DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

Water-Supply Paper 520

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

1923–1924

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

CONTENTS.

[The letters in parentheses preceding the titles are those used to designate the papers for advance publication.]

ILLUSTRATIONS.

SOME FLOODS IN THE ROCKY MOUNTAIN REGION.

By ROBERT FOLLANSBEE and PAUL V. HODGES.

SCOPE OF REPORT.

In 1923 severe floods occurred on the larger streams in Wyoming and a number of cloudburst floods on small streams in Wyoming and especially in Colorado. An investigation of the principal floods in each State was made, and the results are given in this paper, together with descriptions of two Colorado floods of 1922. In addition a study was made of all cloudburst floods to determine the areas chiefly subject to them.

GENERAL FEATURES OF THE FLOODS.

TYPES.

Floods in the Rocky Mountain region are of two types—the floods in the larger streams due to general rains of several days' duration over large areas and the so-called cloudburst floods due to intense rains of short duration covering well-defined small areas. Floods of the first type are relatively infrequent, and, as they are well understood, their characteristics will not be discussed. Only the severe floods of this type that occurred in 1923 are described in this report. Cloudburst floods cause the streams to rise and fall suddenly. Although they cause much less damage than those of the first type, they occur frequently and are especially disastrous to railroads and highways.

AREAS SUBJECT TO CLOUDBURST FLOODS.

Records of nearly 100 floods in Colorado were compiled to determine the areas most subject to cloudburst floods. For many of these floods the available information covered only the date and location of the rises in small streams that were sufficiently pronounced to be called floods by residents. Most of these floods occurred in the eastern foothill region, which extends from the New Mexico line on the south to the Wyoming line on the north, and in a strip of plains area 50 miles wide just east of the mountains. In this area the severest floods occurred between Canon City and Pueblo, in the triangular

valley of the Arkansas. These floods have been described in connection with the Arkansas River flood of June 3–5, 1921.[1]

Another region in which cloudbursts are prevalent lies along the western foothills, in the western part of the State. In this region the area most subject to cloudburst is 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

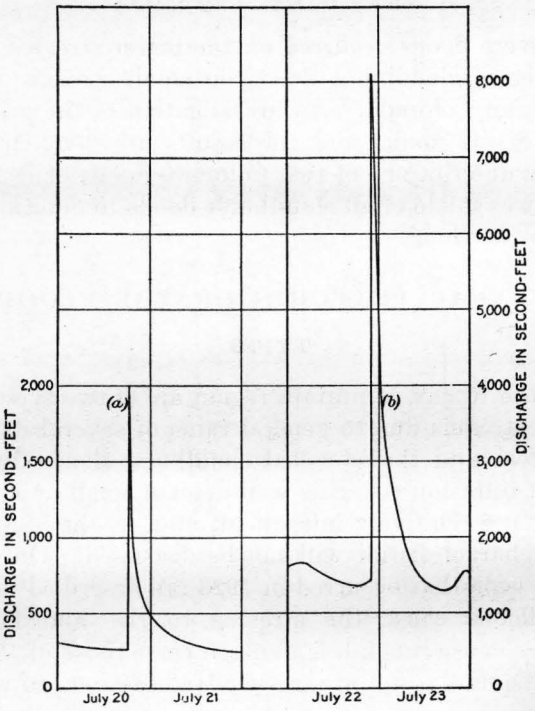


FIGURE 9.—Hydrographs of cloudburst floods. *a*, Skyrocket Creek at Ouray, Colo.; *b*, North Fork of Shoshone River near Wapiti, Wyo.

mountain amphitheater that nearly surrounds Ouray. The cloudburst on Skyrocket Creek is a good example of cloudbursts near Ouray (fig. 9, *a*). Several cloudbursts have been noted on small streams that drain the sides of the Uncompahgre Plateau and the Grand Mesa near Delta and on streams that drain the slopes of the Grand Hogback and Book Cliffs from Rifle to DeBeque.

Few cloudbursts have been recorded within the main mountain area. A small area south of Eagle is subject to occasional heavy

[1] Follansbee, Robert, and Jones, E. E., The Arkansas River flood of June 3–5, 1921: U. S. Geol. Survey Water-Supply Paper 487, 1922.

rains, which are locally termed cloudbursts, and the east side of the Arkansas Valley between Granite and Buena Vista, embracing the western slope of the Park Range, is also subject to occasional cloudbursts, which, however, are not so severe as those in the foothill region. Cloudbursts have also been recorded near the mouth of Texas Creek above the Royal Gorge and on Williams Fork near Hot Sulphur Springs, in Middle Park.

The eastern slope of the Big Horn Mountains is subject to cloudbursts, but it is impossible to determine the other areas in Wyoming where they occur most frequently, as very few records of cloudbursts are available for Wyoming.

Most cloudbursts occur at altitudes between 6,000 and 7,000 feet, although those near Ouray are between 8,000 and 9,000 feet, those near Granite about 9,500 feet, and the one series of cloudbursts recorded on North Fork of Shoshone River in northern Wyoming at 10,000 feet. Cloudbursts occur only where there is a marked range in temperature within a relatively small area. This condition exists chiefly in the foothills, where the warm air from the plains drifts toward the mountains, is deflected upward, and rapidly cools at the higher altitudes near the heads of the canyons. For this reason, cloudbursts generally occur in the afternoon or early evening of an unusually warm day. It is readily seen that they can seldom occur at higher altitudes in the mountains, as there the differences in temperature are usually insufficient and the mass of warm air in the high valleys is not great enough to cause any decided drift toward the adjacent mountains.

The cloudbursts on North Fork of Shoshone River, which occurred at an altitude that is generally considered above the limit for cloudbursts, followed several days of unusually warm weather (p. 114) during which the air in the valleys became so much warmer than the air at higher altitudes as to drift toward the mountain sides, where it was rapidly deflected upward.

INTENSITY OF RAINFALL.

The Weather Bureau maintains regular stations at Denver, Pueblo, and Grand Junction, Colo., and at Cheyenne, Sheridan, and Lander, Wyo., where continuous rainfall records are kept. The stations at Denver, Pueblo, Cheyenne, and Sheridan are on the plains, a short distance east of the mountains, in the zone subject to cloudbursts; and the rainfalls of greatest intensity recorded at these stations are given in the following table. Grand Junction is in western Colorado, in the region of flat-topped mesas, and Lander is in the mountainous area of central Wyoming. At neither Grand Junction nor Lander has the intensity of rainfall been sufficient to be termed excessive.

Rainfalls of greatest intensity in Colorado and Wyoming, recorded by Weather Bureau.

