Summary of Floods in the United States During 1962

By J. O. ROSTVEDT *and others*

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CONTENTS

ILLUSTRATIONS

TABLES

SUMMARY OF FLOODS IN THE UNITED STATES DURING 1962

By J. O. Rostvedt and others

ABSTRACT

This report describes the most outstanding floods in the United States during 1962. The most damaging floods during the year occurred in February in southern Idaho and northern Nevada and Utah, and during the latter part of February and the early part of March in Kentucky and in the Cumberland River basin in Tennessee.

The floods in Idaho and adjacent areas of Nevada and Utah resulted from a combination of prolonged low-intensity rainfall, moderate amounts of snow on low-altitude areas, a period of high temperatures, and a glaze of ice over deeply frozen ground. The floods affected some of the most valuable agricultural land in the region and some of the most heavily populated areas in Idaho. Damage in Idaho was estimated at more than $7 million.

The floods in Kentucky and Tennessee were caused by two storms; precipitation exceeded 7 inches at places during the second storm. Damage in Kentucky totaled about $7 million.

Recordbreaking snowmelt floods occurred in March and April in southeastern South Dakota and adjacent areas. Many peak discharges were much greater than those that can be expected to occur on an average of once in 25 years. Peak discharges on the Floyd River and the Big Sioux River were the greatest snowmelt floods since 1881. Damage in South Dakota was estimated at $4 million.

Heavy rains during May and intense rains in early June caused flooding in Minnesota on tributaries of the Red River of the North. Peak discharges exceeded previous maximums at some areas in the basins of the Buffalo, Clearwater, and Wild Rice Rivers. Damage from the floods of May and June in Minnesota was about $5 million.

The greatest flood since 1920 in Rapid City, S. Dak., caused about $600,000 damage in July. The great runoff of 3,300 cubic feet per second, from a relatively small area downstream from Pactola Reservoir, resulted from rainfall having an intensity greater than that for a 100-year recurrence interval.

Floods caused almost $3 million damage in three river basins in western Florida in September. The greatest damage was in Sarasota where from 3 to 7 feet of water flooded homes and stores. About 70,000 acres of farmland and woodland was inundated.

Unusual floods of September in southern Arizona flooded areas up to 10 miles wide. Damage, which totaled about $3 million, was almost entirely to farms, as the flood area is sparsely populated.

In addition to the floods just mentioned, 15 others of lesser magnitude are considered outstanding enough to be included in this annual summary.

INTRODUCTION

This report summarizes information on outstanding floods in the United States during 1962. The floods selected were unusual hydrologic events in which large areas were affected, great damage resulted, or record-high discharges or stages occurred, and sufficient data were available for the preparation of a report.

Figure 1 shows the location of the areas for which flood events in 1962 are described and the months (time distribution) in which the floods occurred.

A flood is any high streamflow which overtops natural or artificial banks of a stream. By popular definition a flood is a newsworthy discharge or stage of extremely high water that inundates a large area and causes much damage or great loss of life. In a hydrologic sense, however, an outstanding flood need not be newsworthy and may be one of which only a few or possibly no persons are aware. An outstanding flood is a rare flood; one which will not often be duplicated at a given site. An unusually rare flood on an unoccupied or nonutilized flood plain would be little noticed by the public, but to the hydrologist it could be an event of great interest.

Floods result from the combined effects of meteorologic events and physiographic characteristics of a basin. The principal physiographic factors that affect flood flows are drainage area, altitude, geology, vegetation, and basin shape, slope and aspect. With the exception of vegetation, which varies seasonally, these factors are fixed for any area.

Meteorologic factors, of which precipitation is the principal one, are variable with respect to both place and time. Other meteorological factors influencing floods are form of the precipitation (rain, snow, hail, or sleet), amount and intensity of the precipitation, moisture conditions of the soil before the flood-producing precipitation, and temperature which may cause soil to freeze or which may determine the rate of snowmelt. In general, the meteorological conditions determine when and where the floods will be, but the combination of magnitude and intensity of meteorologic factors and the effect of inherent physiographic features on runoff determine the magnitude of a flood.

Many different and variable factors form innumerable combinations to produce floods of all degrees of severity. Of two floods with equal peak discharges from drainage areas of different size (if both sites are assumed to have similar runoff and climatologic characteristics), the one from the smaller drainage area would be the rarer, or the more outstanding, flood. Also, of two floods having equal discharges from equal drainage areas, the rarer flood would be that at the site having geographic and climatologic characteristics which normally produce the smaller flood peak.

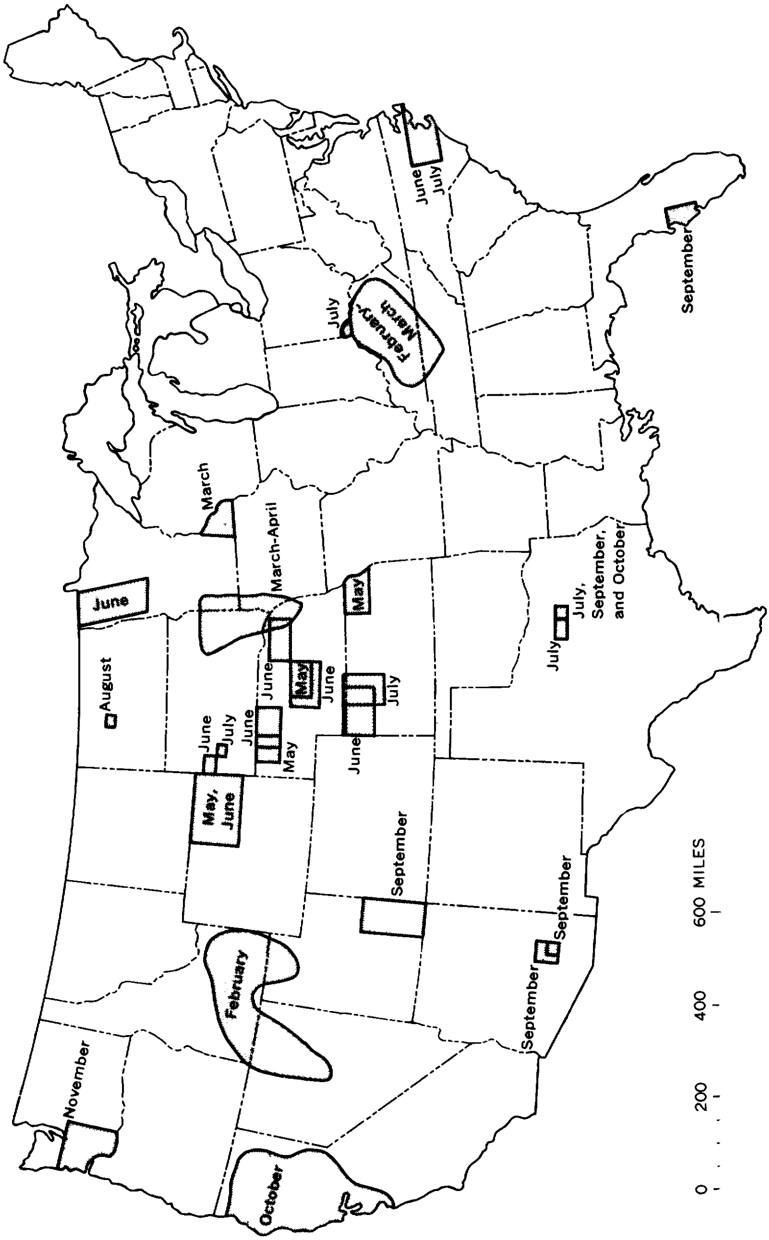


FIGURE 1.—Areas and months of occurrence of outstanding floods in 1962 in conterminous United States.

The severity and prevalence of floods are not wholly determined by the absolute values of the contributing factors—amount and intensity of rainfall, peak discharge, volume of runoff, ratio of runoff to rainfall, and many others—but are greatly influenced by the values of these factors relative to normal conditions.

Losses from floods in the United States during 1962 ($75 million) were the smallest since 1956 and were only about 21 percent of the national annual average of $350 million, based on the 10-year period 1950–59, adjusted to the 1959 price index.

Total loss of life due to floods in 1962 was 19 compared with 52 in 1961 and was much less than the national annual average of 80 lives during the 38-year period 1925–62.

Many of the flood reports give the amount of rainfall and the duration of the storm producing the rain. Recurrence intervals of these storms may be determined from information given by the U.S. Weather Bureau (1961) or from a simplified set of isopluvial maps and charts contained in a report by Rostvedt (1965).

Continuing investigation of surface-water resources in the areas covered by this report is performed by the U.S. Geological Survey in cooperation with State agencies, the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and other Federal or local agencies. Collection of data, computations, and some of the preparation of text were done by the district offices in whose district the floods occurred. Some data were obtained from U.S. Weather Bureau publications.

DETERMINATION OF FLOOD STAGES AND DISCHARGES

Data concerning peak stages and discharges at stations in this report are those which are regularly obtained and compiled in surface-water investigations by the U.S. Geological Survey.

Stream discharges at gaging stations are usually determined by application of a stage-discharge relation to a known stage. The relation at a station is usually defined by current-meter measurements through as much of the range of stage as possible. However, peak discharge at a station may be above the range of the computed stage-discharge relation, and short extensions may be made to the graph of the relation by logarithmic extrapolation, velocity-area studies, or the use of other measurable hydraulic factors.

Peak discharges that are greatly above the range of the stage-discharge relation at gaging stations, and peak discharges at miscellaneous sites, are generally determined by various methods using indirect measurements. During major floods, adverse conditions often make it impossible to obtain current-meter measurements at some sites.

Peak discharges are then measured after the flood has subsided, by indirect methods, based on detailed surveys of selected channel reaches. A general description of these indirect methods was given by Corbett and others (1943), and more detailed descriptions with illustrated examples are contained in reports by Johnson (1936) and Dalrymple (1937, 1939).

EXPLANATION OF DATA

The floods described herein are in chronological order. The data include a description of the storm, the flood, and the resulting damage; a map of the flood area showing the location of flood-determination points, and, for some storms, the location of precipitation stations or isohyets; rainful amounts and intensities; and flood-peak stages and discharges of the streams affected.

When considerable rainfall data are available, they are presented in tabular form and show daily or storm totals. When sufficient data are available to determine the pattern and distribution of rainfall, an isohyetal map is shown.

A summary table of peak stages and discharges is given for each flood unless the number of stations in the report is small, and then the information is included in the text description.

In the summary table the first column under maximum floods shows the period of known floods prior to the 1962 floods. This period does not necessarily correspond to that in which continuous records of discharge were obtained, but the period may extend back to an earlier date. More than one period of known floods are shown for some stations. A period is shown whenever it can be associated with a maximum stage, even though the corresponding discharge may not be known. A second period of floods is then given in which maximums of both discharge and stage are known.

The second column under maximum floods shows the year, within the period of known floods, in which the maximum stage or discharge occurred. The third column gives the date of the peak stage or discharge of the 1962 flood.

The last column gives the recurrence interval for the 1962 peak discharge. The recurrence interval is the average interval, in years, in which a flood of a given magnitude (the 1962 peak) will be equaled or exceeded once as an annual maximum. A flood having a recurrence interval of 20 years can be expected to occur, on the average, once in 20 years, or it is one that has a 5-percent chance of occurring in any year. The recurrence intervals in the tables were obtained from U.S. Geological Survey reports on flood magnitude and frequency. In nearly all flood-frequency reports used, the data that are available limit the determination of recurrence intervals to 50 years; in some reports, to less than 50 years. The severity of a flood whose recurrence interval exceeds the limit of determination is expressed as the ratio of the peak discharge of the flood to the discharge of the flood that has a recurrence interval equal to the limits of determination.

SUMMARY OF FLOODS

FLOODS OF FEBRUARY IN SOUTHERN IDAHO AND NORTHERN NEVADA AND UTAH

By Cecil A. Thomas and Robert D. Lamke

The floods of February in southern Idaho and northern Nevada and Utah were the highest floods known in parts of the area and the most devastating in recent times. The flood area encompasses some of the most valuable agricultural and ranching lands in these States and some of the most heavily populated areas in Idaho.

The floods resulted from an unusual combination of conditions: prolonged low-intensity rainfall, moderate amounts of snow on low-altitude areas, warm days and nights, and a glaze of ice over deeply frozen ground. Total rainfall for the period February 7–12 is shown in figure 2.

Temperatures, rainfall, and snow on the ground during January and February at Elko, Nev., and 46 miles west of Idaho Falls, Idaho, are shown in figure 3. These sites, at opposite ends of the flood area, are in areas that were intensely flooded, and the weather conditions that existed at these sites were similar to those that existed throughout the flood area.

The antecedent weather had a marked effect on the flood. Temperatures were 2°–3°F below normal during October, November, and December. The monthly mean temperature for January were 4°–9° below normal. Alternate freezing and thawing of the existing light cover of snow occurred in December and early January and transformed the snow into a mantle of ice. Flooding occurred on January 8 in Goose Creek basin and other small basins in southern Idaho when light rain fell on these basins and temperatures remained above freezing for about 48 hours. In most low-altitude basins, this short-lived thaw produced little runoff, but it melted and settled the snow. The snow then froze quickly when the temperature dropped sharply on January 9. This freeze increased the depth of frost and ice that covered the ground.

Subfreezing temperatures continued from January 9 until the end of January. Temperatures were especially low January 20–25, when below-zero temperatures during the night and below-freezing temperatures during the day were general. For example, minimum readings of −40°F were recorded during this period near Idaho Falls, and readings of −20° were recorded near Elko. These low temperatures froze the ground under the light cover of snow to a depth of as much as 3 feet. The temperatures then moderated during late January and early February.

Prolonged rain of low intensity fell during the period February 7–12. The amounts measured at Weather Bureau gages ranged from half an inch to about 3 inches in southern Idaho and from half an inch to about 2 inches in northeastern Nevada. Snow fell at higher altitudes. In some areas heavy rainfall occurred, but other factors that would contribute to flooding were absent. The greatest total rainfall measured within the flood areas was 2.91 inches at Ashton, 65 miles northeast of Idaho Falls. In Nevada the maximum was 1.96 inches at Charleston, 60 miles northeast of Elko. The greatest daily rainfalls recorded were 1.06 inches on February 10 at Charleston and 0.90 inch on February 12 at Preston, 60 miles southeast of Pocatello, Idaho. The heaviest hourly rainfall recorded in Nevada was 0.15 inch south of Elko. These amounts of rainfall are small and could occur, on the average, once every 2 years, according to the U.S. Weather Bureau (1961).

The moderation in temperature that began in late January culminated in minimum temperatures of 20°F or higher from February 9 through the flood period. The daytime temperatures were above freezing—up to 50° or higher. The rains and the warm weather melted most of the shallow snow on low-altitude areas. The snow ranged in depth from zero at 4,500 feet to 1 foot at 6,700 feet in Nevada, and from zero to 3 feet at the upper limits of the flood-generation zone in Idaho; deeper snow at higher altitudes did not melt.

The rain and melted snow ran off rapidly because the frozen ground prevented infiltration, and this condition resulted in floods that rose unusually rapidly and that had unusual magnitudes.

Damaging recordbreaking floods occurred in valleys and along streams tributary to the Snake River from St. Anthony as far downstream as King Hill, and in the Bear River basin and Curlew Valley in the Great Basin in Idaho. Flooding occurred in adjacent watersheds in Nevada, including those of the upper Bruneau, Humboldt, and Owyhee Rivers. Discharges were the highest known on many streams in each State. Many of the floodflows have recurrence intervals of more than 50 years.

Runoff was most intense from watersheds ranging in altitude from 4,500 to 6,500 feet. Floods from small tributaries having large parts of their drainage within or near this range altitude rank among the highest winter floods recorded in Idaho. Because of deeper snow and unfrozen ground, little or no runoff occurred at altitudes above 7,000 feet.

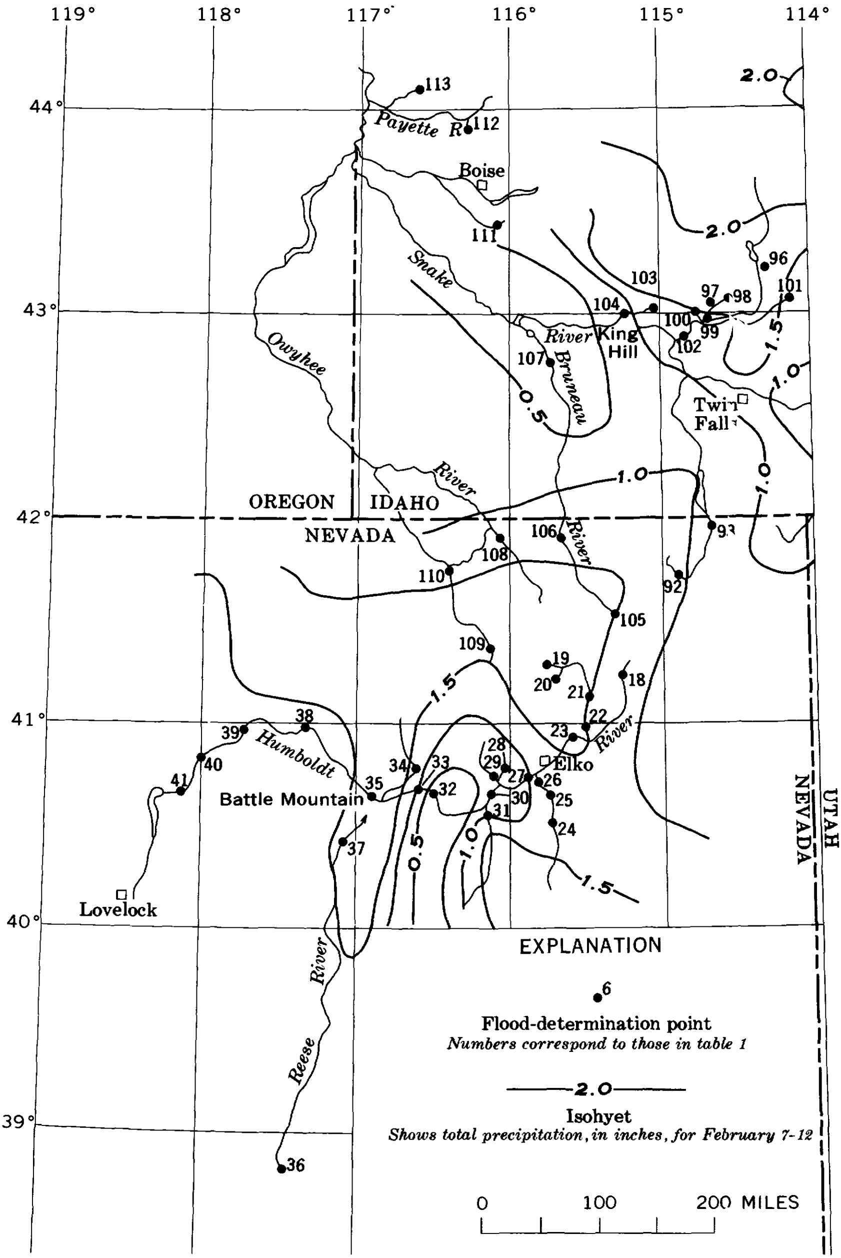
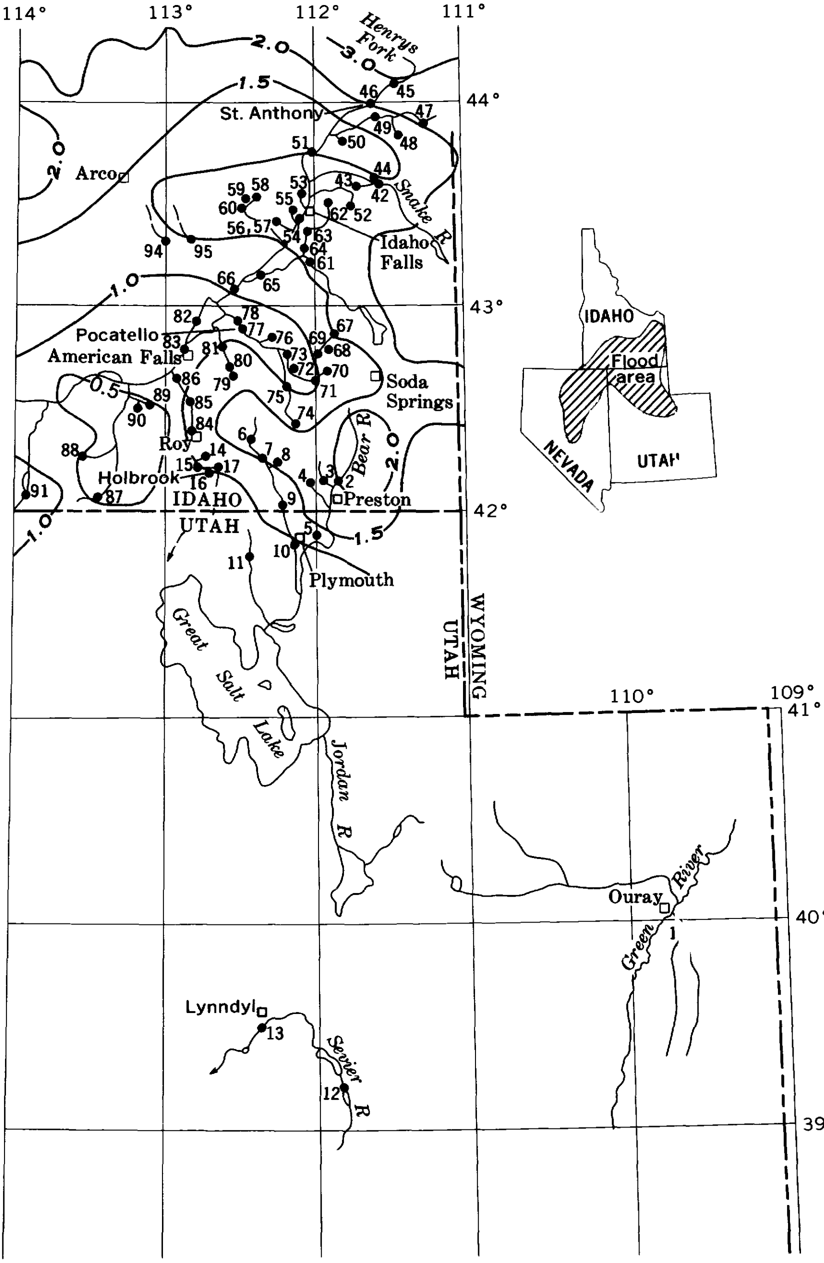


FIGURE 2.—Location of flood-determination points, and isohyets for



February 7–12, floods in southern Idaho and northern Nevada and Utah.

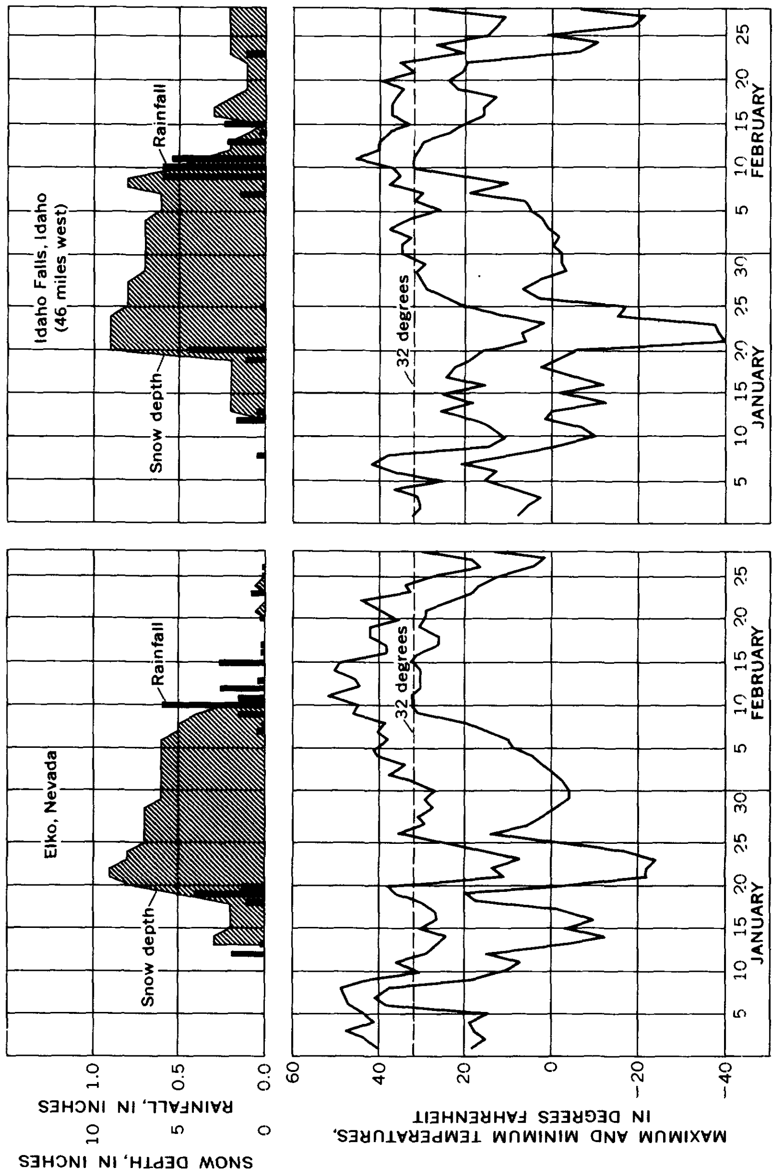


FIGURE 3.—Weather conditions for January and February 1962 at Elko, Nev., and west of Idaho Falls, Idaho.

Streams rose at rates unusually rapid for snowmelt floods, and some flooding occurred because of ice jams. Evacuation from urban and rural areas in Idaho was orderly, and no lives were lost by drowning. Damage was much lighter than if the floods had occurred after crops were planted. Water carried much less silt than it would have carried had the ground not be frozen.

In the following descriptions of the floods, basins are discussed in the downstream order used by the Geological Survey in annual surface-water reports. The descriptions are from Thomas and Lamke (1962).

BEAR RIVER BASIN AND CURLEW VALLEY, UTAH AND IDAHO

Floods occurred in the Malad River, in Deep Creek in Curlew Valley, and in the Bear River near Preston, Idaho, and near Collinston, Utah. The damage was minor along the Bear River. Idaho State Highway 37 from Roy to Holbrook was severely damaged and was closed for several weeks. Many bridges and road fills were washed away, and some of the principal roads were blocked for several days in both the Malad River valley and the Curlew Valley. Floodwater did considerable damage to farmland, farm buildings, crops, feed, and livestock.

The peak discharge of Malad River at Woodruff, Idaho (sta. 9, table 1) was 370 percent of the previous maximum in 24 years of record.

HUMBOLDT RIVER BASIN, NEVADA

The floods in the Humboldt River basin, entirely in Nevada, were limited to the upper part of the basin. The 1962 floods were greater than the 1952 floods in the part of the basin above Battle Mountain. In the lower Humboldt River basin the 1962 flood peaks had been exceeded eight or nine times in 50 years of record. A major flood occurred in February and March 1910 throughout the basin; the 1910 flood discharge of Humboldt River at Palisade (sta. 30) was about 2½ times the 1962 flood discharge.

Discharge hydrographs for the Humboldt River in figure 4 show the effects of storage caused by meanders and overflow below the Palisade gaging station. The first peak at the Palisade gaging station was caused by floodwaters from the South Fork Humboldt River, Maggie Creek, Susie Creek, and other smaller tributaries immediately upstream from Palisade, and the second peak, primarily by floodwaters from the North Fork Humboldt River and Marys River above Elko.

The floods on the Humboldt River and on all measured tributaries above Battle Mountain had recurrence intervals greater than 50 years. These floods were the highest recorded at all gaging stations in the upper Humboldt River basin; some stations have more than 50 years of record. The gaging station on North Fork Humboldt River at Devils

Gate, near Halleck, Nev. (sta. 21), had a flood five times greater than the 50-year flood.

The floods occurred mainly in ranching country, and some ranches lost cattle in the flood. Damage occurred to rural roads, but damage to the main highways was comparatively minor. Battle Mountain was flooded by the normally dry Reese River. U.S. Highway 40 and the Southern Pacific Railroad tracks were cut in Battle Mountain to allow Reese River floodwaters to subside. The small towns of Deeth and Beowawe had minor floods, and small sections of Elko and Carlin next to the Humboldt River were flooded. The damage in the Humboldt River basin was estimated at $1,500,000 by the U.S. Army Corps of Engineers, and the damage to the State highway system was estimated at $114,000.

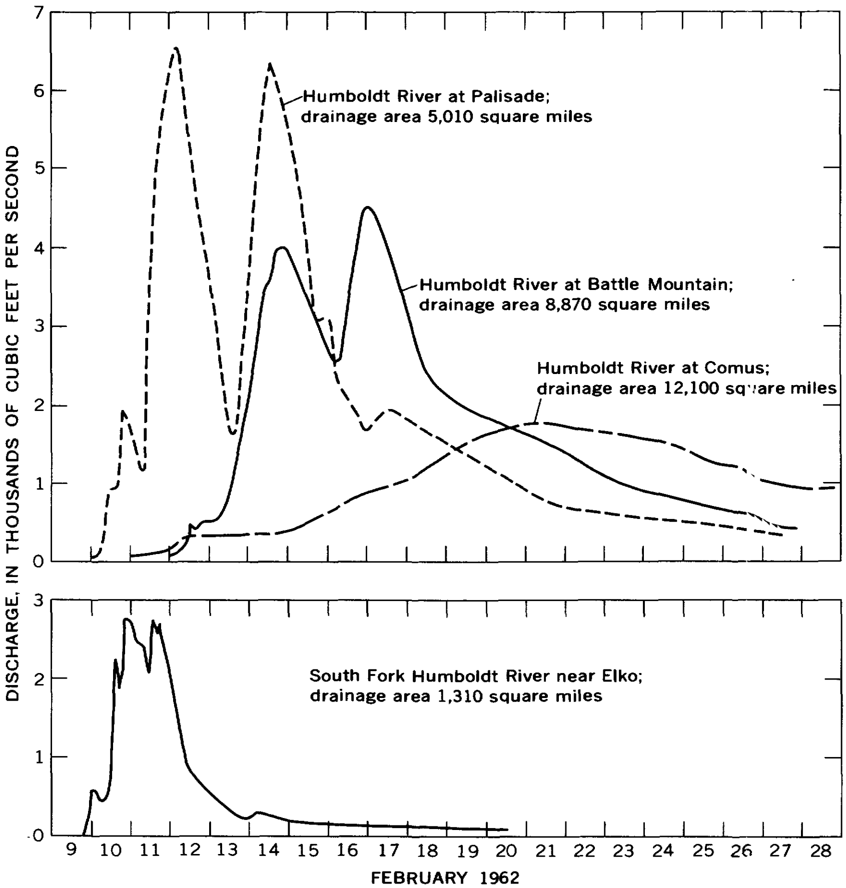


FIGURE 4.—Discharge hydrographs for gaging stations in the Humboldt River basin, Nevada.

HENRYS FORK, IDAHO

The floods in the Rexburg–Sugar City area resulted from unprecedented discharges in the Teton River and in Moody Creek, Lyons (Lyman) Creek, and other tributaries draining the hills to the east. Peak discharge of Teton River near St. Anthony (sta. 49) was nearly twice as high as the previous maximum in 52 years of record. No previous discharge records are available on Moody and Lyons Creeks, but local residents indicate that the flood was more severe than any other in more than 50 years. Considerable water also came from snowmelt and rain on the valley floor. Lyons Creek near Ririe (sta. 44) discharged 84 cfs per sq mi (cubic feet per second per square mile) from 18 square miles. A rate this high occurs only rarely in Idaho streams, except during thunderstorms. Natural channels and canals were clogged with ice as much as 2 feet thick. Ice jams and extremely high discharge resulted in flooding of large areas of valuable farmland and urban areas. Farmland, farmsteads, livestock, stored farm crops, roads, railroads, bridges, canals, and a great many residences in Rexburg, Sugar City, and Teton were damaged considerably. Flooding was not a problem on Henrys Fork above St. Anthony. Some flooding occurred in tributaries to the Teton River above Newdale.

IDAHO FALLS–BLACKFOOT LOWLANDS, IDAHO

The largest area inundated (56,500 acres) was in the lowlands from Ririe southwest toward Blackfoot, and damage totaled $3,185,000. The flood occurred as a result of rain and snowmelt on the valley floor and the adjacent foothills and of runoff in Willow, Birch, Henry, and Cedar Creeks and smaller tributaries. Much of the watershed adjacent to these lowlands was in the altitude range from which the greatest discharges were generated. Sand Creek tributary near Iona (sta. 62) discharged 123 cfs per sq mi from 9.8 square miles, the highest rate ever recorded by the Geological Survey for a winter flood in Idaho.

Large urban developments, agricultural improvements, farm and city dwellings, canals, roads, and railroads were flooded to depths up to 4 feet. Because natural drainage channels are interconnected with canals and diversion laterals in this intensely developed agricultural and industrial area, the flow patterns are complicated and ponding resulted, especially where ice jamming occurred. Canals flowed bankfull and many were overtopped. Some large canals prevented serious damage in heavily populated parts of Idaho Falls and other cities.

NORTH AND WEST OF THE SNAKE RIVER ABOVE AMERICAN FALLS, IDAHO

In most of the flooded areas north and west of the Snake River above American Falls, rain and snowmelt ordinarily infiltrate rapidly into the ground because the soils are loose and shallow and are underlain by porous lava. Thousands of acres of lava have little or no soil cover. Many rivers carry return flows most of the time. Overland flows are scarce over large acreages, especially in the area north and west of the Snake River between St. Anthony and American Falls. There are practically no well-defined channels running into the Snake River on the right bank. Recent lava flows are close to the surface, and water percolates rapidly into the ground under normal conditions. During the flood, the ground was frozen and was glazed with ice. Percolation was inhibited, and runoff occurred at rapid rates over large areas of the lava beds. The pockets of shallow soil scattered over the lava shed water at exceptionally rapid rates.

Residents report that the flows had not been exceeded in 40 years or more. Highways were overtopped, bridges and road fills were damaged, and scattered farms and farm improvements in low-lying areas were flooded.

BLACKFOOT RIVER BASIN, IDAHO

Even though Blackfoot River near Blackfoot (sta. 65) reached a discharge which was 60 percent greater than any peak previously recorded in 32 years of complete records plus 19 years of summer records, damage was comparatively light. Levees, built before the flood and reinforced during the flood, were highly successful in confining the flow within narrow limits.

PORTNEUF RIVER BASIN, IDAHO

Floodflows in the Portneuf River and tributaries greatly exceeded previously recorded maximums; some streams had records of more than 50 years. Highly developed areas at Bancroft, Lava Hot Springs, Pocatello, and, to a lesser degree, Inkom, were severely damaged by the floodwaters.

Practically the entire town of Bancroft was under several feet of water for days. Flow from the surrounding hills and lowlands entered the town much faster than the drainage channels carried it away. Residences, commercial buildings, livestock, highways, railroads, and stocks of grain, feed, groceries, and other commodities were damaged.

Lava Hot Springs was hard hit by the fast-flowing Portneuf River, and damage to buildings, roads, and railroads in the resort town of 593 inhabitants was estimated at more than $1 million. The Union Pacific Railroad and highways were severely damaged by the raging waters between Bancroft and Pocatello. When a fill on U.S. Highway 30 washed out, discharge at the gaging station at Topaz (sta. 71), 2 miles downstream, increased from 2,850 cfs to 6,140 cfs in 1½ hours (fig. 5). The surge overtopped railroad fills, canal headings, and roads downstream and caused heavy damage.

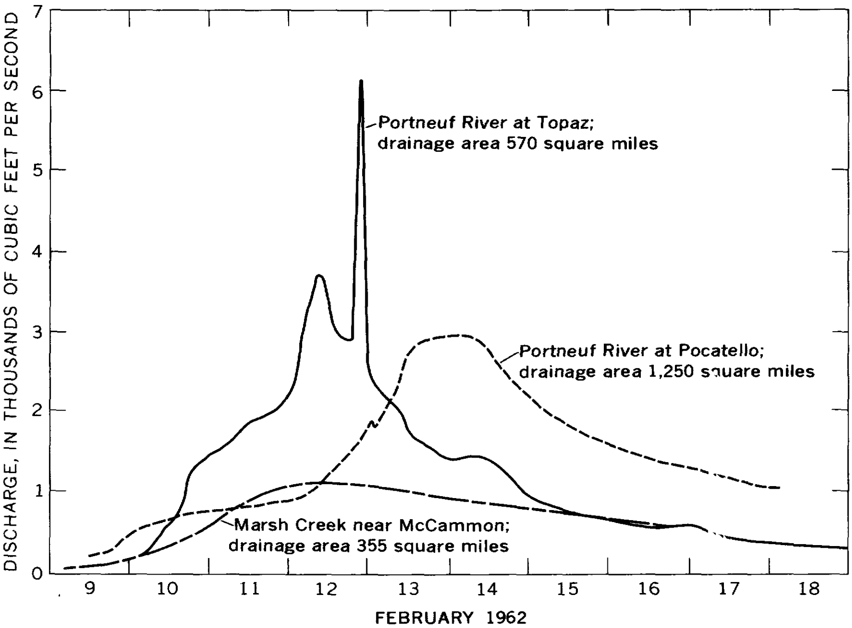


FIGURE 5.—Discharge hydrographs for gaging stations in the Portneuf River basin, Idaho.

Discharge of the natural peak at Portneuf River at Topaz (sta. 71) was 3,700 cfs which is more than 260 percent greater than the previously recorded maximum in 45 years of record; but the flood that occurred after the highway fill broke was much greater. A flood of the magnitude of the natural peak has a recurrence interval of much more than 50 years. This rare discharge was probably caused by the ice and frost glaze over the watershed upstream, as normally, the thin soil over the lava flows in the Bancroft area absorbs the free water before runoff is generated.

The discharge of 2,990 cfs at Pocatello (sta. 77) was less than the sum of the peaks on Marsh Creek and Portneuf River at Topaz because much water was ponded along the river bottom above Pocatello. Channel and valley storage probably prevented a major catastrophe in Pocatello, where the waterway is incapable of passing large flows through the city. Many houses, roads, bridges, and the large switch yards of the Union Pacific Railroad in and near the city were flooded. As in several other localities, a major and timely effort by volunteer helpers, by the Idaho National Guard, and by the U.S. Army Corps of Engineers prevented more serious damage to much valuable property. In Pocatello, workers placed about 12,000 lineal feet of sandbag dikes averaging 2½ feet high. Frequency studies at Pocatello indicate that the recurrence interval of the 1962 flood is more than 50 years.

Damage in the Portneuf River basin was greater than in any other area, because railroads and highways are crowded into narrow canyons and were directly in the path of the swollen, swiftly flowing streams, and Lava Hot Springs and Pocatello are built close to the river channel. During many flood-free years, developments had gradually encroached on the flood plains of many streams in the basin.

SOUTHSIDE TRIBUTARIES OF THE SNAKE RIVER BELOW PORTNEUF RIVER, IDAHO AND NEVADA

Severe flooding occurred in the Bannock Creek and Rock Creek basins. Discharges were unusually high, but damage was limited to roads and bridges. Population is sparse in these basins, and lack of development accounted for low damage. Damage in the two basins was about $90,000. Roads were inundated and several bridges were washed away. U.S. Highway 30N, which crosses the streams near their mouths, was damaged extensively, and the highway fills were nearly lost. Although discharge records are sparse in these basins, available records indicate that this flood has a recurrence interval of more than 50 years.

The Raft River flooded only moderately, but some tributaries had high flows.

Goose Creek above Oakley Reservoir reached stages above previous maximums, and Salmon Falls Creek flooded but did not peak as high as during the flood of 1943. The basins of these streams are thinly populated and underdeveloped, and damage was light.

The Bruneau River flooded near its headwaters in the Charleston area in Nevada. Damage occurred to roads and bridges, and the dam impounding Charleston Reservoir failed. The roads along the Bruneau River were washed away in at least three places. Field inspection, rainfall records, and reports of residents indicated that floods in the Bruneau River basin south of the Idaho-Nevada line were unusually high; the recurrence intervals are probably more than 50 years. Floods occurred north of the Idaho-Nevada border, but those were not noteworthy because the snow cover was less and because only moderate rains fell in that area.

Flooding in the Owyhee River basin was moderate and was limited to the drainages in Nevada.

BIG WOOD RIVER AND CLOVER CREEK BASINS, IDAHO

Flooding in the Little Wood River basin caused damage estimated at $155,000. Although the flow from the adjacent foothills was very high, a large part of the damage was due to water forced out of the river channel by ice jams. Thorn Creek and Dry Creek, which enter the Big Wood River north of Gooding, were extremely high. The Big Wood River crested near the maximum of record even though gates were closed at Magic Reservoir. The magnitude of the flood from the low-altitude tributaries at the lower end of the Big Wood River basin was unusual and probably has a recurrence interval of more than 50 years. Damage was limited to flooding of farmland and erosion of road fills and bridge approaches.

Clover Creek near Bliss (sta. 103) also reached a peak flow of unusual magnitude. Records there cover a short period, but it appears that this flood has at least a 50-year recurrence interval. Damage was slight because the creek flows through a ranching area.

SNAKE RIVER MAIN STEM, IDAHO

Flooding in the Snake River main stem was minor. Peaks were well below previously recorded maximums. Island Park, Jackson Lake, Palisades, Blackfoot-Marsh, American Falls, and Chesterfield Reservoirs either were closed or released only normal flows during the flood period, so that the discharges downstream were moderated.

BASINS IN UTAH

In addition to floods described by Thomas and Lamke (1962), other floods that occurred in three small scattered areas in Utah are considered to be associated with those in the main flood area. The floods were caused by rain on frozen ground, and the floodwaters were augmented by snowmelt in the Ouray and Plymouth areas. Because of the sparsity of rain gages, the rainfall reported may not be representative of the amounts of rain that actually fell.

At Ouray 0.10 inch of precipitation was recorded on Feburary 12, and the temperature reached a maximum of 54° F. The estimated peak discharge in Willow Creek near Ouray (sta. 1; drainage area, 890 sq mi) was 11,000 cfs, which is about three times that of a 50-year flood. The floodwaters carried considerable ice. Two bridges, a diversion dam, and a stream-gaging station on Willow Creek were destroyed.

About 0.3 inch of precipitation was recorded near Snowville. The peak discharge in Blue Spring Creek near Snowville (sta. 11) was greater than that of a 50-year flood. The peak discharge in Malad River near Plymouth (sta. 10) was about 3.5 times that of a 50-year flood even though part of the drainage area was noncontributing because of reservoir storage. Some farmland was flooded; canals and irrigation ditches were filled with silt. Many small gullies were cut in the dry-farm wheatland during the recession of the flood, after the soil had thawed to a depth of 5 or 6 inches, and about 5 percent of the wheat crop was destroyed. Some bridges on secondary roads were washed out or badly damaged, and roadfills were eroded in several places.

At Oak City (10 miles south of Lynndyl) 0.21 inch of precipitation was recorded on February 9 and 0.04 inch on February 10. The peak discharge in Sevier River was 1.7 times that of a 50-year flood. Damage was limited to inundation of several farms near Lynndyl.

FLOOD DAMAGE

The U.S. Weather Bureau estimated that the damage in Idaho was about $7.5 million. Damage in Nevada was much less, and that in Utah was relatively small.

The flood was probably the most damaging ever experienced in these river basins, as new residences, highways and bridges, commercial and industrial developments, and railroad improvements had greatly increased property valuations since the time of previous floods. The 1962 stages were higher in many places than at any time since the area was settled. Damage prevented by floodfighter crews was estimated at $1.8 million.

The damage in Nevada was less than in Idaho because most of the Nevada flood area is primarily ranchland with few improvements. The damage was limited mainly to loss of cattle, rural roads, and irrigation structures. Damage to railroads and main highways was slight. Only one town in Nevada, Battle Mountain, was inundated.

