do	City of Burlington	8	44	36	1893	2	200	35	130.00	125.00
29	do	Adolph Hoss	8	43	19	1889	.....	160	8	70.00	125.00
30	Colorado Springs	Al. Russell	8	44	13	1888	.....	155	4	.....	75.00
31	Haigler	John Keegan	9	51	3	1892	36	78	4	50.00	.....
32	Goodland, Kans.	J. M. Willis	....	....	....	1889	6	149	22	45.00	225.00
33	Lamborn, Kans.	Wm. Rutherford	8	42	8	1889	.....	176	14	60.00	100.00
34	do	C. H. Briggs	9	42	35	1891	.....	130	4	.....	.....
35	do	L. R. Hauks	8	42	2	1890	6	165	15	65.00	125.00
36	do	Jno. Patterson	8	42	25	1892	6	119	16	40.00	40.00
37	do	A. P. Shaw	7	42	23	1889	6	167	11	85.00	107.00

Data relating to wells in Colorado—Continued.

PHILLIPS COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
			N.	*W.*			*In.*	*Feet.*	*Feet.*		
38	Amherst	Jesse Jurgens	9	43	34	1891	10	180	15	$77.00	$140.00
39	do	L. E. Fair	8	43	18			174	30	105.00	95.00
40	Holyoke	Fred Hawkes	7	44	2	1890	12	136	20	30.00	
41	do	F. C. Churning	8	44	33	1887	2	140	15		
42	do	A. T. Guthrie	7	45	12	1890	10	163	7	100.00	80.00
43	do	Frank Austin	7	45	6	1893	6	174	24	100.00	95.00
44	do	B. and M. R. R. R.				1887	7	175	40		
45	do	P. B. Reynolds	6	44	2	1886	10	108	8	55.00	96.00
46	do	A. A. Shafer	7	44	12	1887	12	115	7	35.00	85.00
47	do	W. R. Whitney	7	43	18	1888	8	104	14	65.00	80.00
48	Lamar, Nebr.	W. C. Knapp	7	42	17	1893	8	120	35	70.00	50.00
49	do	Jacob Endicott (tenant).						102	12		
50	Venango, Nebr.	Jno. Scott				1889	8	171	27		
51	do	J. R. Gilmore	8	42	5	1890		143	23	80.00	90.00

SEDGWICK COUNTY.

52	Amherst	Jno. W. Franklin	8	44	9	1891	12	195	18	$69.00	$52.00
53	Julesburg	Uberto Gibello	11	44	4	1894	3	40	13		10.00
54	do	C. M. Harris	12	43	26	1886					
55	do		12	44	26	1893	10	30	6	18.00	75.00
56	do	Jno. Grove						200			
57	do	J. P. Brown	10	43	12	1893	2	265	100	365.00	50.00
58	do	do				1894	12	28	4	15.00	100.00
59	do	Fred Munson	12	44	34	1891	a36	21	3	12.00	110.00
60	do	U. P. R. R.					168	20	5		
61	do	D. B. Morgan	12	44	28		10			8.00	
62	do	H. M. Brown	12	44	28	1884	8	22	6	7.50	8.00
63	do	S. H. Carlson	11	45	12	1888	a36	50	12	25.00	78.00
64	do	Chris. Anderson	11	45	15	1891	a48	16	4		
65	do	H. Smith	12	43	30	1886	8	65	7	70.00	60.00
66	Snyder	Chris. Johnson						60	10		
67	Venango, Nebr.	Conrad Rahns	9	42	18	1889	2	170	28	255.00	95.00
68	do	Ira Clapper	10	40	1	1887	2	265	60	335.00	65.00
69	do	C. H. Fulscher				1888	2	281	70	250.00	100.00
70	do	do	10	42	36	1893	11	177	8	93.00	68.00
71	Wray	W. S. Dorman	1	43	7			160			

YUMA COUNTY.

72	Seebarsee	A. M. Bullard	1	42	30	1890	6	85	20	45.00	100.00
73	do	Jacob Burrel						100			
74	do	Joseph Herman	3	42	4	1894	3½	80	10		

a Inches square.

No. 1.—Drilled well; depth of water does not vary; 250 barrels in 4 hours; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot geared wheel; is used for domestic supply, public supply of the village, and for 200 head of cattle. Strata passed through: Soil, 2 feet; yellow marl, 68 feet; magnesia; gravel with water.

No. 2.—Dug well; depth of water does not vary; can not be lowered by pumping all day; water raised by wind pump with 8-foot wheel and 2-inch cylinder; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 3½ feet; yellow clay, 77 feet; sand, 14 feet; hard magnesia, clay, and sand, 100 feet; gravel and rock.

No. 3.—Depth of water does not vary; can not be easily lowered; water raised by wind pump.

No. 4.—Drilled well (164[1]); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot Monitor wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; yellow clay, 30 feet; rock, clay, and gravel; sand with the water. This well is 3 miles east of No. 5, but not so near the canyon. A well 1 mile north, near the top of the Arickaree canyons, is 240 feet deep.

No. 5.—Drilled well (163); depth of water does not vary; 150 barrels in 12 hours; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 20 head of stock, and for irrigating one-eighth of an acre. Strata passed through: Soil, 4 feet; yellow fine dirt, 96 feet; native lime, 4 feet; sand rock; water in rock.

No. 6.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather hard. Another well near is very alkaline. Water raised by hand pump; is used for domestic supply and for some stock. Strata passed through: Alluvia to gravel. It is on the second bottom of the South Fork Republican Valley. The alkaline water indicates the proximity of shales, which crop out in the sides of the valley in places.

No. 7.—Drilled well (158); depth of water does not vary; can not be easily lowered; quality of water, not very soft; is raised by wind pump with 10-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil; rock; water in sand.

No. 8.—Drilled well (157); depth of water does not vary; not certain as to whether it lowers or not, but it is never exhausted; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply. Strata passed through: Soil, 2 feet; yellow marl, 35 feet; magnesia, 20 feet; rock (magnesia ledges), 14 feet; sand and rock streaks, 30 feet; hard, reddish clay, with bones; sand; sand and clay, and a little gravel with water.

No. 9.—Drilled well (156*a*); depth of water does not vary; 14 barrels per hour; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; sand; rock with water.

No. 10.—Drilled well.

No. 11.—Drilled well; depth of water does not vary; can be pumped continuously day and night; can not be lowered; quality of water, soft; water raised by wind pump with 8-foot geared wheel and 2-inch cylinder; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 2 feet; creamy soil, 90 feet; sand; stone; gravel with water. Wells not far east are 230 feet deep, on slightly higher land. A well 1 mile west is of the same depth as this, and has watered 160 head of cattle in dry seasons.

No. 12.—Dug well; depth of water does not vary; 200 gallons in twenty minutes can be obtained from the well, this lowering it temporarily, at which time quicksand comes in; quality of water, hard and alkaline; water raised by chain and suction pumps; is used for 1,500 head of sheep. Strata passed through: Soil; sandy yellow loam; quicksand with water.

No. 13.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; is used for domestic supply. Strata passed through: As usual on this plateau south of Wray.

No. 14.—Bored well; depth of water does not vary; can not be lowered by pumping all day; quality of water, not very hard; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; yellow dirt, 67 feet; rock, gravel; fine gravel with the water.

No. 15.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by steam pump; is used for the supply of the

[1]The figures in parenthesis are the numbers given to the wells on Pl. XLII, Sixteenth Annual Report U. S. Geological Survey.

town. Strata passed through: Soil, 2 feet; creamy clay, 15 feet; sand and assorted gravel; water in gravel. There is only one well between this and the Kansas line at Chemung.

No. 16.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for a school and for 100 head of stock. Strata passed through: Soil, 20 feet; sand, 60 feet; clay, 3 feet; sand, with a streak of rock and gravel occasionally; coarse gravel, 3 feet at water, and sugar sand below.

