

FLOODS OF APRIL-MAY 1969 IN UPPER MIDWESTERN UNITED STATES



UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Water Resources Division

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by

David B. Anderson and Harlan H. Schwob

Open-File Report 70-7

St. Paul, Minnesota
February 1970

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FLOODS OF APRIL-MAY 1969 IN
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By David B. Anderson and Harlan H. Schwob

ABSTRACT

The 1969 spring floods in upper Midwestern United States can be attributed primarily to an exceptionally heavy blanket of snow which accumulated during the period December 1968 through February 1969. March precipitation was light, but at the end of the month water content of snow on the ground was as much as 8 inches in some parts of the area. Unusually heavy rains in the fall of 1968 throughout the area, and as much as 3 inches of localized spring rain in the Red River basin during the period April 7-10, 1969, accentuated the flooding.

Flood data are presented for 285 gaging sites in this report. Peak stages and discharges exceeded previous known maxima in the upstream tributaries of the Red River of the North, upper Minnesota River basin, upper basin of West Fork Des Moines River, and the James, Vermillion, and Big Sioux River basins. In many other basins the 1969 floods were the second highest in many years of record. Recurrence intervals exceeded 50 years for 71 of the 178 sites for which recurrence intervals were computed.

Flood-crest elevations and flood profiles show the peak stages expressed in mean sea level at many points in the Mississippi, Minnesota, Red, Souris, West Fork Des Moines, Rock, and Little Rock River basins.

Sediment discharge data obtained in a small part of the lower Minnesota River basin indicated varying yields during the month of April ranging from 26 to 396 tons per square mile.

Aerial photography during the flood was obtained in a number of river basins. The river reaches which were photographed are tabulated and the location of the photographs indicated.

Flood damages were estimated to be about \$147 million in the six States of North Dakota, South Dakota, Minnesota, Iowa,

Wisconsin, and Illinois. Eleven lives were lost to the flood, more than 23,000 persons were forced from their homes, more than a million acres of rich agricultural land were inundated, and thousands of culverts and bridges were washed out on highways and secondary roads.

INTRODUCTION

The snow-melt floods of April-May 1969 in upper Midwestern United States affected the six States of North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, and Illinois (fig. 1).

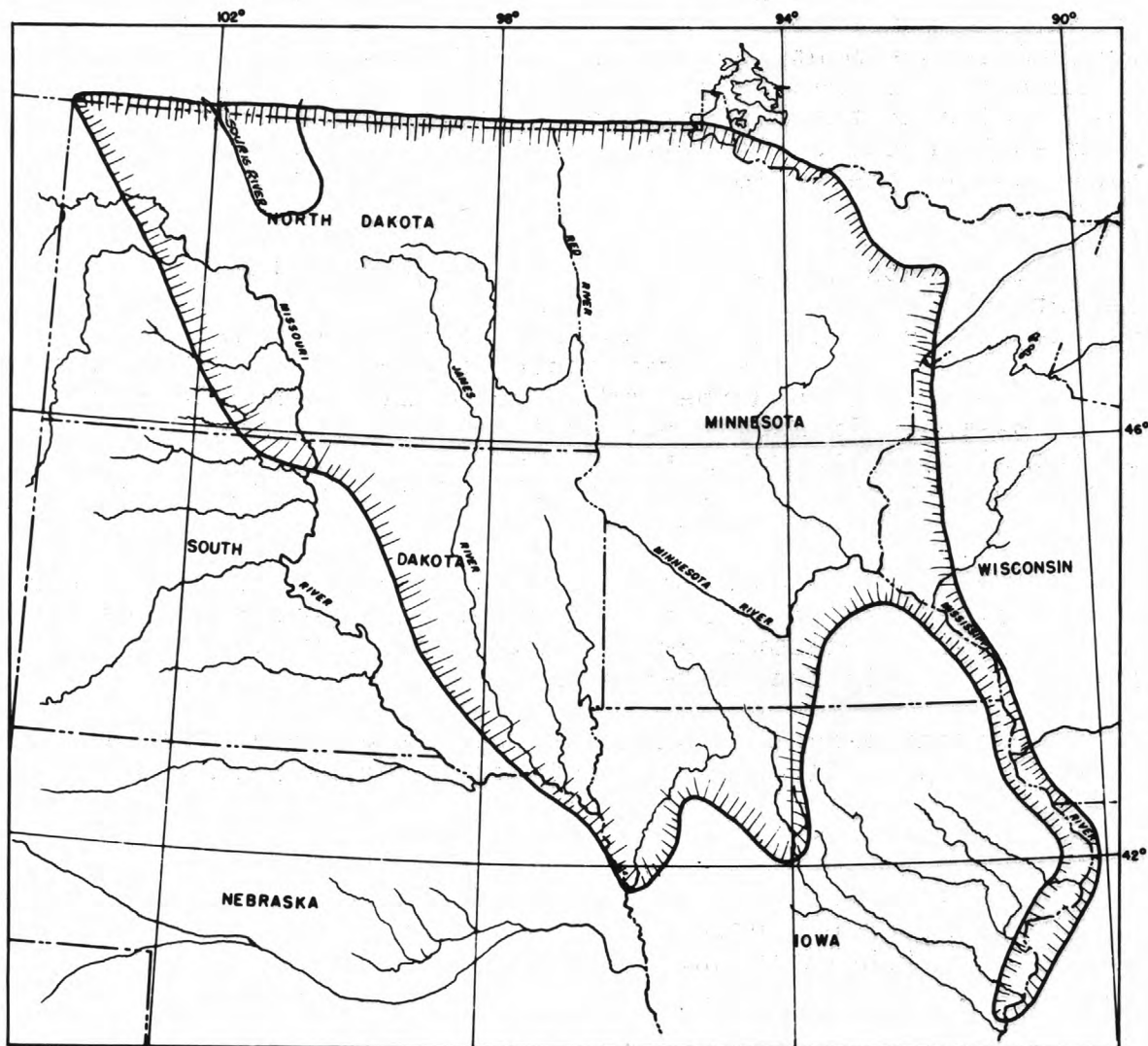


Figure 1.--Area covered by this report.

The flood had its origin in the heavy snow blanket which covered a broad area extending in a southeasterly direction from north central North Dakota to the northwest quadrant of Iowa. The potential for heavy runoff was particularly acute along the north-south center line of this area.

When the snow melted early in April, maximum stages and discharges of record occurred in the Souris River basin, the upstream tributaries of the Red River of the North, the upper part of the Minnesota River basin, and the West Fork Des Moines, James, Vermillion and Big Sioux River basins. In many other locations the second highest discharge of record occurred.

Western Wisconsin received a large amount of snow in the early part of the winter, but the snow melt in this area ran off under ideal conditions and there was little serious flooding in the State except on the main stem of the Mississippi River and the lower St. Croix River.

A unique feature of this flood was the fact that it resulted almost entirely from snow which fell early in the winter. Precipitation was generally less than normal in March and April, although in the headwaters of the Minnesota River and Red River of the North, rain which fell during the period April 7-10 accentuated the flood peaks in these basins. In spite of the light snowfall in March, water equivalent of snow on the ground at the end of the month was as much as 8 inches in some areas. The timing of the winter snowfall provided a mitigating influence on flood runoff. The heavy early winter snow insulated the ground and reduced frost penetration to less than normal, thus permitting greater infiltration of surface water during the snow-melt period.

There has never been a flood in the area affected where there has been more warning of the dire events to come. The certainty that there would be spring floods helped materially to reduce property damage because extensive protective measures were undertaken early. In spite of the many effective measures which were taken, 11 lives were lost to the flood or flood-related events and more than \$147 million dollars in damages occurred. These damages include the cost of the flood fight and losses in wages and profits. More than 23,000 persons were forced from their homes - 15,000 in North Dakota, about 12,000 of whom lived in Minot, 7,000 in Minnesota and South Dakota, and 1,400 in Iowa and Wisconsin.

Purpose and Scope

The purpose of this report is to provide timely hydrologic data pertaining to the many streams which flooded in the spring

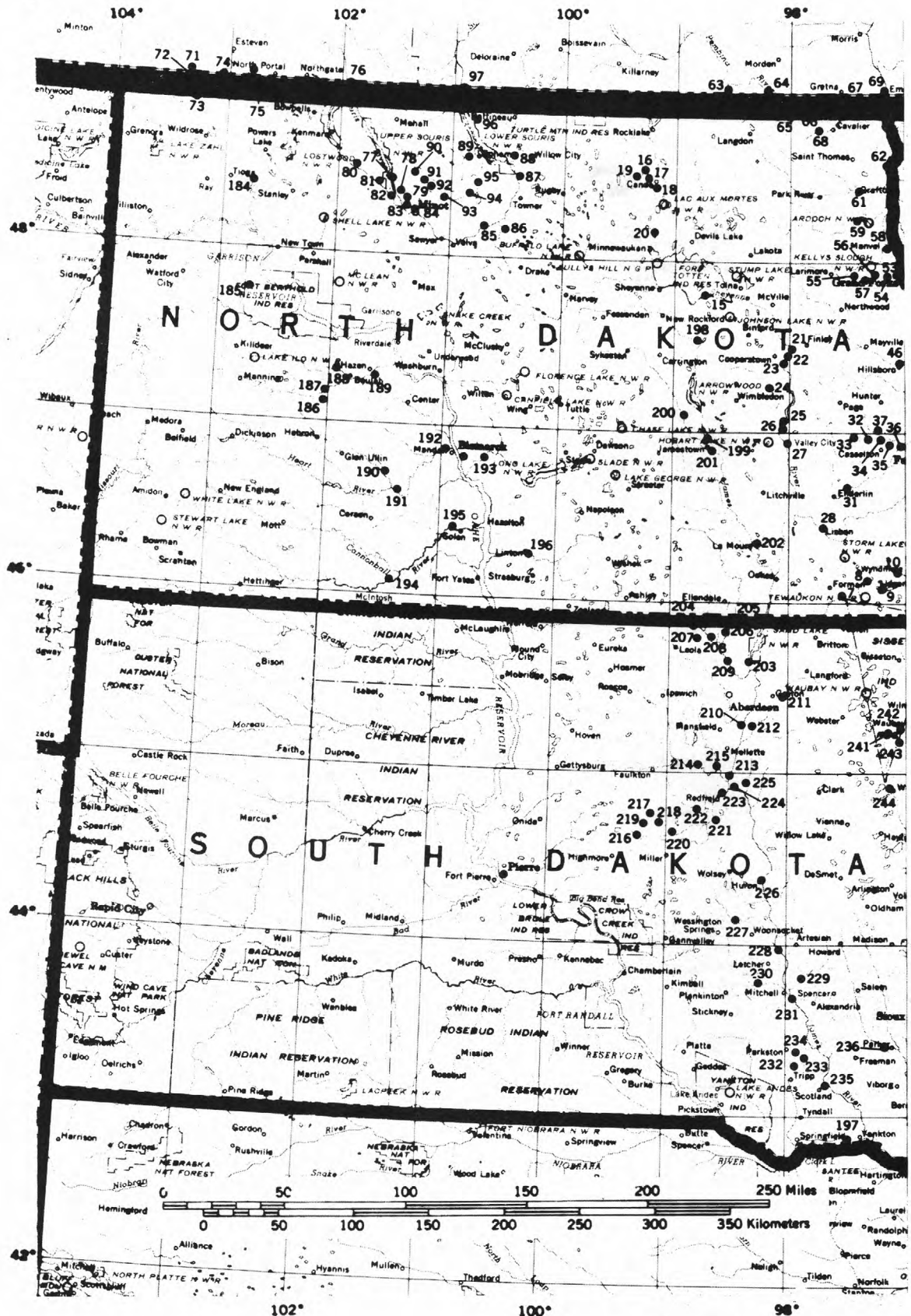


Figure 2.--Location of

flood-determination sites.

of 1969 in upper Midwestern United States. Data are also presented in a few instances for gaging stations which reflect conditions on the edges of the area of extreme flooding. The report provides a statistical and historical record of an exceptionally severe flood. The data presented may be used for planning and designing hydraulic structures and flood-protection works, for bridge and culvert design, for flood-plain management purposes, and for theoretical studies of outstanding hydrologic events.

Flood data are presented for 285 sites (fig. 2) of which 179 are gaging stations where daily discharges are determined, 75 are crest-stage stations designed to collect data on peak stages and discharges, and 31 are sites where miscellaneous flood data are collected. Recurrence intervals are computed for the peak discharges at most of the sites where daily discharge records are obtained. If the maximum discharge exceeds that of a 50-year flood¹, the recurrence interval is expressed as a ratio of the actual discharge to the discharge having a 50-year recurrence interval.

Flood profiles are shown and flood elevations tabulated for the 1969 flood, and in some instances for the previous highest flood of record, for the Red River of the North, Souris, Mississippi, Minnesota, West Fork Des Moines, Rock, and Little Rock Rivers.

Acknowledgments

Most of the flood data appearing in this report were collected as part of cooperative programs between the U.S. Geological Survey and the States of North Dakota, South Dakota, Minnesota, Iowa, and Wisconsin, and the St. Paul, Omaha, and Rock Island districts of the Corps of Engineers. Other Federal, State, and local agencies, municipalities, and corporations provided assistance, financial or otherwise, in collecting the flood data.

Flood-crest elevations used in drawing flood profiles and flood-damage figures were provided largely by the Corps of Engineers. The St. Paul district, Corps of Engineers, also provided ten men to the St. Paul district of the U.S. Geological Survey to assist in collecting stream-flow data. Isohyetal maps and precipitation tables were prepared from data furnished by the U.S. Weather Bureau and the Canadian Weather Service.

¹ For convenience of expression in this report, a flood having a 50-year recurrence interval is referred to as a 50-year flood.

The data for this report were computed and compiled under the supervision of the following engineers or hydrologists of the Water Resources Division: O. A. Crosby, North Dakota; O. J. Larimer, South Dakota; D. W. Ericson and R. W. Lamson, Minnesota; H. H. Schwob, Iowa; and F. C. Dreher, Wisconsin.

Seven U.S. Geological Survey personnel, experienced in the field work and computations pertaining to the preparation of flood data, were detailed to the flood-affected districts. Grateful acknowledgment is made to the Michigan, New York, Indiana, Nebraska, Texas, and New Mexico districts for this assistance.

METEOROLOGICAL CONDITIONS CAUSING FLOODS

Fall and Winter Climatological Events

The pattern of precipitation during the fall and winter of 1968-69 in the upper Midwestern United States was most unusual, even though inconsistent weather is characteristic of the area. Table 1 is a tabulation of monthly precipitation and departures from normal at 26 U.S. Weather Bureau stations. It shows precipitation for an 8-month period which preceded and included the spring flood. The stations are arranged in downstream order according to the basin in which they are located.

Throughout the upper Midwest, precipitation in late summer and fall of 1968 was exceptionally heavy. In such widely divergent localities as Crosby, North Dakota; Roseau, Minnesota; and North Mankato, Minnesota; precipitation for August was more than 4 inches above normal according to U.S. Weather Bureau records. Heavy precipitation continued into September and October throughout most of the area. The copious amount of precipitation which characterized the fall weather decreased markedly in November, and the overall average of the departures from normal for the month at the 26 stations in table 1 was about -0.5 inch. Positive departures exceeding 1 inch for November existed only along the north shore of Lake Superior; whereas, negative departures greater than an inch were experienced at Grand Rapids and Winona, Minnesota, and Dubuque, Iowa. In general therefore, at the end of November, the ground was well charged with moisture but there was no threat of high-magnitude floods. The flood potential was created almost entirely by snowfall which occurred in December and January. February snowfall also increased the flood hazard in most of North Dakota, South Dakota, southwestern Minnesota, and northwestern Iowa.

Table 1.--Precipitation and departure from normal at selected U.S. Weather Bureau stations

Station	1968								1969								8-month average	
	Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		Mar.		Apr.			
	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.
Duluth, Minn.	3.42	.56	5.28	3.11	3.10	1.32	3.70	2.54	4.70	3.55	.26	-.70	.39	-1.23	1.46	-.90	2.79	1.03
Wheaton, Minn.	3.29	1.54	3.02	1.72	.72	-.36	1.14	.57	1.36	.74	.67	-.03	.57	-.57	3.17	.92	1.74	.57
Fargo, N. Dak.	2.23	.75	1.75	.64	.37	-.47	1.11	.53	1.27	.74	.46	-.05	.54	-.21	1.55	-.17	1.16	.22
Crookston, Minn.	1.90	.04	1.02	-.29	.10	-.84	.47	-.11	1.56	.99	.47	-.08	.12	-.77	1.22	-.14	.86	-.15
Grand Forks, N. Dak.	2.03	.19	.63	-.70	.18	-.82	.53	-.05	1.62	1.04	.36	-.17	.01	-.82	.85	-.54	.78	-.23
Roseau, Minn.	2.35	-.05	1.26	-.13	1.06	.21	.21	-.33	3.07	2.52	.11	-.35	.05	-.87	1.27	-.07	1.17	-.12
Crosby, N. Dak.	1.57	.42	.52	-.31	.31	-.15	.66	.26	1.36	1.02	.68	.33	.47	-.12	1.89	1.14	.93	.32
Foxholm, N. Dak.	1.51	.21	1.40	.62	.62	-.02	.31	-.08	.96	.51	1.61	1.25	.32	-.38	.74	-.34	.93	.22
International Falls, Minn.	4.33	1.43	3.22	1.48	.48	-.98	1.60	.76	2.79	1.95	.27	-.44	.19	-.84	1.15	-.41	1.75	.37
Grand Rapids, Minn.	3.74	1.02	3.33	1.46	.37	-1.20	2.76	1.94	2.85	2.03	.49	-.21	.23	-.90	1.45	-.52	1.90	.45
St. Cloud, Minn.	4.74	2.33	5.80	4.16	.58	-.75	1.95	1.22	2.52	1.80	.69	-.11	.47	-.81	3.48	1.46	2.53	1.16
Montevideo, Minn.	2.50	-.01	5.48	4.01	.50	-.73	2.05	1.28	2.58	1.93	1.49	.71	.42	-1.05	2.74	.71	2.22	.86
North Mankato, Minn.	5.28	2.62	5.16	3.65	.62	-.91	2.62	1.72	2.55	1.76	.45	-.47	1.31	-.57	1.75	-.48	2.47	.92
Twin Cities, Minn.	6.16	3.73	5.62	4.03	.54	-.86	2.21	1.35	2.05	1.35	.31	-.47	.90	-.63	1.55	-.30	2.42	1.02
Winona, Minn.	5.82	2.62	3.21	1.36	.87	-1.36	3.44	2.50	3.92	2.87	.08	-.85	1.89	.04	1.55	-.80	2.60	.80
Dubuque, Iowa	5.67	1.93	1.32	-1.42	.76	-1.83	2.70	.80	2.56	.73	.40	-1.00	1.11	-1.65	3.46	.38	2.25	-.26
Fort Dodge, Iowa	5.02	1.82	6.14	4.46	1.15	-.60	2.06	1.07	1.72	.64	1.44	.41	1.52	-.36	3.11	.59	2.77	1.00
Mandan, N. Dak.	1.90	.63	T	-.89	.42	-.21	.65	.30	.71	.24	1.15	.70	.08	-.65	.96	-.34	.73	-.03
Yankton, S. Dak.	--	--	4.40	3.07	.40	-.51	1.06	.57	1.13	.71	1.17	.48	1.63	.42	.56	-1.63	--	--
Jamestown, N. Dak.	1.76	.48	.03	-1.18	.21	-.47	.29	-.16	1.42	.98	1.06	.49	.51	-.27	.55	-.97	.73	-.14
Aberdeen, S. Dak.	1.42	.71	.60	-.59	.83	.09	.94	.33	1.11	.45	1.54	.89	.36	-.73	.92	-1.12	.96	.00
Watertown, S. Dak.	2.71	.88	2.62	1.41	.58	-.23	2.40	1.89	1.47	.97	1.53	.94	.23	-.76	1.02	-1.04	1.57	.51
Brookings, S. Dak.	1.66	.76	3.60	2.38	.54	-.16	2.09	1.61	1.10	.74	2.38	1.91	.63	-.34	1.02	-.75	1.63	.77
Sioux Falls, S. Dak.	4.01	1.40	4.57	3.32	.39	-.61	2.62	1.88	1.71	1.09	2.55	1.62	1.09	-.45	.17	-2.14	2.14	.76
Worthington, Minn.	6.73	3.96	4.95	3.41	.44	-.70	1.42	.68	1.36	.77	1.92	1.17	1.24	-.39	.78	-1.31	2.36	.95
Sioux City, Iowa	4.12	1.38	4.77	3.35	.53	-.63	1.96	1.22	1.22	.44	1.32	.43	.69	-.77	.62	-1.63	1.90	.47

Because of the great variation in weather which occurred during the fall and winter in the flood-affected area, a more detailed description is presented by States in the following paragraphs.

U.S. Weather Bureau stations in Minnesota at Hinckley, Cedar, Cambridge, St. Paul, Lamberton, Tracy, and Willmar recorded between 7 and 8 inches of precipitation for October. At Tracy, total precipitation for September and October was 18.14 inches. A number of stations recorded the maximum October precipitation for periods of record ranging from 64 to 84 years. In a 130-mile wide area, extending from Jackson in southwestern Minnesota to Duluth, Minnesota, total precipitation for September and October ranged from 10 to 18 inches, which is 2 or 3 times greater than normal.

In Minnesota, the December snowfall of 28.7 inches in the Minneapolis-St. Paul area exceeded the previous record of 25 inches which occurred in December 1950. The situation in this metropolitan area was characteristic of most of the State, except that in the northwestern part, December snowfall was slightly less than normal. December snowfall records were broken at more than 40 stations throughout the State, and monthly precipitation was the greatest in many localities since at least 1887.

Heavy snowfall continued into January, and at month's end the season's totals were 106.3 inches in Duluth, 66.1 inches in Grand Rapids, and 55.2 inches in the Twin Cities. Each of these seasonal totals exceeded the previous maximum total snowfall as of January 31. The northwestern part of the State also received heavy snowfall in January, and a flood potential was established in that area. Precipitation records for both December and January at 12 stations covering most of the length and breadth of the State were broken. These stations from north to south are: Tower, Babbitt, Winnibigoshish, Cass Lake, Grand Rapids, Cloquet, Gull Lake, Fort Ripley, Long Prairie, Hinckley, Madison, and Springfield.

During February the amount of precipitation received throughout Minnesota started to abate. Seasonal precipitation records, however, as of the end of the month were broken at 17 U.S. Weather Bureau stations scattered throughout the State because of the accumulation of snow built up during the winter. Precipitation departures from normal in February were practically all negative throughout Minnesota with the exception of the area in the southwestern part of the State where snow depths continued to mount in the Rock, West Fork Des Moines, and upper Minnesota River basins. In an area in northern Minnesota stretching from Bemidji to Duluth, snow on the ground exceeded 40 inches at the end of the month.

In general, precipitation in late summer and fall in North Dakota was above normal, but this pattern was not consistent throughout the State. In August, precipitation in the Souris River basin ranged from 2.80 to 7.92 inches above normal for the month at the reporting stations. For the period August to October, average precipitation in the basin was about twice normal. Precipitation in the Red River basin averaged 125 percent of normal for the 3 months even though October precipitation was slightly less than normal. Approximately the same situation occurred in the central part of the State (Missouri River basin and upper Sheyenne River basin) but here the October rainfall was only 23 percent of normal.

November precipitation was generally less than normal State-wide and freezing temperatures occurred after the first week of the month. With the exception of a few days in late November, there was no thawing until late March and early April. In November and February, temperatures were slightly above normal but they ranged from 6 to 10 degrees below normal in December, January, and March. The potential for the snow-melt floods which occurred in April was established during the months December through February, but the time of occurrence of the most severe snowstorms varied throughout the State. During the winter, snowstorms throughout the State were not of unusual severity but they occurred frequently and after the last significant snowstorm of February 23-27, depths of snow were greater than any that had occurred since the winter of 1896-97.

South Dakota was struck by two State-wide blizzards in December. The first one during the period December 12-13 started with freezing rain, followed by as much as 5 inches of snow which fell in the eastern part of the State. The second blizzard which occurred during the period December 21-22 was more severe. It dumped as much as 18 inches of snow in the southeastern part of the State. In Sioux Falls, the 24-hour snowfall was 16.6 inches, which set a new December record. During the month, Huron received 26.0 inches of snow, Brookings 22.0 inches, and Vermillion 26.3 inches. These amounts all established new records. In the southeastern part of the State, which received the greatest amount of snow, temperatures ranged from 4.5 to 5.0 degrees below normal. Snowfall in January continued above normal and the month was characterized by severe weather. Temperatures were 5 to 6 degrees below normal, and there was a great deal of blowing snow and freezing rain. The U.S. Weather Bureau station at Huron, for instance, reported 12 days of blowing snow and 13 days of freezing rain during the month. The unpleasant weather continued into February. By the end of the month, the seasonal snowfall at Sioux Falls was 91.8 inches and at Brookings it was 67.5

inches. These amounts exceeded previous maximums at the end of February by 12.0 inches and 14.5 inches respectively.

October precipitation in northwestern Iowa was greater than that received in any previous October since records were started in 1890. Many localities received from 6 to 7 inches for the month and the maximum monthly total was 7.33 inches at Sibley. Some 24-hour record rainfalls in excess of 3 inches were recorded. November was characterized by about normal temperatures in northwestern Iowa and some record snowfalls in south central Iowa which is outside the area of this report. Lighter snowfalls were experienced in northwestern Iowa in the area afflicted by the spring floods.

The conditions for outstanding spring floods first made their appearance in December. Snow cover extended over the State during the latter half of the month and reached depths up to 30 inches in the northern part. The heavy snowfall was accompanied by blizzard conditions in northwestern Iowa during the period December 21-23. January precipitation continued to be in excess of normal. Thawing occurred during the middle of the month but at month's end as much as 20 inches of snow remained on the ground in the northern part of the State. Unpleasant weather continued and there was a large amount of icing and cloudy conditions. In February, as much as 22 inches of snow fell in northwestern and north central Iowa. Snow cover ranged from 15 to 25 inches and the water content of the snow from 4 to 8 inches. March was colder than normal, and precipitation was about 50 percent of normal. The State-wide snow cover melted during the month except in the northwestern counties and it became apparent that flooding in that area would occur. During the early part of April temperatures were above normal. Maximum daytime temperatures reached the low seventies in part of northwestern Iowa during the period April 7-16. This coupled with light rainfall, triggered the flood events in Iowa streams recorded in this report.

With the exception of November and February, fall and winter precipitation in Wisconsin was in excess of normal. In northern and central Wisconsin, snow depths at the end of December had established new seasonal records. Heavy snowfall continued into January. By the end of the month as much as 40 inches had accumulated in the northwestern part of the State and the water content ranged from 5 to 8 inches. The precipitation pattern then changed abruptly, and in February there was almost no precipitation at a number of U.S. Weather Bureau stations. The average for the State was about 0.10 inch and many long-term stations recorded the minimum February precipitation record. The fact that Wisconsin was spared the heavy February precipitation which occurred in the Dakotas

and parts of Minnesota and Iowa, played an appreciable part in reducing flood peaks in Wisconsin streams.

From December through February the weather throughout most of the upper Midwest was unpleasant and unpredictable. There was a tremendous amount of drifting snow, and local officials found it impossible to keep rural roads open. The weather created more school closings than occurred in any other winter in the history of this area. Many children living in rural areas were forced to board in town if they wished to attend school. In North Dakota freakish southerly winter winds created huge drifts on the south sides of wind breaks to parallel the drifts created on the north sides of the wind breaks by the normal northerly winter winds.

The situation at the end of February looked grim indeed and March, normally the month of heaviest snowfall, lie ahead. What further potential for disaster would it bring? The residents of the area could only hope for the unlikely development that the grim meteorological events which characterized the winter would reverse themselves in March. Although all odds were against this occurrence, a dramatic reversal in the precipitation pattern did occur in March. Of the 26 U.S. Weather Bureau stations listed in table 1, only 2 showed a positive departure from normal, and the average of all the stations was $-.60$ inch. Destructive as the spring floods were, they would have been much worse had even normal precipitation occurred in March. Had the March precipitation kept pace with the record-breaking precipitation which occurred in December and January in the entire upper Midwest, catastrophic floods would most surely have ensued.

Even though there was little precipitation in March (and also little in February in some areas) the potential for outstanding floods still remained. Figure 3 shows the water content of snow on the ground as of the end of March. Rapid runoff of the snow in this vast area would create a flood of major proportions. Fortunately the fact that there was little frost in the ground tended to lower the magnitude of flood peaks.

The timing of the winter snowfall had a mitigating effect on the depth of frost and the magnitude of spring snow-melt floods. The first heavy snowfall occurred in November in the Duluth area and early in December throughout most of the rest of the upper Midwest. November temperatures were generally above normal, and as a consequence there was little frost in the ground when the first heavy snowfall occurred. As snow continued to fall, the thickness of the insulating blanket increased and so the depth of frost was much less than that

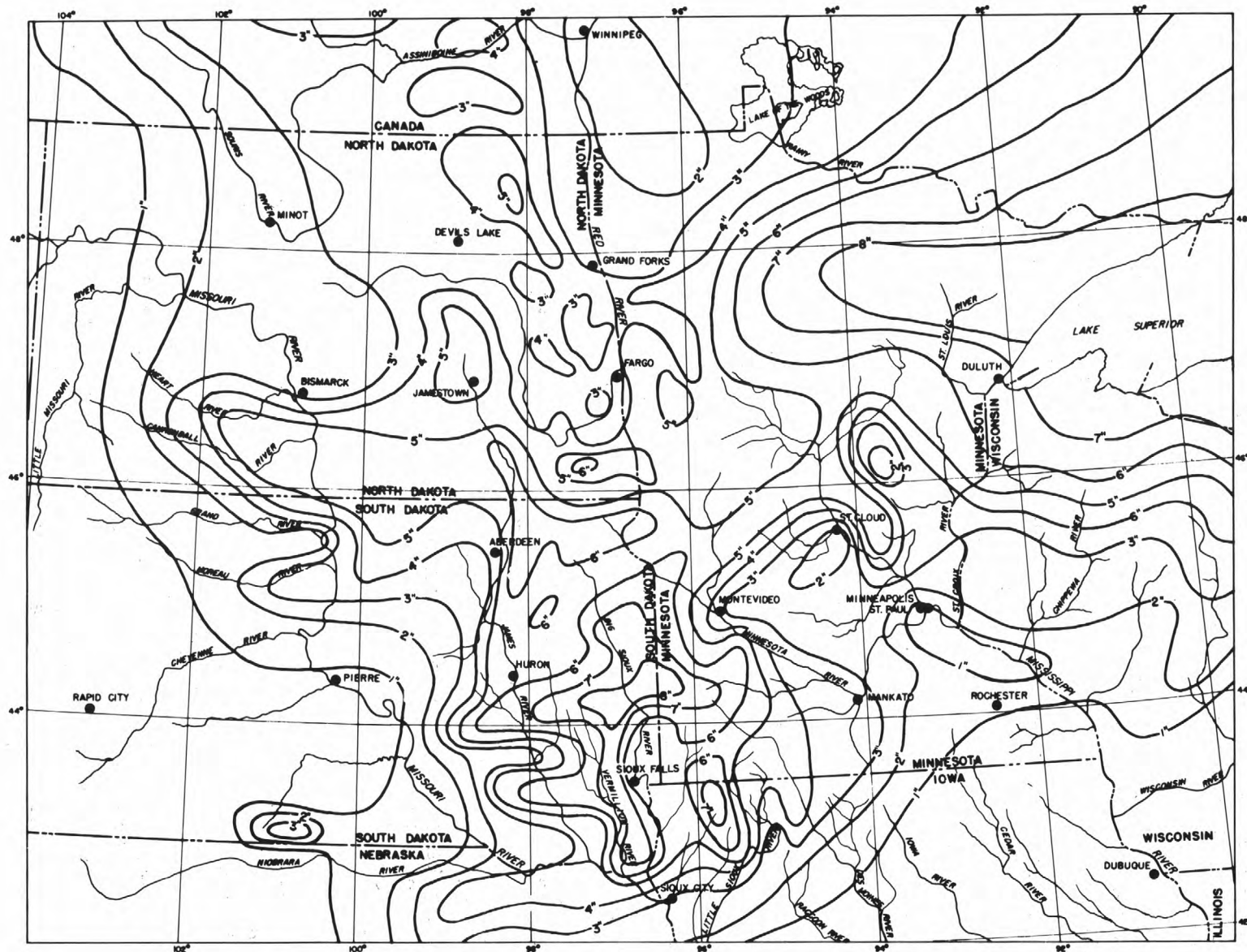


Figure 3.--Water content of snow on the ground at the end of March 1969.
From U.S. Weather Bureau and Canadian Weather Service.

which occurs most winters. In some areas, even in northern Minnesota, there was practically no frost in the ground at the end of February, and in many areas depth of frost was limited to a foot or less. The diminution of flood flows because of the small amount of frost in the ground probably occurred throughout much of the flooded area, but this effect may have been negated in part by heavy fall rains which saturated the soil with moisture. The lack of frost is apparent in the runoff from Wisconsin streams and those tributary to the Mississippi River in southeastern Minnesota. Maximum stages and discharges of streams in this area were considerably less than those in the early forecasts, which were based almost entirely on snow surveys. Most of the forecasts made in March were quite accurate, however, and ample warning was given of the serious floods to come.

APRIL CLIMATOLOGICAL EVENTS

After the severe winter conditions in the upper Midwest, climatological events in April, the usual month of snowmelt runoff, were anti-climactic, yet this was the month when the flood drama would unfold. As the weather warmed, the snow melted, and because it was present in such great quantities, floods were inevitable, even under optimum conditions of thawing and freezing.

Fortunately in April, as in March, precipitation was well below normal in the upper Midwest. Table 1 shows a negative departure from normal at 20 of the 26 representative U.S. Weather Bureau stations. A maximum negative departure of 2.14 inches occurred at Sioux Falls, South Dakota. Total precipitation for the month at Sioux Falls was 0.17 inch, creating the paradoxical situation of the second driest April of record in this city and yet record-breaking floods occurred during the month in the Big Sioux River which passes through the city.

Temperatures warmed early in April and precipitation was moderate as is shown for three characteristic Weather Bureau stations in figure 4. In general, temperatures were above normal for the month and remained above freezing after April 6 except for a brief cold period near the end of the month. The warm temperatures accompanied by more than average sunshine was conducive to rapid runoff. Even though precipitation was less than normal throughout most of the upper Midwest, there were some areas where heavy rains during the period April 7-10 (fig. 5) increased the magnitude of flood peaks. The greatest amount of rainfall which fell during this period was about 3 inches at Pelican Rapids, Minnesota, in the upper Red River

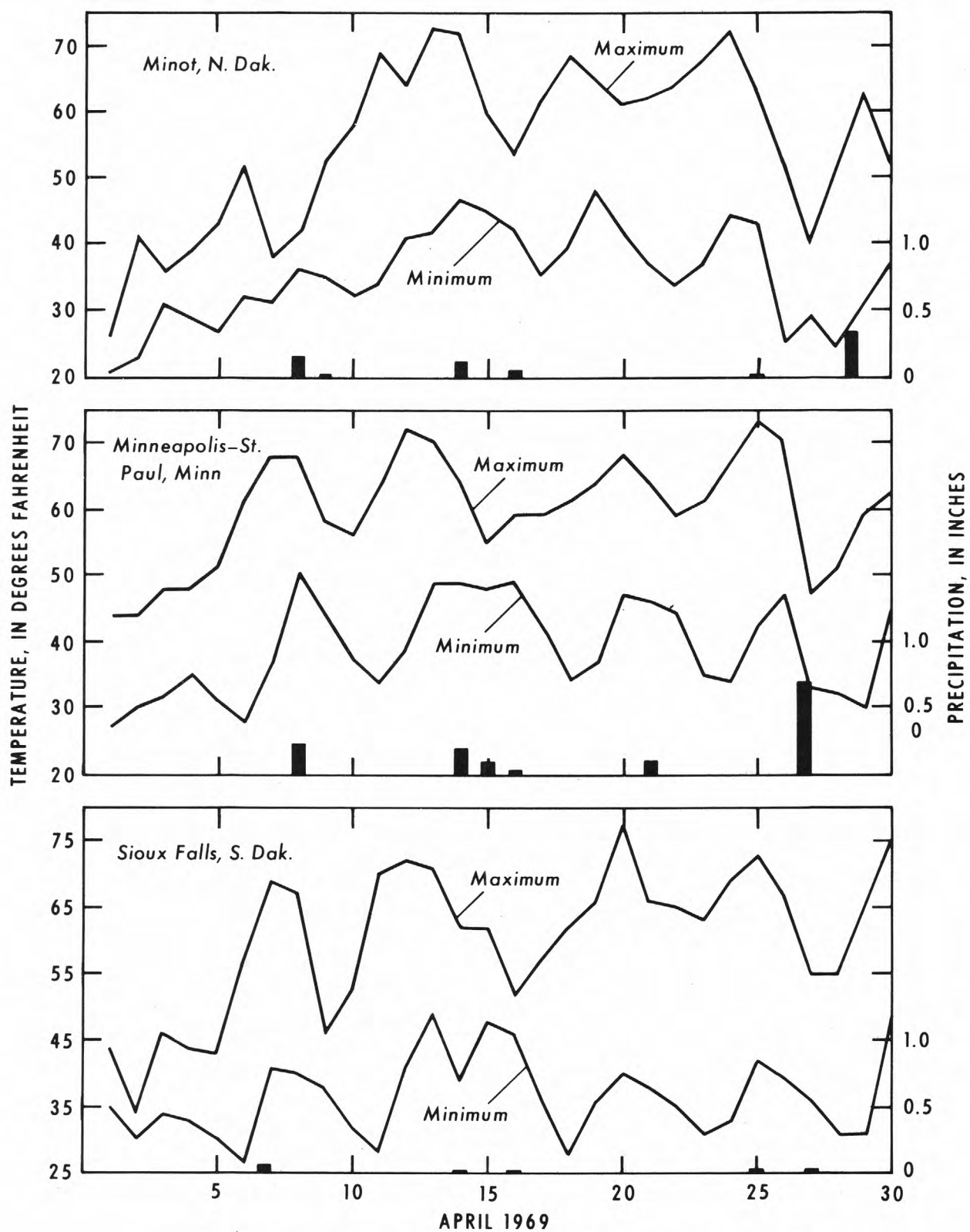


Figure 4.--Temperature and precipitation at selected U.S. Weather Bureau stations.

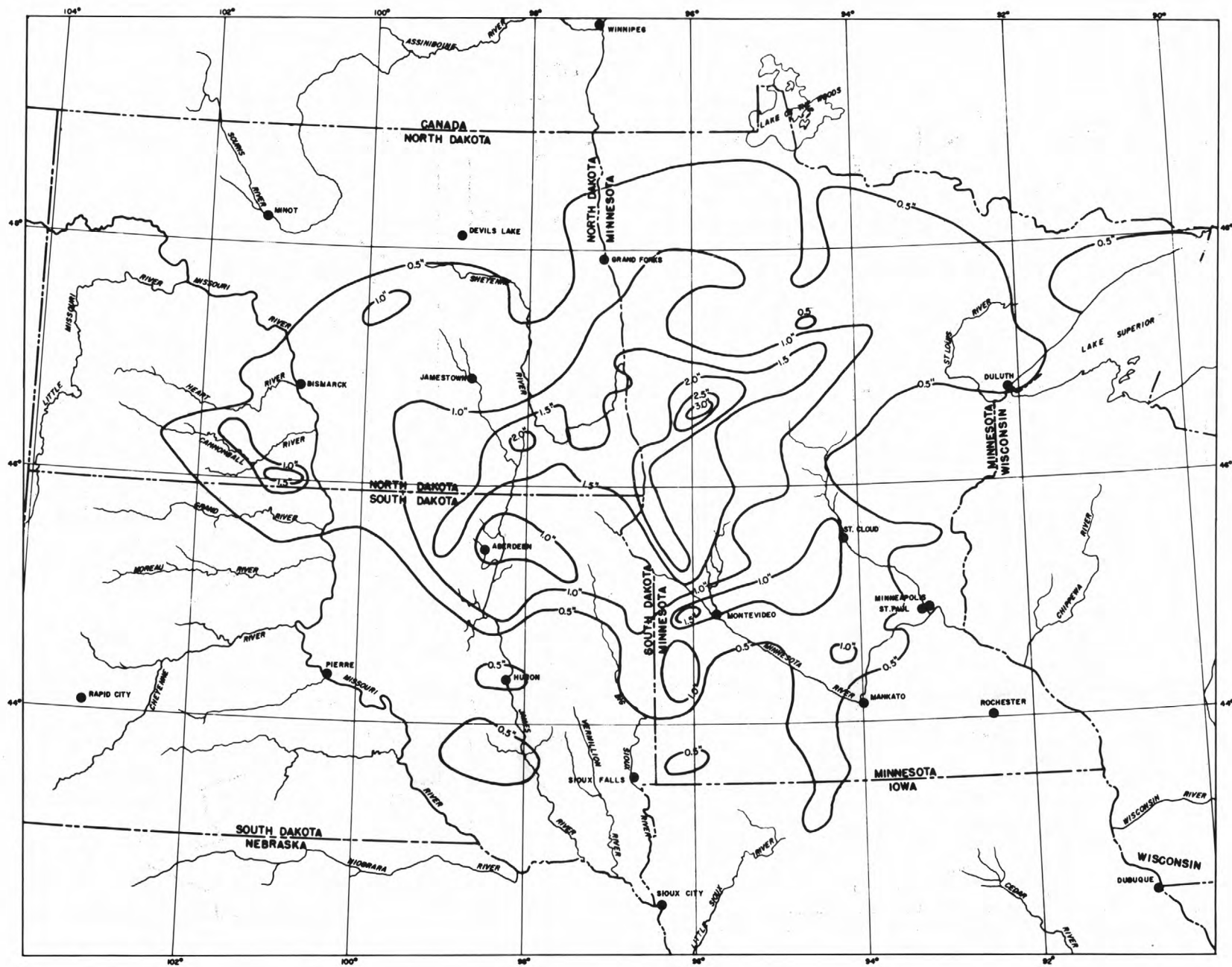


Figure 5.--Precipitation during the period April 7-10, 1969.
Data from U.S. Weather Bureau, isohyets by U.S. Geological Survey.

basin. The southeast corner of North Dakota, which drains to the Red River, also received heavy precipitation during the period as did the upper Minnesota River basin.

The rainfall during the period April 7-10 was significant because it was widespread, and because it occurred just as the snowmelt runoff was gaining impetus. The sharp peaks on some of the upper Minnesota River tributaries are indicative of this situation.

During the last week of the month other significant precipitation occurred at a number of localities, but by this time all the rivers had crested and the precipitation late in the month did not affect the flood peaks.

OPERATION FORESIGHT

The great amount of data showing heavy snowfall and high water equivalent of snow on the ground early in 1969 could lead to only one inescapable conclusion - high-magnitude spring floods were inevitable in the upper Midwest. The great flood of 1965 and the havoc it wrought was still fresh in the minds of most inhabitants of the area, and the flood warnings issued by the U.S. Weather Bureau and Corps of Engineers carried more impact than they ever had previously. The unfortunate communities that lie in the path of the forecasted floods were eager to do all they could to avert or minimize the disaster. Federal and State agencies also were anxious to carry out their roles to their maximum capability if they had a forecasting, flood-protection, or data-collection responsibility. From this set of circumstances Operation Foresight was born.

Under its provisions a continual and up-to-date analysis of the flood situation was presented to the public by the U.S. Weather Bureau, Corps of Engineers, and State agencies. The Corps reviewed their flood-fighting techniques and renewed contracts with the Associated General Contractors because the services of the contractors would be invaluable in the construction of flood walls and other protective works. The Corps also assisted communities in providing the technical knowledge necessary to construct adequate flood-protection works.

Early in March President Nixon requested the Office of Emergency Preparedness to coordinate Federal flood-fighting activities to supplement the efforts of the States and local communities. This request was followed by a conference held at Sioux Falls, South Dakota, on March 11 which was attended

by representatives of the States of North Dakota, South Dakota, Minnesota, Iowa, and Nebraska, and by officials of OEP and other Federal agencies located in those States. It was decided at the conference that the provisions of Public Law 99 would be utilized as a means of providing Federal support to local communities in their flood-fighting efforts. This decision provided a means of financing the flood-fighting effort before the disaster occurred. PL-99 funds which may be used to hire contractors, rent equipment, and buy certain materials had not been used in such a timely manner previously.

President Nixon designated Minnesota and North Dakota flood disaster areas on April 18, Iowa on April 25, and Wisconsin on May 1. After this designation was established, Federal funds became available under the provisions of Public Law 875 which provided \$2.4 million to North Dakota, \$1 million to Minnesota, \$750,000 to Iowa, and \$500,000 to Wisconsin.

The decision to provide Federal funds and other support plus the wide-spread logistical and construction effort that followed became known as Operation Foresight. It involved a cooperation of effort from the Federal, State, and local communities that is probably without precedent and it prevented millions of dollars of flood damage that would otherwise have occurred.

Although personnel of the U.S. Geological Survey were not directly involved in Operation Foresight, the wide-spread publicity it received encouraged the Survey offices to do their utmost in collecting data pertaining to floods which were of unprecedented magnitude in some areas. These data were rapidly passed on to the flood information centers of the U.S. Weather Bureau and Corps of Engineers and played an important part in the successful operations of these agencies. At the request of the Corps of Engineers, special efforts were also made to obtain flood data at a number of miscellaneous sites where additional data were needed.

THE FLOODS

Lake Superior Basin

Water content of the snow at the end of March in the Lake Superior basin in Minnesota was about 8 inches (fig. 3), and there was considerable antecedent precipitation in the fall. Table 1 shows that the total 8-month precipitation for the period September to April was greater in Duluth than in any of the 26 U.S. Weather Bureau stations listed.

In the winter of 1968-69 heavy snowfall started early in November and was augmented by further snowfall in December and January. As a result, frost penetration was shallow, much of the precipitation seeped into the ground, and there was little significant flooding in the basin.

Much of the Lake Superior drainage basin in Minnesota is covered with a thin drift sheet comprised of a mixture of sand, clay, and gravel which is underlain by crystalline rocks. The lower reaches of the rivers draining the area are generally deeply gorged and more precipitous than any others in the State. The area is quite sparsely settled with the exception of the Twin Ports area of Duluth, Minnesota, and Superior, Wisconsin. The combination of topography, runoff characteristics, and location of developed areas are such that flood damage is seldom great in this basin. Because of the heavy snowfall in the area, and because it adjoins areas where flooding was more severe, two stations in the St. Louis River basin (nos. 1 and 2, table 11) are included in this report. All the other Lake Superior tributaries experienced only minor flooding.

Only 2 of the 7 gaging stations in the St. Louis River basin recorded significant flood peaks. A new maximum discharge in 14 years of record occurred on the East Swan River near Toivola, Minnesota, but it was only a 6-year flood. The peak discharge of 1,950 cfs exceeded the previous maximum known discharge, which occurred in 1950, by 260 cfs; but the stage was about three-fourths foot lower than the 20.0 feet experienced at that time.

The peak discharge of 28,300 cfs recorded at the St. Louis River near Scanlon, Minnesota, on April 15, was the second highest discharge recorded since 1908, being exceeded only by the peak recorded in 1950 when the discharge was 37,900 cfs. The recurrence interval of the 1969 flood, however, is only 4 years. There have been a number of floods where the discharge has been only slightly less than that experienced in 1969.

There was no extensive damage reported in the St. Louis River basin. Total damages were estimated at \$51,000 of which almost \$40,000 was sustained by transportation facilities. Traffic was inconvenienced for short periods of time on some secondary roads because of flooded roads or washed-out culverts, but damage was generally light. There were also some local flooding problems, particularly in the vicinity of Duluth, but no serious damage resulted.

Red River of the North Basin
(exclusive of Souris River basin)

The Otter Tail River in Minnesota is considered the headwaters of the Red River of the North. It rises at an elevation of about 1,550 feet in Clearwater County about 13 miles west of Lake Itasca and flows in a southwesterly direction to Breckenridge, Minnesota, and Wahpeton, North Dakota, where it is united with the Bois de Sioux River flowing from the south to form the Red River of the North. The confluence of the two rivers is at an elevation of about 940 feet.

Although the longest tributary upstream from Breckenridge, Minnesota, is the Otter Tail River, the Red River Valley itself is considered to be the north-south valley extending from Lake Traverse on the boundary between Minnesota and South Dakota to Lake Winnipeg in Manitoba, Canada. From Lake Traverse northward throughout its entire length, the Red River basin has a very gentle slope from an elevation of about 970 feet at Lake Traverse to an elevation of about 770 feet at the international boundary 425 miles to the north. The Red River basin lies in the area once occupied by Glacial Lake Agassiz, and as a consequence, except at its eastern and western extremities, the entire area is very flat. One must appreciate this situation to have a full realization of the flood problems which arise in the basin.

In addition to the fact that there is little relief in the topography of the basin, the Red River flows in a northerly direction and usually the ice breaks up in the upstream reaches first. This condition creates more than the usual problems from ice backwater which occur in rivers flowing in a southerly direction. It is probable, however, that in the 1969 flood the ice which formed in the relatively narrow Red River channel had little effect on the magnitude of peak stages when the entire flood plain became inundated.

The headwaters of the Red River of the North are located in an area where the water content of snow on the ground at the end of March was between 6 and 7 inches (fig. 3). The warm weather of April 5-6 started a rapid thaw and water began to flow into the streams. The area then received as much as 3 inches of rainfall during the period April 7-10 (fig. 5). It is not surprising, therefore, that floods of exceptionally high magnitude occurred throughout the basin. The upper tributaries rapidly exceeded bankful stage inundating farmlands and causing damage to highways, secondary roads, and drainage structures.

At the upstream extremity of the Red River Valley, the Mustinka River and other tributaries of Lake Traverse were flooding, but their effect on the Red River was delayed for a while by storage in the lake. Limited storage, however, prevented this measure from being very effective in controlling the magnitude of the peak of the Bois de Sioux River at the outlet of Lake Traverse and Mud Lake where a maximum discharge of 3,770 cfs occurred during the period April 19-21. This was more than twice the previous maximum in 28 years of record. Delaying the peak of the Bois de Sioux River, however, had some effect in diminishing the maximum discharges in the Red River farther downstream in the basin.

The Otter Tail River flows into the Red River from the Minnesota side at Breckenridge, Minnesota. Its flow is controlled by lakes in the headwaters area and by Orwell Dam near Fergus Falls, Minnesota; flood flows were not of sufficient magnitude to be included in this report. Orwell Reservoir operation prevented almost \$2 million in damages according to Corps of Engineers estimates. The maximum discharge downstream from the dam during the flood period was a little more than 1,000 cfs, which is not unusual in this stream.

The next major tributary downstream from the Otter Tail River is the Wild Rice River which rises in southeastern North Dakota and flows in an easterly direction to the vicinity of Great Bend and Wahpeton, North Dakota, where it turns northward and flows for more than 40 miles approximately parallel to the Red River and about 5 miles distant from it. At its northern extremity it converges eastward and joins the Red River about 6 miles south of Fargo, North Dakota. Very severe flooding occurred in the Wild Rice River basin. In Antelope Creek, a tributary of the Wild Rice River, the peak discharge of 9,000 cfs from a drainage area of 294 square miles at Dwight, North Dakota, was 3.2 times the 50-year flood, the highest multiple computed for any site in this report. The discharge of the Wild Rice River, at the downstream gaging station near Abercrombie, North Dakota, was 1.4 times the 50-year flood. The peak discharge of 9,540 cfs was $1\frac{3}{4}$ times the previous maximum experienced in 36 years of record. Upstream in the basin flooding was not as severe. Near Mantador, North Dakota, the peak discharge was of 10-year recurrence interval. Total agricultural damages in this basin were estimated at \$582,000 and about \$38,000 urban damage occurred at Hankinson, North Dakota.

The Sheyenne River flows into the Red River from the North Dakota side, about 15 miles downstream from Fargo, after describing an easterly and southerly course through east central North Dakota. Maximum stages and discharges occurred

in the upper part of the basin during the period April 11-14. Runoff was contained for a time in Lake Ashtabula, the reservoir created by Bald Hill Dam, near Valley City, North Dakota, but flood storage was not sufficient so that the release of moderate flows could be continued through the flood period. On April 13, it became necessary to start releasing flows of flood magnitude. The peak discharge of 4,520 cfs at Valley City on April 19 was very nearly the same magnitude as the maximum flood of record which occurred in April 1948. The city was well diked which minimized flood damages, but nevertheless about \$270,000 damages, including the cost of the flood fight were sustained in the city. As the flood peak moved downstream, damage occurred primarily to farm lands and highways. The highest stage in 39 years of record occurred at West Fargo, occasioned in part by backwater from the Red and Maple Rivers. Flood damages in this locality were held to about \$248,000 by extensive diking and sandbagging measures. Total urban damages sustained in the Sheyenne River basin exclusive of the Maple River basin, were about \$606,000 and agricultural damages were about \$598,000.

The Maple River is tributary to the Sheyenne River and joins it 3 1/2 miles northwest of West Fargo, about 22 river miles upstream from the mouth of the Sheyenne River. Flooding was severe in this subbasin of the Sheyenne River. The peak discharge of 5,750 cfs near Enderlin, North Dakota, was considerably higher than the previous maximum in 12 years of record and was 1.2 times the 50-year flood. As a result of collapsing dikes about 25 homes were flooded. The gaging station and bridge about a mile downstream from town were destroyed. The river was out of its banks from Enderlin to the mouth, and high flows from Swan Creek augmented the peak in the lower reaches. About \$21,000 of urban damage occurred in the Maple River basin and agricultural damage was estimated at \$515,000.

Rush River is also tributary to the Sheyenne River, joining it about 8 river miles downstream from the mouth of the Maple River. The discharge of 1,690 cfs at Amenla, North Dakota was about 1.4 times the previous maximum in 22 years of record and equivalent to a flood of 50-year recurrence interval.

The mouth of the Buffalo River is about 10 river miles downstream from the mouth of the Sheyenne River but about half that distance in air miles. The Buffalo River drains an area in Minnesota which is roughly at the same latitude as the Sheyenne River basin in North Dakota, but the drainage area of the Buffalo River, about 1,150 square miles at the mouth, is much smaller. Peak discharge at each of the 4 gaging sites in

the basin exceeded the previous maximum. In the South Branch of the Buffalo River, and in the lower reaches of the basin, peak discharges were more than twice the discharge of a 50-year flood. Near Dilworth, Minnesota, where records have been collected for 38 years, the peak discharge was about $1 \frac{3}{4}$ times the previous maximum of record which occurred in June 1962. The river was out of its banks in much of the basin, inundating agricultural land and blocking some highways and secondary roads for several days. Urban damage in Dilworth was about \$17,000 and in Hawley about \$9,000. Agricultural damages were extensive amounting to about \$1.7 million, and transportation damages also were considerable. In Clay County, for instance, in the lower part of the basin, they amounted to more than \$213,000.

The Wild Rice River of Minnesota flows into the Red River near Hendrum, Minnesota. It contributed significantly to the Red River discharge. At Twin Valley, in the upper part of the basin, the discharge was 4,850 cfs, 1.08 times the 50-year flood; but far less than the great flood of July 1909 when the discharge was 9,200 cfs. At the downstream gaging station near Hendrum, a peak discharge of 8,300 cfs was experienced, which was the maximum in 25 years of record. The stage was almost 2 feet higher than the previous maximum which occurred in April 1965. Extensive flooding occurred for more than a week in this basin. Agricultural damages amounted to about \$1.5 million and \$215,000 in damages was sustained by roads and highways in Norman County, the downstream county in the basin. Some of Clay County, for which transportation damages were mentioned previously, also is drained by the lower reaches of the Wild Rice River.

Peaks on the tributaries downstream from the Wild Rice River of Minnesota generally were exceeded by earlier floods, yet the 1969 flood was very outstanding and discharges in the lower reaches continued to exceed the discharge of the 50-year flood. Flooding in this area was very severe in 1950 and most of the 1969 peaks were exceeded by those that occurred from the late snowmelt flood in April and May 1950. The maximum discharge of record on the Goose River at Hillsboro, North Dakota, was 9,420 cfs in April 1950 as compared with 7,640 cfs (1.3 times the 50-year flood) in April 1969.

In the Marsh and Sandhill River basins in Minnesota, stages rose slowly because of the flat topography characteristic of the Red River basin, and peaks on the lower reaches did not occur until April 12 and 14, respectively. The recurrence interval of the flood in the lower reaches of the Sandhill River was 1.4 times the 50-year flood, slightly more than the other tributaries in this reach of the Red River.

The Red Lake River which has a drainage area of approximately 5,990 square miles, is the largest tributary of the Red River of the North in Minnesota. The Red Lake River's source is at the outlet of Lower Red Lake, about 100 air miles east of its mouth, at Grand Forks, North Dakota, and East Grand Forks, Minnesota. Upper and Lower Red Lakes are effective regulating reservoirs for controlling the runoff from the 1,950 square miles of drainage area located above the outlet of Lower Red Lake. Total usable storage in the two lakes is about 1.9 million acre feet. During the 1969 flood, only enough water was released at the dam on Lower Red Lake to sustain fish life downstream¹. In spite of this regulation, severe flooding occurred farther downstream in the basin.

Peak discharges at the two gaging stations on the Clearwater River, a principal tributary of the Red Lake River, were within 5 percent of the discharges which occurred in the 1950 flood. On the Lost River, which is tributary to the Clearwater River, the maximum stage in 1950 at Oklee, Minnesota, was about 3 1/2 feet higher than that of 1969, but extensive channel improvement was accomplished in 1964, so that the comparative stage of the two floods is not indicative of the comparative discharge. Recurrence intervals of the peak discharges in the Clearwater River varied from 48 years to 1.13 times the 50-year flood and the Lost River peak at Oklee was 1.16 times the 50-year flood.

The maximum discharge of 28,400 cfs and stage of 27.33 feet on the Red Lake River at Crookston are the highest since at least 1897. The previous maximum discharge and stage occurred in 1950. The 1969 stage exceeded the 1950 stage by 1 1/2 feet, but the 1969 discharge was only 1,000 cfs greater, indicating some constriction in the channel and flood plain since 1950. Figure 6 shows comparative discharge hydrographs of the 1950 and 1969 floods. The maximum discharge at Crookston was 1.78 times the 50-year flood, the second highest ratio computed for the major tributaries of the Red River. It was exceeded only by the flood in the Buffalo River basin.

By the time the crest reached Crookston on April 12, the river was out of its banks all the way from Crookston to East Grand Forks. Ice jams upstream from Crookston added to the problem. Emergency calls for more sandbag crews were issued by the city when temporary dikes were nearly overtopped.

¹ The Red Lakes have been unusually high in recent years and with the exception of 2 or 3 weeks during the flood period, it has been necessary to release full channel capacity of 1,000 to 1,300 cfs for about 3 years preceding the flood.

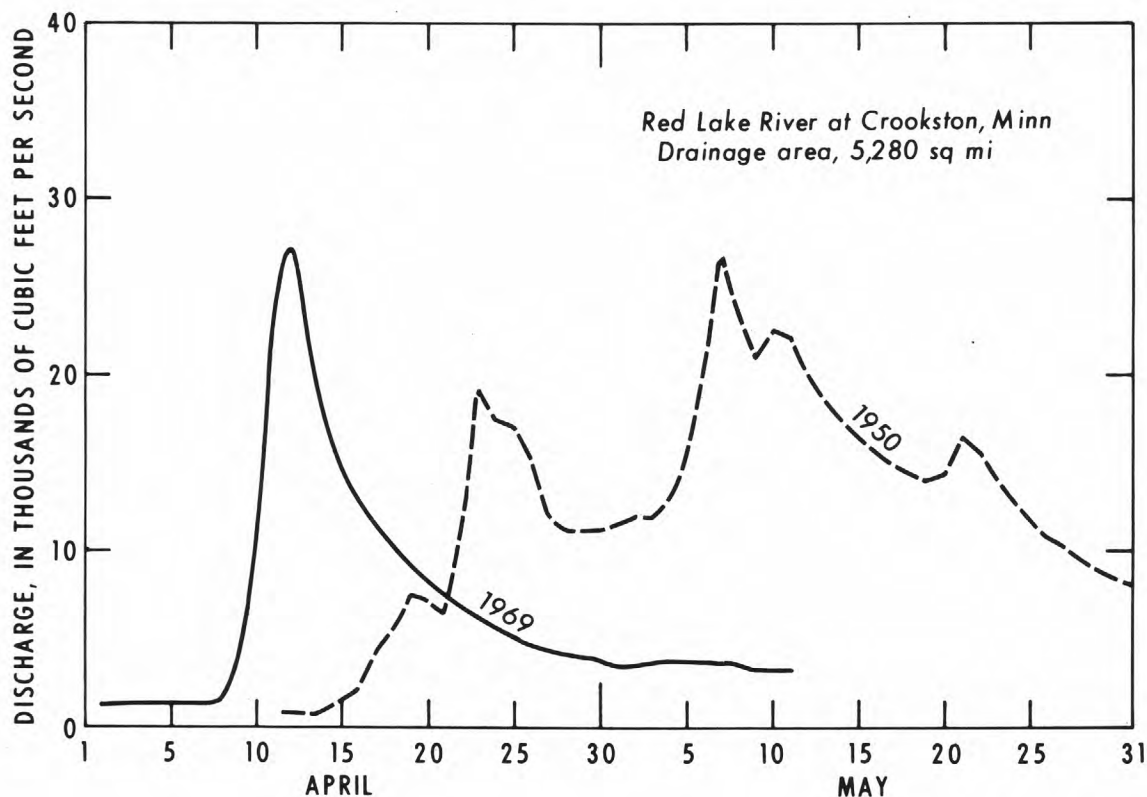


Figure 6.--Comparative discharge hydrographs of two highest floods of record on Red Lake River at Crookston, Minn.

