UPPER COLORADO RIVER AND ITS UTILIZATION

BY

ROBERT FOLLANSBEE

UNITED STATES DEPARTMENT OF THE INTERIOR
Ray Lyman Wilbur, Secretary
GEOLoGICAL SURVEY
George Otis Smith, Director

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trouble in the operation of wood-stave pipes and timber flumes the leakage from such lines is increased by the expansion of the cracks through freezing.

Open ditches can be operated if the temperature is sufficiently low and the velocity sufficiently small to maintain a complete ice cover, and if in addition the flow is sufficiently uniform to prevent sudden changes of stage from breaking of the ice cover.

At the higher altitudes, particularly above 10,000 feet, the winters are so severe that it is practically impossible to release from reservoirs into the natural channels small quantities of water to be utilized farther downstream. The water overflows the ice in the channel and freezes, practically none of it reaching the lower intake.

The daily mean temperature is so constant that little or no ice gorging due to sudden breaking up of the ice caused by thaws occurs on the streams during the winter.

FLOODS

The Colorado River above the Green reached its highest known stage in 1884. The United States Weather Bureau records show that on July 4, 1884, a high stage occurred near Fruita which was later determined from high-water marks to be 18.5 feet on the Geological Survey gage at that point. By running a line of levels across the area flooded at that time and extending the Fruita rating curve, the maximum discharge of this flood has been determined by the writer to be 125,000 second-feet. No record of the duration of this high water exists, nor are precipitation records available. From the author's personal interviews with old settlers, it has been ascertained that during that year all streams in the upper Colorado River Basin were at the highest stages known and that the flood stages remained for weeks. The few small bridges spanning the Colorado and Roaring Fork and several bridges along the lower Gunnison were all destroyed. The Denver & Rio Grande Railroad had four wooden railroad bridges destroyed between Delta and Grand Junction, the one near Escalante Creek collapsing as a passenger train reached it, with the result that the engine and two cars went into the river and several lives were lost. At Delta the Gunnison rose at least 10 feet above the bank-full stage and overflowed an area nearly three-quarters of a mile wide. As the banks were covered with trees and underbrush, the water was retarded. This retardation was aided by the closing in of the sides of the valley a short distance below Delta to form a canyon, through which the Gunnison flows nearly to its mouth. The railroad is in this canyon, and although the flood destroyed four bridges, as previously stated, the water did not reach the rails, which are not more than 15 feet above low water. Neither the Gunnison nor the Colorado overflowed its banks at Grand Junction.
From press notices at that time it appears that the peak discharge of the Gunnison occurred within a few days of that of the Colorado near Fruita (below the Gunnison), indicating that both streams reached their maximum at practically the same time.

From a comparison of the dates of maximum discharge of this flood with the usual dates of maximum discharge (p. 45) it will be seen that the flood occurred unusually late in the season. This was due to the late spring, which held back the run-off from the very heavy snowfall of the previous winter. The settlers interviewed stated that the early snowfall had been unusually heavy, and this was followed by a snow in April, which in the valley near Delta was 1 1/2 feet deep. Judge John L. Noonan, of Glenwood Springs, stated that he crossed Independence Pass (at the head of the Roaring Fork) early in July, 1884, and found drifts from 12 to 15 feet deep at that time. Mr. Robert Kelso, a stockman of Delta, stated that the snowfall was so deep that he was unable to take the cattle to the summer range in the mountains until July.

That the heavy snowfall of the winter of 1883–84 was general throughout the central Rocky Mountain region is shown by the run-off of the Cache la Poudre, which rises on the eastern slope of the Continental Divide, just east of the Colorado River Basin. Incomplete records for 1884 indicate that the total run-off of the Cache la Poudre for that year was the greatest in 41 years of record, being 217 per cent of the 41-year mean. The 1884 hydrograph for that stream is presented in Figure 4, together with the hydrograph for a
normal year (1912), to show the relatively greater discharge during 1884. It is believed that these hydrographs also represent closely the relative discharge of the Colorado during those years. The maximum discharge occurring at the headwaters on June 28 agrees substantially with the maximum stage of the Colorado at Fruita on July 4. In further confirmation of the general character of the heavy snowfall, W. W. Follett, civil engineer, states that the flood of 1884 on the Rio Grande was the greatest since white settlers came to that region.