No. 17.—Dug and driven well; water at 15 feet, and sand point driven 5 feet into it; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and some stock. Strata passed through: Soil and sand. This is on the narrow bottom of Smoky Hill River (South Fork), just west of Old Cheyenne Wells, and 10 feet above the river bed.

No. 18.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply. Strata passed through: Black alluvia to water; water in gravel. Another well close by supplied 400 head of stock in summer. There are 8 wells in two sections on the North Fork Smoky River bottom, but a boring 58 feet deep on higher land obtained little water.

No. 19.—Bored well; water rose slightly when struck; depth of water does not vary, except that there seems to be slightly more water when the wind is from the northwest; water obtained from the well fills 50,000-gallon tank in 48 hours; water raised by steam pump; is used by a railway division station. Some gas still comes from the old Government boring with which this well was connected. Prof. O. St. John, in an article on artesian wells in the Fourth Biennial Report of the Kansas State Board of Agriculture, has preserved the record of the Government test boring made in 1882, and it is here appended:

Section of the artesian boring at Cheyenne wells.

Formations. (a)	Strata.	Feet.
Plains marl	1. Surface clays	30
	2. Chalky rock	30
Tertiary grit	3. Gravelly clay	50
	4. White sandy clay	20
	5. Soft white sand	15
	6. White sandy clay	40
	7. Soft sand, alternating with clay	80
	8. Soft white clay	20
Laramie (?)	9. Soft black shale	319
	10. Soft white arenaceous shales, with gas veins at 610 and 640 feet	726
Montana group	11. Chalk rock; slight inflow of brackish water near base.	70
	12. Fine sand	30
	13. Soft black shale	100
	14. Soft white calcareous (?) rock	50
Colorado group	15. Black shale	190
	Total	1,770

a The names in the first column indicate Prof. Robert Hay's opinion as to the geological age of the strata indicated.

No. 20.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 8-foot wheel; is used for domestic supply. Strata passed through: Soil, 3 feet; creamy clay, magnesia. This well is on the top of the bluffs overlooking canyons to Republican River. It is in a draw leading to Sand Creek.

No. 21.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 77 feet; sand, 3 feet; magnesia lime, 97 feet; hard stone, 10 feet; sand

and gravel to the bottom. This well is one-half mile west of No. 20, on the same quarter section, and on ground 95 feet higher by barometer, and the draws of Sand Creek, both east and west, are deep. The well at Ashland, 2 miles south, is on slightly lower ground, and is 172 feet deep, with 20 feet of water.

No. 22.—Depth of water does not vary; water can be obtained in abundance if mill runs continuously; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 5 feet; creamy yellow soil, 155 feet; coarse gravel with water, 12 feet. Two wells within a mile have 12 and 16 feet of water, respectively, and another 3½ miles south has 11 feet. It is in a beaver draw, and is 139 feet to water.

No. 23.—Drilled well; depth does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 2 feet; yellow clay; sand; rock (at 125 feet); gravel.

No. 24.—Drilled well; depth of water does not vary; 30 barrels in half a day; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 140 head of stock. Strata passed through: Soil, 4 feet; creamy clay, 30 feet; sand, 40 feet; yellow dirt; rock, 1 foot; red clay with water.

No. 25.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 35 head of stock. Strata passed through: Soil, 6 feet; creamy yellow soil; lime; gravel with ledges of rock and sand.

No. 26.—Drilled well; water raised by wind pump; is used for domestic supply.

No. 27.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 3 feet; creamy clay, 30 feet; sand, rock, and gravel to water.

No. 28.—Tubular well; depth of water does not vary; about 200 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 14-foot wheel; is used for public purposes. Strata passed through: Soil, 3 feet; cream-colored clay, 4 feet; clay and sand, 140 feet; gravel (some of it cemented) to bottom. There are 4 other wells in the town besides the old railway well, not now used. These are all of the same depth to water, but the total depth is 180 to 185 feet.

No. 29.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; creamy soil; soft rock; sand with water.

No. 30.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil; rock; gravel.

No. 31.—Dug well; rose slightly at first; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for a hotel. Strata passed through: Soil, 10 feet; magnesia; sand; magnesia; sand; gravel with water. This well is in the town of Flagler.

No. 32.—Drilled well (196); depth of water does not vary; 175 barrels in 12 hours; can not be easily lowered; quality of water, hard; water raised by wind pump with 14-foot wheel; is used for 175 head of stock and for irrigating 3 acres; tank, 35 by 80 feet. Strata passed through: Soil; clay; rock and coarse gravel. A well 1 mile west is 150 feet deep.

No. 33.—Drilled well (195); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; sand, etc.

No. 34.—Bored well; depth of water does not vary; can be easily lowered because not deep enough in the water. Strata passed through: Soil; yellow clay; rock to water.

No. 35.—Drilled well (194); depth of water does not vary; 150 gallons per hour; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 160 head of stock. Strata passed through: Soil, 4 feet; creamy yellow clay, 76 feet; sand, 20 feet; reddish clay rock, 12 feet; sand and gravel, 12 feet; solid rock, 3 feet; reddish dirt, 3 feet; sand, gravel, and clay to bottom. A well 2½ miles east (in Kansas) had water at 142 feet. A well 1 mile west of No. 35 is 145 feet to water, and is on rather higher ground.

No. 36.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 2 feet; creamy clay, 100 feet; reddish clay, 10 feet; gravel and sand to bottom. This well is within a few rods of the Kansas line. Bender's well, 2 miles north, also close to the line, is 162 feet deep, with 13 feet of water.

No. 37.—Drilled well; depth of water does not vary; pump running night and day frequently; can not be easily lowered; quality of water, soft; is raised by wind pump with 10-foot wheel; is used for domestic supply, for 35 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Soil, 3 feet; creamy soil, 77 feet; sand, clay, magnesia; coarse sand with water. No rock.

No. 38.—Bored well; water has decreased, apparently from inflow of sand; depth of water does not vary; 500 gallons per hour, with good wind; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 27 head of stock. Temperature, 56° F. Strata passed through: Soil, 2½ feet; dark soil, 27½ feet; gravel, 30 feet; sand and gravel, 120 feet. No hard rock.

No. 39.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 35 head of stock. Temperature, 54° F. Strata passed through: Soil, 6 feet; hard rock; gravel with water.

No. 40.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump, now removed; is used for domestic supply and for stock. Strata passed through: Soil, 3 feet; yellow clay, with a little gravel, 100 feet; gravel and some yellow clay, 33 feet.

No. 41.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump, now removed; is used for domestic supply of many families and for their stock. Strata passed through: Not known.

No. 42.—Bored well; depth of water does not vary; 30 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for stock, and for irrigating one-half an acre. Strata passed through: Soil; some magnesia; gravel; hard rock at 90 feet, and again at 150 feet.

No. 43.—Bored well; depth of water does not vary; can not be lowered with pump running day and night; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for stock, and for irrigating a small area. Strata passed through: Magnesia; streaks of hard rock and gravel; water in gravel.

No. 44.—Bored well; depth of water does not vary, though steam pump goes day and night; upward of 30,000 gallons per day; can not be lowered; quality of water, hard; water raised by steam pump, which lifts 58 gallons per stroke; is used for railway shops and for the town of Holyoke. Temperature, 56° F. Strata passed through: As usual in this district. A well only 5 feet deep in the bed of the Frenchman, only a few rods away, has the same temperature. A small area is irrigated by the water from this well.

No. 45.—Bored well; depth of water does not vary; 50 barrels per day; can not be lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 140 head of stock. Strata passed through: Soil, 5 or 6 feet; clay, 50 feet; gravel and sand.

No. 46.—Dug and drilled well; depth of water does not vary; temperature, 54° F.; can not be lowered, although mill has run several days without stopping; quality of water, nearly soft; water raised by wind pump; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 8 feet; clay and magnesia, with streaks of conglomerate; water in gravel.

No. 47.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 4 feet; sand; some hard rock; water in gravel. This is a roaring well, the air rushing out of it before and during a storm. Another well to the southwest was used for irrigating a garden and a potato patch.

