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OF THE

## UNITED STATES GEOLOGICAL SURVEY

## No. 38

OPERATIONS AT RIVER STATIONS, 1899.—PART IV

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

# OPERATIONS AT RIVER STATIONS, 1899

A REPORT OF THE

## DIVISION OF HYDROGRAPHY

OF THE

## UNITED STATES GEOLOGICAL SURVEY

## PART IV

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

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# OPERATIONS AT RIVER STATIONS, 1899.

## PART IV.

### MEASUREMENTS AT RIVER STATIONS.[1]

#### DOLORES RIVER AT DOLORES, COLORADO.

This river is the last important tributary of Grand River. It has its source in the La Plata and San Miguel mountains, in which the highest peak, Mount Wilson, attains an elevation of 14,280 feet. Its course is in a general northwesterly direction. Crossing into Utah it shortly joins Grand River. In the vicinity of Dolores considerable irrigation is practiced, both from small ditches and from one or two large systems. The main canal of the Montezuma Valley irrigation system diverts water from the left bank of the river a short distance below the gaging station, and after crossing the divide between the Dolores and San Juan drainage irrigates land in the vicinity of Cortez. A lower lateral of this system serves land to the northwest of Dolores. The gaging station is located one-half mile above the railroad station at Dolores, Colorado. The gage rod consists of a vertical plank bolted to the abutment of a footbridge on the left side of the river. The bench mark consists of a nail driven into the base of a cottonwood tree 18 feet southwesterly from the gage, and is 15.60 feet above gage datum. The right bank is low and the left bank high; the water moves with a good velocity; the bed of the stream is composed of small stones and gravel. Dolores River at Rico, Colorado, was measured three times during the year: April 19 the discharge was 168 second-feet; September 22, 23 second-feet, and November 22, 16 second-feet. Results of measurements at this station may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 263; 1897, Nineteenth Annual Report, Part IV, page 408; 1898, Twentieth Annual Report, Part IV, page 393. The following discharge measurements were made by A. L. Fellows during 1899:

April 20, gage height, 3.60 feet; discharge, 613 second-feet.
May 17, gage height, 4.15 feet; discharge, 963 second-feet.
June 22, gage height, 3.30 feet; discharge, 307 second-feet.
November 22, gage height, 2.70 feet; discharge, 56 second-feet.

[1] Continued from Water-Supply and Irrigation Paper No. 37.

*Daily gage height, in feet, of Dolores River at Dolores, Colorado, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.60 | 3.05 | 3.75 | 3.10 | 2.95 | 2.65 | 2.50 | 2.80 | 2.55 |
| 2 | ..... | 2.70 | 2.90 | 3.75 | 3.15 | 2.95 | 2.60 | 2.50 | 2.80 | 2.55 |
| 3 | ..... | 2.70 | 3.15 | 3.55 | 3.25 | 3.50 | 2.60 | 2.50 | 2.70 | 2.55 |
| 4 | ..... | 2.85 | 3.15 | 3.40 | 3.10 | 3.85 | 2.60 | 2.60 | 2.70 | 2.55 |
| 5 | ..... | 2.85 | 3.80 | 3.40 | 3.10 | 3.60 | 2.50 | 2.60 | 2.70 | 2.75 |
| 6 | ..... | 2.85 | 3.45 | 3.40 | 3.10 | 3.30 | 2.50 | 2.60 | 2.70 | 2.95 |
| 7 | ..... | 2.95 | 3.70 | 3.65 | 3.10 | 3.70 | 2.50 | 2.50 | 2.70 | 3.00 |
| 8 | ..... | 2.95 | 3.70 | 3.75 | 3.10 | 3.40 | 2.50 | 2.50 | 2.60 | 3.10 |
| 9 | ..... | 3.05 | 3.60 | 3.85 | 3.00 | 3.25 | 2.50 | 2.50 | 2.60 | 3.10 |
| 10 | ..... | 3.05 | 3.90 | 3.95 | 2.90 | 3.05 | 2.50 | 2.50 | 2.60 | 3.10 |
| 11 | ..... | 3.20 | 4.10 | 3.90 | 2.90 | 3.00 | 2.50 | 2.50 | 2.60 | 3.10 |
| 12 | ..... | 3.35 | 4.35 | 3.90 | 3.00 | 2.95 | 2.50 | 3.10 | 2.60 | 3.00 |
| 13 | ..... | 3.25 | 4.65 | 3.85 | 3.15 | 2.90 | 2.50 | 3.30 | 2.60 | 3.00 |
| 14 | ..... | 3.40 | 4.75 | 3.85 | 3.15 | 2.90 | 2.55 | 3.25 | 2.65 | 3.00 |
| 15 | ..... | 3.60 | 4.75 | 3.70 | 3.10 | 2.95 | 2.80 | 3.00 | 2.70 | 3.00 |
| 16 | ..... | 3.60 | 4.55 | 3.60 | 3.10 | 3.15 | 2.80 | 3.00 | 2.70 | 3.00 |
| 17 | ..... | 3.60 | 4.15 | 3.50 | 3.10 | 3.15 | 2.70 | 3.00 | 2.70 | 3.05 |
| 18 | ..... | 3.70 | 4.20 | 3.50 | 3.20 | 3.20 | 2.70 | 3.00 | 2.60 | 3.05 |
| 19 | ..... | 4.05 | 4.40 | 3.50 | 3.40 | 3.05 | 2.65 | 3.00 | 2.60 | 3.05 |
| 20 | ..... | 3.65 | 4.05 | 3.40 | 3.15 | 2.90 | 2.60 | 2.95 | 2.60 | 3.00 |
| 21 | ..... | 3.55 | 3.60 | 3.30 | 3.10 | 2.90 | 2.60 | 2.85 | 2.60 | 3.00 |
| 22 | 2.40 | 3.85 | 3.70 | 3.30 | 3.00 | 2.85 | 2.55 | 2.80 | 2.60 | 3.00 |
| 23 | 2.40 | 3.90 | 3.85 | 3.25 | 3.00 | 2.75 | 2.50 | 2.80 | 2.70 | 3.00 |
| 24 | 2.40 | 4.00 | 4.15 | 3.20 | 2.95 | 2.70 | 2.50 | 2.75 | 2.70 | 2.95 |
| 25 | 2.50 | 4.05 | 4.00 | 3.20 | 2.90 | 2.70 | 2.50 | 2.70 | 2.70 | 2.95 |
| 26 | 2.80 | 4.00 | 4.00 | 3.25 | 2.85 | 2.60 | 2.50 | 2.70 | 2.70 | 2.90 |
| 27 | 2.55 | 3.90 | 3.85 | 3.40 | 2.90 | 2.60 | 2.50 | 2.70 | 2.65 | 3.00 |
| 28 | 2.75 | 3.75 | 3.80 | 3.25 | 2.90 | 2.60 | 2.50 | 2.70 | 2.65 | 3.00 |
| 29 | 2.60 | 3.55 | 3.80 | 3.10 | 3.00 | 2.60 | 2.50 | 2.70 | 2.65 | 3.00 |
| 30 | 2.65 | 3.20 | 3.85 | 3.10 | 3.25 | 2.60 | 2.50 | 2.70 | 2.65 | 3.00 |
| 31 | 2.50 | ..... | 3.85 | ..... | 3.15 | 2.55 | ..... | 2.80 | ..... | 3.05 |

## SAN MIGUEL RIVER AT FALLCREEK, COLORADO.

This river has its source in the high mountain peaks in the southwestern corner of San Miguel County, and drains an area immediately to the westward of the head waters of Uncompahgre River. The general direction of the river is northeasterly, and it enters Dolores River in the western part of Montrose County, Colorado. The station, established in June, 1895, is located about 300 yards southwest of Fallcreek, a railroad station on the Rio Grande Southern Railroad. The gage is vertical and spiked to the west side of the north abutment of the wagon bridge. Bench mark No. 1 is a bolthead in the north end of the west truss, 1 foot from the gage, and is 11.15 feet above gage datum. Bench mark No. 2 is a spike driven into a tree 200 feet northwest of the rod, and is 8.65 feet above gage datum. Fall Creek enters the San Miguel about 200 feet below the gage. On May 16, 1899, it was found to be carrying 62 second-feet, and on June 21, 45 second-feet. The results of measurements on the main river may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 265; 1897, Nineteenth Annual Report, Part IV, page 407; 1898, Twentieth Annual Report, Part IV, page 395. The following measurements of discharge were made by A. L. Fellows during 1899:

April 18, gage height, 2.85 feet; discharge, 164 second-feet.
May 16, gage height, 3.70 feet; discharge, 562 second-feet.
June 21, gage height, 3.60 feet; discharge, 449 second-feet.
November 21, gage height, 2.35 feet; discharge, 52 second-feet.

*Daily gage height, in feet, of San Miguel River at Fallcreek, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.... | 2.30 | 2.80 | 3.50 | 3.35 | 2.90 | 2.60 | 17..... | 2.85 | 3.65 | 3.85 | 3.00 | 2.90 | 2.60 |
| 2.... | 2.20 | 2.75 | 3.45 | 3.50 | 3.20 | 2.60 | 18..... | 2.90 | 3.80 | 3.85 | 3.35 | 2.90 | 2.60 |
| 3.... | 2.30 | 2.75 | 3.40 | 3.40 | 3.50 | 2.65 | 19..... | 2.95 | 3.70 | 3.90 | 3.25 | 3.00 | 2.60 |
| 4.... | 2.30 | 2.70 | 3.30 | 3.30 | 3.35 | 2.65 | 20..... | 2.95 | 3.60 | 3.80 | 3.05 | 2.85 | 2.55 |
| 5.... | 2.25 | 2.80 | 3.15 | 3.20 | 3.35 | 2.55 | 21..... | 2.80 | 3.30 | 3.75 | 3.00 | 2.75 | 2.60 |
| 6.... | 2.30 | 2.80 | 3.25 | 3.10 | 3.35 | 2.60 | 22..... | 2.85 | 3.20 | 3.70 | 3.00 | 2.70 | 2.60 |
| 7.... | 2.30 | 3.00 | 3.25 | 3.05 | 3.35 | 2.60 | 23..... | 3.20 | 3.40 | 3.45 | 2.95 | 2.70 | 2.50 |
| 8.... | 2.40 | 3.00 | 3.30 | 3.00 | 3.25 | 2.60 | 24..... | 3.20 | 3.50 | 3.35 | 2.95 | 2.80 | 2.60 |
| 9.... | 2.40 | 3.00 | 3.75 | 3.00 | 3.15 | 2.60 | 25..... | 3.30 | 3.55 | 3.30 | 3.00 | 2.70 | 2.60 |
| 10.... | 2.50 | 3.20 | 4.05 | 3.05 | 3.00 | 2.60 | 26..... | 3.20 | 3.50 | 3.35 | 2.95 | 2.65 | 2.60 |
| 11.... | 2.45 | 3.40 | 4.05 | 3.05 | 2.90 | 2.55 | 27..... | 3.05 | 3.55 | 3.30 | 3.00 | 2.60 | 2.60 |
| 12.... | 2.50 | 3.75 | 3.95 | 3.15 | 3.00 | 2.40 | 28..... | 2.90 | 3.55 | 3.30 | 3.00 | 2.60 | 2.60 |
| 13.... | 2.70 | 3.95 | 3.90 | 3.20 | 3.00 | 2.40 | 29..... | 2.80 | 3.55 | 3.35 | 3.10 | 2.60 | 2.50 |
| 14.... | 2.70 | 4.00 | 4.00 | 3.25 | 3.00 | 2.70 | 30..... | 2.90 | 3.80 | 3.30 | 3.00 | 2.60 | 2.40 |
| 15.... | 2.80 | 3.90 | 4.00 | 3.10 | 3.00 | 2.75 | 31..... | ..... | 3.80 | ..... | 2.90 | 2.60 | ..... |
| 16.... | 2.75 | 3.80 | 3.90 | 3.00 | 2.95 | 2.65 | | | | | | | |

Station discontinued September 30.

## SAN JUAN RIVER AT ARBOLES, COLORADO.

This river has its source on the western slope of the Continental Divide in southern Colorado, its headwater tributaries adjoining those of the Rio Grande. Its general direction is southwesterly, but after it receives the waters of Piedra River and crosses the State line into New Mexico, it takes a more westerly direction for some distance, then turns northwest, passing very close to the four corners of Utah, Colorado, New Mexico, and Arizona. After flowing for a considerable distance through a canyon country in Utah, it enters Colorado River a short distance above Marble Canyon. The gaging station, established June 19, 1895, is located at the town of Arboles, at a footbridge about 1,000 feet below the Rio Grande Southern railroad station and above the mouth of Piedra River. The rod is an inclined timber marked to vertical tenths of a foot, the space between marks being 0.131 foot, and is bolted to the rocky bank on the right-hand side of the stream. The left bank is low and liable to overflow at high stages. The bed is sandy and shifting. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 281; 1897, Nineteenth Annual Report, Part IV, page 410; 1898, Twentieth Annual Report, Part IV, page 401. The following measurements of discharge were made by A. L. Fellows during 1899:

April 23, gage height, 7 feet; discharge, 1,286 second-feet.
May 22, gage height, 6.60 feet; discharge, 737 second-feet.
June 26, gage height, 6.15 feet; discharge, 277 second-feet.
November 26, gage height, 5.75 feet; discharge, 127 second-feet.

*Daily gage height, in feet of San Juan River at Arboles, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 6.40 | 6.65 | 6.05 | 6.25 | 5.70 | 17 | ..... | 6.85 | 6.35 | 6.60 | 6.10 | 6.20 |
| 2 | ..... | 6.35 | 6.55 | 6.00 | 6.15 | 5.70 | 18 | ..... | 6.85 | 6.35 | 7.25 | 6.15 | 6.10 |
| 3 | ..... | 6.30 | 6.55 | 6.05 | 7.25 | 5.70 | 19 | ..... | 7.00 | 6.30 | 7.40 | 5.95 | 6.00 |
| 4 | ..... | 6.30 | 6.50 | 6.00 | 7.30 | 5.70 | 20 | ..... | 6.85 | 6.25 | 7.25 | 5.90 | 6.00 |
| 5 | ..... | 6.30 | 6.50 | 6.05 | 6.95 | 5.70 | 21 | ..... | 6.60 | 6.30 | 7.10 | 5.85 | 6.00 |
| 6 | ..... | 6.25 | 6.50 | 5.95 | 6.60 | 5.65 | 22 | ..... | 6.55 | 6.35 | 6.70 | 5.80 | 5.90 |
| 7 | ..... | 6.35 | 6.55 | 6.25 | 6.65 | 5.60 | 23 | 7.00 | 6.75 | 6.30 | 6.40 | 5.85 | 5.85 |
| 8 | ..... | 6.45 | 6.65 | 6.20 | 6.55 | 5.60 | 24 | 6.95 | 6.85 | 6.20 | 6.35 | 5.85 | 5.80 |
| 9 | ..... | 6.40 | 6.60 | 6.10 | 6.35 | 5.70 | 25 | 6.90 | 6.85 | 6.20 | 6.20 | 5.80 | 5.80 |
| 10 | ..... | 6.50 | 6.65 | 6.00 | 6.30 | 5.70 | 26 | 6.80 | 6.80 | 6.25 | 6.15 | 5.80 | 5.80 |
| 11 | ..... | 6.80 | 6.65 | 5.95 | 6.20 | 5.70 | 27 | 6.75 | 6.85 | 6.35 | 6.20 | 5.80 | 5.70 |
| 12 | ..... | 7.10 | 6.60 | 5.85 | 6.05 | 5.70 | 28 | 6.55 | 6.75 | 6.20 | 6.30 | 5.70 | 5.70 |
| 13 | ..... | 7.50 | 6.55 | 5.90 | 5.95 | 5.60 | 29 | 6.50 | 6.65 | 6.10 | 6.60 | 5.70 | 5.70 |
| 14 | ..... | 7.30 | 6.50 | 5.85 | 5.90 | 5.65 | 30 | 6.45 | 6.65 | 6.15 | 6.70 | 5.70 | 5.70 |
| 15 | ..... | 7.25 | 6.50 | 5.95 | 5.90 | 7.40 | 31 | ..... | 6.75 | ..... | 6.55 | 5.70 | ..... |
| 16 | ..... | 7.00 | 6.45 | 6.00 | 5.95 | 6.65 | | | | | | | |

Station discontinued September 30.

## PIEDRA RIVER AT ARBOLES, COLORADO.

This tributary of San Juan River has its source in Hinsdale and Mineral counties in southern Colorado, and flows in a general southerly direction, entering San Juan River just before the latter crosses into New Mexico. The station, established June 19, 1895, is located at the railroad bridge crossing Piedra River about one-half mile west of the railroad station at Arboles. The gage is bolted to the stone abutment of the railroad bridge on the right-hand side of the stream, and consists of a vertical 4 by 4 inch timber. The bench mark is a cross cut in the top of abutment in the southeast corner of bridge 402–A, and is 14.88 feet above gage datum. The banks are both high, the current is swift, and the bed is composed of small stones. The cross section does not change materially. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 283; 1897, Nineteenth Annual Report, Part IV, page 413; 1898, Twentieth Annual Report, Part IV, page 402. The following measurements were made by A. L. Fellows during 1899:

April 23, gage height, 3.80 feet; discharge, 499 second-feet.
May 22, gage height, 3.40 feet; discharge, 279 second-feet.
June 26, gage height, 2.90 feet; discharge, 111 second-feet.
November 26, gage height, 2.80 feet; discharge, 88 second-feet.

*Daily gage height, in feet, of Piedra River at Arboles, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 3.25 | 3.30 | 2.85 | 3.05 | 2.50 | 17 | ..... | 3.75 | 3.00 | 2.90 | 2.85 | 2.90 |
| 2 | ..... | 3.20 | 3.20 | 2.85 | 3.00 | 2.50 | 18 | ..... | 3.65 | 2.95 | 3.10 | 2.80 | 2.80 |
| 3 | ..... | 3.05 | 3.25 | 3.00 | 4.05 | 2.50 | 19 | ..... | 3.75 | 2.90 | 3.75 | 2.80 | 2.70 |
| 4 | ..... | 3.00 | 3.20 | 2.95 | 4.45 | 2.50 | 20 | ..... | 3.55 | 2.90 | 3.55 | 2.80 | 2.60 |
| 5 | ..... | 3.00 | 3.15 | 2.90 | 3.75 | 2.50 | 21 | ..... | 3.35 | 2.90 | 3.45 | 2.75 | 2.50 |
| 6 | ..... | 3.05 | 3.20 | 2.80 | 3.75 | 2.50 | 22 | ..... | 3.40 | 2.90 | 3.20 | 2.70 | 2.50 |
| 7 | ..... | 3.10 | 3.30 | 3.05 | 3.60 | 2.40 | 23 | 3.80 | 3.35 | 2.95 | 3.00 | 2.70 | 2.50 |
| 8 | ..... | 3.20 | 3.35 | 2.95 | 3.50 | 2.40 | 24 | 3.75 | 3.45 | 2.80 | 2.90 | 2.70 | 2.50 |
| 9 | ..... | 3.25 | 3.35 | 2.95 | 3.35 | 2.50 | 25 | 3.75 | 3.50 | 2.80 | 2.80 | 2.70 | 2.50 |
| 10 | ..... | 3.30 | 3.35 | 2.80 | 3.20 | 2.60 | 26 | 3.70 | 3.40 | 2.85 | 2.80 | 2.70 | 2.50 |
| 11 | ..... | 3.65 | 3.30 | 2.85 | 3.15 | 2.60 | 27 | 3.65 | 3.45 | 3.25 | 2.75 | 2.65 | 2.50 |
| 12 | ..... | 4.05 | 3.25 | 2.65 | 3.00 | 2.50 | 28 | 3.55 | 3.45 | 3.05 | 2.80 | 2.60 | 2.50 |
| 13 | ..... | 4.10 | 3.15 | 2.75 | 2.90 | 2.50 | 29 | 3.45 | 3.30 | 2.90 | 3.05 | 2.60 | 2.45 |
| 14 | ..... | 3.95 | 3.10 | 2.80 | 2.90 | 2.55 | 30 | 3.35 | 3.35 | 2.85 | 3.20 | 2.50 | 2.40 |
| 15 | ..... | 4.05 | 3.10 | 2.85 | 2.90 | 2.95 | 31 | ..... | 3.30 | ..... | 3.15 | 2.50 | ..... |
| 16 | ..... | 3.90 | 3.05 | 2.85 | 2.90 | 3.00 | | | | | | | |

Station discontinued September 30.

## LOS PINOS RIVER AT IGNACIO, COLORADO.

This stream heads in the high mountains of San Juan County in southwestern Colorado, and flows in a nearly southerly direction, crossing the State line into New Mexico and emptying into San Juan River. The station was established by A. L. Fellows on April 22, 1899, and is located at the wagon bridge at Ignacio, the subagency of the Southern Ute Indian Reservation, 2 miles north of the Denver and Rio Grande railroad station. The rod is a vertical 2 by 4 inch timber, 10 feet long, spiked to the bridge, the marks being strips of brass securely nailed to the post. There is one bench mark, the 8-foot mark on the gage rod, which is level with the top of the lower end of a 6 by 8 inch timber protruding downstream from the pier on the right-hand side. The banks are low, but not subject to overflow; the bed of the stream is of gravel, but not liable to radical change. The observer is the clerk at the agency. The following measurements were made by A. L. Fellows during 1899:

April 22, gage height, 3.20 feet; discharge, 437 second-feet.
May 20, gage height, 3.40 feet; discharge, 577 second-feet.
June 25, gage height, 2.80 feet; discharge, 244 second-feet.
November 25, gage height, 2.60 feet; discharge, 124 second-feet.

*Daily gage height, in feet, of Los Pinos River at Ignacio, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.90 | 3.35 | 2.95 | 3.05 | 2.30 | 2.30 | 2.50 | 2.50 |
| 2 | ..... | 2.90 | 3.25 | 2.95 | 3.40 | 2.30 | 2.25 | 2.50 | 2.50 |
| 3 | ..... | 2.80 | 3.15 | 2.95 | 4.05 | 2.30 | 2.20 | 2.50 | 2.50 |
| 4 | ..... | 2.80 | 3.10 | 2.95 | 4.75 | 2.20 | 2.45 | 2.50 | 2.45 |
| 5 | ..... | 2.75 | 3.00 | 2.80 | 3.90 | 2.25 | 2.50 | 2.50 | 2.40 |
| 6 | ..... | 2.70 | 3.05 | 2.80 | 3.60 | 2.20 | 2.40 | 2.50 | 2.40 |
| 7 | ..... | 2.70 | 3.15 | 2.80 | 3.55 | 2.20 | 2.40 | 2.50 | 2.40 |
| 8 | ..... | 2.85 | 3.30 | 2.80 | 3.50 | 2.25 | 2.30 | 2.50 | 2.30 |
| 9 | ..... | 2.90 | 3.35 | 2.75 | 3.35 | 2.25 | 2.30 | 2.50 | 2.30 |
| 10 | ..... | 3.05 | 3.35 | 2.70 | 3.20 | 2.25 | 2.30 | 2.50 | 2.30 |
| 11 | ..... | 3.55 | 3.40 | 2.70 | 3.00 | 2.20 | 2.25 | 2.50 | 2.30 |
| 12 | ..... | 3.85 | 3.45 | 2.65 | 2.95 | 2.30 | 2.55 | 2.50 | 2.30 |
| 13 | ..... | 4.05 | 3.40 | 2.60 | 2.90 | 2.30 | 2.70 | 2.50 | 2.30 |
| 14 | ..... | 3.95 | 3.45 | 2.70 | 2.85 | 2.30 | 2.90 | 2.50 | 2.30 |
| 15 | ..... | 3.85 | 3.45 | 2.70 | 2.80 | 2.85 | 2.85 | 2.60 | 2.30 |
| 16 | ..... | 3.75 | 3.35 | 2.70 | 2.90 | 2.65 | 2.80 | 2.60 | 2.30 |
| 17 | ..... | 3.60 | 3.25 | 2.70 | 2.90 | 2.45 | 2.80 | 2.60 | 2.30 |
| 18 | ..... | 3.60 | 3.20 | 2.80 | 2.90 | 2.40 | 2.70 | 2.60 | 2.30 |
| 19 | ..... | 3.80 | 3.20 | 3.55 | 2.85 | 2.40 | 2.70 | 2.60 | 2.30 |
| 20 | ..... | 3.50 | 3.15 | 3.30 | 2.75 | 2.40 | 2.70 | 2.60 | 2.30 |
| 21 | ..... | 3.25 | 3.10 | 3.10 | 2.65 | 2.40 | 2.70 | 2.60 | 2.30 |
| 22 | ..... | 3.20 | 3.05 | 3.05 | 2.60 | 2.40 | 2.70 | 2.60 | Ice. |
| 23 | 3.40 | 3.30 | 2.95 | 2.95 | 2.55 | 2.40 | 2.70 | 2.60 | Ice. |
| 24 | 3.50 | 3.55 | 2.90 | 2.85 | 2.50 | 2.30 | 2.70 | 2.60 | Ice. |
| 25 | 3.50 | 3.55 | 2.85 | 2.80 | 2.45 | 2.30 | 2.65 | 2.60 | Ice. |
| 26 | 3.40 | 3.35 | 3.25 | 2.80 | 2.40 | 2.30 | 2.60 | 2.60 | Ice. |
| 27 | 3.20 | 3.35 | 3.45 | 2.80 | 2.40 | 2.30 | 2.60 | 2.50 | Ice. |
| 28 | 3.20 | 3.30 | 3.25 | 2.80 | 2.40 | 2.30 | 2.50 | 2.50 | Ice. |
| 29 | 3.00 | 3.35 | 3.15 | 3.15 | 2.35 | 2.30 | 2.50 | 2.50 | Ice. |
| 30 | 2.90 | 3.35 | 3.05 | 3.35 | 2.30 | 2.30 | 2.50 | 2.50 | Ice. |
| 31 | ..... | 3.45 | ..... | 3.20 | 2.30 | ..... | 2.50 | ..... | Ice. |

## ANIMAS RIVER AT DURANGO, COLORADO.

This river is an important tributary of the San Juan, and has its source in the high peaks of southwestern Colorado. It has a nearly southerly course, crossing the State line into New Mexico, where it shortly enters San Juan River. The station originally established June 20, 1895, was located at the wagon bridge one-quarter of a mile west of the railroad station at Durango, and about 200 feet above the Rio Grande Southern railroad bridge. During the early part of the year the old wagon bridge was removed and a new one erected a short distance below. April 1, 1899, a gage rod was placed on the central pier of the new bridge. The bench marks are three horizontal strips, opposite the 10-, 14-, and 16.7-foot marks of the rod, respectively. Owing to this change in location and height of the rod there is no apparent relation between the rating tables for past years and the rating table for 1899. Lightner Creek enters Animas River from the right about 100 feet below the wagon bridge. The channel is straight both above and below the station, and the bed is of gravel and fairly permanent. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 285; 1897, Nineteenth Annual Report, Part IV, page 414; 1898, Twentieth Annual Report, Part IV, page 403. Measurements for 1899 were made by A. L. Fellows, as follows:

April 21, gage height, 7.50 feet; discharge, 698 second-feet.
May 19, gage height, 9.45 feet; discharge, 2,635 second-feet.
June 24, gage height, 8.10 feet; discharge, 1,256 second-feet.
September 28, gage height, 6.52 feet; discharge, 223 second-feet.
November 25, gage height, 6.50 feet; discharge, 201 second-feet.

*Daily gage height, in feet, of Animas River at Durango, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.45 | 7.40 | 9.20 | 7.80 | 7.05 | 6.85 | 6.50 | 6.80 | ..... |
| 2 | 6.50 | 7.35 | 8.75 | 7.85 | 7.25 | 6.80 | ..... | ..... | 6.40 |
| 3 | 6.45 | 7.35 | 8.35 | 8.05 | 8.20 | 6.80 | ..... | ..... | ..... |
| 4 | 6.35 | 7.35 | 8.05 | 7.75 | 8.90 | 6.75 | ..... | 6.70 | 6.40 |
| 5 | 6.35 | 7.35 | 7.75 | 7.65 | 8.45 | 6.70 | ..... | ..... | ..... |
| 6 | 6.30 | 7.25 | 7.90 | 7.60 | 8.15 | 6.70 | ..... | ..... | ..... |
| 7 | 6.35 | 7.25 | 8.20 | 7.65 | 8.15 | 6.65 | 6.50 | 6.80 | ..... |
| 8 | 6.40 | 7.50 | 8.45 | 7.50 | 8.00 | 6.70 | ..... | ..... | ..... |
| 9 | 6.45 | 7.65 | 8.70 | 7.45 | 7.70 | 6.70 | ..... | ..... | 6.40 |
| 10 | 6.50 | 7.80 | 9.15 | 7.45 | 7.55 | 6.65 | ..... | 6.70 | ..... |
| 11 | 6.70 | 8.60 | 9.30 | 7.30 | 7.45 | 6.60 | 6.80 | ..... | ..... |
| 12 | 6.80 | 9.40 | 9.60 | 7.35 | 7.35 | 6.60 | ..... | ..... | 6.50 |
| 13 | 7.00 | 9.85 | 9.65 | 7.40 | 7.30 | 6.60 | ..... | ..... | ..... |
| 14 | 7.10 | 10.00 | 9.55 | 7.40 | 7.20 | 6.60 | 6.90 | 6.70 | ..... |
| 15 | 7.30 | 9.80 | 9.45 | 7.40 | 7.20 | 6.90 | ..... | ..... | ..... |
| 16 | 7.55 | 9.60 | 9.25 | 7.35 | 7.35 | 6.95 | ..... | ..... | 6.70 |
| 17 | 7.50 | 9.50 | 9.15 | 7.20 | 7.55 | 6.90 | 6.80 | ..... | ..... |
| 18 | 7.65 | 9.35 | 9.10 | 7.25 | 7.45 | 6.80 | ..... | 6.70 | ..... |
| 19 | 7.75 | 9.40 | 8.85 | 7.90 | 7.30 | 6.80 | ..... | ..... | ..... |
| 20 | 7.65 | 9.05 | 8.75 | 7.75 | 7.25 | 6.75 | ..... | ..... | ..... |
| 21 | 7.45 | 8.20 | 8.65 | 7.45 | 7.20 | 6.70 | 6.80 | 6.70 | ..... |
| 22 | 7.55 | 8.05 | 8.55 | 7.35 | 7.10 | 6.70 | ..... | ..... | 6.60 |
| 23 | 7.95 | 8.10 | 8.35 | 7.30 | 7.05 | 6.70 | ..... | ..... | ..... |
| 24 | 8.05 | 8.90 | 8.10 | 7.20 | 7.00 | 6.60 | 6.90 | ..... | ..... |
| 25 | 8.10 | 9.00 | 8.00 | 7.15 | 6.95 | 6.60 | ..... | 6.50 | ..... |
| 26 | 8.00 | 8.80 | 8.25 | 7.10 | 6.90 | 6.60 | ..... | ..... | 6.70 |
| 27 | 7.95 | 8.90 | 8.25 | 7.10 | 6.90 | 6.60 | ..... | ..... | ..... |
| 28 | 7.85 | 8.50 | 8.00 | 7.00 | 6.85 | 6.60 | 6.80 | ..... | ..... |
| 29 | 7.65 | 8.80 | 7.95 | 7.00 | 6.80 | 6.55 | ..... | 6.50 | 6.50 |
| 30 | 7.45 | 9.30 | 7.80 | 7.20 | 6.80 | 6.50 | ..... | ..... | ..... |
| 31 | ..... | 9.35 | ..... | 7.15 | 6.80 | ..... | ..... | ..... | ..... |

## FLORIDA RIVER NEAR DURANGO, COLORADO.

This stream is a tributary of Animas River, and rises in the northern part of La Plata County; flowing in a general southerly direction it enters Animas River a short distance before this latter stream passes into New Mexico. During the last season work has been prosecuted on a large storage project near the head of the river, and on this account a gaging station was established by A. L. Fellows May 19, 1899. It is located at a wagon bridge at Stewart's ranch, 9 miles east of Durango. The gage rod consists of a vertical 2 by 4 inch timber fastened to the downstream side of the left-hand abutment of the bridge. In 1899 two measurements of discharge were made at this point by A. L. Fellows. The first, on May 19, at a gage height of 2.25 feet, showed a discharge of 236 second-feet; the second, on June 24, at a gage height of 0.70 feet, showed a discharge of 9 second-feet.

*Daily gage height, in feet, of Florida River near Durango, Colorado, for 1899.*

| Day. | May. | June. | July. | Day. | May. | June. | July. | Day. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.65 | 1.05 | 12 | ..... | 1.70 | 0.65 | 23 | 1.90 | 0.75 | 1.00 |
| 2 | ..... | 1.50 | .95 | 13 | ..... | 1.60 | .70 | 24 | 2.05 | .75 | .95 |
| 3 | ..... | 1.35 | 1.05 | 14 | ..... | 1.60 | .85 | 25 | 2.00 | .75 | .80 |
| 4 | ..... | 1.25 | .95 | 15 | ..... | 1.45 | .65 | 26 | 1.80 | 1.25 | .95 |
| 5 | ..... | 1.20 | .95 | 16 | ..... | 1.30 | .65 | 27 | 1.80 | 1.60 | 1.10 |
| 6 | ..... | 1.40 | .90 | 17 | ..... | 1.25 | .70 | 28 | 1.65 | 1.35 | 1.25 |
| 7 | ..... | 1.60 | .65 | 18 | ..... | 1.15 | 1.60 | 29 | 1.75 | 1.10 | 2.15 |
| 8 | ..... | 1.70 | .75 | 19 | ..... | 1.15 | 1.85 | 30 | 1.70 | 1.00 | 1.90 |
| 9 | ..... | 1.70 | .70 | 20 | ..... | 1.05 | 1.45 | 31 | 1.80 | ..... | 1.60 |
| 10 | ..... | 1.60 | .75 | 21 | 1.65 | 1.00 | 1.25 | | | | |
| 11 | ..... | 1.55 | .65 | 22 | 1.60 | .95 | 1.05 | | | | |

Station discontinued July 31.

## MANCOS RIVER AT MANCOS, COLORADO.

This river is an important tributary of the San Juan, draining the southwestern corner of Colorado. The lower portion of its course is through the Southern Ute Indian Reservation. It enters San Juan River near the adjoining corners of Utah, Colorado, New Mexico, and Arizona. The primary object of a station on this river was to obtain data relative to the amount of water that can be stored for the water supply of the Southern Ute Indian Reservation. The results of this investigation, made by Mr. G. H. Matthes, may be found in the Twentieth Annual Report, Part IV, pages 408 to 434. The gaging station, established by A. L. Fellows April 9, 1898, is located 100 feet below the wagon bridge across the river in the center of the town of Mancos. The gage consists of a vertical timber spiked to a cottonwood tree on the left bank of the river. Measurements are usually made by wading, but the wagon bridge can be used at high stages of water. The banks are not subject to overflow. The channel is in gravel, but is not liable to radical change. The results of measurements in 1898 may be found in the Twentieth Annual Report, Part IV, page 404. The following measurements of discharge were made by A. L. Fellows during 1899:

April 19, gage height, 1.65 feet; discharge, 70 second-feet.
May 18, gage height, 1.60 feet; discharge, 56 second-feet.
June 23, gage height, 1.10 feet; discharge, 9 second-feet.
September 22, gage height, 0.90 foot; discharge, 2 second-feet.
November 24, gage height, 1 foot; discharge, 3 second-feet.

*Daily gage height, in feet, of Mancos River at Mancos, Colorado, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.50 | 1.70 | 1.10 | 1.20 | 1.00 | 1.40 | 1.10 |
| 2 | ..... | 1.40 | 1.70 | 1.00 | 1.20 | 1.00 | 1.40 | 1.10 |
| 3 | ..... | 1.40 | 1.70 | 1.10 | 1.40 | 1.00 | 1.30 | 1.10 |
| 4 | ..... | 1.40 | 1.60 | 1.10 | 1.60 | 1.00 | 1.30 | 1.10 |
| 5 | ..... | 1.30 | 1.50 | 1.10 | 1.60 | 1.00 | 1.30 | ..... |
| 6 | ..... | 1.40 | 1.50 | 1.10 | 1.70 | 1.00 | 1.20 | ..... |
| 7 | ..... | 1.40 | 1.50 | 1.10 | 1.50 | 1.00 | 1.00 | ..... |
| 8 | ..... | 1.40 | 1.50 | 1.10 | 1.60 | 1.00 | 1.50 | ..... |
| 9 | 1.00 | 1.50 | 1.60 | 1.00 | 1.60 | 1.00 | 1.60 | ..... |
| 10 | 1.10 | 1.50 | 1.60 | 1.00 | 1.70 | 1.10 | 1.50 | ..... |
| 11 | 1.00 | 1.75 | 1.60 | 1.00 | 1.70 | 1.10 | 1.50 | ..... |
| 12 | 1.00 | 1.80 | 1.50 | 1.00 | 1.80 | 1.10 | 1.50 | ..... |
| 13 | 1.00 | 2.00 | 1.50 | .90 | 1.80 | 1.10 | 1.50 | ..... |
| 14 | 1.00 | 2.00 | 1.50 | 1.00 | 1.70 | 1.00 | 1.50 | ..... |
| 15 | 1.00 | 1.90 | 1.50 | 1.00 | 1.60 | 1.00 | 1.50 | ..... |
| 16 | 1.50 | 1.80 | 1.50 | 1.00 | 1.60 | 1.00 | 1.50 | ..... |
| 17 | 1.60 | 1.80 | 1.50 | 1.10 | 1.50 | 1.00 | 1.40 | ..... |
| 18 | 1.55 | 1.80 | 1.10 | 1.30 | 1.50 | 1.00 | 1.40 | ..... |
| 19 | 1.65 | 1.80 | 1.10 | 1.30 | 1.40 | 1.90 | 1.30 | ..... |
| 20 | 1.50 | 1.80 | 1.10 | 1.30 | 1.40 | 1.90 | 1.30 | ..... |
| 21 | 1.50 | 1.60 | 1.00 | 1.30 | 1.30 | 1.90 | 1.20 | ..... |
| 22 | 1.50 | 1.70 | 1.00 | 1.30 | 1.30 | 1.70 | 1.10 | ..... |
| 23 | 1.70 | 2.00 | 1.00 | 1.20 | 1.20 | 1.70 | 1.00 | ..... |
| 24 | 1.75 | 1.50 | 1.00 | 1.20 | 1.20 | 1.60 | 1.00 | ..... |
| 25 | 1.70 | 1.55 | 1.00 | 1.10 | 1.10 | 1.60 | 1.00 | ..... |
| 26 | 1.70 | 1.80 | 1.20 | 1.00 | 1.10 | 1.60 | .90 | ..... |
| 27 | 1.70 | 1.80 | 1.20 | 1.00 | 1.10 | 1.50 | .90 | ..... |
| 28 | 1.50 | 1.70 | 1.10 | 1.00 | 1.10 | 1.50 | .80 | ..... |
| 29 | 1.50 | 1.70 | 1.10 | 1.00 | 1.10 | 1.50 | .80 | ..... |
| 30 | 1.50 | 1.60 | 1.10 | 1.10 | 1.10 | 1.50 | 1.10 | ..... |
| 31 | ..... | 1.65 | ..... | 1.10 | 1.15 | ..... | 1.10 | ..... |

Closed for the winter November 4.

## GILA RIVER AT SAN CARLOS, ARIZONA.

This river rises in southwestern New Mexico and has a general southwesterly direction until it crosses the territorial line into Arizona at about 32° 40′ north latitude. Its principal sources of supply are from the Black Range on the east, and from a number of ranges on the west, including Little Range, Mogollon Range, and Diablo Range. The average elevation of these mountain peaks is from 9,000 to 10,000 feet. The general character of the country is a high and rolling plateau, with the river flowing through it in a deep canyon, and with practically no agricultural lands within its area. The river emerges from its upper canyon about 10 miles before it reaches the Arizona line, and thence flows through a valley of considerable width, known as Duncan Valley, until just before it receives the waters of San Francisco River. Duncan Valley, in which a number of ditches divert water for irrigation purposes, will be described at length in the Twenty-first Annual Report. San Francisco River, the principal tributary of the upper Gila, has it source in the northeast corner of Graham County, Arizona, but 15 miles below it passes into New Mexico. Its general course is thence southerly, returning into Arizona at about 33° north latitude. The area drained is high and mountainous, the principal ranges being the San Francisco, the Tularosa, and the western slope of the Mogollon, with elevations ranging from 8,000 to 10,000 feet. The course of the river through this portion is characterized by a succession of canyons alternating with valley-like openings, with the considerable fall of from 35 to 40 feet per mile.

Gila River is in canyon for about 20 miles below the mouth of the San Francisco, or to within 10 miles of Solomonsville. At this point the hills separate, forming a large valley which has been extensively settled and is now one of the finest irrigated portions of the Territory. The results of a series of seepage measurements made from 10 miles above Solomonsville down to Fort Thomas, with a description of the irrigation enterprises in this section, will be published in the Twenty-first Annual Report. This valley extends from a point 10 miles above Solomonsville to 6 miles below the mouth of San Carlos River on the White Mountain Indian Reservation. At this latter place the mountains suddenly close in again, and the river enters another canyon. Seven miles below the Indian agency at San Carlos the canyon boxes to a width of 100 feet, and at this point is located the San Carlos dam site, which was studied in detail by the United States Geological Survey during 1899, in connection with the investigation of the water supply of Gila River. The results of this investigation are published in Water-Supply and Irrigation Paper No. 33, entitled Storage of Water on Gila River, Arizona, by J. B. Lippincott. In connection with this investigation Cyrus C. Babb, on July 11, 1899, established a

station on Gila River one-half mile south of the Indian agency at San Carlos and below the mouth of San Carlos Creek. An inclined rod securely fastened to posts driven into the bank was erected here. The bench mark is a 20-penny nail in the base of a mesquite tree 5 inches in diameter, 85 feet west of the gage rod, at an elevation of 12.67 feet above gage datum. Discharge measurements are made from a cable and car a short distance above the gage rod. The channel is straight for some distance above and below the station, and the water is comparatively swift. The right bank is high, but the left is low and liable to overflow. The bed of the stream is sandy and shifting. The following measurements of discharge were made by Cyrus C. Babb and Stephen Janus during 1899:

*Discharge measurements of Gila River at San Carlos, Arizona.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| August 4 | 3.63 | 1,038 | September 14 | 2.10 | 312 |
| September 6 | 2.30 | 170 | September 19 | 1.90 | 127 |
| September 7 | 3.20 | 849 | September 29 | 1.50 | 77 |
| September 8 | 5.45 | 8,453 | October 6 | 2.30 | 215 |
| September 9 | 3.60 | 2,130 | October 14 | 1.80 | 103 |

*Daily gage height, in feet, of Gila River at San Carlos, Arizona, for 1899.*

| Day. | July. | Aug. | Sept. | Oct. | Day. | July. | Aug. | Sept. | Oct. | Day. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 3.10 | 1.60 | 1.50 | 12 | 3.10 | 2.40 | 2.38 | 1.90 | 23 | 3.50 | 1.70 | 1.70 | ..... |
| 2 | ..... | 3.90 | 1.60 | 1.50 | 13 | 2.70 | 2.40 | 2.30 | 1.85 | 24 | 3.40 | 1.70 | 1.70 | ..... |
| 3 | ..... | 3.20 | 1.60 | 1.50 | 14 | 2.50 | 2.20 | 2.13 | 1.80 | 25 | 3.20 | 1.70 | 1.70 | ..... |
| 4 | ..... | 3.10 | 1.60 | 1.60 | 15 | 2.20 | 2.20 | 2.00 | ..... | 26 | 3.10 | 1.70 | 1.70 | ..... |
| 5 | ..... | 2.80 | 1.55 | 1.60 | 16 | 2.30 | 2.00 | 2.00 | ..... | 27 | 3.13 | 1.60 | 1.60 | ..... |
| 6 | ..... | 2.80 | 2.05 | 2.40 | 17 | 2.10 | 2.00 | 2.00 | ..... | 28 | 3.07 | 1.60 | 1.60 | ..... |
| 7 | ..... | 2.90 | 2.60 | 2.30 | 18 | 2.30 | 1.80 | 2.00 | ..... | 29 | 3.20 | 1.85 | 1.50 | ..... |
| 8 | ..... | 2.70 | 5.25 | 2.30 | 19 | 6.50 | 1.80 | 1.90 | ..... | 30 | 2.90 | 1.60 | 1.50 | ..... |
| 9 | ..... | 3.00 | 3.10 | 2.00 | 20 | 4.90 | 1.80 | 1.85 | ..... | 31 | 2.80 | 1.60 | ..... | ..... |
| 10 | ..... | 2.80 | 2.80 | 1.90 | 21 | 3.60 | 1.80 | 1.80 | ..... | | | | | |
| 11 | 4.00 | 2.50 | 2.60 | 1.90 | 22 | 3.50 | 1.80 | 1.70 | ..... | | | | | |

Station discontinued October 14.

The following measurements were made by Cyrus C. Babb during a reconnaissance trip through the upper basin of Gila River in the spring of 1899. The measurements from March 11 to 17, inclusive, are of San Pedro River and of the ditches diverting water from it. The measurements on March 29, 30, and 31 were made on the ditches diverting water from Gila River above Duncan, Arizona. The measurements from April 15 to 17, inclusive, were made principally on ditches diverting water from Gila River in the Solomonsville Valley, and were made to determine the amount of seepage water returning to the stream. A discussion of these latter measurements will be made in the Twenty-first Annual Report, Part IV.

*Miscellaneous discharge measurements in Gila River Basin, Arizona.*

1893.

| Date. | Stream. | Locality. | Discharge. |
|---|---|---|---|
| | | | *Second-feet.* |
| March 11 | Gila River | Above mouth of San Pedro | 62.0 |
| March 11 | San Pedro River | Dudleyville | 9.6 |
| March 11 | Burns and Lopez ditch | Dudleyville | 4.6 |
| March 12 | Scott and Cunningham ditch. | Dudleyville | 6.6 |
| March 12 | San Pedro River | Below Scott and Cunningham ditch. | 1.0 |
| March 12 | Swingle ditch | At head on San Pedro River | 3.7 |
| March 12 | Finch and Draper ditch. | At head on San Pedro River | 2.8 |
| March 13 | Dodson ditch | At head on San Pedro River | 7.6 |
| March 13 | San Pedro River | Below Dodson ditch | 0.0 |
| March 13 | Cook ditch | At head on San Pedro River | 6.4 |
| March 13 | Busand ditch | At head on San Pedro River | 3.4 |
| March 13 | San Pedro River | 1 mile below Mammoth | 0.0 |
| March 14 | Brown ditch | At head on San Pedro River | 9.1 |
| March 14 | Clark ditch | At head on San Pedro River | 2.3 |
| March 14 | San Pedro River | Pinal and Pima counties line | 1.5 |
| March 15 | San Pedro River | Narrows | 5.1 |
| March 15 | Los Angeles ditch | At head on San Pedro River | 4.2 |
| March 16 | San Pedro River | Line between townships 14 and 15 south. | 10.0 |
| March 17 | St. David canal | 2 miles above St. David | 7.3 |
| March 17 | San Pedro River | Benson, Arizona, ½ mile below railroad. | 6.5 |
| March 17 | Etts ditch | 1 mile below railroad at Benson. | 1.2 |
| March 17 | San Pedro River | 5 miles south of Benson | 5.7 |
| March 22 | Union ditch | Solomonsville | 76.0 |
| March 22 | Gila River | Below head of Union ditch, Solomonsville. | 10.0 |
| March 29 | Gila River | Below Telles ditch | 156.0 |
| March 30 | Telles ditch | Above Duncan | 4.0 |
| March 30 | Rucker ditch | Above Duncan | 1.6 |
| March 30 | Hughes ditch | Above Duncan | 2.8 |
| March 30 | Martin ditch | Above Duncan | 3.0 |
| March 30 | Wilson ditch | Above Duncan | 4.7 |
| March 30 | Casper and Windham ditch. | Above Duncan | 6.8 |
| March 30 | Johnson ditch | Above Duncan | 0.7 |
| March 30 | Schriver ditch | Above Duncan | 6.2 |
| March 30 | Franklin ditch | Above Duncan | 13.9 |
| March 30 | Valley canal | Above Duncan | 22.9 |
| March 30 | Owens canal | Above Duncan | 1.8 |
| March 30 | Day's ditch | Above Duncan | 6.0 |
| March 31 | Ward and Courtney ditch. | Above Duncan | 7.8 |
| March 31 | Black and McCloskey ditch. | Above Duncan | 3.8 |
| March 31 | Gila River | Duncan | 104.0 |
| April 5 | San Francisco River | 7 miles above Clifton | 94.0 |
| April 5 | Blue River | At mouth | 43.0 |
| April 5 | San Francisco River | Above mouth of Blue River | 54.0 |
| April 13 | San Francisco River | Flume power house, below Clifton. | 92.0 |
| April 14 | Gila Piver | 5 miles above San Francisco River. | 95.0 |
| April 15 | Brown ditch | Near head | 0.6 |

*Miscellaneous discharge measurements in Gila River Basin, Arizona*—Continued.

1899—Continued.

| Date | Stream. | Locality. | Discharge. |
|---|---|---|---|
| | | | *Second-feet.* |
| April 15 | Sanchez ditch | Near head | 7.6 |
| April 15 | Gila River | Narrows below Sanchez ditch | 237.0 |
| April 15 | Mejia ditch | Below waste | 4.3 |
| April 15 | Old San Jose ditch | Near head | 11.6 |
| April 15 | San Jose ditch | Near head | 45.0 |
| April 15 | Gila River | Below San Jose ditch | 189.0 |
| April 15 | Waste | North side | 2.0 |
| April 15 | Michelena ditch | Below waste gate | 9.4 |
| April 15 | Montezuma ditch | Below waste gate | 101.0 |
| April 15 | Gonzales ditch | Below waste gate | 4.0 |
| April 15 | Gila River | Below Gonzales ditch | 63.0 |
| April 15 | Waste | Montezuma ditch | 27.0 |
| April 15 | Waste | Above Union ditch | 10.0 |
| April 15 | Union ditch | At head | 93.0 |
| April 15 | Gila River | Below Union ditch | 10.4 |
| April 16 | Lee ditch | At head | 3.3 |
| April 16 | Sunflower ditch | At head | 4.9 |
| April 16 | Graham ditch | At head | 18.6 |
| April 16 | Central ditch | At head | 19.5 |
| April 16 | Gila River | Below Central ditch | 6.8 |
| April 16 | Oregon ditch | At head | 11.1 |
| April 16 | Smithville ditch | At head | 13.2 |
| April 16 | Gila River | Below Smithville ditch | 1.5 |
| April 16 | Brice ditch | At head | 7.4 |
| April 16 | Dodge ditch | At head | 6.7 |
| April 17 | Mathewsville ditch | At head | 33.0 |
| April 17 | Gila River | Below Mathewsville ditch | 2.8 |
| April 17 | Curtis ditch | At head | 14.3 |
| April 17 | Gila River | Below Curtis ditch | 0.0 |
| April 17 | Kempton ditch | At head | 9.3 |
| April 17 | Vogel ditch | At head | 0.0 |
| April 17 | Gila River | Below Vogel ditch | 7.0 |
| April 17 | Reid ditch | At head | 3.8 |
| April 17 | Gila River | Below Reid ditch | 10.8 |
| April 17 | Fort Thomas ditch | At head | 3.7 |
| April 17 | Upper Thompson ditch | At head | 0.0 |
| April 17 | Lower Thompson ditch | At head | 5.3 |
| April 17 | Military ditch | Flume at Fort Thomas | 5.9 |
| April 17 | Saline ditch | At head | 0.7 |
| April 17 | Mexican ditch | At head | 0.8 |
| April 17 | Gila River | Opposite Fort Thomas | 20.0 |
| April 17 | Gila River | 3 miles below Fort Thomas | 32.8 |
| April 25 | Indian ditch | San Carlos | 12.2 |
| April 28 | Gila River | San Carlos Canyon | 27.0 |
| May 15 | Gila River | Duncan | 10.0 |
| May 24 | Gila River | San Carlos Canyon | 7.0 |

## GILA RIVER AT THE BUTTES, ARIZONA.

Gila River is in canyon from a short distance below the mouth of San Carlos River to about the mouth of San Pedro River, a distance of 31 miles. The country then broadens into a valley of considerable size, extending for a distance of about 20 miles, to below the mouth of Mineral Creek. This opening, known as Riverside Valley, was examined in detail in connection with the investigation of the water

supply of Gila River, and the lower portion was mapped by G. H. Matthes as a reservoir site. From the mouth of Mineral Creek the river is in canyon again until what is known as the Buttes are reached—a distance of about 15 miles, when the river appears on the Great Plains region of southwestern Arizona. Its general course is thence westerly until it enters the Colorado River at Yuma. The present station at the Buttes was established February 20, 1896, in connection with the first investigation for a water supply for the Gila River Indian Reservation. It is located about 16 miles above Florence, Arizona. The gage rod is bolted to a solid rock on the right bank where the river emerges from the lower end of the gorge. The bench mark is a rock point chiseled on a ledge 69.4 feet southeast of the south cable support and 4.4 feet above the ground, and is at an elevation of 1,608.45 feet above sea level. The elevation of the zero of the rod is 1,583.00 feet. Measurements at this point were made in connection with the investigation of the water supply of the Gila River by the United States Geological Survey, authorized by special act of Congress. The results of the work are published in Water-Supply and Irrigation Paper No. 33, entitled Storage of Water on Gila River, Arizona, by J. B. Lippincott. The channel of the river at the Buttes is composed of quicksand and likely to change daily with any considerable amount of water in the river. In order to obtain an accurate estimate of the daily discharge, it is necessary to make continuous measurements, which was done during the investigation. The results of the measurements at this point will be found as follows: 1896, Eighteenth Annual Report, Part IV, page 290; 1897, Nineteenth Annual Report, Part IV, page 416; 1898, Twentieth Annual Report, Part IV, page 405; 1899, Water-Supply and Irrigation Paper No. 33, page 26. The following measurements of discharge were made during 1899 by various members of the United States Geological Survey connected with the water-supply investigation:

*Discharge measurements of Gila River at the Buttes, Arizona.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 14 | 3.20 | 634 | March 4 | 2.50 | 139 |
| January 25 | 2.75 | 245 | March 6 | 2.50 | 123 |
| February 3 | 2.90 | 616 | March 8 | 2.50 | 142 |
| February 3 | 2.86 | 547 | March 10 | 2.50 | 146 |
| February 4 | 2.90 | 514 | March 13 | 2.40 | 122 |
| February 6 | 2.80 | 327 | March 15 | 2.40 | 93 |
| February 7 | 2.68 | 222 | March 17 | 2.55 | 120 |
| February 9 | 2.70 | 265 | March 21 | 2.60 | 142 |
| February 11 | 2.80 | 333 | March 23 | 2.60 | 135 |
| February 13 | 2.80 | 270 | March 25 | 2.60 | 130 |
| February 14 | 2.75 | 290 | March 28 | 2.50 | 118 |
| February 15 | 2.75 | 272 | March 30 | 2.50 | 95 |
| February 18 | 2.65 | 193 | April 1 | 2.50 | 86 |
| February 24 | 2.60 | 209 | April 2 | 2.50 | 90 |
| February 27 | 2.60 | 184 | April 5 | 2.50 | 100 |
| March 2 | 2.50 | 165 | April 7 | 2.45 | 97 |

*Discharge measurements of Gila River at the Buttes, Arizona*—Continued.

1899—Continued.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| April 10 | 2.45 | 73 | August 17 | 2.55 | 316 |
| April 12 | 2.40 | 66 | August 19 | 2.40 | 207 |
| April 14 | 2.40 | 64 | August 23 | 2.25 | 112 |
| April 17 | 2.40 | 59 | August 25 | 2.10 | 89 |
| April 19 | 2.35 | 51 | August 29 | 2.00 | 71 |
| April 19 | 2.35 | 53 | August 31 | 2.00 | 77 |
| April 21 | 2.30 | 50 | September 2 | 2.00 | 50 |
| April 21 | 2.30 | 56 | September 4 | 1.90 | 42 |
| April 24 | 2.30 | 48 | September 5 | 1.90 | 24 |
| April 24 | 2.30 | 48 | September 6 | 1.90 | 31 |
| April 26 | 2.30 | 36 | September 7 | 2.70 | 367 |
| April 28 | 2.25 | 38 | September 7 | 3.90 | 2,234 |
| May 1 | 2.25 | 38 | September 8 | 8.30 | 10,187 |
| May 3 | 2.20 | 29 | September 9 | 4.95 | 2,923 |
| May 5 | 2.20 | 32 | September 11 | 3.50 | 1,382 |
| May 6 | 2.15 | 26 | September 12 | 3.00 | 734 |
| May 9 | 2.15 | 26 | September 14 | 2.07 | 399 |
| May 11 | 2.10 | 24 | September 15 | 2.60 | 357 |
| May 13 | 2.10 | 24 | September 16 | 2.50 | 288 |
| May 15 | 2.05 | 19 | September 17 | 2.40 | 249 |
| May 17 | 2.00 | 12 | September 18 | 2.30 | 205 |
| May 18 | 2.00 | 13 | September 19 | 2.30 | 202 |
| May 20 | 2.00 | 14 | September 20 | 2.20 | 147 |
| May 23 | 2.00 | 8 | September 21 | 2.20 | 130 |
| May 25 | 2.00 | 11 | September 22 | 2.20 | 126 |
| May 27 | 1.95 | 13 | September 23 | 2.10 | 99 |
| May 29 | 1.95 | 7 | September 24 | 2.10 | 108 |
| May 31 | 1.90 | 4 | September 25 | 1.05 | 93 |
| June 2 | 2.20 | 30 | September 26 | 2.00 | 82 |
| June 5 | 2.00 | 12 | September 26 | 2.00 | 62 |
| June 7 | 1.90 | 16 | September 27 | 2.00 | 77 |
| June 9 | 1.90 | 4 | September 27 | ..... | 55 |
| June 13 | 1.80 | 2 | September 28 | 2.00 | 68 |
| June 15 | 1.80 | 1 | September 29 | 2.00 | 76 |
| June 19 | 1.75 | 1 | September 29 | 2.00 | 61 |
| June 21 | 1.75 | 1 | September 30 | 1.90 | 54 |
| June 23 | 1.75 | 1 | October 1 | 1.90 | 50 |
| June 26 | 1.75 | 2 | October 2 | 1.90 | 45 |
| June 28 | 1.75 | 1 | October 3 | 1.90 | 40 |
| July 2 | 1.75 | 50 | October 4 | 1.90 | 41 |
| July 4 | 1.70 | 25 | October 5 | 1.80 | 43 |
| July 6 | 1.70 | 25 | October 5 | 2.52 | 330 |
| July 8 | 1.70 | 16 | October 6 | 2.10 | 139 |
| July 10 | 1.80 | 2 | October 7 | 2.25 | 179 |
| July 11 | 2.75 | 302 | October 8 | 2.35 | 219 |
| July 12 | 2.80 | 505 | October 9 | 2.30 | 180 |
| July 13 | 2.70 | 263 | October 10 | 2.25 | 180 |
| July 14 | 2.50 | 142 | October 11 | 2.20 | 98 |
| July 17 | 2.85 | 317 | October 12 | 2.20 | 93 |
| July 18 | 3.40 | 1,094 | October 13 | 2.20 | 110 |
| July 18 | 2.40 | 104 | October 14 | 2.10 | 92 |
| July 19 | 4.00 | 1,567 | October 16 | 2.10 | 96 |
| July 19 | 4.40 | 2,095 | October 17 | 2.10 | 88 |
| July 20 | 6.60 | 5,920 | October 18 | 2.10 | 88 |
| July 20 | 8.00 | 8,739 | October 19 | 2.00 | 71 |
| July 21 | 5.50 | 4,339 | October 20 | 2.00 | 79 |
| August 14 | 2.75 | 397 | October 21 | 2.00 | 76 |

Measurements were also made of Arthur's ditch, which diverts water one-half mile below the gaging station, of the Florence canal, opposite White's ranch, and of Gila River near the latter place.