Crookston suffered damages of almost \$219,000. Agricultural damages in the basin were more than \$1.2 million and damages to transportation in Polk County in which Crookston is located exceeded \$146,000.

Farther north severe flooding occurred in the Snake River basin. Agricultural damages in the basin were estimated at \$316,000. Flood waters covered a substantial part of Warren, Minnesota, where total damages were estimated at almost \$203,000. Alvarado, Minnesota, is located about 15 miles downstream from Warren on the Snake River, but it is also in the flood-plain of the Red River main stem. Damage to Alvarado was limited to about \$9,000 because temporary dikes on the east and south isolated the town and held out the flood water. The diking and isolation of this town was typical of a number of small towns which are located in the flood plain of the Red River. The Middle River, a tributary of the Snake River is gaged at Argyle, Minnesota. Peak discharge was 2,530 cfs which was exceeded by the floods of 1950 and 1965 when the discharges were 2,790 cfs and 2,590 cfs, respectively. The recurrence interval of the 1969 flood at this site was 31 years.

In general, the intensity of flooding diminished in the Red River tributaries in the downstream direction from Grand Forks and the Red Lake River. Peak discharges at gaging stations on the Turtle, Forest, and Park Rivers in North Dakota had recurrence intervals of 9, 15, and 31 years, respectively. Drainage areas of these basins varied between 600 and 800 square miles. Farther north, in the Pembina River basin in North Dakota, where the drainage area exceeds 3,300 square miles, the recurrence interval of the flood varied between 30 and 22 years in the downstream direction. This was contrary to the variation in most of the tributaries where the greatest recurrence intervals occurred in the downstream reaches.

In the Two Rivers and Roseau River basins in Minnesota, a warming trend starting on April 8 caused bank-full stages and moderate flooding during the period April 10-20. Flooding was not as severe as that which occurred in the 1950 and 1966 floods. In the Roseau River basin, the discharge at Ross was 3,500 cfs, a 10-year flood, which was only slightly more than half the maximum of record which occurred in May 1950. The peak discharge at the Ross gaging station was reduced and delayed by storage in Roseau Lake just upstream from the station. Peaks were also reduced in the lower Roseau River basin, much of which is in Canada, by storage in low areas downstream from Ross. One of these areas is part of the Roseau River Wildlife Area. Some sandbagging was necessary in Roseau, Minnesota, mostly to prevent water from backing up into business establishments. There were several washouts at culverts and bridge approaches on secondary roads in Roseau and Kittson Counties.

In general, the timing of the flood peak on the main stem of the Red River occurred later at each successive gaging station in a downstream direction from Wahpeton, North Dakota, to the international boundary. The only exception was the peak at Halstad, North Dakota, which occurred 2 days later than at Grand Forks, North Dakota, 68 river miles downstream. This, no doubt was occasioned by the Red Lake River which had a very significant influence on the Red River at Grand Forks where the two rivers join. The peak discharge of the Red Lake River at Crookston, 53 miles above the mouth, was 28,400 cfs on April 12. On the same date this discharge was about equal to that of the Red River just above the mouth of the Red Lake River.

The peak at Wahpeton occurred on April 10, and at the international boundary on April 26. This sustained period of high water is characteristic of the basin and is occasioned primarily by the flat slope. The fact that there is little topographic relief in the basin causes the main stem to back well up into the tributaries, and as a consequence the maximum



Figure 7.--Flooding of Red River at Perley, Minn. Photograph by Minneapolis Tribune.

stages on the downstream reaches of the tributaries sometimes occur later than the maximum discharges.

Extensive flooding along the Red River affected all the towns situated close to the river. Perley, Minnesota, located on the main stem between the Buffalo and Wild Rice Rivers, is an example. Most of the 165 residents of the town were evacuated, the town was isolated, and the business district was a little island in a sea of flood water. Figure 7 shows the town and gives some indication of the flatness of the topography. This very characteristic, however, lends itself to agriculture on which the economy of the area depends. The little town of Perley sustained damages of about \$165,000. Other towns along the Red River which sustained damages in excess of \$100,000 were Moorhead, Halstad, and St. Vincent. Much of the damages in the latter two towns were charged to the cost of traffic detours which had to be constructed. In North Dakota, damages from flooding of the main stem exceeded \$100,000 in Fargo, Grand Forks, and Pembina, where total urban damages were about \$910,000, \$420,000, and \$492,000, respectively. Figure 8 shows the flooding in Pembina.



Figure 8.--Flooding of Red River at Pembina, N. Dak., April 25, 1969.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

The recurrence interval of the main-stem flood decreased gradually, in a downstream direction, from 1.4 times the 50-year flood at Fargo, North Dakota, to a 30-year flood at Emerson, Manitoba, at the international boundary. At Wahpeton, upstream from Fargo, the maximum discharge of 9,200 cfs and stage of 16.34 feet were the highest in 27 years of record. The great flood of 1897 was about 0.7 foot higher in stage, but the discharge of that flood is unknown.

At Fargo continuous records are available for the last 67 years and for the years 1882 and 1897. The 1969 peak discharge of 25,300 cfs far exceeded the previous maximum of 16,300 cfs during the 67-year period of continuous record. The peak discharge in 1897, however, was 25,000 cfs, practically equal to that which occurred in the 1969 flood. Figure 9 shows some of the flooding in the Fargo-Moorhead area.

Continuous records are available at Grand Forks since 1882. At this site, the maximum discharge of record, which occurred in April 1897, was 80,000 cfs, 1 1/2 times the discharge of 53,500 cfs which occurred in 1969. The second highest known flood at Grand Forks occurred in April 1882, when the discharge reached 68,800 cfs. Other high floods of record at this site, all between 50,000 and 55,000 cfs, occurred as snowmelt floods in 1893, 1950, 1965, and 1966.

Total urban damages in the Red River basin, exclusive of the Souris River basin, were estimated at about \$5.5 million. Agricultural damages were set at \$22 million, of which \$2.8 million occurred to more than 750 farmsteads that were flooded. Damages to railroads, highways, and secondary roads were estimated at \$3.0 million. The sum of the total damages in the basin, exclusive of the Souris River basin, is about \$30.5 million.

Flood-crest elevations of the Red River of the North for the 1965 and 1969 floods are shown in table 2, and a flood-crest profile is shown in figures 10 to 12.

Souris River Basin

The Souris River rises in the province of Saskatchewan, Canada, and flows in a southeasterly direction to Velva, North Dakota, where it changes direction and meanders easterly and northerly until it returns again to Canada in the province of Manitoba. There are three main branches in Saskatchewan, the mainstem Souris, Moose Mountain Creek, and Long Creek. Water content of the snow at the end of March varied from 1 to 3 inches (fig. 3) over the Canadian Souris basin. The heaviest



Figure 9.--Flooding of Red River at Moorhead, Minn. and Fargo, N. Dak.
Photograph by Minneapolis Tribune.

Table 2.--Flood-crest elevations, Red River of the North
(furnished by Corps of Engineers except as noted)

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Staff gage near Minnesota Highway 210 bridge between Wahpeton, N. Dak. and Breckenridge, Minn.	549.0			Apr. 10	959.56
USGS recording gage, Wahpeton, N. Dak.	548.6	Apr. 11	957.34	Apr. 10	959.34
Staff gage in Chahinkapa Park, Wahpeton, N. Dak.	548.0			Apr. 10	958.20
Highwater mark at Wilkin County High- way 18 bridge, Brushvale, Minn.	536.0				942.14
Highwater mark at Wilkin County High- way 22 bridge, Kent, Minn.	515.0				930.04
Staff gage at Wil- kin County Highway 28 bridge near Kent, Minn.	502.0				925.1
Staff gage 750 ft east of Wilkin County Highway 30 bridge near Wolver- ton, Minn.	495.5				921.09
Staff gage 150 feet east of Wilkin County Highway 90 bridge near Wolver- ton, Minn.	485.0				917.98

Table 2.--Flood-crest elevations, Red River of the North--Continued

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Staff gage near Clay County Highway 2 bridge near Comstock, Minn.	482.5				912.49
Staff gage at Clay County Highway 8 bridge near Rustad, Minn.	474.5				908.39
Staff gage on power pole at Clay County Highway 65 bridge near Rustad, Minn.	472.0				907.60
Staff gage 250 ft northwest of water tower near Clay County Highway 74 bridge near Moorhead, Minn.	462.0				902.54
Highwater mark on upstream side of Interstate Highway 94 bridge at Moorhead, Minn.	458.0				900.00
Highwater mark on downstream side of Interstate Highway 94 bridge at Moorhead, Minn.	458.0				900.05
USGS recording gage at Fargo, N. Dak.	453.0	Apr. 15	892.30	Apr. 15	899.14
Reference mark on U.S. Highway 10 and 52 bridge at Moorhead, Minn.	452.0				898.74

Table 2.--Flood-crest elevations, Red River of the North--Continued

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Staff gage on Northern Pacific Railroad bridge at Moorhead, Minn.	451.8				898.48
Highwater mark on Intercity bridge on 2nd Ave., Moorhead, Minn.	451.2				897.66
Highwater mark Great Northern Railroad bridge, Moorhead, Minn.	450.8				897.44
Staff gage at Clay County Highway 22 bridge near Moor- head, Minn.	440.5				889.07
Profile point near Georgetown, Minn.	424.5				881.76
Profile point near Georgetown, Minn.	417.4		875.6		
Reference mark on Norman County High- way 39 bridge at Perley, Minn.	403.0		871.0		874.36
Profile point near Hendrum, Minn.	393.5				871.80
USGS recording gage at Halstad, Minn.	375.2	Apr. 17	861.87		864.94
Profile point near Halstad, Minn.	369.0		861.5		
Profile point near Halstad, Minn.	364.0			Apr. 18	860.46

Table 2.--Flood-crest elevations, Red River of the North--Continued

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Highwater mark Norman County Highway 3 bridge near Shelly, Minn.	357.0		858.0		857.91
Highwater mark Polk County Highway 1 bridge near Nielsville, Minn.	347.0				852.70
Profile point near Climax, Minn.	338.0				848.99
Highwater mark Polk County Highway 7 bridge near Climax, Minn.	335.0				847.41
Profile point near Climax, Minn.	329.0				844.22
Highwater mark at Minnesota Ave. bridge East Grand Forks, N. Dak.	298.0		825.58		826.17
Highwater mark at Great Northern Railroad bridge, Grand Forks, N. Dak.	297.6		825.33		825.68
Highwater mark at Demers Ave. bridge, Grand Forks, N. Dak.	297.4				825.14
Highwater mark at Northern Pacific Railroad bridge, Grand Forks, N. Dak.	297.3		824.45		825.37
USGS recording gage at Grand Forks, N. Dak.	296.0	Apr. 17	823.27	Apr. 16	824.04

Table 2.--Flood-crest elevations, Red River of the North--Continued

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Profile point near Grand Forks, N. Dak.	293.0				822.32
Profile point near Grand Forks, N. Dak.	291.0				821.18
Highwater mark on upstream piling of Soo Line Railroad bridge, Oslo, Minn.	271.0				809.63
Minnesota Highway 1 bridge at Oslo, Minn.	270.8				809.81
USGS wire-weight gage at Oslo, Minn.	270.8			Apr. 17	809.45
Profile point near Oslo, Minn.	263.0				806.55
Profile point near Oslo, Minn.	260.0				804.30
North Dakota High- way 17 bridge near Grafton, N. Dak.	235.8				798.86
USGS recording gage at Drayton, N. Dak.	207.0	Apr. 22	795.43	Apr. 23	796.35
Profile point near Drayton, N. Dak.	205.0				795.80
Profile point near Mattson, Minn.	189.0				794.04
Profile point near Mattson, Minn.	182.0		791.7		
Profile point near Hallock, Minn.	173.0				792.13

Table 2.--Flood-crest elevations, Red River of the North--Continued

Location	Miles above mouth of Red River of the North	1965		1969	
		Date	Elevation in feet 1929 Adjustment	Date	Elevation in feet 1929 Adjustment
Profile point near Pembina, N. Dak.	165.0				790.88
Profile point near Pembina, N. Dak.	162.0				790.57
Canadian Inland Waters Branch recording gage at Emerson, Manitoba	154.3	Apr. 26	785.19	Apr. 26	787.61

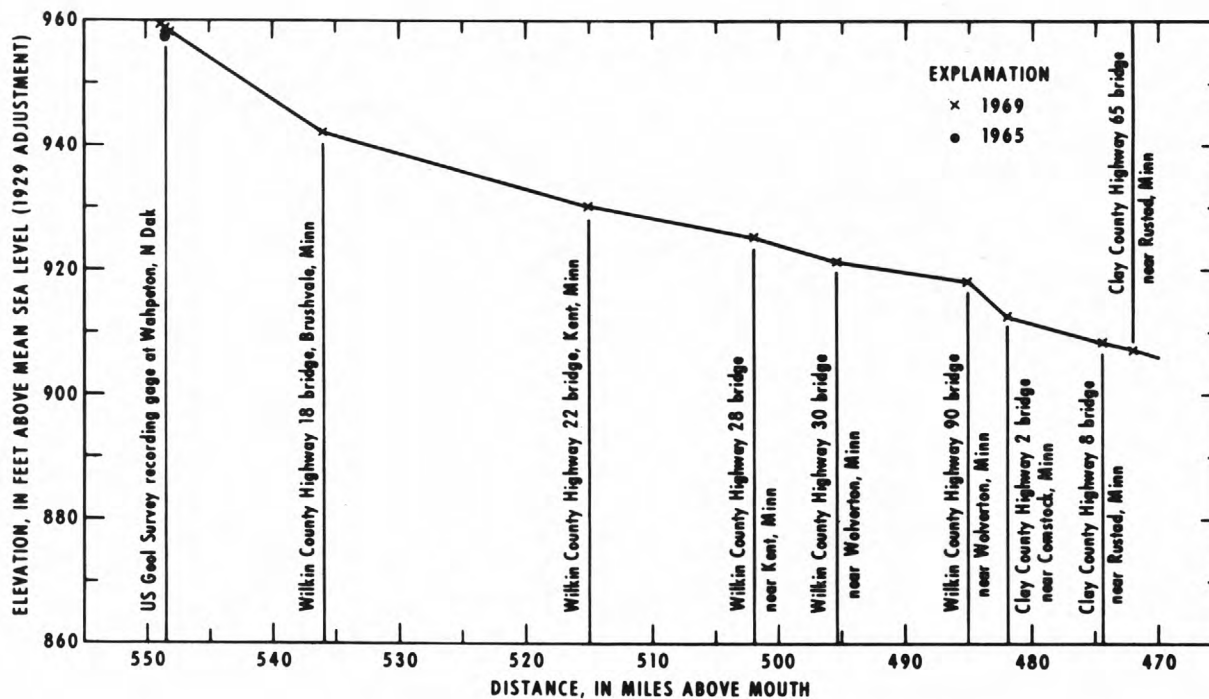


Figure 10.--Flood-crest profiles, Red River of the North, mile 550 to 470.

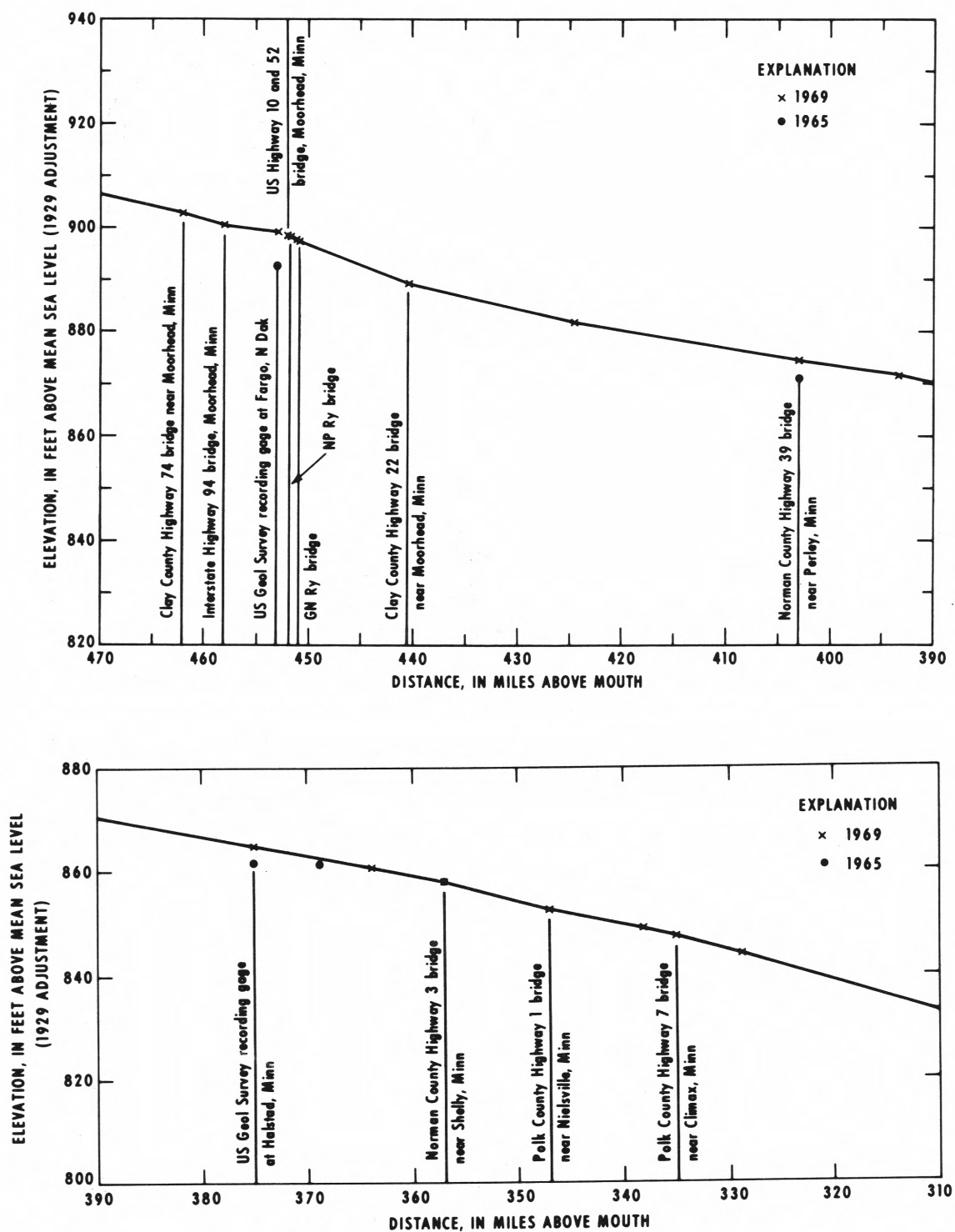


Figure 11.--Flood-crest profiles, Red River of the North, mile 470 to 310.

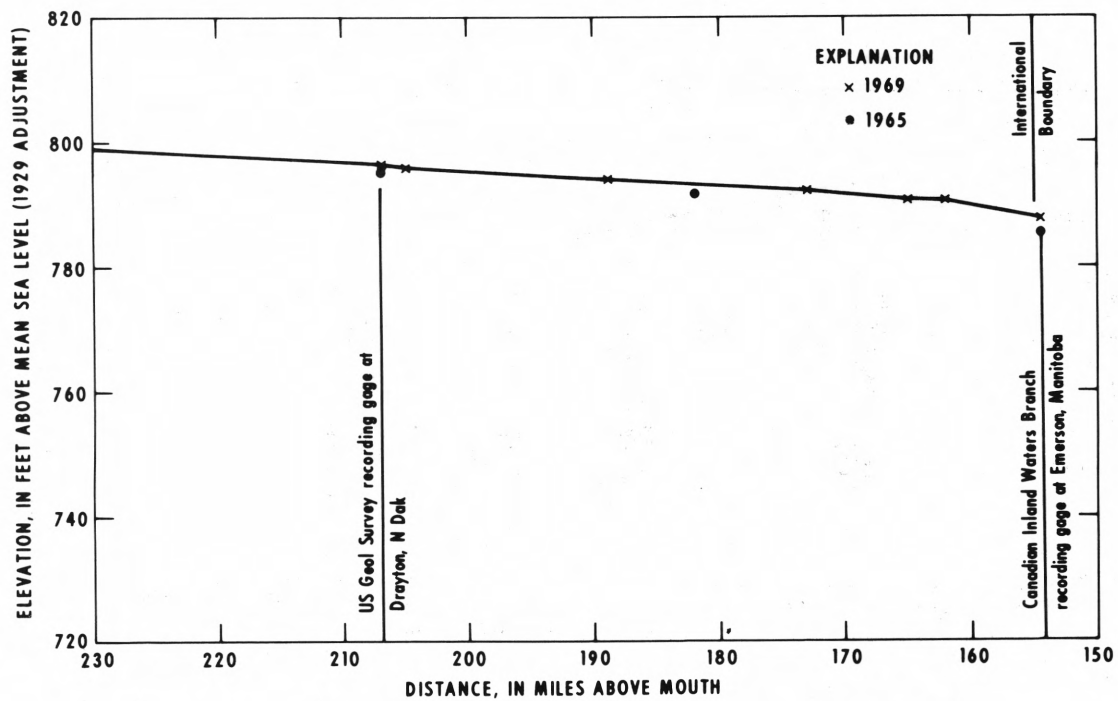
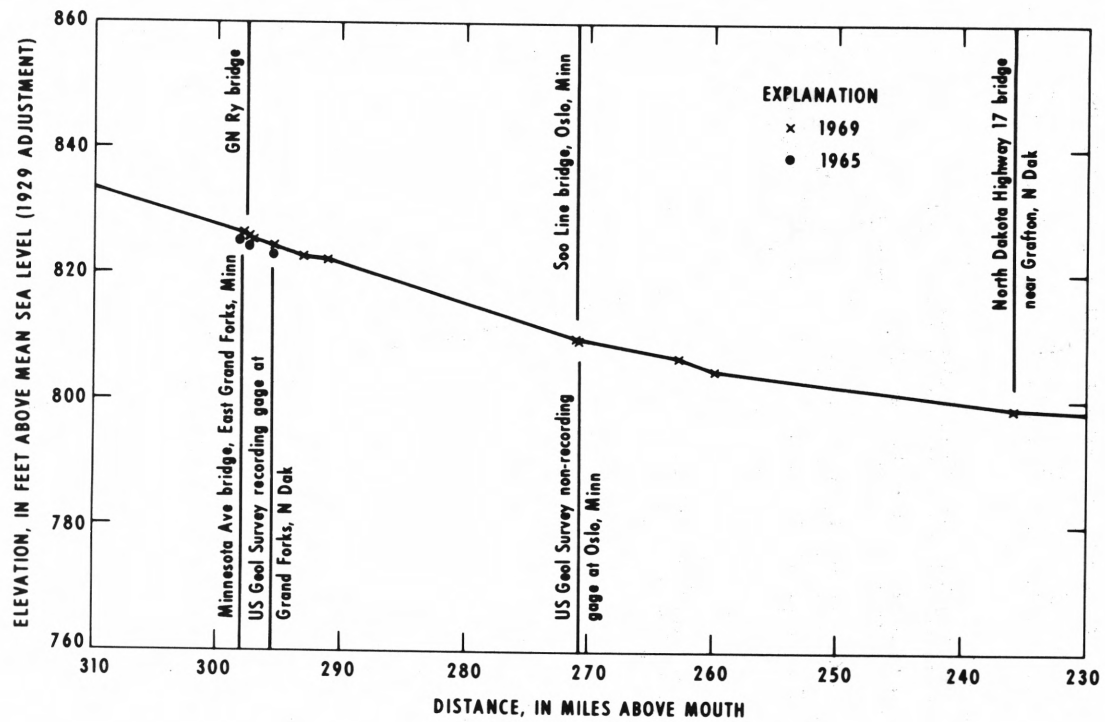


Figure 12.--Flood-crest profiles, Red River of the North, mile 310 to 150.

concentration was in the Moose Mountain Creek area. The main tributaries in downstream order in North Dakota are the Des Lacs and Wintering Rivers. The water equivalent in the North Dakota Souris basin varied from 3 to 4 inches. The heaviest concentration was near the Turtle Mountains in the downstream end of the basin in North Dakota. Flood warnings had been forecast for the basin by late March, but alternate freezing and thawing during this period resulted in settling of the snow and caused little or no runoff. The warm temperatures commencing April 5 and 6 started rapid melting throughout the basin.

The Des Lacs River and some of the downstream tributaries were the first streams to reach flood stage in North Dakota. The upper portion of the Des Lacs River passes through a series of U.S. Fish and Wildlife Service pools which stored 40,000 acre-feet of water during the critical flood period. In spite of this storage, most of the river was out of its banks for the period, April 8-10. The peak stage exceeded the previous maximum at the gaging station at Foxholm, North Dakota, by 1.8 feet. There was extensive flooding of farmland throughout the basin and some minor flooding in the small towns. As the water from the Des Lacs River joined the Souris River, there was a sharp increase in flood damage. The town of Burlington, North Dakota, just below the junction of the two rivers, experienced flooding. There was extensive damage, estimated at \$3 million, in Minot, North Dakota, as the first crest of the Souris River moved through on April 16 at a stage of 17.03 feet. An estimated 300 homes were damaged and 2,000 people evacuated. As the waters receded, Minot began to prepare for a greater flood that had been building in the headwaters of the Souris. The gates of Lake Darling above Minot had been closed to avoid adding anything to the flood from the Des Lacs River. On April 11, a record peak discharge of 12,400 cfs occurred at the gaging station on the Souris River near Sherwood, North Dakota. Figure 13 shows the attenuation effected by Lake Darling between the gaging station near Sherwood and the station above Minot. About 68,000 acre-feet of water were stored in the lake during the period April 1-15. The peak near Sherwood was caused primarily by water from Moose Mountain Creek. The main-stem Souris and Long Creek were out of their banks throughout most of their reaches in Canada, causing considerable damage to farmlands, highways, and reservoir structures, and some minor urban damage. Flood-in in Long Creek and the main-stem Souris created a secondary peak of 6,300 cfs on April 20 at the gaging station near Sherwood.

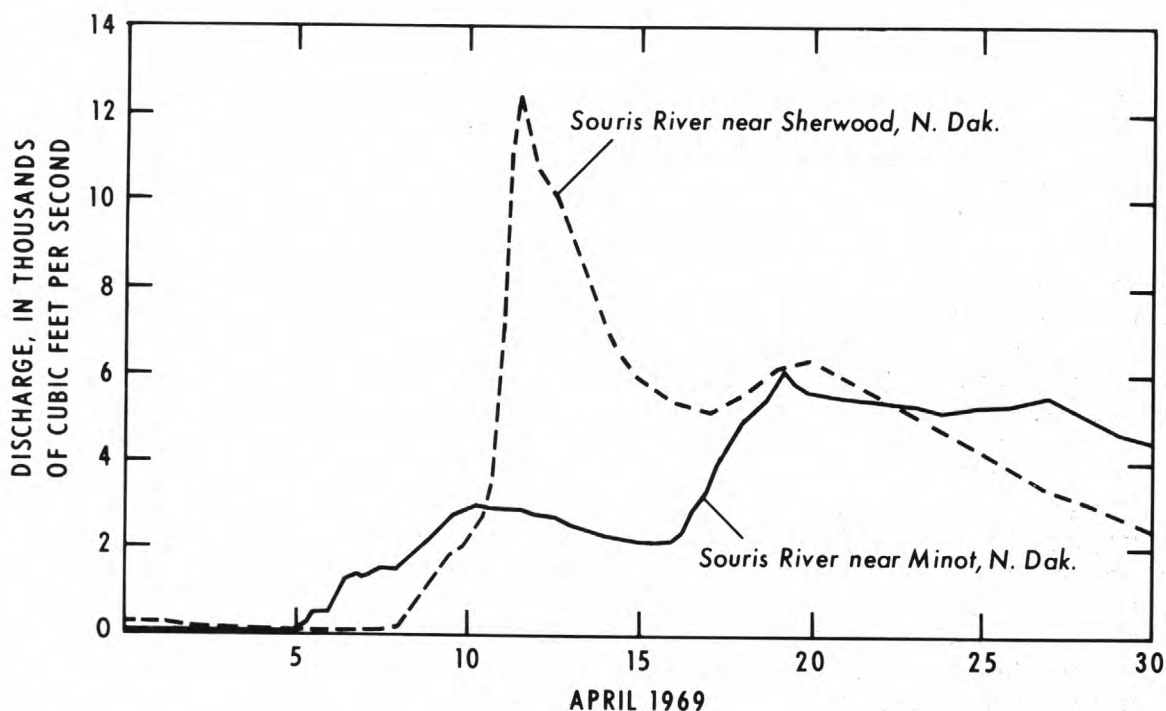


Figure 13.--Discharge hydrographs of selected gaging stations on Souris River.

There was no adequate flood forecasting for Minot, but late flood warnings pertaining to the second peak caused flood officials and the citizens of Minot to redouble their efforts in making preparations for the coming emergency. Federal, State, and local organizations had combined forces to dike, evacuate, and set up emergency facilities. The city evacuated 12,000 people from 3,000 homes in the low-lying areas.

The meandering of the Souris River through Minot, about 17 miles in a straight-line distance of 7 miles, compounded the flood problem. The river peaked a second time at 6,020 cfs and a stage of 20.36 feet on April 19 at the gaging station above Minot, but the water did not recede to bankfull stage until May 9. The channel capacity is only about 2,000 cfs through the city, and the river was out of its banks for about a month. The peak discharge of the 1969 flood was the greatest since 1904; however, the 1904 peak discharge was almost twice that of 1969. The flood of 1882 is reported to have been about 2 feet higher than that of 1904. The 1969 peak would have been higher if the Des Lacs River peak had occurred at more nearly the same time as the main-stem Souris above the Des Lacs River as it often does.

Many of the dikes had failed and many areas could not be protected, resulting in the flooding of 3,000 residences and 250 business establishments. On April 7, a dike in the southwestern part of the city failed and about 25 blocks were inundated with little warning. Some areas were covered with water 5 to 6 feet deep. At least one home blew up and burned because of gas leaks. Total damages in the city were estimated at \$11 million. The Souris River, sometimes called the Mouse River, was indeed "the mouse that roared" - the terminology used by a number of national and local news media which aptly described the situation. Figures 14 to 16 show some of the flooding which occurred in Minot.



Figure 14.--Flooding of Souris River in northeast area of Minot, N. Dak., April 24, 1969. Photograph by U.S. Army Corps of Engineers, St. Paul district.



Figure 15.--Flooding of Souris River in southwest area of Minot, N. Dak., April 19, 1969. Photograph by U.S. Army Corps of Engineers, St. Paul district.

As the flood wave moved downstream, there was little further urban damage, but the valley farmlands were inundated. Emergency diking saved Velva, North Dakota, from almost complete flooding. Flood damages suffered throughout the basin were extremely severe. Minot was by far the hardest hit of any town or city in the entire flooded area of the upper Midwest. The damages in Minot were 88 percent of the total urban damages of \$12.5 million which occurred in the basin. Agricultural losses also were heavy, amounting to \$4.6 million and transportation damages amounted to almost a million dollars. Total damages in the basin were about \$18 million.



Figure 16.--Flooding of Souris River in northwest area of Minot, N. Dak. Photograph by Minneapolis Tribune. 43

The lower tributaries of the Souris River had peaked during the period April 9-12 (most of them well in excess of a 50-year flood) and this water had run off considerably ahead of the delayed peak from upstream. The Souris River near the Westhope, North Dakota, gaging station went over its banks April 12 and was still in flood in mid-June. The volume of water passing the station during April and May was 488,400 acre-feet compared to a previous two-month high of 281,300 acre-feet in 1949.

Data pertaining to maximum flood elevations were obtained from the St. Paul district, Corps of Engineers, and are presented in table 3 and a flood-crest profile is shown in figures 17 to 19.

Lake of the Woods Basin

In this report, flood data for streams in Lake of the Woods basin pertain only to those located in Minnesota, in the western part of the basin downstream from Rainy Lake. This part of the basin is covered with glacial drift and, in general, there is little topographic relief. There are fewer lakes in the eastern part of the basin, but there are a number of swampy areas owing to the relatively poor drainage caused by the flat northward slope to Rainy River. During the glacial age the whole area was covered by Glacial Lake Agassiz which accounts for the smooth terrain.

On the basis of total volume of flow, the Rainy River is the second largest river flowing within or along the boundaries of Minnesota. Average discharge of the Rainy River at Manitou Rapids exceeds that of the Mississippi River as far downstream as Prescott, Wisconsin, and Hastings, Minnesota, where the St. Croix River joins the Mississippi River.

No floods exceeding previous maximums were experienced at gaging stations in the Lake of the Woods basin, but because of the large volume of runoff involved in the 1969 spring flood, and the high water content of snow in the basin (fig. 3) some representative stations in the basin are included. Maximum discharge of the Rainy River at Manitou Rapids was 58,300 cfs, the third highest in 41 years of record. A comparative discharge hydrograph of the 1969 flood and the highest flood of record, occurring in 1950, is shown in figure 20. More than half the 19,400 square mile drainage area at this site is located in Canada, and the runoff from approximately three-fourths of the drainage area is regulated to some extent by the dam located 35 miles upstream at the outlet of Rainy Lake at International Falls, Minnesota. Peak discharge of the

Table 3.--Flood-crest elevations, Souris River
(furnished by Corps of Engineers except as noted)

45

Location	Miles above mouth	Date 1969	Elevation in feet 1929 Datum
USGS recording gage near Sherwood, N. Dak.	512.3	Apr. 11	1,628.72
Renville County Highway 728 bridge near Sherwood, N. Dak.	509.0		1,623.9
Profile point near Sherwood, N. Dak.	503.0		1,619.9
Renville County Highway 759 bridge near Sherwood, N. Dak.	495.0		1,612.6
Renville County Highway 729 bridge near Tolley, N. Dak.	484.5		1,604.5
North Dakota Highway 5 bridge near Tolley, N. Dak.	475.0		1,601.2
Profile point at bridge, 3 miles east of Tolley, N. Dak.	471.8		1,599.9
USGS recording gage at Lake Darling, near Foxholm, N. Dak.	430.0	Apr. 16	1,599.18
USGS recording gage near Foxholm, N. Dak.	414.5	Apr. 17, 18	1,576.21
Profile point at Burlington, N. Dak.	394.5		1,572.1
Profile point near Burlington, N. Dak.	392.5		1,569.6
USGS recording gage above Minot, N. Dak.	388.5	Apr. 19	1,566.11
Reference mark at Soo Line Railroad bridge at Minot, N. Dak.	386.0		1,563.7
Reference mark at end of Soo Line Railroad trestle at Minot, N. Dak.	381.2		1,556.4
Reference mark on bridge at 9th St. S.E., Minot, N. Dak.	376.3		1,551.7
Profile point at highway bridge near Minot, N. Dak.	367.0		1,545.5
Reference mark on Soo Line Railroad bridge near Logan, N. Dak.	359.0		1,538.0

Table 3.--Flood-crest elevations, Souris River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet 1929 Datum
Reference mark on highway bridge at Logan, N. Dak.	358.0		1,537.13
Reference mark on highway bridge at Sawyer, N. Dak.	345.0		1,523.55
Reference mark on North Dakota Highway 41 bridge at Velva, N. Dak.	330.5		1,507.95
USGS recording gage at Verendrye, N. Dak.	302.0	Apr. 30	1,481.92
Profile point near Verendrye, N. Dak.	295.0		1,477.35
Highway bridge near junction with Wintering River near Verendrye, N. Dak.	283.0		1,471.84
Profile point at bridge near Wintering School No. 2, near Verendrye, N. Dak.	277.0		1,467.14
Profile point near Towner, N. Dak.	266.6		1,460.34
U.S. Highway 2 bridge near Towner, N. Dak. upstream	261.8		1,458.03
downstream			1,457.84
North Dakota Highway 14 bridge at Towner, N. Dak.	255.0		1,455.5
USGS recording gage near Bantry, N. Dak.	228.0	May 4	1,441.36
U.S. Fish and Wildlife dam 320	193.0	Apr. 18, 19 May 3-6	1,425.8
U.S. Fish and Wildlife dam 326	186.0	Apr. 22 May 7	1,422.2 1,422.4
North Dakota Highway 14 bridge near Upham, N. Dak.	185.5		1,422.4
U.S. Fish and Wildlife dam 332	181.0	Apr. 18 May 9	1,421.9 1,421.6
U.S. Fish and Wildlife dam 341	172.0	Apr. 18 May 7	1,420.2 1,419.4
USGS recording gage near Westhope, N. Dak.	154.5	Apr. 19 May 12	1,420.08 1,418.55

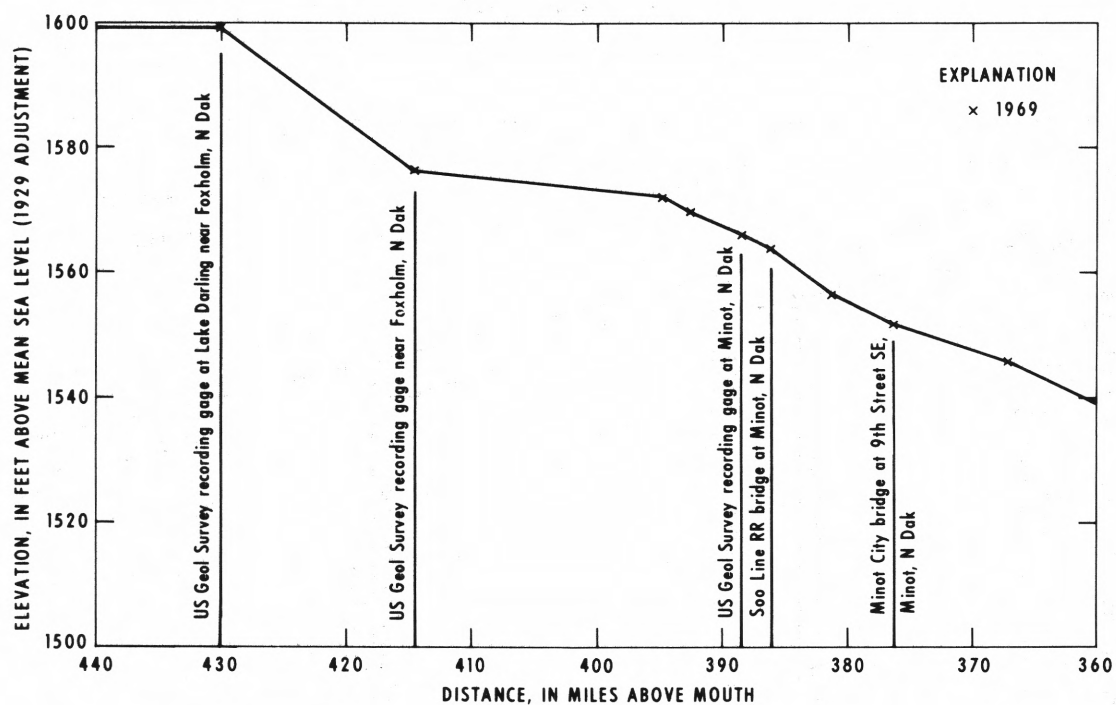
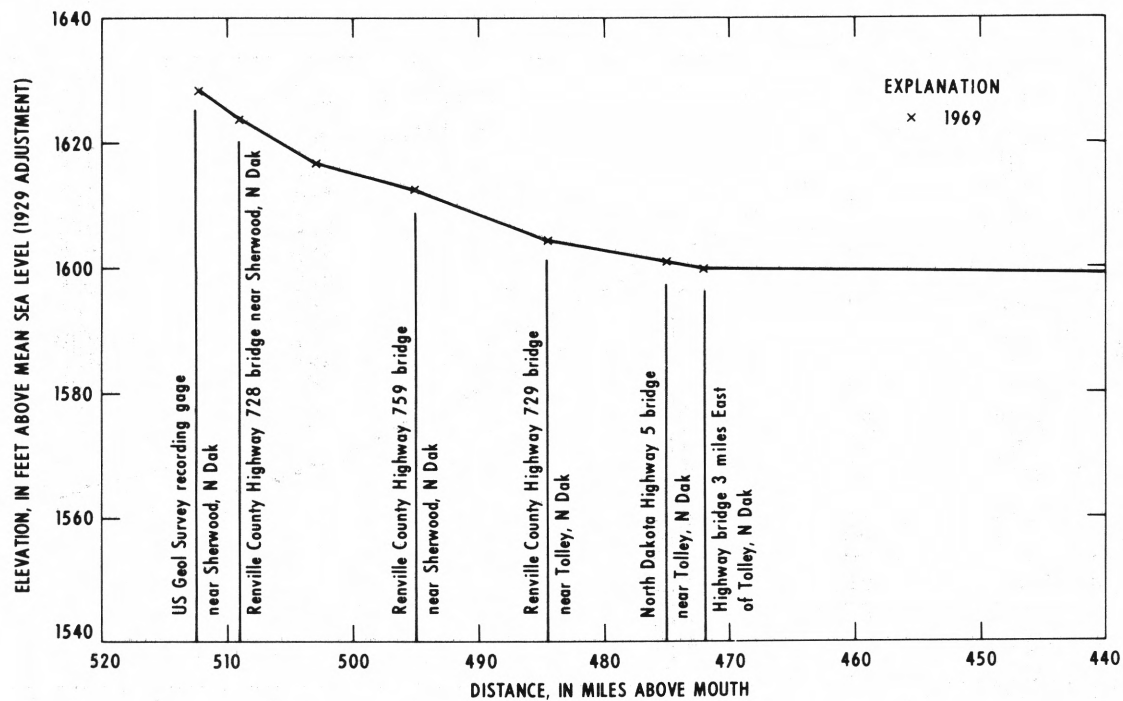


Figure 17.--Flood-crest profiles, Souris River, mile 512 to 360.

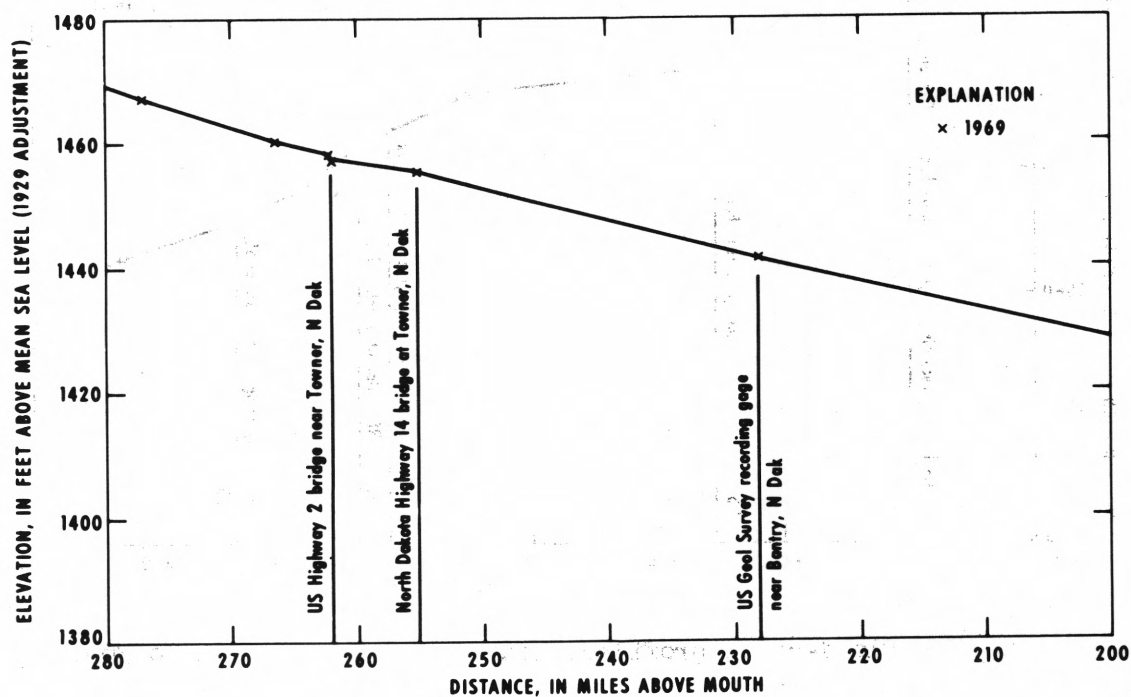
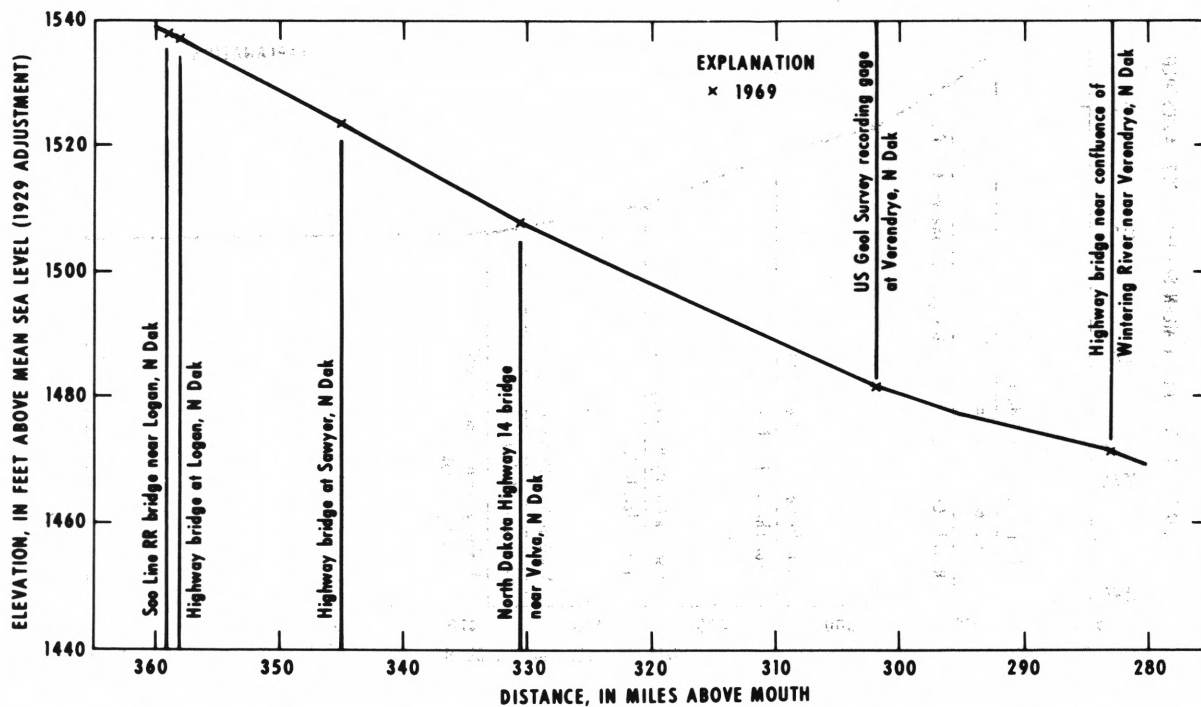


Figure 18.--Flood-crest profiles, Souris River, mile 360 to 200.

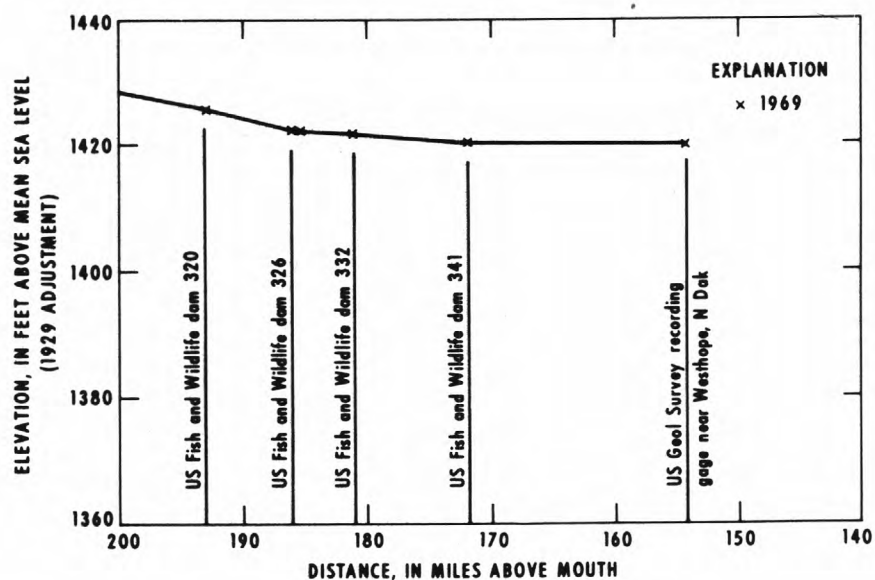


Figure 19.--Flood-crest profiles, Souris River, mile 200 to 154.

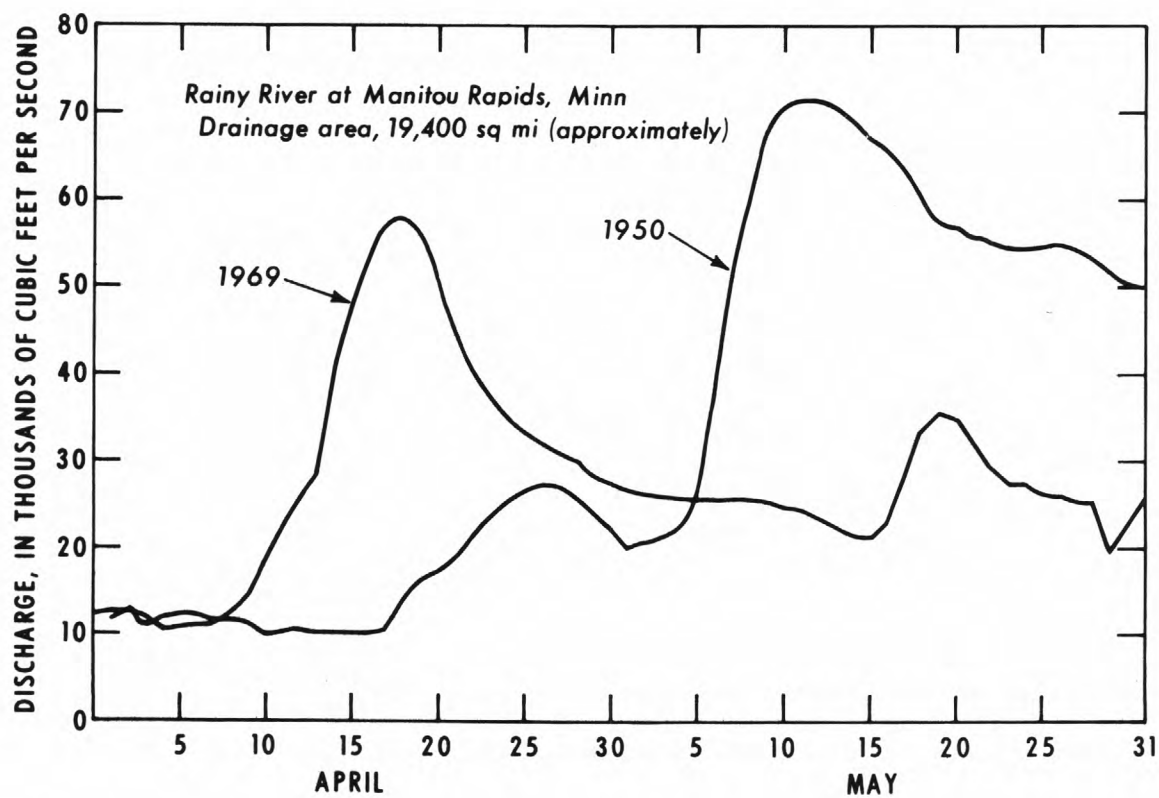


Figure 20.--Comparative discharge hydrographs for Rainy River at Manitou Rapids, Minn.

Sturgeon River near Chisholm, Minnesota, was 2,200 cfs, the third highest in 37 years of record. This was a flood of 25-year recurrence interval. Peak discharge in the Little Fork River was also the third highest of record, and the Big Fork River peak discharge was the second highest. The length of stream-gaging records on these streams is 49 and 43 years, respectively. Farther to the west in the basin, the relative magnitude of flood flows decreased and only a 3-year flood occurred in the Rapid River near Baudette, Minnesota.

The population density in the Lake of the Woods basin is low, there are few roads, and agricultural activity is confined to a small portion of the area, so damage was light.

Mississippi River Basin Headwaters to St. Paul, Minnesota
(exclusive of Minnesota River basin)

Water content of snow on the ground at the end of March in the headwaters of the Mississippi River varied from 5 to 7 inches (fig. 3) so the potential existed for heavy runoff. In this area, however, there is much natural storage in lakes. The two largest lakes in the area are Leech Lake and Lake Winnibigoshish which with Sandy, Pokegama, Pine, and Gull Lakes are controlled by the Corps of Engineers to augment flow in the Mississippi River for navigation at Minneapolis and downstream. These natural reservoirs also have a local flood-control capability, but they are too far upstream, and the limits of operation are too narrow for them to be effective flood-control reservoirs for areas as far downstream as the Twin Cities. In the 1969 flood, however, they were used effectively to reduce flood flows at Aitkin, Minnesota, and upstream. The diversion channel at Aitkin, which has been in use since 1955, also helped reduce flood damages. Total damages in Aitkin, exclusive of the flood fight were only about \$8,000, but an additional \$85,000 was spent for the flood fight and cleanup. Highway damages in Aitkin County were considerable amounting to \$486,900.

Peak discharge in the Mississippi River below Sandy River near Libby, the most upstream gaging station in the Mississippi River basin in this report, was 9,080 cfs, an 8-year flood. The gaging station near Libby has been operated for 39 years and the 1969 flood was the second highest of record. It was surpassed considerably, however, by the flood of May 1950 when the discharge reached 16,000 cfs. At Aitkin the 1969 peak discharge was 14,400 cfs, an 18-year flood, also the second highest during the 24 years of record at this site. The maximum of record was 20,000 cfs in May 1950.

The Crow Wing River is a major tributary of the Mississippi River in central Minnesota, and drains much of the western part of the Mississippi River basin in that area. It has a drainage area at the mouth of approximately 3,760 square miles. There are many lakes and swampy areas which create a natural regulation of the flow in the upper part of the basin. At the upstream gaging site near Nimrod, Minnesota, 6.3 percent of the drainage area is comprised of lakes. At this site, the peak discharge of 2,200 cfs on April 15 was equivalent to the discharge of a 7-year flood. The maximum discharge in 43 years of record was 2,890 cfs in April 1965. The snowmelt floods of 1943, 1944, 1962, and 1966 also surpassed the 1969 flood and the flood in May 1950 was equal to it at the Nimrod gaging site. Downstream in the basin near the mouth, the effect of the lakes is not so pronounced. The maximum daily discharge, which is not greatly different from the maximum instantaneous discharge, was 16,600 cfs near Pillager, Minnesota, 3.6 miles above the mouth. Records furnished by Minnesota Power and Light Company are available at this site for 45 years. Only the flood of April 1965 (18,300 cfs) surpassed the 1969 maximum discharge.

At the Blanchard Power Plant near Royalton, Minnesota, the maximum daily discharge of the Mississippi River was 32,400 cfs, a 29-year flood. In 25 years of record, this discharge was exceeded only by the flood of April 1965 when the maximum daily discharge reached 37,700 cfs.

St. Cloud, Minnesota, is about 30 river miles downstream from the Blanchard Power Plant. Here miscellaneous measurements showed the peak discharge to be 42,900 cfs but comparative discharge data for other floods are not available. Stages at the Northern States Power Plant in St. Cloud were about 2.4 feet higher in 1965, and there is no doubt that the 1965 flood discharge exceeded that of 1969.

At St. Cloud and for some distance downstream in the Mississippi River basin, flooding became increasingly intense. The Sauk River, which is gaged 5 miles above the mouth, joins the Mississippi River at St. Cloud. It was the first of the Mississippi River tributaries downstream from the headwaters to exceed the 50-year flood. The peak discharge of 5,300 cfs was 1.06 times the 50-year flood, and was the fourth highest flood in 44 years of record. Flooding in this area in 1965 was very intense and the peak discharge on that occasion was 9,100 cfs. Other floods surpassing the 1969 flood occurred in April of 1951 and 1952 when the discharges were 5,580 and 5,410 cfs, respectively.

The next major tributary of the Mississippi River downstream from the Sauk River is the Elk River which enters from the left bank at the town of Elk River, Minnesota, and drains an area northwest of there. The drainage basin of the Elk River is primarily in a sandy outwash area and there are a number of lakes and swamps in its headwaters. As a consequence, highly damaging floods have never occurred in this basin. In the 1969 flood, however, highway damages in Sherburne County, in the lower part of the basin, were estimated at \$140,000. The peak discharge of 5,980 cfs at the gaging station near Big Lake, Minnesota, was 1.19 times the 50-year flood, the second highest in 44 years of record. It was exceeded by the flood of April 1965 when all the basins in this area of the State experienced their maximum floods.

At Elk River, maximum discharge in the main stem was 48,100 cfs, a 40-year flood. It is interesting to note that although the tributaries of the main stem exceeded the 50-year flood for some distance above Elk River, the main stem itself had not yet reached the magnitude of a 50-year flood.



Figure 21.--Mississippi River at Elk River, Minn., April 10, 1969.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

The Mississippi River at Elk River is in the shape of a horseshoe which is readily apparent in figure 21. In the 1965 flood the inexorable force of the rushing waters caused the river to cut across the base of the horseshoe and form a channel carrying several thousand second feet of water. All the houses in the path of this errant torrent were thoroughly demolished. Happily this situation was not repeated in 1969, although there was residential damage amounting to about \$24,000 and public damage of \$1,700. The Corps of Engineers emergency works at Elk River was estimated to have saved \$674,400 in damages.

Very intense flooding occurred in the Crow River basin which has a fairly large drainage area of about 2,760 square miles at the mouth. Throughout most of this basin also, the second highest known flood occurred, but it was far from the magnitude of the tremendous flood of April 1965. At Rockford, Minnesota, near the mouth, the peak discharge was 15,100 cfs as compared to 22,400 cfs in 1965. Nevertheless, the 1969 flood was 1.16 times the 50-year flood and exceeded all other floods in 48 years of record, excepting the 1965 flood. Upstream in the basin flood intensity was even more pronounced. On the South Fork at both Hutchinson and Mayer, the peak discharge was 1.5 times the 50-year flood. At Mayer, Minnesota, discharge records have been obtained for 35 years. At this site the 1969 peak discharge of 9,770 cfs was the third highest of record being exceeded by 16,100 cfs in April 1965 and 11,000 cfs in April 1952.

A tremendous effort was made in the flood fight in the Crow River basin primarily in the towns of Hutchinson and Delano, Minnesota, where the Corps of Engineers emergency works prevented damages of \$2.5 million and \$366,000, respectively. An additional \$100,000 in damages was prevented by local interests in the town of Delano. Actual damages sustained were \$58,700 in Hutchinson and \$247,100 in Delano. In Rockford about \$140,000 in damages occurred, of which \$112,000 was expended on the flood fight. Total agricultural damages were \$560,000 and there were considerable damages to roads and highways. Highway damages in Wright County where Delano is located amounted to \$105,000.

The Rum River rises in Mille Lacs Lake and flows in a generally southerly direction until it joins the Mississippi River at Anoka, Minnesota. The upper part of the basin is in a flat marshy area but most of the basin is devoted to agriculture. The Rum River drainage area at the mouth is approximately 1,550 square miles, and it is gaged near St. Francis where the drainage area is approximately 1,360 square miles. In this basin the flood was practically the same magnitude as the 1965 flood. The peak discharge of 10,100 cfs on April 13 at the St. Francis gaging station was exactly the same as

that which occurred in 1965, but the 1965 peak was one week later in the month. This identical discharge in the two different floods is the maximum in 40 years of record. In the upper part of the basin, the 1965 flood was slightly higher than in 1969. At West Point, Minnesota, the peak discharge in 1965 was 10,800 cfs compared to 8,900 cfs in 1969, and at Isanti, Minnesota, the comparative figures were 9,400 cfs in 1965 and 9,100 cfs in 1969. These figures point out that in 1965 there was an attenuation of discharge which did not occur in 1969. The Rum River was characteristic of all the Mississippi River tributaries from St. Cloud to the Twin Cities in that it exceeded the magnitude of a 50-year flood.

The combined influence of these tributaries plus the significant flood in the main stem above St. Cloud caused the Mississippi River itself to exceed the 50-year flood downstream from Anoka. At the gaging station 6 1/2 miles downstream from Anoka, a discharge of 72,500 cfs, 1.14 times the 50-year flood, occurred on April 14. This was the third highest flood in 38 years of record, being exceeded by a flood of 91,000 cfs in April 1965 and 75,900 cfs in April 1952. Coincidentally, the maximum discharge in 1952 and 1969 occurred on the same day of the month, April 14.