No. 48.—Drilled well; water was reached at 110 feet, when it rose 25 feet; depth of water does not vary; can not be lowered with pump running a day and a night; quality of water, soft; water raised by wind pump; is used for domestic supply, for 13 head of stock, and for irrigating one-third of an acre. Strata passed through: Soil; a few feet of white magnesia; a hard ledge at 90 feet; water in gravel and sand. Some wells near here are only 85 feet deep and are easily pumped dry.

No. 49.—Depth of water does not vary; water raised by windlass and buckets; is used for domestic supply and for stock. Strata passed through: Soil, 5 feet; magnesia; sand and gravel.

No. 50.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft. Strata passed through: Soil, 1 foot; magnesia; gravel, etc., as usual on this Platte-Frenchman plateau.

No. 51.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 50 head of stock; temperature, 54° F. Strata passed through: Soil, 4 feet; yellow clay (plains marl), 20 feet; sand and gravel, 40 feet; gravel, 56 feet; rock (with the water), 23 feet.

No. 52.—Bored well; depth of water does not vary; 20 barrels per day; can not be easily lowered; quality of water, not very soft; water raised by wind pump; not a very good well; water used for domestic supply and for 30 head of stock. Strata passed through: Soil, 3 feet; sand and gravel all the way down.

No. 53.—Drilled well; water rose a little when first reached; depth of water does not vary; water in abundance obtained from the well; can not be easily lowered; quality of water, soft; is used for domestic supply. Strata passed through: Magnesia all the way. This is close to the river, to which the outcrop of magnesia reaches very nearly, and the water is about the same as the underflow of the river bed, which is usually dry.

No. 54.—This is an inclosed spring which gives 4 gallons per minute steadily; quality of water, soft; water raised by hand pump and overflow pipe, which supplies a tank and reservoir and irrigates a small area; water used for domestic supply and for 375 head of cattle, which number might be more than doubled.

No. 55.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; is used for domestic supply and for 1,200 head of sheep. Strata passed through: Soil; gravel. There is another well within 200 feet. This well is within 30 rods of the river (south side). A well one-half mile west, on the bank of the river, gets water at 29 feet, and the river bank is nearly 20 feet high.

No. 56.—Bored well; depth of water does not vary; can not be easily lowered.

No. 57.—Depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; it is used for domestic

supply and for 20 head of stock. Strata passed through: Soil, 6 inches; gravel; magnesia; clay and gravel. A well 1 mile south is 246 feet deep, and another 1 mile west is over 200 feet in depth.

No. 58.—Bored well; depth of water does not vary; 1,500 gallons per hour; can not be easily lowered; water raised by wind wheel and Hay's pump; is used for irrigation.

No. 59.—Dug well; depth of water does not vary; 1,200 gallons per hour; can not be easily lowered; quality of water, hard; water raised by wind pump with 4-inch cylinder; is used for irrigation, being held in a cemented tank. Strata passed through: Sand; soil; clay or magnesia; hard sand and gravel. This well is on the south side of the river, just east of Julesburg bridge. Another well close by is 18 feet to water, and has a 12-foot wind wheel, which, with steady wind, raises 1,800 gallons per hour.

No. 60.—Dug well; depth of water does not vary; water obtained from the well will fill 50,000-gallon tank in 4 hours; can be lowered by the steam pump, but the water level is soon restored; quality of water, soft; water raised by steam pump; is used for supplying a railway roundhouse and for other purposes. Strata passed through: River alluvia.

No. 61.—Bored well; depth of water does not vary; not tested as to quantity; can not be easily lowered; quality of water, hard; water raised by hand buckets; is used for domestic supply and by the traveling public. Strata passed through: Soil, 2 feet; light-colored clay and dark-blue clay, 8 feet; sand to water.

No. 62.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for domestic supply and for a large hotel. Strata passed through: Soil; sand; gravel. This well is in the town of Julesburg. There are over 30 wells in the town, which is situated on the South Platte bottom, on the north side of the river.

No. 63.—Dug well; water rose a few feet; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for 400 head of stock, and for irrigating 1 acre. Strata passed through: Soil, 2½ feet; gravel, 2½ feet; magnesia, 1 foot; gravel and sand, 34 feet; hardpan (blue hard clay), 10 feet.

No. 64.—Dug well. This is a spring well, the water creating a marsh along the edge of the hill, in the slope of which the well is made. Depth of water does not vary; 60 to 70 gallons per minute; can not be lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for a few head of stock, and irrigates 15 acres from a reservoir of about 10 feet square. Strata passed through: Soil; red material; gravel; magnesia and sandy cemented gravel. Temperature, 58° F., apparently influenced by the atmosphere, it being an open well.

No. 65.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating one-half an acre. Strata passed through: Soil, 1 foot; sand. This well is on the second slope, on the south side of South Platte, which is 1½ miles distant.

No. 66.—Depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 100 head of stock. Strata passed through: Magnesia.

No. 67.—Drilled well; depth of water does not vary; water obtained from the well will supply 60 teams daily; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Soil, and layers of hard rock above the water gravel.

No. 68.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 40 to 50 head of stock. Strata passed through: Magnesia; sand and gravel.

No. 69.—Drilled well; depth of water does not vary; 50 to 60 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 4 feet; magnesia; gravel; loam; gravel.

No. 70.—Bored well; depth of water does not vary; 60 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by aermotor with 8-foot wheel; supplies 70 head of stock and irrigates 1 acre. Strata passed through: Soil, 1½ feet; magnesia, 10 feet; gravel, 12 feet; clay and gravel, 25 feet; gravel, 18 feet; magnesia, 102 feet; gravel, 8 feet.

No. 71.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for 50 head of stock, and for irrigating a garden. Strata passed through: Soil, 2 feet; yellow clay and sand; rock; gravel; water in rock.

No. 72.—This, with the following wells, is on the Republican (North Fork) Arickaree divide. Jordan's well, 1 mile farther west, is 130 feet deep; another well, 7 miles from Burrel's, is 175 feet deep; and yet another, at Galilean, 9 miles from Burrel's, is 190 feet deep. Beyond this the wells have not so great a depth.

No. 73.—Drilled well; rose slightly; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for stock, and for irrigation. Strata passed through: Sandy soil, 1 foot; sand 10 feet; quicksand, 25 feet; clay, 2 feet; gravel with water, 6 feet; gravel and streaks of clay, dividing the water into layers, 36 feet. This well is in the sand hills.

No. 74.—Depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Clay, magnesia, gravel, etc. This well is on the bluffs south of Wray. The wells in the valley at Wray are from 15 to 25 feet in depth, and the water in some of them rises to a height of 10 feet.

Data relating to wells in Kansas.