Flood stages and discharges at sites shown in figure 2 are summarized in table 1. The data in the last column show recurrence intervals up to 50 years, the limit to which the recurrence intervals are defined in the report area. If the recurrence interval is greater than the defined limit, the recurrence interval of the peak discharge is listed as more than 50 (>50) years.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962, Period	Maximum floods: Prior to February 1962, Year	Maximum floods: February 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge, Cfs	Maximum floods: Discharge, Recurrence interval (years)
	Green River basin							
1	Willow Creek near Ouray, Utah.	890			12	17.73	11,000	>50
	Bear River basin							
2	Bear River near Preston, Idaho.	4,500	1889–1962	1907			8,500	
				1917		(1)		
			1943–62	1950		5.61	4,420	
					12	5.51	4,240	5
3	Battle Creek tributary near Treasureton, Idaho.	4.5			11	11.17	81	(1)
4	Deep Creek near Clifton, Idaho.	120			13		180	>50
5	Bear River near Collinston, Utah.	6,000	1889–1962	1909		(1)	11,600	
					14	8.23	[2] 9,710	15
6	Little Malad River above Elkhorn Reservoir, near Malad, Idaho.	120	1911–13, 1931–32, 1940–62.	1955		3.63	351	
					10	4.85	1,450	>50
7	Little Malad River below Sand Ridge damsite, near Malad, Idaho.	226	1945–51	1948		9.6	[3] 240	
					11		1,720	
8	Devil Creek 2 miles northwest of Malad City, Idaho.	45	1932–43, 1946–53.	1952			[4] 261	
					11		193	5
9	Malad River at Woodruff, Idaho.	485	1938–62	1943		8	650	
					12	8.93	2,530	>50
10	Malad River near Plymouth, Utah.	616			11		3,240	>50
	Tributary to Great Salt Lake							
11	Blue Spring Creek near Snowville, Utah.	180			12		1,820	>50
	Sevier River basin							
12	Sevier River below San Pitch River near Gunnison, Utah.	4,880	1917–62	1922		5.68	2,620	
					10	5.40	1,290	10
13	Sevier River near Lynndyl, Utah.	6,270	1914–19, 1942–62.	1914			[5] 1,820	
					10	11.73	2,980	>50
	Curlew Valley tributaries							
14	Deep Creek 7 miles north of Holbrook, Idaho.	72			11		1,220	>50
15	Rock Creek 7 miles north of Holbrook, Idaho.	42			11		1,390	>50
16	Rock Creek at State Highway 37 crossing, at Holbrook, Idaho.	93			10		1,630	(1)
17	Wood Canyon at State Highway 38 crossing 3½ miles northeast of Holbrook, Idaho.	1.3			10		29	(1)

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Prior to February 1962: Year	February 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Humboldt River basin							
18	Marys River above Hot Springs Creek, near Deeth, Nev.	415	1943–62	1952		6.57	1,250	
					12	7.63	4,210	>50
19	Jim Creek at State Highway 43, near Tuscarora, Nev.	25			10		541	(1)
20	Pie Creek at State Highway 43, near Tuscarora, Nev.	70			10		1,380	(1)
21	North Fork Humboldt River, at Devils Gate near Halleck, Nev.	830	1913–21, 1943–62.	1952		9.63	2,450	
					11	16.12	1[illegible],400	>50
22	North Fork Humboldt River, near mouth, near Halleck, Nev.	960			13		5,220	>50
23	Humboldt River near Elko, Nev.	2,800	1895–1902, 1944–62.	1952		9.60	3,860	
					13	12.3	7,070	>50
24	Huntington Creek near Lee, Nev.	770	1948–62	1952		6.54	1,210	
					10	7.99	2,160	(1)
25	South Fork Humboldt River above Dixie Creek near Elko, Nev.	1,150	1948–62	1952			1,700	
				1957		5.58		
					11	7.2	2,760	(1)
26	South Fork Humboldt River near Elko, Nev.	1,310	1896–1909, 1911–32, 1936–62.	1914		(1)	[5] 2,400	
					11	8.00	2,830	(1)
27	Humboldt River near Carlin, Nev.	4,310	1943–62	1943		9.8	5,900	
					14	10.21	6,160	>50
28	Susie Creek at Carlin, Nev.	194	1943	1943			[6] 1,900	
					11		1,980	(1)
29	Maggie Creek at Carlin, Nev.	400	1913–24, 1943.	1943			[7] 12,000	
					12		2,440	(1)
30	Humboldt River at Palisade, Nev.	5,010	1902–62	1910		17	17,000	
					12	10.0	6,610	>50
31	Pine Creek near Palisade, Nev.	1,000	1912–14, 1946–58.	1952		4.69	1,010	
					11	8.51	3,140	>50
32	Humboldt River at Dunphy, Nev.	7,470			12		7,620	>50
33	Humboldt River near Argenta, Nev.	7,490	1946–62	1952		(1)	5,700	
					15	10.78	6,000	>50
34	Rock Creek near Battle Mountain, Nev.	875	1918–25, 1927–29, 1945–62.	1952		5.60	3,000	
					11	6.89	4,800	>50
35	Humboldt River at Battle Mountain, Nev.	8,870	1896–97, 1921–23, 1945–62.	1952		(1)	[5] 5,800	
					17	9.66	4,600	(1)
36	Reese River near Ione, Nev.	44	1951–62	1956		4.86	512	
					11	2.02	210	3
37	Reese River at State Highway 84, near Battle Mountain, Nev.	2,200			12, 13		4,760	(1)
38	Humboldt River at Comus, Nev.	12,100	1894–1926, 1946–62.	1952		11.52	5,860	
					21	9.91	1,740	5
39	Humboldt River near Winnemucca, Nev.	(1)			28	8.32	1,160	5
40	Humboldt River near Rose Creek, Nev.	15,200	1948–62	1952		11.41	5,810	
					March 2	5.06	922	5
41	Humboldt River near Imlay, Nev.	15,700	1935–41, 1945–62.	1952		12.15	6,080	
					March 3	6.17	814	5

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Maximum floods: Prior to February 1962: Year	Maximum floods: February 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Snake River main stem							
42	Snake River near Heise, Idaho.	5,752	1910–62	1927	--------	16.0	[8]60,000	--------
			--------	--------	12	2.52	[2]3,940	1
	Birch Creek basin							
43	Birch Creek 3.5 miles southwest of Heise, Idaho.	21	--------	--------	11	--------	988	>50
	Lyons Creek basin							
44	Lyons (Lyman) Creek 4.5 miles northeast of Ririe, Idaho.	18	--------	--------	11 or 12	--------	1,560	>50
	Henrys Fork basin							
45	Henrys Fork near Ashton, Idaho.	1,040	1890–91, 1902–09, 1920–62.	1925	--------	(1)	6,220	--------
			--------	--------	11	6.09	[2]1,210	--------
46	Henrys Fork at St. Anthony, Idaho.	1,770	1919–62	1925	--------	6.78	[9]9,030	--------
			--------	--------	12	4.69	[2]3,180	1
47	Milk Creek at Highway 33 near Tetonia, Idaho.	18	--------	--------	11 or 12	7.72	179	>50
48	Canyon Creek at Highway 33 near Clementsville, Idaho.	76	--------	--------	11 or 12	--------	814	>50
49	Teton River near St. Anthony, Idaho.	890	1890–93, 1903–09, 1920–62.	1893	--------	(1)	5,830	--------
			--------	--------	12	9.36	10,600	>50
50	Moody Creek at railroad crossing 0.4 miles south of Moody, Idaho.	88	--------	--------	11 or 12	--------	[10]2,700	>50
51	Henrys Fork near Rexburg, Idaho.	2,920	1909–62	1927	--------	--------	[5]9,490	--------
			--------	--------	14	[11]10.02	[2]7,100	4
	Willow Creek basin							
52	Willow Creek 6 miles southeast of Ririe, Idaho.	622	1903–04, 1916–25, 1928.	1917	--------	16.3	4,200	--------
			--------	--------	11	15.0	5,080	>50
	Snake River tributary basin							
53	Snake River tributary No. 2 at Interstate Highway 1.5 miles east of Osgood, Idaho.	[12]8.74	--------	--------	11	--------	83	>50

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to February 1962		February 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
Snake River main stem								
54	Snake River near Shelley, Idaho.	9,790	1894	1894		([1])	75,000	
			1915–62	1918		16.97	47,200	
					14	8.00	9,790	1
Tributaries to Snake River between Shelley and Blackfoot								
55	Snake River tributary 2.2 miles west of Osgood, Idaho.	7.6			11	12.4	387	>50
56	Snake River tributary No. 3 at U.S. Highway 20 crossing 10.6 miles west of Idaho Falls, Idaho.	16			11		632	>50
57	Snake River tributary No. 3a at U.S. Highway 20 crossing 11 miles west of Idaho Falls, Idaho.	3.5			11		120	>50
58	Snake River tributary No. 4 at U.S. Highway 20 crossing 16.5 miles west of Idaho Falls, Idaho.	2.0			11		270	>50
59	Snake River tributary No. 5 at U.S. Highway 20 crossing 20.5 miles west of Idaho Falls, Idaho.	5.2			11		114	>5
60	Snake River tributary No. 6 along U.S. Highway 26 above Peoples Canal 4 miles northwest of Moreland, Idaho.	64			11 or 12		1,540	([1])
Blackfoot River basin								
61	Blackfoot River near Shelley, Idaho.	[13] 909	1910–50	1923		6.30	1,830	
					12		1,600	>50
62	Sand Creek tributary 2.1 miles southeast of Iona, Idaho.	9.8			11		1,210	>50
63	Henry Creek 6 miles south of Ammon, Idaho.	29			11		716	>50
64	Cedar Creek 1 mile east of Goshen, Idaho.	10.5			11		194	>50
65	Blackfoot River near Blackfoot, Idaho.	[13] 1,295	1913–62	1960		6.42	1,070	
					11	7.68	1,710	>50
Snake River main stem								
66	Snake River near Blackfoot, Idaho.	11,310	1910–62	1918		14.8	46,200	
					15	7.14	[2]12,600	1

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Prior to February 1962: Year	February 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Portneuf River basin							
67	Portneuf River tributary 1 mile northwest of Bancroft, Idaho.	130			12		473	>50
68	Portneuf River tributary No. 2, 2½ miles north of Pebble, Idaho.	[14]			11 or 12		1,150	>50
69	Portneuf River 6½ miles northwest of Bancroft, Idaho.	332			11 or 12		2,380	>50
70	Fish Creek 4 miles east of Lava Hot Springs, Idaho.	16.1			11 or 12		54	5
71	Portneuf River at Topaz, Idaho.	570	1913–15, 1919–62.	1957		5.71	1,040	
					12	7.83	[15] 6,140	>50
72	Robbers Roost Creek near McCammon, Idaho.	5.7	1961–62	1961		6.90	6	
					10	7.15	10	1
73	Portneuf River at railroad bridge 1.1 miles southeast of Inkom, Idaho.	650			13		4,380	>50
74	Marsh Creek at Highway 191, 2.5 miles southeast of Downey, Idaho.	68			12		573	>50
75	Marsh Creek near McCammon, Idaho.	355	1954–62	1958		6.72	416	
					12	13.25	1,120	>50
76	Gibson Jack Creek 5 miles southeast of Pocatello, Idaho.	10.3					57	>50
77	Portneuf River at Pocatello, Idaho.	1,250	1897–99, 1911–62.	1917		[1]	2,000	
					14	11.35	2,990	>50
78	Portneuf River at county bridge 5 miles northeast of Pocatello, Idaho.	1,290			14		2,970	>50
	Bannock Creek basin							
79	Bannock Creek near Pocatello, Idaho.	230	1955–58	1957		7.00	675	
					11	10.6	4,130	>50
80	Rattlesnake Creek near mouth, near Pocatello, Idaho.	78			11 or 12		1,170	>50
81	Bannock Creek at Highway 30 near Pocatello, Idaho.	413			11		4,010	>50
	Snake River main stem							
82	Inflow to American Falls Reservoir, Idaho	13,580			13, 14		[5] 14,600	
83	Snake River at Neeley, Idaho.	13,600	1906–62	1918		[1]	[5] 48,400	
					15	2.37	[15] 497	1
	Rock Creek basin							
84	Rock Creek 2.5 miles north of Roy, Idaho.	96			11		1,770	>50
85	Rock Creek above East Fork at Rockland, Idaho.	216	1955–60	1960		6.21	[16] 275	
					11		2,120	>50
86	Rock Creek at mouth near American Falls, Idaho.	320			11		3,300	>50

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Prior to February 1962: Year	February 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Raft River basin							
87	Raft River at Peterson Ranch, near Bridge, Idaho.	412	1946–53, 1955–62.	1951	----	4.52	1,090	----
			----	----	11	4.14	669	25
88	Cassia Creek near Elba, Idaho.	84	1956–62	1957	----	4.61	233	----
			----	----	11	4.71	253	(1)
89	Heglar Creek below North and South Heglar Canyons, near Rockland, Idaho.	45	----	----	11	----	153	>50
90	Heglar Canyon tributary below North and South Heglar Canyons near Rockland, Idaho.	7.7	1958–62	1958	----	7.6	1,930	----
			----	----	11	6.02	137	>50
	Goose Creek basin							
91	Goose Creek above Trappers Creek, near Oakley, Idaho.	633	1911–16, 1919–62.	1943	----	7.6	1,670	----
			----	----	11	9.3	3,240	>50
	Salmon Falls Creek basin							S
92	Salmon Falls Creek above upper Vineyard ditch near Contact, Nev.	461	1914–15, 1948–62.	1952	----	4.82	1,170	----
			----	----	12	6.69	4,420	>50
93	Salmon Falls Creek near San Jacinto, Nev.	1,450	1909–16, 1918–62.	1943	----	10.2–11.4	1,820–2,040	----
			----	----	12	12.65	1,970	35
94	Big Lost River tributary at U.S. Highway 20 crossing 40 miles west of Idaho Falls, Idaho.	20	----	----	11	----	190	>50
95	Big Lost River tributary No. 2 at U.S. Highway 20 crossing 29 miles west of Idaho Falls, Idaho.	8.7	----	----	11	----	424	>50
	Big Wood River basin							
96	Big Wood River tributary at Highway 93 20 miles north of Shoshone, Idaho.	15.8	----	----	12	----	226	>50
97	Thorn Creek above Preacher Creek, 9 miles northeast of Gooding, Idaho.	46	----	----	11	----	647	>50
98	Preacher Creek near mouth 9.5 miles northeast of Gooding, Idaho.	26	----	----	10	----	646	>50
99	Big Wood River at Gooding, Idaho.	[17] 2,190	1896, 1898–99, 1921–48.	1896	----	9.6	5,940	----
			----	----	10	6.50	2,300	(1)
100	Dry Creek at bridge, 6 miles northwest of Gooding, Idaho.	84	----	----	10	----	1,390	(1)
101	Jim Byrnes Slough at Highway 20, 1 mile east of Richfield, Idaho.	(1)	----	----	12	----	1,520	(1)
102	Big Wood River near Gooding, Idaho.	[17] 2,990	1916–62	1952	----	10.67	6,500	----
			----	----	10	10.34	5,500	>50

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February in southern Idaho and northern Nevada and Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Prior to February 1962: Year	February 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Clover Creek basin							
103	Clover Creek near Bliss, Idaho.	140	1955	1955		10.2	(1)	
			1938–43, 1957–62.	1960		7.57	2,700	
					10	8.59	4,100	(1)
	Snake River main stem							
104	Snake River at King Hill, Idaho.	35,800	1909–62	1918		16.3	47,200	
					11	9.04	[2]16,200	(1)
	Bruneau River basin							
105	Bruneau River near Charleston, Nev.	44			11	15.15	1,890	>50
106	Bruneau River near Rowland, Nev.	380			11	13.0	2,120	
107	Bruneau River near Hot Springs, Idaho.	2,630	1909–15, 1943–62.	1910		13.0	6,500	
					13	8.99	3,220	
	Owyhee River basin							
108	Owyhee River above China diversion dam, near Owyhee, Nev.	[18]458	1939–62	1952		10.07	2,710	
					12	8.83	1,280	(1)
109	South Fork Owyhee River at Spanish Ranch near Tuscarora, Nev.	330	1959–62	1961		3.94	198	
					10	7.40	4,130	>50
110	Sourh Fork Owyhee River near Whiterock, Nev.	1,080	1955–62	1957		7.17	3,420	
					11	7.06	3,320	(1)
111	Bryans Run near Boise, Idaho.	7.03			10	11.01	116	(1)
112	Cottonwood Creek near Horseshoe Bend, Idaho.	6.53	1961	1961		11.5	45	
					10	13.05	112	(1)
113	Fourmile Creek near Emmett, Idaho.	6.5			10	4.80	112	(1)

1 Not determined.
2 Affected by regulation.
3 At site 1.5 miles upstream; drainage area, 223 sq mi.
4 At site 5 miles upstream; drainage area, 36 sq mi.
5 Daily discharge.
6 At site 2.5 miles upstream.
7 At site 4.5 miles upstream.
8 From release of water impounded by landside on Gros Ventre River.
9 May have been higher during winter.
10 Peak flow into pool at upstream end of culvert; maximum outflow through culvert, 1,840 cfs.
11 Affected by backwater from ice.
12 Of which 4.34 sq mi are believed to be noncontributing.
13 Of the drainage area, 581 sq mi is above dam and was not contributing.
14 Part of contributing area in lava beds; boundary indefinite.
15 Peak discharge due to break in highway fill 2 miles upstream; natural peak, 3,690 cfs (gage height, 6.79 ft).
16 At site 3.5 miles upstream; drainage area, 182 sq mi.
17 Of the drainage area, 1,600 sq mi is above Magic Reservoir and was not contributing.
18 Of the drainage area, 209 sq mi is above Wild Horse Dam and was not contributing.

264-262 O—67——3

FLOODS OF FEBRUARY–MARCH IN SOUTHEASTERN KENTUCKY AND IN THE CUMBERLAND RIVER BASIN, TENNESSEE

By C. H. HANNUM and W. J. RANDOLPH

Two successive storms moved northeastward across Kentucky and northwestern Tennessee during the period February 15–28. Precipitation from the first storm, on February 15–24, ranged from 2 to 3 inches along the Kentucky-Tennessee border and from 1 to 2 inches along the Ohio River.

The second and heavier storm moved across both States on February 25–28 in a path similar to that of the first storm. Precipitation exceeded 7 inches between Franklin and Greensburg, Ky., and in an area surrounding Livingston, Tenn., and ranged from 4 to 6 inches over the rest of the flood area (fig. 6). Severe flooding occurred throughout most of southeastern Kentucky and in Cumberland River tributaries of small drainage areas in Tennessee.

Peak discharges exceeded the maximum for the period of record at 24 flood-determination sites and were second highest at many others. Twelve gaging stations had peak discharges exceeding the 50-year flood.

Peak discharges at gaging stations on Paint Creek at Staffordsville, Ky. (sta. 3), and on Blaine Creek at Yatesville, Ky. (sta. 6), tributaries to Big Sandy River, and on Tygarts Creek at Olive Hill, Ky. (sta. 7), tributary to the Ohio River, were equal to or greater than a 50-year flood. Maximum discharges for the period of record occurred at the gaging stations on Blaine Creek at Yatesville, Ky., Tygarts Creek at Olive Hill, Ky., and Tygarts Creek near Greenup, Ky. (sta. 8). The peak discharge on Blaine Creek was 21,000 cfs from 217 square miles, which exceeded the previous maximum discharge by 35 percent and was 1.51 times a 50-year flood.

Along tributaries of the Kentucky River, five gaging stations had peak discharges that exceeded the previous maximum discharges. Stillwater Creek at Stillwater (sta. 22) had a peak discharge of 7,390 cfs from 24 square miles, which was 1.9 times greater than the previous maximum. The peak discharge of 95,700 cfs on Kentucky River at Frankfort, Ky. (sta. 27) was the second highest since 1895.

The upper Green and the Barren River basins were in the area of highest precipitation that caused severe flooding. Maximum discharges occurred at seven gaging stations in the basins. Peak discharge at six gaging stations exceeded that of a 50-year flood. The peak discharge on Green River at Greensburg, Ky. (sta. 33), was 60,600 cfs, which was 1.29 times the previous maximum and 1.36 times a 50-year flood. Peak discharges on Green River main stem at Woodbury, Ky. (sta. 43), and downstream were the second highest for the period of record. The record for Green River at Calhoun, Ky. (sta. 45), dates from 1898. Peak stages and discharges are summarized in table 2.

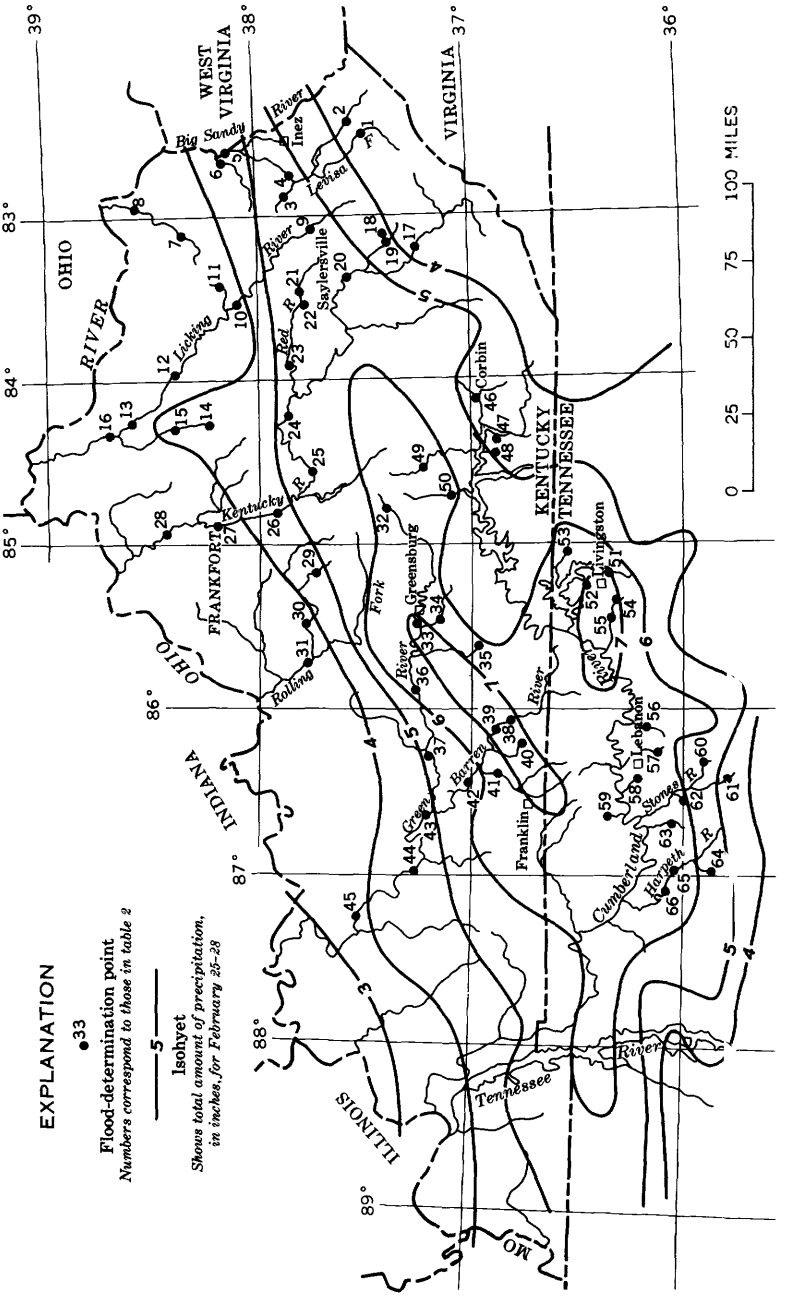


FIGURE 6.—Location of flood-determination points and isohyets for February 25–28, floods of February–March in southeastern Kentucky and in the Cumberland River basin, Tennessee.

TABLE 2.—*Flood stages and discharges, February–March in Kentucky and Tennessee*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Maximum floods: Prior to February 1962: Year	Maximum floods: February–March 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Big Sandy River basin							
1	Levisa Fork at Pikeville, Ky.	1,237	1862–1962	1957		52.72	85,500	
					Feb. 28	33.90	34,600	2
2	Johns Creek near Meta, Ky.	55.8	1937–39, 1941–62.	1957		14.54	4,680	
					Feb. 27	14.20	4,420	4
3	Paint Creek at Staffordsville, Ky.	103	1925, 1927, 1939, 1950–62.	1961		31.41	17,400	
					Feb. 27	28.60	14,700	50
4	Levisa Fork at Paintsville, Ky.	2,143	1862	1862		46.6	(1)	
			1915–16, 1918, 1928–62.	1957		45.92	69,700	
					Feb. 27	38.57	43,600	5
5	Big Sandy River near Louisa, Ky.	3,892	1938–62	1955			89,400	
				1958		46.37		
					Feb. 28		72,900	6
					Mar. 1	45.87		
6	Blaine Creek at Yatesville, Ky.	217		(2)		27.6	(1)	
			1915–20, 1937–62.	1939		26.55	15,500	
					Feb. 28	29.64	21,000	[3] 1.51
	Tygarts Creek basin							
7	Tygarts Creek at Olive Hill, Ky.	59.6	1957–62	1958		14.20		
				1960			6,190	
					Feb. 27	13.45	7,310	[3] 1.34
8	Tygarts Creek near Greenup, Ky.	242	1934, 1937, 1940–62.	1948		20.35	12,800	
					Feb. 28	21.38	14,800	42
	Licking River basin							
9	Licking River near Salyersville, Ky.	140	1938–62	1939		25.4	14,300	
					Feb. 27	23.70	11,300	[3] 1.10
10	Licking River at Farmers, Ky.	831	1904–62	1918		[4] 31.1		
			1938–62	1939		24.8	22,200	
					Feb. 28	26.70	24,000	7
11	Triplett Creek at Morehead, Ky.	47.9	1939–62	1939		18.9	44,000	
					Feb. 27	11.73	7,730	7
12	Licking River at Blue Lick Springs, Ky.	1,785	1854–1962	1937		47.4	(1)	
			1938–62	1948		45.0	35,900	
					Mar. 1	39.45	28,100	2
13	Licking River at McKinneysburg, Ky.	2,326	1937	1937		47.8	(1)	
			1924–26, 1938–62.	1948		47.59	54,100	
					Feb. 28	39.09	41,800	4
14	Stoner Creek at Paris, Ky.	239	1928–62	1951		19.5	(1)	
			1953–62	1956		15.84	10,000	
					Feb. 28	17.65	12,200	7
15	South Fork Licking River at Cynthiana, Ky.	621	1918–62	1948		23.32	35,300	
					Feb. 28	20.55	25,000	8
16	Licking River at Catawba, Ky.	3,300	1854, 1888–1962.	1948		47.0	86,300	
					Feb. 28	39.57	65,400	9

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, February–March in Kentucky and Tennessee*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to February 1962		February–March 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Kentucky River basin							
17	North Fork Kentucky River at Hazard, Ky.	466	1926–62	1957		37.54	47,800	
					Feb. 27	20.90	22,100	3
18	Bear Branch near Noble, Ky.	2.21	1955–62	1957		3.20	375	
					Feb. 27	3.36	415	(1)
19	Troublesome Creek at Noble, Ky.	177	1939–62	1939		29	(1)	
			1949–62	1951		24.78	15,600	
					Feb. 27	26.86	18,300	20
20	North Fork Kentucky River at Jackson, Ky.	1,101	1905–07, 1917–21, 1927–31, 1935–62.	1939		43.10		
				1957			53,500	
					Feb. 28	37.99	45,400	5
21	Red River near Hazel Green, Ky.	65.8	1954–62	1955		10.64	3,020	
					Feb. 27	22.12	9,080	[3] 1.15
22	Stillwater Creek ar Stillwater, Ky.	24.0	1954–62	1956		12.91	3,890	
					Feb. 27	17.43	7,390	(1)
23	Red River at Clay City, Ky.	362	1930–32, 1936–62.	1938		22.8	21,100	
					Feb. 28	23.90	22,600	20
24	Kentucky River at Lock 10, near Winchester, Ky.	3,955	1907–62	1913		35.1		
				1939			92,400	
					Mar. 1	36.07	91,500	17
25	Kentucky River at Lock 8, near Camp Nelson, Ky.	4,414	1900–62	1913			103,000	
				1937		41.2		
					Mar. 2	41.3	92,800	10
26	Kentucky River at Lock 6, near Salvisa, Ky.	5,102	1895–1962	1913			115,000	
				1937		43.35		
					Feb. 28		101,000	10
					Mar. 1	38.2		
27	Kentucky River at Lock 4, at Frankfort, Ky.	5,412	1895–1962	1937		[5] 47.46	115,000	
					Mar. 1		95,700	5
					do	40.73		
28	Kentucky River at Lock 2, at Lockport, Ky.	6,180	1884–1962	1937		[6] 56.85	123,000	
					Mar. 1		103,000	5
					Mar. 3	46.87		
	Salt River basin							
29	Beech Fork near Springfield, Ky.	85.9	1952–62	1961		27.8	8,840	
					Feb. 28	25.0	7,080	20
30	Beech Fork at Bardstown, Ky.	669	1939–62	1957		39.5	27,600	
					Feb. 28	39.65	27,900	10
31	Rolling Fork near Boston, Ky.	1,299	1937	1937		[6] 55.2	(1)	
			1938–62	1948			41,300	
				1961		47.15		
					Mar. 1		41,000	5
					do	48.35		

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, February–March in Kentucky and Tennessee*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Maximum floods: Prior to February 1962: Year	Maximum floods: February–March 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Green River basin							
32	Green River near McKinney, Ky.	22.4	1951–62	1952		8.93	10,400	
					Feb. 27	8.08	4,840	(1)
33	Green River at Greensburg, Ky.	736	1913	1913		36.2	(1)	
			1939–62	1952		33.50	47,000	
					Feb. 28	37.17	60,600	[1] 1.36
34	Russell Creek near Columbia, Ky.	188	1937, 1939–62	1952		23.8	15,900	
					Feb. 27	24.34	16,700	[3] 1.05
35	South Fork Little Barren River near Edmonton, Ky.	18.3	1941–62	1949		10.00	2,140	
					Feb. 27	8.83	1,790	(1)
36	Green River at Munfordville, Ky.	1,673	1913–62	1913		54.0	67,000	
					Mar. 1	57.72	76,800	[3] 1.03
37	Green River at Lock 6, at Brownsville, Ky.	2,762	1907–62	1937		44.94	120,000	
					Mar. 2	41.85	90,200	[3] 1.10
38	Barren River near Pageville, Ky.	531	1939–62	1952		27.26	70,000	
					Feb. 27	25.66	50,000	22
39	Barren River near Finney, Ky.	940	1941–50, 1960–62.	1948		103.83	51,800	
					Feb. 27	110.6	78,000	36
40	West Bays Fork at Scottsville, Ky.	7.47	1950–62	1952		6.09		
				1957			1,720	
					Feb. 26	6.00	1,690	(1)
41	Drakes Creek near Alvaton, Ky.	478	1937, 1939–62.	1957		31.54	34,300	
					Feb. 27	34.00	49,500	[3] 1.08
42	Barren River at Bowling Green, Ky.	1,848	1913, 1937	1913		52.2	(1)	
			1938–62	1952		44.63	77,400	
					Feb. 28		85,000	26
					do	49.55		
43	Green River at Lock 4, at Woodbury, Ky.	5,403	1913, 1936–62.	1937		43.1	205,000	
					Mar. 2		161,000	[3] 1.22
					do	37.94		
44	Green River at Paradise, Ky.	6,182	1939–50, 1959–62.	1950		38.3	89,300	
					Mar. 5		107,000	8
					do	40.46		
45	Green River at Lock 2, at Calhoun, Ky.	7,564	1898–1962	1937		[7] 43.7	208,000	
					Mar. 8		106,000	12
					Mar. 10	33.97		
	Cumberland River basin							
46	Laurel River at Corbin, Ky.	201	1911, 1913, 1921–24, 1942–62.	1957		19.30	19,600	
					Feb. 28	16.82	14,900	5
47	Cane Branch near Parkers Lake, Ky.	.67	1956–62	1957		[8] 2.43	198	
					Feb. 27	1.85	184	(1)
48	Helton Branch at Greenwood, Ky.	.85	1956–62	1956		[9] 1.46		
				1957			136	
					Feb. 27	1.45	182	(1)
49	Buck Creek near Shopville, Ky.	165	1952–62	1957		19.55	14,900	
					Feb. 27	23.31	19,900	20
50	Pitman Creek at Somerset, Ky.	31.3	1953–62	1959		8.74	2,850	
					Feb. 27	9.95	3,460	5
51	West Fork Obey River near Alpine, Tenn.	115	1942–62	1955		16.30	15,100	
		[10] 81			Feb. 27	13.27	9,980	5
52	Big Eagle Creek near Livingston, Tenn.	7.98	1954–62	1957		4.48	962	
					Feb. 27	6.23	1,170	(1)
53	Wolf River near Byrdstown, Tenn.	105	1942–62	1957		10.84	22,600	
					Feb. 27	9.45	15,000	10

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, February–March in Kentucky and Tennessee*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1962: Period	Prior to February 1962: Year	February–March 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Cumberland River basin—Continued							
54	Mathews Branch tributary near Livingston, Tenn.	.49	1954–62	1956		5.54	273	
					Feb. 27	4.97	227	(1)
55	Roaring River near Hilham, Tenn.	78.7	1931–62	1955		9.39	5.550	
		[10] 51.6			Feb. 27	12.02	8,530	25
56	Jennings Fork near Lebanon, Tenn.	11.8			Feb. 27		5,060	(1)
57	Spring Creek near Lebanon, Tenn.	35.3	1954–62	1955		10.13	7,980	
					Feb. 27	10.65	9,140	30
58	Spencer Creek near Lebanon, Tenn.	3.32	1954–62	1957		8.4	2,220	
					Feb. 27	6.92	1,060	(1)
59	Drakes Creek above Hendersonville, Tenn.	19.2	1954–62	1957		10.56	3,370	
					Feb. 26	[11] 10.70	3,100	12
60	Bradley Creek at Lascassas, Tenn.	37.0	1954–62	1955		10.66	12,800	
					Feb. 27	9.35	9,150	24
61	West Fork Stones River near Murfreesboro, Tenn.	128	1902	1902		25.0	50,000	
		[10] 125	1931–62	1948		22.73	38,000	
					Feb. 27	14.00	9,000	2
62	Stewart Creek near Smyrna, Tenn.	69.7	1952–62	1955		17.61	8,700	
		[10] 62.1			Feb. 27	16.88	7,770	12
63	Mill Creek near Antioch, Tenn.	64.0	1953–62	1955		19.73	17,000	
					Feb. 27	18.38	13,800	[3] 1.46
64	West Harpeth River near Leipers Fork, Tenn.	66.9	1954–62	1960		15.23	25,000	
					Feb. 27	14.62	16,700	[3] 1.70
65	Harpeth River at Belleview, Tenn.	408	1920–62	1948		24.34	40,000	
					Feb. 27	20.98	23,700	9
66	Harpeth River near Kingston Springs, Tenn.	687	1924–62	1946		32.20	60,000	
					Feb. 27	29.51	47,800	20

[1] Unknown.
[2] Unknown; prior to 1915.
[3] Ratio of peak discharge to 50-year flood.
[4] Result of ice jam, at site 400 ft downstream at datum 0.21 foot lower.
[5] At site 0.9 mile downstream.
[6] Affected by backwater from the Ohio River.
[7] At site 0.2 mile upstream at datum 1.35 ft higher.
[8] Affected by backwater from ice.
[9] Affected by backwater from debris.
[10] Area contributing to direct runoff.
[11] Affected by backwater.

The floods caused two deaths and severe property damages to homes, business establishments, streets, highways, and railroads.

Salyersville, Ky., was isolated as flood waters from the Licking River closed main highways into town. Flood waters were 4 to 8 feet deep in the business section, and about 300 persons were evacuated from their homes. A 101-year-old resident of Salyersville said the February 1962 flood was the second highest flood he could remember, the highest being the flood of February 1939.

Lynn Camp Creek in the Cumberland River basin overflowed its banks, flooding the business district of Corbin, Ky., and damage was estimated at $500,000. At least 50 families were evacuated from their homes in low areas near Corbin.

Rockcastle Creek, tributary to Tug Fork, flooded 100 to 175 homes in the town of Inez in eastern Kentucky. This flood was reported to be the worst since the flood of 1927, which was about 1.3 feet lower.

Local residents said that the flood on Spring Creek near Lebanon, Tenn. (Sta. 57), was probably the highest in 70 years. Water in the town of Lebanon was 4 feet deep in the business district, and residents reported that the flood was the worst in 23 years. Damage to business places was estimated at more than $250,000.

Generally, most damage to urban areas occurs in mountainous eastern Kentucky, where the towns are on the flood plains. Inundation of low-lying urban areas is an annual event in this part of the State. The topography of south-central Kentucky is flatter, and urban areas are generally above the flood plains; thus, potential flood damage is reduced. However, in this flood, the greatest damage was in the basins of the Licking, Kentucky, and Green Rivers, where thousands of acres of farmland were inundated and homes, businesses, highways, and railroads were damaged.

Damage figures, by stream basins, in the critical flood area in Kentucky provided by the Corps of Engineers, Louisville District, from stage-damage curves are listed below.

Stream basin	*Damage*
Licking River	$750,000
Kentucky River	4,510,000
Green River	1,528,000
Barren River (tributary to Green River)	202,000

FLOODS OF MARCH 22 AND 24 IN CENTRAL NEBRASKA

Snowmelt flooding during March in central Nebraska (fig. 7) was outstanding on the North Loup River at Taylor and in the Lillian Creek watershed near Walworth. Other sites in this area may have had equally high, or higher, rates of runoff that were unobserved.

The peak discharge measured on a tributary of Lillian Creek (table 3) was only slightly less than the maximum in the period of record for that site, which began in 1951, and was more than twice as large as the snowmelt peak (255 cfs) of March 1960.

The peak discharge at Taylor also was the second largest in the period of record, which began in 1936, and was 37 percent greater than the snowmelt peak (1,700 cfs) of March 1960.

The causes of the flooding were similar to those that caused the March–April 1960 floods in the same area—unusually heavy snow cover having a high water equivalent (table 4); unseasonably low temperatures during the first half of March, followed by a sharp rise in temperatures during the last half of the month; thawing temperatures, generally above 40°F each day; and rainfall averaging about 1 inch over the area on March 23–24.

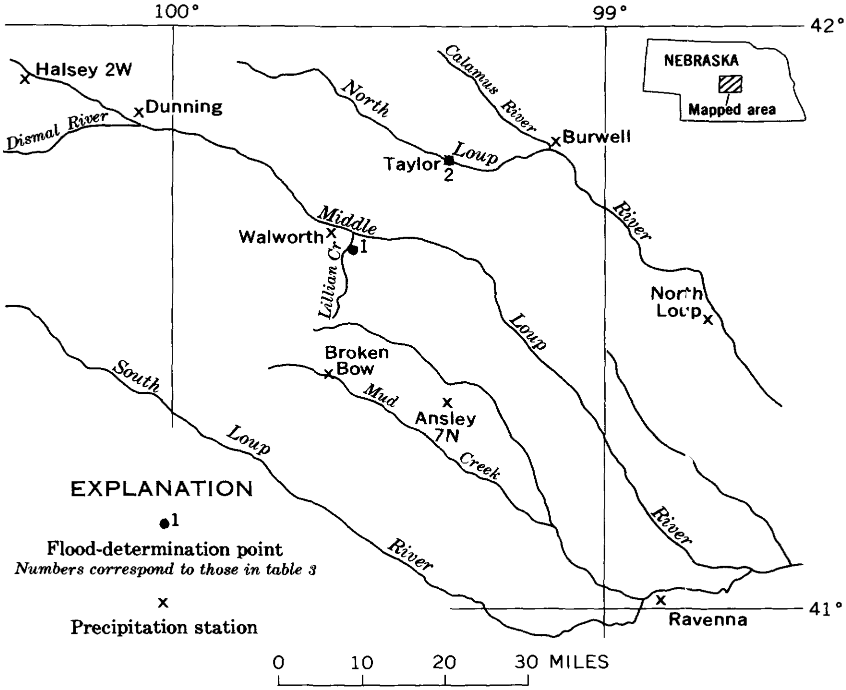


FIGURE 7.—Location of flood-determination points and rainfall measurement sites, floods of March 22 and 24 in central Nebraska.

TABLE 3.—*Flood stages and discharges, March 22 and 24 in central Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1962: Period	Prior to March 1962: Year	March 1962	Gage height (ft)	Discharge: Cfs	Discharge: Ratio to Q_{25}
	Platte River basin							
1	Lillian Creek tributary No. 2 near Walworth.	2.04	1951-62	1951		(1)	585	
					24	12.32	550	2.1
2	North Loup River at Taylor	[2] 2,210	1936-62	1951		(1)	2,770	
		180			22	6.00	2,330	1.3

[1] Not determined.
[2] Contributing drainage area.

Another significant factor in the cause of the high peak discharge at Taylor was the west-to-east movement of the rapidly increasing temperatures. Rising temperatures began in the North Loup River headwaters area near Valentine Lakes Game Refuge about March 15 and progressed eastward, which increased runoff in the downstream direction, and resulted in the flood peak at Taylor 1 week later, on

March 22. This effect was not significant in the Lillian Creek watershed, which is north-south oriented, and the peak discharge occurred 2 days later than at Taylor.

Neither of these floods caused appreciable amounts of damage because of the absence of structures, other than bridges, within reach of the floodwater.

TABLE 4.—*Depth of snow on ground and water equivalent, in inches, in central Nebraska*

[Tr., trace]

Station	March 1962							
	2	6	9	13	14	16	20	23
Ansley 7N	------	------	------	------	8	------	------	------
	------	------	------	------	1.6	------	------	------
Broken Bow	10	10	9	21	------	17	2	------
	------	1.1	.6	1.5	------	1.2	.2	------
Burwell	8	9	8	10	10	8	2	------
	------	------	------	------	------	------	------	------
Dunning	------	------	------	------	7	------	------	------
	------	------	------	------	1 3	------	------	------
Halsey 2W	10	10	12	15	14	13	1	------
	------	------	------	------	------	------	------	------
North Loup	12	11	10	14	------	14	8	4
	2.2	1.8	1.9	2.4	------	3.0	2.3	1.6
Ravenna	9	9	7	10	------	10	6	Tr.
	1.1	1.0	1.1	1.6	------	1.6	.8	------

FLOODS OF MARCH 27–29 IN SOUTHEASTERN MINNESOTA

By L. E. BIDWELL

A rapid warmup on March 25–28, accompanied by continuous strong dry winds on March 27–28, caused severe flooding from snowmelt in the basins of the Cedar, Root, Whitewater, and Zumbro Rivers (fig. 8).

The depth of snow cover averaged about 2 feet over the four river basins. Figure 8 shows the depth of snow on the ground at four U.S. Weather Bureau stations in the area. Temperatures from December to March were generally below long-term means. The snow cover remained intact, although it was compacted by above-freezing afternoon temperatures in March. The average water equivalent throughout the area was 4 inches or more at the beginning of the spring warmup on March 25.