The Anoka gaging station is not far upstream from the Twin Cities and the Mississippi River continues on into Minneapolis without the addition of flow from any significant tributaries. The suburb of Fridley is located on the left bank of the river on the north side of Minneapolis, and damages of about \$172,000 were sustained here, of which about \$80,000 was expended for the flood fight and cleanup.

Minneapolis is fortunate in that there is little low-lying area along the river's banks, and as a consequence, the city has never suffered severe flood losses. Total damages during the 1969 flood in this city of about 500,000 population was \$165,000. The river, however, made a spectacular sight as it roared over historic St. Anthony Falls (fig. 22). The upper St. Anthony Falls Lock and Dam is also shown in the photograph.

For about 4 miles throughout its 24-mile course within the Twin Cities, the Mississippi River forms the boundary between Minneapolis and St. Paul. All this reach of the river lies above the mouth of the Minnesota River, and no significant flood damages occurred in this area. Downstream from the Minnesota River, however, a different set of circumstances prevailed, and as a result, St. Paul and its suburbs were not so fortunate as their neighbors to the west. The greater losses in St. Paul and its suburbs can be attributed in part



Figure 22.--Mississippi River at St. Anthony Falls, Minneapolis, Minn. Photograph by Minneapolis Tribune.

to the fact that there is more low-lying ground which has been developed, and in part to the fact that the Minnesota River itself experienced the greatest known flood in its upper reaches and the second greatest in its lower reaches. Because of the large drainage area of the Minnesota River basin and the tremendous flood that occurred in the basin, it is discussed separately in the next section of this report.

Maximum discharge at the mouth of the Minnesota River and in the Mississippi River above the mouth of the Minnesota River, occurred on April 14. This is the first time during the period of concurrent records (35 years) when the maximum discharges of significant snowmelt floods occurred on the same day. During the five highest previous snowmelt floods, the Minnesota River has crested first 3 times and the Mississippi River has been first 2 times. In 1965 the crest of the Minnesota River at the mouth was on April 11, and on the Mississippi River at Anoka it was 6 days later on April 17. The combination of these circumstances in 1965 caused the Mississippi River at St. Paul, downstream from the Minnesota River, to crest April 16. In 1969, the crest at St. Paul was on April 15, the day following the crests of the two rivers above the mouth of the Minnesota River. This unfortunate timing of peaks in 1969 had a considerable effect in intensifying the flood situation at St. Paul and downstream. Had a similar situation occurred in 1965 the maximum discharge at St. Paul would have been about 200,000 cfs instead of 171,000 cfs. If the flood walls had been able to contain the flow to the same areas of overflow at that time, the maximum stage would have been about 2 1/2 feet higher than the 26.01 feet which was experienced. These figures point out dramatically the significance of the timing of peaks in the Minnesota and Mississippi Rivers in the Twin City area. Figure 23 shows the hydrographs for the two highest floods of record at the most significant gaging stations in the Twin Cities area and indicates the timing of the flood peaks.

The discharge of the Mississippi River at St. Paul was the second highest since at least 1851, being surpassed only by the flood of April 1965. The maximum discharge of 156,000 cfs, which occurred on April 15, was 1.54 times the 50-year flood. Maximum stage was 24.52 feet; almost exactly 1 1/2 feet lower than the 1965 flood. The Minnesota River, which enters the Mississippi River at Fort Snelling at the southwestern corner of St. Paul, provided 54 percent of the flow at St. Paul and the remainder came from the Mississippi River basin above the mouth of the Minnesota River. The drainage area of the Minnesota River basin, however, comprises only 45 percent of the total at St. Paul.

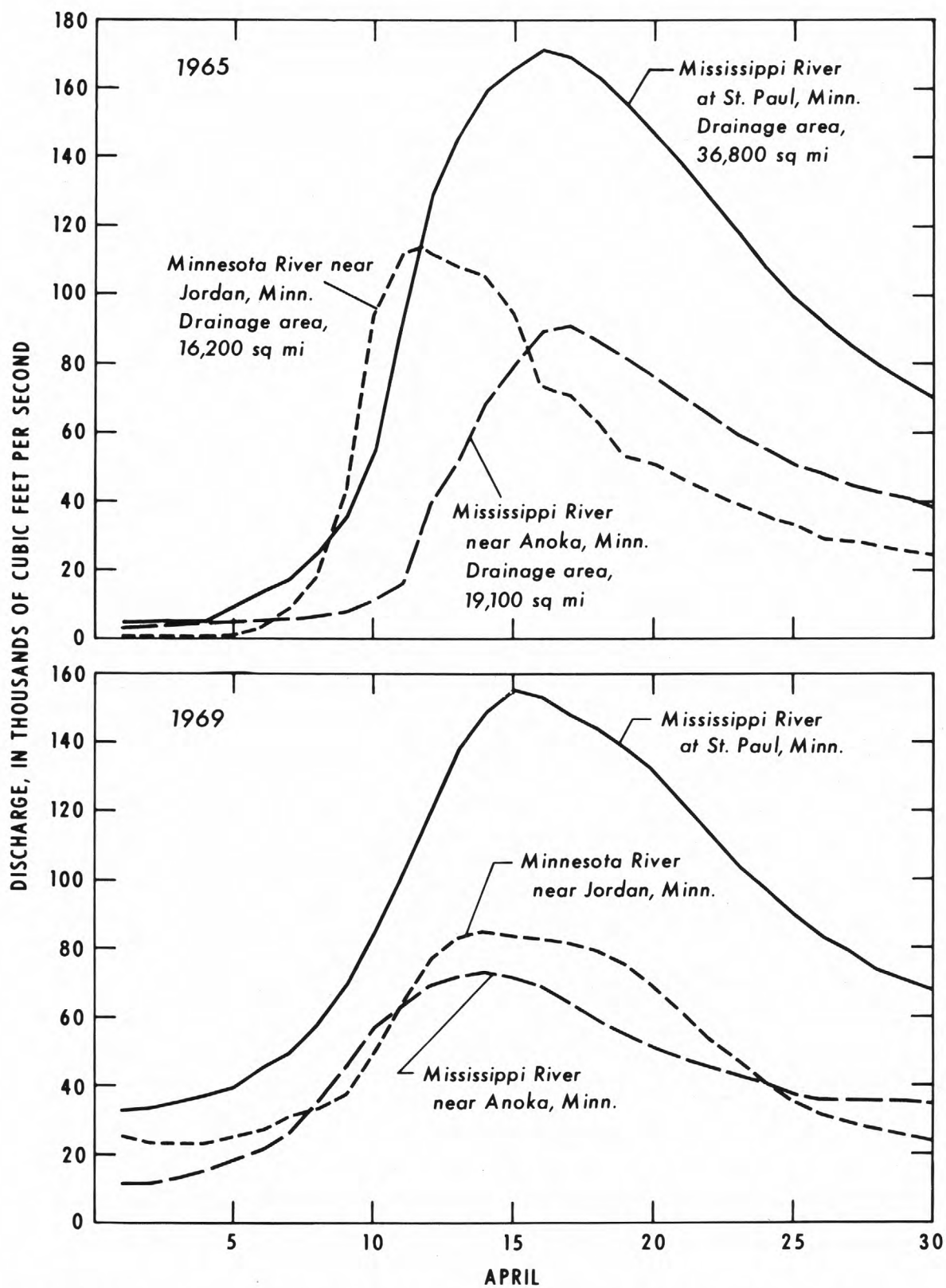


Figure 23.--Comparative discharge hydrographs of two highest floods of record in Twin City area showing timing of flood peaks.

Although the gaging station at St. Paul was inaccessible for about a week, it operated continuously throughout the flood and provided an accurate stage record. The photograph on the cover shows the gaging station on April 15 at the height of the flood.

Diking operations performed under Operation Foresight were very successful in St. Paul, yet some of the areas outside of the dikes were inundated. Warner Road and Shepard Road, on the left bank of the river, were covered by more than 4 feet of water (fig. 24). Discharge measurements and sediment samples were obtained from Lafayette Bridge, shown in the background. Figure 25 also shows Lafayette Bridge, flooding on Kellogg Boulevard, and some of the inundated area which was unprotected by dikes. The St. Paul downtown airport, on the right bank downstream from Lafayette Bridge, was covered by water about 5 feet deep. Harriet Island and Navy Island were inundated. Water was 6 feet deep in some of the mail-handling rooms adjoining the St. Paul Post Office, but in the main building itself, water was kept out of the basement area by pumping. The American Express Company, located on Kellogg Boulevard, was forced to cease its operations because of the flood waters.

The St. Paul Union Depot was shut down and trains of the Great Northern Railway and the Milwaukee Road, which ordinarily originated in St. Paul, were shifted to Minneapolis. The Burlington Railroad discontinued service on April 14 because much of its right-of-way, which is located along the river from Prescott, Wisconsin, to Savanna, Illinois, was under water. The Chicago and Northwestern Railway was able to continue operating its line from St. Paul to Chicago. A number of highways were closed including the southbound lane of U.S. Highway 61 at Battle Creek Park in St. Paul.

The residents of low-lying Lilydale, on the right bank of the river across from St. Paul, are accustomed to flooding. They accepted the high water with aplomb and either moved their mobile homes or evacuated permanent type buildings. Flood losses in Lilydale from all causes amounted to about \$157,000.

High water forced the Twin City Sanitary District sewage treatment plant at Pigs Eye Island to cease its operations on April 9, but the problem of pollution of Mississippi River waters was not considered a serious threat because of the great volume of water in the river.



Figure 24.--Flooding of Warner Road and Shepard Road, St. Paul, Minn. Photograph by St. Paul Pioneer Press.



Figure 25.--Flooding of Kellogg Boulevard and surrounding area, St. Paul, Minn.
Photograph by St. Paul Pioneer Press.

Total damages in St. Paul were \$1.8 million, which includes the cost of the flood fight and economic losses in wages and profits. This was the greatest amount suffered by any city along the Mississippi River.

Minnesota River Basin

The Minnesota River rises in Big Stone Lake, a long, narrow body of water lying on the boundary between northern South Dakota and central Minnesota. The lake is about 26 miles long and about 1 mile to 1 1/2 miles in width. There is a low divide between it and the Red River basin to the north. During the glacial epoch the present-day Red River and Minnesota River valleys provided drainage for Glacial Lake Agassiz, a huge body of water about 110,000 square miles in area which occupied what is now the Red River basin in Minnesota and North Dakota and parts of Ontario and Manitoba, Canada. When the glacial ice blocked the northern drainage of this lake a tremendous volume of water passed down the present Minnesota River valley. As a result, the valley is characterized by wide flood plains which have been developed for agriculture and agricultural communities. The Minnesota River passes through a rich agricultural area, and the valley bottom lands, sometimes a mile or two in width, are very productive. The low, wide, flood plains and the flat slope of the basin, however, make it especially susceptible to flooding.

From its source the Minnesota River proceeds in a southeasterly direction for about 225 miles to Mankato, where it turns abruptly to the northwest and flows another 106 miles to its mouth at Ft. Snelling. It drains an area exceeding 16,000 square miles and is by far the largest tributary of the Mississippi River in Minnesota.

The water content of snow on the ground at the end of March in the headwaters of the Minnesota River basin was about 6 inches (fig. 3), and as much as 1.5 inches of rain fell in the upper part of the basin during the period April 7-10 (fig. 5) just as the snowmelt runoff was nearing its peak. Conditions were such that severe flooding was inevitable. In the upper two-thirds of the basin upstream from Judson, Minnesota, with the exception of the discharge near the outlet of Big Stone Lake, the severity of the flood in the Minnesota River was greater than any that was previously known. With the exception of the Redwood River, the maximum discharges in all the tributaries from Big Stone Lake to Judson exceeded any previously known maximum discharges. Downstream from Judson, the maximum discharge in the Minnesota River was the second

highest in many years of record, but some of the maximum discharges of the tributaries in this area were not so outstanding.

The Little Minnesota River is in the extreme headwaters of the basin and flows directly into the upper end of Big Stone Lake. In this relatively small basin, which drains almost 500 square miles of the eastern slopes of the Dakota foothills (Coteau des Prairies), the flood was not exceptionally severe. At the gaging station near Peever, South Dakota, 8 miles upstream from Big Stone Lake, the flood was the third highest in 30 years of record. The discharge of 3,270 cfs, an 8-year flood, was exceeded by 4,730 cfs in April 1952, and 4,320 cfs in March 1943.

The Whetstone River joins the Minnesota River just below the outlet of Big Stone Lake. It drains an area of almost 400 square miles, mostly in South Dakota. The Whetstone River carried a large amount of ice and debris which caused severe problems at the bridges over the Minnesota River at the outlet of Big Stone Lake. Tons of debris plugged the outlet of the lake and prevented outflow necessitating a drag-line operation to open the channel (fig. 26). Total damages in Ortonville were almost \$50,000. Maximum discharge in the Whetstone River near Big Stone City, South Dakota, was 6,870 cfs, a 35-year flood, and the maximum gage height was 14.32 feet. The previous maximum known discharge was 5,780 cfs in April 1952, but evidently a more severe flood occurred in June 1919 when the stage reached about 26 feet. The discharge of this 1919 flood is not known, but comparative data are available for the Minnesota River at Montevideo, Minnesota, for the 1919 flood and other historical floods which have occurred in the last 60 years at that site.

The Yellow Bank River enters the Minnesota River from the right bank near Odessa, Minnesota. Its peak discharge of 6,970 cfs was a 22-year flood and exceeded the previous maximum of 6,260 cfs which also occurred in April 1952. Agricultural damages in the basin during the 1969 flood were \$515,000.

The 1952 flood was of high magnitude and most of the previously known maximum discharges in the upper Minnesota River tributaries and main stem occurred during the snow-melt flood of that year.

Downstream from the Yellow Bank River the 1969 flood grew more severe. Maximum discharges in all the tributaries and in the main stem exceeded the 50-year flood all the way to the mouth of the Minnesota River.



Figure 26.--Flood-borne debris at outlet of Big Stone Lake, Ortonville, Minn. Photograph by Ortonville Independent.

The Pomme de Terre River flows into the Minnesota River at the lower end of Marsh Lake Reservoir about 2 miles upstream from the upper end of Lac qui Parle Reservoir. There are dams at the outlets of Marsh Lake and Lac qui Parle Reservoirs. There is also a dam and diversion channel on the Chippewa River near Watson, Minnesota, which diverts flood waters of the Chippewa River into Lac qui Parle Reservoir. Marsh Lake Reservoir and Lac qui Parle Reservoir have a limited flood-control capacity. The Corps of Engineers estimated that during the 1969 flood they prevented damages of \$60,800.

The peak discharge of the Pomme de Terre River at Appleton, Minnesota, was 5,520 cfs as compared to the previous maximum of 5,050 cfs in April 1952. The 1969 flood peak was 1.21 times the 50-year flood, and was the maximum in 38 years of record. Agricultural losses in the basin amounted to \$733,000, and damages in the town of Appleton were about \$28,000.

In the Lac qui Parle River, the peak discharge of 17,100 cfs near Lac qui Parle, Minnesota, was 1.86 times the 50-year flood, far exceeding the previous maximum of 11,100 cfs in 1952. Agricultural damages in this basin were estimated at \$3,180,000, greater than in any of the other basins of Minnesota River tributaries. Damages to highways also were severe. They were estimated at \$838,800 in Lac qui Parle County and \$617,700 in Yellow Medicine County. These two counties include most of the drainage basin of the Lac qui Parle River. Many farmers found themselves marooned for considerable periods of time because of washed-out bridges and water running over secondary roads.

The Minnesota River is gaged just below Lac qui Parle dam. Here the peak discharge was 29,400 cfs as compared to 19,700 cfs, the previous maximum, which occurred in 1952. The 1969 flood was the highest in 27 years of record at this site.

The Chippewa River drains an area north of Montevideo, Minnesota, which exceeds 2,000 square miles. The basin includes most of Swift and Pope Counties, and parts of Chippewa, Kandiyohi, Douglas, and Otter Tail Counties. There was considerable highway damage in this area, especially in the lower part of the basin. In Chippewa County alone highway damages exceeded \$533,000. Agricultural damages in the basin were \$1,518,000. The maximum discharge in the Chippewa River at Milan where records have been collected for 32 years was 11,400 cfs, 1.16 times a 50-year flood and considerably more than the previous maximum of 6,930 cfs which occurred in 1952.

The gaging station on the Minnesota River at Montevideo is about 400 feet downstream from the mouth of the Chippewa River. Discharge records have been collected at this site continuously since 1909 with the exception of about 12 years when no winter records were collected. The 1969 peak discharge at Montevideo was 35,100 cfs, 1.63 times the 50-year flood. The previous highest discharge during the 60 years of record was 24,500 cfs on April 10, 1952. The third highest peak (22,000 cfs) occurred in June 1919, and the peaks that followed in descending order were of much smaller magnitude, less than 13,000 cfs. Flood damages sustained in the town of Montevideo were almost \$397,000, of which about \$160,000 were expended on the flood fight and cleanup. Figure 27 shows some of the flooding in the western part of Montevideo, caused by water from the Minnesota River backing up into the Chippewa River channel.



Figure 27.--Flooding of Minnesota River at Montevideo, Minn., April 14, 1969.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

Flood damages in Granite Falls, Minnesota, 19 river miles downstream from Montevideo were greater than at Montevideo. Total urban damage was almost \$706,000, of which \$245,000 was expended in the flood fight and cleanup. Figure 28 shows some of the flooding which occurred in Granite Falls. Miscellaneous discharge measurements at Granite Falls established the peak discharge at 43,400 cfs. Maximum discharge data are not available for previous floods at Granite Falls, but based on the discharge at Montevideo, it is almost certain that the discharge of the 1969 flood at Granite Falls surpassed any flood in at least the last 60 years.

The Yellow Medicine River joins the Minnesota River about 10 river miles downstream from Granite Falls. Its drainage basin lies largely within Lincoln, Lyon, and Yellow Medicine Counties. Damages to highways and secondary roads in these counties were \$265,600, \$816,000, and \$617,700, respectively.

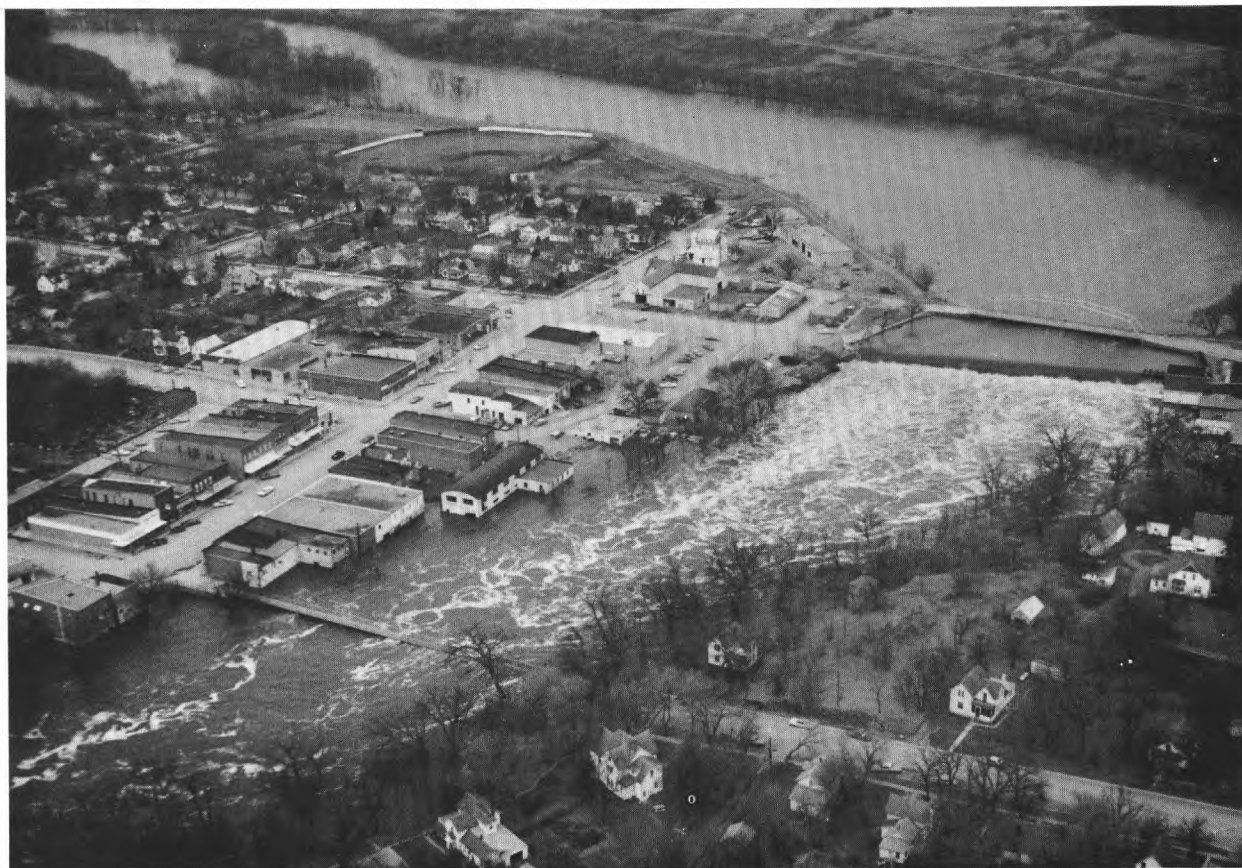


Figure 28.--Flooding of Minnesota River at Granite Falls, Minn., April 14, 1969.
 Photograph by U.S. Army Corps of Engineers, St. Paul district.

Highway damages in Lyon and Yellow Medicine Counties were the second and third highest of all the counties in Minnesota, being exceeded only by those which occurred in Lac qui Parle County. Hundreds of bridges and culverts were washed out and the rural transportation system practically ceased to function. Agricultural damages in the Yellow Medicine River basin were \$2,100,000, the third highest of the Minnesota River tributaries, being exceeded only by the Lac qui Parle and Cottonwood River basins. At the gaging station on the Yellow Medicine River near Granite Falls, 6 miles upstream from the mouth, the maximum discharge was 17,200 cfs, 1.07 times the 50-year flood and by far the greatest in 37 years of record. The maximum gage height was 14.90 feet which was exceeded by the flood of June 1919 when the stage reached approximately 17.5 feet. Little is known about the 1919 flood in the upper Minnesota River basin, but there is reason to suspect that at least in some of the Minnesota River tributaries, discharges were even greater than those experienced in 1969.

The Redwood River joins the Minnesota River from the right bank near North Redwood, Minnesota. It drains an area of 739 square miles which lies generally south of the Yellow Medicine River basin. The Redwood River flows through an agricultural area which has two different physiographic characteristics. Upstream from Marshall, Minnesota, the basin is part of an upland plain, the Coteau des Prairies, whereas downstream from Marshall the basin lies in a lowland plain. The slope between the two plains is relatively steep. The fall between Russell, Minnesota, and Marshall, 15 miles downstream, is about 350 feet.

In June 1957, heavy, prolonged rainfall was centered in the Redwood River basin and some of the adjoining basins on each side of the Minnesota River. This rainfall was sufficient to create the maximum discharge in 44 years of record at the downstream gaging station near Redwood Falls, Minnesota, where the drainage area is 697 square miles. The 1957 peak discharge was 19,700 cfs as compared to 14,100 cfs on April 9, 1969, the second highest of record. The third highest was considerably less, 7,660 cfs on March 31, 1960. The 1969 flood had a recurrence interval of 42 years. The Redwood River in its lower reaches was one of the few Minnesota River tributaries where the recurrence interval was less than 50 years. Based on recurrence intervals, the flood in the upper part of the basin was more severe. At Marshall where the drainage area is 307 square miles, the 1969 peak discharge was 5,450 cfs, the maximum of record, and 1.01 times the discharge of a flood having a 50-year recurrence interval. At Marshall, the June 1957 peak discharge was 5,370 cfs, only slightly less than that of the 1969 flood and the second highest of record.

Flood damages at Marshall were about \$203,000, of which about \$123,000 was for the flood fight and cleanup. Both ends of a bridge at Garvin Park in Marshall were washed out. The Corps of Engineers estimates that their flood protection project in this city prevented about \$4.5 million damages. The main part of the project is a 2 1/2-mile diversion channel which passes around the northwest side of Marshall and rejoins the river downstream from the town. The river channel through town has also been cleared and straightened, and an earth levee half a mile long has been built on the southwest side of town. When the maximum combined flow in the two channels occurred, 4,440 cfs passed down the diversion channel, and only 1,010 cfs flowed in the river channel through town. A break in the dikes on the southwest side of town caused some water to flow into Lake Marshall and the Cottonwood River basin. This trans-basin flow, however, was not considered significant in its effect on flood peaks in the Cottonwood River basin. At Redwood Falls only about \$9,000

damage occurred, but at North Redwood damages were much more severe, amounting to about \$141,000. Agricultural damages in the Redwood River basin were \$870,000 and highway damages in Redwood County, which includes the lower part of the basin, were about \$230,000.

The Cottonwood River basin drains an area south and east of the Redwood River basin and is considerably larger in size. The drainage area at the mouth is about 1,300 square miles. This basin also is a very productive agricultural area and, like the Redwood River basin, is characterized by an upland plain in the upper basin and a lowland plain in the lower basin.

Miscellaneous measurements were made near Lamberton, Minnesota, and at Springfield, Minnesota. Maximum discharge near Lamberton was 8,720 cfs, and at Springfield it was 20,500 cfs. About 60 families moved out of their homes in Springfield on April 9, and water flowed over Brown County Highway 2 southwest of Springfield. Flooding at Springfield is shown in figure 29. There are no historic data with which to compare the peaks at Lamberton and Springfield, but it is probable that they are highest in at least the last 40 years. Miscellaneous measurements also were made on the Little Cottonwood River, a separate basin located just to the south of the Cottonwood River. Peak discharge in this basin at Searles, Minnesota, near the mouth was 2,310 cfs.

Forty-two years of discharge records have been obtained for the Cottonwood River at New Ulm, Minnesota, 2 miles upstream from the mouth. The 1969 flood at this site was of exceptionally high magnitude, 2.45 times the 50-year flood, which is one of the highest ratios to the 50-year flood tabulated in this report. The peak discharge of 28,700 cfs was the maximum of record, exceeding the previous maximum of 26,000 cfs which occurred in April 1965. The 1965 peak stage of 20.86 feet, the maximum of record, was about 1.7 feet higher than the stage of the 1969 flood, however, because of considerable backwater from ice during the 1965 flood.

Flandrau Dam, which is located on the outskirts of New Ulm, was constructed in 1936 to provide a small lake for Flandrau State Park. In 1947 it washed out and was rebuilt. The flood of 1965 destroyed it a second time, and it was rebuilt to include a 45-foot wide inflatable rubber dam section which would supplement a 22-foot wide tainter gate. Before the 1969 flood the rubber dam section was removed and the gates were opened to the maximum, but once again the dam was severely damaged and the right bank washed out. Figure 30 and 31 show the dam before and after the washout.



Figure 29.--Flooding of Cottonwood River at Springfield, Minn., April 6, 1969.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

Agricultural damages in the Cottonwood River basin were over \$2.5 million and highway damages in Brown and Cottonwood Counties, which include much of the basin, were \$166,000. Some of the basin also lies in Lyon and Redwood Counties for which highway damage figures have been mentioned previously.

The Watonwan River is ungaged, but a gaging station had been operated near Garden City, Minnesota, 7.3 miles upstream from the mouth, during the period 1940-45. Miscellaneous measurements made in 1969 established the maximum discharge at this site to be 11,800 cfs as compared to 19,000 cfs in April 1965, and 17,700 cfs in June 1953. The 1965 stage was 24.11 feet as compared to 20.07 feet in 1969. An earlier report lists a stage lower than 24.11 feet for the 1965 flood, but this discrepancy occurred because of a change in datum and a tie of the gage to mean sea level after the 1965 flood.



Figure 30.--Flandrau Dam at New Ulm, Minn., April 6, 1969. Photograph by U.S. Army Corps of Engineers, St. Paul district.

The Blue Earth River joins the Minnesota River at Le Hillier, Minnesota, near the southwest outskirts of Mankato, Minnesota. Flooding in the Blue Earth River basin was much less severe than that which occurred in 1965 even though recurrence intervals of the discharge at the two principal gaging stations in the basin exceeded 50 years. In the 1965 flood, the peak discharge of 43,100 cfs at the gaging site near Rapidan, Minnesota, was more than twice the peak discharge of 21,100 cfs which occurred in 1969. On the Le Sueur River, a tributary of the Blue Earth River, the peak discharge at a gaging site near Rapidan, 2.5 miles upstream from the mouth, was 24,700 cfs in 1965 and 10,900 cfs in 1969. The 1969 peak discharges were also exceeded by the floods of May 1960 and April 1951 at the Le Sueur River site and by the flood of April 1951 at the Blue Earth River site.



Figure 31.--Flandrau Dam at New Ulm, Minn., April 11, 1969. Photograph by Minneapolis Star.

Total urban damages in the town of Blue Earth were about \$82,000. Agricultural damages were \$481,000 in the Blue Earth River basin and \$197,000 in the Le Sueur River basin. Highway damages in Blue Earth, Watonwan, and Faribault Counties, which include most of the drainage area of the Blue Earth River, totalled about \$336,000.

Discharge records have been obtained only since November 1967 at the gaging station on the Minnesota River at New Ulm. The gaging site is about 6 river miles upstream from the mouth of the Cottonwood River, but because of the meandering of the river it is only about 4 air miles upstream. High stages on the Cottonwood River can create considerable backwater at this station (almost 5 feet in April 1969). Peak discharge on April 15, 1969 at New Ulm was 58,000 cfs, and the stage was 30.65 feet. In the 1965 flood the peak stage was 28.00 feet, and historical data indicate that in April 1881, the peak stage was 29.17 feet. Other outstanding floods occurred in 1951 and 1952, but peak stages were less than in 1965. Comparative data available from the long-term records for the gaging stations at Mankato and Montevideo, Minnesota, suggest that the 1969 peak stage at New Ulm was the highest since at least 1881. Much of New Ulm is on high ground so the main part of the city was not seriously affected by the flood. Total urban damages were about \$123,000 of which about \$14,000 was expended for the flood fight and cleanup.

A gaging station was operated on the Minnesota River at Judson, Minnesota, during the period 1938-50. Miscellaneous measurements made during the 1969 flood established the maximum discharge at 64,000 cfs as compared to 58,000 cfs in April 1965. The 1969 peak discharge was 1.68 times a 50-year flood and the maximum since 1938. Discharge of the 1881 flood is not known but the stage was 1.9 feet higher than in 1969.

Data pertaining to flood peaks are available for the Minnesota River at Mankato since 1881, although the collection of continuous discharge data started in 1903. The 1969 peak discharge of 76,700 cfs is 1.24 times the 50-year flood, and in 88 years of record, was exceeded only by the peak discharges of 94,100 cfs in April 1965 and 90,000 cfs in April 1881. Peak stage in the 1969 flood was 27.07 feet which was exceeded by a stage of 29.9 feet in 1881 and 29.09 feet in 1965. The degree of accuracy of the 1881 peak discharge is somewhat less than that which applies to the 1965 and 1969 peak discharges, and based on comparative gage heights there is some reason for believing the 1881 discharge should be somewhat greater. Flood elevations for all three of these outstanding floods are accurate.

In the upper Minnesota River, the maximum discharges of record occurred in the April 1969 flood, and the second highest occurred in April 1952. At Judson and downstream, the maximum floods of record for which discharge hydrographs can be drawn occurred in 1965, and the second highest were in 1969. For the long-term record at Mankato, the second highest peak was in 1881, but no discharge hydrograph can be drawn for this flood period. Figure 32 shows comparative discharge hydrographs for the two highest floods of record for the Minnesota River at Montevideo, in the upper part of the basin, and Minnesota River at Mankato in the lower basin.

In the Mankato area, urban damages were \$105,600 in Le Hillier, \$528,200 in North Mankato, and \$350,500 in Mankato, totalling \$984,300. Emergency protective works constructed in this area were very extensive. Dikes were built or raised in the Mounds Park and Sibley Park area of Mankato, and additional diking was placed on top of the railroad tracks near the Main Street Bridge. In North Mankato a levee 3.6 miles long was built on top of four-lane U.S. Highway 169. The Corps of Engineers estimated that more than \$16.5 million in damages was prevented by the emergency works in this area.

St. Peter, Minnesota, is located about 12 miles by highway downstream from Mankato. Damages owing to the flood were more than a million dollars in St. Peter and more than \$270,000 in East St. Peter. A large part of the flood damage in St. Peter, more than \$980,000, was charged to the construction of highway detours. Emergency dikes built under Operation Foresight encircled East St. Peter. For a time failure of these dikes was imminent, but round-the-clock emergency operations prevented their failure.

Flooding in the Minnesota River basin continued to be severe downstream from St. Peter although there were no major tributaries in this reach to make a significant contribution to the flood discharge. The great volume of water flowing in the channel and over the wide flood plains inundated thousands of acres of agricultural land and rendered many roads and highways unusable.

Le Sueur, Minnesota, is 12 miles by highway downstream from St. Peter. Here urban damages were estimated at more than \$378,000, of which \$334,000 was charged to the cost of traffic detours.

Downstream from St. Peter, 16 miles by highway and 23 miles by river, is Henderson, Minnesota, located in the flood plain on the left bank of the Minnesota River. Flood costs in Henderson were about \$646,000, even though there was not

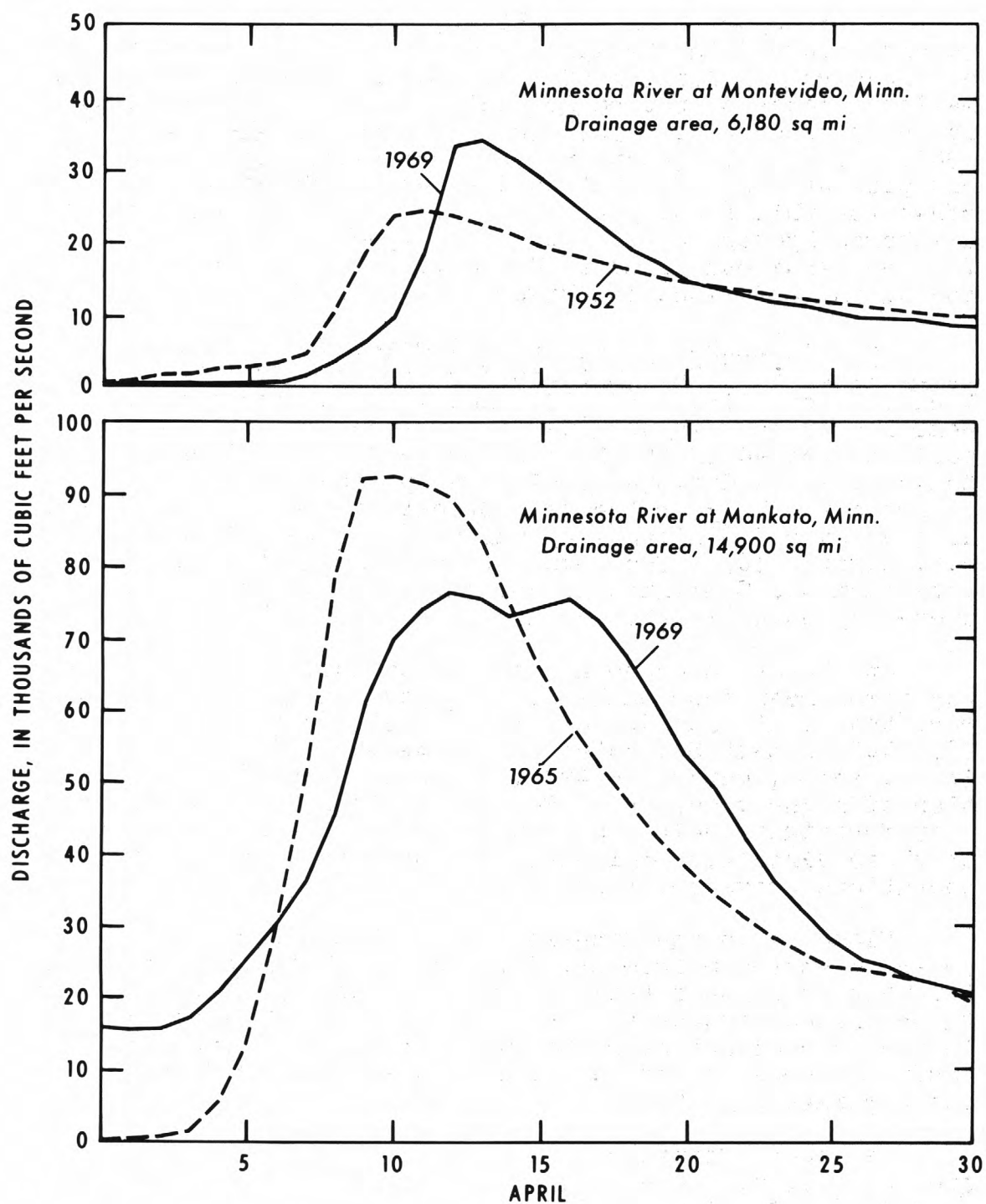


Figure 32.--Comparative discharge hydrographs of two highest floods of record at selected gaging stations on Minnesota River.

a large amount of damage within the town. Traffic detours in the Henderson area cost about \$455,000, and about \$152,000 was spent on the flood fight and cleanup. Figure 33, showing flooded farm buildings near Henderson, is typical of the flooding sustained by many farms located in the valley. Figure 34 shows the flooding of Minnesota Highway 19 where it crosses the Minnesota River valley east of Henderson.



Figure 33.--Flooded farm buildings near Henderson, Minn. Photograph by U.S. Army Corps of Engineers, St. Paul district.

In the downstream towns along the river, urban damage occurred principally in Carver, Chaska, Shakopee, and the Savage industrial area. Mitigation of flood losses in the small town of Carver (population 467) depended largely on evacuation of inhabitants in low-lying areas. Some persons in this town are moving their homes to higher ground. Total flood damages in Carver were estimated at about \$207,000.



Figure 34.--Flooding of Minnesota Highway 19 east of Henderson, Minn.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

Chaska suffered severe flood damages in 1965 when the dikes were overtopped, but it was more fortunate in 1969 as the river, confined by the dikes, flowed by at an elevation 4 to 5 feet above first-floor level of many homes in the town. In spite of the effectiveness of the dikes, about \$104,000 damage occurred to business and residential structures. Total damages were about \$658,000, but more than half of this amount was charged to traffic detours. The town of Chaska voted a \$60,000 bond issue to help raise and improve the dikes protecting the town.

Losses of over \$3 million can be attributed to the closing of highways and the establishment of traffic detours in the Shakopee area. Heavily trafficked U.S. Highway 169, which

crosses the Minnesota River valley north of Shakopee, was closed for some time. There was little damage to businesses and residences in Shakopee, however.

During periods of normal flow, barge traffic extends up the Minnesota River past the town of Savage, Minnesota. An extensive industrial complex which provides facilities for grain and oil industries has been built in this area. When the cost of detours and the losses in wages and profits are considered, these industries lost about \$2.6 million to the flood. By their own efforts they prevented losses of more than \$18 million. The residential area and the small business district in the town of Savage itself was not seriously threatened by the flood, but it was necessary to build dikes along Highway 13 and 101. The deck of the bridge on Normandale Road just north of Savage was under water, and the bridge was closed to traffic (fig. 35). The flood conditions also obviously prevented any barge traffic on either the Minnesota or Mississippi Rivers.



Figure 35.--Flooding of Minnesota River on Normandale Road north of Savage, Minn. Photograph by Dakota County Tribune, Farmington, Minn.

In the 1965 flood, severe traffic congestion occurred in the southern suburbs of Minneapolis and St. Paul because it was necessary to close Interstate Highway 35W which leads south out of Minneapolis. Although the highway bridge crossing the river has plenty of clearance, water ran over the section of highway which crosses the flood plain between the south end of the bridge and Minnesota Highway 13. In the 1969 flood the interstate highway was not closed, but traffic was restricted to one lane in each direction because of the sandbagging necessary to keep the highway open.

Northern States Black Dog Power Plant located 8.7 miles above the mouth of the Minnesota River was completely surrounded by flood waters. It remained in full operation, but power plant employees had to travel by boat to reach the plant.

The most downstream highway crossing the Minnesota River is Minnesota Highway 36 (Cedar Avenue) which crosses the valley over three bridges between Bloomington and Burnsville, 7.4 miles above the mouth. The entire valley, 1 1/4 miles in width, and the westernmost of the bridges on this crossing were under water (fig. 36).

The Chicago and Northwestern Railway, which is located in the river valley in the lower reaches of the basin, was inundated in places and rail traffic ceased.

Agricultural damages in the Minnesota River valley, exclusive of tributaries, amounted to more than \$3.2 million. Agricultural damages for the whole basin exceeded \$15.8 million. Total transportation damages in the basin were \$5.2 million and urban damages were about \$12.4 million. The total damages were \$33.4 million, more than half of the \$60.0 million damage in the entire Mississippi River basin above Guttenberg, Iowa.

The downstream gaging station on the Minnesota River is located 1 1/2 miles northwest of Jordan, Minnesota, and 39.4 miles upstream from the mouth. Records have been collected here or at the equivalent gaging site near Carver for 39 consecutive years. The peak discharge of the flood was 84,600 cfs, 1.34 times a 50-year flood, and the second highest of record. It was exceeded only by the 1965 flood which reached a peak discharge of 117,000 cfs. Owing to the smaller contribution of the tributaries in the lower reaches of the Minnesota River from Mankato downstream, the recurrence interval of the flood in the lower Minnesota River decreased. The greatest intensity of flooding appeared to be in a 168-mile reach between Lac qui Parle Dam and Judson, where peak discharges were all greater than 1.5 times the 50-year flood.



Figure 36.--Flooding of Minnesota River at Cedar Avenue, Bloomington, Minn.
Photograph by Dakota County Tribune, Farmington, Minn.

During April, the month of maximum flooding, about 2.9 million acre-feet ran off from the basin in 1969, and 2.7 million acre-feet in 1965. Even though the 1965 peak discharge was higher, the sustained high flows early in April 1969, caused the runoff for that month to exceed the April 1965 runoff. The runoff at Mankato in April 1965, however, was almost exactly the same as the April 1969 runoff.

Flood-crest elevations have been obtained for the 1969 flood in the Minnesota River (table 4) and flood profiles have been drawn for the 1969 and 1965 floods (fig. 37 and 38).

Table 4.--Flood-crest elevations, Minnesota River
(furnished by Corps of Engineers except as noted)

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
USGS recording gage $\frac{1}{4}$ mile downstream from dam at Ortonville, Minn.	329.5	Apr. 12	968.47
Reference mark on bridge 3 miles southeast of Ortonville, Minn.	324.1		958.0
USGS gage at upstream side highway bridge 0.6 mile southwest of Odessa, Minn.	321.0	Apr. 11	954.61
Reference mark on bridge south of Big Stone County Highway 21, 1 mile upstream from U.S. Highway 75 bridge.	319.0		951.65
Reference mark on U.S. Highway 75 bridge.	317.2		949.5
Reference mark on bridge 1 mile downstream from U.S. Highway 75 bridge.	316.2		947.8
Reference mark on highway bridge on Correl to Louisburg road in sec.5, T.120 N., R.44 W., about 2 miles west of Correll.	309.0		945.87
Marsh Lake dam	303.4		
Headwater gage			945.55
Tailwater gage			944.13
Minn. State Highway 119 bridges 4 miles southwest of Appleton, Minn.	301.3		
North bridge reference mark			943.45
South bridge reference mark			943.31
Minn. State Highway 40 bridge $3\frac{1}{2}$ miles west of Milan, Minn.	295.7		
Upstream reference mark			942.95
Downstream reference mark			942.81

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Outlet of Lac qui Parle Lake at Lac qui Parle dam			
Headwater gage	288.1		942.9
USGS recording gage 200 ft downstream from dam	288.0	Apr. 12	939.74
Reference mark on upstream left side of bridge on Chippewa County Highway 20; between sections 29 and 32, T.118 N., R.42 W., 6 miles northwest of Montevideo, Minn.	284.0		936.24
Reference mark on upstream left side of bridge on Chippewa County Highway 15, Lac qui Parle County Highway 18; in sec.9, T.117 N., R.41 W., 4 miles west of Montevideo, Minn.	279.6		933.94
USGS recording gage on right bank, 100 ft upstream from U.S. Highway 212 bridge at Montevideo, Minn.	271.2	Apr. 12	930.80
Profile point, right bank, on U.S. Highway 212 across river from Wegdahl in sec.3, T.116 N., R.40 W.	264.2		924.67
Profile point, right bank, 6 miles northwest of Granite Falls, Minn. in sec.11, T. 116 N., R.40 W.	260.7		922.81
Profile point in tree about 25 ft from concrete culvert on river side of dike near Granite Falls, Minn.	257.3		920.4
Profile point, in 10-inch tree about 75 ft from centerline of dike near Granite Falls, Minn.	254.5		916.0

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Profile point in 36-inch tree about 42 ft from centerline of dike at end of 3rd Street, Granite Falls, Minn.	253.5		910.2
Profile point in 30-inch elm tree behind water treatment plant at end of drive on south side of plant, Granite Falls, Minn.	253.0		899.2
Based on USGS reference point described as chiseled square painted orange on downstream concrete curb 65 ft from right end of U.S. Highway 212 bridge, Granite Falls, Minn.	252.3	Apr. 13	895.49
Profile point in 12-inch tree about 175 ft north of bridge abutment of overflow channel on Minn. Highway 67, Granite Falls, Minn.	252.3		895.8
Profile point in 12-inch tree behind Yellow Medicine County Museum 25 ft west of east end of building, Granite Falls, Minn.	252.2		895.6
Water line on power pole near northwest corner of WPA building in Granite Falls, Minn.	252.0		895.2
Profile point in 30-inch tree in Memorial Park, Granite Falls, Minn.	251.9		894.3
Gage at Minnesota Valley Power Plant, Minnesota Falls, Minn.	249.7		892.6
Profile point in large tree near Renville County Highway 10, sec.27, T.115 N., R.38 W., 5 miles southwest of Sacred Heart, Minn.	238.4		878.67

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Reference point on bridge, Renville County 9, Redwood County Highway 7, 6 miles south of Sacred Heart, Minn.	231.7		872.60
Profile point in first tree on left bank and 550 ft from sign showing T-intersection at intersection of Renville County Highways 15 and 12.	228.5		867.63
Profile point in tree on left bank 600 ft south of driveway on Renville County Highway 6, 9 miles south of Renville, Minn.	223.6		862.22
Profile point in telephone pole on left bank on Renville County Highway 21, 800 ft south of intersection with Renville County Highway 15, 7 miles northwest of Redwood Falls, Minn.	219.6		855.59
Profile point in power pole on left bank on Renville County Highway 1, 1100 ft south of intersection with Renville County Highway 15, just north of North Redwood, Minn.	212.1		843.97
U.S. Highway 71 bridge at southwest corner of Morton, Minn.	202.8		
Upstream reference mark			833.8
Downstream reference mark			833.3
Chain gage on downstream rail			833.6
Reference marks on bridge on Renville County Highway 5, Redwood County Highway 11, just south of Franklin, Minn.	192.4		826.0
Profile point on left bank sec.20, T.112 N., R.33 W., on Renville County Highway 3, 4 miles southwest of Franklin, Minn.	186.0		821.89

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Profile point on left bank in SW $\frac{1}{4}$ sec.35, T.112 N., R.33 W., on Renville County Highway 5.	180.5		819.85
At bridge on Minn. State Highway 4, 10 miles north of Sleepy Eye, Minn. Upstream reference mark Downstream reference mark Chain gage on downstream rail	175.4	Apr. 15	816.8 816.8 816.99
Debris line on left bank in SW $\frac{1}{4}$ sec.24, T.111 N., R.32 W., on Nicollet County High- way 21.	163.5		813.70
Debris line in NW $\frac{1}{4}$ sec.30, T.111 N., R.32 W., on Nicollet Highway 21.	161.5		813.60
Debris line on left bank at Eight Mile Creek, sec.29, T.111 N., R.31 W., on Nicollet County Highway 21.	159.0		812.26
Highway gage on power pole, SE $\frac{1}{4}$ sec.1, T.111 N., R.30 W., on left bank at intersection of Nicollet County Highways 21 and 72.	151.3		811.0
Profile point in tree on left bank, 50 ft riverward from Nicollet County Highway 21, across river from New Ulm, Minn.	150.4		810.87
Mark on corner pole of trans- mission line on 19th St. North, 300 ft riverward from Front St., New Ulm, Minn.	149.3		810.1
Debris line along upstream side of U.S. Highway 14 about 500 ft north of bridge.	146.9		809.53

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
USGS gage at bridge on U.S. Highway 14, New Ulm, Minn.	146.8	Apr. 15	809.37
Profile point on post on east side of Center St., about 70 ft riverward from Front St., New Ulm, Minn.	146.0		809.03
Profile point on power pole at southeast end of Front St., New Ulm, Minn.	143.9		808.41
Debris line on right bank at junction of Minn. State Highways 24 and 68, near Courtland, Minn.	134.3		799.24
Debris line on right bank on Blue Earth County Highway 6, in sec.16, T.109 N., R.29 W.	130.4		796.0
Reference point on bridge on Nicollet County Highway 23, Blue Earth County Highway 42 at Judson, Minn.	120.0	Apr. 16	788.6
Profile point on Blue Earth County Highway 134, 0.2 mile north of Minn. State Highway 68, 7 miles west of Mankato, Minn.	116.8		783.55
Second railroad bridge river- ward, just off U.S. Highway 169, $\frac{1}{2}$ mile east of inter- section with Minn. State Highway 68, 2 miles west of Mankato, Minn.	110.0		778.46
In Sibley Park, Mankato, Minn.	107.8		777.3
USGS recording gage at Main Street Bridge, Mankato, Minn.	106.4	Apr. 12	774.99
Profile point in 30-inch elm tree on right bank at down- stream limits of Kasota, Minn.	92.0		761.5

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Debris line upstream from 7th and Minnesota Sts. on Minn. State Highway 22 at St. Peter, Minn.	91.4		760.5
Profile point on W. Pine St. near South Front St., in St. Peter, Minn.	90.9		759.73
Profile point in 12-inch elm tree about 80 ft riverward of intersection of South Front St. and West Walnut St., St. Peter, Minn.	90.5		759.5
Profile point on Minn. State Highway 99 about 10 ft down- stream from Broadway Ave. Bridge, St. Peter, Minn.	89.9		757.71
Profile point riverward of intersection of West Madison St. and North Front St., St. Peter, Minn.	88.8		756.71
Terminal power pole for St. Peter Sewage Treatment Plant, St. Peter, Minn.	88.3		755.60
Debris line on right bank in SW $\frac{1}{4}$ sec.2, T.111 N., R.26 W., about 1 mile upstream from LeSueur, Minn.	76.1		746.9
Debris lines at U.S. Highway 169 bridge, LeSueur, Minn. Upstream Downstream	72.2		742.3 742.2
Profile point on left bank about $\frac{1}{2}$ mile upstream from Minn. State Highway 19 bridge, at Henderson, Minn.	67.7		738.17
Staff gage on southwest corner of Minn. State Highway 19 bridge in Henderson, Minn.	67.2		737.55

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Profile point on extension of Oak St. in city park, Henderson, Minn.	66.8		737.06
Profile point near downstream end of levee about 20 ft west of 6th St., in Henderson, Minn.	66.2		736.87
Profile point in NW $\frac{1}{4}$ sec.31 T.113 N., R.25 W., at Chicago Northwestern Railroad bridge.	63.7		736.6
Stone arch culvert of Chicago Northwestern Railroad about 300 ft northwest of Blakeley, Minn.	56.6		732.5
Profile point in Blakeley, Minn., southwest of intersection of road leading to river and railroad tracks.	56.1		732.36
Profile point in W $\frac{1}{2}$ sec.2 T. 113, N., R.25 W., on right bank about 1 mile west of Belle Plaine, Minn.	51.4		729.31
Bridge on Minn. State Highway 25, Belle Plaine, Minn.	48.8		728.4
Profile point in SE $\frac{1}{4}$ sec.21, T.114 N., R.24 W., on Richard Klehr farm.	44.0		725.6
USGS gage on left bank 1 $\frac{1}{2}$ miles northwest of Jordan, Minn.	39.4	Apr. 14	722.85
USGS gage on left bank 2 $\frac{1}{2}$ miles south of Carver, Minn.	36.0		722.16
Profile point on power pole about 350 ft east of west end of levee, Carver, Minn.	32.8		721.67

Table 4.--Flood-crest elevations, Minnesota River--Continued

Location	Miles above mouth	Date 1969	Elevation in feet (datum of 1929)
Waterline on Masonic Lodge Bldg., Carver, Minn.	32.4		721.7
Profile point on railroad embankment opposite Carver Grain Elevator, Carver, Minn.	31.5		721.1
Debris line, 150 ft north of stadium, Chaska, Minn.	30.0		721.07
Staff gage, 300 ft riverward from northeast corner of Carver County Court House, Chaska, Minn.	29.5		720.35
Water line on levee about 200 ft southwest of 2nd and Beach Sts., Chaska, Minn.	29.0		720.22
Waterline on building in fair- grounds about 200 ft upstream from U.S. Highway 169, Shakopee, Minn.	25.4		719.25
Reference mark on bridge on Minn. State Highway 18 about 3 miles upstream from Savage, Minn.	16.8		718.29
Staff gage on power pole at bridge about 1 mile northwest of Savage, Minn.	14.3		717.2
High water elevation furnished by Port Cargill, Savage, Minn.	13.1		716.90
Waterline inside warehouse about 500 ft upstream from Interstate 35W bridge in Burnsville, Minn.	11.4		716.04
High water elevation at Black Dog Power Plant furnished by Northern States Power Co.	8.7		715.3

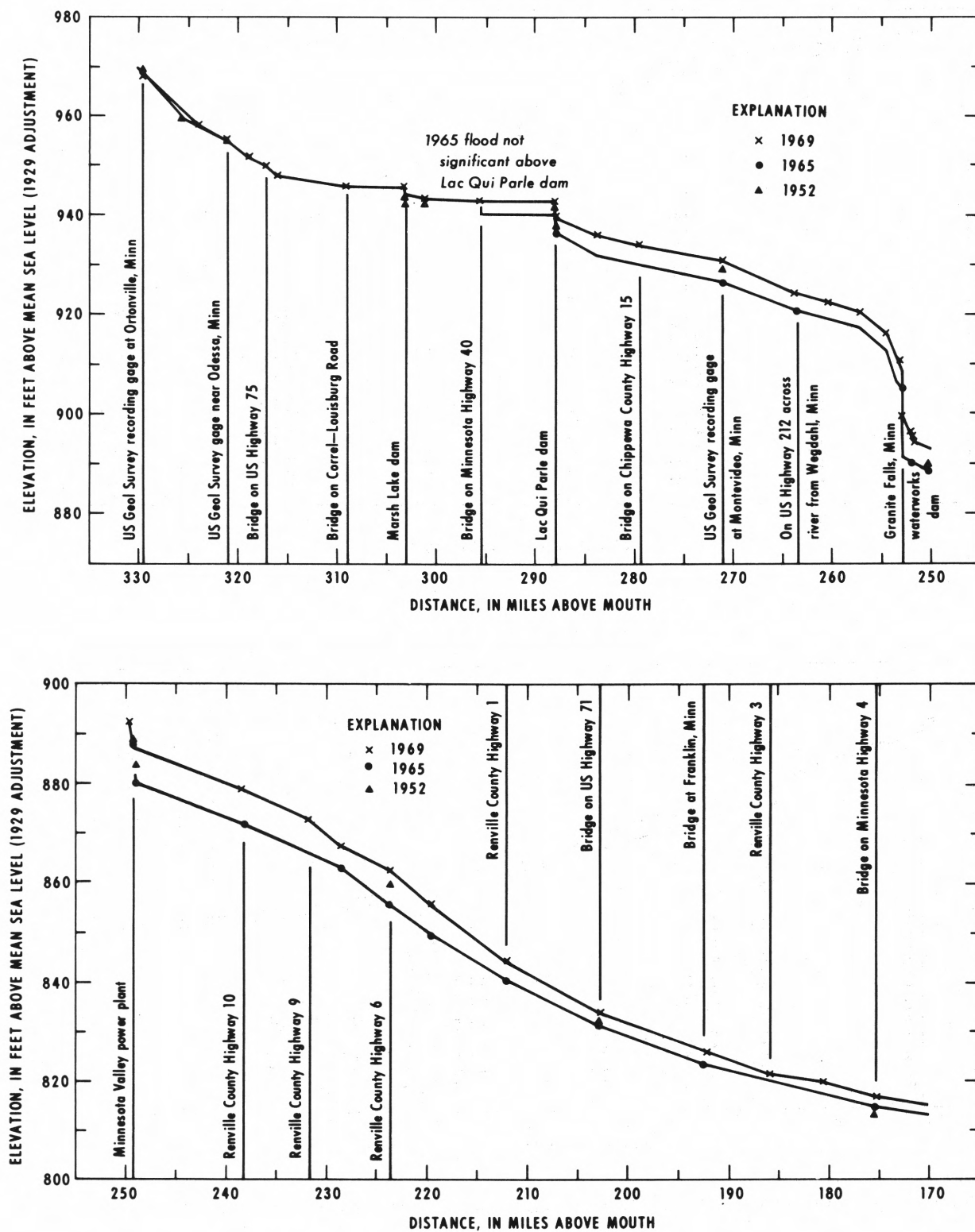


Figure 37.--Flood-crest profiles, Minnesota River, mile 330 to 170.

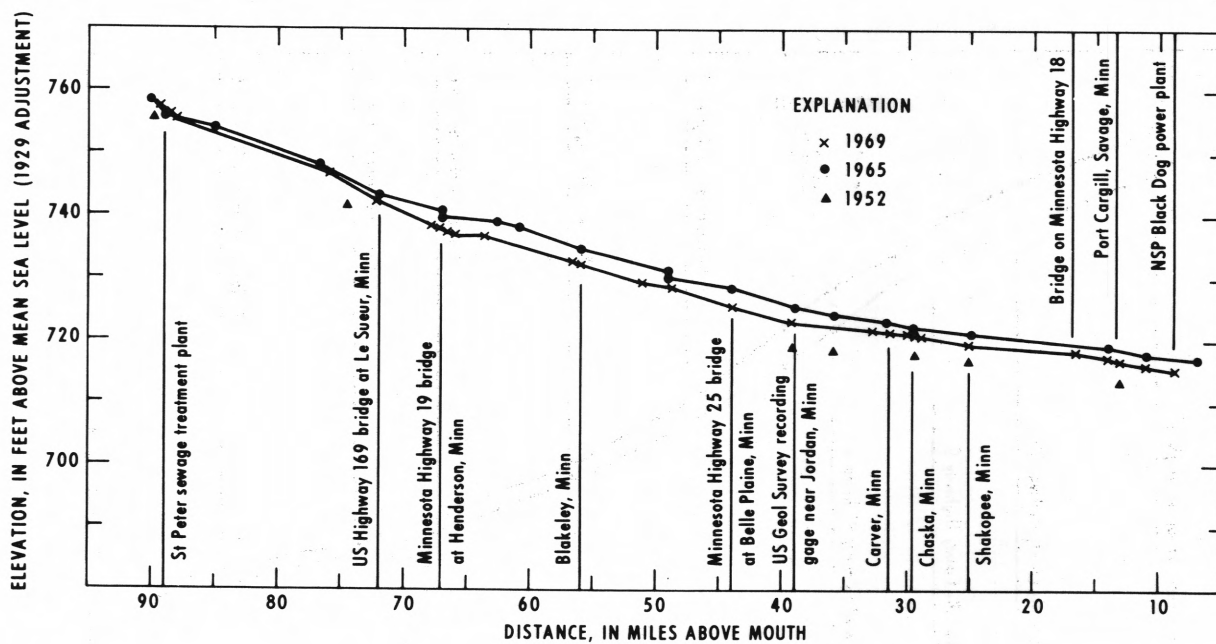
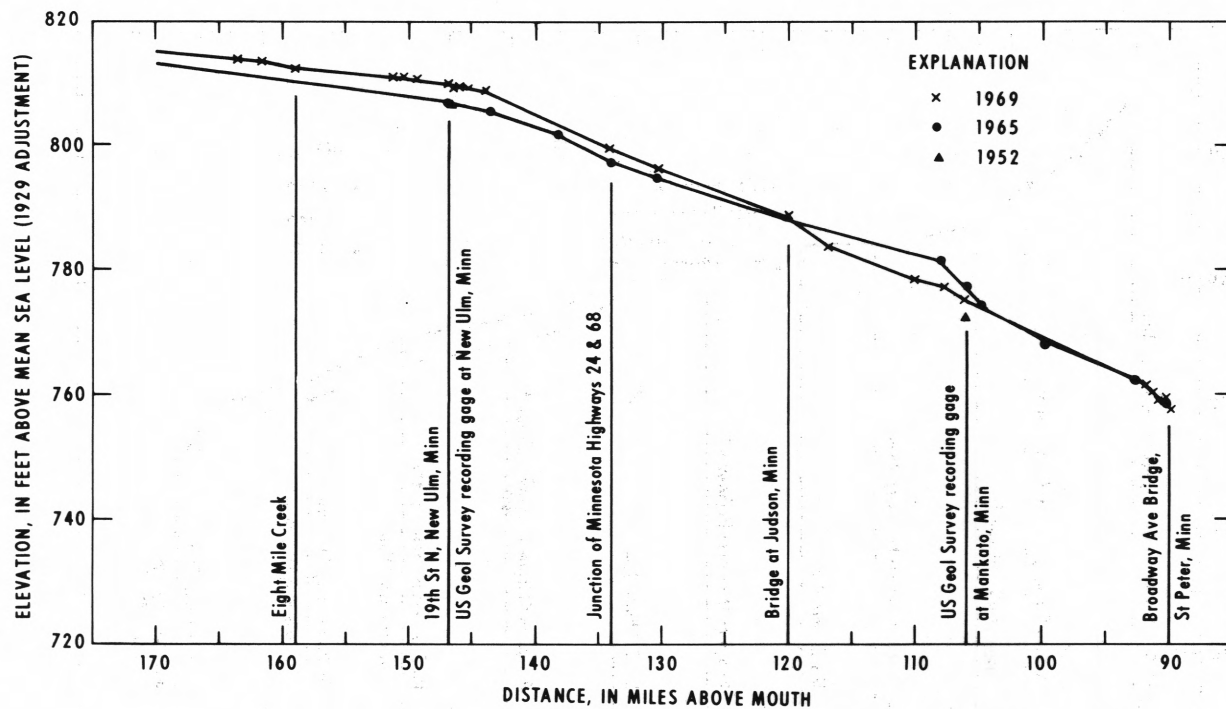


Figure 38.--Flood-crest profiles, Minnesota River, mile 170 to 10.