CHEYENNE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
							In.	*Feet.*	*Feet.*		
1	Benkelman, Nebr	Peter Courtright	....	....	....	1893	12	85	35	$34.00	.....
2	Gurney	Old town of Gurney	3	42	26	.....	.....	200	3	.....	.....
3	.....do	Hemen B. Rice	....	....	....	1890	3	200	9	185.00	$65.00
4	Haigler, Nebr	Isaac M. Clark	1	42	3	1889	a 30	24	5	.....	.....
5	.....do	Harry Clark	2	42	1	1894	36	19	1	5.00	.....
6	.....do	C. M. Corbett	3	42	4	.....	.....	240	.....	.....	.....
7	.....do	S. E. Gulliams	1	41	31	1887	42	85	5	20.00	75.00
8	.....do	F. H. Rose	1	41	23	1890	36	30	5	10.00	100.00
9	.....do	Charlee Zonge	1	41	24	1888	42	80	10	25.00	100.00
10	Jaqua, Kans	W. J. Baker	5	42	28	1890	6	98	18	40.00	50.00
11	.....do	E. M. Collins	4	42	33	1894	8	17	10	10.00	7.50
12	Lawnridge	J. A. Clinger	.....	.....	.....	.....	.....	215	10	.....	.....
13	.....do	Frank Vanschowm	4	40	27	.....	.....	190	20	.....	.....
14	.....do	.....	5	39	19	1893	2	190	5	125.00	.....
15	Lansing, Col	R. Cassens	3	42	8	1893	12	222	7	90.00	100.00
16	Lawnridge	C. H. Tromble	....	....	....	1887	6	210	14	150.00	200.00
17	St. Francis	H. H. Griffiths	5	40	19	1891	6	210	15	.....	.....
18	.....do	Old town of Wano	....	....	....	1889	36	23	0	12.00	.....
19	.....do	John Bear	4	40	4	1886	66	65	5	20.00	25.00
20	.....do	Pat McCloskey	3	40	9	1888	6	35	5	16.00	125.00
21	.....do	O. C. Blackburn	3	40	22	1890	36	25	3	.....	.....
22	.....do	B. F. Campbell	3	40	22	1888	36	18	3	15.00	.....
23	.....do	J. W. Tucker	2	41	7	.....	.....	175	0	.....	.....
24	.....do	J. S. Patton	4	40	5	1893	1¼	19	9	15.00	40.00
25	.....do	W. H. Wellmeyer	3	40	32	1893	2	40	5	40.00	35.00
26	.....do	.....	3	41	33	1893	5¼	203	3	83.00	75.00
27	.....do	L. J. Nettleton	....	....	....	1887	36	225	20	.....	.....
28	.....do	J. J. Finnegan	5	40	26	1888	36	140	3	75.00	112.00
29	.....do	John Bridges	3	41	28	1892	6	190	16	171.00	151.00

a Inches, square.

Data relating to wells in Kansas—Continued.

CHEYENNE COUNTY—Continued.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
30	St. Francis	Dolph Gibboney	3	41	25	1889	6	120	12	72.00	65.00
31	do	J. B. Gillespie	3	39	4	1889	6	69	11	24.00	88.00
32	do	G. Reile	2	41	25	1889	36	118	6	30.00	110.00
33	do	D. F. Lyman	3	40	6	1886	46	130	5	30.00	85.00
34	do	M. W. Benson	3	40	23	.....	6	52	8	15.00	80.00
35	do	A. E. Small	3	40	24	1892	5	106	11	45.00	75.00
36	Wheeler	Town well	3	39	28	1887	3	190	50	.....	.....
37	do	Wm. Bridgefort	.....	.....	.....	.....	.....	172	12	.....	.....
38	do	W. E. Hotchkiss	3	39	27	1888	6	210	10	100.00	130.00
39	do	Chas. Pritchett	4	39	9	1889	2	215	100	215.00	140.00
40	do	Sam Wilson	.....	.....	.....	1889	6	203	15	.....	.....
41	do	S. Jackson	4	39	3	1893	2	155	15	120.00	80.00
42	do	Henry Sump	1	28	35	1892	4	446	.....	.....	.....
43	do	Frank Williams	3	39	14	1892	6	173	20	68.00	100.00

SHERMAN COUNTY.

44	Klink	B. F. Hunraker	9	42	1	1892	6	112	12	$36.00	$94.00
45	do	O. M. Fee	8	42	36	1891	9	116	10	25.00	20.00
46	Goodland	T. R. Roupe	8	40	14	1894	3	.....	.....	32.00	110.00
47	do	L. A. Chatfield	8	40	18	1892	6	109	14	50.00	.....
48	do	Frank Sylvester	8	41	25	1890	8	60	9	.....	80.00
49	do	F. L. Jones	8	40	28	1888	.....	126	10	.....	40.00
50	do	J. M. Whistenaud	8	40	35	1887	6	140	16	84.00	.....
51	do	C. Campbell	8	39	32	1888	2½	140	11	100.00	.....
52	do	C. O. Miller	.....	.....	.....	1893	8	122	8	.....	.....
53	do	John Sullivan	8	40	34	1889	6	132	15	60.00	85.00
54	do	Andrew Frydandall	10	40	2	1891	36	100	3	.....	.....
55	do	D. J. Byran	9	39	31	1888	2½	94	5	56.00	.....
56	do	W. S. Cochran	7	41	24	1888	12	76	10	.....	50.00
57	do	John K. Buss	7	41	2	1891	2	180	50	122.00	68.00
58	do	John Carden	6	39	31	1889	12	136	5	58.00	100.00
59	do	.....	7	39	7	1886	36	55	14	15.00	90.00
60	do	Wm. Thacker	8	39	6	1892	12	122	13	45.00	70.00
61	do	R. I. R. R	8	39	19	1888	a180	176	19	.....	.....
62	do	Henry J. Fletcher	8	41	1	1891	12	130	12	68.00	84.00
63	do	Gus Anderson	8	40	8	1893	.....	115	10	.....	.....
64	do	M. Prunesky	8	40	10	1893	2	150	10	90.00	100.00
65	do	A. Fender	8	40	12	1887	6	140	20	56.00	100.00
66	do	Commissioners of Sherman County.	8	39	19	1894	10	180	15	90.00	310.00
67	do	Mrs. Cushman	8	40	1	1894	.....	146	20	60.00	110.00
68	do	C. C. Prideaux	7	39	7	1891	48	30	2	15.00	10.00
69	do	Ira Wilson	6	40	36	1893	4½	156	8	70.00	100.00
70	do	W. M. Dice	6	40	3	.....	12	148	8	.....	.....
71	Griswold	J. H. Hart	10	42	5	1889	6	125	15	.....	97.00
72	do	A. B. Pantyer	10	42	20	1892	9	75	10	30.00	75.00
73	do	W. G. Tittle	9	42	20	.....	36	115	4	60.00	85.00
74	do	J. Crosby	9	42	4	1886	36	100	3	80.00	115.00
75	La Blanche	A. W. Monk	9	41	26	1889	6	120	36	50.00	60.00
76	do	.....	9	41	34	.....	.....	138	36	.....	.....
77	Lamborn	Town of Kanorado	8	42	29	1888	8	120	20	55.00	75.00
78	do	A. C. Brown	8	42	20	1889	6	120	18	50.00	75.00
79	do	J. Q. Thompson	8	42	16	.....	.....	110	.....	.....	.....
80	do	Jno. Geisinger	8	42	5	.....	.....	142	14	.....	.....
81	do	Jno. Christenson	7	42	8	1892	9	160	9	50.00	86.00
82	do	A. Swann	9	42	21	1889	.....	122	9	.....	.....
83	do	The. Laurent	8	42	22	1889	6	105	20	35.00	80.00
84	do	H. Hartstine	8	42	29	1892	9	118	18	42.00	85.00
85	Ruleton	J. E. Hill	8	41	5	1892	8	70	18	30.00	80.00
86	do	Charles Alin	8	41	34	1886	8	135	10	.....	.....
87	do	Town of Ruleton	8	41	22	.....	.....	114	30	.....	.....
88	do	.....	8	41	23	.....	.....	103	5	.....	.....
89	do	Wm. Buckridge	7	41	36	.....	10	96	10	.....	.....
90	do	Jno. Boden	6	41	11	1894	2	198	63	70.00	180.00
91	do	.....	6	42	8	.....	.....	213	20	.....	.....
92	do	.....	7	42	17	.....	.....	106	7	.....	.....
93	do	Anthony Hengstler	9	42	8	1892	6	135	15	.....	.....
94	do	A. B. Montgomery	8	39	19	1894	.....	181	40	.....	.....

a Inches, square.

Data relating to wells in Kansas—Continued.