The area of greatest runoff and flooding was in the headwaters of the Cedar, Root, Whitewater, and South Fork Zumbro Rivers. As is typical of many snowmelt floods, the peak flows from small drainage basins were not outstanding. The most notable floodflow occurred on the South Fork Zumbro River. The peak stage at the gaging station near Rochester (sta. 1) was the highest since at least 1908, and the discharge exceeded all others for the period of record. Maximum dis-

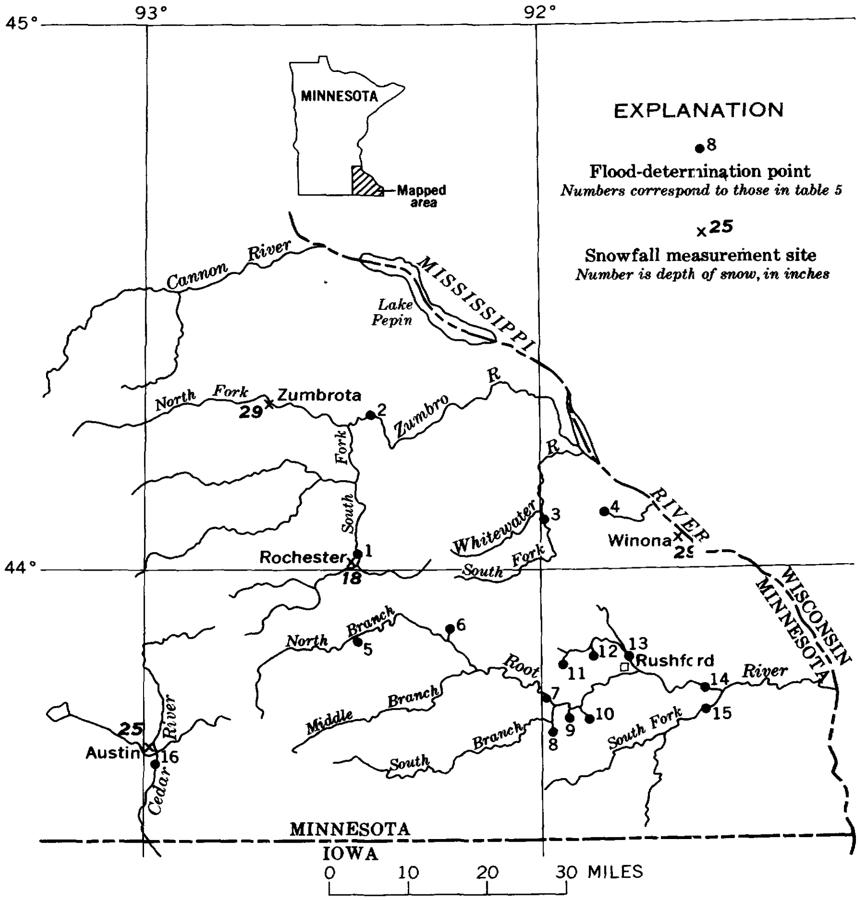


FIGURE 8.—Location of flood-determination points and depth of snow on the ground, floods of March 27–29 in southeastern Minnesota.

charges of record also occurred at the gaging stations Root River near Lanesboro (sta. 7), South Fork Root River near Houston (sta. 15), and Cedar River near Austin (sta. 16).

A summary of peak stages and discharges at 16 sites (fig. 8) and related data are listed in table 5. Composite flood-frequency curves applicable to this area (Prior and Hess, 1961) were used to compute the recurrence intervals shown in table 5. The recurrence intervals were not computed for sites in small drainage basins owing to lack of flood data. The peak discharge for South Fork Zumbro River near Rochester (sta. 1) was more than 1½ times a 30-year flood.

The greatest urban damage resulted in Rochester, on the South Fork Zumbro River, and was estimated at $1,670,000 by the U.S. Army

Corps of Engineers. Lesser urban damage in Rushford from overflow of Rush Creek and the Root River was estimated at $100,000. The corps estimated damage of about $500,000 to highways, bridges, and agricultural lands in the lower Zumbro River Valley and along the Root River.

TABLE 5.—*Flood stages and discharges, March 27–29 in southeastern Minnesota*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1962: Period	Maximum floods: Prior to March 1962: Year	Maximum floods: March 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Zumbro River basin							
1	South Fork Zumbro River near Rochester.	304	1908–62	1951		17.5	(1)	
			1952–62	1961		15.43	10,900	
					29	18.46	18,000	[2] 1.56
2	Zumbro River at Zumbro Falls	1,130	1888	1888		30.5	(1)	
			1909–17, 1929–62.	1951		30.80	30,700	
					29	28.20	28,100	26
	Whitewater River basin							
3	South Fork Whitewater River near Altura.	76.8	1939–62	1947		10.61	5,460	
					28	10.01	4,870	[2] 1.18
	Garvin Brook basin							
4	Straight Valley Creek near Rollingstone.	5.16	1959–62	1959		17.28	1,200	
					28	15.23	(1)	(1)
	Root River basin							
5	North Branch Root River tributary near Stewartville.	.73	1959–62	1960		13.47	328	
					28	[3] 8.60	(1)	(1)
6	Mill Creek tributary near Chatfield.	2.36	1959–62	1960		15.46	703	
					28	13.39	460	(1)
7	Root River near Lanesboro	615	1910–17, 1940–62.	1950		15.55	20,500	
					29	16.11	22,100	[2] 1.09
8	Trout Creek tributary near Lanesboro.	4.08	1959–62	1960		17.74	561	
					28	14.19	188	(1)
9	Root River tributary near Whalan.	.30	1959–62	1960		9.05	42	
					28	5.85	6.1	(1)
10	Whalan Creek near Whalan	7.85	1959–62	1960		22.17	4,880	
					28	16.95	830	(1)
11	Big Springs Creek near Arendahl.	.14	1959–62	1960		10.67	40	
					27	9.19	19	(1)
12	Pine Creek near Arendahl	28.1	1959–62	1961		14.42	2,020	
					27	13.44	910	(1)
13	Rush Creek near Rushford	129	1942–62	1950		13.54	11,600	
					28	9.98	4,550	3
14	Root River near Houston	1,270	1909–17, 1929–62.	1952			37,000	
				1961		15.10		
					30	14.36	29,500	26
15	South Fork Root River near Houston.	275	1953–62	1961		[3] 13.74	6,980	
					29	13.35	8,420	5

See footnotes at end of table.

TABLE 5.—*Flood stages and discharges, March 27–29 in southeastern Minnesota*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to March 1962		March 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
			Cedar River basin					
16	Cedar River near Austin	425	1909–14, 1944–62.	1950		17.81	8,800	
					29	17.18	9,530	[2] 1.12

[1] Undetermined.
[2] Ratio of peak discharge to mean annual flood.
[3] Affected by backwater from ice.

FLOODS OF MARCH–APRIL IN SOUTHEASTERN SOUTH DAKOTA AND ADJACENT AREAS

Record-breaking snowmelt floods occurred in late March and early April in the same general area where previous record-breaking floods had occurred only 2 years earlier. The 1962 floods produced peak discharges greater than those of 1960 in virtually the entire flood area delineated in figure 9. A comprehensive report of the 1960 floods has been published as Water-Supply Paper 1790–A, "Floods of March–April 1960 in Eastern Nebraska and Adjacent States."

The direct causes of the 1960 and 1962 floods were basically the same. Both floods resulted when excessive snowpacks that had accumulated during a cold period melted during a following period of rapid-warming in late March. Although the times of accumulation of the two snowpacks were significantly different, there were no appreciable differences between the runoff characteristics of the two resulting floods. Unique characteristics of the two floods were caused by differences in temperatures and in amounts of precipitation during the course of the floods.

Mild temperatures during the last week in January and the first half of February melted most of the snow in the flood area, and the 3–5 inches of thawed topsoil absorbed most of the resulting water.

Temperatures dropped below freezing on February 16 and remained below freezing for about 1 month. Heavy snowstorms from February 17 to 21 covered the area from central South Dakota into northeastern Nebraska, northwestern Iowa, and southwestern Minnesota. At the end of February, snow depths ranged from 1 to 2½ feet over eastern South Dakota and from 13 to 21 inches in the flood area in Nebraska. An additional 8 to 16 inches of snow was deposited on the flood area March 11–13.

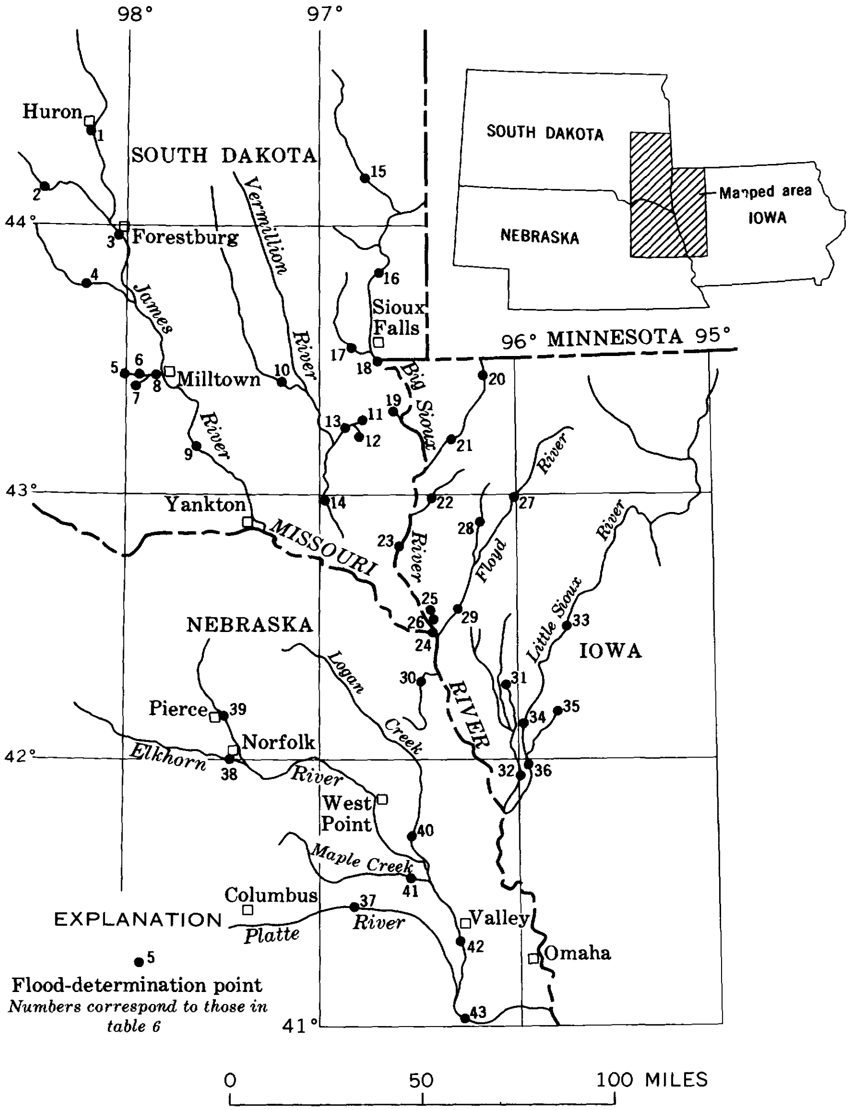


FIGURE 9.—Location of flood-determination points, floods of March–April in southeastern South Dakota and adjacent areas.

Some of the largest snowfall totals in South Dakota from the middle of February to the middle of March were 57 inches at Huron, 61 inches at Sioux Falls, and 47 inches at Vermillion.

The water equivalent of the snowpack on March 20, compiled by the U.S. Army Corps of Engineers, is shown in figure 10. The average water equivalent of the snowpack in the basins of the James River south of Aberdeen, S. Dak., the Vermillion River, and the Big Sioux River were estimated by the U.S. Army Corps of Engineers at 2.3, 2.4, and 3.1 inches respectively, whereas just before the breakup in 1960 the water equivalents were 2.5, 2.5, and 2.3 inches, respectively.

On March 23 and 24, from a quarter to a half of an inch of rain fell from Sioux City, Iowa, northward to the Minnesota line. The heavy snow cover absorbed the rain and no runoff occurred. In northeast Nebraska about three-fourths of an inch of rain fell, and there was a slight increase in runoff.

Rapid warming on March 27 accelerated melting of the concentrated snowpack, and appreciable runoff began over the entire area of this report. The temperature pattern (fig. 11) showed that the maximum daily temperatures during the breakup in 1962 were similar to those in 1960 and that the minimum temperatures rose earlier in March

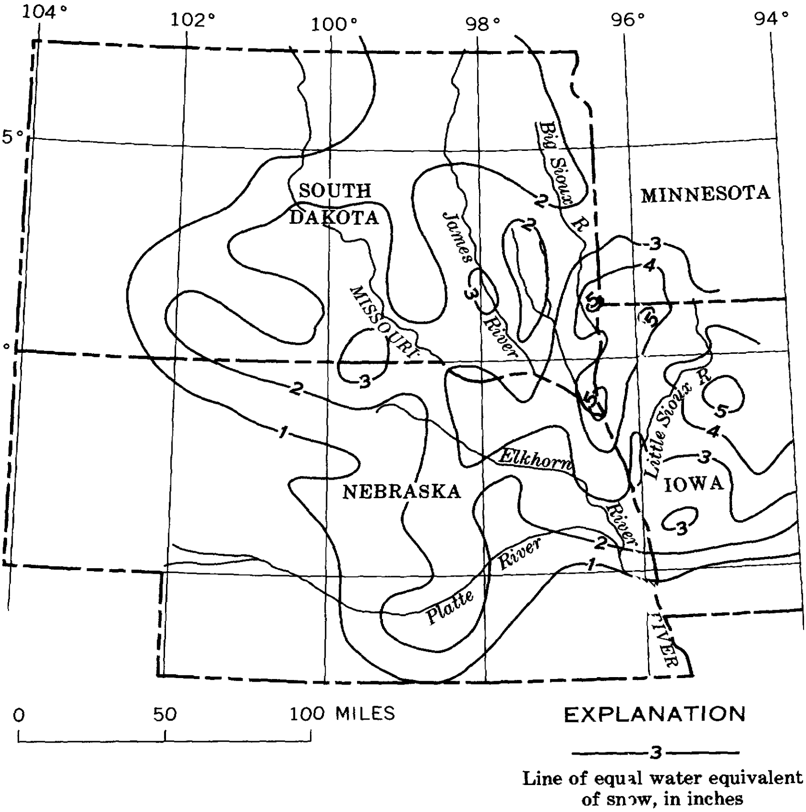


FIGURE 10.—Water equivalent of snow on ground on March 20 in portions of South Dakota, Nebraska, Iowa, and Minnesota. Compiled by the U.S. Army Corps of Engineers.

1962 than they had in 1960. Streamflow responded to the nearly continuous melting temperatures of March 23–25, and principal streams began rising on March 26, a day or two earlier than they did in March 1960.

The floods along the James River were slightly higher than the floods of 1960, which local residents believed to be somewhat lower than the great floods of 1881 in the Forestburg-Mitchell reach and slightly higher between Milltown and the mouth. The crest of the Vermillion River near Wakonda, S. Dak. (sta. 14), was 0.2 foot higher than the flood crest of 1960, which, according to longtime local residents, was the greatest in about 80 years.

The flood on the Big Sioux River along the South Dakota–Iowa border was the second highest flood known, having been exceeded by the rain and snowmelt flood of 1881. The Big Sioux River at Akron, Iowa (sta. 23), was above bankfull stage from March 28 to April 14.

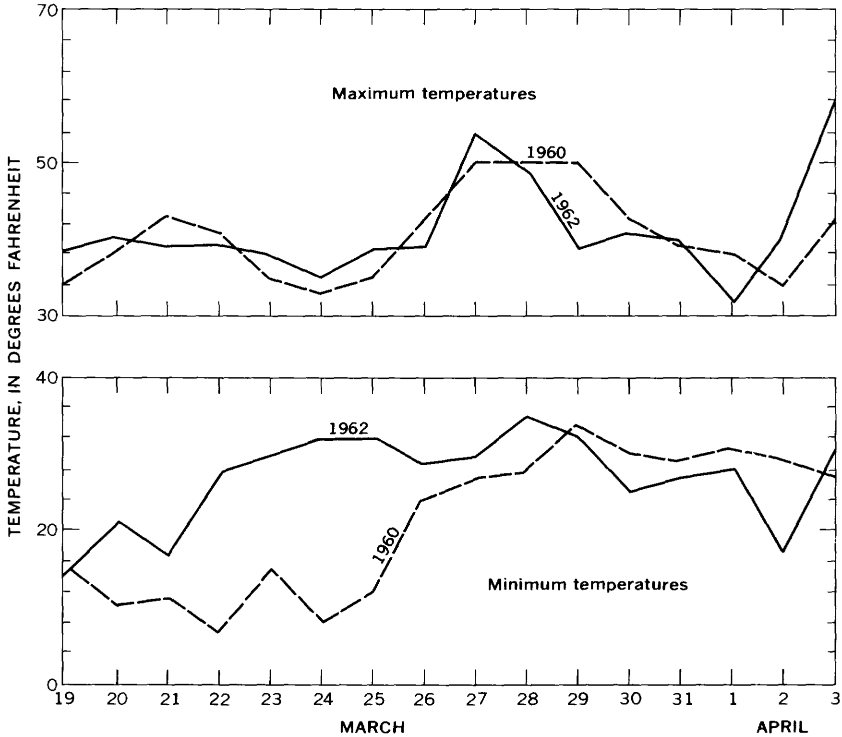


FIGURE 11.—Maximum and minimum daily temperatures during snowmelt periods of 1960 and 1962 at Bridgewater, S. Dak.

The second highest crest of record was reached on the Rock River near Rock Valley, Iowa (sta. 21). The crest was only 0.1 foot lower than the record crest of 1897.

Floods on the Floyd River in Iowa were the greatest snowmelt floods known, but they were far less than the rainfall flood of 1953. Damage to roads, bridges, farmland, and farmsteads was high in the Big Sioux River, Floyd River, and James River basins. Many families were evacuated from the leveed areas along the Floyd River.

Light rain added to water from rapidly melting snow from March 24 to 26 and caused flooding along the Platte River in the low-lying residential and industrial areas in Columbus, Nebr. Water covered about 45 blocks to a depth of 1 or 2 feet. Some of Valley, Nebr., was flooded, but the inundated area was less than that covered during the floods of 1960.

Floods in the Elkhorn River basin, which is entirely within Nebraska, were very severe owing to rapid snowmelt, rainfall, and ice jams.

On Elkhorn River near Norfolk (sta. 38) the peak discharge upstream from the mouth of North Fork was only about half as large as during the snowmelt flood of March 1960. Between Norfolk and Waterloo the peak inflow from Maple Creek was somewhat less than in March 1960, but the peak inflow from Logan Creek was almost twice that of the March–April 1960 flood. Inflow from the North Fork Elkhorn River was also great, but no 1960 records of discharge for that stream are available for comparison. Local residents reported that the 1962 stage at Pierce was 2 inches higher than that of March–April 1960. Thirty blocks of Pierce were inundated, and damage to private property was extensive.

The flood crest on March 28 near the mouth of the North Fork Elkhorn River at Norfolk, was reported by local officials to have been 4 inches higher than that of the March–April 1960 flood. Floodwaters breached a dike and covered more than a hundred blocks of residential and business districts with 2 to 3 feet of water. Damage was estimated at about $600,000.

The peak discharge of Elkhorn River at Waterloo (sta. 42) exceeded that of the March–April 1960 snowmelt flood because of the unusually great runoff from Logan Creek basin. The runoff resulted from the sudden release of approximately 5 inches of water from the snowpack, and an average rainfall of about 0.7 inch over the basin March 23–25. The suddenness of the release resulted from the extended period of subnormal temperatures through the first half of March, and the compression into a few days of the seasonal temperature rise which usually covers a period of at least 2 to 3 weeks.

More than 300 families were forced to evacuate their homes along the reach of the Elkhorn River in the King Lake–Waterloo area on March 27–29. Damage to homes, churches, businesses, and other property was very severe.

Flooding on the Elkhorn River at Winslow, just downstream from the mouth of Logan Creek, forced nearly all the 136 residents to leave their homes, but a sandbag dike constructed by volunteers succeeded in preventing complete inundation of the village.

Twenty blocks of residential area in West Point had to be evacuated twice—once in the early morning of March 25, as backwater caused by a large ice jam on Elkhorn River flooded the village, and again at midafternoon March 26, when water released by the breaking of an ice jam upstream flooded the same 20-block section.

At the height of the flooding on March 28 the following highway closures were reported by the Nebraska Department of Highways:

1. Nebraska 15, 3 miles south of Hartington; overflow caused by ice jam on Bow Creek.
2. Nebraska 64, west of Valley; overflow from Platte River.
3. Nebraska 64, between Elkhorn and Waterloo; overflow from Elkhorn River.
4. U.S. 275, at West Point and at junction with Nebraska 91; overflow from Elkhorn River.
5. U.S. 81, 2 miles north of Norfolk; overflow from North Fork Elkhorn River.
6. U.S. 30, at Arlington; overflow from Elkhorn River.
7. Nebraska 36, at Elk City; overflow from Elkhorn River.
8. Nebraska 91, east of Nickerson; overflow from Elkhorn River.
9. Nebraska 51, east of Bancroft; overflow from Logan Creek.
10. U.S. 275 and Nebraska 24, at and east of Norfolk; overflow from North Fork Elkhorn River.
11. Nebraska 35, in Norfolk-Winside area; overflow from tributary of North Fork Elkhorn River and from Logan Creek.

The length of time that each of these closures was in effect is not known, but the closing of 11 arterial highways covering a large segment of northeastern Nebraska for only a 1-day period would result in an appreciable economic loss to commercial interests and could endanger the lives of many persons. National Guard helicopter service was used for emergency movement of persons needing medical care. The list of highway closures does not cover the entire flood period or flood area, but only the situation as of March 28.

One life was lost by drowning when an 8-year-old girl fell into Pebble Creek near Dodge, Nebr. on March 26 as the bank gave way beneath her. Stage and discharge associated with the flooding on this stream were not obtained.

The U.S. Army Corps of Engineers estimated damage in South Dakota basins as follows: James River, $650,000; Vermillion River, $750,000; and Big Sioux River, $2,500,000. The largest single item of damage occurred when floodwaters undermined the piers of the bridge on Interstate Highway 29 in Sioux City near the mouth of the Big Sioux River. The upstream bridge of the dual crossing collapsed, and the companion bridge was severely weakened. Estimated damage to the two bridges was $600,000.

A summary of the peak stage and discharge on streams in the flood area is given in table 6.

TABLE 6.—*Flood stages and discharges, March–April in southeastern South Dakota and adjacent areas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1962: Period	Maximum floods: Prior to March 1962: Year	Maximum floods: March–April 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	James River basin							
1	James River at Huron, S. Dak.	16,800	1881–1962	1881		19.8	(1)	
		[2] 12,010	1928–32, 1943–62.	1960		15.42	6,050	
					Apr. 2	15.80	6,250	21
2	Sand Creek near Alpena, S. Dak.	240	1950–62	1950		[3] 14.1		
				1960		13.35	2,240	
					Mar. 31	[3] 12.96	1,000	12
3	James River near Forestburg, S. Dak.	18,600	1920	1920		18	(1)	
		[2] 13,810	1922	1922		18	(1)	
			1950–62	1960		16.27	10,900	
					Mar. 31	16.40	12,000	[4] 1.6
4	Firesteel Creek near Mount Vernon, S. Dak.	540	1955–62	1960		[3] 15.13	5,780	
					Mar. 31	16.85	3,600	[4] 1.9
5	North Branch Dry Creek tributary near Parkston, S. Dak.	3.19	1956–62	1960		6.52	340	
					Mar. 30	[3] 6.24	(1)	
6	North Branch Dry Creek near Parskton, S. Dak.	37.0	1956–62	1960		8.55	1,470	
					Mar. 30	[3] 9.05	(1)	
7	South Branch Dry Creek near Parkston, S. Dak.	17.1	1956–62	1960		7.37	920	
					Mar. 30	[3] 8.10	(1)	
8	Dry Creek near Parkston, S. Dak.	76.8	1956–62	1960		12.70	4,210	
					Mar. 30	[3] 11.36	(1)	
9	James River near Scotland, S. Dak.	21,550	1928–62	1960		18.66	13,900	
		[2] 16,760			Apr. 3	18.74	15,200	[4] 1.5
	Vermillion River basin							
10	West Fork Vermillion River near Parker, S. Dak.	370	1961–62	1961			(5)	
					Mar. 28	12.33	4,340	[4] 1.2
11	Saddlerock Creek near Canton, S. Dak.	14.8	1956–62	1960		7.83	710	
					Mar. 27	[3] 8.90	[6] 400	(1)
12	Saddlerock Creek tributary near Canton, S. Dak.	2.32	1956–62	1960		5.93	72	
					Mar. 27	[3] 7.80	[6] 80	(1)
13	Saddlerock Creek near Beresford, S. Dak.	26.3	1956–62	1960			1,100	
					Mar. 28	[3] 10.24	[6] 700	(1)
14	Vermillion River near Wakonda, S. Dak.	1,680	1945–62	1960		16.94	7,300	
					Mar. 28	16.75		
					Mar. 31		8,660	25

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, March–April in southeastern South Dakota and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1962: Period	Year	March–April 1962	Gage height (ft)	Discharge: Cfs	Recurrence interval (years)
	Big Sioux River basin							
15	Big Sioux River near Brookings, S. Dak.	4,420	1953–62	1960		12.28	9,620	
		[2] 2,450			Mar. 29	12.95	10,600	25
16	Big Sioux River near Dell Rapids, S. Dak.	5,060	1948–62	1957		14.93	15,500	
		[2] 3,090			Mar. 30	15.14	18,400	[4] 1.4
17	Skunk Creek near Sioux Falls, S. Dak.	520	1948–62	1957		17.78	29,400	
					Mar. 28	12.43	6,430	[4] 1.5
18	Big Sioux River near Brandon, S. Dak.	5,810	1959–62	1960		18.61	14,400	
		[2] 3,840			Mar. 31	19.93	17,100	[4] 1.1
19	Little Beaver Creek tributary near Canton, S. Dak.	.22	1956–62	1959		3.78	(1)	
					Mar. 27	[3] 4.70	[6] 25	(1)
20	Rock River at Rock Rapids, Iowa.	788	1959–62	1960		8.86	15,500	
					Mar. 29	9.56	16,400	[4] 2.04
21	Rock River near Rock Valley, Iowa.	1,600	1897	1897		17.0	(1)	
			1948–62	1953		15.99		
				1954			19,200	
					Mar. 30	16.91	28,400	[4] 2.50
22	Dry Creek at Haywarden, Iowa.	48.4	1926	1926		18.0	(1)	
			1948–62	1953		17.57	10,900	
					Mar. 28	15.88	2,330	(1)
23	Big Sioux River at Akron, Iowa.	9,030	1928–62	1960		21.56	49,500	
		[2] 7,060			Mar. 31	22.08	54,300	[4] 1.4
	Missouri River main stem							
24	Missouri River at Sioux City, Iowa.	314,600	1928–31, 1938–62.	1952		24.28	441,000	
					Apr. 2	6.92	71,600	
	Perry Creek basin							
25	Perry Creek near Hinton, Iowa.	30.7			Mar. 27	17.05	3,800	(1)
26	Perry Creek at 38th Street, Sioux City, Iowa.	65.1	1944–62	1944		25.5	9,600	
					Mar. 27	13.27	3,580	(1)
	Floyd River basin							
27	Floyd River at Alton, Iowa	265	1955–62	1960		17.27	4,150	
					Mar. 28	18.35	12,200	[4] 2.41
28	West Branch Floyd River near Struble, Iowa.	181	1955–62	1960		14.72	3,880	
					Mar. 28	15.08	5,260	(1)
29	Floyd River at James, Iowa	882	1934–62	1953		25.3	71,500	
					Mar. 29	22.41	20,600	[4] 2.39
	Omaha Creek basin							
30	Omaha Creek at Homer, Nebr.	170	1940	1940		32.5	(1)	
			1945–62	1958		23.62	14,400	
					Mar. 28		1,850	4

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, March–April in southeastern South Dakota and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1962: Period	Year	March–April 1962	Gage height (ft)	Discharge: Cfs	Recurrence interval (years)
	Monona-Harrison Ditch basin							
31	West Fork Ditch at Holly Springs, Iowa.	399	1939–62	1960		[7] 22.43	10,000	
					Mar. 28	22.46	12,400	(1)
32	Monona-Harrison Ditch near Turin, Iowa.	900	1958–62	1960		16.32	10,400	
					Mar. 28	16.09	11,400	(1)
	Little Sioux River basin							
33	Little Sioux River at Correctionville, Iowa.	2,500	1891	1891		29.34	(1)	
			1918–25, 1928–32, 1936–62.	1954		23.36	20,900	
					Mar. 30	23.14	19,800	[4] 1.43
34	Little Sioux River near Kennebec, Iowa.	2,738	1939–62	1954		26.63		
				1960			16,400	
					Mar. 28	[8] 22.40		
					Mar. 31		19,000	[4] 1.35
35	Maple River at Mapleton, Iowa.	669	1941–62	1950		22.1		
				1954			15,600	
					Mar. 28	16.05	13,530	[4] 1.70
36	Little Sioux River near Turin, Iowa.	3,526	1958–62	1960		25.08	23,900	
					Mar. 29	23.97	24,400	(1)
	Platte River basin							
37	Platte River at North Bend, Nebr.	77,800	1949–62	1952		[3] 8.17		
				1960			112,000	
					Mar. 23	[3] 6.78		
					Mar. 26		39,000	5
38	Elkhorn River near Norfolk, Nebr.	2,790	1945–62	1960		8.60	13,500	
		[2] 1,790			Mar. 28	6.24	7,320	6
39	North Fork Elkhorn River near Pierce, Nebr.	520	1960–62	1960		12.38	1,410	
					Mar. 28	14.90	11,600	[4] 2.04
40	Logan Creek near Uehling, Nebr.	1,030	1940–62	1940		18.6	22,200	
					Mar. 27	18.15	19,400	[4] 1.42
41	Maple Creek near Nickerson, Nebr.	450	1944	1944		16.28	35,000	
			1951–62	1960		14.67	10,800	
					Mar. 25	13.95		
					Mar. 26		5,500	6
42	Elkhorn River at Waterloo, Nebr.	6,900	1880–1962	1944		(1)	100,000	
		[2] 5,630			Mar. 29	17.12	50,200	[4] 1.10
43	Platte River near South Bend, Nebr.	85,500	1881–1962	1960		[9] 12.45	124,000	
					Mar. 27	8.90	60,400	7

[1] Unknown.
[2] Contributing drainage area.
[3] Backwater from ice or snow.
[4] Ratio of peak discharge to 25-year flood.
[5] No peak above base discharge (400 cfs).
[6] Estimated.
[7] Affected by levee break near gage.
[8] Affected by backwater from Maple River.
[9] Maximum known 1953–62; may not have been maximum since 1881.

FLOODS OF MAY IN NORTHWESTERN NEBRASKA

By H. D. Brice

Almost continuous rainfall on May 14–21 in northwestern Nebraska caused floods of extraordinarily great discharge in a small area near Rushville.

One of the severest floods within the memory of local residents occurred on Rush Creek near Rushville on May 20 (fig. 12). The headwaters of this stream are about 5 miles northwest of town, and one of its principal tributary drains an area southwest of town. The confluence of the tributary and the main stem is about 2½ miles south of town.

Unofficial rainfall amounts of 4–8 inches were reported by ranchers around Rushville and by residents in the town (table 7). The official rainfall observation for Rushville, made at Consumers Public Power District maintenance yard just south of the city, showed 4.80 inches

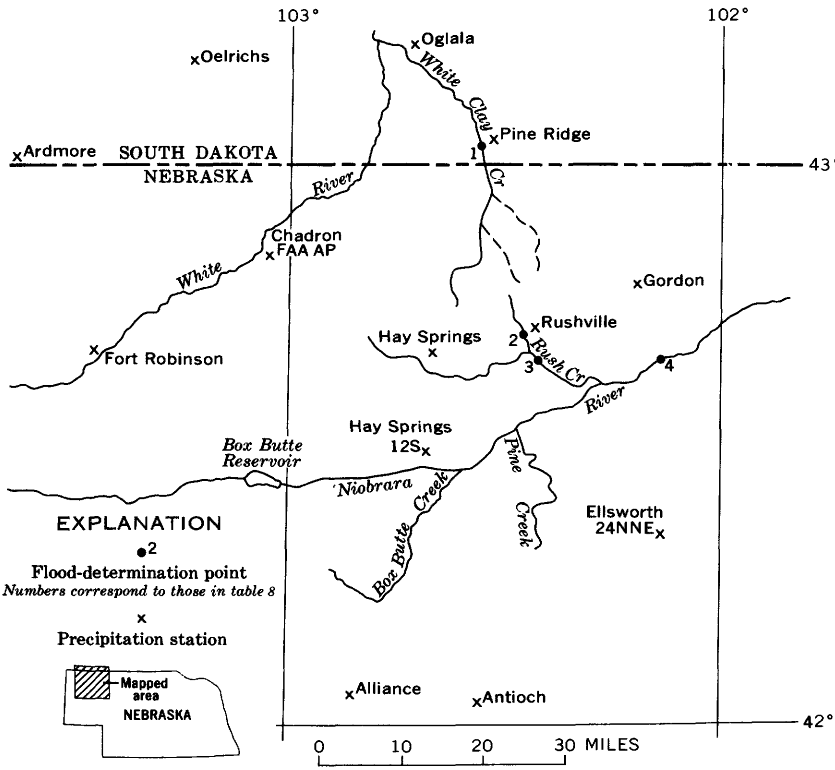


Figure 12.—Location of flood-determination points and rainfall data sites, floods of May 20–21 in northwestern Nebraska.

between 1400 and 2400 hours May 20 with the major portion falling between 1530 and 1830 hours.

In addition to the large quantity of rainfall, hail ranging in diameter from about half an inch to almost 4 inches was observed in the Rushville area. Hundreds of acres of wheat and grassland were damaged by the hail. Several head of livestock were missing after the flood, and two cows were found in tree crotches some 15–20 feet above the ground on a ranch northwest of Rushville.

TABLE 7.—*Daily precipitation, in inches, associated with the floods of May 20–21 in northwestern Nebraska and southwestern South Dakota*

[From U.S. Weather Bureau records. Tr., trace]

Station	Time of observation	May								
		14	15	16	17	18	19	20	21	Total
Ardmore, S. Dak	1800	0.52	0.04	0.02	0.93	1.33	0.05	Tr.	0.98	2.87
Chadron, Nebr	2400	.36	0	.57	.83	.50	0	Tr.	.22	2.48
Fort Robinson, Nebr	0800	0	.62	0	1.10	.53	1.00	0	.05	3.30
Gordon, Nebr	1700	.40	.10	.70	.50	1.35	0	0	.19	3.24
Hay Springs, Nebr	0800	0	.13	.30	1.51	.41	.04	0	.48	2.87
Hay Springs 12S, Nebr	1700	.15	.30	.75	.76	.58	0	1.10	.52	4.16
Oelrichs, S. Dak	1800	.83	.05	.07	1.06	.71	.03	.01	.47	3.23
Pine Ridge 1 NNW, S. Dak	1800	0	.20	.65	.85	.57	0	.27	.36	2.90
Rushville, Nebr	0800	0	.37	.57	1.97	.54	.34	0	4.80	8.59

U.S. Highway 20 was overtopped at three points between Hay Springs and Rushville and was closed briefly at the Rushville bridge while a washed-out section of the approach fill was being replaced. The bridge on State Highway 87 at the north edge of Rushville was partly washed out, and about 50 feet of the approach to the bridge across Rush Creek on State Highway 250, about 5 miles south of Rushville, was washed away. At the height of the flooding on May 20, water stood within 4 feet of the tops of the telephone poles along this highway south of town.

Damage to one ranch about 12 to 15 miles southeast of Rushville was estimated to be nearly $10,000. Seven of the nine farm buildings and all corrals were washed away, and all machinery was damaged.

On the basis of the streamflow-data available, the recurrence interval of this flood is indeterminable, but the peak discharge in Rush Creek 1 mile west of Rushville was about seven times as great as a 50-year flood (table 8).

On the basis of rainfall records compiled by the U.S. Weather Bureau, and reported in USWB Technical Papers 40 (1961) and 49 (1964), the recurrence interval of the point rainfall that was observed within the basin is much greater than 100 years. Paper 40 shows that a point rainfall of about 3½ inches in 3 hours has a recurrence interval of

100 years at this site, and paper 49 shows that an 8-inch rainfall in a period of 10 days has a recurrence interval of 100 years.

TABLE 8.—*Flood stages and discharges, May in northwestern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1962: Period	Prior to May 1962: Year	May 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	White River basin							
1	White Clay Creek ½ mile west of Pine Ridge, S. Dak.				20		1,880	(1)
	Niobrara River basin							
2	Rush Creek 1 mile west of Rushville, Nebr.	26.8			20		7,580	[2] 7.1
3	Rush Creek 3 miles south of Rushville, Nebr.	162			20		17,400	[2] 5.6
4	Niobrara River near Gordon, Nebr.	2,595	1928–32, 1945–62.	1951		(1)	5,940	
					21	5.25	9,130	13

[1] Not determined.
[2] Ratio of peak discharge to 50-year flood.

This same storm extended northward into White Clay Creek basin, causing some local flooding near Pine Ridge, S. Dak. The rainfall observed at the rain gage 1 mile north-northwest of that village (table 7) is believed to be only a small part of the amount that fell elsewhere in White Clay Creek basin. Rush Creek and White Clay Creek basins are contiguous just north of Rushville, and it is probable that rainfall amounts of up to 8 inches may also have occurred over parts of White Clay Creek headwaters.

Further evidence of the magnitude of the flood in Rush Creek about 4 miles upstream from the Niobrara gaging station near Gordon is shown by its effect on the Niobrara River.

The peak discharge of Niobrara River near Gordon (sta. 4) on May 21 resulted largely from the floodwaters from Rush Creek and was the greatest observed during the periods of record, 1928–32 and 1945–62. The gaging station about 40 miles upstream, near Hay Springs, recorded a small decrease in flow from May 20 to 21. Two large tributaries, Box Butte Creek and Pine Creek, enter the Niobrara River from the south between the Hay Springs and Gordon stations, but observed rainfall at Alliance and Antioch, short distances south and west of these two stream basins, was only 0.30 inch and 0.49 inch, respectively, for that 2-day period.

Smaller tributaries that enter the Niobrara River from the north in that reach may have contributed some flow, for the U.S. Weather Bureau station 12 miles south of Hay Springs reported rainfall of 1.10 inches and 0.52 inch on May 20 and 21, respectively (table 7).

The damage along the Niobrara River was limited to bank and channel erosion and the loss of a county highway bridge. The bridge, about 120 miles downstream from the mouth of Rush Creek, washed out after its right abutment had been undercut.

FLOODS OF MAY AND JUNE IN NORTHEASTERN WYOMING

General rains accompanied by severe thunderstorms occurred over most of northeastern Wyoming from May 12 to June 20. Moorcroft received 11.00 inches of rain from May 12 to June 19, and Sundance received 11.99 inches from May 15 to June 15. The rains kept discharges in streams above normal and conditioned the soil to produce high rates of runoff. Within the period of general rains there were three storm periods—May 21–22, May 25–26, and June 15–17—in which rather intense rainfall caused flooding in scattered areas in northeastern Wyoming (fig. 13). Several U.S. Weather Bureau precipitation stations reported up to 2 inches of rainfall in the 2 days preceding the peak discharges on the flooding streams.

Maximum discharges during the period of gaging-station record (14–20 years) occurred at one gaging station in the Yellowstone River basin and at three gaging stations in the Cheyenne River basin (table 9).

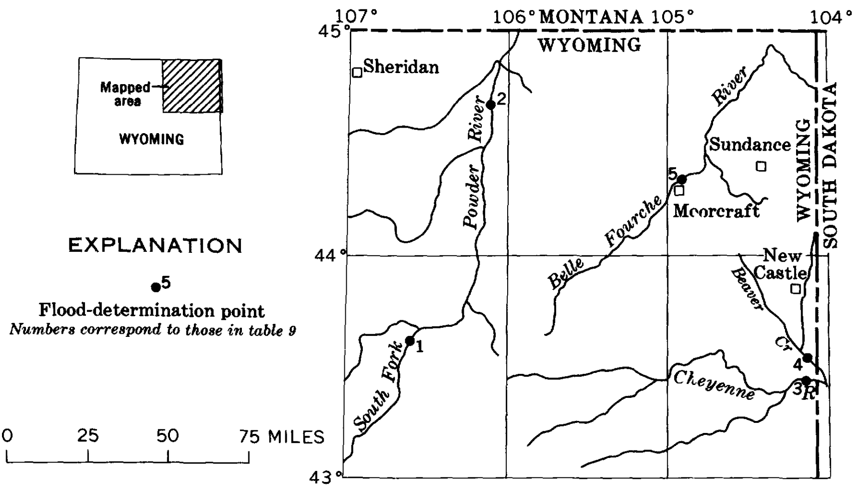


FIGURE 13.—Location of flood-determination points, floods of May and June in northeastern Wyoming.

Two exceptionally high discharges occurred; one was on South Fork Powder River near Kaycee (sta. 1) on May 22, and the other was on Beaver Creek near Newcastle (sta. 4) on June 16. Near Kaycee the peak discharge was about 2.5 times the previous maximum discharge in 15 years of discharge record, and near Newcastle the peak discharge was about 6.5 times the previous maximum discharge in 19 years of discharge record.

TABLE 9.—*Flood stages and discharges, May and June in northeastern Wyoming*

No.	Stream and place of determination	Drainage (sq mi)	Maximum floods: Prior to May 1962: Period	Prior to May 1962: Year	May, June 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Yellowstone River basin							
1	South Fork Powder River near Kaycee.	1,150	1938–39, 1950–62.	1952		9.00	14,400	
					May 22	13.17	35,500	[1] 1.41
2	Powder River at Arvada	6,050	1919–62	1923		[2] 23.7	100,000	
					May 23	15.52	32,000	18
	Cheyenne River basin							
3	Cheyenne River near Spencer	5,270	1949–62	1952		[3] 8.6	9,840	
					May 27	8.74	16,000	16
4	Beaver Creek near Newcastle	1,320	1943, 1945–62.	1943		14.00	1,840	
					June 16	19.98	11,900	33
5	Belle Fourche River below Moorcroft.	1,670	1908	1908		(4)	(5)	
			1924	1924		(5)	12,500	
			1943–62	1952		12.30	1,800	
					May 27	14.33	4,420	7

[1] Ratio of peak discharge to 50-year flood.
[2] At site 2500 ft downstream at datum 0.14 ft lower.
[3] At site 1800 ft downstream at datum 4.04 ft lower.
[4] Stage about 2.5 ft higher than that of April 1924.
[5] Not determined.

Flooding caused widespread destruction of county bridges and culverts and loss of livestock and stock-water ponds. Crook County was especially hard hit; 17 bridges and numerous culverts were washed out on 48 miles of county roads. Ranchers in the upper Powder River basin said that flooding was the worst that had occurred in about 80 years.

FLOODS OF MAY–JULY IN NORTHERN KANSAS

By T. J. Irza

The greater part of precipitation in Kansas results from summer thunderstorms, which may be very severe at times. About 75 percent of the precipitation falls from April to September, and the greatest monthly amount falls in June. Rainfalls of 5 inches in 24 hours occur rather frequently in some parts of the State, and most of the floods in Kansas result from this type of storm.

Rainfall in 1962 followed the usual seasonal pattern, and floods occurred in three areas in northern Kansas during a 6-week period May 28 to July 10. The maximum daily point rainfall reading during each of the storms ranged from 4.18 inches to 5.90 inches.

Heavy rainfall in northeastern Kansas on May 28–29 (fig. 14) produced notable flooding. Rainfall readings on May 29 ranged from 3 inches to almost 6 inches in the flood area, and totals for the 2-day storm period were as much as 6.42 inches. The heavy rainfalls produced some peak discharges of high recurrence intervals.

