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UPPER COLORADO RIVER AND ITS UTILIZATION

BY

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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 Whitewater 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.[34] 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

[34] Follansbee, Robert, and Hodges, P. V., Some floods in the Rocky Mountain region: U. S. Geol. Survey Water-Supply Paper 520, pp. 124–125, 1925.

edge of Middle Park, the Colorado carries little or no sediment; but those tributaries contribute considerable sediment to the river water, although at Kremmling the sediment content is low. Below Kremmling this content does not increase rapidly until the water of the tributary streams below the Eagle River is received. At the intake to the Shoshone power plant, near Glenwood Springs, the Colorado carries much sediment during periods of high water, but no analysis of the water at this point has been made. Below the Palisade station the content increases more rapidly. Samples of water have been analyzed for sediment as follows:

Colorado River near Kremmling, 262 samples from April 23, 1905, to May 15, 1906.

Colorado River near Palisade, 172 samples from March 15, 1905, to April 5, 1906.

Gunnison River at Whitewater, 199 samples from April 2 to October 31, 1905.

The results of these analyses are expressed by Stabler [35] as tons per day of suspended material. The writer has reduced these results to acre-feet by assuming the weight of the material to be 85 pounds to the cubic foot, and has estimated the silt for the days when analyses were not made. The annual load of suspended material passing the measuring point near Cisco, Utah, is determined from one year's investigations of the sediment in Colorado River in the Dewey reservoir site, near Cisco,[36] lasting from August, 1914, to July, 1915.

Annual load of suspended material in Colorado and Gunnison Rivers

	Acre-feet
Colorado River near Kremmling, Colo	167
Colorado River near Palisade, Colo	950
Gunnison River at Whitewater, Colo	1,200
Colorado River near Cisco, Utah	8,175

The great increase in the suspended load near Cisco over that at the upper stations may be accounted for in small part by the fact that the records represent different years and were computed by somewhat different methods.

The annual variation in the sediment of the upper Colorado is not known, but a comparison between sediment and discharge for a 16-year period in the Rio Grande indicates that it may vary between wide limits but not in accordance with the discharge.

The foregoing records represent only the material carried in suspension. In addition there is a considerable quantity of sediment and coarser material which is rolled along the bottom. No method has

[35] Stabler, Herman, Some stream waters of the Western United States: U. S. Geol. Survey Water-Supply Paper 274, pp. 42-50, 1911.

[36] Unpublished data compiled by Bureau of Reclamation.

yet been devised for measuring this moving material, and a close estimate of its magnitude is impossible. The upper courses of the tributary streams have gradients so steep that although the water may be free from suspended material, sand, gravel, and even small boulders are rolled along the bottom by the swiftness of the current. Not only can this be observed, but such material is found deposited in front of diversion dams, usually piling up against the upstream face flush with the spillway.

Some of the mountain streams carry tailings from concentration mills, and these tailings may contain an appreciable quantity of sand. The percentage of sand in the tailings in upper Canyon Creek above Ouray was so high that the nozzles on the Pelton water wheels in the Revenue Tunnel plant were worn out in 10 days by the action of the sand at high velocities.[37]

BASIS OF ESTIMATES OF POWER CAPACITY

At the present time there is no generally accepted basis for rating the power capacity of a stream. In an endeavor to reach such a basis, the American Engineering Standards Committee on Rating of Rivers is investigating the subject. The following quotation from a statement by the sectional committee sums up the requirements for such a common basis:

> The rating of a river should be
>
> 1. Something that will show within reasonable limits the water-power resources of the region, basin, or political entity, (*a*) for statistical purposes of various kinds, (*b*) for broad surveys of power supply as against present or future demand, (*c*) for economic comparisons of various kinds, (*d*) for guidance in determination of public policy.
>
> 2. Something that will give the engineer, manufacturer, or power developer * * * a fairly close expression from which he may derive an over-all idea of the power possibilities of several streams.

In accordance with the tentative recommendations of the sectional committee, the power capacity as stated in this report is based upon the discharge for 90 per cent and 50 per cent of the time, the former approximating primary power and the latter representing more nearly the probable wheel installation. To determine the 90 per cent and 50 per cent discharge for the streams considered in this report, the mean monthly discharges are arranged in order of magnitude, and from them a duration curve is constructed. (See fig. 5.) From this curve the required values are readily determined. For more detailed studies daily records should be used.

[37] Rickard, T. A., Across the San Juan Mountains: Eng. and Min. Jour., vol. 76, p. 82, July 18, 1903