Length of rainfall (minutes).	Denver.[a]		Pueblo.[b]		Cheyenne.[c]		Sheridan.[d]	
	Rainfall (inches).	Frequency in years.	Rainfall (inches).	Frequency in years.	Rainfall (inches).	Frequency in years.	Rainfall (inches).	Frequency in years.
5	0.87	34	0.44	24	0.48	20	0.48	15
	.59	17	.38	12	.46	10	.41	7.5
	.52	11.3	.35	4	.38	6.7	.30	3.8
	.47	8.5	.34	3	.35	5.0	.29	3.0
	.41	5.7	.33	2.4	.33	4.0	.28	2.1
10	1.20	34	.80	24	.73	20	.69	15
	.97	17	.71	12	.68	10	.51	7.5
	.89	11.3	.68	8	.61	5	.50	3.8
	.86	8.5	.64	6	.60	4	.49	3.0
	.70	4.9	.61	4.8	.57	3.3	.46	2.5
15	1.52	34	.97	24	.89	20	.85	15
	1.14	17	.93	12	.84	10	.77	7.5
	1.04	11.3	.90	8	.81	6.7	.69	5.0
	.95	8.5	.81	6	.71	5.0	.68	3.8
	.94	6.8	.80	4.8	.69	4.0	.59	3.0
20	1.62	34	1.20	24	1.13	20	.97	15
	1.24	17	1.12	12	.93	10	.85	7.5
	1.19	11.3	1.04	8	.86	6.7	.81	5.0
	1.18	8.5	.99	6	.81	5.0	.78	3.0
	1.10	6.8	.95	4.8	.74	4.0	.69	2.5
30	1.72	34	1.59	24	1.19	20	1.04	15
	1.49	17	1.45	12	1.01	10	.97	7.5
	1.39	11.3	1.37	8	.98	6.7	.91	5.0
	1.35	8.5	1.28	6	.93	4.0	.81	3.8
	1.24	6.8	1.12	4.8	.90	3.3	.78	3.0
60	2.20	34	2.08	24	1.36	20	1.53	15
	1.90	17	1.82	12	1.35	10	1.28	7.5
	1.72	11.3	1.75	8	1.25	6.7	1.00	5.0
	1.36	8.5	1.45	6	1.15	5.0	.91	3.8
	1.35	6.8	1.32	4.8	1.10	4.0	.78	3.0

[a] 34 years' records.
[b] 24 years' records.
[c] 20 years' records.
[d] 15 years' records.

NOTE.—Column headed "Frequency in years" indicates the probable time interval between the occurrence of rainfalls of approximately the same intensity, as determined from existing records.

As the above-recorded rainfalls occurred outside the foothill region, in which the cloudbursts are heaviest, the intensity during such storms is probably greater. A local observer stated that during the Arkansas River flood of June 3–5, 1921, within the area of severest cloudbursts recorded (pp. 105–106), 5 inches of rain fell in 30 minutes in Boggs Flat, in or near sec. 35, T. 21 S., R. 66 W., but the method of obtaining this measurement is not known.

FLOODS IN BIG HORN RIVER BASIN, WYO.

FLOOD OF JULY 23–24, 1923.

GENERAL FEATURES.

From July 22 to 26 a series of heavy rains in the Big Horn River basin caused the greatest flood on the Big Horn at Thermopolis in the last 24 years for which records are available. The following table shows all available Weather Bureau records of rainfall in the Big Horn drainage basin during that period:

Rainfall in Big Horn drainage basin, Wyo., July 14–26, 1923, in inches.

Station.	14	15	16	17	18	19	20	21	22	23	24	25	26	Total.
Pavillion								0.40			1.20		0.70	2.30
Diversion dam	Tr.	0.19	Tr.			Tr.			Tr.	0.10	.38	2.32	.03	3.06
Lander [a]	0.16	.22					0.02	.05	0.86	.10	.21		.36	1.98
Middle Fork	.45	.22	0.03						.39	.39	.24	.05	.65	2.42
Riverton	.40	.58							.07	.02	1.90	.12	.02	3.11
Ervay	.54									.38		.25	.30	1.47
Thermopolis										.17	1.20	1.22	.40	2.99
Worland [b]		.81								.02	.94		.16	1.93
Hyattville											1.50			1.50
Basin		.15						Tr.					Tr.	.17
Cody	.05								.30		.20	.65	.12	1.32
Clark		.11	Tr.	Tr.				.18	Tr.	.15	.12	.10	.33	1.02
Shoshone dam									.30	.10		.60	.10	1.10
Deaver [b]								.31	.11			.04	Tr.	.47
Lovell	Tr.											.07		.08
Powell [b]		Tr.	Tr.					.13	.07	Tr.	Tr.	.24	Tr.	.49

[a] Regular Weather Bureau station; precipitation for 24-hour period ending at midnight.
[b] Precipitation measured in morning for 24-hour period ending at that time.

NOTE.—Except as otherwise indicated, observations are generally made late in the afternoon, near sunset, and precipitation recorded is for 24-hour period ending at that time.

One account of the storm on the Big Horn was given by U. S. G. Early, agent of the Chicago, Burlington & Quincy Railroad at Bonneville, who stated that a severe electric storm began about 10.30 p. m. July 23, and heavy rain fell until 3.30 a. m. July 24. The total amount of rainfall during this period was estimated at several inches, although no measurement was made. A storm appeared to come from the southwest and met one from the northeast about 20 miles east of Bonneville (about the center of the Badwater drainage basin).

H. D. Comstock, of the Bureau of Reclamation, project manager at Riverton, made the following statement regarding the storm near Riverton:

Heavy, scattered showers fell on the evening of July 21 but did little damage. Very heavy rain fell between 4 and 7 p. m. July 22. One cloudburst extended some 15 or 20 miles east of Hudson, which is 17 miles southwest of Riverton. I reached Hudson near the end of the storm and estimated that at least 1.5 inches fell there in 1½ hours. To the east the rain was probably heavier. Simultaneously there was a heavy storm beginning near Lander and extending northwest along the foot of the mountains. The heavy general rain began at Riverton about 10 p. m. July 23 and lasted until 3 a. m. July 24. Riverton seems to be near the south boundary of the storm area, which extended at least 50 miles east and over 50 miles northwest and north to a point beyond the Owl Creek Mountains. About 5 p. m. July 24 a very severe cloudburst occurred over an area 10 miles in diameter, centering over sec. 23, T. 3 N., R. 2 W., during which 2.20 inches of rain fell in less than an hour. Heavy rains occurred at various points every afternoon and evening until July 27. The area just west of Pavillion received its most intense rainfall on the evening of July 25.

Stream-flow records at regular gaging stations, estimated maximum run-off of small tributaries in the drainage basin (p. 111), and statements of residents show, in connection with the rainfall records, that there were three distinct areas in which the rainfall was high. The main area, the rain in which was the chief cause of the flood, centered

above Bonneville; it had an east-west diameter of 90 miles and a north-south diameter of 65 miles. The rainfall was highest in the northern third of this area. The other areas were on Wood River above Meeteetse, Wyo., and on Paintrock Creek (Pl. XII). The North Fork of Shoshone River was also subject to heavy rains during this period, but as the flood waters were stored in Shoshone reservoir, they did not contribute materially to the flood in the lower Big Horn.