Mississippi River Basin Downstream from St. Paul, Minnesota

Downstream from St. Paul diking operations were successful in preventing the large property loss that occurred in 1965, but nevertheless, some damage was sustained. South St. Paul is well protected by dikes about 2 1/2 miles in length, which were completed by the Corps of Engineers in May 1968. These protected the packing plants and stockyards and curtailed flood damages to about \$195,000. A section of sandbags washed out at Inver Grove Heights on April 12, but after heroic efforts, the dikes were restored. During the emergency, 164 persons were removed from their homes. Total damages at Newport and Inver Grove Heights, Minnesota, totalled \$275,000 and \$279,000, respectively.

Flood flows in Mississippi River tributaries in southeastern Minnesota and western Wisconsin, downstream from St. Paul, were not extreme. When these streams peaked early in April below the forecast stage, hope arose in many areas that the flood would not be as severe as anticipated. The maximum discharges in many of these streams were sufficiently low so that their inclusion in this report is not warranted. The Zumbro River at Zumbro Falls, Minnesota, for instance, peaked on April 5 at 14,300 cfs (gage height, 20.07 feet) and the Root River near Houston, Minnesota, peaked on the same day at 7,900 cfs (gage height, 9.22 feet). These discharges were near those of the mean annual flood and the maximum stages were considerably lower than the forecasts of March 13, lending credence to the unfounded hope that anticipated stages in other areas would also fail to materialize.

Flood data for three sites in Wisconsin are presented. Daily discharge data are shown for the St. Croix River at St. Croix Falls and Chippewa River at Durand, and the maximum discharge, based on miscellaneous measurements, is shown for the Wisconsin River at Bridgeport.

Even though there were no exceptional flood peaks in Wisconsin, runoff for the month of April was very high in many basins in the western part of the State. For instance, April runoff of the Namekagon River near Trego in the St. Croix River basin was the second highest in 42 years of record; yet the peak discharge was barely higher than the mean annual flood.

The most significant flood in the tributaries of the Mississippi River in Wisconsin and southeastern Minnesota was in the St. Croix River. The St. Croix River rises in northwestern Wisconsin and flows in a southerly direction until it joins the Mississippi River at Prescott, Wisconsin.

It forms the boundary between Wisconsin and Minnesota throughout most of its course. The downstream gaging station on the St. Croix River is at St. Croix Falls, Wisconsin, where discharge records have been collected for 67 years. Here the maximum discharge was 41,600 cfs, a 17-year flood. This peak has been exceeded 5 times, in 1945, 1950, 1952, 1954, and 1965. The lower reach of the St. Croix River forms Lake St. Croix, located between Stillwater, Minnesota, and the mouth of the St. Croix River, about 21 miles downstream. The Corps of Engineers' Lock and Dam 3 is located on the Mississippi River about 14 miles downstream from the mouth of the St. Croix River. During normal flow, the operation of the dam for navigation purposes creates backwater in the St. Croix River as far upstream as Marine-on-St. Croix, Minnesota, about 10 miles upstream from Stillwater, Minnesota. There is no backwater from the dam during extreme floods because all the gates are set in the wide-open position, but nevertheless, backwater from the Mississippi River extends into Lake St. Croix and well up the St. Croix River probably as far as Marine-on-St. Croix. For this reason the maximum stage at Stillwater was the second highest in many years of record, just as it was in the Mississippi River at the mouth of the St. Croix River. The Interstate Bridge across the St. Croix River at Stillwater was closed as a result of the flood (fig. 39).

The Corps of Engineers has obtained continuous stage records at Stillwater since 1890 and has an additional 10 years of fragmentary record dating back to 1850. The two highest elevations during these years of record were 694.09 feet in April 1965 and 692.32 feet in April 1969.

Including the cost of the flood fight, a number of cities and towns in the St. Croix basin suffered flood damages in excess of \$100,000. Heaviest damages, almost \$1.6 million, were suffered by Bayport, Minnesota, 4 miles downstream from Stillwater (fig. 40). On the Minnesota side, damages in Stillwater were \$927,000, in Point Douglas \$366,000, and in St. Croix Beach, St. Mary's Point, and Afton, they varied between \$111,000 and \$167,000. Total damages in Hudson, Wisconsin, were \$237,000.

In Prescott, Wisconsin, at the mouth of the St. Croix River, flood damages were \$405,000. Downstream in the main stem on the Minnesota side they were \$581,000 in Red Wing, \$108,000 in Wacouta, \$341,000 in Lake City, and \$213,000 in Wabasha. In addition to losses caused directly by the flood in these communities, economic losses occurred, because of the necessity for constructing traffic detours, disruption of business activities, and other flood-associated problems.

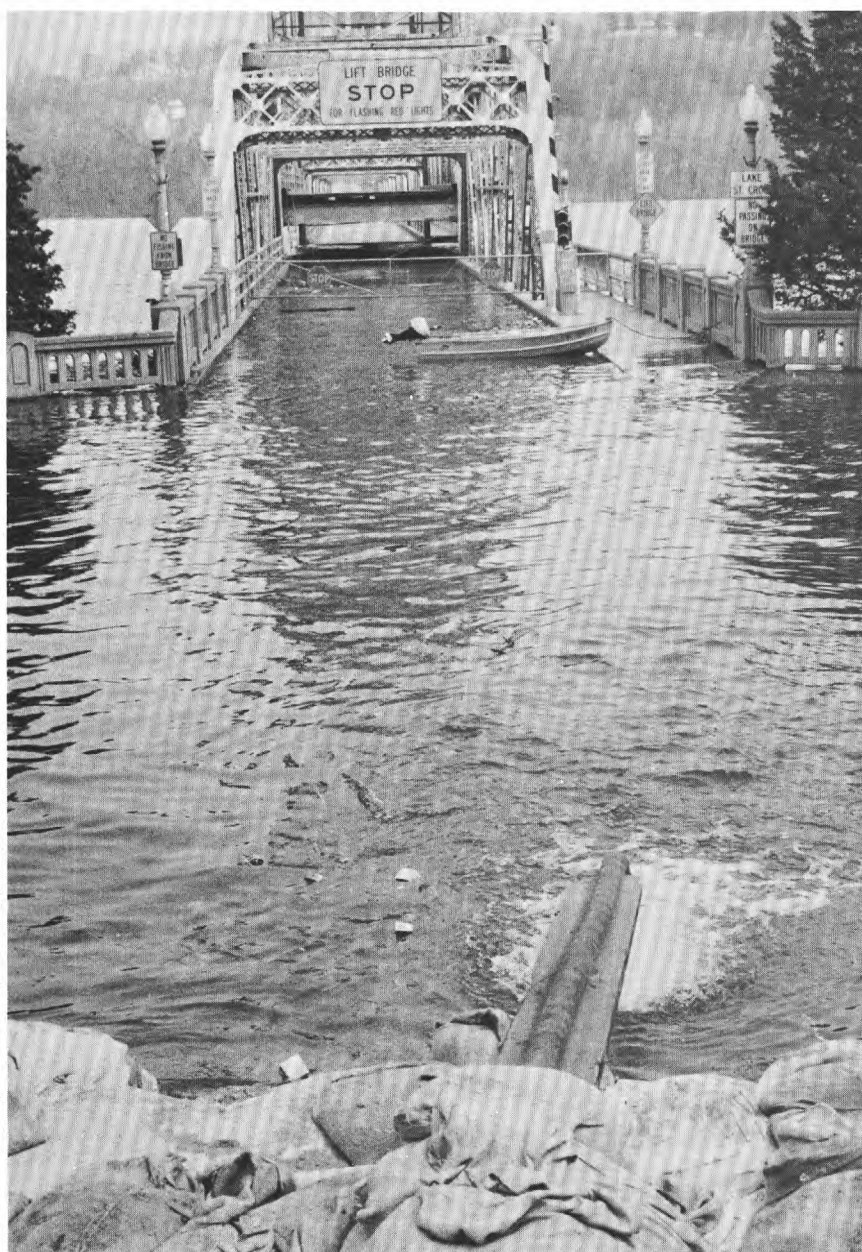


Figure 39.--Flooding of Interstate Bridge at Stillwater, Minn.
 Photograph by St. Paul Pioneer Press.

Many other areas were similarly affected even though direct loss from the flood waters was not significant.

At Lake City, between Red Wing and Wabasha on the shores of Lake Pepin, the government pier was under water. Residents in this area were concerned about the erosion caused by the wave action on the lake through which the Mississippi River



Figure 40.--Flooding of St. Croix River at Bayport, Minn., April 18, 1969.
Photograph by U.S. Army Corps of Engineers, St. Paul district.

flows. International Milling Company closed down at Wabasha on April 15 because it no longer had rail service available. In the Sand Prairie Resort area, 4 miles south of Wabasha, about 300 families were temporarily isolated.

The Chippewa River is the first major tributary of the Mississippi River entering from the Wisconsin side downstream from the St. Croix River. In this basin, the water content of snow on the ground at the end of March was as much as 6 inches, yet there were no outstanding flood peaks. The maximum discharge of 53,600 cfs occurring on April 10 was only a 3-year flood and it preceded the maximum discharge of the Mississippi River at the mouth of the Chippewa River by almost a week. Nevertheless, a considerable volume of water ran off

from the Chippewa River basin during April and, therefore, the discharge data are included. Also the data define the hydrologic conditions on the edges of the area of maximum flooding and show that the magnitude of flood peaks diminished rapidly from north to south in western Wisconsin.

At Fountain City, Wisconsin, water was more than a foot deep over a part of Shore Drive. The only highway open into town was Wisconsin Highway 95, which approached from the east. In the 1965 flood, the Mississippi River water backed into Cochrane, Wisconsin, but a dike prevented this from happening in 1969.

Winona called for National Guard troops to help raise its emergency dikes, control traffic, and guard vacated property. Some of Winona's storm sewers were plugged with air-filled plastic bags which burst from the water pressure and popped man-hole covers, but these difficulties were overcome. Permanent flood barriers constructed in Winona by the Corps of Engineers are approximately 6.6 miles long and they prevented damages of \$3.8 million according to Corps' estimates. Emergency works prevented an additional \$16.9 million damages. Total damages sustained including the cost of the flood fight were estimated at \$587,500.

The Chicago Northwestern Railway and the Burlington Railway were forced to shut down in La Crosse, Wisconsin, but the Milwaukee Road remained in operation. On the north side of La Crosse, emergency work was performed on the dikes in the French Island area where about 4,500 persons reside. A railroad bed later washed out and forced the evacuation of some families from French Island. Market Street bridge leading to Houska Park was closed but most of the city was protected from extensive flood damage. Total damages and cost of flood fight according to Corps of Engineers' estimates were about \$800,000.

At Prairie du Chien, Wisconsin, more than 60 families were forced from their homes and others moved to the second story to get above the flood waters. Radio station WPRE, in Prairie du Chien, was flooded but the station continued to operate from the second floor of their building. Here damages sustained and flood fight costs were estimated at \$779,000.

Fragmentary flood data at the mouth of the Wisconsin River are available from the results of 5 discharge measurements made at Bridgeport, Wisconsin, during the period April 9-28. They indicate that the maximum discharge of the Wisconsin River was about 41,100 cfs in April 1969 as compared

to about 44,600 cfs in the April 1965 flood. The recurrence interval of floods of this magnitude at this site is about 2 years. The peak discharge of the Mississippi River near Bridgeport followed the peak discharge of the Wisconsin River by 7 days, and when the Mississippi River peaked, the Wisconsin River was contributing only about 18,000 cfs.

Downstream from the Wisconsin River, the Mississippi River ranged from 1 to 4 feet lower in 1969 than in the great flood of 1965. Figure 41 shows comparative discharge hydrographs of the 1965 and 1969 floods at McGregor and Keokuk, Iowa. The gaging station at McGregor is 2.6 miles upstream from the Wisconsin River, and the one at Keokuk is 2.8 miles upstream from the Des Moines River and about 270 river miles downstream from the McGregor gaging station.

In the Guttenberg, Iowa area, total damages sustained in the town, U.S. Sport Fisheries and Wildlife installations, and Guttenberg Island, including cost of flood fight, were estimated at \$509,100 by Corps of Engineers. Figure 42 shows part of the flooding that occurred at Guttenberg. Extensive permanent flood protection works have been authorized for the Guttenberg area. These works are in the planning stage and according to Corps of Engineers' estimates, would be capable of preventing damages of about \$2 million in a flood of the magnitude of that which occurred in April 1969. Downstream from Guttenberg the total damages in Iowa and Illinois were estimated at \$4.4 million.

All navigation on the Mississippi River between Minneapolis, Minnesota, and Guttenberg, Iowa, was discontinued on April 12 and the gates on the locks and dams were left in the wide-open position.

Ample warning and early flood-protection measures were effective in minimizing damages in towns located on the Mississippi River and its tributaries. A number of cities which did no diking, or built hurried, inadequate dikes in 1965 undertook well-planned extensive measures in 1969. Existing works were examined for adequacy and reinforced if necessary as a part of Operation Foresight. In spite of these measures, the total damages sustained in the Upper Mississippi River basin, upstream from Guttenberg, Iowa, were more than \$60 million according to Corps of Engineers' estimates. Of this figure about \$26.5 million consisted of damages to urban areas and \$22.5 million to agricultural areas. The remainder of the damages occurred to transportation facilities and to the locks and dams. The Corps estimated the damages prevented in the basin upstream from Guttenberg were about \$128 million, and in the reach from Guttenberg to Keokuk, about \$23 million.

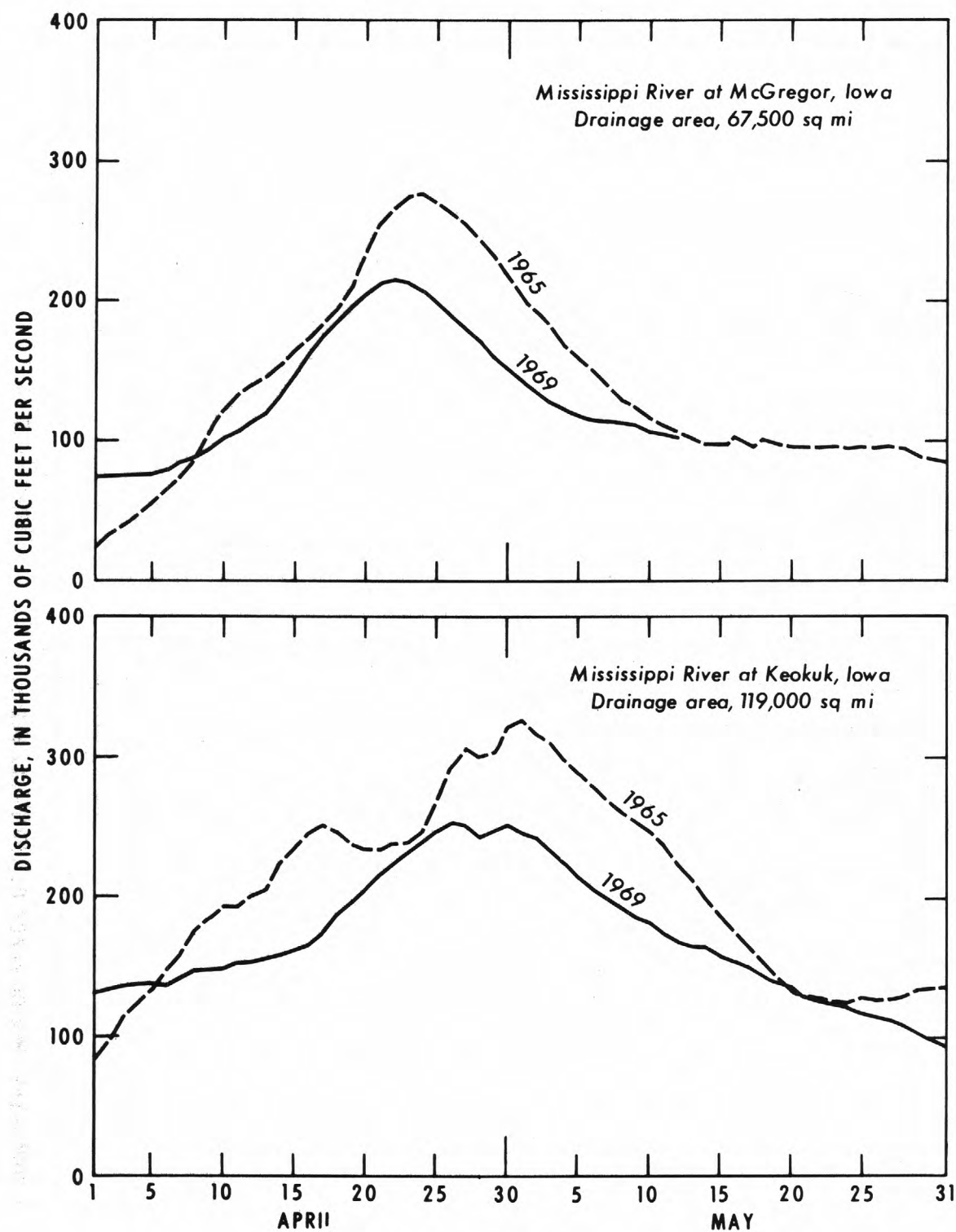


Figure 41.---Comparative discharge hydrographs for selected gaging stations on Mississippi River.



Figure 42.--Flooding of Mississippi River at Guttenberg, Iowa, April 22, 1969.
 Photograph by U.S. Army Corps of Engineers, St. Paul district.

Of the latter amount, \$15.8 million in damages were prevented in Iowa and the remainder in Illinois.

The intensity of flooding in the lower reaches of Mississippi River tributaries upstream from St. Paul was greater than it was in those located downstream. As a result, recurrence intervals in the main stem increased gradually in the downstream direction from the headwaters to St. Paul, after which they decreased gradually. Peak discharge in the main stem was 1.54 times the 50-year flood at St. Paul. At Aitkin, Minnesota, 217 miles upstream from St. Paul, the recurrence interval was 18 years, whereas, at McGregor, Iowa, almost an equal distance downstream, the recurrence interval was about 50 years. This points out that the intensity of flooding in the main stem persisted for a greater distance downstream from St. Paul than it did upstream.

The most downstream gaging station on the main stem for which data are presented in this report is at Keokuk, Iowa. The maximum discharge at this station was 253,000 cfs, a 13-year flood. The maximum was far below the 360,000 cfs experienced in 1851, and the 327,000 cfs which occurred in April 1965. Near Keokuk, at Lock and Dam 19, the flood-crest elevations of the pool readings for the floods of 1965 and 1969 approached the same elevation, but the tailwater reading was more than 4 feet in the 1969 flood.

Flood-crest elevations during the 1965 and 1969 floods were obtained for the Mississippi River in a reach stretching from the Blanchard Power Plant near Royalton, Minnesota, to Warsaw, Illinois. These elevations are shown in table 5 and flood profiles are shown in figures 43 to 46.

Downstream from St. Paul, the only Mississippi River tributaries located in Minnesota which experienced outstanding floods were those which had their headwaters in the southwestern part of the State. Most noteworthy of these was the West Fork Des Moines River, which meanders for almost a hundred miles in a southeasterly direction through Minnesota before it reaches the Minnesota-Iowa line. It proceeds in a southerly direction through Iowa until it joins the East Fork Des Moines River south of Humboldt, Iowa, to form the Des Moines River. The Des Moines River continues in a southeasterly direction through Iowa until it joins the Mississippi River near Keokuk, Iowa, 2.8 miles downstream from the gaging station on the Mississippi River near Keokuk.

The West Fork Des Moines River is gaged at Jackson, Minnesota, and the maximum discharge was also determined at Windom, Minnesota, 22 miles upstream. The peak discharge of 15,700 cfs at Jackson was 2.02 times the 50-year flood and was by far the greatest discharge of any experienced in the 43 years of record. The ratio to the 50-year flood was among the greatest of those documented in this report. The maximum discharge at Windom was 15,000 cfs, only slightly less than that which occurred at Jackson.

In Windom diking operations were carried on under the supervision of the Rock Island District Corps of Engineers, but nevertheless, more than a hundred families were forced from their homes and an additional hundred were threatened with evacuation. Forty National Guardsmen from the local unit were called to duty to route traffic, prevent unnecessary sight-seeing, and guard the homes of families who were forced to evacuate. For a time both U.S. Highway 71 and Minnesota Highway 60 were closed, preventing any traffic through town.

Table 5.--Flood-crest elevations, Mississippi River
(furnished by Corps of Engineers except at USGS gages)

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Blanchard Hydro- Power Plant dam near Royalton, Minn.	956.0	Apr. 15, 16	1,045.40	Apr. 14	1,082.05
Pool				Apr. 14	1,044.80
Tailwater					
Reference mark on bridge on Benton County Highway 2, near Rice, Minn.	945.2	--	--	Apr. 14	1,025.52
Profile point in tree near Benton County Highway 55, 2½ miles south of Rice, Minn.	941.7	--	--	Apr. 14	1,020.8
St. Regis Paper Co. dam, Sartell, Minn.	932.5	Apr. 14	1,019.10	Apr. 14	1,015.51
Pool				Apr. 14	1,002.87
Tailwater					
NSP Hydro-Plant dam, St. Cloud, Minn.	926.5	Apr. 14	984.9 971.2	Apr. 14	982.60
Pool				Apr. 14	968.80
Tailwater					
Reference mark on Sherburne County Highway 8, near Long Lake, Minn.	916.9	--	--	Apr. 14	950.33
Reference mark on Minn. Highway 24, at Clearwater, Minn.	912.6	Apr. 15	946.96	Apr. 14	944.46

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Reference mark on upstream side of Minn. Highway 25 bridge, at Monticello, Minn.	896.9	Apr. 15	906.82	Apr. 14	904.6
Reference mark off Sherburne County Highway 14 between Elk River and Monticello, Minn.	891.6	--	--	Apr. 14	886.82
USGS recording gage 2,500 ft downstream from mouth of Elk River, at Elk River, Minn.	884.6	Apr. 16	865.12	Apr. 14	862.22
Reference mark near mouth of Crow River, at Dayton, Minn.	879.0	Apr. 16	857.06	Apr. 14	853.8
Reference mark on U.S. Highway 52 bridge, at Champlin, Minn. (Rum River mouth).	871.5	Apr. 17	844.1	Apr. 14	841.40
NSP dam, Coon Rapids, Minn.	866.3				
Pool		--	831.4	Apr. 14	830.55
Tailwater		--	826.6	Apr. 14	823.60
USGS recording gage on right bank near Anoka, Minn.	864.8	Apr. 17	824.55	Apr. 14	821.83
Recording gage at 41st Ave. and Marshall St. N.E., Minneapolis, Minn.	858.6	--	814.30	Apr. 14	812.16

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
St. Anthony Falls Upper Lock and Dam Minneapolis, Minn.	853.8				
Pool		Apr. 17	803.43	Apr. 14	802.49
Tailwater		Apr. 17	760.00	--	--
St. Anthony Falls Lower Lock and Dam Minneapolis, Minn.	853.5				
Pool		Apr. 17	751.42	Apr. 14	750.45
Tailwater		Apr. 17	739.02	Apr. 14	737.50
Staff gage at down- stream end of Barge Terminal Building, Minneapolis, Minn.	852.6	--	--	Apr. 14	737.00
Lock and Dam 1, Minneapolis, Minn.					
Pool	847.6	Apr. 17	734.47	Apr. 15	733.02
Tailwater	847.5	Apr. 16, 17	719.02	Apr. 15	716.14
USGS recording gage 300 ft upstream from Robert St. bridge, St. Paul, Minn.	839.3	Apr. 16	710.17	Apr. 15	708.67
USGS recording gage at Grand Ave. pump- ing station, South St. Paul, Minn.	833.7	--	--	Apr. 15	705.78
Lock and Dam 2, Hastings, Minn.					
Pool	815.4	Apr. 17	697.07	Apr. 16	697.40
Tailwater	815.0	Apr. 17	696.13	Apr. 16	694.90
USGS recording gage at Prescott, Wis.	811.4	Apr. 18	693.11	Apr. 16	691.48

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Lock and Dam 3, Red Wing, Minn.					
Pool	797.1	Apr. 18	688.22	Apr. 17	686.60
Tailwater	796.7	Apr. 18	687.93	Apr. 17	686.08
Red Wing, Minn.	790.9	--	685.98	Apr. 17	683.93
Lake City, Minn.	764.9	--	683.22	Apr. 17,18	681.30
Recording gage at lower end of Peter's Boatyard, Wabasha, Minn.	760.4	--	--	Apr. 17	677.64
Lock and Dam 4, Alma, Wis.					
Pool	753.0	--	676.45	Apr. 17,18	674.20
Tailwater	752.6	--	675.78	Apr. 17,18	673.60
Lock and Dam 5, Minneiska, Minn.					
Pool	738.3	Apr. 19	668.73	Apr. 18,19	665.88
Tailwater	737.9	Apr. 19	667.85	Apr. 18,19	665.14
Lock and Dam 5A, Winona, Minn.					
Pool	728.6	Apr. 19	663.74	Apr. 19	661.87
Tailwater	728.3	Apr. 20	663.35	Apr. 19	661.42
USGS recording gage at Winona, Minn.	725.7	Apr. 19	660.89	Apr. 19	659.56
Lock and Dam 6, near Trempealeau, Wis.					
Pool	714.4	Apr. 20	654.65	Apr. 19	652.00
Tailwater	714.1	Apr. 20	653.02	Apr. 19	650.80
Lock and Dam 7, Dresbach, Minn.					
Pool	702.6	Apr. 21	648.18	Apr. 19,20	645.50
Tailwater	702.2	Apr. 21	647.38	Apr. 19,20	645.50

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
La Crosse, Wis. (at discontinued USGS gaging station).	697.8	Apr. 22	644.28	Apr. 20	642.02
Staff gage 600 ft downstream from railroad station at Brownsville, Minn.	688.6	--	--	Apr. 21	637.32
Lock and Dam 8, Genoa, Wis.	679.4	Apr. 22	639.05	Apr. 21	636.00
Pool	679.0	Apr. 22, 23	638.40	--	635.25
Tailwater					
Bad Axe River (Left bank)	675.2	--	--		
Upper Iowa River (Right bank)	670.6	--	--		
CE gage, Lansing, Iowa	663.0	Apr. 24	634.8		
Lock and Dam 9, Pool	647.9	Apr. 24	633.8		
Tailwater		Apr. 24	633.2	--	629.4
Yellow River (Right bank)	637.7	--	--	--	--
USGS gage, McGregor, Iowa	633.4	Apr. 24	630.68	Apr. 22	626.87
Wisconsin River (Left bank)	631.0	--	--	--	--
CE gage, Clayton, Iowa	624.8	Apr. 24	627.2	--	--

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Lock and Dam 10 Pool Tailwater	615.2	Apr. 24 Apr. 24	624.2 623.6	-- Apr. 23	-- 619.9
Profile point	612.0	--	622.7	Apr. 23	619.0
Yellow River (Right bank)	608.1	--	--	--	--
CE gage, Cassville, Wis.	606.3	Apr. 25	620.4	Apr. 23	616.8
Profile point, North Buena Vista, Iowa	603.7	--	618.9	Apr. 23	615.4
CE gage, Waupeton, Iowa	599.9	Apr. 25	617.0	Apr. 23	613.3
Profile point	596.1	--	616.0	Apr. 23	612.1
Grant River (Left bank)	593.3	--	--	--	--
CE gage, Specht's Ferry, Iowa	592.3	Apr. 25	615.5	Apr. 23	611.5
Profile point	590.2	--	615.3	Apr. 23	611.3
Platte River (Left bank)	588.3	--	--	--	--
Profile point	587.5	--	615.1	Apr. 23	611.0
Profile point	585.2	--	614.8	Apr. 23	--
Lock and Dam 11 Pool Tailwater	583.0	Apr. 26 Apr. 26	614.5 613.9	Apr. 23 Apr. 23	610.5 609.9
Profile point	581.7	--	613.5	Apr. 23	--
Profile point	581.0	--	613.2	Apr. 23	--

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
USWB gage, Dubuque, Iowa	579.9	Apr. 26	612.3	Apr. 23	608.6
Profile point	578.8	--	611.9	Apr. 23	--
Profile point	578.5	--	--	Apr. 23	608.0
Profile point	578.0	--	611.7	Apr. 23	--
Profile point	577.6	--	611.2	Apr. 23	607.6
Profile point	574.6	--	609.8	Apr. 23	606.3
Profile point	571.5	--	--	Apr. 23	605.3
Profile point	569.4	--	607.7	Apr. 23	604.2
CE gage, Gordon's Ferry, Iowa	566.2	Apr. 26	606.4	Apr. 24	603.0
Profile point	562.6	--	605.2	Apr. 24	601.8
Profile point	559.7	--	604.6	Apr. 24	601.1
Lock and Dam 12 Pool	556.7	Apr. 26	604.5	Apr. 24	600.9
Tailwater		Apr. 26	603.7	Apr. 24	600.3
Profile point	553.9	--	602.9	Apr. 24	599.5
Profile point	549.4	--	601.7	--	598.4
Maquoketa River (Right bank)	548.6	--	--	--	--
Profile point	547.0	--	600.6	Apr. 24	597.3
Profile point	544.1	--	599.5	Apr. 24	596.3
Profile point	541.2	--	598.2	Apr. 24	595.0
Profile point	537.8	--	596.8	Apr. 24	593.7

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Plum River (Left bank)	536.6	--	--	--	--
CE gage, Sabula, Iowa	535.0	Apr. 27,28	594.9	Apr. 25	592.3
Profile point	532.2	--	594.1	Apr. 25	591.1
Profile point	528.0	--	593.9	Apr. 25	590.8
Lock and Dam 13 Pool	522.5	Apr. 28	593.7	Apr. 25	590.5
Tailwater		Apr. 28	593.4	Apr. 26	590.1
Profile point	520.8	--	--	Apr. 26	589.2
Clinton, Iowa, above Lyons-Fulton bridge	520.3	--	592.2	Apr. 26	588.9
Profile point	520.0	--	--	Apr. 26	588.7
CE gage	518.0	Apr. 28	591.1	Apr. 26	587.5
Profile point	515.9	--	589.2	Apr. 26	586.5
Profile point	513.3	--	--	Apr. 26	585.6
USGS gage, Camanche, Iowa	511.8	Apr. 28	587.82	Apr. 26	584.74
Profile point	509.8	--	586.3	Apr. 26	584.3
Profile point	507.0	--	586.0	Apr. 26	583.2
Wapsipinicon River (Right bank)	506.8	--	--	--	--
Profile point	503.3	--	--	Apr. 26	581.4
CE gage, Princeton, Iowa	502.1	Apr. 28	583.7	Apr. 26	580.5

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Profile point	499.3	--	581.9	--	--
Profile point	497.1	--	--	Apr. 26	577.7
CE gage, LeClaire, Iowa	497.0	Apr. 28	580.2	Apr. 26	577.5
I-80 Highway bridge	495.4	--	578.5	Apr. 26	576.7
Lock and Dam 14 Pool	493.3	Apr. 28	577.0	Apr. 26	573.9
Tailwater		Apr. 28	574.8	Apr. 27	571.7
Profile point	491.0	--	574.2	--	--
Profile point	490.1	--	--	Apr. 27	570.6
Profile point	589.8	--	573.3	--	--
Profile point	488.4	--	--	Apr. 27	569.3
CE gage, 48th St., Moline, Illinois	487.9	Apr. 28	572.1	Apr. 27	568.9
Moline-34th St.	487.0	--	--	Apr. 27	568.0
Moline-Bettendorf bridge	485.9	--	569.6	--	--
Bettendorf, below Highway bridge	485.6	--	--	Apr. 27	566.2
Profile point	484.4	--	567.7	Apr. 27	564.2
Arsenal pump house	484.2	--	--	Apr. 27	564.0
Profile point Davenport Water Co.	483.9	--	567.2	Apr. 27	563.7
Lock and Dam 15 Pool	483.0	Apr. 28	565.9	Apr. 26, 27	562.7
Tailwater		Apr. 28	565.0	Apr. 27	561.8

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Profile point	482.4	--	564.9	--	--
Centennial bridge	482.1	--	--	Apr. 27	561.5
Profile point	481.9	--	564.7	--	--
Profile point	481.4	--	564.5	Apr. 27	561.2
Kalke Boatyard	480.8	--	--	Apr. 27	560.8
Head Credit Island	480.2	--	--	Apr. 27	560.6
Rock River (Left bank)	479.2	--	--	--	--
CE gage, Lock 32, I&M Canal	479.1	Apr. 28	563.8	Apr. 27	560.2
Head Horse Island	476.7	--	--	Apr. 27	559.2
Profile point	475.4	--	562.3	--	--
Profile point	473.8	--	--	Apr. 27	558.2
Profile point	473.0	--	561.5	Apr. 27	558.0
Profile point	471.1	--	560.7	--	--
Hooker Chemical plant	470.7	--	--	Apr. 27	557.1
Montpelier, Iowa Powerplant	467.7	--	--	Apr. 27	556.2
CE gage	467.5	Apr. 28	559.6	Apr. 27	556.1
CE gage, Fairport, Iowa	463.5	Apr. 28	558.8	Apr. 27	555.2
Profile point	460.0	--	557.9	Apr. 27	554.2

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Lock and Dam 16 Pool	457.2	Apr. 28,29	557.5	Apr. 26	553.8
Tailwater		Apr. 28,29	556.9	Apr. 26	553.3
CE gage, Muscatine, Iowa	455.2	Apr. 29	556.3	Apr. 26	552.9
Water plant	453.0	--	555.3	Apr. 26	551.7
CE gage	450.2	--	--	Apr. 26	550.5
CE gage, Bass Island, Iowa	448.4	Apr. 28	553.1	Apr. 26	549.9
Profile point	443.7	--	551.9	Apr. 26	548.8
Profile point	441.3	--	551.0	Apr. 26	548.1
Lock and Dam 17 Pool	437.1	Apr. 28	550.1	Apr. 26	546.8
Tailwater		Apr. 28	549.8	Apr. 26	546.5
Iowa River (Right bank)	433.5	--	--	--	--
Profile point	432.9	--	548.6	Apr. 26	544.2
Edwards River (Left bank)	431.8	--	--	--	--
CE gage, Keithsburg, Ill.	428.0	Apr. 27	543.6	Apr. 26	540.4
Profile point	425.9	--	542.2	Apr. 26	539.2
Profile point	420.6	--	539.7	Apr. 26	536.8
Profile point	418.2	--	538.6	Apr. 26	535.7
CE gage, Oquawka, Illinois	415.2	Apr. 30	537.4	Apr. 26	534.6

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
Profile point	413.0	--	536.6	Apr. 26	534.0
Lock and Dam 18 Pool	410.5	Apr. 30	535.9	Apr. 26	533.5
Tailwater		Apr. 30	535.4	Apr. 26	533.0
Henderson River (Left bank)	409.8	--	--	--	--
Profile point	408.4	--	534.8	Apr. 26	532.4
Profile point	406.5	--	534.1	Apr. 26	531.6
Highway bridge, Burlington, Iowa	404.1	--	533.1	Apr. 26	530.4
CE gage	403.1	Apr. 30, May 1	532.4	Apr. 27	529.8
Profile point	400.0	--	531.9	--	--
Profile point	396.0	--	530.1	Apr. 27	527.4
Skunk River (Right bank)	396.0	--	--	--	--
Profile point	392.6	--	528.5	Apr. 27	526.0
Profile point	391.0	--	--	Apr. 27	525.6
Profile point	390.0	--	--	Apr. 27	525.3
Profile point	389.5	--	527.3	--	--
Profile point	388.1	--	527.0	--	--
Profile point	388.0	--	--	Apr. 27	524.8
Profile point	387.5	--	--	Apr. 27	524.6
Profile point	387.0	--	526.5	Apr. 27	524.5

Table 5.--Flood-crest elevations, Mississippi River--Continued

Location	Miles above mouth of Ohio River	1965		1969	
		Date	Elevation in feet 1912 Adjustment	Date	Elevation in feet 1912 Adjustment
CE gage, Fort Madison, Iowa	383.9	May 1	525.1	Apr. 30	523.4
Profile point	382.7	--	524.7	--	--
Profile point	381.5	--	524.3	Apr. 27	522.8
Profile point	379.0	--	523.5	--	--
Profile point	374.9	--	522.2	Apr. 27	521.1
Profile point	372.6	--	--	Apr. 27	520.4
Profile point	368.4	--	519.5	Apr. 27	519.2
Lock and Dam 19 Keokuk, Iowa	364.3				
Pool		May 1	517.2	Apr. 29	518.2
Tailwater (CE gage)	364.2	May 1	500.0	Apr. 27	495.7
Profile point	362.9	--	499.9	--	--
Profile point	362.3	--	--	Apr. 27	494.0
Profile point	362.1	--	499.8	--	--
Profile point	361.9	--	499.2	--	--
Des Moines River (Right bank)	361.5	--	--	--	--
Profile point	361.4	--	498.7	--	--
CE gage, Warsaw, Illinois	359.9	May 1	498.2	Apr. 27	494.0

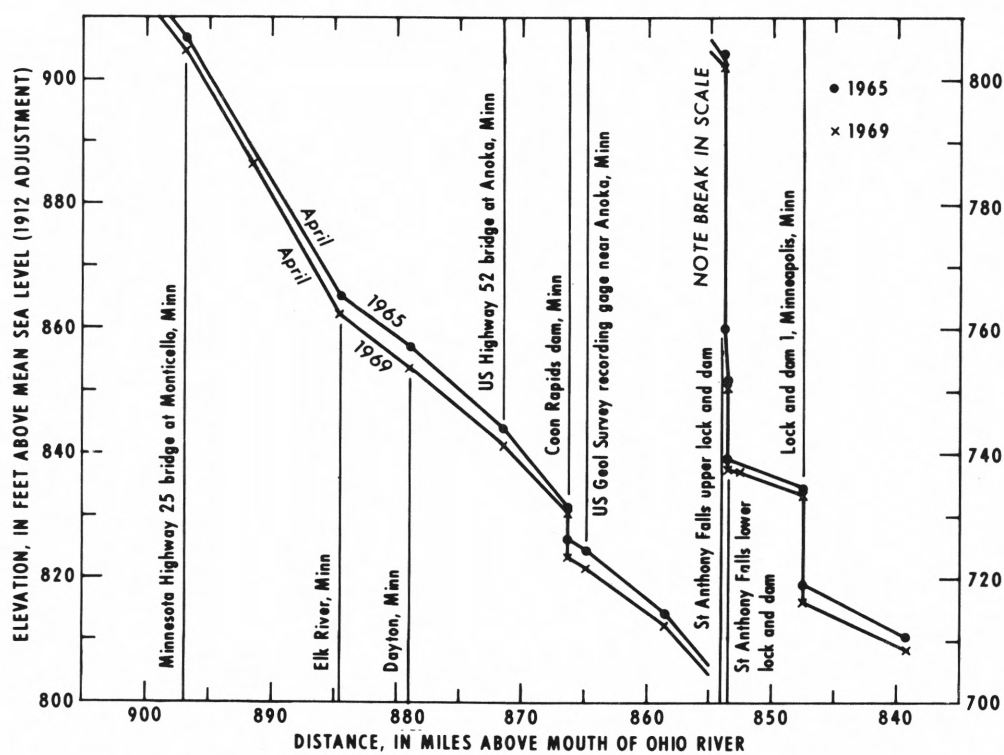
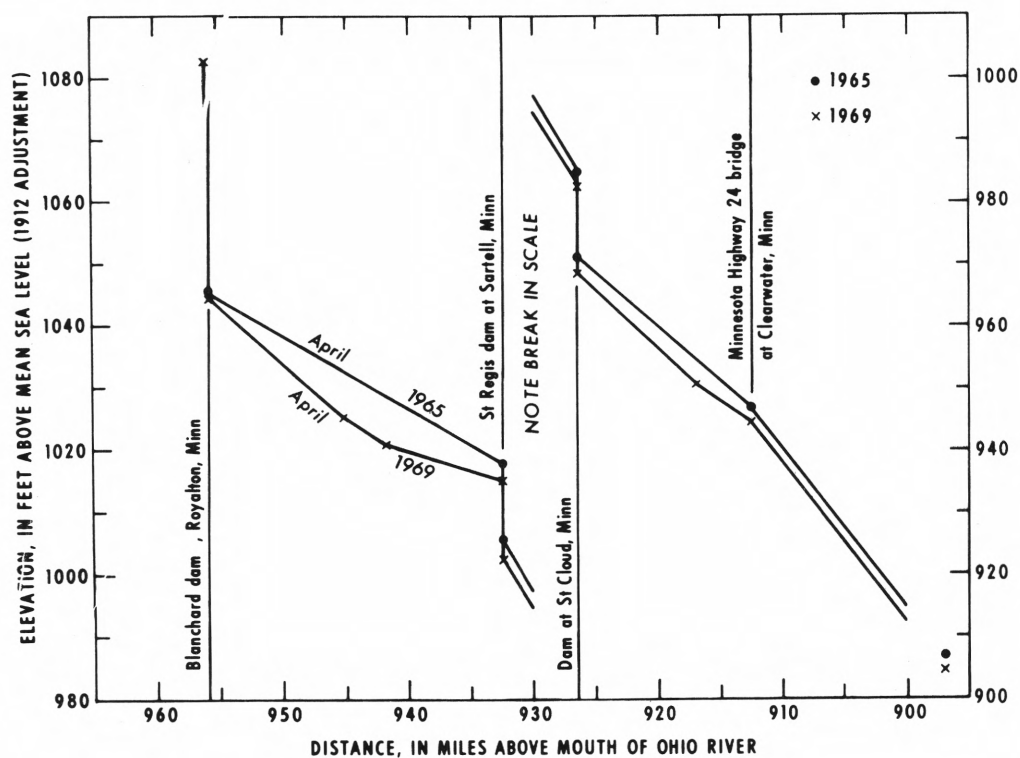


Figure 43.--Flood-crest profiles, Mississippi River, mile 956 to 840.

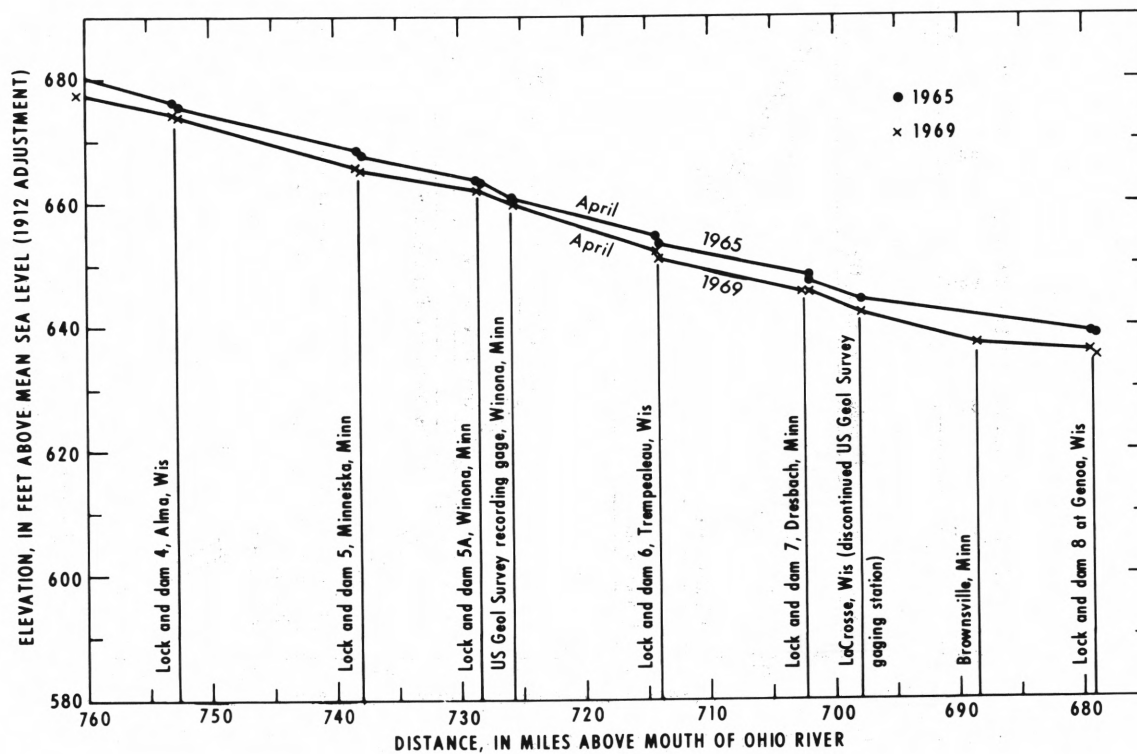
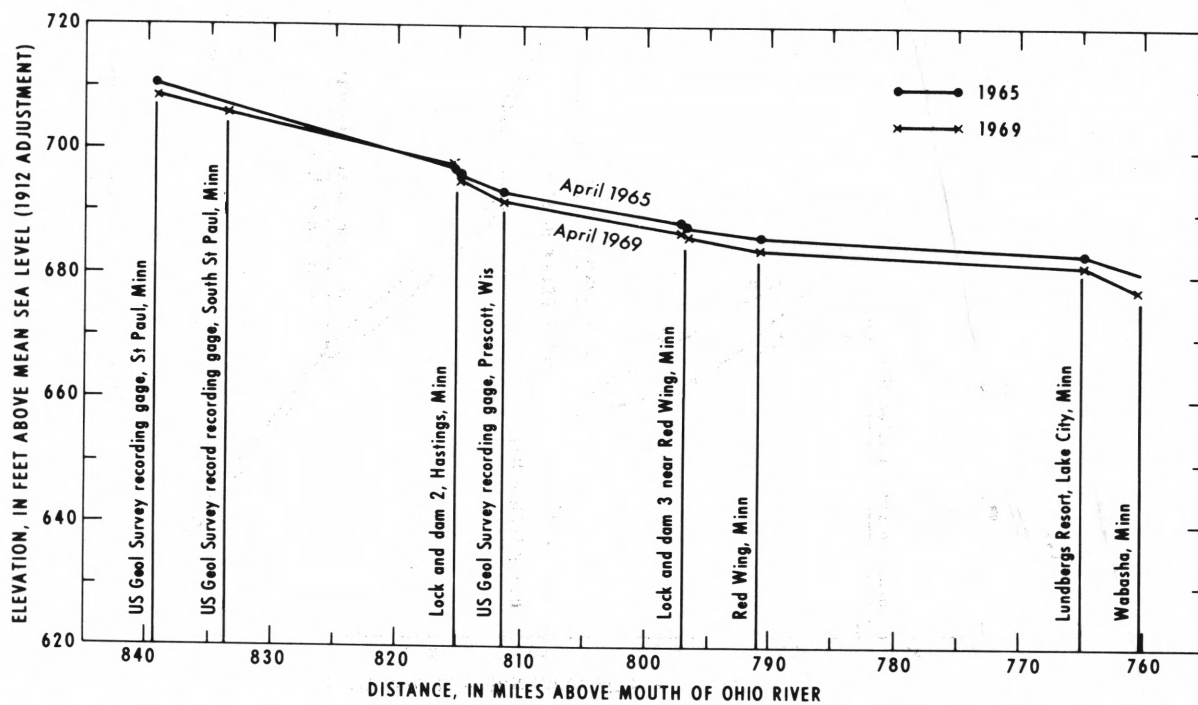


Figure 44.--Flood-crest profiles, Mississippi River, mile 840 to 680.

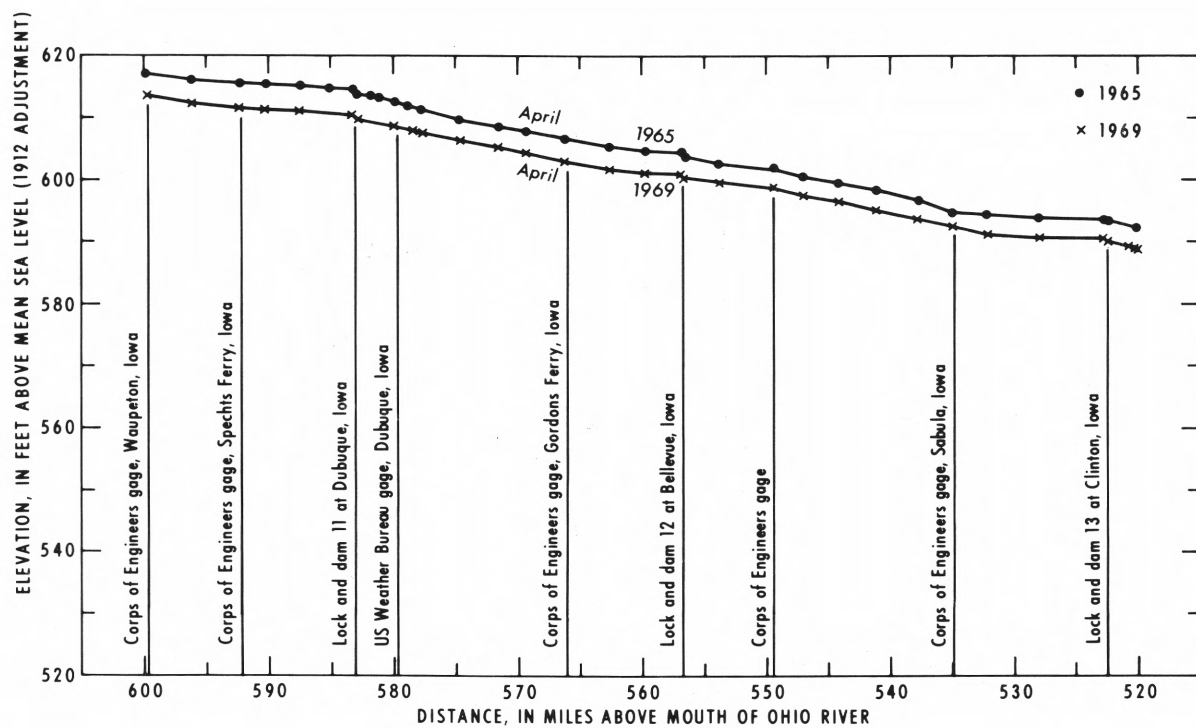
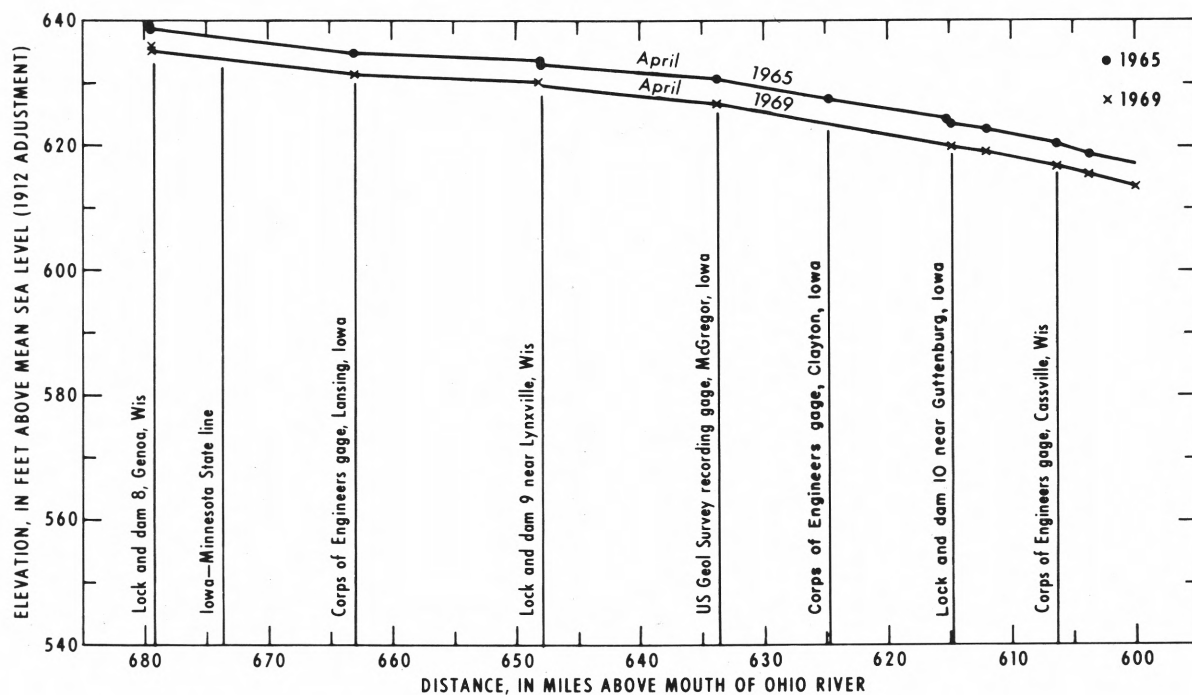


Figure 45.--Flood-crest profiles, Mississippi River, mile 680 to 520.

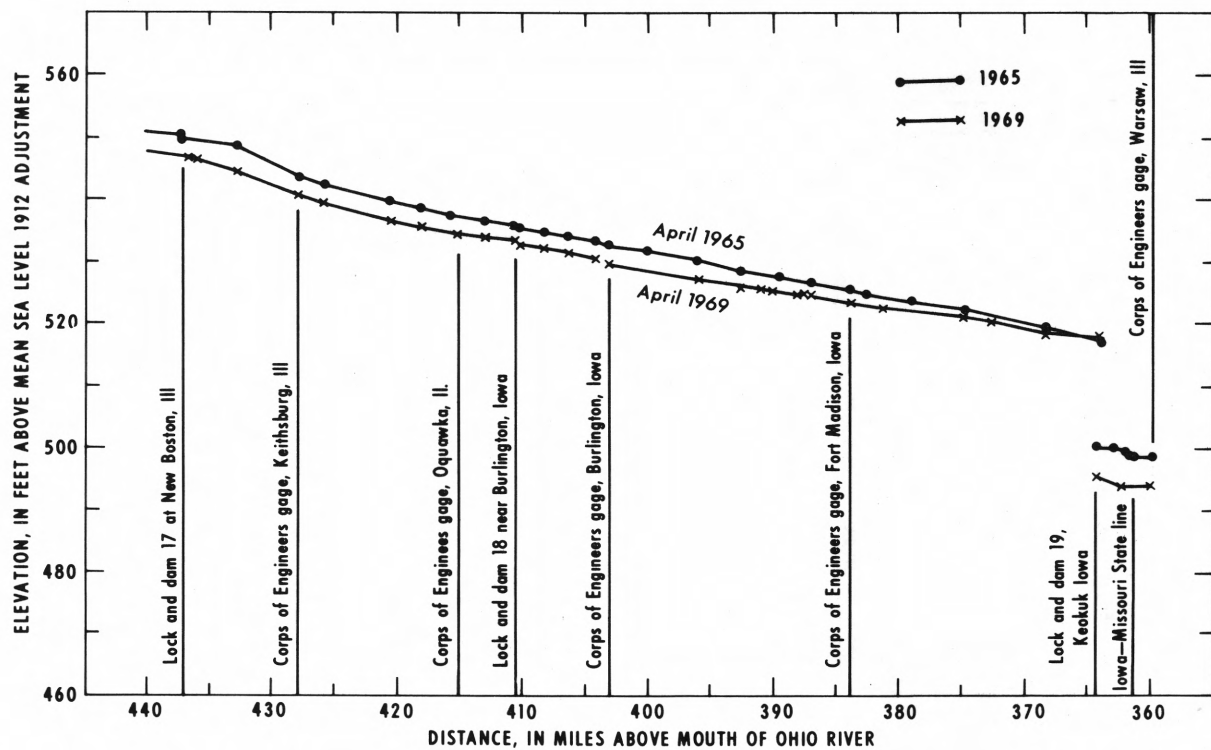
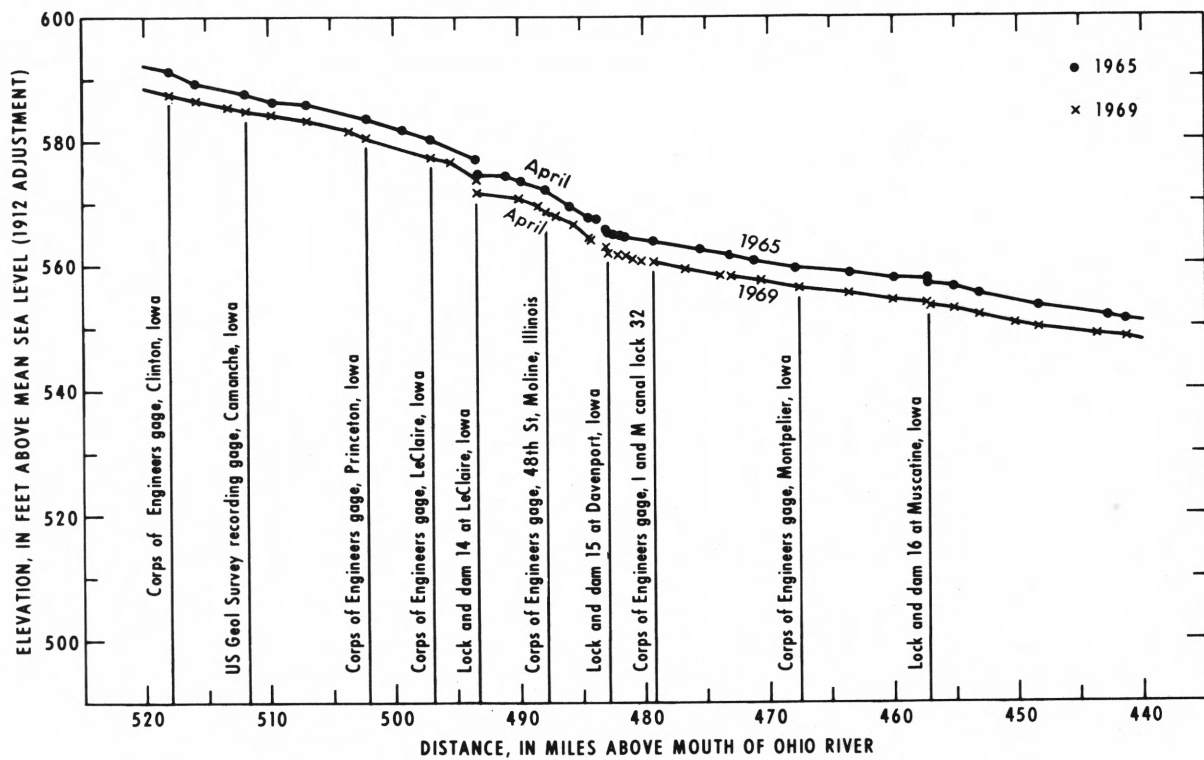


Figure 46.--Flood-crest profiles, Mississippi River, mile 520 to 360.

Four levees were constructed in Jackson under the supervision of the Corps of Engineers in the expectation that the river would crest at a level between 21 and 22 feet on April 12. Fortunately the river crested somewhat lower than anticipated, at 19.45 feet on April 11. Nevertheless, considerable flooding occurred in Jackson. For several days the State Street bridge, 1 of 3 bridges across the West Fork Des Moines River, was the only one open in the town and only emergency traffic was permitted. Figure 47 shows flooding in Jackson and water over U.S. Highway 16 which runs from left to right through the center of the picture. About 20 families were evacuated during the flood and about a dozen business establishments were closed, but the municipal power-plant was saved from serious damage. Many of the townspeople and farmers from the surrounding area were involved in the flood fight to prevent further damage from occurring. Some farm families and their livestock were also forced to evacuate. One rescue operation near Okabena, about 30 miles west of Jackson, involved floating out 200 hogs to higher ground.