WALLACE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
							In.	*Feet.*	*Feet.*		
95	Lester	L. Eitle	12	42	10	1893	12	108	19	$45.00	$95.00
96	do	W. F. Corden	11	42	24	1893	36	65	4	25.00	.....
97	do	G. L. Baughman	11	40	2	1888	42	76	8	40.00	85.00
98	Presley	Oscar Post	11	40	14	1889	48	125	5	.....	.....
99	Sharon Springs.	N. A. Ferlen	.....	.....	.....	1894	48	39	18	12.00	100.00
100	do	Hugh Graham	13	40	26	1894	48	44	16	15.00	102.00
101	do	J. M. Ewell	13	40	26	1894	48	38	12	15.00	99.00
102	do	Samuel Halsey	12	41	22	1889	72	20	4	20.00	65.00
103	do	B. G. Hurlburt	13	40	34	1891	.....	24	14	10.00	180.00
104	do	N. W. Hayes	13	40	20	1888	60	21	3	10.00	.....
105	do	W. M. Swartz	13	41	24	1890	72	50	5	35.00	.....
106	do	J. M. Ericson	13	40	27	1894	72	27	7	11.00	105.00
107	do	.....	13	40	24	1887	a36	20	3	5.00	.....
108	do	H. H. Yost	13	39	30	1893	60	40	4	20.00	15.00
109	do	Wm. Blodgett	14	40	12	1893	6	135	12	37.50	56.00
110	do	.....	13	41	34	1888	42	36	12	15.00	.....
111	do	Water Co	13	40	27	1889	72	35	5	.....	150.00
112	do	J. Gorsuck	13	40	22	.....	30	.....	.....	.....	.....
113	Wallace	Geo. Allman	13	39	26	1884	1½	13	2	19.00	.....
114	Weskan	S. D. Yoxall	13	42	24	1885	36	10	2	.....	.....
115	do	C. E. Seed	13	42	34	1894	6	159	18	60.00	70.00
116	do	U. P. R. R	14	42	2	1880	180	143	7	.....	.....
117	do	Samuel Johnson	13	42	32	1894	36	40	7	.....	.....
118	do	Schoolhouse	12	42	10	1894	6	130	12	65.00	.....
119	do	Laycock's ranch	.....	.....	.....	.....	.....	14½	1	.....	.....
120	do	.....	.....	.....	.....	.....	.....	68	15	.....	.....

a Inches, square.

No. 1.—Bored well; depth of water does not vary; can be lowered with a bucket; quality of water, soft, but salty; water raised by hand buckets; is used for domestic supply. Strata passed through: Soil, 3 feet; sand, 26 feet; blue shale, 56 feet.

No. 2.—Now closed (156[1]). Two wells, a mile west, each have a depth of 175 feet.

No. 3.—Drilled well (155); depth of water does not vary; 180 barrels per day; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 100 head of stock. Strata: Soil, 15 feet; whitish clay, magnesia rock; sand, gravel with water.

No. 4.—Dug well (139); depth of water does not vary, but has decreased from caving; quality of water, hard; water raised by pulley and bucket; is used for domestic supply. Strata passed through: Soil, 2 feet; yellow dirt; sand, blue clay (shale) with water in top. This well is on the Arickaree bottom.

No. 5.—Dug well; depth of water does not vary; 3 barrels per hour lowers it, but the level is restored in half an hour; quality of water, hard; water raised by pulley and buckets; is used for domestic supply and 8 head of horses. Strata passed through: Soil, 1 foot; yellow clay, 13 feet; fine, hard sand, 3½ feet; gravel, 1½ feet.

No. 6.—Drilled well (168); depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump.

No. 7.—Dug well; depth of water does not vary; 4 to 5 barrels per hour; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 26 head of stock. Strata passed through: Soil, 2 feet; yellow clay to water; soapstone with water at top.

No. 8.—Dug well; depth of water does not vary; can be lowered, but the level is soon restored; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 30 head of stock, and from 60 to 70 hogs. Strata passed through: All yellow clay; water in quicksand. This well is in a canyon on the Hackberry, very deep, the yellow clay (plains marl) rising high all around.

[1] The figures in parentheses are the numbers given to wells on Pl. XLII, Sixteenth Annual Report.

No. 9.—Dug well; depth of water does not vary; 8 to 10 barrels per day; can be lowered by several hours pumping; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of stock. Temperature, 57° F. Strata passed through: Soil, 4 feet; yellow clay and sand, 60 feet; sand and gravel, with water, 10 feet. This well is in a draw leading to Hackberry Creek.

No. 10.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; is used for domestic supply, for 40 head of stock, and for irrigating a small garden. Strata passed through: Soil, 10 feet; magnesia rock, 70 feet; gravel; rock and gravel, with water, 18 feet. A (229) well on the northwest quarter of section 22 is 136 feet deep, with 20 feet of water.

No. 11.—Bored well (230); depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by hand pump; is used for domestic supply and for stock. Strata passed through: Sandy alluvia of the Republican bottom. The water in the well is more abundant since the completion of the Ericson irrigation ditch, which is distant about a quarter of a mile. The water in the well increased 10 days after water had been turned into the ditch.

No. 12.—Depth of water in well (177) does not vary; can not be easily lowered.

No. 13.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump.

No. 14.—Drilled well (246); depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for 25 head of stock. Strata passed through: Soil; yellow clay; rock; sand and gravel at the water.

No. 15.—Drilled well; depth of water does not vary; water can be pumped from the well continuously without lowering the level; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 3 feet; yellow sandy clay, 100 feet; magnesia; rock; gravel with water. A well to the north, on lower ground, is 206 feet deep.

No. 16.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 250 head of stock. Strata passed through: Soil, 4 feet; cream-colored canyon clay; magnesia rock; gravel at water.

No. 17.—Bored well; depth of water does not vary; 1,200 gallons per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for stock, and for irrigating one-half acre. Strata passed through: Soil, 3 feet; creamy yellow subsoil, etc. On the Beaver bottom, to the south, is Birkner's well, 130 feet deep, with 11 feet of water—sec. 29, T. 5, R. 40.

No. 18.—Dug well; has no water. Strata passed through: Soil, sand only slightly damp; soapstone (shale). Other wells near have abundance of water, not reaching the shale.

No. 19.—Dug well; water was found at bottom and rose 5 feet; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by hand pump; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 2 feet; yellow soil, 10 feet; rock, 28 feet; yellow sand, 4 feet; rock, 15 feet; rock of reddish tint, 5 feet; gravel with water, 4 inches. Half a mile north, in a ravine, a well has water at 14 feet.

No. 20.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; water used for domestic supply, for 60 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Soil, 1 foot; sandy loam, 29 feet; coarse gravel, 5 feet. This well is in a draw.

No. 21—Dug well; depth of water does not vary; can not be easily lowered; water raised by hand pump; is used for domestic supply. Strata passed through:

Soil; sandy loam to bottom; but the last 5 feet had shale diagonally across the well. Every house in the town has a well, eight of these being supplied with wind pumps. E. S. Flanney sunk a well 36 feet, 10 feet being in shale, and got no water. A few feet away he got the usual abundant supply at 26 feet, without shale.

No. 22.—Dug well; depth of water does not vary; the supply is inexhaustible; can not be lowered; quality of water, soft; water raised by hand pump; is used for stock of all kinds. Strata passed through: Sandy alluvia, with a streak of black soil 6 inches thick about 12 feet down; gravel below with water.

No. 23.—No water. Strata passed through: Yellow clay, 135 feet; shale, 40 feet. This well was sunk near the head of Hackberry Creek, in the vicinity of head of draws to Arickaree. The shale was also reached, without water, at Joel Taylor's, on the SW. ¼ of sec. 30, T. 1 S., R. 41, 4 miles north of Tucker's, and at a few other places in this region.

No. 24.—Driven well; depth of water does not vary; 7½ barrels per hour; can not be easily lowered; water raised by wind pump with 9-foot wheel; is used for domestic supply, for 25 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Sand and gravel. This well is in a ravine where Mr. Wellmeyer (of No. 25) has impounded springs, which come from under the magnesia, for irrigation, having a reservoir 16 by 100 by 2½ feet.

No. 25.—Tubular well (170); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 1 foot; magnesia; sand rock, 35 feet; shale, 4 feet.

No. 26.—Drilled well (169); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 or 40 head of stock. Strata passed through: Soil, 5 feet; yellow clay; magnesia; hard gravel; gravel rock, 35 feet, with water. A well on high ground, southwest, is 235 feet deep.