The greatest peak discharges were in the area of most intense rainfall (see table 10)—the basins of Fancy Creek, Rock Creek, and the Black Vermillion River. The peak discharge in Fancy Creek at Winkler (sta. 7) was 1.1 times as great as a 50-year flood, and the peak stage was 1.1 feet lower than the maximum stage known since at least 1915. The peak discharge (14,100 cfs) on Rock Creek near Louisville (sta. 11) had a recurrence interval of 35 years and was greater than the peak discharge (13,100 cfs) of the flood of July 1951 at a site 5.6 miles downstream, where the drainage area was about 16 percent greater.

Where the storm rainfall was less than 4 inches the peak discharges were negligible, and at many sites they were less than the mean annual flood.

Heavy rains fell in northwestern Kansas on June 6–8 and caused floods in a small area (fig. 15). The rainfalls causing the greatest floods were more than 4 inches for the storm period and were centered in the Goodland, Brewster, Winona, and Wallace areas. Outside of this area the runoff was minor. (See table 11.)

High unit peak discharges were determined at two points: 1,080 cfs per sq. mi. from 1 square mile on the North Fork Smoky Hill River tributary near Winona (sta. 8), and 650 cfs per sq. mi. from 4 square miles on South Fork Sappa Creek tributary near Goodland (sta. 1).

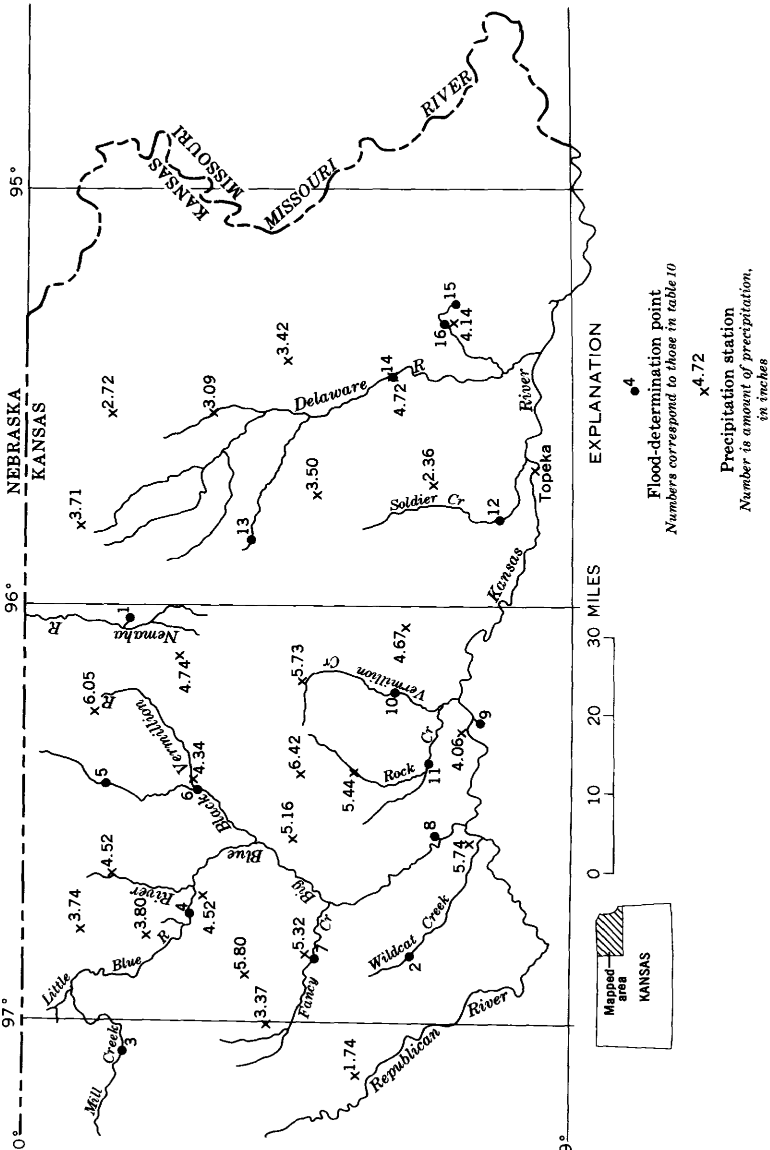


FIGURE 14.—Location of flood-determination points and precipitation stations, floods of May 28–29 in northeastern Kansas.

TABLE 10.—*Flood stages and discharges, May 28–29 in northeastern Kansas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1962 — Period	Prior to May 1962 — Year	May 1962	Gage height (ft)	Discharge — Cfs	Discharge — Recurrence interval (years)
	Nemaha River basin							
1	Tennessee Creek tributary near Seneca.	0.90	1957–62	1959		18.64	1,220	
					28	[1] 17.38	550	(2)
	Kansas River basin							
2	Wild Cat Creek at Riley	13	1957–62	1960		19.85	2,050	
					28	17.98	1,400	(2)
3	Mill Creek at Washington	344	1903–62	1941		36	(2)	
			1959–62	1960		25.58	9,690	
					28	13.98	1,840	<2
4	Little Blue River at Waterville.	3,330	1903	1903		[3] 28	(2)	
			1922–25, 1928–62.	1941		[3] 26.20	[3] 50,400	
					28	13.33	8,120	<2
5	Robidoux Creek at Beattie	40	1957–62	1960		22.46	6,200	
					28	20.12	3,300	(2)
6	Black Vermillion River near Frankfort.	412	1948, 1951	1948		30.2	(2)	
			1953–62	1959		29.40	38,300	
					29	29.03	27,400	28
7	Fancy Creek at Winkler	176	1915–62	1944		22.3	(2)	
			1953–62	1958		21.80	19,600	
					28	21.21	19,200	[4] 1.1
8	Cedar Creek near Manhattan	14.5	1957–62	1958		18.97	3,000	
					28	19.80	3,500	(2)
9	Kansas River tributary near Wamego.	2.3	1951, 1957–62.	1958		[1] 18.55	1,290	
					28	12.29	200	(2)
10	Vermillion Creek near Wamego	243	1873–1962	1915		30.9	38,500	
					29	28.51	13,600	15
11	Rock Creek near Louisville	128	1958–62	1959		[1] 27.8	6,040	
					29	33.23	14,100	35
12	Soldier Creek near Delia	157	1909–62	1951		24	(2)	
			1958–62	1961		21.00	4,000	
					29	20.40	3,260	2
13	Spring Creek near Wetmore	20	1957–62	1958		21.38	8,710	
					28	17.91	1,100	(2)
14	Delaware River at Valley Falls.	922	1865–1962	1951		32.08	94,600	
					29	18.23	13,400	2
15	Slough Creek tributary near Oskaloosa.	1	1957–62	1961		21.3	948	
					28	15.5	390	(2)
16	Slough Creek near Oskaloosa	29	1957–62	1961		22.31	11,900	
					28	13.50	3,300	(2)

[1] Affected by backwater.
[2] Unknown.
[3] At site 11.5 miles downstream at datum 29.19 ft lower.
[4] Ratio of peak discharge at 50-year flood.

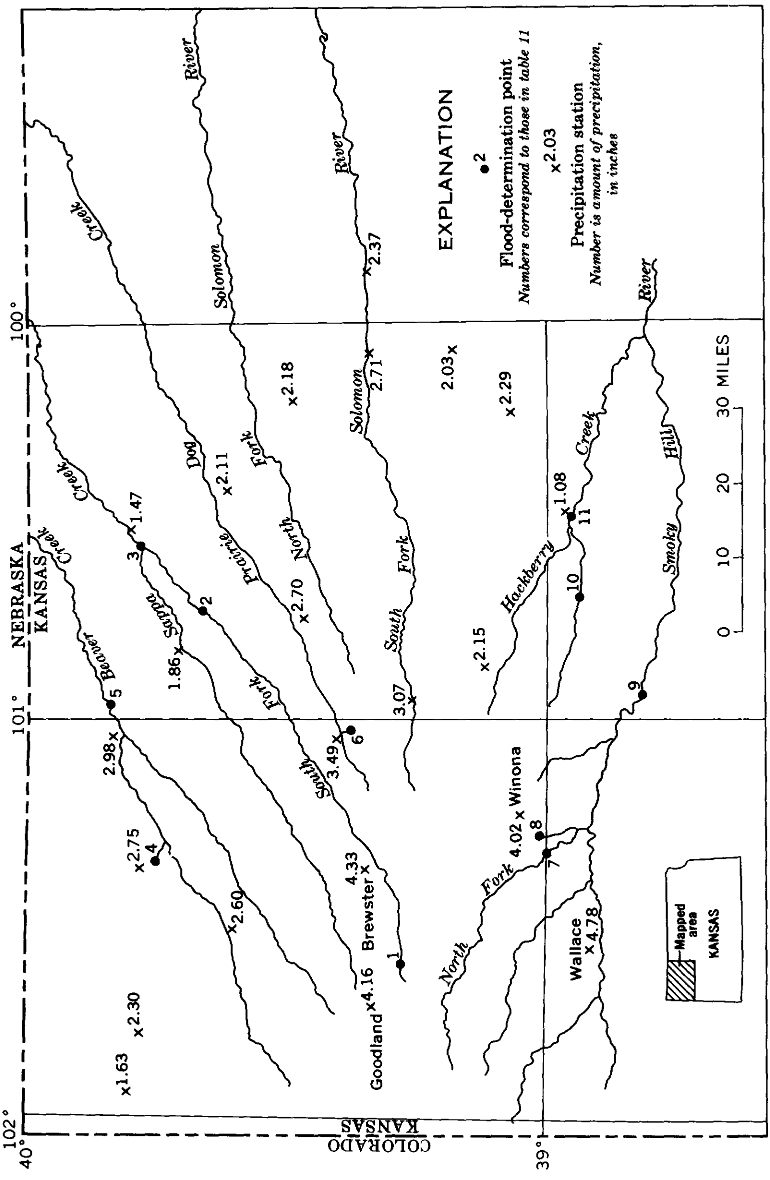


FIGURE 15.—Location of flood-determination points and precipitation stations, floods of June 7–8 in northwestern Kansas.

TABLE 11.—*Flood stages and discharges, June 7–8 in northwestern Kansas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1962: Period	Maximum floods: Prior to June 1962: Year	Maximum floods: June 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
1	South Fork Sappa Creek tributary near Goodland.	4	1957–62	1958		14.0	1,720	
					7	14.83	2,600	(1)
2	South Fork Sappa Creek near Achilles.	434	1959–62	1960		9.03	4,120	
					8	7.91	375	<2
3	Sappa Creek near Oberlin	1,040	1928–32, 1943–62.	1944		[2] 15.28	10,600	
					8	5.58	278	<2
4	Little Beaver Creek tributary near McDonald.	12	1957–62	1957		12.91	1,100	
					7	11.40	50	(1)
5	Beaver Creek at Ludell	1,460	1930–53, 1961–62.	1930		[3] 15.0	3,300	
					8	11.71	1,400	2
6	Prairie Dog Creek tributary at Colby.	6	1957–62	1957		17.86	682	
					8	16.66	350	(1)
7	North Fork Smoky Hill River near McAllaster.	670	1930	1930		[4] 14.4	(1)	
			1946–53, 1959–62.	1951		[4,5] 10.95	12,200	
					8	[6] 10.40	21,700	[7] 1.59
8	North Fork Smoky Hill River tributary near Winona.	1	1957–62	1957		[8] 12.38	(1)	
					7	12.47	1,080	(1)
9	Smoky Hill River at Elkader	3,560	1938–62	1938		13.2	71,000	
					8	7.58	13,800	8
10	South Branch Hackberry Creek near Orion.	49	1957–62	1960		18.86	2,300	
					8	10.60	38	(1)
11	Hackberry Creek near Gove	426	1947–53, 1960–62.	1951		19.0	18,200	
					8	3.75	60	<2

[1] Unknown.
[2] At site 7 miles downstream, at datum 49.2 ft lower.
[3] Site and datum then in use.
[4] At site 2 miles upstream at datum 15.75 ft higher.
[5] 11.7 ft from floodmark.
[6] 11.8 ft from floodmark.
[7] Ratio of peak discharge to 50-year flood.
[8] At site 100 ft upstream at datum 1.00 ft higher.

The local nature of the floods is indicated by comparison of the peak discharge on North Fork Smoky Hill River near McAllaster (sta. 7) with the peak discharge downstream on Smoky Hill River at Elkader (sta. 9). The peak discharge on North Fork (21,700 cfs; drainage area, 670 sq. mi.) had a recurrence interval much greater than 50 years, whereas the peak discharge on Smoky Hill River (13,800 cfs; drainage area, 3,560 sq. mi.) had a recurrence interval of 8 years.

Heavy rain fell on July 1–2 in a small area in northwestern Kansas about 100 miles east of the flood area of June 7–8. The maximum rainfall recorded for the storm was 5.74 inches at Wakeeney (fig. 16). June precipitation totals of three to four times normal had caused high soil moisture, and the locally heavy rain near Wakeeney greatly affected runoff into the South Fork Solomon River and the Saline River.

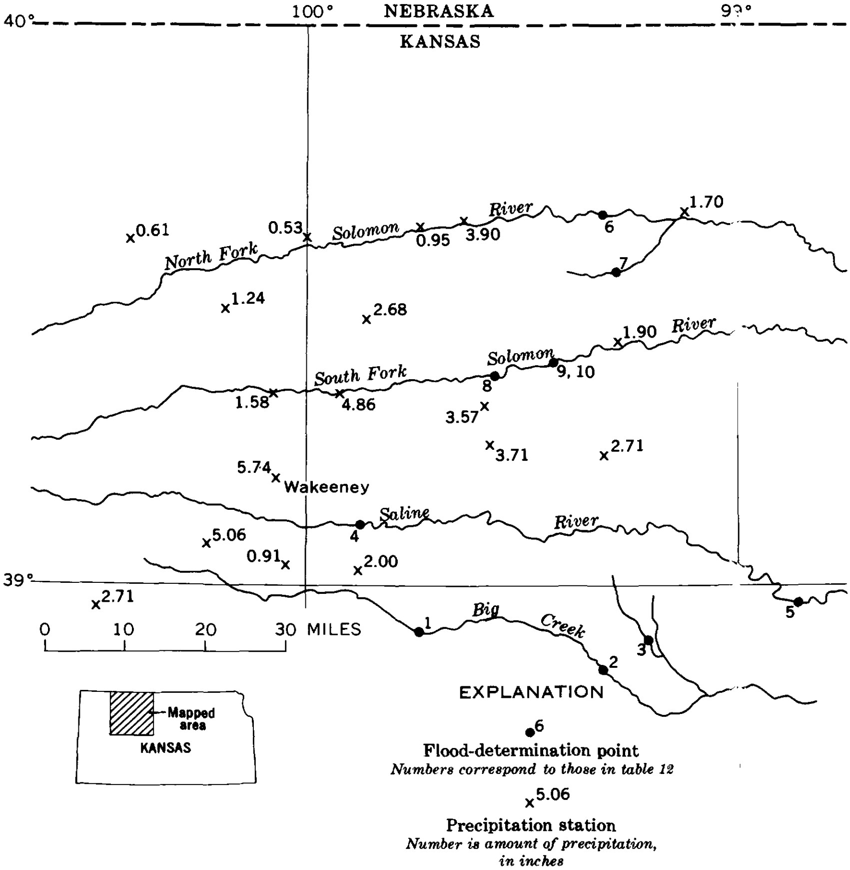


Figure 16.—Location of flood-determination points and precipitation stations, floods of July 2–5 in northwestern Kansas.

The peak discharges in the streams near the storm were exceptionally high (see table 12), but the storm area was small and the high discharges were not sustained. The peak discharge of 11,900 cfs in Saline River near Wakeeney (sta. 4) had a recurrence interval of 50 years, but the crest of 4,780 cfs downstream at Russell (sta. 5) had a recurrence interval of only 2 years. The peak discharge in South Fork Solomon River above Webster Reservoir (sta. 8 had a recurrence interval greater than 50 years. The discharge was contained in Webster Reservoir; on July 2 the water altitude increased 5.21 feet and the contents increased by 20,400 acre-feet, equivalent to a mean flow for the day of 10,300 cfs. The daily discharge out of Webster Reservoir on July 2 was controlled to about 5 cfs.

Discharges on streams outside of the Wakeeney vicinity were minor, many of them being about equal to the mean annual flood.

TABLE 12.—*Flood stages and discharges, July 1–10 in northwestern Kansas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to July 1962		July 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
1	Big Creek near Ogallah	297	1914–62	1957		19.02	18,500	
					3	10.95	1,600	2
2	Big Creek near Hays	542	1908–62	1957		22.07	22,400	
					5	9.10	862	2
3	North Fork Big Creek near Victoria.	54	1962	1962		10.88	750	
					2	6.94	266	(1)
4	Saline River near Wakeeney	696	1879–1962	1950		27	(1)	
			1955–62	1957		19.40	13,000	
					2	18.95	11,900	50
5	Saline River near Russell	1,502	1945–53, 1959–62.	1951		19.12	17,000	
					4	13.61	4,780	2
6	North Fork Solomon River at Glade.	849	1952–62	1957		16.55	23,300	
					2	10.72	4,260	2
7	Bow Creek near Stockton	337	1950–62	1951		13.6	12,900	
					1	9.21	1,410	2
8	South Fork Solomon River above Webster Reservoir.	1,040	1945–62	1951		[2] 14.9	55,200	
					2	12.92	20,100	[3] 1.1
9	Webster Reservoir near Stockton.	1,200	1958–61	1961		1899.66	[4] 107,600	
					5	1896.97	[4] 95,600	(1)
10	South Fork Solomon River below Webster Reservoir.	1,200	1956–62	1958		13.00	[5] 1,740	
					10	12.62	[6] 2,070	(1)

[1] Unknown.
[2] At site 8 miles downstream at datum 94.52 ft lower.
[3] Ratio of peak discharge to 50-year flood.
[4] Contents in acre-feet.
[5] 1,500 cfs at spillway; 242 cfs at river outlet.
[6] 2,070 cfs at spillway: 0.5 cfs at river outlet.

FLOODS OF JUNE IN NEBRASKA

June floods in Nebraska were associated with several storms periods in four loosely defined areas of the State, so the events are reported in chronological order.

Appreciable damage from flooding and from hail and wind occurred over much of a narrow area (fig. 17) between Curtis and Albion in central Nebraska on June 6–7 and 16.

Relatively heavy and almost continuous rainfall preceded the flood-producing rains of June 5–6, and this rain, supplemented by that which fell during the following 10 days (table 13), maintained a high soil-moisture condition throughout the area and contributed appreciably to the flooding that followed the heavy rainfall on June 15–16.

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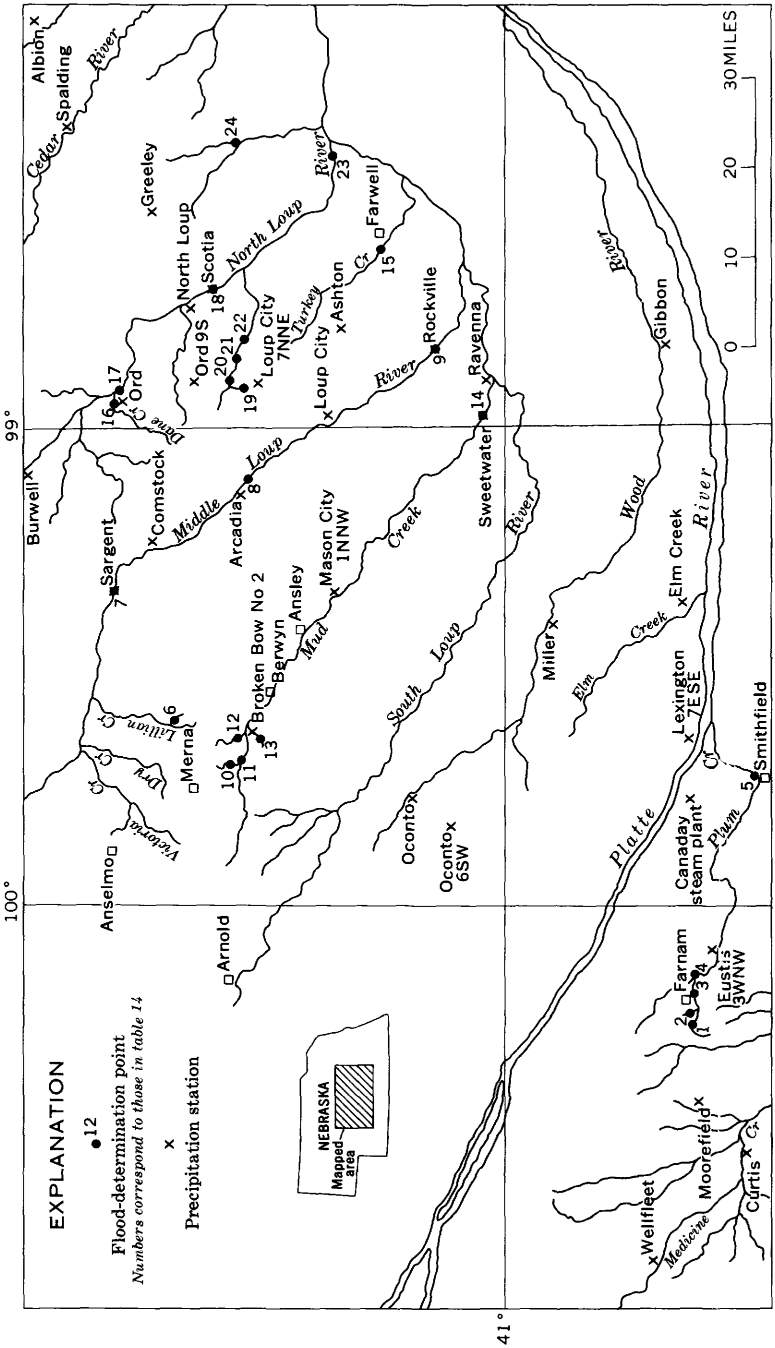

FIGURE 17.—Location of flood-determination points and precipitation stations, floods of June 6–7 and 16 in central Nebraska.

TABLE 13.—*Daily precipitation, in inches, associated with the floods of June 6–7 and 16 in central Nebraska*

[Tr., trace]

Station	Time of observ-ation	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Albion 7 WNW	2400	0	0.07	0.28	0.27	0.19	0.90	0.38	0.37	0.04	0	0	0	0	0	0	1.39	0.16
Albion	0800	0	.14	.36	.04	.61	.86	.36	0	.30	Tr.	0	0	0	0	0	1.61	0
Albion 9 NE	2400	0	.05	.21	.06	.34	1.02	.13	.25	.03	0	0	0	0	0	0	1.13	.07
Ashton	2400	0	.14	.25	.42	.15	.34	1.06	.42	0	0	0	0	0	0	0	1.80	0
Broken Bow No. 2	2400	.02	.44	.16	.54	.15	1.79	2.31	.26	.05	0	0	0	0	0	0	1.10	0
Burwell	2400	0	.14	.05	.37	.02	1.86	1.16	.21	0	0	0	.86	0	0	0	.98	0
Canaday steam-plant	2400	.02	.76	.20	0	.22	1.14	1.64	.84	0	0	0	0	.03	0	0	.04	0
Comstock	0700	0	.07	.24	0	.60	2.15	2.82	.71	.03	.38	0	0	.20	0	.02	0	1.17
Curtis	2400	.81	.61	.19	0	.03	.62	1.23	1.06	0	0	0	.50	.85	0	0	2.58	0
Elm Creek	2400	.10	.65	.30	0	.03	.08	.42	.40	0	0	0	1.45	0	0	0	0	0
Eustis 3 WNW	0700	.18	.34	.47	0	.04	.57	1.40	1.33	0	0	0	.24	.13	0	Tr.	0	1.90
Gibbon	2400	.13	.47	.18	0	0	0	.33	.16	0	0	0	2.04	0	0	0	0	0
Gothenburg	1900	.34	.69	.20	0	.08	1.73	2.51	.93	0	0	0	.05	.35	0	.01	1.57	0
Greeley	1800	0	.14	.36	.01	.45	1.58	.73	.40	0	.05	0	0	0	0	.03	0	2.16
Lexington 7 ESE	(1)	.01	.78	.31	0	.32	.90	2.09	1.99	0	.02	0	Tr.	.57	Tr.	0	.02	0
Loup City	0700	0	.27	.27	0	.84	.90	1.70	.44	.07	0	0	.12	0	0	0	0	2.24
Loup City 7 NNE	1800	Tr.	.24	.18	0	.65	.98	.96	.38	0	0	0	0	0	0	0	0	2.32
Mason City 1 NNW	0800	.28	.40	.49	0	.20	.92	1.43	.60	0	0	0	0	.20	0	0	.22	1.95
Miller	1800	.37	.72	.30	0	.13	.27	.80	.56	0	0	0	1.24	.67	0	0	1.39	.09
Moorefield	0700	.70	.39	.50	0	.04	.35	1.52	1.03	0	0	0	.30	.41	0	0	0	2.88
North Loup	0700	Tr.	.13	.16	.07	.77	1.26	1.96	.23	.19	0	0	0	0	0	Tr.	Tr.	1.94
Oconto	0800	.32	.31	.52	0	.17	1.36	2.10	.42	0	0	0	0	.12	0	0	0	1.93
Oconto 6 SW	1800	.29	.58	.26	0	.12	.91	1.99	.50	0	0	0	0	.03	0	.05	1.47	.05
Ord	1900	Tr.	.17	.13	0	.56	2.38	3.81	.39	0	.07	0	.37	0	0	.02	2.04	.02
Ord 9 S	0800	0	.18	.16	Tr.	.65	1.94	1.65	.28	.09	0	0	0	0	0	Tr.	0	1.45
Ravenna	1800	Tr.	.35	.24	0	.25	.27	.43	.38	0	0	0	Tr.	.14	0	Tr.	0	Tr.
Spalding	2400	0	.09	.17	.35	.13	.92	.34	.27	.03	0	0	0	0	0	0	1.75	.09
Wellfleet	0700	.38	.18	.54	0	0	1.13	.89	.97	.03	0	0	.28	.12	0	0	0	.56

[1] Near sunset.

The rainfall amounts shown in table 13 are for the 24-hour period preceding the hour listed as "Time of observation," and because some of the larger amounts were observed on June 17, it is possible that some of the peak discharges shown in table 14 as occurring June 16 may have occurred during the early morning hours of June 17. The peak stages were obtained from nonrecording gages, and the exact time of occurrence of the peaks is indeterminable. The peak discharges shown in table 14 exceed previously observed maximums at several sites for which records were collected only subsequent to the 1947 floods. The peak discharges of 1947 at most of the sites in the table 14 probably were greater than any that have occurred since. For example, the records for tributaries to South Fork and to North Fork Plum Creek do not include the flood of 1947, and the June 1962 peak is the greatest in the period of record. At downstream stations in the Plum Creek basin, records include the 1947 floods, which were the greatest in the period.

TABLE 14.—*Flood stages and discharges, June 6–7 and 16 in central Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1962: Period	Prior to June 1962: Year	June	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interva (years)
	Platte River basin							
1	South Fork Plum Creek tributary near Farnum.	9.81	1951–62	1951			1,170	
					16	15.81	2,320	[1] 4.02
2	North Fork Plum Creek tributary near Farnum.	1.83	1952–62	1960			206	
					16	12.50	435	[1] 1.87
3	Plum Creek tributary at Farnum.	19.8	1947–48, 1951–62.	1947			4,300	
				1948			4,300	
					16	17.31	3,110	[1] 4.15
4	Plum Creek near Farnum	79.8	1947, 1951–62.	1947			3,800	
					16	18.74	1,970	[1] 1.32
5	Plum Creek near Smithfield	229	1947–62	1947			2,800	
					21		562	2
6	Lillian Creek near Broken Bow.	4.77	1947, 1951–62.	1947			930	
					6	11.68	607	[1] 1.42
7	Middle Loup River at Sargent.	4,480 [2] 475	1936–38, 1952–62.	1960			3,400	
					6	3.56	3,200	5
8	Middle Loup River at Arcadia	4,730 [2] 820	1937–62	1947			(3)	
				1960		[4] 6.41		
					7	4.71	7,140	20
9	Middle Loup River at Rockville.	(3)	1955–62	1957			10,400	
				1960		[4] 6.20		
					7	4.99	7,810	
10	South Branch Mud Creek tributary near Broken Bow.	.43	1951–62	1958			184	
					6	12.53	93	[1] 1.14
11	South Branch Mud Creek at Broken Bow.	440	1945, 1951–62.	1956			1,790	
					6	13.08	188	<2
12	North Branch Mud Creek at Broken Bow.	15.5	1951–62	1956			1,550	
					6	14.75	960	22
13	Mud Creek tributary near Broken Bow.	5.98	1945, 1951–62.	1945			1,500	
					7	13.35	260	6
14	Mud Creek near Sweetwater	1,020 [2] 655	1929–62	1947		23.20	(3)	
					9	17.52	2,380	
					18	17.93	2,520	2
15	Turkey Creek near Farwell	27.2	1950, 1953–62.	1950			1,600	
					16	16.46	1,220	[1] 1.87
16	Dane Creek at Ord	(3)			7		1,320	(3)
17	North Loup River at Ord	850	1936–38, 1952–62.	1956			4,430	
				1960		4.94		
					7	5.52	10,100	12
18	North Loup River at Scotia	4,100 [2] 910	1936–62	1947		8.18	[5] 32,000	
					7	6.14	16,500	[1] 1.09
19	Davis Creek tributary near North Loup.	2.29	1951–62	1951			1,680	
					16	17.84	1,780	[1] 6.50
20	Davis Creek tributary No. 2 near North Loup.	6.79	1951–62	1957			722	
					16	14.22	262	6
21	Davis Creek near North Loup	21.1	1951–62	1957			1,820	
					16	16.77	1,520	[1] 1.32
22	Davis Creek southwest of North Loup.	41.6	1951–62	1957			2,220	
					16	20.31	1,730	20
23	North Loup River near St. Paul.	4,460 [2] 1,270	1894–1915, 1928–62.	1896			[5] 90,000	
					7	6.67	12,300	12
24	Marys Creek at Wolbach	7.63	1952–62	1958			440	
					16	12.75	251	4

1 Ratio of peak discharge to 25-yr flood.
2 Approximate contributing drainage area.
3 Unknown.
4 Affected by backwater from ice.
5 Estimated.

The peak on Plum Creek decreased markedly as it moved downstream, thus indicating that the flood-producing rainfall was concentrated in the headwaters area. The peak discharge corresponding to the June 16 peak in the headwaters of Plum Creek is believed to have passed Smithfield on June 21.

The peak discharges on Elm Creek and the Wood River were relatively small. The stage of Lillian Creek tributary near Broken Bow was the maximum of record (1952–1962). The peak at Lillian Creek near Broken Bow (sta. 6) on June 6 was exceeded only by that of June 1947.

The peak stage for the 1947 flood at Mud Creek near Sweetwater (sta. 14) was about 5 feet higher than the 1962 peak. The flooding of Mud Creek on June 6 and 7 caused considerable damage in Broken Bow. High stages prevented sanitary sewers from discharging and thereby caused basement flooding. Downstream, overflow from Mud Creek flooded many buildings along the channel at Ansley. Many fields in that vicinity were severely eroded, and many roads were washed out.

At Anselmo, drainage ditches could not carry the huge volume of overland flow reaching the village from the northwest, and homes and other buildings were flooded.

State Highway 92 between Arnold and Merna was overtopped by floodwater from June 7 to 9, probably owing to unobserved heavy rainfall in the headwaters of Victoria Creek on which no streamflow data were collected.

Flooding on the North Loup River and tributaries on June 7 prompted the Ord Quiz to report in its edition of June 14, 1962:

> Flood water reminiscent of the big drenching of June 21, 1947, poured from every creek and rivulet in Valley County last Tuesday (June 5) soaking basements by the score in Ord, North Loup, and Arcadia, swelling the North Loup River to a high stage for the year of 5.52 feet and drowning bottomland farm acreages. Rainfall of 3.81 inches fell in Ord Wednesday night and Thursday prior to 8 a.m. Several farms north of Ord reported more than 7 inches in three days ending Thursday morning. Rainfall during the period June 1–14 was 7.88 inches, June 1947 recorded 10.57 inches, June 1905 and June 1908 also topped the 10-inch marks. Highway No. 11 ran deep with water about 3 a.m., Thursday (June 7). Water from three branches of Dane Creek converged * * *. The creek then tumbled over its banks and onto the golf course, carrying away two bridges and washing out three greens.

Previous records of flood discharge are not available on Dane Creek for comparison.

Unofficial observations of rainfall included 4 inches on June 5 and 5.30 inches on June 7 at Berwyn and a storm total of nearly 4 inches at a farm 7 miles west of Broken Bow on State Highway 2. Larger amounts may have fallen unobserved at other points in the area.

The June 16 flood discharge at Davis Creek tributary near North Loup (sta. 19) was the greatest in the period of record, 1951–62, but the comparable peaks at the downstream stations were slightly smaller than those previously observed because of the wide variability of the storm rainfall.

On June 10 the highest stage since at least 1947 was recorded on Elkhorn River at Ewing and at Neligh (fig. 18).

The flood wave was reduced by channel and valley storage and by infiltration as it moved downstream from Neligh.

Rainfall causing these flood conditions began falling over the basin on June 3 and 4 and continued until June 9 and 10. Daily amounts, and the total for the period June 4–10, for rain-gage sites in or near the basin are given in table 15. The June 14, 1962, edition of the Holt County Independent describes the rainfall-runoff condition in the headwater area as follows: "At Stuart, at the headwaters of the Elkhorn, the hay meadows are swelled with rainwater trying to run off. Ditches were overflowing with water and for miles the meadows were under water." Highway 20–275 east of O'Neill was reported inundated from about midnight June 7 until late the following day, and the stage in O'Neill was observed to be almost as high as it was in 1947.

The approach to the county-road bridge east of Ewing washed out during this flood and again during high water of June 16, when the crest stage at the Ewing gaging station was about 1 foot lower than it had been on June 10.

TABLE 15.—*Daily and total precipitation, in inches, associated with the floods of June 10–11 in Elkhorn River basin*

[Tr., trace]

Station	Time of observation	June							
		4	5	6	7	8	9	10	Total
Ainsworth		0	0.49	1.03	0.51	0.17	0.07	Tr.	2.27
Amelia	2400	.22	.14	1.51	1.36	.15	.11	0	3.49
Atkinson		Tr.	.87	1.05	1.22	.12	0	0	3.26
Bartlett 7NNE		0	.39	1.62	.85	.28	0	.16	3.30
Bassett	2400	1.16	.15	.85	.46	.05	0	0	2.77
Burwell		.39	.02	1.72	1.37	.22	0	0	3.72
Creighton		.01	.65	1.05	.60	.09	0	.30	2.70
Elgin 9WSW Arden		.07	.55	.92	1.35	.32	.22	.12	3.55
Ewing		0	.39	1.23	.63	.51	Tr.	.34	3.10
Meadow Grove		.35	.25	.18	.46	1.70	.10	.28	3.32
Neligh		.12	.29	.25	1.12	.12	.31	0	2.21
Newport		.04	1.43	.88	.58	.25	.07	0	3.25
Norfolk WBAP		0	.14	1.15	.16	0	.11	0	1.56
Oakdale		0	.37	.59	.84	.45	0	.07	2.32
O'Neill		0	.61	1.40	.62	.23	0	.16	3.02
Pierce	2400	.03	.24	.85	1.23	.04	.04	.02	2.45
Spalding	2400	.35	.13	.92	.34	.27	.03	0	2.04
Walnut 1SE	2400	0	.46	1.40	.47	.10	0	.49	2.92

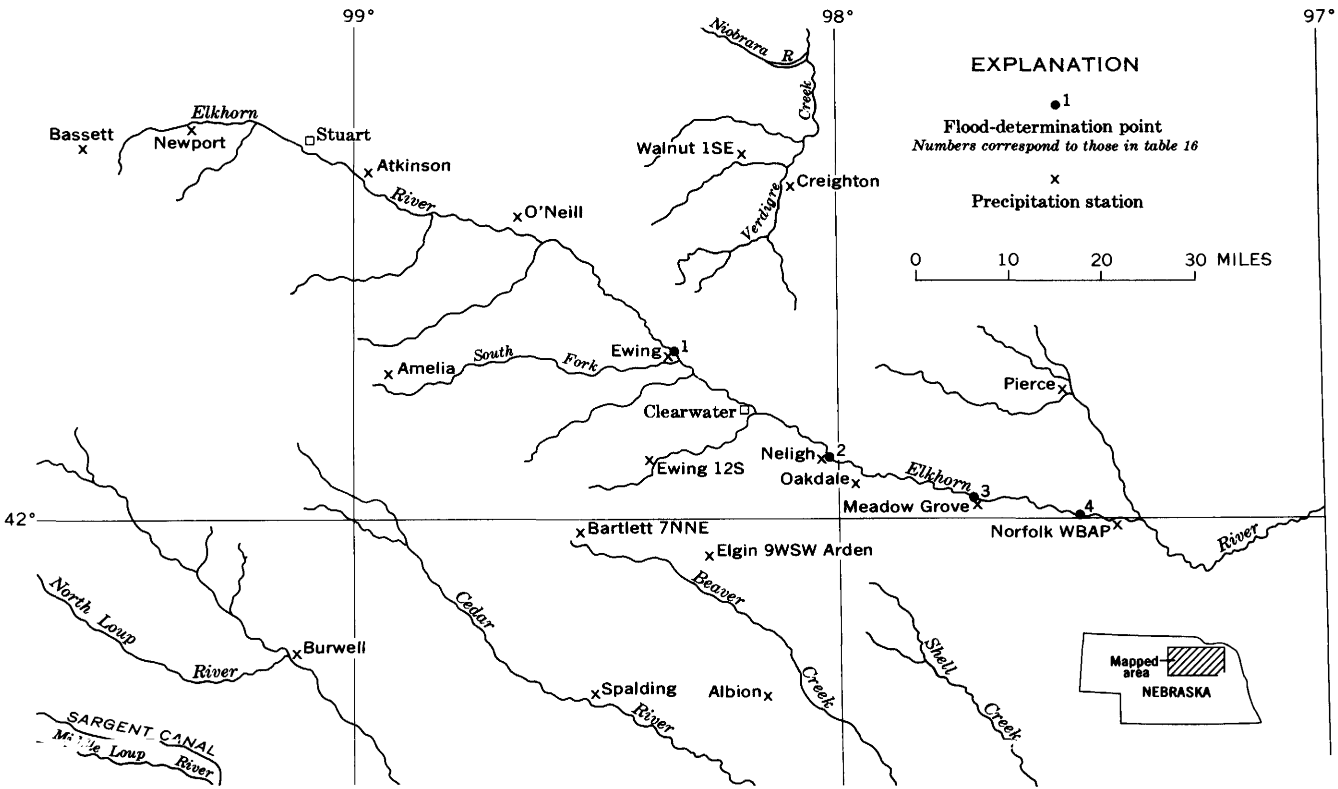

Figure 18.—Location of flood-determination points and precipitation stations, floods of June 10–11 in Elkhorn River basin, Nebraska.

The Neligh Leader of June 13, 1962, reports,

> The Elkhorn River went out of its banks in the Neligh area the past week and flooded lowlands west and to the south of the city. For a time it was feared that the approach to the river bridge might go out but the water began receding Tuesday [June 12], and the danger was past. All the lowlands along the river between Neligh and Clearwater were under water. The dam at Sportsman's Club went out early Sunday morning [June 10], and considerable bank cutting was in evidence. Water licked at the edge of the pavement on the west side of the highway just west of the Hixson place but never crossed the highway.

The county road north from Clearwater to the river was inundated and damaged extensively by the overflow. One home in the northeastern part of that village was surrounded by the flood water.

The peak discharges at Ewing and Neligh on June 10 were about four times greater than the mean annual flood (table 16), while those at Meadow Grove and Norfolk were almost two times greater than the mean annual flood.

Damaging floods occurred in the Chadron–Hay Springs–Gordon area (fig. 19) on June 11 and 12 following torrential and highly localized rainfall over parts of the basins of Chadron, Deadhorse, Big Cottonwood, Lone Tree, Hay Springs, and Antelope Creeks.

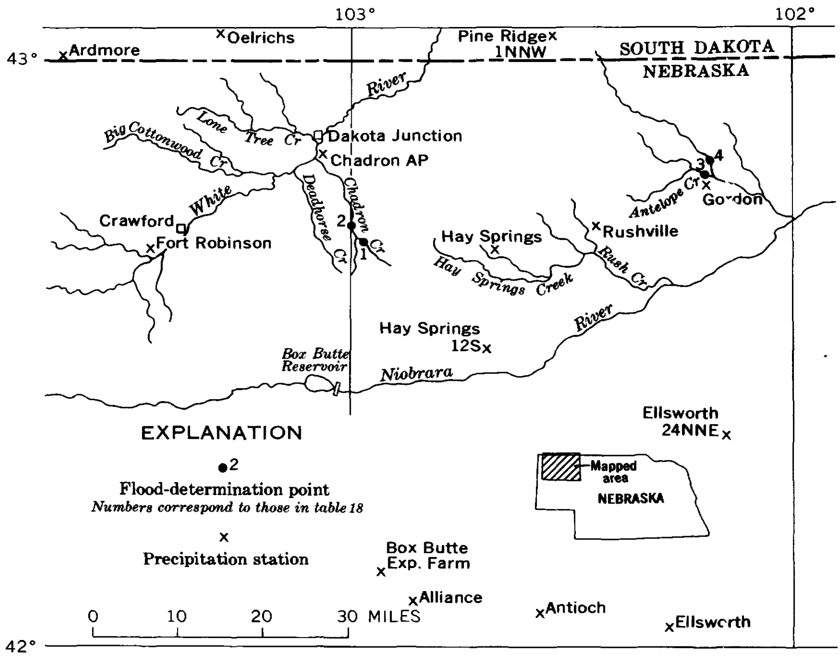

Figure 19.—Location of flood-determination points and precipitation stations, floods of June 11–12 in northwestern Nebraska.

Rainfall observation points are sparsely distributed in the area, so the official records of observed rainfall (table 17) probably do not show the maximum amounts that fell in any one of those six drainage basins during that 2-day period. For example, the record collected at Chadron airport shows 1.07 inches of rain at that point, near the mouth of Chadron Creek, during the 24-hour period ending at midnight June 11, but eyewitness accounts of the flooding on this stream in Chadron State Park as reported in the Chadron Record of June 14

TABLE 16.—*Flood stages and discharges, June 10–11 in Elkhorn River basin, Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 10, 1962		June 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
Platte River basin								
1	Elkhorn River at Ewing	1,400	1947–62	1947		11.32		
		[1] 740		1949			7,280	
					10	10.60	7,500	45
2	Elkhorn River at Neligh	2,200	1931–62	1947		12.53		
		[1] 1,200		1960			12,300	
					10	9.17	10,800	45
3	Elkhorn River at Meadow Grove.	2,500	1960–62	1960		9.8	12,000	
		[1] 1,500			10	8.12	9,600	6
4	Elkhorn River near Norfolk	2,790	1945–62	1960		(2)	13,500	
		[1] 1,790			11	6.93	9,720	5

[1] Contributing area.
[2] Not determined.