The recurrence intervals of maximum discharges or ratios to the 50-year flood in the West Fork Des Moines River basin gradually decreased at successive gaging stations downstream from Jackson. At the gage at Humboldt, Iowa, the discharge of 18,000 cfs was 1.18 times the 50-year flood. The East Fork Des Moines River experienced only minor flooding. On this stream the peak discharge near the mouth (gaging station at Dakota City, Iowa) was a 3-year flood; however, 5 days later when the West Fork peak reached its mouth the discharge had dropped only about 20 percent. At the gaging station on the Des Moines River at Fort Dodge, Iowa, about 16 miles downstream from the confluence of the East and West Forks of the Des Moines River, only a 5-year flood was experienced.

Some minor protective diking was required in cities and towns along the West Fork Des Moines River in Iowa. Most of this diking was successful in preventing damage from the flood. In this reach of the river, highway traffic could cross the river in only three locations for several days at and near the peak. These places were at Estherville, Emmetsburg (but only by fording the flow of water over U.S. Highway 18), and Humboldt.

Comparative discharge hydrographs of two highest floods of record at selected gaging stations on West Fork Des Moines River are shown in figure 48. Flood-crest elevations were obtained on the West Fork Des Moines River and are tabulated in table 6. Flood-crest profiles are shown in figures 49 and 50.



Figure 47.--Flooding of West Fork Des Moines River at Jackson, Minn. Photograph by Owen Ensrud, Jackson, Minn.

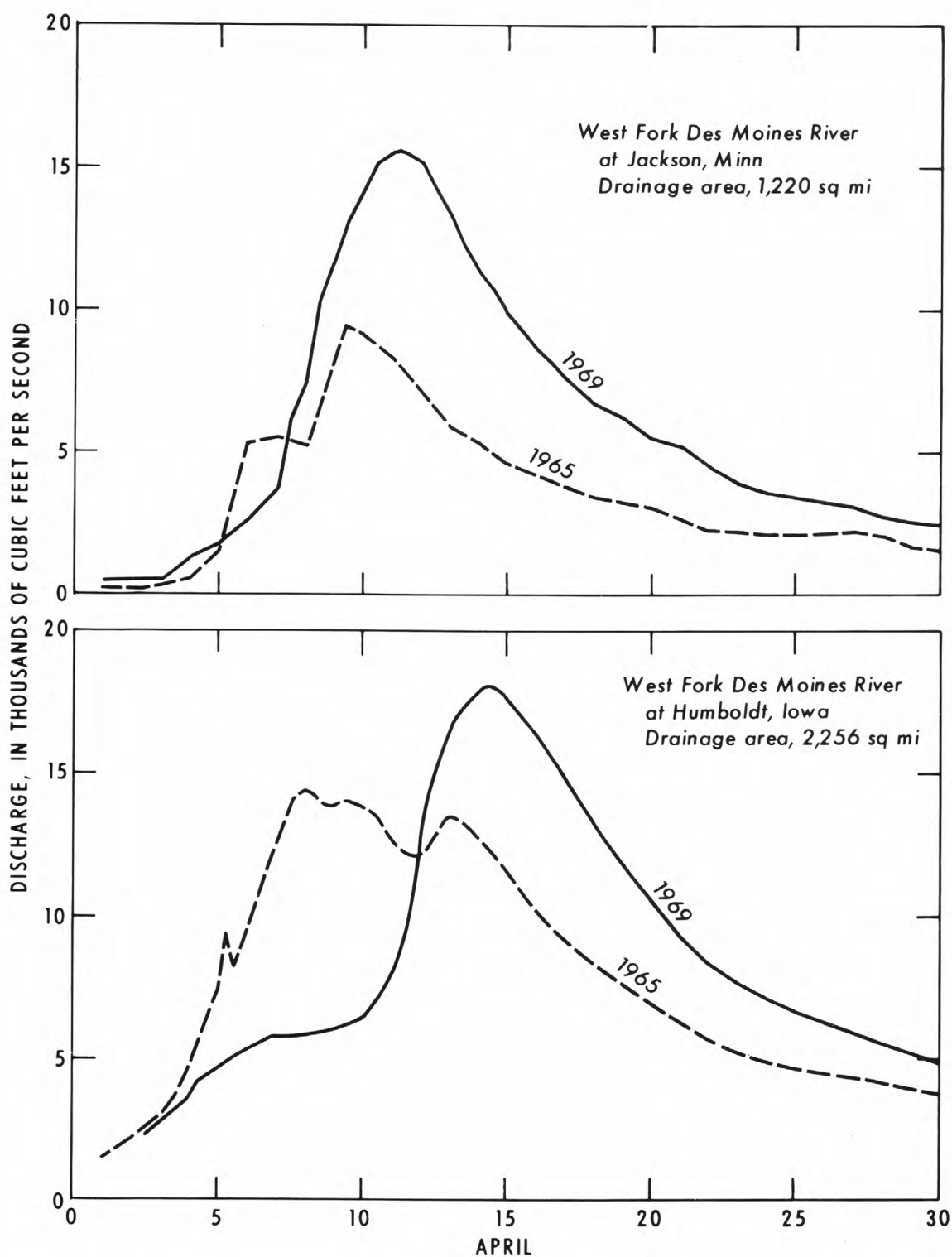


Figure 48.--Comparative discharge hydrographs of two highest floods of record at selected gaging stations on West Fork Des Moines River.

Table 6.--Flood-crest elevations, West Fork Des Moines River

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At Windom, Minn ¹		Apr. 11	
Mouth of Perkins Cr.	448.15		1353.7
Hwy 62 bridge	447.04		
upstream			1353.0
downstream			1352.0
Dam (crest 1344 ft.)	446.8		--
Hwy 60 & 71 bridge	446.55		
upstream			1351.4
downstream			1350.5
C& NW RR bridge	446.32		
upstream			1349.6
downstream			1348.9
At Jackson, Minnesota ¹			
U.S. Highway 71 bridge	426.8		
upstream			1311.4
downstream			1310.3
State Street bridge	426.3		
upstream			1309.3
downstream			1308.6
Ashley Street bridge	426.1		
upstream			1308.5
downstream			1308.0
Power plant dam	426.0		
upstream			1307.8
downstream			1306.9
U.S. Geological Survey gage	425.96	Apr. 11	1307.2
	425.6		1306.5
Petersburg Street bridge	425.5		1306.4
Iowa Minnesota State Line	413.55		
In SW $\frac{1}{4}$ sec.8, T.100 N., R.34 W., about 1.1 miles below Minnesota-Iowa State line	412.8		1280.91
At bridge on county road 4 miles northwest of Estherville, Iowa	409.8		
upstream			1276.18
downstream			1275.14

¹Furnished by Corps of Engineers

Table 6.--Flood-crest elevations, West Fork Des Moines River--Continued

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road 2½ miles north of Estherville, Iowa	407.4	Apr. 12	
upstream			1270.38
downstream			1270.00
At Estherville, Iowa			
bridge on extension of Fourth Street	404.9		
upstream			1267.86
downstream			1267.02
riverward end of Fourth Avenue	404.6		1266.75
Chicago, Rock Island RR bridge			
downstream	404.6		1266.18
bridge on State Highway 9	404.4		
upstream			1266.30
downstream			1265.46
U.S. Geological Survey recording gage	404.2		1265.23
bridge on State Highway 4	402.9		
upstream			1262.63
downstream			1260.95
Chicago, Rock Island RR bridge			
downstream	402.7		1259.14
At bridge on county road 3½ miles southeast of Estherville, Iowa	399.5		
upstream			1252.76
downstream			1251.82
At bridge on county road at east edge of Wallingford, Iowa	396.6		
upstream			1245.28
downstream			1244.14
At bridge on county road 3 miles south of Wallingford, Iowa	393.1		
upstream			1236.80
downstream			1236.25
In SE¼ sec.33, T.98 N., R.33 W., 1½ miles northeast of Graettinger, Iowa	390.8		1233.13

Table 6.--Flood-crest elevations, West Fork Des Moines River--Continued

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road B14 at east edge of Graettinger, Ia. upstream downstream	389.7		1232.19 1231.08
At Chicago, Rock Island & Pacific R.R. bridge at southeast edge of Graettinger, Iowa upstream downstream	388.9		1229.80 1228.50
At bridge on county road 4 miles south of Graettinger, Iowa upstream downstream	385.0		1219.64 1219.38
In NW $\frac{1}{4}$ sec.2, T.96 N., R.33 W., 5 $\frac{1}{2}$ miles southeast of Graettinger, Iowa	383.4		1215.51
At bridge on U.S. Highway 18 near northwest corner of Emmetsburg, Iowa upstream downstream			1211.12 1210.46
At Chicago, Milwaukee, St. Paul & Pacific R.R. bridge 1 $\frac{3}{4}$ miles west of Emmetsburg, Iowa upstream	379.8		1208.78
At bridge on county road 1 $\frac{3}{4}$ miles west of Emmetsburg, Iowa upstream downstream	379.6		1207.12 1206.30
In SW $\frac{1}{4}$ sec.26, T.96 N., R.33 W., 2 $\frac{1}{4}$ miles southwest of Emmetsburg, Iowa	378.4		1204.40

Table 6.--Flood-crest elevations, West Fork Des Moines River--Continued

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road N.38, 2½ miles southwest of Emmetsburg Iowa	377.6		
upstream			1202.40
downstream			1201.80
At bridge on State Highway 4, 3 miles south of Emmetsburg, Iowa	375.6	Apr. 12	
upstream			1195.90
downstream			1195.18
In NE¼ sec.7, T.95 N., R.32 W., 3½ miles southeast of Emmetsburg Iowa	375.2		1193.68
In SE¼ sec.17, T.95 N., R.23 W., 5½ miles southeast of Emmetsburg, Iowa	373.0		1187.23
At bridge on county road 5 miles west of Rodman, Iowa	372.1		
downstream			1183.47
At bridge on county road 2½ miles southwest of Rodman, Iowa	369.2		
upstream			1173.51
downstream			1173.18
At bridge on county road B55, 1½ miles southwest of Rodman, Iowa	367.1		
upstream			1166.08
downstream			1165.02
At bridge on county road 3½ miles south of Rodman, Iowa	365.0		
upstream			1159.84
downstream			1159.32
At bridge on county road B63, 4½ miles west of West Bend, Iowa	363.4		
upstream			1155.52
downstream			1154.73

Table 6.--Flood-crest elevations, West Fork Des Moines River--Continued

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road 4 miles southwest of West Bend, Iowa upstream downstream	362.0		1151.49 1151.24
At bridge on county road 4 miles south of West Bend, Iowa upstream downstream	357.8		1141.10 1140.68
At bridge on State Highway 15, 4½ miles south of West Bend, Iowa upstream downstream	356.6		1137.58 1136.38
At bridge on county road C18, 4½ miles northeast of Rolfe, Iowa upstream downstream	353.4		1130.45 1129.27
At bridge on county road C26 1½ miles northwest of Bradgate, Iowa upstream downstream	350.8		1123.54 1123.27
At bridge on county road ½ mile west of Bradgate, Iowa upstream downstream	349.9		1121.28 1120.61
At bridge on county road 1 mile south of Bradgate, Iowa upstream downstream	348.4		1118.64 1118.47
At bridge on county road P23, 3 miles northwest of Rutland Iowa	344.2		1109.60
At dam at Rutland, Iowa upstream downstream	340.7		1101.29 1097.51

Table 6.--Flood-crest elevations, West Fork Des Moines River--Continued

Location	Miles above mouth of Des Moines R.	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road at south edge of Rutland, Iowa upstream downstream	340.3		1096.53 1094.56
At bridge on county road 2 miles northwest of Humboldt, Iowa upstream downstream	337.50		1086.71 1085.90
At bridge on State Highway 3, 2 miles west of Humboldt, Iowa upstream downstream	336.8		1084.82 1084.48
At dam at Humboldt, Iowa upstream downstream	335.2		1079.14 1075.55
At bridge on U.S. Highway 169 in Humboldt, Iowa upstream downstream	334.8		1072.36 1072.25
At bridge on Sumner Avenue in Humboldt, Iowa upstream downstream	334.4		1070.71 1069.5
At U.S. Geological Survey record- ing gage at bridge on First Avenue in Humboldt, Iowa upstream downstream	334.3	Apr. 14	1069.5 1069.17
At riverward end of Ninth Avenue South in Humboldt, Iowa	333.7		1066.44
At bridge on county road 3 miles south of Humboldt, Iowa upstream downstream	330.8		1053.82 1053.26

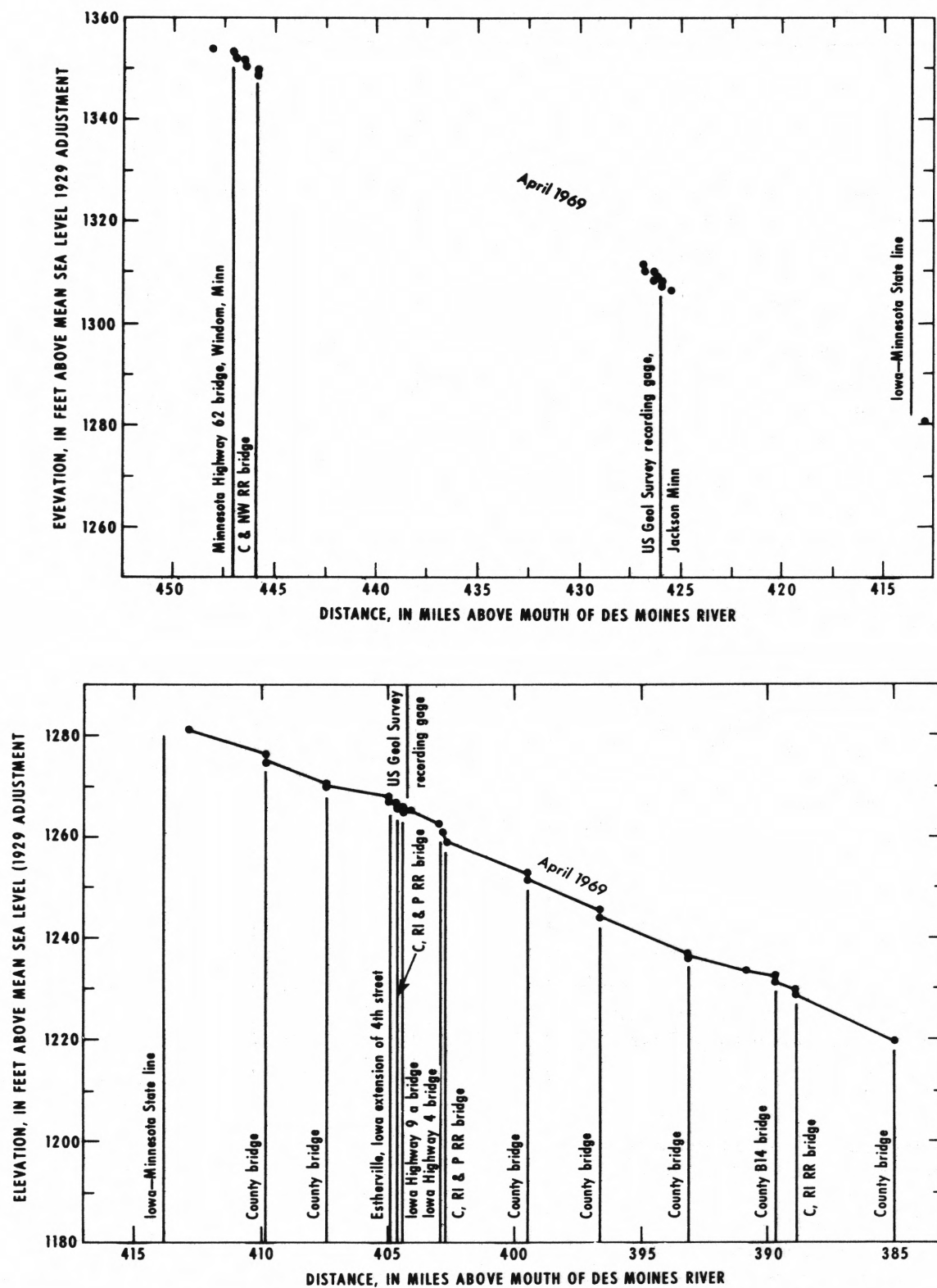


Figure 49.--Flood-crest profiles, West Fork Des Moines River, mile 448 to 385.

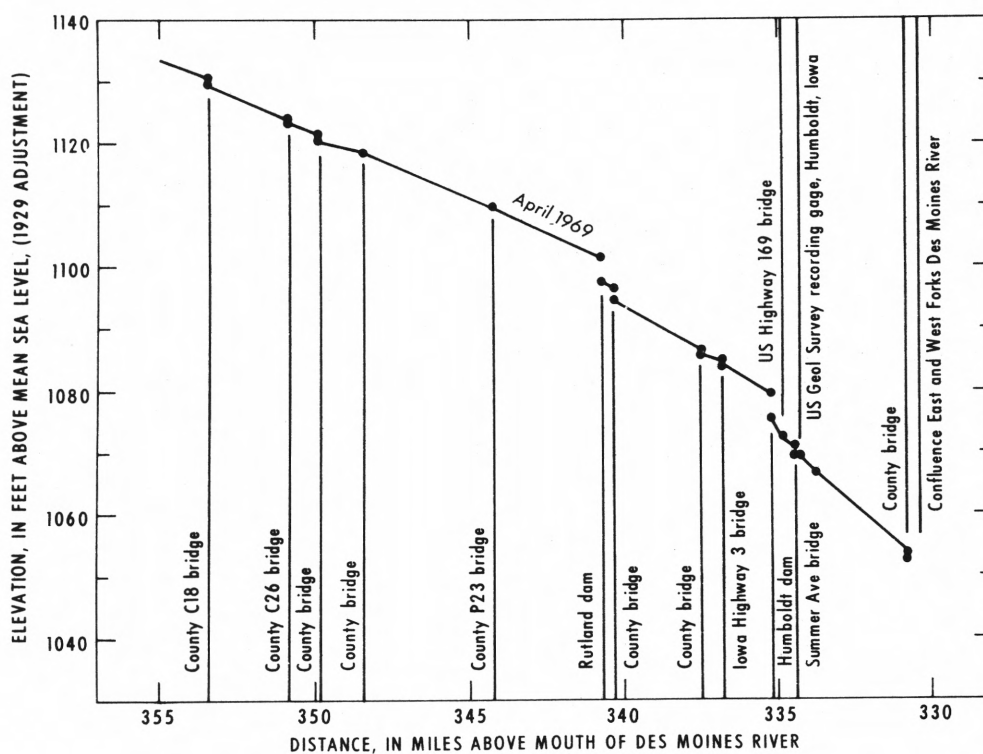
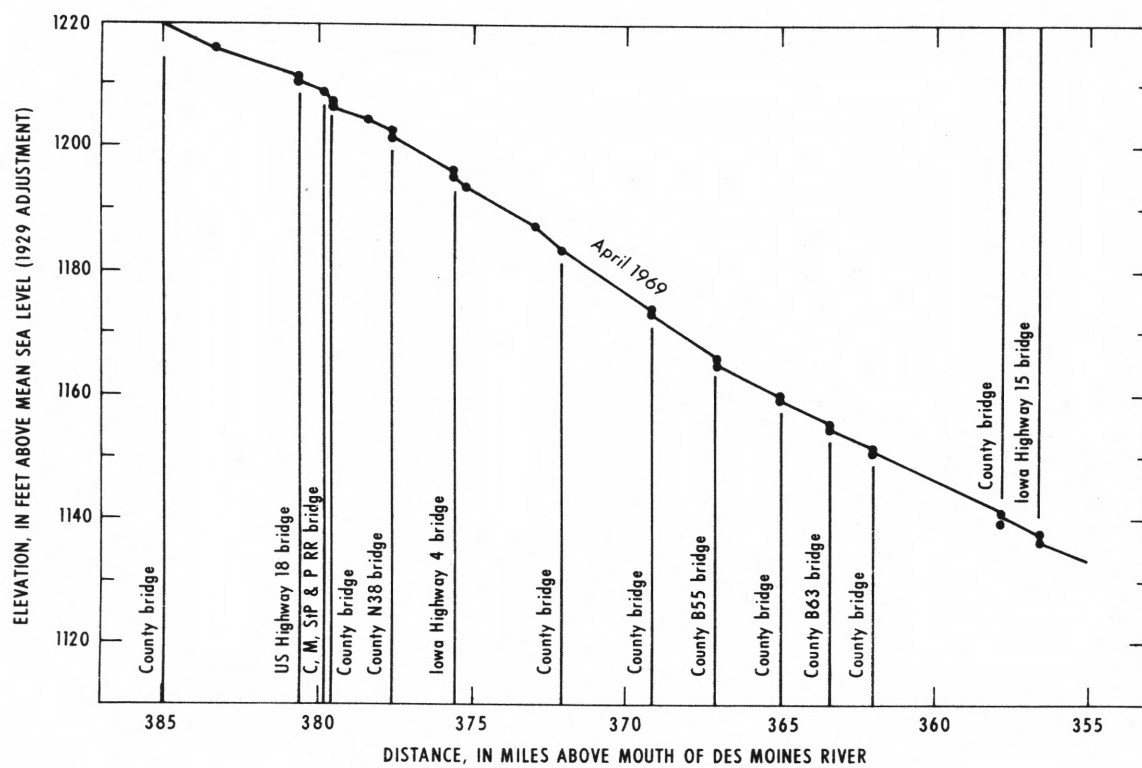


Figure 50.--Flood-crest profiles, West Fork Des Moines River, mile 385 to 330.

Missouri River Basin

There was a flood potential over most of the Missouri River basin in North Dakota throughout the winter; but alternate freezing and thawing in March alleviated or removed the threat. Some flooding occurred, however, in the main-stem tributaries flowing from the east, the downstream reaches of the western tributaries, and the James River. Significant runoff began early in April and most of the smaller tributaries had crested by April 7. Recurrence intervals of peaks on the eastern tributaries ranged from 5 to 20 years, but most of them were less than 10 years. Little flood damage occurred in this area, although several houses and some equipment were flooded by Beaver Creek in the low-lying areas of Linton, North Dakota.

In the western tributaries, a flood of 10-year recurrence interval occurred in the Knife River at Hazen, North Dakota. Some flooding also occurred in the lower portions of other tributaries flowing from the west. About 10 houses were flooded at Zap, North Dakota, by Spring Creek which is tributary to the Knife River. Several farm homes in this area were also damaged. The city of Mandan, North Dakota, was saved from major flooding by dikes. Total damages in the Heart and Knife River basins were \$200,000 and \$100,000, respectively.

Flooding was more severe in the James River basin. Pipestem Creek caused a large amount of damage in the city of Jamestown, North Dakota. The construction of Jamestown dam on the upstream side of Jamestown and 4 miles upstream from Pipestem Creek was completed in 1953. In the 1969 flood, water was impounded in Jamestown Reservoir during the critical flood period, yet the peak at the gaging station in Jamestown (fig. 51) was nearly the same as the previous high in 1950. Had it not been for the storage in Jamestown Reservoir, peak discharge would probably have been 500 to 1,000 cfs higher. Nearly a third of the city was inundated (fig. 52). An estimated 960 homes, 65 businesses, and 15 public utilities were flooded and several basements collapsed. The North Dakota Crippled Children's Home in northwest Jamestown suffered major damage. Hastily built dikes proved ineffective and soon washed away. Total urban damages in Jamestown were more than \$1.5 million.

In South Dakota, record snowfall for December was general throughout most of the James, Vermillion, and Big Sioux River basins. The additional snow that fell during January and February resulted in record seasonal snowfall for much of this

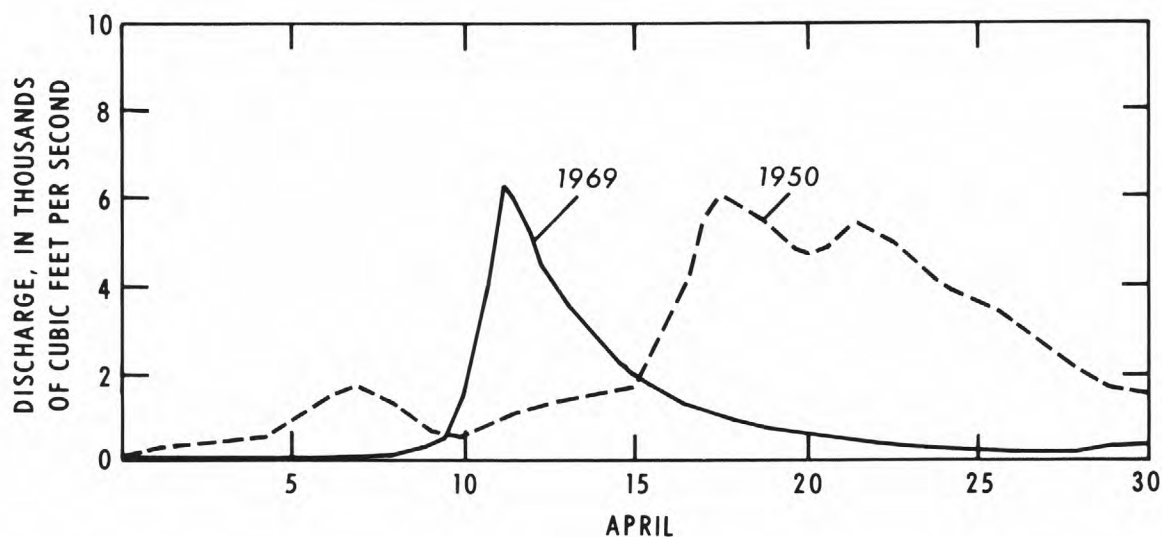


Figure 51.--Comparative discharge hydrographs of two highest floods of record on James River at Jamestown, N. Dak.

area. No significant runoff occurred during March as temperatures stayed below seasonal averages and streams remained covered with a blanket of ice and snow.

Runoff increased on April 1 as temperatures began to climb and by Easter Sunday, April 6, flooding was general over most of the Missouri River tributaries; but the larger rivers remained ice-covered. Ice breakup began on the lower reaches of the James River and proceeded upstream as tributary inflow reached the main stream.

Flooding in the James River basin began April 2 on the upper reaches of Snake, Turtle, Sand, and Firesteel Creeks. The station on the James River at Columbia, South Dakota, in the northern part of the State, was in backwater from the Elm River until April 15. A maximum discharge of 12,600 cfs (1.61 times the 50-year flood) occurred on the Elm River at Westport, South Dakota, on April 10. Some of this water was forced to flow upstream past Columbia in the James River channel because of backwater from downstream tributaries. Similarly reverse flow occurred in the James River at Ashton, South Dakota, because of backwater from Snake and Turtle Creeks. The peak stage of the James River at Huron, South Dakota, was 16.70 feet, 0.9 foot higher than the previous maximum in 30 years of record, but considerably lower than the highest historical peak of 19.8 feet which occurred in 1881. The 1969 peak discharge was almost 1 1/2 times greater than the previous maximum during the period of record. The James River remained in flood throughout April. Within the basin a discharge of 2.27 times the 50-year flood occurred in the



Figure 52.--Aerial photograph of flooding in Jamestown, North Dakota, April 12, 1969. Photograph by K. D. MacKichan and Associates, Grand Forks, N. Dak.

small basin (drainage area, 5.41 square miles) of Matter Creek tributary near Orient, South Dakota. In the lower basin, the discharge of the James River near Forestburg, South Dakota, (drainage area, 13,810 square miles, contributing) was 1.02 times the 50-year flood. Total flood damages in the James River basin exceeded \$16 million.

Significant tributary inflow began in the upper Vermillion River basin on April 4 and discharges increased rapidly. A maximum discharge of 9,880 cfs (16-year recurrence interval) occurred at the downstream station near Wakonda, South Dakota, on April 8. Total damages in the Vermillion River basin were about \$1 million.

The Big Sioux River was ice-free in the downstream reaches on April 1. The breakup proceeded in an upstream direction, and by April 9 the entire river was free of ice. Tributary inflow generally began on April 4 in the lower part of the basin and on April 6 in the upper part. Runoff was accelerated by more than an inch of rain which fell in the upper part of the basin during the night of April 7-8 (fig. 5). With the exception of the gaging station near Watertown, South Dakota, peak discharges at all main-stem stations exceeded the 50-year flood. In the Watertown area, Lake Kampeska, upstream from the gaging station, acts as an off-channel storage area. On April 8 a discharge measurement near the peak was obtained in the channel which serves as the inlet and outlet to Lake Kampeska, and also at the gaging station 1 mile downstream. These measurements showed that 3,500 cfs was flowing into the lake, but only 1,750 cfs was passing the gaging station. Maximum discharge at the gaging station near Brookings, South Dakota, was 3.2 times greater than the previous flood of record and 2.61 times the 50-year flood; and at Dell Rapids, South Dakota, it was 2.3 times the previous flood of record and 2.56 times the 50-year flood. Throughout the entire reach from Watertown to Sioux Falls, discharge of the Big Sioux River was more than twice the previous maximum of record which occurred in the spring of 1962.

Watertown (population 15,000) suffered from the flooding Big Sioux River. The homes of about 200 families in southeastern Watertown were surrounded by flood waters over a foot deep on April 8, and about 10 families were evacuated. Total damages in the city were about \$270,000. Nine families were evacuated in the Brookings, South Dakota area, and an additional 4 families in Dempster and 5 in Estelline. Flandreau, South Dakota, (population 2,100) south of Brookings was isolated by flood waters and families in low-lying areas were evacuated. More than 50 families were evacuated in Moody County where Flandreau is located. Water ran down the main

street of Renner, South Dakota, as a result of the Big Sioux River backing up into Silver Creek, and the 50 residents of the town were evacuated on April 8. Dell Rapids, South Dakota, located between Flandreau and Renner, was flooded and a number of residents were evacuated. More than a hundred National Guard troops were called out to help with the flood emergency in southeastern South Dakota.

Discharge of the Big Sioux River from Watertown to Sioux Falls, South Dakota, was more than twice the previous maximum of record which occurred in the spring of 1962.

At Sioux Falls the Corps of Engineers has constructed extensive flood-protection works consisting of a bypass channel on the north edge of the city, and extensive dike and levee systems along the river within the city. These were reinforced with splashboards in the weeks prior to the flood. At the peak of the flood the normal low-water channel around the city was carrying about 9,000 cfs while nearly 30,000 cfs was flowing in the bypass channel. The maximum discharge at Akron, Iowa, also occurred on April 9 as a result of inflow from tributaries downstream from Sioux Falls. At this location the maximum discharge was 80,800 cfs, 1.22 times the 50-year flood and 1 1/2 times greater than the previous flood of record.

Discharge of the Missouri River at Yankton, South Dakota, and downstream was partially controlled during the flood period by Gavins Point Dam, located just upstream from the city. Water was stored in Lewis and Clark Lake above the dam, thereby reducing the discharge at Yankton from 28,000 cfs on April 1 to 6,000 cfs on April 9. Later, as tributary inflow decreased, the discharge through the dam was allowed to increase to a maximum of 33,600 cfs on April 25. Because of the many reservoirs on the Missouri River, there was no significant flooding in the main stem.

The Rock River which drains part of southwestern Minnesota and northwestern Iowa is the principal tributary of the Big Sioux River between Sioux Falls, South Dakota, and Sioux City, Iowa, where the Big Sioux River joins the Missouri River.

No gaging stations providing daily discharge are maintained in the Rock River basin in Minnesota, but it was apparent early in April that floods of outstanding magnitude were occurring in the basin. As a consequence an effort was made to obtain the maximum stage and discharge at Luverne, Minnesota, where a gaging station had been operated during the years 1911-14. Although a discharge measurement was not obtained at the peak, sufficient measurements were made at high stage to define the upper part of the rating, which was

extended logarithmically to the maximum stage. The maximum discharge of 19,000 cfs in the 1969 flood was 1.7 times the previous known maximum which occurred in June 1914. It is difficult to compare the 1969 peak with previous maximum discharges because of the absence of comparable records in the same part of the basin. Based on downstream discharges of the Big Sioux River and precipitation records, however, it would appear that the 1969 discharge of the Rock River in both Minnesota and Iowa was the highest in at least 40 years.

Luverne is the county seat of Rock County, the only county in Minnesota which drains wholly to the Missouri River. Travel throughout the county was seriously curtailed by the flood. East-west Interstate Highway 90 and U.S. Highway 16 were closed temporarily as well as north-south U.S. Highway 75. Numerous county and township roads were flooded and many bridges were washed out. The Chicago and Northwestern Railway was forced to cease its operations temporarily because of a washed-out bridge over the Rock River near Luverne. Total road and bridge damage in the county was estimated to be \$132,000.

The maximum discharge at Rock Rapids, Iowa, on April 8 was 29,000 cfs, a flood of 50-year recurrence interval. This runoff was largely from the drainage area in Minnesota since Rock Rapids is only about 5 miles downstream from the Minnesota-Iowa State line.

A dike along the city park in Rock Rapids was breached resulting in damage to the park from sand and debris deposited by the flood water. Several low areas including the county fair grounds were flooded (fig. 53). Flood damages in Rock Rapids were estimated to be about \$7,000.

The Little Rock River rises just west of Worthington, Minnesota, and flows in a southwesterly direction until it joins the Rock River about 18 miles downstream from Rock Rapids. An indirect discharge measurement made at Little Rock, Iowa, about 5 miles downstream from the Minnesota-Iowa State line, showed the maximum discharge on April 6 to be 9,100 cfs. a 31-year flood. On April 7, the peak of the flood in the Little Rock River reached Doon, Iowa, near the mouth of the river. The discharge was 14,300 cfs and recurrence interval was 17 years. The maximum discharge in the Rock River near Rock Valley, Iowa, 8 miles downstream from the mouth of the Little Rock River, also occurred on April 7. Here the discharge was 40,400 cfs, a 42-year flood. This discharge was the greatest in 20 years of record, and 1.4 times greater than the previous maximum which occurred in March 1962. Comparative discharge hydrographs showing the two highest floods of record are shown in figure 54.



Figure 53.--Flooding of Rock River at Rock Rapids, Iowa, April 7, 1969.
Photograph by U.S. Army Corps of Engineers, Omaha district.

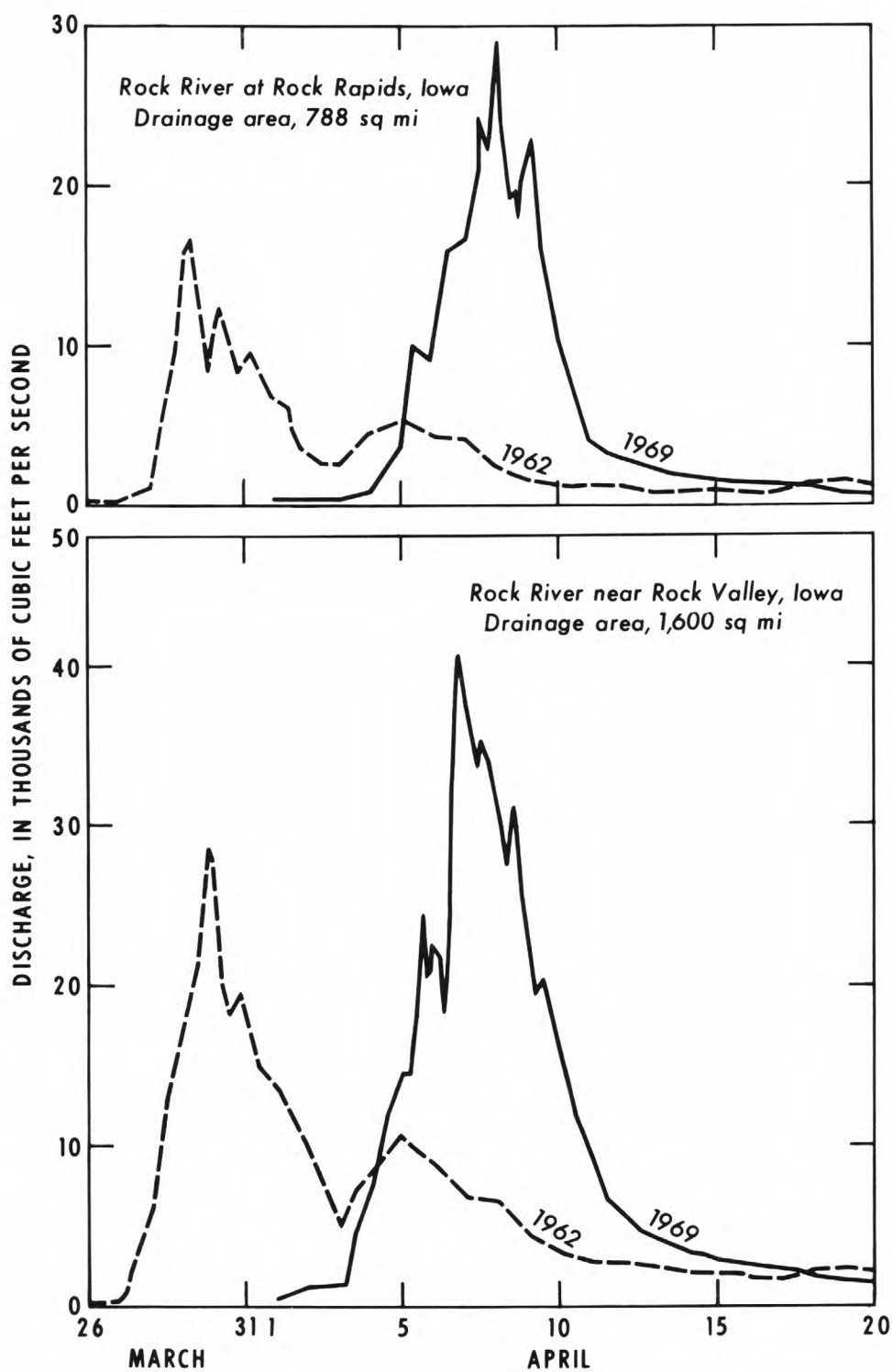


Figure 54.--Comparative discharge hydrographs of two highest floods of record at Rock River gaging stations.



Figure 55.--Flooding of Rock River at Rock Valley, Iowa, April 10, 1969.
Photograph by U.S. Army Corps of Engineers, Omaha district.

A hastily built dike around the west and southwest sides of Rock Valley was effective in excluding flood water from city residences except for seep water reported in 15 to 20 homes. Figure 55 shows a general view of the flooding at Rock Valley where the total urban damages were estimated to be \$30,000. Total damage in the Rock and Little Rock River basins was \$795,000.

Maximum flood elevations were obtained on the Rock and Little Rock Rivers and flood profiles were drawn. Tables 7 and 8 provide data pertaining to flood elevations and figures 56 to 58 show the flood-crest profiles.

Table 7.--Flood-crest elevations, Rock River

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At bridge at Minnesota-Iowa State line	49.8		
upstream			1368.7
downstream			1368.5
In SW $\frac{1}{4}$ sec.16, T.100 N., R.45 W., 3 miles north of Rock Rapids, Iowa	47.2		1360.0
At bridge on county road A16, 2 miles north of Rock Rapids, Iowa	45.4		
upstream			1355.0
downstream			1354.6
In SW $\frac{1}{4}$ sec.28, T.100 N., R.45 W., 1 $\frac{1}{4}$ miles north of Rock Rapids, Iowa	44.0		1348.0
In NW $\frac{1}{4}$ sec.33, T.100 N., R.45 W., 3/4 mile north of Rock Rapids, Iowa	43.2		1344.3

Table 7.--Flood-crest elevations, Rock River--Continued

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At Rock Rapids, Iowa			
north edge of town at bridge on tributary	42.8		1342.6
U.S. Geological Survey recording gage at dam in city park			
upstream	42.8	Apr. 8	1342.5
downstream	42.6		1341.0
Chicago, Rock Island and Pacific RR bridge,			
downstream	42.55		1340.8
entrance to Island Park	42.5		1340.8
bridge on State Highway 9	42.4		
upstream			1339.6
downstream			1339.4
riverward end South Second Avenue	42.3		1338.4
riverward end South Third Avenue	42.23		1338.3
County Fairgrounds	42.08		1337.3
County Fairgrounds	42.05		1337.0
County Fairgrounds	42.00		1336.9
riverward end South Seventh Street	41.45		1333.8
Illinois Central RR bridge	41.3		
upstream			1333.1
downstream			1332.6
At bridge on county road, 2 miles southeast of Rock Rapids, Iowa	39.8		
upstream			1326.0
downstream			1325.1
In SE $\frac{1}{4}$ sec.22, T.99 N., R.45 W., 3 $\frac{3}{4}$ miles southeast of Rock Rapids, Iowa	37.0		1314.4
At bridge on U.S. Highway 75, 5 $\frac{1}{2}$ miles south of Rock Rapids, Iowa	34.2		
upstream			1302.2
downstream			1300.0

Table 7.--Flood-crest elevations, Rock River--Continued

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At bridge on county road, 4 miles northeast of Doon, Iowa upstream downstream	32.6		1293.6 1292.9
In NW $\frac{1}{4}$ sec.24, T.98 N., R.46 W., 1 $\frac{1}{2}$ miles north of Doon, Iowa	29.1		1276.2
At bridge on county road, 1 mile north of Doon, Iowa upstream downstream	28.6		1275.1 1273.6
At bridge on county road near northwest corner of Doon, Iowa upstream downstream	27.7		1272.0 1271.4
At Great Northern RR bridge, $\frac{1}{2}$ mile northwest of Doon, Iowa upstream downstream	27.4		1269.8 1269.1
At county road bridge, 1 mile southwest of Doon, Iowa upstream downstream	25.6		1264.5 1264.3
Little Rock River (L. bank)	25.2		1263.0
At county road bridge K30 near north edge of Rock Valley, Iowa upstream downstream	19.0		1244.1 1242.6
In Rock Valley, Iowa at west end of 14th Street	18.2		1240.9

Table 7.--Flood-crest elevations, Rock River--Continued

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At Chicago, Milwaukee, St. Paul & Pacific RR bridge at west edge of Rock Valley, Iowa	17.6		1239.6 1237.4
upstream			
downstream			
In SE $\frac{1}{4}$ sec.19, T.97 N., R.46 W., near southwest corner of Rock Valley, Iowa	17.2		1235.9
At bridge on U.S. Highway 18, 1.8 miles west of Rock Valley, Iowa (USGS gaging station)	15.9	Apr. 7	1231.5 1228.8
upstream			
downstream			
In NW $\frac{1}{4}$ sec.35, T.97 N., R.47 W., 4 miles southwest of Rock Valley, Iowa	11.5		1220.4
At bridge on county road B20, 5 $\frac{1}{2}$ miles southwest of Rock Valley, Iowa	9.0		1213.7 1213.4
upstream			
downstream			
At bridge on county road, 7 $\frac{1}{2}$ miles southwest of Rock Valley, Iowa	6.4		1203.7 1203.1
upstream			
downstream			
In SW $\frac{1}{4}$ sec.20, T.96 N., R.47 W., 9 $\frac{1}{2}$ miles southwest of Rock Valley, Iowa	3.5		1195.0
At bridge on county road K18, 6 $\frac{1}{2}$ miles northeast of Hawarden, Iowa	0.8		1192.4

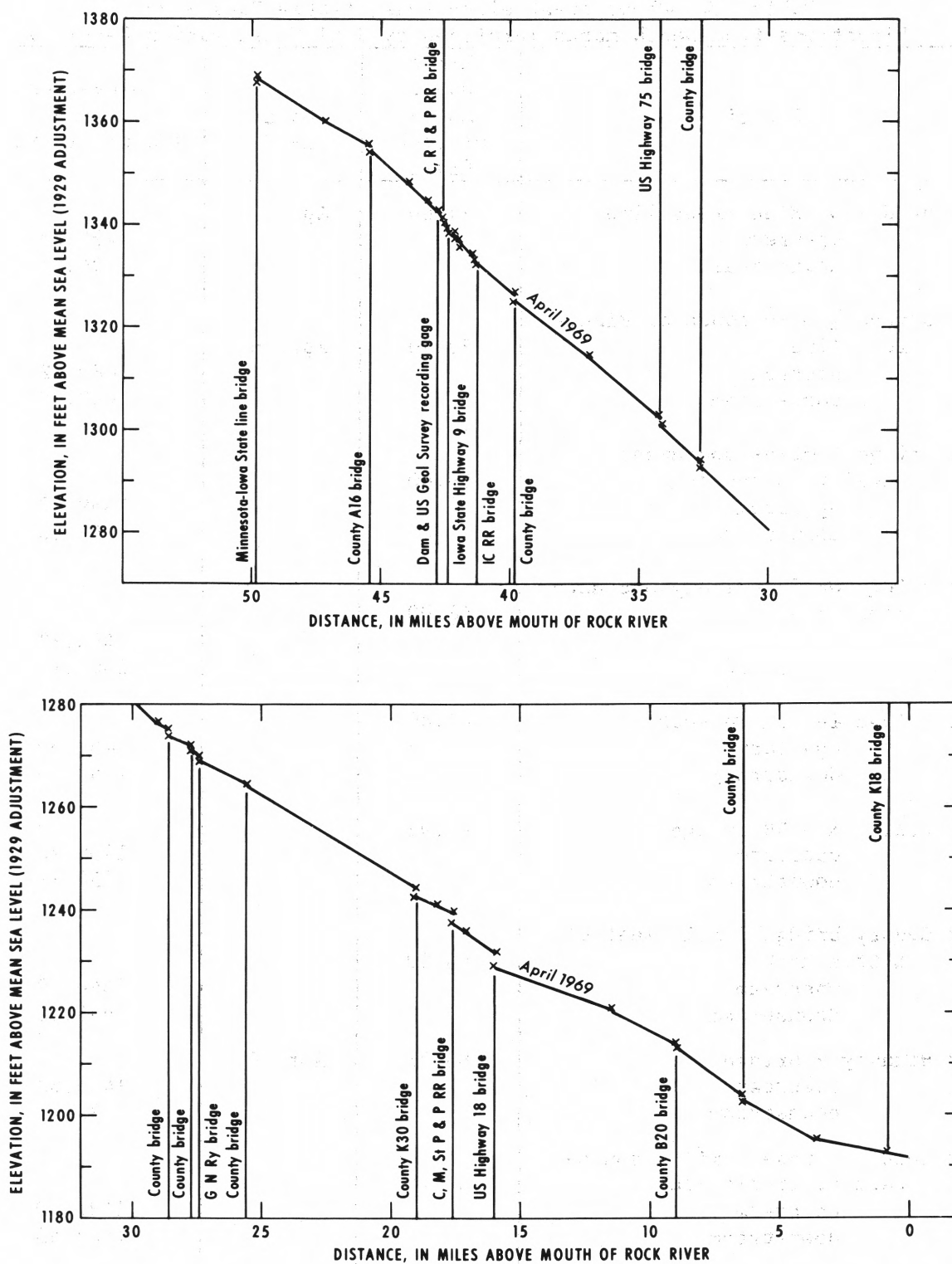


Figure 56.--Flood-crest profiles, Rock River, mile 50 to 0.

Table 8.--Flood-crest elevations, Little Rock River
(Elevations from bench marks furnished by Soil Conservation Service)

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At bridge on Minn.-Iowa line upstream	74.80	Apr. 6	1495.03
downstream			1494.41
At bridge $\frac{1}{2}$ mile south of Minn.- Iowa line	73.00	Apr. 6	
upstream			1489.72
downstream			1488.50
At bridge 4 miles southwest Bigelow, Minnesota	68.80		
upstream			1469.97
downstream			1467.60
At bridge on Osceola-Lyon county line	68.00		
upstream			1463.82
downstream			1463.12
At bridge in Little Rock	66.80		
upstream			1454.50
downstream			1453.65
At C.R.I. & P RR bridge	65.97		
upstream			1450.76
downstream			1450.11
At County bridge 1 mile west of Little Rock	65.20		
upstream			1446.29
downstream			1445.56
At Highway 9 bridge	63.78	Apr. 6	
upstream			1436.62
downstream			1435.02
At County bridge 2 miles south- west of Little Rock	62.00		
upstream			1426.10
downstream			1425.55
At County bridge 3.5 miles south- west of Little Rock	60.50		
upstream			1416.76
downstream			1415.85

Table 8.--Flood-crest elevations, Little Rock River--Continued
(Elevations from bench marks furnished by Soil Conservation Service)

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At County bridge 4 miles north- east of George upstream downstream	57.65		1398.69 1397.84
At County bridge 3 miles north- east of George upstream downstream	55.70		1389.91 1389.29
At County bridge 2 miles north- east of George upstream downstream	54.30		1383.60 1382.90
At County bridge 2.5 miles east of George upstream downstream	52.35		1376.59 1376.06
At County bridge 1 mile east of George upstream downstream	50.10		1364.40 1363.61
At I.C. RR bridge southeast of George upstream downstream	49.45		1359.68 1359.31
At County bridge south side of George upstream downstream	48.70	Apr. 6	1357.24 1355.98
At County bridge 2 miles south- west of George upstream downstream	45.80		1343.00 1342.16

Table 8.--Flood-crest elevations, Little Rock River--Continued
(Elevations from bench marks furnished by Soil Conservation Service)

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
At County bridge downstream of mouth of Otter Creek	42.06	Apr. 7	
upstream			1324.84
downstream			1323.69
At County bridge 5 miles south- west of George	38.47		
upstream			1312.74
downstream			1311.90
At County bridge 6 miles south- west of George	36.65		
upstream			1306.81
downstream			1306.56
At County bridge 5 miles north- east of Doon	34.52		
upstream			1298.28
downstream			1297.87
At County bridge 4 miles north- east of Doon	32.93		
upstream			1292.72
downstream			1292.06
At County bridge 3 miles east of Doon	30.65		
upstream			1285.58
downstream			1285.14
At Hwy 75 bridge	30.10		
upstream			1283.50
downstream			1282.62
At County bridge 1.5 miles east of Doon	27.90	Apr. 7	
upstream (L. bank)			1273.38
upstream (R. bank)			1272.26
downstream			1271.63
At County bridge 1 mile south of Doon	25.80		
upstream			1264.60
downstream			1263.88

Table 8.--Flood-crest elevations, Little Rock River--Continued
(Elevations from bench marks furnished by Soil Conservation Service)

Location	Miles above mouth of Rock River	Date 1969	Elevation in feet (datum of 1929)
Mouth of Little Rock R Crest elevation Rock River	25.25		1263.0

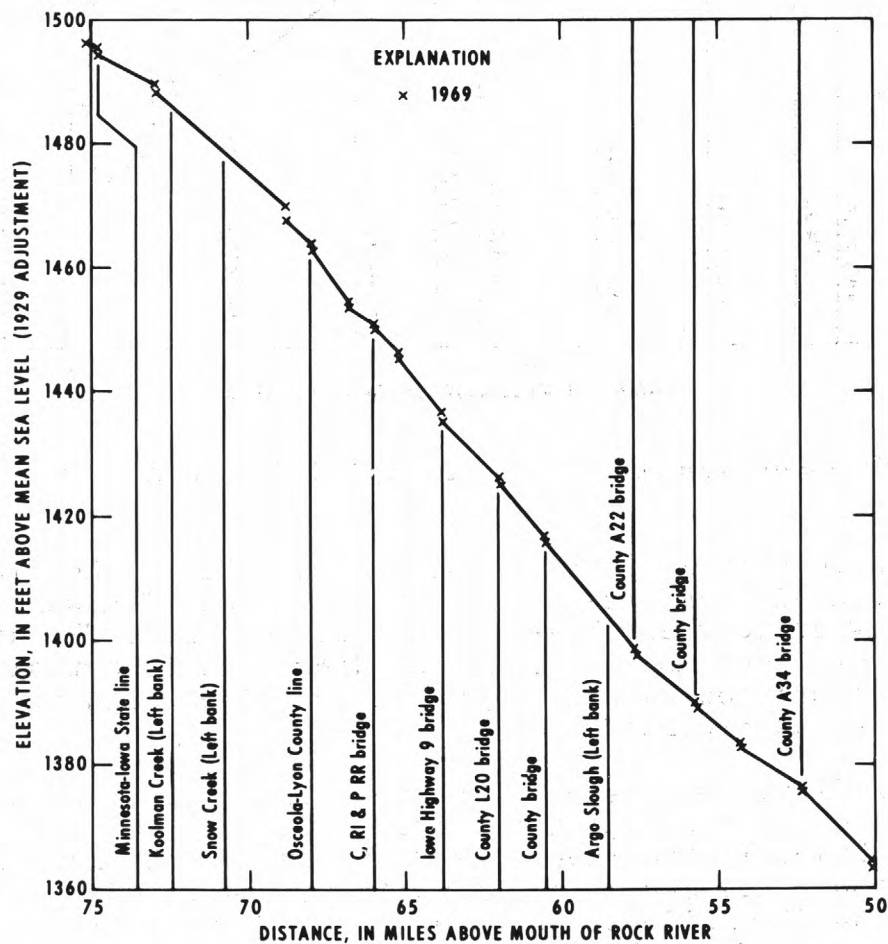


Figure 57.--Flood-crest profile, Little Rock River, mile 75 to 50.

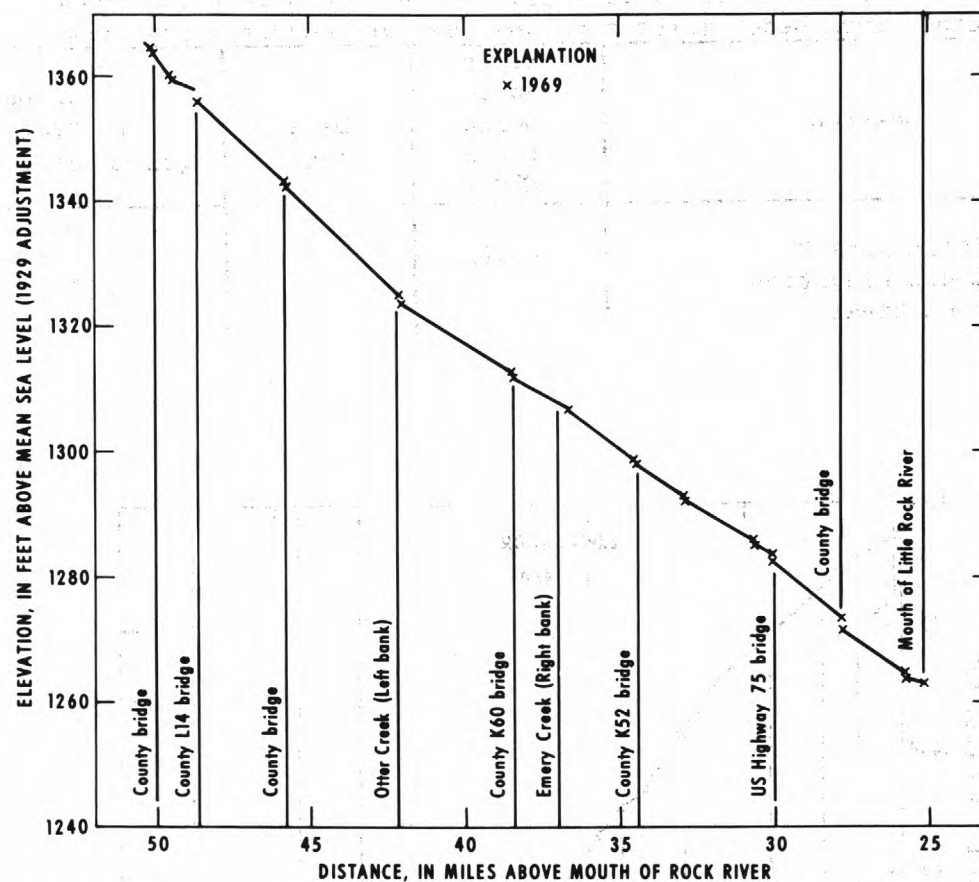


Figure 58.--Flood-crest profile, Little Rock River, mile 50 to 25.

Downstream from the mouth of the Rock River the Big Sioux River forced six families in an outlying area of Hawarden, Iowa, to evacuate their homes. In addition, some flooding of basements of homes and business buildings was reportedly caused by storm sewers backing up but no direct inundation by river water was reported.

Sioux City, Iowa, and North Sioux City, South Dakota, are separated by the Big Sioux River. Near the mouth of the Big Sioux River in the Riverside district, in the northern part of Sioux City and North Sioux City, the flood threat was extreme. At Riverside along River Road in Sioux City a 2,800-foot extension of a dike was constructed which protected about 900 households in part of the district, but even so, 41 homes were unprotected. Sandbags and volunteer labor were used in an attempt to protect these residences, but it was necessary to evacuate 8 of the 41 families on April 9. In North Sioux City, the entire population of about 800 persons was ordered to evacuate their homes on April 9 when the City Hall, located

on the highest ground in the town, was threatened by floodwaters. About 50 National Guard troops helped evacuate the city. After the flood subsided it was reported that 35 homes, 15 trailer homes, and 6 businesses had suffered flood damage in North Sioux City. Total damages in Sioux City and North Sioux City were more than \$1 1/4 million. Figure 59 shows some of the flooding in these two cities. Total flood damages in the Big Sioux River basin exceeded \$14 million.

The Floyd River, lying entirely within northwestern Iowa, flows into the Missouri River about 4 miles below the mouth of the Big Sioux River. Snowmelt in this basin was earlier than that farther north and flood peaks occurred April 4 and 5. These peaks were high but did not approach the record stages and discharges of June 1953. At James, Iowa, the flood discharge was 17,300 cfs, a 28-year recurrence interval flood. Total flood damage in the Floyd River basin was \$150,000.

The Little Sioux River rises in southwestern Minnesota, flows across the northwest quarter of Iowa and joins the Missouri River about 70 miles downstream from Sioux City. It experienced major flooding in Minnesota where the discharge was the third highest since 1948, being surpassed only by the floods of June 1953 and April 1965. Major flooding also occurred in Iowa as far downstream as Correctionville, but maximum discharges which occurred on April 7 and 8 were less than previous record floods that are documented by Schwob (1966). The flood ranged from 2.7 times the 50-year flood at Spencer to a 32-year flood at Correctionville. Principal damage was at Cherokee, Iowa, where 140 acres in the city were flooded and about 90 families were evacuated from their homes. About 150 National Guard troops were brought into the city to aid in the flood fight. Figures 60 and 61 show the flooded areas in Cherokee and Correctionville, where flood damages were \$254,000 and \$20,000, respectively. Total damages in the Little Sioux River basin were \$800,000. Total damages in the Missouri River basin, exclusive of those that occurred in Nebraska, were \$33.4 million.

AERIAL PHOTOGRAPHY

Flood-plain management is gaining increasing importance as a measure to minimize the ever-mounting national flood losses. In order to manage the flood plains efficiently, it is very helpful to have information concerning the areas that are inundated by floods of outstanding magnitude. Federal agencies and others concerned with flood-plain management were fully cognizant of the desirability of obtaining aerial photographs near the peak of the 1969 flood in the basins where



Figure 59.--Flooding of Big Sioux River at Sioux City, Iowa, and North Sioux City, S. Dak., April 10, 1969.
Photograph by U.S. Army Corps of Engineers, Omaha district.



Figure 60.--Flooding of Little Sioux River at Cherokee, Iowa, April 10, 1969.
Photograph by U.S. Army Corps of Engineers, Omaha district.



Figure 61.--Flooding of Little Sioux River at Correctionville, Iowa, April 10, 1969.
Photograph by U.S. Army Corps of Engineers, Omaha district.

outstanding floods occurred. Contracts were let with private aerial survey companies who were able to obtain photographic coverage on very short notice.

Obtaining adequate photographic coverage was difficult because of the great amount of cloud cover which is characteristic of the upper Midwest during the snowmelt period, and also because the flood crests in many areas occurred about the same time. In spite of these difficulties, however, a large number of aerial photographs were obtained by the Corps of Engineers, U.S. Geological Survey, and other agencies. Data obtained from the photographs will be used to delineate flooded areas on topographic maps, particularly in urban communities.

The basins where aerial photographs were obtained are indicated in table 9.

FLOOD DAMAGES

Operation Foresight undoubtedly reduced by a considerable amount the damage caused by the 1969 flood. In spite of this, the loss of 11 lives was attributed to the flood and much unpreventable damage occurred throughout the flood area.

Preliminary figures are available for the flood damages resulting from the floods of April-May in a six-State area. These damage figures, furnished by the Corps of Engineers, are summarized in table 10. Where it seems appropriate, damage figures other than those shown in the table are presented throughout this report for individual basins and communities. Costs incurred by other agencies are not now known, but will certainly swell the total of \$147 million in damages and costs. Reports by the Corps of Engineers, and other agencies will provide a firmer figure of the damages resulting from the floods upon their completion. These reports will also show the amount of damage that was prevented by Operation Foresight.

SUSPENDED SEDIMENT DATA

The suspended-sediment discharges of the Minnesota River at New Ulm, Minnesota, Cottonwood River near New Ulm, and Minnesota River at Mankato, Minnesota, are presented in this report. Tables showing the daily mean concentration, in mg/l (milligrams per liter), and daily suspended sediment discharge, in tons per day, for April 1969 are included and follow the table of daily mean discharge for those stations.