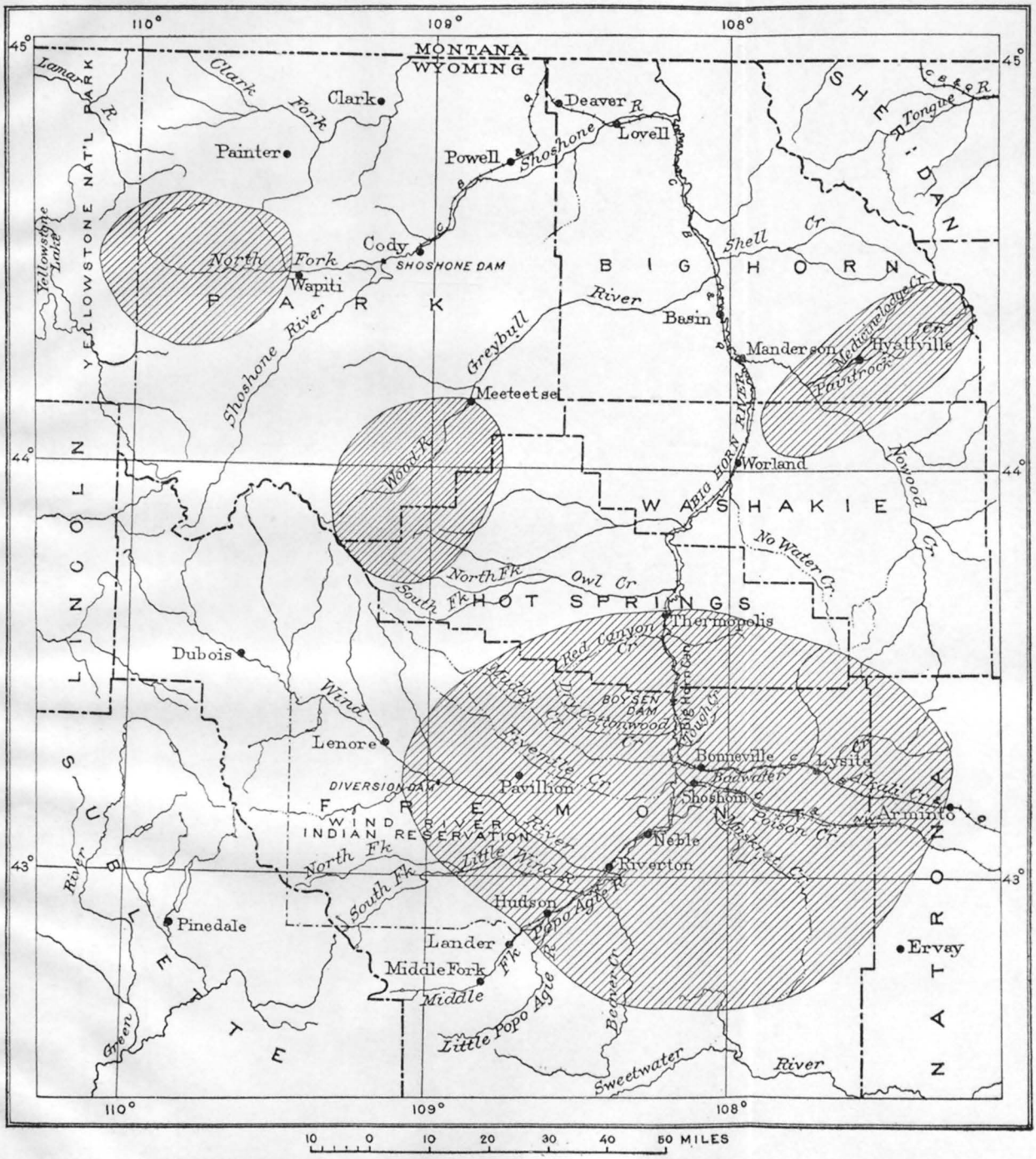
The flood caused the greatest damage along Badwater Creek and below the mouth of the Badwater as far as the head of the Big Horn Canyon. In this stretch the Chicago, Burlington & Quincy Railroad had 20 miles of track washed out, of which about 8 miles was subsequently relocated away from the river bottom. Three steel bridges were destroyed. The entire town of Bonneville was covered with 2 to 5 feet of water. Several buildings and 10 freight cars were washed downstream, and additional buildings were wrecked. Just east of the railroad station, where the railroad formerly crossed Badwater Creek on a 120-foot steel bridge, the channel is now more than 300 feet wide. In front of the station the 80-foot channel was widened to 500 feet. The loss to the railroad alone was estimated at more than $1,000,000. Two lives were lost near Shoshoni, and a 13-year-old boy was carried by the flood for more than a mile before being rescued.

The heavy rains caused many slides on the railroad track through Big Horn Canyon and filled two tunnels with water from 2 to 5 feet deep. The new highway that is being constructed through the canyon was severely damaged. The Wyoming Power Co.'s plant at Boysen dam was put out of commission by 2 feet of water over the floor of the power house, which is inside the dam. The water was 20 feet deep over the dam and 4.9 feet deep in the railroad tunnel at that point. Transmission lines along Badwater, Poison, and Muskrat creeks were destroyed.

The Chicago & Northwestern Railway lost five bridges and 500 feet of track between Shoshoni and Hudson.

Thermopolis was flooded as far east as the Burlington station, and buildings at the Hot Springs resort on the east side of the river were considerably damaged. At the crest of the flood the water surface was 2.3 feet above the top of the center arches of the concrete bridge at the lower end of the town and 3.7 feet above the top of the arches at each end of the bridge. This submergence of the arches caused backwater above the bridge, which amounted to a maximum of 0.8 foot. The main channel carried 22,000 second-feet before overflow began; overflow occurred at a stage of 13.4 feet on the Geological Survey gage located on the bridge.

The Hanover and Big Horn County canals, which divert water from the Big Horn a few miles above Worland for the irrigation of



MAP OF BIG HORN RIVER BASIN, WYO., SHOWING RAINFALL AREAS CAUSING FLOOD OF JULY, 1923

35,000 acres, were badly damaged; and the Illinois Pipe Line Co.'s line was broken between Chatham and Grass Creek and several thousand barrels of oil was lost. At Manderson the water surface reached the ties of the railroad track, but the railroad embankment prevented flooding of the town.

An investigation of this flood was made soon after it occurred, and the slope and cross sections of the maximum discharge were obtained from well-defined high-water marks on streams that had no gaging stations. The results are summarized in the following table:

Maximum discharge of streams in the Big Horn drainage basin, July 24–26, 1923.

[Localities in Wyoming except as otherwise specified.]

Stream.	Locality.	Maximum discharge (second-feet).		Drainage area (square miles).	Time of flood crest.	Source of information.
		Total.	Per square mile.			
Wind River	Riverton	11,100	4.8	2,320	4 a. m. July 25	Recording gage chart at gaging station.
Muskrat Creek	Sec. 16, T. 2 N., R. 6 E.	[a] 6,400	8.3	770	4 a. m. July 24	Slope measurement.
Fivemile Creek	Sec. 17, T. 3 N., R. 6 E.	3,500	9.5	368	do	Estimated by Bureau of Reclamation.
Poison Creek	Shoshoni	3,000	5.8	518	do	Do.
Badwater Creek	Bonneville	[b] 18,600	23.4	794	9.45 a. m. July 24	Slope measurement.
Muddy Creek	Sec. 29, T. 4 N., R. 6 E.	[c] 16,300	41.8	390	do	Do.
Tough Creek	Sec. 28, T. 39 N., R. 94 E.	1,500	62.5	24	do	Estimated by Bureau of Reclamation.
Big Horn River	Sec. 2, T. 5 N., R. 6 E.	28,700	3.7	7,740	5 p. m. July 24	Estimated at Boysen dam by E. C. Bebb, Federal Power Commission.
Do	Thermopolis	29,800	3.7	8,080	11 p. m. July 24	Measurement of overflow area and extension of gaging-station rating curve.
Do	Manderson			10,900	9.30 a. m. July 26	State Highway Department.
Do	Greybull			14,500	9 p. m. July 26	Observer.
Do	Hardin, Mont.	29,500	1.4	20,700	9 p. m. July 27	Gaging-station record.
Paintrock Creek	Sec. 25, T. 50 N., R. 89 W.	5,580	34.0	164	1 a. m. July 24	Recording gage chart at gaging station.
Greybull River	Meeteetse	2,200	3.2	690	5.30 a. m. July 24	Do.