TABLE 17.—*Daily precipitation, in inches, associated with the floods of June 11–12 in northwestern Nebraska*

[Tr., trace]

Station	Time of observation	June								
		5	6	7	8	9	10	11	12	13
Alliance, Nebr.	2400	0.13	0.03	0.25	Tr.	0	0	0.21	0.23	0
Antioch, Nebr.	2400	.29	.06	.30	.01	0	0	.80	.42	.03
Ardmore, S. Dak.	1800	0	.40	.13	0	0	0	.86	Tr.	Tr.
Box Butte Exper. Farm, Nebr.	0700	.08	.11	.01	.22	.02	0	0	.29	.36
Chadron AP, Nebr.	2400	.52	Tr.	.09	0	0	0	1.07	.01	Tr.
Ellsworth, Nebr.	1800	.05	.62	.17	.17	Tr.	0	Tr.	1.25	.43
Ellsworth 24 NNE	0600	.11	.66	.02	.12	0	0	0	.39	.37
Fort Robinson, Nebr.	0800	.03	.56	.17	.12	0	0	0	.72	.05
Gordon, Nebr.	1700	.07	.75	0	.04	0	0	0	1.05	.70
Hay Springs, Nebr.	0800	.10	.93	.03	.02	0	.02	.04	1.24	1.27
Hay Springs 12S, Nebr.	1700	0	.63	0	0	0	Tr.	.66	.72	0
Oelrichs, S. Dak.	1800	0	.25	.04	0	0	0	.12	1.08	.05
Pine Ridge 1 NNW, S. Dak.		0	.77	0	0	0	0	0	1.71	2.45
Rushville, Nebr.	0800	.12	0	0	.03	0	0	.02	1.47	.75

describe a "roaring 9-foot wave of water ripping down Chadron Creek through the State Park" shortly after 2000 hours June 11. Several campers near the creek escaped to higher ground with only moments to spare, and the highway bridge in the park was torn from its abutments and carried 200 feet downstream. Water reportedly reached the top of the floor on the bridge just south of the park entrance, but did not move the bridge.

The peak discharge on Chadron Creek near Chadron (sta. 2; table 18) was the largest observed since the gage was installed in 1953, but upstream on Chadron Creek at Chadron State Park (sta. 1) the peak discharge was relatively low. This indicates a high degree of concentration of the rainfall in that immediate vicinity and supports the assumption that several inches of rain may have fallen within a short time period over the basin upstream from the Chadron station while relatively light rainfall was occurring in the area upstream from the State Park station.

The basins of Deadhorse Creek and Big Cottonwood Creek, immediately west of Chadron Creek, also received extremely heavy rainfall on June 11, and although the amount of this rain is unknown, the resulting flooding, particularly along the White River downstream from the mouths of these two streams, received widespread attention when U.S. Highway 20, a transcontinental arterial, became inundated and was closed to traffic early on June 12.

TABLE 18.—*Flood stages and discharges, June 11–12 in northwestern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 1962		June 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	White River basin							
1	Chadron Creek at Chadron State Park near Chadron.	3.35	1953–62	1960			165	
					11	11.73	95	4
2	Chadron Creek near Chadron	14.9	1953–62	1960			2,020	
					11	14.47	2,740	[1] 3.57
	Niobrara River basin							
3	Antelope Creek at Gordon	61.1	1953–62	1958			444	
					12	14.60	348	2
4	Antelope Creek tributary near Gordon.	26.6	1953–62	1955			1,900	
					12	15.15	1,260	[1] 1.15

[1] Ratio of peak discharge to 50-year flood.

Flooding along the White River was intensified by additional heavy rainfall during the evening of June 12 over these same basins and over the Lone Tree Creek basin northwest of Chadron. The 1.08 inches of rain observed at Oelrichs, S. Dak. (table 17), is probably much less than the maximum amount falling within that basin. Damage to the Chicago and North Western Railway included loss of about a quarter of a mile of track and roadbed and derailment of a locomotive and six freight cars near Dakota Junction.

Travel on U.S. Highway 20 west of Chadron was not resumed until June 14, and the White River continued to flow over the road on that date. Highway workmen reported that floodwater began receding at that bridge about 1230 hours on June 13, at which time it was more than 3 feet deep on the highway.

U.S. Highway 385 also was flooded at the White River crossing north of Chadron airport, and traffic was detoured around the bridge during the night of June 12–13.

The flow of White River at the gaging station at Crawford increased from 24 cfs on June 11 to 28 cfs on June 12, and then receded to 23 cfs on June 13, indicating that very little rain fell upstream from that point. The peak discharge on White River near Oglala, S. Dak., on June 14 (2,720 cfs) was the maximum peak of the year.

The storms occurring near Hay Springs and Gordon on June 12 are assumed to have been of the same highly localized type as those near Chadron on June 11 and 12, and the Weather Bureau rainfall data are probably not representative of the maximum amounts that fell in those areas. One local resident reported a rainfall of 3 inches in 15 minutes 2 miles north of Hay Springs, but the U.S. Weather Bureau gage in the village recorded only 0.72 inch in the 24-hour period ending at 1700 hours June 12.

A 5-foot wave of water was reported to have thundered into west Hay Springs at about 1700 hours on June 12, catching the entire community by surprise. Three square blocks of homes and several business places were flooded, and more than 1 foot of mud was deposited over parts of that area. Several stock dams were washed out. Damage amounted to several thousand dollars, including the loss of some livestock and the inundation of several homes along the creek north of Hay Springs.

No streamflow data were collected on Hay Springs Creek during or following this flood, but the maximum discharges determined at two Antelope Creek sites were the second highest since the gages were installed in 1953. The recurrence interval of the June 12 flood on Antelope Creek is about 2 years, whereas the peak discharge on Antelope Creek tributary was 1.15 times that of a 50-year flood.

Recurrence interval information cannot be deduced for the Hay

Springs Creek flood because the discharge is not known. However, the U.S. Weather Bureau (1961) indicated that a point rainfall of about 2.5 inches in 30 minutes may be expected in this vicinity about once in 100 years, and therefore the expectancy of a 3-inch rainfall in 15 minutes would be somewhat greater than 100 years.

The greatest flood discharge observed since June 1947 occurred on Snake River near Burge (fig. 20) on June 30 as a result of torrential rain over the lower part of the basin.

Light rainfall observed at Gordon, Ellsworth 24NNE, Whitman 24N, and Merriman indicates the probability that the headwaters of Snake River did not receive as much rain as the 5.64 inches observed at the rainfall station, Nenzel 20S.

The July 5, 1962, edition of Valentine Newspaper states,

> Rains throughout the Sandhills late Saturday [June 30] had telling effects Sunday when bridges and roads were damaged by the gushing water. The Perry Miller Ranch near Valentine reported 10.21 inches for the night, of which 9.5 inches reportedly fell in 2½ hours. The Miller ranch has recorded 29.27 inches since early May, and according to reports, the 10+ inches shower is believed to be the largest amount at one time recorded in the United States this year.

In addition, the paper reports, "An estimated 6 to 8 inches of rain fell on the Merritt Dam project, causing damage to the road, canal slopes, and spillway and outlet works." The spillway and outlet works are located about 2 miles upstream from the Burge gaging station. Also reported by this paper were an unofficial record of 7 inches of rain in the Cody area and flooding in the village of Wood Lake on June 30–July 1.

Numerous bridges were washed out and erosion damage to hay and pasture lands was extensive. According to the U.S. Weather Bureau (1961), a point rainfall of 3.5 to 4.0 inches in 3 hours has a recurrence interval of 100 years in this vicinity. This is less than half the actual observed rainfall of 9.5 inches in 2½ hours at the Perry Miller ranch, and is about half of the observed 24-hour rainfall in the Cody and Merritt Dam areas.

Recordbreaking floods also occurred on June 30 and July 1 on the Niobrara River downstream from the Snake River, and in Plum Creek and Long Pine Creek basins just east of the Snake River (table 19). The floods were caused by highly localized rainstorms similar to those that struck the Snake River basin (table 20). In addition to the official rainfall observations reported in table 20, unofficial observations of as much as 10 inches in the area just north of Ainsworth were reported in the July 5 edition of the Ainsworth Star-Journal. Of the observed rainfall of 4.95 inches at Ainsworth for the 24-hour period ending at 1800 hours on July 1 (table 20), 4.78 inches reportedly fell between 2030 and 2330 hours on June 30. On the basis of this informa-

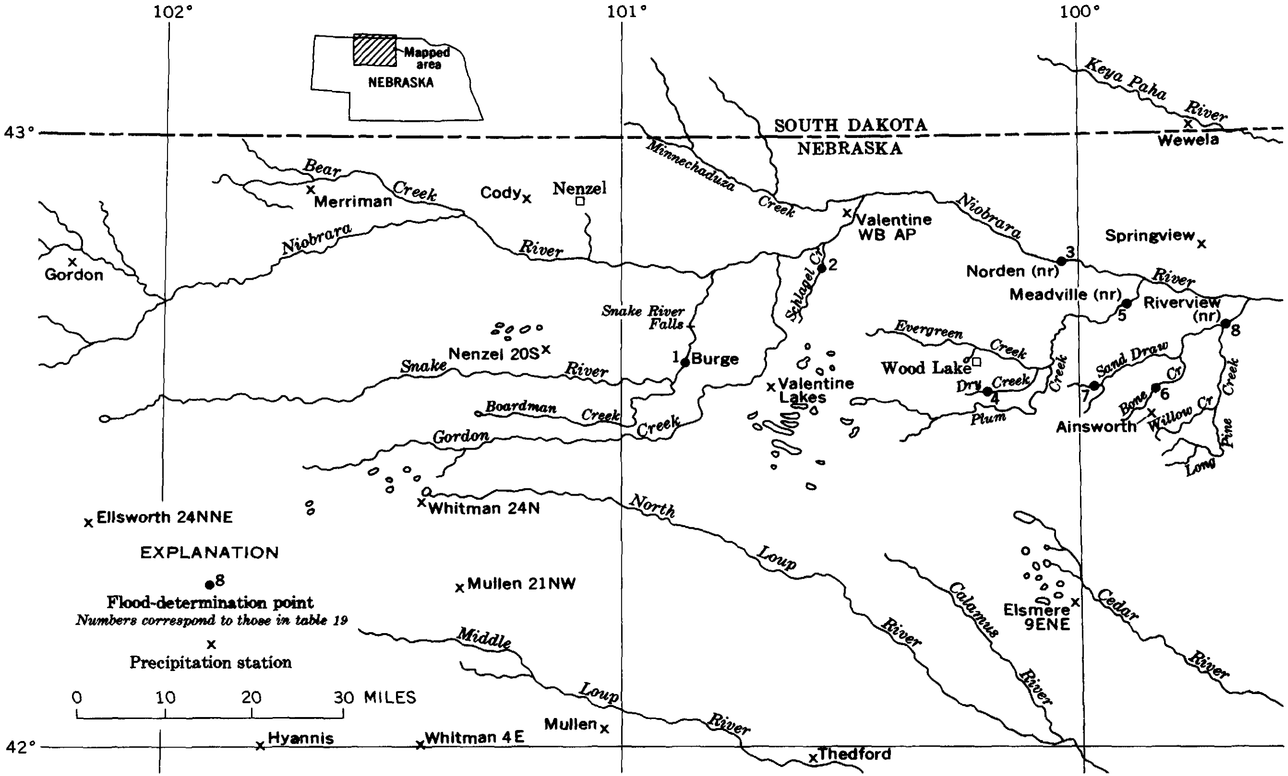

FIGURE 20.—Location of flood-determination points and precipitation stations, floods of June 30–July 1 in northwestern Nebraska.

tion and the observed 9.5 inches in 2½ hours on June 30 at the Perry Miller ranch near Valentine, it might be assumed that much of the 10 inches reported to have fallen in the area north of Ainsworth fell within the same period of time.

TABLE 19.—*Flood stages and discharges, June 30–July 1 in northwestern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 30, 1962 — Period	Prior to June 30, 1962 — Year	June 30–July 1, 1962	Gage height (ft)	Discharge — Cfs	Discharge — Recurrence interval (years)
	Niobrara River basin							
1	Snake River near Burge	[1] 100	1947–62	1955			577	
					June 30	5.39	1,830	[2] 1.36
2	Schlagel Creek near Valentine.	(3)			July 1		130	
3	Niobrara River near Norden	(3)	1952–62	1957			4,370	
					July 1	[4] 7.10	7,380	(3)
4	Dry Creek near Johnstown	(3)			July 1		880	(3)
5	Plum Creek near Meadville	[1] 330	1947–62	1952			790	
					July 1	6.23	2,060	7
6	Bone Creek tributary No. 2 near Ainsworth.	2.18	1958–62	1960			216	
					June 30	13.29	640	[2] 1.79
7	Sand Draw tributary near Ainsworth.	1.07	1956–62	1960			710	
					June 30	14.4	747	[2] 3.31
8	Long Pine Creek near Riverview.	390	1948–62	1951			5,410	
					July 1	15.68	9,560	35

[1] Approximate contributing area.
[2] Ratio of peak discharge to 50-year flood.
[3] Unknown.
[4] Affected by backwater from bridge in channel.

TABLE 20.—*Daily precipitation, in inches, associated with the floods of June 30–July 1 in northwestern Nebraska*

[From U.S. Weather Bureau records. Tr., trace]

Station	Time of observation	June 25	June 26	June 27	June 28	June 29	June 30	July 1
Ainsworth, Nebr	1800	0.73	0	0	0	Tr.	0.05	4.95
Bassett, Nebr	2400	.42	0	0	0	0.04	1.77	.09
Ellsworth 24 NNE, Nebr	0600	1.12	0	0	0	0	.18	0
Elsmere 9 ENE, Nebr	1800	1.16	0	0	0	0	.15	.80
Hyannis, Nebr	1700	0	0	0	0	0	.55	0
Gordon, Nebr	1700	0	.34	0	0	0	.05	0
Merriman, Nebr	1800	.40	0	0	0	0	.93	0
Mission 14 SSE, S. Dak	1800	1.29	0	0	0	Tr.	.75	.42
Mullen 21 NW, Nebr	0800	1.17	0	0	0	0	.13	.06
Mullen, Nebr	1700	.82	0	0	0	0	.80	.50
Nenzel 20 S, Nebr	1800	1.11	Tr.	0	0	0	5.64	.14
Springview, Nebr	1700	.50	0	0	0	0	1.65	3.91
Thedford, Nebr	2400	.03	0	0	0	0	.30	.13
Valentine Lakes Game Refuge, Nebr	1700	1.07	0	0	0	.08	.30	3.07
Valentine WBAP, Nebr	2400	.05	0	0	0	.05	1.87	Tr.
Whitman 4E, Nebr	0700	.25	0	0	0	0	.25	0
Whitman 24N, Nebr	1800	.98	0	0	0	0	.62	Tr.
Wewela, S. Dak	1800	.75	0	0	0	0	1.15	2.22

The flood discharge in Niobrara River near Norden (sta. 3) was the largest observed since the station was established in October 1952, but, on the basis of the record for the station at Sparks, it may have been exceeded by the flood of March 5, 1949. Damage in this reach from June 30 to July 1 was limited to erosion of banks and low-lying fields.

The peak discharge on Plum Creek near Meadville (sta. 5) was the greatest since the station was established in 1947 and was almost three times larger than the maximum previously observed. The flood damaged the hydroelectric plant and dam about 500 feet upstream from the station and released a huge quantity of sand which completely filled the downstream channel and the recording gage well.

Rainfall of more than 3 inches was observed in the headwaters area of Plum Creek from June 29 to July 1, and amounts up to 10 inches may have fallen over the downstream portion of the drainage area.

The flood discharges on Bone Creek tributary No. 2 (sta. 6) and Sand Draw tributary (sta. 7) near Ainsworth were greater than those of 50-year floods. The gages on these two streams are nonrecording; hence, the times of occurrence of the respective peaks are not known, nor is the time of the flood-producing rainfall known, but the combined flows from these two small tributaries of Long Pine Creek undoubtedly made a significant contribution to the peak discharge that passed the recording stage gage on Long Pine Creek near Riverview (sta. 8) at 0300 hours on July 1.

The Ainsworth Star-Journal of Thursday, July 5, 1962 estimated that the damage from the flooding caused by the storm of June 29–July 1 amounted to hundreds of thousands of dollars. Brown County Commissioners estimated the damage to their highways, bridges, and culverts at between $60,000 and $70,000. Approximately 40 bridges were reported to have been destroyed or severely damaged, and innumerable culverts were washed out. The bridge over Bone Creek on State Highway 7 between Ainsworth and Springview was closed to traffic after 20 feet of the approach fill washed out at the north end of the bridge. Many small dams on farms and ranches were washed away, and a section of the Chicago and North Western Railway tracks was washed out at the Willow Creek crossing about 5 miles east of Ainsworth.

Also associated with the storm of June 30 was significant flooding on Dry Creek south of Wood Lake. The peak discharge at Dry Creek near Johnstown (sta. 4) represents the flow from only a small part of the Plum Creek drainage area but is equal to more than one-third of the peak discharge at Plum Creek near Meadville (sta. 5), near the downstream end of the Plum Creek basin.

FLOODS OF JUNE 8–17 IN NORTHWESTERN MINNESOTA

By L. E. Bidwell

Heavy rains during May, coupled with additional intense rains on June 7 and 8, caused flooding on the Minnesota tributaries of the Red River of the North (fig. 21). Rainfall records from 26 U.S. Weather Bureau stations and 7 Geological Survey observers in the general storm area are listed in table 21. Weather Bureau records indicate that the total May precipitation for the flood area was more than two times the normal amount, or about 4 inches above normal. The intense rains which occurred from the midafternoon on June 7 through the forenoon on June 8 were most intense between 0600 and 1200 hours on June 7. The heaviest rainfall occurred in an area extending northeast from Wahpeton through the Buffalo River and Wild Rice River basins; the heaviest concentration measured by the Weather Bureau was 4.86 inches at Wahpeton. More than 3 inches of rain was reported at the official stations at Hawley and Mahnomen. An observation of 4.4 inches was made by a Geological Survey observer at Barnesville, near the center of the downpour area. A resident east of Downer measured 4.4 inches of rain, and unofficial estimates of 6 or 7 inches were reported from an area 2 to 3 miles father east.

The June storm period was preceded by above median flows in April and by medium high floods during the last week of May. Flows had partly receded before the occurrence of the storm of June 7 and 8. Notable flood stages occurred over most of the basins beginning on June 8, and major peaks exceeded previous maximum discharges at some sites in the basins of the Buffalo, Clearwater, and Wild Rice Rivers. Peak discharges were obtained at 31 sites (table 22). One peak-flow miscellaneous measurement was made on South Branch Wild Rice River near Felton (sta. 15). Composite flood-frequency curves, defined to a 30-year recurrence interval applicable to this area (Prior and Hess, 1961), were used to compute recurrence intervals. Excluded from computations were five small-area sites whose drainage areas are not defined. Data at two other sites were not sufficient to compute recurrence intervals, but the discharges were so great that there is no doubt that they exceeded a 30-year flood. The peak discharges at at least three sites were two or more times greater than a 30-year flood.

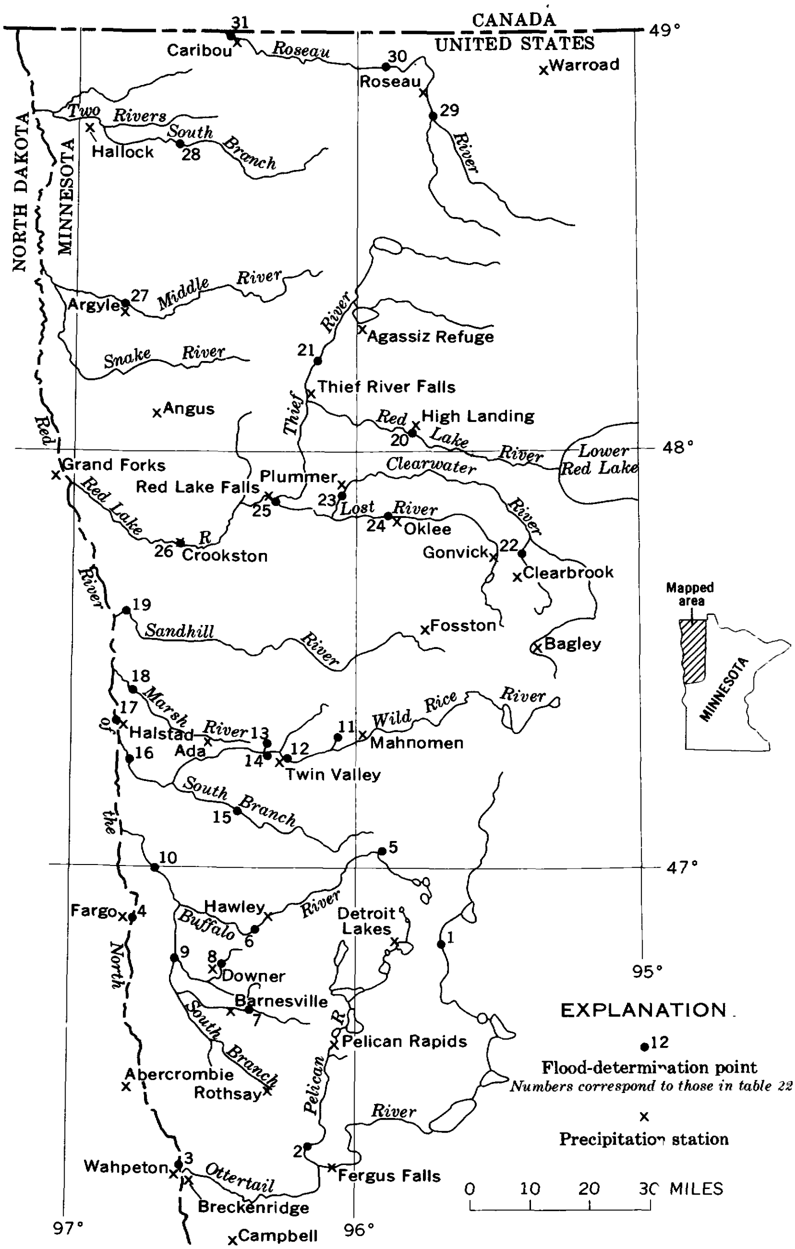

FIGURE 21.—Location of flood-determination points, floods of June 8–17 in northwestern Minnesota.

TABLE 21.—*Rainfall, in inches, at U.S. Weather Bureau and Geological Survey stations, May and June in northwestern Minnesota and eastern North Dakota*

[Tr., trace]

Station	May (total)	June 1-6	June 7-8	June 9-10
Minnesota				
Ada	7.75	0.23	1.70	0.23
Agassiz Refuge	6.11	.09	1.07	.47
Angus	4.83	.07	.68	.46
Argyle	4.40	.12	.41	.30
Barnesville [1]	9.7	.3	4.4	1.0
Bagley [1]	8.25	0	.75	.50
Campbell	8.64	.21	1.78	1.05
Caribou	5.88	0	.42	2.38
Clearbrook [1]	4.4	1.4	----------	.3
Detroit Lakes	6.05	.11	.88	.09
Downer	----------	----------	[2] 4.50	----------
Fergus Falls	7.06	.17	1.19	.38
Fosston	7.76	.06	2.58	.22
Gonvick [1]	5.5	0	2.3	.5
Gonvick	7.84	.15	2.56	.10
Hallock	6.17	.12	.04	.60
Halstad	6.43	.20	.90	.95
Hawley	6.71	.20	3.31	1.20
Highlanding	4.63	.08	2.00	.55
Mahnomen	6.44	.08	3.40	.22
Oklee	7.70	.03	2.99	.21
Pelican Rapids	7.51	.10	2.38	.06
Plummer [1]	8.10	2.25	----------	.65
Red Lake Falls	7.48	.09	1.26	.78
Roseau	5.90	0	.94	1.75
Rothsay	8.61	1.35	1.45	0
Thief River Falls	7.54	.07	1.17	.64
Twin Valley [1]	8.65	Tr.	2.45	.55
Warroad	5.56	.05	1.80	.44
North Dakota				
Abercrombie	7.43	.13	2.67	.76
Fargo	5.95	.18	1.05	.01
Grand Forks	6.52	.07	.53	.18
Wahpeton	7.91	.12	4.93	2.08

[1] Data from Geological Survey observers.
[2] Report from farmer near crest-stage gage. He also reported resident 2 or 3 miles east estimated rainfall of 6 or 7 inches of rain during same storm.

Estimates of flood damage (table 23) compiled by the U.S. Army Corps of Engineers include those from the preceding floods in May and those in June. Figures for the basins of the Buffalo and Wild Rice Rivers include agricultural, road, and bridge damage. Those for basins of the Red Lake and Roseau Rivers are for urban damage in Crookston and Roseau and for damage to agricultural lands, roads, and bridges. Only urban damage occurred on the Red River near Breckenridge. No loss of life resulted from the floods.

TABLE 22.—*Flood stages and discharges, June 8–17 in northwestern Minnesota*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1962: Period	Prior to June 1962: Year	June, 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Red River of the North basin							
1	Otter Tail River near Detroit Lakes, Minn.	270	1937–62	1943			371	
				1950		[1] 6.96		
					8	4.65	316	10
2	Pelican River near Fergus Falls, Minn.	482	1909–12, 1942–62.	1943			756	
				1950		[1] 5.60		
					10	3.35	341	6
3	Red River of the North at Wahpeton, N. Dak.	4,010	1897–1962	1897		17.0	([2])	
			1942–62	1952		14.99	7,130	
					11	13.98	5,650	8
4	Red River of the North at Fargo, N. Dak.	[3] 6,130	1897–1962	1897		[4] 40.1	([2])	
			1901–62	1952		28.79	16,300	
					14	22.83	9,580	12
5	Buffalo River near Callaway, Minn.	([2])	1959–62	1960		[1] 12.92	246	
					8	13.34	370	([2])
6	Buffalo River near Hawley, Minn.	322	1921–62	1921		11.3	([2])	
			1945–62	1955		9.31	1,590	
					10	9.11	1,430	[5] 1.16
7	Whisky Creek at Barnesville, Minn.	[3] 23	1960–62	1961		[1] 5.75	40	
					8	6.52	292	([6])
8	Hay Creek above Downer, Minn.	([2])	1960–62	1961		6.96	21	
					8	13.46	382	([2])
9	South Branch Buffalo River at Sabin, Minn.	522	1945–62	1953		15.38	3,410	
					9	17.04	6,340	[5] 2.46
10	Buffalo River near Dilworth, Minn.	1,040	1931–62	1943		22.60	4,530	
					11	23.56	6,140	[5] 1.12
11	Marsh River tributary near Mahnomen, Minn.	([2])	1960–62	1961		[1] 10.55	6	
					8	10.27	116	([2])
12	Wild Rice River at Twin Valley, Minn.	888	1909–17, 1930–62.	1909		[7] 20.0	9,200	
					9	9.83	2,760	13
13	Wild Rice River tributary near Twin Valley, Minn.	([2])	1960–62	1961		10.63	6	
					8	12.39	107	([2])
14	Coon Creek near Twin Valley, Minn.	([2])			8	12.68	896	([2])
15	South Branch Wild Rice River near Felton, Minn.	195			9	9.20	1,390	[5] 2
16	Wild Rice River at Hendrum, Minn.	1,600	1944–62	1956		[8] 24.26	4,660	
					13	[8] 22.26	3,680	4
17	Red River of the North at Halstad, Minn.	[3] 14,900	1897	1897		38.5	([2])	
			1936–37, 1942–62.	1947		34.00	24,500	
					16	24.70	15,900	6
18	Marsh River near Shelly, Minn.	151	1944–61	1950		18.96	4,660	
					11	9.87	1,240	[5] 2.2
19	Sandhill River at Climax, Minn.	405	1943–61	1950		16.31	3,040	
					13	8.36	629	2
20	Red Lake River at Highlanding near Goodridge, Minn.	2,300	1929–62	1950		13.42	3,720	
					11	12.10	3,060	11
21	Thief River near Thief River Falls, Minn.	959	1909–17, 1919–26, 1928–62.	1950		17.38	5,610	
					10	12.68	2,800	9
22	Ruffy Brook near Gonvick, Minn.	45.2	1960–62	1961		3.74	66	
					12	4.82	166	
23	Clearwater River at Plummer, Minn.	512	1939–62	1950		11.33	3,630	
					9	11.90	3,640	[5] 1.73
24	Lost River at Oklee, Minn.	266	1897–1962	1950		10.39	2,790	
					11	8.70	1,480	([6])
25	Clearwater River at Red Lake Falls, Minn.	1,370	1909–17, 1934–62.	1950		11.28	9,310	
					10	10.96	8,600	[5] 1.22
26	Red Lake River at Crookston, Minn.	5,280	1901–62	1950		25.70	27,400	
					11	21.90	16,700	16
27	Middle River at Argyle, Minn.	265	1945–62	1950		15.25	2,790	
					12	14.12	1,620	[5] 1.19

See footnotes at end of table.

TABLE 22.—*Flood stages and discharges, June 8–17 in northwestern Minnesota*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 1962		June 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Red River of the North basin—Continued							
28	South Branch Two Rivers at Lake Bronson, Minn.	444	1928–37, 1941–47, 1953–62.	1956	--------	10.79	2,650	--------
			------------	------	13	10.82	2,960	28
29	Roseau River below South Fork near Malung, Minn.	573	1946–62----	1950	--------	22.51	3,650	--------
			------------	------	12	16.98	2. 500	9
30	Roseau River at Ross, Minn.	1,220	1896–1962--	1896	--------	19	(2)	--------
			1928–62----	1950	--------	18.25	6,560	--------
			------------	------	17	13.86	2,120	5
31	Roseau River below State ditch 51 near Caribou, Minn.	1,570	1917, 1920–62.	1950	--------	11.81	4,080	--------
			------------	------	11	8.63	2,070	4

1 Affected by backwater from ice.
2 Unknown.
3 Contributing area.
4 At site 3½ miles downstream at datum 6.65 ft lower.
5 Ratio of peak discharge to 30-year flood.
6 Greater than 30 years.
7 At site ¼ mile downstream at different datum.
8 Affected by backwater from Red River of the North.

TABLE 23.—*Flood damage, May and June, northwestern Minnesota*

[Preliminary estimates by Corps of Engineers]

River basin	*Flood damage (dollars)*
Buffalo River	$1,566,000
Wild Rice River	1,531,000
Red Lake River	1,309,000
Roseau River	433,000
Red River at Breckenridge	66,000

FLOODS OF JUNE 15–16 IN NORTHERN BLACK HILLS, S. DAK.

Rains began at about 1700 hours on June 15, continued about 6 hours, and caused flash floods on Belle Fourche River tributaries that drain the northern edge of the Black Hills, S. Dak. (fig. 22). The rainstorm centered near Whitewood, where reliable measurements of 6 to 7 inches of precipitation were reported by residents of the town. Unconfirmed reports were received of as much as 12 inches of rainfall in a small area south of Whitewood. Weather Bureau rain gages—one 20 miles northwest and another 10 miles southeast of Whitewood—recorded between 4 and 5 inches during the storm.

Flood discharges at 4 gaging stations—1 crest-stage station and 3 miscellaneous sites—are listed in table 24.

The peak discharge of Redwater River above Belle Fourche (sta. 2; 16,400 cfs) was nearly six times the maximum discharge that had occurred during the preceding 17 years of record. Most of the flow

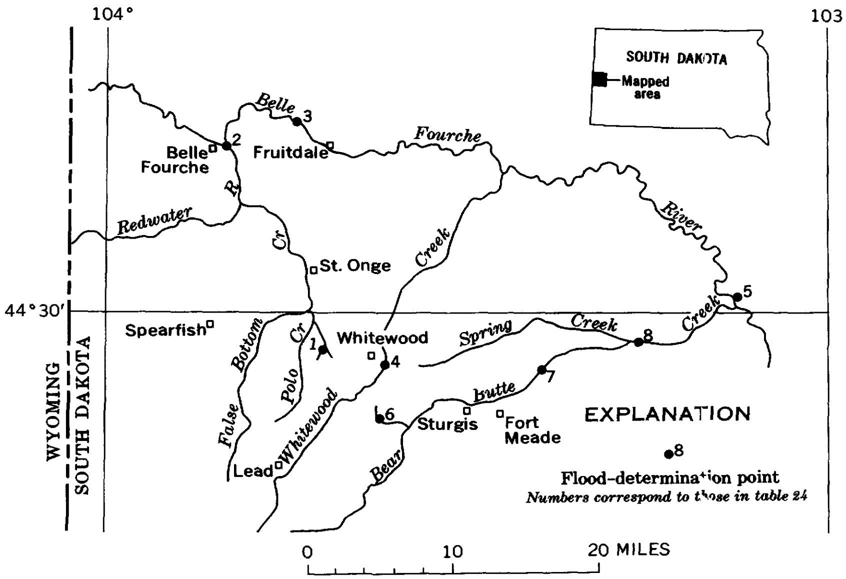

FIGURE 22.—Location of flood-determination points, floods of June 15–16 in northern Black Hills, S. Dak.

in Redwater River at this point originated in the relatively small area in the False Bottom Creek basin downstream from a point east of Spearfish. The peak flow of Redwater Creek (the upstream reach of Redwater River) at Wyoming–South Dakota State line (drainage area, 471 sq mi) was only 2,340 cfs, and there was little indication of flooding along False Bottom and Polo Creeks where they are crossed by U.S. Highway 14 east of Spearfish.

According to a local rancher, the maximum flow of Whitewood Creek about 4 miles upstream from the miscellaneous-measurement site was only about twice the normal low-water flow, or about 50 cfs. Thus, only a small part of the 59-square-mile drainage basin upstream from the measurement site contributed appreciably to the flood (peak discharge, 8,460 cfs) at Whitewood.

The flood of June 16 was the highest in 17 years of record at the gaging station on Bear Butte Creek near Sturgis (sta. 6), but according to local residents, it was lower than floods in 1883 and 1909.

The floods were intense from small drainage basins, but owing to channel storage and diversions, peak discharges on the main stem of the Belle Fourche River downstream from the Redwater River were only about twice the mean annual flood.

Most of the damage in rural areas was to roads and bridges. About 2 miles of grade on U.S. Highway 14A was destroyed or extensively damaged in Boulder Canyon a few miles upstream from Sturgis, where the highway parallels Bear Butte Creek. There were many other road washouts, and travel was disrupted for a week or two after the flood. Four people clung to trees until they were rescued after their car had been washed off the highway by the flood on False Bottom Creek. No lives were lost in the flood. About 400 persons were evacuated from their homes in Belle Fourche, Whitewood, St. Onge, and Sturgis, and a number of homes were damaged or destroyed. Damage was extensive in Sturgis, where more than 100 residences were flooded to some degree by Bear Butte Creek and a small tributary, Vanocker Creek. Bank erosion at the State Highway Maintenance Shop yard in Sturgis caused heavy road equipment valued at about $100,000 to fall into Bear Butte Creek and to be destroyed or badly damaged.

An open-file flood-frequency report (McCabe and Crosby, 1959) includes the area affected by this flood. The flood-frequency curves applicable to the flood area show the relation of peak discharges to floods of selected recurrence intervals (fig. 23). The curves are not

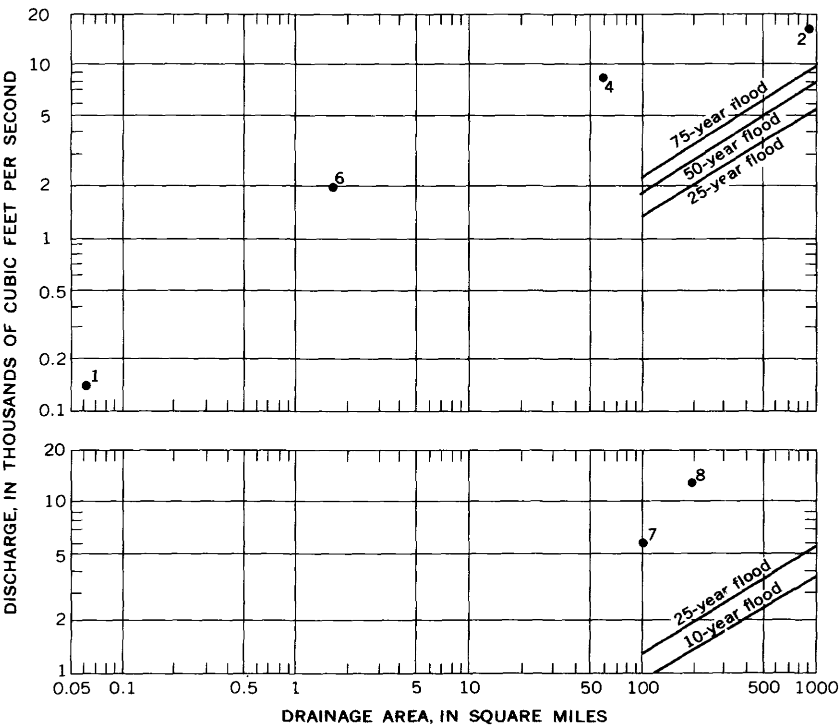

Figure 23.—Relation of peak discharge to floods of selected recurrence intervals, floods of June 15–16 in northern Black Hills, S. Dak. Data are in table 24.

defined above the 75-year recurrence interval in the flood region that includes measurement sites 1, 2, 4, and 6 (table 24), or above the 25-year flood in the region that includes sites 7 and 8. The curves are not defined for drainage areas of less than 100 square miles, and they cannot be accurately extrapolated beyond their range of definition. Therefore, it is not possible to assign recurrence intervals to the peak discharges observed during this flood, but the plotting position of the points indicates that these flood discharges were rare occurrences for this area. For example, the peak discharge at site 6, which has a drainage area of 1.63 square miles, is equal to the discharge of a 50-year flood from 100 square miles in this same area.

TABLE 24.—*Flood stages and discharges, June 15–16 in northern Black Hills, S. Dak.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 1962		June 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Ratio to Q_{30}
	Cheyenne River basin							
1	Polo Creek tributary near Whitewood.	0.061	1955–62	1958		16.30	(1)	
					15	20.11	137	
2	Redwater River above Belle Fourche.	920	1945–62	1947		8.98	2,800	
				1954		[2] 9.45		
					16	11.69	16,400	2.74
3	Belle Fourche River near Fruitdale.	4,540	1945–62	1947		11.03	7,460	
					16	11.25	7,840	.75
4	Whitewood Creek at Whitewood.	59.0			15		8,460	
5	Belle Fourche River near Sturgis.	5,870	1945–62	1946		13.86	17,900	
					16	14.32	11,900	.50
6	Bear Butte Creek tributary near Sturgis.	1.63			15		1,940	
7	Bear Butte Creek near Fort Meade.	101			16		5,980	4.20
8	Bear Butte Creek near Sturgis	192	1945–62	1946		12.07	9,800	
					16	12.45	12,700	6.15

[1] Unknown.
[2] Affected by ice jam.

FLOODS OF JUNE AND JULY IN EASTERN NORTH CAROLINA

By G. C. GODDARD, JR.

Heavy rains during late June and early July caused record floods at several gaging stations in eastern North Carolina. The storms came in two periods. A rainy period during the last third of June culminated on June 29 in an offshore storm which produced phenomenal rainfall at some stations in the Pamlico Sound area. In "Climatological Data" for North Carolina (U.S. Weather Bur., 1962), A. V. Hardy, State Climatologist, described the June storms as follows:

with very heavy rains extending inland fifty to sixty miles. Cedar Island reported 17 inches in about 18 hours, the second greatest one-day rain in North Carolina weather history. Several stations in that section of the State had their greatest 24-hour rainfall of record, and their greatest June total of record.

Relatively light rain occurred each day at some stations in the area during July 1–3, and this rain was followed by heavy rains about July 4. The July rains covered a larger area than those of June and were not uniform in intensity or areal distribution. Total amounts for the period July 1–5 generally were largest in an area between Goldsboro and Trenton. Hardy described the July storms as follows:

Although the areas of heaviest rain were not identical with those of the June 29 rains, the general area affected was similar. Over a roughly triangular area extending from Manteo to Goldsboro to Southport [at mouth of the Cape Fear River], 24-hour totals on July 3–4 ranged from two to eight inches. Between June 30 and July 3 moderate to occasionally heavy showers fell daily over much of the same area, resulting in one-week totals of rainfall up to almost twenty inches.

Location of Weather Bureau rain gages is shown in figure 24; totals and maximum daily values of rainfall for the two separate periods are listed in table 25.

TABLE 25.—*Rainfall, in inches, June 25–30 and July 1–5 in eastern North Carolina*

[U.S. Weather Bureau data. Rainfall amounts are totals between times of observation. Times of observation are given in "Climatological Data" (U.S. Weather Bur., 1962)]

No.	Station	Location		June 25-30			July 1-5		
		Lat	Long	Total	Maximum		Total	Maximum	
					Day	Amount		Day	Amount
1	Bath 2 WSW	35°27′	76°50′	12.20	30	9.15	2.69	3	2.00
2	Belhaven	35°33′	76°38′	15.99	30	12.41	4.21	4	3.79
3	Cedar Island	34°59′	76°18′	19.05	30	10.44	1.60	4	1.11
4	Clayton 3 W	35°39′	78°30′	2.60	30	2.15	4.75	4	4.56
5	Clinton 2 S	34°58′	78°19′	.36	25	.34	4.14	4	2.07
6	Faison	35°06′	78°09′	3.89	30	3.27	5.49	4	5.25
7	Goldsboro 1 SSW	35°21′	78°01′	3.45	30	3.15	7.54	4	6.00
8	Greenville	35°37′	77°22′	2.69	30	2.23	2.56	4	2.12
9	Greenville 3 S	35°34′	77°23′	7.40	30	4.50	3.75	4	3.26
10	Hatteras	35°13′	75°41′	4.75	30	2.04	1.65	4	1.04
11	Kinston	35°16′	77°35′	4.92	30	4.30	4.99	4	4.23
12	Maysville 6 SW	34°50′	77°18′	5.79	30	4.51	5.31	4	4.80
13	McCullers 1 W	35°40′	78°42′	1.78	30	.93	4.36	4	4.03
14	Morehead City	34°43′	76°44′	6.60	29	2.96	2.89	4	2.51
15	Mount Olive	35°12′	78°04′	4.77	30	3.90	4.07	4	3.03
16	New Bern 3 NW	35°08′	77°05′	12.41	30	8.38	2.68	4	2.11
17	New Bern FAA AP	35°05′	77°02′	11.86	29	5.61	2.99	3	1.51
18	New Holland	35°27′	76°11′	9.29	30	5.94	7.54	4	5.65
19	Ocracoke	35°07′	75°59′	13.03	30	6.55	2.33	4	2.11
20	Oriental	35°02′	76°42′	15.28	30	9.64	1.76	4	1.35
21	Plymouth 5 E	35°52′	76°39′	6.65	30	4.17	3.53	4	2.09
22	Raleigh	35°47′	78°38′	2.43	27	.92	2.34	4	2.01
23	Sloan 3 S	34°47′	77°49′	6.55	30	3.47	4.66	4	3.20
24	Smithfield	35°31′	78°21′	3.00	30	2.25	5.79	4	5.00
25	Sneads Ferry	34°33′	77°24′	4.28	30	2.52	3.56	4	3.21
26	Trenton	35°04′	77°21′	8.91	30	7.16	6.94	4	5.25
27	Washington Main St	35°32′	77°03′	8.34	30	6.67	4.09	3	2.83
28	Willard 1 N	34°43′	77°59′	4.69	30	4.31	5.51	4	3.18
29	Williamston 1 ENE	35°51′	77°02′	5.84	30	4.45	5.17	4	4.18

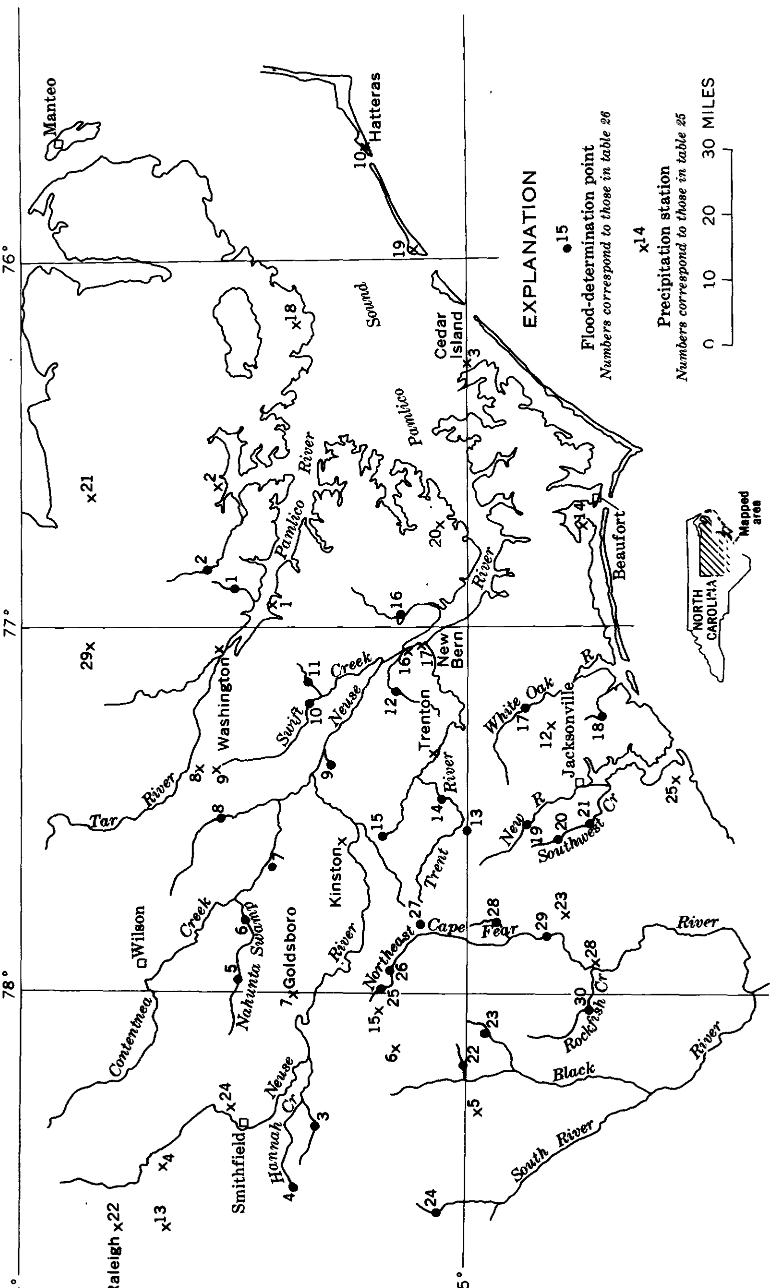

FIGURE 24.—Location of flood-determination points and rainfall data sites, floods of June and July in eastern North Carolina.