The following table shows the measurements made during 1899:

*Discharge measurements of Gila River, Arthur's ditch, and Florence canal, Arizona.*

1899.

| Date. | Stream. | Locality. | Discharge. |
|---|---|---|---|
| | | | *Second-feet.* |
| March 17 | Arthur's ditch | One-half mile below station | 4.23 |
| March 21 | Arthur's ditch | One-half mile below station | 4.20 |
| March 21 | Gila River | One-half mile below gate of Florence canal. | 19.28 |
| March 21 | Florence canal | Opposite White's ranch | 101.19 |
| April 17 | Arthur's ditch | One-half mile below Butte station. | 2.15 |
| April 17 | Gila River | Below head gate, opposite White's house. | 13.43 |
| April 17 | Florence canal | At White's ranch, opposite house. | 42.61 |
| May 6 | Arthur's ditch | On Gila River | 3.48 |
| May 6 | Gila River | Below Florence canal | 8.51 |
| May 6 | Florence canal | At White's ranch | 10.76 |
| May 18 | Gila River | At head of Arthur's ditch at the Buttes. | 2.70 |
| May 18 | Gila River | Below Florence canal | 2.27 |
| May 18 | Gila River | Opposite White's ranch | 2.94 |

*Daily gage height, in feet, of Gila River at the Buttes, Arizona, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.80 | 2.69 | 2.50 | 2.50 | 2.25 | 1.90 | 1.75 | 4.00 | 2.00 | 1.90 |
| 2 | 2.78 | 2.73 | 2.50 | ..... | 2.20 | 2.20 | 1.70 | 4.70 | 2.00 | 1.90 |
| 3 | 2.80 | 2.88 | 2.50 | 2.45 | 2.20 | 2.10 | 1.70 | 5.50 | ..... | 1.90 |
| 4 | 2.73 | 2.93 | 2.50 | 2.50 | 2.20 | ..... | 1.70 | 4.50 | 1.90 | 1.90 |
| 5 | 2.70 | 2.91 | ..... | 2.50 | 2.20 | 2.00 | 1.70 | 4.00 | 1.87 | 2.15 |
| 6 | 2.65 | 2.78 | 2.50 | 2.50 | 2.15 | 1.95 | 1.70 | 3.70 | 1.95 | 2.15 |
| 7 | 2.60 | 2.69 | 2.50 | 2.45 | ..... | 1.90 | 1.70 | 3.30 | 3.30 | 2.25 |
| 8 | 2.63 | 2.71 | 2.50 | 2.45 | 2.15 | 1.90 | 1.70 | 4.50 | 8.30 | 2.37 |
| 9 | 2.68 | 2.72 | 2.50 | ..... | 2.15 | 1.90 | ..... | 3.70 | 4.85 | 2.30 |
| 10 | 2.60 | 2.70 | 2.50 | 2.45 | 2.10 | 1.85 | 1.80 | 3.30 | 4.30 | 2.22 |
| 11 | 2.73 | 2.73 | 2.40 | 2.45 | 2.10 | 1.80 | 2.75 | 3.30 | 3.35 | 2.20 |
| 12 | 2.70 | 2.80 | ..... | 2.40 | 2.10 | 1.80 | 2.80 | 3.10 | 3.00 | 2.20 |
| 13 | 3.30 | 2.80 | 2.40 | 2.40 | 2.10 | 1.80 | 2.70 | 2.80 | 2.80 | 2.20 |
| 14 | 3.15 | 2.78 | 2.40 | 2.40 | ..... | 1.80 | 2.50 | 2.80 | 2.65 | 2.10 |
| 15 | 3.00 | 2.75 | 2.40 | 2.40 | 2.05 | 1.80 | 2.40 | 2.70 | 2.60 | 2.10 |
| 16 | 3.00 | 2.70 | 2.50 | ..... | 2.05 | 1.75 | ..... | 2.60 | 2.50 | 2.10 |
| 17 | 2.95 | 2.67 | 2.55 | 2.40 | 2.00 | 1.75 | 2.70 | 2.50 | 2.40 | 2.10 |
| 18 | 2.93 | 2.68 | 2.55 | 2.40 | 2.00 | ..... | 3.10 | 2.50 | 2.30 | 2.05 |
| 19 | 2.80 | 2.65 | ..... | 2.35 | 2.00 | 1.75 | 4.20 | 2.40 | 2.30 | 2.00 |
| 20 | 2.73 | 2.63 | 2.60 | 2.30 | 2.00 | 1.75 | 7.30 | 2.40 | 2.20 | 2.05 |
| 21 | 2.70 | ..... | 2.60 | 2.30 | ..... | 1.75 | 5.50 | ..... | 2.20 | 2.05 |
| 22 | 2.70 | 2.65 | ..... | 2.30 | 2.00 | 1.75 | 4.50 | 2.30 | 2.20 | ..... |
| 23 | 2.80 | 2.60 | 2.60 | ..... | 2.00 | 1.75 | ..... | 2.30 | 2.10 | ..... |
| 24 | 2.80 | 2.60 | 2.50 | 2.30 | 2.00 | 1.75 | 4.00 | 2.20 | 2.10 | ..... |
| 25 | 2.75 | 2.60 | 2.60 | 2.30 | 2.00 | 1.75 | 3.90 | 2.10 | 2.05 | ..... |
| 26 | ..... | 2.60 | ..... | 2.30 | 2.00 | 1.75 | 4.00 | 2.10 | 2.00 | ..... |
| 27 | 2.75 | 2.60 | 2.50 | 2.30 | 1.95 | 1.75 | 4.00 | 2.10 | 2.00 | ..... |
| 28 | 2.70 | 2.50 | 2.50 | 2.25 | ..... | 1.75 | 5.25 | 2.00 | 2.00 | ..... |
| 29 | 2.75 | ..... | 2.50 | 2.25 | 1.95 | 1.75 | ..... | 2.00 | 1.97 | ..... |
| 30 | 2.70 | ..... | 2.50 | ..... | 1.90 | ..... | ..... | 2.00 | 1.90 | ..... |
| 31 | 2.68 | ..... | 2.50 | ..... | 1.90 | ..... | ..... | 2.00 | ..... | ..... |

Station discontinued October 11.

## QUEEN CREEK AT WHITLOW'S RANCH, ARIZONA.

This creek is a tributary of the Gila, and has its source in the Pinal Mountains, 40 miles northeast of Florence, Arizona. A short distance below Whitlow's ranch its waters ordinarily are lost in the sands of the desert, and it is only during protracted floods that the discharge continues southwestward, entering Gila River below the Sacaton Range. This basin was under examination in connection with the investigation of the water supply of Gila River.[1]

The discharge of this creek is intermittent, depending upon sudden and violent floods, which are generally of short duration, usually extending over a period of only one day. In order to obtain an accurate estimate of its flow, it is necessary to have an observer constantly on the ground. The station at Whitlow's was established in February, 1896, and was discontinued in April, 1897. It was resumed November 16, 1898, when the original rod was extended, lowering the zero 3 feet. On the same day a sloping rod, referred to the same datum, was placed 431 feet upstream from the main gage. Measurements can be made from a cable and car. It was impracticable, during 1899, to use a meter at this point, so the observer, during the flood stages, observed both gages at short intervals and took soundings from which a cross section could be computed. The discharges were figured by Kutter's formula from these measurements of soundings, and from the slope as determined by the observations of heights on the two rods. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 293; 1897, Nineteenth Annual Report, Part IV, page 418. The following table shows the dates on which there was a discharge in the creek, together with the number of second-feet.

*Discharge measurements of Queen Creek at Whitlow's ranch, Arizona.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 12 | 2.00 | ..... | June 26 | 2.30 | 10 |
| January 12 | 3.00 | ..... | July 9 | 3.00 | 81 |
| January 13 | 2.60 | ..... | July 10 | 3.10 | 148 |
| January 13 | 2.40 | ..... | July 13 | 4.50 | 884 |
| January 14 | 2.30 | ..... | July 13 | 2.40 | 3 |
| January 14 | 2.20 | ..... | July 16 | 4.00 | 529 |
| February 3 | 3.00 | 87 | July 18 | 3.50 | 274 |
| February 3 | 2.80 | 57 | July 25 | 2.50 | 2 |
| February 4 | 2.70 | 49 | July 26 | 2.50 | 2 |
| February 4 | 2.50 | 11 | July 29 | 2.60 | 27 |
| February 5 | 2.40 | 8 | July 30 | 7.10 | 5,515 |
| March, April, May: Creek dry | ..... | ..... | August 1 | 4.50 | 492 |
| | | | August 2 | 8.00 | 4,600 |
| | | | August 2 | 6.00 | 1,562 |
| June 2 | 2.70 | 62 | September 7 | 7.50 | ..... |
| June 2 | 2.30 | 16 | September 8 | 7.00 | ..... |
| June 25 | 5.00 | 1,171 | | | |

[1] Storage of water on Gila River, Arizona, by J. B. Lippincott: Water-Supply and Irrigation Paper No. 33.

## SALT RIVER AT MCDOWELL, ARIZONA.

This river is the principal tributary of Gila River, and rises in Graham County, Arizona, its headwater tributaries adjoining those of San Francisco River. A large portion of its course is through the mountainous district of the White Mountain Indian Reservation. Irrigation is practiced to a small extent in what is known as Tonto Valley, but shortly after Tonto Creek joins it the river enters a canyon again and continues in it until a short distance above the mouth of Verde River. At this point the river reappears from its canyon, and its course is thence across the Plains district until it enters Gila River at the northwest corner of Gila River Indian Reservation. From the mouth of Verde River down to Gila River a number of large canals divert the water of Salt River and serve the extensively irrigated lands in the vicinity of Phœnix on the north side and Mesa on the south side of the river. During ordinary seasons all of the water of Salt River is diverted, and at the present time there is a shortage in the summer months. The gaging station, established April 20, 1897, is located one-half mile above the mouth of the Verde and 30 miles northeast of Phœnix. The gage consists of a 2 by 6 inch scantling bolted to rocks on the south side of the river about 300 feet above the cable. The bench mark is a nail in a palo verde tree about 75 feet west of the north cable anchorage and is 17.33 feet above gage zero. The bed of the river is sandy and shifting, and it is necessary to make a large number of measurements in order to obtain an accurate estimate of the discharge. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 420; 1898, Twentieth Annual Report, Part IV, page 406. The following discharge measurements were made by W. A. Farish during 1899:

*Discharge measurements of Salt River at McDowell, Arizona.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 15 | 11.40 | 530 | July 16 | 10.35 | 204 |
| January 22 | 11.05 | 367 | August 22 | 10.55 | 244 |
| February 12 | 11.20 | 390 | September 4 | 10.20 | 144 |
| February 28 | 11.20 | 426 | September 10 | 11.50 | 716 |
| March 12 | 11.20 | 519 | October 8 | 10.40 | 178 |
| March 31 | 11.30 | 602 | October 15 | 11.90 | 496 |
| April 29 | 10.85 | 481 | November 30 | 11.00 | 226 |
| April 30 | 10.89 | 475 | December 1 | 10.95 | 331 |
| June 29 | 10.10 | 173 | | | |

A series of measurements of canals diverting water from Salt River in the vicinity of Phœnix were made by Cyrus C. Babb from June 12 to 5, inclusive, in order to determine the amount of return water to the river through seepage. A similar series of measurements were made

in June, 1896. A discussion of these two sets of seepage measurements will be made in the Twenty-first Annual Report.

*Miscellaneous discharge measurements in Salt River Valley, Arizona.*

1899.

| Date. | Stream. | Locality. | Discharge. |
|---|---|---|---|
| | | | *Second-feet.* |
| June 12 | Salt River | Gaging station | 197.0 |
| June 12 | Verde River | Gaging station | 140.0 |
| June 13 | Arizona canal | Below waste gate | 185.0 |
| June 13 | Arizona waste | At river | 88.0 |
| June 13 | Salt River | Opposite Arizona waste gate | 18.7 |
| June 13 | Highland canal | Opposite Arizona waste gate | 31.7 |
| June 13 | Mesa Consolidated | Below waste gate | 67.7 |
| June 13 | Small flume | Mesa waste gate | 1.8 |
| June 13 | Mesa Consolidated waste. | Near gate | 15.3 |
| June 13 | Salt River | Opposite Mesa Consolidated waste gate. | 5.8 |
| June 13 | Tempe canal | Ford near head | 70.6 |
| June 13 | Salt River | Opposite Tempe canal head | 0.0 |
| June 13 | Salt River | Railroad bridge | 59.8 |
| June 15 | Salt River | South of Phœnix | 0.0 |
| June 15 | St. Johns canal | At head | 7.8 |
| June 15 | Salt River | Below head of St. Johns canal. | 23.9 |
| June 15 | Buckeye canal | At head | 102.3 |
| June 15 | Salt River | Below Buckeye canal | 1.0 |

*Daily gage height, in feet, of Salt River at McDowell, Arizona, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10.80 | 10.95 | 11.20 | 11.30 | 10.90 | 10.25 | 10.10 | 13.50 | 10.30 | 10.30 | 10.95 |
| 2 | 10.85 | 11.00 | 11.15 | 11.25 | 10.95 | 10.35 | 10.10 | 17.00 | 10.35 | 10.30 | 10.80 |
| 3 | 10.70 | 11.10 | 11.10 | 11.20 | 10.80 | 10.40 | 10.10 | 14.30 | 10.30 | 10.30 | 10.80 |
| 4 | 10.70 | 11.40 | 11.10 | 11.15 | 10.75 | 10.45 | 10.05 | 13.00 | 10.40 | 10.40 | 10.80 |
| 5 | 10.70 | 11.30 | 11.15 | 11.15 | 10.80 | 10.45 | 10.10 | 12.90 | 10.40 | 10.40 | 10.90 |
| 6 | 10.65 | 11.25 | 11.20 | 11.10 | 10.75 | 10.40 | 10.10 | 12.70 | 10.40 | 10.40 | 10.90 |
| 7 | 10.70 | 11.20 | 11.25 | 11.20 | 10.75 | 10.35 | 10.05 | 12.20 | 10.35 | 10.40 | 10.90 |
| 8 | 10.70 | 11.15 | 11.25 | 11.30 | 10.70 | 10.35 | 10.05 | 11.90 | 10.30 | 10.45 | 10.90 |
| 9 | 10.70 | 11.10 | 11.20 | 11.30 | 10.65 | 10.35 | 10.05 | 11.10 | 11.45 | 10.40 | 10.90 |
| 10 | 10.70 | 11.05 | 11.20 | 11.30 | 10.60 | 10.40 | 10.10 | 11.95 | 12.60 | 10.40 | 10.90 |
| 11 | 10.65 | 11.30 | 11.20 | 11.35 | 10.55 | 10.30 | 10.25 | 11.30 | 11.65 | 10.40 | 10.90 |
| 12 | 11.05 | 11.20 | 11.25 | 11.30 | 10.50 | 10.25 | 10.60 | 11.40 | 11.50 | 10.55 | 10.90 |
| 13 | 11.90 | 11.30 | 11.30 | 11.35 | 10.50 | 10.20 | 10.50 | 11.20 | 11.30 | 12.70 | 10.90 |
| 14 | 11.65 | 11.35 | 11.25 | 11.35 | 10.45 | 10.20 | 10.80 | 11.00 | 11.00 | 11.90 | 11.00 |
| 15 | 11.70 | 11.30 | 11.20 | 11.35 | 10.50 | 10.20 | 10.50 | 11.00 | 10.80 | 11.85 | 11.00 |
| 16 | 11.30 | 11.20 | 11.15 | 11.35 | 10.55 | 10.20 | 10.40 | 10.90 | 10.70 | 12.30 | 11.00 |
| 17 | 11.20 | 11.15 | 11.10 | 11.30 | 10.55 | 10.20 | 10.90 | 11.05 | 10.60 | 11.80 | 11.00 |
| 18 | 11.15 | 11.15 | 11.05 | 11.35 | 10.55 | 10.15 | 10.90 | 10.95 | 10.55 | 11.50 | 11.00 |
| 19 | 11.15 | 11.10 | 11.05 | 11.35 | 10.50 | 10.15 | 10.80 | 10.80 | 10.50 | 11.30 | 11.00 |
| 20 | 11.25 | 11.10 | 11.10 | 11.30 | 10.55 | 10.10 | 10.70 | 10.60 | 10.45 | 11.00 | 11.00 |
| 21 | 11.10 | 11.10 | 11.10 | 11.25 | 10.55 | 10.20 | 11.00 | 10.60 | 10.45 | 11.00 | 11.00 |
| 22 | 11.10 | 11.10 | 11.10 | 11.25 | 10.55 | 10.15 | 10.75 | 10.55 | 10.45 | 11.00 | 11.00 |
| 23 | 11.05 | 11.10 | 11.10 | 11.20 | 10.55 | 10.20 | 11.50 | 10.40 | 10.40 | 11.00 | 11.00 |
| 24 | 11.05 | 11.15 | 11.10 | 11.15 | 10.60 | 10.30 | 11.40 | 10.40 | 10.35 | 11.00 | 11.00 |
| 25 | 11.00 | 11.15 | 11.10 | 11.15 | 10.60 | 10.20 | 12.50 | 10.45 | 10.35 | 11.00 | 11.00 |
| 26 | 11.00 | 11.20 | 11.10 | 11.15 | 10.55 | 11.10 | 11.60 | 10.40 | 10.35 | 11.00 | 11.00 |
| 27 | 10.90 | 11.20 | 11.20 | 11.10 | 10.50 | 10.50 | 11.70 | 10.40 | 10.35 | 10.95 | 11.00 |
| 28 | 10.90 | 11.20 | 11.35 | 11.10 | 10.45 | 10.15 | 11.60 | 10.35 | 10.35 | 10.95 | 11.00 |
| 29 | 10.90 | ..... | 11.30 | 11.05 | 10.40 | 10.10 | 12.70 | 10.30 | 10.35 | 10.95 | 11.00 |
| 30 | 10.90 | ..... | 11.40 | 10.90 | 10.35 | 10.10 | 12.80 | 10.30 | 10.30 | 10.90 | 11.00 |
| 31 | 10.90 | ..... | 11.30 | ..... | 10.30 | ..... | 13.00 | 10.40 | ..... | 10.90 | ..... |

Station discontinued November 30.

## VERDE RIVER AT MCDOWELL, ARIZONA.

This river rises in north-central Arizona and flows in a general southerly direction, entering Salt River 30 miles northeast of Phœnix. A number of large irrigation enterprises have recently been planned and are now in course of construction, designed to divert water from the lower stretch of the river to irrigate lands north of Phœnix. The results of measurements of this river combined with those of Salt River show the amount of water available for the irrigable lands of Phœnix Valley. The dam of the Arizona Canal Company is located on Salt River immediately below the mouth of the Verde. The gaging station of this latter stream is located three-fourths of a mile above its mouth and 30 miles northeast of Phœnix. It was established April 20, 1897. The station is equipped with a cable, car, and tagged wire. The gage consists of a 2 by 4 inch inclined rod fastened to posts driven into the east bank of the river about 400 feet below the gaging cable. The bench mark is on a cat's claw tree about 100 feet southeast from the old gage, on a cottonwood tree, which latter is 60 feet below the cable. The elevation of the bench mark is 27.02 feet above gage datum. The channel of the river is similar to that of Salt River—sandy and liable to change during a slight rise, and a large number of measurements are necessary in order to accurately determine the discharge. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 420; 1898, Twentieth Annual Report, Part IV, page 407. The following measurements of discharge were made by W. A. Farish during 1899.

*Discharge measurements of Verde River at McDowell, Arizona.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 15 | 7.65 | 454 | July 16 | 7.50 | 254 |
| January 22 | 7.50 | 356 | August 5 | 8.90 | 1,213 |
| February 12 | 7.70 | 374 | August 22 | 7.35 | 139 |
| February 28 | 7.55 | 324 | September 4 | 7.40 | 146 |
| March 12 | 7.55 | 262 | September 10 | 8.20 | 481 |
| March 30 | 7.50 | 231 | October 8 | 7.50 | 206 |
| April 29 | 7.35 | 191 | October 15 | 9.20 | 1,670 |
| April 30 | 7.40 | 209 | November 30 | 7.80 | 303 |
| June 29 | 7.15 | 127 | December 1 | 7.75 | 265 |

*Daily gage height, in feet, of Verde River at McDowell, Arizona, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.45 | 7.55 | 7.55 | 7.50 | 7.40 | 7.15 | 7.20 | 8.00 | 7.35 | 7.35 | 7.70 |
| 2 | 7.45 | 7.55 | 7.50 | 7.50 | 7.40 | 7.20 | 7.15 | 8.30 | 7.40 | 7.35 | 7.70 |
| 3 | 7.45 | 7.60 | 7.50 | 7.50 | 7.35 | 7.25 | 7.15 | 9.00 | 7.50 | 7.35 | 7.70 |
| 4 | 7.50 | 7.40 | 7.55 | 7.50 | 7.30 | 7.20 | 7.10 | 9.00 | 7.40 | 7.60 | 7.65 |
| 5 | 7.40 | 7.60 | 7.55 | 7.50 | 7.30 | 7.35 | 7.10 | 9.50 | 7.40 | 7.70 | 7.70 |
| 6 | 7.40 | 7.60 | 7.55 | 7.50 | 7.30 | 7.35 | 7.10 | 8.90 | 7.35 | 7.50 | 7.70 |
| 7 | 7.40 | 7.60 | 7.55 | 7.45 | 7.30 | 7.35 | 7.10 | 8.60 | 7.40 | 7.45 | 7.70 |
| 8 | 7.45 | 7.55 | 7.55 | 7.40 | 7.30 | 7.35 | 7.10 | 8.30 | 9.60 | 7.45 | 7.70 |
| 9 | 7.40 | 7.55 | 7.55 | 7.45 | 7.35 | 7.35 | 7.10 | 8.10 | 9.70 | 7.45 | 7.70 |
| 10 | 7.40 | 7.65 | 7.55 | 7.40 | 7.35 | 7.30 | 7.25 | 8.00 | 8.30 | 7.50 | 7.70 |
| 11 | 7.45 | 7.70 | 7.55 | 7.40 | 7.25 | 7.20 | 7.40 | 7.80 | 8.00 | 7.55 | 7.70 |
| 12 | 7.40 | 7.70 | 7.55 | 7.40 | 7.20 | 7.25 | 7.70 | 7.60 | 7.85 | 10.50 | ..... |
| 13 | 7.80 | 7.65 | 7.55 | 7.40 | 7.20 | 7.20 | 7.60 | 7.65 | 7.70 | 8.60 | ..... |
| 14 | 7.75 | 7.65 | 7.55 | 7.40 | 7.20 | 7.20 | 7.80 | 7.55 | 7.65 | 8.50 | ..... |
| 15 | 7.70 | 7.65 | 7.55 | 7.40 | 7.20 | 7.20 | 7.60 | 7.45 | 7.50 | 9.30 | ..... |
| 16 | 7.45 | 7.60 | 7.55 | 7.35 | 7.25 | 7.20 | 7.70 | 7.40 | 7.50 | 9.25 | ..... |
| 17 | 7.40 | 7.55 | 7.55 | 7.30 | 7.25 | 4.20 | 7.50 | 7.55 | 7.50 | 8.60 | ..... |
| 18 | 7.45 | 7.65 | 7.55 | 7.35 | 7.25 | 7.15 | 7.40 | 7.50 | 7.50 | 8.20 | ..... |
| 19 | 7.45 | 7.65 | 7.50 | 7.35 | 7.20 | 7.15 | 7.60 | 7.40 | 7.50 | 8.20 | ..... |
| 20 | 7.60 | 7.55 | 7.50 | 7.35 | 7.15 | 7.10 | 8.40 | 7.35 | 7.45 | 8.00 | ..... |
| 21 | 7.60 | 7.60 | 7.50 | 7.35 | 7.10 | 7.10 | 7.60 | 7.35 | 7.45 | 8.00 | ..... |
| 22 | 7.50 | 7.60 | 7.55 | 7.35 | 7.10 | 7.10 | 7.45 | 7.35 | 7.45 | 7.90 | ..... |
| 23 | 7.45 | 7.60 | 7.55 | 7.35 | 7.10 | 7.20 | 8.50 | 7.30 | 7.40 | 7.85 | ..... |
| 24 | 7.50 | 7.60 | 7.50 | 7.35 | 7.10 | 7.30 | 8.25 | 7.30 | 7.45 | 7.80 | ..... |
| 25 | 7.55 | 7.60 | 7.50 | 7.35 | 7.15 | 7.20 | 9.05 | 7.25 | 7.45 | 7.80 | ..... |
| 26 | 7.50 | 7.70 | 7.50 | 7.35 | 7.20 | 7.20 | 8.60 | 7.25 | 7.40 | 7.80 | ..... |
| 27 | 7.40 | 7.60 | 7.50 | 7.40 | 7.20 | 7.45 | 7.70 | 7.25 | 7.40 | 7.80 | ..... |
| 28 | 7.55 | 7.55 | 7.50 | 7.35 | 7.20 | 7.25 | 7.75 | 7.20 | 7.40 | 7.80 | ..... |
| 29 | 7.45 | ..... | 7.55 | 7.35 | 7.20 | 7.15 | 8.20 | 7.20 | 7.35 | 7.75 | ..... |
| 30 | 7.55 | ..... | 7.55 | 7.40 | 7.20 | 7.15 | 8.00 | 7.20 | 7.40 | 7.75 | ..... |
| 31 | 7.55 | ..... | 7.55 | ..... | 7.20 | ..... | 7.80 | 7.35 | ..... | 7.70 | ..... |

Station discontinued November 11.

## COLORADO RIVER AT YUMA, ARIZONA.

This river drains one of the largest areas in the West. It is formed by the junction of Green and Grand rivers in Utah, and flows in a general southerly direction until it enters the Grand Canyon in northern Arizona, when its general direction is westerly for some distance, and then southerly. It forms the boundary line between Nevada and Arizona, and lower down between California and Arizona. It enters the Gulf of California 70 miles below Yuma. The station is located at the Southern Pacific railroad bridge across the Colorado River at Yuma, Arizona. The gage is fastened to a tall pile about 100 feet east of the north end of the bridge. Low-water readings are taken from a gage placed on the west end of the southern pier. The record here has been kept by the Southern Pacific Railroad Company since April, 1878, and is furnished to this office. No measurements of discharge were made here in 1899.

*Daily gage height, in feet, of Colorado River at Yuma, Arizona, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.... | 17.75 | 18.58 | 19.00 | 19.00 | 20.50 | 23.42 | 25.67 | 20.83 | 18.83 | 18.00 | 18.25 | 18.58 |
| 2.... | 17.92 | 18.50 | 19.08 | 18.83 | 20.67 | 23.33 | 25.58 | 20.83 | 18.75 | 17.92 | 18.25 | 18.58 |
| 3.... | 18.00 | 18.58 | 19.25 | 19.00 | 21.25 | 23.67 | 25.58 | 20.75 | 18.75 | 17.83 | 18.25 | 18.67 |
| 4.... | 17.92 | 18.58 | 19.50 | 19.00 | 21.50 | 23.67 | 25.50 | 20.67 | 18.67 | 17.75 | 18.25 | 18.58 |
| 5.... | 17.83 | 18.58 | 19.75 | 19.00 | 21.75 | 23.67 | 25.33 | 20.92 | 18.58 | 17.75 | 18.33 | 18.50 |
| 6.... | 17.75 | 18.67 | 19.75 | 19.00 | 22.00 | 23.83 | 25.00 | 21.17 | 18.50 | 17.75 | 18.33 | 18.58 |
| 7.... | 17.75 | 18.67 | 19.75 | 19.00 | 22.08 | 23.83 | 24.75 | 21.33 | 18.42 | 17.75 | 18.25 | 18.58 |
| 8.... | 17.92 | 18.67 | 19.67 | 19.00 | 22.17 | 24.00 | 24.67 | 21.50 | 18.42 | 17.67 | 18.33 | 18.58 |
| 9.... | 18.08 | 18.67 | 19.58 | 19.83 | 21.83 | 24.33 | 24.50 | 21.17 | 18.42 | 17.50 | 18.33 | 18.67 |
| 10.... | 18.08 | 18.75 | 19.58 | 20.17 | 21.42 | 24.17 | 24.33 | 21.50 | 18.42 | 17.50 | 18.33 | 18.58 |
| 11.... | 18.00 | 18.75 | 19.42 | 19.83 | 21.17 | 24.00 | 24.33 | 21.67 | 18.42 | 17.50 | 18.25 | 18.33 |
| 12.... | 17.83 | 18.75 | 19.08 | 19.75 | 21.00 | 23.67 | 24.08 | 21.75 | 18.42 | 17.50 | 18.25 | 18.33 |
| 13.... | 17.75 | 18.75 | 19.00 | 19.58 | 20.75 | 23.67 | 24.00 | 21.67 | 18.25 | 17.33 | 18.25 | 18.25 |
| 14.... | 17.67 | 18.83 | 19.00 | 19.50 | 20.50 | 23.83 | 23.83 | 21.83 | 18.33 | 17.25 | 18.17 | 18.17 |
| 15.... | 17.75 | 18.83 | 19.00 | 19.50 | 20.50 | 24.00 | 23.75 | 20.83 | 18.33 | 17.17 | 18.17 | 18.17 |
| 16.... | 18.00 | 18.92 | 19.00 | 19.50 | 20.67 | 24.08 | 23.33 | 20.33 | 18.33 | 17.00 | 18.17 | 18.25 |
| 17.... | 18.42 | 18.92 | 19.17 | 19.58 | 21.00 | 24.33 | 23.17 | 20.00 | 18.33 | 17.00 | 18.17 | 18.25 |
| 18.... | 18.58 | 18.75 | 19.17 | 19.50 | 21.50 | 24.33 | 23.00 | 19.92 | 18.17 | 17.00 | 18.17 | 18.08 |
| 19.... | 18.67 | 18.67 | 19.25 | 19.50 | 22.33 | 24.33 | 22.83 | 19.67 | 18.17 | 17.08 | 18.17 | 18.00 |
| 20.... | 18.67 | 18.58 | 19.17 | 19.50 | 23.42 | 24.58 | 22.58 | 19.50 | 18.08 | 17.08 | 18.25 | 17.83 |
| 21.... | 18.67 | 18.67 | 19.08 | 19.42 | 23.83 | 24.83 | 22.42 | 19.42 | 18.00 | 17.08 | 18.50 | 17.75 |
| 22.... | 18.67 | 18.75 | 19.17 | 19.42 | 24.00 | 25.00 | 22.17 | 19.33 | 17.92 | 17.17 | 18.50 | 17.67 |
| 23.... | 18.75 | 18.83 | 19.17 | 19.50 | 24.17 | 25.00 | 22.00 | 19.33 | 17.83 | 18.67 | 18.42 | 17.67 |
| 24.... | 18.67 | 18.75 | 19.17 | 19.58 | 24.33 | 25.17 | 22.00 | 19.42 | 17.83 | 19.17 | 18.42 | 17.67 |
| 25.... | 18.67 | 18.83 | 19.25 | 19.67 | 24.50 | 25.25 | 21.67 | 19.50 | 17.67 | 18.92 | 18.42 | 17.58 |
| 26.... | 18.67 | 18.75 | 19.33 | 20.33 | 24.50 | 25.33 | 21.83 | 19.00 | 17.50 | 18.67 | 18.50 | 17.67 |
| 27.... | 18.67 | 18.92 | 19.25 | 20.92 | 24.50 | 25.33 | 21.75 | 19.00 | 18.67 | 18.50 | 18.50 | 17.58 |
| 28.... | 18.58 | 18.92 | 19.17 | 20.92 | 24.17 | 25.50 | 21.50 | 19.08 | 18.17 | 18.25 | 18.50 | 17.50 |
| 29.... | 18.42 | ..... | 19.08 | 20.83 | 23.83 | 25.75 | 21.33 | 19.00 | 18.08 | 18.17 | 18.50 | 17.50 |
| 30.... | 18.50 | ..... | 19.00 | 20.58 | 23.50 | 25.67 | 21.17 | 18.92 | 18.00 | 18.17 | 18.58 | 17.33 |
| 31.... | 18.50 | ..... | 19.00 | ..... | 23.33 | ..... | 21.00 | 18.83 | ..... | 18.25 | ..... | 17.42 |

## NORTH FORK OF HUMBOLDT RIVER AT PEKO, NEVADA.

This tributary of Humboldt River rises in northern Nevada, its headwaters adjoining those of the Owyhee River on the north. Its general course is southerly through a rolling country until it joins the main Humboldt River. The gaging station, established March 25, 1898, by L. H. Taylor, is located at the Southern Pacific railroad bridge about 2 miles west of Peko and a short distance above the mouth of the river. The gage is a vertical timber spiked to the pile support of the railroad bridge. The bench mark is on the stone abutment on the east end of the bridge, on the left bank, and is 12 feet above gage datum. The channel above and below the station is curved, and the current is moderately swift. The bed of the stream is of sand and gravel, shifting somewhat during high stages. The results of measurements for 1898 are shown in the Twentieth Annual Report, Part IV, page 436. The following measurements of discharge were made by L. H. Taylor during 1899:

April 28, gage height, 5 feet; discharge, 732 second-feet.
May 15, gage height, 4.50 feet; discharge, 504 second-feet.
June 26, gage height, 5.70 feet; discharge, 1,053 second-feet.
July 22, gage height, 4 feet; discharge, 331 second-feet.
August 29, gage height, 3.10 feet; discharge, 104 second-feet.
September 30, gage height, 1.75 feet; discharge, 6 second-feet.

*Daily gage height, in feet, of North Fork of Humboldt River at Peko, Nevada, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.20 | 2.40 | 2.60 | 4.00 | 4.50 | 4.20 | 4.60 | 4.20 | 2.70 | 1.70 | 2.30 | 2.10 |
| 2 | 2.20 | 2.60 | 2.60 | 4.00 | 4.40 | 4.00 | 4.50 | 4.10 | 2.70 | 1.70 | 2.30 | 2.00 |
| 3 | 2.40 | 2.60 | 2.70 | 4.00 | 4.30 | 4.00 | 4.50 | 4.00 | 2.70 | 1.70 | 2.30 | 2.20 |
| 4 | 2.40 | 2.60 | 2.70 | 4.20 | 4.20 | 4.00 | 4.60 | 4.00 | 2.70 | 1.70 | 2.30 | 2.20 |
| 5 | 2.60 | 2.50 | 2.80 | 4.20 | 4.10 | 4.10 | 4.60 | 4.00 | 2.80 | 1.80 | 2.30 | 2.30 |
| 6 | 2.70 | 2.50 | 2.90 | 4.30 | 4.00 | 4.20 | 4.50 | 3.90 | 2.80 | 1.80 | 2.30 | 2.30 |
| 7 | 2.70 | 2.60 | 2.90 | 4.30 | 4.00 | 4.30 | 4.40 | 3.70 | 2.70 | 1.80 | 2.30 | 2.30 |
| 8 | 2.20 | 2.60 | 3.00 | 4.30 | 3.40 | 4.40 | 4.30 | 3.60 | 2.60 | 1.70 | 2.40 | 2.30 |
| 9 | 2.20 | 2.60 | 3.40 | 4.80 | 3.00 | 4.40 | 4.20 | 3.40 | 2.60 | 1.70 | 2.40 | 2.30 |
| 10 | 2.30 | 2.70 | 3.50 | 4.90 | 3.00 | 4.40 | 4.20 | 3.20 | 2.70 | 1.70 | 2.40 | 2.30 |
| 11 | 2.30 | 2.70 | 3.60 | 5.00 | 3.40 | 4.20 | 4.30 | 3.10 | 2.80 | 1.80 | 2.40 | 2.30 |
| 12 | 2.40 | 2.50 | 3.20 | 5.00 | 3.50 | 4.30 | 4.20 | 3.10 | 2.80 | 1.80 | 2.40 | 2.30 |
| 13 | 2.40 | 2.50 | 3.20 | 5.40 | 3.40 | 4.40 | 4.10 | 3.00 | 2.80 | 1.80 | 2.40 | 2.40 |
| 14 | 2.40 | 2.60 | 3.30 | 5.60 | 4.40 | 4.50 | 4.20 | 3.00 | 2.70 | 1.90 | 2.30 | 2.40 |
| 15 | 2.70 | 2.60 | 3.30 | 6.30 | 4.50 | 4.70 | 4.10 | 2.90 | 2.60 | 2.00 | 2.30 | 2.40 |
| 16 | 2.70 | 2.60 | 3.40 | 6.80 | 4.60 | 4.90 | 4.20 | 2.80 | 2.60 | 2.00 | 2.20 | 2.40 |
| 17 | 2.80 | 2.60 | 3.40 | 6.80 | 4.70 | 5.00 | 4.20 | 2.80 | 2.60 | 2.00 | 2.10 | 2.20 |
| 18 | 2.80 | 2.60 | 3.50 | 6.70 | 4.70 | 5.60 | 4.00 | 2.70 | 2.60 | 2.00 | 2.10 | 2.30 |
| 19 | 2.90 | 3.30 | 3.60 | 6.70 | 4.80 | 5.80 | 4.00 | 2.70 | 2.60 | 2.10 | 2.10 | 2.30 |
| 20 | 3.00 | 3.30 | 3.60 | 6.60 | 4.80 | 5.90 | 4.10 | 3.00 | 2.50 | 2.10 | 2.10 | 2.30 |
| 21 | 3.00 | 3.30 | 3.70 | 6.50 | 4.00 | 6.00 | 4.00 | 3.00 | 2.50 | 2.10 | 2.20 | 2.30 |
| 22 | 2.40 | 3.40 | 3.70 | 6.00 | 4.10 | 6.00 | 4.00 | 2.90 | 2.50 | 2.10 | 2.20 | 2.30 |
| 23 | 2.40 | 3.40 | 3.80 | 5.20 | 4.20 | 6.10 | 4.60 | 2.90 | 2.40 | 2.10 | 2.20 | 2.30 |
| 24 | 2.50 | 3.50 | 3.90 | 5.20 | 4.30 | 6.00 | 4.60 | 2.80 | 2.30 | 2.10 | 2.20 | 2.30 |
| 25 | 2.50 | 3.50 | 4.00 | 5.30 | 4.30 | 5.90 | 4.50 | 2.80 | 2.20 | 2.10 | 2.30 | 2.30 |
| 26 | 2.60 | 2.50 | 3.60 | 5.30 | 4.40 | 5.60 | 4.50 | 2.80 | 2.00 | 2.20 | 2.20 | 2.30 |
| 27 | 2.60 | 2.50 | 3.70 | 5.20 | 4.40 | 5.30 | 4.40 | 2.80 | 1.90 | 2.20 | 2.20 | 2.20 |
| 28 | 2.60 | 2.50 | 3.70 | 5.00 | 4.00 | 5.20 | 4.20 | 2.90 | 1.80 | 2.20 | 2.20 | 2.20 |
| 29 | 2.20 | ..... | 3.70 | 4.70 | 4.00 | 4.90 | 4.20 | 2.90 | 1.80 | 2.20 | 2.10 | 2.30 |
| 30 | 2.20 | ..... | 3.80 | 4.60 | 4.10 | 4.70 | 4.30 | 2.80 | 1.80 | 2.20 | 2.10 | 2.30 |
| 31 | 2.40 | ..... | 3.90 | ..... | 4.20 | ..... | 4.30 | 2.80 | ..... | 2.30 | ..... | 2.30 |

## HUMBOLDT RIVER AT ELKO, NEVADA.

This river rises in the extreme northeastern part of Nevada, and flows in a general westerly and southerly direction, finally entering Humboldt Lake, whence its waters find their way into Humboldt and Carson sinks. The general direction of the mountain ranges of this basin is north and south, crossed at nearly right angles by the main Humboldt River. The tributaries flow in the general direction of the mountain ranges and drain either northward or southward. The basin may be divided into three divisions—the eastern, or headwater division, separated from the middle or Battle Mountain Valley by Palisade Canyon; the central and western divisions, separated by Hot Springs Range on the north and by Battle Mountain and Sonoma ranges on the south. There is a large body of agricultural land in the basin of Humboldt River which at the present time is not wholly reclaimed. During low stages the river is wholly diverted. For the future development of the country recourse must be had to the construction of reservoirs for storage purposes. The station at Elko, established June 17, 1895, by L. H. Taylor, is located at the highway bridge 1 mile southwest of the town. The gage is inclined, fastened to iron bolts driven into the solid rock, and is placed on the left bank immediately below the bridge. The bench mark is on the southwest corner of the cofferdam surrounding the stone pier of the bridge 80 feet north of the gage, and is at an elevation of 7.50 feet above gage datum. The right bank is quite low, the left is high and rocky. The

bed of the stream is of gravel and sand, with a slight tendency to change its channel during flood stages. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 300; 1897, Nineteenth Annual Report, Part IV, page 425; 1898, Twentieth Annual Report, Part IV, page 437. The following measurements of discharge were made by L. H. Taylor during 1899:

*Discharge measurements of Humboldt River at Elko, Nevada.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| April 27 | 6.40 | 1,421 | July 2 | 7.10 | 1,817 |
| May 10 | 5.40 | 984 | July 22 | 4.50 | 630 |
| June 10 | 5.90 | 1,245 | August 28 | 2.80 | 144 |
| June 26 | 7.80 | 2,260 | September 29 | 2.10 | 31 |

*Daily gage height, in feet, of Humboldt River at Elko, Nevada, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.90 | 2.30 | 2.75 | 4.35 | 6.40 | 5.70 | 7.20 | 3.70 | 2.80 | 2.15 | 3.50 | 2.80 |
| 2 | 1.90 | 2.30 | 2.80 | 4.25 | 6.10 | 5.80 | 7.15 | 3.60 | 2.80 | 2.15 | 3.50 | 2.75 |
| 3 | 1.90 | 2.35 | 2.85 | 4.20 | 5.80 | 5.80 | 7.00 | 3.40 | 2.80 | 2.15 | 3.55 | 2.60 |
| 4 | 1.90 | 2.35 | 2.85 | 4.20 | 5.60 | 5.80 | 6.90 | 3.30 | 2.80 | 2.15 | 3.55 | 2.59 |
| 5 | 1.90 | 2.35 | 2.90 | 4.20 | 5.60 | 5.80 | 6.90 | 3.20 | 2.80 | 2.15 | 3.55 | 2.58 |
| 6 | 1.90 | 2.35 | 3.00 | 4.20 | 5.60 | 5.80 | 6.75 | 3.20 | 2.80 | 2.15 | 3.55 | 2.57 |
| 7 | 1.90 | 2.35 | 3.00 | 4.20 | 5.80 | 5.90 | 6.60 | 3.10 | 2.80 | 2.15 | 3.55 | 2.58 |
| 8 | 1.90 | 2.35 | 3.05 | 4.20 | 5.70 | 5.90 | 6.40 | 3.10 | 2.80 | 2.20 | 3.55 | 2.59 |
| 9 | 1.90 | 2.30 | 3.05 | 4.35 | 5.55 | 5.90 | 6.20 | 3.10 | 2.80 | 2.20 | 3.55 | 2.60 |
| 10 | 1.90 | 2.30 | 3.05 | 4.40 | 5.40 | 5.95 | 6.05 | 3.10 | 2.70 | 2,20 | 3.60 | 2.60 |
| 11 | 1.95 | 2.30 | 3.05 | 4.90 | 5.20 | 6.00 | 5.80 | 2.90 | 2.70 | 2.20 | 3.60 | 2.60 |
| 12 | 1.95 | 2.30 | 3.05 | 5.15 | 5.20 | 6.20 | 5.65 | 2.90 | 2.70 | 2.40 | 3.60 | 2.60 |
| 13 | 1.95 | 2.35 | 3.05 | 5.50 | 5.20 | 6.30 | 5.50 | 2.70 | 2.70 | 2.80 | 3.60 | 2.65 |
| 14 | 1.95 | 2.35 | 3.10 | 6.20 | 5.35 | 6.40 | 5.30 | 2.60 | 2.70 | 2.90 | 3.62 | 2.65 |
| 15 | 1.90 | 2.35 | 3.15 | 6.90 | 5.65 | 6.60 | 5.25 | 2.50 | 2.70 | 3.15 | 3.62 | 2.60 |
| 16 | 1.95 | 2.35 | 3.15 | 7.30 | 5.90 | 7.00 | 5.20 | 2.50 | 2.70 | 3.15 | 3.65 | 2.60 |
| 17 | 2.00 | 2.40 | 3.10 | 7.20 | 6.30 | 7.25 | 5.10 | 2.60 | 2.60 | 3.20 | 3.65 | 2.58 |
| 18 | 2.00 | 2.40 | 3.05 | 7.15 | 6.50 | 7.20 | 4.90 | 2.60 | 2.60 | 3.20 | 3.65 | 2.55 |
| 19 | 2.00 | 2.50 | 3.15 | 7.15 | 6.75 | 7.30 | 4.75 | 2.70 | 2.60 | 3.25 | 3.65 | 2.54 |
| 20 | 2.05 | 2.55 | 3.20 | 7.15 | 6.80 | 7.30 | 4.50 | 2.90 | 2.60 | 3.30 | 3.65 | 2.54 |
| 21 | 2.05 | 2.60 | 3.20 | 7.10 | 6.65 | 7.50 | 4.50 | 2.80 | 2.60 | 3.30 | 3.66 | 2.53 |
| 22 | 2.15 | 2.60 | 3.30 | 7.10 | 6.40 | 7.75 | 4.50 | 2.80 | 2.60 | 3.30 | 3.67 | 2.52 |
| 23 | 2.15 | 2.70 | 3.40 | 6.80 | 6.10 | 8.00 | 4.50 | 2.80 | 2.50 | 3.35 | 3.67 | 2.50 |
| 24 | 2.20 | 2.70 | 3.70 | 6.60 | 5.85 | 8.00 | 4.50 | 2.80 | 2.50 | 3.35 | 3.67 | 2.50 |
| 25 | 2.25 | 2.70 | 3.75 | 6.50 | 5.40 | 8.00 | 4.35 | 2.80 | 2.40 | 3.40 | 3.67 | 2.48 |
| 26 | 2.30 | 2.75 | 4.60 | 6.50 | 5.10 | 7.80 | 4.30 | 2.80 | 2.30 | 3.40 | 3.60 | 2.45 |
| 27 | 2.35 | 2.75 | 4.55 | 6.40 | 5.10 | 7.70 | 4.20 | 2.80 | 2.20 | 3.45 | 3.40 | 2.43 |
| 28 | 2.35 | 2.75 | 4.45 | 6.40 | 5.10 | 7.60 | 4.15 | 2.80 | 2.10 | 3.45 | 3.15 | 2.40 |
| 29 | 2.30 | ..... | 4.40 | 6.40 | 5.45 | 7.50 | 4.00 | 2.80 | 2.10 | 3.45 | 3.00 | 2.39 |
| 30 | 2.30 | ..... | 4.35 | 6.40 | 5.50 | 7.35 | 3.90 | 2.80 | 2.10 | 3.45 | 2.90 | 2.36 |
| 31 | 2.30 | ..... | 4.35 | ..... | 5.60 | ..... | 3.80 | 2.80 | ..... | 3.45 | ..... | 2.35 |

## SOUTH FORK OF HUMBOLDT RIVER AT MASON'S RANCH, NEVADA.

This tributary rises in Eureka and White Pine counties, and takes a nearly due north course, entering the main Humboldt River 10 miles below Elko. The little irrigation practiced in the basin is almost exclusively for forage plants. The measurements of discharge show the amount of water available for storage. There is a good site for a reservoir a short distance above the station. The station, established August 29, 1896, by L. H. Taylor, is located 10 miles southwest of

the town of Elko and about 6 miles above the junction of the South Fork with the main stream. The gage is inclined and spiked to posts driven firmly into the right bank. The bench mark is the top of a 2 by 4 inch post, 2½ feet long, driven flush with the ground 10 feet north of the gage, and is at an elevation of 7.50 feet above gage datum. The measurements are made from a cable and suspended car, at a point 1 mile above the gage, the latter being placed near the farm of the observer, for his convenience. At the point of measurement the banks are high, and the channel is straight for some distance above and below the station. The bed of the stream is of rock and gravel and quite stable. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 311; 1897, Nineteenth Annual Report, Part IV, page 430; 1898, Twentieth Annual Report, Part IV, page 440. The following discharge measurements were made by L. H. Taylor during 1899:

April 27, gage height, 2.50 feet; discharge, 404 second-feet.
May 10, gage height, 1.80 feet; discharge, 227 second-feet.
June 10, gage height, 3.30 feet; discharge, 658 second-feet.
June 25, gage height, 4.80 feet; discharge, 1,122 second-feet.
July 2, gage height, 4.15 feet; discharge, 910 second-feet.
August 28, gage height, 0.75 foot; discharge, 42 second-feet.
September 29, gage height, 0.55 foot; discharge, 20 second-feet.

*Daily gage height, in feet, of South Fork of Humboldt River at Mason's ranch, Nevada, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | 1.30 | 1.20 | 1.85 | 2.00 | 2.30 | 4.25 | 1.75 | 0.60 | 0.60 | 0.80 | 0.90 |
| 2 | 1.00 | 1.30 | 1.30 | 1.85 | 1.90 | 2.35 | 4.25 | 1.75 | .55 | .60 | .80 | .90 |
| 3 | 1.00 | 1.30 | 1.30 | 1.85 | 1.85 | 2.45 | 4.10 | 1.70 | .55 | .60 | .80 | .90 |
| 4 | 1.00 | 1.30 | 1.25 | 1.80 | 1.80 | 2.35 | 3.90 | 1.60 | .55 | .65 | .80 | .90 |
| 5 | 1.00 | 1.20 | 1.20 | 1.90 | 1.75 | 2.45 | 3.70 | 1.60 | .55 | .65 | .80 | .90 |
| 6 | 1.00 | 1.20 | 1.20 | 1.95 | 1.70 | 2.65 | 3.70 | 1.60 | .55 | .65 | .80 | .90 |
| 7 | 1.00 | 1.25 | 1.20 | 2.15 | 1.65 | 2.90 | 3.70 | 1.60 | .55 | .65 | .80 | .90 |
| 8 | 1.10 | 1.25 | 1.45 | 2.40 | 1.65 | 3.00 | 3.50 | 1.60 | .55 | .65 | .80 | .90 |
| 9 | 1.10 | 1.35 | 1.55 | 2.30 | 1.65 | 3.10 | 3.40 | 1.50 | .55 | .70 | .80 | .90 |
| 10 | 1.10 | 1.50 | 1.40 | 2.80 | 1.75 | 3.30 | 3.30 | 1.45 | .55 | .70 | .80 | .90 |
| 11 | 1.10 | 1.80 | 1.30 | 2.80 | 2.00 | 3.65 | 3.25 | 1.40 | .55 | .70 | .80 | .90 |
| 12 | 1.10 | 1.65 | 1.25 | 2.90 | 2.15 | 3.80 | 3.10 | 1.40 | .55 | .70 | .80 | .85 |
| 13 | 1.20 | 1.65 | 1.25 | 2.90 | 2.35 | 4.60 | 3.00 | 1.30 | .55 | .70 | .80 | .85 |
| 14 | 1.20 | 1.40 | 1.20 | 2.90 | 2.50 | 4.60 | 3.00 | 1.25 | .55 | .70 | .85 | .85 |
| 15 | 1.20 | 1.50 | 1.20 | 2.90 | 2.65 | 4.40 | 2.90 | 1.20 | .55 | .70 | .85 | .85 |
| 16 | 1.20 | 2.10 | 1.45 | 2.90 | 2.65 | 4.30 | 2.80 | 1.15 | .55 | .70 | .85 | .85 |
| 17 | 1.20 | 2.15 | 1.45 | 2.90 | 2.55 | 4.40 | 2.70 | 1.10 | .55 | .70 | .85 | .70 |
| 18 | 1.20 | 2.20 | 1.45 | 2.90 | 2.40 | 4.80 | 2.60 | 1.10 | .55 | .70 | .90 | .70 |
| 19 | 1.20 | 2.10 | 1.50 | 2.70 | 2.30 | 5.20 | 2.60 | 1.10 | .55 | .70 | .90 | .70 |
| 20 | 1.20 | 2.10 | 1.50 | 2.50 | 2.20 | 5.40 | 2.50 | 1.00 | .55 | .70 | .90 | .70 |
| 21 | 1.20 | 1.80 | 1.50 | 2.45 | 2.20 | 5.65 | 2.50 | 1.00 | .55 | .70 | .90 | .70 |
| 22 | 1.30 | 1.50 | 1.50 | 2.45 | 2.10 | 5.30 | 2.50 | .95 | .55 | .75 | .90 | .70 |
| 23 | 1.30 | 1.50 | 1.50 | 2.60 | 2.00 | 5.00 | 2.30 | .90 | .55 | .80 | .90 | .70 |
| 24 | 1.30 | 1.40 | 2.15 | 2.60 | 1.95 | 4.70 | 2.10 | .90 | .55 | .80 | .90 | .75 |
| 25 | 1.30 | 1.40 | 2.70 | 2.60 | 1.90 | 4.60 | 2.10 | .85 | .55 | .80 | .90 | .80 |
| 26 | 1.30 | 1.15 | 2.70 | 2.50 | 2.00 | 4.50 | 2.10 | .80 | .55 | .85 | .90 | .80 |
| 27 | 1.30 | 1.25 | 2.30 | 2.45 | 2.20 | 4.40 | 2.00 | .75 | .55 | .85 | .90 | .80 |
| 28 | 1.30 | 1.20 | 2.10 | 2.35 | 2.20 | 4.20 | 2.00 | .70 | .60 | .85 | .90 | .90 |
| 29 | 1.30 | ..... | 2.10 | 2.10 | 2.15 | 4.20 | 2.00 | .70 | .60 | .85 | .90 | .90 |
| 30 | 1.30 | ..... | 1.95 | 2.10 | 2.20 | 4.30 | 1.90 | .65 | .60 | .85 | .90 | .90 |
| 31 | 1.30 | ..... | 1.85 | ..... | 2.20 | ..... | 1.80 | .60 | ..... | .85 | ..... | .90 |

## HUMBOLDT RIVER AT GOLCONDA, NEVADA.

The gaging station at Golconda is located near the great northern bend of Humboldt River and below the central valley. It is about 15 miles above the mouth of Little Humboldt River. The station was established by L. H. Taylor October 24, 1894, and has been maintained continuously since that time. It is loçated 1¼ miles north of the town. The gage is vertical and spiked to posts driven into the left bank of the river. Bench mark No. 1 is the top of a 2 by 4 inch post driven flush with the ground surface 20 feet from the gage, and is at an elevation of 10.55 feet above gage datum. Bench mark No. 2 is the top of a large spike driven into a post which is set firmly into the ground about 15 feet from the gage, and is 13.70 feet above gage datum. Measurements are made from cable and suspended car. The banks are moderately high, but liable to overflow at extreme high stages. The bed of the stream is of gravel and sand, somewhat shifting. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 306; 1897, Nineteenth Annual Report, Part IV, page 427; 1898, Twentieth Annual Report, Part IV, page 438. The following measurements were made by L. H. Taylor in 1899:

April 29, gage height, 8.10 feet; discharge, 2,157 second-feet.
May 26, gage height, 7 feet; discharge, 1,440 second-feet.
June 30, gage height, 7.60 feet; discharge, 1,767 second-feet.
July 30, gage height, 6.30 feet; discharge, 1,058 second-feet.
August 25, gage height, 3.50 feet; discharge, 316 second-feet.
September 28, gage height, 1.05 feet; discharge, 37 second-feet.