[a] On cross section measured and slope determined as 0.007 from high-water marks 550 feet apart; "*n*" taken as 0.040.

[b] Fairly uniform channel found beginning 2,000 feet below railroad station. Two cross sections measured 737 feet apart. Upper section had not scoured out as badly as lower section, and original banks remained. Slope determined by difference in altitude of high-water marks at each section and also by altitude of high-water marks 2,000 feet above upper section. Both methods give slope of 0.0040, "*n*" taken as 0.030. Maximum discharge based on mean of upper and lower sections was 20,900 second-feet, but to eliminate possible scour in lower section the discharge was computed by using upper section alone, which gave 16,200 second-feet. The most probable maximum discharge was taken as the average of the two figures, or 18,600 second-feet.

[c] Two cross sections measured 313 feet apart. Slope from high-water marks 0.0095; "*n*" taken as 0.045.

The only point on Big Horn River at which fairly complete records of the flood are available is Thermopolis, where a gaging station is maintained on the concrete highway bridge that connects the town with the Hot Springs resort. It was impossible to read the gage at the

highest stage at Thermopolis, because the water was over each end of the bridge, but from high-water marks, levels run to determine the overflow area, and statements of citizens a hydrograph showing the entire flood discharge has been prepared (fig. 10). At 6 p. m. July 23 the river started to rise, and by 2 a. m. July 24 it was discharging 24,800 second-feet. It then fell rapidly until 8 a. m., when the discharge was 15,000 second-feet. A second rise began at that time and continued until 11 p. m., when the maximum discharge of 29,800 second-feet was reached at a stage of 16.2 feet above the zero of the gage. From the peak, which was of relatively short duration, the discharge fell to 22,300 second-feet at 8 a. m. July 26 and to 14,500 second-feet at midnight on the 27th. A slight rise occurred during that night, but after that time the river fell steadily until

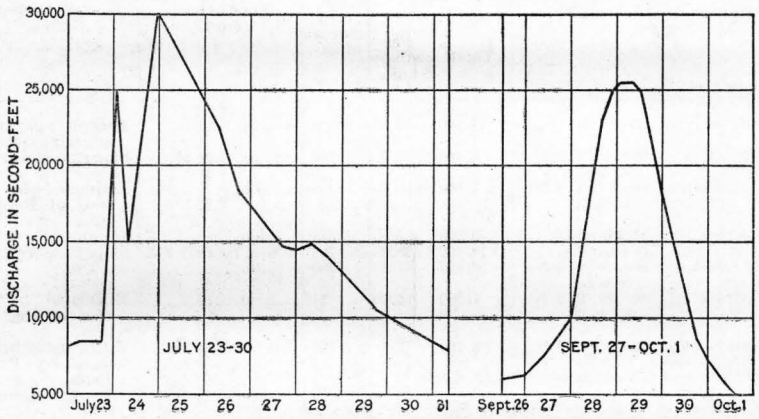


FIGURE 10.—Hydrographs of floods in 1923 on Big Horn River at Thermopolis, Wyo.

the discharge was 8,000 second-feet on July 31. During this period a total of 235,000 acre-feet passed Thermopolis.

The first rise was undoubtedly caused by a cloudburst in Red Canyon, a small tributary that enters Big Horn River a few miles above Thermopolis. The flood was so severe on this tributary that it washed out the railroad bridge and several hundred feet of track.

A study of the time at which the tributaries were at crest stage indicates that the chief source of the main flood was the crest flows from Badwater and Muddy creeks and, to a lesser extent, from Muskrat, Fivemile, Poison, and Tough creeks. Wind River did not reach its maximum stage at Riverton until 4 a. m. July 25, and as this point is 64 miles above Thermopolis by river, it took at least 12 hours for this peak to reach Thermopolis. If the Wind River crest had coincided with the others the discharge at Thermopolis would have increased by at least 5,000 second-feet.

The maximum discharge probably decreased below Thermopolis, because the flood crest flattened out. Nowood Creek contributed about 3,400 second-feet to the Big Horn at Manderson, but this flow reached the river 24 hours ahead of the crest stage. The maximum flow from the Greybull entered the Big Horn during the night of July 24, nearly 24 hours ahead of the crest flow in that stream.

BADWATER CREEK.

The severest flood in the entire region occurred in the Badwater drainage basin, which was within the area of heaviest rainfall. The residents at Lysite stated that the flood was the highest in 20 years. An Associated Press item of July 25 stated that a rancher and his family barely escaped from a wall of water 6 miles west of Lysite. The crest at that point occurred about 4 a. m. July 24. The Chicago, Burlington & Quincy Railroad agent at Bonneville stated that the creek started to rise there at 1.30 a. m. and rose gradually until 6 a. m., when the rise was much more rapid, being as much as 1 foot every five minutes just prior to the crest, which occurred at 9.45 a. m. The creek fell gradually for two days. The total rise was about 12 feet.

PAINTROCK CREEK.

The heavy rain that fell during the night of July 23 flooded the entire Paintrock Creek basin and swept away practically every bridge. The maximum stage occurred about midnight, when the creek at the gaging station rose from 470 to 5,580 second-feet, an increase in stage of 4½ feet, in an hour's time. The observer reported that high water lasted several hours. Residents state that it was the largest flood ever experienced since white settlers have lived in the valley. Medicine Lodge Creek, which joins Paintrock Creek below the gaging station, had a severe flood, the crest of which was 45 minutes earlier.

GREYBULL RIVER.

The hydrograph for the gaging station on Greybull River at Meeteetse, Wyo. (not included in this report), shows that the upper basin of that stream was subject to almost daily cloudbursts from July 21 to 26. The chief area of cloudburst was on Wood River, a tributary of the Greybull. The floods caused by these cloudbursts did not exceed 2,200 second-feet, which was not excessive for that stream, and the resulting damage was not great.

North Fork of Owl Creek, whose drainage area adjoins that of Wood River on the south, was at the highest stage known, but the South Fork was not very high.

NORTH FORK OF SHOSHONE RIVER.

The series of cloudbursts that occurred in northern Wyoming during July culminated on the night of July 22 in a somewhat general rainfall covering a large territory. Heavy rains in the mountains near Sylvan Pass caused a serious landslide 14 miles east of the eastern entrance to Yellowstone Park and stopped all traffic for two days. C. C. Spencer, forest ranger at Wapiti, gives the following description of the storm:

> On July 19, 20, 21, and 22 we had a spell of unusually hot, sultry weather. In fact, it was about the worst I can remember in this country during the past 18 years. The cloudbursts followed this on July 22 and seemed to strike all of the high divides, as well as a few places lower down. Most of them struck near or above timber line (about 10,000 feet elevation). The ten which struck the North Fork of the Shoshone and its tributaries came between 6 and 8 p. m. They came down the following streams: Main North Fork, Grinnell, Gunbarrel, Clearwater, Blackwater, and Sweetwater creeks about 6 p. m., and Elk Fork, Clocktower, Canyon, and Big creeks at 8 p. m. Canyon Creek carried the largest volume of water for the area drained, and the run lasted for more than an hour. Very little rain fell in the valley, and the storm on the divides lasted but a few minutes. We have no records of precipitation. One thing I have noticed during the last few years is that these cloudbursts always come about the last of July and follow a period of hot, sultry weather. Those this year (1923) were many times larger and worse than any others of which I have knowledge in this section.