The June storms produced extremely heavy rainfall only in Pamlico Sound and in areas near the coast, mostly causing unusually large floods on small ungaged streams near the shores of the Pamlico River estuary and Pamlico Sound. Consequently, a record flood resulted only on a tributary to Upper Broad Creek near Grantsboro (Sta. 16). However, moderate rainfall in fringe areas produced antecedent conditions which, combined with the heavy rains of July 4, produced floods at many stations that approached in magnitude or exceeded the great floods of 1955. Floods of record occurred at three crest gages and two regular gages in the flood area (table 26). Although there were several exceptions, the greater floods occurred mostly on larger streams in the Northeast Cape Fear and the Trent River basins. Peak discharges during the June–July period had recurrence intervals of 10 or more years at 14 of 30 stations in the flood area. The stage, discharge, and recurrence interval of these flood peaks and previous maximums of stage and discharge are listed in table 26.

TABLE 26.—*Flood stages and discharges, June–July in eastern North Carolina*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1962 — Period	Prior to June 1962 — Year	June–July 1962	Gage height (ft)	Discharge — Cfs	Discharge — Recurrence interval (years)
	Pamlico River basin							
1	Upper Goose Creek near Yeatsville.	1.49	1952–62	1955		24.00	300	
					June 30	24.09	237	10
2	Acre Swamp near Pinetown	30	1952–62	1955		24.46	2,950	
					June 30	22.08	1,210	5
	Neuse River basin							
3	Stone Creek near Newton Grove.	28	1952–62	1960		23.06	1,420	
					July 4	24.58	3,110	50
4	Hannah Creek near Benson	2.6	1952–62	1959		23.17	808	
					July 4	22.44	460	21
5	Nahunta Swamp near Pikeville.	19	1953–62	1960		20.38	1,070	
					July 4	19.82	780	5
6	Nahunta Swamp near Shine	77.6	1954–62	1960		12.21	2,910	
					July 5	10.47	1,330	5
7	Shepherd Run near Snow Hill.	1.5	1952–62	1960		21.69	250	
					July 4	20.47	105	2
8	Little Contentnea Creek near Farmville.	93.3	1955	1955		18.9	(1)	
			1956–62	1960		17.39		
				1960			2,490	
					July 4	14.78	1,370	2
9	Halfmoon Creek near Fort Barnwell.	4.9	1952–62	1955		21.67	1,600	
					July 4	19.78	420	4
10	Swift Creek near Vanceboro	182	1909	1909		16.00	(1)	
			1950–62	1955		13.67	6,060	
					July 5	11.59	3,950	37
11	Palmetto Swamp near Vanceboro.	24	1952–62	1955		26.14	3,700	
					July 1	23.83	1,800	9
12	Batchelders Creek near New Bern.	34	1952–62	1955		23.58	7,000	
					June 30	19.89	2,700	12

See footnotes at end of table.

TABLE 26.—*Flood stages and discharges, June–July in eastern North Carolina*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1962: Period	Maximum floods: Prior to June 1962: Year	Maximum floods: June–July 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Neuse River basin—Continued							
13	Rattlesnake Branch near Comfort.	3.2	1952–62	1955		25.50	1,120	
					July 4		1,280	[2]1.2
					July 6	26.6		
14	Trent River near Trenton	168	1951–62	1955		17.84	9,100	
					July 6	17.20	7,300	[2]1.7
15	Vine Swamp near Kinston	6.30	1952–62	1955		23.71	840	
					July 4	22.66	460	4
16	Upper Broad Creek tribu- near Grantsboro.	3.3	1952–62	1955		22.99	800	
					June 30	22.97	1,600	[2]2.2
	White Oak River basin							
17	White Oak River at Belgrade.	53	1952–62	1955		23.49	8,900	
					July 4	16.64	1,700	5
	Queen Creek basin							
18	Bell Swamp near Hubert	5.0	1952–62	1955		25.70	1,320	
					July 4	21.81	305	4
	New River basin							
19	New River near Gum Branch	74.5	1949–62	1955		19.99	7,900	
					July 4	19.82	7,320	15
20	Southwest Creek tributary near Jacksonville.	1.0	1952–62	1955		22.50	282	
					July 4	21.66	200	4
21	Southwest Creek near Jacksonville.	27	1952–62	1955		26.9	5,500	
					July 6	23.65	2,520	6
	Cape Fear River basin							
22	Turkey Creek near Turkey	16	1952–62	1955		22.60	1,190	
					July 4	21.84	720	4
23	Stewarts Creek tributary near Warsaw.	1.6	1952–62	1959		24.20	142	
					July 4	22.91	84	4
24	Big Swamp near Roseboro	32	1952–62	1960		21.32	1,220	
					July 4	<18.70	<240	<2
25	Northeast Cape Fear River tributary near Mount Olive.	.63	1952–62	1955		21.63	118	
					July 4	20.80	80	8
26	Northeast Cape Fear River near Seven Springs.	47.5	1958–62	1960		8.80	1,810	
					July 4	9.51	2,250	24
27	Mathews Creek near Pink Hill.	8.61	1952–62	1955		21.96	809	
					July 4	21.85	760	27
28	Limestone Creek near Beulaville.	50	1952–62	1955		24.50	3,300	
					July 4	25.65	6,560	39
29	Northeast Cape Fear River near Chinquapin.	600	1908	1908		22.6	([1])	
			1940–62	1955		17.97	15,200	
					July 6	20.16	20,400	[2]1.6
30	Rockfish Creek near Wallace	63.8	1935–62	1948, 1955		([1])	2,800	
					July 5	12.82	4,450	10

[1] Not determined.
[2] Ratio of peak discharge to 50-year flood.

The intensity and great duration of storm rainfall on saturated ground produced unusually large volumes of runoff, as shown by hydrographs in figure 25.

Damage resulted primarily from heavy rainfall rather than from stream overflow. The two storms caused extensive damage to crops and relatively minor damage to highways and other property. Damages for June are described in "Climatological Data" for June as follows:

Agricultural losses from the storm rainfall were very high, with the greatest loss due to drowning of the nearly mature tobacco crop. Poultry losses were also high and some other livestock were lost; numerous washouts of roads and bridges occurred, and field erosion was extensive.

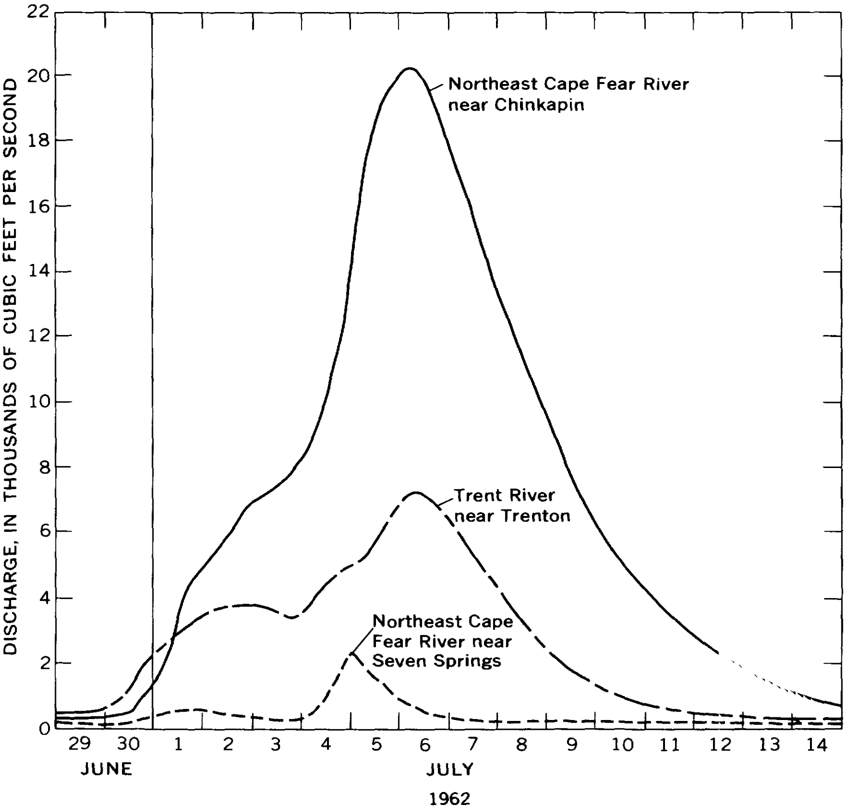

FIGURE 25.—Discharge hydrographs, June 29–July 14, for streams in eastern North Carolina.

The additional damage resulting from the storm of July 3–4 was described by Hardy in "Climatological Data" for July as follows:

Crops which were already partially drowned suffered further from the heavy rains of July 3–4, and a considerable additional acreage of tobacco which had survived the June 29 downpours drowned as a result of the early July rains. Other crops less vulnerable to drowning were seriously damaged by being blown to the ground, their roots having been loosened in the rain-soaked soil. Authorities have declared portions of fourteen counties disaster areas, with crop damage as high as 90 percent of total value.

Storm damage during June and July was estimated by the Weather Bureau as class 7 ($5,000,000–$50,000,000) for crops, and class 5 ($50,000–$500,000) for other damage.

Some additional damage was caused by overflow of floodwaters onto the floodplains of the larger streams. In many instances crops were already badly damaged by wind and rain, and additional damage due to the floods was not estimated.

FLOODS OF JULY IN NEBRASKA

By H. D. Brice

Rainfall amounts up to 5 inches in 8 hours were recorded on June 30–July 1, and greater amounts and rates may have occurred unobserved in the Rock Creek basin northwest of Parks (fig. 26). The resulting flood peak on Rock Creek at Parks was the greatest in the period of record which began in 1940.

Heavy rainfall occurred also in the Curtis-Maywood area on June 30–July 1 (table 27), but the distribution of this rain over the basin of Elkhorn Canyon apparently was quite different from that of the rainfall that caused the 1956 maximum peak discharges, shown in table 28. The peak discharge of 1956 at the upstream station, Elkhorn Canyon near Maywood (sta. 7), was approximately the same as that of July 1, 1962; but at the downstream station, Elkhorn Canyon southwest of Maywood (sta. 8), the 1956 peak discharge was 3.5 times the July 1, 1962, peak. This indicates that much heavier rainfall occurred over the area between these two sites prior to the 1956 flood than prior to the July 1, 1962, flood.

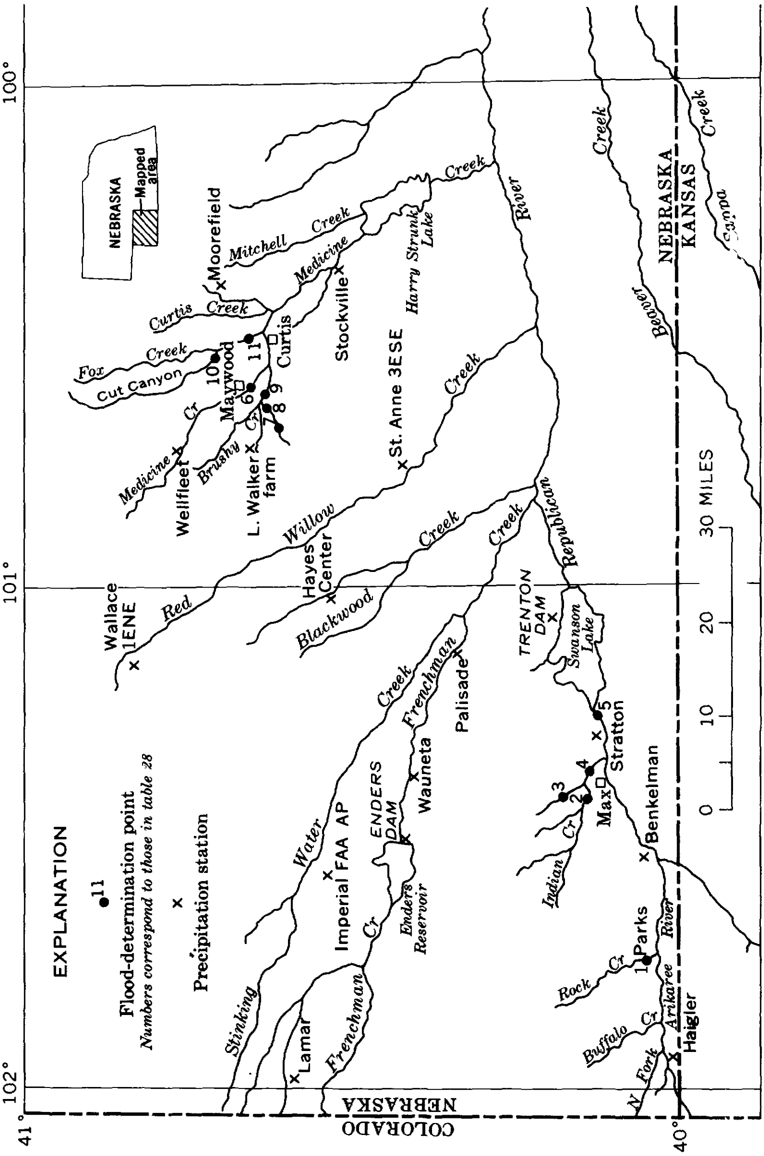

FIGURE 26.—Location of flood-determination points and precipitation stations, floods of July 1, 17, and 31 in southwestern Nebraska.

TABLE 27.—*Daily precipitation, in inches, associated with the floods of July 1, 17, and 31 in southwestern Nebraska*

[Tr., trace]

Site of observation	Time of observation	June		July																		
		29	30	1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18	29	30	31
Benkelman	0700	0	0.49	2.78	0	0	1.15	0	0	0	0.31	0	0	0	0	0	0	1.22	0.52	0.86	0	0.79
Curtis	2400	.17	1.02	1.17	0	.17	.08	0	0	.48	.02	.40	0	.09	0	0	2.04	1.24	0	0	0	.83
Enders Dam	0800	0	.67	1.30	0	0	0	.11	0	0	.24	0	0	0	1.23	0	0	.09	.58	0	0	1.19
Haigler	0700	0	.85	2.00	0	0	.13	0	0	0	0	0	0	0	0	0	0	1.08	.48	.99	0	1.61
Hayes Center	2400	1.80	1.11	.49	0	0	.05	0	0	.40	0	0	0	.56	.16	.70	0	0	0	0	.16	1.26
Imperial FAA	2400	2.13	1.06	.13	0	Tr.	0	.25	0	0	0	0	Tr.	.92	.04	0	.16	.57	0	0	2.00	1.23
Lamar	0700	.98	0	1.15	0	0	0	0	0	0	.55	0	0	.37	.57	0	0	.29	.52	.28	0	1.48
Lenord Walker Farm	(1)		2.60	2.00																		
Moorefield	0700	0	.05	1.07	0	0	.25	0	0	0	.55	.37	Tr.	Tr.	0	0	0	1.68	.95	.04	.22	.22
Palisade	0800	0	.85	1.66	0	0	.40	0	Tr.	0	.41	0	0	Tr.	0	0	0	.25	.63	.11	0	2.98
Rock Creek Hatchery				[1]5.00																		
St. Ann 3 ESE	0800	0	.05	1.43	0	0	.32	0	Tr.	0	.72	0	0	0	0	0	0	.78	.85	.51	.05	.28
Stockville	0700	0	.44	.88	0	0	.07	Tr.	0	0	.92	.50	0	0	.03	0	0	.78	1.16	.30	.15	.37
Stratton	0700	0	.05	2.35	0	0	.60	0	0	0	.44	0	0	.05	.01	.01	0	.51	1.58	.60	0	1.41
Trenton Dam	0800	0	.24	2.73	0	0	.35	0	0	0	1.07	0	0	0	.08	.02	0	0	1.30	.50	0	1.27
Wallace 1 ENE	0800	0	1.05	.47	Tr.	0	.01	0	0	0	.47	.08	0	.11	2.31	0	0	.82	.52	0	Tr.	.48
Wauneta	0800	0	.50	1.03	0	0	Tr.	.08	0	0	.25	0	0	0	.45	0	0	.28	.91	Tr.	0	3.90
Wellfleet	0800	0	1.00	1.10	0	0	.04	0	0	0	1.22	.46	0	.11	.55	0	0	1.90	.47	.20	0	.41

[1] Observation made after each storm event.

TABLE 28.—*Flood stages and discharges, July 1, 17, and 31 in southwestern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1962: Period	Maximum floods: Prior to July 1962: Year	Maximum floods: July 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Kansas River basin							
1	Rock Creek at Parks	[1] 14 [2] 180	1940–62	1951			95	
					1	4.57	110	3
2	Indian Creek near Max (Secs. 16 and 17, T. 2 N., R. 36 W.).	72.6			31		13,300	[3] 7.9
3	North Branch Indian Creek near Max.	4.76			31		12,900	[3] 77
4	Indian Creek near Max (sec. 15, T. 2 N., R. 36 W.).	81.8			31		27,000	[3] 14
5	Republican River at Stratton	([4]) [2] 7,940	1827–1962	1935			200,000	
					31		26,800	([5])
6	Medicine Creek at Maywood	207	1951–58, 1960–62.	1951			2,120	
					17	10.55	2,650	3
7	Elkhorn Canyon near Maywood.	6.74	1951–62	1956			1,220	
					1	17.47	1,250	18
8	Elkhorn Canyon southwest of Maywood.	13.2	1952–62	1956			8,660	
					1	18.54	2,450	41
9	Brushy Creek near Maywood	[1] 72 [2] 130	1947, 1951–58, 1960–62.	1956			5,250	
					17	19.40	4,700	25
10	Cut Canyon near Curtis	25.6	1951–62	1955			1,040	
					17	17.41	1,070	4
11	Fox Creek at Curtis	73.2	1947, 1951–58, 1960–62.	1951			3,340	
					17	19.66	1,490	3

[1] Contributing.
[2] Total.
[3] Ratio of peak discharge to 50-year flood.
[4] Contributing area unknown; only small part of total.
[5] Unknown.

Rain-gage coverage in this area is inadequate for precise definition of the large rainfall variations that are believed to occur. U.S. Weather Bureau gages (fig. 26) are at population centers, and the U.S. Geological Survey rain gage is on the Lenord Walker farm in the South Brushy Creek drainage basin about 3 miles north of the headwaters of Elkhorn Canyon. Rainfalls of 2.60 inches in a 5-hour period (2200 hours June 29 to 0300 hours June 30) and 2.00 inches in 10½ hours (2130 hours June 30 to 0800 hours July 1) were recorded at the Walker farm gage.

Intense rainfall occurred again in the Curtis-Maywood area on July 17 and resulted in peak discharges greater than any observed since records began at the discharge stations—Medicine Creek at Maywood (sta. 6) and Cut Canyon near Curtis (sta. 10). The resultant peak discharges on Brushy Creek near Maywood (sta. 9) and Fox Creek at Curtis (sta. 11) were the second highest since records began at those two stations. Rainfall amounts greater than 2 inches and less than 4 inches were observed at the U.S. Weather Bureau stations in the area during the period from 2400 hours June 16 to 0800 hours June 18 (table 27), but larger amounts may have fallen over those parts of the four basins mentioned above that are upstream from the gage sites.

Severe flooding occurred July 31 in Indian Creek basin near Max (table 28). The Benkelman Post of August 2, 1962, described the flood as "a 6-foot wall of water" and reported that various buildings and pieces of farm machinery at the Clyde Brown farm, east of Max, were damaged by the "rushing water" and that the flood waters reached the window sills of the Brown home. Residents of Max described the rain as so intense that they could hardly see across the street during the height of the deluge. The greatest amount of rainfall reported in Max was 3½ inches, but farmers within the basin upstream from Max reported rainfall amounts ranging from 3 to 10 inches. According to the U.S. Weather Bureau (1961), a rainfall of about 4½ inches in a 6-hour period may be expected to recur in the vicinity of Max at average intervals of 100 years, and a 10-inch rainfall in a period of as much as 24 hours would have an average recurrence interval greatly in excess of 100 years. The duration of the storm over Indian Creek is not known, but from eyewitness accounts of the deluge in Max, it seems reasonable to assume that most of the flood-producing rain fell within a 6-hour period.

The flood peak of 27,000 cfs which passed the gage on Indian Creek near Max (sta. 4) on July 31 continued downstream into the Republican River and passed the gage at Stratton (sta. 5) a few hours later on that date with only a small reduction (table 28). The peak discharge of 26,800 cfs at Stratton is not significant in comparison with the 200,000 cfs peak discharge of May 31, 1935 (maximum known since 1826), but it was the maximum discharge at the Stratton gage since continuous discharge records began in 1950 and is noteworthy because of the relatively small size of the tributary drainage area from which it originated.

Recordbreaking peak discharges occurred on a small tributary of the White River near Glen (sta. 1) and at Niobrara River near Dunlap (sta. 3; fig. 27) on July 31, and 30, respectively. The maximum stage near Dunlap occurred at about 2300 hours on June 30, 3 hours after the rise began. The time of occurrence of the peak on White River tributary was not recorded.

Local residents reported rainfall of about 6½ inches in Dry Creek basin near Dunlap, but the time of occurrence and duration of the storm were not recorded. According to the U.S. Weather Bureau

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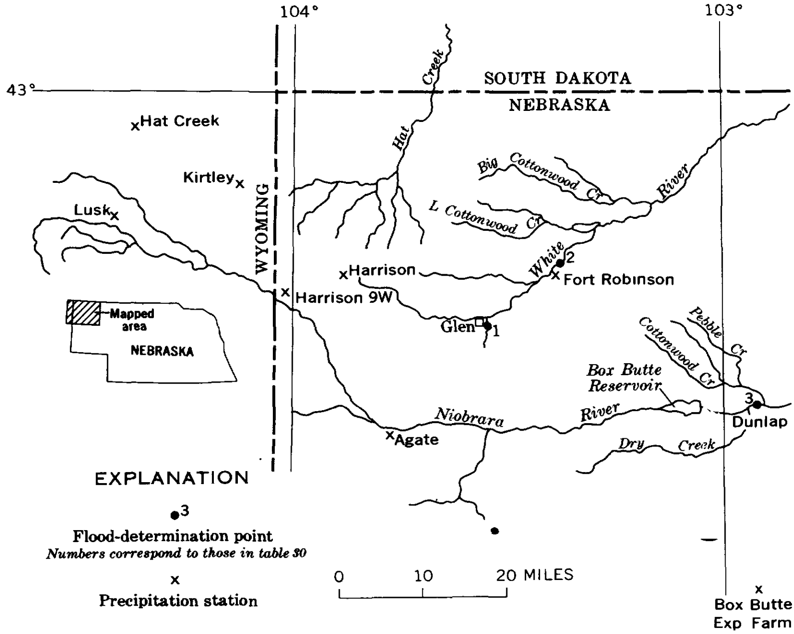

FIGURE 27.—Location of flood-determination points and precipitation stations, floods of July 30–31 in northwestern Nebraska.

(1961), this amount of rainfall in 24 hours at a point near Dunlap has a recurrence interval much greater than 100 years. The recurrence interval for the peak discharge is, however, related to several other factors in addition to point rainfall.

Table 29 lists all the rainfall records collected at U.S. Weather Bureau stations in the areas around Glen and Dunlap from July 26 to 31 and indicates that the flood-producing rainfall must have occurred between the two towns.

The daily mean discharges of White River at Crawford (sta. 2) on July 30 and 31 were 20 and 83 cfs, respectively. Table 30 shows that the peak discharge at that station on July 31 was 280 cfs. Comparison of these data with the peak discharge of 435 cfs on the White River tributary near Glen provides additional illustration of the highly localized rainfall in the tributary area.

TABLE 29.—*Daily precipitation, in inches, associated with the floods of July 30–31 in northwestern Nebraska*

[Tr., trace]

Station	Time of observation	July 26	27	28	29	30	31
Agate, Nebr	1600	0.36	0	0	0	0	0
Box Butte Experiment Farm, Nebr	0700	0	.04	Tr.	.05	0	.05
Fort Robinson, Nebr	0800	0	0	Tr.	0	0	.30
Harrison, Nebr	0600	0	Tr.	.22	0	0	0
Harrison 9W, Nebr	2400	0	.23	.04	0	0	.45
Hat Creek, Wyo	1700	0	.91	.02	0	0	.27
Kirtley, Wyo	Sunset	.07	.28	.15	0	0	.15
Lusk, Wyo	1800	0	.07	.23	0	0	.80

TABLE 30.—*Flood stages and discharges, July 30–31 in northwestern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1962: Period	Prior to July 1962: Year	July 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	White River basin							
1	White River tributary near Glen.	7.97	1953–62	1955			229	
					31	14.40	435	[1] 1.6
2	White River at Crawford	313	1931–43, 1947–62.	1953			1,270	
					31		280	<2
	Niobrara River basin							
3	Niobrara River near Dunlap	1,550	1930–42, 1960–62.	1937			2,890	
					30		3,230	30

[1] Ratio of peak discharge to 50-year flood.

FLOODS OF JULY 13 IN RAPID CITY AREA, SOUTH DAKOTA

Severe flash floods developed on Rapid Creek tributaries during the evening of July 13, when thunderstorms reportedly produced up to 6 inches of rainfall over a small area of mountainous terrain near the western edge of Rapid City (fig. 28). Weather Bureau rain gages recorded 1.78 inches (1.15 in. between 1900 and 2000 hours) at the airport, 10 miles east of Rapid City, and 2.33 inches in downtown Rapid City. There were unofficial reports of 3 inches of rainfall near Canyon Lake in the southwest corner of the city, 6 inches at Nameless Cave, and 4.7 inches at Hisega, a small community about 3 miles west of Nameless Cave. According to a resort operator at Hisega, this was the most intense downpour he had seen in the 35 years he had lived in

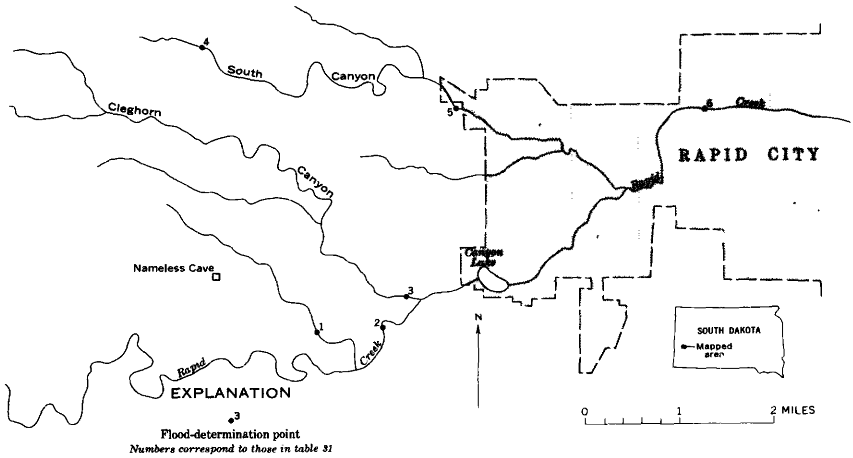

FIGURE 28.—Location of flood-determination points, floods of July 13 in Rapid City area, South Dakota.

the community. He reported that all but about half an inch of the precipitation received at Hisega during the storm fell between 1720 and 1830 hours. The rarity of this storm is indicated by intensity-duration-frequency curves published by the Weather Bureau (1961), which show that the 100-year 1-hour storm at Rapid City is about 2½ inches.

Two gaging stations on Rapid Creek were affected by the flood. Peak discharges at these two stations and at four miscellaneous sites are listed in table 31.

Streams in the area of heaviest precipitation, west of Rapid City, have very steep slopes and flow in deep, narrow canyons. Owing to crest flattening, when flow from the confining canyons entered the relatively wider channel of Rapid Creek, and also to the storage effect of Canyon Lake, peak discharges at the gaging stations were markedly reduced from those at the miscellaneous sites on tributaries.

Pactola Dam, on Rapid Creek 13 miles west of Rapid City, effectively controls the runoff from 319 square miles of the drainage basin and was releasing less than 5 cfs during the flood period. Virtually all the flow at the gaging station on Rapid Creek above Canyon Lake (sta. 2), therefore, originated within a few miles upstream from the gaging station. The peak flow of Rapid Creek at Rapid City (sta. 6) was the highest in 22 years of discharge record and, according to local residents, was the highest since the flood of May 1920.

An indication of the great recurrence intervals of the tributary floods can be seen from the plotting of the miscellaneous-site peak discharges with respect to the curves in figure 29. The curves depict the magnitude of the 25-, 50-, and 75-year floods from on open-file flood-frequency report (McCabe and Crosby, 1959) that includes the

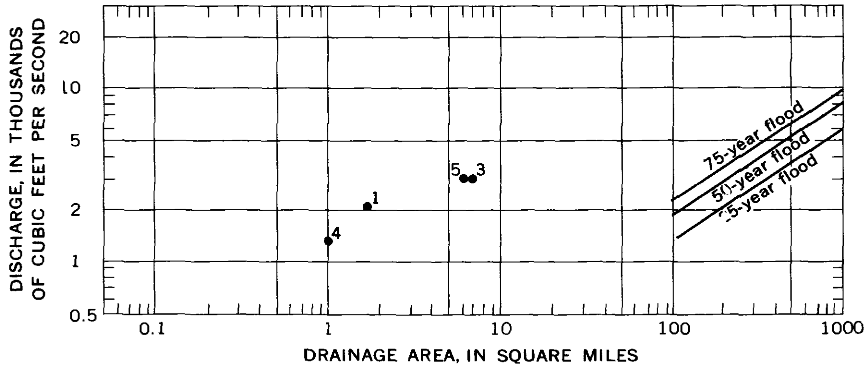

FIGURE 29.—Relation of peak discharge to floods of selected recurrence intervals, floods of July 13 in Rapid City area, South Dakota. Data are in table 31.

flood area. These curves are not defined below 100 square miles and should not be extrapolated to the small drainage areas of the miscellaneous sites. Although recurrence intervals cannot be assigned to the peak discharges at these miscellaneous sites, it may be concluded that the floods were rare occurrences. For example, the peak discharges at sites 3 and 5 (drainage areas between 6 and 7 sq. mi.), are comparable to the 75-year flood from a drainage area of 150 square miles in this area. Owing to regulation, that part of the main stem of Rapid Creek in the flood area is excluded from the flood-frequency report, and peak discharges at the gaging stations on Rapid Creek cannot be compared with the curves in figure 29.

Considerable damage was caused by the floods in outlying areas of Rapid City. Some residences were flooded, and a number of cars and at least one trailer house were destroyed in Cleghorn Canyon. Roads and bridges in the canyons also sustained heavy damage. Recent development of a residential area had nearly obliterated the stream channel in parts of the South Canyon section of Rapid City, and flooding of homes and streets in this area was extensive. About 1,500 persons were evacuated from their homes in Cleghorn Canyon and South Canyon and along Rapid Creek in Rapid City. The Iseman Mobile Home Corp. had a loss estimated at $150,000 when their offices and stock of trailer homes were flooded in a low area adjacent to Rapid Creek. The Corps of Engineers estimated that property damage in Rapid City totaled $800,000.

TABLE 31.—*Flood stages and discharges, July 13 in Rapid City area, South Dakota*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1962: Period	Year	July 1962	Gage height (ft)	Discharge: Cfs	Cfs per sq mi
	Rapid Creek basin							
1	Rapid Creek tributary near Rapid City.	1.67	----------	------	13	--------	2,130	1,280
2	Rapid Creek above Canyon Lake, near Rapid City.	[1] 371	1946–62----	1952	--------	8.08	2,600	--------
			----------	------	13	6.02	1,310	3.5
3	Cleghorn Canyon at Rapid City.	6.96	----------	------	13	--------	2,920	420
4	South Canyon near Rapid City.	.92	----------	------	13	--------	1,310	1,420
5	South Canyon at Rapid City---	6.06	----------	------	13	--------	2,960	488
6	Rapid Creek at Rapid City----	[1] 410	1904–06, 1920–62.	1920	--------	13.6	(2)	--------
			1904–06, 1942–62.	1952	--------	6.20	2,540	--------
			----------	------	13	8.37	3,300	8.0

[1] 319 sq mi above Pactola Dam practically noncontributing.
[2] Unknown.

FLOOD OF JULY 15 IN BANKLICK CREEK BASIN, KENTUCKY

By C. H. HANNUM

A heavy storm struck the Banklick Creek basin, a tributary to Licking River, between 0700 and 1100 hours on July 15. The outstanding characteristic of this storm was its great intensity over a small area, and this caused a flood of great magnitude that was confined to the small drainage area of Banklick Creek. The Weather Bureau at Greater Cincinnati Airport, 9 miles west of Covington, Ky., reported 3.93 inches of precipitation on July 15. Of this amount, 3.06 inches was reported as falling between 0700 and 1300 hours. A "bucket survey" of precipitation made in the Banklick Creek basin showed between 7 and 7.5 inches over the basin between the evening of July 14 and midday of July 15. Local residents reported that the heaviest rainfall occurred between 0700 and 1100 hours on July 15. This storm followed 3 days of general rains, from which the Greater Cincinnati Airport reported 1.54 inches of precipitation.

The antecedent conditions set by the 3 days of general rain and the rain up to 0700 hours on July 15 contributed greatly to the peak flow that followed the heavy storm between 0700 and 1100 hours on July 15.

The floods caused one death, and about 100 families were driven from their homes in Kenton County. Many families were driven from their trailers in a trailer camp south of Sanfordtown when Banklick Creek overtopped a levee built for the protection of the camp. The Red Cross set up an emergency feeding station near Sanfordtown and provided shelter to the homeless.

Six bridges were destroyed and many roads were damaged in low-lying areas in Kenton County. Local residents in the vicinity of Sanfordtown reported that the flood of July 15 was the highest known headwater flood on Banklick Creek and that the stage was exceeded only by the backwater flood of 1937, which was the greatest known flood on the Ohio River.

The discharge of Banklick Creek 0.5 mile south of Sanfordtown (fig. 30) was 16,400 cfs from 49.5 square miles. This flood had a

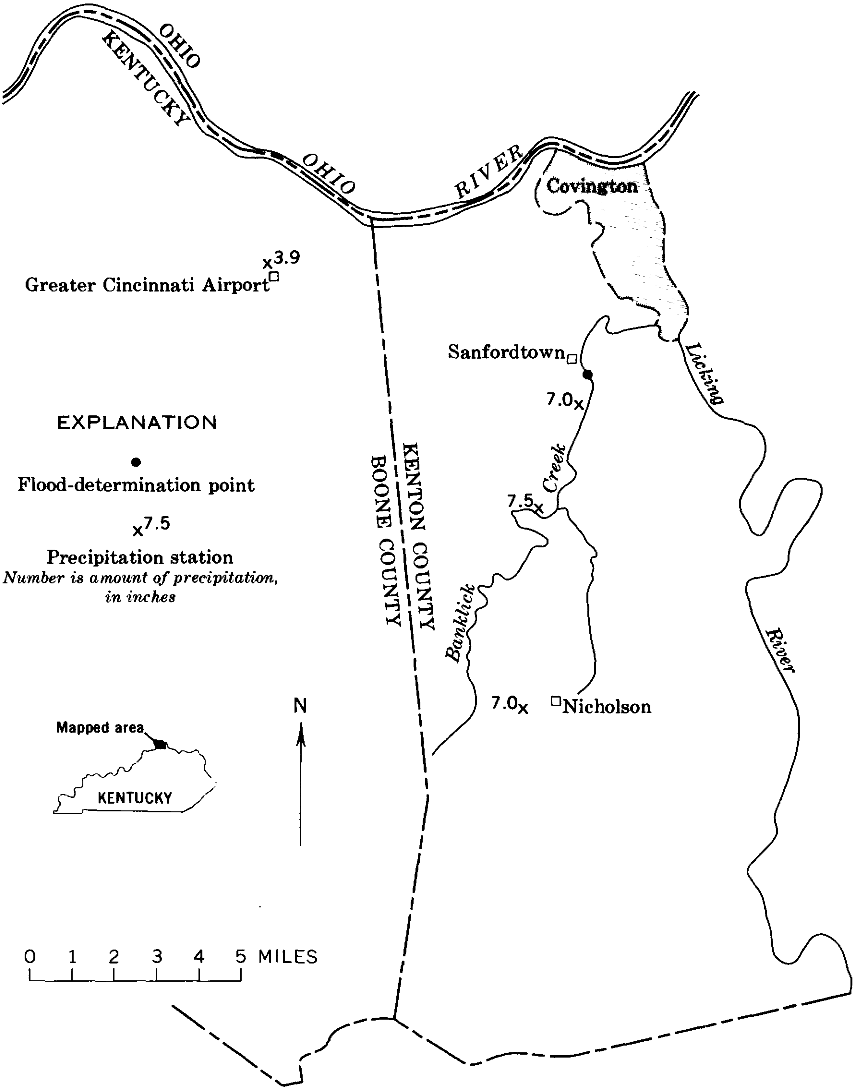

FIGURE 30.—Location of flood-determination point and total rainfall, flood of July 15 in Banklick Creek basin, Kentucky.

magnitude more than twice that of a 50-year flood. Damage to crops, trailers, and homes was estimated at $500,000 by Kenton County officials.

FLOODS OF JULY 27, SEPTEMBER 7–8, AND OCTOBER 8 IN NORTHEASTERN TEXAS

Several small-area floods of high intensity caused by summer storms occurred in northeastern Texas. Heavy rains caused flooding in two separate areas—near Mineral Wells and near Dallas—on July 27, and on October 8 heavy rains again caused flooding near Dallas. Locally intense thunderstorms on September 6–7 following general rains on September 1–6 caused floods with high rates of runoff on small streams in the upper Trinity River basin north of Fort Worth and Dallas.

Heavy rain at Mineral Wells and vicinity in the early morning of July 27 caused floods at Mineral Wells that were the most damaging in the memory of many longtime (about 50 yr) residents. The Mineral Wells Index reported that property damage exceeded half a million dollars. Damage also occurred in Palo Pinto, Parker, and other surrounding counties; however the heaviest damage was concentrated in the Mineral Wells and Camp Wolters area (fig. 31). The dam forming Lake Pinto on Pollard Creek was breached.

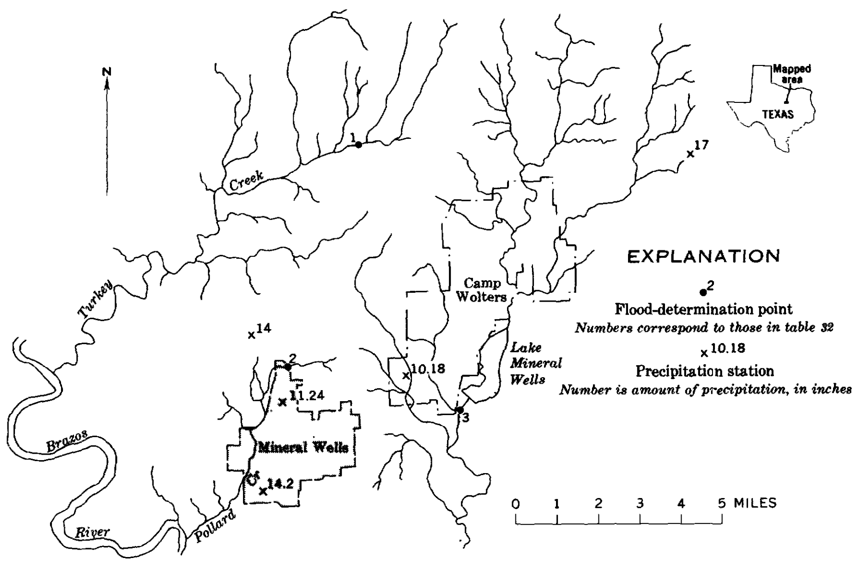

FIGURE 31.—Location of flood-determination points and total rainfall, floods of July 27 in the vicinity of Mineral Wells, Tex.

Heavy rainfall of about 5 inches to 17 inches occurred within a radius of 40 miles of Mineral Wells during July 25-27. Accumulated rainfall at a rain gage in Mineral Wells (fig. 32) illustrates antecedent rainfall and intensity of the rain that caused the flooding on July 27. The recurrence interval of 11 inches of rainfall in 2 days in the Mineral Wells area is 100 years according to U.S. Weather Bureau (1964).

Peak discharges of flash floods were measured at three sites (table 32). The recurrence interval for the peak that occurred on Rock Creek (Sta. 3; 212 cfs per sq mi from 74.4 sq mi) is greater than 50 years. No data are available to compute the recurrence interval of the high runoff from Pollard Creek (sta. 2; 3,150 cfs per sq mi from 3.84 sq mi), but it is obvious that the discharge was unusually high at this site, because the magnitude of the peak was greater than a 50-year flood from a drainage area of 100 square miles in the vicinity.

TABLE 32.—*Flood discharges, July 27 near Mineral Wells, Tex.*

Station No.	*Stream and place of determination*	*Drainage area (sq mi)*	*Discharge (cfs)*
1	Turkey Creek near Mineral Wells	9.66	4,300
2	Pollard Creek near Mineral Wells	3.84	12,100
3	Rock Creek near Mineral Wells	74.4	15,800

On July 27 the area upstream from Greenville Avenue in Dallas (fig. 33) received an average rainfall of 6.2 inches after almost 2 inches had fallen on the previous day. The rainfall caused flooding along White Rock Creek comparable to the flood of 1949, the second highest since at least 1922. The highest flood since 1886 occurred in 1942.