*Daily gage height, in feet, of Humboldt River at Golconda, Nevada, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.70 | 2.60 | 3.60 | 5.70 | 8.10 | 7.00 | 7.70 | 6.10 | 2.20 | 1.00 | 1.30 | 2.00 |
| 2 | .80 | 2.70 | 3.50 | 5.80 | 8.10 | 6.80 | 7.70 | 6.00 | 1.90 | 1.00 | 1.35 | 2.00 |
| 3 | .80 | 2.80 | 3.50 | 5.90 | 8.20 | 7.00 | 7.80 | 5.90 | 1.70 | 1.00 | 1.40 | 2.00 |
| 4 | .80 | 2.80 | 3.50 | 6.00 | 8.30 | 7.10 | 8.00 | 5.80 | 1.60 | .95 | 1.50 | 2.05 |
| 5 | .80 | 2.80 | 3.50 | 6.10 | 8.20 | 7.05 | 8.00 | 5.50 | 1.50 | .95 | 1.55 | 2.05 |
| 6 | .80 | 2.90 | 3.50 | 6.20 | 8.20 | 7.00 | 8.00 | 5.40 | 1.45 | .95 | 1.60 | 2.05 |
| 7 | .80 | 2.90 | 3.50 | 6.30 | 8.20 | 7.00 | 8.00 | 5.30 | 1.40 | .95 | 1.60 | 2.05 |
| 8 | .80 | 2.90 | 3.50 | 6.40 | 8.20 | 6.90 | 8.10 | 5.20 | 1.40 | .90 | 1.65 | 2.05 |
| 9 | .80 | 2.90 | 3.60 | 6.40 | 8.20 | 6.90 | 8.10 | 5.00 | 1.40 | .90 | 1.65 | 2.10 |
| 10 | .80 | 2.90 | 3.60 | 6.50 | 8.10 | 6.80 | 8.10 | 5.00 | 1.35 | .90 | 1.70 | 2.10 |
| 11 | .80 | 2.90 | 3.60 | 6.60 | 8.00 | 6.70 | 7.90 | 4.90 | 1.35 | .90 | 1.70 | 2.10 |
| 12 | .80 | 2.90 | 3.60 | 6.70 | 8.00 | 6.70 | 7.80 | 4.80 | 1.30 | .90 | 1.70 | 2.10 |
| 13 | .80 | 3.10 | 3.60 | 6.70 | 8.00 | 6.60 | 7.70 | 4.80 | 1.30 | .90 | 1.75 | 2.10 |
| 14 | .80 | 3.50 | 3.60 | 6.70 | 8.00 | 6.60 | 7.60 | 4.70 | 1.30 | .90 | 1.75 | 2.15 |
| 15 | .80 | 3.60 | 3.60 | 6.70 | 8.00 | 6.50 | 7.60 | 4.60 | 1.25 | .90 | 1.80 | 2.15 |
| 16 | .90 | 3.80 | 3.60 | 6.80 | 7.90 | 6.50 | 7.50 | 4.50 | 1.25 | .90 | 1.80 | 2.15 |
| 17 | 1.30 | 3.80 | 3.60 | 6.80 | 7.80 | 6.60 | 7.50 | 4.50 | 1.20 | .95 | 1.85 | 2.15 |
| 18 | 1.20 | 3.80 | 3.60 | 6.90 | 7.70 | 6.70 | 7.40 | 4.30 | 1.20 | .95 | 1.85 | 2.15 |
| 19 | 1.40 | 3.90 | 3.60 | 6.90 | 7.60 | 6.80 | 7.40 | 4.30 | 1.15 | 1.00 | 1.85 | 2.15 |
| 20 | 1.50 | 3.90 | 3.60 | 7.50 | 7.50 | 6.90 | 7.30 | 4.20 | 1.15 | 1.00 | 1.90 | 2.15 |
| 21 | 1.50 | 3.90 | 4.00 | 7.50 | 7.50 | 7.10 | 7.30 | 4.10 | 1.10 | 1.00 | 1.90 | 2.20 |
| 22 | 1.50 | 3.90 | 4.40 | 7.50 | 7.40 | 7.30 | 7.00 | 4.00 | 1.10 | 1.05 | 1.90 | 2.20 |
| 23 | 1.70 | 3.80 | 4.50 | 7.50 | 7.20 | 7.40 | 7.00 | 3.80 | 1.10 | 1.05 | 1.90 | 2.20 |
| 24 | 1.80 | 3.70 | 4.50 | 7.60 | 7.20 | 7.50 | 6.90 | 3.60 | 1.05 | 1.10 | 1.95 | 2.20 |
| 25 | 2.10 | 3.70 | 4.70 | 7.70 | 7.00 | 7.50 | 6.80 | 3.50 | 1.05 | 1.10 | 1.95 | 2.15 |
| 26 | 2.50 | 3.70 | 4.70 | 7.80 | 7.00 | 7.70 | 6.80 | 3.30 | 1.05 | 1.15 | 1.95 | 2.15 |
| 27 | 2.60 | 3.70 | 5.10 | 7.80 | 7.10 | 7.80 | 6.60 | 3.10 | 1.05 | 1.15 | 1.95 | 2.10 |
| 28 | 2.60 | 3.70 | 5.40 | 7.90 | 7.20 | 7.70 | 6.50 | 2.90 | 1.05 | 1.20 | 2.00 | 2.10 |
| 29 | 2.60 | ..... | 5.70 | 8.10 | 7.20 | 7.60 | 6.40 | 2.70 | 1.05 | 1.20 | 2.00 | 2.15 |
| 30 | 2.60 | ..... | 5.70 | 8.10 | 7.30 | 7.60 | 6.30 | 2.60 | 1.05 | 1.25 | 2.00 | 2.15 |
| 31 | 2.60 | ..... | 5.70 | ..... | 7.40 | ..... | 6.20 | 2.40 | ..... | 1.25 | ..... | 2.20 |

## HUMBOLDT RIVER AT OREANA, NEVADA.

On the lower reaches of this river measurements have been made for a number of years at Oreana, and the results show the amount of water available for storage at the possible reservoir sites in the vicinity of Humboldt Station, and also for the six canal systems now in operation below Oreana. The station, established by L. H. Taylor January 27, 1896, is located 1½ miles above the old Oreana highway bridge, 12 miles northeast of Lovelock, and above all the canals diverting water in the vicinity of that town. The gage rod is an inclined 2 by 4 inch pine timber, spiked to posts driven well into the bank of the river. The bench mark is a 10 by 10 inch post near the left bank of the stream, about 40 feet from the gage, and is at an elevation of 10 feet above gage datum. The station is provided with a cable and car. The river banks are high and not liable to overflow. The bed of the river is sandy and shifting. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 307; 1897, Nineteenth Annual Report, Part IV, page 428; 1898, Twentieth Annual Report, Part IV, page 439. The following measurements of discharge were made by L. H. Taylor during 1899:

June 29, gage height, 4.50 feet; discharge, 1,951 second-feet.
August 2, gage height, 3.60 feet; discharge, 1,214 second-feet.
August 30, gage height, 1.80 feet; discharge, 241 second-feet.
September 26, gage height, 1.20 feet; discharge, 100 second-feet.
October 27, gage height, 0.90 foot; discharge, 60 second-feet.

*Daily gage height, in feet, of Humboldt River at Oreana, Nevada, for 1899.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| 1 | ..... | 4.50 | 3.70 | 1.80 | 1.10 | 0.90 | 1.20 |
| 2 | ..... | 4.50 | 3.60 | 1.70 | 1.10 | .90 | 1.20 |
| 3 | ..... | 4.55 | 3.50 | 1.70 | 1.05 | .90 | 1.20 |
| 4 | ..... | 4.55 | 3.30 | 1.70 | 1.05 | .90 | 1.30 |
| 5 | ..... | 4.55 | 3.20 | 1.60 | 1.05 | .90 | 1.30 |
| 6 | ..... | 4.60 | 3.20 | 1.60 | 1.00 | .90 | 1.30 |
| 7 | ..... | 4.60 | 3.10 | 1.60 | 1.00 | .90 | 1.30 |
| 8 | ..... | 4.60 | 3.00 | 1.50 | 1.00 | 1.00 | 1.30 |
| 9 | ..... | 4.65 | 3.00 | 1.50 | 1.00 | 1.00 | 1.30 |
| 10 | ..... | 4.70 | 2.90 | 1.50 | .95 | 1.10 | 1.40 |
| 11 | ..... | 4.70 | 2.90 | 1.50 | .95 | 1.10 | 1.40 |
| 12 | ..... | 4.70 | 2.80 | 1.50 | .95 | 1.20 | 1.40 |
| 13 | ..... | 4.80 | 2.80 | 1.45 | .95 | 1.20 | 1.40 |
| 14 | ..... | 4.80 | 2.70 | 1.45 | .90 | 1.20 | 1.40 |
| 15 | ..... | 4.90 | 2.60 | 1.40 | .90 | 1.20 | 1.50 |
| 16 | ..... | 4.90 | 2.60 | 1.40 | .90 | 1.20 | 1.50 |
| 17 | ..... | 4.90 | 2.50 | 1.40 | .90 | 1.20 | 1.50 |
| 18 | ..... | 5.00 | 2.50 | 1.35 | .90 | 1.20 | 1.60 |
| 19 | ..... | 5.00 | 2.40 | 1.35 | .90 | 1.20 | 2.00 |
| 20 | ..... | 5.00 | 2.40 | 1.30 | .90 | 1.20 | 2.00 |
| 21 | ..... | 5.00 | 2.30 | 1.30 | .90 | 1.20 | 2.00 |
| 22 | ..... | 4.90 | 2.20 | 1.30 | .90 | 1.20 | 2.00 |
| 23 | ..... | 4.70 | 2.10 | 1.25 | .90 | 1.20 | 2.00 |
| 24 | ..... | 4.55 | 2.10 | 1.25 | .90 | 1.20 | 2.60 |
| 25 | ..... | 4.30 | 2.00 | 1.20 | .90 | 1.20 | 2.60 |
| 26 | ..... | 4.10 | 2.00 | 1.20 | .90 | 1.20 | 2.60 |
| 27 | ..... | 3.95 | 2.00 | 1.20 | .90 | 1.20 | 2.40 |
| 28 | ..... | 3.85 | 1.90 | 1.15 | .90 | 1.20 | 2.40 |
| 29 | 4.50 | 3.80 | 1.90 | 1.15 | .90 | 1.20 | 2.40 |
| 30 | 4.50 | 3.90 | 1.80 | 1.10 | .90 | 1.20 | 2.40 |
| 31 | ..... | 3.80 | 1.80 | ..... | .90 | ..... | 2.40 |

### TRUCKEE RIVER AT NEVADA–CALIFORNIA STATE LINE.

This river has its source on the slopes of the Sierra Nevada in eastern California and flows northward, entering Lake Tahoe. This lake is at an elevation of 6,225 feet, and is the largest body of fresh water in the United States at this considerable altitude. The area of the lake itself is 193 square miles. As the State line between Nevada and California passes through the lake, a portion of it is in each State. The outlet of the lake is at Tahoe, California, and Truckee River from this point has a general northward course, receiving a number of important tributaries which contribute to its flow. There are a number of lakes at the head waters of the branch streams, which have been surveyed and recommended as reservoir sites. The drainage area is mapped on the Pyramid Peak, Truckee, Carson, and Markleeville atlas sheets of the United States Geological Survey. The basin is now partially included in the Lake Tahoe Forest Reserve, set apart by Executive proclamation of April 13, 1899. September 7, 1899, a station was established on this river by L. H. Taylor, at the State line, 17 miles west of Reno, Nevada. The gage is vertical, driven into the bed of the river and wired to a granite bowlder. The bench mark is the top of the rock to which the rod is fastened, and is at an elevation of 10 feet above gage datum. The channel is straight for a short distance above and below the station. The banks are not liable to overflow. The bed of the river is of gravel and cobbles and quite stable. One measurement of discharge was made by L. H. Taylor on September 7, 1899, when at a gage height of 2 feet a discharge of 303 second-feet was found.

*Daily gage height, in feet, of Truckee River at Nevada–California State line, for 1899.*

| Day. | Sept. | Oct. | Nov. | Dec. | Day. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.90 | 2.10 | 1.90 | 17 | 2.00 | 1.90 | 2.70 | 1.90 |
| 2 | ..... | 1.90 | 2.10 | 1.90 | 18 | 1.90 | 1.90 | 2.50 | 1.90 |
| 3 | ..... | 1.90 | 2.00 | 1.90 | 19 | 1.90 | 1.90 | 2.50 | 1.90 |
| 4 | ..... | 1.90 | 2.00 | 1.90 | 20 | 1.90 | 2.40 | 2.30 | 1.90 |
| 5 | ..... | 1.90 | 2.00 | 1.90 | 21 | 1.90 | 2.50 | 2.20 | 1.90 |
| 6 | ..... | 1.90 | 2.60 | 1.80 | 22 | 1.90 | 2.70 | 2.10 | 1.90 |
| 7 | 2.00 | 1.90 | 2.80 | 1.80 | 23 | 1.90 | 2.50 | 2.00 | 1.90 |
| 8 | 2.00 | 1.90 | 3.20 | 1.80 | 24 | 2.00 | 2.40 | 2.00 | 1.90 |
| 9 | 1.90 | 1.90 | 3.80 | 1.90 | 25 | 1.90 | 2.30 | 2.00 | 1.90 |
| 10 | 1.90 | 1.90 | 4.00 | 1.90 | 26 | 1.90 | 2.20 | 2.00 | 1.90 |
| 11 | 1.90 | 1.90 | 4.20 | 1.90 | 27 | 1.90 | 2.10 | 2.00 | 1.90 |
| 12 | 1.90 | 2.00 | 3.50 | 1.90 | 28 | 1.90 | 2.00 | 2.00 | 1.90 |
| 13 | 1.90 | 2.00 | 3.00 | 2.00 | 29 | 1.90 | 2.00 | 1.90 | 1.90 |
| 14 | 1.90 | 2.00 | 2.70 | 2.00 | 30 | 1.90 | 2.10 | 1.90 | 1.90 |
| 15 | 1.90 | 1.90 | 2.90 | 2.00 | 31 | ..... | 2.10 | ..... | 1.90 |
| 16 | 2.10 | 1.90 | 2.70 | 1.90 | | | | | |

### TRUCKEE RIVER AT VISTA, NEVADA.

On the lower courses of this river are located considerable stretches of irrigable land, which, however, have not yet been developed to their fullest extent. The drainage basin is peculiar in that its moun-

tainous collecting area is located in the State of California, while the lands which can be irrigated are situated in Nevada. This may lead in the future to certain legal difficulties, but not to the extent that it would if there were agricultural lands in both States. Truckee River after entering Nevada flows in a general easterly and then northerly direction, emptying into Pyramid Lake. The drainage area is mapped on the following atlas sheets of the United States Geological Survey: Pyramid Peak, Truckee, Markleeville, Carson, Reno, and Wadsworth. The station at Vista, Nevada, was established August 18, 1899, by L. H. Taylor, and is located 7 miles east of Reno, near the point where measurements were made in 1890, 1891, and 1892, the results of which are shown in the Thirteenth Annual Report, Part III, page 95. The rod is spiked to posts driven into the bed of the river. The bench mark is on a bluff of rocks 500 feet east of the gage, and is at an elevation of 17.50 feet above gage datum. Both banks are high and not liable to overflow. The bed is rocky and not subject to change. Three ditches diverting water from Truckee River above Reno were measured by L. H. Taylor on September 4, 1899, with the following results: Highland ditch, 6 miles above Reno, 4 miles below the head of ditch, discharge 16.7 second-feet; Maybury ditch at flume across Hunter Creek, 1 mile below head of ditch and 5 miles west of Reno, discharge 47 second-feet; Orr ditch at stone culvert under Southern Pacific Railroad, 1 mile below head of ditch, discharge 42 second-feet. Two measurements of discharge were made by L. H. Taylor during 1899, as follows: The first, on September 5, at a gage height of 2 feet, showed a discharge of 105 second-feet; the second measurement, on October 28, at a gage height of 2.75 feet, gave a discharge of 477 second-feet.

*Daily gage height, in feet, of Truckee River at Vista, Nevada, for 1899.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1.95 | 2.10 | 2.70 | 2.55 | 17 | ..... | 2.15 | 2.60 | 3.50 | 2.90 |
| 2 | ..... | 1.90 | 2.15 | 2.70 | 2.50 | 18 | 2.00 | 2.10 | 2.60 | 3.20 | 2.80 |
| 3 | ..... | 2.00 | 2.15 | 2.60 | 2.60 | 19 | 2.10 | 2.10 | 2.50 | 3.10 | 2.80 |
| 4 | ..... | 2.00 | 2.15 | 2.60 | 2.65 | 20 | 2.20 | 2.10 | 3.50 | 2.90 | 2.80 |
| 5 | ..... | 2.00 | 2.15 | 2.60 | 2.60 | 21 | 2.00 | 2.10 | 3.90 | 2.80 | 2.60 |
| 6 | ..... | 2.00 | 2.15 | 2.60 | 2.60 | 22 | 2.10 | 2.10 | 3.60 | 2.70 | 2.60 |
| 7 | ..... | 2.00 | 2.15 | 2.70 | 2.60 | 23 | 2.00 | 2.10 | 3.00 | 2.60 | 2.60 |
| 8 | ..... | 2.00 | 2.15 | 2.70 | 2.50 | 24 | 2.10 | 2.10 | 2.90 | 2.70 | 2.65 |
| 9 | ..... | 2.05 | 2.15 | 2.80 | 2.50 | 25 | 2.05 | 2.10 | 2.80 | 2.70 | 2.65 |
| 10 | ..... | 2.10 | 2.15 | 2.80 | 2.60 | 26 | 2.00 | 2.10 | 2.80 | 2.70 | 2.65 |
| 11 | ..... | 2.05 | 2.15 | 3.00 | 2.60 | 27 | 2.00 | 2.10 | 2.80 | 2.70 | 2.70 |
| 12 | ..... | 2.10 | 2.30 | 4.00 | 3.10 | 28 | 1.90 | 2.10 | 2.80 | 2.60 | 2.90 |
| 13 | ..... | 2.10 | 2.50 | 3.70 | 2.90 | 29 | 1.95 | 2.10 | 2.80 | 2.55 | 3.20 |
| 14 | ..... | 2.05 | 2.60 | 3.20 | 2.80 | 30 | 1.95 | 2.10 | 2.80 | 2.55 | 3.00 |
| 15 | ..... | 2.15 | 2.50 | 3.20 | 3.25 | 31 | 1.90 | ..... | 2.70 | ..... | 3.00 |
| 16 | ..... | 2.20 | 2.50 | 3.60 | 3.10 | | | | | | |

## BEAR RIVER AT BATTLECREEK, IDAHO.

This river has its source on the northern slope of the Uinta Mountains, in the northeastern part of Utah. Its general course is northerly, entering Wyoming at the southwestern corner of the State. It

shortly afterwards swings back into Utah again and then reenters Wyoming. After its junction with Smiths Fork it swings to the westward again, leaves Wyoming for the last time, and enters Idaho. Twenty-eight miles below the outlet of Bear Lake the river makes a sudden bend to the south, and its course is thence southerly, reentering Utah and finally discharging its waters into Great Salt Lake. There are a number of reservoir sites in its upper basin, which have not, however, been examined in detail. Considerable irrigation is practiced, commencing at a point where the river first enters Wyoming and thence extending downstream to the outlet of Bear Lake. At the present time all of the low-water flow is thus utilized, resulting in a scarcity during the latter part of the irrigation season. Bear Lake acts as a regulator to the discharge of the portion of the river below it. The lake itself is one of the finest natural reservoir sites in the country and could be utilized with small expense. That it has not been utilized before this is due to the abundant water supply of the lands below. The agricultural lands in Idaho adjacent to this river are of small extent, and at the present time little water is diverted; nor does it receive a large additional supply in this State, except in times of flood discharges. The gaging station at Battlecreek was established on October 11, 1889, and is located about 10 miles north of the Utah-Idaho boundary line. The measurements show the amount of water of this river available for irrigation purposes in Cache Valley, Utah. The gage consisted of a vertical board nailed to a pile. This was carried away June 30, 1899, but was replaced on August 4 by a wire and weight, readings being made on a horizontal scale. The bench mark for the old gage is described in Water-Supply Paper No. 16, page 157. It was a nail in the southeast corner of a house near the gage, about 1.5 feet from the ground and 10.95 feet above gage datum. The bench mark for the present gage is a mark of black paint on the top of a log projecting from the southeast corner of the observer's house, about 2 feet above the surface of the ground and 11.118 feet above gage datum. The station is equipped with a cable and car. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 315; 1897, Nineteenth Annual Report, Part IV, page 432; 1898, Twentieth Annual Report, Part IV, page 459. The following measurements of discharge were made by J. S. Baker and G. L. Swendsen during 1899:

March 28, gage height, 1.75 feet; discharge, 773 second-feet.
May 8, gage height, 3.25 feet; discharge, 2,376 second-feet.
July 3, gage out; discharge, 4,781 second-feet.
August 4, gage height, 3.01 feet; discharge, 1,732 second-feet.
December 4, gage height, 2.21 feet; discharge, 1,312 second-feet.

*Daily gage height, in feet, of Bear River at Battlecreek, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.60 | 1.60 | 1.50 | 1.90 | 3.50 | 4.10 | ..... | 2.10 | 2.00 | 2.20 | 2.20 |
| 2 | 1.60 | 1.60 | 1.50 | 1.90 | 3.50 | 4.10 | ..... | 2.10 | 2.00 | 2.20 | 2.20 |
| 3 | 1.60 | 1.60 | 1.50 | 2.00 | 3.40 | 4.10 | ..... | ..... | 2.00 | 2.20 | 2.20 |
| 4 | 1.60 | 1.60 | 1.50 | 2.00 | 3.40 | 4.10 | 3.10 | ..... | 2.00 | 2.20 | 2.20 |
| 5 | 1.60 | 1.60 | 1.50 | 2.15 | 3.40 | 4.10 | 3.00 | ..... | 2.00 | 2.20 | 2.10 |
| 6 | 1.60 | 1.60 | 1.50 | 2.15 | 3.30 | 4.15 | 3.00 | ..... | 2.00 | 2.20 | 2.10 |
| 7 | 1.60 | 1.60 | 1.50 | 2.15 | 3.20 | 4.20 | 2.90 | ..... | 2.00 | 2.20 | 2.00 |
| 8 | 1.60 | 1.60 | 1.50 | 2.25 | 3.20 | 4.20 | 2.90 | ..... | 2.00 | 2.20 | 1.90 |
| 9 | 1.60 | 1.60 | 1.50 | 2.60 | 3.30 | 4.20 | 2.90 | ..... | 2.00 | 2.20 | 1.90 |
| 10 | 1.60 | 1.60 | 1.50 | 2.85 | 3.40 | 4.25 | 2.90 | 2.10 | 2.00 | 2.20 | 1.80 |
| 11 | 1.60 | 1.60 | 1.50 | 2.90 | 3.40 | 4.30 | 2.90 | 2.10 | 2.00 | 2.20 | 1.70 |
| 12 | 1.60 | 1.60 | 1.50 | 3.10 | 3.50 | 4.30 | 2.90 | 2.10 | 2.00 | 2.40 | 2.30 |
| 13 | 1.60 | 1.60 | 1.50 | 3.45 | 3.60 | 4.30 | 2.90 | 2.10 | 2.15 | 2.40 | 2.20 |
| 14 | 1.60 | 1.60 | 1.50 | 3.55 | 3.60 | 4.40 | 2.90 | 2.10 | 2.20 | 2.40 | 2.20 |
| 15 | 1.60 | 1.60 | 1.50 | 3.60 | 3.60 | 4.40 | 2.80 | 2.10 | 2.20 | 2.40 | 2.10 |
| 16 | 1.60 | 1.60 | 1.50 | 3.50 | 3.60 | 4.40 | 2.80 | 2.10 | 2.20 | 2.40 | 2.10 |
| 17 | 1.60 | 1.60 | 1.50 | 3.50 | 3.60 | 4.40 | 2.70 | 2.10 | 2.20 | 2.40 | 2.10 |
| 18 | 1.60 | 1.50 | 1.50 | 3.40 | 3.70 | 4.40 | 2.70 | 2.10 | 2.20 | 2.40 | 2.00 |
| 19 | 1.60 | 1.50 | 1.50 | 3.45 | 3.80 | 4.40 | 2.60 | 2.10 | 2.20 | 2.40 | 2.00 |
| 20 | 1.60 | 1.50 | 1.60 | 3.30 | 3.80 | 4.40 | 2.60 | 2.10 | 2.20 | 2.40 | 2.00 |
| 21 | 1.60 | 1.50 | 1.60 | 3.30 | 3.80 | 4.40 | 2.50 | 2.10 | 2.20 | 2.30 | 1.90 |
| 22 | 1.60 | 1.50 | 1.60 | 3.30 | 3.80 | 4.50 | 2.50 | 2.10 | 2.30 | 2.30 | 1.90 |
| 23 | 1.60 | 1.50 | 1.60 | 3.40 | 3.80 | 4.50 | 2.40 | 2.10 | 2.30 | 2.30 | 1.90 |
| 24 | 1.60 | 1.50 | 1.65 | 3.40 | 3.80 | 4.50 | 2.30 | 2.00 | 2.30 | 2.30 | 1.90 |
| 25 | 1.60 | 1.50 | 1.90 | 3.40 | 3.90 | 4.60 | 2.30 | 2.00 | 2.30 | 2.30 | 1.90 |
| 26 | 1.60 | 1.50 | 1.90 | 3.45 | 3.90 | 4.60 | 2.30 | 2.00 | 2.30 | 2.20 | 1.90 |
| 27 | 1.60 | 1.50 | 1.80 | 3.50 | 3.90 | 4.60 | 2.20 | 2.00 | 2.30 | 2.20 | 1.90 |
| 28 | 1.60 | 1.50 | 1.80 | 3.50 | 3.90 | 4.60 | 2.20 | 2.00 | 2.30 | 2.20 | 1.90 |
| 29 | 1.60 | ..... | 1.80 | 3.50 | 4.00 | 4.70 | 2.20 | 2.00 | 2.20 | 2.20 | 1.90 |
| 30 | 1.60 | ..... | 1.80 | 3.50 | 4.00 | ..... | 2.20 | 2.00 | 2.20 | 2.20 | 1.90 |
| 31 | 1.60 | ..... | 1.80 | ..... | 4.00 | ..... | 2.20 | ..... | 2.20 | ..... | ..... |

From June 29 to August 4 no readings; gage out.

## LOGAN RIVER AT LOGAN, UTAH.

This river rises in the elevated region west of Bear Lake and flows in a general southwesterly direction until it enters Cache Valley, when it bends northward and enters Bear River before this stream reaches its lower canyon. Logan River has a good water supply, and as soon as it appears from its canyon a number of canals divert its waters for the irrigation of a large portion of Cache Valley. The station on Logan River was established June 1, 1896, and is located in the river canyon about 2 miles east of Logan, Utah. One gage is a vertical iron post, set firmly in the middle of the river's bed and graduated to feet and tenths. A second gage rod is a wooden post driven into the ground near the north bank of the river. The bench mark for both rods is a stone 35 feet northeast of the end of the cable on the north side of the river, and is at an elevation of 14.01 feet above gage datum. It is marked by a cross chiseled on the rock and by the letters "B. M." in red paint. The equipment consists of a cable and car. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 316; 1897, Nineteenth Annual Report, Part IV, page 434; 1898, Twentieth Annual Report, Part IV, page 462. The following discharge measurements were made by J. S. Baker and G. L. Swendsen during 1899:

*Discharge measurements of Logan River at Logan, Utah.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| April 22 | 3.10 | 420 | July 3 | 4.60 | 1,526 |
| May 9 | 3.57 | 628 | August 5 | 3.52 | 525 |
| May 15 | 3.67 | 750 | November 1 | 2.82 | 323 |
| May 29 | 3.80 | 931 | December 2 | 2.75 | 301 |
| June 17 | 4.65 | 1,630 | | | |

*Daily gage height, in feet, of Logan River at Logan, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.55 | 2.50 | 2.50 | 2.55 | 3.05 | 3.70 | 4.75 | 3.55 | 3.10 | 2.90 | 2.80 | 2.75 |
| 2 | 2.50 | 2.50 | 2.50 | 2.55 | 3.00 | 3.75 | 4.70 | 3.50 | 3.10 | 2.90 | 2.80 | 2.75 |
| 3 | 2.50 | 2.50 | 2.45 | 2.55 | 3.00 | 3.80 | 4.65 | 3.50 | 3.10 | 2.90 | 2.80 | 2.75 |
| 4 | 2.45 | 2.35 | 2.45 | 2.55 | 3.00 | 4.20 | 4.60 | 3.50 | 3.05 | 2.90 | 2.80 | 2.70 |
| 5 | 2.45 | 2.30 | 2.45 | 2.60 | 3.10 | 4.45 | 4.50 | 3.50 | 3.05 | 2.90 | 2.80 | 2.75 |
| 6 | 2.45 | 2.80 | 2.40 | 2.60 | 3.15 | 4.25 | 4.45 | 3.50 | 3.05 | 2.90 | 2.80 | 2.75 |
| 7 | 2.50 | 2.50 | 2.45 | 2.65 | 3.20 | 4.15 | 4.40 | 3.50 | 3.05 | 3.90 | 2.80 | 2.75 |
| 8 | 2.55 | 2.50 | 2.50 | 2.65 | 3.30 | 4.15 | 4.35 | 3.45 | 3.05 | 2.90 | 2.80 | 2.75 |
| 9 | 2.50 | 2.50 | 2.50 | 2.75 | 3.65 | 4.20 | 4.30 | 3.40 | 3.05 | 2.90 | 2.80 | 2.75 |
| 10 | 2.50 | 2.50 | 2.50 | 2.85 | 3.50 | 4.30 | 4.25 | 3.40 | 3.05 | 2.90 | 2.80 | 2.75 |
| 11 | 2.50 | 2.50 | 2.45 | 3.00 | 3.60 | 4.50 | 4.20 | 3.35 | 3.00 | 2.90 | 2.80 | 2.75 |
| 12 | 2.50 | 2.50 | 2.45 | 3.00 | 3.80 | 4.75 | 4.20 | 3.35 | 3.00 | 2.90 | 2.80 | 2.70 |
| 13 | 2.50 | 2.50 | 2.45 | 3.00 | 3.75 | 4.65 | 4.15 | 3.35 | 3.00 | 2.90 | 2.80 | 2.70 |
| 14 | 2.50 | 2.50 | 2.45 | 3.05 | 3.70 | 4.50 | 4.15 | 3.30 | 3.00 | 2.90 | 2.80 | 2.70 |
| 15 | 2.50 | 2.50 | 2.45 | 3.05 | 3.65 | 4.45 | 4.10 | 3.30 | 3.00 | 2.90 | 2.80 | 2.70 |
| 16 | 2.50 | 2.50 | 2.45 | 3.05 | 3.55 | 4.50 | 4.05 | 3.30 | 3.00 | 2.90 | 2.80 | 2.70 |
| 17 | 2.50 | 2.45 | 2.45 | 3.05 | 3.50 | 4.65 | 4.00 | 3.25 | 3.00 | 2.90 | 2.80 | 2.70 |
| 18 | 2.50 | 2.45 | 2.45 | 3.00 | 3.60 | 4.70 | 4.00 | 3.25 | 3.00 | 2.90 | 2.75 | 2.70 |
| 19 | 2.50 | 2.45 | 2.45 | 2.95 | 3.65 | 4.90 | 3.95 | 3.20 | 2.95 | 2.90 | 2.75 | 2.65 |
| 20 | 2.50 | 2.45 | 2.50 | 2.95 | 3.70 | 5.00 | 3.90 | 3.20 | 2.95 | 2.90 | 2.75 | 2.65 |
| 21 | 2.50 | 2.45 | 2.50 | 2.95 | 3.60 | 4.85 | 3.85 | 3.20 | 2.95 | 2.90 | 2.75 | 2.60 |
| 22 | 2.50 | 2.40 | 2.50 | 3.10 | 3.50 | 4.80 | 3.80 | 3.20 | 2.95 | 2.85 | 2.75 | 2.60 |
| 23 | 2.40 | 2.35 | 2.50 | 3.30 | 3.55 | 4.75 | 3.80 | 3.15 | 2.95 | 2.85 | 2.75 | 2.75 |
| 24 | 2.50 | 2.45 | 2.50 | 3.40 | 3.65 | 4.70 | 3.75 | 3.15 | 2.95 | 2.85 | 2.75 | 2.70 |
| 25 | 2.50 | 2.45 | 2.65 | 3.30 | 3.70 | 4.70 | 3.75 | 3.15 | 2.95 | 2.85 | 2.75 | 2.70 |
| 26 | 2.50 | 2.45 | 2.65 | 3.25 | 3.75 | 4.70 | 3.70 | 3.15 | 2.95 | 2.85 | 2.75 | 2.70 |
| 27 | 2.50 | 2.45 | 2.60 | 3.20 | 3.85 | 4.65 | 3.70 | 3.10 | 2.90 | 2.85 | 2.75 | 2.70 |
| 28 | 2.50 | 2.45 | 2.60 | 3.10 | 3.75 | 4.65 | 3.65 | 3.10 | 2.90 | 2.85 | 2.75 | 2.65 |
| 29 | 2.50 | ..... | 2.60 | 3.05 | 3.75 | 4.70 | 3.65 | 3.10 | 2.90 | 2.85 | 2.75 | 2.70 |
| 30 | 2.50 | ..... | 2.60 | 3.10 | 3.80 | 4.75 | 3.60 | 3.10 | 2.90 | 2.80 | 2.75 | 2.70 |
| 31 | 2.50 | ..... | 2.55 | ..... | 3.70 | ..... | 3.55 | 3.10 | ..... | 2.80 | ..... | 2.70 |

## BEAR RIVER AT COLLINSTON, UTAH.

After entering the northern end of Cache Valley this river receives a number of important tributaries, viz, Cub Creek, Logan River, Blacksmith Fork, and Little Bear River. Below the mouth of Logan River, Bear River has cut through the northern extension of the Wasatch Range, forming what is known as its lower canyon. On its appearance from this it turns southerly and enters Great Salt Lake. A large canal was in process of construction during 1899, and next year a considerable portion of the summer flow of Bear River will be diverted by it to irrigate lands on the west side of Cache Valley. One of the most notable irrigation enterprises of the country diverts water from Bear River in the lower canyon and irrigates land principally to the westward of Malade River, the lowest of the important tributaries of Bear River. The gaging station at Collinston was established in July, 1889, and is located about 4 miles from the railroad station at Collinston, 2 miles east of the town of Fielding, Utah, and below the headworks of

the Bear River canal. The gage consists of a vertical iron rod graduated to tenths of a foot. The bench mark is a nail in an oak post 20 feet west of the gage and 20 feet north of the cable, and is at an elevation of 7.35 feet above gage datum. The equipment consists of a cable, tagged wire, and a boat. The observer is generally the ditch rider of the Bear River Canal Company, who has a house near the station. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 320; 1897, Nineteenth Annual Report, Part IV, page 435; 1898, Twentieth Annual Report, Part IV, page 460. The following measurements of discharge were made during 1899:

May 5, gage height, 4 feet; discharge, 4,438 second-feet.
June 23, gage height, 5.60 feet; discharge, 6,653 second-feet.
July 14, gage height, 4.61 feet; discharge, 4,819 second-feet.
November 29, gage height, 2.40 feet; discharge, 2,083 second-feet.

*Daily gage height, in feet, of Bear River at Collinston, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.30 | 1.90 | 2.00 | 2.60 | 4.40 | 4.90 | 5.60 | 3.00 | 2.00 | 1.80 | 2.40 | 2.40 |
| 2 | 1.50 | 1.90 | 2.00 | 2.60 | 4.30 | 4.90 | 5.40 | 3.00 | 2.00 | 1.90 | 2.30 | 2.40 |
| 3 | 1.50 | 1.90 | 1.90 | 2.60 | 4.20 | 4.90 | 5.50 | 2.90 | 1.90 | 1.90 | 2.40 | 2.40 |
| 4 | 1.50 | 1.40 | 1.90 | 2.60 | 4.20 | 4.90 | 5.50 | 2.90 | 1.90 | 1.90 | 2.30 | 2.30 |
| 5 | 1.70 | 1.40 | 1.90 | 2.60 | 4.20 | 4.90 | 5.40 | 3.00 | 2.00 | 1.90 | 2.30 | 2.20 |
| 6 | 1.70 | 1.40 | 1.90 | 2.60 | 4.10 | 5.10 | 5.40 | 3.00 | 1.90 | 1.90 | 2.30 | 2.20 |
| 7 | 1.70 | 1.40 | 1.90 | 2.70 | 4.10 | 5.30 | 5.40 | 2.90 | 1.80 | 1.90 | 2.30 | 2.10 |
| 8 | 1.70 | 1.40 | 1.90 | 2.80 | 4.20 | 5.30 | 5.30 | 2.90 | 1.80 | 1.90 | 2.30 | 2.00 |
| 9 | 1.70 | 1.40 | 2.10 | 2.90 | 4.10 | 5.30 | 5.20 | 2.90 | 1.60 | 1.90 | 2.30 | 2.00 |
| 10 | 1.70 | 1.60 | 2.10 | 3.00 | 4.20 | 5.20 | 5.10 | 2.90 | 2.00 | 1.90 | 2.40 | 2.00 |
| 11 | 1.70 | 1.60 | 2.10 | 3.60 | 4.40 | 5.20 | 5.00 | 2.90 | 2.00 | 2.00 | 2.40 | 2.20 |
| 12 | 1.70 | 1.60 | 2.00 | 3.60 | 4.70 | 5.30 | 4.90 | 2.80 | 1.90 | 2.20 | 2.50 | 2.00 |
| 13 | 1.70 | 1.80 | 2.00 | 3.80 | 4.80 | 5.40 | 4.80 | 2.80 | 1.90 | 2.20 | 2.50 | 1.90 |
| 14 | 1.70 | 1.80 | 2.00 | 4.10 | 4.90 | 5.50 | 4.70 | 2.80 | 1.90 | 2.30 | 2.50 | 2.10 |
| 15 | 1.70 | 1.80 | 2.10 | 4.50 | 5.10 | 5.60 | 4.60 | 2.80 | 1.80 | 2.40 | 2.50 | 2.20 |
| 16 | 1.80 | 1.70 | 2.10 | 4.50 | 5.10 | 5.50 | 4.50 | 2.70 | 1.90 | 2.30 | 2.50 | 2.20 |
| 17 | 1.80 | 1.70 | 2.20 | 4.50 | 5.20 | 5.50 | 4.40 | 2.60 | 1.90 | 2.50 | 2.60 | 2.20 |
| 18 | 1.80 | 1.70 | 2.40 | 4.40 | 5.20 | 5.50 | 4.30 | 2.40 | 1.90 | 2.50 | 2.60 | 2.20 |
| 19 | 1.80 | 1.70 | 2.40 | 4.20 | 5.00 | 5.40 | 4.20 | 2.40 | 1.90 | 2.50 | 2.60 | 2.20 |
| 20 | 1.80 | 1.70 | 2.40 | 4.10 | 4.80 | 5.50 | 4.10 | 2.40 | 2.00 | 2.50 | 2.60 | 2.10 |
| 21 | 1.80 | 1.80 | 2.40 | 4.10 | 4.80 | 5.50 | 4.00 | 2.30 | 1.90 | 2.50 | 2.50 | 2.00 |
| 22 | 1.80 | 1.80 | 2.40 | 4.10 | 4.80 | 5.60 | 3.80 | 2.20 | 1.90 | 2.40 | 2.50 | 1.90 |
| 23 | 1.80 | 1.80 | 2.40 | 4.20 | 4.80 | 5.60 | 3.70 | 2.20 | 1.90 | 2.40 | 2.50 | 2.00 |
| 24 | 1.80 | 1.80 | 2.50 | 4.30 | 4.70 | 5.60 | 3.60 | 2.30 | 1.90 | 2.50 | 2.50 | 2.00 |
| 25 | 1.80 | 1.80 | 2.50 | 4.40 | 4.70 | 5.60 | 3.60 | 2.20 | 1.90 | 2.50 | 2.40 | 1.90 |
| 26 | 1.80 | 1.90 | 2.50 | 4.50 | 4.80 | 5.60 | 3.50 | 2.20 | 1.80 | 2.50 | 2.40 | 2.00 |
| 27 | 1.80 | 1.90 | 2.50 | 4.50 | 4.80 | 5.60 | 3.40 | 2.10 | 1.60 | 2.50 | 2.40 | 2.10 |
| 28 | 1.90 | 2.00 | 2.60 | 4.50 | 4.90 | 5.50 | 3.40 | 2.10 | 1.70 | 2.40 | 2.40 | 2.10 |
| 29 | 1.90 | ..... | 2.60 | 4.50 | 4.90 | 5.60 | 3.30 | 2.10 | 1.70 | 2.40 | 2.40 | 2.20 |
| 30 | 1.90 | ..... | 2.60 | 4.40 | 4.90 | 5.60 | 3.20 | 2.10 | 1.70 | 2.40 | 2.40 | 2.20 |
| 31 | 1.90 | ..... | 2.60 | ..... | 4.90 | ..... | 3.10 | 2.00 | ..... | 2.40 | ..... | 2.20 |

## OGDEN RIVER AT OGDEN, UTAH.

This river rises in the high land to the east of the Wasatch Range and flows in a general southerly direction. Passing through the Wasatch Mountains in a picturesque canyon, and appearing on the plains in the vicinity of Ogden, it shortly enters Weber River, and thus finds its way into Great Salt Lake. The present station was established in the spring of 1897, and is located at the old powder mill in the canyon, 5 miles east of Ogden and about 5 miles below the headworks of the Pioneer Electric Power Company; therefore the results do not show the amount of water used by that company. The gage is inclined and

divided into tenths of a foot. On June 22 the dam below the gage was washed out and the daily readings were not continued after that date. On June 30, 1899, the gage itself was carried away, but was reestablished on August 26. The bench mark of the new gage is the top of a large quartzite bowlder on the south side of the wagon road, about 60 feet southwest of the south end of the cable, and is at an elevation of 12.642 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 321; 1897, Nineteenth Annual Report, Part IV, page 437; 1898, Twentieth Annual Report, Part IV, page 465. The following measurements of discharge were made by W. B. Dougall and J. S. Baker in 1899:

May 2, gage height, 1.70 feet; discharge, 1,008 second-feet.[1]
May 4, gage height, 1.25 feet; discharge, 833 second-feet.
June 30, gage out; discharge, 396 second-feet.
July 12, gage height, 2.38 feet; discharge, 221 second-feet.
August 26, gage height, 1.25 feet; discharge, 72 second-feet.

*Daily gage height, in feet, of Ogden River at Ogden, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | Day. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.40 | 1.50 | 2.50 | 3.80 | 1.90 | 1.40 | 17 | 1.60 | 1.60 | 2.00 | 3.10 | 2.60 | 1.40 |
| 2 | 1.90 | 1.70 | 2.40 | 3.80 | 1.80 | 2.50 | 18 | 1.70 | 1.70 | 2.20 | 3.00 | 2.50 | 1.10 |
| 3 | 1.50 | 1.70 | 2.10 | 3.50 | 1.70 | 2.40 | 19 | 1.60 | 1.80 | 2.30 | 2.70 | 2.60 | 1.00 |
| 4 | 1.50 | 1.60 | 2.00 | 3.50 | 1.50 | 2.70 | 20 | 1.60 | 1.80 | 2.40 | 2.40 | 2.70 | .80 |
| 5 | 1.50 | 1.50 | 2.10 | 3.80 | 1.50 | 2.80 | 21 | 1.60 | 1.90 | 2.60 | 2.30 | 2.40 | .70 |
| 6 | 1.55 | 1.40 | 2.00 | 4.10 | 1.90 | 2.60 | 22 | 1.70 | 1.90 | 2.50 | 2.80 | 2.50 | ..... |
| 7 | 1.60 | 1.40 | 2.00 | 4.10 | 2.10 | 2.40 | 23 | 1.70 | 1.80 | 2.60 | 3.00 | 2.60 | ..... |
| 8 | 1.60 | 1.40 | 2.00 | 4.50 | 2.80 | 2.20 | 24 | 1.50 | 1.80 | 3.70 | 3.50 | 2.80 | ..... |
| 9 | 1.50 | 1.40 | 2.00 | 4.50 | 3.20 | 2.20 | 25 | 1.70 | 1.80 | 4.10 | 3.50 | 2.50 | ..... |
| 10 | 1.50 | 1.40 | 2.10 | 4.90 | 3.30 | 2.30 | 26 | 1.70 | 1.80 | 4.30 | 3.10 | 2.50 | ..... |
| 11 | 1.50 | 1.50 | 1.90 | 4.70 | 3.50 | 2.30 | 27 | 1.70 | 1.80 | 3.90 | 2.80 | 2.40 | ..... |
| 12 | 1.50 | 1.60 | 2.10 | 4.00 | 3.60 | 2.70 | 28 | 1.70 | 1.90 | 3.70 | 2.60 | 2.20 | ..... |
| 13 | 1.50 | 1.50 | 2.10 | 4.25 | 3.60 | 2.60 | 29 | 1.80 | ..... | 3.55 | 2.30 | 2.00 | ..... |
| 14 | 1.40 | 1.50 | 2.10 | 4.00 | 3.50 | 2.40 | 30 | 1.70 | ..... | 3.55 | 2.10 | 1.70 | ..... |
| 15 | 1.70 | 1.50 | 2.00 | 3.40 | 2.90 | 1.30 | 31 | 1.70 | ..... | 3.50 | ..... | 1.60 | ..... |
| 16 | 1.70 | 1.50 | 2.00 | 3.40 | 2.60 | 1.20 | | | | | | | |

Dam below washed out June 22.

## WEBER RIVER AT UINTA, UTAH.

This river, like Ogden River, rises in the high country east of the Wasatch Mountains, passes through this range, and appears in the plains region in the vicinity of Ogden, where, after it receives the waters of Ogden River, it discharges into Great Salt Lake. There are a number of good reservoir sites on its upper tributaries, and within the last few years some of them have been utilized by the construction of notable storage works. The gaging station, established in October, 1899, is located in the canyon 5 miles east of Uinta, on the Union Pacific Railroad, immediately above the narrows known as Devils Gate. The gage is vertical, and is supported from above by a projecting timber placed out of reach of high water. The bench mark consists of a spike driven into the first telegraph pole in the canyon above the gage, and is at an elevation of 17.44 feet above gage

[1] At old powder-mill dam.

datum. The equipment consists of a cable, car, and tagged wire. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 324; 1897, Nineteenth Annual Report, Part IV, page 440; 1898, Twentieth Annual Report, Part IV, page 466. The following measurements of discharge were made by W. B. Dougall and J. S. Baker during 1899:

May 3, gage height, 3.20 feet; discharge, 1,857 second-feet.
May 6, gage height, 3.30 feet; discharge, 1,969 second-feet.
July 1, gage height, 4.10 feet; discharge, 2,582 second-feet.
July 10, gage height, 2.80 feet; discharge, 1,284 second-feet.

*Daily gage height, in feet, of Weber River at Uinta, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.70 | 1.70 | 1.80 | 2.80 | 4.60 | 4.60 | 4.10 | 1.70 | 1.60 | 1.50 |
| 2 | 1.70 | 1.70 | 1.80 | 2.80 | 4.75 | 4.75 | 4.00 | 1.70 | 1.50 | 1.50 |
| 3 | 1.70 | 1.70 | 1.80 | 2.80 | 5.00 | 4.80 | 3.65 | 1.70 | 1.50 | 1.50 |
| 4 | 1.70 | 1.70 | 1.80 | 3.05 | 5.15 | 5.05 | 3.50 | 1.70 | 1.50 | 1.50 |
| 5 | 1.70 | 1.70 | 1.80 | 3.30 | 5.50 | 5.25 | 3.50 | 1.70 | 1.50 | 1.50 |
| 6 | 1.70 | 1.70 | 1.80 | 3.50 | 5.75 | 5.50 | 3.30 | 1.70 | 1.50 | 1.50 |
| 7 | 1.70 | 1.70 | 1.80 | 3.60 | 5.75 | 5.80 | 3.20 | 1.70 | 1.50 | 1.50 |
| 8 | 1.70 | 1.70 | 1.80 | 3.75 | 5.55 | 5.80 | 3.00 | 1.70 | 1.50 | 1.50 |
| 9 | 1.70 | 1.70 | 1.80 | 3.90 | 5.55 | 5.80 | 2.80 | 1.70 | 1.50 | 1.60 |
| 10 | 1.70 | 1.70 | 1.80 | 4.15 | 5.90 | 5.85 | 2.80 | 1.70 | 1.50 | 1.65 |
| 11 | 1.70 | 1.70 | 1.80 | 4.85 | 6.30 | 5.95 | 2.70 | 1.70 | 1.50 | 1.70 |
| 12 | 1.70 | 1.80 | 1.80 | 5.00 | 6.50 | 6.25 | 2.60 | 1.70 | 1.50 | 1.75 |
| 13 | 1.70 | 1.80 | 1.80 | 5.10 | 6.35 | 6.30 | 2.60 | 1.80 | 1.50 | 1.80 |
| 14 | 1.70 | 1.80 | 1.80 | 5.15 | 5.90 | 5.85 | 2.60 | 1.70 | 1.50 | 1.80 |
| 15 | 1.70 | 1.80 | 1.80 | 4.95 | 5.50 | 5.35 | 2.50 | 1.70 | 1.50 | 1.80 |
| 16 | 1.70 | 1.80 | 1.80 | 4.80 | 5.05 | 5.25 | 2.50 | 1.60 | 1.50 | ..... |
| 17 | 1.70 | 1.80 | 1.80 | 4.75 | 4.65 | 5.40 | 2.45 | 1.60 | 1.50 | ..... |
| 18 | 1.70 | 1.80 | 1.90 | 4.60 | 4.40 | 5.50 | 2.30 | 1.60 | 1.50 | ..... |
| 19 | 1.70 | 1.80 | 1.90 | 4.00 | 4.30 | 5.80 | 2.30 | 1.60 | 1.50 | ..... |
| 20 | 1.70 | 1.80 | 1.90 | 3.50 | 4.30 | 6.15 | 2.30 | 1.60 | 1.50 | ..... |
| 21 | 1.70 | 1.80 | 1.90 | 3.40 | 4.55 | 6.30 | 2.20 | 1.60 | 1.50 | ..... |
| 22 | 1.70 | 1.80 | 1.90 | 3.40 | 4.70 | 5.90 | 2.00 | 1.60 | 1.50 | ..... |
| 23 | 1.70 | 1.80 | 2.10 | 4.80 | 4.85 | 5.15 | 2.00 | 1.60 | 1.50 | ..... |
| 24 | 1.70 | 1.80 | 2.50 | 5.15 | 4.80 | 4.80 | 1.90 | 1.60 | 1.50 | ..... |
| 25 | 1.70 | 1.80 | 3.15 | 5.35 | 5.15 | 4.65 | 1.80 | 1.60 | 1.50 | ..... |
| 26 | 1.70 | 1.80 | 3.10 | 5.00 | 5.30 | 4.60 | 1.80 | 1.60 | 1.50 | ..... |
| 27 | 1.70 | 1.80 | 2.85 | 4.30 | 5.25 | 4.35 | 1.80 | 1.60 | 1.50 | ..... |
| 28 | 1.70 | 1.80 | 2.80 | 4.30 | 4.95 | 4.35 | 1.70 | 1.60 | 1.50 | ..... |
| 29 | 1.70 | ..... | 2.80 | 4.30 | 4.65 | 4.20 | 1.70 | 1.60 | 1.50 | ..... |
| 30 | 1.70 | ..... | 2.80 | 4.45 | 4.60 | 4.20 | 1.70 | 1.60 | 1.50 | ..... |
| 31 | 1.70 | ..... | 2.80 | ..... | 4.60 | ..... | 1.70 | 1.60 | ..... | ..... |

Station discontinued October 15.

## PROVO RIVER AT PROVO, UTAH.

This river rises on the western slope of the Uinta Mountains and after receiving a number of tributaries enters what is known as Heber Valley, where considerable irrigation is practiced. After crossing this valley it passes through the Wasatch Mountains in a picturesque canyon, finally entering Utah Valley, where its summer flow is completely diverted for irrigation purposes. Its flood waters discharge into Utah Lake. The gaging station, established July 27, 1889, is located in the canyon, about 6 miles from Provo and above the head of most of the irrigation canals of Utah Valley. The diversion works of the company which develop power at the mouth of Provo Canyon for electric transmission to the mines west of Provo, are located about 5 miles above the station. The gage is inclined and fastened to stakes set in the ground. The bench mark is a stone firmly bedded in the

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 gage datum. The channel is straight for some distance above and below the station. The bed of the river is gravel and not liable to change. The equipment consists of a cable, car, and tagged wire. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 226; 1897, Nineteenth Annual Report, Part IV, page 442; 1898, Twentieth Annual Report, Part IV, page 468. The following measurements of discharge were made by W. B. Dougall and J. S. Baker in 1899:

May 8, gage height, 4.70 feet; discharge, 496 second-feet.
June 29, gage height, 6.70 feet; discharge, 1,745 second-feet.
July 13, gage height, 5.22 feet; discharge, 535 second-feet.
August 16, gage height, 4.69 feet; discharge, 340 second-feet.
September 4, gage height, 4.60 feet; discharge, 352 second-feet.

*Daily gage height, in feet, of Provo River at Provo, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.20 | 4.20 | 4.30 | 4.90 | 5.20 | 5.80 | 6.50 | 4.60 | 4.60 | 4.80 |
| 2 | 4.20 | 4.20 | 4.30 | 4.80 | 5.20 | 5.80 | 6.90 | 4.60 | 4.60 | 4.80 |
| 3 | 4.20 | 4.20 | 4.30 | 4.80 | 5.20 | 5.80 | 6.30 | 4.60 | 4.60 | 4.80 |
| 4 | 4.20 | 4.20 | 4.30 | 4.80 | 5.20 | 6.20 | 6.20 | 4.60 | 4.60 | 4.80 |
| 5 | 4.20 | 4.00 | 4.30 | 4.80 | 5.20 | 6.40 | 6.10 | 4.60 | 4.60 | 4.80 |
| 6 | 4.20 | 4.00 | 4.30 | 4.80 | 5.20 | 6.70 | 5.90 | 4.60 | 4.60 | 4.80 |
| 7 | 4.20 | 4.00 | 4.30 | 4.70 | 4.80 | 6.70 | 5.70 | 4.60 | 4.60 | 4.80 |
| 8 | 4.20 | 4.00 | 4.30 | 4.70 | 4.90 | 6.80 | 5.60 | 4.60 | 4.60 | 4.80 |
| 9 | 4.20 | 4.00 | 4.30 | 4.90 | 5.00 | 6.80 | 5.50 | 4.70 | 4.60 | 4.80 |
| 10 | 4.20 | 3.90 | 4.30 | 4.90 | 5.30 | 6.90 | 5.40 | 4.70 | 4.60 | 4.80 |
| 11 | 4.20 | 3.90 | 4.40 | 5.00 | 5.40 | 7.10 | 5.30 | 4.70 | 4.60 | 4.80 |
| 12 | 4.20 | 4.20 | 4.40 | 5.00 | 5.70 | 7.10 | 5.20 | 4.70 | 4.60 | 4.80 |
| 13 | 4.20 | 4.20 | 4.40 | 5.00 | 5.70 | 7.10 | 5.20 | 4.70 | 4.60 | 4.80 |
| 14 | 4.20 | 4.20 | 4.40 | 5.10 | 5.70 | 7.20 | 5.20 | 4.70 | 4.60 | 4.80 |
| 15 | 4.20 | 4.20 | 4.40 | 5.10 | 5.70 | 7.20 | 5.20 | 4.70 | 4.60 | 4.80 |
| 16 | 4.20 | 4.20 | 4.40 | 5.10 | 5.60 | 7.20 | 5.10 | 4.70 | 4.60 | 4.80 |
| 17 | 4.20 | 4.20 | 4.50 | 5.10 | 5.50 | 7.20 | 5.10 | 4.70 | 4.60 | 4.80 |
| 18 | 4.20 | 4.20 | 4.50 | 5.10 | 5.50 | 7.60 | 5.10 | 4.70 | 4.60 | 4.80 |
| 19 | 4.20 | 4.20 | 4.80 | 5.20 | 5.50 | 7.70 | 5.00 | 4.70 | 4.60 | 4.80 |
| 20 | 4.20 | 4.20 | 5.00 | 5.20 | 5.50 | 7.80 | 5.00 | 4.60 | 4.60 | 4.80 |
| 21 | 4.20 | 4.20 | 5.00 | 5.30 | 5.50 | 7.90 | 5.00 | 4.60 | 4.60 | 4.80 |
| 22 | 4.20 | 4.20 | 5.00 | 5.30 | 5.30 | 8.00 | 5.00 | 4.60 | 4.60 | ..... |
| 23 | 4.20 | 4.20 | 5.00 | 5.30 | 5.30 | 7.60 | 4.90 | 4.60 | 4.60 | ..... |
| 24 | 4.20 | 4.20 | 5.30 | 5.30 | 5.30 | 7.60 | 4.90 | 4.60 | (a) | ..... |
| 25 | 4.20 | 4.20 | 5.30 | 5.30 | 5.60 | 7.40 | 4.90 | 4.60 | (a) | ..... |
| 26 | 4.20 | 4.20 | 5.00 | 5.30 | 5.80 | 7.40 | 4.80 | 4.60 | (a) | ..... |
| 27 | 4.20 | 4.20 | 5.00 | 5.20 | 5.80 | 7.20 | 4.80 | 4.60 | (a) | ..... |
| 28 | 4.20 | 4.20 | 5.00 | 5.20 | 5.80 | 7.10 | 4.80 | 4.60 | (a) | ..... |
| 29 | 4.20 | ..... | 5.00 | 5.20 | 5.80 | 6.70 | 4.80 | 4.60 | (a) | ..... |
| 30 | 4.20 | ..... | 5.00 | 5.20 | 5.80 | 6.60 | 4.60 | 4.60 | (a) | ..... |
| 31 | 4.20 | ..... | 5.00 | ..... | 5.80 | ..... | 4.60 | 4.60 | ..... | ..... |

*a* No reading. Station discontinued October 21.