Table 9.--Aerial photography obtained during flood of 1969

Stream	Reach	Date of photographs	Date of flood crest	Approximate scale	Location of photographs
Mustinka River	Minn. Highway 28 to mouth	Apr. 10	Apr. 9-10	1:20,000	C of E, St. Paul, Minn.
Rabbit River	Wendell, Minn. to mouth	Apr. 10	Apr. 9-10	1:20,000	C of E, St. Paul, Minn.
Bois de Sioux-Red River	Mud Lake to Comstock, Minn.	Apr. 11	Apr. 10-21	1:20,000	C of E, St. Paul, Minn.
Otter Tail River	Fergus Falls, Minn. to mouth	Apr. 12	Apr. 14-15	1:20,000	C of E, St. Paul, Minn.
Red River	Breckenridge to Climax, Minn.	Apr. 17	Apr. 10-18	1:20,000	C of E, St. Paul, Minn.
Buffalo River	Hawley, Minn. to mouth	Apr. 12	Apr. 9-12	1:20,000	C of E, St. Paul, Minn.
Wild Rice River	Twin Valley, Minn. to mouth	Apr. 12	Apr. 10-15	1:20,000	C of E, St. Paul, Minn.
Red Lake River	Thief River Falls, Minn. to mouth	Apr. 13	Apr. 12-16	1:20,000	C of E, St. Paul, Minn.
Red River	Climax, Minn. to Emerson, Manitoba	Apr. 16	Apr. 16-26	1:20,000	C of E, St. Paul, Minn.
Roseau River	Malung, Minn. to Minn. Highway 310	Apr. 16	Apr. 11-12	1:20,000	C of E, St. Paul, Minn.
South Fork Crow and Crow River	Hutchinson, Minn. to mouth	Apr. 12	Apr. 9-13	1:19,000	C of E, St. Paul, Minn.
Minnesota River	Ortonville, Minn. to Marsh Lake	Apr. 12	Apr. 12-13	1:10,000	C of E, St. Paul, Minn.
Pomme de Terre River	Morris, Minn. to mouth	Apr. 12	Apr. 9-12	1:20,000	C of E, St. Paul, Minn.
Lac qui Parle River	Canby, Minn. to mouth	Apr. 10	Apr. 10	1:19,000	C of E, St. Paul, Minn.
Chippewa River	Benson, Minn. to mouth	Apr. 11	Apr. 9	1:21,000	C of E, St. Paul, Minn.
Minnesota River	Marsh Lake to Granite Falls, Minn.	Apr. 12	Apr. 12-13	1:15,000	C of E, St. Paul, Minn.

South Branch Yellow Medicine and Yellow Medicine River	Minneota, Minn. to mouth	Apr. 10	Apr. 8-10	1:18,000	C of E, St. Paul, Minn.
Redwood River	Marshall, Minn. to mouth	Apr. 10	Apr. 10	1:18,000	C of E, St. Paul, Minn.
Cottonwood River	South of Marshall, Minn. to mouth	Apr. 9	Apr. 4-10	1:18,000	C of E, St. Paul, Minn.
Minnesota River	Granite Falls, Minn. to Mankato, Minn.	Apr. 12	Apr. 12-15	1:20,000	C of E, St. Paul, Minn.
Minnesota River	Mankato, Minn. to St. Peter, Minn.	Apr. 14	Apr. 12-13	1:20,000	C of E, St. Paul, Minn.
Minnesota River	St. Peter, Minn. to Le Sueur, Minn.	Apr. 14	Apr. 13	1:10,000	C of E, St. Paul, Minn.
Minnesota River	Le Sueur, Minn. to mouth	Apr. 14	Apr. 13-14	1:20,000	C of E, St. Paul, Minn.
St. Croix River	St. Croix Falls, Wis. to mouth	Apr. 17	Apr. 13-16	1:20,000	C of E and USGS, St. Paul, Minn.
Mississippi River	Aitkin, Minn. to mouth of Crow Wing River	Apr. 21	Apr. 14-23	1:17,000	C of E, St. Paul, Minn.
Mississippi River	Mouth of Crow Wing River to St. Paul, Minn.	Apr. 14	Apr. 13-15	1:9,000	C of E, St. Paul, Minn.
Mississippi River	St. Paul, Minn. to Hastings, Minn.	Apr. 14	Apr. 15-16	1:13,000	C of E, St. Paul, Minn.
Mississippi River	Hastings, Minn. to Harpers Ferry, Iowa	Apr. 18	Apr. 16-22	1:20,000	C of E, St. Paul, Minn.
Mississippi River	Hastings, Minn. to La Crosse, Wis.	Apr. 22	Apr. 16-20	1:7,000	C of E, St. Paul, Minn.

Table 9.--Aerial photography obtained during flood of 1969--Continued

Stream	Reach	Date of photographs	Date of flood crest	Approximate scale	Location of photographs
Mississippi River	Harpers Ferry, Iowa to Guttenberg, Iowa	Apr. 23	Apr. 22-23	1:20,000	C of E, St. Paul, Minn.
Mississippi River	Guttenberg, Iowa to Clinton, Iowa	Apr. 24	Apr. 23-26	1:20,000	C of E, Rock Island, Ill.
Mississippi River	Clinton, Iowa to Burlington, Iowa	Apr. 25	Apr. 26	1:20,000	C of E, Rock Island, Ill.
Mississippi River	Burlington, Iowa to Lock and Dam 22 at Saverton, Mo.	May 2	Apr. 26- May 1	1:20,000	C of E, Rock Island, Ill.
Mississippi River	Princeton, Iowa to mouth of Rock River	Apr. 19	Apr. 26	1:12,000	C of E, Rock Island, Ill.
Mississippi River	Dubuque, Iowa	Apr. 24	Apr. 23	1:10,000	C of E, Rock Island, Ill.
Mississippi River	East Dubuque, Ill.	Apr. 25	Apr. 23	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Savanna, Ill. - Sabula, Iowa Area	Apr. 25	Apr. 25	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Fulton, Ill. to Albany, Ill.	Apr. 25	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Princeton, Iowa to mouth of Rock River	Apr. 25	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Andalusia, Ill. - Buffalo, Iowa Area	Apr. 30	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Muscatine, Iowa	Apr. 30	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Keithsburg, Ill.	Apr. 30	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Oquawka, Ill.	Apr. 26	Apr. 26	1:10,000	C of E, Rock Island, Ill.
Mississippi River	Burlington, Iowa	Apr. 30	Apr. 26	1:10,000	C of E, Rock Island, Ill.
West Fork Des Moines River	Windom, Minn. to Graettinger, Iowa	Apr. 12	Apr. 11-12	1:16,000	USGS, Iowa City, Iowa and St. Paul, Minn.

East Fork Des Moines River	Tuttle Lake, Minn. to Algona, Iowa	Apr. 12	Apr. 6-9	1:16,000	USGS, Iowa City, Iowa
Knife River	West Mercer County line, N. Dak. to mouth	Apr. 5	Apr. 4-7	1:16,000	USGS, Bismarck, N. Dak.
Heart River	Mouth of Antelope Creek to Mandan, N. Dak.	Apr. 5	Apr. 4-7	1:16,000	USGS, Bismarck, N. Dak.
James River	Dam at Jamestown, N. Dak. to Adrian, N. Dak.	Apr. 12	Apr. 11	1:16,000	USGS, Bismarck, N. Dak.
Pipestem Creek	Buchanan, N. Dak. to mouth	Apr. 12	Apr. 10	1:16,000	USGS, Bismarck, N. Dak.
James River	North Dakota State line to State Highway 34, S. Dak.	Apr. 17	Apr. 11-13	1:45,000	C of E, Omaha, Nebr.
James River	Northern boundary of Sanborn County, S. Dak. to mouth	Apr. 19	Apr. 9-13	1:24,000	Lower James Conservancy Dist., Mitchell, S. Dak.
Vermillion River	Confluence of East & West Branches to mouth at Vermillion, S. Dak.	Apr. 10	Apr. 10	1:24,000	East Dakota Conservancy Dist., Brookings, S. Dak.
Big Sioux River	Watertown, S. Dak. to State line southeast of Sioux Falls, S. Dak.	Apr. 18	Apr. 8-10	1:2,000	East Dakota Conservancy Dist., Brookings, S. Dak.
Big Sioux River	Flandreau, S. Dak. to Sioux City, S. Dak.	Apr. 10	Apr. 9-10	1:12,000	C of E, Omaha, Nebr.
Skunk Creek	Minnehaha-Moody County line, S. Dak. to mouth	Apr. 7	Apr. 6	1:24,000	East Dakota Conservancy Dist., Brookings, S. Dak.
Little Sioux River	Spencer, Iowa to 35 miles downstream	Apr. 10	Apr. 8	1:16,000	USGS, Iowa City, Iowa

Note: The Oahe Conservancy Subdistrict office, Huron, S. Dak. also has high and low-level 35mm pictures and slides of the James River obtained about April 15 which cover the reach from the North Dakota-South Dakota State line to the southern Sanborn County line.

Table 10.--Flood damage in six-State area in thousands of dollars, flood of April-May 1969
(compilation of preliminary figures furnished by Corps of Engineers)

State	Classification of damage							Total
	Urban	Agri- cultural	Trans- portation	Municipal	Lock and dam	Miscel- laneous	Unclass- sified	
North Dakota	a16,843	14,726	4,819	420	--	--	--	36,808
South Dakota	a1,131	13,634	7,853	1,471	--	746	--	24,835
Minnesota	a24,552	33,930	10,495	--	305	--	218	69,500
Wisconsin	a3,273	942	1,669	--	132	--	77	6,093
Iowa	a1,531	1,784	1,431	347	19	5	b3,080	8,197
Illinois	--	--	--	--	--	--	b1,519	1,519
TOTAL	47,330	65,016	26,267	2,238	456	751	4,894	146,952

a Includes cost of flood fight in urban areas.

b Includes crop damage and cost of flood fight in rural areas, and clean-up costs.

Samples were collected with depth integrating U.S. D-49 suspended-sediment samplers daily or more frequently during periods of rapidly changing stage. The samples were analyzed for concentration of sediment by a method of weighing, decantation, filtration, and drying. The concentrations were computed as the dry weight of sediment per unit weight of the water-sediment mixture and converted to weight per unit volume of water. The concentration of each sample was plotted and a continuous concentration curve was drawn. Daily mean concentrations were determined from the curve. Daily sediment discharges, in tons per day, were computed as the product of the daily mean concentration, in mg/l, multiplied by the daily mean discharge, in cfs, and the conversion factor 0.0027.

During April 1969, the sediment yields of different areas in the Minnesota River basin varied significantly. At New Ulm, the Minnesota River drainage area is about 9,540 square miles, the sediment discharge was more than 246,000 tons during April, and the yield was 26 tons per square mile. Downstream at Mankato, the drainage area is 14,900 square miles, the sediment discharge was nearly 1,800,000 tons for April, and the sediment yield increased to 121 tons per square mile.

The increased yield at Mankato reflects the higher yields contributed by the Cottonwood and Blue Earth River basins. The Cottonwood River, which drains about 1,280 square miles, discharged more than 507,000 tons of sediment in April, and yielded 396 tons per square mile, more than 15 times the yield of the upper Minnesota River basin. The drainage area of the Minnesota River basin between New Ulm and Mankato, excluding the Cottonwood River, is about 4,140 square miles, much of which is drained by the Le Sueur and Blue Earth Rivers. The sediment yield for this area was computed at 252 tons per square mile.

Variations in sediment yield of this magnitude are not unusual during a flood from runoff due to both snowmelt and precipitation. Sediment concentrations and yields are generally less from snowmelt than from rainstorms on thawed ground. Also differences in soils, geology, topography, land use, and vegetive cover affect the quantity of sediment available for transport by the streams.

MAGNITUDE AND FREQUENCY

A series of Water-Supply Papers (WSP) on the magnitude and frequency of floods in the United States has been prepared by the U.S. Geological Survey. Four of these reports (Wiitala 1965, Patterson 1966, Matthai 1968, Patterson and Gamble 1968) are

applicable to parts of the areas covered by this report. The index-flood method of frequency analysis was used in all three reports. This method uses a graphical relation between drainage area and the MAF (mean annual flood) to determine the MAF, or index flood, at a selected location within an area of flood homogeneity. In some areas additional characteristics, such as altitude or area of lakes are used to modify the MAF for the effect of these characteristics. A second graphical relation is used to define the ratio of peak discharge to the index flood for recurrence intervals up to 50 years within hydrologic regions. In general, the record of annual peaks available for the gaging stations in the several areas to compute the flood-frequency relation was too short to permit the definition of frequencies rarer than the 50-year recurrence interval. The two relationships serve to regionalize flood-frequency determination with the various areas. The reader is referred to the cited reports for more details on the methods and for the maps and curves used to define the frequency of flood discharges.

In this report the frequency of the peak discharges for the 1969 floods has been determined from the regional relations given in the four Water-Supply Papers. The computed frequency is shown in terms of recurrence interval in years up to the 50-year level. For the rarer floods the frequency is reported as a ratio of the peak discharge to that of the 50-year flood. In a few instances the frequency of a flood discharge in this report could not be computed because of limitations imposed by the regional relations or lack of drainage area data. Computed flood frequencies for individual gaging sites are shown in the last column of table 11.

The tabulation of flood frequencies reveals that the most intense floods occurred in the upstream part of the Red River of the North basin, Souris River basin, upper Minnesota River basin, part of the Mississippi River basin, upper basin of West Fork Des Moines River, and the James, Vermillion, and Big Sioux River basins. Throughout the flood area, recurrence intervals exceeded 50 years for 71 of the 178 sites for which recurrence intervals were computed.

DETERMINATION OF FLOOD DISCHARGES

The Geological Survey determines stream discharge at a gaging station by (1) developing a stage-discharge relation, (2) collecting a record of the stage of the stream, and (3) application of the stage to the stage-discharge relation to derive the discharge.

The stage-discharge relation is developed by making measurements of the discharge of the stream at various stages throughout the entire range in stage. Standard methods using a current meter and sounding equipment are employed wherever possible. At times, however, it is necessary to make indirect measurements of discharge which are based upon surveys of high-water profiles, channel geometry, and hydraulic-structure geometry, and are computed in accordance with established hydraulic principles. They are indirect only in the sense that data collected after the peak are used to define the peak discharge by using the slope-area or contracted-opening methods or by computing the flow over dams or weirs. The principles of discharge measurements of all types are explained in many books on hydraulics. These principles are supplemented by the experience of engineers of the Geological Survey in their application. The reliability of the stage-discharge relation is dependent upon how well the discharge measurements define that part of the relation used to compute the discharge data.

Gaging stations are generally of two types--those that collect a complete record of stage throughout the year and those that collect only a partial record such as at times of high or low flow. The method of collection may be by (1) frequent manual readings of a gage, (2) continuous or punch-type recording of stage fluctuations by an automatic instrument, (3) recording of the peak stage by a pipe device installed vertically, called a crest-stage gage, or (4) determinations of peak stage from high-water marks left by a flood. Occasionally, all four methods or a combination of some of the four are used to define the water surface elevation, particularly that which occurs at a flood peak.

The discharge data published in this report in the form of the daily mean discharge, or the discharge at a specific time and gage height, are computed by applying the gage height to a table which expresses the stage-discharge relation. Peak discharges are usually computed by this method but are sometimes (usually at miscellaneous sites) the result of a single current meter or indirect measurement.

STREAMFLOW DATA

Flood-peak data for 179 continuous-record gaging stations, 85 crest-stage stations, and 20 miscellaneous sites are summarized in table 11. The location of the station or miscellaneous site and derivation of the peak data are shown in the station descriptions in the following pages.

Table 11 has been compiled in the numerical order of the part number assigned by the Geological Survey to various basins in the United States. Parts 4, 5 and 6¹ include the area affected by the spring floods. Within each Part the data are arranged in downstream order. In this ordering, the data for a station on a tributary joining the main stem between two main-stem stations are listed between the data for those two stations. With a few exceptions, each station or site listed has been assigned a sequential number that corresponds to the number shown on the location map (fig. 2). Data for 11 stations became available after the numbering had been accomplished and the location map had been prepared. Consequently, these stations are not numbered sequentially and do not appear on the location map although they are listed in table 11 and stations descriptions have been prepared as for other stations. The 11 stations not plotted on the location map are indicated by footnotes in table 11. With the exceptions noted, the data for each station and miscellaneous site include sequential number, name of site, drainage area upstream from that site, maximum flood data previously known, and the peak data for the April-May 1969 floods. The columns on maximum flood previously known show the period of record of flood data collection and the year, gage height, and discharge of that flood. Data for the April-May 1969 flood include the date of the peak, the gage height, the discharge, and the recurrence interval of the flood. Where the recurrence interval of the flood of 1969 is larger than the 50-year frequency defined by the published studies, the recurrence-interval column shows the ratio of the flood to that of the 50-year flood.

A description is included for each gaging station, crest-stage station, and miscellaneous site. The description contains the name of the station or site preceded by the permanent station number if one has been assigned by the Geological Survey. The permanent station number is preceded by the sequential number in parentheses. The body of the description gives the location, size of drainage area at the site, nature of the gage-height record, definition of the stage-discharge relation, the maximum stage and discharge for the current flood and for the period of prior record, and, where necessary, remarks concerning regulation or other matters affecting the record at the station.

- ¹ Part 4: St. Lawrence River Basin
- Part 5: Hudson Bay and Upper Mississippi River Basins
- Part 6A: Missouri River Basin above Sioux City, Iowa
- Part 6B: Missouri River Basin below Sioux City, Iowa

A tabulation of daily mean discharges follows the description. This table shows the daily mean discharge for a period of 1 or 2 months covering the flood period and includes the maximum discharge. Monthly mean discharge and runoff in inches or acre-feet are shown for each complete month of record included in the table. Crest-stage stations and miscellaneous sites do not provide the data necessary for a similar tabulation at those sites.

Following the mean discharge table, for recording-gage stations, is a second tabulation that includes the gage height and discharge at selected times during several days preceding and following the peak flow. For days when backwater from ice was present, only the gage height is shown for the selected times--the daily mean flow is shown in the table of mean discharges. Daily mean flows computed from the data in the second table may vary slightly from those shown in the mean discharge tabulation. This could occur if the daily mean was computed by subdividing the day into smaller intervals than those shown in the second table. At stations equipped with digital recorders the mean discharge may be derived by a computer from stage data punched as often as at 15-minute intervals. The difference between the two means that could be computed will generally be small and of no significance in the use of the data.

The station data described above will give the user of the report the maximum information available at the time of preparation of the report. They will allow an adequate study of the hydrology of the flood. Hydrographs of gage height and discharge may be prepared from the data included in the tabulation for subdivided days.

Table 11.--Summary of flood stages and discharges

No.	Perm. station number	Stream and place of determination	Contributing drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur-rence interval (years)
Streams tributary to Lake Superior											
1	4-0195	East Swan River near Toivola, Minn.	112	1950, 1953-62, 1964-69	1950, 1954, 1956	20.0 b18.45 - -	(a) - 1,690	Apr. 11 Apr. 12 Apr. 15	b19.61 - 12.60	- 1,950 28,300	- 6 4
2	4-0240	St. Louis River at Scanlon, Minn.	3,430	1908-69	1950, 1950	- 15.8	c37,900 (a)				
Red River of the North basin											
3	5-0476	West Branch Mustinka River near Graceville, Minn.	56.7	1964-69	1966	9.41	(a)	Apr. 9	12.50	686	-
4	5-0477	West Branch Mustinka River tributary near Graceville, Minn.	3.37	1964-69	1964	8.76	96	Apr. 9	10.56	418	-
5	5-0500	Bois de Sioux River near White Rock, S. Dak.	1,160	1941-69	1962	11.41	d1,620	Apr.19-21	15.07	d3,770	-
6	5-0515	Red River of the North at Wahpeton, N. Dak.	4,010	1897, 1942-69	1897, 1952	17.0 14.99	- 7,130	Apr. 10	16.34	9,200	-
7	5-0516	Wild Rice River near Rutland, N. Dak.	296	1960-69	1966	b7.12	660	Apr. 8	b8.78	1,270	10
8	5-0517	Wild Rice River near Cayuga, N. Dak.	565	1957-69	1962	8.95	1,080	Apr. 7	b10.90	-	-
9	5-0518	Grass Lake tributary near Lidgerwood, N. Dak.	.61	1958-69	1967	4.07	30	Apr. 12	-	1,710	10
10	5-0519	Wild Rice River tributary near Mantador, N. Dak.	6	1959-69	1966	b4.17	9.5	Apr. 6	b2.91	-	-
11	5-0520	Wild Rice River near Mantador, N. Dak.	790	1944-69	1952	10.74	2,200	Apr. 9	-	12	-
12	5-0525	Antelope Creek at Dwight, N. Dak.	278	1944-47, 1949-69	1952	16.31	3,670	Apr. 10	17.82	9,000	*3.2
13	5-0530	Wild Rice River near Abercrombie, N. Dak.	1,490	1897, 1933-69	1897, 1943	27.5 21.02	- 5,500	Apr. 11	24.58	9,540	*1.4
14	5-0540	Red River of the North at Fargo, N. Dak.	6,800	1882, 1897, 1902-69	1897, 1952	e40.1 28.79	25,000 16,300	Apr. 15	37.34	25,300	*1.4
(f) 5-0545	Sheyenne River above Harvey, N. Dak.	154	1956-69	1966	-	410	-	Apr. 10	9.70	-	-
15	5-0560	Sheyenne River near Warwick, N. Dak.	760	1950-69	1956	7.83	4,250	Apr. 11	-	370	3
16	5-0560.2	Mauvais Coulee tributary near Bisbee, N. Dak.	2.83	1955-69	1956	b5.05	220	Apr. 14	7.51	4,660	50
17	5-0560.4	Mauvais Coulee tributary No. 2 near Cando, N. Dak.	8.48	1955-69	1956	-	180	Apr. 11	6.05	300	-
18	5-0560.6	Mauvais Coulee tributary No. 3 near Cando, N. Dak.	60.2	1955-69	1956	-	180	Apr. 11	6.02	520	-
19	5-0560.8	Mauvais Coulee tributary No. 4 near Bisbee, N. Dak.	24.4	1955-69	1956	b5.5 (a)	850	Apr. 14	9.35	2,300	-
(f) 5-0561	Mauvais Coulee near Cando, N. Dak.	377	1957-69	1960, 1966	-	570	-	Apr. 11	5.17	1,100	-
						9.25	-	Apr. 14	11.16	2,500	25

(f)	5-0562	Edmore Coulee near Edmore, N. Dak.	282	1956-69	1956	6.63	-						
					1956	-	875	Apr. 13	6.18	779	5		
20	5-0564	Big Coulee near Churchs Ferry, N. Dak.	1,820	1950-69	1950	4.4	620	Apr. 27	6.49	964	-		
21	5-0569	Sheyenne River tributary near Cooperstown, N. Dak.	15.2	1959-69	1965	-	700	gApril	9.80	1,000	-		
22	5-0569.5	Sheyenne River tributary No. 2 near Cooperstown, N. Dak.	.08	1959-69	1965	b9.81	-	Apr. 7	b2.04	.5	-		
23	5-0570	Sheyenne River near Cooperstown, N. Dak.	1,270	1945-69	1950	18.69	7,830	Apr. 17	18.07	5,050	30		
24	5-0572	Baldhill Creek near Dazey, N. Dak.	351	1956-69	1965	b9.90	-	Apr. 10	b11.21	-			
25	5-0575	Lake Ashtabula at Baldhill Dam, N. Dak.	1,910	1949-69	1950	h1,269.46	i91,400	Apr. 11	-	2,510	28		
26	5-0580	Sheyenne River below Baldhill Dam, N. Dak.	1,910	1948,	1948	-	4,600	Apr. 21	h1,267.52	i79,900	-		
27	5-0585	Sheyenne River at Valley City, N. Dak.	2,110	1919,				Apr. 19	35.47	4,580	-		
28	5-0587	Sheyenne River at Lisbon, N. Dak.	2,490	1938-69	1948	17.51	4,580	Apr. 19	17.62	4,520	-		
29	5-0590	Sheyenne River near Kindred, N. Dak.	3,020	1957-69	1966	16.23	4,260	Apr. 24	16.54	4,380	-		
				1947 or									
				1948,		22.1	3,600	Apr. 14	b21.54	-			
				1950-69	1966	20.50	3,380	Apr. 15	-	4,690	-		
30	5-0595	Sheyenne River at West Fargo, N. Dak.	3,090	1903-06,									
				1919,	1966	b21.05	-	Apr.16,17	21.70	-			
31	5-0597	Maple River near Enderlin, N. Dak.	796	1930-69	1966	-	3,110	Apr. 22	-	3,060	-		
32	5-0598	Swan Creek near Absaraka, N. Dak.	22	1957-69	1965	11.05	3,390	Apr. 11	13.55	5,750	*1.2		
				1955-69	1966	b6.14	-	gApril	5.69	620	-		
					1967	-	307						
33	5-0598.5	Swan Creek tributary near Ayr, N. Dak.	2	1955,									
34	5-0599	Swan Creek near Casselton, N. Dak.	30	1957-69	1965	4.98	73	Apr. 10	6.56	120	-		
35	5-0599.5	Swan Creek tributary near Casselton, N. Dak.	2.5	1955-69	1965	b8.2	550	Apr. 10	b9.19	2,000	-		
36	5-0600	Maple River near Mapleton, N. Dak.	1,379	1955-69	1965	6.98	200	Apr. 11	8.47	225	-		
37	5-0605	Rush River at Amenla, N. Dak.	116	1945-69	1952	b18.91	-	Apr. 11	14.00	7,000	*1.1		
				1953		-	4,840						
38	5-0608	Buffalo River near Callaway, Minn.	49.9	1947-69	1947	-	1,230	Apr. 10	11.41	1,690	50		
39	5-0610	Buffalo River near Hawley, Minn.	322	1966		b12.15	-						
40	5-0615	South Branch Buffalo River at Sabin, Minn.	522	1960-69	1962	13.35	370	Apr. 10	b15.11	446	-		
41	5-0620	Buffalo River near Dilworth, Minn.	1,040	1945-69	1955	9.31	1,590	Apr. 9	9.07	1,880	38		
(f)	5-0622	Elm River near Kelso, N. Dak.	193	1945-69	1962	17.04	6,340	Apr. 10	18.12	6,410	*2.02		
42	5-0624.7	Marsh River tributary near Mahnomon, Minn.	6.57	1931-69	1962	23.56	6,140	Apr. 11	25.55	10,400	*2.10		
43	5-0625	Wild Rice River at Twin Valley, Minn.	888	1956-69	1966	12.48	1,000	gApril	12.16	930	8		
44	5-0640	Wild Rice River at Hendrum, Minn.	1,600	1961-69	1965	b12.90	241	Apr. 11	13.76	436	-		
45	5-0645	Red River of the North at Halstad, Minn.	21,800	1909-17,	1909	e20.0	9,200						
				1930-69				Apr. 10	11.83	4,850	*1.08		
(f)	5-0649	Beaver Creek near Finley, N. Dak.	160	1944-69	1965	b29.52	-	Apr. 15	31.42	8,300	-		
						-	6,800						
						(a)							
				1897,	1897	38.5							
				1936-37,									
				1942-69	1966	b35.35	26,800	Apr. 18	38.29	35,700	*1.3		
				1965-69	1965	-	1,250	Apr. 9	7.44	-			
					1966	b9.70	-	Apr. 9	-	1,320	18		
(f)	5-0655	Goose River near Portland, N. Dak.	407	1940-69	1950	20.12	8,530	Apr. 13	18.17	3,660	*1.1		
46	5-0665	Goose River at Hillsboro, N. Dak.	1,093	1882,									
				1897,									
				1904,									
				1916,	1950	14.96	-						
				1931-69	1950	-	9,420	Apr. 12	14.14	7,640	*1.3		

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contributing drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
Red River of the North basin--Continued											
47	5-0675	Marsh River near Shelly, Minn.	151	1944-69	1950	18.96	4,660	Apr. 12	22.28	3,910	-
48	5-0690	Sandhill River at Climax, Minn.	-	1943-69	1965	e17.81	4,560	Apr. 14	-	j4,180	*1.4
49	5-0780	Clearwater River at Plummer, Minn.	512	1939-69	1962	-	3,640	Apr. 17, 18	b28.22	-	-
50	5-0782.3	Lost River at Oklee, Minn.	266	1897-1969	1950	b11.97	-	Apr. 10	b12.31	-	-
51	5-0785	Clearwater River at Red Lake Falls, Minn.	1,370	1960-69	1967	14.17	(a) 2,880	Apr. 11	-	3,630	*1.13
52	5-0790	Red Lake River at Crookston, Minn.	5,280	1909-17, 1913	1950	be17.5	-	Apr. 11	14.91	3,210	*1.16
53	5-0825	Red River of the North at Grand Forks, N. Dak.	30,100	1934-69	1950	-	9,310	Apr. 12	11.82	9,740	48
54	5-0826	English Coulee tributary near Grand Forks, N. Dak.	4.68	1901-69	1950	-	27,400	Apr. 12	27.33	28,400	*1.78
55	5-0826.8	Saltwater Coulee tributary near Emerado, N. Dak.	22.0	1965	1965	b25.82	-	Apr. 16	45.69	53,500	*1.1
56	5-0827	Saltwater Coulee near Emerado, N. Dak.	110	1882-1969	1897	e50.2	80,000	Apr. 10	3.08	164	-
57	5-0829	Freshwater Coulee near Emerado, N. Dak.	31.0	1967	1967	-	130	Apr. 10	6.30	230	-
58	5-0830	Turtle River at Manvel, N. Dak.	613	1955-69	1966	b7.10	-	Apr. 10	7.09	710	5
59	5-0850	Forest River at Minto, N. Dak.	620	1950, 1955-69	1950	11.3	3,500	Apr. 10	7.09	710	5
60	5-0875	Middle River at Argyle, Minn.	265	1950, 1955-69	1950	11.5	(a) 1,180	Apr. 10	b6.54	190	3
61	5-0900	Park River at Grafton, N. Dak.	695	1955-69	1957	5.0	1,180	Apr. 10	b6.54	190	3
62	5-0920	Red River of the North at Drayton, N. Dak.	34,800	1965	1965	5.0	1,180	Apr. 10	b6.54	190	3
63	5-0991	Snowflake Creek near Snowflake, Manitoba	348	1946-69	1950	21.5	28,000	Apr. 13	17.38	3,470	9
(f)	5-0991.5	Mowbray Creek near Mowbray, Manitoba	93.9	1882, 1897, 1907, 1916, 1944-69	1950	11.80	16,600	Apr. 12	7.67	3,960	15
64	5-0993	Pembina River near Windygates, Manitoba	3,020	1945, 1950, 1951-69	1950	15.25	2,790	Apr. 11	b15.92	2,530	31
65	5-0994	Little Pembina River near Walhalla, N. Dak.	172	1945, 1950, 1951-69	1950	15.25	2,790	Apr. 13	18.13	4,990	15
66	5-0996	Pembina River at Walhalla, N. Dak.	3,350	1950, 1965	1965	-	2,590	Apr. 19	41.35	59,000	40
67	5-1000	Pembina River at Neche, N. Dak.	3,410	1932-69	1950	20.13	12,600	Apr. 10	7.80	c623	-
				1860-1969	1950	41.58	86,500	Apr. 13, 14	6.35	c414	-
				1962-69	1966	7.88	-	Apr. 19	b17.30	8,400	-
				1967	1967	-	c392	Apr. 9	12.76	6,000	*1.7
				1962-69	1967	b11.80	1,890	Apr. 20	14.58	8,440	30
				1957-69	1960	13.28	4,160	Apr. 21	21.32	7,360	22
				1940, 1942-69	1950	19.2	20,400				
				1904-08, 1910-15, 1919-69	1950	21.58	10,700				

68	5-1010	Tongue River at Akra, N. Dak.	162	1860-1969	1950	e48.7	11,800	Apr. 14	7.85	606	3
69	5-1025	Red River of the North at Emerson, Manitoba	40,200	1913-69	1950	90.89	95,500	Apr. 26	87.61	52,500	30
70	5-1075	Roseau River at Ross, Minn.	1,220	1896, 1928-69	1896 1950	19 18.25	- 6,560	- Apr. 20	- 16.36	- 3,500	10
71	5-1133.6	Long Creek at western crossing of international boundary	750	1959-69	1960	b8.61	cl,330	Apr. 10	12.15	4,610	-
72	5-1134.5	Long Creek tributary No. 2 near Crosby, N. Dak.	5.58	1960-69	1967	b5.29	43	Apr. 6	7.07	260	-
73	5-1135.2	Long Creek tributary near Crosby, N. Dak.	.35	1960-69	1965	4.13	20	Apr. 6	6.99	55	-
74	5-1136	Long Creek near Noonan, N. Dak.	630	1960-69	1960	b14.4	3,200	Apr. 10	16.23	4,980	*1.2
75	5-1138	Short Creek below international boundary near Roche Percee, Saskatchewan	480	1960-69	1960	14.39	1,360	Apr. 7	14.35	1,700	-
76	5-1140	Souris (Mouse) River near Sherwood, N. Dak.	3,040	1930-31, 1933-69	1948	23.80	7,400	Apr. 11	b24.72	12,400	*1.2
77	5-1155	Lake Darling near Foxholm, N. Dak.	3,250	1936-69	1943	22.83	il30,000	Apr. 16	22.18	il24,000	-
78	5-1160	Souris (Mouse) River near Foxholm, N. Dak.	3,270	1937-69	1948	14.79	3,040	Apr. 17, 18	15.84	5,380	-
79	5-1161	Souris River tributary near Burlington, N. Dak.	.13	1959-69	1963	8.01	29	Apr. 5	b4.5	3.0	-
80	5-1162	Des Lacs River tributary near Donnybrook, N. Dak.	3.82	1956-69	1963	6.40	135	Apr. 6	6.79	160	-
81	5-1165	Des Lacs River at Foxholm, N. Dak.	539	1886-1969 1904-06, 1946-69	1939 1949	18.8 18.04	(a) 2,000	Apr. 10	19.82	2,460	17
82	5-1165.5	Fuller Coulee at Foxholm, N. Dak.	5.9	1955-69	1955	4.73	140	Apr. 6	5.65	222	-
83	5-1172	Souris River tributary No. 2 near Burlington, N. Dak.	2.04	1960-69	1963	7.42	148	Apr. 5	5.01	89	-
84	5-1175	Souris (Mouse) River above Minot, N. Dak.	3,900	1904, 1906-17, 1919-69	1904	ek21.9	12,000	Apr. 19	20.36	6,020	-
85	5-1200	Souris (Mouse) River near Verendrye, N. Dak.	4,400	1937-69	1949	b17.7	4,200	Apr. 30	17.05	5,960	-
86	5-1205	Wintering River near Karlsruhe, N. Dak.	285	1937-69	1949	b12.0	3,000	Apr. 11	b10.12	1,480	-
87	5-1220	Souris (Mouse) River near Bantry, N. Dak.	4,700	1937-69	1949	13.76	4,760	May 4	13.80	5,660	-
88	5-1234	Willow Creek near Willow City, N. Dak.	730	1957-69	1960	14.03	1,190	Apr. 12	16.76	5,900	*1.3
89	5-1235.1	Deep River near Upham, N. Dak.	370	1951, 1953-69	1951 1960	16 10.90	- 580	Apr. 12	18.18	6,760	*2.1
90	5-1235.2	Egg Creek near Glenburn, N. Dak.	7.0	1955-69	1956	4.59	75	gApril	5.19	165	-
91	5-1235.4	Egg Creek near Ruthville, N. Dak.	26.4	1955-69	1963	2.62	430	gApril	4.28	600	-
92	5-1235.6	Egg Creek tributary near Deering, N. Dak.	3.50	1955-69	1963	2.77	25	gApril	4.75	14	-
93	5-1235.8	Egg Creek near Deering, N. Dak.	40.8	1955-69	1963	5.42	118	gApril	7.50	430	-
94	5-1236	Egg Creek near Granville, N. Dak.	139	1957-69	1960	5.44	258	Apr. 10	7.28	1,710	35
95	5-1237	Cutbank Creek at North Lake Outlet near Granville, N. Dak.	244	1957-69	1960	.62	1.0	Apr. 14	3.78	339	-
96	5-1239	Boundary Creek near Landa, N. Dak.	170	1958-69	1960	10.22	660	Apr. 9	12.70	3,580	*1.7
97	5-1240	Souris (Mouse) River near Westhope, N. Dak.	6,600	1930-69	1949 1949	- 16.9	6,400 -	Apr. 19 Apr. 22	b17.56 -	- 6,300	-

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contrib- uting drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
Lake of the Woods basin											
98	5-1305	Sturgeon River near Chisholm, Minn.	187	1942-69	1950	6.41	3,630	Apr. 15	5.55	2,200	25
99	5-1315	Little Fork River at Littlefork, Minn.	1,730	1909-17, 1928-69	1916 1950	37.00 37.00	25,000 25,000	Apr. 17	32.61	20,600	14
100	5-1320	Big Fork River at Big Falls, Minn.	1,460	1910-12, 1928-69	1950	17.08	14,800	Apr. 16	15.79	13,300	20
101	5-1335	Rainy River at Manitou Rapids, Minn.	19,400	1928-69	1950	21.04	71,600	Apr. 18	18.37	58,300	-
102	5-1342	Rapid River near Baudette, Minn.	543	1950, 1956-69	1950 1962	21.1 17.13	8,500 5,160	Apr. 14	17.86	5,500	3
Prairie River basin											
103	5-2127	Prairie River near Taconite, Minn.	-	1967-69	1967	7.96	1,020	Apr. 17	11.81	3,260	-
Swan River basin											
104	5-2170	Swan River near Warba, Minn.	254	1950, 1954-69	1950 1965	11.5 b9.53	(a) 1,080	Apr. 12 Apr. 15	b9.74 9.33	- 1,360	-
Mississippi River main stem											
105	5-2205	Mississippi River below Sandy River near Libby, Minn.	5,060	1930-69	1950	20.02	16,000	Apr. 20	16.46	9,080	8
106	5-2275	Mississippi River at Aitkin, Minn.	6,140	1945-69	1950	22.49	20,000	Apr. 23	17.32	14,400	18
Crow Wing River basin											
107	5-2440	Crow Wing River at Nimrod, Minn.	1,010	1910-14, 1930-69	1950 1965	b7.64 -	- 2,890	Apr. 15	5.26	2,200	7
108	5-2475	Crow Wing River near Pillager, Minn.	-	1924-66, 1968-69	1965	-	c18,300	Apr. 12, 13	-	c16,600	-
Mississippi River main stem											
109	5-2670	Mississippi River near Royalton, Minn.	11,600	1924-69	1965	-	c37,700	Apr. 14	-	c32,400	29
Sauk River basin											
110	5-2705	Sauk River near St. Cloud, Minn.	925	1909-13, 1929-69	1965	10.68	9,100	Apr. 11	7.96	5,300	*1.06

Mississippi River main stem											
111		Mississippi River at St. Cloud, Minn.	-	1965-69	1965	m984.9 971.2	-	Apr. 14	m982.6 968.8	42,900	-
Johnson Creek basin											
112	5-2723	Johnson Creek near St. Augusta, Minn.	-	1964-69	1965	14.77	682	Apr. 7	14.23	532	-
Elk River basin											
113	5-2750	Elk River near Big Lake, Minn.	615	1911-17, 1931-69	1965	10.86	7,360	Apr. 10	10.08	5,980	*1.19
Mississippi River main stem											
114	5-2755	Mississippi River at Elk River, Minn.	14,500	1915-69	1965	17.20	62,000	Apr. 13	14.28	48,100	40
Crow River basin											
115		South Fork Crow River at Hutchinson, Minn.	462	1965-69	1965	ml,044.10 1,040.44	4,670	Apr. 9	ml,041.9 1,038.0	3,100	*1.50
116	5-2790	South Fork Crow River near Mayer, Minn.	1,170	1910-11, 1934-69	1965	19.23	16,100	Apr. 11	16.48	9,770	*1.49
117		South Fork Crow River at Delano, Minn.	-	1965-69	1965	18.40	-	Apr. 11, 12	15.10	9,680	-
118	5-2800	Crow River at Rockford, Minn.	2,520	1909-17, 1929-69	1965	19.27	22,400	Apr. 13	16.48	15,100	*1.16
Rum River basin											
119		Rum River at West Point, Minn.	-	1958-69	1965	29.38	10,800	Apr. 10	29.15	8,900	-
120		Rum River at Isanti, Minn.	-	1958-69	1965	h907.60	9,400	Apr. 13	h907.46	9,100	-
121	5-2860	Rum River near St. Francis, Minn.	1,360	1905-06, 1910-13, 1929-69	1965	11.57	10,100	Apr. 13	11.63	10,100	*1.11
Mississippi River main stem											
122	5-2885	Mississippi River near Anoka, Minn.	19,100	1931-69	1965	19.53	91,000	Apr. 14	16.84	72,500	*1.14
Minnesota River basin											
123	5-2900	Little Minnesota River near Peever, S. Dak.	447	1939-69	1943 1952	b13.35 -	- 4,730	Apr. 6	11.31	3,270	8
124	5-2910	Whetstone River near Big Stone City, S. Dak.	389	1899-1903, 1910-69, 1910-12, 1931-69	1919 1947 1952	26 13.95 -	(a) - 5,710	Apr. 8 Apr. 13	14.32 12.09	6,870 2,550	35 -
125	5-2920	Minnesota River at Ortonville, Minn.	1,160	1938-69	1952	12.92	3,060				
126	5-2930	Yellow Bank River near Odessa, Minn.	398	1939-69	1943 1952	b17.98 -	- 6,260	Apr. 9	19.07	6,970	22

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contrib- uting drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
Minnesota River basin--Continued											
127	5-2940	Pomme de Terre River at Appleton, Minn.	905	1931-69	1952	e10.13	5,050	Apr. 9 Apr. 11	b14.58 -	- 5,520	*1.21
128	5-3000	Lac qui Parle River near Lac qui Parle, Minn.	983	1910-14, 1931-69	1952 1965	- b19.37	11,100 -	Apr. 10	18.94	17,100	*1.86
129	5-3010	Minnesota River near Lac qui Parle, Minn.	4,050	1942-69	1952	37.98	19,700	Apr. 12	39.75	29,400	-
130	5-3034.5	Hassel Creek near Clontarf, Minn.	4.03	1962-69	1962	11.92	177	Apr. 7	b12.62	190	-
131	5-3045	Chippewa River near Milan, Minn.	1,870	1937-69	1952	b12.29	-	Apr. 9	15.45	11,400	*1.16
					1952	-	6,930				
132	5-3052	Spring Creek near Montevideo, Minn.	16.3	1959-69	1962	18.22	492	Apr. 7	17.94	463	-
133	5-3110	Minnesota River at Montevideo, Minn.	6,180	1909-69	1952	20.02	24,500	Apr. 12	21.68	35,100	*1.63
134		Minnesota River at Granite Falls, Minn.	-	-	-	-	-	Apr. 13	h895.49	43,400	-
135	5-3112	North Branch Yellow Medicine River near Ivanhoe, Minn.	15.2	1960-69	1967	e14.17	540	Apr. 7	18.70	940	-
136	5-3112.5	North Branch Yellow Medicine River tributary near Wilno, Minn.	.33	1960-69	1968	10.64	56	Apr. 4 Apr. 4	b11.69 -	- 54	-
137	5-3113	North Branch Yellow Medicine River tributary near Porter, Minn.	1.46	1960-69	1962	b16.79	247	Apr. 3 Apr. 7	b17.61 -	- 212	-
138	5-3114	South Branch Yellow Medicine River at Minneota, Minn.	111	1960-69	1960	11.10	1,830	Apr. 8	13.41	4,430	*1.58
139	5-3135	Yellow Medicine River near Granite Falls, Minn.	653	1919-69	1919	17.5	(a)				
140	5-3149	Redwood River at Ruthton, Minn.	5.90	1931-69	1957	12.41	11,800	Apr. 10	14.90	17,200	*1.07
141	5-3150	Redwood River at Marshall, Minn.	307	1959-69	1962	16.09	472	Apr. 8	18.19	728	-
				1940-69	1951	11.05	-	Apr. 10	-	5,450	*1.01
					1957	-	5,370				
142	5-3152	Prairie Ravine near Marshall, Minn.	-	1959-69	1962	b7.62	75	Apr. 6 Apr. 7	b11.0 -	- 221	-
143	5-3165	Redwood River near Redwood Falls, Minn.	697	1909-14, 1930-69	1957	15.92	19,700	Apr. 9	14.58	14,100	42
144	5-3167	Spring Creek near Sleepy Eye, Minn.	30.0	1959-69	1965	17.79	930	Apr. 6	15.93	683	-
145	5-3167.7	Minnesota River at New Ulm, Minn.	9,540	1881, 1967-69	1881	29.17	(a)				
					1968	b21.88	-	Apr. 15	30.65	58,000	*1.81
					1968	-	7,220				
146	5-3168	Cottonwood River tributary near Balaton, Minn.	.50	1959-69	1963	6.74	73	Apr. 4 Apr. 6	b8.41 -	- 106	-
147		Cottonwood River near Lamberton, Minn.	-	-	-	-	-	Apr. 8	h1,062.23	j8,720	-
148		Cottonwood River at Springfield, Minn.	-	-	-	-	-	Apr. 8	h1,019.17	20,500	-
149	5-3170	Cottonwood River near New Ulm, Minn.	1,280	1909-13, 1931-69	1965	b20.86	26,000	Apr. 10 Apr. 7	19.15 -	28,700 j2,310	*2.45 -
150		Little Cottonwood River at Searles, Minn.	-	-	-	-	-				

151	5-3175	Minnesota River at Judson, Minn.	11,200	1881, 1938-69	1881 1965	h790.5 -	- 58,000	Apr. 13	h788.6	64,000	*1.68
(f)	5-3195	Watonwan River near Garden City, Minn.	812	1940-45, 1953-69	1965	24.11	19,000	Apr. 9	20.07	11,800	-
152	5-3200	Blue Earth River near Rapidan, Minn.	2,430	1909-10, 1939-45, 1949-69	1965	21.36 22.24	43,100 526	Apr. 10 Apr. 4	13.54 15.56	21,100 120	*1.05 -
153	5-3203	Cobb River tributary near Mapleton, Minn.	7.25	1959-69	1960	22.72	-				
154	5-3205	Le Sueur River near Rapidan, Minn.	1,100	1939-45, 1949-69	1960 1965	-	24,700	Mar. 27	12.75	10,900	*1.46
155	5-3250	Minnesota River at Mankato, Minn.	14,900	1881-1969	1881	29.9	-	Apr. 12	27.07	76,700	*1.24
156	5-3300	Minnesota River near Jordan, Minn.	16,200	1934-69	1965 1965	- b34.37	94,100 117,000 -	Apr. 14	32.85	84,600	*1.34
Mississippi River main stem											
157	5-3310	Mississippi River at St. Paul, Minn.	36,800	1851-1969	1965	26.01	171,000	Apr. 15	24.52	156,000	*1.54
St. Croix River basin											
158	5-3385	Snake River near Pine City, Minn.	958	1913-17, 1950-69	1950 1965	- 9.56	j12,500 -	Apr. 12	9.08	10,200	30
159	5-3405	St. Croix River at St. Croix Falls, Wis.	5,930	1902-69	1950	25.19	54,900	Apr. 13	19.19	41,600	17
160		St. Croix River at Prescott, Wis.	-	-	-	-	-	Apr. 16	-	j38,400	-
Mississippi River main stem											
161	5-3445	Mississippi River at Prescott, Wis.	44,800	1928-69	1965	93.11	228,000	Apr. 16	91.48	199,000	*1.37
Chippewa River basin											
162	5-3695	Chippewa River at Durand, Wis.	9,010	1884, 1928-69	1884 1967	18.4 16.93	(a) 123,000	Apr. 10	12.46	53,600	3
Mississippi River main stem											
163		Mississippi River at Lock and Dam 4 near Alma, Wis.	-	1935-69	1965	m676.45 675.78	256,000	Apr. 17, 18	m674.20 673.60	214,000	-
164	5-3785	Mississippi River at Winona, Minn.	59,200	1880-1969	1965	20.77	268,000	Apr. 19	19.48	219,000	*1.10
165	5-3835	Mississippi River at La Crosse, Wis.	62,800	1880-1969	1965	17.96	278,000	Apr. 20	15.7	214,000	50
166		Mississippi River at Lansing, Iowa	66,280	1880-1969	1965	h634.8	j272,000	Apr. 22	h631.14	205,000	-
167	5-3895	Mississippi River at McGregor, Iowa	67,500	1937-69	1965	25.38	276,000	Apr. 22	21.57	216,000	*1.01
Wisconsin River basin											
168		Wisconsin River at Bridgeport, Wis.	11,700	-	-	-	-	Apr. 15 Apr. 23	- b26.47	j41,100 -	-

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contrib- uting drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
Mississippi River main stem											
169		Mississippi River at Dubuque, Iowa	81,600	1965	1965	26.71	304,000	Apr. 23	23.11	230,000	42
170	5-4205	Mississippi River at Clinton, Iowa	85,600	1873-1969	1965	24.65	307,000	Apr. 26	21.52	231,000	40
171	5-4745	Mississippi River at Keokuk, Iowa	119,000	1851, 1878-1969	1851 1965	21.0 22.14	360,000 327,000	Apr. 26 Apr. 27	- 17.85	c253,200 -	13
Des Moines River basin											
172		West Fork Des Moines River at outlet of Talcot Lake near Dundee, Minn.	-	-	-	-	-	Apr. 9	12.48	8,730	-
173		West Fork Des Moines River at Windom, Minn.	-	1965-69	1965	1,351.4	-	Apr. 11	1,352.8	15,000	-
174	5-4758	West Fork Des Moines River tribu- tary near Jackson, Minn.	1.42	1960-69	1962	b16.34	69	Apr. 4 Apr. 6	b17.57 -	- 77	-
175	5-4759	West Fork Des Moines River tribu- tary near Lakefield, Minn.	4.52	1960-69	1963	7.00	119	Apr. 7	8.76	221	-
176	5-4760	West Fork Des Moines River at Jackson, Minn.	1,220	1909-13, 1930-69	1965 1965	b18.62 -	- 9,530	Apr. 11	19.45	15,700	*2.02
177	5-4761	Story Brook near Petersburg, Minn.	25.2	1960-69	1962	12.77	2,110	Apr. 5 Apr. 6	b16.54 -	- 1,790	-
178	5-4765	West Fork Des Moines River at Estherville, Iowa	1,372	1952-69	1953	15.53	10,800	Apr. 12	17.68	16,000	*1.84
179		West Fork Des Moines River at Emmetsburg, Iowa	1,671	-	-	-	-	Apr. 13	h1,210.4	16,100	*1.36
180	5-4767.5	West Fork Des Moines River at Humboldt, Iowa	2,256	1940-69	1965	13.90	14,400	Apr. 14	15.40	18,000	*1.18
181	5-4769	East Fork Des Moines River tribu- tary near Dunnell, Minn.	7.88	1960-69	1962	16.15	2,200	Apr. 6	13.71	421	-
182	5-4790	East Fork Des Moines River at Dakota City, Iowa	1,308	1938, 1940-69	1938 1954	e17.4 24.02	22,000 17,400	Apr. 9	16.21	5,990	3
183	5-4805	Des Moines River at Fort Dodge, Iowa	4,190	1914-27, 1947-69	1965	17.79	35,600	Apr. 15	12.83	22,900	5
Little Muddy Creek basin											
(f)	6-3310	Little Muddy Creek below Cow Creek near Williston, N. Dak.	775	1955-69	1960	13.57	6,910	Apr. 4	12.43	4,380	19
White Earth River basin											
184	6-3320	White Earth River at White Earth, N. Dak.	490	1929, 1955-69	1929 1960	21.8 18.02	- 2,300	Apr. 6	17.58	2,040	12

Bear Den Creek basin											
185	6-3325.15	Bear Den Creek near Mandaree, N. Dak.	74	1967-69	1967	7.90	290	Apr. 6	10.03	1,100	12
Shell Creek basin											
(f)	6-3325.2	Shell Creek near Parshall, N. Dak.	465	1966-69	1966	5.52	458	Apr. 6	7.57	2,270	6
Knife River basin											
(f)	6-3391	Knife River at Manning, N. Dak.	205	1968-69	1968	b10.44	420	Apr. 4	14.48	1,060	5
186	6-3394.9	Elm Creek near Golden Valley, N. Dak.	82	1968-69	1968	7.20	191	Apr. 4	17.25	980	8
187	6-3395	Knife River near Golden Valley, N. Dak.	1,230	1903-69	1943	26.7	11,500	Apr. 4	22.67	5,410	5
188	6-3400	Spring Creek at Zap, N. Dak.	549	1924, 1946-69	1952	20.03	6,130	Apr. 6	20.27	5,360	12
189	6-3405	Knife River at Hazen, N. Dak.	2,240	1938-69	1966	27.01	35,300	Apr. 7	24.75	11,800	10
Heart River basin											
190	6-3475	Big Muddy Creek near Almont, N. Dak.	456	1946-69	1950	30.7	20,200	Apr. 7	24.80	4,760	6
191	6-3480	Heart River near Lark, N. Dak.	2,750	1947-69	1950	20.70	29,200	Apr. 4	17.59	12,700	-
192	6-3490	Heart River near Mandan, N. Dak.	3,310	1924, 1929-33, 1938-69	1950, 1952	- b25.75	30,500 -	Apr. 4 Apr. 7	b22.84 -	- 18,800	8
Apple Creek basin											
193	6-3495	Apple Creek near Menoken, N. Dak.	1,180	1947-69	1950	17.07	6,750	Apr. 10	16.68	4,040	5
Cannonball River basin											
194	6-3530	Cedar Creek near Raleigh, N. Dak.	1,750	1939, 1950, 1962-69	1950	18	45,000	Apr. 3	11.30	5,860	5
195	6-3540	Cannonball River at Breien, N. Dak.	4,100	1906-8, 1912-18, 1922, 1924, 1928-69	1950	22.30	94,800	Apr. 4	13.91	16,900	6
Beaver Creek basin											
196	6-3545	Beaver Creek at Linton, N. Dak.	617	1943, 1950-69	1952	17.50	9,800	Apr. 9	16.7	5,160	9
Missouri River main stem											
197	6-4675	Missouri River at Yankton, S. Dak.	279,500	1881-1969, 1930-69	1881, 1952	bn50.5 n35.5	(a) 480,000	Apr. 25	21.67	d33,600	-
James River basin											
198	6-4681.7	James River near Grace City, N. Dak.	410	-	-	-	-	Apr. 13	12.00	3,100	30

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contrib- uting drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
James River basin--Continued											
199	6-4690	Jamestown Reservoir near Jamestown, N. Dak.	750	1953-69	1966	1,439.90	i70,530	Apr. 30	1,443.56	i102,750	-
200	6-4695	Pipestem Creek near Buchanan, N. Dak.	298	1950-69	1950	11.89 -	- 4,480	Apr. 10	12.08	6,080	*1.5
201	6-4700	James River at Jamestown, N. Dak.	1,170	1928-33, 1938-39, 1943-69	1950	e15.82	6,390	Apr. 11	16.94	6,330	-
202	6-4705	James River at La Moure, N. Dak.	1,790	1950-69	1950	15.34	5,730	Apr. 14	16.17	6,800	-
203	6-4710	James River at Columbia, S. Dak.	4,050	1945-69	1950	16.89	5,420	Apr. 11	-	pl,750	-
					1952	-	pl,860	Apr. 22	17.09	4,670	37
204	6-4710.5	Elm River tributary near Leola, S. Dak.	14.7	1956-69	1964	8.62	418	Apr. 8	11.0	(a)	-
205	6-4712	Maple River at North Dakota- South Dakota State line	480	1956-69	1966	12.43	2,620	Apr. 11	b16.05	-	-
								Apr. 11	-	5,930	*1.42
206	6-4713.5	Maple River at Frederick, S. Dak.	552	1956-69	1962	12.70	3,000	Apr. 11	b14.3	-	-
								Apr. 11	-	6,000	*1.31
207	6-4714	Willow Creek tributary near Leola, S. Dak.	3.74	1956-69	1964	2.58	33	Apr. 8	4.81	(a)	-
208	6-4714.5	Willow Creek tributary near Barnard, S. Dak.	.18	1956-69	1960	2.59	20	Apr. 9	4.93	(a)	-
209	6-4715	Elm River at Westport, S. Dak.	1,140	1945-69	1952	20.10	7,520	Apr. 10	22.11	12,600	*1.61
210	6-4720	James River near Stratford, S. Dak.	6,070	1950-68	1950	-	5,580	Apr. 19	18.18	(a)	-
					1952	18.13	-				
211	6-4722.5	Mud Creek tributary No. 2 near Groton, S. Dak.	60.0	1956-69	1966	5.54	272	Apr. 8	5.60	310	5
212	6-4725	Mud Creek near Stratford, S. Dak.	460	1955-69	1962	e10.53	637	Apr. 10	7.92	1,180	5
213	6-4730	James River at Ashton, S. Dak.	6,810	1945-69	1950	-	5,170	Apr. 9	-	p2,100	-
					1952	19.59	-	Apr. 13	b21.17	-	-
					1952	-	pl,500	Apr. 24	-	5,680	*1.08
214	6-4735	South Fork Snake Creek near Athol, S. Dak.	1,090	1950-69	1952	b16.42	2,200	Apr. 7	b19.15	-	-
								Apr. 7	-	6,810	40
215	6-4737	SNAKE Creek near Ashton, S. Dak.	1,770	1955-69	1966	13.69	1,210	Apr. 10	17.21	6,980	19
216	6-4737.5	Wolf Creek near Ree Heights, S. Dak.	265	1959-69	1960	-	842	Apr. 5	9.33	990	7
					1966	b9.57	-				
217	6-4738	Matter Creek tributary near Orient, S. Dak.	5.41	1956-69	1960	-	325	Apr. 3	9.01	400	*2.27
					1966	b7.90	-				
218	6-4738.2	Shaefer Creek near Orient, S. Dak.	45.1	1956-69	1960	5.12	870	Apr. 3	5.98	1,280	*1.66
219	6-4738.5	Shaefer Creek tributary near Orient, S. Dak.	6.08	1956-69	1960	6.12	221	Apr. 3	7.98	350	*1.89
220	6-4738.8	Shaefer Creek tributary near Miller, S. Dak.	5.75	1956-69	1960	4.61	120	Apr. 3	6.40	245	*1.39
					1967	4.61	120				
221	6-4740	Turtle Creek near Tulare, S. Dak.	1,120	1953-56	1966	12.10	1,980	Apr. 5	b18.51	-	-
					1965-69			Apr. 5	-	6,000	26
222	6-4743	Medicine Creek near Zell, S. Dak.	210	1959-69	1966	10.28	1,250	Apr. 5	12.41	2,210	40
223	6-4745	Turtle Creek at Redfield, S. Dak.	1,540	1945-69	1952	15.51	6,420	Apr. 7	15.94	7,660	27
224	6-4750	James River near Redfield, S. Dak.	10,200	1950-69	1952	22.12	6,100	Apr. 13	24.93	7,310	26

225	5-4755	Dry Run near Frankfort, S. Dak.	225	1955-69	1962	9.16	772	Apr. 7	8.81	465	4
226	6-4760	James River at Huron, S. Dak.	12,010	1881, 1928-32, 1943-69	1881	19.8	-				
227	6-4765	Sand Creek near Alpena, S. Dak.	240	1950-69	1950	15.80	6,250	Apr. 13	16.70	9,000	25
228	6-4770	James River near Forestburg, S. Dak.	13,810	1950-69	1960	b14.1	-	Apr. 4	b13.00	-	
229	6-4771.5	Rock Creek near Fulton, S. Dak.	270	1966-69	1967	-	2,240	Apr. 5	-	2,220	12
230	6-4775	Firesteel Creek near Mount Vernon, S. Dak.	540	1955-69	1960	16.40	12,000	Apr. 9	17.16	12,500	*1.02
231	6-4780	James River near Mitchell, S. Dak.	15,010	1953-58	1966	7.22	625	Apr. 7	10.21	2,040	9
232	6-4782.6	North Branch Dry Creek near Parkston, S. Dak.	37.0	1956-69	1962	-	5,780	Apr. 3	b17.12	-	
233	6-4782.8	South Branch Dry Creek near Parkston, S. Dak.	17.1	1956-69	1960	b16.85	-	Apr. 4	-	6,610	40
234	6-4783	Dry Creek near Parkston, S. Dak.	76.8	1956-69	1960	12.98	2,750	Apr. 11	18.32	13,800	46
235	6-4785	James River near Scotland, S. Dak.	16,760	1928-69	1962	8.76	1,540	Apr. 8	10.28	3,200	*1.38

Vermillion River basin

236	6-4786.9	West Fork Vermillion River near Parker, S. Dak.	370	1961-69	1962	12.33	4,340	Apr. 4	b12.30	-	
237	6-4788	Saddlerock Creek near Canton, S. Dak.	14.8	1956-69	1965	8.81	945	Apr. 6	-	3,760	20
238	6-4788.2	Saddlerock Creek tributary near Beresford, S. Dak.	2.32	1956-69	1965	6.79	97	Apr. 8	b8.80	700	*1.26
239	6-4788.4	Saddlerock Creek near Beresford, S. Dak.	26.3	1956-69	1965	9.80	1,480	Apr. 8	4.53	32	-
240	6-4790	Vermillion River near Wakonda, S. Dak.	1,680	1945-69	1960	16.94	-	Apr. 8	8.39	900	*1.07
					1962	-	8,660	Apr. 6	b17.17	-	
								Apr. 8	-	9,880	16

Big Sioux River basin

241	6-4792	Big Sioux River near Ortle, S. Dak.	53.8	1956-69	1962	5.73	950	Apr. 6	(q)	(q)	-
242	6-4792.4	Big Sioux River tributary No. 2 near Summit, S. Dak.	.26	1956-69	1962	5.16	53	Apr. 6	4.32	40	-
243	6-4792.6	Big Sioux River tributary No. 3 near Summit, S. Dak.	6.60	1956-69	1965	6.15	600	Apr. 6	10.11	800	*2.56
244	6-4795	Big Sioux River at Watertown, S. Dak.	400	1945-69	1952	b10.35	-	Apr. 8	11.40	1,750	23
245	6-4797.5	Peg Munky Run near Estelline, S. Dak.	25.4	1956-69	1965	-	2,220	Apr. 8	7.25	1,480	30
246	6-4798	North Deer Creek near Estelline, S. Dak.	48.3	1956-69	1962	7.29	1,540	Apr. 8	7.25	1,480	30
247	6-4799	Sixmile Creek tributary near Brookings, S. Dak.	9.42	1956-69	1965	7.61	590	Apr. 8	8.45	3,550	*1.26
248	6-4799.5	Deer Creek near Brookings, S. Dak.	4.21	1956-69	1961	6.68	820	Apr. 8	b9.08	1,000	*1.05
249	6-4800	Big Sioux River near Brookings, S. Dak.	2,450	1953-69	1962	5.83	194	Apr. 8	7.72	(a)	-
250	6-4810	Big Sioux River near Dell Rapids, S. Dak.	3,090	1948-69	1962	12.95	10,600	Apr. 9	14.77	33,900	*2.61
						15.14	18,400	Apr. 9	16.47	41,300	*2.56

See footnotes at end of table.