A map of the North Fork drainage basin shows that the creeks subject to the earlier cloudbursts were at a higher general altitude than those on which the cloudbursts occurred about 8 p. m.

The Bureau of Reclamation maintains a gaging station in sec. 15, T. 52 N., R. 104 W., 6 miles east of Wapiti, and the recording gage at that point showed that the river started to rise at 10 p. m., when its flow was 1,460 second-feet, and rose to a maximum discharge of 8,100 second-feet in a few minutes' time. The period of crest flow was equally short, and the river quickly fell again, although it did not reach normal stage until noon of the following day (fig. 9, *B*). The almost instantaneous rise shows that the floods from both the upper and lower areas described above reached the gaging station at the same time, a condition which would cause the severest flood for that amount of rainfall over the basin.

FLOOD OF SEPTEMBER 27–29, 1923.

Heavy rains from September 27 to 29 covered the entire central and northern parts of the State and caused a flood on Big Horn River that was second in size only to that of July 23–24 at Thermopolis and exceeded it in the lower river.

The following table shows all available Weather Bureau rainfall records in the Big Horn River drainage basin:

Rainfall in Big Horn River drainage basin, Sept. 26–30, 1923, in inches.

Station.	26	27	28	29	30	Total.
Dubois	2.00	1.01				3.01
Pavillion		2.00	0.88	0.18	Tr.	3.07
Diversion dam		1.77	1.19	.09	Tr.	3.06
Lander [a]		2.87	.92	Tr.	0.01	3.81
Riverton		2.14	1.79	.26	.06	4.25
Middle Fork		3.00	2.05	.17	.03	5.25
Thermopolis [b]					4.94	4.94
Worland [c]		.91	.53	1.01	.19	2.64
Basin		.76	.23	.23	.28	1.50
Cody		.65	.90	.35	.36	2.26
Deaver [c]		.31	.26	.10	.18	.85
Lovell		.21	.17	.15	.21	.74
Powell [c]		.70	.03	.28	Tr.	1.02

[a] Regular Weather Bureau station; precipitation for 24-hour period ending at midnight.
[b] Precipitation recorded on Sept. 30 is accumulation for four days.
[c] Precipitation measured in morning for 24-hour period ending at that time.

NOTE.—Except as otherwise indicated, observations are generally made late in the afternoon, near sunset, and precipitation is recorded for 24-hour period ending at that time.

Stream-flow records are also available at a number of points in the drainage basin, and the daily discharge for the period September 25–30 is given in the following table:

Daily and maximum discharge of streams in Big Horn River basin, Wyo., Sept. 25–30, 1923.

Station.	Distance (miles).	Discharge (second-feet).						Maximum discharge recorded (second-feet).			Drainage area (square miles).
		Sept. 25.	Sept. 26.	Sept. 27.	Sept. 28.	Sept. 29.	Sept. 30.	Time.	Total.	Per square mile.	
Wind River at Riverton.	0	860	831	1,470	4,880	2,330	1,860	1.30 p. m. Sept. 28	6,550	2.8	2,320
Big Horn River at Thermopolis.	64	1,640	1,640	3,720	18,900	20,400	11,100	2–4 a. m. Sept. 29	25,500	3.2	8,080
Big Horn River at Manderson.	124							Midnight Sept. 29			
Big Horn River at Greybull.	154							8–10 a. m. Sept. 30			
Big Horn River at Hardin.	284	4,270	6,280	4,690	4,460	28,900	35,100	8 p. m. Sept. 30	36,200	1.8	20,700
Middle Fork of Popo Agie River near Lander.		71	68	84	111	113	101	6 p. m. Sept. 28	152	1.8	84
Greybull River at Meeteetse.		280	260	610	905	580	590	4 a. m. Sept. 28	1,300	1.9	690
Shoshone River near Ishawooa.		375	315	699	733	585	548	6 p. m. Sept. 27	900	1.7	532
Tensleep Creek near Tensleep.		181	177	208	325	315	283	1 a. m. Sept. 28	366	1.6	238
Paintrock Creek near Hyattville.		240	215	225	282	290		11 p. m. Sept. 27	940	.6	164
Nowood Creek at Bonanza.		604	604	572	1,280	3,650	3,150	6 a. m. Sept. 29	3,850	2.2	1,790
Shell Creek at Shell		115	125		140	182	250				256

The records of precipitation and stream flow show that although the rainfall was general throughout the drainage basin, the heaviest precipitation occurred in the southeastern part, where the rainfall exceeded 2.5 inches. Within this area were two smaller areas where the rainfall ranged from 4 to 5 inches, one near Thermopolis and the other an oval area about 15 miles wide that extended 40 miles from the vicinity of Neble to a point above Lander. The fact that the floods on the tributaries had low unit run-offs indicates

that the rainfall was a steady downpour rather than a series of short storms of cloudburst intensity.

The chief damage caused by the flood was in the Big Horn River basin, although a considerable stretch of the new roadbed of the Chicago, Burlington & Quincy Railroad near Bonneville was washed out. At Thermopolis the lower ground was flooded, but as the flood was 1.3 feet lower than that of July, the damage was not so extensive. The railroad fill south of the station at Manderson was washed away and the water entered the town and flooded it to a depth of 2 or 3 feet. People living on the lowlands near Basin and Greybull were forced to move. Many of the streets in Greybull were covered with water to a depth of 3 feet. Part of the fill between the two highway bridges over the Big Horn at that point was carried away, thus increasing the the carrying capacity of the channel.

A hydrograph of the flood (fig. 10) has been prepared from the records at the Thermopolis gaging station. This graph shows that the river rose gradually from 6,200 second-feet at midnight September 26 to 10,000 second-feet in 24 hours. In the succeeding 26 hours the river rose to its maximum stage of 25,500 second-feet, which was reached at 2 a. m. September 29; it remained at or near that stage for 10 hours and then steadily fell to 8,800 second-feet at 6 p. m. September 30 and to 5,000 second-feet by noon October 1. During that period a total of 110,000 acre-feet passed the station.

Practically the entire drainage basin above Thermopolis contributed to the flood at that point. As the crest at Riverton occurred 12 hours earlier, the average rate of travel for the crest between Riverton and Thermopolis was 5 miles an hour, and as its volume increased from 6,500 to 25,500 second-feet, all the intervening streams must have contributed. These streams, however, were not so high as during the July flood.

The crest flow increased considerably through the Big Horn River basin as rains occurred over its entire area; and the tributaries, notably Nowater and Nowood creeks, had moderate floods, the crests of which reached the Big Horn about the time of the main crest itself.

COMPARISON BETWEEN FLOODS OF JULY AND SEPTEMBER, 1923.