## UTAH LAKE.

This fresh-water lake receives the surplus waters and seepage of a number of streams that receive their water supply from the Wasatch Mountains, the principal ones being Currant Creek, Spanish Fork, Hobble Creek, Provo River, and American Fork. The ordinary flow of these streams is diverted, on their appearance from their canyons, to irrigate the lands of Utah Valley. A gaging station has been maintained on Provo River, as described on page 338 of this report. A number of miscellaneous measurements were made during 1899 on

the other tributaries as well as on the canals diverting water from the same during the last season. On May 11 Spanish Fork, at the second bridge in the canyon, was discharging 679 second-feet; May 10, Hobble Creek, at the second bridge in the canyon, above Springville, was discharging 244 second-feet; American Fork, on May 9, was carrying 106 second-feet, with a gage height of 0.1 foot, on a temporary gage established that day. The following table shows the discharge of a number of canals in Utah County as determined by J. S. Baker:

*Discharge of canals in Utah County, Utah.*

1899.

| Date. | Stream. | Source. | Discharge. | Remarks. |
|---|---|---|---|---|
| | | | *Sec.-feet.* | |
| June 22 | Boxelder Creek | Mountain springs | 31.46 | |
| Aug. 16 | Timpanogas canal | Provo River | 10.40 | |
| Aug. 16 | Timpanogas canal | Provo River | 7.84 | 9,500 feet below last measurement. |
| Aug. 17 | Little Dry Creek canal. | Provo River | 4.64 | |
| Aug. 17 | Tanner's race | Provo River | 16.94 | |
| Aug. 17 | Lake Bottom canal | Provo River | 7.14 | |
| Aug. 17 | West Union canal | Provo River | 55.98 | |
| Aug. 17 | Provo Bench canal | Provo River | 53.65 | |
| Aug. 17 | Provo Bench canal | Provo River | 57.96 | 1½ miles above last measurement. |
| Aug. 17 | Park & Nuttall's ditch. | Provo River | 11.84 | |
| Aug. 17 | Upper East Union canal. | Provo River | 28.27 | |
| Aug. 17 | Upper East Union canal. | Provo River | 27.52 | 1 mile below last measurement. |
| Aug. 18 | City race | Provo River | 12.40 | |
| Aug. 18 | Factory race | Provo River | 51.44 | |
| Aug. 18 | East Union canal | Provo River | 18.22 | |
| Aug. 18 | Bomb & Richardson's canal. | Provo River | 1.00 | Estimated. |
| Aug. 18 | Stubbs & Furgeson's canal. | Provo River | 5.00 | By floats. |
| Aug. 18 | Richmond & Penrod's canal. | Provo River | 4.00 | Estimated. |
| Aug. 21 | Mapleton Union canal. | Hobble Creek | 19.11 | |
| Aug. 21 | Mapleton Union canal. | Hobble Creek | 17.95 | 1 mile above last measurement. |
| Aug. 21 | Mapleton reservoir canal. | Hobble Creek | 3.09 | |
| Aug. 21 | Mapleton reservoir canal. | Hobble Creek | 2.73 | One-half mile above last measurement. |
| Aug. 21 | North Bench canal | Hobble Creek | 8.35 | |
| Aug. 21 | North Bench canal | Hobble Creek | 8.39 | Three-fourths mile below last measurement. |
| Aug. 21 | Island canal | Hobble Creek | 4.02 | |
| Aug. 21 | Sage Creek canal | Hobble Creek | 5.96 | |
| Aug. 21 | South Big Field ditch | Hobble Creek | 5.52 | |
| Aug. 21 | City ditch | Hobble Creek | 2.21 | |
| Aug. 22 | City canal | Spanish Fork | 38.51 | |
| Aug. 22 | Salem Irrigation Company's canal. | Spanish Fork | 22.05 | |
| Aug. 22 | South Field Irrigation Company's canal. | Spanish Fork | 37.39 | |

*Discharge of canals in Utah County, Utah*—Continued.

1899—Continued.

| Date. | Stream. | Source. | Discharge. | Remarks. |
|---|---|---|---|---|
| | | | *Sec.-feet.* | |
| Aug. 22 | East Bench canal | Spanish Fork | 28.19 | |
| Aug. 22 | Lake Shore canal | Spanish Fork | 12.43 | |
| Aug. 22 | Salem Pond canal | Low springs | 4.99 | |
| Aug. 23 | Summit Creek | Mountain springs | 14.64 | |
| Aug. 23 | Spring Lake Creek | Low springs | 2.89 | |
| Aug. 25 | American Fork canal. | American Fork | 28.85 | |
| Aug. 25 | Lehi canal | American Fork | 17.82 | |
| Aug. 25 | Pleasant Grove canal | American Fork | 10.71 | |

NOTE.—All measurements were made by current meter unless otherwise stated.

A station has been maintained on Utah Lake at Geneva, where has been recorded the rise and fall of the water surface since November 6, 1896. The gage consists of a vertical rod attached to one end of a bath house at that point. The bench mark of the lake commissioners, a sandstone monument at the edge of the bluff opposite the south end of the pavilion, is 18.644 feet above gage datum, which was placed 4 feet below compromise point. The results of observations at this station will be found as follows: 1896, Eighteenth Annual Report, Part IV, page 330; 1897, Nineteenth Annual Report, Part IV, page 443; 1898, Twentieth Annual Report, Part IV, page 467.

*Daily gage height, in feet, of Utah Lake at Geneva, Utah, for 1899.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.60 | 0.80 | | 1.50 | | | 1.70 | | |
| 2 | | | | | | | | | 0.60 |
| 3 | | | 1.30 | | | 2.25 | | | |
| 4 | .65 | .85 | | 1.50 | | | | 1.05 | |
| 5 | | | | | 1.70 | 2.00 | 1.50 | | |
| 6 | .65 | .90 | 1.35 | 1.55 | | | | .95 | |
| 7 | | | | | | | 1.50 | | .30 |
| 8 | | | 1.35 | 1.50 | 1.85 | 2.15 | | | |
| 9 | .60 | .95 | | | | | | 1.00 | |
| 10 | | | 1.35 | 1.50 | 1.90 | 2.10 | 1.55 | | .10 |
| 11 | .60 | 1.00 | | | | | | .90 | |
| 12 | | | | | | 2.10 | 1.50 | | |
| 13 | .65 | 1.00 | 1.40 | 1.55 | | | | | |
| 14 | | | | | 2.00 | | 1.40 | .90 | .20 |
| 15 | .70 | | 1.45 | | | 2.00 | | | |
| 16 | | 1.00 | | | | | | .80 | |
| 17 | | | 1.40 | | 2.10 | 1.90 | 1.40 | | |
| 18 | .70 | 1.05 | | | | | | .80 | |
| 19 | | | | | 2.20 | | 1.30 | | |
| 20 | | 1.05 | 1.40 | 1.55 | | | | | |
| 21 | | | | | 2.15 | | 1.25 | | |
| 22 | | | 1.45 | 1.60 | | 1.80 | | | |
| 23 | | 1.05 | | | | | | .75 | |
| 24 | | | 1.45 | 1.60 | | 1.80 | 1.20 | | |
| 25 | .70 | | | | | | | .70 | |
| 26 | | | | | 2.20 | | 1.15 | | |
| 27 | .75 | | 1.50 | 1.70 | | | | .70 | |
| 28 | | | | | | | 1.10 | | |
| 29 | | 1.25 | 1.50 | 1.65 | | 1.75 | | | |
| 30 | | | | | 2.20 | | | .65 | |
| 31 | | 1.30 | | 1.65 | | | 1.10 | | |

Station discontinued October 14.

## JORDAN RIVER.

Utah Lake discharges toward the north through Jordan River, which empties into Great Salt Lake. A number of large canals divert the waters of this stream and supply lands in Salt Lake County, one of them taking water to Salt Lake City. Measurements of the flow of Jordan River and the amount diverted into the canals have not been made systematically, owing largely to conservatism or distrust. When the hydrographic investigations were begun in 1889, an attempt was made on behalf of the Geological Survey to secure cooperation, or at least the sympathy of the persons interested, but there appeared to be a sentiment against obtaining records of this character, due possibly to the fear that private interests might be injured. There was a tacit agreement at least that it was better not to meddle with the systems in vogue. Even ten years later, when attempts were made by the city engineer to obtain weir measurements of the canals, these were opposed and the weirs destroyed. The conditions, however, have become so onerous that a private corporation has taken upon itself the measurement of the river, systematic observations being begun in May, 1899.

The plant of the Salt Lake City Water and Electrical Power Company was completed in 1899, and is developing electric power which is used in the mining camps of Bingham and Mercur, Utah. The plant is located on Jordan River, about 20 miles south of Salt Lake City and 9 miles below the outlet of Utah Lake. This water-power company has been keeping a record of the discharge of Jordan River and of the various canals diverting water immediately above, but on account of pending lawsuits the data are not at present available. The water necessary to develop the power of this plant is diverted from Utah and Salt Lake canal, which heads about 2 miles above the plant, at what is known as the Point of the Mountain. It is taken from the west side of the river, at the same diversion point where the East Jordan canal diverts water to the east side. When the power house is reached, an elevation of about 73 feet above the river has been attained by both canals, and this is the fall that is at present utilized. Halfway between the above-described dam and the power house there is a second dam across the river, from which two canals divert water—the City canal on the east side and the South Jordan canal on the west side. At the power plant, 1 mile below, these two canals have attained elevations of about 20 feet above the river. On December 6, 1899, measurements of the discharge of these canals, as well as of Jordan River, were made by Cyrus C. Babb at the gaging stations of the Salt Lake City Water and Electrical Power Company. Utah and Salt Lake canal below the power company's diversion, at a gage height of 2.40 feet, was discharging 27 second-feet; Utah and Salt Lake canal, above the power company's diversion, at a gage height of 4.13 feet, was dis-

charging 80 second-feet; the South Jordan canal, at a gage height of 2.33 feet, was discharging 19 second-feet; Jordan canal, at a gage height of 4.15 feet, was carrying 111 second-feet; City canal, at a gage height of 3.20 feet, was discharging 45 second-feet; East Jordan canal, with a gage height of 1.02 feet, was discharging 6 second-feet. A measurement was also made of the tailrace of the power plant, in order to compare it with the difference in the two measurements of Utah and Salt Lake canal, and a discharge of 56 second-feet was found.

The city engineer of Salt Lake City, Mr. Frank C. Kelsey, has been keeping a record of the discharge of various small streams in the vicinity of Salt Lake City, in connection with the city water supply. The following are the creeks, with the drainage areas in their respective canyons: Little Cottonwood Creek, 27.72 square miles; Big Cottonwood Creek, 48.47 square miles; Mill Creek, 21.29 square miles; Parleys Creek, 50.14 square miles; Emigration Creek, 18.92 square miles; Red Butte Creek, 11.59 square miles; City Creek, 19.15 square miles.

On Little Cottonwood Creek measurements are taken twice a day of the height of water passing over a Cippoletti weir 18 feet long. The record is from November 11, 1898, to May 20, 1899. At this latter date the weir was washed out by a flood and funds could not be procured to replace it.

The station on Big Cottonwood Creek is placed below the Utah Power Company's building. A record was commenced on October 30, 1898, the measurements being taken over a rectangular weir 16 feet long.

The measurements on Mill Creek were started September 8, 1898, and are made over a Cippoletti weir placed in the canyon. April 10, 1899, this weir was removed by the water master of the district, but was replaced on the 30th of the same month.

There is an interesting double Cippoletti weir on Parleys Creek, which is so controlled that the entire weir can be lifted, allowing the gravel and deposit from above to be washed out from time to time. The records from this point are fragmentary and were not obtained by this office.

*Daily mean discharge, in second-feet, of Little Cottonwood Creek near Salt Lake City, Utah, for 1898.*

[Drainage area, 27.72 square miles.]

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

*Daily mean discharge, in second-feet, of Little Cottonwood Creek near Salt Lake City, Utah. for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | Day. | Jan. | Feb. | Mar. | Apr. | May. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 12 | 13 | 13 | 52 | 17 | 10 | 12 | 13 | 50 | 121 |
| 2 | 12 | 12 | 12 | 14 | 48 | 18 | 12 | 12 | 13 | 53 | 121 |
| 3 | 12 | 11 | 11 | 13 | 46 | 19 | 13 | 12 | 13 | 50 | 120 |
| 4 | 12 | 10 | 10 | 14 | 44 | 20 | 13 | 12 | 13 | 46 | 120 |
| 5 | 13 | 9 | 10 | 14 | 44 | 21 | 12 | 12 | 13 | 48 | ..... |
| 6 | 12 | 9 | 13 | 13 | 48 | 22 | 12 | 11 | 12 | 54 | ..... |
| 7 | 13 | 11 | 12 | 14 | 47 | 23 | 11 | 12 | 13 | 54 | ..... |
| 8 | 14 | 12 | 12 | 15 | 53 | 24 | 12 | 12 | 13 | 64 | ..... |
| 9 | 12 | 9 | 13 | 18 | 65 | 25 | 12 | 12 | 14 | 64 | ..... |
| 10 | 12 | 9 | 12 | 23 | 72 | 26 | 12 | 12 | 14 | 63 | ..... |
| 11 | 12 | 11 | 12 | 30 | 92 | 27 | 12 | 12 | 13 | 61 | ..... |
| 12 | 12 | 11 | 12 | 34 | 119 | 28 | 12 | 12 | 13 | 55 | ..... |
| 13 | 12 | 13 | 12 | 41 | 146 | 29 | 12 | ..... | 13 | 52 | ..... |
| 14 | 12 | 12 | 12 | 41 | 149 | 30 | 12 | ..... | 13 | 51 | ..... |
| 15 | 12 | 12 | 12 | 46 | 135 | 31 | 12 | ..... | 13 | ..... | ..... |
| 16 | 11 | 12 | 12 | 51 | 120 | | | | | | |

May 21 weir washed out and not replaced.

*Daily mean discharge, in second-feet, of Big Cottonwood Creek near Salt Lake City, Utah, for 1898.*

[Drainage area, 48.47 square miles.]

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 34 | 36 | 12 | ..... | 31 | 26 | 22 | ..... | 35 | 19 |
| 2 | ..... | 34 | 36 | 13 | ..... | 33 | 30 | 23 | ..... | 33 | 20 |
| 3 | ..... | 36 | 30 | 14 | ..... | 32 | 30 | 24 | ..... | 35 | 16 |
| 4 | ..... | 36 | 30 | 15 | ..... | 32 | 21 | 25 | ..... | 31 | 19 |
| 5 | ..... | 35 | 33 | 16 | ..... | 33 | 21 | 26 | ..... | 31 | 18 |
| 6 | ..... | 35 | 32 | 17 | ..... | 31 | 22 | 27 | ..... | 31 | 21 |
| 7 | ..... | 34 | 31 | 18 | ..... | 34 | 21 | 28 | ..... | 33 | ..... |
| 8 | ..... | 35 | 29 | 19 | ..... | 33 | 20 | 29 | ..... | 37 | ..... |
| 9 | ..... | 27 | 31 | 20 | ..... | 30 | 21 | 30 | 34 | 36 | ..... |
| 10 | ..... | 30 | 29 | 21 | ..... | 32 | 19 | 31 | 33 | ..... | ..... |
| 11 | ..... | 32 | 26 | | | | | | | | |

*Daily mean discharge, in second-feet, of Big Cottonwood Creek near Salt Lake City, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 25 | 26 | 36 | 78 | 211 | 240 | 71 |
| 2 | ..... | 26 | 28 | 36 | 74 | 220 | 218 | 68 |
| 3 | ..... | 21 | 26 | 35 | 68 | 237 | 204 | 70 |
| 4 | ..... | 18 | 27 | 35 | 67 | 320 | 203 | 78 |
| 5 | ..... | 12 | 25 | 42 | 68 | 335 | 207 | 71 |
| 6 | ..... | 12 | 28 | 43 | 77 | 326 | 202 | 78 |
| 7 | ..... | 13 | 29 | 47 | 93 | 326 | 182 | 73 |
| 8 | ..... | 19 | 32 | 53 | 108 | 335 | 174 | 65 |
| 9 | ..... | 9 | 37 | 68 | 141 | 377 | 170 | 63 |
| 10 | ..... | 34 | 30 | 83 | 154 | 407 | 168 | 61 |
| 11 | ..... | 29 | 31 | 114 | 180 | 560 | 157 | 61 |
| 12 | ..... | 27 | 29 | 102 | 231 | 632 | 165 | 58 |
| 13 | ..... | 26 | 30 | 135 | 263 | 593 | 154 | 57 |
| 14 | ..... | 28 | 29 | 127 | 260 | 481 | 147 | 53 |
| 15 | 22 | 27 | 31 | 130 | 236 | 472 | 134 | 53 |
| 16 | 21 | 27 | 30 | 140 | 217 | 479 | 137 | 52 |
| 17 | 26 | 29 | 31 | 134 | 212 | 494 | 128 | ..... |
| 18 | 25 | 28 | 32 | 130 | 214 | 523 | 121 | ..... |
| 19 | 25 | 27 | 30 | 105 | 215 | 561 | 117 | ..... |
| 20 | 24 | 27 | 31 | 92 | 216 | 587 | 115 | ..... |
| 21 | 25 | 28 | 29 | 87 | 188 | 387 | 112 | ..... |
| 22 | 26 | 26 | 31 | 112 | 173 | 301 | 105 | ..... |
| 23 | 24 | 27 | 32 | 130 | 183 | 276 | 86 | ..... |
| 24 | 25 | 27 | 39 | 150 | 228 | 267 | 94 | ..... |
| 25 | 25 | 26 | 43 | 147 | 258 | 273 | 90 | ..... |
| 26 | 25 | 25 | 44 | 135 | 254 | 254 | 88 | ..... |
| 27 | 25 | 26 | 40 | 121 | 266 | 244 | 85 | ..... |
| 28 | 29 | 26 | 37 | 103 | 240 | 244 | 84 | ..... |
| 29 | 25 | ..... | 35 | 89 | 225 | 246 | 80 | ..... |
| 30 | 26 | ..... | 35 | 83 | 211 | 246 | 82 | ..... |
| 31 | 26 | ..... | 36 | ..... | 198 | ..... | 76 | ..... |

*Daily mean discharge, in second-feet, of Mill Creek near Salt Lake City, Utah, for 1898.*

[Drainage area, 21.29 square miles.]

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

*Daily mean discharge, in second-feet, of Mill Creek near Salt Lake City, Utah, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 12 | 12 | 12 | 24 | 35 | 36 | 20 | 17 | 12 | 14 |
| 2 | 12 | 12 | 12 | 13 | 26 | 38 | 34 | 20 | 17 | 12 | 14 |
| 3 | 13 | 12 | 12 | 13 | 25 | 41 | 32 | 20 | 17 | 12 | 14 |
| 4 | 12 | 5 | 12 | 13 | 24 | 46 | 32 | 20 | 17 | 12 | 14 |
| 5 | 12 | 3 | 12 | 14 | 23 | 60 | 32 | 19 | 17 | 12 | 14 |
| 6 | 12 | 3 | 12 | 15 | 25 | 51 | 30 | 19 | 17 | 12 | 14 |
| 7 | 12 | 3 | 12 | 15 | 27 | 46 | 30 | 19 | 17 | 12 | 14 |
| 8 | 12 | 7 | 12 | 22 | 31 | 53 | 27 | 19 | 17 | 14 | 14 |
| 9 | 12 | 8 | 13 | 22 | 36 | 55 | 27 | 19 | 17 | 14 | 14 |
| 10 | 12 | 12 | 12 | ..... | 31 | 55 | 27 | 18 | 17 | 14 | 14 |
| 11 | 12 | 12 | 12 | ..... | 39 | 57 | 27 | 18 | 17 | 14 | 14 |
| 12 | 12 | 12 | 12 | ..... | 43 | 60 | 25 | 18 | 15 | 14 | 13 |
| 13 | 12 | 12 | 12 | ..... | 47 | 66 | 25 | 18 | 15 | 14 | 13 |
| 14 | 12 | 12 | 12 | ..... | 47 | 66 | 25 | 18 | 15 | 14 | 13 |
| 15 | 12 | 12 | 12 | ..... | 42 | 62 | 25 | 18 | 15 | 14 | 13 |
| 16 | 12 | 12 | 12 | ..... | 40 | 59 | 25 | 18 | 15 | 14 | ..... |
| 17 | 12 | 12 | 12 | ..... | 38 | 66 | 25 | 18 | 15 | 14 | ..... |
| 18 | 12 | 12 | 12 | ..... | 40 | 60 | 25 | 18 | 15 | 14 | ..... |
| 19 | 12 | 12 | 12 | ..... | 40 | 56 | 25 | 18 | 15 | 14 | ..... |
| 20 | 12 | 12 | 12 | ..... | 35 | 56 | 25 | 18 | 15 | 14 | ..... |
| 21 | 12 | 12 | 12 | ..... | 32 | 56 | 25 | 18 | 15 | 14 | ..... |
| 22 | 12 | 12 | 12 | ..... | 33 | 48 | 22 | 18 | 15 | 14 | ..... |
| 23 | 8 | 12 | 12 | ..... | 35 | 46 | 22 | 18 | 15 | 14 | ..... |
| 24 | 12 | 12 | 12 | ..... | 37 | 45 | 22 | 17 | 15 | 14 | ..... |
| 25 | 12 | 12 | 14 | ..... | 37 | 41 | 22 | 17 | 15 | 14 | ..... |
| 26 | 12 | 12 | 15 | ..... | 41 | 40 | 22 | 17 | 15 | 14 | ..... |
| 27 | 12 | 12 | 14 | ..... | 42 | 38 | 21 | 17 | 15 | 14 | ..... |
| 28 | 12 | 12 | 13 | ..... | 40 | 37 | 21 | 17 | 15 | 18 | ..... |
| 29 | 12 | ..... | 13 | ..... | 42 | 40 | 21 | 17 | 15 | 18 | ..... |
| 30 | 12 | ..... | 12 | 25 | 36 | 40 | 20 | 17 | 15 | 18 | ..... |
| 31 | 12 | ..... | 13 | ..... | 34 | ..... | 20 | 17 | ..... | 18 | ..... |

April 10 weir removed by water master; replaced April 30.

## GREAT SALT LAKE.

Streams that contribute water to this lake have their sources in the Wasatch Mountains. The lake is very shallow, not averaging 20 feet, while the deepest point is only 60 feet. The western and eastern shores slope very gradually, and the fall of a foot will expose many square miles, while a rise of 6 feet would cover nearly one-tenth more area. At ordinary stages the area of the lake itself is about 2,280 square miles. A record of the fluctuations of the surface has been maintained since 1875, and they are published below, referred to Garfield Beach gage. The table published in the Thirteenth Annual Report, Part III, page 20, refers to the shore gage, which datum is 4.6 feet above Garfield Beach gage. A further description of the fluctuations of this lake will be found in Monograph I of the United States Geological Survey, entitled Lake Bonneville, by G. K. Gilbert, pages 233 to 238.

*Gage heights of Great Salt Lake, referred to Garfield Beach gage.*

| Date. | Gage height. |
|---|---|
| 1875. | *Feet.* |
| September 14 | 10.4 |
| September 22 | 10.3 |
| September 25 | 10.3 |
| October 6 | 10.2 |
| October 12 | 10.2 |
| October 18 | 10.2 |
| October 26 | 10.1 |
| November 9 | 10.0 |
| November 16 | 10.0 |
| November 23 | 10.2 |
| November 29 | 10.3 |
| December 7 | 10.3 |
| December 14 | 10.3 |
| December 21 | 10.4 |
| 1876. | |
| January 5 | 10.5 |
| January 11 | 10.6 |
| January 29 | 10.6 |
| February 1 | 10.6 |
| February 15 | 10.7 |
| February 22 | 10.7 |
| March 15 | 10.8 |
| March 22 | 10.9 |
| March 28 | 10.9 |
| April 17 | 11.0 |
| April 25 | 11.1 |
| May 2 | 11.2 |
| May 22 | 11.6 |
| June 2 | 11.8 |
| June 8 | 11.9 |
| June 13 | 12.0 |
| June 23 | 12.2 |
| June 30 | 12.4 |
| July 18 | 12.1 |
| July 25 | 12.2 |
| August 1 | 12.1 |
| August 10 | 12.0 |
| August 22 | 11.6 |
| August 29 | 11.5 |
| August 30 | 11.5 |
| September 14 | 11.5 |
| September 19 | 11.4 |
| September 26 | 11.4 |
| October 9 | 11.3 |
| 1877. | |
| July 12 | 12.9 |
| October 19 | 11.7 |
| November 24 | 10.4 |
| 1878. | |
| January 21 | 10.5 |
| March 28 | 10.6 |
| May— | 10.8 |
| June 30 | 10.9 |
| July 18 | 10.7 |
| November 1 | 9.4 |
| December 11 | 9.3 |
| 1879. | |
| May 2 | 9.6 |
| November 19 | 7.1 |
| December 2 | 7.1 |
| December 16 | 7.2 |
| December 31 | 7.3 |
| 1880. | |
| January 14 | 7.4 |
| January 29 | 7.2 |
| February 23 | 7.2 |
| March 10 | 7.4 |
| March 30 | 7.4 |
| April 15 | 7.5 |
| April 28 | 7.6 |
| May 12 | 7.7 |
| May 26 | 7.9 |
| June 10 | 7.9 |
| June 28 | 8.0 |
| 1880—Continued. | *Feet.* |
| July 13 | 7.9 |
| July 30 | 7.7 |
| August 14 | 7.5 |
| August 29 | 7.3 |
| September 14 | 7.0 |
| September 29 | 6.8 |
| October 15 | 6.6 |
| October 29 | 6.5 |
| November 12 | 6.3 |
| November 29 | 6.3 |
| December 11 | 6.3 |
| December 14 | 6.3 |
| December 27 | 6.4 |
| 1881. | |
| January 14 | 6.4 |
| January 28 | 6.8 |
| February 14 | 7.1 |
| February 28 | 7.1 |
| March 14 | 7.2 |
| April 1 | 7.2 |
| April 16 | 7.3 |
| May 1 | 7.6 |
| May 16 | 7.9 |
| June 1 | 8.0 |
| June 16 | 8.0 |
| July 1 | 7.8 |
| July 16 | 7.8 |
| July 23 | 7.7 |
| August 2 | 7.5 |
| August 19 | 7.3 |
| September 8 | 7.0 |
| September 16 | 7.9 |
| October 2 | 6.7 |
| October 16 | 6.7 |
| November 2 | 6.6 |
| November 16 | 6.6 |
| December 1 | 6.6 |
| December 15 | 6.7 |
| 1882. | |
| January 2 | 6.7 |
| January 16 | 6.8 |
| February 2 | 6.8 |
| February 16 | 6.9 |
| March 2 | 6.9 |
| March 21 | 7.0 |
| April 1 | 7.2 |
| April 16 | 7.2 |
| May 2 | 7.4 |
| May 16 | 7.5 |
| June 2 | 7.5 |
| June 16 | 7.5 |
| July 2 | 7.3 |
| July 17 | 7.2 |
| August 2 | 7.0 |
| August 15 | 6.8 |
| September 2 | 6.4 |
| September 16 | 6.2 |
| October 2 | 6.1 |
| October 15 | 6.0 |
| December 15 | 6.0 |
| December 30 | 6.0 |
| 1883. | |
| January 15 | 6.0 |
| January 30 | 6.0 |
| February 15 | 6.1 |
| February 30 | 6.1 |
| March 15 | 6.1 |
| April 2 | 6.3 |
| September 3 | 6.5 |
| September 16 | 6.1 |
| October 3 | 5.6 |
| October 15 | 5.4 |
| November 1 | 5.2 |
| November 15 | 5.0 |
| December 2 | 5.0 |
| December 15 | 5.0 |

*Gage heights of Great Salt Lake, referred to Garfield Beach gage*—Continued.

| Date. | Gage height. |
|---|---|
| 1884. | *Feet.* |
| January 2 | 5.0 |
| January 15 | 5.0 |
| February 2 | 5.0 |
| February 15 | 5.1 |
| March 1 | 5.2 |
| March 15 | 5.5 |
| April 1 | 5.6 |
| April 15 | 5.9 |
| May 2 | 6.2 |
| May 15 | 6.5 |
| June 1 | 7.0 |
| June 15 | 7.2 |
| July 1 | 7.4 |
| July 15 | 7.4 |
| August 2 | 7.2 |
| August 15 | 7.0 |
| September 1 | 7.0 |
| September 15 | 7.0 |
| October 2 | 7.0 |
| October 15 | 6.9 |
| November 1 | 6.9 |
| November 15 | 6.8 |
| December 2 | 6.8 |
| December 15 | 6.9 |
| 1885. | |
| January 2 | 7.1 |
| January 15 | 7.2 |
| February 2 | 7.3 |
| February 16 | 7.4 |
| March 2 | 7.5 |
| March 16 | 7.7 |
| April 3 | 7.8 |
| April 16 | 7.9 |
| May 2 | 8.1 |
| May 15 | 8.2 |
| June 1 | 8.5 |
| June 16 | 8.7 |
| July 2 | 8.8 |
| July 15 | 8.8 |
| August 2 | 8.6 |
| August 15 | 8.6 |
| September 2 | 8.2 |
| September 15 | 8.0 |
| October 2 | 8.0 |
| October 15 | 7.9 |
| November 1 | 7.9 |
| November 15 | 7.7 |
| December 2 | 7.7 |
| December 15 | 7.9 |
| 1886. | |
| January 2 | 8.0 |
| January 15 | 8.1 |
| February 2 | 8.3 |
| February 15 | 8.4 |
| March 2 | 8.6 |
| March 15 | 8.7 |
| April 1 | 8.8 |
| April 15 | 8.9 |
| May 2 | 9.0 |
| May 15 | 9.1 |
| June 2 | 9.2 |
| July 29 | 8.8 |
| October 2 | 8.2 |
| November 6 | 8.0 |
| December 28 | 8.2 |
| 1887. | |
| February 5 | 8.1 |
| March 5 | 8.3 |
| March 19 | 8.4 |
| April 2 | 8.4 |
| April 16 | 8.5 |
| May 7 | 8.4 |
| May 22 | 8.7 |
| May 30 | 8.7 |
| June 10 | 8.7 |
| June 22 | 8.6 |
| July 4 | 8.5 |
| 1887—Continued. | *Feet.* |
| July 14 | 8.4 |
| August 6 | 8.1 |
| September 5 | 7.7 |
| September 20 | 7.3 |
| October 4 | 7.3 |
| October 25 | 7.1 |
| November 11 | 7.1 |
| 1888. | |
| January 1 | 7.1 |
| January 10 | 7.2 |
| February 1 | 7.2 |
| February 24 | 7.3 |
| March 3 | 7.3 |
| March 23 | 7.5 |
| April 6 | 7.6 |
| May 8 | 7.4 |
| May 30 | 7.5 |
| June 22 | 7.3 |
| July 3 | 7.1 |
| July 23 | 6.8 |
| August 1 | 6.7 |
| August 16 | 7.5 |
| September 1 | 6.3 |
| September 15 | 6.1 |
| October 1 | 5.9 |
| November 1 | 5.4 |
| November 10 | 5.6 |
| December 10 | 5.6 |
| 1889. | |
| January 1 | 5.6 |
| January 15 | 5.6 |
| February 1 | 5.7 |
| February 15 | 5.8 |
| March 1 | 6.0 |
| March 25 | 6.1 |
| April 15 | 6.8 |
| May 1 | 5.9 |
| May 20 | 5.8 |
| June 1 | 5.7 |
| June 25 | 5.4 |
| July 12 | 4.9 |
| August 10 | 4.5 |
| August 30 | 4.1 |
| September 23 | 3.6 |
| October 12 | 3.6 |
| December 14 | 3.7 |
| 1890. | |
| January 4 | 3.8 |
| February 1 | 4.2 |
| February 15 | 4.3 |
| March 6 | 4.5 |
| March 28 | 4.8 |
| April 15 | 4.8 |
| May 6 | 5.3 |
| June 14 | 5.6 |
| June 27 | 5.6 |
| July 17 | 5.4 |
| August 2 | 5.2 |
| August 12 | 4.9 |
| September 11 | 4.6 |
| October 13 | 4.2 |
| November 5 | 4.2 |
| December 12 | 4.2 |
| 1891. | |
| January 5 | 4.3 |
| January 30 | 4.3 |
| February 18 | 4.3 |
| March 2 | 4.6 |
| March 16 | 4.6 |
| April 2 | 4.7 |
| April 15 | 4.7 |
| May 1 | 4.9 |
| June 2 | 5.0 |
| August 15 | 4.3 |
| September 9 | 4.3 |
| September 19 | 3.9 |

*Gage heights of Great Salt Lake, referred to Garfield Beach gage*—Continued.

| Date. | Gage height. |
|---|---|
| 1891—Continued. | *Feet.* |
| October 5 | 3.9 |
| October 17 | 3.8 |
| November 2 | 3.9 |
| November 18 | 3.8 |
| December 1 | 3.8 |
| December 16 | 3.8 |
| 1892. | |
| January 1 | 3.8 |
| 1893. | |
| January 1 | 3.2 |
| January 14 | 3.3 |
| January 30 | 3.4 |
| February 14 | 3.5 |
| February 28 | 3.5 |
| March 14 | 3.7 |
| March 30 | 3.9 |
| April 14 | 4.1 |
| April 29 | 4.3 |
| May 13 | 4.5 |
| May 29 | 4.5 |
| June 15 | 4.5 |
| July 1 | 4.3 |
| July 15 | 4.2 |
| July 31 | 3.5 |
| August 15 | 3.3 |
| August 30 | 3.3 |
| September 15 | 3.0 |
| September 30 | 2.8 |
| October 1 | 2.5 |
| 1894. | |
| January 3 | 3.0 |
| January 30 | 3.2 |
| February 14 | 3.1 |
| February 28 | 3.1 |
| March 14 | 3.3 |
| March 31 | 3.6 |
| April 14 | 3.8 |
| April 30 | 4.0 |
| May 31 | 4.5 |
| August 16 | 3.8 |
| October 1 | 3.4 |
| November 1 | 3.1 |
| 1896. | |
| January 1 | 2.3 |
| February 1 | 2.5 |
| March 1 | 2.6 |
| April 1 | 2.8 |
| May 1 | 2.8 |
| June 1 | 3.3 |
| July 1 | 3.3 |
| August 1 | 2.8 |
| September 1 | 2.4 |
| October 1 | 2.2 |
| November 1 | 1.9 |
| December 1 | 2.0 |
| 1897. | |
| January 1 | 2.3 |
| January 15 | 2.4 |
| February 1 | 2.5 |
| February 15 | 2.6 |
| March 1 | 2.8 |
| March 15 | 2.9 |
| April 1 | 3.1 |
| 1897—Continued. | *Feet.* |
| April 15 | 3.2 |
| May 1 | 3.4 |
| May 15 | 3.6 |
| June 1 | 3.8 |
| June 15 | 3.7 |
| July 1 | 3.5 |
| July 15 | 3.3 |
| August 1 | 3. |
| August 15 | 2.7 |
| September 1 | 2.7 |
| September 15 | 2.3 |
| October 1 | 2.2 |
| October 15 | 2.2 |
| November 1 | 2. |
| November 15 | 2. |
| December 1 | 2.1 |
| December 15 | 2.2 |
| 1898. | |
| January 1 | 2.3 |
| January 15 | 2.4 |
| February 1 | 2.4 |
| February 15 | 2.5 |
| March 1 | 2.7 |
| March 15 | 2.8 |
| April 1 | 2.9 |
| April 15 | 3.1 |
| May 1 | 3.2 |
| May 15 | 3.3 |
| June 1 | 3.4 |
| June 15 | 3.3 |
| July 1 | 3.3 |
| July 15 | 3.1 |
| August 1 | 2.8 |
| August 15 | 2.6 |
| September 1 | 2.2 |
| September 15 | 1.9 |
| October 1 | 1.8 |
| October 15 | 1.7 |
| November 1 | 1.5 |
| November 15 | 1.4 |
| December 1 | 1.3 |
| December 15 | 1.3 |
| 1899. | |
| January 1 | 1.4 |
| January 15 | 1.5 |
| February 1 | 1.7 |
| February 15 | 1.8 |
| March 1 | 2.0 |
| March 15 | 2.1 |
| April 1 | 2.3 |
| April 15 | 2.3 |
| May 1 | 2.4 |
| May 15 | 2.6 |
| June 1 | 2.7 |
| June 15 | 2.8 |
| July 1 | 2.7 |
| July 15 | 2.6 |
| August 1 | 2.3 |
| August 15 | 2.1 |
| September 1 | 2.0 |
| September 15 | 1.8 |
| October 1 | 1.7 |
| October 15 | 1.6 |
| November 1 | 1.7 |
| November 15 | 1.6 |
| December 1 | 1.4 |
| December 15 | 1.4 |

## SNAKE RIVER AT GROVANT, WYOMING.

This river rises on the southern slope of the Continental Divide, in the Yellowstone National Park, draining the country west and southwest of Yellowstone Lake. From Shoshone, Lewes, and Heart lakes, near its head, the river flows in a southerly direction through a timbered and mountainous country, resulting in a long period of high water. After continuing through this area for about 20 miles it broadens into Jackson Lake, a deep body of water about 3 miles wide and 8 miles long. Below the lake the river flows through Jackson Hole Valley—about 40 miles long and 8 miles wide—and then enters a long canyon near the Idaho-Wyoming line. All of the large tributaries come from the east, receiving their waters from the Wind River Range. The west side of the valley is bounded by the high Teton Mountains, from which most of the drainage flows westward through Teton River into North Fork of Snake River.

This area has been mapped in part by T. M. Bannon, who states that about 8,000 acres can be irrigated in Jackson Hole Valley. To do this will necessitate the construction of five or six canals, owing to the position of the agricultural lands. The small area now irrigated is watered by ditches, usually constructed by individuals and at little cost beyond the labor. Cultivation is confined to small gardens and forage crops, the latter for winter feed of the stock that range in the country during the summer season. During the winter the snow is so deep that the cattle must be fed for from three to five months.

The river station at Grovant was established April 2, 1899, by T. M. Bannon, at Menors Ferry, the location being shown on the Grand Teton atlas sheet. A bench mark is located near Mr. Menor's house, west of the gage rod. The elevation of the bench mark is 6,457.864 feet above sea level. The 5-foot mark on the gage rod is at an elevation of 6,448.483 feet. The channel above and below the ferry is straight and the bank sufficiently high to confine flood waters, this being about the only place of this kind in the valley. The bed of the stream is of gravel. The place is most readily reached by hired conveyance from St. Anthony, Idaho. The road crosses the North Fork of Snake River and the Teton River at the lower end of Teton Basin. Measurements can readily be made at these localities, particularly at the latter, where there is a stage station.

No measurements of discharge were made at this point during 1899.

*Daily gage height, in feet, of Snake River at Grovant, Wyoming, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|
| 1 | ..... | 0.44 | 2.75 | 6.66 | 2.75 | 0.75 | 0.25 |
| 2 | 0.02 | .40 | 2.83 | 6.58 | 2.50 | .75 | .25 |
| 3 | .04 | .33 | 3.00 | 6.42 | 2.50 | .75 | .25 |
| 4 | .08 | .35 | 3.42 | 6.25 | 2.42 | .75 | .25 |
| 5 | .10 | .42 | 3.58 | 6.17 | 2.33 | .75 | .17 |
| 6 | .10 | .44 | 3.42 | 6.00 | 2.25 | .67 | .17 |
| 7 | .10 | .50 | 3.33 | 5.92 | 2.17 | .67 | .17 |
| 8 | .13 | .60 | 3.33 | 5.83 | 2.08 | .67 | .17 |
| 9 | .15 | .83 | 3.50 | 5.75 | 2.17 | .67 | .17 |
| 10 | .13 | .92 | 3.75 | 5.58 | 2.08 | .67 | .17 |
| 11 | .13 | 1.17 | 4.08 | 5.50 | 2.00 | .58 | .17 |
| 12 | .17 | 1.08 | 4.50 | 5.33 | 1.92 | .58 | .13 |
| 13 | .25 | 1.17 | 4.50 | 5.50 | 1.83 | .58 | .13 |
| 14 | .25 | 1.25 | 4.25 | 5.42 | 1.75 | .58 | .13 |
| 15 | .25 | 1.33 | 4.33 | 5.17 | 1.67 | .58 | .17 |
| 16 | .25 | 1.42 | 4.67 | 4.83 | 1.58 | .50 | .17 |
| 17 | .23 | 1.42 | 5.08 | 4.67 | 1.50 | .50 | .21 |
| 18 | .21 | 1.50 | 5.75 | 4.50 | 1.42 | .50 | .21 |
| 19 | .21 | 1.67 | 6.25 | 4.33 | 1.33 | .50 | .25 |
| 20 | .19 | 1.83 | 6.75 | 4.25 | 1.33 | .42 | .25 |
| 21 | .23 | 1.83 | 6.83 | 4.17 | 1.25 | .42 | .29 |
| 22 | .21 | 1.83 | 6.50 | 4.17 | 1.25 | .42 | ..... |
| 23 | .23 | 1.75 | 6.25 | 4.00 | 1.17 | .42 | ..... |
| 24 | .38 | 1.83 | 6.25 | 3.67 | 1.17 | .42 | ..... |
| 25 | .52 | 2.08 | 6.13 | 3.42 | 1.08 | .42 | ..... |
| 26 | .58 | 2.33 | 6.34 | 3.25 | 1.00 | .42 | ..... |
| 27 | .54 | 2.42 | 6.41 | 3.17 | .92 | .33 | ..... |
| 28 | .46 | 2.50 | 6.41 | 3.17 | .92 | .33 | ..... |
| 29 | .44 | 2.67 | 6.63 | 3.00 | .83 | .33 | ..... |
| 30 | .42 | 2.83 | 6.75 | 3.00 | .83 | .33 | ..... |
| 31 | ..... | 2.75 | ..... | 2.92 | .75 | ..... | ..... |

Closed for winter October 21.

## PORTNEUF RIVER AT POCATELLO, IDAHO.

This river is a tributary of Snake River, and rises in southeastern Idaho, its headwater tributaries draining the area immediately west of those of Blackfoot River. Its basin is almost wholly included within the Fort Hall Indian Reservation. There is little agricultural country along its course until Pocatello is reached, where the valley broadens to a considerable extent. This river will probably not be developed for irrigation purposes by private capital until the reservation is thrown open for settlement. The gaging station at Pocatello was established May 8, 1897, and is located at the wagon bridge one-eighth of a mile below the plant of the Pocatello Electric Power Company. The rod is vertical and is securely spiked to the west abutment of the bridge. The bench mark is a spike driven into the end of a log on the east abutment of the bridge, and is opposite the 13-foot mark. The channel above the station is curved, while below it is straight. The right bank is high, but the left is liable to overflow at a 12-foot gage height. The bed of the stream is rocky. The results of measurements may be found as follows: 1897–98, Twentieth Annual Report, Part IV, page 474. The following discharge measurements were made by F. S. Shirley and N. S. Dils during 1899:

March 30, gage height, 8 feet; discharge, 368 second-feet.
May 22, gage height, 9.10 feet; discharge, 614 second-feet.
June 25, gage height, 8.90 feet; discharge, 558 second-feet.
July 28, gage height, 7 feet; discharge, 123 second-feet.
August 27, gage height, 7.05 feet; discharge, 129 second-feet.

*Daily gage height, in feet, of Portneuf River at Pocatello, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.60 | 7.40 | 7.30 | 7.75 | 8.55 | 9.50 | 8.00 | (a) | 6.80 | 7.00 |
| 2 | 7.60 | 7.30 | 7.30 | 7.80 | 8.55 | 9.50 | 8.00 | (a) | 6.70 | 7.00 |
| 3 | 7.60 | 7.30 | 7.30 | 7.80 | 8.50 | 9.55 | 8.10 | (a) | 6.70 | 7.00 |
| 4 | 7.50 | 7.30 | 7.30 | 7.80 | 8.50 | 9.55 | 8.00 | (a) | 6.90 | 7.00 |
| 5 | 7.50 | 7.30 | 7.30 | 7.95 | 8.55 | 9.60 | 8.00 | (a) | 7.00 | 7.00 |
| 6 | 7.50 | 7.30 | 7.30 | 8.00 | 8.45 | 9.65 | 7.90 | (a) | 7.15 | 7.00 |
| 7 | 7.50 | 7.30 | 7.40 | 8.00 | 8.55 | 9.60 | 8.00 | (a) | 7.20 | 7.00 |
| 8 | 7.50 | 7.40 | 7.40 | 8.15 | 8.70 | 9.55 | 8.00 | (a) | 7.25 | 7.20 |
| 9 | 7.50 | 7.50 | 7.50 | 8.35 | 8.85 | 9.40 | 8.00 | (a) | 7.20 | 7.20 |
| 10 | 7.50 | 7.60 | 7.50 | 8.50 | 9.15 | 9.40 | 8.00 | (a) | 7.20 | 7.20 |
| 11 | 7.50 | 7.60 | 7.50 | 8.50 | 9.40 | 9.45 | 8.10 | (a) | 7.10 | 7.20 |
| 12 | 7.50 | 7.50 | 7.50 | 8.60 | 9.80 | 9.30 | 8.10 | (a) | 7.00 | 7.20 |
| 13 | 7.50 | 7.40 | 7.50 | 8.60 | 9.75 | 9.40 | 8.10 | (a) | 7.00 | 7.20 |
| 14 | 7.50 | 7.30 | 7.50 | 8.70 | 9.50 | 9.35 | 7.80 | (a) | 7.00 | 7.20 |
| 15 | 7.50 | 7.40 | 7.50 | 8.55 | 9.70 | 9.15 | 6.70 | (a) | 7.20 | ..... |
| 16 | 7.60 | 7.50 | 7.50 | 8.55 | (a) | 9.05 | 7.80 | (a) | 7.00 | ..... |
| 17 | 7.60 | 7.60 | 7.50 | 8.60 | (a) | 9.10 | 8.00 | (a) | 7.00 | ..... |
| 18 | 7.50 | 7.70 | 7.50 | 8.55 | (a) | 9.00 | 8.00 | (a) | 7.00 | ..... |
| 19 | 7.40 | 7.70 | 7.50 | 8.55 | (a) | 9.15 | 7.20 | (a) | 6.90 | ..... |
| 20 | 7.40 | 7.60 | 7.50 | 8.40 | (a) | 9.25 | 7.00 | (a) | 6.90 | ..... |
| 21 | 7.40 | 7.50 | 7.50 | 8.25 | (a) | 9.28 | 7.20 | (a) | 6.90 | ..... |
| 22 | 7.60 | 7.40 | 7.50 | 8.40 | 9.20 | 9.00 | 7.40 | (a) | 6.90 | ..... |
| 23 | 7.70 | 7.30 | 7.50 | 8.50 | 8.90 | 9.00 | 7.30 | (a) | 6.90 | ..... |
| 24 | 7.60 | 7.40 | 7.50 | 8.60 | 9.00 | 8.95 | 6.80 | (a) | 7.00 | ..... |
| 25 | 7.60 | 7.30 | 7.50 | 8.75 | 9.05 | 8.50 | 7.10 | (a) | 7.00 | ..... |
| 26 | 7.60 | 7.30 | 7.80 | 8.80 | 9.00 | 8.40 | 7.20 | (a) | 7.00 | ..... |
| 27 | 7.50 | 7.30 | 7.40 | 8.80 | 9.10 | 8.60 | 7.20 | 6.80 | 7.00 | ..... |
| 28 | 7.50 | 7.30 | 8.20 | 8.75 | 9.20 | 8.70 | 7.10 | 6.90 | 7.00 | ..... |
| 29 | 7.50 | ..... | 7.90 | 8.55 | 9.25 | 8.60 | 7.20 | 6.85 | 7.00 | ..... |
| 30 | 7.50 | ..... | 7.80 | 8.65 | 9.45 | 8.10 | 7.20 | 6.90 | 7.00 | ..... |
| 31 | 7.40 | ..... | 7.80 | ..... | 9.45 | ..... | ..... | 6.80 | ..... | ..... |

*a* No reading. Station discontinued October 14.

## SNAKE RIVER AT MONTGOMERY FERRY, IDAHO.

This river passes from Wyoming into Idaho through a long and inaccessible canyon in the Snake River Range. Its north fork has its source in Henry Lake, in the Rocky Mountain divide, in the northeastern corner of Idaho, and flows southerly, entering the main stream near Idaho Falls. In the vicinity of Market Lake and Idaho Falls there is a large area of land under cultivation, irrigated from canals heading on Snake River and its smaller tributaries. Ten miles above the gaging station at Montgomery Ferry occurs a natural dam site, from which, as a starting point, surveys for canal lines have been run, covering the large extent of rolling country susceptible of irrigation on both sides of the river. This is a feasible project which up to the present time has not been utilized. Measurements at Montgomery Ferry show the amount of water available for irrigation purposes there, and also the amount that could be developed for power purposes at Shoshone Falls, about 45 miles below. The station, established August 5, 1895, is located at Montgomery Ferry, on the stage road from Minidoka to Albion. The gage is inclined and fastened to posts set in the ground. The bench mark is the head of a spike in the east post of the tool house, 1.2 feet above the ground and 52 feet west of the gage. Its elevation is 17.50 feet above gage datum. The letters "B. M." are marked in black paint on the post. The river is 800 feet wide at this section, with a hard gravel bottom not subject to change. When the

station was visited by N. S. Dils on October 14, 1899, a comparison was made of the gage rod with the bench mark, and it was found that the rod had moved to a considerable extent, due to the action of the quicksand on the inclined portion of the rod. The heights as recorded by the observer, as well as the discharge measurements, have been corrected. The rod is inclined from zero to 6.5 feet, and is vertical above this latter elevation. The lower portion is fastened at various intervals to posts driven into the ground. Owing to its considerable length the rod has not moved uniformly, and the corrections, therefore, are not in a constant ratio. From zero to 2.5 feet the correction to the gage heights is below one-tenth of a foot; from 2.6 to 3.7 feet, one-tenth of a foot should be added to the gage heights; from 3.8 to 4.9 feet, as the correction is below one-tenth of a foot it is negligible; from 5.0 feet to 6.5 feet the correction varies from 0.2 foot to 0.4 foot. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 335; 1897, Nineteenth Annual Report, Part IV, page 447; 1898, Twentieth Annual Report, Part IV, page 474. The following measurements of discharge were made by F. S. Shirley and N. S. Dils during 1899:

March 29, gage height, 3.04 feet; discharge, 5,688 second-feet.
May 23, gage height, 6.40 feet; discharge, 16,587 second-feet.
June 27, gage height, 10.70 feet; discharge, 35,718 second-feet.
July 29, gage height, 6.10 feet; discharge, 15,012 second-feet.
August 28, gage height, 3.68 feet; discharge, 7,292 second-feet.
October 14, gage height, 3.15 feet; discharge, 5,911 second-feet.

*Daily gage height, in feet, of Snake River at Montgomery Ferry, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.40 | 2.85 | 2.95 | 2.90 | 4.30 | 7.35 | 10.50 | 5.65 | 3.60 | 3.05 |
| 2 | 3.45 | 2.80 | 3.00 | 2.95 | 4.10 | 7.40 | 10.70 | 5.50 | 3.55 | 3.05 |
| 3 | 3.50 | 2.85 | 2.90 | 2.95 | 4.05 | 7.40 | 10.80 | 5.30 | 3.50 | 3.05 |
| 4 | 3.35 | 3.80 | 2.80 | 2.85 | 4.05 | 7.55 | 10.60 | 5.00 | 3.40 | 3.05 |
| 5 | 3.35 | 3.95 | 2.75 | 2.90 | 3.90 | 7.75 | 10.50 | 4.85 | 3.40 | 3.05 |
| 6 | 3.35 | 3.85 | 2.55 | 2.85 | 3.80 | 8.05 | 10.45 | 4.85 | 3.40 | 3.05 |
| 7 | 3.40 | 3.70 | 2.75 | 2.80 | 3.70 | 8.45 | 10.25 | 4.75 | 3.30 | 3.05 |
| 8 | 3.40 | 3.55 | 2.75 | 2.80 | 3.70 | 8.65 | 10.00 | 4.75 | 3.30 | 3.10 |
| 9 | 3.40 | 3.35 | 2.70 | 2.75 | 3.80 | 8.35 | 9.85 | 4.65 | 3.30 | 3.10 |
| 10 | 3.40 | 3.15 | 2.90 | 2.75 | 4.10 | 8.05 | 9.55 | 4.55 | 3.25 | 3.10 |
| 11 | 3.30 | 3.00 | 2.85 | 2.80 | 4.45 | 7.75 | 9.30 | 4.55 | 3.20 | 3.15 |
| 12 | 3.30 | 2.90 | 2.85 | 2.80 | 5.40 | 7.95 | 9.05 | 4.45 | 3.20 | 3.15 |
| 13 | 3.45 | 3.05 | 2.80 | 2.85 | 6.05 | 8.30 | 8.85 | 4.45 | 3.20 | 3.15 |
| 14 | 3.55 | 3.20 | 2.85 | 3.00 | 6.40 | 8.80 | 8.65 | 4.35 | 3.20 | 3.15 |
| 15 | 3.65 | 3.45 | 2.85 | 3.00 | 6.80 | 9.10 | 8.60 | 4.25 | 3.10 | 3.15 |
| 16 | 3.75 | 3.80 | 2.80 | 3.10 | 6.65 | 9.15 | 8.55 | 4.15 | 3.10 | ..... |
| 17 | 3.90 | 3.75 | 2.85 | 3.35 | 6.60 | 8.80 | 8.45 | 4.15 | 3.10 | ..... |
| 18 | 4.15 | 3.85 | 2.90 | 3.25 | 6.65 | 8.65 | 8.30 | 4.05 | 3.10 | ..... |
| 19 | 4.25 | 2.95 | 2.90 | 3.55 | 6.50 | 8.85 | 8.10 | 3.95 | 3.00 | ..... |
| 20 | 4.25 | 2.55 | 2.90 | 3.50 | 6.20 | 9.35 | 7.70 | 3.95 | 3.05 | ..... |
| 21 | 4.50 | 2.75 | 2.90 | 3.50 | 6.20 | 9.95 | 7.45 | 3.85 | 3.10 | ..... |
| 22 | 4.50 | 2.85 | 2.90 | 3.40 | 6.35 | 10.35 | 7.25 | 3.80 | 3.10 | ..... |
| 23 | 4.50 | 2.80 | 2.85 | 3.30 | 6.40 | 10.75 | 7.05 | 3.80 | 3.10 | ..... |
| 24 | 4.35 | 2.70 | 2.90 | 3.20 | 6.25 | 11.05 | 6.80 | 3.80 | 3.10 | ..... |
| 25 | 4.35 | 2.70 | 2.90 | 3.30 | 6.10 | 11.20 | 6.75 | 3.80 | 3.10 | ..... |
| 26 | 3.85 | 2.70 | 3.00 | 3.65 | 6.10 | 10.90 | 6.65 | 3.80 | 3.10 | ..... |
| 27 | 3.20 | 2.45 | 3.00 | 3.95 | 6.45 | 10.55 | 6.50 | 3.80 | 3.10 | ..... |
| 28 | 2.95 | 2.85 | 3.00 | 4.30 | 6.65 | 10.40 | 6.35 | 3.68 | 3.08 | ..... |
| 29 | 2.75 | ..... | 3.00 | 4.65 | 7.10 | 10.40 | 6.15 | 3.65 | 3.05 | ..... |
| 30 | 2.70 | ..... | 3.00 | 4.50 | 7.20 | 10.40 | 5.90 | 3.60 | 3.05 | ..... |
| 31 | 3.00 | ..... | 3.00 | ..... | 7.25 | ..... | 5.80 | 3.60 | ..... | ..... |

Station discontinued October 15.

## LITTLE WOOD RIVER AT TOPONIS, IDAHO.

The headwater tributaries of this river drain a country adjoining those of Malade River on the east. It enters Snake River Desert and the lava area on its appearance from its mountainous basin. Irrigation is practiced along its course to such an extent that on the lower reaches the river is dry during the summer period. A measurement on this river at Shoshone, made by N. S. Dils on August 29, 1899, showed a discharge of 71 second-feet. At this time the gage at Toponis showed a discharge of 9 second-feet. The station was established June 2, 1896, and is located at the highway bridge one-half mile south of the railroad. The rod of the old wire gage was fastened to the floor of the bridge, but it was replaced March 28, 1899, by a vertical rod which is spiked to one of the supports of the bridge. The bench mark is a spike opposite the 8-foot mark on the bridge support to which the rod is fastened. During the flood periods two side channels have to be measured, as well as the main stream. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 337; 1897, Nineteenth Annual Report, Part IV, page 449. The following discharge measurements were made by F. S. Shirley and N. S. Dils during 1899:

March 28, gage height, 4.40 feet; discharge, 164 second-feet.
March 28, gage height;[1] discharge, 25 second-feet.
May 25, gage height, 1.50 feet; discharge, 0.1 second-feet.
June 24, gage height, 2 feet; discharge, 11 second-feet.

*Daily gage height, in feet, of Little Wood River at Toponis, Idaho, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|
| 1 | 4.50 | 4.25 | 3.05 | 1.00 | 1.60 | 1.30 | 1.80 | 2.50 |
| 2 | 5.60 | 4.25 | 3.15 | .90 | 1.70 | 1.20 | 1.80 | 2.60 |
| 3 | 5.60 | 4.20 | 3.05 | .90 | 1.70 | 1.10 | 1.80 | 2.60 |
| 4 | 5.40 | 4.40 | 3.05 | 1.00 | 1.70 | 1.00 | 2.25 | 2.70 |
| 5 | 5.30 | 4.40 | 2.90 | 1.20 | 1.75 | 1.00 | 2.25 | 2.90 |
| 6 | 5.20 | 4.50 | 2.85 | 1.75 | 1.70 | 1.70 | 2.00 | 2.90 |
| 7 | 5.00 | 4.40 | 2.65 | 1.60 | 1.70 | 1.50 | 1.80 | 2.90 |
| 8 | 5.00 | 4.30 | 2.65 | 1.70 | 1.60 | 1.50 | 1.70 | 2.90 |
| 9 | 4.80 | 4.40 | 2.60 | 1.70 | 1.70 | 1.30 | 1.70 | 3.00 |
| 10 | 4.85 | 4.25 | 2.60 | 1.65 | 1.70 | 1.50 | 1.70 | 3.00 |
| 11 | 4.80 | 4.10 | 2.50 | 1.70 | 1.85 | 1.70 | 1.60 | 3.00 |
| 12 | 5.00 | 4.10 | 2.40 | 1.70 | 1.80 | 1.75 | 1.60 | 3.00 |
| 13 | 4.60 | 4.00 | 2.25 | 1.60 | 1.80 | 1.75 | 1.60 | 3.10 |
| 14 | 4.50 | 3.90 | 2.05 | 1.60 | 1.75 | 1.75 | 1.70 | 3.10 |
| 15 | 4.50 | 3.80 | 2.00 | 1.50 | 1.70 | 1.75 | 1.70 | ..... |
| 16 | 4.30 | 3.80 | 1.80 | 1.45 | 1.70 | 1.75 | 1.70 | ..... |
| 17 | 4.00 | 3.75 | 1.70 | 1.35 | 1.70 | 1.75 | 1.50 | ..... |
| 18 | 3.90 | 3.70 | 1.30 | 1.30 | 1.75 | 1.75 | 1.50 | ..... |
| 19 | 4.00 | 3.70 | 1.50 | 1.25 | 1.75 | 1.80 | 1.60 | ..... |
| 20 | 3.80 | 3.70 | 1.50 | 1.10 | 1.70 | 1.80 | 1.70 | ..... |
| 21 | 3.80 | 3.70 | 1.50 | 1.00 | 1.70 | 1.75 | 1.70 | ..... |
| 22 | 3.85 | 3.50 | 1.50 | 1.90 | 1.55 | 1.75 | 1.60 | ..... |
| 23 | 3.85 | 3.50 | 1.50 | 2.00 | 1.60 | 1.90 | 1.60 | ..... |
| 24 | 3.90 | 3.50 | 1.50 | 1.95 | 1.70 | 2.10 | 2.10 | ..... |
| 25 | 4.00 | 3.30 | 1.50 | 1.65 | 1.60 | 2.00 | 2.30 | ..... |
| 26 | 4.20 | 3.20 | 1.50 | 1.65 | 1.70 | 1.80 | 2.40 | ..... |
| 27 | 4.35 | 3.25 | 1.50 | 1.70 | 1.70 | 1.80 | 2.50 | ..... |
| 28 | 4.45 | 3.25 | 1.40 | 1.70 | 1.70 | 1.80 | 2.50 | ..... |
| 29 | 4.20 | 3.20 | 1.40 | 1.65 | 1.75 | 1.80 | 2.50 | ..... |
| 30 | 4.10 | 2.95 | 1.20 | 1.60 | 1.70 | 1.80 | 2.50 | ..... |
| 31 | 4.10 | ..... | 1.00 | ..... | 1.50 | 1.80 | ..... | ..... |

Station discontinued October 14.