Table 11.--Summary of flood stages and discharges--Continued

No.	Perm. station number	Stream and place of determination	Contrib- uting drainage area (sq mi)	Maximum previously known				Maximum April-May 1969			
				Period	Year	Gage height (feet)	Discharge (cfs)	Date	Gage height (feet)	Discharge	
										cfs	Recur- rence interval (years)
Big Sioux River basin--Continued											
251	6-4815	Skunk Creek near Sioux Falls, S. Dak.	520	1948-69	1957	17.78	29,400	Apr. 6	13.24	9,710	22
252	6-4821	Big Sioux River near Brandon, S. Dak.	3,840	1959-69	1962	19.93	17,100	Apr. 10	24.56	36,800	*1.58
253	6-4828.7	Little Beaver Creek tributary near Canton, S. Dak.	.22	1956-69	1968	3.54	(a)	Apr. 8	b4.91	(a)	-
254	6-4829.5	Mound Creek near Hardwick, Minn.	2.77	1959-69	1960	10.49	106	Apr. 7	11.54	274	-
255	6-4830	Rock River at Luverne, Minn.	440	1911-14	1914	h1,437.78	11,600	Apr. 8	h1,439.39	19,500	-
256	6-4832.7	Rock River at Rock Rapids, Iowa	788	1960-69	1962	9.56	16,400	Apr. 9	10.23	29,000	50
257		Little Rock River near Little Rock, Iowa	134	-	-	-	-	Apr. 6	h1,435.02	9,100	31
258		Little Rock River at George, Iowa	195	-	-	-	-	Apr. 6	h1,355.98	10,200	29
259	6-4834.6	Otter Creek near Ashton, Iowa	88.0	1952-69	1953	12.16	17,400	Apr. 6	10.77	4,900	16
260		Otter Creek near Matlock, Iowa	179	-	-	-	-	Apr. 6-7	h1,360.46	8,510	24
261		Little Rock River near George, Iowa	416	-	-	-	-	Apr. 7	h1,323.69	14,600	20
262		Little Rock River near Doon, Iowa	470	-	-	-	-	Apr. 7	h1,271.63	14,300	17
263	6-4835	Rock River near Rock Valley, Iowa	1,600	1949-69	1962	16.91	28,400	Apr. 7	17.32	40,400	42
264	6-4855	Big Sioux River at Akron, Iowa	7,060	1928-69	1962	22.08	54,300	Apr. 9	22.99	80,800	*1.22
Missouri River main stem											
265	6-4860	Missouri River at Sioux City, Iowa	314,600	1928-31, 1938-69	1952	24.28	441,000	Apr. 10	7.58	77,700	-
Floyd River basin											
266	6-6001	Floyd River at Alton, Iowa	265	1953, 1956-69	1953 1962	- 18.35	45,500 12,200	Apr. 4	17.78	8,510	27
267	6-6003	West Branch Floyd River near Struble, Iowa	181	1956-69	1962	15.63	8,060	Apr. 4	14.90	4,380	12
268	6-6005	Floyd River at James, Iowa	882	1935-69	1953	25.3	71,500	Apr. 5	21.54	17,300	28
Little Sioux River basin											
269	6-6035.3	Little Sioux River near Spafford, Minn.	-	1962-69	1965	b11.08	2,700	Apr. 6	10.03	2,040	-
270	6-6051	Little Sioux River at Spencer, Iowa	990	1936-69	1953	20.20	30,000	Apr. 8	16.1	b16,700	*2.7
271	6-6056	Little Sioux River at Gillett Grove, Iowa	1,334	1953, 1958-69	1953 1965	17.87 18.67	24,000 20,200	Apr. 8	17.78	15,900	45
272	6-6063	Mill Creek near Cherokee, Iowa	292	-	1953	14.30	11,500	Apr. 6	10.9	7,300	45
273		Little Sioux River at Cherokee, Iowa	2,173	-	1965	25.6	33,700	Apr. 7	24.24	21,000	43
274	6-6066	Little Sioux River at Correction- ville, Iowa	2,500	1891, 1918-69	1891 1965	29.34 25.86	(a) 29,800	Apr. 8	23.61	21,000	32

FOOTNOTES TO TABLE 11

- * Ratio of maximum discharge to that of 50-year flood.
- a Unknown.
- b Affected by backwater; see station description.
- c Daily mean discharge.
- d Flow regulated or partly regulated.
- e At different site and (or) datum; see station description.
- f Not numbered sequentially and not shown on location map.
- g Day of month not known.
- h Mean sea level elevation.
- i Contents in acre-feet.
- j From discharge measurement at or near peak.
- k At least 3 feet higher in 1882.
- m Headwater and tailwater elevations in mean sea level.
- n Present datum.
- p Daily reverse flow.
- q Station destroyed by flood.

(1) 4-0195. East Swan River near Toivola, Minn.

Drainage area.--112 sq mi.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-12.

Flood in May 1950 reached a stage of about 20.0 ft.

[illegible]

STREAMS TRIBUTARY TO LAKE SUPERIOR

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East Swan River near Toivola, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	8.70		2000	18.24		1200	17.96	1,630
			2400	18.64		2400	17.52	1,530
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
1000	8.80		0600	19.00		1200	17.05	1,430
2000	9.43		1000	19.08		2400	16.39	1,290
2400	9.53		1400	19.33				
<u>Apr. 7</u>			1800	19.60		<u>Apr. 17</u>		
0400	9.67		2200	19.58		1200	15.51	1,130
0800	9.95		2245	19.61		2400	14.44	974
1200	10.41		2400	19.58				
2000	11.45					<u>Apr. 18</u>		
2400	11.90		<u>Apr. 12</u>			1200	13.20	814
			0600	19.57		2400	12.15	696
<u>Apr. 8</u>			1800	19.25				
1000	13.19		1930	19.27	1,950	<u>Apr. 19</u>		
2400	14.73		2400	19.24	1,940	1200	11.37	617
						2400	10.73	553
<u>Apr. 9</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
0600	15.33		1200	18.64	1,800	1200	10.26	506
0800	15.40		1600	18.59	1,780	2400	9.97	477
1000	15.64		2400	18.67	1,800			
2400	16.55					<u>Apr. 21</u>		
<u>Apr. 10</u>			<u>Apr. 14</u>			1200	10.01	481
1000	17.08		1200	18.41	1,740	2400	9.86	466
1600	17.68		1800	18.34	1,720			
			2400	18.30	1,710			

Location.--Lat 46°42'12", long 92°25'07", in NW $\frac{1}{4}$ sec.30, T.49 N., R.16 W., on right bank 25 ft downstream from lower bridge on U. S. Highway 61 at Scanlon, 0.6 mile downstream from Minnesota Power and Light Co. powerplant, 3 miles upstream from Thomson Reservoir, and 3.2 miles upstream from Midway River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,101.23 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 28,300 cfs 0330 hours Apr. 15 (gage height, 12.60 ft).

1908 to March 1969: Daily discharge, 37,900 cfs May 9, 1950; gage height, 15.8 ft May 9, 1950, from Minnesota Highway Department (discharge uncertain).

Remarks.--Flow regulated by Whiteface Reservoir and Boulder, Island, Rice, and Fish Lakes (combined capacity, 332,160 acre-ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

STREAMS TRIBUTARY TO LAKE SUPERIOR

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St. Louis River at Scanlon, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 15</u>		
2400	5.77	5,370	0600	10.58	20,700	1200	12.59	28,300
			0800	10.62	20,800	2000	12.51	27,900
<u>Apr. 9</u>			1200	10.48	20,300	2400	12.46	27,700
0200	5.84	5,540	1400	10.47	20,300			
0400	5.86	5,590	1600	10.72	21,200	<u>Apr. 16</u>		
0800	6.18	6,390	1800	10.82	21,500	0400	12.41	27,500
1200	6.37	6,880	2000	10.69	21,100	1800	12.20	26,700
1400	6.78	8,080	2400	10.86	21,700	2400	12.09	26,300
1800	6.84	8,260						
2400	7.22	9,400	<u>Apr. 13</u>			<u>Apr. 17</u>		
			0400	11.26	23,200	0600	12.01	26,000
<u>Apr. 10</u>			1000	11.46	23,900	2000	11.73	24,900
0600	7.64	10,700	1400	11.53	24,200	2400	11.67	24,700
2000	8.31	12,800	1600	11.77	25,000			
2200	8.36	13,000	2200	11.76	25,000	<u>Apr. 18</u>		
2400	8.54	13,600	2400	11.83	25,300	0400	11.58	24,300
						1400	11.31	23,300
<u>Apr. 11</u>			<u>Apr. 14</u>			2400	11.02	22,300
0200	8.71	14,100	0200	11.92	25,600			
0600	8.93	14,900	0800	12.20	26,700	<u>Apr. 19</u>		
1200	9.10	15,400	1200	12.35	27,300	1000	10.70	21,100
2200	9.81	17,900	2030	12.52	28,000	2000	10.34	19,800
2400	10.28	19,600	2400	12.57	28,200	2400	10.20	19,300
<u>Apr. 12</u>			<u>Apr. 15</u>			<u>Apr. 20</u>		
0200	10.60	20,800	0330	12.60	28,300	0400	10.05	18,800
0400	10.36	19,900	0600	12.60	28,300	1400	9.74	17,700
						2400	9.47	16,700

(3) 5-0476. West Branch Mustinka River near Graceville, Minn.

(Crest-stage station)

Location.--Lat $45^{\circ}37'43''$, long $96^{\circ}26'35''$, in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.22, T.125 N., R.46 W.,
at culverts on county highway, 4.1 miles north of Graceville.

Drainage area.--56.7 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Discharge obtained from indirect measurement.

Maxima.--April 1969: Discharge, 686 cfs Apr. 9 (gage height, 12.50 ft, from
high-water profile).

1964 to March 1969: Gage height, 9.41 ft Mar. 18, 1966 (discharge not
determined).

(4) 5-0477. West Branch Mustinka River tributary near Graceville, Minn.

(Crest-stage station)

Location.--Lat $45^{\circ}36'53''$, long $96^{\circ}19'47''$, in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.28, T.125 N., R.45 W.,
at culvert on county highway, 0.6 mile northeast of Graceville.

Drainage area.--3.37 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Discharge obtained from indirect measurement.

Maxima.--April 1969: Discharge, 418 cfs Apr. 9 (gage height, 10.56 ft).

1964 to March 1969: Discharge, 96 cfs Apr. 13, 1964 (gage height,
8.76 ft).

Location.--Lat 45°51'45", long 96°34'35", in SW¹₄SW¹₄ sec.27, T.128 N., R.47 W., on left bank just downstream from Big Slough Outlet, 300 ft downstream from White Rock Dam, 4 miles south of White Rock, and 5 miles northwest of Wheaton, Minn.

Gage-height record.--Water-stage recorder graph, except Apr. 17-24, for which graph was reconstructed on basis of once-daily staff gage readings. Datum of gage is 960.00 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 3,770 cfs (time unknown) during period Apr. 19-21 (gage-height, 15.07 ft, result of unusual regulation).
1941 to March 1969: Discharge, 1,620 cfs Aug. 6, 1962 (gage height, 11.41 ft).

Remarks.--Flow regulated by Lake Traverse-Bois de Sioux Flood Control and Water Conservation project (available capacity for flood control, 137,000 acre-ft).

[illegible]

Location.--Lat 46°15'55", long 96°35'40", in NE¼ sec.8, T.132 N., R.47 W., on left bank in Wahpeton, 800 ft downstream from confluence of Bois de Sioux and Otter Tail Rivers and at mile 548.6.

Gage-height record.--Water-stage recorder graph.

Maxima.--April-May 1969: 9,200 cfs 1100 hours Apr. 10 (gage height, 16.34 ft).

1942 to March 1969: Discharge, 7,130 cfs Apr. 12, 1952 (gage height, 14.99 ft).

Maximum stage known, 17.0 ft in spring of 1897.

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1966								
Day	April	May	Day	April	May	Day	April	May
1...	540	3,350	11...	8,890	2,650	21...	4,720	2,450
2...	520	3,120	12...	8,590	2,630	22...	4,550	2,450
3...	510	2,980	13...	7,780	2,580	23...	4,440	2,440
4...	550	2,950	14...	7,390	2,470	24...	4,390	2,430
5...	590	2,950	15...	7,210	2,440	25...	4,360	2,410
6...	818	2,920	16...	6,590	2,460	26...	4,290	2,390
7...	1,260	2,880	17...	5,970	2,490	27...	4,200	2,380
8...	2,560	2,830	18...	5,520	2,490	28...	4,060	2,340
9...	6,250	2,790	19...	5,180	2,470	29...	3,860	2,310
10...	8,940	2,710	20...	4,920	2,450	30...	3,620	2,300
						31...	--	2,280
Monthly mean discharge, in cubic feet per second							4,436	2,606
Runoff, in acre-feet							263,900	160,200

Red River of the North at Wahpeton, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	5.99	658	1800	15.51	7,500	2400	15.29	7,420
			2100	15.78	8,000			
<u>Apr. 6</u>			2400	15.97	8,410	<u>Apr. 15</u>		
1200	6.08	817				0800	15.21	7,300
2400	6.41	978	<u>Apr. 10</u>			1600	15.09	7,150
			0400	16.17	8,770	2400	14.93	6,940
<u>Apr. 7</u>			0800	16.25	9,000			
1200	6.71	1,170	1100	16.34	9,200	<u>Apr. 16</u>		
1800	7.15	1,460	1400	16.28	9,080	0800	14.73	6,700
2400	7.61	1,720	2400	16.20	8,930	1600	14.52	6,470
						2400	14.29	6,250
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
0600	8.02	1,980	0300	16.15	8,840	0800	14.07	6,060
1200	8.60	2,400	0900	16.17	8,880	1600	13.83	5,870
1400	8.93	2,560	1600	16.19	8,910	2400	13.62	5,720
1600	9.37	2,790	2400	16.18	8,890			
1800	9.85	3,040				<u>Apr. 18</u>		
2000	10.42	3,340	<u>Apr. 12</u>			0800	13.41	5,580
2200	11.00	3,650	0800	16.09	8,730	1600	13.22	5,460
2400	11.57	3,960	1600	15.96	8,500	2400	13.03	5,330
			2400	15.79	8,200			
<u>Apr. 9</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
0200	12.19	4,310	0800	15.61	7,910	0800	12.86	5,220
0400	12.74	4,680	1600	15.43	7,620	1600	12.74	5,150
0600	13.32	5,090	2400	15.29	7,420	2400	12.58	5,040
0800	13.82	5,350						
1000	14.25	5,830	<u>Apr. 14</u>			<u>Apr. 20</u>		
1200	14.75	6,300	0800	15.25	7,360	1200	12.39	4,920
1500	15.20	6,900				2400	12.24	4,820

Location.--Lat 46°01'20", long 97°30'40", in SE~~1~~⁴SE~~4~~⁴ sec.36, T.130 N., R.55 W., on right bank 1,000 ft upstream from bridge on county highway, 2 miles south of Rutland, and 10 miles upstream from Lake Tewaukon.

Gage-height record.--Water-stage recorder graph except Apr. 7-30 when twice-daily staff or reference point readings were used. Datum of gage is 1,197.73 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 1,270 cfs 2400 hours Apr. 8 (gage height, 8.77 ft, backwater from ice); gage height, 8.78 ft Apr. 8 (backwater from ice).
1960 to March 1969: Discharge, 660 cfs Mar. 15, 1966 (gage height, 7.12 ft, backwater from ice).

[illegible]

RED RIVER OF THE NORTH BASIN

185

Wild Rice River near Rutland, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	2.78	0	1700	7.58	1,040	0800	6.54	703
			2400	7.52	1,020	1700	6.34	642
<u>Apr. 7</u>						2400	6.28	624
0200	3.13	.10	<u>Apr. 10</u>			<u>Apr. 15</u>		
0400	3.48	2.0	1200	7.61	1,050	0800	6.22	606
0700	4.18	10	1900	7.58	1,040	1700	6.12	576
1100	5.20	30	2400	7.46	997	2400	6.06	558
1500	4.88	20	<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	6.88	180	0900	7.27	936	0800	5.98	534
<u>Apr. 8</u>			2400	7.10	882	1700	5.96	529
0600	8.13	480	<u>Apr. 12</u>			2400	5.88	506
0900	8.53	660	0800	6.98	846	<u>Apr. 17</u>		
1200	8.71	850	1800	6.73	764	1700	5.68	450
1700	8.78	1,160	2400	6.64	735	2400	5.65	442
2400	8.77	1,270	<u>Apr. 13</u>			<u>Apr. 18</u>		
<u>Apr. 9</u>			0800	6.54	703	0800	5.66	445
0600	8.68	1,240	1700	6.56	709	1400	5.46	389
0800	8.58	1,220	2400	6.56	709	2400	5.40	372
1300	7.73	1,090						

Location.--Lat 46°07'30", long 97°21'40", on line between secs.29 and 30, T.131 N., R.53 W., on left bank 20 ft downstream from county highway bridge, 1½ miles downstream from Shortfoot Creek, 2½ miles downstream from Crooked Creek, and 3½ miles northeast of Cayuga.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,095.64 ft above mean sea level, datum of 1929 (levels by Bureau of Reclamation).

Maxima.--April 1969: Discharge, 1,710 cfs 1300 hours Apr. 12 (gage height, 9.32 ft); gage height, 10.90 ft Apr. 7 (backwater from ice).
1957 to March 1969: Discharge, 1,080 cfs July 6, 1962 (gage height, 8.95 ft).

[illegible]

RED RIVER OF THE NORTH BASIN

187

Wild Rice River near Cayuga, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	6.42	98	1200	9.20	1,650	2400	8.29	1,270
			2400	9.27	1,690			
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
0200	6.38	62	1000	9.28	1,690	1200	8.12	1,200
0300	7.20	125	1300	9.32	1,710	2400	7.98	1,150
0500	8.32	265	1800	9.25	1,680			
0700	9.60	490	2400	9.17	1,640	<u>Apr. 18</u>		
0900	10.90	720				1200	7.82	1,100
1500	10.55	680				2400	7.63	1,030
1800	10.20	820	<u>Apr. 13</u>					
2200	9.65	800	0900	9.06	1,590	<u>Apr. 19</u>		
2400	9.68	850	1200	8.93	1,530	1200	7.45	973
			2200	8.26	1,260	2400	7.27	914
			2400	8.20	1,230			
<u>Apr. 8</u>			<u>Apr. 14</u>			<u>Apr. 20</u>		
0300	9.70	924	0200	8.22	1,240	1200	7.11	863
1200	8.67	980	1200	8.77	1,460	2200	7.00	829
2400	7.63	1,030	1600	8.82	1,480	2400	6.97	820
<u>Apr. 9</u>			2400	8.74	1,450	<u>Apr. 21</u>		
0900	7.22	898				1200	6.81	770
1500	7.31	927	<u>Apr. 15</u>			2400	6.64	717
1600	7.33	934	1200	8.56	1,380			
2400	7.63	1,030	2400	8.44	1,320	<u>Apr. 22</u>		
<u>Apr. 10</u>			<u>Apr. 16</u>			1100	6.44	657
0800	7.87	1,120	0300	8.42	1,320	1200	6.42	651
1800	8.71	1,440	1100	8.43	1,320	2400	6.16	575
2400	9.13	1,620						

- (9) 5-0518. Grass Lake tributary near Lidgerwood, N. Dak.
(formerly Silver Lake tributary near Lidgerwood, N. Dak.)

(Crest-stage station)

Location.--Lat 46°04'45", long 97°11'40", at west line sec.15, T.130 N., R.52 W., at culvert on county road just off State Highway 11, 2 miles west of Lidgerwood.

Drainage area.--0.61 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 10 cfs and extended above on the basis of logarithmic plotting.

Maxima.--April-May 1969: Discharge, 12 cfs Apr. 9 (gage height, 2.51 ft); gage height, 2.91 ft Apr. 6 (backwater from snow).

1958 to March 1969: Discharge, 30 cfs June 14, 1967 (gage height, 4.07 ft).

- (10) 5-0519. Wild Rice River tributary near Mantador, N. Dak.

(Crest-stage station)

Location.--Lat 46°10'15", long 97°04'15", at east line sec.9, T.131 N., R.51 W., at bridge on county highway 4½ miles west of Mantador.

Drainage area.--6 sq mi, approximately.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 26 cfs and extended above on the basis of logarithmic plotting.

Maxima.--April-May 1969: Discharge, 64 cfs Apr. 10 (gage height, 4.87 ft).

1959 to March 1969: Discharge 9.5 cfs Mar. 13, 1966 (gage height, 4.17 ft, backwater from ice).

Location.--Lat 46°10'20', long 97°00'35", on south half of east line of sec.12, T.131 N., R.51 W., on downstream side of county highway bridge, 1½ miles west of Mantador.

Gage-height record.--Twice-daily readings by observer and crest-stage gage.

Maxima.--April 1969: Discharge, 2,360 cfs 1000 hours Apr. 13 (gage height, 10.83 ft).

1944 to March 1969: Discharge, 2,200 cfs Apr. 12, 1952 (gage height, 10.74 ft).

Remarks.--Some regulation by Fish and Wildlife Service reservoirs, of which Lake Tewaukon is the largest.

[illegible]

Wild Rice River near Mantador, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	7.97	170	2400	10.35	1,660	1200	10.45	1,930
						2400	10.42	1,900
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
0800	6.85	230	1200	10.32	1,800	1200	10.68	2,160
1200	7.73	280	2400	10.30	1,780	2400	10.60	2,080
1800	8.70	340						
2400	9.40	430	<u>Apr. 12</u>			<u>Apr. 17</u>		
			1200	10.62	2,100	1200	10.48	1,960
<u>Apr. 9</u>			2400	10.87	2,350	2400	10.39	1,870
0600	9.77	560						
1200	9.90	670	<u>Apr. 13</u>			<u>Apr. 18</u>		
2400	9.70	740	1000	10.88	2,360	1200	10.30	1,780
			2400	10.86	2,340	2400	10.22	1,700
<u>Apr. 10</u>			<u>Apr. 14</u>					
0400	9.55	800	1200	10.80	2,280			
1200	9.80	1,090	2400	10.63	2,110			
1800	10.10	1,340						

(12) 5-0525. Antelope Creek at Dwight, N. Dak.

Location.--Lat 46°18'50", long 96°44'05", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.20, T.133 N., R.48 W., at bridge on former U.S. Highway 81, half a mile north of Dwight and 7 miles upstream from mouth.

Drainage area.--294 sq mi, approximately, of which 16 sq mi is probably noncontributing.

Gage-height record.--Twice-daily readings by observer except Apr. 1-7; crest-stage gage.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Discharge Apr. 1-7 estimated from weather records.

Maxima.--April-May 1969: Discharge, 9,000 cfs 0700 hours Apr. 10 (gage height, 17.82 ft).

1944-47, 1949 to March 1969: Discharge, 3,670 cfs Apr. 8, 1952 (gage height, 16.31 ft).

Antelope Creek at Dwight, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8.....	995	15.....	1,070	23.....	210
2.....	0	9.....	6,270	16.....	816	24.....	160
3.....	0	10.....	7,900	17.....	706	25.....	115
4.....	0	11.....	5,380	18.....	605	26.....	83
5.....	0	12.....	3,280	19.....	533	27.....	64
6.....	10	13.....	2,000	20.....	430	28.....	53
7.....	100	14.....	1,370	21.....	347	29.....	44
				22.....	267	30.....	36
Monthly mean discharge, in cubic feet per second.....							1,095
Runoff, in acre-feet							65,150

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 12</u>		
2400	7.85	484	1900	17.82	8,800	1600	15.15	2,960
			2400	17.81	8,770	2400	14.75	2,550
<u>Apr. 8</u>			<u>Apr. 10</u>			<u>Apr. 13</u>		
0400	9.40	649	0600	17.70	8,420	0800	14.35	2,180
0800	10.78	806	1200	17.55	7,950	1600	13.80	1,770
1200	11.40	935	1800	17.40	7,500	2400	13.45	1,580
1600	12.00	1,090	2400	17.12	6,720			
2000	12.70	1,300				<u>Apr. 14</u>		
2400	14.00	1,900	<u>Apr. 11</u>			0800	13.10	1,440
			0800	16.70	5,660	1600	12.70	1,300
<u>Apr. 9</u>			1600	16.40	4,980	2400	12.30	1,180
0400	15.40	3,260	2400	16.05	4,290			
0800	16.48	5,160				<u>Apr. 15</u>		
1200	17.14	6,770	<u>Apr. 12</u>			1200	11.94	1,070
1600	17.65	8,260	0800	15.55	3,470	2400	11.46	950

Location.--Lat 46°28'05", long 96°47'00", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.36, T.135 N., R.49 W., on right bank 420 ft upstream from bridge on county highway, three-quarters of a mile upstream from rubble masonry dam which serves as control, 3 $\frac{1}{4}$ miles northwest of Abercrombie, and 7 miles downstream from Antelope Creek.

Drainage area.--2,080 sq mi, of which about 590 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 907.94 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 9,540 cfs 2000 hours Apr. 11 (gage height, 24.58 ft).

1933 to March 1969: Discharge, 5,500 cfs Apr. 2, 1943 (gage height, 21.02 ft. from floodmark).

Flood in spring of 1897 reached a stage of 27.5 ft, present site and datum, from floodmarks pointed out by local residents.

Remarks.--Some regulation by Fish and Wildlife Service reservoirs, of which Lake Tewaukon is the largest.

Mean discharge, in cubic feet per second, 1969

[illegible]

Wild Rice River near Abercrombie, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 13</u>			<u>Apr. 23</u>		
2400	1.71	26	2400	23.16	7,950	0800	14.03	2,360
						1600	13.73	2,280
<u>Apr. 8</u>			<u>Apr. 14</u>			2400	13.43	2,210
0600	4.36	574	1200	22.63	7,430			
1200	6.46	904	2400	22.10	6,900	<u>Apr. 24</u>		
1800	10.81	1,620				0800	13.10	2,120
2400	14.11	2,380	<u>Apr. 15</u>			1600	12.79	2,050
			1200	21.48	6,280	2400	12.46	1,970
<u>Apr. 9</u>			2400	20.95	5,790			
0200	14.96	2,620				<u>Apr. 25</u>		
0400	15.67	2,840	<u>Apr. 16</u>			0800	12.13	1,900
0600	16.24	3,040	1200	20.35	5,310	1600	11.78	1,820
0800	16.86	3,270	2400	19.81	4,890	2400	11.46	1,750
1000	17.56	3,580						
1200	18.16	3,870	<u>Apr. 17</u>			<u>Apr. 26</u>		
1600	19.21	4,480	1200	19.33	4,660	0800	11.13	1,690
2000	20.28	5,250	2400	18.88	4,280	1600	10.75	1,610
2400	21.13	5,970				2400	10.39	1,540
			<u>Apr. 18</u>					
<u>Apr. 10</u>			1200	18.45	4,030	<u>Apr. 27</u>		
0800	22.34	7,140	2400	18.03	3,810	0800	10.02	1,470
1600	23.21	8,030				1600	9.62	1,410
2400	23.95	8,840	<u>Apr. 19</u>			2400	9.24	1,350
			0800	17.73	3,660			
<u>Apr. 11</u>			1600	17.42	3,510	<u>Apr. 28</u>		
0400	24.22	9,140	2400	17.12	3,380	0800	8.85	1,290
0800	24.40	9,340				1600	8.48	1,230
1200	24.49	9,440	<u>Apr. 20</u>			2400	8.12	1,170
1600	24.56	9,520	0800	16.82	3,260			
2000	24.58	9,540	1600	16.54	3,150	<u>Apr. 29</u>		
2400	24.56	9,520	2400	16.22	3,030	0800	7.80	1,120
						1600	7.54	1,080
<u>Apr. 12</u>			<u>Apr. 21</u>			2400	7.24	1,030
0600	24.47	9,420	0800	15.94	2,930			
1200	24.33	9,260	1600	15.64	2,830	<u>Apr. 30</u>		
1800	24.18	9,100	2400	15.32	2,730	0800	6.96	984
2400	24.00	8,900				1600	6.72	945
			<u>Apr. 22</u>			2400	6.49	908
<u>Apr. 13</u>			0800	15.03	2,630			
1200	23.64	8,500	1600	14.68	2,530			
			2400	14.36	2,440			

Location.--Lat 46°51'40", long 96°47'00", in NW¼NE¼ sec.18, T.139 N., R.48 W., at city waterplant on 4th St. S. in Fargo, 25 miles upstream from mouth of Sheyenne River and at mile 453.

Gage-height record.--Water-stage recorder graph. Datum of gage is 861.8 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 25,300 cfs 0100 hours Apr. 15 (gage height, 37.34 ft).

Maximum stage known, 40.1 ft Apr, 7, 1897, site and datum then in use prior to 1914 (discharge, 25,000 cfs).

Day	April	May	Day	April	May	Day	April	May
1...	410	6,550	11...	9,580	3,600	21...	13,700	2,770
2...	430	6,150	12...	14,300	3,400	22...	12,100	2,750
3...	489	5,800	13...	21,700	3,250	23...	11,000	2,730
4...	510	5,500	14...	24,800	3,090	24...	10,100	2,720
5...	496	5,200	15...	23,900	2,990	25...	9,400	2,700
6...	552	4,900	16...	21,600	2,920	26...	8,850	2,670
7...	772	4,650	17...	19,800	2,830	27...	8,300	2,650
8...	1,910	4,400	18...	18,200	2,790	28...	7,950	2,600
9...	3,940	4,250	19...	16,900	2,780	29...	7,450	2,560
10...	6,170	3,750	20...	15,400	2,780	30...	7,000	2,530
						31...	--	2,520
Monthly mean discharge, in cubic feet per second							9,924	3,574
Runoff, in acre-feet							590,500	219,700

RED RIVER OF THE NORTH BASIN

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Red River of the North at Fargo, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 18</u>		
2400	15.24	1,150	1600	32.36	14,800	1200	35.38	18,200
			2400	34.18	18,200	2400	35.05	17,500
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
0800	15.66	1,450	0800	35.41	21,000	1200	34.74	17,000
1600	16.20	2,250	1600	36.27	22,900	2400	34.37	16,200
2000	17.11	2,650	2400	36.79	24,100			
2400	17.30	2,750				<u>Apr. 20</u>		
<u>Apr. 9</u>			<u>Apr. 14</u>			1200	33.96	15,500
0800	18.33	3,400	1200	37.23	25,000	2400	33.54	14,500
1600	19.81	4,400	2400	37.33	25,200			
2400	21.21	5,300	<u>Apr. 15</u>			<u>Apr. 21</u>		
<u>Apr. 10</u>			0100	37.34	25,300	1200	33.04	13,700
0800	22.27	5,350	1200	37.26	23,900	2400	32.50	12,800
1600	23.19	6,700	2400	37.02	22,500	<u>Apr. 22</u>		
2400	24.51	7,600				1200	31.98	12,100
<u>Apr. 11</u>			<u>Apr. 16</u>			2400	31.44	11,500
0800	26.20	8,900	1200	36.74	21,600			
1600	27.93	10,200	2400	36.38	20,600	<u>Apr. 23</u>		
2400	29.50	11,700	<u>Apr. 17</u>			1200	30.95	10,900
<u>Apr. 12</u>			1200	36.04	19,800	2400	30.49	10,500
0800	31.02	13,200	2400	35.70	19,100	<u>Apr. 24</u>		
						1200	30.04	10,100
						2400	29.63	9,750

Location.--Lat 47°42'10", long 99°56'55", in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.24, T.149 N., R.73 W., on right bank just downstream from county road, 2 miles upstream from unnamed tributary and 4 $\frac{1}{2}$ miles south of Harvey.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,547.30 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 370 cfs 1400 hours Apr. 11 (gage height, 9.45 ft); gage height, 9.70 ft Apr. 10 (backwater from ice).
1956 to March 1969: Discharge, 410 cfs Mar. 15, 1966 (gage height, 9.21 ft); gage height, 9.94 ft Mar. 26, 1967 (backwater from ice).

[illegible]

RED RIVER OF THE NORTH BASIN

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Sheyenne River above Harvey, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 18</u>		
2400	8.36	4.1	2400	9.39	324	1200	8.84	143
						2400	8.79	136
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 19</u>		
0700	8.31	3.6	1200	9.24	238	1200	8.75	131
1300	8.49	5.3	2400	9.15	205	2400	8.69	124
1600	9.24	72						
2400	9.09	68	<u>Apr. 13</u>			<u>Apr. 20</u>		
			1200	9.07	183	1200	8.64	119
<u>Apr. 8</u>			2400	9.03	175	2400	8.55	111
1200	9.04	82	<u>Apr. 14</u>			<u>Apr. 21</u>		
2400	9.15	107	1200	8.97	163	1200	8.47	105
<u>Apr. 9</u>			2400	8.94	158	2400	8.38	99
1100	9.26	138	<u>Apr. 15</u>			<u>Apr. 22</u>		
1500	9.51	161	1200	8.93	156	1200	8.30	94
2400	9.40	179	2400	8.93	156	2400	8.21	89
<u>Apr. 10</u>			<u>Apr. 16</u>			<u>Apr. 23</u>		
0730	9.70	304	1200	8.92	154	1200	8.09	82
1200	9.43	283	2400	8.92	154	2400	7.96	76
1700	9.38	317	<u>Apr. 17</u>			<u>Apr. 24</u>		
2400	9.43	354	1200	8.91	153	1200	7.79	71
<u>Apr. 11</u>			2400	8.86	145	2400	7.66	67
1400	9.45	370						

Location.--Lat 47°48'20", long 98°42'57", in south quarter of line between secs.15 and 16, T.150 N., R.63 W., on left bank on downstream side of highway bridge, 3.3 miles south of Warwick.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,370 ft (by barometer).

Maxima.--April 1969: Discharge, 4,660 cfs 0530 hours Apr. 14 (gage height, 7.51 ft).
1950 to March 1969: Discharge, 4,250 cfs Apr. 18, 1956 (gage height, 7.83 ft).

[illegible]

Sheyenne River near Warwick, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 16</u>		
2400	2.28	20	0800	6.25	1,800	1200	6.96	3,140
			1600	6.47	1,910	2400	6.84	2,930
<u>Apr. 8</u>			2400	6.85	2,250			
1200	2.43	51				<u>Apr. 17</u>		
1800	2.68	116	<u>Apr. 13</u>			1200	6.69	2,720
2400	2.95	188	0600	7.14	2,540	2400	6.49	2,490
			0700	7.05	2,450			
<u>Apr. 9</u>			1030	7.38	3,000	<u>Apr. 18</u>		
1200	3.15	251	1230	6.95	2,670	1200	6.38	2,380
1800	3.57	392	1330	7.03	2,910	2400	6.17	2,210
2400	3.77	465	1600	6.70	2,610			
			2100	6.88	2,840	<u>Apr. 19</u>		
<u>Apr. 10</u>			2130	7.35	4,120	1200	5.85	2,010
1200	4.16	637	2400	7.43	4,380	2400	5.44	1,740
1800	4.68	878						
2400	5.10	1,100	<u>Apr. 14</u>			<u>Apr. 20</u>		
			0530	7.51	4,660	1200	4.91	1,350
<u>Apr. 11</u>			2400	7.31	4,000	2400	4.86	1,030
1200	5.65	1,400						
2400	6.03	1,630	<u>Apr. 15</u>			<u>Apr. 21</u>		
			1200	7.19	3,660	1200	4.11	811
			2400	7.06	3,350	2400	3.87	667

(16) 5-0560.2. Mauvais Coulee tributary near Bisbee, N. Dak.

(Crest-stage station)

Location.--Lat 48°31'00", long 99°23'10", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.11, T.158 N.,
R.68 W., at bridge on county highway 7 $\frac{1}{2}$ miles south of Bisbee.

Drainage area.--2.83 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 300 cfs Apr. 11 (gage height, 6.05 ft).
1955 to March 1969: Discharge, 220 cfs Apr. 18, 1956 (gage height
3.98 ft); gage height, 5.05 ft March 1967 (backwater from snow).

(17) 5-0560.4. Mauvais Coulee tributary No. 2 near Cando, N. Dak.

(Crest-stage station)

Location.--Lat 48°29'10", long 99°24'20", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.23, T.158 N., R.68 W., at culvert on State Highway 17, 9 miles west of Cando.

Drainage area.--8.48 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 520 cfs Apr. 11 (gage height, 6.02 ft).
1955 to March 1969: Discharge, 180 cfs April 1956, Apr. 4, 1960;
gage height, 5.5 ft Apr. 4, 1962 (backwater from snow).

(18) 5-0560.6. Mauvais Coulee tributary No. 3 near Cando, N. Dak.

(Crest-stage station)

Location.--Lat 48°27'20", long 99°12'40", in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.5, T.157 N., R.66 W., at bridge on U.S. Highway 281, 2 $\frac{1}{4}$ miles south of Cando.

Drainage area.--60.2 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 2,300 cfs Apr. 14 (gage height, 9.35 ft).
1955 to March 1969: Discharge, 850 cfs April 1956 (gage height, 7.0 ft).

RED RIVER OF THE NORTH BASIN

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Mauvais Coulee near Cando, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8....	0	15....	2,340	23....	587
2.....	0	9....	0	16....	2,320	24....	511
3.....	0	10....	0	17....	1,950	25....	440
4.....	0	11....	365	18....	1,570	26....	369
5.....	0	12....	750	19....	1,200	27....	309
6.....	0	13....	1,570	20....	930	28....	288
7.....	0	14....	2,290	21....	775	29....	249
				22....	663	30....	205
Monthly mean discharge, in cubic feet per second.....							656
Runoff, in acre-feet.....							39,040

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 10</u>			<u>Apr. 12</u>			<u>Apr. 14</u>		
2400	7.60	0	1600	8.93	739	1200	11.06	2,420
			1800	9.09	892	1800	11.16	2,500
<u>Apr. 11</u>			2200	9.39	1,120	2100	11.16	2,500
0200	8.38	24	2300	9.69	1,380	2400	11.12	2,470
0400	8.87	91	2400	9.65	1,520			
0600	9.32	185				<u>Apr. 15</u>		
0830	9.63	280	<u>Apr. 13</u>			0600	10.95	2,330
1100	9.06	479	0700	9.69	1,540	1200	10.87	2,270
1500	8.32	511	1000	9.64	1,510	1800	10.95	2,330
2400	8.48	563	2330	9.98	1,690	2400	11.06	2,420
			2400	10.07	1,740			
<u>Apr. 12</u>			<u>Apr. 14</u>			<u>Apr. 16</u>		
0200	8.56	579	0600	10.65	2,100	1200	10.97	2,350
1000	8.51	569				2400	10.76	2,180

Location.--Lat 48°20'10", long 98°39'40", on line between secs.17 and 18, T.156 N., R.62 W., on left downstream wingwall of bridge on county highway, 11 miles southwest of Edmore and about 13 miles from Sweet-water Lake.

Gage-height record.--Water-stage recorder graph except Apr. 8.

Maxima.--April 1969: Discharge, 779 cfs 2400 hours Apr. 13 (gage height, 6.18 ft).

1956 to March 1969: Discharge, 875 cfs Apr. 23, 1956 (gage height, 6.30 ft, backwater from ice); gage height, 6.63 ft Mar. 25, 1966 (backwater from ice).

Mean discharge, in cubic feet per second, 1900							
Day	April	Day	April	Day	April	Day	April
1.....	0	8....	1.0	15....	732	23....	175
2.....	0	9....	4.5	16....	664	24....	142
3.....	0	10....	18	17....	577	25....	116
4.....	0	11....	125	18....	479	26....	93
5.....	0	12....	581	19....	390	27....	69
6.....	0	13....	762	20....	326	28....	55
7.....	0	14....	763	21....	244	29....	48
				22....	205	30....	43
Monthly mean discharge, in cubic feet per second.....							220
Runoff, in acre-feet.....							13,120

Edmore Coulee near Edmore, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
2400	1.5	0	0800	6.14	764	1600	4.91	385
			1600	6.16	771	2400	4.81	361
<u>Apr. 9</u>			2400	6.18	779			
0800	4.10	3.0	<u>Apr. 14</u>			<u>Apr. 20</u>		
1300	4.42	3.2	1600	6.13	760	0800	4.72	341
1800	3.90	8.2	2100	6.09	745	1600	4.62	318
2400	3.57	9.5	2400	6.11	753	2400	4.41	275
<u>Apr. 10</u>						<u>Apr. 21</u>		
0700	3.56	9.3	<u>Apr. 15</u>			0800	4.29	251
0800	3.67	16	0800	6.08	742	1600	4.21	236
1400	3.57	20	1200	6.06	735	2400	4.09	214
1600	3.75	34	1800	6.02	720			
2000	3.35	23	2400	5.96	699	<u>Apr. 22</u>		
2400	2.98	14				0800	4.06	209
<u>Apr. 11</u>			<u>Apr. 16</u>			1600	4.02	202
0400	2.77	12	0800	5.91	682	2400	3.96	193
0600	3.36	34	1600	5.82	651			
0800	3.60	52	2400	5.72	618	<u>Apr. 23</u>		
1000	4.02	86				1200	3.84	174
1200	4.32	131	<u>Apr. 17</u>			2400	3.73	158
1600	4.42	178	0800	5.63	589			
1900	4.40	208	1600	5.55	564	<u>Apr. 24</u>		
2400	4.54	301	2400	5.47	539	1200	3.60	141
<u>Apr. 12</u>			<u>Apr. 18</u>			2400	3.50	129
0300	5.05	421	0800	5.35	504	<u>Apr. 25</u>		
0600	5.40	518	1600	5.18	456	1200	3.37	115
0800	5.56	567	2400	5.03	416	2400	3.28	105
1600	5.82	651	<u>Apr. 19</u>					
2400	6.03	724	0800	4.95	396			

(19) 5-0560.8. Mauvais Coulee tributary No. 4 near Bisbee, N. Dak.

(Crest-stage station)

Location.--Lat 48°29'10", long 99°26'50", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.21, T.158 N., R.68 W., at culvert on State Highway 17, 10 miles southwest of Bisbee.

Drainage area.--24.4 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 1,100 cfs Apr. 11 (gage height, 5.17 ft).

1955 to March 1969: Discharge, 450 cfs Apr. 18, 1956 (gage height, 3.09 ft).

5-0561. Mauvais Coulee near Cando, N. Dak.

Location.--Lat 48°26'53", long 99°06'08", in SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.1, T.157 N., R.66 W., on left bank a third of a mile upstream from highway bridge, about 4 miles upstream from West Fork, 5 $\frac{1}{2}$ miles southeast of Cando, and 7 miles northeast of Maza.

Drainage area.--387 sq mi, of which about 10 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,445 ft above mean sea level (unadjusted).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 10-12.

Maxima.--April 1969: Discharge, 2,500 cfs 1800-2100 hours Apr. 14 (gage height, 11.16 ft).

1957 to March 1969: Discharge, 570 cfs Apr. 10, 1960 (gage height, 8.14 ft, backwater from ice); maximum gage height, 9.25 ft Mar. 18, 1966 (backwater from ice).

Flood of June 16, 1954, reached a stage of 9.83 ft, and flood of Apr. 20, 1956, reached a stage of 10.71 ft, from floodmarks set by local resident.

Location.--Lat 48°10'40", long 99°13'15", in NW¼NW¼ sec.12, T.154 N., R.67 W., on downstream side of right abutment of bridge on U.S. Highway 281, 1 mile downstream from Little Coulee and 6 miles south of Churchs Ferry.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1432.65 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 964 cfs 0700 hours Apr. 27 (gage height, 6.49 ft).
1950 to March 1969: Discharge, 620 cfs June 6, 1950 (gage height, 4.4 ft, site and datum then in use).

Remarks.--Flow affected by many lakes on the mainstem and tributaries.

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1968								
Day	April	May	Day	April	May	Day	April	May
1...	0	720	11...	76	675	21...	396	452
2...	0	690	12...	156	680	22...	474	413
3...	0	740	13...	86	685	23...	537	396
4...	0	756	14...	48	655	24...	620	399
5...	0	740	15...	36	655	25...	821	399
6...	0	710	16...	47	675	26...	896	396
7...	0	660	17...	134	605	27...	931	396
8...	0	680	18...	232	524	28...	825	390
9...	0	700	19...	317	493	29...	788	370
10...	90	685	20...	367	489	30...	784	377
						31...	---	367
Monthly mean discharge, in cubic feet per second							289	567
Runoff, in acre-feet							17,180	34,850

Big Coulee near Churchs Ferry, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 24</u>			<u>Apr. 26</u>			<u>Apr. 28</u>		
2400	6.14	762	0800	6.38	898	1200	6.23	812
			1600	6.36	886	2400	6.19	790
<u>Apr. 25</u>			2400	6.43	928			
1200	6.22	806				<u>Apr. 29</u>		
1700	6.33	868	<u>Apr. 27</u>			1200	6.19	790
2400	6.35	880	0700	6.49	964	2400	6.18	784
			1200	6.45	940			
			2400	6.36	886			

(21) 5-0569. Sheyenne River tributary near Cooperstown, N. Dak.

(Crest-stage station)

Location.--Lat 47°28', long 98°00', at sec. corner 13-14-25-26, T.146 N., R.58 W., on bridge on county highway 1.4 miles north of State Highway 7 and 5 miles east of Cooperstown.

Drainage area.--15.2 sq mi.

Gage-height record.--Crest-stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, about 1,000 cfs April (gage height, 9.80 ft, from floodmark).

1959 to March 1969: Discharge, 700 cfs Apr. 11, 1965 (gage height, 7.90 ft); gage height, 9.81 ft March 1966 (backwater from snow).

(22) 5-0569.5. Sheyenne River tributary No. 2 near Cooperstown, N. Dak.

(Crest-stage station)

Location.--Lat 47°27', long 98°01', on east line sec.27, T.146 N., R.58 W., at culvert on county highway 0.1 mile south of State Highway 7, and 4 miles east of Cooperstown.

Drainage area.--0.08 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 0.5 cfs Apr. 7 (gage height, 2.04 ft, backwater from ice).

1959 to March 1969: Discharge, 59 cfs July 1965 (gage height, 7.95 ft).

(23) 5-0570. Sheyenne River near Cooperstown, N. Dak.

Location.--Lat 47°26'01", long 98°01'43", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.27, T.146 N., R.58 W., on right bank 150 ft downstream from county bridge and 5 miles east of Cooperstown.

Drainage area.--6,470 sq mi, approximately, of which about 5,200 sq mi is probably noncontributing (includes about 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,271.04 ft above mean sea level, datum of 1929 (Corps of Engineers bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-11.

Maxima.--April-May 1969: Discharge, 5,050 cfs 0100 hours Apr. 17 (gage height, 18.07 ft).

1945 to March 1969: Discharge, 7,830 cfs Apr. 17, 1950 (gage height, 18.69 ft).

Sheyenne River near Cooperstown, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	12	591	11...	1,640	233	21...	3,060	191
2...	12	498	12...	2,250	221	22...	2,760	184
3...	14	431	13...	2,710	210	23...	2,530	179
4...	14	392	14...	3,130	218	24...	2,290	168
5...	18	363	15...	2,940	663	25...	1,990	155
6...	70	334	16...	4,150	367	26...	1,710	144
7...	380	308	17...	4,890	254	27...	1,430	135
8...	850	287	18...	4,400	232	28...	1,280	125
9...	1,240	266	19...	3,850	218	29...	938	120
10...	1,300	247	20...	3,430	202	30...	729	115
						31...	--	123
Monthly mean discharge, in cubic feet per second							1,867	264
Runoff, in acre-feet.....							111,100	16,210

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
2400	7.00	220	1200	14.60	1,560	0100	18.07	5,050
			2400	15.61	2,090	1200	18.01	4,900
<u>Apr. 7</u>						2400	17.92	4,700
0600	7.72	300	<u>Apr. 12</u>			<u>Apr. 18</u>		
1200	8.26	370	0600	15.93	2,260	1200	17.78	4,390
1800	8.88	460	1200	15.87	2,230	2400	17.65	4,120
2400	9.63	570	1800	15.94	2,270			
			2400	16.10	2,360	<u>Apr. 19</u>		
<u>Apr. 8</u>						1200	17.50	3,830
0600	10.60	710	<u>Apr. 13</u>			2400	17.39	3,630
1200	11.58	860	1200	16.60	2,680			
1800	12.40	1,000	2400	17.04	3,120	<u>Apr. 20</u>		
2400	13.10	1,120				1200	17.25	3,420
			<u>Apr. 14</u>			2400	17.14	3,260
<u>Apr. 9</u>			1200	17.09	3,190	<u>Apr. 21</u>		
0600	13.65	1,230	2400	16.97	3,030	1200	16.96	3,020
1200	13.79	1,260				2400	16.87	2,920
1800	13.88	1,270	<u>Apr. 15</u>			<u>Apr. 22</u>		
2400	14.01	1,300	1200	16.84	2,890	1200	16.67	2,740
			2400	16.92	2,970	2400	16.54	2,630
<u>Apr. 10</u>			<u>Apr. 16</u>					
1200	13.93	1,280	1200	17.74	4,300			
2400	14.12	1,340	2400	18.06	5,020			

RED RIVER OF THE NORTH BASIN

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Baldhill Creek near Dazey, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
	2.60	4.0	1800	8.22	898	0800	7.30	873
			2100	8.12	866	1600	7.16	824
<u>Apr. 5</u>			2400	8.40	926	2400	7.04	782
1200	2.60	4.0				<u>Apr. 15</u>		
1800	2.83	9.6	<u>Apr. 10</u>			0800	6.92	737
2400	3.01	16.7	0100	8.42	932	1600	6.68	665
			0200	10.00	1,210	2400	6.44	595
<u>Apr. 6</u>			0300	10.65	1,460			
1200	3.29	28.2	0730	11.21	2,020	<u>Apr. 16</u>		
1400	3.95	80	0900	10.07	1,900	0800	6.25	548
1500	4.55	151	1100	10.30	1,990	1600	6.08	504
1600	5.36	267	1200	9.75	1,760	2400	5.92	464
1800	6.00	372	1500	10.85	2,440			
2100	6.47	464	2400	10.85	2,440	<u>Apr. 17</u>		
2200	6.47	449				0800	5.77	433
2400	6.25	386	<u>Apr. 11</u>			1600	5.64	405
			0200	10.76	2,410	2400	5.51	378
<u>Apr. 7</u>			0700	10.90	2,510			
0300	6.00	318	1200	10.50	2,260	<u>Apr. 18</u>		
0600	5.80	282	1600	10.34	2,230	1200	5.34	346
0900	5.80	282	2000	9.95	2,030	2400	5.17	314
1300	6.00	318	2400	9.55	1,850			
1800	6.62	444				<u>Apr. 19</u>		
2100	7.11	567	<u>Apr. 12</u>			1200	5.05	295
2400	7.14	575	0600	9.12	1,670	2400	4.90	268
			1100	8.90	1,560			
<u>Apr. 8</u>			1400	8.84	1,530	<u>Apr. 20</u>		
0600	7.34	592	1800	8.68	1,440	1200	4.83	258
1200	7.29	564	2400	8.40	1,290	2400	4.74	243
1500	7.12	525						
1800	7.72	606	<u>Apr. 13</u>			<u>Apr. 21</u>		
2400	8.32	845	0600	8.13	1,180	1200	4.62	225
			1200	7.90	1,090	2400	4.51	207
<u>Apr. 9</u>			1800	7.71	1,020			
0800	8.60	974	2400	7.52	954			
1200	8.15	862						

Location.--Lat 47°13'45", long 98°07'28", in NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.2, T.143 N., R.59 W., on left bank 500 ft upstream from bridge on county highway, 4 $\frac{1}{2}$ miles northeast of Dazey, and 14 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,320 ft (from topographic map).

Maxima.--April 1969: Discharge, 2,510 cfs 0700 hours April 11 (gage height, 10.90 ft, backwater from ice); gage height, 11.21 ft 0730 hours April 10 (backwater from ice).
1956 to March 1969: Discharge, 1,880 cfs Mar. 13, 1966 (gage height, 8.69 ft, backwater from ice); gage height, 9.90 ft Apr. 10, 1965 (backwater from temporary fill).

[illegible]

(25) 5-0575. Lake Ashtabula at Baldhill Dam, N. Dak.

Location.--Lat 47°02'00", long 98°05'00", in NW¼ sec.18, T.141 N., R.58 W., at Baldhill Dam on Sheyenne River, 8 miles northwest of Valley City.

Drainage area.--7,470 sq mi, approximately, of which about 5,560 sq mi is probably noncontributing (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is mean sea level, datum of 1929.

Maxima.--April-May 1969: Contents, 79,900 acre-ft Apr. 21 (elevation, 1267.52 ft).

1949 to March 1969: Contents, 91,400 acre-ft May 14, 1950 (elevation, 1,269.46 ft).

Gage height, in feet, and contents, in acre-feet, at 2400 hours, 1969

Day	April		May		Day	April		May	
	Gage height	Contents	Gage height	Contents		Gage height	Contents	Gage height	Contents
1	57.84	33,690	66.25	72,020	16	67.00	76,300	66.19	71,680
2	57.80	33,560	66.21	71,800	17	67.09	76,820	66.16	71,510
3	57.79	33,530	66.19	71,680	18	67.31	78,100	66.13	71,340
4	57.78	33,500	66.11	71,230	19	67.47	79,030	66.17	71,570
5	57.88	33,820	66.02	70,710	20	67.48	79,080	66.13	71,340
6	58.29	35,190	65.98	70,490	21	67.42	78,740	66.12	71,280
7	59.12	38,070	66.00	70,600	22	67.26	77,810	66.05	70,880
8	60.58	43,820	66.02	70,710	23	66.93	75,900	66.09	71,110
9	62.12	50,540	66.10	71,170	24	66.61	74,080	66.10	71,170
10	63.50	57,000	66.03	70,770	25	66.23	71,910	66.04	70,830
11	65.10	65,560	66.00	70,600	26	66.44	73,130	66.03	70,770
12	66.42	72,990	65.98	70,490	27	65.88	69,930	65.83	69,650
13	67.21	77,520	65.97	70,430	28	65.97	70,430	66.13	71,340
14	65.35	78,330	65.84	69,980	29	66.12	71,280	66.01	70,660
15	67.28	77,920	66.21	71,800	30	66.20	71,740	65.96	70,380
					31	--	--	66.15	71,450
Change in contents.....							+37,920	--	- 290

Add 1200.00 ft to change to mean sea level.

Location.--Lat 47°01'50", long 98°05'00", in NW¼ sec.18, T.141 N., R.58 W., on right bank 600 ft downstream from Baldhill Dam, 8 miles northwest of Valley City, and at mile 270.5.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals.
Datum of gage is 1,200.00 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 4,580 cfs 0930 hours Apr. 19 (gage height, 35.47 ft).
1948, 1950 to March 1969: Discharge, about 4,600 cfs Apr. 27 and 28, 1948.

Remarks.--Flow regulated by Lake Ashtabula since 1949 (capacity at maximum pool elevation, 116,500 acre-ft).

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	58	678	11...	97	304	21...	4,060	255
2...	58	682	12...	149	271	22...	3,860	232
3...	58	682	13...	1,140	250	23...	3,820	177
4...	59	683	14...	3,160	250	24...	3,710	177
5...	60	683	15...	4,010	250	25...	3,260	173
6...	63	460	16...	4,530	250	26...	2,980	172
7...	68	301	17...	4,540	250	27...	2,350	176
8...	76	302	18...	4,560	250	28...	1,180	175
9...	83	301	19...	4,450	250	29...	675	173
10...	90	305	20...	4,210	255	30...	676	175
						31...	--	175
Monthly mean discharge, in cubic feet per second							1,940	313
Runoff, in acre-feet							115,200	19,270

RED RIVER OF THE NORTH BASIN

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Sheyenne River below Baldhill Dam, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 11</u>			<u>Apr. 14</u>			<u>Apr. 19</u>		
2400	26.59	101	1600	33.59	3,640	0400	35.45	4,570
			2400	33.81	3,740	0930	35.47	4,580
<u>Apr. 12</u>			<u>Apr. 15</u>			1200	35.25	4,460
1000	26.58	98	1000	33.98	3,830	1400	35.20	4,440
2400	27.04	270	1400	34.52	4,100	1800	34.93	4,300
			1800	34.63	4,160	2400	34.82	4,250
<u>Apr. 13</u>			2400	35.24	4,460	<u>Apr. 20</u>		
0400	27.33	470				1200	34.74	4,210
1000	27.33	470	<u>Apr. 16</u>			2400	34.71	4,200
1200	28.21	1,210	1200	35.40	4,540			
1800	28.62	1,400	2400	35.41	4,550	<u>Apr. 21</u>		
2000	29.35	1,690				1000	34.66	4,170
2400	29.93	1,900	<u>Apr. 17</u>			1600	34.21	3,940
<u>Apr. 14</u>			1200	35.39	4,540	2400	34.11	3,900
0200	30.97	2,340	2400	35.41	4,550	<u>Apr. 22</u>		
0400	31.21	2,450				1200	34.04	3,860
0600	31.96	2,820	<u>Apr. 18</u>			2400	34.00	3,840
0800	32.14	2,910	1200	35.44	4,560			
1000	32.52	3,100	2400	35.45	4,570			

Location.--Lat 46°54'50", long 98°00'30", in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.28, T.140 N., R.58 W., on left bank 100 ft downstream from College Dam in Valley City, 13 miles downstream from Baldhill Dam, and at mile 253.0.

Gage-height record.--Digital recorder tape punched at 15-minute intervals and water-stage recorder graph. Datum of gage is 1,199.27 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April-May 1969: Discharge, 4,520 cfs 1415 hours Apr. 19 (gage height, 17.62 ft).
1919, 1938 to March 1969: Discharge, 4,580 cfs Apr. 28, 1948 (gage height, 17.51 ft).

Remarks.--Flow regulated by Lake Ashtabula above Baldhill Dam (capacity, 70,700 acre-feet to normal full pool).

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	58	719	11...	590	329	21...	4,190	255
2...	58	717	12...	411	319	22...	4,020	255
3...	59	714	13...	804	226	23...	3,910	255
4...	62	713	14...	2,280	259	24...	3,840	183
5...	64	713	15...	3,470	255	25...	3,620	152
6...	112	691	16...	4,040	263	26...	3,330	167
7...	327	316	17...	4,340	253	27...	2,910	171
8...	1,130	321	18...	4,450	253	28...	1,920	169
9...	1,420	331	19...	4,500	253	29...	805	167
10...	960	329	20...	4,330	249	30...	724	169
						31...	-	181
Monthly mean discharge, in cubic feet per second							2,091	334
Runoff, in acre-feet							124,400	20,520

RED RIVER OF THE NORTH BASIN

215

Sheyenne River at Valley City, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 17</u>		
2400	6.71	867	2200	8.62	1,420	2400	17.46	4,420
			2400	8.53	1,390			
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 18</u>		
0200	6.81	894	2400	5.05	428	1200	17.52	4,450
0400	7.01	948				2400	17.58	4,500
0600	7.41	1,060	<u>Apr. 13</u>			<u>Apr. 19</u>		
0800	7.64	1,130	0300	5.85	636	1415	17.62	4,520
1000	7.76	1,160	0600	5.98	644	1800	17.61	4,520
1200	7.82	1,180	1200	6.01	678	2400	17.53	4,460
1400	7.71	1,150	1600	6.07	694			
1600	7.61	1,120	2400	8.74	1,450	<u>Apr. 20</u>		
1800	7.76	1,160				1200	17.29	4,320
2000	8.00	1,230	<u>Apr. 14</u>			2400	17.13	4,240
2200	8.33	1,330	1200	11.43	2,300	<u>Apr. 21</u>		
2400	8.63	1,420	2400	13.77	3,070	1200	17.01	4,190
<u>Apr. 9</u>			<u>Apr. 15</u>			2400	16.79	4,110
0200	8.86	1,490	1200	15.03	3,500	<u>Apr. 22</u>		
0400	8.97	1,520	2400	15.88	3,790	1200	16.52	4,010
0600	8.97	1,520				2400	16.33	3,950
0800	8.70	1,440	<u>Apr. 16</u>			<u>Apr. 23</u>		
1000	8.46	1,770	1200	16.66	4,060	1200	16.21	3,900
1200	8.40	1,350	2400	17.12	4,240	2400	16.13	3,880
1400	8.41	1,350	<u>Apr. 17</u>					
1600	8.45	1,360	1200	17.34	4,340			
1800	8.54	1,390						
2000	8.62	1,420						

Location.--Lat 46°26'49", long 97°40'44", on line between secs. 1 and 2, T.134 N., R.56 W., on left bank 150 ft downstream from dam at State fish hatchery at north edge of city of Lisbon, 3 miles upstream from Timber Coulee, and at mile 162.1.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,066.64 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,380 cfs 0500 hours Apr. 24 (gage height, 16.54 ft).
1957 to March 1969: Discharge, 4,260 cfs Mar. 30, 1966 (gage height, 16.23 ft).