The following table summarizes the principal facts about the July and September floods:

Comparison between floods of July and September, 1923, on Big Horn River.

Point.	July crest (second-feet).	September crest (second-feet).	Remarks.
Riverton, Wyo	11,100	6,550	
Thermopolis, Wyo	29,800	25,500	Maximum stage, 1.3 feet lower in September.
Manderson, Wyo			Maximum stage, 1 foot higher in September.
Hardin, Mont	29,500	36,200	Do.

The chief difference in the two floods was that the July flood was caused by heavy rains of almost cloudburst intensity over a comparatively small area that centered chiefly over Badwater Creek, with little inflow below Thermopolis; and the September flood was caused by general rains of less intensity over the entire drainage basin, with considerable inflow below Thermopolis.

An idea of the relative size of the floods of 1923 on Big Horn River at Thermopolis as compared with the maximum discharge each year for which records are available is given by the following table:

Annual maximum discharge of Big Horn River at Thermopolis, Wyo., 1900–1923.

Year.	Date.	Discharge (second-feet).	Year.	Date.	Discharge (second-feet).
1900	June 8	14,600	1915	June 3	11,800
1901	May 22	17,500	1916	21	13,000
1902	June 12	9,890	1917	24, 27	19,400
1903	19	10,100	1918	17	19,200
1904	22	14,600	1919	1	5,000
1905	6, 8	10,600	1920	14	13,800
1911	19	18,000	1921	10	20,800
1912	11	19,500	1922	11	12,100
1913	May 31	17,700	1923	July 24	29,800
1914	June 5	12,800	1923	Sept. 29	25,500

NOTE.—Maximum discharge for extreme stage recorded except for 1902 and 1911–1914, when it is for the 24-hour period.

FLOOD ON POWDER RIVER, WYO.

GENERAL FEATURES.

The general rains which caused the September flood on Big Horn River covered the entire drainage basin of Powder River and extended north into Montana. The flood on Powder River was the largest that has occurred in the 40 years that white settlers have lived in the valley.

The following table shows all available rainfall records at Weather Bureau stations in the Powder River basin:

Rainfall in Powder River basin, Wyo., Sept. 26–30, 1923, in inches.

Station.	26	27	28	29	30	Total.
Ervay		2.47	1.20	0.27	0.13	4.07
Salt Creek [a]		.25	1.88	1.27	.35	3.75
Barnum		.81	1.75	.04	.15	2.75
Ninemile Creek [b]		.70	1.25		2.50	4.45
Buffalo		1.46	4.03	.61	.19	6.29
Gillette		Tr.	2.12	.40	.95	3.48
Echeta		.04	2.20	1.35	1.10	4.69
Clearmont [a]		1.00	1.00	1.90	.25	4.15
Sheridan [c]		2.04	2.23	.96	.94	6.17
Sheridan field station [a]		.44	2.20	1.74	1.51	5.89
Verona [a]	1.20	1.50	1.55	1.33	.38	5.96
Hunters station	.09	1.80	1.07	.90	.70	4.56

[a] Precipitation measured in morning for 24-hour period ending at that time.
[b] Precipitation recorded on Sept. 30 is accumulation for two days.
[c] Regular Weather Bureau station; precipitation for 24-hour period ending at midnight.

NOTE.—Except as otherwise indicated, observations are made late in the afternoon, near sunset, and precipitation is recorded for 24-hour period ending at that time.

Roughly approximate records were also obtained at other points. B. F. Horton, who lives 4½ miles northeast of Arvada, measured 8½ inches of rainfall from September 20 to 30 in a coffee can in his yard. William La Follett, who lives in sec. 23, T. 45 N., R. 87 W., had a water tank 3 by 8 by 2½ feet deep in an exposed position. The rain began at 4 a. m. September 27, and by 4 p. m. on the 29th the tank contained 5 inches of water; two days later this had increased to 6 inches. A rancher near Savageton, in T. 45 N., R. 76 W., stated that a 14-quart water pail with nearly vertical sides, which stood in an exposed place, was filled twice in 48 hours, indicating an almost unbelievable rainfall of 17 inches. At Ross, just east of the Powder River basin, in T. 40 N., R. 75 W., no records were kept, but the postmaster stated that the rainfall was the heaviest in years. As much of the basin is very sparsely settled, it is possible that heavy rainfall occurred at other points and was not recorded.

The available data show that the rainfall over practically the entire drainage basin was at least 4 inches and that in some small areas it was considerably greater.

The flood was severe throughout the valley, and channels were changed and rechanged by it. All residents in the valley were forced to abandon their homes temporarily, as the water was from 10 to 12 feet deep in the river bottom above the main channel. Houses were destroyed, practically all hay was washed away, and whole flocks of sheep, as well as much other livestock, were swept away.

At Arvada the Chicago, Burlington & Quincy Railroad's 270-foot steel-girder bridge of five spans resting on large concrete piers was destroyed. The first pier began to settle during the afternoon of September 29, and by the next morning the entire bridge was gone, the piers having been undermined and overthrown. About 300 feet of high railroad fill at the north end of the bridge was also washed out.

PROGRESS OF FLOOD.

Records of Salt Creek, taken by the Midwest Refining Co. below Salt Creek reservoir, in sec. 36, T. 41 N., R. 79 W. (drainage area 520 square miles), show that the creek rose from 1 second-foot about 4 p. m. September 27 to 32,000 second-feet[2] at 2.30 a. m. September 28 and fell to 1,000 second-feet at 3 p. m. September 29. By October 8 the discharge had fallen to 10 second-feet. The crest of the flood on Powder River occurred at Arvada at 8 p. m. September 29, 30 hours later than at the reservoir, and as Arvada is 145 miles distant by river the crest traversed this distance at an average rate of 4.8 miles an hour. Usually a flood crest flattens out as it

[2] Slope measurement from high-water marks and area of cross section checked by computation of flow through contracted openings.

proceeds downstream, but this one was augmented by floods from all the tributaries. Undoubtedly one of the chief contributors was Crazy Woman Creek, which rises in the south end of the Big Horn Mountains. Although no record of that stream is available, it is known that prior to the time of the flood in Powder River a heavy fall of wet snow, beginning September 24, occurred in the mountains. This was later followed by rain, which melted the snow and caused all the streams that flow eastward from the mountains to reach severe flood stages.

FLOOD AT ARVADA.