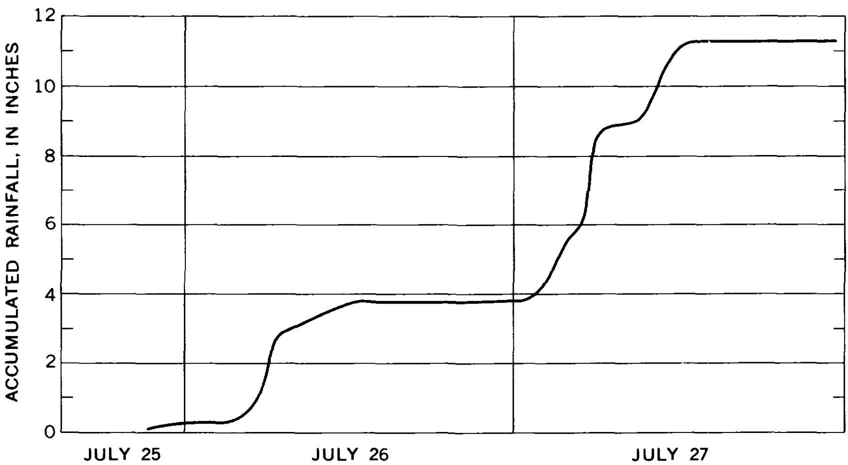

FIGURE 32.—Accumulated rainfall, in inches, at U.S. Weather Bureau station at Mineral Wells, Tex., July 25-27, 1962.

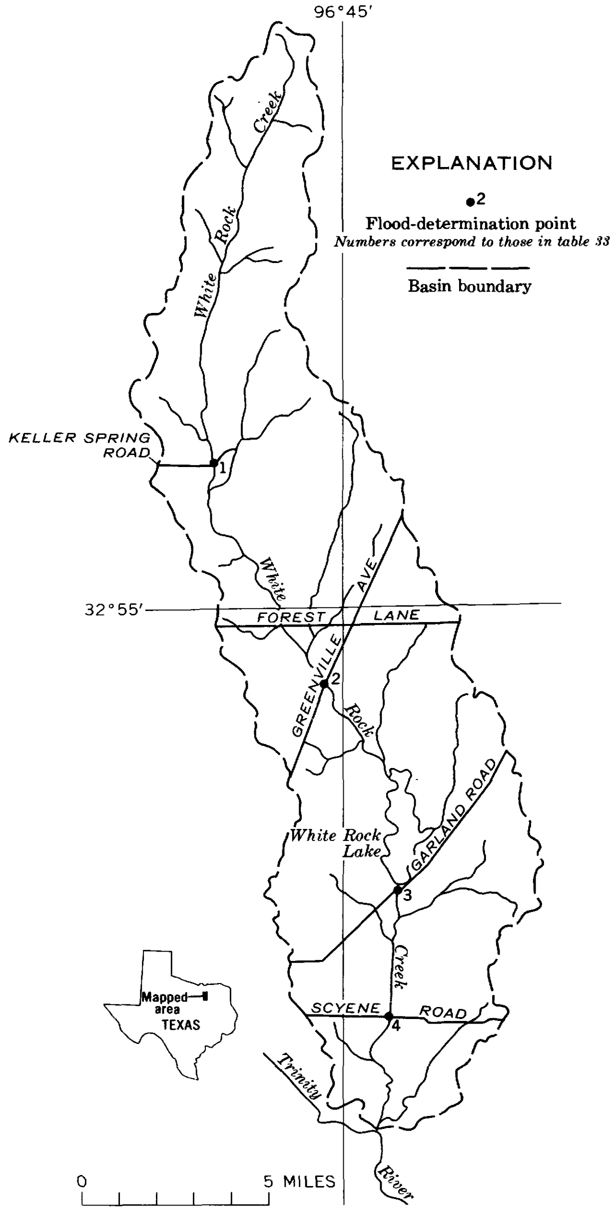

FIGURE 33.—Location of flood-determination points, floods of July 27 and October 8 in White Rock Creek basin, Dallas, Tex.

In the early morning of October 8, an intense storm of short duration centered over Cottonwood Creek in the upper White Rock Creek basin. An average of 4.6 inches of rain fell over the basin in about 3 hours. Flooding was more severe than in July in the reach downstream from Forest Lane. Rainfall in Cottonwood Creek basin ranged from about 4 inches in the upper part of the basin to more than 7 inches in the lower part. Flood heights were comparable to those of June 1949 on Cottonwood Creek and to those of April 1942 on Floyd Branch.

The attenuating effect of White Rock Lake upon peak flows in lower White Rock Creek was illustrated by these two floods. Table 33 shows the peak discharges for these floods at Greenville Avenue (sta. 2; upstream from White Rock Lake) and the peak discharges at White Rock Lake (sta. 3; downstream from White Rock Lake). The passage of the flood wave through the lake reduced the peak discharge on July 27 from 20,000 cfs to 13,700 cfs, and on October 8 from 24,500 cfs to 10,200 cfs.

An open-file report (Gilbert, 1963) prepared by the Texas district, in cooperation with the city of Dallas, shows the areas along White Rock Creek that were inundated by the floods of July and October.

TABLE 33.—*Flood stages and discharges, July 27 and October 8 on White Rock Creek in Dallas, Tex.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to July 1962		July and October 1962	Altitude	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
1	White Rock Creek at Keller Springs Road at Dallas.	29.4	1886–1962	1942		569.6	(1)	
					July 27	565.88	9,410	(1)
					October 8	555.46	2,360	(1)
2	White Rock Creek at Greenville Avenue at Dallas.	66.4	1886–1962	1942		490.1	(1)	
					July 27	488.80	20,000	(1)
					October 8	489.23	24,500	(1)
3	White Rock Creek at White Rock Lake Dallas.	100	1910–62	1942		465.2	25,000	
					July 27	[2]463.7	13,700	14
					October 8	461.90	10,200	7
4	White Rock Creek at Scyene Road at Dallas.	125	1886–1962	1908		[3]409.2	(1)	
					July 27	402.44	17,400	22
					October 8	401.60	9,550	6

[1] Not determined.
[2] Affected by backwater from flashboards on spillway.
[3] Affected by backwater from Trinity River.

General rains on September 1–6 saturated the soil in the upper Trinity River basin. Locally intense thunderstorms on September 6–7 caused flooding with high rates of runoff on some small streams north on Forth Worth and Dallas (fig. 34). The area immediately north of Fort Worth received an intense rainfall in the late evening

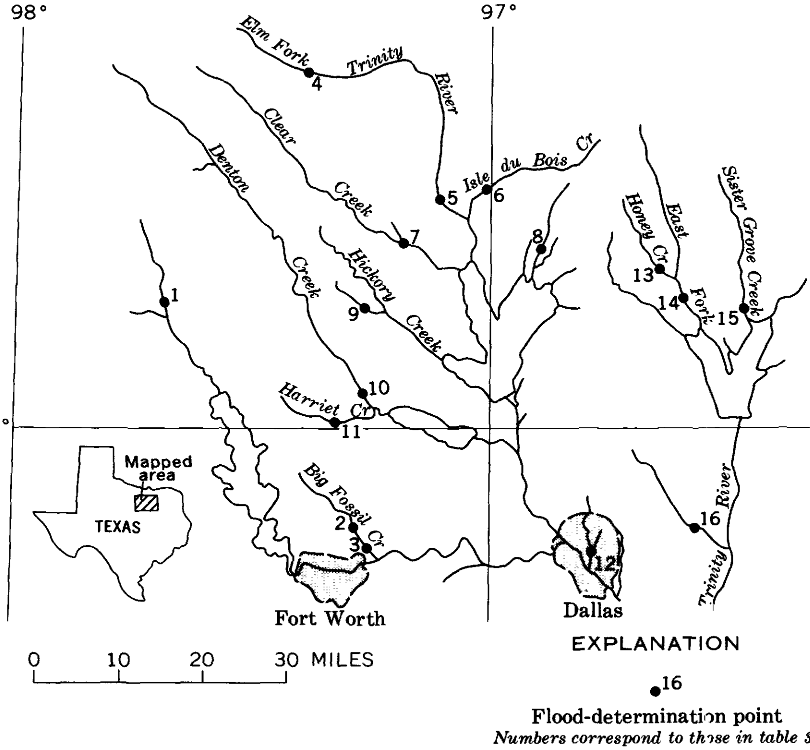

FIGURE 34.—Location of flood-determination points, floods of September 7–8 near Fort Worth and Dallas, Tex.

of September 7, and flood damage in Big Fossil Creek basin was the greatest ever known. Up to 11 inches of rain fell on September 7 in the upper part of Big Fossil Creek basin; the lower part of the basin received 2–4 inches (fig. 35).

The intensity of the rain was very high. During the afternoon of September 7, the recording rain gage near Justin, about 13 miles northeast of the Big Fossil Creek basin, measured 5 inches in 1 hour (1730 to 1830 hours) and 2 inches more in the following hour.

The great amount of rain falling within a short time caused a flash flood on Big Fossil Creek. The stream discharge at Haltom City (sta. 3) increased from 1,000 cfs at 2000 hours to a peak of 27,000 cfs at 2230 hours (fig. 36), and receded to base flow during the morning of September 8.

Peak discharge determined at 13 gaging stations and 3 miscellaneous measurement sites (fig. 34) are listed in table 34. Flood frequencies are not defined for drainage areas of less than 70 square miles in this region. The 50-year flood from 70 square miles is about 17,000 cfs. Table 34, therefore, indicates that the peak discharges on the small-area streams Big Fossil Creek, South Hickory Creek, and Harriet Creek must have been much greater than 50-year floods.

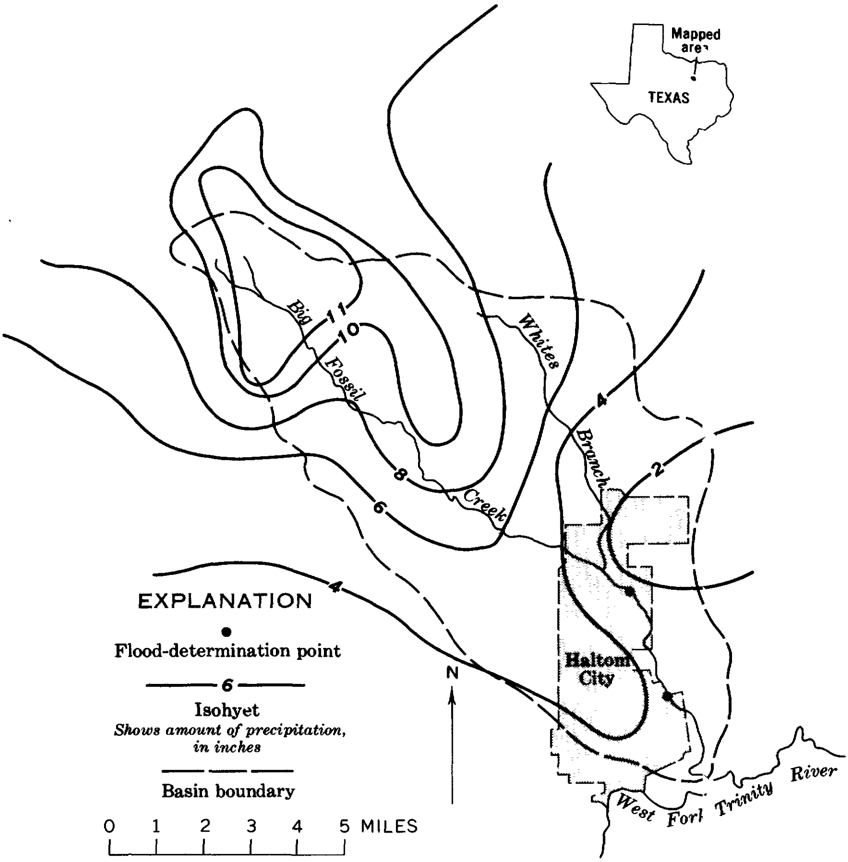

FIGURE 35.—Big Fossil Creek basin showing amount of precipitation for September 7. Prepared by U.S. Weather Bureau.

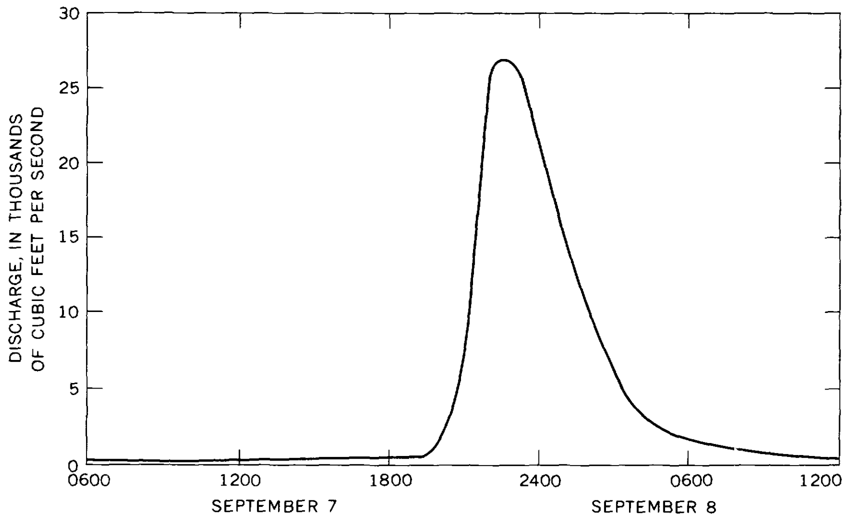

FIGURE 36.—Discharge hydrograph, September 7–8 on Big Fossil Creek near Haltom City, Tex.

The U.S. Army Corps of Engineers estimated the property damage in Big Fossil Creek basin at $750,000. The U.S. Soil Conservation Service estimated the agricultural damage at $27,000.

TABLE 34.—*Flood stages and discharges, September 7–8 near Fort Worth and Dallas, Tex.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to September 1962		September 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
1	Big Sandy Creek near Bridgeport.	333	1900–62	1908, 1915		15.70	(1)	
			1936–62	1941		15.69	5[illegible] 000	
					8	9.66	5,900	2
2	Big Fossil Creek at Highway 377.	42.8			7		3[illegible],800	>50
3	Big Fossil Creek at Haltom City.	52.8	1900–62	1942		24.80	(1)	
			1960–62	1961		23.06	1[illegible] 300	
					7	24.90	27,000	>50
4	Elm Fork Trinity River near Muenster.	46.0	1900–62	1935		23	(1)	
			1956–62	1958		20.20	5,900	
					7	10.45	1,310	(1)
5	Elm Fork Trinity River near Sanger.	381	1903–62	1908		30.7	(1)	
			1949–62	1958		29.1	27,500	
					7	28.1	22,500	8
6	Isle du Bois Creek near Pilot Point.	266	1900–62	1908		30.4	(1)	
			1949–62	1957		28.2	22,700	
					8	27.81	1[illegible] 000	9
7	Clear Creek near Sanger	295	1880–1962	1908		31.5	(1)	
			1949–62	1950		24.8	1[illegible] 200	
					8	24.3	1[illegible],200	6

See footnote at end of table.

TABLE 34.—*Flood stages and discharges, September 7–8 near Fort Worth and Dallas, Tex.*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to September 1962		September 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
8	Little Elm Creek near Aubrey.	75.5	1900–62	1941		18.2	(1)	
			1956–62	1957		17.34	7,830	
					6	16.43	5,030	5
9	South Hickory Creek near Ponder.	23.0			7		18,400	>50
10	Denton Creek near Justin	400	1908–62	1935		20.6	(1)	
			1949–62	1957		17.64	29,800	
					7	16.83	17,200	5
11	Harriet Creek near Haslet	14.3			7		14,100	>50
12	Turtle Creek at Dallas	7.98	1903–62	1959		8.10	4,650	
					7	4.9	1,690	(1)
13	Honey Creek near McKinney	39.0	1930–62	1950		23.00	(1)	
			1951–62	1957		20.29	7,920	
					6	13.52	1,390	(1)
14	East Fork Trinity River near McKinney.	190	1913–62	1942		21	(1)	
			1949–62	1957		16.65	23,900	
					6	16.75	12,000	6
15	Sister Grove Creek near Princeton.	113	1865–1962	1913		22	(1)	
			1949–62	1957		16.23	9,080	
					8	15.16	3,650	2
16	Duck Creek near Garland	31.6	1895–1962	1949		17.5	(1)	
			1958–62	1958		14.12	7,400	
					8	12.87	3,730	(1)

[1] Not determined.

FLOODS OF AUGUST 10 NEAR VELVA, N. DAK.

A severe thunderstorm on August 10 over the upper reaches of Bonnes Coulee, a tributary to the Souris River, caused a flash flood throughout the Bonnes Coulee basin and flooded the town of Velva (fig. 37). Water was 3 feet deep in the streets of Velva, and the amount of damage caused by the flood was estimated at $700,000. Three persons were drowned when the flood crest swept their cars off U.S. Highway 52 near Velva. The storm caused flooding in adjacent basins also, but less damage resulted.

A survey of residents indicated that more than 10 inches of rain fell in 1½ hours at some places. This intensity of rain was almost four times that for a 100-year 1½-hour storm as defined by the Weather Bureau (1961).

Extremely high peak discharges of August 10 were measured, by indirect methods, at two miscellaneous sites: 1,470 cfs (1,040 cfs per sq mi from 1.42 sq mi) on a tributary to Bonnes Coulee, and 26,300 cfs (500 cfs per sq mi from 52.5 sq mi) on Bonnes Coulee. The storm area was small and the flow in the Souris River was not materially affected. By the time the flood crest reached Verendrye on August 12, it was reduced to 1,380 cfs, about 5 percent of the peak on Bonnes Coulee.

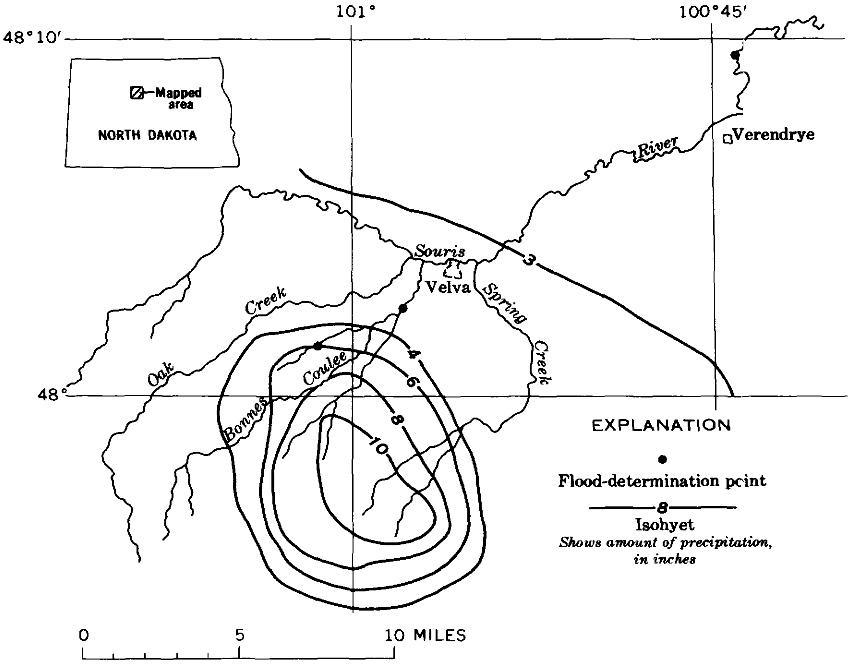

FIGURE 37.—Location of flood-determination points and isohyets for August 10, floods of August 10 near Velva, N. Dak.

The peak discharges had high recurrence intervals, but definite frequencies cannot be computed. An open-file flood-frequency report (McCabe and Crosby, 1959) includes the area affected by this flood. Flood-frequency curves applicable to the area in which the miscellaneous sites are located show the relation of discharges to 10-, 25-, 50-, and 75-year floods (fig. 38), but the curves are defined for drainage areas of 100 or more square miles. The curves in figure 38 are not dependable if extrapolated to the small drainage areas of the two miscellaneous sites, and recurrence intervals cannot be determined for them.

The peak discharge in Bonnes Coulee from 52.5 square miles is about 11 times as great as a 75-year flood from 100 square miles, and the peak discharge from only 1.42 square miles is equal to a 25-year flood from 100 square miles.

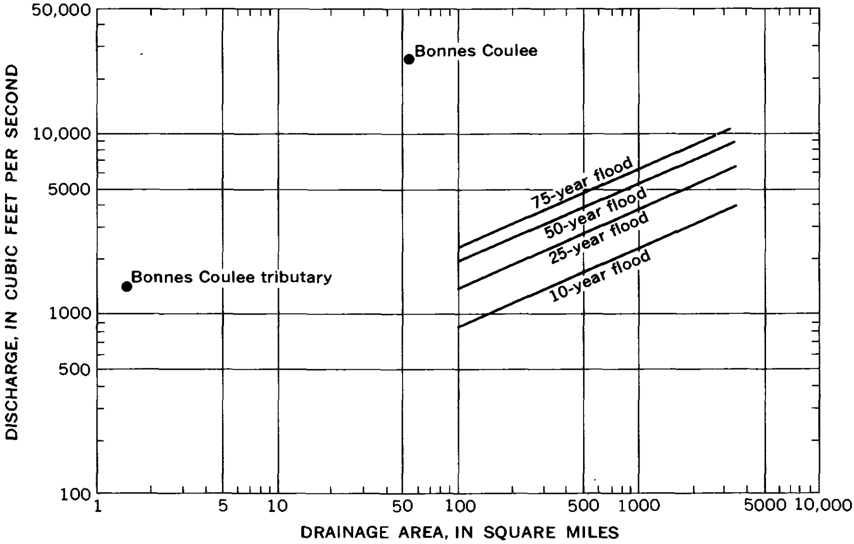

FIGURE 38.—Relation of peak discharge to 10-, 25-, 50-, and 75-year floods, floods of August 10 near Velva, N. Dak.

FLOOD OF SEPTEMBER 13 NEAR MARANA, ARIZ.

By B. N. ALDRIDGE

On September 13, the small town of Marana and surrounding farmland (fig. 39) were flooded with 6 to 18 inches of water as a result of a thunderstorm on the west side of the Tortolita Mountains. Schools and several homes were flooded, Interstate Highway 10 was blocked, and cotton crops that were about ready for harvest suffered extensive damage. It is estimated that the flood caused about $50,000 damage.

The storm moved eastward, parallel to the drainage which flows westward. The rainfall during a 2-hour period reportedly was 3 or 4 inches; one resident reported 4.6 inches. More rain may have fallen at higher altitudes where no data were available.

The flood originated in a 15-square-mile area centered about 8 miles northeast of Marana. At several places the runoff was estimated to be between 700 and 1,000 cfs per sq mi. One slope-area measurement was made on Cottonwood Canyon in NW1/4SW1/4 sec. 32, T. 10 S., R. 12 E., 1½ miles downstream from the Carpenter Ranch and 6 miles northeast of Marana. The discharge was 5,700 cfs from an area of 8.06 square miles—a unit runoff of 708 cfs per sq mi.

After leaving the well-defined valleys of the mountains the water flowed in sheets over the alluvial fan between the mountains and Marana.

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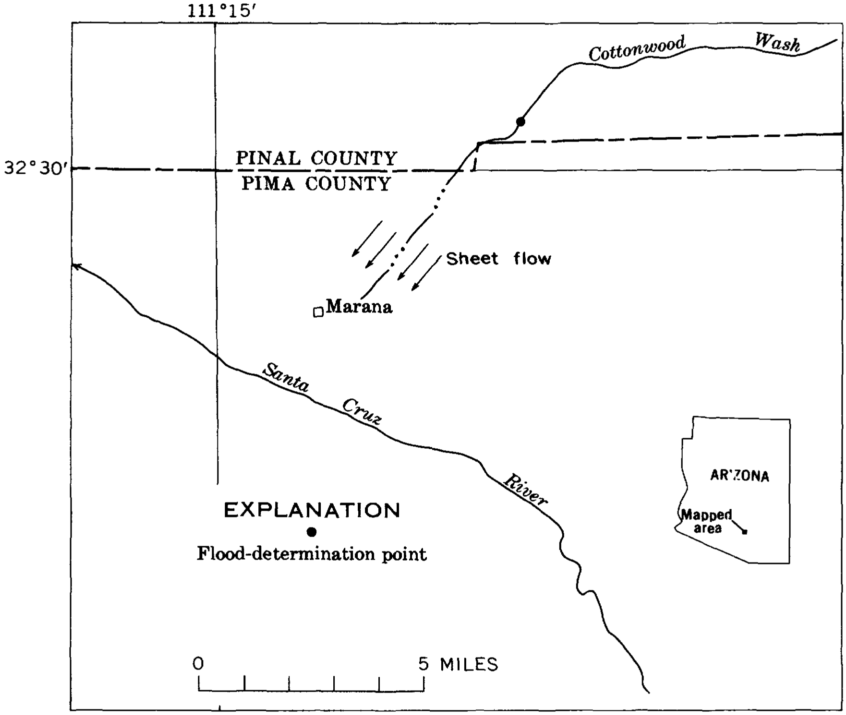

FIGURE 39.—Location of flood-determination point, flood of September 13 near Marana, Ariz.

The flood is the highest in recent years, but there are not enough data available to determine the frequency of the flood. A recurrence of a flood of this magnitude would be infrequent at any one site. However, on September 26, 1962, only 2 weeks later, a flood nearby reached discharges comparable to that of September 13 in Cottonwood Canyon. Discharges 10–15 miles southeast of Marana on September 26 in tributaries to the Santa Cruz River ranged from 500 to 1,000 cfs per sq mi. from drainage areas of 1.3 to 4.0 square miles. The floods of September 26 in southern Arizona are described on page 115.

FLOODS OF SEPTEMBER 21 IN SOUTHEASTERN UTAH

By ELMER BUTLER

General rain fell over most of Utah on September 21, and highest intensities caused flooding in small areas near Green River and Hite. (See fig. 40.)

The Weather Bureau recorded rainfalls of 0.30 inch at Green River, 1.67 inches at Price, 50 miles northwest of Green River, and 0.38 inch at Hite. The rainfall stations are too widely scattered to give a good indication of the average depth of rain which fell over the basins of the flooding streams.

The streams affected were Fry Canyon near Hite and Saleratus Wash and its tributaries near Green River and Woodside.

Discharges were high in the area (table 35). Fry Canyon had about a 50-year flood. Saleratus Wash had peaks greater than 50-year floods. Flood-frequency relations are undefined for areas of less than 20 square miles in Utah; therefore frequencies cannot be computed for the flood on tributaries to Saleratus Wash, but the probability of such floods occuring in any year is very small.

The floods were in sparsely settled regions; therefore damage was light. About 400 feet of Denver & Rio Grande Western Railroad track along a Saleratus Wash tributary near Woodside was damaged, and

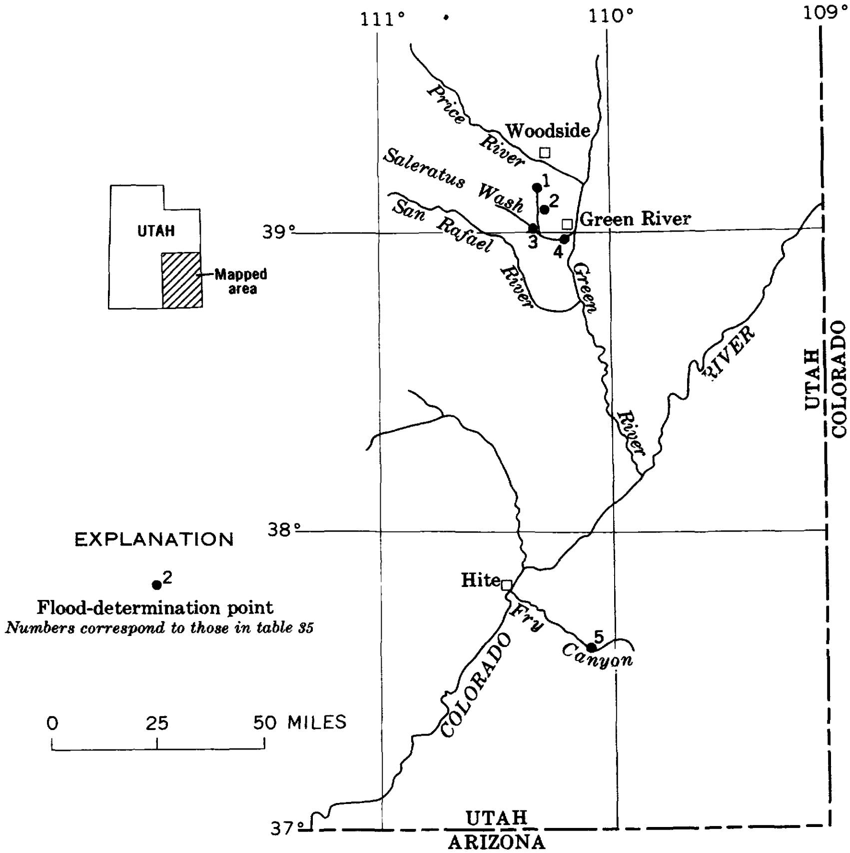

FIGURE 40.—Location of flood-determination points, floods of September 21 in southeastern Utah.

other sections of railroad track and parts of U.S. Highways 50–6 about 10 miles south of Woodside were overtopped by floodwaters of Saleratus Wash.

TABLE 35.—*Flood stages and discharges, September 21 in southeastern Utah*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to September 1962: Period	Maximum floods: Prior to September 1962: Year	Maximum floods: September 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Ratio 50 to year flood
	Green River basin							
1	Saleratus Wash tributary near Woodside.	10	1959–62	1961	----------	17.06	929	--------
					21	20.0	5,340	(1)
2	Saleratus Wash tributary No. 2 near Woodside.	4.4	1959–62	1961	----------	15.15	531	--------
					21	18.3	3,720	(1)
3	Saleratus Wash above Cottonwood Wash near Green River.	120	1959–62	1959	----------	--------	2,720	--------
					21	16.5	13,500	1.6
4	Saleratus Wash at Green River.	180	1948–62	1950	----------	--------	4,850	--------
					21	11.60	14,200	1.1
5	Fry Canyon near Hite	20.9	1960–62	1961	----------	13.17	1,000	--------
					21	16.05	3,500	1.0

1 Not determined.

FLOODS OF SEPTEMBER 21–24 IN SOUTHWESTERN FLORIDA

By J. W. RABON

Circulation of moist air around a low pressure area off the lower west coast of Florida, coupled with a weak stationary front lying across the peninsula, caused intense rainfall in the coastal area from Tampa to Naples.

Streamflow for the 8 months January to August ranged from about 20 to 70 percent above median in the Myakka, Manatee, and Little Manatee River basins. Runoff in excess of the median ranged from about 1.5 inches in the Little Manatee River basin to about 2.7 inches in the Myakka River basin. East of these basins, streamflow for the 8 months preceding the storm was below median. In the Peace River basin, runoff ranged from about 20 to 45 percent below median, equivalent to about 2.3 inches less than the median in the upper part of the basin and 1.2 inches less than the median in the lower part of the basin.

The storm centered in the area just north of Sarasota, where 14.5 inches of rain fell in a period of 24 hours. Figure 41 shows the pattern and distribution of rainfall for the storm. The isohyets are based on rainfall measurements from a network of stations having a density of about one station per hundred square miles of land area. The amounts shown are for a 48-hour period ending September 21. Figure 42 shows accumulated rainfall at four selected stations in the area of

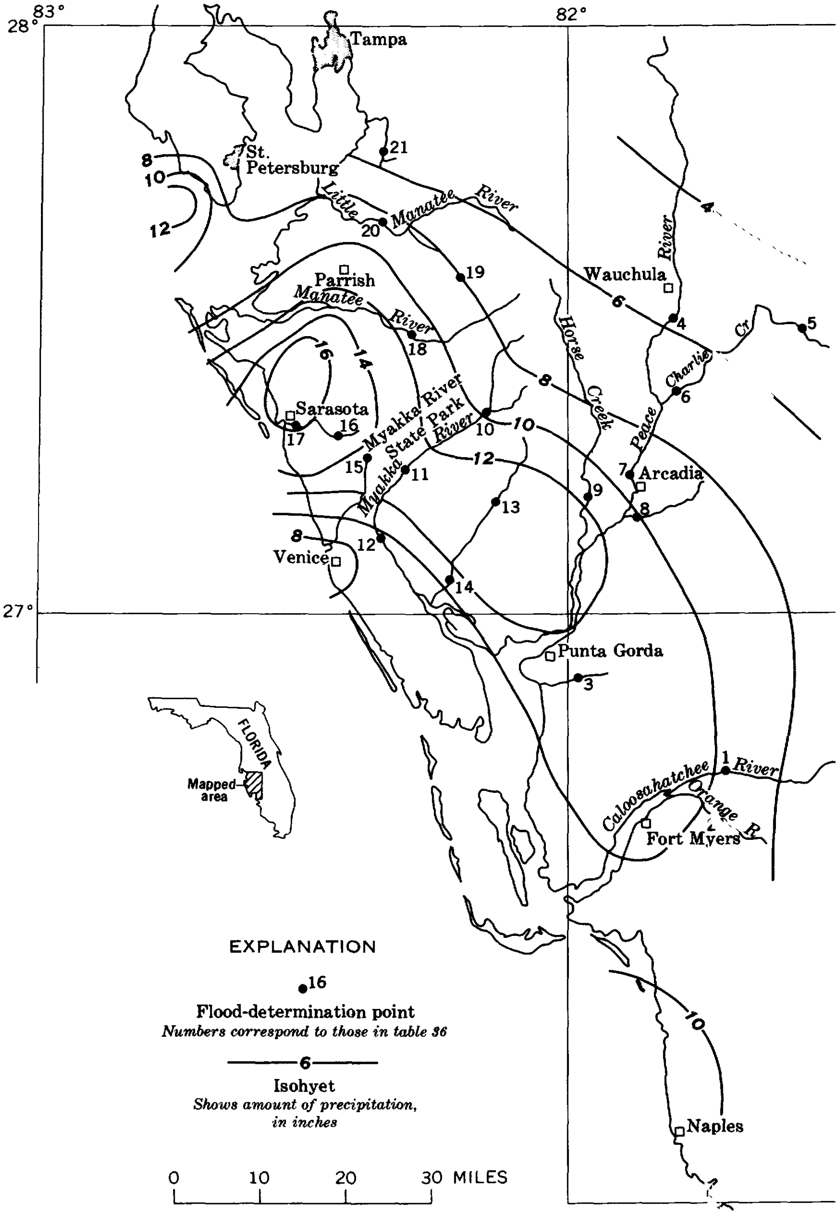

FIGURE 41.—Location of flood-determination points and isohyets (from map furnished by the U.S. Army Corps of Engineers) for September 20–21, floods of September 21–24 in southwestern Florida.

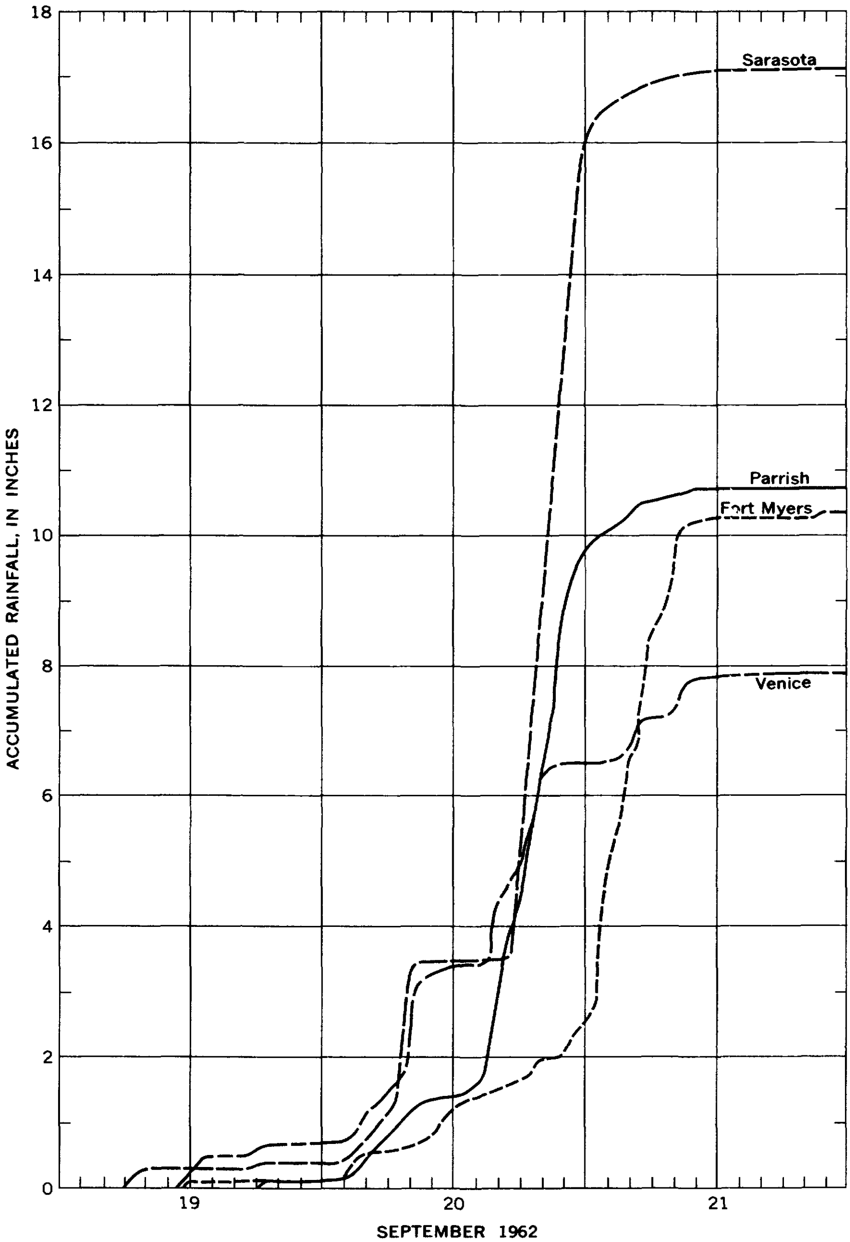

FIGURE 42.—Accumulated rainfall for September 19–21 at selected precipitation stations in southwestern Florida.

heaviest rainfall. The curves were obtained from recording gages except that for Sarasota, which was drawn from twice-daily observations. In the area of heaviest rainfall, estimated recurrence intervals for the 48-hour amounts ranged from once in about 5 years to once in 100 or more years. Figure 43 shows estimated recurrence intervals for the four stations in figure 42 and for three other stations whose 2-observational-day rainfalls were estimated to be practically the same as their respective 48-hour rainfalls. The return-period diagrams are based on interpolated values of durations and frequencies compiled by the U.S. Weather Bureau (1964).

Streamflow gaging-station records indicate that flood peaks in the area were generally of lesser magnitude than those of some past occurrences (table 36). According to a report by the U.S. Army Corps of Engineers (1962), however, peaks occurring in the lower Phillippi Creek and Manatee River basins were the highest known. The peak

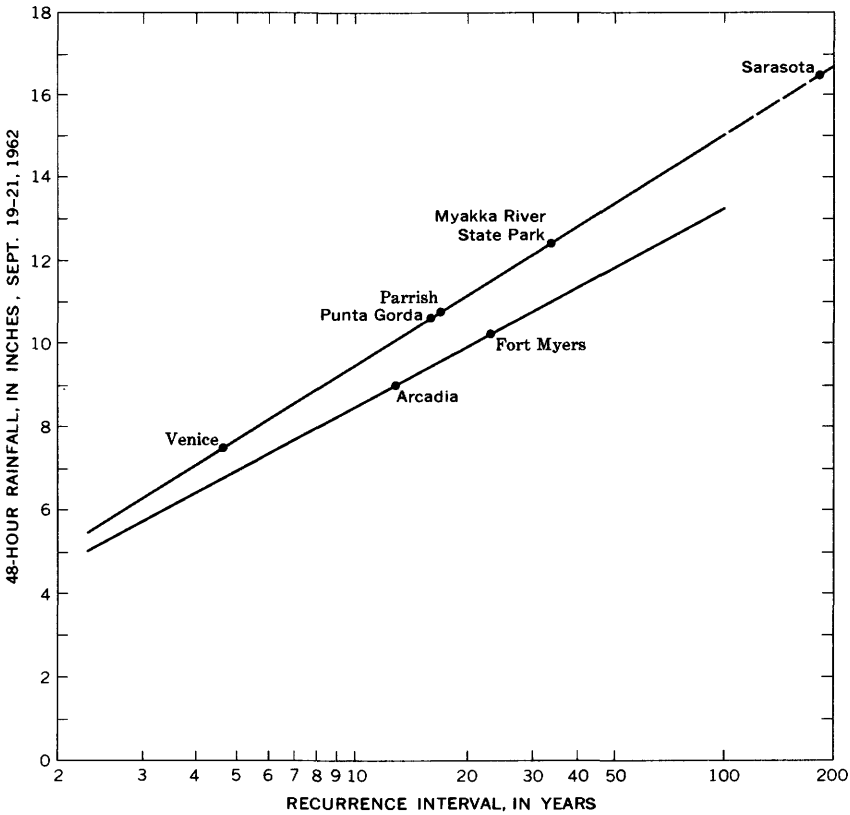

FIGURE 43.—Rainfall frequency curves for southwestern Florida.

flow on September 21 at the crest-stage gaging station on Phillippi Creek at Sarasota (sta. 17; drainage area, 45 sq mi) was about 60 percent greater than that of 1960, and the peak stage was about 2.7 feet higher.

The greatest damage occurred in the residential area of Sarasota, which comprises much of the 55-square-mile drainage area of Phillippi Creek. Nearly all streets and roads in and around Sarasota were under water. Several feet of water stood over main highway bridges that cross Phillippi Creek and drainage canals. Stores, homes, and streets in Sarasota were flooded by 3 to 7 feet of water for 4 to 6 hours.

TABLE 36.—*Flood stages and discharges, September 21–24 in southwestern Florida*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to September 1962		September 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Caloosahatchee River basin							
1	Caloosahatchee River at Olga	906	1947–62	1947	--------	--------	(1)	--------
					23	(2)	(1)	--------
2	Orange River at Buckingham near Fort Myers.	70	1960–62	1960	--------	11.28	1,630	--------
			--------	--------	21	12.43	2,180	(1)
	Alligator Creek basin							
3	Alligator Creek near Punta Gorda.	31.1	1960–62	1960	--------	7.87	1,660	--------
			--------	--------	21	11.30	3,370	(1)
	Peace River basin							
4	Peace River at Zolfo Springs	826	1933–62	1933	--------	20.05	23,300	--------
			--------	--------	23	13.06	6,270	2
5	Little Charley Bowlegs Creek near Sebring.	41.9	1952–62	1960	--------	17.61	874	--------
			--------	--------	22	16.47	351	(1)
6	Charlie Creek near Gardner	330	1928	1928	--------	24.2	(1)	--------
			1950–62	1960	--------	18.77	8,160	--------
			--------	--------	22	17.16	5,900	(1)
7	Peace River at Arcadia	1,367	1912–62	1912	--------	20.6	43,000	--------
			--------	--------	24	15.07	11,200	3
8	Joshua Creek at Nocatee	132	1950–62	1953	--------	18.80	8,670	--------
			--------	--------	22	19.05	8,220	(1)
9	Horse Creek near Arcadia	218	1948–62	1960	--------	17.94	11,700	--------
			--------	--------	21	16.70	6,690	(1)
	Myakka River basin							
10	Myakka River at Myakka City.	125	--------	--------	21	16.6	7,190	8
11	Myakka River near Sarasota	235	1936–62	1960	--------	11.58	8,670	--------
			--------	--------	23	11.60	7,850	6
12	Myakka River near Venice	270	--------	--------	21	11.2	(1)	--------
13	Big Slough Canal near Myakka City.	[3] 53.0	--------	--------	21	9.39	2,480	(1)
14	Big Slough near Murdock	87.5	--------	1962	21	16.35	3,900	(1)

See footnotes at end of table.