[1] Measurement made on a slough, 500 feet south of railroad, into which water had been diverted from Little Wood River for irrigation purposes.

## MALADE RIVER AT TOPONIS, IDAHO.

Malade River, or Big Wood, as it is sometimes called, has its source in the high, mountainous area north of Ketchum, Idaho, and flows southerly. Below the mouth of its tributary, Camas Creek, which enters from the west, the main stream enters a broken lava country in which there is no surface addition to its flow, the rainfall percolating down through the soil of the lava beds. Considerable irrigation is practiced within its basin, and a number of canal diversions are made above the station. Recourse must be had to storage on this river for further increase of its agricultural lands. The station, established June 2, 1896, is located at the wagon bridge one-half mile north of the town of Toponis. The gage is vertical and is spiked to the south face of one of the bridge piers. The bench mark is the head of a spike driven into the pier opposite the 12-foot mark. The channel is straight for some distance above and below the station, and the current is moderately swift. The banks are high and not liable to overflow. The results of measurements are found as follows: 1896, Eighteenth Annual Report, Part IV, page 337; 1897, Nineteenth Annual Report, Part IV, page 449; 1898, Twentieth Annual Report, Part IV, page 477. The following measurements of discharge were made by F. S. Shirley and N. S. Dils during 1899:

March 28, gage height, 2.40 feet; discharge, 42 second-feet.
May 25, gage height, 3.80 feet; discharge, 523 second-feet.
June 24, gage height, 5 feet; discharge, 1,356 second-feet.
July 27, gage height, 2.80 feet; discharge, 125 second-feet.

*Daily gage height, in feet, of Malade River at Toponis, Idaho, for 1899.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.00 | 2.60 | 3.80 | 4.20 | 4.60 | 2.50 | 1.20 | 2.00 |
| 2 | ..... | 2.30 | 2.85 | 3.80 | 4.25 | 4.60 | 2.40 | 1.20 | 1.95 |
| 3 | ..... | 2.45 | 2.75 | 3.30 | 4.25 | 4.60 | 2.30 | 1.20 | 1.95 |
| 4 | ..... | 2.35 | 2.80 | 3.75 | 4.40 | 4.55 | 2.30 | 1.20 | 1.90 |
| 5 | ..... | 2.20 | 2.70 | 3.80 | 4.55 | 4.50 | 2.20 | 1.20 | 1.90 |
| 6 | ..... | 2.30 | 2.65 | 3.90 | 4.60 | 4.10 | 2.10 | 1.20 | 1.90 |
| 7 | ..... | 2.45 | 2.75 | 3.90 | 4.60 | 3.90 | 2.00 | 1.90 | 1.85 |
| 8 | ..... | 2.50 | 2.75 | 3.90 | 4.60 | 3.80 | 2.00 | 1.90 | 1.85 |
| 9 | ..... | 2.55 | 2.90 | 3.70 | 4.40 | 3.70 | 2.00 | 1.90 | 1.90 |
| 10 | ..... | 2.30 | 3.00 | 4.05 | 4.10 | 3.65 | 2.00 | 1.80 | 2.00 |
| 11 | ..... | 2.05 | 3.00 | 4.30 | 4.20 | 3.65 | 1.90 | 1.70 | 2.00 |
| 12 | ..... | 2.00 | 3.60 | 4.65 | 4.40 | 3.60 | 2.10 | 1.70 | 2.00 |
| 13 | ..... | 2.00 | 4.10 | 5.00 | 4.40 | 3.55 | 2.10 | 1.70 | 2.00 |
| 14 | ..... | 1.95 | 4.60 | 4.80 | 4.40 | 3.65 | 2.00 | 1.65 | 2.00 |
| 15 | ..... | 1.70 | 4.75 | 4.60 | 4.40 | 3.60 | 2.00 | 1.60 | ..... |
| 16 | ..... | 1.60 | 5.10 | 4.70 | 4.40 | 3.45 | 2.00 | 1.60 | ..... |
| 17 | ..... | 2.60 | 5.55 | 4.50 | 4.50 | 3.30 | 2.00 | 1.60 | ..... |
| 18 | 3.30 | 2.45 | 5.45 | 4.30 | 4.85 | 3.20 | 2.00 | 1.70 | ..... |
| 19 | 2.90 | 2.45 | 6.20 | 4.20 | 4.70 | 3.10 | 1.90 | 1.80 | ..... |
| 20 | 3.00 | 2.45 | 6.10 | 4.10 | 4.90 | 3.00 | 1.90 | 1.90 | ..... |
| 21 | 2.60 | 2.45 | 5.10 | 4.00 | 5.20 | 3.00 | 1.80 | 1.80 | ..... |
| 22 | 2.50 | 2.10 | 5.00 | 3.90 | 5.40 | 2.95 | 1.70 | 1.90 | ..... |
| 23 | 2.40 | 2.40 | 5.00 | 3.90 | 5.05 | 2.90 | 1.50 | 1.90 | ..... |
| 24 | 2.00 | 2.60 | 5.00 | 3.80 | 4.90 | 2.90 | 1.30 | 1.80 | ..... |
| 25 | 2.10 | 3.70 | 5.00 | 3.80 | 4.90 | 2.80 | 1.30 | 1.90 | ..... |
| 26 | 2.10 | 2.95 | 5.00 | 3.80 | 4.80 | 2.70 | 1.30 | 2.00 | ..... |
| 27 | 2.05 | 2.50 | 5.40 | 4.00 | 4.75 | 2.70 | 1.55 | 2.00 | ..... |
| 28 | 2.10 | 2.40 | 4.90 | 4.00 | 4.55 | 2.65 | 1.55 | 2.00 | ..... |
| 29 | ..... | 2.50 | 4.40 | 4.15 | 4.60 | 2.65 | 1.40 | 2.00 | ..... |
| 30 | ..... | 2.50 | 4.00 | 4.35 | 4.60 | 2.55 | 1.30 | 2.00 | ..... |
| 31 | ..... | 2.50 | ..... | 4.30 | ..... | 2.50 | 1.20 | ..... | ..... |

Closed for winter October 14.

## MALADE RIVER AT BLISS, IDAHO.

There is a large increase in the discharge of this river below the mouth of Little Wood River, which is evidently due to the entrance of springs from the lava desert. Surveys have recently been completed in order to determine the practicability of carrying water from lower Malade River across Snake River for placer mining and irrigation purposes. In order to determine the increase by the underground flow, and the amount available for future hydraulic developments, a station was established by Frank S. Shirley March 27, 1899. The station is located at the wagon bridge 8 miles southwest from the railroad station at Bliss, and is reached by stage from the latter place. The rod is vertical and consists of a 2 by 4 inch timber spiked to the bridge abutment. The bench mark is two nails driven into the east abutment opposite the 12-foot mark. The locality is a good one for measurements, with high banks not subject to overflow, and with a rocky bed not liable to change. The following measurements of discharge were made by F. S. Shirley and N. S. Dils in 1899:

March 27, gage height, 2.50 feet; discharge, 1,345 second-feet.
May 26, gage height, 2.70 feet; discharge, 1,736 second-feet.
June 23, gage height, 3.50 feet; discharge, 2,878 second-feet.
July 26, gage height, 2.30 feet; discharge, 1,203 second-feet.
September 23, gage height, 2.15 feet; discharge, 1,095 second-feet.

*Daily gage height, in feet, of Malade River at Bliss, Idaho, for 1899.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.40 | 2.90 | 2.90 | 3.00 | 2.20 | 2.15 | 2.20 |
| 2 | ..... | 2.70 | 2.80 | 2.90 | 3.00 | 2.20 | 2.15 | 2.20 |
| 3 | ..... | 2.70 | 2.80 | 2.90 | 3.00 | 2.20 | 2.15 | 2.20 |
| 4 | ..... | 2.60 | 2.70 | 2.90 | 3.00 | 2.20 | 2.15 | 2.20 |
| 5 | ..... | 2.50 | 2.70 | 2.90 | 3.00 | 2.20 | 2.15 | 2.20 |
| 6 | ..... | 2.60 | 2.60 | 3.00 | 2.90 | 2.15 | 2.15 | 2.20 |
| 7 | ..... | 2.50 | 2.50 | 3.00 | 2.80 | 2.15 | 2.15 | 2.20 |
| 8 | ..... | 2.50 | 2.50 | 3.00 | 2.70 | 2.15 | 2.15 | 2.20 |
| 9 | ..... | 2.90 | 2.50 | 2.90 | 2.70 | 2.15 | 2.15 | 2.20 |
| 10 | ..... | 2.90 | 2.70 | 2.90 | 2.70 | 2.15 | 2.15 | 2.20 |
| 11 | ..... | 2.90 | 2.90 | 2.90 | 2.70 | 2.15 | 2.15 | 2.20 |
| 12 | ..... | 3.00 | 3.10 | 3.00 | 2.60 | 2.15 | 2.15 | 2.20 |
| 13 | ..... | 3.00 | 3.50 | 3.00 | 2.60 | 2.15 | 2.15 | 2.20 |
| 14 | ..... | 3.10 | 3.30 | 3.10 | 2.60 | 2.15 | 2.15 | 2.20 |
| 15 | ..... | 3.30 | 3.30 | 3.00 | 2.60 | 2.15 | 2.15 | ..... |
| 16 | ..... | (a) | 3.00 | 2.90 | 2.50 | 2.15 | 2.15 | ..... |
| 17 | ..... | 3.50 | 3.00 | 2.90 | 2.50 | 2.15 | 2.15 | ..... |
| 18 | ..... | 3.80 | 3.00 | 3.00 | 2.50 | 2.15 | 2.15 | ..... |
| 19 | ..... | 3.90 | 2.90 | 3.30 | 2.40 | 2.15 | 2.15 | ..... |
| 20 | ..... | 4.00 | 2.80 | 3.50 | 2.40 | 2.15 | 2.15 | ..... |
| 21 | ..... | 3.50 | (a) | 3.80 | 2.30 | 2.15 | 2.15 | ..... |
| 22 | ..... | 3.30 | 2.80 | 3.70 | 2.30 | 2.15 | 2.15 | ..... |
| 23 | ..... | (a) | 2.70 | 3.50 | 2.30 | 2.15 | 2.15 | ..... |
| 24 | ..... | 3.40 | 2.70 | 3.40 | 2.30 | 2.15 | 2.15 | ..... |
| 25 | ..... | 3.60 | 2.60 | 3.30 | 2.30 | 2.15 | 2.15 | ..... |
| 26 | ..... | 3.50 | 2.70 | 3.30 | 2.30 | 2.15 | 2.15 | ..... |
| 27 | 2.50 | 3.50 | 2.80 | 3.20 | 2.30 | 2.15 | 2.15 | ..... |
| 28 | 2.40 | 3.40 | 2.80 | 3.20 | 2.20 | 2.15 | 2.20 | ..... |
| 29 | 2.30 | 3.10 | 2.80 | 3.10 | 2.20 | 2.15 | 2.20 | ..... |
| 30 | 2.30 | 3.00 | 2.90 | 3.10 | 2.20 | 2.15 | 2.20 | ..... |
| 31 | 2.40 | ..... | 2.90 | ..... | 2.20 | 2.15 | ..... | ..... |

a No reading. Closed for winter October 14.

## BRUNEAU RIVER AT GRANDVIEW, IDAHO.

This river has its source in northern Nevada, and flows in a general northerly course, entering Snake River in Owyhee County. Its basin is of a rolling character and is devoted to stock raising. Systematic measurements on this river have been maintained by Mr. Andrew J. Wiley, for the Owyhee Land and Irrigation Company, immediately below the headworks of their canal system, 10 miles east of Grandview, Idaho. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 340; 1897, Nineteenth Annual Report, Part IV, page 450; 1898, Twentieth Annual Report, Part IV, page 482. No measurements were made at this station during 1899.

*Daily gage height, in feet, of Bruneau River at Grandview, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.50 | 1.80 | 1.70 | 2.40 | 3.20 | 3.95 | 3.75 | 1.90 | 1.45 | 1.45 | 1.70 | 1.70 |
| 2 | 1.50 | 1.80 | 1.70 | 2.50 | 3.10 | 4.00 | 3.70 | 1.85 | 1.40 | 1.50 | 1.70 | 1.70 |
| 3 | 1.50 | 1.70 | 1.90 | 2.50 | 3.00 | 4.25 | 3.60 | 1.80 | 1.45 | 1.50 | 1.70 | 1.65 |
| 4 | 1.50 | 1.60 | 1.90 | 2.50 | 2.90 | 4.65 | 3.50 | 1.80 | 1.40 | 1.50 | 1.70 | 1.65 |
| 5 | 1.50 | 1.30 | 1.70 | 2.50 | 2.80 | 4.65 | 3.45 | 1.75 | 1.40 | 1.50 | 1.70 | 1.65 |
| 6 | 1.55 | 1.25 | 1.75 | 2.60 | 2.80 | 7.85 | 3.30 | 1.85 | 1.40 | 1.50 | 1.75 | 1.60 |
| 7 | 1.55 | 1.20 | 1.75 | 2.70 | 2.95 | 4.95 | 3.25 | 1.90 | 1.40 | 1.50 | 1.75 | 1.60 |
| 8 | 1.55 | 1.20 | 1.70 | 2.80 | 3.30 | 4.80 | 3.20 | 1.80 | 1.40 | 1.55 | 1.75 | 1.65 |
| 9 | 1.60 | 1.50 | 2.30 | 3.10 | 3.50 | 4.75 | 3.15 | 1.80 | 1.40 | 1.55 | 1.70 | 1.65 |
| 10 | 1.60 | 1.65 | 2.50 | 3.40 | 4.00 | 4.70 | 3.00 | 1.85 | 1.40 | 1.55 | 1.70 | 1.65 |
| 11 | 1.60 | 2.50 | 2.30 | 4.50 | 4.65 | 4.75 | 3.00 | 1.80 | 1.45 | 1.50 | 1.75 | 1.65 |
| 12 | 1.55 | 2.30 | 2.00 | 4.50 | 4.85 | 4.90 | 2.90 | 1.80 | 1.45 | 1.55 | 1.75 | 1.65 |
| 13 | 1.55 | 1.90 | 1.90 | 5.00 | 5.00 | 5.15 | 2.80 | 1.75 | 1.40 | 1.55 | 1.75 | 1.70 |
| 14 | 1.55 | 1.80 | 1.90 | 5.20 | 5.00 | 5.15 | 2.80 | 1.75 | 1.45 | 1.60 | 1.70 | 1.70 |
| 15 | 1.60 | 1.80 | 1.80 | 5.00 | 4.80 | 4.80 | 2.75 | 1.70 | 1.45 | 1.65 | 1.80 | 1.65 |
| 16 | 3.90 | 1.80 | 1.80 | 4.80 | 4.55 | 4.60 | 2.70 | 1.65 | 1.45 | 1.65 | 1.75 | 1.65 |
| 17 | 2.55 | 1.80 | 1.85 | 5.00 | 4.40 | 4.65 | 2.60 | 1.60 | 1.40 | 1.70 | 1.70 | 1.70 |
| 18 | 2.30 | 1.75 | 1.85 | 5.00 | 4.00 | 4.75 | 2.55 | 1.65 | 1.40 | 1.70 | 1.70 | 1.70 |
| 19 | 2.30 | 1.70 | 2.00 | 4.40 | 3.80 | 5.00 | 2.50 | 1.65 | 1.45 | 1.70 | 1.70 | 1.65 |
| 20 | 2.00 | 1.75 | 1.95 | 4.20 | 3.70 | 5.00 | 2.45 | 1.65 | 1.45 | 1.70 | 1.70 | 1.60 |
| 21 | 1.85 | 2.30 | 1.90 | 3.90 | 3.55 | 5.20 | 2.40 | 1.60 | 1.45 | 1.75 | 1.70 | 1.55 |
| 22 | 1.90 | 2.40 | 1.90 | 4.00 | 3.45 | 5.00 | 2.35 | 1.65 | 1.45 | 1.75 | 1.70 | 1.55 |
| 23 | 1.80 | 2.00 | 1.90 | 4.40 | 3.40 | 4.60 | 2.25 | 1.60 | 1.45 | 1.70 | 1.70 | 1.50 |
| 24 | 1.80 | 1.80 | 1.85 | 4.40 | 3.50 | 4.30 | 2.20 | 1.65 | 1.45 | 1.70 | 1.70 | 1.50 |
| 25 | 1.75 | 1.80 | 3.00 | 4.30 | 3.70 | 4.20 | 2.20 | 1.60 | 1.45 | 1.70 | 1.70 | 1.50 |
| 26 | 1.80 | 1.75 | 4.40 | 4.30 | 3.95 | 4.25 | 2.10 | 1.60 | 1.45 | 1.75 | 1.70 | 1.50 |
| 27 | 1.80 | 1.70 | 3.40 | 3.80 | 4.00 | 4.10 | 2.05 | 1.60 | 1.50 | 1.75 | 1.70 | 1.55 |
| 28 | 1.80 | 1.70 | 3.00 | 3.70 | 3.85 | 4.00 | 2.00 | 1.55 | 1.50 | 1.75 | 1.70 | 1.50 |
| 29 | 1.80 | ..... | 2.80 | 3.50 | 3.90 | 3.80 | 2.00 | 1.55 | 1.50 | 1.75 | 1.70 | 1.55 |
| 30 | 1.80 | ..... | 2.60 | 3.30 | 3.85 | 3.75 | 1.95 | 1.50 | 1.50 | 1.70 | 1.70 | 1.60 |
| 31 | 1.80 | ..... | 2.50 | ..... | 4.15 | ..... | 1.90 | 1.50 | ..... | 1.70 | ..... | 1.65 |

## BOISE RIVER AT BOISE, IDAHO.

This river drains a mountainous and well-wooded country in Elmore County, Idaho. The effects of the forests are shown in the high flow that is maintained throughout the summer season, in contrast to the discharge of Weiser River farther to the west, which drains a more barren country. Below the gaging station, which is located in the canyon, a large number of canals divert water to irrigate lands in Boise Valley. These diversions are now carried to such an extent that frequent complaint of the scarcity of water is heard. It is estimated that 13,000 acres of land are irrigated by canals from Boise River. The station, established December 15, 1894, is located about 9 miles

above Boise, Idaho, at the mouth of the canyon. June 17, 1897, the present rod was placed, consisting of an inclined timber firmly attached to a cottonwood tree. Bench mark No. 1 is a 20-penny spike in the upstream face of the 6 by 8 cable support, about 2 feet above the ground, and is at an elevation of 15 feet above gage datum. Bench mark No. 2 consists of two spikes in the same post, at a height of 14 feet above gage datum. The equipment consists of a cable and car. At ordinary stages the channel is straight both above and below the station. The banks are high and not liable to overflow. About 300 feet below the cable is a gravel bar reducing the width of the river in low water to about one-third of the channel, and forcing the entire flow against the south bank. The channel is liable to change during extreme high floods. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 342; 1897, Nineteenth Annual Report, Part IV, page 453; 1898, Twentieth Annual Report, Part IV, page 483. The following discharge measurements were made by F. S. Shirley and N. S. Dils during 1899:

*Discharge measurements of Boise River at Boise, Idaho.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| March 24 | 1.90 | 1,846 | July 11 | 4.30 | 7,394 |
| April 4 | 2.70 | 3,418 | August 2 | 2.00 | 2,054 |
| May 16 | 5.10 | 9,927 | August 26 | 1.55 | 1,583 |
| May 28 | 5.10 | 10,711 | September 14 | 1.20 | 1,105 |

*Daily gage height, in feet, of Boise River at Boise, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.30 | 1.30 | 1.60 | 2.40 | 3.90 | 5.10 | 5.40 | 2.20 | 1.40 | 1.10 | 1.40 | 2.00 |
| 2 | 2.30 | 1.30 | 1.60 | 2.50 | 3.60 | 5.20 | 5.10 | 2.00 | 1.40 | 1.10 | 1.40 | 1.70 |
| 3 | 2.30 | 1.20 | 1.60 | 2.50 | 3.50 | 5.80 | 5.10 | 2.00 | 1.40 | 1.10 | 1.30 | 1.55 |
| 4 | 2.30 | 1.20 | 1.60 | 2.60 | 3.40 | 6.10 | 5.00 | 2.00 | 1.40 | 1.10 | 1.40 | 1.35 |
| 5 | 2.30 | 1.30 | 1.50 | 2.90 | 3.60 | 6.10 | 4.70 | 2.00 | 1.35 | 1.10 | 1.40 | 1.30 |
| 6 | 2.40 | 1.30 | 1.50 | 2.90 | 3.80 | 5.40 | 4.50 | 2.00 | 1.30 | 1.10 | 1.40 | 1.30 |
| 7 | 2.40 | 1.20 | 1.50 | 2.90 | 4.80 | 5.20 | 4.45 | 2.10 | 1.30 | 1.10 | 1.40 | 1.40 |
| 8 | 2.40 | 1.40 | 1.50 | 3.30 | 5.00 | 5.20 | 4.60 | 2.20 | 1.30 | 1.15 | 1.50 | 1.40 |
| 9 | 2.40 | 1.60 | 1.40 | 3.70 | 6.00 | 5.00 | 4.45 | 2.20 | 1.30 | 1.15 | 1.45 | 1.50 |
| 10 | 2.40 | 1.90 | 1.40 | 4.20 | 7.50 | 5.10 | 4.40 | 2.00 | 1.30 | 1.15 | 1.40 | 1.60 |
| 11 | 2.40 | 1.60 | 1.40 | 4.40 | 7.00 | 5.50 | 4.30 | 1.90 | 1.30 | 1.15 | 1.55 | 1.60 |
| 12 | 2.40 | 1.60 | 1.45 | 4.60 | 6.20 | 6.10 | 4.20 | 1.90 | 1.20 | 1.20 | 1.75 | 1.50 |
| 13 | 2.40 | 1.60 | 1.45 | 4.55 | 6.00 | 5.10 | 4.10 | 1.75 | 1.20 | 1.20 | 1.80 | 1.50 |
| 14 | 2.40 | 1.40 | 1.40 | 4.35 | 5.80 | 5.40 | 3.90 | 1.70 | 1.20 | 1.25 | 1.70 | 1.50 |
| 15 | 2.50 | 1.50 | 1.40 | 4.30 | 5.40 | 5.20 | 3.70 | 1.70 | 1.30 | 1.25 | 1.60 | 1.40 |
| 16 | 2.50 | 1.50 | 1.40 | 5.10 | 5.10 | 5.40 | 3.50 | 1.70 | 1.35 | 1.25 | 1.70 | 1.40 |
| 17 | 2.50 | 1.60 | 1.40 | 4.65 | 5.00 | 6.10 | 3.40 | 1.70 | 1.25 | 1.30 | 1.65 | 1.60 |
| 18 | 2.50 | 1.60 | 1.60 | 4.70 | 4.80 | 6.70 | 3.30 | 1.60 | 1.20 | 1.50 | 1.60 | 1.60 |
| 19 | 2.50 | 1.60 | 1.90 | 4.20 | 4.40 | 7.00 | 3.25 | 1.55 | 1.20 | 1.85 | 1.60 | 1.80 |
| 20 | 2.50 | 1.60 | 2.00 | 4.10 | 4.30 | 7.40 | 3.10 | 1.60 | 1.20 | 2.00 | 1.60 | 1.80 |
| 21 | 2.50 | 1.50 | 2.00 | 4.10 | 4.30 | 6.40 | 3.10 | 1.70 | 1.20 | 2.20 | 1.50 | 1.60 |
| 22 | 2.50 | 1.50 | 1.80 | 4.50 | 4.60 | 5.40 | 2.90 | 1.80 | 1.15 | 2.00 | 1.50 | 1.60 |
| 23 | 2.40 | 1.40 | 1.80 | 5.30 | 4.80 | 5.20 | 2.80 | 1.80 | 1.15 | 1.90 | 1.50 | 1.60 |
| 24 | 2.40 | 1.30 | 1.90 | 5.90 | 5.00 | 5.60 | 2.50 | 1.70 | 1.15 | 1.80 | 1.40 | 1.80 |
| 25 | 2.40 | 1.30 | 2.90 | 5.40 | 5.30 | 5.60 | 2.50 | 1.60 | 1.15 | 1.60 | 1.40 | 1.60 |
| 26 | 2.40 | 1.40 | 2.05 | 5.50 | 5.00 | 5.40 | 2.40 | 1.50 | 1.10 | 1.50 | 1.40 | 1.60 |
| 27 | 2.00 | 1.50 | 2.30 | 4.80 | 4.80 | 5.20 | 2.30 | 1.45 | 1.10 | 1.50 | 1.40 | 1.60 |
| 28 | 1.60 | 1.50 | 2.40 | 4.50 | 5.15 | 5.40 | 2.30 | 1.30 | 1.10 | 1.50 | 1.50 | 1.80 |
| 29 | 1.40 | ..... | 2.40 | 4.30 | 5.20 | 5.65 | 2.20 | 1.30 | 1.10 | 1.50 | 1.80 | 1.80 |
| 30 | 1.30 | ..... | 2.40 | 4.10 | 5.40 | 5.40 | 2.25 | 1.20 | 1.10 | 1.50 | 2.00 | 1.60 |
| 31 | 1.30 | ..... | 2.30 | ..... | 5.30 | ..... | 2.20 | 1.20 | ..... | 1.40 | ..... | 1.80 |

A series of measurements of Boise River and canals taking water from it were made by N. S. Dils September 12 to 16, 1899. The route followed was similar to that taken by Cyrus C. Babb, as noted in the Twentieth Annual, Part IV, page 484. The following list gives the localities, together with the results obtained:

*Discharge measurements of canals in Boise Valley, Idaho.*

1899.

| Date. | Canal. | Locality. | Discharge. |
|---|---|---|---|
| | | | *Second-feet.* |
| Sept. 12 | Sebree | Near head | 198 |
| Sept. 12 | Seitenberg slough | Near head | 47 |
| Sept. 12 | Boise River | 300 feet below Caldwell bridge. | 439 |
| Sept. 12 | Riverside canal | Near head | 10 |
| Sept. 12 | Waste east of Caldwell | Near river | 7 |
| Sept. 12 | Waste Tenmile | Near river | 35 |
| Sept. 12 | Strahorn canal | Near head | 49 |
| Sept. 12 | Four small wastes | Near river | 2 |
| Sept. 12 | Boise River | Star bridge | 486 |
| Sept. 13 | Waste south of Star | Near river | 22 |
| Sept. 13 | Waste south of Star bridge | Near river | 5 |
| Sept. 13 | Eureka canal | Near head | 47 |
| Sept. 13 | Phyllis canal | Near head; dry | ---------- |
| Sept. 13 | Settlers canal | Near head | 52 |
| Sept. 13 | McCarty canal | Near head | 11 |
| Sept. 13 | Davis canal | Near head | 20 |
| Sept. 13 | Waste Rossi | Near river | 43 |
| Sept. 13 | Payne canal | Near head | 5 |
| Sept. 13 | Rossi canal | Below waste gate | 51 |
| Sept. 14 | Perault canal | Below mill | 25 |
| Sept. 14 | Ellis canal | Near head | 3 |
| Sept. 14 | Perault canal [1] | Below waste gate | 88 |
| Sept. 14 | Boise River | United States Geological Survey gaging station. | 1,105 |
| Sept. 14 | Costin canal | Near head | 3 |
| Sept. 14 | Ridenbaugh canal | Near head | 356 |
| Sept. 14 | Jacobs canal | Near head | 43 |
| Sept. 15 | Waste Carline | Main street bridge | 29 |
| Sept. 15 | Farmers Union | Near head | 47 |
| Sept. 15 | Waste | One-half mile below Soldiers' Home. | 7 |
| Sept. 15 | Waste | Two miles below Soldiers' Home. | 7 |
| Sept. 15 | Dry Creek canal | Near head | 23 |
| Sept. 15 | Union canal | Near head; dry | ---------- |
| Sept. 15 | Ballentine canal | Near head; dry | ---------- |
| Sept. 15 | Waste Dry Creek | Near river | 2 |
| Sept. 15 | Waste | Near head; Cassiday | 3 |
| Sept. 15 | Cassiday canal | Near head; dry | ---------- |
| Sept. 15 | Middleton canal | Near head | 84 |
| Sept. 15 | Swallew & McDowell | Near head | 8 |
| Sept. 16 | Catlin & Macey | Eagle Island | 14 |
| Sept. 16 | Aitken | Eagle Island | 7 |
| Sept. 16 | Conway & Aitken | Eagle Island | 7 |
| Sept. 16 | Davis & Hart | Eagle Island | 7 |
| Sept. 16 | Middleton Mill slough | Near head | 14 |
| Sept. 16 | Pioneer canal | Near head | 3 |
| Sept. 16 | Middleton Water Company | Near head | 32 |
| Sept. 16 | Waste West Middleton | Willow Creek | 13 |
| Sept. 16 | Waste West Middleton | Near river | 1 |
| Sept. 16 | Waste East Middleton | Near river | 17 |

[1] Perault above mill feeds Perault below mill and waste flows into Ellis canal.

SUMMARY.

| | Second-feet. |
|---|---|
| In river at Star bridge | 486 |
| Taken out by canals above Star | 891 |
| | 1,377 |
| In river above canals | 1,105 |
| Return water above Star | 91 |
| | 1,196 |
| Gain | 181 |
| In river at Caldwell | 439 |
| Taken out by canals | 1,227 |
| | 1,666 |
| In river above canals | 1,105 |
| Return water | 192 |
| | 1,297 |
| Gain 34 miles | 369 |
| Gain per mile, 1899 | 11 |
| Gain per mile, 1898 | 8 |
| Increase | 3 |

PAYETTE RIVER AT PAYETTE, IDAHO.

This river drains a well-wooded mountainous area similar to the basin of the Boise. The effect of the forest is shown in the well-sustained summer flow. Systematic measurements were formerly made on this river, but owing to the excess of water above the needs of the irrigators, this station is not now maintained. September 10, 1899, a measurement at Payette by N. S. Dils showed a discharge of 1,677 second-feet.

WEISER RIVER AT WEISER, IDAHO.

The drainage basin of this river is mountainous and rocky, in contrast to the well-wooded areas of the Boise and Payette basins, and the effect is shown in the high flood discharges and low summer flow. A number of small ditches utilize considerable water from this river, but the principal canal is the Galloway canal, which irrigates lands north of Weiser. Above this canal is a bench country susceptible of cultivation if water could be brought to it. The gaging station, established December 6, 1894, is located in the canyon of the river, about 10 miles from Weiser. The gage rod which was set in 1898 was covered during the process of grading for the roadbed of the new Pacific and Idaho Northern railroad, which is a line intended to run from Weiser to the mining country in the mountainous district to the north. The new gage, located on October 31, 1899, 100 feet

above the old one, is inclined and bolted to a rock bluff; 1.15 feet along the gage equals one foot in elevation. The bench mark consists of a cross cut in the top of the lava rim rock above the gage, and is at an elevation of 12.90 feet. The elevation of the zero of the gage taken from the levels of the railroad is 2,191.34 feet above sea level. Discharge measurements are made from a cable and car about 300 feet below the gage. Both banks are high and not liable to overflow. The bed of the river is of gravel and not susceptible to change. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 353; 1897, Nineteenth Annual Report, Part IV, page 457; 1898, Twentieth Annual Report, Part IV, page 488. The following discharge measurements were made by F. S. Shirley and N. S. Dils in 1899:

March 22, gage height, 3.80 feet; discharge, 2,822 second-feet.
April 16, gage height, 4.70 feet; discharge, 3,831 second-feet.
May 18, gage height, 4.20 feet; discharge, 3,092 second-feet.
May 29, gage height, 4 feet; discharge, 2,839 second-feet.
July 8, gage height, 2.40 feet; discharge, 1,195 second-feet.
September 9, gage height, 0.75 foot; discharge, 145 second-feet.

*Daily gage height, in feet, of Weiser River at Weiser, Idaho, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.00 | 1.60 | 2.10 | 5.00 | 3.80 | 4.10 | 3.20 | 1.20 | 0.80 | 0.50 | 1.10 | 2.40 |
| 2 | 2.00 | 1.50 | 2.20 | 5.00 | 3.40 | 4.30 | 3.00 | 1.20 | .80 | .50 | 1.10 | 2.30 |
| 3 | 2.00 | 1.60 | 2.30 | 5.10 | 3.20 | 4.70 | 2.90 | 1.20 | .80 | .50 | 1.10 | 2.20 |
| 4 | 2.00 | 1.80 | 2.40 | 5.00 | 3.05 | 4.90 | 2.80 | 1.10 | .80 | .50 | 1.10 | 2.10 |
| 5 | 2.00 | 1.90 | 2.30 | 5.00 | 3.00 | 4.60 | 2.70 | 1.10 | .80 | .50 | 1.10 | 2.00 |
| 6 | 2.00 | 2.00 | 2.30 | 5.10 | 3.15 | 4.30 | 2.60 | 1.10 | .80 | .50 | 1.10 | ..... |
| 7 | 2.00 | 1.80 | 2.40 | 5.00 | 3.70 | 4.00 | 2.50 | 1.10 | .80 | .50 | 1.10 | ..... |
| 8 | 2.00 | 1.70 | 2.50 | 4.90 | 4.40 | 3.80 | 2.40 | 1.00 | .80 | .50 | 1.50 | ..... |
| 9 | 2.00 | 1.60 | 2.60 | 5.05 | 4.90 | 3.80 | 2.30 | 1.00 | .80 | .50 | 1.60 | ..... |
| 10 | 2.00 | 1.50 | 2.70 | 5.15 | 5.15 | 3.90 | 2.20 | 1.00 | .80 | .50 | 1.70 | ..... |
| 11 | 2.00 | 1.40 | 2.80 | 5.10 | 5.30 | 4.00 | 2.20 | 1.00 | .80 | .60 | 1.90 | ..... |
| 12 | 2.00 | 1.40 | 2.60 | 5.20 | 5.20 | 4.10 | 2.10 | 1.00 | .70 | .60 | 2.00 | ..... |
| 13 | 2.00 | 1.40 | 2.60 | 5.60 | 5.20 | 4.20 | 2.10 | .90 | .70 | .60 | 2.00 | ..... |
| 14 | 2.00 | 1.40 | 2.70 | 5.30 | 4.70 | 4.20 | 2.00 | .90 | .70 | .60 | 1.90 | ..... |
| 15 | 2.00 | 1.40 | 2.80 | 4.70 | 4.40 | 4.30 | 2.00 | .90 | .70 | .60 | 1.80 | ..... |
| 16 | 2.10 | 1.40 | 3.00 | 4.70 | 4.00 | 4.30 | 2.90 | .90 | .70 | .80 | 1.70 | ..... |
| 17 | 2.20 | 1.40 | 4.70 | 4.90 | 3.80 | 4.30 | 2.90 | .90 | .70 | .80 | 1.60 | ..... |
| 18 | 2.40 | 1.45 | 4.80 | 4.60 | 3.70 | 4.40 | 2.80 | .90 | .70 | .90 | 1.60 | ..... |
| 19 | 2.60 | 1.50 | 4.60 | 4.30 | 3.60 | 4.60 | 1.80 | .80 | .70 | 1.00 | 1.60 | ..... |
| 20 | 3.60 | 1.65 | 4.50 | 4.10 | 3.60 | 4.60 | 1.70 | .80 | .70 | 1.20 | 1.70 | ..... |
| 21 | 3.90 | 1.70 | 4.20 | 4.00 | 3.60 | 4.50 | 1.70 | .80 | .60 | 1.30 | 1.70 | ..... |
| 22 | 4.40 | 1.70 | 3.80 | 4.30 | 3.60 | 4.10 | 1.60 | .80 | .60 | 1.40 | 1.80 | ..... |
| 23 | 5.00 | 1.70 | 3.70 | 4.20 | 3.70 | 3.80 | 1.60 | .80 | .60 | 1.40 | 1.90 | ..... |
| 24 | 5.60 | 1.60 | 6.35 | 4.00 | 4.00 | 3.80 | 1.50 | .80 | .60 | 1.30 | 2.00 | ..... |
| 25 | 5.00 | 1.60 | 6.40 | 4.60 | 4.30 | 3.70 | 1.50 | .90 | .60 | 1.30 | 2.50 | ..... |
| 26 | 3.60 | 1.70 | 6.30 | 4.60 | 4.30 | 3.70 | 1.40 | .90 | .60 | 1.20 | 2.80 | ..... |
| 27 | 3.00 | 1.80 | 6.80 | 4.00 | 4.20 | 3.60 | 1.40 | .90 | .50 | 1.20 | 3.00 | ..... |
| 28 | 2.60 | 1.90 | 4.90 | 3.80 | 4.20 | 3.50 | 1.40 | .80 | .50 | 1.20 | 4.10 | ..... |
| 29 | 2.20 | ..... | 4.80 | 3.80 | 4.00 | 3.40 | 1.30 | .80 | .50 | 1.10 | 4.20 | ..... |
| 30 | 2.20 | ..... | 5.20 | 3.70 | 4.00 | 3.30 | 1.30 | .80 | .50 | 1.10 | 4.30 | ..... |
| 31 | 1.70 | ..... | 5.00 | ..... | 4.05 | ..... | 1.30 | .80 | ..... | 1.10 | ..... | ..... |

River frozen; closed for winter December 5.

## PALOUSE RIVER AT HOOPER, WASHINGTON.

The headwater tributaries of this river have their sources in western Idaho, adjoining the headwater streams of Potlatch River, a tributary of Clearwater River. After passing into Washington they

unite to form the main Palouse, which has a general southwesterly direction, passing through a rolling country. Six miles below Hooper, Washington, the river bends suddenly southward and enters its canyon, through which it continues until its junction with Snake River. For some distance above Hooper the river consists of a succession of deep pools, from 10 to 15 feet in depth, connected by short riffles. Its valley is about one-half mile in width and bordered with basaltic cliffs approximately 300 feet in height. A short distance above the mouth of the river are the Palouse Falls, which are approximately 130 feet in height.

The measurements of Palouse River are of value in showing the amount of water that could be utilized for irrigation on the lands of Washtucna Valley and in the section north of Pasco. The gaging station, established September 9, 1897, is located near Hooper, opposite the water tank of the railroad company. It is about 3 miles above the mouth of Cow Creek and 2 miles below the head of the ditch of the Palouse Irrigation Company, which carries, when full, 25 second-feet. The rod is inclined and fastened to posts driven into the right bank. The bench mark is a point of rock, marked with red paint, on the left bank of the river, opposite the gage, and its elevation is 7.60 feet above gage datum. The channel is gravel and not liable to change. The left bank is high and can not overflow, but the right bank overflows at extreme high water. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 460; 1898, Twentieth Annual Report, Part IV, page 489. No measurements of discharge were made at this point in 1899.

*Daily gage height, in feet, of Palouse River at Hooper, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 5.30 | 4.70 | 5.10 | 5.40 | 3.45 | 2.25 | 1.60 | 1.60 | 1.50 | 2.10 | 4.40 |
| 2 | 2.60 | 5.20 | 6.45 | 5.00 | 5.40 | 3.35 | 2.30 | 1.60 | 1.60 | 1.50 | 2.05 | 5.00 |
| 3 | 2.60 | 4.70 | 6.30 | 5.30 | 5.25 | 3.30 | 2.35 | 1.55 | 1.60 | 1.50 | 2.05 | 5.50 |
| 4 | 2.60 | 4.30 | 5.90 | 5.30 | 4.90 | 3.25 | 2.30 | 1.55 | 1.60 | 1.50 | 2.00 | 5.80 |
| 5 | 2.55 | 4.00 | 5.40 | 5.45 | 4.50 | 3.30 | 2.25 | 1.55 | 1.60 | 1.50 | 1.95 | 5.50 |
| 6 | 2.30 | 4.00 | 5.25 | 5.30 | 4.30 | 3.35 | 2.25 | 1.50 | 1.65 | 1.50 | 1.95 | 4.70 |
| 7 | 2.10 | 3.90 | 5.10 | 5.20 | 4.20 | 3.40 | 2.20 | 1.50 | 1.60 | 1.50 | 1.95 | 4.30 |
| 8 | 2.30 | 3.80 | 5.45 | 5.20 | 4.40 | 3.20 | 2.20 | 1.45 | 1.60 | 1.50 | 1.90 | 4.10 |
| 9 | 2.45 | 3.80 | 5.80 | 5.60 | 4.90 | 3.10 | 2.15 | 1.45 | 1.60 | 1.50 | 1.90 | 3.90 |
| 10 | 2.50 | 3.90 | 6.40 | 5.85 | 5.65 | 3.00 | 2.10 | 1.45 | 1.65 | 1.50 | 1.95 | 3.90 |
| 11 | 2.55 | 4.20 | 6.50 | 6.35 | 5.85 | 2.80 | 1.95 | 1.40 | 1.70 | 1.50 | 1.95 | 3.90 |
| 12 | 2.55 | 3.90 | 5.90 | 6.85 | 5.90 | 2.70 | 1.80 | 1.40 | 1.70 | 1.50 | 1.95 | 3.90 |
| 13 | 2.50 | 3.90 | 5.70 | 7.65 | 5.55 | 2.70 | 1.75 | 1.40 | 1.65 | 1.50 | 1.95 | 3.80 |
| 14 | 2.50 | 3.90 | 5.45 | 9.65 | 5.20 | 2.80 | 1.75 | 1.40 | 1.65 | 1.50 | 2.00 | 4.05 |
| 15 | 2.80 | 5.15 | 5.15 | 8.75 | 4.90 | 2.80 | 1.70 | 1.40 | 1.65 | 1.50 | 2.00 | 3.90 |
| 16 | 4.10 | 7.30 | 5.00 | 7.30 | 4.40 | 2.65 | 1.70 | 1.45 | 1.65 | 1.50 | 2.05 | 3.65 |
| 17 | 3.90 | 8.10 | 4.80 | 6.50 | 4.15 | 2.55 | 1.95 | 1.45 | 1.60 | 1.55 | 2.10 | 3.50 |
| 18 | 5.60 | 8.15 | 5.40 | 6.60 | 4.00 | 2.45 | 1.90 | 1.40 | 1.60 | 1.60 | 2.15 | 3.40 |
| 19 | 6.40 | 8.00 | 5.10 | 7.00 | 4.05 | 2.35 | 1.80 | 1.50 | 1.65 | 1.65 | 2.15 | 3.30 |
| 20 | 6.45 | 7.90 | 4.90 | 6.70 | 4.00 | 2.35 | 1.65 | 1.60 | 1.70 | 1.80 | 2.15 | 3.10 |
| 21 | 6.55 | 7.50 | 4.85 | 6.40 | 3.90 | 2.25 | 1.60 | 1.55 | 1.65 | 2.05 | 2.20 | 3.35 |
| 22 | 7.55 | 7.00 | 5.25 | 5.80 | 3.85 | 2.25 | 1.60 | 1.65 | 1.60 | 2.30 | 3.15 | 3.40 |
| 23 | 8.00 | 6.50 | 5.00 | 5.65 | 3.80 | 2.25 | 1.55 | 1.65 | 1.60 | 2.30 | 3.10 | 3.60 |
| 24 | 8.50 | 5.30 | 5.15 | 5.80 | 3.65 | 2.20 | 1.50 | 1.60 | 1.60 | 2.60 | 2.90 | 4.70 |
| 25 | 7.70 | 5.00 | 5.70 | 5.60 | 3.70 | 2.20 | 1.40 | 1.60 | 1.60 | 2.40 | 2.90 | 5.00 |
| 26 | 7.10 | 4.70 | 5.45 | 5.40 | 3.85 | 2.20 | 1.45 | 1.55 | 1.55 | 2.30 | 2.70 | 5.20 |
| 27 | 6.50 | 4.50 | 5.10 | 5.35 | 4.00 | 2.15 | 1.50 | 1.50 | 1.55 | 2.30 | 2.60 | 5.00 |
| 28 | 6.30 | 4.60 | 4.80 | 6.00 | 4.00 | 2.15 | 1.60 | 1.55 | 1.55 | 2.25 | 2.70 | 4.80 |
| 29 | 6.05 | ..... | 4.70 | 6.20 | 3.80 | 2.15 | 1.60 | 1.60 | 1.55 | 2.20 | 2.85 | 4.60 |
| 30 | 5.90 | ..... | 4.80 | 5.90 | 3.60 | 2.20 | 1.60 | 1.65 | 1.50 | 2.10 | 3.60 | 4.40 |
| 31 | 5.70 | ..... | 5.00 | ..... | 3.45 | ..... | 1.60 | 1.65 | ..... | 2.10 | ..... | 4.10 |

## BLACKFOOT RIVER AT BONNER, MONTANA.

This river has its source on the western slope of the main divide of the Rocky Mountains in Deerlodge County. Its drainage basin is mountainous and well wooded, and little cultivation is possible within the area. The Clearwater Lakes near the head serve as a reservoir, giving the stream a relatively constant flow. The principal industrial applications of the river are found near its mouth, where the water can be used for power purposes as well as for the irrigation of the adjacent lands. Measurements at this point are affected to a certain extent by the dam of the Big Blackfoot Milling Company, which is located about 1,000 yards above the station, and which furnishes water for the mills and electric-power stations. The opening and closing of the flood gates of the dam cause abrupt changes in the recorded gage heights. The station, established July 7, 1898, is located at the wagon bridge one-half mile west of Bonner and 6 miles east of Missoula. The rod of the wire gage is fastened to the upper side of the bridge. Bench mark No. 1, established by the Topographic Division of the United States Geological Survey, is a cross cut by a chisel on the top and northeast corner of the northeast buttress of the Northern Pacific railway bridge over Big Blackfoot River near Bonner, and is at an elevation above sea of 3,290.298 feet. Bench mark No. 2 is a regulation United States Geological Survey iron post on the east side of the river, 10 yards south of the highway and 20 yards north of Mr. McCormick's house, outside of dooryard fence, and at an elevation of 3,246.038 feet. The elevation of the axle of the pulley of the wire gage is 3,251.678 feet. The length of the wire gage is 22.75 feet. This gage was verified June 10, 1899, and September 8, 1899, when a stretch of the cable or a movement of the index of 0.55 foot was found to have occurred. The results of measurements for 1898 may be found in the Twentieth Annual Report, Part IV, page 491. The following measurements of discharge for 1899 were made under the direction of F. D. Smith:

*Discharge measurements of Blackfoot River at Bonner, Montana.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 28 | 1.20 | 1,026 | July 17 | 4.10 | 4,042 |
| April 22 | 2.58 | 2,420 | July 29 | 2.68 | 2,848 |
| May 13 | 5.30 | 9,253 | August 25 | 1.65 | 1,578 |
| June 12 | 7.40 | 13,873 | September 8 | 1.17 | 1.235 |
| June 20 | 8.70 | 17,324 | October 21 | 1.05 | 1,188 |

*Daily gage height, in feet, of Blackfoot River at Bonner, Montana, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 0.75 | ..... | 0.25 | 2.45 | 6.90 | 6.65 | 2.65 | 1.40 | 1.00 | 0.95 | 0.95 |
| 2 | ..... | ..... | ..... | .20 | 2.35 | 6.90 | 6.35 | 2.50 | 1.35 | .95 | 1.00 | 1.45 |
| 3 | ..... | ..... | 1.65 | .20 | 2.35 | 7.50 | 6.10 | 2.40 | 1.45 | .95 | .90 | .80 |
| 4 | ..... | ..... | 1.40 | .35 | 2.25 | 8.00 | 6.00 | 2.35 | 1.50 | 1.00 | .90 | .70 |
| 5 | ..... | ..... | .85 | .45 | 2.30 | 8.35 | 5.85 | 2.35 | 1.40 | .75 | 1.15 | .90 |
| 6 | ..... | ..... | 1.10 | .60 | 2.55 | 8.00 | 5.60 | 2.30 | 1.40 | .90 | .95 | .70 |
| 7 | ..... | ..... | .85 | .80 | 3.00 | 7.35 | 5.40 | 2.25 | 1.35 | .85 | .95 | .85 |
| 8 | ..... | ..... | .85 | .80 | 3.45 | 6.75 | 5.35 | 2.20 | 1.35 | .85 | .95 | .85 |
| 9 | ..... | ..... | .60 | 1.10 | 4.10 | 6.30 | 5.35 | 2.20 | 1.35 | .85 | .90 | .85 |
| 10 | ..... | ..... | .50 | 2.30 | 5.00 | 6.15 | 5.35 | 2.15 | 1.30 | .90 | .90 | .65 |
| 11 | ..... | ..... | .55 | 3.35 | 5.30 | 6.55 | 5.25 | 2.15 | 1.25 | 1.00 | .90 | .70 |
| 12 | ..... | ..... | .45 | 3.65 | 5.55 | 7.55 | 5.05 | 2.10 | 1.20 | .85 | .95 | .75 |
| 13 | ..... | ..... | .50 | 4.80 | 5.35 | 7.55 | 4.90 | 2.00 | 1.25 | .90 | .95 | .70 |
| 14 | ..... | ..... | .60 | 3.95 | 5.25 | 7.20 | 4.65 | 1.95 | 1.40 | .80 | .95 | .75 |
| 15 | ..... | ..... | .50 | 3.10 | 4.95 | 6.80 | 4.40 | 1.85 | 1.30 | .90 | .95 | .60 |
| 16 | ..... | ..... | .55 | 3.05 | 4.70 | 6.80 | 4.30 | 1.80 | 1.20 | .90 | .95 | .55 |
| 17 | ..... | ..... | .40 | 2.75 | 4.70 | 7.25 | 4.10 | 1.85 | 1.15 | .95 | .95 | .50 |
| 18 | ..... | ..... | .55 | 2.65 | 4.70 | 7.85 | 4.00 | 1.80 | 1.10 | .95 | .85 | .75 |
| 19 | ..... | ..... | .25 | 2.55 | 4.85 | 8.55 | 3.85 | 1.75 | 1.15 | .90 | 1.25 | .90 |
| 20 | ..... | .90 | .35 | 2.25 | 4.80 | 8.70 | 3.90 | 1.75 | 1.30 | .95 | .90 | 1.00 |
| 21 | ..... | .65 | .30 | 2.45 | 4.85 | 8.45 | 3.75 | 1.75 | 1.10 | 1.15 | .90 | .85 |
| 22 | 0.65 | 1.65 | .25 | 2.67 | 4.85 | 7.75 | 3.55 | 1.75 | 1.05 | 1.00 | .95 | .95 |
| 23 | .60 | ..... | .35 | 2.80 | 5.05 | 7.10 | 3.55 | 1.95 | 1.00 | 1.00 | .90 | .85 |
| 24 | .85 | ..... | .35 | 2.45 | 5.25 | 6.80 | 3.25 | 1.80 | .90 | 1.05 | .80 | 1.15 |
| 25 | .70 | ..... | .40 | 2.45 | 6.20 | 6.65 | 3.10 | 1.70 | 1.10 | .95 | .95 | 1.10 |
| 26 | .75 | ..... | .20 | 3.05 | 7.10 | 6.95 | 3.05 | 1.65 | 1.00 | 1.00 | 1.05 | 1.15 |
| 27 | 1.00 | ..... | .30 | 3.25 | 7.65 | 7.10 | 2.80 | 1.65 | 1.05 | .95 | .95 | .95 |
| 28 | 1.05 | ..... | .15 | 3.05 | 7.60 | 6.65 | 2.75 | 1.70 | 1.00 | .95 | .85 | .75 |
| 29 | .95 | ..... | .20 | 2.80 | 7.10 | 6.55 | 2.70 | 1.65 | 1.05 | .95 | .90 | .50 |
| 30 | .90 | ..... | .30 | 2.60 | 7.25 | 6.80 | 2.70 | 1.45 | .90 | .95 | .80 | .55 |
| 31 | 1.00 | ..... | .20 | ..... | 7.00 | ..... | 2.65 | 1.45 | ..... | 1.00 | ..... | .70 |

## RATTLESNAKE CREEK AT MISSOULA, MONTANA.

This is a stream having its source north of Missoula and draining a small extent of country. It enters Missoula River in the city of Missoula. The most important application of this stream is by the Missoula waterworks, for the water supply of the city of Missoula. About 15 second-feet are used for this purpose. Twelve ditches, with a capacity of from 1 to 10 second-feet each, divert water from the creek and irrigate lands in Rattlesnake Valley and in the vicinity of Missoula. Another ditch, with a capacity of 20 second-feet, diverts water from the mouth of the stream and is used for power purposes in a cabinet shop in the town of Missoula. At a medium stage of water in 1899 this stream was carrying 108 second-feet above the ditch diversions. At the same time it was discharging into Missoula River 45 second-feet, the difference, 63 second-feet, being used for power and irrigation purposes. The station was established May 27, 1899, and is located at the Ivy street bridge in the center of the city. The bench mark is the top of the capstone of the stone steps of the house owned by Thomas Greenough, 25 yards southeast from the gage and 1.983 feet above center of axle of the pulley of the gage. Between May 27 and September 7 a stretch of 0.15 foot was noticed, and the records, as published, have been correspondingly corrected.

The following discharge measurements were made during 1899 under the direction of Prof. F. D. Smith:

*Discharge measurements of Rattlesnake Creek at Missoula, Montana.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| May 30 | 4.55 | 653 | July 28 | 3.20 | 124 |
| June 12 | 6.05 | 1,712 | August 22 | 2.85 | 63 |
| June 17 | 5.70 | 1,695 | September 7 | 2.85 | 68 |
| July 4 | 5.00 | 1,097 | September 28 | 2.60 | 47 |
| July 12 | 4.30 | 570 | | | |

*Daily gage height, in feet, of Rattlesnake Creek at Missoula, Montana, for 1899.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 4.35 | 5.00 | 2.98 | 2.68 | 2.53 | 2.85 | 2.98 |
| 2 | ..... | 4.65 | 5.13 | 2.98 | 2.68 | 2.50 | 2.85 | 2.98 |
| 3 | ..... | 4.90 | 5.03 | 2.95 | 2.73 | 2.50 | 2.83 | 3.00 |
| 4 | ..... | 5.03 | 4.95 | 2.90 | 2.90 | 2.50 | 2.80 | 3.00 |
| 5 | ..... | 4.98 | 5.00 | 2.80 | 2.80 | 2.50 | 2.93 | 2.98 |
| 6 | ..... | 4.60 | 4.78 | 2.73 | 2.83 | 2.50 | 2.75 | 2.95 |
| 7 | ..... | 4.35 | 4.70 | 2.68 | 2.83 | 2.50 | 2.75 | 2.93 |
| 8 | ..... | 4.20 | 4.70 | 2.78 | 2.78 | 2.50 | 2.73 | 2.93 |
| 9 | ..... | 4.23 | 4.70 | 2.88 | 2.80 | 2.55 | 2.70 | 2.90 |
| 10 | ..... | 4.70 | 4.58 | 2.88 | 2.73 | 2.58 | 2.75 | 2.88 |
| 11 | ..... | 6.05 | 4.50 | 2.85 | 2.68 | 2.55 | 2.83 | 2.85 |
| 12 | ..... | 5.95 | 4.38 | 2.80 | 2.70 | 2.58 | 2.88 | 2.80 |
| 13 | ..... | 5.20 | 4.30 | 2.75 | 2.80 | 2.58 | 2.85 | 2.80 |
| 14 | ..... | 4.85 | 4.18 | 2.78 | 2.80 | 2.50 | 2.80 | 2.73 |
| 15 | ..... | 4.68 | 4.10 | 2.75 | 2.80 | 2.58 | 2.78 | 2.35 |
| 16 | ..... | 5.18 | 3.98 | 2.75 | 2.80 | 2.58 | 2.75 | 2.30 |
| 17 | ..... | 5.90 | 3.80 | 2.70 | 2.78 | 2.65 | 2.75 | (*a*) |
| 18 | ..... | 6.25 | 3.83 | 2.68 | 2.75 | 2.63 | 2.75 | (*a*) |
| 19 | ..... | 6.18 | 3.73 | 2.63 | 2.73 | 2.65 | 2.75 | (*a*) |
| 20 | ..... | 6.05 | 3.63 | 2.65 | 2.68 | 2.90 | 2.75 | (*a*) |
| 21 | ..... | 5.12 | 3.60 | 2.78 | 2.68 | 2.93 | 2.75 | (*a*) |
| 22 | ..... | 4.83 | 3.60 | 2.80 | 2.65 | 2.90 | 2.70 | (*a*) |
| 23 | ..... | 4.70 | 3.53 | 2.85 | 2.60 | 2.90 | 2.73 | (*a*) |
| 24 | ..... | 5.00 | 3.43 | 2.83 | 2.60 | 2.88 | 2.68 | 2.90 |
| 25 | ..... | 5.40 | 3.40 | 2.75 | 2.55 | 2.88 | 2.65 | 2.95 |
| 26 | ..... | 5.73 | 3.35 | 2.78 | 2.55 | 2.85 | 2.70 | 3.05 |
| 27 | 5.15 | 5.35 | 3.33 | 2.83 | 2.55 | 2.85 | 2.73 | 3.00 |
| 28 | 4.78 | 5.05 | 3.23 | 2.73 | 2.55 | 2.88 | 2.98 | 2.90 |
| 29 | 4.45 | 5.35 | 3.13 | 2.68 | 2.55 | 2.90 | 3.05 | 3.00 |
| 30 | 4.65 | 5.33 | 3.03 | 3.65 | 2.53 | 2.85 | 3.03 | 2.85 |
| 31 | 4.40 | ..... | 3.08 | 2.68 | ..... | 2.85 | ..... | ..... |

*a* December 17 to 23 no readings.

## MISSOULA RIVER AT MISSOULA, MONTANA.

This river has its source in Silverbow County and flows northerly until it receives the waters of Little Blackfoot River, when it takes a more northwesterly course. The name Missoula is usually applied to that section of the river between the junction of Blackfoot and Hellgate rivers and the mouth of Pend Oreille River. The name usually applied to it from this point down to its junction with Columbia River is Clark Fork of the Columbia. The station, established July 10, 1898, is located at Higgins avenue bridge in Missoula. The river at this point flows in two channels, and in order to study their fluctuations a second rod was placed on the south channel January 28, 1899.