In order to obtain all available flood data the gaging station on Powder River at Arvada was visited on October 7 and 8. The gage is at the highway bridge in the outskirts of Arvada. Paint marks

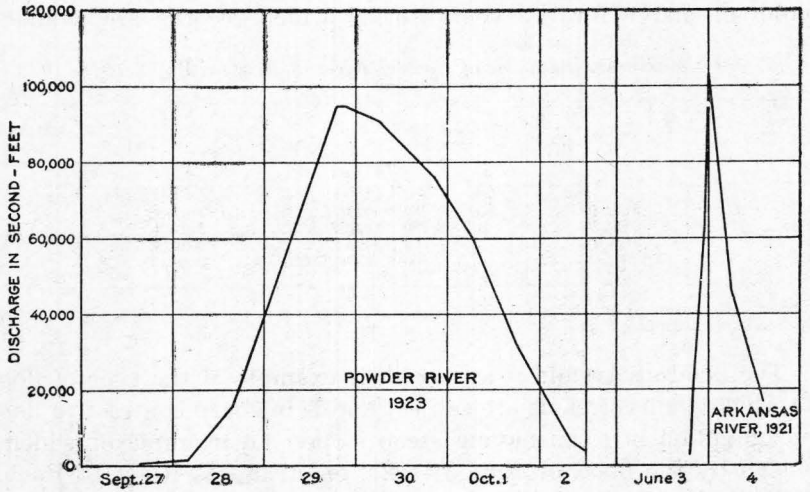


FIGURE 11.—Hydrographs of floods in 1923 on Powder River at Arvada, Wyo., and in 1921 on Arkansas River at Pueblo, Colo.

at each end of the bridge indicated the maximum stage; this was determined by level to be 4.7 feet above the floor of the bridge, or 23.7 feet above the zero of the gage. From statements of citizens the height of the river at various times during its rise and fall was determined. A fairly straight section of river beginning 200 yards below the railroad bridge was selected to measure the high-water slope and cross sections. The slope was well defined by fine drift on one side of the river; on the other the bank was formed by a nearly vertical shale cliff. Two cross sections 515 feet apart were measured to the water's edge, and the width of the river at each section was determined by triangulation. From this the maximum discharge was computed to be 95,000 second-feet, the value of "n" being taken as 0.030.

An approximate hydrograph for the period September 27 to October 2 has been prepared (fig. 11) and shows that the river rose

from 300 second-feet on the 27th to 15,000 second-feet at 3 p. m. on the 28th. After that it rose rapidly to the maximum of 95,000 second-feet at 8 p. m. on the 29th. It remained at crest stage for an hour and then fell slowly to 90,000 second-feet at 6 a. m. September 30. After that the fall was more rapid, the discharge decreasing to 60,000 second-feet at 11 a. m. October 1 and to 32,000 second-feet at 6 p. m. the same day. By noon of October 2 the river was nearly back to normal stage. The total discharge during the flood was estimated at 438,000 acre-feet, which is greater than the total yearly flow for each year but one in the eight preceding years for which records are available.

An idea of the unprecedented discharge of the river during the flood is given by the following table, which shows the annual maximum discharge for the years during which records are available:

Annual maximum discharge of Powder River at Arvada, Wyo., 1916–1923.

Year.	Date.	Discharge (second-feet).	Year.	Date.	Discharge (second-feet).
1916	June 29	6,080	1920	June 19	10,700
1917	May 22	8,780	1921	June 3	6,680
1918	July 14	10,800	1922	Aug. 3	6,030
1919	Aug. 3	2,460	1923	Sept. 29	95,000

NOTE.—From 1916 to 1918, inclusive, the station was maintained just above the mouth of Clear Creek, 17 miles downstream.

The flood at Arvada is an excellent example of the type of floods to which plains streams are subject and is in sharp contrast to floods on mountain streams having steep slopes, an example of which is shown by the flood of June 3, 1921, on Arkansas River at Pueblo, Colo. (See fig. 11.) The maximum stages were almost equal, but the Arkansas rose and fell very rapidly, and the total discharge during the portion of the flood shown by the hydrograph in Figure 11 was less than 90,000 acre-feet.

FLOODS AT SHERIDAN, WYO.

Sheridan lies just north of the Powder River basin at the confluence of Goose and Little Goose creeks. The storms that caused the flood in Powder River were very severe near Sheridan and on the eastern slope of the Big Horn Mountains, a few miles distant.

Goose and Little Goose creeks rose suddenly on the night of September 27. Sheridan was flooded, 300 basements being filled with water, and scores of citizens were driven from their homes. Much of the wooden-block street paving was scattered or carried down Goose Creek. The total damage at Sheridan was estimated at $500,000.

Sheridan experienced another flood on the night of September 30, caused by a rise on Little Goose Creek which flooded some of the houses to a depth of 5 feet. Part of the best residential section was reported to have suffered considerably by the overflow. No discharge estimates for these floods are available.

CLOUDBURST FLOODS.

TEMPLETON GAP NEAR COLORADO SPRINGS, COLO.[3]

Between 6 and 9 p. m. May 27, 1922, a very heavy rain above Templeton Gap, 5 miles northwest of Colorado Springs, Colo., produced a flood that caused much damage to property in and near Colorado Springs. An investigation of the flood by the United States Geological Survey was made a few days after it occurred.

Northeast of Colorado Springs is a semicircular range of hills, which rise abruptly from the plains and reach an altitude 800 feet higher than that of Colorado Springs. The hills are of rocky formation and support little vegetation. They inclose a basin having a narrow outlet called Templeton Gap.

About 6 p. m. May 27 heavy clouds from the southwest passed over Colorado Springs and upon reaching the hills above Templeton Gap were forced upward until their moisture was condensed and precipitated in a rainfall that reached cloudburst intensity. A rancher living above the gap estimated from the amount of water caught in a pail standing in his yard that the rainfall was 7 inches. It was reported that farther up toward the summit of the hills 10 inches of hail fell.

The resulting flood reached Papeton, 1 mile below Templeton Gap, about 8.30 p. m., flooded some of the streets to a depth of 4 feet, and washed out fences, barns, streets, and sidewalks. Half a mile below Papeton it destroyed a considerable stretch of railroad track. A peculiarity of the flood was the mud balls left in the channel. These were composed of black clay or gumbo and ranged from 6 to 30 inches in diameter. So fine was their texture that they closely resembled black boulders.

A straight section of channel was found a short distance below Templeton Gap, and three cross sections 200 feet apart were measured. The total slope between the sections was determined from high-water marks to be 0.0108, and the maximum discharge was computed as 6,120 second-feet, or 862 second-feet a square mile from 7.1 square miles of drainage area. The total discharge was estimated at 757 acre-feet. The area above Templeton Gap is subject to frequent cloudbursts, but residents state that this flood was the greatest in 50 years or more.

[3] Abstracted from Hodges, P. V., Cloudburst flood near Colorado Springs, Colo.: Eng. News-Record, Nov. 30, 1922.

CHERRY CREEK NEAR PARKER, COLO.

During the afternoon of July 28, 1922, heavy rain fell near Parker, Colo., about 20 miles southeast of Denver, causing a severe flood in the upper Cherry Creek basin and filling the channel of the stream at Denver. An investigation of this flood was made by the United States Geological Survey in cooperation with the State engineer's office.

The area of heavy rainfall extended from a point 3 miles north of Parker to a point 1 mile south of Franktown and from the county line on the east to a point 4 miles west of the creek. The heaviest rainfall was in the basin of Bayou Gulch.

Mrs. William Boegle, who lives 3 miles above the mouth of Bayou Gulch, in sec. 30, T. 7 S., R. 65 W., stated that the storm, which came from the west, began about 2 p. m. and lasted for two hours. The total rainfall was about 3½ inches as measured in an iron wheelbarrow with nearly vertical sides. The water stood 2 feet deep in the road, and the resulting flood was the highest in nearly 50 years. A rancher at the mouth of the gulch stated that two storms met over the gulch; one came from the north and the other from the west. Heavy rain lasted one hour. A rancher living 1 mile above the mouth of the gulch stated that the heavy rain lasted 45 minutes and that the flood crest was reached at 3.45 p. m. and remained near that stage for 1 hour. A. W. Payne, a rancher living in sec. 3, T. 7 S., R. 66 W., near Cherry Creek, halfway between Bayou Gulch and Parker, stated that the rain lasted from 2 to 4 p. m. and amounted to 2 inches as measured in a wash tub in the yard. The rise in Cherry Creek came about 3 p. m. The total discharge of the Cherry Creek flood was estimated at 3,960 acre-feet.