No. 27.—Dug well (168*a*); depth of water does not vary; 100 barrels in a day; can not be easily lowered; quality of water, medium soft; is used for domestic supply. Strata passed through: Soil; marl, 90 feet; sand, 4 feet; rock, 3 feet; sand, 1 foot; rock, about 70 feet, etc.

No. 28.—Dug well (179); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 4 feet; yellow creamy clay; rock; gravel. This well is on the north slope of Beaver Creek, south of Lawnridge.

No. 29.—Drilled well (154); depth of water does not vary; with pump running constantly, can not be easily lowered; quality of water, medium soft; water raised by wind pump, 8-foot aermotor; is used for 40 head of stock, for domestic supply, and for irrigating a small garden. Strata passed through: Soil, 3 feet; yellow soil, 47 feet; rock (magnesia and sandstone); hard sand rock with water.

No. 30.—Bored well (152); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 65 head of stock. Strata passed through: Soil, 1 foot; yellow clay, 50 feet; sand; gravel with water. A mile west is a well 120 feet deep, and a mile north of that is one 135 feet in depth.

No. 31.—Drilled well; depth of water does not vary; 150 barrels per day; can not be easily lowered; has decreased slightly by inflow of sand, but will be cleaned out; quality of water, hard; water raised by wind pump with 8-foot "Gem" wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 4 feet; yellow packed sand, 4 feet; coarse sand, 5 feet; rock and sand, 27 feet; magnesia, 28 feet; honeycomb rock with water, 1 foot. This well is on a ridge between canyons. A well in a canyon in section 9 has water at 20 feet, and in southeast of section 5 the water is at the surface in the canyon.

No. 32.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil; yellow clay; sand. This well is on the Hackberry and South Fork Republican divide.

No. 33.—Dug well; water rose 1½ feet from second sheet to first sheet; depth of water varied at first, but does not do so now; 250 barrels per day; can be easily lowered to second sheet, but no farther; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating 3 to 5 acres. Strata passed through: Soil, 7 feet; yellow sandy clay, 60 feet; reddish clay, 20 feet; sand with rock, 30 feet; rock, magnesia, and sand, 9 feet; gravel with water, 4 feet. At 87 feet and 97 feet bones were found.

No. 34.—Dug and drilled well (144); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; gravel.

No. 35.—Drilled well (145); depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; ashy white clay; gravel; magnesia; gravel with water.

No. 36.—Drilled well (146); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump; is used by all the neighborhood. Strata passed through: Soil; yellow soil; magnesia; gravel.

No. 37.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for stock. Another well, one-half mile south and one-half mile west of No. 37, is 175 feet deep and has 13 feet of water.

No. 38.—Drilled well (147); depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating a small area. Strata passed through: Soil, 1 foot; yellow clay (plains marl), 40 feet; magnesia and red clay, 120 feet; sand, 40 feet; gravel, 10 feet.

No. 39.—Tubular well (148); water was found at bottom, and rose 100 feet, remaining at that level; depth of water does not vary; 75 to 100 barrels per day; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 2 feet; yellow clay, 60 feet; rock and reddish magnesia; coarse gravel with water. There were two smaller sheets of water above the main supply, which seemed to rise to the level of the highest.

No. 40.—Drilled well (178); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 75 head of stock. Strata passed through: Soil, 8 feet; yellow clay; magnesia; water in gravel. Pearson's well, 1 mile north and 1 mile east, is 240 feet deep.

No. 41.—Tubular well (149); depth of water does not vary; 70 barrels per day; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil; yellow clay; gravel. Another well on the same section gave the following record: Soil, 6 feet; yellow sand, 8 feet; rock magnesia, 5 feet; white magnesia, 15 feet; yellow sand and pink rock, 165 feet; coarse gravel and sand with water, 1 foot. Other wells give water at same horizon.

No. 42.—Drilled well; depth of water does not vary; can not be easily lowered; water used for domestic supply. Strata passed through: Soil, etc., 75 feet; soapstone, 75 feet; blue shale, 296 feet.

No. 43.—Bored well; depth of water does not vary; 10 barrels per hour; can not be easily lowered; quality of water hard; water raised by wind pump; is used for

domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; yellow soil, 50 feet; sandy rock, 10 feet; red clay and sand, 90 feet; quicksand, 20 feet.

No. 44.—Bored well; depth of water does not vary; nearly 6,000 gallons per day; can not be lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating three-fourths of an acre. The tank, which is 28 feet by 28 by 1 foot, is filled in one day. Strata passed through: Soil, 3½ feet; creamy "badger dirt," 36½ feet; sand and gravel, 72 feet; blue clay (shale?) at bottom.

No. 45.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump with "Jumbo" wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 2 feet; creamy clay; magnesia; sand and gravel.

No. 46.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 60 head of stock. This well is on the slope of the Sappa, where the gravel is very near the surface. Strata passed through: Soil; clay; sand rock; sand and gravel with the water.

No. 47.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by rope and pulley; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 2 feet; yellowish clay, 25 feet; sand, 50 feet; sand-rock streaks, 3 feet; reddish rock and sand, 15 feet; sand and gravel, 14 feet. A well on the northwest quarter of section 20 is 10 feet deeper to water, but is on slightly higher ground.

No. 48.—Bored well; depth of water does not vary; 4 barrels per hour; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; creamy clay, 25 feet; soft magnesia with harder streaks, 20 feet; sand, quicksand, and coarse gravel at bottom. This well is in a Beaver draw.

No. 49.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 5 feet; creamy soil; salt rock; sand.

No. 50.—Bored well (217); depth of water does not vary; an abundance of water is obtained from the well; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for stock. Strata passed through: Soil, 5 feet; creamy clay; reddish clay; sand with water. A well one-half mile north by east of section 25 is 135 feet deep and has supplied the town (Goodland) and a herd of 75 cattle all summer; temperature, 57° F.

No. 51.—Dug originally, now tubular well (216); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Not known; water in gravel and sand.

No. 52.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; rock; gravel with water. A well 300 feet away is as well supplied.

No. 53.—Drilled well (215); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil; creamy soil; rock; gravel; sand.

No. 54.—Dug well (261); depth of water does not vary; can not be easily lowered, but at times needs to be made deeper; water raised by pulley and buckets; is used for domestic supply and for 10 head of cattle. Strata passed through: Soil, 2 feet; creamy clay; sand; gravel. A well on the northwest quarter of section 3 is 78 feet deep, with 6 feet of water. It is in a depression of a Smoky draw.

No. 55.—Tubular well (260); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 100 head of stock, besides irrigating one-fourth of an acre, which area is to be increased; tank, 24 by 30 feet. Strata passed through: Soil, 2 or 3 feet; creamy soil; gravel with water.

No. 56.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating over one-fourth of an acre; tank, 40 by 60 feet. Strata passed through: Soil, 2 feet; yellow clay; clay and magnesia to bottom. This well is within a few feet of the bottom land of the Middle Beaver. The bottom is one-quarter of a mile wide.

No. 57.—Drilled tubular well; water rose slightly when first struck; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; water used for domestic supply, for 6 head of stock, and for irrigation; has a reservoir 45 by 45 by 4 feet. Strata passed through: Soil, 4 feet; creamy clay, 30 feet; magnesia and rock with alternations of sand; water in gravel.

No. 58.—Bored well (245); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating one-half acre of garden and some trees. Strata passed through: Soil; yellow clay; magnesia; gravel with water. This well is in a depression of a Beaver draw. A well (245*a*) on section 18 of the same township is 155 feet deep, with 15 feet of water.

No. 59.—Dug to water; tubular well (244); depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 120 head of stock. Strata passed through: Soil, 1½ feet; yellowish white clay, 15 feet; sand, 16 feet; reddish clay 8 feet; sand and gravel to bottom.

No. 60.—Bored well (243); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil, 3 feet; creamy flour clay, 57 feet; sand and magnesia to water; coarse gravel with the water. A well (243*a*) 1 mile north of No. 60 is 70 feet deep, with 10 feet of water; is situated in a beaver draw.