This second rod is vertical and attached to the pier of the bridge. The readings of the two rods were made to correspond on the date of the establishment of the second rod, and they were 2.85 feet. The original rod is known as rod No. 1, and the gage in the south channel is known as rod No. 2. Discharge measurements are always made at the bridge of the Bitterroot Valley division of the Northern Pacific Railway some distance below the Higgins avenue bridge. The river at this point is practically in one channel, except in times of flood, when some water finds its way through a slough 600 feet south of the bridge. On account of the difficulty of accurately measuring the fluctuations of the river at rods Nos. 1 and 2 a third rod was placed May 27, 1899, below the junction of the two branches and 150 yards east of the railroad bridge. The rod at this point consists of a horizontal 20-foot timber bolted to a cottonwood tree immediately below the buildings of the Garden City Bottling Works. The rod is securely braced with timbers both above and below and guyed by wires on both sides. To the horizontal timber is attached a wire gage, the length of which is 22 feet. The bench mark consists of a United States Geological Survey iron post, at the junction of McCormick and West Cedar streets, 100 yards west of the gage, on the north side of the highway. Its elevation above sea is 3,194.642 feet. The top of the horizontal bar of the gage at a point exactly over the iron bolt which holds the rod to the cottonwood tree is 3,178.338 feet. The height of the river was read at the three rods during 1899, but observations during 1900 will only be taken at rod No. 3, the other two being discontinued. The results of measurements for 1898 may be found in the Twentieth Annual Report, Part IV, page 491. Measurements for 1898 and 1899 were made under the direction of F. D. Smith and are as follows:

*Discharge measurements of Missoula River at Missoula, Montana.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| April 22 | *a* 4.75 | 6,876 | August 1 | 5.35 | 4,822 |
| May 30 | 9.50 | 23,295 | August 24 | 4.75 | 3,127 |
| June 19 | 10.55 | 34,634 | September 8 | 4.15 | 2,492 |
| July 6 | 8.30 | 17,872 | October 21 | 4.10 | 2,273. |
| July 14 | 7.30 | 9,235 | | | |

*a* Gage height at rod No. 1. The other gage heights were taken on rod No. 3.

*Daily gage height, in feet, of Missoula River at Missoula, Montana, for 1899.*

[Rod No. 1.]

| Day. | Jan. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | 2.33 | 4.15 | 9.10 | 8.90 | 4.35 | 3.33 | 2.95 |
| 2 | ..... | ..... | 2.35 | 4.15 | 8.95 | 8.50 | 4.30 | 3.30 | 2.95 |
| 3 | ..... | ..... | 2.40 | 3.95 | 9.60 | 8.30 | 4.28 | 3.33 | 2.95 |
| 4 | ..... | ..... | 2.50 | 3.80 | 10.10 | 8.15 | 4.20 | 3.38 | 2.95 |
| 5 | ..... | ..... | 2.70 | 3.80 | 10.50 | 8.00 | 4.20 | 3.38 | 2.95 |
| 6 | ..... | ..... | 3.00 | 4.15 | 10.30 | 7.75 | 4.08 | 3.33 | 2.95 |
| 7 | ..... | 2.30 | 3.33 | 4.50 | 9.60 | 7.38 | 4.00 | 3.20 | 2.95 |
| 8 | ..... | 2.35 | 3.63 | 5.10 | 8.80 | 7.35 | 4.00 | 3.20 | 2.95 |
| 9 | ..... | 2.48 | 3.73 | 5.75 | 8.35 | 7.40 | 4.03 | 3.15 | 2.95 |
| 10 | ..... | 2.50 | 4.87 | 6.70 | 8.40 | 7.33 | 4.05 | 3.15 | 2.95 |
| 11 | ..... | 2.55 | 5.85 | 7.05 | 9.15 | 7.25 | 4.00 | 3.13 | 2.95 |
| 12 | ..... | 2.58 | 6.20 | 7.30 | 10.08 | 6.93 | 3.95 | 3.10 | 2.95 |
| 13 | ..... | 2.60 | 7.60 | 7.15 | 9.90 | 6.75 | 3.93 | 3.10 | 3.00 |
| 14 | ..... | 2.38 | 6.40 | 6.95 | 9.65 | 6.50 | 3.95 | 3.10 | 2.98 |
| 15 | ..... | ..... | 4.95 | 6.65 | 9.43 | 6.38 | 3.90 | 3.10 | 2.93 |
| 16 | ..... | 2.15 | 4.95 | 6.45 | 9.45 | 6.23 | 3.80 | 3.10 | 2.98 |
| 17 | ..... | 2.15 | 4.78 | 6.40 | 9.85 | 5.90 | 3.75 | 3.03 | 3.00 |
| 18 | ..... | 2.20 | 4.55 | 6.40 | 10.60 | 5.65 | 3.70 | 3.00 | 3.00 |
| 19 | ..... | 2.18 | 4.40 | 6.35 | 10.90 | 5.48 | 3.68 | 3.00 | 2.98 |
| 20 | ..... | 2.28 | 4.05 | 6.45 | 11.30 | 5.43 | 3.63 | 2.95 | 3.00 |
| 21 | ..... | 2.25 | 3.98 | 6.50 | 10.73 | 5.38 | 3.63 | 2.95 | 3.03 |
| 22 | ..... | 2.20 | 4.53 | 6.55 | 10.10 | 5.30 | 3.70 | 2.95 | 3.03 |
| 23 | ..... | 2.15 | 4.70 | 6.75 | 9.35 | 5.15 | 3.75 | 2.95 | 3.00 |
| 24 | ..... | 2.28 | 4.35 | 7.05 | 8.95 | 4.90 | 3.73 | 2.95 | 3.00 |
| 25 | ..... | 2.35 | 4.28 | 8.00 | 9.05 | 4.73 | 3.70 | 2.95 | 3.05 |
| 26 | ..... | 2.35 | 4.83 | 9.10 | 9.50 | 4.68 | 3.63 | 2.95 | 3.00 |
| 27 | ..... | 2.48 | 4.95 | 9.80 | 9.70 | 4.60 | 3.55 | 2.95 | 3.05 |
| 28 | ..... | 2.58 | 4.70 | 9.75 | 9.15 | 4.53 | 3.50 | 2.90 | 3.00 |
| 29 | 2.80 | 2.53 | 4.45 | 9.35 | 9.00 | 4.50 | 3.50 | 2.90 | 2.95 |
| 30 | 2.75 | 2.40 | 4.25 | 9.30 | 9.10 | 4.40 | 3.45 | 2.90 | 2.93 |
| 31 | 2.75 | 2.30 | ..... | 9.15 | ..... | 4.30 | 3.43 | ..... | 2.90 |

No record for February; ice. Station discontinued October 31.

*Daily gage height, in feet, of Missoula River at Missoula, Montana, for 1899.*

[Rod No. 2.]

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.50 | 3.80 | 7.60 | 7.25 | 3.83 | 3.20 | 2.95 |
| 2 | ..... | 2.50 | 3.70 | 7.28 | 6.93 | 3.88 | 3.20 | 2.95 |
| 3 | ..... | 2.55 | 3.60 | 7.80 | 6.78 | 3.83 | 3.23 | 2.95 |
| 4 | ..... | 2.60 | 3.50 | 8.20 | 6.65 | 3.75 | 3.20 | 2.95 |
| 5 | ..... | 2.75 | 3.60 | 8.60 | 6.55 | 3.78 | 3.20 | 2.95 |
| 6 | ..... | 2.90 | 4.00 | 8.45 | 6.35 | 3.73 | 3.15 | 2.95 |
| 7 | ..... | 3.10 | 4.20 | 7.65 | 7.13 | 3.63 | 3.15 | 2.95 |
| 8 | ..... | 3.30 | 4.60 | 7.15 | 6.00 | 3.65 | 3.15 | 2.95 |
| 9 | ..... | 3.50 | 5.30 | 6.85 | 6.00 | 3.65 | 3.13 | 2.95 |
| 10 | ..... | 4.70 | 5.60 | 6.75 | 6.00 | 3.70 | 3.05 | 3.00 |
| 11 | 2.50 | 5.30 | 6.00 | 7.40 | 5.98 | 3.68 | 3.03 | 3.05 |
| 12 | 2.58 | 5.30 | 6.20 | 8.35 | 5.83 | 3.60 | 3.00 | 3.05 |
| 13 | 2.60 | 6.20 | 5.90 | 8.35 | 5.55 | 3.60 | 3.00 | 3.08 |
| 14 | (a) | 4.80 | 5.75 | 7.90 | 5.48 | 3.65 | 3.00 | 3.05 |
| 15 | (a) | 4.30 | 5.60 | 7.43 | 5.40 | 3.53 | 3.05 | 2.93 |
| 16 | (a) | 4.50 | 5.50 | 7.45 | 5.20 | 3.45 | 3.03 | 3.03 |
| 17 | 2.40 | 4.20 | 5.40 | 7.80 | 5.00 | 3.45 | 3.05 | 3.05 |
| 18 | 2.28 | 4.20 | 5.30 | 8.65 | 4.80 | 3.40 | 3.00 | 3.05 |
| 19 | 2.28 | 3.90 | 5.30 | 8.80 | 4.73 | 3.35 | 3.00 | 3.03 |
| 20 | 2.40 | 3.70 | 5.40 | 8.90 | 4.54 | 3.40 | 2.98 | 3.15 |
| 21 | (a) | 3.70 | 5.40 | 8.85 | 4.50 | 3.40 | 2.95 | 3.08 |
| 22 | (a) | 4.20 | 5.50 | 8.40 | 4.48 | 3.48 | 2.95 | 3.10 |
| 23 | (a) | 4.10 | 5.70 | 7.90 | 4.43 | 3.50 | 2.95 | 3.05 |
| 24 | 2.40 | 3.90 | 5.80 | 7.45 | 4.28 | 3.45 | 5.95 | 3.10 |
| 25 | 2.45 | 4.00 | 6.80 | 7.50 | 4.20 | 3.43 | 2.95 | 3.05 |
| 26 | 2.55 | 4.30 | 7.60 | 8.05 | 4.00 | 3.38 | 2.98 | 3.05 |
| 27 | 2.60 | 4.40 | 8.00 | 7.80 | 4.00 | 3.33 | 2.95 | 3.10 |
| 28 | 2.55 | 4.10 | 7.80 | 7.48 | 3.90 | 3.30 | 2.90 | 3.05 |
| 29 | 2.61 | 3.90 | 7.40 | 7.40 | 3.90 | 3.30 | 2.90 | 3.00 |
| 30 | 2.50 | 3.80 | 7.50 | 7.48 | 3.85 | 3.25 | 2.90 | 2.98 |
| 31 | 2.45 | ..... | 7.50 | ..... | 3.85 | 3.23 | ..... | 2.95 |

*a* Ice. Station discontinued October 31.

*Daily gage height, in feet, of Missoula River at Missoula, Montana, for 1899.*

[Rod No. 3.]

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 9.30 | 9.30 | 5.40 | 4.25 | 3.78 | 3.98 | 3.95 |
| 2 | ..... | 9.22 | 8.95 | 5.35 | 4.23 | 3.75 | 3.95 | 3.93 |
| 3 | ..... | 9.60 | 8.75 | 5.25 | 4.28 | 3.75 | 3.90 | 3.88 |
| 4 | ..... | 10.00 | 8.60 | 5.10 | 4.33 | 3.75 | 3.95 | 3.60 |
| 5 | ..... | 10.23 | 8.55 | 5.08 | 4.33 | 3.75 | 3.95 | 3.53 |
| 6 | ..... | 10.05 | 8.33 | 4.98 | 4.25 | 3.75 | 3.98 | 3.60 |
| 7 | ..... | 10.38 | 8.13 | 4.83 | 4.18 | 3.75 | 3.93 | 3.60 |
| 8 | ..... | 9.10 | 8.05 | 4.95 | 4.15 | 3.75 | 3.90 | 3.65 |
| 9 | ..... | 8.73 | 8.03 | 5.08 | 4.13 | 3.75 | 3.95 | 3.75 |
| 10 | ..... | 8.78 | 8.00 | 5.15 | 4.10 | 3.75 | 3.93 | 3.70 |
| 11 | ..... | 9.38 | 7.93 | 5.12 | 4.08 | 3.80 | 3.90 | 3.70 |
| 12 | ..... | 10.05 | 7.73 | 5.00 | 4.05 | 3.80 | 3.93 | 3.75 |
| 13 | ..... | 10.05 | 7.58 | 4.90 | 4.05 | 3.88 | 3.98 | 3.80 |
| 14 | ..... | 9.73 | 7.38 | 4.93 | 4.05 | 3.80 | 3.95 | 3.80 |
| 15 | ..... | 9.43 | 7.20 | 4.78 | 4.08 | 3.68 | 3.98 | 3.30 |
| 16 | ..... | 9.23 | 6.95 | 4.73 | 4.08 | 3.88 | 3.88 | ..... |
| 17 | ..... | 9.80 | 6.88 | 4.65 | 4.05 | 3.95 | 3.88 | ..... |
| 18 | ..... | 10.38 | 6.70 | 4.58 | 4.00 | 3.98 | 3.90 | ..... |
| 19 | ..... | 10.55 | 6.48 | 4.53 | 4.00 | 4.03 | 3.90 | ..... |
| 20 | ..... | 10.65 | 6.43 | 4.70 | 3.93 | 4.10 | 3.90 | ..... |
| 21 | ..... | 10.45 | 6.33 | 4.65 | 3.90 | 4.10 | 3.95 | ..... |
| 22 | ..... | 10.03 | 6.23 | 4.73 | 3.90 | 4.20 | 3.90 | ..... |
| 23 | ..... | 8.95 | 6.13 | 4.85 | 3.85 | 4.15 | 3.88 | ..... |
| 24 | ..... | 9.30 | 5.98 | 4.75 | 3.75 | 4.18 | 3.83 | ..... |
| 25 | ..... | 9.30 | 5.83 | 4.65 | 3.80 | 4.10 | 3.75 | ..... |
| 26 | ..... | 9.58 | 5.68 | 4.52 | 3.78 | 4.08 | 3.65 | ..... |
| 27 | 9.85 | 9.65 | 5.50 | 4.50 | 3.73 | 4.15 | 3.75 | ..... |
| 28 | 9.80 | 9.38 | 5.45 | 4.50 | 3.75 | 4.05 | 3.88 | ..... |
| 29 | 9.55 | 9.25 | 5.45 | 4.48 | 3.75 | 4.00 | 3.98 | ..... |
| 30 | 9.55 | 9.33 | 5.40 | 4.38 | 3.75 | 3.98 | 3.95 | ..... |
| 31 | 9.45 | ..... | 5.40 | 4.28 | ..... | 3.95 | ..... | ..... |

## BITTERROOT RIVER AT COMO, MONTANA.

The main source of supply of this river is in the high mountains forming the boundary line between Montana and Idaho. The general direction of the stream is northerly, entering Missoula River a short distance below the city of Missoula. The tributaries on the east side drain comparatively low hills and contribute little to the supply of the river. The west-side branches, on the contrary, are numerous, draining a precipitous and heavily wooded area. Their discharges are regulated by many small lakes fed by banks of snow which continue far into the summer season before disappearing altogether. In the vicinity of Hamilton are a number of large canals, the principal ones diverting water on the east side of the river for use by the Bitterroot Stock Farm. The higher bench lands west of the river are served by small ditches taken directly from the smaller tributaries. The ranchers on these bench lands have within the last few years increased the summer flow of their ditches by the construction of rude gates at the outlets of a number of the lakes on the headwaters of the side streams. This is done at the heads of Canyon, Bear, and Big creeks. An additional supply can be had by utilizing Lake Como. This lake is about 1 mile long and one-half mile wide and is near the mouth of Rock Creek. The gaging station, established by Cyrus C.

Babb in October, 1898, is located at the Harlan bridge near Como, and is 9 miles south of Grantsdale, Montana. A wire gage was placed on the downstream hand-rail of the bridge, and later a vertical rod was fastened to the upstream side of the south pier. The bench mark is on a cottonwood tree 10 feet west of the south end of the bridge, and is at an elevation of 6.10 feet above gage datum. The right bank of the river is high, while the left bank is low and liable to overflow. Gage readings have not yet been maintained at this point, and but one discharge measurement was made during 1899. H. S. Lord, on January 21, 1899, at a gage height of 1 foot, found a discharge of 384 second-feet.

### BITTERROOT RIVER AT MISSOULA, MONTANA.

The fall of this river from Hamilton to Missoula, a distance of 48 miles, is 350 feet, or 7.3 feet to the mile. The lower portion of Bitterroot Valley has not been as extensively cultivated as the section in the vicinity of Hamilton. There is a good flow of water in the river, but owing to the lighter grade of the lower country a greater length of canal is necessary than in the upper section, and therefore this latter district has been first developed. The gaging station is located at the Buckhouse wagon bridge, on the main road southwest of Missoula, and was established July 6, 1898. The bench mark is the regulation iron post of the United States Geological Survey, set 25 yards northwest of the bridge, near a fence at the side of the highway, and is 3.801 feet above the center of the axle of the gage pulley. The length of the gage wire is 22.83 feet. The channel of the river is nearly straight. The right bank is low and liable to overflow, but the left bank is high and rocky. The results obtained at the Buckhouse bridge, which is near the mouth of the river, are of value mainly in giving the total discharge of the stream. The results of measurements for 1898 may be found in the Twentieth Annual Report, Part IV, page 495. The following measurements of discharge were made under the direction of F. D. Smith in 1899:

*Discharge measurements of Bitterroot River at Missoula, Montana.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| April 29 | 3.75 | 3,794 | July 17 | 7.21 | 11,569 |
| May 16 | 5.18 | 7,405 | August 1 | 4.55 | 5,410 |
| June 10 | 6.70 | 11,732 | August 25 | 2.78 | 2,595 |
| June 17 | 9.00 | 20,355 | October 21 | 2.18 | 1,810 |
| June 20 | 11.40 | 37,012 | | | |

*Daily gage height, in feet, of Bitterroot River at Missoula, Montana, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (a) | (a) | 1.25 | 1.55 | 3.50 | 6.80 | 9.60 | 4.55 | 2.40 | 1.55 | 2.30 | 1.90 |
| 2 | (a) | (a) | 1.25 | 1.70 | 3.40 | 6.70 | 9.55 | 4.50 | 2.35 | 1.60 | 2.15 | 2.00 |
| 3 | (a) | (a) | 1.30 | 1.75 | 3.20 | 7.15 | 9.40 | 4.30 | 2.40 | 1.70 | 2.05 | 2.00 |
| 4 | (a) | (a) | 1.35 | 1.80 | 3.10 | 8.30 | 9.20 | 4.10 | 2.50 | 1.70 | 2.00 | 1.80 |
| 5 | (a) | (a) | 1.40 | 1.80 | 3.00 | 8.90 | 9.10 | 4.00 | 2.60 | 1.65 | 2.00 | 1.80 |
| 6 | (a) | (a) | 1.45 | 1.95 | 3.30 | 8.00 | 9.05 | 4.05 | 2.50 | 1.60 | 2.00 | 1.90 |
| 7 | (a) | (a) | 1.50 | 1.95 | 3.45 | 7.20 | 8.75 | 4.00 | 2.45 | 1.60 | 2.00 | 1.94 |
| 8 | (a) | (a) | 1.70 | 2.05 | 3.90 | 6.80 | 8.70 | 4.05 | 2.30 | 1.55 | 1.95 | 1.95 |
| 9 | (a) | (a) | 1.65 | 2.15 | 4.90 | 6.70 | 8.85 | 4.10 | 2.25 | 1.55 | 1.95 | 1.96 |
| 10 | (a) | (a) | 1.60 | 2.50 | 5.93 | 6.75 | 8.95 | 4.15 | 2.20 | 1.60 | 2.00 | 1.80 |
| 11 | (a) | (a) | 1.55 | 2.80 | 6.30 | 7.95 | 8.90 | 4.10 | 2.10 | 1.60 | 2.00 | 1.80 |
| 12 | (y) | (a) | 1.45 | 3.20 | 6.45 | 9.40 | 8.85 | 4.00 | 2.05 | 1.60 | 2.05 | 1.85 |
| 13 | (a) | (a) | 1.40 | 3.80 | 6.40 | 10.80 | 8.60 | 3.70 | 2.10 | 1.65 | 2.00 | 1.75 |
| 14 | (a) | (a) | 1.35 | 3.65 | 6.25 | 10.50 | 8.10 | 3.50 | 2.30 | 1.65 | 1.95 | 1.75 |
| 15 | (a) | (a) | 1.40 | 3.45 | 6.00 | 9.20 | 7.75 | 3.40 | 2.25 | 1.70 | 1.90 | 1.80 |
| 16 | (a) | (a) | 1.40 | 3.50 | 5.20 | 8.50 | 7.50 | 3.25 | 2.25 | 1.70 | 1.95 | (a) |
| 17 | 1.50 | (a) | 1.35 | 3.50 | 5.00 | 8.98 | 7.50 | 3.05 | 2.15 | 1.75 | 2.00 | (a) |
| 18 | 1.55 | (a) | 1.40 | 3.60 | 4.70 | 9.90 | 7.20 | 3.00 | 2.10 | 1.80 | 2.00 | (a) |
| 19 | 1.55 | (a) | 1.40 | 3.65 | 4.65 | 10.95 | 7.15 | 2.85 | 2.10 | 1.80 | 2.00 | (a) |
| 20 | 1.60 | (a) | 1.40 | 3.45 | 4.60 | 11.45 | 7.00 | 3.50 | 2.00 | 1.90 | 1.90 | (a) |
| 21 | 1.65 | (a) | 1.40 | 3.40 | 4.60 | 11.28 | 6.95 | 2.95 | 1.90 | 2.10 | 1.85 | (a) |
| 22 | 1.65 | (a) | 1.40 | 3.30 | 4.60 | 11.13 | 6.60 | 3.10 | 1.80 | 2.25 | 1.85 | (a) |
| 23 | 1.70 | (a) | 1.35 | 3.50 | 5.00 | 9.65 | 5.95 | 3.20 | 1.80 | 2.40 | 1.80 | (a) |
| 24 | 1.70 | (a) | 1.55 | 3.70 | 5.48 | 9.40 | 5.50 | 3.00 | 1.75 | 2.30 | 1.75 | (a) |
| 25 | 1.65 | (a) | 1.55 | 3.75 | 5.90 | 9.10 | 5.15 | 2.85 | 1.75 | 2.25 | 1.70 | 1.65 |
| 26 | 1.70 | (a) | 1.60 | 3.80 | 7.40 | 9.80 | 5.00 | 2.75 | 1.65 | 2.30 | 1.60 | 1.65 |
| 27 | 1.80 | (a) | 1.65 | 3.95 | 7.95 | 10.20 | 4.85 | 2.70 | 1.60 | 2.50 | 1.70 | 1.60 |
| 28 | 1.80 | (a) | 1.65 | 4.00 | 7.70 | 9.90 | 4.80 | 2.65 | 1.60 | 2.55 | 1.80 | 1.60 |
| 29 | (a) | ..... | 1.65 | 3.75 | 7.30 | 9.60 | 4.75 | 2.60 | 1.65 | 2.60 | 1.90 | 1.68 |
| 30 | (a) | ..... | 1.65 | 3.60 | 7.50 | 9.85 | 4.75 | 2.50 | 1.55 | 2.55 | 1.90 | 1.70 |
| 31 | (a) | ..... | 1.60 | ..... | 6.95 | ..... | 4.60 | 2.45 | ..... | 2.40 | ..... | 1.70 |

*a* Frozen.

## SPOKANE RIVER AND LAKE CŒUR D'ALENE.

This river receives the outflow of Lake Cœur d'Alene, the outlet being at the northern end of the lake near the town of Cœur d'Alene. The greater part of the lake is shown on the topographic atlas sheet of the same name. The bench mark near the lake was established by Mr. Van H. Manning in 1899. From his notes it appears that this bench mark, consisting of an aluminum tablet in the southeast corner of the Merriam Building, corner of Sherman and Fourth streets, Cœur d'Alene, Idaho, is 2 feet above the sidewalk and 1 foot from the door, at an elevation of 2,157.404 feet. The bench mark at the lake consists of a spike in a cottonwood tree at Johnson's boat landing. This is at an elevation of 2,130.645 feet. When placed, May 20, 1899, it was at the exact surface of the water of the lake. The fluctuations of lake level during 1899 are shown by the following readings by Mr. Manning:

*Elevation of water surface of Lake Cœur d'Alene.*

1899.

| Date. | Elevation. |
|---|---|
| | *Feet.* |
| May 20 | 2,130.645 |
| May 23 | 2,130.000 |
| July 3 | 2,128.242 |
| July 24 | 2,123.643 |
| August 5 (5 p.m.) | 2,122.551 |
| August 23 | 2,121.469 |

The level of the water in the lake is influenced by a dam at Post Falls, 8¾ miles below the outlet of the lake. On August 5, at 3.30 p. m., the elevation of the surface of the water at the dam at Post Falls was 2,119.580 feet. Observations were made on the same day, at 5 p. m., at Cœur d'Alene, giving the elevation of water surface above noted—2,122.551 feet—and showing a difference of 2.971 feet between the lake surface and the water in the river at the dam. It is proposed to maintain occasional observations of the height of water at Cœur d'Alene.

Fernan Lake is a small body of water 2 miles east of the town of Cœur d'Alene. A bench mark has been established at the west end of the lake on a stone about 20 inches by 30 inches, 20 inches in diameter, 15 feet north of and 200 feet east of Fernan's house. The cross on this stone is at an elevation of 2,133.16 feet. The surface of the lake on August 18, 1899, was at a height of 2,129.028 feet.

Hayden Lake is east of Rathdrum Prairie and about 6 miles north of Cœur d'Alene. Although a body of water of considerable size and receiving drainage from a mountain area it has no visible outlet. A bench mark has been placed at the west end of the lake and consists of a nail in a pine tree 40 feet north of and 200 feet east of gate to King's ranch. Its elevation is 2,261.495 feet. The surface of the lake on August 10, 1899, was 2,242.764 feet; on August 29, 2,242.666 feet; on October 10, 2,241.369 feet.

Spirit Lake is a small body of water 12 miles north of Rathdrum Prairie. An iron post marked "2,490 S" has been placed at the east end of the lake, 200 feet east of the landing and 15 feet south of the road. The correct elevation is 2,489.993 feet. The elevation of the lake surface on September 14, 1899, was 2,444.037 feet.

Fish Lake is 3 miles north of Rathdrum. An iron post marked "2,366 S" has been placed one-fourth of a mile east of the south end of the lake and 8 feet east of the fork of the roads. The elevation is 2,365.706 feet. The elevation of lake surface on September 4, 1899, was 2,314.016 feet. Irrigation of Rathdrum Prairie has been begun by the Spokane Valley Irrigation Company.

Pend Oreille Lake is the source of Clark Fork of the Columbia. The elevation of its surface on September 22, 1899, as determined by Mr. Van H. Manning, was 2,055 feet.

### SPOKANE RIVER AT SPOKANE, WASHINGTON.

The falls at Spokane, aggregating 142 feet in height, have been utilized to a considerable extent by a number of flour mills, as well as by the power plant of the Washington Water Power Company, which furnishes electric power for the street-car service and for the lighting of the city. The river station established October 17, 1896, is located a short distance above the falls, at the bridge of the Oregon Railroad and Navigation Company. The length of the wire gage is 22 feet. The gage was connected with the bench mark of the city engineering

department and referred to sea level, the zero being 1,880 feet above sea level. The banks are high and do not overflow except in unusual floods. The velocity is quite swift, even at low stages. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 359; 1897, Nineteenth Annual Report, Part IV, page 488; 1898, Twentieth Annual Report, Part IV, page 511. One measurement of discharge was made here during 1899 by Sydney Arnold, on June 23, when at a gage height of 9.30 feet a discharge of 23,258 second-feet was found.

*Daily gage height, in feet, of Spokane River at Spokane, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.40 | 5.50 | 3.75 | 3.65 | 8.65 | 10.60 | 8.30 | 3.75 | 2.40 | 2.00 | 2.40 | 3.95 |
| 2 | 2.50 | 5.40 | 3.75 | 3.70 | 8.50 | 10.55 | 8.20 | 3.75 | 2.40 | 2.00 | 2.40 | 4.50 |
| 3 | 2.60 | 5.25 | 3.75 | 3.75 | 8.40 | 10.40 | 8.00 | 3.75 | 2.40 | 2.00 | 2.40 | 5.00 |
| 4 | 2.60 | 5.10 | 3.70 | 3.80 | 8.20 | 10.45 | 7.80 | 3.70 | 2.40 | 2.00 | 2.40 | 5.30 |
| 5 | 2.60 | 5.00 | 3.65 | 3.90 | 8.00 | 10.60 | 7.60 | 3.70 | 2.40 | 2.00 | 2.35 | 5.35 |
| 6 | 2.55 | 4.85 | 3.65 | 4.00 | 7.90 | 10.70 | 7.40 | 3.60 | 2.40 | 1.90 | 2.35 | 5.40 |
| 7 | 2.55 | 4.70 | 3.60 | 4.10 | 7.70 | 10.65 | 7.15 | 3.50 | 2.40 | 1.90 | 2.35 | 5.35 |
| 8 | 2.50 | 4.60 | 3.60 | 4.35 | 7.80 | 10.50 | 7.05 | 3.40 | 2.40 | 1.95 | 2.35 | 5.25 |
| 9 | 2.50 | 4.50 | 3.65 | 4.45 | 8.05 | 10.35 | 6.85 | 3.30 | 2.40 | 1.95 | 2.35 | 5.20 |
| 10 | 2.50 | 4.40 | 3.70 | 4.85 | 8.55 | 10.10 | 6.70 | 3.30 | 2.40 | 1.90 | 2.35 | 5.10 |
| 11 | 2.50 | 4.30 | 3.80 | 5.05 | 9.00 | 10.00 | 6.50 | 3.25 | 2.40 | 1.90 | 2.35 | 4.90 |
| 12 | 2.50 | 4.20 | 3.85 | 5.45 | 9.45 | 9.85 | 6.40 | 3.10 | 2.30 | 1.90 | 2.30 | 4.85 |
| 13 | 2.50 | 4.10 | 3.85 | 6.20 | 9.90 | 9.89 | 6.30 | 3.00 | 2.30 | 1.90 | 2.30 | 4.75 |
| 14 | 2.50 | 4.05 | 3.85 | 6.90 | 10.20 | 9.85 | 6.20 | 2.95 | 2.30 | 1.90 | 2.30 | 4.70 |
| 15 | 2.60 | 4.00 | 3.85 | 7.40 | 10.35 | 9.85 | 6.10 | 2.90 | 2.30 | 1.90 | 2.30 | 4.65 |
| 16 | 2.60 | 3.90 | 3.85 | 7.50 | 10.35 | 9.75 | 5.85 | 2.85 | 2.30 | 1.90 | 2.30 | 4.55 |
| 17 | 2.60 | 3.90 | 3.85 | 7.85 | 10.20 | 9.60 | 5.70 | 2.85 | 2.30 | 1.90 | 2.30 | 4.40 |
| 18 | 2.60 | 3.85 | 3.80 | 8.00 | 10.10 | 9.60 | 5.60 | 2.80 | 2.30 | 1.90 | 2.30 | 4.25 |
| 19 | 2.60 | 3.85 | 3.70 | 8.20 | 10.00 | 9.70 | 5.25 | 2.75 | 2.25 | 1.90 | 2.50 | 4.10 |
| 20 | 2.85 | 3.90 | 3.65 | 8.30 | 9.85 | 9.74 | 5.05 | 2.75 | 2.20 | 1.95 | 2.50 | 4.00 |
| 21 | 2.95 | 3.95 | 3.65 | 8.30 | 9.70 | 9.70 | 4.90 | 2.75 | 2.20 | 2.00 | 2.65 | 3.90 |
| 22 | 3.65 | 3.95 | 3.70 | 8.25 | 9.50 | 9.60 | 4.75 | 2.75 | 2.15 | 2.10 | 2.80 | 3.85 |
| 23 | 4.55 | 3.90 | 3.70 | 8.20 | 9.50 | 9.50 | 4.65 | 2.75 | 2.15 | 2.20 | 2.85 | 3.80 |
| 24 | 5.20 | 3.90 | 3.70 | 8.20 | 9.50 | 9.40 | 4.50 | 2.65 | 2.15 | 2.25 | 2.90 | 3.90 |
| 25 | 5.60 | 3.90 | 3.70 | 8.15 | 9.70 | 9.30 | 4.45 | 2.60 | 2.10 | 2.30 | 2.90 | 4.15 |
| 26 | 5.55 | 3.90 | 3.70 | 8.15 | 9.95 | 9.15 | 4.30 | 2.60 | 2.10 | 2.35 | 2.90 | 4.50 |
| 27 | 5.55 | 3.80 | 3.65 | 8.35 | 10.25 | 8.85 | 4.20 | 2.55 | 2.10 | 2.35 | 3.00 | 4.75 |
| 28 | 5.55 | 3.80 | 3.60 | 8.60 | 10.55 | 8.55 | 4.00 | 2.55 | 2.10 | 2.35 | 3.00 | 4.90 |
| 29 | 5.55 | ..... | 3.60 | 8.70 | 10.80 | 8.50 | 3.90 | 2.55 | 2.05 | 2.35 | 3.20 | 4.90 |
| 30 | 5.55 | ..... | 3.60 | 8.70 | 10.80 | 8.40 | 3.80 | 2.50 | 2.05 | 2.35 | 3.50 | 4.80 |
| 31 | 5.60 | ..... | 3.65 | ..... | 10.80 | ..... | 3.75 | 2.45 | ..... | 2.40 | ..... | 4.70 |

## LAKE CHELAN AT LAKESIDE, WASHINGTON.

This lake is situated in the north-central part of Washington, on the eastern slope of the Cascade Mountains. The streams which contribute to it have their sources in the glaciers, and thus there is a constant supply. The outlet of the lake is at the southern extremity, through Chelan River, which empties into Columbia River 4 miles below. The lake itself is very deep, a depth of 1,400 feet having been found by soundings made by the topographers of the United States Geological Survey. As the surface of the lake is at an elevation of about 1,100 feet, this would show that the bottom was about 300 feet below sea level. The country surrounding the lower extremity of this body of water is of a rolling character and is largely used for grazing purposes. The gage on the lake was established by Capt. Charles Johnson September 1, 1897, at the base of the rock pier on the lake shore north of his house, about one-half mile from the steamboat landing.

The bench mark is a United States Geological Survey iron post, with the elevation—1,121 feet above sea level—stamped on the top. This bench mark is just 21 feet above datum of the gage, so that to obtain the elevation of the surface of the lake above sea level 1,100 feet should be added to the rod readings.

*Daily gage height, in feet, of Lake Chelan at Lakeside, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.10 | 7.85 | 7.35 | 6.85 | 7.40 | 10.10 | 11.60 | 10.90 | 8.45 | 7.70 | 7.05 | 7.90 |
| 2 | 7.20 | 7.85 | 7.35 | 6.90 | 7.45 | 10.10 | 11.55 | 10.85 | 8.40 | 7.70 | 7.10 | 7.95 |
| 3 | 7.30 | 7.80 | 7.30 | 6.90 | 7.45 | 10.20 | 11.55 | 10.80 | 8.40 | 7.70 | 7.20 | 7.95 |
| 4 | 7.35 | 7.75 | 7.30 | 6.90 | 7.45 | 10.40 | 11.60 | 10.65 | 8.35 | 7.65 | 7.25 | 7.95 |
| 5 | 7.35 | 7.70 | 7.30 | 6.95 | 7.50 | 10.60 | 11.65 | 10.60 | 8.35 | 7.65 | 7.30 | 8.00 |
| 6 | 7.40 | 7.65 | 7.25 | 6.95 | 7.50 | 10.65 | 11.70 | 10.60 | 8.30 | 7.60 | 7.35 | 8.00 |
| 7 | 7.45 | 7.60 | 7.25 | 7.00 | 7.55 | 10.65 | 11.70 | 10.55 | 8.25 | 7.55 | 7.40 | 8.05 |
| 8 | 7.45 | 7.60 | 7.25 | 7.00 | 7.65 | 10.70 | 11.60 | 10.50 | 8.25 | 7.50 | 7.45 | 8.05 |
| 9 | 7.50 | 7.55 | 7.20 | 7.05 | 7.85 | 10.70 | 11.55 | 10.40 | 8.20 | 7.50 | 7.50 | 8.10 |
| 10 | 7.50 | 7.50 | 7.20 | 7.10 | 8.00 | 10.75 | 11.55 | 10.30 | 8.15 | 7.45 | 7.55 | 8.10 |
| 11 | 7.45 | 7.50 | 7.15 | 7.10 | 8.20 | 10.85 | 11.60 | 10.20 | 8.10 | 7.40 | 7.55 | 8.15 |
| 12 | 7.45 | 7.45 | 7.15 | 7.15 | 8.30 | 11.00 | 11.60 | 10.10 | 8.10 | 7.35 | 7.60 | 8.15 |
| 13 | 7.40 | 7.45 | 7.15 | 7.15 | 8.40 | 11.10 | 11.65 | 10.05 | 8.05 | 7.30 | 7.65 | 8.20 |
| 14 | 7.45 | 7.40 | 7.10 | 7.15 | 8.45 | 11.15 | 11.70 | 10.00 | 8.05 | 7.25 | 7.65 | 8.20 |
| 15 | 7.45 | 7.35 | 7.10 | 7.20 | 8.50 | 11.20 | 11.75 | 9.85 | 8.00 | 7.25 | 7.70 | 8.20 |
| 16 | 7.45 | 7.35 | 7.05 | 7.20 | 8.50 | 11.35 | 11.75 | 9.75 | 8.00 | 7.20 | 7.75 | 8.25 |
| 17 | 7.50 | 7.30 | 7.05 | 7.25 | 8.55 | 11.60 | 11.80 | 9.65 | 7.95 | 7.15 | 7.80 | 8.25 |
| 18 | 7.50 | 7.30 | 7.00 | 7.25 | 8.55 | 11.65 | 11.80 | 9.60 | 7.95 | 7.15 | 7.85 | 8.20 |
| 19 | 7.55 | 7.30 | 7.00 | 7.25 | 8.60 | 11.65 | 11.75 | 9.50 | 7.90 | 7.10 | 7.90 | 8.20 |
| 20 | 7.60 | 7.35 | 7.00 | 7.25 | 8.65 | 11.70 | 11.70 | 9.40 | 7.90 | 7.10 | 7.90 | 8.25 |
| 21 | 7.60 | 7.35 | 6.95 | 7.30 | 8.70 | 11.65 | 11.65 | 9.35 | 7.90 | 7.05 | 7.95 | 8.25 |
| 22 | 7.60 | 7.35 | 6.95 | 7.30 | 8.80 | 11.60 | 11.60 | 9.30 | 7.90 | 7.05 | 8.00 | 8.30 |
| 23 | 7.65 | 7.30 | 6.90 | 7.35 | 8.90 | 11.60 | 11.40 | 9.25 | 7.85 | 7.00 | 8.00 | 8.30 |
| 24 | 7.65 | 7.30 | 6.90 | 7.35 | 9.05 | 11.65 | 11.30 | 9.10 | 7.85 | 7.00 | 8.00 | 8.35 |
| 25 | 7.60 | 7.25 | 6.90 | 7.35 | 9.30 | 11.85 | 11.20 | 9.00 | 7.80 | 7.05 | 7.95 | 8.35 |
| 26 | 7.60 | 7.25 | 6.85 | 7.40 | 9.70 | 11.75 | 11.05 | 8.90 | 7.80 | 7.10 | 7.95 | 8.40 |
| 27 | 7.65 | 7.30 | 6.85 | 7.40 | 9.90 | 11.70 | 11.00 | 8.80 | 7.80 | 7.10 | 7.90 | 8.40 |
| 28 | 7.70 | 7.30 | 6.80 | 7.45 | 10.00 | 11.60 | 10.95 | 8.75 | 7.75 | 7.05 | 7.85 | 8.40 |
| 29 | 7.75 | ..... | 6.80 | 7.40 | 10.00 | 11.55 | 11.00 | 8.70 | 7.75 | 7.05 | 7.85 | 8.45 |
| 30 | 7.75 | ..... | 6.80 | 7.40 | 10.00 | 11.60 | 11.00 | 8.60 | 7.75 | 7.00 | 7.90 | 8.45 |
| 31 | 7.80 | ..... | 6.85 | ..... | 10.05 | ..... | 11.00 | 8.50 | ..... | 7.00 | ..... | 8.50 |

## NACHES RIVER AT NORTH YAKIMA, WASHINGTON.

This river has its source on the eastern slope of the Cascade Mountains in Yakima County, Washington. It flows in a general southeasterly direction, entering Yakima River a short distance above the town of North Yakima. Irrigation is practiced in the narrow valley along the lower course of the river, but its waters are of greater value for the irrigation of lands west of North Yakima. The river has considerable fall, and the water can be easily diverted by means of comparatively short canals. On this account it is of more value for irrigation purposes than Yakima River, which has less fall. The original station was established August 14, 1893, but was abandoned in 1897. It was reestablished February 1, 1898, and is now located near the Northern Pacific railway bridge at the mouth of the river. Owing to the fact that the wire gage was removed a number of times, an inclined rod was established June 20, 1899, with its zero 1.64 feet below the datum of the old gage; consequently, all heights recorded previous to June 20 should be increased by this amount to make them agree with those recorded since that date. The bench mark is the top

of the north end of the east sill of clearance post, about 150 feet north of the railroad bridge, and is at an elevation of 25.406 feet above datum of new gage. The bed of the river is rocky and is not liable to change at ordinary stages, but during the excessive floods to which this stream is subject the section is liable to great change. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 355; 1898, Twentieth Annual Report, Part IV, page 503. The following discharge measurements were made by Sydney Arnold in 1899:

May 4, gage height, 5.35 feet; discharge, 1,847 second-feet.
May 12, gage height, 6.85 feet; discharge, 5,434 second-feet.
May 26, gage height, 7.10 feet; discharge, 6,753 second-feet.
July 27, gage height, 7.25 feet; discharge, 2,856 second-feet.
August 16, gage height, 6.35 feet; discharge, 1,357 second-feet.
September 20, gage height, 5.70 feet; discharge, 588 second-feet.

*Daily gage height, in feet, of Naches River at North Yakima, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5.50 | 4.80 | 4.60 | 5.40 | 6.80 | 8.50 | 7.10 | 6.00 | ..... | 5.90 | 8.40 |
| 2 | 4.70 | 5.30 | 4.80 | ..... | 5.40 | 6.90 | ..... | 7.00 | 6.00 | 5.80 | 5.90 | 8.20 |
| 3 | 4.70 | 4.90 | 4.70 | 4.60 | 5.40 | 6.90 | 8.50 | 6.90 | ..... | 5.70 | 5.80 | ..... |
| 4 | 4.50 | 4.80 | 4.70 | 4.80 | 5.40 | ..... | 8.50 | 6.80 | 6.00 | 5.70 | 5.80 | 7.70 |
| 5 | 4.40 | ..... | ..... | 4.90 | 5.50 | 6.90 | 8.40 | 6.80 | 6.00 | 5.60 | ..... | 7.50 |
| 6 | 4.40 | 4.70 | 4.70 | 4.90 | 5.80 | 7.00 | 8.40 | ..... | 5.90 | 5.60 | 5.80 | 7.30 |
| 7 | 4.30 | 4.70 | 4.70 | 5.00 | ..... | 7.00 | 8.30 | 6.80 | 5.90 | 5.60 | 5.90 | 7.20 |
| 8 | ..... | 4.80 | 4.70 | 5.10 | 6.40 | 7.10 | 8.30 | 6.70 | 5.80 | ..... | 6.10 | 7.10 |
| 9 | 4.30 | 5.10 | 4.60 | ..... | 6.80 | 7.10 | ..... | 6.60 | 5.80 | 5.60 | 6.20 | 6.90 |
| 10 | 4.30 | 5.20 | 4.60 | 5.50 | 7.20 | 7.00 | 8.30 | 6.60 | ..... | 5.60 | 6.40 | ..... |
| 11 | 4.20 | 5.20 | 4.60 | 5.50 | 7.20 | ..... | 8.30 | 6.60 | 5.80 | 5.60 | 6.50 | 6.70 |
| 12 | 4.20 | ..... | ..... | 5.70 | 7.20 | ..... | 8.30 | 6.60 | 5.80 | 5.60 | ..... | 6.60 |
| 13 | 4.10 | 5.10 | 4.50 | 5.70 | 6.80 | ..... | 8.40 | ..... | 5.80 | 5.50 | 6.50 | 6.60 |
| 14 | 4.10 | 5.00 | 4.50 | 5.50 | ..... | 7.86 | 8.40 | 6.50 | 5.70 | 5.50 | 6.50 | 6.60 |
| 15 | ..... | 5.00 | 4.40 | 5.50 | 6.50 | ..... | 8.40 | 6.50 | 5.70 | ..... | 7.20 | 6.50 |
| 16 | 4.30 | 5.00 | 4.40 | ..... | 6.40 | ..... | ..... | 6.40 | 5.70 | 5.50 | 7.20 | 6.50 |
| 17 | 4.30 | 5.00 | 4.40 | 5.50 | 6.40 | ..... | 8.40 | 6.40 | ..... | 5.50 | 7.10 | ..... |
| 18 | 4.40 | 5.10 | 4.40 | 5.40 | 6.30 | ..... | 8.30 | 6.40 | 5.70 | 5.60 | 6.90 | 6.30 |
| 19 | 4.40 | ..... | ..... | 5.30 | 6.20 | ..... | 8.20 | 6.30 | 5.70 | 5.80 | ..... | 6.30 |
| 20 | 4.50 | 5.00 | 4.40 | 5.30 | 6.20 | a8.85 | 8.00 | ..... | 5.60 | 6.40 | 8.10 | 6.20 |
| 21 | 5.80 | 5.00 | 4.40 | 5.20 | ..... | 8.80 | 7.80 | 6.30 | 5.60 | 6.30 | 8.00 | 6.20 |
| 22 | ..... | 5.10 | 4.40 | 5.20 | 6.40 | 8.70 | 7.50 | 6.20 | 5.60 | ..... | 7.60 | 7.00 |
| 23 | 6.30 | 5.10 | 4.40 | ..... | 6.40 | 8.70 | ..... | 6.20 | 5.60 | 6.00 | 7.20 | 7.40 |
| 24 | 6.10 | 5.00 | 4.40 | 5.20 | 6.50 | 8.70 | 7.30 | 6.20 | ..... | 6.00 | 7.00 | ..... |
| 25 | 5.80 | 5.00 | 4.40 | 5.30 | 6.50 | ..... | 7.30 | 6.10 | 5.60 | 5.90 | 7.00 | 8.30 |
| 26 | 5.80 | ..... | ..... | 5.30 | 6.60 | 8.70 | 7.20 | 6.10 | 5.60 | 5.90 | ..... | 8.20 |
| 27 | 5.70 | 4.90 | 4.40 | 5.40 | 6.60 | 8.60 | 7.20 | ..... | 5.60 | 6.00 | 7.80 | 8.00 |
| 28 | 5.70 | 4.80 | 4.40 | 5.40 | ..... | 8.60 | 7.30 | 6.10 | 5.60 | 6.20 | 9.00 | 7.80 |
| 29 | ..... | ..... | 4.50 | 5.50 | 6.60 | 8.50 | 7.40 | 6.10 | 5.70 | ..... | 8.90 | 7.60 |
| 30 | 5.70 | ..... | 4.50 | ..... | 6.70 | 8.50 | 7.20 | 6.10 | 5.80 | 6.00 | 8.60 | 7.40 |
| 31 | 5.60 | ..... | 4.60 | ..... | 6.80 | ..... | ..... | 6.00 | ..... | 6.00 | ..... | ..... |

a New gage, datum 1.64 lower than old gage.

## YAKIMA RIVER AT UNION GAP, WASHINGTON.

This river has its source in Keechelus Lake, on the eastern slope of the Cascade Mountains, in Kittitas County, Washington. In a short distance it receives the waters of Kachess Lake, and 2½ miles above Cle Elum it receives the outlet of the last of the three large headwater lakes. The valley of Yakima River is comparatively narrow until it widens out in the vicinity of Ellensburg, where considerable irrigation is practiced. At the lower end of this valley it enters a canyon 20

miles long, and then flows into Selah Valley, which is only 4 miles in length. At the lower end of this opening the river passes through a narrow gap to enter Yakima Valley. This section is the most extensively irrigated area in Washington, and is served principally by canals from Naches River. Seven miles below North Yakima the river passes through what is known as Union Gap, and thence enters its lower valley, which extends to Kiona. Yakima River enters Columbia River 23 miles below this point and just above the town of Pasco. The gaging station, established August 14, 1893, is located at Union Gap, 6 miles below North Yakima, Washington, and 1,000 feet below the highway bridge. It is about 3 miles above the head gate of the Sunnyside canal. The gage rod is inclined and is attached to a willow stump and posts set in the ground. The bench mark is the highest point of a large rock mound 25 feet north of the gage and 10 feet east of the fence, and is at an elevation of 17.52 feet above gage datum. The equipment consists of cable, car, and tagged wire. The station is of value in showing the amount of water available for the extensive irrigable lands below. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 358; 1897, Nineteenth Annual Report, Part IV, page 479; 1898, Twentieth Annual Report, Part IV, page 500. The following measurements of discharge were made by Sydney Arnold in 1899:

May 8, gage height, 8.03 feet; discharge, 8,500 second-feet.
August 18, gage height, 6 feet; discharge, 3,777 second-feet.
September 16, gage height, 5 feet; discharge, 1,730 second-feet.
October 6, gage height, 4.77 feet; discharge, 1,479 second-feet.

*Daily gage height, in feet, of Yakima River at Union Gap, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.00 | 7.20 | 6.40 | 5.80 | 7.00 | 8.80 | 8.40 | 6.70 | 5.50 | 4.90 | 5.50 | 8.50 |
| 2 | 6.70 | 6.90 | 6.40 | 5.90 | 7.10 | 8.90 | 8.30 | 6.60 | 5.50 | 4.90 | 5.40 | 8.20 |
| 3 | 6.40 | 6.60 | 6.30 | 5.60 | 7.10 | 8.90 | 8.30 | 6.60 | 5.50 | 4.90 | 5.40 | 8.00 |
| 4 | 6.00 | 6.30 | 6.30 | 5.60 | 6.70 | 9.50 | 8.20 | 6.50 | 5.40 | 4.80 | 5.50 | 7.80 |
| 5 | 5.90 | 6.30 | 6.20 | 6.10 | 7.00 | 9.80 | 8.20 | 6.50 | 5.40 | 4.80 | 5.40 | 7.40 |
| 6 | 5.60 | 6.30 | 6.20 | 6.10 | 7.20 | 9.50 | 8.10 | 6.50 | 5.40 | 4.80 | 5.40 | 7.00 |
| 7 | 5.30 | 6.30 | 6.10 | 6.20 | 7.50 | 9.00 | 8.10 | 6.40 | 5.30 | 4.70 | 5.40 | 6.80 |
| 8 | 5.30 | 6.30 | 6.10 | 6.30 | 8.30 | 8.70 | 8.10 | 6.30 | 5.30 | 4.70 | 5.50 | 6.70 |
| 9 | 5.30 | 6.30 | 6.00 | 6.60 | 8.70 | 8.80 | 8.00 | 6.20 | 5.30 | 4.70 | 5.70 | 6.60 |
| 10 | 5.30 | 6.20 | 6.00 | 6.80 | 9.30 | 9.10 | 8.00 | 6.10 | 5.20 | 4.80 | 5.70 | 6.60 |
| 11 | 5.20 | 6.20 | 6.00 | 6.80 | 9.20 | 9.40 | 8.00 | 6.10 | 5.20 | 4.70 | 5.80 | 6.50 |
| 12 | 5.20 | 6.30 | 5.90 | 6.70 | 9.00 | 9.80 | 7.90 | 6.10 | 5.20 | 4.70 | 5.80 | 6.40 |
| 13 | 5.20 | 6.30 | 5.90 | 7.40 | 8.80 | 10.10 | 7.90 | 6.00 | 5.10 | 4.70 | 6.00 | 6.30 |
| 14 | 5.20 | 6.50 | 5.90 | 7.20 | 8.70 | 10.10 | 8.00 | 6.00 | 5.10 | 4.70 | 6.20 | 6.20 |
| 15 | 5.20 | 6.80 | 5.80 | 7.10 | 8.60 | 9.90 | 8.00 | 6.00 | 5.10 | 4.70 | 6.30 | 6.10 |
| 16 | 5.30 | 7.00 | 5.80 | 7.00 | 8.40 | 9.80 | 7.90 | 6.00 | 5.00 | 4.70 | 6.40 | 6.00 |
| 17 | 5.60 | 7.30 | 5.70 | 6.80 | 8.20 | 9.80 | 7.85 | 6.00 | 5.00 | 4.80 | 6.40 | 5.90 |
| 18 | 5.80 | 7.60 | 5.70 | 6.60 | 8.10 | 9.80 | 7.80 | 6.00 | 5.00 | 4.80 | 6.50 | 5.70 |
| 19 | 6.10 | 7.70 | 5.60 | 6.40 | 7.90 | 9.70 | 7.80 | 5.90 | 5.00 | 5.00 | 6.80 | 5.60 |
| 20 | 6.30 | 7.90 | 5.70 | 6.30 | 7.70 | 9.60 | 7.60 | 5.90 | 5.00 | 5.60 | 7.60 | 5.40 |
| 21 | 7.40 | 7.60 | 5.60 | 6.30 | 7.70 | 9.50 | 7.50 | 5.90 | 5.00 | 5.80 | 8.00 | 5.40 |
| 22 | 8.00 | 7.30 | 5.70 | 6.20 | 7.60 | 9.50 | 7.50 | 5.80 | 5.00 | 5.70 | 7.90 | 5.30 |
| 23 | 8.50 | 7.10 | 5.60 | 6.40 | 7.70 | 9.40 | 7.50 | 5.80 | 5.00 | 5.60 | 7.60 | 6.20 |
| 24 | 8.00 | 6.90 | 5.60 | 6.50 | 8.90 | 9.10 | 7.50 | 5.80 | 5.00 | 5.50 | 7.40 | 7.00 |
| 25 | 7.70 | 6.70 | 5.60 | 6.70 | 9.40 | 9.00 | 7.50 | 5.70 | 5.00 | 5.50 | 7.20 | 9.00 |
| 26 | 8.40 | 6.60 | 5.50 | 6.80 | 9.40 | 8.90 | 7.30 | 5.70 | 4.90 | 5.50 | 7.00 | 9.50 |
| 27 | 8.60 | 6.60 | 5.50 | 7.00 | 9.10 | 8.70 | 7.10 | 5.70 | 4.90 | 5.50 | 7.00 | 9.20 |
| 28 | 8.40 | 6.50 | 5.50 | 7.10 | 9.00 | 8.60 | 7.05 | 5.60 | 4.90 | 5.60 | 8.00 | 8.90 |
| 29 | 8.00 | ..... | 5.60 | 7.00 | 8.90 | 8.40 | 6.90 | 5.60 | 4.90 | 5.60 | 9.00 | 8.10 |
| 30 | 7.80 | ..... | 5.70 | 7.00 | 8.90 | 8.50 | 6.80 | 5.60 | 4.90 | 5.60 | 8.70 | 7.70 |
| 31 | 7.50 | ..... | 5.80 | ..... | 8.80 | ..... | 6.70 | 5.50 | ..... | 5.50 | ..... | 7.70 |

## YAKIMA RIVER AT KIONA, WASHINGTON.

This station is located on the lower course of the river, at the point where it bends northerly, sweeping around a point of hill to enter Columbia River 23 miles below. The station, established August 20, 1895, is located at the highway bridge at Kiona. The length of the wire gage is 27.21 feet. The channel of the river is straight for some distance above and below. The banks are of medium height and the bed is composed of firm gravel. The bridge crosses the river with one span, and the section is an ideal one for discharge measurements. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 359; 1897, Nineteenth Annual Report, Part IV, page 484; 1898, Twentieth Annual Report, Part IV, page 502. The following discharge measurements were made by Sydney Arnold in 1899:

July 18, gage height, 9.65 feet; discharge, 11,180 second-feet.
August 10, gage height, 6.16 feet; discharge, 3,482 second-feet.
September 7, gage height, 5.31 feet; discharge, 2,107 second-feet.
October 18, gage height, 4.42 feet; discharge, 1,244 second-feet.