TABLE 36.—*Flood stages and discharges, September 21–24 in southwestern Florida*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to September 1962: Period	Prior to September 1962: Year	September 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Coastal basins between Myakka River and Phillippi Creek							
15	Cow Pen Slough near Bee Ridge.	38	----------	------	21	15.86	4,110	(1)
	Phillippi Creek basin							
16	Phillippi Creek near Sarasota	24	----------	------	21	21.25	2,060	(1)
17	Phillippi Creek at Sarasota	45	1960–62	1960	----------	11.48	4,240	--------
			----------	------	21	14.2	6,740	25
	Manatee River basin							
18	Manatee River near Bradenton	80	1939–62	1960	----------	25.67	8,410	--------
			----------	------	21	25.79	9,420	30
	Little Manatee River basin							
19	South Fork Little Manatee River near Duette.	9.4	1960–62	1960	----------	6.96	(1)	--------
			----------	------	21	6.23	875	(1)
20	Little Manatee River near Wimauma.	149	1939–62	1960	----------	17.59	14,000	--------
			----------	------	21	16.62	11,600	24
	Bullfrog Creek basin							
21	Bullfrog Creek near Wimauma	29.1	1957–62	1960	----------	30.59	(1)	--------
			----------	------	21	29.82	(1)	--------

[1] Not determined.
[2] About 1.6 ft. higher than the previous maximum in 1947.
[3] Includes that of Mud Lake Slough.

In Sarasota County, in addition to the urban areas, about 60,000 acres of ranchland and 10,700 acres of woodland were damaged. Large areas in adjoining counties were also covered by floodwaters that remained for only a few hours. Areas adjacent to streams and drainage works, however, were flooded for 1 to 3 days, and farms and pasturelands more remote from the streams remained flooded for several weeks. The following summary gives the areas flooded, in percentage of basin areas, as abstracted from a map prepared by the Corps of Engineers:

Basin	*Percentage flooded*
Horse Creek (part of Peace River basin)	40
Peace River (between station at Zolfo Springs and mouth)	25
Myakka River	30
Phillippi Creek (including area between Myakka River and Phillippi Creek)	35
Manatee River (including Braden River)	25
Little Manatee River	10
Average	25

The floods caused damage amounting to about $2,700,000 in basins of three streams—Peace River, Manatee River, and Phillippi Creek. Greatest damage was to personal property such as homes, lawns, automobiles, and personal effects. Second greatest damage was to public property such as roads, bridges, and culverts; and third greatest was to agriculture. County agents reported a 2- to 5-week delay in planting. Information on damage, including that summarized in table 37, was taken from the flood report prepared by the Corps of Engineers, Jacksonville District.

Recurrence intervals of peak discharges are given in table 36 for stations having long-term records. The peaks had recurrence intervals between 5 and 10 years in the upper part of the Myakka River basin and about 25 years in the upper part of the Manatee and Little Manatee River basins. The peak discharge for Manatee River near Bradenton (sta. 18; drainage area, 80 sq mi) was about 10 percent greater than that of 1960, which was the greatest previously known since 1939. The peak for Phillippi Creek at Sarasota (sta. 17; crest-stage station) is estimated to have a recurrence interval of about 25 years. Figure 44 shows discharge hydrographs at gaging stations in several basins during the flood.

TABLE 37.—*Summary of estimated damage from floods of September 21–24 in southwestern Florida*

[Data furnished by Corps of Engineers, Jacksonville District]

	Peace River basin	Phillippi Creek basin	Manatee River basin	Other basins	Total
	Charlotte County	Sarasota County	Manatee County	Lee County	
Private property, including homes, lawns, automobiles, and personal effects	$50,000	$1,385,000	$150,000		$1,585,000
Public property, including municipal buildings	24,000	236,000			260,000
Roads, bridges, culverts and canals		342,000	100,000	$66,500	508,500
Agriculture	100,000	300,000		25,000	425,000
Total	174,000	2,263,000	250,000	91,500	2,778,500

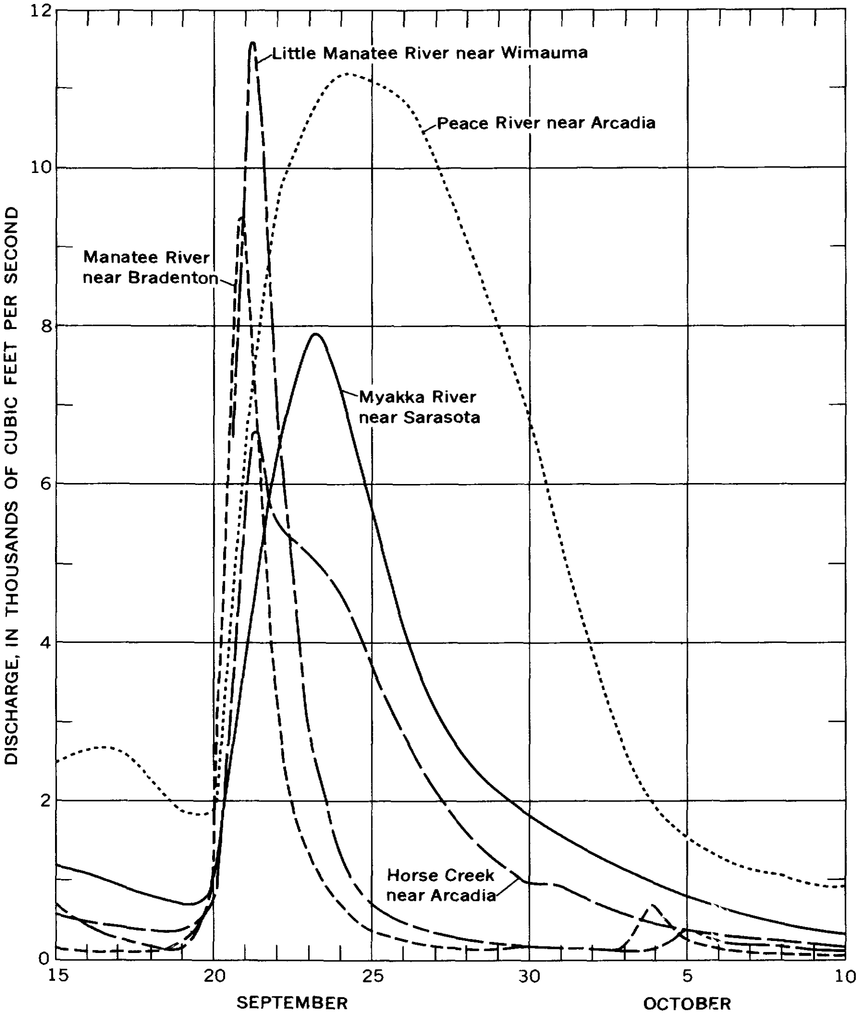

FIGURE 44.—Discharge hydrographs, Sept. 15–Oct. 10 for selected streams in southwestern Florida.

FLOODS OF SEPTEMBER 26–28 IN SOUTHERN ARIZONA

From LEWIS (1963)

Major floods occur infrequently in the desert lowlands of Arizona because, normally, rainfall is scanty. Heavy storms give variable rainfall amounts, and it is improbable that high volumes and intensities will be distributed over a large drainage basin; as a general rule, floodwaters derive from only a part of the drainage basin. Floods of September 26–28 in southern Arizona are vivid examples of intense floods resulting from rainfall on small parts of a river basin. The floods spread over the Santa Cruz River, Brawley Wash, Santa Rosa Wash, and Sells Wash, but no entire basin received great amounts of rainfall.

Moist air from tropical storm Claudia arrived over the southwestern corner of Arizona on September 24. The main moist stream of air was about 70 miles wide and followed a path over Organ Pipe National Monument, Sells, the Tucson Mountains-Cortaro area, and Safford, and crossed the Continental Divide north of Silver City, N. Mex. The heaviest rain fell during the night of September 25 and during most of September 26. Rainfall totals amounted to 6 inches over the Avra Valley area southwest of Marana, about 4 inches in the Sells area, and from 2 to 3 inches in the Safford-Clifton region. Records were obtained at precipitation stations of the U.S. Weather Bureau. Readings were obtained from gages owned by ranchers and farmers and also from the Corps of Engineers, Soil Conservation Service, and the Geological Survey. The amount and distribution of rainfall during September 25–26 is shown in figure 45.

Some sections of the storm area had two periods of precipitation. The time of rainfall varied. The first heavy rainfall over Tucson occurred before 0800 hours on September 26, and another period of intense precipitation started about noon. The fact that two separate crests left floodmarks in many channels indicates that the first crest was the higher.

The heaviest rain fell over the Roskruge Mountains and extended eastward across Sells Wash, the upper part of Santa Rosa Wash, and Brawley Wash. Rainfall at Tucson was not as intense, nor was the total as great, as in areas to the west, but reports of high intensity runoff came first from Tucson because a high percentage of the rainfall quickly became surface runoff that flooded streets, disrupted traffic, and damaged roads, culverts, and bridges. A few automobiles were swept downstream and destroyed.

Intense runoff came from all except the southern slopes of the Tucson Mountains; runoff from eastern slopes was probably greater than that from western slopes. Roads were cut in several places where they were crossed by the intense runoff, and severe gullying occurred in some arroyos. Heavy precipitation on other mountains ran off rapidly, as it did from the Tucson Mountains. As the water reached the valley floor it intermingled with water accumulated from local precipitation. The channels in the valleys are poorly defined, and their low capacity caused wide overflows which covered the entire valley floor.

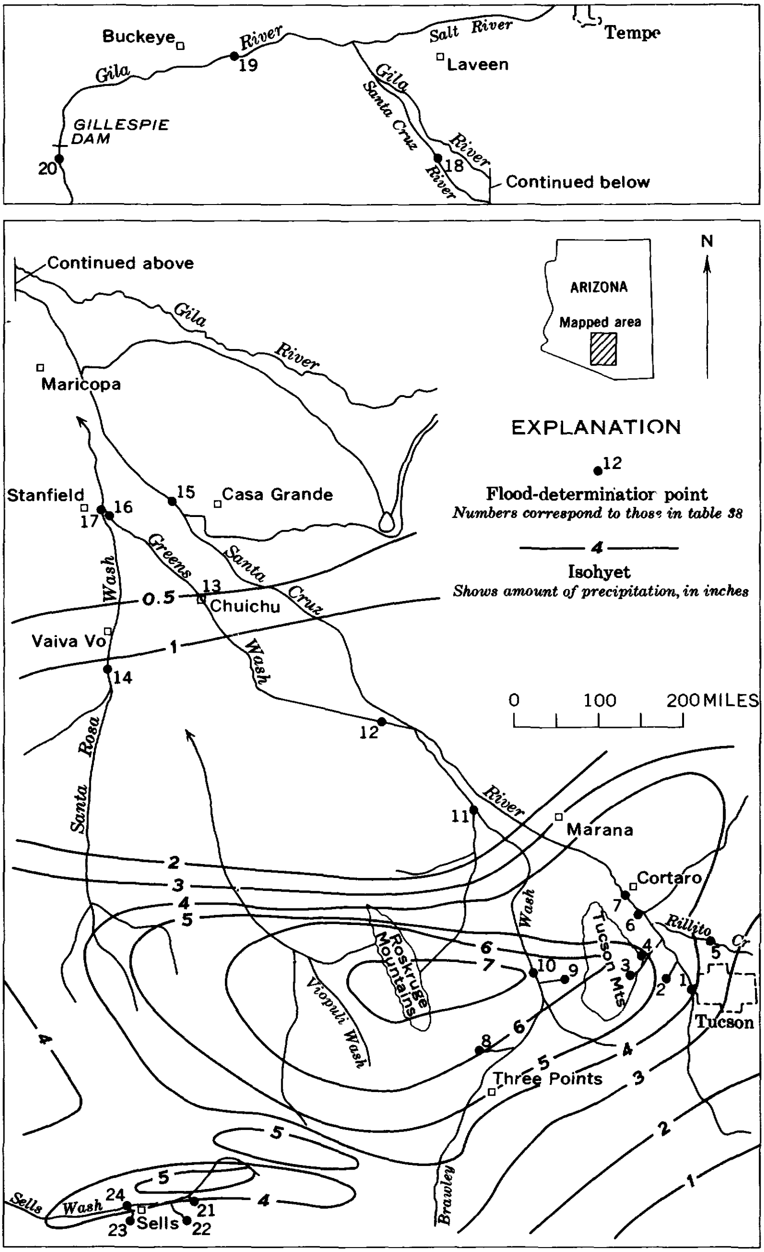

FIGURE 45.—Location of flood-determination points and isohyets for September 25–26, floods of September 26–28 in southern Arizona.

TABLE 38.—*Flood stages and discharges, September 26–28 in southern Arizona*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to September 1962		September 1962	Gage height (ft)	Discharge	
			Period	Year			Cfs	Runoff acre-feet
	Gila River basin							
1	Santa Cruz River at Tucson	2,222	1905–62	1961		15.60	15,600	
					26	7.90	4,980	2,900
	Tributaries to Santa Cruz River:							
2	NW1/4NE1/4 Sec. 6, T. 14 S., R. 13 E.	5.31			26		2,740	
3	NW1/4SE1/4 Sec. 2, T. 14 S., R. 12 E.	1.26			26		940	
4	E½ sec. 25, T. 13 S., R. 12 E.	3.98			26		3,980	
5	Rillito Creek near Tucson	918	1908–62	1929		(1)	24,000	
					26	6.48	2,960	
6	Tributary to Santa Cruz River, SE1/4SE1/4SE1/4 sec. 11, T. 13 S., R. 12 E.	2.77			26		1,400	
7	Santa Cruz River at Cortaro	3,503	1939–47, 1950–62.	1940		(1)	17,000	
					26	9.22	11,200	7,600
	Tributaries to Brawley Wash:							
8	SE1/4NW1/4 sec. 16, T. 15 S., R. 10 E.	11.9			26		13,800	
9	NE1/4NW1/4 sec. 1, T. 14 S., R. 11 E.	.008			26		69	
10	Brawley Wash at Mile Wide Road 15 miles west of Tucson.	1,077			26		38,800	40,000
11	Los Robles Wash at confluence of Brawley and Blanco Washes, 8 miles west of Marana.	1,350			26		32,600	
12	Greens Canal, 12 miles south of Eloy.	(1)			26		24,100	
13	Greens Wash at Indian Service Road at Chuichu.	(1)			26		17,200	25,000
14	Santa Rosa Wash near Vaiva Vo near Sells.	1,782	1954–62	1957		13.2	17,000	
					27	16.9	53,100	50,000
15–17	Combined flow of Santa Cruz River, Greens Wash, and Santa Rosa Wash at State Highway 84 between Casa Grande and Stanfield.	7,920			27		15,800	
18	Santa Cruz River near Laveen.	8,581	1940–46, 1948–62.	1951		17.00	5,060	
					29	17.50	9,200	17,400
19	Gila River near Buckeye							7,500
20	Gila River below Gillespie Dam.	49,650						700
	Rio Sonoyta basin							
	Tributaries to Sells Wash:							
21	State Highway 86, 8 miles east of Sells.	4.08			26		1,600	
22	At State Highway 86, 5 miles east of Sells.	1.35			26		430	
23	At Sells	26.8			26		2,750	
24	Sells Wash below State Highway 86, ½ mile northwest of Sells.	140			26		17,200	

[1] Not determined.

Water from the upper part of Sells Wash inundated the village of Sells; several persons were left homeless, and one life was lost. The flood of September 1962 is the greatest ever reported in the vicinity, but the unit runoff was not as great as that in other parts of the flood area.

Severe flooding occurred along Brawley, Blanco, and Los Robles Washes. Brawley Wash overtopped Ajo Highway (State Highway 86) near Three Points and caused some damage to road shoulders and abutment fills. A few miles downstream from Three Points the flood reached the first cotton farmlands. Most of the damage was caused by floodwaters overtopping and crevassing dikes around farmlands.

Much of the flood plain along Santa Rosa Wash and Greens Wash was inundated, but, except for the village of Chuichu, there was little damage because the valley is undeveloped and otherwise sparsely populated. Many residents in Chuichu were left homeless when the village was inundated.

The flows of Santa Rosa Wash, Greens Wash, and the Santa Cruz River converged and inundated areas up to 10 miles wide. A large part of the inundated land was farmland, and agricultural damage was high. There was little damage beyond the village of Maricopa.

Two gaging stations—Santa Rosa Wash near Vaiva Vo (sta. 14) and Santa Cruz River at Cortaro (sta. 7)—are in the area of greatest flooding. The gaging station on Santa Cruz River at Tucson (sta. 1) provided discharge data pertaining to the Santa Cruz River above the flood area. Gaging stations on Santa Cruz River near Laveen (sta. 18) and Gila River below Gillespie Dam (sta. 20) provided data downstream from the flood area. A water-stage recorder was temporarily installed in an abandoned gage well on Gila River at Jackrabbit Road near Buckeye (sta. 19). A moderately small discharge occurred at the gaging station on Rillito Creek about 5 miles north of Tucson (sta. 5). Table 38 gives peak discharges at 5 gaging stations and at 17 miscellaneous sites and gives the volume of runoff at the gaging stations and in Greens Wash near Chuichu (sta. 13) and in Brawley Wash west of Tucson (sta. 10).

The approximate limits of the large area inundated (fig. 46) were defined on the basis of aerial photographs obtained during the flood, newspaper reports, and observations by field parties.

As is usual in the alluvial valleys of the arid Southwest, large channel losses in rate of discharge and in volume occurred throughout the flood area. The combined discharge at sites on the two principal contributing streams—Brawley Wash at Mile Wide Road (sta. 10) and Santa Rosa Wash near Vaiva Vo (sta. 14)—was 90,000 acre-feet. There were large undetermined inflows from tributaries to Brawley

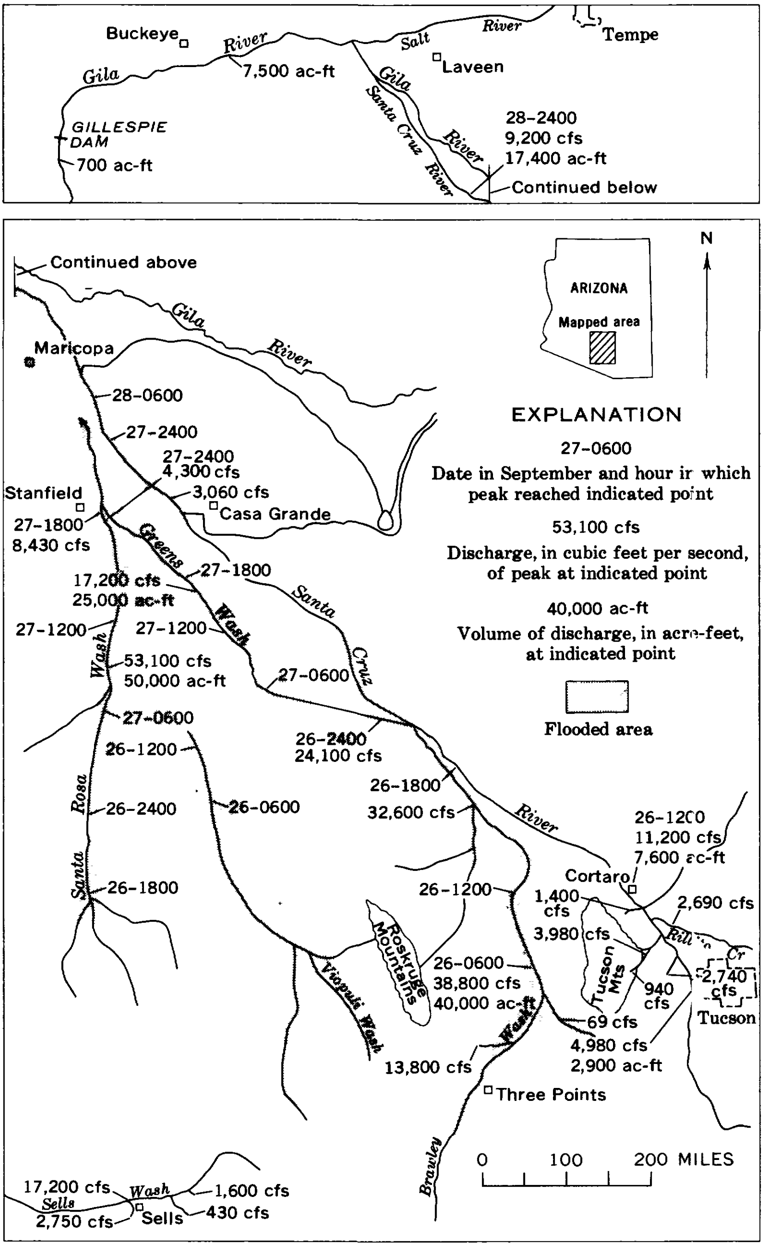

FIGURE 46.—Area inundated by floodwaters and the peak discharge and volume of flows as the floodwave progressed downstream, floods of September 26–28 in southern Arizona. Data are in table 38.

Wash below Mile Wide Road and to the Santa Cruz River. Flow decreased steadily as the floodwaves moved downstream. At Santa Cruz River near Laveen (sta. 18) the discharge was reduced to 17,400 acre-feet.

The combined discharge of the Gila River and Buckeye Canal near Buckeye was about 7,500 acre-feet. Although 700 acre-feet of water passed Gillespie Dam, most of this was probably return flow from upstream irrigation, and all but a small portion of it was diverted at the dam. None of the floodwater reached Painted Rock Dam about 40 miles downstream. Figure 46 shows the decrease of discharge rate and loss of volume with respect to time as the floodwave moved downstream.

The U.S. Department of Agriculture State Disaster Committee reported $3.2 million damage to 135 farms. Many farm dikes constructed to divert floodwaters from cultivated areas were breached, and potholes and gullies formed at the breaks. Much of the cultivated land was planted to cotton. The floodwater pulled the cotton from the open bolls, and muddy water caused deterioration in quality of bolls that were not fully opened. Heavy deposits of silt were left in farm buildings, farm machinery, and feed yards. Long sections of concrete-lined irrigation ditches were washed out. An undetermined amount of damage occurred to roads and highways.

FLOODS OF OCTOBER IN NORTHERN CALIFORNIA

By S. E. Rantz

The Pacific Coast from central California to British Columbia was buffeted by winds of gale or hurricane force on October 10–14, but severe flooding occurred only in northern California. Several storm fronts passed over the flood-affected area—the first during the evening of October 10 and the last, and most severe, during the evening of October 12. Heavy precipitation fell on October 10–13.

The precipitation was exceptionally heavy for early fall and was the maximum for any October of record in most of the area. The freezing level throughout most of the storm period was at an altitude of about 7,000 feet, and most of the precipitation therefore was rain. The rainfall was orographically influenced. On the Sacramento Valley floor, storm totals generally ranged from 4 to 8 inches (fig. 47) ; but in the Sierra Nevada, totals from 16 to 28 inches were recorded. In the San Francisco Bay area, storm totals ranged from 5 to 8 inches at the low altitudes and up to 22 inches in the Santa Cruz mountains to the south, where daily catches of more than 13 inches were reported.

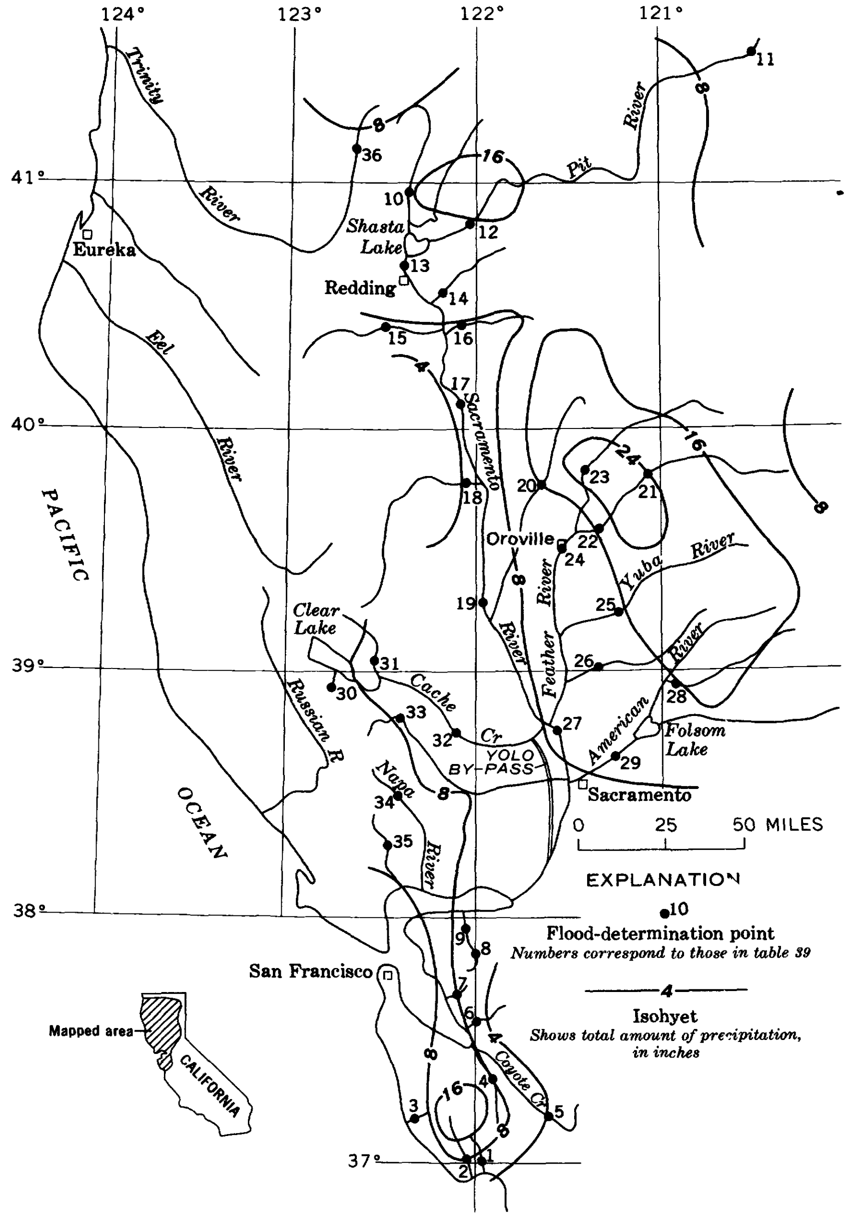

FIGURE 47.—Location of flood-determination points and isohyets for October 10–14, floods of October 12–15 in northern California.

The runoff, although heavy, was generally lighter than might be expected from the rainfall. This general storm was the first one of the season, and large soil-moisture deficiencies existed when the rains began. Local runoff from impervious surfaces in urban areas was high.

Peak discharges were high in the Sacramento River tributaries that drain the Sierra Nevada, but few Coast Range tributaries north of San Francisco Bay had excessively high rates of flow. Notable exceptions were extremely high peak discharges in the Coast Range area south of Clear Lake. Adobe Creek near Kelseyville (sta. 30) reached a record-breaking discharge of 1,440 cfs. To the south of the Sacramento River and San Francisco Bay, only a relatively narrow coastal area was affected. A distinguishing feature of the storm was the scatter of intense bursts of rainfall over small areas. Consequently, there were large differences in the peak runoff per square mile in some adjacent basins. Recordbreaking peak discharges occurred in the east San Francisco Bay region at the gaging stations on San Lorenzo Creek at Hayward (sta. 7) and on San Ramon Creek at San Ramon (sta. 8). High tides were a major factor contributiong to the peak stages in many low-lying areas. Table 39 lists peak discharges at selected gaging stations in the flood area. Figure 48 shows discharge patterns for two selected streams in regions of severe flooding. Walnut Creek is a small coastal stream; the Feather River is a large Sierra Nevada stream.

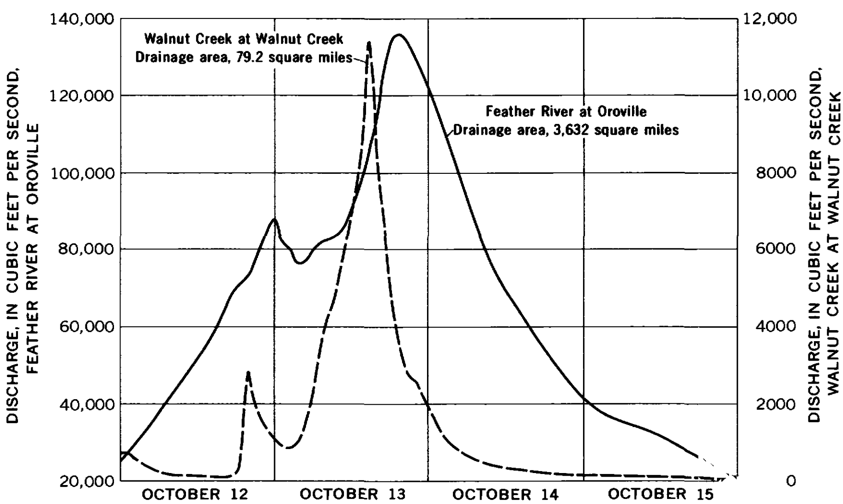

FIGURE 48.—Discharge hydrographs for selected stream-gaging stations, October 12–15 in northern California.

TABLE 39.—*Flood stages and discharges, October 12–15 in northern California*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to October 1962: Period	Year	October 1962	Gage height (ft)	Discharge (cfs)
	Central coast drainage						
1	Soquel Creek at Soquel	40.2	1951–62	1955		22.33	15,800
					13	13.5	5,120
2	San Lorenzo River at Big Trees	111	1936–62	1955		22.55	30,400
					13	12.10	[1]7,390
3	Pescadero Creek near Pescadero	45.9	1951–62	1955		21.27	9,420
					13	16.40	4,630
4	Guadalupe River at San Jose	146	1929–62	1958		16.55	[1]9,150
					13	10.85	[1]7,820
5	Coyote Creek near Madrone	195	1902–12, 1916–62.	1911		(2)	25,000
					13	2.00	[1]9
6	Alameda Creek near Niles	633	1891–1962	1955		14.9	[1]29,000
					13	5.77	[1]1,700
7	San Lorenzo Creek at Hayward	37.5	1939–40, 1946–62.	1958		17.45	5,100
					13	19.73	7,460
8	San Ramon Creek at San Ramon	5.89	1952–62	1958		15.30	1,490
					13	16.98	1,600
9	Walnut Creek at Walnut Creek	79.2	1952–62	1958		20.2	12,200
					13	13.68	11,400
	Sacramento River basin						
10	Sacramento River at Delta	427	1944–62	1955		19.50	37,000
					12	16.10	26,300
11	North Fork Pit River near Alturas.	209	1929–32, 1957–62.	1958		9.85	2,140
					14	11.07	2,440
12	Pit River near Montgomery Creek.	5,170	1944–62	1955		14.12	[1]37,100
					15	9.67	[1]19,500
13	Sacramento River at Keswick	6,710	1938–62	1940		(2)	186,000
					12	13.87	[1]10,600
14	Cow Creek near Millville	427	1949–62	1951		21.55	45,200
					12	16.98	24,800
15	Cottonwood Creek near Cottonwood.	945	1940–62	1941		15.4	52,300
					12	7.08	6,560
16	Battle Creek near Cottonwood	362	1937–62	1937		15.8	35,000
					12	11.31	7,400
17	Sacramento River near Red Bluff	9,300	1892–1962	1940		38.9	291,000
					13	12.25	[1]47,200
18	Stony Creek near Hamilton City	764	1941–62	1958		18.31	[1]39,900
					13	7.34	[1]1,040
19	Sacramento River at Colusa		1940–62	1942		69.20	[1]49,000
					14	63.02	[1]34,700
20	Butte Creek near Chico	148	1930–62	1955		13.35	18,700
					13	10.34	10,900
21	Middle Fork Feather River near Merrimac.	1,078	1951–62	1955		21.2	62,000
					13	17.00	35,500
22	Feather River at Bidwell Bar	1,347	1862	1862		31.2	(2)
			1911–62	1955		25.5	104,000
					13	19.31	[1]53,900
23	North Fork Feather River at Big Bar.	1,953	1911–62	1955		35.60	[1]72,400
					13	27.0	[1]38,000
24	Feather River at Oroville	3,632	1901–62	1907		67.5	230,000
					13	60.13	[1]136,000
25	Yuba River at Englebright Dam	1,104	1941–62	1955		(2)	[1]148,000
					13	40.27	[1]91,000
26	Bear River near Wheatland	295	1928–62	1955		19.30	[1]33,000
					13	16.85	[1]27,700
27	Sacramento River at Verona		1926–62	1940		41.20	[1]79,200
					14	38.08	[1]69,200
28	Middle Fork American River near Auburn.	619	1911–62	1955		33.9	79,000
					14	22.69	36,500
29	American River at Fair Oaks	1,889	1904–62	1950		31.85	180,000
					13	3.85	[1]5,080
30	Adobe Creek near Kelseyville	6.39	1954–62	1955		8.72	1,250
					12	9.81	1,440

See footnotes at end of table.

TABLE 39.—*Flood stages and discharges, October 12–15 in northern California*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to October 1962: Period	Year	October 1962	Gage height (ft)	Discharge (cfs)
	Sacramento River basin—Continued						
31	North Fork Cache Creek near Lower Lake.	198	1930–62	1937		13.98	20,300
					12	8.50	5,950
32	Cache Creek near Capay	1,052	1942–62	1958		20.90	[1] 51,600
					13	10.51	[1] 8,470
33	Putah Creek near Guenoc	112	1904–06, 1930–62.	1937		22.7	32,000
					12	13.3	9,280
	North coast drainage						
34	Napa River near St. Helena	81.1	1929–32, 1939–62.	1955		16.17	12,600
					13	8.55	4,160
35	Sonoma Creek at Boyes Hot Springs.	62.2	1955–62	1955		17.10	8,800
					13	10.85	3,800
36	Trinity River above Coffee Creek, near Trinity Center.	149	1957–62	1958		10.50	12,800
					12	9.33	8,990

[1] Affected by storage and(or) diversion.
[2] Not determined.

The Sacramento River Flood Control Project, an extensive system of dams, levees, and floodways, functioned very efficiently. Shasta Lake controlled the flow in the reach of the Sacramento River immediately below the lake, and Folsom Lake controlled the flow in the American River. Potential floodwater retained in each of these reservoirs amounted to more than 200,000 acre-feet. In the lower reaches of the Sacramento Valley, Sutter and Yolo bypasses were utilized as the Sacramento River spilled over the Colusa, Tisdale, and Fremont relief weirs. The principal area of flood damage was along the Feather River near Oroville, where the river reached its highest October stage of record and swept away a cofferdam and part of a fish hatchery that was under construction. Urban areas, including the city of Sacramento, were damaged by local runoff, and agricultural and highway damages were appreciable. There was also minor damage in secondary channels in the Sacramento Valley, caused primarily by accumulated drift on bridges.

In the coastal areas south of San Francisco Bay, the heavy runoff was concentrated in the East Bay area and in parts of the Santa Clara Valley. The city of Oakland was virtually isolated as local floodwaters and mud slides closed many access roads and streets. To a less serious degree, the cities of Concord, Pleasant Hill, and Walnut Creek in Contra Costa County were encircled by local floodwaters, and roads to these cities were blocked by slides and washouts. Throughout the San Francisco Bay area, mudslides and flooding destroyed scores of homes and business establishments.

In storm-battered Pacifica, on the coast just south of San Francisco, more than 200 persons were evacuated from their homes as masses of mud and water poured down from the hills. In parts of the town, water stood at depths of 1 to 5 feet. Agricultural and highway damage was heavy throughout the region, and many low-lying areas were inundated.

Nineteen persons lost their lives as a result of the storm and floods. Three victims were buried in mudslides, one was drowned, one was electrocuted, one was killed by a falling tree, and the others were killed in weather-influenced traffic accidents. Damage in California was estimated at $10 million of which $2 to $3 million was damage to roadways and drainage structures. The heaviest losses were concentrated in the urban areas of the San Francisco Bay region.

FLOODS OF NOVEMBER 19–25 IN SOUTHWESTERN WASHINGTON

By J. H. Bartells

Two major storms crossed southwestern Washington during the period November 19–25. The first storm, on November 19–21, dropped 4 to 8 inches of precipitation over much of the flood area. The freezing level rose to about 10,000 feet, and runoff from melting snow and the heavy precipitation caused streams to rise rapidly and caused flooding in many of the lower valleys. The second storm, on November 24–25, dropped 3 to 7 inches of precipitation on the already saturated ground and produced flood discharges that were nearly as high; in at least one area, the discharges were higher than those of November 19–20.

U.S. Weather Bureau records show that 8.70 inches of rain fell at Naselle on November 19–20. Maximum daily precipitations recorded in the area (fig. 49) were 6.00 inches on November 19 at Naselle and 6.10 inches on November 20 at Cathlamet.

Floods in the lower Naselle and upper Kalama River basins were the largest known to local residents since at least 1900.

A relationship of the total amount of precipitation on November 19–21 to the peak discharge during the first storm is noticeable. In general, floods of high recurrence intervals occurred where the major part of the drainage basin received 7 or more inches of precipitation. The peaks at selected gaging stations shown in table 40 are either the highest or second highest during the period of record. Many other stations within the report area had peaks that were not of unusual magnitude.

The second storm kept many of the streams in flood stage until November 25.

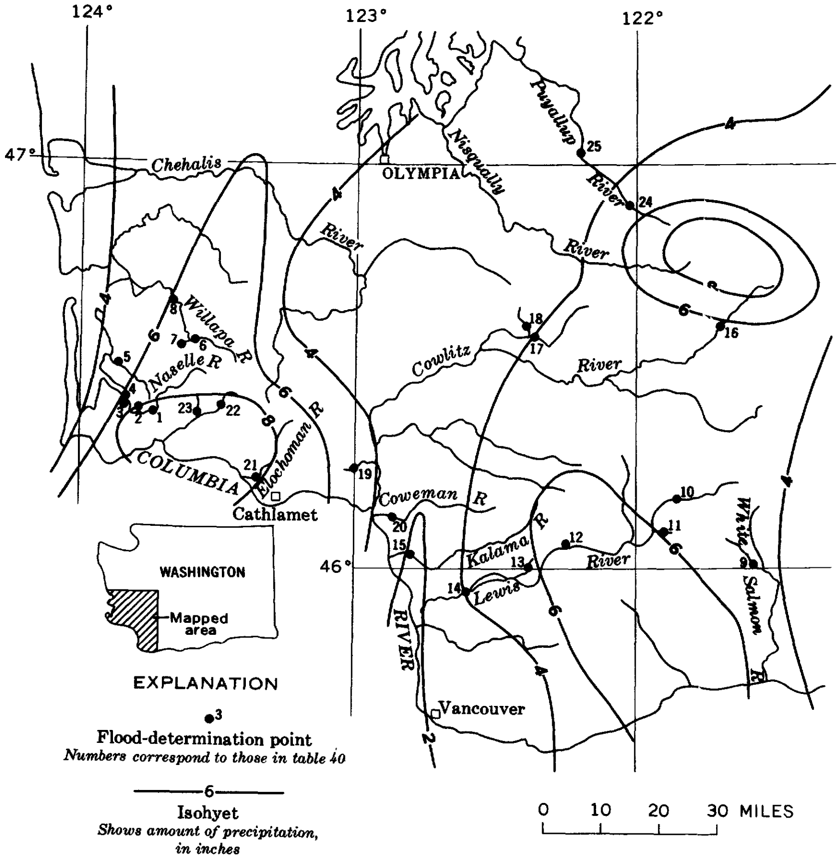

FIGURE 49.—Location of flood-determination points and isohyets for November 19–21, floods of November 19–25 in southwestern Washington.

The floods were noticeable because the peak discharges, related to drainage area, were unusually high for southwestern Washington. However, flood damage was relatively light and affected mainly Forest Service land and secondary roads, bridges and low-lying farmlands.

TABLE 40.—*Flood stages and discharges, November 19–25 in southwestern Washington*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Nov. 1962: Period	Prior to Nov. 1962: Year	November 1962	Gage height (ft)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Naselle River basin							
1	Naselle River near Naselle, Wash.	54.8	1929–63	1935		[1] 15.9	11,100	
					19	17.77	10,500	50
2	Salmon Creek near Naselle, Wash.	16.4	1953–63	1955			1,970	
				1959		8.03		
					20	10.28	3,210	[2] 1.34
3	Lane Creek near Naselle, Wash.	2.15	1950–63	1959		15.16	211	
					20	15.54	249	12
4	Naselle River at Naselle, Wash.	101			20	14.14	[3] 16,900	[2] 1.07
	Nemah River basin							
5	North Nemah River tributary near South Bend, Wash.	.46	1949–63	1956		10.82	68	
					19	13.85	101	[2] 1.50
	Willapa River basin							
6	Willapa River at Lebam, Wash.	41.4	1948–63	1949		17.53	4,930	
					25	15.14	4,010	30
7	Fork Creek near Lebam, Wash.	20.4	1953–63	1956		7.75	3,500	
					20	8.58	4,400	[2] 1.50
8	Willapa River near Willapa	130	1947–63	1949		24.22	11,400	
					20	23.04	11,200	25
	White Salmon River basin							
9	Trout Lake Creek near Trout Lake.	69.3	1909–11, 1959–63.	1960		5.25	2,030	
					20	6.02	2,680	25
	Lewis River basin							
10	Lewis River near Trout Lake	127	1958–63	1960		24.84	6,600	
					20	26.40	9,920	25
11	Rush Creek above Meadow Creek near Trout Lake.	5.87	1955–63	1960		3.15	790	
					20	3.91	1,180	50
12	Dog Creek near Cougar	2.31	1955–63	1955		14.50	420	
					20	15.07	476	12
13	Speelyai Creek near Cougar	12.6	1959–63	1960		5.59	1,830	
					20	[4] 8.23	3,600	[2] 1.09
14	Lewis River at Ariel	731	1909, 1922–63.	1933		35.0	129,000	
					20	25.7	75,500	30
	Kalama River basin							
15	Kalama River below Italian Creek, near Kalama.	198	1946–63	1953		14.93	16,000	
					20	15.28	16,600	15

See footnotes at end of table.

TABLE 40.—*Flood stages and discharges, November 19–25 in southwestern Washington*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Nov. 1962: Period	Maximum floods: Prior to Nov. 1962: Year	Maximum floods: November 1962	Maximum floods: Gage height (ft)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Cowlitz River basin							
16	Cowlitz River at Packwood	287	1911–19, 1929–63.	1933			36,600	
				1959		13.54		
					20	13.23	32,100	[2]1.24
17	Tilton River above Bear Canyon Creek near Cinebar.	141	1956–63	1959		12.73	16,400	
					20	14.16	20,700	10
18	Cinnabar Creek near Cinebar.	4.55	1956–36	1959		3.27	498	
					19	3.75	710	15
19	Delameter Creek near Castle Rock.	19.6	1949–63	1953		6.26	2,270	
					19	6.53	2,420	35
20	Coweman River near Kelso	119	1950–63	1950		12.8	7,730	
					20	14.10	9,720	45
	Elochoman River basin							
21	Elochoman River near Cathlamet.	65.8	1933	1933		17.2	([5])	
			1940–63	1956		12.49	8,180	
					20	12.86	8,530	4
	Grays River basin							
22	Grays River above South Fork, near Grays River.	39.9	1955–63	1956		10.23	7,050	
					19	11.10	8,900	25
23	West Fork Grays River near Grays River.	15.2	1949–63	1949		6.89	3,700	
					19	7.50	4,770	[2]1.16
	Puyallup River basin							
24	Puyallup River near Electron.	92.8	1908–26, 1944–49, 1957–63.	1959		[1]11.9	10,800	
					20	6.71	10,600	40
25	Puyallup River near Orting	172	1931–63	1959		7.25	12,900	
					20	6.82	15,300	[2]1.09

[1] At different site or datum.
[2] Ratio of peak discharge to 50-year flood.
[3] Maximum known since about 1900.
[4] Backwater from debris.
[5] Not determined.

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INDEX

[Italic page numbers indicate major references]