No 61.—Dug well; depth of water does not vary; can be lowered to 5 feet, but not below that level; water raised by steam pump; is used for railway tanks, hotel, and cottages; 6,400 barrels per day is used for railway only. Strata passed through: Soil, 5 feet; creamy clay, 30 feet; reddish clay with streaks of sand; sand; gravel with the 19 feet of water. There is a drilled well 75 feet away, 180 feet deep, with 19 feet of water, which is operated by a steam pump. These wells have been in constant use, the last for 4 years. They are three-fourths of a mile from the city wells, which are also pumped by steam.

No. 62.—Bored well (195); depth of water does not vary; 10 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 80 head of stock, and for irrigating one-quarter of an acre; tank, 31 by 60 feet. Strata passed through: Soil, 5 feet; creamy flour soil, 8 feet; magnesia dirt, 7 feet; magnesia with hard streaks, 98 feet; sand, 8 feet; sand and gravel, 4 feet. A well one-fourth of a mile southeast gets water at the same depth (118 feet), but was bored deeper to 137 feet, thus giving 19 feet of water.

No. 63.—Drilled well (191); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil; creamy clay; clay and rock.

No. 64.—Tubular well (190); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is

used for domestic supply and for 100 head of stock. Strata: Soil, 3 feet; white creamy clay, 15 feet; sand in streaks with cemented sand; sand with the water. A well less than half a mile north in a Beaver draw gets water at 110 feet.

No. 65.—Drilled well; depth of water does not vary; water obtained from the well by continual pumping; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating one-half an acre. Strata passed through: Soil, 2 feet; creamy clay, 30 feet; magnesia; coarse gravel with the water; no rock; a weak vein of water higher up. This well is north of the Sappa. On the south side of the Sappa the Tertiary grit crops out.

No. 66.—Bored well (184); depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 18-foot wheel; is used as a public well, and irrigates court-house yard. Strata passed through: Soil, 2 feet; yellow clay, 90 feet; sand and dry gravel.

No. 67.—Bored well (183); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 15 head of stock. Strata: Soil, 5 feet; yellow soil; rock; gravel.

No. 68.—Dug well (182); depth of water does not vary; can be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for 15 head of stock. Strata passed through: Soil; yellow clay and sand; magnesia gravel with water. This well is in a bottom, about 20 feet above the bed of one of the Beavers.

No. 69.—Drilled well (181); depth of water does not vary; 600 gallons per hour; mill will drain it in 2 hours, but the level of the water is restored in 20 minutes; quality of water, medium soft, but is becoming softer the longer it is used; water raised by wind pump; is used for domestic supply, for 100 head of stock, and for irrigating a small garden. Strata passed through: Soil; yellow clay; rock; sandy clay.

No. 70.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil; yellow clay; rock. A well 1 mile south, with surface at about the same altitude, is 180 feet deep.

No. 71.—Drilled well (207); depth of the water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating a small area. Strata passed through: Soil, 1 foot; creamy clay, 20 feet; sand; sandstone, 4 feet; sand; sand and limestone, 6 inches; sand to bottom; water in quicksand.

No. 72.—Bored well (240); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 95 head of stock. Strata passed through: Soil, 2 feet; creamy soil; rock and gravel with water.

No. 73.—Dug well (239); depth of water does not vary; can be easily lowered slightly—should be made deeper; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 4 feet; creamy yellow soil, 41 feet; sand, 5 feet; rock and magnesia 12 feet; sand, 38 feet; magnesia, 2 feet; coarse sand and quicksand at water.

No. 74.—Dug well (208); depth of water does not vary; sufficient water obtained to supply 4 farms, besides travelers; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; water used for domestic supply, as above, and 150 head of stock. Strata passed through: Soil, 3 feet; creamy soil, 30 feet; sand and gravel to bottom. This well is at Griswold post-office, 4 miles south of No. 93. A. J. McKinney's well, 3 miles east of Griswold, is 105 feet deep, with 5 feet of water. Four miles farther east is a well 90 feet to water.

No. 75.—Drilled well; depth of water does not vary; water obtained from the well fills a tank 17 by 29 by 2 feet in 36 hours, besides supplying stock; can not be

easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for 35 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 2 feet; creamy yellow soil; magnesia; sand with water. A well one-quarter of a mile north is 170 feet deep, with water at 100 feet. Wells 1 mile east are plentifully supplied with water.

No. 77.—Bored well; depth of water does not vary; can be easily lowered, on account of bad curbing; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for public purposes. Strata passed through: Soil, 2 feet; creamy soil, 13 feet; gravel and sand. There are 5 wells on the town site, all having about the same depth; one is the Rock Island Railway well, 147 feet deep, apparently inexhaustible. A steam pump fills the 1,600-barrel tank in 11 hours.

No. 78.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 20 head of cattle. Strata passed through: Soil, 3½ feet; creamy soil, 10 feet; magnesia, red clay, and sand in layers, 80 feet; coarse gravel, 27 feet.

No. 79.—Drilled well (226); depth of water does not vary; can not be easily lowered; quality of water, soft.

No. 80.—Depth of water does not vary; can not be easily lowered (227). Soil; magnesia.

No. 81.—Bored well (228); depth of water does not vary; can be slightly lowered; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 4 feet; creamy clay, 76 feet; sand and rock; magnesia and gravel.

No. 82.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply.

No. 83.—Bored well; depth of water does not vary; 75 barrels per day; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for stock, and for irrigating one-half an acre. Strata passed through: Soil, 2½ feet; creamy dirt, 52½ feet; sand, gravel, and rock, 50 feet. A well 1 mile south in Beaver Valley is 59 feet deep, with 2½ feet of water.

No. 84.—Bored well (238); depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for hotel, for 100 head of stock, and for irrigating a garden. Temperature, 56° F. Strata passed through: Soil, 5 feet; creamy clay, 75 feet; sand; whitish clay; sand; magnesia; gravel. This well is in the town of Kanorado.

No. 85.—Bored well (193); depth of water does not vary; mill running often day and night; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply, for 25 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 2 feet; cream-colored loam nearly to water; magnesia and gravel at water. A well on the next section west is 75 feet to water, being on higher ground.

No. 86.—Bored well; depth of water does not vary; can be lowered at times; quality of water, soft; water raised by wind pump; is used for domestic supply and for 10 head of stock. Strata passed through: Soil; creamy clay and fine gravel.

No. 87.—The water-bearing stratum was pierced only 4 feet, and the water rose 26 feet; depth of water does not vary; water raised by wind pump; is used for 300 to 400 head of stock and by travelers. This well is only 2 or 3 feet above the railway level at the depot.

No. 88.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for stock, and for irrigating 1 acre, for which there is a pool supplied by the well.

No. 89.—Bored well; depth of water does not vary; can not be easily lowered; water used for domestic supply and for 30 head of stock. Strata passed through: Soil, yellow clay, etc.

No. 90.—Tubular well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10 foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 3 feet; yellow clay; some rock; gravel with water. A well on section 2 is 170 feet deep.

No. 91.—Another well on the same section is 156 feet to water. A well 1 mile north is 192 feet deep, with 10 feet of water. These are on a high promontory, at the beginning of the descent to the Republican River.

No. 92.—This well is on the south bank of a Beaver, about 15 feet above the bed. The prairie south is considerably higher. At a distance of one-half mile northeast is an outcrop of the magnesia at a higher level, but the breaks all around, both higher and lower, are the plains marl.

No. 93.—Bored well (188); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Soil, 2 feet; creamy subsoil; rock; gravel with water.

No. 94.—Dug 146 feet and bored 35 feet; depth of water does not vary; can not be easily lowered; water raised by wind pump with 16-foot wheel; is to be used for irrigating 10 acres (185). Strata passed through: Soil, 3½ feet; creamy subsoil, 40 feet; flinty rock, 4 feet; sand, 23 feet; hard clay, 15 feet; sand, 16 feet; sand rock, 6 feet; clay and sand, 40 feet to water.