*Daily gage height, in feet, of Yakima River at Kiona, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.00 | 8.00 | 6.83 | 5.72 | 7.45 | 9.65 | 9.35 | 7.15 | 5.25 | 4.58 | 5.50 | 9.76 |
| 2 | 7.85 | 7.55 | 6.75 | 5.78 | 7.40 | 9.60 | 9.20 | 7.03 | 5.22 | 4.57 | 5.45 | 10.35 |
| 3 | 7.80 | 6.80 | 6.50 | 5.90 | 7.25 | 9.70 | 9.30 | 6.90 | 5.18 | 4.60 | 5.38 | 10.57 |
| 4 | 7.20 | 6.38 | 6.50 | 5.98 | 7.05 | 10.20 | 9.60 | 6.63 | 5.18 | 4.70 | 5.30 | 9.75 |
| 5 | 6.80 | 6.20 | 6.50 | 6.05 | 7.00 | 11.20 | 10.00 | 6.50 | 5.20 | 4.68 | 5.28 | 9.16 |
| 6 | 5.45 | 6.10 | 6.40 | 6.17 | 7.30 | 11.00 | 9.85 | 6.35 | 5.28 | 4.60 | 5.25 | 8.63 |
| 7 | 5.25 | 6.09 | 6.40 | 6.32 | 7.80 | 10.45 | 9.60 | 6.25 | 5.30 | 4.58 | 5.20 | 8.12 |
| 8 | 5.35 | 6.09 | 6.30 | 6.40 | 8.30 | 10.15 | 9.45 | 6.15 | 5.26 | 4.52 | 5.10 | ..... |
| 9 | 5.40 | 6.15 | 6.35 | 6.50 | ..... | 9.80 | 9.35 | 6.15 | 5.21 | 4.50 | 5.18 | 7.60 |
| 10 | 5.50 | 6.26 | 6.40 | 6.75 | ..... | 9.90 | 9.38 | 6.15 | ..... | 4.48 | 5.40 | 7.55 |
| 11 | 5.56 | 6.95 | 6.25 | 7.13 | 10.35 | 10.65 | 9.45 | 6.15 | 5.12 | 4.52 | 5.65 | 7.40 |
| 12 | 5.60 | 6.95 | 6.10 | 7.13 | 10.43 | 11.10 | 9.30 | 6.18 | 5.05 | 4.50 | 5.72 | 7.28 |
| 13 | 5.54 | 6.80 | 6.08 | 7.90 | 10.41 | 11.35 | 9.18 | 6.08 | 4.95 | 4.48 | 5.85 | 6.94 |
| 14 | 5.50 | 6.56 | 6.05 | 8.05 | 9.90 | 11.20 | 9.50 | 6.03 | 4.98 | 4.50 | 5.95 | 6.86 |
| 15 | 5.45 | 6.61 | 5.90 | 7.85 | 9.35 | 10.70 | 9.40 | 6.00 | 5.03 | 4.52 | 6.03 | 6.71 |
| 16 | 5.45 | 7.10 | 5.85 | 7.68 | 8.97 | 10.43 | 9.55 | 6.04 | 5.04 | 4.48 | 6.62 | 6.45 |
| 17 | 5.43 | 7.73 | 5.85 | 7.53 | 8.75 | 10.45 | 9.60 | 6.10 | 4.98 | 4.42 | 6.79 | 6.32 |
| 18 | 5.70 | 8.70 | 5.73 | 7.45 | ..... | 10.80 | 9.60 | 6.08 | 4.95 | 4.48 | 6.96 | 6.20 |
| 19 | 6.22 | 9.23 | 5.60 | 7.38 | 8.40 | 11.25 | 9.33 | 6.00 | 4.92 | 4.80 | 7.25 | 6.05 |
| 20 | 6.40 | 8.50 | 5.60 | ..... | 8.20 | 11.45 | 9.10 | 5.90 | 4.87 | 5.05 | 7.92 | 5.97 |
| 21 | 6.85 | 8.48 | 5.62 | 7.10 | 8.15 | 11.35 | 8.85 | 5.78 | 4.85 | 5.50 | 8.40 | 5.83 |
| 22 | 8.45 | 8.15 | 5.63 | 7.20 | 8.20 | 11.10 | 8.65 | 5.75 | 4.78 | 5.60 | 8.98 | 6.22 |
| 23 | 9.55 | 7.80 | 5.65 | 7.30 | 8.60 | 10.65 | 8.18 | 5.72 | 4.74 | 5.62 | 8.42 | 7.34 |
| 24 | 9.30 | 7.50 | 5.65 | 7.10 | 9.15 | 10.85 | 7.90 | 5.70 | 4.70 | 5.56 | 7.85 | 8.65 |
| 25 | 8.87 | 7.35 | 5.65 | 7.00 | 10.10 | 10.20 | 7.58 | 5.55 | 4.67 | 5.45 | 7.45 | 9.78 |
| 26 | 8.80 | 7.20 | 5.65 | 7.10 | 10.50 | 10.40 | 7.38 | 5.48 | 4.63 | 5.47 | 7.18 | 10.69 |
| 27 | 9.30 | 7.05 | 5.60 | 7.40 | 10.55 | 10.35 | 7.25 | 5.50 | 4.58 | 5.38 | 6.98 | 10.88 |
| 28 | 9.30 | 6.90 | 5.60 | 7.65 | 10.45 | 10.15 | 7.20 | 5.50 | 4.58 | 5.43 | 7.95 | 10.50 |
| 29 | 8.95 | ..... | 5.65 | 7.55 | 10.30 | 9.70 | 7.20 | 5.45 | 4.57 | 5.52 | 8.46 | 9.77 |
| 30 | 8.65 | ..... | 5.68 | 7.45 | 10.10 | 9.50 | 7.20 | 5.38 | 4.58 | 5.56 | 9.05 | 9.20 |
| 31 | 8.25 | ..... | 5.70 | ..... | 9.90 | ..... | 7.25 | 5.32 | ..... | 5.50 | ..... | 8.96 |

## WALLAWALLA RIVER AT WHITMAN, WASHINGTON.

The tributaries of this river drain the northern and western slopes of the Blue Mountains in southeastern Washington. The general course of the stream is westerly, entering Columbia River 2 miles below the mouth of Snake River. The Blue Mountains attain elevations of over 2,000 feet above their foothills, and their slopes are

well timbered. Agriculture is practiced to a considerable extent on the foothill regions in the vicinity of Wallawalla, the crops being raised without irrigation. A number of canals divert water from the river below Whitman and from the lower course of its tributary, Touchet River. To determine the amount of water available for irrigation below, a gaging station was established at Whitman, 7 miles below Wallawalla, July 19, 1897. The gage consists of a horizontal timber fastened to two posts set in the ground and projecting out over the water surface. To this horizontal rod is attached a wire gage. The bench mark is a nail driven into the northwest corner of a barn 70 feet north of the gage and 1 foot above the sill, and is at an elevation of 11 feet above gage datum. The length of gage wire is 19.62 feet. The discharge measurements were to have been made from a bridge, which, however, has not yet been erected. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 492; 1898, Twentieth Annual Report, Part IV, page 512. There were no discharge measurements made at this point during 1899.

*Daily gage height, in feet, of Wallawalla River at Whitman, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.60 | 2.45 | 3.00 | 3.05 | 3.30 | 3.85 | 2.30 | 1.45 | 1.85 | 1.75 | 2.10 | 3.95 |
| 2 | 2.45 | 2.25 | 3.05 | 3.05 | 3.25 | 4.00 | 2.25 | 1.45 | 1.85 | 1.75 | 2.10 | 4.55 |
| 3 | 2.30 | 2.20 | 2.95 | 3.15 | 3.15 | 3.95 | 2.15 | 1.45 | 1.85 | 1.75 | 2.10 | 3.95 |
| 4 | 2.20 | 2.20 | 2.90 | 3.30 | 3.10 | 3.95 | 2.10 | 1.45 | 1.90 | 1.75 | 2.10 | 3.50 |
| 5 | 2.20 | 2.20 | 2.85 | 3.40 | 3.20 | 3.75 | 2.15 | 1.45 | 2.05 | 1.80 | 2.10 | 3.35 |
| 6 | 2.20 | 2.20 | 2.80 | 3.30 | 3.30 | 3.35 | 2.05 | 1.40 | 1.95 | 1.80 | 2.10 | 3.05 |
| 7 | 2.20 | 2.20 | 2.85 | 3.40 | 3.35 | 3.30 | 2.00 | 1.40 | 1.90 | 1.80 | 2.10 | 3.05 |
| 8 | 2.20 | 2.20 | 3.10 | 3.60 | 3.80 | 3.15 | 2.00 | 1.40 | 1.95 | 1.80 | 2.10 | 2.90 |
| 9 | 2.20 | 2.95 | 3.10 | 4.15 | 4.30 | 3.25 | 1.95 | 1.50 | 1.95 | 1.80 | 2.10 | 2.80 |
| 10 | 2.20 | 4.20 | 3.05 | 4.05 | 4.50 | 3.40 | 1.90 | 1.55 | 1.90 | 1.80 | 2.10 | 2.80 |
| 11 | 1.90 | 3.65 | 3.00 | 4.10 | 4.35 | 3.95 | 1.90 | 1.50 | 1.95 | 1.85 | 2.10 | 3.00 |
| 12 | 1.95 | 3.25 | 2.95 | 4.50 | 4.05 | 3.85 | 1.90 | 1.50 | 1.90 | 1.90 | 2.10 | 3.00 |
| 13 | 1.95 | 3.30 | 2.85 | 4.50 | 3.90 | 3.50 | 1.80 | 1.50 | 1.95 | 1.90 | 2.10 | 2.85 |
| 14 | 1.95 | 3.85 | 2.75 | 4.05 | 3.65 | 3.35 | 1.80 | 1.60 | 1.95 | 1.90 | 2.10 | 2.80 |
| 15 | 2.15 | 4.60 | 2.75 | 3.95 | 3.50 | 3.30 | 1.70 | 1.70 | 1.95 | 1.90 | 2.10 | 2.80 |
| 16 | 2.70 | 4.40 | 2.75 | 4.40 | 3.40 | 3.30 | 1.60 | 1.65 | 1.90 | 1.90 | 2.15 | 2.80 |
| 17 | 3.50 | 4.35 | 2.75 | 4.10 | 3.45 | 3.30 | 1.60 | 1.65 | 1.85 | 2.30 | 2.15 | 2.80 |
| 18 | 3.45 | 4.30 | 2.75 | 3.85 | 3.40 | 3.25 | 1.60 | 1.65 | 1.90 | 2.20 | 2.25 | 2.70 |
| 19 | 3.45 | 4.45 | 2.80 | 3.65 | 3.25 | 3.20 | 1.50 | 1.65 | 1.85 | 2.35 | 2.70 | 2.60 |
| 20 | 3.55 | 4.30 | 2.95 | 3.60 | 3.20 | 3.15 | 1.55 | 1.65 | 1.85 | 2.60 | 2.75 | 2.55 |
| 21 | 5.00 | 4.10 | 3.00 | 3.75 | 3.20 | 3.00 | 1.50 | 1.70 | 1.80 | 2.40 | 2.65 | 2.60 |
| 22 | 5.50 | 3.60 | 3.00 | 3.95 | 3.50 | 2.85 | 1.60 | 1.90 | 1.85 | 2.35 | 2.55 | 2.85 |
| 23 | 4.00 | 3.25 | 3.00 | 3.75 | 3.85 | 2.75 | 1.55 | 1.90 | 1.85 | 2.30 | 2.50 | 3.10 |
| 24 | 3.30 | 3.30 | 3.00 | 3.70 | 4.35 | 2.65 | 1.55 | 1.85 | 1.80 | 2.25 | 2.45 | 3.50 |
| 25 | 3.20 | 3.10 | 3.00 | 3.75 | 4.55 | 2.65 | 1.55 | 1.85 | 1.80 | 2.30 | 2.30 | 3.35 |
| 26 | 3.10 | 2.90 | 3.00 | 3.75 | 4.30 | 2.65 | 1.55 | 1.85 | 1.80 | 2.30 | 2.35 | 3.20 |
| 27 | 3.00 | 2.80 | 3.00 | 3.70 | 4.10 | 2.55 | 1.55 | 1.95 | 1.75 | 2.25 | 2.35 | 3.15 |
| 28 | 2.95 | 2.85 | 3.00 | 3.45 | 4.05 | 2.45 | 1.55 | 1.95 | 1.75 | 2.20 | 2.90 | 3.00 |
| 29 | 2.85 | ..... | 3.00 | 3.25 | 4.05 | 2.40 | 1.45 | 1.90 | 1.75 | 2.20 | 3.50 | 2.90 |
| 30 | 2.75 | ..... | 3.00 | 3.35 | 3.75 | 2.35 | 1.45 | 1.90 | 1.75 | 2.20 | 3.80 | 2.80 |
| 31 | 2.65 | ..... | 3.00 | ..... | 3.65 | ..... | 1.45 | 1.90 | ..... | 2.15 | ..... | 2.80 |

## UMATILLA RIVER AT GIBBON, OREGON.

This river rises in the well-wooded country in northeastern Oregon and flows in a general westerly direction, entering Columbia River below the mouth of Wallawalla River. The country north of Umatilla is high and rolling. Agriculture is practiced here to a consider-

able extent, cereals being the principal crops raised. A number of canals divert water from the lower course of the stream to irrigate lands on either side. Surveys have been made for diverting water in the vicinity of Gibbon to irrigate the high country between Umatilla and Wallawalla rivers. None of the canals have yet been completed, however. The station at Gibbon, Oregon, was established July 22, 1896, and is located one-half mile west of the railroad station. The rod is inclined and is fastened to a rock ledge by bolts soldered into holes drilled into the rock. The bench mark is a cross in black paint on the highest point of the rock to which the rod is fastened, and is 4.40 feet above gage datum. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 361; 1897, Nineteenth Annual Report, Part IV, page 493; 1898, Twentieth Annual Report, Part IV, page 515. There were no measurements of discharge made at this point during 1899.

*Daily gage height, in feet, of Umatilla River at Gibbon, Oregon, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.55 | 2.50 | 2.40 | 2.65 | 2.50 | 3.85 | 1.90 | 1.05 | 1.00 | 1.00 | 1.60 | 3.20 |
| 2 | 1.45 | 2.20 | 2.50 | 2.70 | 2.50 | 3.80 | 1.80 | 1.05 | 1.00 | 1.00 | 1.50 | 2.90 |
| 3 | 1.40 | 2.00 | 2.50 | 2.75 | 2.50 | 3.70 | 1.75 | 1.05 | 1.00 | 1.00 | 1.45 | 2.75 |
| 4 | 1.30 | 1.95 | 2.40 | 3.30 | 2.55 | 3.50 | 1.65 | 1.05 | 1.10 | 1.00 | 1.45 | 2.60 |
| 5 | 1.30 | 1.80 | 2.25 | 3.30 | 3.05 | 3.10 | 1.65 | 1.00 | 1.20 | 1.00 | 1.45 | 2.40 |
| 6 | 1.25 | 1.75 | 2.20 | 3.30 | 3.80 | 3.00 | 1.60 | 1.00 | 1.10 | 1.00 | 1.40 | 2.30 |
| 7 | 1.25 | 2.00 | 2.40 | 3.50 | 4.40 | 3.00 | 1.60 | .95 | 1.10 | 1.00 | 1.40 | 2.20 |
| 8 | 1.15 | 2.70 | 2.75 | 3.70 | 4.40 | 3.20 | 1.60 | .95 | 1.10 | 1.00 | 1.40 | 2.20 |
| 9 | 1.10 | 3.30 | 2.60 | 4.30 | 4.90 | 3.30 | 1.55 | .95 | 1.05 | 1.00 | 1.40 | 2.20 |
| 10 | 1.00 | 3.30 | 2.30 | 4.30 | 4.60 | 3.50 | 1.50 | 1.05 | 1.05 | 1.00 | 1.40 | 2.20 |
| 11 | .95 | 2.90 | 2.30 | 4.10 | 4.40 | 3.20 | 1.50 | 1.05 | 1.00 | 1.00 | 1.40 | 2.20 |
| 12 | .90 | 2.60 | 2.10 | 5.00 | 4.20 | 3.10 | 1.45 | 1.00 | 1.00 | 1.00 | 1.40 | 2.25 |
| 13 | .90 | 2.50 | 2.10 | 4.20 | 4.05 | 2.95 | 1.45 | 1.00 | 1.05 | 1.00 | 1.40 | 2.20 |
| 14 | .90 | 2.80 | 2.10 | 3.60 | 3.50 | 3.10 | 1.45 | 1.00 | 1.00 | 1.00 | 1.45 | 2.20 |
| 15 | .90 | 3.45 | 2.15 | 3.60 | 3.20 | 3.00 | 1.40 | 1.00 | 1.00 | 1.00 | 1.50 | 2.20 |
| 16 | 1.80 | 3.30 | 2.15 | 3.80 | 3.10 | 2.90 | 1.35 | 1.00 | 1.00 | 1.20 | 1.50 | 2.20 |
| 17 | 2.50 | 3.40 | 2.20 | 3.40 | 3.05 | 2.90 | 1.35 | 1.00 | 1.00 | 1.40 | 1.50 | 2.15 |
| 18 | 2.90 | 3.60 | 2.30 | 3.20 | 3.05 | 2.75 | 1.35 | 1.00 | 1.00 | 1.40 | 1.90 | 2.15 |
| 19 | 2.70 | 3.90 | 2.60 | 3.05 | 3.00 | 2.70 | 1.30 | 1.00 | 1.00 | 1.60 | 2.10 | 2.10 |
| 20 | 3.30 | 3.70 | 2.50 | 3.40 | 2.95 | 2.60 | 1.30 | 1.05 | 1.00 | 1.50 | 2.10 | 2.10 |
| 21 | 4.50 | 3.20 | 2.50 | 3.40 | 3.00 | 2.50 | 1.30 | 1.05 | 1.00 | 1.50 | 2.00 | 2.10 |
| 22 | 4.00 | 2.80 | 2.40 | 3.45 | 3.80 | 2.45 | 1.25 | 1.35 | 1.00 | 1.50 | 1.80 | 2.05 |
| 23 | 3.40 | 2.60 | 2.20 | 3.50 | 4.10 | 2.40 | 1.20 | 1.20 | 1.00 | 1.50 | 1.80 | 2.00 |
| 24 | 3.00 | 2.45 | 2.60 | 3.50 | 4.40 | 2.25 | 1.20 | 1.10 | 1.00 | 1.60 | 1.70 | 2.00 |
| 25 | 2.80 | 2.40 | 2.70 | 3.60 | 4.30 | 2.20 | 1.20 | 1.10 | 1.00 | 1.65 | 1.70 | 2.10 |
| 26 | 3.50 | 2.20 | 2.60 | 3.30 | 4.00 | 2.10 | 1.15 | 1.05 | 1.00 | 1.70 | 1.70 | 2.20 |
| 27 | 3.30 | 2.10 | 2.50 | 3.20 | 3.80 | 2.00 | 1.15 | 1.05 | 1.00 | 1.70 | 2.40 | 2.20 |
| 28 | 3.10 | 2.40 | 2.50 | 3.00 | 3.80 | 1.95 | 1.10 | 1.05 | 1.00 | 1.75 | 2.70 | 2.15 |
| 29 | 3.00 | ..... | 2.55 | 2.75 | 4.00 | 1.90 | 1.10 | 1.05 | 1.00 | 1.70 | 3.10 | 2.15 |
| 30 | 2.70 | ..... | 2.50 | 2.60 | 4.00 | 1.90 | 1.10 | 1.00 | 1.00 | 1.65 | 3.15 | 2.15 |
| 31 | 2.60 | ..... | 2.60 | ..... | 3.90 | ..... | 1.10 | 1.00 | ..... | 1.60 | ..... | 2.10 |

## DESCHUTES RIVER AT MORO, OREGON.

This river drains a large area in central Oregon and flows in a general northerly direction, entering Columbia River about 15 miles east of The Dalles, Oregon. The headwater tributaries have their source in the snow-clad peaks of the Cascade Mountains. The plains region on which they enter upon their appearance from the mountain canyons is of a very porous lava formation, which has a tendency to regulate the flow of the river. The rains and snows of the winter are absorbed

by the porous rocks, to be slowly discharged into the river later in the season. In the vicinity of the town of Lava the river is noted for its unchanging flow, the height not varying, on an average, more than 12 to 18 inches during the year, with a comparatively large discharge. The river is a surface stream until about due west of Prineville, when it gradually cuts down, and on its lower course is in a canyon about 1,000 feet in depth. The lower portion of the river is also subject to greater fluctuations in height than the upper part. The general character of the lower basin of Deschutes River is high and rolling and it is difficult to irrigate, except from the high tributaries. Crooked River is an important tributary of the Deschutes, entering it from the east. Considerable irrigation, principally for forage crops, is practiced in its basin above Prineville. The station on Deschutes River, established October 19, 1897, is located at Moro, 3 miles above what is known as the "free bridge" and 16 miles east of The Dalles, Oregon. The rod is inclined. The bench mark is the head of a nail in a large alder tree, to which the rod is spiked, and is at an elevation of 8.41 feet above gage datum. Discharge measurements are taken at the iron bridge 3 miles below. The section here is poor, owing to its rocky cross section. The current is quite swift. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 97; 1898, Twentieth Annual Report, Part IV, page 516. One measurement of discharge was made in 1899 by Sydney Arnold, on June 10, when, at a gage height of 3.80 feet, a discharge of 10,772 second-feet was found.

*Daily gage height, in feet, of Deschutes River at Moro, Oregon, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.70 | 2.50 | 5.50 | 2.70 | 3.50 | 4.00 | 3.30 | 2.50 | 2.30 | 1.90 | 2.30 | 3.70 |
| 2 | 1.70 | 2.40 | 3.90 | 2.90 | 3.40 | 4.00 | 3.30 | 2.50 | 2.30 | 2.00 | 2.30 | 3.60 |
| 3 | 1.60 | 2.20 | 3.30 | 2.90 | 3.30 | 4.00 | 3.40 | 2.50 | 2.30 | 2.00 | 2.30 | 3.50 |
| 4 | 1.60 | 1.90 | 3.00 | 3.00 | 3.10 | 3.90 | 3.40 | 2.40 | 2.40 | 2.00 | 2.30 | 3.40 |
| 5 | 1.50 | 1.70 | 2.80 | 3.30 | 3.10 | 3.80 | 3.30 | 2.40 | 2.50 | 1.90 | 2.30 | 3.40 |
| 6 | 1.40 | 1.60 | 2.70 | 3.60 | 3.20 | 3.80 | 3.30 | 2.40 | 2.50 | 1.90 | 2.40 | 3.30 |
| 7 | 1.40 | 1.50 | 2.70 | 3.70 | 3.30 | 3.70 | 3.30 | 2.40 | 2.40 | 1.90 | 2.40 | 3.30 |
| 8 | 1.30 | 1.40 | 2.60 | 3.80 | 3.70 | 3.70 | 3.20 | 2.40 | 2.40 | 1.90 | 2.40 | 3.20 |
| 9 | 1.30 | 3.60 | 2.60 | 3.90 | 4.10 | 3.60 | 3.20 | 2.40 | 2.40 | 2.00 | 2.40 | 3.20 |
| 10 | 1.20 | 5.00 | 2.50 | 4.10 | 4.30 | 3.70 | 3.20 | 2.30 | 2.30 | 2.00 | 2.40 | 3.10 |
| 11 | 1.20 | 4.00 | 2.50 | 4.30 | 4.30 | 3.70 | 3.30 | 2.30 | 2.30 | 2.00 | 2.30 | 3.20 |
| 12 | 1.30 | 3.60 | 2.60 | 4.60 | 4.40 | 3.80 | 3.30 | 2.30 | 2.30 | 2.00 | 2.30 | 3.30 |
| 13 | 1.30 | 3.00 | 2.50 | 4.70 | 4.40 | 3.90 | 3.30 | 2.30 | 2.30 | 2.10 | 2.30 | 3.60 |
| 14 | 1.20 | 2.80 | 2.50 | 4.90 | 4.20 | 3.90 | 3.20 | 2.20 | 2.20 | 2.10 | 2.30 | 4.10 |
| 15 | 1.30 | 2.60 | 2.40 | 4.60 | 4.00 | 3.80 | 3.20 | 2.20 | 2.20 | 2.10 | 2.30 | 4.10 |
| 16 | 2.90 | 2.50 | 2.40 | 4.30 | 3.90 | 3.80 | 3.10 | 2.20 | 2.20 | 2.10 | 2.30 | 3.90 |
| 17 | 2.70 | 2.50 | 2.30 | 4.10 | 3.80 | 3.70 | 3.10 | 2.20 | 2.20 | 2.10 | 2.30 | 3.70 |
| 18 | 3.40 | 2.80 | 2.30 | 3.90 | 3.60 | 3.80 | 3.10 | 2.10 | 2.20 | 2.20 | 2.20 | 3.60 |
| 19 | 3.20 | 2.80 | 2.50 | 3.70 | 3.40 | 3.90 | 3.00 | 2.20 | 2.10 | 2.50 | 2.20 | 3.60 |
| 20 | 3.40 | 2.90 | 2.50 | 3.50 | 3.40 | 3.90 | 3.00 | 2.10 | 2.10 | 3.10 | 2.20 | 3.70 |
| 21 | 3.70 | 2.80 | 2.40 | 3.80 | 3.30 | 3.80 | 2.90 | 2.10 | 2.10 | 2.50 | 2.20 | 3.90 |
| 22 | 4.10 | 2.70 | 2.40 | 4.00 | 3.30 | 3.70 | 2.80 | 2.20 | 2.10 | 2.30 | 2.20 | 3.80 |
| 23 | 3.60 | 2.70 | 2.50 | 4.10 | 3.40 | 3.70 | 2.80 | 2.40 | 2.10 | 2.30 | 2.20 | 3.70 |
| 24 | 3.10 | 2.60 | 2.50 | 4.10 | 3.50 | 3.60 | 2.70 | 2.40 | 2.00 | 2.30 | 2.20 | 3.60 |
| 25 | 2.80 | 2.60 | 2.80 | 4.00 | 3.60 | 3.60 | 2.70 | 2.40 | 2.00 | 2.30 | 2.20 | 3.60 |
| 26 | 2.70 | 2.50 | 3.50 | 3.90 | 3.70 | 3.50 | 2.70 | 2.50 | 2.00 | 2.40 | 2.30 | 3.50 |
| 27 | 2.60 | 2.40 | 3.30 | 3.80 | 3.80 | 3.50 | 2.60 | 2.50 | 2.00 | 2.40 | 3.70 | 3.40 |
| 28 | 2.40 | 2.50 | 2.90 | 3.70 | 3.90 | 3.50 | 2.60 | 2.50 | 1.90 | 2.40 | 4.10 | 3.30 |
| 29 | 2.20 | ..... | 2.90 | 3.70 | 3.90 | 3.40 | 2.60 | 2.40 | 1.90 | 2.40 | 4.10 | 3.20 |
| 30 | 2.30 | ..... | 2.80 | 3.60 | 3.90 | 3.40 | 2.60 | 2.40 | 1.90 | 2.40 | 4.10 | 3.20 |
| 31 | 2.70 | ..... | 2.70 | ..... | 4.00 | ..... | 2.50 | 2.40 | ..... | 2.40 | ..... | 3.10 |

A survey of a portion of Deschutes River, from Pringle Falls above the East Fork down to and including the country around Prineville, on Crooked River, and below Warmspring, was made during May and June, 1899, by Mr. G. F. Allardt, civil engineer for the Oregon Irrigation Company. Sufficient information was obtained to locate the general routes of the main irrigating canals and to determine the limits of the country that could be watered. The following details are taken from the report by Mr. Allardt:

Measurements of the river were made on May 27, 1899, at Sizemore bridge, about 1 mile above Emigrant Ford, giving a flow of 3,014 second-feet. At the time of measurement the river was somewhat above its ordinary stage and was 380 feet wide, with an average depth of about 3 feet and a mean velocity of nearly 3 feet per second. At its lowest stage the discharge of the river was estimated, from marks pointed out by the oldest settlers, to amount to 1,740 second-feet. It is stated that the difference between the high- and low-water marks does not exceed 2 feet in the wider portions of the river.

The low banks of the river make possible the diversion of water into canals by means of open cuts from the river channel at points a short distance above the various falls or rapids, thus dispensing with dams. The slight fluctuations in surface level reduce the cost of headworks to a minimum, and as the river never freezes it is unnecessary to adopt precautionary measures against ice.

Five principal canals were surveyed, leading out in succession from the east or right-hand side of the river. The first of these heads at Pringle Falls and has a length of 30 miles; the next heads at Benham Falls, 18 miles below, and has a length of 15 miles; the third heads at Lava Island, 4 miles below, and has a length of 34 miles; the fourth heads at Emigrant Ford, 5 miles below, and has a length of 33 miles; the fifth, or North canal, heads 20 miles below, and has a length of 47 miles, extending to Trout Creek. The following table gives the principal facts concerning the acreage irrigable and the altitude of the lands. Of the total acreage about one-fourth, or 92,000 acres, is timbered:

*Proposed canals from Deschutes River.*

| Name. | Length. | Area irrigable. | Altitude. |
|---|---|---|---|
| | *Miles.* | *Acres.* | *Feet.* |
| Pringle Falls canal | 30 | 36,000 | 4,100–4,300 |
| Benham Falls canal | 15 | 22,000 | 3,800–4,100 |
| Lava Island canal | 34 | 103,000 | 3,600–3,800 |
| Emigrant Ford canal | 33 | 168,000 | 2,900–3,600 |
| North canal | 47 | 58,000 | 2,400–2,900 |
| Total | 159 | 387,000 | |

The slope of the irrigable country from south to north is fairly uniform, averaging about 23 feet to the mile. The soil is mainly composed of volcanic ash or finely disintegrated lava, easily cultivated, and when wet of a dark or chocolate color. About one-fourth of the irrigable land is somewhat stony or broken by outcroppings of lava. The rainfall at Prineville averages about 9 inches per annum.

A large amount of power can be created by the use of the surplus waters of the river, as the total fall of the river is 1,360 feet between Pringle Falls and Crooked River. It is estimated that more than 50,000 effective horsepower can be produced by diverting the water by means of short flumes and without the construction of dams.

## HOOD RIVER AT TUCKER, OREGON.

This river rises at the base of Mount Hood, which has an elevation of 11,225 feet and is covered with snow throughout the year. The upper part of its basin is mountainous and well wooded. The river itself flows in a very narrow valley throughout its entire course, and empties into Columbia River almost opposite White Salmon River, which enters from the State of Washington. Hood River Valley, so called, is a level, elevated district, extending from the edge of the bluff overlooking Columbia River southward for a distance of from 7 to 10 miles. The river in its 30-mile course has a heavy fall, so that canals diverting water from it can in a short distance attain considerable elevation above the river. A number of canals divert water from East Fork and from the main Hood River, and irrigate the bench land south of the town of Hoodriver. The chief products are berries and fruits. The gaging station, established October 20, 1897, is located at Tucker, 5 miles south of Hoodriver, Oregon. The rod of the wire gage is nailed to a wooden member of the bridge. The length of the gage wire is 33.85 feet. The bottom of the river is a rock ledge and the sides are precipitous, thus insuring a stable cross section. Results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 499; 1898, Twentieth Annual Report, Part IV, page 516. One measurement of discharge was made by Sydney Arnold during 1899, on June 9, when at a gage height of 4.55 feet a discharge of 2,548 second-feet was found.

*Daily gage height, in feet, of Hood River at Tucker, Oregon, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.20 | 4.40 | 7.50 | 2.80 | 3.80 | 4.60 | 3.80 | 3.00 | 2.60 | 3.20 | 2.10 | 9.00 |
| 2 | 4.00 | 4.00 | 6.00 | 2.90 | 3.60 | 4.50 | 3.90 | 3.00 | 2.50 | 2.60 | 2.10 | 6.60 |
| 3 | 3.80 | 3.80 | 4.80 | 3.00 | 3.50 | 4.50 | 4.00 | 2.90 | 2.50 | 2.30 | 2.00 | 5.60 |
| 4 | 3.60 | 3.50 | 4.60 | 3.50 | 3.50 | 4.50 | 4.10 | 2.90 | 2.70 | 2.30 | 2.20 | 4.80 |
| 5 | 3.50 | 3.60 | 4.20 | 3.40 | 3.40 | 4.70 | 4.00 | 2.90 | 2.50 | 2.20 | 2.20 | 4.60 |
| 6 | 3.30 | 3.20 | 4.00 | 3.30 | 3.60 | 4.10 | 4.00 | 2.90 | 2.60 | 2.20 | 2.20 | 4.20 |
| 7 | 3.00 | 3.30 | 4.00 | 3.20 | 3.50 | 4.10 | 3.90 | 2.90 | 2.40 | 2.10 | 2.70 | 3.80 |
| 8 | 2.80 | 4.10 | 3.80 | 3.20 | 3.70 | 4.50 | 3.80 | 2.80 | 2.40 | 2.10 | 2.60 | 3.60 |
| 9 | 2.60 | 6.15 | 3.80 | 3.50 | 4.20 | 4.70 | 3.80 | 2.80 | 2.40 | 2.10 | 2.70 | 3.20 |
| 10 | 2.40 | 6.50 | 3.70 | 3.50 | 4.40 | 4.50 | 3.80 | 3.60 | 2.30 | 2.10 | 2.80 | 3.50 |
| 11 | 2.30 | 5.50 | 3.60 | 4.50 | 4.90 | 5.50 | 3.80 | 3.00 | 2.30 | 2.10 | 2.80 | 4.50 |
| 12 | 2.20 | 4.80 | 3.50 | 6.60 | 4.40 | 5.20 | 3.80 | 2.80 | 2.40 | 2.10 | 2.80 | 4.20 |
| 13 | 2.10 | 4.60 | 3.50 | 5.50 | 4.30 | 5.00 | 3.90 | 2.70 | 2.40 | 2.00 | 2.70 | 4.00 |
| 14 | 2.00 | 4.40 | 3.30 | 4.50 | 3.90 | 4.50 | 4.00 | 2.60 | 2.40 | 1.90 | 2.70 | 3.80 |
| 15 | 4.00 | 5.50 | 3.70 | 4.20 | 3.60 | 4.50 | 4.10 | 2.60 | 2.30 | 1.70 | 2.60 | 3.60 |
| 16 | 6.30 | 4.80 | 3.20 | 4.50 | 3.60 | 4.40 | 4.10 | 2.70 | 2.30 | 1.80 | 2.70 | 3.50 |
| 17 | 6.20 | 4.50 | 3.00 | 4.50 | 3.60 | 4.60 | 4.00 | 2.70 | 2.30 | 2.00 | 2.70 | 3.40 |
| 18 | 6.10 | 4.50 | 3.00 | 4.00 | 3.60 | 4.80 | 4.00 | 2.60 | 2.30 | 2.60 | 2.80 | 3.40 |
| 19 | 5.80 | 4.40 | 3.00 | 4.00 | 3.60 | 5.00 | 3.90 | 2.60 | 2.30 | 5.10 | 5.40 | 3.40 |
| 20 | 7.15 | 4.30 | 3.00 | 3.90 | 3.50 | 4.60 | 3.90 | 2.60 | 2.30 | 4.00 | 4.50 | 3.30 |
| 21 | 11.00 | 4.20 | 3.00 | 3.90 | 3.50 | 4.20 | 3.50 | 2.60 | 2.30 | 3.60 | 4.40 | 4.80 |
| 22 | 7.50 | 4.00 | 3.00 | 3.90 | 3.60 | 4.20 | 3.40 | 4.00 | 2.20 | 3.00 | 4.00 | 4.90 |
| 23 | 6.50 | 3.90 | 2.90 | 5.30 | 3.70 | 4.20 | 3.20 | 2.90 | 2.10 | 2.70 | 3.80 | 4.70 |
| 24 | 5.30 | 3.70 | 2.90 | 5.45 | 3.90 | 4.20 | 3.20 | 2.70 | 2.10 | 2.60 | 3.50 | 4.70 |
| 25 | 4.90 | 3.60 | 2.80 | 6.00 | 4.00 | 4.40 | 3.20 | 2.70 | 2.10 | 2.50 | 3.20 | 4.70 |
| 26 | 5.80 | 3.50 | 2.70 | 5.45 | 4.00 | 4.20 | 3.20 | 2.80 | 2.10 | 2.50 | 3.30 | 4.60 |
| 27 | 4.50 | 4.20 | 2.70 | 5.50 | 4.00 | 4.20 | 3.20 | 3.30 | 2.20 | 2.40 | 6.00 | 4.40 |
| 28 | 4.20 | 5.65 | 2.70 | 5.30 | 4.40 | 3.90 | 3.30 | 2.80 | 2.20 | 2.30 | 5.80 | 4.20 |
| 29 | 4.10 | ..... | 2.70 | 5.35 | 4.40 | 3.90 | 4.00 | 2.70 | 2.20 | 2.30 | 7.20 | 3.80 |
| 30 | 4.10 | ..... | 2.80 | 3.90 | 4.40 | 3.90 | 3.40 | 2.60 | 2.60 | 2.20 | 6.60 | 3.70 |
| 31 | 4.80 | ..... | 2.80 | ..... | 4.00 | ..... | 3.20 | 2.60 | ..... | 2.20 | ..... | 3.60 |

## WHITE RIVER AT BUCKLEY, WASHINGTON.

This river has its source in the glaciers of Mount Rainier, in the Cascade Range in Washington, and flows in a general northwesterly direction, entering Puget Sound at Seattle. Its mountainous collecting area is densely forested, and owing to the great precipitation on the western slope of the Cascade Mountains the basin has a high run-off. On account of the great fall of the rivers on the western slope of the Cascade Mountains in Washington, there are a number of fine water powers. These have lately been under investigation. In order to determine the amount of power that could be developed on White River, a station was established by Sydney Arnold, April 22, 1899, at the new highway bridge, 500 feet above the Northern Pacific railway bridge, and one-half mile north of the town of Buckley, Washington. The location is in sec. 34, T. 20 N., R. 6 E. of the Willamette meridian. The rod of the wire gage is fastened to the guard rail of the highway bridge. The length of the wire rope is 20 feet. The elevation of the top of the guard rail at the pulley is 19.56 feet above gage datum. The bridge is a clear span of 180 feet, crossing the river a trifle obliquely. The channel is straight for some distance above and below the bridge, but the section is not a very good one, owing to the sudden fall a short distance below. About 300 feet above the bridge is a good section, with fine gravel bottom in calmer water, but in order to utilize it it would be necessary to erect a cable. An examination of the river channel for some distance above and below this point was made, but the present location is about the only one available for accurate results. The following measurements of discharge were made by Sydney Arnold in 1899:

*Discharge measurements of White River at Buckley, Washington.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| June 5 | 3.15 | 3,825 | August 23 | 2.50 | 2,065 |
| June 21 | 3.37 | 3,971 | September 13 | 1.78 | 1,216 |
| July 25 | 2.37 | 2,321 | September 27 | 1.55 | 1,015 |
| August 8 | 2.05 | 1,618 | October 9 | 1.45 | 993 |

*Daily gage height, in feet, of White River at Buckley, Washington, for 1899.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 2.00 | 2.86 | 2.80 | 2.30 | 2.00 | 1.67 | 1.67 | 5.78 |
| 2 | ..... | 1.85 | 3.05 | 3.07 | 2.17 | 1.93 | 1.45 | 1.60 | 4.08 |
| 3 | ..... | 1.78 | 3.19 | 3.47 | 2.05 | 1.93 | 1.40 | 1.55 | 3.55 |
| 4 | ..... | 1.75 | 3.44 | 3.30 | 2.10 | 1.90 | 1.40 | 1.65 | 3.15 |
| 5 | ..... | 1.96 | 3.08 | 2.97 | 2.07 | 1.80 | 1.33 | 1.50 | 3.05 |
| 6 | ..... | 2.13 | 3.00 | 2.93 | 2.03 | 1.75 | 1.33 | 1.45 | 2.65 |
| 7 | ..... | 2.15 | 2.78 | 2.90 | 2.00 | 1.63 | 1.30 | 1.95 | 2.50 |
| 8 | ..... | 2.78 | 2.82 | 3.00 | 2.05 | 1.63 | 1.75 | 1.75 | 2.37 |
| 9 | ..... | 3.17 | 3.20 | 2.95 | 2.05 | 1.55 | 1.45 | 1.93 | 2.25 |
| 10 | ..... | 2.88 | 3.81 | 3.05 | 2.08 | 1.55 | 1.45 | 1.93 | 2.20 |
| 11 | ..... | 2.98 | 4.31 | 3.00 | 1.95 | 1.70 | 1.40 | 1.93 | 2.45 |
| 12 | ..... | 2.70 | 3.83 | 3.13 | 1.85 | 1.85 | 1.40 | 1.80 | 2.55 |
| 13 | ..... | 2.64 | 3.58 | 3.15 | 1.80 | 1.78 | 1.33 | 1.95 | 2.40 |
| 14 | ..... | 2.64 | 3.15 | 3.20 | 2.33 | 1.65 | 1.20 | 2.50 | 2.40 |
| 15 | ..... | 2.35 | 3.27 | 3.20 | 2.27 | 1.65 | 1.10 | 2.63 | 2.10 |
| 16 | ..... | 2.28 | 3.65 | 3.33 | 2.13 | 1.60 | 3.10 | 2.63 | 1.87 |
| 17 | ..... | 2.37 | 3.85 | 3.15 | 2.05 | 1.60 | 2.25 | 2.35 | 1.85 |
| 18 | ..... | 2.56 | 3.95 | 2.95 | 2.05 | 1.53 | 1.95 | 3.40 | 1.65 |
| 19 | ..... | 2.67 | 3.78 | 2.90 | 1.93 | 1.53 | 2.90 | 4.50 | 1.70 |
| 20 | ..... | 2.62 | 3.56 | 2.75 | 1.93 | 1.57 | 2.45 | 3.85 | 1.95 |
| 21 | ..... | 2.70 | 3.37 | 2.55 | 1.85 | 1.50 | 2.13 | 3.35 | 2.88 |
| 22 | 1.93 | 2.75 | 3.23 | 2.47 | 2.86 | 1.43 | 1.93 | 2.80 | 4.00 |
| 23 | 2.10 | 3.07 | 3.30 | 2.45 | 2.47 | 1.40 | 1.75 | 2.65 | 5.38 |
| 24 | 1.98 | 3.32 | 3.42 | 2.50 | 2.15 | 1.47 | 1.95 | 2.40 | 3.95 |
| 25 | 1.95 | 3.30 | 3.28 | 2.37 | 2.05 | 1.60 | 1.85 | 2.27 | 3.33 |
| 26 | 2.05 | 3.06 | 3.15 | 2.45 | 2.05 | 1.60 | 2.23 | 2.80 | 3.15 |
| 27 | 2.05 | 3.05 | 2.93 | 2.66 | 2.10 | 1.55 | 2.23 | 3.10 | 3.05 |
| 28 | 1.95 | 2.92 | 2.90 | 2.73 | 1.95 | 1.45 | 2.10 | 4.20 | 2.55 |
| 29 | 2.00 | 2.85 | 2.90 | 2.60 | 1.85 | 1.45 | 1.90 | 3.95 | 2.50 |
| 30 | 2.05 | 2.78 | 2.75 | 2.53 | 1.80 | 1.73 | 1.87 | 3.80 | 2.40 |
| 31 | ..... | 2.66 | ..... | 2.37 | 1.80 | ..... | 1.75 | ..... | 2.22 |

## CEDAR RIVER AT VAUGHN BRIDGE, WASHINGTON.

This river is a tributary of White River and has its source on the western slope of the Cascade Mountains. Flowing in a general northwesterly direction, it enters White River a few miles above its mouth. A study of its discharge has been made during several years by T. A. Noble, for the Seattle Power Company, as there are a number of fine water-power privileges along its course. The station was at first established at Clifford bridge, but was moved in July, 1898, to Vaughn bridge, 15 miles above, and about 3,000 feet below the outlet of Cedar Lake. The drainage area at this point is 80 square miles. In order to reduce the gage heights to sea-level datum 990 feet should be added. The channel was changed during the high water of 1898 and 1899, so that all readings at Vaughn bridge after October, 1898, are not absolutely reliable.

*Daily gage height, in feet, of Cedar River at Vaughn bridge, Washington, for 1898.*

| Day. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.... | 2.24 | 1.50 | 1.30 | 2.01 | 2.10 | 2.40 | 17..... | 1.80 | 1.30 | 1.20 | 1.90 | 3.25 | 1.70 |
| 2.... | 2.20 | 1.50 | 1.30 | 2.10 | 2.62 | 2.35 | 18..... | 1.80 | 1.30 | 1.20 | 1.80 | 3.31 | 1.73 |
| 3.... | 2.20 | 1.50 | 1.30 | 1.96 | 2.41 | 2.32 | 19..... | 1.90 | 1.30 | 1.20 | 1.80 | 3.31 | 1.80 |
| 4.... | 2.20 | 1.50 | 1.40 | 1.84 | 2.60 | 2.30 | 20..... | 1.90 | 1.30 | 1.30 | 1.72 | 3.20 | 2.30 |
| 5.... | 2.20 | 1.50 | 1.30 | 1.75 | 2.73 | 2.30 | 21..... | 1.80 | 1.30 | 1.35 | 1.74 | 3.10 | 2.30 |
| 6.... | 2.20 | 1.50 | 1.30 | 1.70 | 2.80 | 2.22 | 22..... | 1.70 | 1.30 | 1.60 | 1.74 | 3.20 | 1.92 |
| 7.... | 2.10 | 1.40 | 1.30 | 1.63 | 2.84 | 2.22 | 23..... | 1.70 | 1.30 | 1.70 | 1.75 | 2.70 | 2.27 |
| 8.... | 2.10 | 1.40 | 1.30 | 1.58 | 2.75 | 1.99 | 24..... | 1.70 | 1.30 | 1.60 | 1.70 | 2.57 | 2.93 |
| 9.... | 2.00 | 1.40 | 1.20 | 1.64 | 2.63 | 1.85 | 25..... | 1.60 | 1.30 | 1.50 | 1.70 | 2.51 | 3.30 |
| 10.... | 2.00 | 1.40 | 1.20 | 1.69 | 2.40 | 1.80 | 26..... | 1.60 | 1.30 | 1.60 | 1.70 | 2.31 | 3.70 |
| 11.... | 2.00 | 1.40 | 1.20 | 1.74 | 2.31 | 1.80 | 27..... | 1.60 | 1.30 | 1.50 | 1.74 | 2.50 | 4.80 |
| 12.... | 1.90 | 1.40 | 1.20 | 1.65 | 2.30 | 1.74 | 28..... | 1.60 | 1.30 | 1.60 | 1.85 | 2.35 | 5.40 |
| 13.... | 1.90 | 1.40 | 1.25 | 1.80 | 2.21 | 1.70 | 29..... | 1.60 | 1.30 | 1.71 | 1.87 | 2.40 | 4.60 |
| 14.... | 1.90 | 1.40 | 1.20 | 1.90 | 2.06 | 1.70 | 30..... | 1.50 | 1.30 | 1.95 | 1.80 | 2.43 | 3.50 |
| 15.... | 1.80 | 1.40 | 1.20 | 1.94 | 2.13 | 1.70 | 31..... | 1.50 | 1.30 | ..... | 2.00 | ..... | 3.40 |
| 16.... | 1.80 | 1.40 | 1.20 | 1.94 | 2.25 | 1.70 | | | | | | | |

## DUNGENESS RIVER AT DUNGENESS, WASHINGTON.

This river rises on the eastern slope of the Olympic Mountains and flows in a general northerly direction, entering the strait of Juan de Fuca at the town of Dungeness, Washington, about 15 miles east of Port Angeles. Its mountainous drainage basin is highly picturesque and very heavily timbered. Although this section of the country receives a heavy precipitation, it occurs when least needed, and during the summer season recourse must be had to irrigation. The station originally established—July 5, 1897—was located 9 miles above the mouth of the river. July 29, 1898, it was moved to the bridge 8½ miles below. This bridge crosses the river diagonally, at an angle of about 15°. The length of the wire rope of the gage is 26.04 feet. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 504; 1898, Twentieth Annual Report, Part IV, page 518. The following measurements of discharge were made by W. J. Ware during 1899:

*Discharge measurements of Dungeness River at Dungeness, Washington.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| January 31 ..... | 4.00 | 440 | May 30 ..... | 4.10 | 536 |
| February 22 ..... | 3.80 | 443 | July 5 ..... | 4.55 | 627 |
| March 29 ..... | 2.95 | 228 | August 31 ..... | 3.35 | 223 |
| April 28 ..... | 3.25 | 253 | September 16..... | 3.25 | 205 |

*Daily gage height, in feet, of Dungeness River at Dungeness, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.55 | 3.90 | 3.60 | 3.00 | 3.20 | 4.25 | 4.40 | 4.10 | 3.35 | 3.05 | 3.80 | 8.10 |
| 2 | 3.45 | 3.70 | 3.55 | 3.00 | 3.20 | 4.50 | 4.45 | 4.05 | 3.40 | 3.05 | 3.85 | 7.20 |
| 3 | 3.40 | 3.55 | 3.50 | 3.05 | 3.20 | 4.50 | 4.70 | 4.00 | 3.40 | 3.00 | 3.90 | 6.00 |
| 4 | 3.30 | 3.55 | 3.50 | 3.10 | 3.15 | 4.45 | 4.50 | 3.95 | 3.40 | 3.00 | 3.95 | 5.00 |
| 5 | 3.20 | 3.45 | 3.45 | 3.20 | 3.20 | 4.45 | 4.60 | 4.00 | 3.35 | 2.95 | 3.95 | 4.80 |
| 6 | 3.10 | 3.40 | 3.40 | 3.30 | 3.25 | 4.40 | 4.60 | 4.00 | 3.35 | 3.00 | 3.95 | 4.50 |
| 7 | 3.00 | 3.45 | 3.55 | 3.35 | 3.40 | 4.40 | 4.55 | 3.90 | 3.35 | 2.95 | 3.95 | 4.35 |
| 8 | 2.95 | 3.60 | 3.55 | 3.40 | 3.60 | 4.50 | 4.50 | 3.85 | 3.30 | 2.95 | 4.00 | 4.20 |
| 9 | 3.00 | 3.60 | 3.50 | 3.45 | 4.55 | 4.70 | 4.45 | 3.80 | 3.30 | 2.95 | 4.20 | 4.00 |
| 10 | 3.85 | 3.65 | 3.50 | 3.45 | 4.20 | 4.80 | 4.40 | 3.75 | 3.35 | 2.90 | 5.40 | 3.90 |
| 11 | 3.55 | 3.70 | 3.50 | 3.45 | 4.10 | 4.90 | 4.35 | 3.70 | 3.35 | 2.90 | 5.55 | 3.90 |
| 12 | 3.15 | 3.70 | 3.45 | 4.05 | 4.00 | 5.00 | 4.40 | 3.60 | 3.35 | 2.85 | 4.90 | 3.85 |
| 13 | 3.05 | 3.75 | 3.40 | 3.90 | 3.85 | 4.65 | 4.45 | 3.50 | 3.30 | 2.85 | 5.40 | 3.85 |
| 14 | 3.30 | 3.80 | 3.35 | 3.80 | 3.75 | 4.55 | 4.45 | 3.40 | 3.30 | 2.80 | 6.00 | 3.75 |
| 15 | 3.15 | 4.20 | 3.30 | 3.65 | 3.70 | 4.75 | 4.50 | 3.30 | 3.25 | 2.80 | 5.50 | 3.70 |
| 16 | 3.25 | 4.30 | 3.20 | 3.50 | 3.65 | 4.90 | 4.55 | 3.20 | 3.20 | 2.90 | 5.40 | 3.65 |
| 17 | 3.40 | 4.10 | 3.15 | 3.45 | 3.80 | 5.05 | 4.55 | 3.00 | 3.20 | 3.00 | 5.45 | 3.60 |
| 18 | 4.80 | 4.00 | 3.15 | 3.40 | 3.75 | 4.95 | 4.50 | 2.80 | 3.20 | 3.50 | 5.35 | 3.80 |
| 19 | 4.40 | 4.30 | 3.10 | 3.30 | 3.80 | 4.85 | 4.50 | 2.50 | 3.15 | 4.05 | 7.10 | 4.00 |
| 20 | 4.80 | 4.15 | 3.10 | 3.30 | 3.90 | 4.65 | 4.40 | 2.35 | 3.15 | 4.50 | 6.00 | 4.50 |
| 21 | 5.20 | 3.80 | 3.15 | 3.25 | 4.00 | 4.55 | 4.30 | 2.40 | 3.10 | 4.00 | 5.75 | 5.00 |
| 22 | 4.70 | 3.75 | 3.10 | 3.20 | 4.10 | 4.55 | 4.15 | 2.40 | 3.10 | 3.65 | 5.30 | 6.25 |
| 23 | 4.65 | 3.70 | 3.10 | 3.20 | 4.20 | 4.60 | 4.00 | 2.40 | 3.10 | 3.40 | 5.00 | 6.50 |
| 24 | 4.60 | 3.60 | 3.05 | 3.30 | 4.50 | 4.50 | 4.05 | 2.40 | 3.20 | 3.30 | 5.50 | 6.00 |
| 25 | 4.50 | 3.50 | 3.00 | 3.35 | 4.65 | 4.50 | 4.05 | 2.45 | 3.20 | 3.25 | 6.00 | 5.60 |
| 26 | 4.40 | 3.50 | 2.95 | 3.40 | 4.65 | 4.40 | 4.10 | 2.45 | 3.15 | 3.40 | 7.45 | 5.20 |
| 27 | 4.35 | 3.55 | 3.00 | 3.35 | 4.45 | 4.30 | 4.10 | 3.40 | 3.10 | 3.55 | 7.55 | 4.85 |
| 28 | 4.30 | 3.60 | 3.00 | 3.30 | 4.30 | 4.30 | 4.15 | 3.35 | 3.10 | 3.60 | 7.20 | 4.65 |
| 29 | 4.20 | ..... | 3.00 | 3.25 | 4.20 | 4.25 | 4.15 | 3.30 | 3.05 | 3.80 | 7.20 | 4.50 |
| 30 | 4.10 | ..... | 3.00 | 3.20 | 4.10 | 4.35 | 4.20 | 3.30 | 3.05 | 3.85 | 9.00 | 4.40 |
| 31 | 4.00 | ..... | 3.00 | ..... | 4.10 | ..... | 4.25 | 3.35 | ..... | 3.95 | ..... | 4.40 |

## ELWHA RIVER AT MCDONALD, WASHINGTON.

This river rises in the Olympic Mountains and flows northerly, entering the strait of Juan de Fuca. Its upper basin is very heavily wooded, and is almost inaccessible on account of its rugged character and the dense undergrowth that covers the mountain slopes. In the lower course of the river a number of falls occur where power could be advantageously developed, and within the last few years surveys having this object in view have been made.

Morse River drains a small area east of Elwha River. It flows northward, entering the strait of Juan de Fuca 4 miles east of Port Angeles. Plans contemplating the use of this stream for the city supply of Port Angeles are under consideration. The river also furnishes opportunities for the development of water power. Three measurements of the discharge of the river were made by W. J. Ware in 1899. The first, on June 3, showed a discharge of 242 second-feet; the second, on July 6, showed a discharge of 189 second-feet; the third, on September 15, gave a discharge of 62 second-feet.

Indian Creek is a tributary of Elwha River, entering it from the west about one-fourth of a mile below the gaging station. On June 16 it was discharging 45 second-feet.

Little River is another tributary of Elwha River and enters it from the east side about one-fourth of a mile below the bridge at which the gaging station on the main stream is located. On June 16 it was carrying 84 second-feet.

Clallam River drains an area in northwest Washington, entering the strait of Juan de Fuca at the town of East Clallam. On March 22, 1899, its discharge, as measured by W. J. Ware, was found to be 45 second-feet.

The gaging station on Elwha River, established October 8, 1897, is located 9 miles southwest of Port Angeles, at the new county bridge of Clallam County, Washington. The horizontal rod of the wire gage is fastened to the guard rail at the north side of the bridge. The length of the gage wire is 49.26 feet. The bench mark is the top edge of the top side rail on the north side of the bridge at the third upright post from the east end, and is at an elevation of 41.34 feet above datum. The channel is straight for some distance above and below the station. Both banks are high and rocky and will not overflow. The bed of the stream is rocky. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 506; 1898, Twentieth Annual Report, Part IV, page 521. The following discharge measurements were made by W. J. Ware during 1899:

January 27, gage height, 3.29 feet; discharge, 1,978 second-feet.
March 18, gage height, 2.20 feet; discharge, 674 second feet.
March 31, gage height, 1.75 feet; discharge, 547 second-feet.
April 24, gage height, 2.15 feet; discharge, 727 second-feet.
June 16, gage height, 4.10 feet; discharge, 2,420 second-feet.
July 31, gage height, 3.40 feet; discharge, 1,644 second-feet.
August 30, gage height, 1.95 feet; discharge, 586 second-feet.

*Daily gage height, in feet, of Elwha River at McDonald, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.85 | 3.00 | 2.48 | 1.80 | 2.00 | 3.79 | 3.40 | 3.16 | 2.15 | 2.01 | 2.09 | 6.30 |
| 2 | 2.84 | 2.70 | 2.44 | 1.74 | 1.93 | 3.50 | 3.70 | 3.15 | 2.16 | 1.60 | 1.95 | 5.58 |
| 3 | 2.70 | 2.62 | 2.26 | 1.63 | 1.91 | 3.95 | 3.90 | 3.15 | 1.96 | 1.58 | 2.60 | 4.80 |
| 4 | 2.48 | 2.51 | 2.20 | 1.70 | 1.90 | 3.96 | 4.10 | 3.00 | 1.91 | 1.57 | 2.56 | 4.71 |
| 5 | 2.40 | 2.47 | 2.18 | 1.69 | 2.04 | 3.55 | 4.01 | 2.90 | 1.94 | 1.55 | 2.09 | 4.35 |
| 6 | 2.24 | 2.34 | 2.22 | 1.72 | 2.06 | 3.40 | 3.90 | 2.90 | 1.91 | 1.55 | 2.03 | 3.96 |
| 7 | 2.19 | 2.32 | 2.65 | 1.86 | 2.24 | 3.33 | 3.75 | 2.85 | 1.82 | 1.54 | 2.96 | 3.92 |
| 8 | 2.10 | 2.74 | 2.85 | 1.90 | 3.13 | 3.72 | 3.60 | 2.76 | 1.76 | 1.80 | 2.66 | 3.66 |
| 9 | 2.20 | 3.13 | 2.46 | 1.84 | 3.43 | 3.85 | 3.66 | 2.97 | 1.72 | 1.69 | 4.78 | 3.62 |
| 10 | 2.85 | 2.67 | 2.42 | 2.20 | 3.42 | 4.46 | 3.60 | 3.30 | 1.69 | 1.65 | 4.73 | 3.54 |
| 11 | 2.40 | 2.59 | 2.34 | 3.33 | 3.31 | 4.52 | 3.40 | 2.75 | 2.00 | 1.61 | 5.11 | 3.80 |
| 12 | 2.28 | 2.79 | 2.27 | 3.58 | 3.28 | 3.85 | 3.60 | 2.68 | 2.02 | 1.50 | 3.88 | 3.53 |
| 13 | 2.34 | 2.87 | 2.19 | 3.42 | 3.19 | 3.85 | 3.92 | 2.60 | 1.98 | 1.35 | 5.58 | 3.20 |
| 14 | 2.68 | 3.29 | 2.16 | 2.60 | 3.02 | 3.65 | 4.02 | 2.65 | 1.95 | 1.30 | 5.48 | 3.19 |
| 15 | 2.40 | 4.94 | 1.99 | 2.48 | 2.95 | 3.80 | 4.15 | 2.42 | 1.77 | 1.31 | 4.64 | 2.99 |
| 16 | 2.48 | 5.00 | 1.95 | 2.34 | 2.90 | 4.01 | 4.10 | 2.60 | 1.74 | 1.96 | 3.98 | 2.95 |
| 17 | 3.45 | 3.65 | 2.00 | 2.30 | 2.40 | 4.46 | 4.05 | 2.70 | 1.72 | 1.68 | 3.65 | 2.96 |
| 18 | 4.52 | 3.52 | 2.20 | 2.25 | 2.39 | 4.15 | 4.10 | 2.55 | 1.72 | 1.80 | 6.46 | 2.70 |
| 19 | 3.90 | 3.46 | 1.91 | 2.14 | 2.45 | 4.02 | 3.95 | 2.49 | 1.66 | 3.23 | 8.83 | 2.61 |
| 20 | 4.93 | 3.25 | 1.85 | 2.12 | 2.47 | 3.77 | 3.73 | 2.40 | 1.65 | 3.33 | 5.65 | 3.16 |
| 21 | 5.00 | 2.92 | 1 90 | 2.08 | 2.70 | 3.74 | 3.64 | 2.32 | 1.66 | 2.62 | 5.62 | 5.26 |
| 22 | 4.10 | 2.80 | 1.84 | 2.07 | 2.74 | 3.75 | 3.40 | 2.35 | 1.71 | 2.19 | 6.31 | 8.57 |
| 23 | 3.80 | 2.99 | 1.83 | 2.05 | 2.78 | 3.80 | 3.33 | 2.37 | 1.66 | 2.07 | 5.46 | 6.45 |
| 24 | 3.45 | 2.80 | 1.76 | 2.10 | 3.45 | 3.94 | 3.42 | 2.20 | 1.78 | 2.00 | 5.22 | 5.10 |
| 25 | 3.72 | 2.69 | 1.74 | 2.05 | 3.54 | 3.88 | 3.32 | 2.20 | 1.82 | 1.98 | 4.87 | 4.98 |
| 26 | 3.38 | 2.85 | 1.62 | 2.00 | 3.64 | 3.75 | 3.50 | 2.20 | 1.80 | 2.05 | 8.09 | 4.50 |
| 27 | 3.29 | 2.58 | 1.63 | 1.97 | 3.71 | 3.54 | 3.56 | 2.04 | 1.79 | 3.35 | 7.80 | 4.19 |
| 28 | 3.22 | 2.55 | 1.61 | 2.05 | 3.29 | 3.48 | 3.64 | 2.01 | 1.63 | 3.36 | 8.38 | 3.86 |
| 29 | 3.10 | ..... | 1.70 | 2 08 | 3.20 | 3.35 | 3.74 | 1.95 | 1.61 | 3.00 | 5.67 | 3.82 |
| 30 | 2.97 | ..... | 1.78 | 2.04 | 3.18 | 3.32 | 3.65 | 1.90 | 2.35 | 2.39 | 10.00 | 3.79 |
| 31 | 3.30 | ..... | 1.75 | ..... | 3.25 | ..... | 3.39 | 1.90 | ..... | 2.10 | ..... | 3.69 |

## CALOWA RIVER AT FORKS, WASHINGTON.

This river has its source on the western slopes of the Olympic Mountains, and flows in a general westerly and southerly direction, uniting with the Solduck and Bogachiel rivers, to form Quillayute River, which enters the Pacific Ocean at Lapush, Washington. The gaging station, established November 12, 1897, is located at the county highway bridge in the southwestern part of Clallam County, near Forks, Washington, and is reached by steamer from Port Angeles to Clallam Bay, and thence overland 30 miles by wagon. The horizontal rod of the wire gage is nailed to the railing of the wagon bridge. The banks are high and rocky, and do not overflow. The results of measurements may be found as follows: 1897 and 1898, Twentieth Annual Report, Part IV, page 522. Three measurements of discharge were made by W. J. Ware during 1899. The first, on March 24, at a gage height of 1.65 feet, gave a discharge of 584 second-feet; the second, on June 23, at a gage height of 0.85 foot, showed a discharge of 265 second-feet; the third measurement, on September 12, at a gage height of 0.20 foot, showed a discharge of 81 second-feet.