There is no record of unusual high water in other years, but the settlers interviewed stated that the stage of 1885 was nearly as high as that of 1884 and was due to the same cause but did not last as long. As a matter of passing interest, it may be related that when Delta was first settled, an Indian squaw, Chipeta, the wife of the famous Ute chief Ouray, stated that within her lifetime of 50 years she had seen the Uncompahgre Valley at Delta “flooded from bluff to bluff” (a favorite expression of the Indians in describing prehistoric floods).

Although heavy general rains over the upper Colorado River Basin are of infrequent occurrence, there have been four periods of such rains during the last 20 years—September 3–6, 1909; October 4–6, 1911; and June 3–7, and 14–15, 1921.

Practically no records of stream flow were kept in the basin during 1909, but records of precipitation show that the greatest rainfall and greatest flood flow occurred in the San Juan Mountain region between Durango, Silverton, and the upper Lake Fork of the San Miguel. The maximum rainfall recorded for the four-day period, September 3–6, was about 3 inches. The resulting flood was especially severe in the San Juan River Basin, which is outside the scope of this report, and also on the Lake Fork of the San Miguel River, where two power reservoirs were destroyed. No definite estimate of the maximum discharge of Lake Fork is available. In no other part of the region was the rainfall as much as 1.5 inches.

For the period October 4–6, 1911, the heaviest rainfall again occurred in the upper San Juan Basin and the headwater region on the northern slope of the San Juan Mountains, where the recorded precipitation ranged from 3 to 8 inches. The greatest floods occurred outside the area covered by this report, but floods of considerable size occurred on the Dolores and Uncompahgre Rivers, that on the Dolores at Dolores being estimated at 10,000 second-feet, which was much greater than the maximum discharge of the Uncompahgre.

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River. The only other areas where the rainfall exceeded 2 inches were at Marble and on the Uncompahgre Plateau and Grand Mesa, and the resulting high water in the streams was not extreme.

During the two periods of general rain in June, 1921, the rainfall was not so heavy as in 1909 and 1911. The highest rainfall recorded June 3-7 was 2.50 inches at Ashcroft, near Aspen; 2.21 inches at Trout Lake, in the upper San Miguel Basin; and 2.04 inches on Grand Mesa. Severe floods occurred in the Dolores River, Henson Creek, Lake-Fork, and East and West Rifle Creeks. On the Dolores River and Lake Fork many miles of railroad track were washed out, and at Lake City considerable damage was done by Henson Creek cutting a new channel through the lower end of the town. No records of the maximum discharges on these streams exist. From June 13 to 15, 1921, the rainfall was heaviest in the San Juan region and the southwestern part of the State generally. An inspection of the dates of maximum discharge at regular gaging stations (p. 45) shows that the highest stages recorded on the Colorado at Hot Sulphur Springs, the Roaring Fork at Glenwood Springs, Tomichi Creek at Sargents, the Lake Fork at Lake City, the Uncompahgre River below Ouray, the San Miguel River at Naturita, and Kahnah Creek near White-water occurred in June, 1921.

During none of the periods of general rains described above was the rainfall in the Colorado River Basin above Glenwood Springs sufficient to cause the streams to overflow their banks to any extent. Within the basin are several regions subject to cloudburst floods from very small areas. The region of greatest frequency lies along the western foothills, especially in the extreme upper end of the Uncompahgre Valley, where the sides converge and join the main mass of the San Juan Mountains above Ouray. Cloudbursts have been noted in this area from Dallas Creek near Ridgway southward to and including the streams draining the almost vertical walls of the mountain amphitheater that nearly surround Ouray. A flood of 2,000 second-feet from 1 square mile drained by Skyrocket Creek has been described in connection with floods in the Rocky Mountain region. Several cloudbursts have been noted on small streams that drain the sides of the Uncompahgre Plateau and Grand Mesa near Delta, and on streams that drain the slopes of the Grand Hogback and Book Cliffs from Rifle to De Beque.

SEDIMENT

The quantity of suspended material in the upper Colorado and its tributaries is small compared with that in the streams in the lower basin. Above the Blue, Troublesome, and Muddy, near the western

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