No. 95.—Bored well; depth of water does not vary; 60 barrels in 4 hours; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 300 head of stock. Strata passed through: Soil, 3 feet; cream-colored clay, 23 feet; white magnesia, 4 feet; sand rock, 1 foot; sand, 8 feet; rock, 4 feet; sand and rock, 65 feet; water in clay and sand.

No. 96.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by pulley and buckets; is used for domestic supply and for 12 head of stock. Strata passed through: Soil, 2 feet; cream soil, 18 feet; yellow sand and magnesia, 41 feet; gravel with water, 4 feet. A well one-half mile north is 58 feet deep.

No. 97.—Dug well (259); depth of water does not vary; can not now be easily lowered. The well has recently been made deeper; prior to its deepening the water level could be lowered. Water raised by wind pump with 8-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating a small area, which is being increased. Temperature, 54° F. Strata passed through: Soil, 5 feet; creamy soil, 30 feet; soapstone (?), 5 feet; sand rock, 36 feet.

No. 98.—Dug well; depth of water does not vary; can be exhausted in 2 hours with a good wind, but refills in 30 minutes; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 to 70 head of stock, and for irrigating a small area. Strata passed through: Soil, 5 feet; creamy soil, 75 feet; hard conglomerate, 18 feet; sandstone; sand with water. Spurlock's well, on section 22, on the breaks of Lake Creek, 60 feet deep, with 1½ feet of water, irrigates 2 acres during winter.

No. 99.—Dug and bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for irrigation; tank, 85 by 45 by 5 feet. Strata passed through: Soil, 15 feet; clay, 6 feet; sand and gravel to bottom.

No. 100.—Dug and bored well; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for irrigation. Strata passed through: Soil, 28 feet; sand and gravel below; stopped at blue clay (shale?).

No. 101.—Dug and bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 12-foot wheel; is used for irrigation. Strata passed through: Soil; sandy soil; streaks of sand; gravel and sand in water.

No. 102.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 80 head of stock. Strata passed through: Soil and creamy subsoil, 20 feet; sand, 4 feet; shale below. This well is on the bottom of a branch of Goose Creek. A well at the house at 30 feet higher level got no water, after passing through these strata: Marl, 30 feet; sand, 4 feet; shale, 4 feet; shale, 30 feet. Rocky magnesia (Tertiary grit) crops out on the south side of the valley 50 feet above the level of No. 102.

No. 103.—Dug well, but has a tube 8 inches in diameter; water struck at 14 feet and rose 4 feet; depth of water does not vary; 650 gallons in 1 hour; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 40 head of stock, and one-half acre irrigated. Strata passed through: Soil, 1 foot; black earth, 7 feet; joint clay, 16 feet; sand to bottom; reached shale at 27 feet.

No. 104.—Dug well; depth of water does not vary, though heavy rains slightly raise the level; can not be easily lowered; quality of water, medium soft; water raised by pulley and buckets; is used for domestic supply and for 8 head of horses. Strata passed through: Soil, 2 feet; creamy clay, 14 feet; sand; coarse gravel at water.

No. 105.—Dug well; water was struck at 50 feet and rose 5 feet, where it has remained; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by pulley and buckets; is used for domestic supply and for 12 head of stock. Strata passed through: Soil, 1½ feet; gray soil (creamy), 10 feet; reddish clay and gravel, with streaks of sand, 35 feet; coarse sand gravel, 2 feet; reddish, putty-like clay at water; gravel below.

No. 106.—Dug well; water rose a little when first struck; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and for irrigating three acres; tank, 65 by 30 by 4 feet. Strata passed through: Soil, 1 foot; cream-colored soil, 19 feet; sand; joint clay and coarse sand, 7 feet. This well is in Eagletail Valley at Sharon Springs. Mr. Ericson has another well between Eagletail and a northern draw, and a reservoir 50 by 100 feet. The water level this year is lower in the wells than formerly, and a water elevator here was found too short.

No. 107.—Dug well; depth of water does not vary; can not be easily lowered except by the running in of sand; quality of water, soft; water raised by pulley and buckets; is used for domestic supply and for 15 head of stock. Strata passed through: Sandy alluvia. This well is on the second bottom of the South Fork of the Smoky Hill River, east of Sharon Springs, on the right bank of the river.

No. 108.—Dug well; flow increased slightly at first, but sand gets in and clogs it; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by hand pump; has also a "Jumbo" wind wheel; is used for domestic supply and for several head of stock. Strata passed through: Soil, 10 feet; sand to water.

No. 109.—Bored well; water was struck at 129 feet and rose 6 feet; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for several head of stock. Strata passed through: Soil, 3 feet; creamy soil, 14 feet; rock (red) to water. Rock crops out in a ravine one-fourth of a mile east.

No. 110.—Dug well; depth of the water varies by rising slightly in the spring of the year; can be easily lowered, but is very soon replenished; quality of water, rather soft; water raised by pulley and buckets; is used for domestic supply and for 4 head of stock. Strata passed through: Soil, 1 foot; creamy clay, 14 feet; streak of sand; creamy clay, 6 feet. The bottom of the well is in soapstone (shale), and water is from the gravel. Another well, somewhat lower in the draw, has water at the same depth, and another still lower has water at 16 feet.

No. 111.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 16-foot wheel; is used for town supply and is very abundant. Strata passed through: Soil, 5 feet; yellow creamy soil, 25 feet; sand and gravel, 5 feet. This well is in the valley of Eagletail Creek, within the city limits of Sharon Springs. Wells in the higher part of the town have little or no water.

No. 112.—Dug well (258). Strata passed through: Soil, 2 feet; cream-colored clay, 28 feet; shale; no water. Mr. Garsuck has made several wells, but always with the same result, reaching the shale without the water-bearing gravel at 25 to 30 feet.

No. 113.—Driven well; depth of water does not vary; can not easily be lowered; quality of water, medium hard; is used for domestic supply and for stock. Strata passed through: Soil, with streaks of clay and sand, 6 feet; sand and gravel to bottom; quicksand at bottom. This well is in the South Smoky Hill bottom. Mr. Allman has two other wells near, watering 60 head of stock, and there are four others on the bottom between here and Yost's (No. 98), all having an abundance of water. Mr. Allman irrigates from a stream.

No. 114.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by hand pump; is used for domestic supply. Strata passed through: Sandy alluvia, shale at bottom. It is on the second bottom of the South Fork of the Smoky Hill River, which has pools connected by running streams which disappear in the sands farther east. There are also springs on the banks running off the shale, which crops in ravines, under the Tertiary beds.

No. 115.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 15 head of stock, and for irrigating one-quarter of an acre. Strata passed through: Soil, 5 feet; creamy soil, 15 feet; magnesia, rock, and sand; gravel with water, 18 feet. Two wells on Weskan town site are 148 feet deep. A well on section 28, 157 feet deep, has 15 feet of water, and has rock at about the same level as No. 115.

No. 116.—Dug well; depth of water does not vary; can be lowered slightly; quality of water, soft; water raised by steam pump; is used for railway purposes. This well is on rather lower ground than No. 115, from which it is distant about 1 mile.

No. 117.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by hand pump; is used for domestic supply. Strata passed through: Soil; cream-colored subsoil; water in gravel and sand.

No. 118.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by pulley and bucket; is used for a schoolhouse. Strata passed through: Soil, 3 feet; creamy clay, 23 feet; magnesia, 4 feet; running gravel, 16 feet; rock and sand to bottom. This well is on nearly the highest land in Kansas.

No. 119.—This well is in a bed of a branch of Goose Creek.

No. 120.—Bored well. The water was reached at 68 feet, and rose 15 feet. It has slightly affected the water of No. 97, which is on the same section. Strata passed through: Soil, 6 feet; creamy soil, 20 feet; sand, 15 feet; soapstone (?), 3 feet; hard clay (magnesia red clay?), 24 feet.