*Daily gage height, in feet, of Calowa River at Forks, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.85 | 2.25 | 5.20 | 1.40 | 2.20 | 1.85 | .60 | 0.00 | −.20 | .00 | 1.45 | 8.25 |
| 2 | 2.00 | 1.85 | 3.85 | 1.05 | 2.25 | 1.85 | .60 | 0.05 | −.25 | .00 | 1.20 | 5.20 |
| 3 | 2.70 | 1.80 | 3.65 | 2.45 | 2.25 | 1.80 | .60 | 0.00 | −.20 | .00 | 2.85 | 4.40 |
| 4 | 2.85 | 1.65 | 3.45 | 2.25 | 2.45 | 1.65 | .60 | 0.00 | −.05 | − .05 | 2.20 | 4.65 |
| 5 | 2.80 | 1.65 | 3.60 | 2.20 | 2.20 | 1.60 | .60 | − .05 | .00 | − .20 | 2.05 | 4.85 |
| 6 | 2.60 | 1.85 | 3.05 | 2.20 | 2.20 | 1.45 | .45 | − .20 | −.05 | − .05 | 2.20 | 4.85 |
| 7 | 2.20 | 2.00 | 5.60 | 2.05 | 2.20 | 1.40 | .45 | .05 | −.25 | − .05 | 2.40 | 4.80 |
| 8 | 2.05 | 2.45 | 5.00 | 2.05 | 3.00 | 1.25 | .45 | .00 | −.25 | .00 | 2.60 | 4.65 |
| 9 | 2.85 | 3.65 | 5.20 | 2.65 | 2.25 | 1.25 | .45 | .00 | −.20 | .05 | 5.05 | 4.45 |
| 10 | 7.45 | 3.00 | 5.00 | 2.05 | 3.00 | 1.45 | .40 | .05 | −.20 | .05 | 4.85 | 4.40 |
| 11 | 5.25 | 3.20 | 3.85 | 7.60 | 2.85 | 1.65 | .40 | .20 | −.25 | .00 | 5.00 | 4.25 |
| 12 | 5.00 | 4.00 | 3.45 | 5.40 | 2.25 | 1.60 | .25 | .05 | −.20 | − .05 | 4.60 | 4.20 |
| 13 | 4.85 | 4.60 | 3.05 | 4.30 | 2.20 | 1.40 | .20 | .20 | −.25 | − .20 | 4.45 | 4.20 |
| 14 | 5.40 | 7.05 | 2.85 | 3.45 | 2.20 | 1.20 | .20 | .05 | −.25 | − .20 | 5.05 | 4.20 |
| 15 | 6.80 | 7.60 | 2.60 | 3.60 | 2.20 | 1.20 | .25 | .00 | −.25 | + .05 | 5.00 | 3.25 |
| 16 | 6.00 | 6.05 | 2.40 | 3.45 | 2.25 | 1.20 | .25 | .05 | −.25 | 1.80 | 4.25 | 2.45 |
| 17 | 8.00 | 6.85 | 2.05 | 3.20 | 2.25 | 1.20 | .20 | .05 | −.40 | 1.05 | 3.65 | 2.60 |
| 18 | 8.45 | 6.60 | 2.00 | 3.20 | 2.20 | 1.05 | .20 | .00 | −.40 | .80 | 11.40 | 2.40 |
| 19 | 9.00 | 6.00 | 1.85 | 3.40 | 2.20 | 1.00 | .20 | .00 | −.40 | 3.85 | 8.20 | 2.25 |
| 20 | 10.80 | 4.00 | 1.85 | 2.80 | 2.20 | .80 | .25 | − .05 | −.45 | 4.45 | 8.25 | 4.25 |
| 21 | 8.00 | 3.80 | 1.80 | 2.45 | 2.05 | .85 | .20 | − .15 | −.60 | 2.65 | 8.45 | 7.85 |
| 22 | 6.80 | 3.20 | 1.80 | 2.40 | 2.05 | .80 | .20 | − .05 | −.60 | 2.05 | 8.05 | 14.60 |
| 23 | 5.00 | 3.05 | 1.85 | 2.20 | 2.00 | .85 | .05 | − .20 | −.60 | 1.65 | 8.25 | 7.85 |
| 24 | 4.00 | 3.20 | 1.65 | 2.20 | 1.85 | .85 | .05 | − .20 | −.60 | 2.25 | 6.25 | 6.00 |
| 25 | 4.25 | 3.60 | 1.60 | 2.25 | 1.85 | .85 | .00 | − .25 | −.45 | 1.80 | 5.05 | 5.60 |
| 26 | 4.00 | 5.20 | 1.60 | 2.80 | 1.85 | 1.40 | .00 | − .25 | −.40 | 1.60 | 6.45 | 4.45 |
| 27 | 3.60 | 5.00 | 1.45 | 2.60 | 2.25 | 1.00 | .00 | − .25 | −.45 | 4.20 | 7.25 | 4.40 |
| 28 | 3.00 | 5.60 | 1.45 | 2.20 | 2.05 | .85 | −.05 | − .25 | −.65 | 3.80 | 6.65 | 4.40 |
| 29 | 2.85 | ..... | 1.45 | 2.45 | 2.00 | .80 | −.05 | − .25 | −.20 | −3.60 | 5.00 | 4.25 |
| 30 | 2.45 | ..... | 1.45 | 2.00 | 1.85 | .65 | −.20 | − .25 | .25 | 2.20 | 13.00 | 4.25 |
| 31 | 2.40 | ..... | 1.45 | ..... | 1.85 | ..... | −.05 | − .20 | ..... | 1.85 | ..... | 4.20 |

## SOLDUCK RIVER AT QUILLAYUTE, WASHINGTON.

This river has its source on the high western slope of the Olympic Mountains, and drains the country immediately north of the Calowa, joining it, as noted above, to form Quillayute River. The drainage

basin is very heavily wooded, the greater portion of it being included in the Olympic Forest Reserve. The station, established November 13, 1897, is located at the county highway bridge 9 miles northeast of Lapush, near Quillayute, Washington. The horizontal rod of the wire gage is fastened to the rail of the wagon bridge. The channel is straight for some distance above and below the station. The banks are high and rocky and do not overflow. The bed of the stream is composed of rock and gravel and is not liable to change. The results of measurements for 1897 and 1898 may be found in the Twentieth Annual Report, Part IV, page 523. Three measurements of discharge were made by W. J. Ware in 1899: The first, on March 24, at a gage height of 3.15 feet, showed a discharge of 1,023 second-feet; the second, on June 23, at a gage height of 3.20 feet, gave a discharge of 800 second-feet; the third, on September 12, at a gage height of 1.55 feet, gave a discharge of 297 second-feet.

*Daily gage height, in feet, of Solduck River at Quillayute, Washington, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.20 | 4.35 | 5.00 | 2.75 | 3.60 | 3.30 | 2.85 | 2.50 | 1.70 | 1.70 | 2.95 | 9.45 |
| 2 | 3.95 | 4.10 | 4.90 | 2.75 | 3.40 | 3.65 | 2.95 | 2.40 | 1.65 | 1.80 | 2.80 | 7.65 |
| 3 | 3.70 | 3.90 | 4.65 | 2.90 | 3.35 | 3.60 | 3.45 | 2.30 | 1.65 | 1.70 | 2.70 | 6.60 |
| 4 | 3.55 | 3.75 | 4.55 | 3.20 | 3.30 | 3.85 | 3.20 | 2.25 | 1.70 | 1.60 | 3.20 | 6.45 |
| 5 | 3.40 | 3.65 | 4.35 | 3.10 | 3.25 | 3.80 | 3.05 | 2.20 | 1.70 | 1.50 | 3.20 | 6.30 |
| 6 | 3.35 | 3.55 | 4.25 | 3.05 | 3.25 | 3.50 | 2.95 | 2.30 | 1.65 | 1.50 | 3.25 | 6.10 |
| 7 | 3.30 | 3.60 | 5.05 | 3.00 | 3.30 | 3.30 | 2.90 | 2.30 | 1.65 | 1.55 | 3.30 | 5.95 |
| 8 | 3.25 | 3.65 | 5.70 | 2.95 | 3.50 | 3.20 | 2.90 | 2.25 | 1.60 | 1.55 | 3.55 | 5.85 |
| 9 | 3.25 | 4.05 | 5.10 | 3.20 | 4.45 | 3.40 | 2.85 | 2.35 | 1.60 | 1.50 | 3.45 | 5.70 |
| 10 | 5.45 | 4.50 | 4.90 | 4.05 | 4.00 | 3.80 | 2.85 | 2.50 | 1.55 | 1.55 | 5.40 | 5.55 |
| 11 | 5.25 | 4.25 | 4.60 | 5.10 | 5.05 | 3.85 | 2.85 | 2.55 | 1.55 | 1.55 | 5.30 | 7.05 |
| 12 | 4.75 | 4.75 | 4.55 | 7.80 | 4.45 | 3.80 | 2.80 | 2.45 | 1.55 | 1.50 | 5.10 | 6.40 |
| 13 | 4.50 | 5.35 | 4.45 | 5.40 | 4.05 | 3.85 | 2.90 | 2.30 | 1.50 | 1.50 | 4.55 | 5.70 |
| 14 | 5.60 | 6.70 | 4.25 | 4.75 | 3.80 | 3.35 | 3.00 | 2.35 | 1.45 | 1.45 | 6.50 | 5.40 |
| 15 | 6.00 | 9.30 | 3.95 | 4.25 | 3.60 | 3.30 | 3.00 | 2.30 | 1.45 | 1.55 | 5.70 | 4.90 |
| 16 | 6.35 | 6.95 | 3.75 | 4.35 | 3.65 | 3.45 | 3.05 | 2.10 | 1.40 | 1.80 | 5.35 | 4.60 |
| 17 | 6.85 | 7.50 | 3.60 | 4.25 | 3.70 | 3.75 | 3.00 | 2.15 | 1.45 | 2.10 | 6.30 | 4.50 |
| 18 | 9.70 | 6.40 | 3.50 | 4.15 | 3.50 | 3.60 | 2.95 | 2.20 | 1.45 | 2.35 | 8.20 | 4.20 |
| 19 | 7.65 | 6.00 | 3.40 | 4.10 | 3.40 | 3.45 | 2.90 | 2.05 | 1.40 | 2.80 | 12.70 | 4.25 |
| 20 | 8.80 | 5.50 | 3.35 | 4.00 | 3.35 | 3.35 | 2.85 | 2.00 | 1.40 | 3.45 | 9.60 | 4.35 |
| 21 | 8.75 | 5.20 | 3.25 | 4.05 | 3.35 | 3.20 | 2.65 | 1.95 | 1.40 | 4.20 | 8.45 | 9.30 |
| 22 | 6.85 | 4.95 | 3.25 | 4.05 | 3.40 | 3.15 | 2.60 | 1.90 | 1.35 | 3.65 | 7.80 | 9.50 |
| 23 | 6.10 | 4.65 | 3.20 | 3.80 | 3.40 | 3.20 | 2.60 | 1.90 | 1.35 | 3.00 | 7.50 | 11.20 |
| 24 | 5.80 | 4.55 | 3.10 | 3.70 | 3.80 | 3.20 | 2.55 | 1.85 | 1.35 | 3.00 | 7.40 | 9.35 |
| 25 | 5.60 | 4.45 | 3.05 | 3.65 | 3.90 | 3.20 | 2.60 | 1.85 | 1.35 | 2.95 | 7.15 | 7.90 |
| 26 | 5.40 | 4.50 | 3.00 | 3.60 | 3.80 | 3.20 | 2.70 | 1.80 | 1.35 | 2.95 | 7.10 | 6.40 |
| 27 | 5.05 | 5.30 | 2.90 | 3.65 | 3.85 | 3.35 | 2.70 | 1.80 | 1.35 | 4.10 | 7.05 | 5.70 |
| 28 | 4.80 | 5.10 | 2.85 | 3.65 | 3.75 | 3.10 | 2.75 | 1.75 | 1.35 | 5.00 | 9.40 | 5.65 |
| 29 | 4.45 | ..... | 2.85 | 3.70 | 3.50 | 3.00 | 2.80 | 1.75 | 1.30 | 4.30 | 7.65 | 5.60 |
| 30 | 4.50 | ..... | 2.80 | 3.75 | 3.35 | 2.90 | 2.70 | 1.75 | 1.55 | 3.45 | 10.30 | 5.80 |
| 31 | 4.65 | ..... | 2.75 | ..... | 3.30 | ..... | 2.60 | 1.70 | ..... | 3.00 | ..... | 5.60 |

## SACRAMENTO RIVER AT JELLYS FERRY, CALIFORNIA.

This river rises in the extreme northeastern corner of California and flows in a general southerly direction, draining the large area in northern California between the Coast Range on the west and the Sierra Nevada on the east. It discharges into San Francisco Bay. A number of storage reservoirs have been constructed on the various tributaries of the river, and are used principally for hydraulic mining purposes and to a less extent for irrigation. The gaging station,

established April 30, 1895, is located 12 miles above the town of Redbluff, at the crossing of the county road at Jellys Ferry. The gage consists of a vertical rod made in three sections and nailed firmly to trees near the ferry landing. A second rod is located 1,206 feet above the gage, and a third one 350 feet below the main rod, in order to determine the slope of the water surface. The three rods are referred to the same datum. Bench mark No. 1 is on an oak tree on the left bank, 1,200 feet above the ferry and 65 feet north of the upper rod, and is 22.724 feet above gage datum. Bench mark No. 2 is on an oak tree on the left bank of the river, 300 feet below the cable, and is 22.429 feet above gage datum. The ferry cable is used in the discharge measurements. The channel for 1,000 feet above and below the station is nearly straight. The right bank is high, but the left bank is liable to overflow when the water rises above the 25-foot mark. The bed of the stream consists of gravel and changes only slightly. Results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 367; 1897, Nineteenth Annual Report, Part IV, page 509; 1898, Twentieth Annual Report, Part IV, page 527. The following measurements of discharge were made under the direction of J. B. Lippincott:

*Discharge measurements of Sacramento River at Jellys Ferry, California.*

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| 1898. | | | 1899. | | |
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| December 28 | 5.3 | 4,462 | April 28 | 7.3 | 7,813 |
| | | | May 13 | 6.65 | 7,630 |
| 1899. | | | June 3 | 6.9 | 8,409 |
| | | | June 13 | 5.9 | 6,104 |
| January 14 | 11.4 | 21,211 | June 28 | 5.5 | 4,866 |
| January 28 | 7.5 | 10,299 | July 13 | 5.25 | 4,276 |
| February 13 | 5.9 | 5,848 | July 28 | 5.05 | 4,025 |
| February 28 | 6.1 | 6,380 | August 13 | 5.0 | 3,969 |
| March 13 | 6.15 | 6,644 | August 28 | 5.0 | 3,764 |
| March 29 | 11.5 | 21,985 | September 13 | 5.0 | 4,087 |
| April 13 | 7.8 | 10,659 | September 28 | 5.0 | 4,009 |

*Daily gage height, in feet, of Sacramento River at Jellys Ferry, California, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.55 | 7.05 | 8.40 | 9.50 | 6.60 | 9.20 | 5.40 | 5.10 | 5.00 | 5.00 | 5.50 | 11.20 |
| 2 | 6.10 | 6.85 | 8.70 | 9.30 | 6.60 | 7.30 | 5.40 | 5.00 | 5.00 | 5.00 | 5.40 | 9.70 |
| 3 | 6.20 | 6.70 | 8.00 | 8.90 | 6.50 | 6.90 | 5.40 | 5.00 | 5.00 | 5.00 | 5.40 | 8.90 |
| 4 | 5.75 | 6.40 | 7.50 | 8.80 | 6.50 | 6.70 | 5.40 | 5.00 | 5.00 | 5.00 | 5.40 | 8.30 |
| 5 | 5.65 | 6.15 | 7.30 | 8.70 | 6.50 | 6.60 | 5.40 | 5.00 | 5.00 | 5.00 | 5.40 | 8.70 |
| 6 | 5.60 | 6.00 | 7.10 | 8.50 | 6.50 | 6.50 | 5.40 | 5.00 | 5.00 | 5.00 | 5.40 | 7.90 |
| 7 | 6.00 | 6.00 | 7.00 | 8.30 | 6.50 | 6.30 | 5.30 | 5.00 | 5.00 | 5.00 | 5.40 | 7.60 |
| 8 | 5.95 | 6.00 | 6.90 | 8.40 | 6.60 | 6.20 | 5.30 | 5.00 | 5.00 | 5.00 | 5.40 | 7.90 |
| 9 | 5.90 | 5.90 | 6.70 | 8.30 | 6.50 | 6.10 | 5.30 | 5.00 | 5.00 | 5.00 | 6.40 | 7.50 |
| 10 | 13.65 | 5.90 | 6.60 | 8.30 | 6.50 | 6.10 | 5.30 | 5.00 | 5.00 | 5.00 | 10.80 | 7.40 |
| 11 | 10.05 | 5.90 | 6.50 | 8.10 | 6.60 | 6.00 | 5.30 | 5.00 | 5.00 | 5.00 | 14.50 | 8.70 |
| 12 | 7.75 | 5.90 | 6.40 | 8.00 | 6.60 | 6.00 | 6.30 | 5.00 | 5.00 | 5.00 | 8.20 | 10.20 |
| 13 | 7.15 | 5.90 | 6.30 | 7.80 | 6.60 | 5.90 | 5.30 | 5.00 | 5.00 | 5.10 | 7.60 | 9.00 |
| 14 | 10.90 | 6.00 | 6.30 | 7.70 | 6.60 | 5.80 | 5.30 | 5.00 | 5.00 | 5.10 | 7.60 | 8.70 |
| 15 | 16.20 | 6.00 | 8.80 | 7.60 | 6.50 | 5.70 | 5.20 | 5.00 | 5.00 | 5.10 | 7.00 | 16.80 |
| 16 | 16.00 | 6.15 | 18.95 | 7.60 | 6.40 | 5.70 | 5.20 | 5.00 | 5.00 | 5.10 | 7.70 | 12.40 |
| 17 | 11.05 | 6.15 | 12.90 | 7.50 | 6.30 | 5.60 | 5.20 | 5.00 | 5.00 | 5.00 | 11.10 | 11.70 |
| 18 | 13.10 | 6.20 | 10.00 | 7.40 | 6.30 | 5.60 | 5.20 | 5.00 | 5.00 | 5.10 | 8.70 | 10.00 |
| 19 | 10.70 | 6.40 | 8.80 | 7.20 | 6.30 | 5.50 | 5.20 | 5.00 | 5.00 | 5.10 | 9.00 | 8.90 |
| 20 | 8.85 | 6.60 | 8.60 | 7.20 | 6.30 | 5.50 | 5.20 | 5.00 | 5.00 | 7.65 | 7.60 | 8.30 |
| 21 | 8.25 | 6.70 | 8.70 | 7.20 | 6.20 | 5.50 | 5.20 | 5.00 | 5.00 | 7.60 | 9.10 | 8.10 |
| 22 | 7.95 | 6.30 | 9.70 | 7.00 | 6.00 | 5.50 | 5.20 | 5.00 | 5.00 | 7.30 | 9.40 | 7.80 |
| 23 | 7.65 | 6.50 | 14.80 | 7.00 | 6.10 | 5.50 | 5.10 | 5.00 | 5.00 | 6.90 | 8.20 | 7.70 |
| 24 | 7.35 | 6.50 | 20.40 | 7.00 | 6.10 | 5.50 | 5.10 | 5.00 | 5.00 | 5.90 | 7.60 | 7.70 |
| 25 | 7.15 | 6.40 | 23.00 | 7.00 | 6.20 | 5.60 | 5.10 | 5.00 | 5.00 | 5.70 | 7.40 | 7.40 |
| 26 | 7.15 | 6.30 | 16.50 | 6.90 | 6.20 | 5.60 | 5.10 | 5.00 | 5.00 | 5.60 | 7.10 | 7.40 |
| 27 | 7.35 | 6.10 | 13.90 | 6.80 | 6.20 | 5.50 | 5.10 | 5.00 | 5.00 | 5.60 | 8.20 | 7.30 |
| 28 | 7.50 | 6.10 | 12.40 | 6.80 | 6.10 | 5.50 | 5.10 | 5.00 | 5.00 | 5.50 | 17.80 | 7.20 |
| 29 | 7.55 | ..... | 11.40 | 6.70 | 6.10 | 5.50 | 5.10 | 5.00 | 5.00 | 5.50 | 18.20 | 7.10 |
| 30 | 7.45 | ..... | 10.40 | 6.70 | 6.10 | 5.50 | 5.10 | 5.00 | 5.00 | 5.40 | 14.60 | 8.90 |
| 31 | 7.15 | ..... | 9.80 | ..... | 6.00 | ..... | 5.10 | 5.00 | ..... | 5.60 | ..... | 8.50 |

## SAN MATEO CREEK, CALIFORNIA.

San Francisco obtains its domestic water supply from a series of impounding reservoirs located in the southern portion of the peninsula between San Francisco Bay and the Pacific Ocean. The drainage basin of these reservoirs ranges in elevation from 250 to 1,800 feet, with an average of about 750 feet. The hills are undulating. There is a limited growth of timber on the northern slopes near the summit, but a large amount of brush covers other portions of the basin. On the southern slopes and crests the hills are frequently bare of brush, but are covered with grasses. The Spring Valley Water Company owns the entire area of the drainage basin and protects the forest covering, not even permitting grazing within its limits. Mr. Herman Schussler, chief engineer of the water company, has furnished this office with a statement of the rainfall and run-off of the drainage basins which contribute to the water supply under the control of the company. The table given below extends from 1869 to the present date, and shows the seasonal rainfall, together with the percentage collected in the reservoirs. The record is, therefore, thirty years in length, and is by far the oldest table of run-off in the State, thus making it of unusual value. The seasonal year, rather than the calendar, is given. Column No. 1 shows the year; column No. 2 the inches of rainfall in the respective basins; column No. 3 the percentage of this rainfall which is caught and delivered, the evaporation being deducted. The portion of the discharge table marked "Southeasterly

portion of the watershed southeast of old dam," etc., refers to the area above the reservoir, which was constructed at an early date. At a later period, at a point lower down the stream, the Crystal Springs dam was constructed and flooded water over the top of the original dam and into the valleys of other streams. This explains the change in the description of the drainage basin which occurs in 1888. The portion of the table marked "Above southeasterly and northeasterly portion of peninsula watershed, total Crystal Lake drainage," is for the entire area above the Crystal Springs gage datum. The remarkable variation in percentage strikingly illustrates the necessity for storing water from the drainage basins in order to provide for periods of drought. In the western portion of the drainage basin there was practically no run-off in the season of 1876–77, and in the easterly portion of the basin there was practically no run-off in the seasons of 1881–82, 1882–83, and 1897–98. It would therefore be necessary to store enough water in the reservoirs to furnish a supply for two summers and at least one winter. Another feature of interest in this table is that while the run-off in the seasons of 1881–82 and 1882–83 was practically nothing from the easterly portion of the basin, the percentage of rainfall in the western portion of the watershed was 29.4 and 23, respectively.

*Rainfall and run-off from basin of San Mateo Creek, California.*

| Year. | Rainfall. | Run-off. | Year. | Rainfall. | Run-off. |
|---|---|---|---|---|---|
| Western portion of peninsula watershed: | *Inches.* | *Per cent.* | Southeasterly portion of peninsula watershed (southeast from old dam): | *Inches.* | *Per cent.* |
| 1869–70 | 41.95 | 22.6 | 1877–78 | 57.7 | 29.3 |
| 1870–71 | 34.70 | 9.8 | 1878–79 | 43.12 | 12.2 |
| 1871–72 | 80.42 | 31.4 | 1879–80 | 48.01 | 15.1 |
| 1872–73 | 39.31 | 28.4 | 1880–81 | 38.78 | 34.1 |
| 1873–74 | 48.88 | 29.5 | 1881–82 | 25.02 | .9 |
| 1874–75 | 44.26 | 21.2 | 1882–83 | 23.06 | .0 |
| 1875–76 | 69.24 | 39.2 | 1883–84 | 40.32 | 26.8 |
| 1876–77 | 23.83 | .7 | 1884–85 | 25.67 | 13.1 |
| 1877–78 | 72.51 | 37.8 | 1885–86 | 35.58 | 25.4 |
| 1878–79 | 56.10 | 29.2 | 1886–87 | 28.61 | 9.7 |
| 1879–80 | 56.14 | 35.0 | 1887–88 | 32.96 | 5.3 |
| 1880–81 | 53.81 | 43.0 | 1888–89 | 35.70 | 7.4 |
| 1881–82 | 34.23 | 29.4 | | | |
| 1882–83 | 33.89 | 23.0 | | | |
| 1883–84 | 54.99 | 33.2 | Total | 434.53 | 179.5 |
| 1884–85 | 38.25 | 30.0 | Mean | 36.21 | 14.94 |
| 1885–86 | 51.90 | 43.9 | | | |
| 1886–87 | 34.44 | 29.1 | Above southeasterly and northeasterly portions of peninsula watershed, total Crystal Lake drainage: | | |
| 1887–88 | 37.53 | 29.2 | | | |
| 1888–89 | 41.17 | 28.1 | | | |
| 1889–90 | 73.67 | 44.7 | | | |
| 1890–91 | 37.69 | 22.8 | 1889–90 | 72.68 | 53.2 |
| 1891–92 | 43.10 | 13.3 | 1890–91 | 31.92 | 24.4 |
| 1892–93 | 58.25 | 24.4 | 1891–92 | 24.16 | 8.0 |
| 1893–94 | 54.90 | 21.8 | 1892–93 | 47.07 | 34.3 |
| 1894–95 | 66.93 | 25.2 | 1893–94 | 33.08 | 29.0 |
| 1895–96 | 49.45 | 21.0 | 1894–95 | 55.77 | 33.8 |
| 1896–97 | 50.47 | 34.0 | 1895–96 | 32.62 | 16.2 |
| 1897–98 | 26.26 | 9.6 | 1896–97 | 35.62 | 19.3 |
| 1898–99 | 42.56 | 17.7 | 1897–98 | 18.17 | 0.0 |
| | | | 1898–99 | 30.37 | 11.0 |
| Total | 1,450.83 | 808.2 | Total | 381.46 | 230.1 |
| Mean | 48.36 | 26.94 | Mean | 38.15 | 23.01 |

## STANISLAUS RIVER AT OAKDALE, CALIFORNIA.

This river has its source on the western slope of the Sierras Nevada in California. It drains a country between the basins of Mokelumne River on the north and Tuolumne River on the south, and flows in a general southwesterly direction, entering San Joaquin River 23 miles above Stockton. A number of canals divert water from this stream, on either side, the principal one being the canal of the Stanislaus and San Joaquin Water Company, which irrigates lands in the vicinity of Oakdale and between Knights Ferry and Stockton. The present location of the station is 1,000 feet below the railroad bridge and one-half mile north of the town of Oakdale, California. The station as first established, May 3, 1895, was at the railroad bridge, but on July 30, 1898, a cable was stretched across the river at the present location, at J. W. Bell's ranch house. The channel of the river is straight for some distance above and below the station, but the bed is of sand and liable to shift at times of sudden change in the volume of the river. On this account numerous discharge measurements will have to be made each year in order to construct an accurate rating curve for the station.

The canal of the Stanislaus and San Joaquin Water Company diverts water from Stanislaus River at a point 3 miles above Knights Ferry, or approximately 15 miles above Oakdale. The volume of this canal at what is known as Section 3 was rated on June 1, 1898, by turning in various amounts of water and measuring the same with a meter. It was found on June 6, 1899, that silt had accumulated in the bottom of the flume at the old gage, and a new station was adopted. This point was rated similarly to the one of the year previous. The superintendent for the canal company, James Y. Beveridge, kindly reports the depths of water at this station, and from the rating tables discharges are computed. The observations on the gage rod are accurate, but during the spring and fall, when the amount of water which is used for irrigation is not important, it is difficult to obtain accurate reports, because it is of no particular interest to the canal company to record them. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 371; 1897, Nineteenth Annual Report, Part IV, page 511; 1898, Twentieth Annual Report, Part IV, page 530. The following measurements of discharge of the Stanislaus and San Joaquin Water Company's canal were made under the direction of Mr. J. B. Lippincott during 1899:

[1] May 19, gage height, 0.45 foot; discharge, 73.5 second-feet.
June 6, gage height, 2.37 feet; discharge, 71.40 second-feet.
June 6, gage height, 2.95 feet; discharge, 52.28 second-feet.
June 6, gage height, 3.64 feet; discharge, 30.60 second-feet.
June 6, gage height, 4.85 feet; discharge, 0.00 second-feet.

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[1] Measurement made at old station; new rod read 2.28.

*Estimated daily discharge of Stanislaus and San Joaquin Water Company's canal for 1899.*

| Day. | Apr. | May. | June. | July. | Day. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 32 | 65 | 69 | 49 | 17 | 66 | 75 | 72 | 57 |
| 2 | 36 | 62 | 71 | 41 | 18 | 67 | 76 | 68 | 57 |
| 3 | 0 | 62 | 70 | 33 | 19 | 69 | 74 | 69 | 57 |
| 4 | 0 | 62 | 70 | 34 | 20 | 71 | 74 | 69 | 54 |
| 5 | 69 | 62 | 71 | 32 | 21 | 75 | 73 | 67 | 57 |
| 6 | 0 | 69 | 71 | 41 | 22 | 76 | 76 | 65 | 58 |
| 7 | 0 | 69 | 72 | 39 | 23 | 73 | 76 | 65 | 57 |
| 8 | 15 | 72 | 72 | 41 | 24 | 73 | 75 | 64 | 55 |
| 9 | 36 | 74 | 72 | 43 | 25 | 71 | 74 | 56 | 54 |
| 10 | 51 | 75 | 73 | 41 | 26 | 67 | 72 | 51 | 47 |
| 11 | 62 | 74 | 73 | 46 | 27 | 67 | 69 | 50 | 61 |
| 12 | 65 | 73 | 0 | 62 | 28 | 67 | 67 | 48 | 57 |
| 13 | 66 | 74 | 65 | 62 | 29 | 67 | 69 | 48 | 0 |
| 14 | 65 | 72 | 67 | 55 | 30 | 67 | 69 | 53 | 55 |
| 15 | 61 | 71 | 73 | 52 | 31 | ..... | 66 | ..... | 53 |
| 16 | 64 | 73 | 68 | 46 | | | | | |

*Measurements of Stanislaus River at Oakdale, California.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| March 3 | 5.13 | 487 | June 28 | 6.3 | 1,167 |
| April 20 | 8.8 | 3,873 | August 3 | 4.53 | 143 |
| May 18 | 7.68 | 2,634 | September 9 | 4.41 | 88 |
| June 5 | 7.94 | 3,057 | December 6 | 5.41 | 531 |
| June 18 | 8.42 | 3,599 | | | |

*Daily gage height, in feet, of Stanislaus River at Oakdale, California, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.30 | 5.00 | 5.20 | 7.60 | 6.60 | 7.50 | 6.00 | 4.60 | 4.40 | 4.50 | 5.00 | 5.60 |
| 2 | 4.80 | 5.00 | 5.10 | 7.40 | 6.50 | 7.60 | 6.10 | 4.50 | 4.40 | 4.50 | 4.80 | 5.60 |
| 3 | 5.60 | 4.80 | 5.10 | 7.20 | 6.60 | 7.60 | 6.00 | 4.50 | 4.50 | 4.40 | 4.80 | 5.70 |
| 4 | 4.80 | 4.80 | 5.00 | 7.20 | 6.50 | 7.70 | 5.90 | 4.50 | 4.40 | 4.40 | 4.60 | 5.60 |
| 5 | 4.60 | 4.60 | 5.00 | 7.80 | 6.60 | 7.60 | 5.80 | 4.60 | 4.40 | 4.40 | 4.50 | 5 40 |
| 6 | 4.50 | 4.50 | 4.80 | 7.80 | 6.70 | 8.40 | 5.60 | 4.60 | 4.50 | 4.40 | 4.60 | 5.50 |
| 7 | 4.50 | 4.50 | 4.80 | 8.70 | 6.80 | 8.20 | 5.60 | 4.80 | 4.40 | 4.50 | 4.40 | 5.40 |
| 8 | 4.40 | 4.60 | 4.70 | 8.80 | 7.00 | 8.50 | 5.60 | 4.80 | 4.40 | 4.40 | 4.40 | 5.40 |
| 9 | 4.40 | 4.60 | 4.80 | 9.60 | 7.60 | 8.20 | 5.50 | 4.70 | 4.40 | 4.50 | 5.20 | 5.30 |
| 10 | 5.10 | 4.60 | 5.00 | 9.80 | 8.00 | 8.30 | 5.50 | 4.60 | 4.30 | 4.50 | 6.40 | 5.40 |
| 11 | 6.25 | 4.70 | 4.80 | 9.00 | 9.20 | 8.50 | 5.50 | 4.60 | 4.40 | 4.50 | 7.20 | 5.40 |
| 12 | 5.40 | 4.70 | 4.80 | 9.00 | 10.20 | 9.30 | 5.40 | 4.60 | 4.50 | 4.50 | 7.00 | 5.80 |
| 13 | 5.00 | 4.70 | 4.80 | 8.80 | 10.00 | 8.60 | 5.40 | 4.60 | 4.50 | 4.60 | 6.80 | 7.80 |
| 14 | 4.80 | 4.80 | 5.00 | 9.00 | 9.20 | 8.30 | 5.30 | 4.50 | 4.40 | 5.00 | 6.40 | 6.00 |
| 15 | 5.00 | 4.80 | 5.50 | 8.80 | 8.60 | 8.20 | 5.10 | 4.60 | 4.40 | 5.00 | 6.40 | 7.00 |
| 16 | 4.80 | 4.70 | 6.90 | 9.60 | 8.60 | 8.00 | 5.10 | 4.50 | 4.40 | 4.80 | 7.40 | 9.60 |
| 17 | 4.80 | 4.80 | 6.00 | 9.60 | 8 20 | 8.40 | 5.00 | 4.50 | 4.40 | 4.50 | 7.00 | 8.80 |
| 18 | 5.00 | 5.00 | 5.60 | 9.10 | 7.80 | 8.50 | 4.90 | 4.50 | 4.30 | 4.40 | 7.00 | 8.40 |
| 19 | 5.20 | 5.30 | 5.40 | 8.80 | 7.40 | 8.20 | 4.80 | 4.50 | 4.30 | 4.40 | 6.80 | 7.50 |
| 20 | 5.20 | 5.50 | 7.80 | 8.80 | 7.20 | 7.60 | 4.60 | 4.50 | 4.30 | 4.60 | 6.60 | 7.00 |
| 21 | 5.50 | 5.50 | 6.10 | 8.90 | 7.30 | 7.10 | 4.60 | 4.50 | 4.30 | 4.80 | 6.20 | 6.80 |
| 22 | 5.50 | 5.40 | 5.90 | 9.10 | 7.50 | 7.00 | 4.70 | 4.50 | 4.30 | 5.80 | 7.00 | 6.50 |
| 23 | 5.40 | 5.40 | 11.10 | 8.80 | 7.70 | 6.90 | 4.80 | 4.60 | 4.20 | 6.20 | 6.60 | 6.30 |
| 24 | 5.40 | 5.30 | 13.30 | 8.60 | 7.50 | 6.90 | 4.80 | 4.70 | 4.30 | 6.00 | 6.20 | 6.20 |
| 25 | 5.50 | 5.20 | 16.60 | 8.20 | 7.10 | 6.60 | 4.70 | 4.40 | 4.30 | 5.60 | 5.80 | 6.20 |
| 26 | 5.50 | 5.20 | 11.70 | 7.60 | 6.80 | 6.60 | 4.70 | 4.40 | 4.20 | 5.40 | 6.00 | 6.00 |
| 27 | 5.50 | 5.20 | 10.00 | 7.40 | 6.80 | 6.40 | 4.70 | 4.40 | 4.20 | 5.20 | 6.00 | 6.00 |
| 28 | 5.60 | 5.20 | 10.30 | 7.00 | 6.80 | 6.40 | 4.60 | 4.40 | 4.30 | 5.00 | 5.80 | 6.20 |
| 29 | 5.40 | ..... | 9.00 | 7.00 | 6.80 | 6.10 | 4.70 | 4.40 | 4.40 | 4.80 | 5.70 | 6.00 |
| 30 | 5.20 | ..... | 8.60 | 6.50 | 7.00 | 6.00 | 4.70 | 4.50 | 4.40 | 5.00 | 5.80 | 6.40 |
| 31 | 5.20 | ..... | 8.00 | ..... | 7.00 | ..... | 4.60 | 4.40 | ..... | 4.80 | ..... | 6.80 |

## TUOLUMNE RIVER AT LAGRANGE, CALIFORNIA.

This river rises on the western slope of the Sierras Nevada in California, and drains the country located between Stanislaus River on the north and Merced River on the south. The northern half of the Yosemite National Park includes a portion of the drainage basin of this stream. The river is fed largely from small mountain lakes occurring high in the drainage basin, where the snow remains on the mountain slopes throughout the year, thus insuring a large run-off. The stream has a heavy fall, and the opportunities for power development are numerous. There are also a number of reservoir sites in the basin where water could be stored during the irrigation season. The station, established August 29, 1895, is located at the wagon bridge in the town of Lagrange, California. The rod is vertical and bolted to the right-hand pier of the bridge. The bench mark is a nail driven into the bottom of the west post of the fifth bent south of the south iron cylinder, and is 15.31 feet above gage datum. The station is located below the high dam of the Turlock and Modesto irrigation districts, and also below the head of the canal of the Lagrange Hydraulic Mining Company. This latter canal diverts water from the left bank of the river 3 miles above Lagrange dam. During 1898 water was first turned down the Turlock canal in small quantity, and was used for puddling the banks and testing dams of certain reservoirs. Whenever measurements at the gaging station were made, the Turlock canal and the mining company's canal were also measured. The channel at the station, both above and below the bridge, is straight for several hundred feet, and the velocity of the stream is quite uniform. Both banks are high and not subject to overflow. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 381; 1897, Nineteenth Annual Report, Part IV, page 513; 1898, Twentieth Annual Report, Part IV, page 532. The following measurements were made under the direction of J. B. Lippincott during 1899:

*Discharge measurements of Turlock canal for 1899.*

April 20, discharge, 10 second-feet.
April 21, discharge, 10 second-feet.
May 19, discharge, 61 second-feet.
June 6, discharge, 10 second-feet.
June 29, discharge, 18 second-feet.
August 3, discharge, 85 second-feet.
September 11, discharge, 29 second-feet.

*Estimated daily discharge of Turlock canal for 1899.* [a]

| Day. | July. | Aug. | Sept. | Oct. | Nov. | Day. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 80 | 34 | 10 | 3 | 17 | 10 | 85 | 10 | 10 | 0 |
| 2 | 5 | 80 | 34 | 10 | 3 | 18 | 48 | 85 | 10 | 1 | 0 |
| 3 | 5 | 80 | 34 | 10 | 3 | 19 | 48 | 85 | 10 | 1 | 0 |
| 4 | 5 | 80 | 34 | 10 | 3 | 20 | 48 | 86 | 10 | 1 | 0 |
| 5 | 5 | 80 | 34 | 10 | 3 | 21 | 10 | 86 | 10 | 1 | 0 |
| 6 | 5 | 80 | 34 | 10 | 3 | 22 | 5 | 86 | 10 | 3 | 0 |
| 7 | 5 | 1 | 34 | 10 | 3 | 23 | 8 | 10 | 10 | 3 | 0 |
| 8 | 5 | 20 | 34 | 10 | 3 | 24 | 8 | 8 | 10 | 3 | 0 |
| 9 | 10 | 20 | 34 | 10 | 3 | 25 | 1 | 8 | 10 | 3 | 0 |
| 10 | 10 | 85 | 34 | 10 | 3 | 26 | 1 | 8 | 10 | 3 | 0 |
| 11 | 10 | 85 | 34 | 10 | 3 | 27 | 1 | 10 | 10 | 3 | 0 |
| 12 | 10 | 85 | 8 | 10 | 1 | 28 | 1 | 10 | 10 | 3 | 0 |
| 13 | 10 | 85 | 8 | 10 | 1 | 29 | 1 | 10 | 10 | 3 | 0 |
| 14 | 10 | 85 | 8 | 10 | 0 | 30 | 8 | 10 | 10 | 3 | 0 |
| 15 | 10 | 85 | 10 | 10 | 0 | 31 | 28 | 10 | ..... | 3 | ..... |
| 16 | 10 | 85 | 10 | 10 | 0 | | | | | | |

[a] The quantities are not included in volumes discharged at the Lagrange bridge. There was no flow during the months of January to June, inclusive, nor during December.

*Discharge measurements of Lagrange Hydraulic and Mining Company's canal for 1899.*

April 20, discharge, 23.5 second-feet.
April 21, discharge, 23.5 second-feet.
May 19, discharge, 24 second-feet.
June 6, discharge, 24 second-feet.
June 29, discharge, 24 second-feet.
August 3, discharge, 24 second-feet.
September 11, discharge, 24 second-feet.

*Discharge measurements of Tuolumne River at Lagrange, California, for 1899.*

March 3, gage height, 5 feet; discharge, 774 second-feet.
April 20, gage height, 7.55 feet; discharge, 5,712 second-feet.
April 21, gage height, 7.85 feet; discharge, 6,943 second-feet.
May 19, gage height, 6.72 feet; discharge, 3,616 second-feet.
June 6, gage height, 8.47 feet; discharge, 8,964 second-feet.
June 29, gage height, 6.15 feet; discharge, 2,347 second-feet.
August 3, gage height, 3.70 feet; discharge, 23 second-feet.
September 11, gage height, 3.58 feet; discharge, 12 second-feet.

*Daily gage height, in feet, of Tuolumne River at Lagrange, California, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.10 | 4.77 | 5.00 | 6.60 | 6.10 | 7.10 | 6.20 | 4.40 | 3.80 | 3.70 | 5.30 | 5.60 |
| 2 | 4.30 | 4.75 | 5.00 | 6.50 | 6.00 | 6.90 | 6.10 | 4.30 | 3.80 | 3.65 | 5.00 | 5.50 |
| 3 | 4.60 | 4.70 | 5.00 | 6.60 | 6.00 | 6.80 | 6.00 | 4.20 | 3.70 | 3.60 | 4.90 | 5.40 |
| 4 | 4.30 | 4.70 | 4.90 | 6.40 | 6.00 | 7.20 | 6.00 | 4.20 | 3.70 | 3.60 | 4.90 | 5.40 |
| 5 | 4.27 | 4.65 | 4.90 | 6.90 | 6.30 | 8.10 | 5.90 | 4.10 | 3.70 | 3.55 | 4.90 | 5.30 |
| 6 | 4.20 | 4.60 | 4.90 | 7.10 | 6.10 | 8.50 | 5.80 | 4.00 | 3.70 | 3.55 | 4.90 | 5.20 |
| 7 | 4.22 | 4.62 | 5.10 | 7.40 | 6.10 | 8.50 | 5.70 | 4.00 | 3.70 | 3.55 | 5.10 | 5.20 |
| 8 | 4.35 | 4.62 | 5.20 | 7.60 | 6.40 | 8.40 | 5.60 | 4.50 | 3.70 | 3.50 | 5.60 | 5.20 |
| 9 | 4.32 | 4.63 | 5.30 | 7.90 | 6.90 | 8.70 | 5.50 | 4.60 | 3.70 | 3.50 | 6.20 | 5.20 |
| 10 | 4.32 | 4.67 | 5.20 | 7.80 | 7.40 | 8.80 | 5.40 | 4.50 | 3.60 | 3.50 | 7.70 | 5.10 |
| 11 | 5.95 | 4.75 | 5.10 | 7.80 | 8.10 | 8.80 | 5.30 | 4.50 | 3.70 | 3.50 | 7.10 | 5.20 |
| 12 | 5.12 | 4.75 | 5.00 | 7.80 | 8.30 | 8.70 | 5.20 | 4.40 | 3.70 | 3.50 | 7.00 | 5.50 |
| 13 | 4.72 | 4.85 | 4.80 | 7.90 | 8.40 | 8.50 | 5.20 | 4.80 | 3.70 | 3.50 | 6.30 | 6.60 |
| 14 | 4.60 | 4.95 | 4.80 | 8.00 | 8.30 | 8.00 | 5.10 | 4.10 | 3.80 | 4.70 | 6.00 | 7.30 |
| 15 | 4.42 | 5.00 | 4.90 | 8.10 | 7.40 | 7.90 | 5.10 | 3.90 | 3.80 | 4.60 | 6.50 | 7.90 |
| 16 | 4.35 | 4.90 | 6.60 | 8.20 | 7.90 | 8.00 | 5.00 | 4.00 | 3.80 | 4.60 | 7.10 | 8.20 |
| 17 | 4.92 | 4.90 | 6.30 | 7.90 | 7.00 | 7.90 | 5.00 | 3.90 | 3.80 | 4.40 | 6.80 | 6.90 |
| 18 | 4.92 | 5.02 | 5.70 | 7.80 | 7.30 | 7.80 | 4.90 | 3.90 | 3.80 | 4.60 | 6.70 | 6.80 |
| 19 | 4.92 | 5.20 | 5.60 | 7.50 | 7.30 | 7.70 | 4.90 | 3.90 | 3.80 | 4.70 | 6.70 | 6.90 |
| 20 | 4.82 | 5.40 | 6.20 | 7.60 | 7.70 | 7.80 | 4.90 | 3.90 | 3.75 | 4.80 | 6.50 | 6.80 |
| 21 | 4.80 | 5.60 | 5.90 | 7.80 | 7.30 | 7.40 | 4.80 | 3.80 | 3.70 | 4.80 | 6.70 | 7.00 |
| 22 | 4.80 | 5.50 | 5.80 | 7.80 | 7.10 | 6.90 | 4.80 | 3.80 | 3.60 | 6.10 | 6.60 | 6.80 |
| 23 | 4.87 | 5.40 | 9.10 | 7.50 | 7.40 | 6.80 | 4.70 | 4.10 | 3.70 | 5.70 | 6.50 | 6.90 |
| 24 | 4.82 | 5.40 | 11.40 | 6.90 | 7.30 | 6.80 | 4.70 | 4.10 | 3.70 | 5.40 | 6.80 | 6.80 |
| 25 | 4.72 | 5.30 | 12.50 | 6.60 | 7.00 | 6.50 | 4.70 | 4.00 | 3.70 | 5.20 | 5.68 | 6.80 |
| 26 | 4.72 | 5.20 | 8.60 | 6.40 | 6.40 | 6.30 | 4.70 | 4.00 | 3.70 | 5.20 | 5.60 | 6.90 |
| 27 | 4.80 | 5.10 | 7.70 | 6.30 | 6.40 | 6.40 | 4.70 | 3.90 | 3.65 | 5.10 | 5.40 | 6.70 |
| 28 | 4.85 | 5.10 | 7.50 | 6.30 | 6.50 | 6.20 | 4.60 | 3.80 | 3.70 | 5.00 | 5.60 | 6.70 |
| 29 | 4.97 | ..... | 7.10 | 6.20 | 6.90 | 6.10 | 4.60 | 3.80 | 3.70 | 5.00 | 5.70 | 6.90 |
| 30 | 4.92 | ..... | 6.80 | 6.10 | 6.90 | 6.10 | 4.55 | 3.90 | 3.60 | 5.50 | 5.60 | 6.80 |
| 31 | 4.80 | ..... | 6.60 | ..... | 6.90 | ..... | 4.50 | 3.80 | ..... | 5.50 | ..... | 6.40 |

## SAN JOAQUIN RIVER AT HERNDON, CALIFORNIA.

The headwater tributaries of this river receive the drainage from the crests of the Sierras Nevada north of Mount Whitney. The fall of the river is rapid, with many favorable locations for power development, and in one case advantage has been taken of the fall on the North Fork and a power plant constructed developing electric power for transmission to Fresno and Hanford, California. During the last year a second storage reservoir has been under course of construction on the North Fork, which will tend further to regulate the flow of the river. No permanent diversions above the gaging station are made, but the water is extensively used below for irrigation purposes. The station was established by the Southern Pacific Railway Company in 1879. The old trestle bridge was torn down by the railroad company during the last year and a new iron structure was erected in its place. This necessitated a new gage rod, which was referred to the datum of the old gage and bolted to the western side of the central concrete pier. The bench mark is a nail in a post at the south end of the bridge on the west side, 0.2 foot above the ground and marked "B. M." It is at an elevation of 24.12 feet above gage datum. The channel for some distance above and below the bridge is straight and the water has a uniform velocity. The right bank is high, rocky, and steep. The bed of the stream is of sand and gravel. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 387; 1897, Nineteenth Annual Report,

Part IV, page 515; 1898, Twentieth Annual Report, Part IV, page 529. The following discharge measurements were made under the direction of J. B. Lippincott during 1899:

*Discharge measurements of San Joaquin River at Herndon, California.*

1899.

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Second-feet.* | | *Feet.* | *Second-feet.* |
| March 5 | 3.25 | 786 | June 27 | 4.90 | 2,922 |
| April 18 | 6.34 | 5,310 | August 1 | 3.32 | 743 |
| May 13 | 7.00 | 7,435 | September 8 | 2.67 | 196 |
| June 2 | 5.76 | 4,177 | September 8 *a* | ..... | 269 |

*a* This measurement was made at Pollasky, California. The measurement made at the regular gaging station at 6 p. m. showed a loss by evaporation, etc., of 73 second-feet in 18 miles.

*Daily gage height, in feet, of San Joaquin River at Herndon, California, for 1899.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.67 | 3.17 | 3.25 | 4.71 | 4.29 | 5.63 | 5.08 | 3.33 | 2.67 | 2.33 | 2.75 | 3.00 |
| 2 | 2.67 | 3.17 | 3.25 | 4.58 | 4.38 | 5.63 | 4.96 | 3.25 | 2.67 | 2.33 | 2.70 | 3.00 |
| 3 | 2.67 | 3.17 | 3.25 | 4.42 | 4.25 | 5.42 | 5.00 | 3.25 | 2.67 | 2.33 | 2.63 | 3.00 |
| 4 | 2.75 | 3.08 | 3.25 | 4.42 | 4.25 | 5.38 | 4.96 | 3.25 | 2.67 | 2.33 | 2.67 | 3.00 |
| 5 | 2.67 | 3.00 | 3.25 | 4.62 | 4.29 | 5.71 | 4.92 | 3.25 | 2.67 | 2.33 | 2.67 | 3.00 |
| 6 | 2.67 | 3.00 | 3.25 | 4.67 | 4.38 | 6.54 | 4.63 | 3.00 | 2.67 | 2.33 | 2.67 | 3.00 |
| 7 | 2.67 | 3.00 | 3.25 | 5.75 | 4.50 | 7.13 | 4.54 | 3.00 | 2.67 | 2.33 | 2.58 | 2.75 |
| 8 | 2.67 | 3.00 | 3.25 | 5.67 | 4.50 | 7.17 | 4.42 | 3.00 | 2.67 | 2.25 | 2.58 | 2.75 |
| 9 | 2.92 | 2.92 | 3.42 | 6.33 | 4.71 | 7.50 | 4.25 | 3.08 | 2.67 | 2.25 | 2.58 | 2.75 |
| 10 | 3.00 | 2.92 | 3.42 | 6.29 | 5.25 | 7.75 | 4.21 | 3.08 | 2.67 | 2.25 | 2.50 | 2.75 |
| 11 | 3.25 | 3.00 | 3.42 | 6.04 | 6.21 | 7.67 | 4.17 | 3.17 | 2.67 | 2.25 | 3.50 | 2.75 |
| 12 | 3.67 | 3.00 | 3.33 | 6.17 | 6.96 | 7.58 | 4.17 | 3.17 | 2.58 | 2.25 | 3.25 | 2.67 |
| 13 | 3.25 | 3.00 | 3.25 | 6.21 | 6.96 | 7.42 | 4.17 | 3.08 | 2.50 | 2.33 | 3.58 | 3.00 |
| 14 | 3.00 | 3.00 | 3.25 | 6.38 | 6.71 | 7.13 | 3.96 | 3.08 | 2.50 | 2.42 | 3.67 | 2.87 |
| 15 | 3.00 | 3.00 | 3.25 | 6.58 | 6.13 | 7.00 | 3.92 | 3.00 | 2.50 | 2.42 | 3.50 | 3.20 |
| 16 | 3.00 | 3.08 | 3.25 | 7.08 | 5.67 | 6.96 | 3.88 | 2.92 | 2.50 | 2.58 | 3.29 | 6.00 |
| 17 | 3.08 | 3.17 | 3.62 | 6.70 | 5.63 | 6.92 | 3.83 | 2.92 | 2.50 | 2.58 | 3.63 | 5.12 |
| 18 | 3.08 | 3.17 | 3.50 | 6.29 | 5.58 | 6.79 | 3.83 | 2.83 | 2.50 | 2.58 | 3.50 | 4.16 |
| 19 | 3.08 | 3.17 | 3.33 | 6.33 | 5.58 | 6.71 | 3.75 | 2.83 | 2.42 | 2.66 | 3.29 | 4.10 |
| 20 | 3.08 | 3.50 | 3.37 | 6.21 | 5.46 | 6.79 | 3.75 | 2.83 | 2.42 | 2.66 | 3.17 | 3.91 |
| 21 | 3.08 | 3.54 | 3.62 | 6.25 | 5.25 | 6.50 | 3.75 | 2.83 | 2.42 | 2.66 | 3.17 | 3.83 |
| 22 | 3.00 | 3.58 | 3.67 | 6.17 | 5.54 | 6.00 | 3.75 | 2.83 | 2.42 | 2.75 | 3.17 | 3.67 |
| 23 | 3.17 | 3.58 | 4.58 | 6.25 | 6.00 | 5.88 | 3.75 | 2.83 | 2.42 | 3.33 | 3.33 | 3.54 |
| 24 | 3.08 | 3.58 | 9.21 | 5.91 | 6.08 | 5.67 | 3.58 | 2.83 | 2.33 | 3.33 | 3.21 | 3.33 |
| 25 | 3.08 | 3.58 | 10.40 | 5.38 | 5.92 | 5.88 | 3.50 | 2.83 | 2.33 | 3.00 | 3.17 | 3.33 |
| 26 | 3.00 | 3.42 | 8.75 | 5.04 | 5.58 | 5.67 | 3.67 | 2.83 | 2.33 | 3.00 | 3.25 | 3.25 |
| 27 | 3.00 | 3.33 | 7.17 | 5.00 | 5.25 | 5.13 | 3.75 | 2.83 | 2.33 | 2.96 | 3.08 | 3.25 |
| 28 | 3.17 | 3.25 | 5.75 | 4.92 | 5.17 | 4.83 | 3.54 | 2.83 | 2.33 | 2.86 | 3.08 | 3.25 |
| 29 | 3.17 | ..... | 5.62 | 4.88 | 5.17 | 4.96 | 3.50 | 2.75 | 2.33 | 2.80 | 3.00 | 3.25 |
| 30 | 3.17 | ..... | 5.37 | 4.54 | 5.79 | 5.00 | 3.50 | 2.75 | 2.33 | 2.80 | 3.00 | 3.25 |
| 31 | 3.17 | ..... | 4.91 | ..... | 5.38 | ..... | 3.50 | 2.75 | ..... | 2.75 | ..... | 5.90 |

[Continued in Water-Supply and Irrigation Paper No. 39.]

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