Maximum discharge of Cherry Creek at the points measured, July, 1922.

Stream.	Locality.	Maximum discharge (second-feet).		Drainage area affected (square miles).
		Total.	Per square mile of area affected.	
Bayou Gulch	Sec. 23, T. 7. S., R. 66 W.	8,670	460	19
Cherry Creek	Sec. 4, T. 6 S., R. 66 W.	17,000	195	87

The flood of July 14, 1912, the highest recorded at Denver, was caused by a storm which covered an area that extended from Parker for a distance of 5 miles toward Denver and by a very severe storm in Denver at the same time. At the point where the flood of 1922 was measured the flood of 1912 was at practically the same stage, but in Denver the maximum discharge was estimated at 11,000 to 14,000 second-feet and caused considerable damage and the loss of several lives. The maximum discharge of the flood of 1922 in Denver was

about 6,000 second-feet. The difference between 17,000 second-feet near Parker and 6,000 second-feet at Denver shows the effect of the flattening out of the flood crest as it progressed downstream, owing to the channel and overflow storage afforded it. If the storm of 1922 had occurred nearer Denver, the resulting flood in Denver would probably have almost equaled that of 1912.

BUCKHORN CREEK NEAR LOVELAND, COLO.

From June 14 to 16, 1923, heavy rains occurred over an area that extended from a point a few miles east of Greeley, Colo., to the western edge of R. 70 W., in the foothill region.

The only Weather Bureau records within this area are those at Fort Collins, which show a precipitation of 2.07 inches; those at Waterdale, which show 2.39 inches; and those at Greeley, which show 2.63 inches during the entire period. The heaviest precipitation was south of Fort Collins, near Loveland, in the foothill area, and appeared to center over the lower part of the Buckhorn Creek basin. This caused the highest flood known on Buckhorn Creek and several of its tributaries. All bridges on the lower Buckhorn and on Big Thompson Creek below the Buckhorn were washed out, two lives were lost, thousands of acres of rich agricultural land was ruined, and much livestock was drowned.

The drainage area of the lower Buckhorn Creek consists of three narrow, troughlike valleys, which converge slightly toward the northwest. Narrow ridges 400 to 500 feet high separate these valleys. The middle valley is drained by Buckhorn Creek, which flows southeastward. The other two valleys are drained by a number of small tributaries that have cut through the narrow ridges, forming side canyons, and join the main stream at short intervals. These small tributaries drain fan-shaped areas which converge at the outlet canyons. The slopes are steep and rocky and support little vegetation except some scrubby pines and a small amount of brush.

The United States Geological Survey made an investigation of the flood within a week of its occurrence, determined the maximum discharge at three points by means of slope measurements from well-defined high-water marks, measured the cross sections of flood areas, and interviewed residents to obtain all possible information on the rainfall.

The storm came from the south and followed the course of Buckhorn and Redstone creeks. In its progress northward the storm was augmented by clouds from the southeast. Observers at Loveland stated that swiftly moving clouds passed over Loveland and continued northwestward to the foothills, where they appeared to join the main storm, which was traveling northward. The troughlike valleys up which the clouds traveled converge at their north ends,

and their convergence caused a concentration of the clouds, which resulted in a cloudburst. The area thus affected extended from the mouth of Buckhorn Creek to a point near Fletcher Hill, 5 miles above Masonville; above that point little rain fell. The rain started about 5 p. m. June 15 and lasted for several hours. A rancher who lives a short distance above the mouth of Missouri Canyon reported that during the period of greatest intensity 2½ inches of water was caught in 30 minutes in a tub in his yard. The ground was well saturated from previous rains, being thus unable to absorb much of this rainfall. The following table shows the maximum discharge at the three points where it was measured:

Maximum discharge at points in Buckhorn Creek basin, June 15, 1923.

Stream.	Locality.	Maximum discharge (second-feet).		Drainage area (square miles).		Time of flood crest.
		Total.	Per square mile of area affected.	Total.	Area producing flood.	
Buckhorn Creek [a]	Half a mile south of Masonville.	10,500	262	134	40	10 p. m.
Redstone Creek [b]	Masonville	6,820	325	31	21	Do.
Missouri Canyon [c]	Near mouth (sec. 26, T. 6 N. R. 70 W.).	4,350	1,820	2.4	2.4	6.30 p. m.

[a] Two cross sections, measured 544 feet apart, and slope between found to be 0.0085; some brush and débris, otherwise smooth; "*n*"=0.045.

[b] Two cross sections measured 392 feet apart, and slope between found to be 0.0148; some brush but fairly smooth section; "*n*"=0.035.

[c] Three cross sections measured in distance of 280 feet, and slope of entire distance found to be 0.027; fairly smooth except in places where it is rocky; "*n*"=0.035.

The flood in Missouri Canyon occurred several hours before that in Buckhorn Creek and probably did not contribute greatly to the latter flood. As the point at which the Buckhorn flood was estimated is below the mouth of Redstone Creek, the measured flow in the Buckhorn includes the flow of the Redstone, which leaves about 3,700 second-feet to be contributed by the Buckhorn itself during the crest flow.

MINOR FLOODS.

Data on three minor floods in small areas are presented in the following table:

Maximum discharge of minor floods in the Rocky Mountain region, 1923.

Stream.	Date.	Maximum discharge (second-feet).		Drainage area square (miles).
		Total.	Per square mile.	
Magpie Gulch 1½ miles above Golden, Colo	July 26, 1923	[a] 1,900	1,270	1.5
Skyrocket Creek at Ouray, Colo	July 20, 1923	2,000	2,000	1.0
South Sand Draw in sec. 3, T. 3 N., R. 3 W. Wind River meridian, Wyo	Aug. 21, 1923	2,840	----------	----------

[a] From two cross sections 194 feet apart; slope found to be 0.090; "*n*"=0.045.

Cloudbursts in the foothills above Golden, Colo., occurred July 26, 1923, and caused floods in all the gulches that enter Clear Creek from the north within 2 miles of Golden. At the mouth of Magpie Gulch the rainfall was moderate, but half a mile above it was a cloudburst. The rain began about 12.45 p. m., and the flood reached its crest by 1 p. m. and then fell so rapidly that by 1.40 p. m. the flow in the gulch was again normal. This flood deposited a gravel and boulder dam 10 feet high entirely across Clear Creek, a distance of about 70 feet. Some of the boulders moved by the flood weighed as much as 5 tons.

The recording gage on Uncompahgre River at Ouray, Colo., registered a severe flood on July 20, 1923. This flood was caused by a cloudburst on Skyrocket Creek, which drains the almost vertical walls of the mountains back of Ouray and enters the Uncompahgre at the gage. The hydrograph of the flood (fig. 9, *A*) shows that the discharge of the river increased from 275 to 2,000 second-feet in about 30 minutes and fell almost as quickly.

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