Remarks.--Flow regulated by Lake Ashtabula above Baldhill Dam (capacity, 70,700 acre-feet to normal full pool).

Day	April	May	Day	April	May	Day	April	May
1...	110	1,250	11...	3,460	404	21...	4,000	293
2...	105	881	12...	4,080	388	22...	4,180	291
3...	90	804	13...	3,820	378	23...	4,320	289
4...	75	785	14...	2,770	369	24...	4,360	284
5...	65	767	15...	1,880	314	25...	4,270	277
6...	85	751	16...	2,350	318	26...	4,090	250
7...	236	737	17...	2,860	355	27...	3,890	195
8...	635	710	18...	3,220	342	28...	3,660	188
9...	1,930	519	19...	3,500	318	29...	3,360	186
10...	2,780	420	20...	3,760	298	30...	2,520	184
						31...		186
Monthly mean discharge, in cubic feet per second							2,548	443
Runoff, in acre-feet							151,600	27,240

RED RIVER OF THE NORTH BASIN

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Sheyenne River at Lisbon, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	2.93	70	1200	15.84	2,690	1200	9.20	1,780
			1800	15.75	2,820	1800	9.39	1,840
<u>Apr. 6</u>			2400	15.95	3,080	2400	9.88	2,000
1200	2.94	70						
1500	3.06	75	<u>Apr. 11</u>			<u>Apr. 16</u>		
1800	3.58	110	0600	15.96	3,280	1200	11.02	2,360
2100	3.94	120	1200	15.86	3,450	2400	11.99	2,690
2400	3.92	115	1800	15.80	3,620			
			2400	16.00	3,890	<u>Apr. 23</u>		
<u>Apr. 7</u>						2400	16.52	4,370
0600	3.64	100	<u>Apr. 12</u>					
1200	3.60	95	0600	16.19	4,120	<u>Apr. 24</u>		
1800	5.15	400	1200	16.00	4,120	0500	16.54	4,380
2400	6.77	580	1800	15.79	4,080	1200	16.50	4,360
			2400	15.78	4,080	2400	16.47	4,340
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 28</u>		
0600	6.96	520	0600	15.49	3,960	2400	14.84	3,540
1200	7.13	500	1200	15.08	3,810			
1800	8.34	700	1800	14.86	3,720	<u>Apr. 29</u>		
2400	9.99	1,060	2400	14.31	3,510	1200	14.39	3,370
						2400	13.73	3,130
<u>Apr. 9</u>			<u>Apr. 14</u>			<u>Apr. 30</u>		
0600	11.36	1,370	0600	13.45	3,200	1200	12.22	2,610
1200	13.64	2,000	1200	12.14	2,740	2400	9.44	1,720
1800	15.34	2,460	1800	10.93	2,330			
2400	16.34	2,730	2400	10.14	2,080	<u>May 1</u>		
						1200	7.46	1,150
<u>Apr. 10</u>			<u>Apr. 15</u>			2400	6.74	968
0200	16.39	2,760	0600	9.40	1,850			
0600	16.24	2,730						

Location.--Lat 46°37'35", long 97°00'05", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.5, T.136 N., R.50 W., on right bank 25 ft downstream from Great Northern Railway bridge, 1 $\frac{1}{2}$ miles southeast of Kindred, and at mile 68.1.

Drainage area.--8,800 sq mi, approximately, of which about 5,780 sq mi is probably noncontributing (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is 925.55 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-15.

Maxima.--April-May 1969: Discharge, 4,690 cfs 1500 hours Apr. 15 (gage height, 21.03 ft); gage height, 21.54 ft Apr. 14 (backwater from ice).
1950 to March 1969: Discharge, 3,380 cfs Apr. 3, 1966; gage height, 20.50 ft, May 13, 14, 1950.

Spring flood in 1947 or 1948 reached a stage of 22.1 ft, from flood-marks (discharge, about 3,600 cfs).

Remarks.--Flow regulated by Lake Ashtabula above Baldhill Dam (capacity, 70,700 acre-feet at normal full pool).

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	130	3,930	11...	1,680	891	21...	3,110	500
2...	120	3,680	12...	2,410	719	22...	3,330	484
3...	110	2,910	13...	3,290	648	23...	3,520	470
4...	120	1,740	14...	4,020	612	24...	3,690	462
5...	130	1,320	15...	4,600	588	25...	3,860	451
6...	150	1,220	16...	4,500	587	26...	3,990	443
7...	250	1,120	17...	3,660	592	27...	4,080	434
8...	560	1,060	18...	2,910	542	28...	4,120	422
9...	810	1,020	19...	2,670	529	29...	4,120	380
10...	1,090	1,010	20...	2,840	520	30...	4,060	328
						31...	--	307
Monthly mean discharge, in cubic feet per second							2,464	965
Runoff, in acre-feet							146,600	59,340

RED RIVER OF THE NORTH BASIN

219

Sheyenne River near Kindred, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	5.43	410	1200	17.75	2,380	1200	20.08	3,620
			2400	19.25	2,860	2400	18.55	3,190
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 18</u>		
0600	6.40	520	1200	20.45	3,320	1200	16.80	2,870
1200	7.15	560	2400	21.22	3,650	2400	15.79	2,700
1800	7.74	600						
2400	9.32	700	<u>Apr. 14</u>			<u>May 1</u>		
			0600	21.49	3,830	2400	19.50	3,830
<u>Apr. 9</u>			1100	21.54	3,980			
0600	10.16	790	1800	21.24	4,230	<u>May 2</u>		
1200	10.36	800	2400	20.98	4,370	1200	19.16	3,700
1800	10.64	830				2400	18.42	3,470
2400	11.11	910	<u>Apr. 15</u>			<u>May 3</u>		
			1200	21.00	4,670	1200	16.71	2,960
<u>Apr. 10</u>			1500	21.03	4,690	2400	14.07	2,240
1200	11.87	1,060	2400	21.01	4,680			
2400	13.36	1,330				<u>May 4</u>		
<u>Apr. 11</u>			<u>Apr. 16</u>			1200	11.75	1,660
1200	14.96	1,690	1200	20.97	4,570	2400	10.60	1,420
2400	16.33	2,020	2400	20.70	4,200			

Location.--Lat 46°53'20", long 96°54'55", in sec.31, T.140 N., R.49 W., on left bank 80 ft downstream from county highway bridge, 1 mile north of West Fargo, 3 miles upstream from Maple River, and at mile 24.5.

Gage-height record.--Water-stage recorder graph except Apr. 1, 2, 4-6.
Datum of gage is 877.19 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 3,060 cfs 1200 hours Apr. 22; gage height, 21.70 ft 2300 hours Apr. 16 to 1700 hours Apr. 17 (backwater from Red and Maple Rivers).

1903-6, 1919, 1930 to March 1969: Discharge, 3,110 cfs Apr. 4, 1966; gage height, 21.05 ft Mar. 22, 1966 (backwater from Maple River).

Remarks.--Flow regulated by Lake Ashtabula above Baldhill Dam (capacity, 70,700 acre-feet at normal full pool) beginning in August 1949. Records do not include overbank discharge which leaves Sheyenne River in vicinity of Horace and flows into Red River of the North above Fargo.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	180	2,900	11...	1,060	1,120	21...	3,000	608
2...	180	2,890	12...	1,460	1,010	22...	3,030	588
3...	180	2,880	13...	1,960	851	23...	2,920	568
4...	180	2,850	14...	2,130	761	24...	2,840	551
5...	180	2,510	15...	2,200	716	25...	2,810	539
6...	180	1,910	16...	2,460	680	26...	2,790	526
7...	170	1,550	17...	2,660	679	27...	2,800	516
8...	195	1,390	18...	2,740	704	28...	2,820	507
9...	344	1,230	19...	2,830	646	29...	2,870	494
10...	678	1,150	20...	2,930	616	30...	2,900	468
						31...	--	432
Monthly mean discharge, in cubic feet per second							1,789	1,124
Runoff, in acre-feet.....							106,500	69,100

Sheyenne River at West Fargo, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 18</u>		
2400	6.12	187	1200	19.67	1,430	2400	21.63	2,800
			2400	20.69	1,740			
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
1200	6.00	180	1200	21.12	1,980	1200	21.62	2,820
1800	6.38	203	2400	21.35	2,130	2400	21.57	2,890
2400	6.96	242				<u>Apr. 20</u>		
<u>Apr. 9</u>			<u>Apr. 14</u>			1200	21.51	2,930
0600	7.70	294	1200	21.43	2,130	2400	21.43	2,970
1200	8.28	338	2400	21.43	2,130			
1800	8.84	384	<u>Apr. 15</u>			<u>Apr. 21</u>		
2400	10.03	480	1200	21.47	2,180	1200	21.37	3,000
<u>Apr. 10</u>			2400	21.52	2,320	2400	21.27	3,030
0600	11.10	560	<u>Apr. 16</u>			<u>Apr. 22</u>		
1200	12.18	650	1200	21.59	2,430	1200	21.20	3,060
1800	13.82	790	2400	21.70	2,660	2400	21.11	2,970
2400	15.45	940	<u>Apr. 17</u>			<u>Apr. 23</u>		
<u>Apr. 11</u>			1200	21.70	2,660	1200	21.04	2,920
0600	16.36	990	2400	21.69	2,680	2400	20.97	2,880
1200	17.00	1,050	<u>Apr. 18</u>			<u>Apr. 24</u>		
1800	17.62	1,120	1200	21.67	2,740	1200	20.89	2,840
2400	18.44	1,220				2400	20.80	2,820

Location.--Lat 46°37'10", long 97°34'20", on west line sec.2, T.136 N., R.55 W., on right bank 25 ft downstream from county highway bridge, 1 mile downstream from South Branch, and 1½ miles east of Enderlin.

Gage-height record.--Water-stage recorder graph through Apr. 9; graph drawn Apr. 10-30 on basis of engineers and observers measurements from reference points to water surface, observer's once-daily readings on temporary staff gage and from highwater marks. Datum of gage is 1,056.72 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 5,750 cfs 0100 hours Apr. 11 (gage height, 13.55 ft, from floodmark).
1957 to March 1969: Discharge, 3,390 cfs Apr. 12, 1965 (gage height, 11.05 ft).

[illegible]

RED RIVER OF THE NORTH BASIN

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Maple River near Enderlin, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 8</u>			<u>Apr. 10</u>		
2400	2.89	5	1500	7.30	371	0600	10.78	2,160
			2000	7.86	512	1200	11.50	2,800
<u>Apr. 7</u>			2400	8.92	910	1500	12.30	3,650
1300	2.82	4				1800	13.05	4,850
1900	3.37	14	<u>Apr. 9</u>			2400	13.52	5,720
2200	4.12	32	0600	9.86	1,430			
2400	4.27	38	1000	10.50	1,860	<u>Apr. 11</u>		
			1400	10.94	2,300	0100	13.55	5,750
<u>Apr. 8</u>			1800	10.92	2,280	0700	13.20	5,400
0200	5.72	154	2000	11.90	3,200	1200	12.75	4,950
0400	6.87	305	2400	11.47	2,770	1800	12.30	4,500
0930	7.67	458				2400	12.00	4,200

(32) 5-0598. Swan Creek near Absaraka, N. Dak.

(Crest-stage station)

Location.--Lat 46°58'30", long 97°21'30", on north line sec.3, T.140 N.,
R.53 W., at bridge on county highway 1½ miles east of Absaraka.

Drainage area.--22 sq mi, approximately.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 300 cfs and extended above on the basis of logarithmic plotting.

Maxima.--April-May 1969: Discharge, 620 cfs Apr. 11 (gage height, 5.69 ft).

1955 to March 1969: Discharge, 307 cfs April 1967 (gage height, 3.70 ft); gage height, 6.14 ft Mar. 11, 1966 (backwater from snow).

(33) 5-0598.5. Swan Creek tributary near Ayr, N. Dak.

(Crest-stage station)

Location.--Lat 46°58'30", long 97°30'00", in NE¼ sec.4, T.140 N., R.54 W., at culvert on county highway 4½ miles south of Ayr.

Drainage area.--2 sq mi, approximately.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 50 cfs and extended above on the basis of logarithmic plotting.

Maxima.--April-May 1969: Discharge, 120 cfs Apr. 10 (gage height, 6.56 ft).
1955, 1957 to March 1969: Discharge, 73 cfs April 1965 (gage height, 4.98 ft).

(34) 5-0599. Swan Creek near Casselton, N. Dak.

(Crest-stage station)

Location.--Lat 46°55'00", long 97°15'30", in NW¼ sec.28, T.140 N., R.52 W., at bridge on county highway, 2.6 miles northwest of Casselton.

Drainage area.--30 sq mi, approximately.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 2,000 cfs Apr. 10 (gage height, 9.19 ft, backwater from ice).
1955 to March 1969: Discharge, 550 cfs April 1965 (gage height, 8.2 ft, backwater from snow).

(35) 5-0599.5. Swan Creek tributary near Casselton, N. Dak.

(Crest-stage station)

Location.--Lat 46°53'10", long 97°12'40", near center sec.2, T.139 N., R.52 W., at culverts on State Highway 18, 1 mile south of Casselton.

Drainage area.--2.5 sq mi, approximately.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 110 cfs and extended above on the basis of indirect measurement at 225 cfs.

Maxima.--April-May 1969: Discharge, 225 cfs Apr. 11 (gage height, 8.47 ft).
1955 to March 1969: Discharge, 200 cfs April 1965 (gage height, 6.98 ft).

(36) 5-0600. Maple River near Mapleton, N. Dak.

Location.--Lat 46°51'40", long 97°06'10", in SW¼SE¼ sec.10, T.139 N., R.51 W., on left bank 25 ft upstream from dam, 3 miles southwest of Mapleton, and 14 miles upstream from mouth.

Drainage area.--1,450 sq mi, of which about 71 sq mi is probably non-contributing.

Gage-height record.--Water-stage recorder graph. Altitude of gage is about 898 ft (estimated on basis of comparison with gage at former site).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 8-10.

Maxima.--April-May 1969: Discharge, 7,000 cfs 0930 to 1130 hours Apr. 11 (gage height, 14.00 ft).
1945 to March 1969: Discharge, 4,840 cfs June 17, 1953 (gage height, 18.62 ft, at former site and datum); maximum gage height, 18.91 ft Apr. 6, 1952 (former site and datum, backwater from ice).

RED RIVER OF THE NORTH BASIN

Maple River near Mapleton, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	0	277	11...	6,070	106	21...	1,810	104
2...	0	228	12...	5,570	99	22...	1,550	89
3...	0	197	13...	4,840	95	23...	1,300	77
4...	0	177	14...	4,770	92	24...	1,040	69
5...	0	175	15...	4,170	83	25...	888	64
6...	0	151	16...	3,760	210	26...	736	58
7...	0	138	17...	3,420	768	27...	590	52
8...	4.7	130	18...	2,970	502	28...	492	48
9...	404	123	19...	2,500	213	29...	397	42
10...	1,560	112	20...	2,080	136	30...	331	41
						31...	-	40
Monthly mean discharge, in cubic feet per second							1,708	151
Runoff, in acre-feet							101,700	9,310

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 10</u>		
2400	2.70	0	0230	7.00	122	1630	11.00	1,500
			0600	7.88	357	1800	12.45	2,580
<u>Apr. 8</u>			1200	8.71	468	2400	13.53	3,550
2100	3.06	0	1900	8.80	500			
2200	6.03	31	2400	9.55	600	<u>Apr. 11</u>		
2230	5.05	29				0600	13.92	5,570
2300	5.75	52	<u>Apr. 10</u>			0930	14.00	7,000
2400	6.18	73	0500	10.16	894	1130	14.00	7,000
			0900	10.09	884	1800	13.89	6,530
			1200	10.72	1,100	2400	13.82	6,260

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Location.--Lat 47°01', long 97°13', in sec.24, T.141 N., R.52 W., on left bank on downstream side of bridge on State Highway 18, 0.6 mile north of Amenia.

Gage-height record.--Water-stage recorder graph. Datum of gage is about 935 ft above mean sea level, datum of 1929 (from railroad profile).

Maxima.--April 1969: Discharge, 1,690 cfs 0230 hours Apr. 10 (gage height, 11.41 ft).
1947 to March 1969: Discharge, 1,230 cfs Apr. 14, 1947 (gage height, 8.90 ft, at former site and datum); gage height, 12.15 ft Mar. 23, 1966 (backwater from ice).

[illegible]

Rush River at Amenia, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 9</u>			<u>Apr. 12</u>			<u>Apr. 14</u>		
2400	11.34	1,650	0600	10.58	1,260	2400	7.17	280
			0900	10.32	1,140			
<u>Apr. 10</u>			1130	9.40	800	<u>Apr. 15</u>		
0230	11.41	1,690	1400	8.89	647	1200	6.96	252
0830	11.19	1,560	2400	8.33	502	2400	6.77	227
1200	11.06	1,500						
1800	10.95	1,440	<u>Apr. 13</u>			<u>Apr. 16</u>		
2100	10.94	1,440	0600	8.04	433	1200	6.54	200
2400	11.02	1,480	1200	7.85	393	2400	6.29	172
			1700	7.82	387			
<u>Apr. 11</u>			2400	7.56	339	<u>Apr. 17</u>		
0700	11.20	1,570				1200	6.02	144
1400	10.80	1,360	<u>Apr. 14</u>			2400	5.77	120
2400	10.78	1,360	1500	7.22	287			

(38) 5-0608. Buffalo River near Callaway, Minn.

(Crest-stage station)

Location.--Lat 47°01'15", long 95°54'50", in SW¹₄SW¹₄ sec.17, T.141 N., R.41 W.,
at culvert on U. S. Highway 59, 2.7 miles north of Callaway.

Drainage area.--49.9 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments below 200 cfs and by indirect measurements at 370 cfs and 446 cfs.

Maxima.--April 1969: Discharge, 446 cfs Apr. 10 (gage height, 15.11 ft,
backwater from ice).

1960 to March 1969: Discharge, 370 cfs June 8, 1962 (gage height,
13.35 ft).

Location.--Lat 46°51'00", long 96°19'45", near center of SE $\frac{1}{4}$ sec.14, T.139 N., R.45 W., near left downstream end of bridge on farm lane, 2 miles southwest of Hawley.

Gage-height record.--Digital recorder tape punched at 15-minute intervals except 2400 hours Mar. 31 to 1800 hours Apr. 2 for which graph was reconstructed on basis of digital record before and after this period. Datum of gage is 1,111.91 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 1,880 cfs 2330 hours Apr. 9 (gage height, 9.07 ft).

Maximum stage known, about 11.3 ft present datum, spring of 1921, from information by local resident.

[illegible]

RED RIVER OF THE NORTH BASIN

Buffalo River near Hawley, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	3.32		0400	8.80	1,480	0800	8.59	1,230
			0600	8.92	1,650	1600	8.51	1,150
<u>Apr. 6</u>			0900	8.86	1,560	2400	8.46	1,110
0400	3.28		1200	8.97	1,720			
1000	3.29		1800	8.96	1,710	<u>Apr. 15</u>		
1400	3.40		2200	8.82	1,510	1200	8.38	1,050
1800	3.99		2330	9.07	1,880	2400	8.31	1,000
2400	4.69		2400	9.03	1,820			
						<u>Apr. 16</u>		
<u>Apr. 7</u>			<u>Apr. 10</u>			1200	8.22	947
0800	4.73		0200	8.99	1,760	2400	8.11	886
1200	4.85		0800	9.00	1,770			
1600	5.23		1600	8.90	1,620	<u>Apr. 17</u>		
1800	5.61		2400	8.83	1,520	1200	7.97	798
2400	6.07					2400	7.85	749
			<u>Apr. 11</u>					
<u>Apr. 8</u>			1200	8.75	1,420	<u>Apr. 18</u>		
0200	6.07		2400	8.64	1,280	1200	7.70	681
0600	6.35					2400	7.57	641
0800	6.54		<u>Apr. 12</u>					
1000	6.86		1200	8.61	1,250	<u>Apr. 19</u>		
1400	8.19		2400	8.59	1,230	1200	7.46	599
1730	8.60					2400	7.33	566
1800	8.53		<u>Apr. 13</u>					
2400	8.83	1,520	1200	8.56	1,200			
			2400	8.62	1,260			

Location.--Lat 46°46'20", long 96°37'40", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.9, T.138 N., R.47 W., near center of span on downstream side of Highway bridge, a quarter of a mile downstream from Whisky Creek, and 1 mile east of Sabin.

Gage-height record.---Graph based on once or twice-daily wire-weight gage readings by observer supplemented by hydrographers readings. Datum of gage is 902.39 ft above mean sea level, datum of 1929 (levels by Soil Conservation Service).

Maxima.--April 1969: Discharge, 6,410 cfs 0600 hours Apr. 10 (gage height, 18.12 ft).
1945 to March 1969: Discharge, 6,340 cfs June 9, 1962 (gage height, 17.04 ft).

[illegible]

South Branch Buffalo River at Sabin, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	5.41		0600	17.21	5,360	0800	11.81	713
			1200	16.85	4,960	1600	11.58	663
<u>Apr. 7</u>			1800	16.50	4,570	2400	11.43	634
0800	5.84		2400	16.14	4,190			
1200	6.34					<u>Apr. 17</u>		
1900	9.98		<u>Apr. 12</u>			0800	11.29	609
2400	9.65		0600	15.75	3,780	1600	11.10	577
			1200	15.32	3,350	2400	10.88	540
<u>Apr. 8</u>			1800	14.90	2,940			
0500	9.06		2400	14.46	2,530	<u>Apr. 18</u>		
0700	9.06					0800	10.63	502
0900	9.15		<u>Apr. 13</u>			1600	10.37	462
1200	13.20		0600	14.00	2,120	2400	10.08	422
2000	16.32		1200	13.69	1,840			
2400	17.08		1800	13.41	1,590	<u>Apr. 19</u>		
			2400	13.15	1,380	0800	9.77	382
<u>Apr. 9</u>						1600	9.44	341
0400	17.58		<u>Apr. 14</u>			2400	9.18	311
1000	17.94		0600	12.93	1,220			
1800	18.10		1600	12.64	1,040	<u>Apr. 20</u>		
2400	18.11	6,400	2400	12.44	935	0800	8.95	286
						1600	8.76	266
<u>Apr. 10</u>			<u>Apr. 15</u>			2400	8.58	248
0600	18.12	6,410	0800	12.28	862			
1200	18.06	6,340	1600	12.15	812	<u>Apr. 21</u>		
1800	17.85	6,100	2400	12.00	762	0800	8.45	235
2400	17.55	5,750				1600	8.29	219
						2400	8.11	202

Location.--Lat $46^{\circ}57'40''$, long $96^{\circ}39'40''$, in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.6, T.140 N., R.47 W., on left bank $4\frac{1}{2}$ miles southeast of Kragles, $6\frac{1}{2}$ miles northeast of Dilworth, and 9 miles downstream from South Branch.

Gage-height record.---Water-stage recorder graph except 0725 hours Apr. 9 to 1400 hours Apr. 15 for which graph was reconstructed on basis of two or more daily readings on outside staff gages by observer, supplemented by hydrographer's readings. Peak stage determined from floodmark in gage house. Altitude of gage is 870 ft (from topographic map).

Maxima.--April 1969: Discharge, 10,400 cfs 0300 hours Apr. 11 (gage height, 25.55 ft, from high-water mark).
1931 to March 1969: Discharge, 6,140 cfs June 11, 1962 (gage height, 23.56 ft).

[illegible]

RED RIVER OF THE NORTH BASIN

Buffalo River near Dilworth, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
2400	6.37		0300	25.55	10,400	0900	18.12	2,200
			0600	25.49	10,300	2400	17.64	2,050
<u>Apr. 7</u>			0900	25.44	10,200			
1200	6.67		1200	25.32	9,940	<u>Apr. 18</u>		
1900	7.37		1800	25.14	9,580	1500	17.11	1,880
2400	8.03		2400	24.87	9,040	2400	16.79	1,790
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 19</u>		
0500	9.20		0600	24.57	8,440	0900	16.47	1,710
0800	10.38		1200	24.25	7,800	2400	15.92	1,560
1400	11.32		1800	23.87	7,000			
2000	12.69		2400	23.48	6,240	<u>Apr. 20</u>		
2400	13.40					1500	15.37	1,440
			<u>Apr. 13</u>			2400	15.03	1,360
<u>Apr. 9</u>			0600	23.07	5,610			
0400	13.89		1200	22.65	5,150	<u>Apr. 21</u>		
0700	14.32		1800	22.27	4,770	0900	14.68	1,280
1200	15.73		2400	21.93	4,440	1800	14.31	1,200
1500	17.70					2400	14.08	1,150
1800	20.00		<u>Apr. 14</u>					
2100	22.00		0600	21.54	4,100	<u>Apr. 22</u>		
2400	23.21	5,980	1200	21.19	3,820	0600	13.83	1,100
			1800	20.92	3,600	1700	13.40	1,020
<u>Apr. 10</u>			2400	20.57	3,350	2400	13.16	977
0300	23.98	7,320						
0600	24.62	8,540	<u>Apr. 15</u>			<u>Apr. 23</u>		
0900	25.00	9,300	0600	20.23	3,110	0700	12.94	937
1200	25.22	9,740	1400	19.82	2,860	1600	12.64	884
1500	25.30	9,900	2400	19.38	2,650	2400	12.37	838
1800	25.39	10,100						
2100	25.47	10,200	<u>Apr. 16</u>			<u>Apr. 24</u>		
2400	25.51	10,300	1000	18.97	2,490	0800	12.10	794
			1500	18.78	2,420	2400	11.54	711
			2400	18.43	2,290			

5-0622. Elm River near Kelso, N. Dak.

(Crest-stage station)

Location.--Lat $47^{\circ}17'$, long $97^{\circ}07'$, on west line sec.14, T.144 N., R.51 W., on downstream side of county highway bridge, 5 miles southwest of Kelso, and 14 miles upstream from North Branch.

Drainage area.--193 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 360 cfs and extended above by logarithmic plotting.

Maxima.--April-May 1969: Discharge, 930 cfs April (gage height, 12.16 ft).
1956 to March 1969: Discharge, 1,000 cfs March 1966 (gage height, 12.48 ft).

(42) 5-0624.7 Marsh River tributary near Mahanomen, Minn.

(Crest-stage station)

Location.--Lat $47^{\circ}19'35''$, long $96^{\circ}04'40''$, in $SE\frac{1}{4}SW\frac{1}{4}$ sec.36, T.145 N., R.43 W., at culvert on State Highway 31, a quarter mile above mouth, and $5\frac{1}{4}$ miles west of Mahanomen.

Drainage area.--6.57 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 90 cfs and by indirect measurements at 241 cfs and 436 cfs.

Maxima.--April 1969: Discharge, 436 cfs Apr. 11 (gage height, 13.76 ft).
1961 to March 1969: Discharge, 241 cfs Apr. 10, 1965 (gage height, 12.90 ft, backwater from ice).

Location.--Lat 47°16'00", long 96°14'40", in NE $\frac{1}{4}$ sec.27, T.144 N., R.44 W., on left bank 100 ft upstream from highway bridge, three-quarters of a mile northeast of village of Twin Valley, and 2 miles upstream from small tributary.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,008.16 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,850 cfs 0200 hours Apr. 10 (gage height, 11.83 ft); gage height, 12.00 ft Apr. 9 (backwater from ice).
1909-17, 1931 to March 1969: Discharge, 9,200 cfs July 22, 1909 (gage height, 20.0 ft, at site a quarter of a mile downstream at different datum).

Remarks.--Flow slightly regulated by Rice Lake and many other small lakes above station.

[illegible]

Wild Rice River at Twin Valley, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
2400	2.75		2200	11.99		0800	9.83	2,760
			2230	12.00		1200	9.76	2,720
<u>Apr. 7</u>			2400	11.94		2400	9.36	2,470
1000	2.69		<u>Apr. 10</u>			<u>Apr. 14</u>		
1400	2.72		0200	11.83	4,850	0800	9.13	2,340
1600	3.04		0500	11.73	4,730	2400	8.85	2,190
2000	5.30		0830	11.54	4,500	<u>Apr. 15</u>		
2200	5.34		1100	11.33	4,250	1200	8.67	2,100
2400	5.69		1830	10.87	3,710	2400	8.54	2,040
<u>Apr. 8</u>			2000	10.85	3,680	<u>Apr. 16</u>		
0800	7.57		2400	11.04	3,900	1100	8.40	1,970
1400	9.31		<u>Apr. 11</u>			1600	8.39	1,970
1600	9.52		0430	10.85	3,680	2400	8.28	1,910
1900	11.91		1000	10.77	3,600	<u>Apr. 17</u>		
2100	10.23		1400	10.80	3,630	0400	8.21	1,880
2200	9.96		2200	10.71	3,530	1400	8.05	1,800
2400	9.98		2400	10.72	3,540	2400	7.95	1,760
<u>Apr. 9</u>			<u>Apr. 12</u>			<u>Apr. 18</u>		
0300	10.30		0400	10.76	3,590	0600	7.88	1,720
0700	10.40		0600	10.70	3,520	1600	7.73	1,660
0900	10.56		1200	10.22	3,060	2400	7.62	1,610
1100	10.78		1600	10.00	2,880			
1500	11.47		2000	9.90	2,810			
1700	11.72		2400	9.85	2,780			

Location.--Lat 47°16'05", long 96°47'50", in SE $\frac{1}{4}$ sec.19, T.144 N., R.48 W., near center of span on downstream side of highway bridge, half a mile east of Hendrum and 4 miles upstream from mouth.

Gage-height record.--Graph based on once or twice-daily wire-weight gage readings by observer supplemented by hydrographer's readings. Datum of gage is 836.75 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 8,300 cfs 1100 Apr. 15 (gage height, 31.42 ft).
1944 to March 1969: Discharge, 6,800 cfs Apr. 14, 1965; gage height, 29.52 ft Apr. 15, 1965 (backwater from Red River of the North).

Remarks.--Large part of high flow diverted into Marsh River basin at overflow section 3 $\frac{1}{2}$ miles east of Ada.

[illegible]

Wild Rice River at Hendrum, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 12</u>			<u>Apr. 19</u>		
2400	5.80		0600	28.25	6,360	0800	30.58	
			1400	29.12	6,780	1600	30.48	
<u>Apr. 6</u>			2000	29.69	7,090	2400	30.36	
1000	5.95		2400	29.93	7,240			
1400	6.00					<u>Apr. 20</u>		
1800	6.08		<u>Apr. 13</u>			0800	30.20	
2000	6.12		0400	30.18	7,410	1600	30.13	
2400	6.23		1000	30.48	7,620	2400	29.98	
			1400	30.65	7,740			
<u>Apr. 7</u>			2400	30.91	7,920	<u>Apr. 21</u>		
0400	6.35					0800	29.87	
1000	6.52		<u>Apr. 14</u>			1600	29.79	
1600	6.80		1000	31.18	8,120	2400	29.65	
2400	7.42		1600	31.28	8,190			
			2400	31.37	8,260	<u>Apr. 22</u>		
<u>Apr. 8</u>						0800	29.50	
0800	8.00		<u>Apr. 15</u>			1600	29.38	
1600	8.58		0800	31.40	8,280	2400	29.25	
2400	9.18		1600	31.42	8,300			
			2400	31.40		<u>Apr. 23</u>		
<u>Apr. 9</u>						0800	29.10	
0800	14.10		<u>Apr. 16</u>			1600	28.90	
1600	18.92		0800	31.35		2400	28.72	
1800	19.18		1600	31.28				
2400	19.75		2400	31.20		<u>Apr. 24</u>		
						0800	28.55	
<u>Apr. 10</u>			<u>Apr. 17</u>			1600	28.31	
0600	20.38		0800	31.15		2400	28.08	
1200	20.84		1600	31.09				
1600	21.57		2400	31.04		<u>Apr. 25</u>		
2400	22.45					0800	27.81	
			<u>Apr. 18</u>			1600	27.53	
<u>Apr. 11</u>			0800	30.95		2400	27.27	
0800	23.50		1600	30.85				
1400	24.60		2400	30.70		<u>Apr. 26</u>		
1800	25.56					0800	26.96	
2400	26.95	5,850				1600	26.62	
						2400	26.28	

(45) 5-0645. Red River of the North at Halstad, Minn.

Location.--Lat 47°21'10", long 96°50'50", on line between secs.24 and 25, T.145 N., R.49 W., on left bank on upstream side of highway bridge, half a mile west of Halstad, 2½ miles downstream from Wild Rice River, and at mile 375.2.

Drainage area.--21,800 sq mi, approximately (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is 826.65 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-11.

Maxima.--April-May 1969: Discharge, 35,700 cfs 0700 hours to 1500 hours Apr. 18 (gage height, 38.29 ft).

1936-37, 1942 to March 1969: Discharge, 26,800 cfs Mar. 27, 1966 (gage height, 35.35 ft, backwater from ice).

Flood in 1897 reached a stage of about 38.5 ft.

Remarks.--Flow regulated by many lakes and reservoirs on tributaries.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	930	17,500	11...	14,600	6,000	21...	33,200	4,370
2...	910	15,900	12...	24,700	5,600	22...	32,100	4,110
3...	860	14,200	13...	30,700	5,310	23...	30,900	3,980
4...	850	12,900	14...	33,300	5,040	24...	29,600	3,930
5...	930	11,700	15...	34,600	4,740	25...	28,100	3,870
6...	970	10,900	16...	35,200	4,680	26...	26,500	3,770
7...	1,000	9,810	17...	35,600	4,750	27...	24,600	3,700
8...	1,480	8,720	18...	35,600	4,690	28...	22,400	3,640
9...	5,070	7,640	19...	35,100	4,800	29...	20,600	3,560
10...	8,900	6,680	20...	34,200	4,700	30...	19,000	3,490
						31...	--	3,470
Monthly mean discharge, in cubic feet per second							20,080	6,715
Runoff, in acre-feet							1,195,000	412,900

RED RIVER OF THE NORTH BASIN

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Red River of the North at Halstad, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
2400	7.79	1,050	0800	24.58	12,800	1200	37.56	34,700
			1600	26.24	15,400	2400	37.79	35,000
<u>Apr. 8</u>			2400	28.19	20,000			
0600	8.08	1,150				<u>Apr. 16</u>		
1200	8.47	1,300	<u>Apr. 12</u>			1200	37.98	35,300
1800	9.16	1,600	0800	30.08	23,700	2400	38.12	35,400
2400	11.38	2,700	1600	31.69	26,300			
			2400	33.04	28,400	<u>Apr. 17</u>		
<u>Apr. 9</u>						1200	38.21	35,600
0800	14.09	4,450	<u>Apr. 13</u>			2400	38.26	35,600
1600	16.24	5,850	0800	34.16	30,000			
2400	18.05	7,100	1600	35.22	31,600	<u>Apr. 18</u>		
			2400	35.83	32,500	1200	38.29	35,700
<u>Apr. 10</u>						2400	38.27	35,500
0800	19.57	8,150	<u>Apr. 14</u>					
1600	21.24	9,500	1200	36.50	33,300	<u>Apr. 19</u>		
2400	22.95	11,000	2400	37.18	24,200	1200	38.22	35,100
						2400	38.10	34,700

Location.--Lat 47°36', long 97°43', in NE¼ sec.31, T.148 N., R.55 W., on right bank 500 ft upstream from bridge on county road 7 miles northeast of Finley.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1170.08 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 1,320 cfs 0900 hours Apr. 9 (gage height, 6.55 ft); gage height, 7.44 ft, Apr. 9 (backwater from ice).
1965 to March 1969: Discharge, 1,250 cfs Apr. 11, 1965 (gage height, 6.88 ft, backwater from ice); gage height, 9.70 ft Mar. 14, 1966 (backwater from ice).

[illegible]

RED RIVER OF THE NORTH BASIN

243

Beaver Creek near Finley, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 7</u>			<u>Apr. 10</u>		
2400	1.78	0	1800	5.57	80	1900	5.83	852
			2400	5.48	85	2100	5.95	920
<u>Apr. 4</u>			<u>Apr. 8</u>			2300	5.90	890
1300	1.95	0	0200	5.74	90	2400	5.90	890
1700	2.35	1.0	1600	5.17	123	<u>Apr. 11</u>		
2400	2.48	1.5	1900	5.59	190	0200	6.10	1,010
<u>Apr. 5</u>			2400	5.99	300	0830	5.67	764
0330	2.50	1.6	<u>Apr. 9</u>			1000	5.73	796
1130	2.27	1.3	0530	5.67	250	1100	5.60	725
1400	2.67	1.7	0730	6.07	350	1230	5.72	791
1700	3.26	5.0	0800	6.37	600	1330	5.67	764
2000	3.86	10	0845	7.44	1,270	1400	5.69	774
2400	4.22	15	0900	6.55	1,320	2000	5.49	670
<u>Apr. 6</u>			1100	6.29	1,130	2400	5.81	840
0300	4.68	25	1200	6.35	1,180	<u>Apr. 12</u>		
0500	4.99	30	1230	6.30	1,140	0630	5.05	465
0800	5.37	35	1330	6.44	1,240	1300	4.43	248
0930	5.76	40	1600	6.23	1,070	2200	4.94	421
1030	5.74	45	1830	6.52	1,270	2400	5.09	481
1200	5.84	50	2000	6.15	1,030	<u>Apr. 13</u>		
1700	5.48	55	2400	6.02	944	0200	4.99	441
1800	5.82	60	<u>Apr. 10</u>			1030	4.64	315
2400	5.51	65	0600	5.98	938	2400	4.50	269
<u>Apr. 7</u>			1400	6.05	980			
1500	5.18	70	1500	5.97	932			
1630	5.27	75	1600	6.08	998			

Location.--Lat 47°32', long 97°27', in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.19, T.147 N., R.53 W., on left bank 75 ft upstream from the bridge on State Highway 18, 1 $\frac{1}{2}$ miles upstream from unnamed tributary, 4 miles downstream from Beaver Creek, and 5 miles northwest of Portland.

Gage-height record.--Water-stage recorder graph. Datum of gage is 967.48 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 3,660 cfs 0300 hours Apr. 13 (gage height, 18.17 ft).
1940 to March 1969: Discharge, 8,530 cfs May 9, 1950 (gage height, 20.12 ft).

[illegible]

RED RIVER OF THE NORTH BASIN

245

Goose River near Portland, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 13</u>		
2400	3.44	2.2	0100	11.40	686	2400	17.88	3,212
			0600	11.68	723			
<u>Apr. 7</u>			1030	12.29	805	<u>Apr. 14</u>		
1600	3.49	3.1	1400	13.21	1,010	0600	17.77	3,060
2000	3.95	22	1600	13.82	1,190	1200	17.61	2,880
2300	3.77	11	1800	14.47	1,380	1800	17.42	2,720
2400	3.82	14	2030	14.97	1,630	2400	17.17	2,550
			2400	15.65	1,920			
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
0400	4.43	46	0600	16.35	2,190	0600	16.89	2,410
0800	4.28	32	1200	17.20	2,570	1200	16.55	2,330
1200	4.68	61	1400	17.39	2,690	1800	16.10	2,100
1600	4.81	73	1830	17.63	2,900	2400	15.42	1,880
1630	4.78	70	2400	17.75	3,040			
1730	5.00	81				<u>Apr. 16</u>		
1900	5.73	125	<u>Apr. 12</u>			0300	14.97	1,750
2100	6.58	180	0800	17.80	3,100	0600	14.58	1,660
2400	7.24	260	1800	18.07	3,500	1200	13.70	1,470
			2400	18.16	3,640	1800	12.77	1,280
<u>Apr. 9</u>						2400	11.92	1,110
0600	7.91	280	<u>Apr. 13</u>			<u>Apr. 17</u>		
1200	8.44	323	0300	18.17	3,660	0600	11.18	974
1600	9.30	407	0600	18.16	3,640	1200	10.55	864
1830	9.95	492	1200	18.08	3,510	1800	10.10	788
2100	10.49	554	1800	17.98	3,360	2400	9.49	692
2400	11.00	646						

Location.--Lat 47°24'20", long 97°03'40", in NW¼ sec.5, T.145 N., R.50 W., on right bank 600 ft upstream from Foogman Dam in Hillsboro and 22 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Datum of gage is 879.52 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 7,640 cfs 1700 hours Apr. 12 (gage height, 14.14 ft).

1882, 1897, 1904, 1916, 1931 to March 1969: Discharge, 9,420 cfs
Apr. 19, 1950; gage height, 14.96 ft Apr. 19, 1950.

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1966							
Day	April	Day	April	Day	April	Day	April
1.....	11	8....	39	15....	5,520	23....	521
2.....	11	9....	293	16....	4,620	24....	425
3.....	11	10....	1,850	17....	3,490	25....	356
4.....	11	11....	3,640	18....	2,150	26....	311
5.....	9.4	12....	6,680	19....	1,280	27....	272
6.....	12	13....	6,680	20....	1,020	28....	241
7.....	17	14....	6,170	21....	826	29....	220
				22....	648	30....	212
Monthly mean discharge, in cubic feet per second.....							1,585
Runoff, in acre-feet							94,310

RED RIVER OF THE NORTH BASIN

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Goose River at Hillsboro, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	1.78	28	1800	11.68	4,030	2000	11.46	4,300
			2400	12.49	4,700	2400	11.18	4,110
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
1200	1.79	30	0400	13.11	5,600	0600	10.74	3,830
1800	1.87	35	0800	13.62	6,520	1000	10.35	3,610
2400	2.13	92	1200	14.00	7,200	1400	10.00	3,420
<u>Apr. 9</u>			1700	14.19	7,640	1600	9.71	3,280
0600	2.60	185	2100	14.01	7,220	2000	9.16	3,030
1200	2.93	237	2400	13.89	6,980	2400	8.58	2,790
1600	3.27	301						
2000	3.71	431	<u>Apr. 13</u>			<u>Apr. 18</u>		
2400	4.50	770	1500	13.68	6,630	0400	7.99	2,560
			2400	13.52	6,370	0800	7.38	2,350
<u>Apr. 10</u>			<u>Apr. 14</u>			1200	6.74	2,120
0400	5.67	1,320	1200	13.40	6,200	1600	6.06	1,920
0800	6.55	1,630	2400	13.18	5,910	2000	5.50	1,770
1200	7.21	1,810				2400	5.01	1,600
1600	8.02	2,150	<u>Apr. 15</u>			<u>Apr. 19</u>		
2000	8.79	2,430	1200	12.87	5,550	0600	4.36	1,340
2400	9.47	2,720	2400	12.44	5,100	1200	4.13	1,230
<u>Apr. 11</u>			<u>Apr. 16</u>			2400	3.88	1,120
0300	10.00	2,980	0800	12.08	4,770			
0600	10.47	3,240	1600	11.71	4,480			
1200	11.06	3,590						

(47) 5-0675. Marsh River near Shelly, Minn.

Location.--Lat 47°24'45", long 96°45'50", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.3, T.145 N., R.48 W., near center of span on downstream truss of bridge, 3 3/4 miles southeast of Shelly, and 10 miles upstream from mouth.

Drainage area.--151 sq mi.

Gage-height record.--Graph of once or twice-daily wire-weight gage readings by observer supplemented by hydrographer's readings. Datum of gage is 841.14 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 7-10. Backwater from Red River of the North, Apr. 13-29.

Maxima.--April 1969: Discharge, 3,910 cfs 1300 hours Apr. 12 (gage height, 22.28 ft).
1944 to March 1969: Discharge, 4,660 cfs May 11, 1950 (gage height, 18.96 ft, from floodmark).

Mean discharge, in cubic feet per second, 1969

[illegible]

RED RIVER OF THE NORTH BASIN

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Marsh River near Shelly, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	4.08		1200	22.28	3,910	2400	16.10	
			1800	22.15	3,870			
<u>Apr. 8</u>			2400	21.70	3,720	<u>Apr. 18</u>		
1200	4.45					1200	16.00	
1800	4.75		<u>Apr. 13</u>			1800	15.93	
2400	6.00		0600	21.52		2400	15.90	
			1200	21.40				
<u>Apr. 9</u>			1800	21.25		<u>Apr. 19</u>		
0600	9.20		2400	21.15		0600	15.82	
1200	9.45					1200	15.73	
1800	8.95		<u>Apr. 14</u>			2400	15.48	
2400	9.30		0600	20.98				
			1200	20.72		<u>Apr. 20</u>		
<u>Apr. 10</u>			2400	19.85		1200	15.15	
0400	9.92					2400	14.79	
1200	10.55		<u>Apr. 15</u>					
1800	11.00		1200	18.50		<u>Apr. 21</u>		
2400	12.00	976	2400	17.60		1200	14.40	
						2400	13.97	
<u>Apr. 11</u>			<u>Apr. 16</u>					
0600	13.42	1,330	1200	16.82		<u>Apr. 22</u>		
1200	15.20	1,790	1800	16.58		1200	13.50	
1800	17.75	2,520	2400	16.40		2400	13.03	
2400	21.10	3,530						
			<u>Apr. 17</u>			<u>Apr. 23</u>		
<u>Apr. 12</u>			0600	16.27		1200	12.56	
0600	21.95	3,800	1200	16.20		2400	12.10	

Location.--Lat 47°36'43", long 96°48'52", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.30, T.148 N., R.48 W., near center of span on downstream side of bridge on U.S. Highway 75 in Climax, and 3.7 miles upstream from mouth.

Gage-height record.--Graph based on once or twice-daily wire-weight gage readings by observer supplemented by hydrographer's readings. Altitude of gage is 820 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-12. Backwater from Red River of the North, Apr. 13-30.

Maxima.--April 1969: Discharge, 4,180 cfs Apr. 14 (result of discharge measurement); gage height, 28.32 ft Apr. 17 (from floodmark, backwater from Red River of the North).
1943 to March 1969: Discharge, 4,560 cfs Apr. 14, 1965 (gage height, 17.81 ft, site and datum then in use).

Mean discharge, in cubic feet per second, 1969

[illegible]

RED RIVER OF THE NORTH BASIN

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Sandhill River at Climax, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
2400	6.12		1000	19.19		1400	27.45	
			2400	21.71		2400	27.12	
<u>Apr. 8</u>			<u>Apr. 14</u>			<u>Apr. 21</u>		
1200	6.62		1400	24.10		1000	26.79	
2400	7.25		2400	25.56		2400	26.27	
<u>Apr. 9</u>			<u>Apr. 15</u>			<u>Apr. 22</u>		
1200	8.61		1000	26.54		1400	25.68	
1800	9.59		2400	27.37		2400	25.31	
2400	10.68							
<u>Apr. 10</u>			<u>Apr. 16</u>			<u>Apr. 23</u>		
0600	11.79		1400	27.84		1000	24.87	
1200	12.33		2400	28.04		2400	24.27	
1500	12.44		<u>Apr. 17</u>			<u>Apr. 24</u>		
2400	12.30		1000	28.16		1400	23.67	
<u>Apr. 11</u>			2200	28.32		2400	23.26	
0600	12.38		2400	28.30				
1800	13.24		<u>Apr. 18</u>			<u>Apr. 25</u>		
2400	13.52		0600	28.22		1000	22.78	
<u>Apr. 12</u>			1400	28.22		2400	22.12	
0600	13.81		2400	28.16		<u>Apr. 26</u>		
1400	14.24		<u>Apr. 19</u>			1400	21.47	
2400	16.96		1000	28.05		2400	21.02	
			2400	27.82				

Location.--Lat 47°55', long 96°03', in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.4, T.151 N., R.42 W., on right bank 200 ft downstream from Soo Line Railroad bridge, 300 ft downstream from bridge on U. S. Highway 59, 0.9 mile northwest of railroad depot in Plummer, and 8 miles upstream from Hill River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,099.12 ft above mean sea level, adjustment of 1912
(levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 3,630 cfs 0800 hours Apr. 11 (gage height, 11.89 ft); gage height, 12.31 ft Apr. 10 (backwater from ice).
1939 to March 1969: Discharge, 3,640 cfs June 9, 1962 (gage height, 11.90 ft); maximum gage height, 11.97 ft Apr. 11, 1965 (backwater from ice).

[illegible]

Clearwater River at Plummer, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
2400	4.94		0200	11.85	3,600	0800	9.14	1,910
			0800	11.89	3,630	1600	9.00	1,840
<u>Apr. 8</u>			1600	11.83	3,580	2400	8.93	1,800
0600	5.08		2400	11.33	3,230			
1400	5.73					<u>Apr. 16</u>		
2400	7.39		<u>Apr. 12</u>			0800	8.88	1,780
			0800	10.93	2,950	1600	8.85	1,760
<u>Apr. 9</u>			1600	10.80	2,860	2400	8.83	1,760
1000	7.81		2400	10.85	2,900			
1200	8.14					<u>Apr. 17</u>		
1400	8.17		<u>Apr. 13</u>			0800	8.78	1,730
1800	8.79		0800	10.84	2,890	1600	8.70	1,700
2400	11.08		1600	10.55	2,700	2400	8.60	1,650
			2400	10.20	2,480			
<u>Apr. 10</u>						<u>Apr. 18</u>		
0600	12.01		<u>Apr. 14</u>			0800	8.49	1,600
1000	12.15		0800	9.84	2,270	1600	8.39	1,560
1200	12.31		1600	9.52	2,100	2400	8.28	1,510
1400	12.25		2400	9.31	2,000			
1600	12.28							
2200	11.94							
2400	11.93							

Location.--Lat 47°50'35", long 95°51'30", on west edge of sec.1, T.150 N., R.41 W., on upstream side of bridge on State Highway 222, at northwest edge of Oklee, 12 miles upstream from mouth.

Gage-height record.--Graph of once or twice daily reading from wire-weight gage. Peak stage determined from floodmark. Datum of gage is 1,126.94 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Maxima.---April 1969: Discharge, 3,210 cfs Apr. 11 (gage height, 14.91 ft, from floodmark).
1960 to March 1969: Discharge, 2,880 cfs Mar. 31, 1967 (gage height, 14.17 ft).
Maximum stage known since at least 1897, 18.39 ft Apr. 21, 1950, present datum.

[illegible]

RED RIVER OF THE NORTH BASIN

255

Lost River at Oklee, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	4.52		0600	14.23		0600	8.93	823
			1400	14.10		1200	8.82	807
<u>Apr. 6</u>			1800	13.90		1800	8.85	815
1200	4.67		2000	13.95		2400	8.91	834
1800	4.76		2400	14.34	2,950			
2400	4.77					<u>Apr. 16</u>		
			<u>Apr. 11</u>			0600	8.90	831
<u>Apr. 7</u>			0400	14.70	3,120	1200	8.80	807
0600	4.82		0800	14.87	3,190	1800	8.64	767
1200	5.00		1000	14.91	3,210	2400	8.25	682
1400	5.14		1200	14.80	3,160			
1600	5.40		1400	14.65	3,090	<u>Apr. 17</u>		
2000	6.60		1600	14.48	3,020	0600	7.70	585
2400	7.40		1800	14.28	2,930	1200	7.40	537
			2400	14.04	2,820	1800	7.20	508
<u>Apr. 8</u>						2400	7.08	492
0400	7.90		<u>Apr. 12</u>					
1200	9.00		0600	13.86	2,740	<u>Apr. 18</u>		
1800	9.80		1200	13.51	2,590	0600	7.00	481
2400	11.00		1800	12.98	2,350	1200	6.98	480
			2400	11.82	1,850	1800	6.98	480
<u>Apr. 9</u>						2400	6.88	467
0600	13.30		<u>Apr. 13</u>					
0800	13.50		0600	10.66	1,360	<u>Apr. 19</u>		
1800	13.93		1200	10.23	1,170	0600	6.72	447
2400	14.12		2000	9.95	1,090	1200	6.51	420
			2400	9.83	1,060	1800	6.21	382
						2400	6.12	370
			<u>Apr. 14</u>					
			0400	9.72	1,030			
			1200	9.49	966			
			1800	9.35	925			
			2400	9.17	883			

Location.--Lat 47°53'15", long 96°16'25", in NW¹₄NE¹₄ sec.22, T.151 N., R.44 W., on left bank 40 ft downstream from Great Northern Railroad bridge in Red Lake Falls, 1.4 miles upstream from mouth, and 3 miles downstream from Badger Creek.

Gage-height record.--Water-stage recorder graph. Datum of gage is 949.49 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 9,740 cfs 0230 hours Apr. 12 (gage height, 11.82 ft).

1910-17, 1935 to March 1969: Discharge, 9,310 cfs May 6, 1950 (gage height, 11.28 ft); gage height observed, 17.5 ft Apr. 5, 1913, site and datum then in use (backwater from ice).

Mean discharge, in cubic feet per second, 1969

[illegible]

RED RIVER OF THE NORTH BASIN

257

Clearwater River at Red Lake Falls, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 16</u>		
2400	3.86		1600	10.05		1200	7.54	3,620
			2400	10.79	8,010	2400	7.44	3,530
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
0400	3.68		0600	11.32	8,860	1200	7.30	3,410
0800	3.62		1200	11.20	8,670	2400	7.12	3,260
1500	4.37		1800	11.78	9,660			
1600	4.54		2400	11.80	9,700	<u>Apr. 18</u>		
1900	6.00					1200	6.92	3,090
2100	8.62		<u>Apr. 12</u>			2400	6.72	2,920
2200	11.37		0230	11.82	9,740			
2400	10.72		0900	11.56	9,270	<u>Apr. 19</u>		
			1600	11.02	8,380	1200	6.53	2,780
<u>Apr. 9</u>			2400	10.25	7,180	2400	6.34	2,610
0500	9.62		<u>Apr. 13</u>			<u>Apr. 20</u>		
0800	7.14		1200	9.58	6,170	1200	6.15	2,430
1200	7.29		2400	9.13	5,570	2400	5.96	2,250
1300	7.58					<u>Apr. 21</u>		
1600	7.55		<u>Apr. 14</u>			1200	5.81	2,110
1900	7.67		1200	8.65	4,950	2400	5.69	2,000
2300	9.75		2400	8.23	4,380			
2400	9.59		<u>Apr. 15</u>			<u>Apr. 22</u>		
<u>Apr. 10</u>			1200	7.95	4,040	1200	5.54	1,870
0700	9.13		2400	7.70	3,760	2400	5.42	1,760
0900	9.13							

Location.--Lat 47°46'32", long 96°36'33", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.30, T.150 N., R.46 W., on right bank at downstream side of highway bridge in Crookston, 0.3 mile downstream from Interstate Power Co.'s dam, 0.6 mile downstream from bridge on U. S. Highway 75, and 53 miles above mouth.

Gage-height record.--Digital recorder tape punched at 15-minute intervals except from 2130 hours Apr. 10 to 0715 hours Apr. 14 for which graph was reconstructed on basis of hourly wire-weight gage readings by observer. Datum of gage is 832.72 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 28,400 cfs 1030 hours Apr. 12 (gage height, 27.33 ft).
1902 to March 1969: Discharge, 27,400 cfs May 7, 1950 (gage height, 25.70 ft); gage height, 25.82 ft Apr. 12, 1965 (backwater from ice).

mean discharge, in cubic feet per second, 1969								
Day	April	May	Day	April	May	Day	April	May
1...	1,220	3,490	11...	22,700	3,300	21...	7,640	4,420
2...	1,270	3,470	12...	27,100	3,200	22...	6,890	4,190
3...	1,270	3,620	13...	22,400	3,130	23...	6,160	3,970
4...	1,260	3,700	14...	17,700	3,080	24...	5,590	3,760
5...	1,250	3,670	15...	14,800	3,480	25...	5,100	3,550
6...	1,240	3,630	16...	12,900	4,020	26...	4,640	3,450
7...	1,300	3,640	17...	11,600	4,570	27...	4,400	3,300
8...	1,530	3,590	18...	10,400	5,140	28...	4,270	3,090
9...	4,000	3,470	19...	9,330	5,020	29...	4,050	2,830
10...	11,000	3,370	20...	8,400	4,670	30...	3,790	2,690
						31...		2,680
Monthly mean discharge, in cubic feet per second							7,840	3,651
Runoff, in <u>acre-feet</u>							466,500	224,500

RED RIVER OF THE NORTH BASIN

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Red Lake River at Crookston, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
2400	6.02		1600	25.65	23,400	1400	20.16	14,600
			1800	25.98	24,400	2400	19.42	13,700
<u>Apr. 8</u>			2200	26.03	24,500			
0400	6.12		2400	26.28	25,200	<u>Apr. 16</u>		
1200	6.49					1000	18.80	13,000
1600	6.72		<u>Apr. 12</u>			2400	18.12	12,200
1800	6.97		0200	26.49	25,900			
2000	7.36		0700	27.13	27,800	<u>Apr. 17</u>		
2400	8.52		0800	27.14	27,800	1400	17.53	11,500
			0900	27.32	28,400	2400	17.07	11,000
<u>Apr. 9</u>			1030	27.33	28,400			
0400	10.16		1200	27.30	28,300	<u>Apr. 18</u>		
0800	12.07		1400	27.15	27,800	1000	16.60	10,500
1400	14.39		1500	26.85	27,000	2400	15.99	9,850
2000	15.83		1700	26.96	27,300			
2400	16.51		2000	26.84	26,900	<u>Apr. 19</u>		
			2300	26.42	25,700	1400	15.42	9,240
<u>Apr. 10</u>			2400	26.39	25,600	2400	15.06	8,860
0400	17.67							
0800	18.35		<u>Apr. 13</u>			<u>Apr. 20</u>		
1000	18.49		0100	26.22	25,100	1000	14.68	8,460
1200	20.44		1100	25.30	22,500	1800	14.42	8,200
1600	21.56		1800	24.63	21,000	2400	14.20	7,980
2000	23.19		2400	24.03	19,800			
2200	24.30					<u>Apr. 21</u>		
2400	24.55	20,800	<u>Apr. 14</u>			0600	14.05	7,830
			0600	23.38	18,700	1000	13.97	7,750
<u>Apr. 11</u>			1000	22.77	17,800	1800	13.66	7,440
0200	24.69	21,100	2400	21.40	16,100	2400	13.48	7,260
1000	25.12	22,000						

(53) 5-0825. Red River of the North at Grand Forks, N. Dak.

Location.--Lat 47°56'34", long 97°03'10", in SW¼NE¼ sec.33, T.152 N., R.50 W., on left bank on second floor of old sewage plant in Grand Forks, 2.3 miles downstream from Red Lake River, and at mile 296.0.

Drainage area.--30,100 sq mi, approximately (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is 778.35 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-7.

Maxima.--April-May 1969: Discharge, 53,500 cfs 1430 hours Apr. 16 (gage height, 45.69 ft).

1882 to March 1969: Discharge, about 80,000 cfs Apr. 10, 1897 (gage height, 50.2 ft, site and datum then in use), from rating curve extended above 54,000 cfs.

Remarks.--Flow regulated by many lakes and reservoirs on tributaries.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	2,050	29,000	11...	18,900	11,100	21...	45,300	9,750
2...	2,050	25,900	12...	32,400	9,900	22...	43,300	9,200
3...	2,100	24,000	13...	42,200	9,050	23...	41,400	8,600
4...	2,150	22,200	14...	48,800	8,400	24...	39,600	8,100
5...	2,150	20,400	15...	52,100	7,950	25...	38,200	7,800
6...	2,150	18,800	16...	53,400	7,700	26...	36,400	7,450
7...	2,250	17,200	17...	53,000	7,650	27...	35,400	7,150
8...	2,860	15,600	18...	51,400	8,600	28...	34,400	6,900
9...	5,130	14,100	19...	49,600	9,900	29...	33,000	6,590
10...	10,100	12,500	20...	47,500	10,100	30...	31,300	6,330
						31...	--	6,130
Monthly mean discharge, in cubic feet per second							28,690	12,070
Runoff, in acre-feet							1,706,000	741,900

RED RIVER OF THE NORTH BASIN

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Red River of the North at Grand Forks, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	11.24	2,450	0600	37.37	29,600	1200	45.62	53,100
			1200	39.06	32,800	2400	45.54	52,400
<u>Apr. 8</u>			1800	40.30	35,300			
0600	11.55	2,650	2400	41.42	37,800	<u>Apr. 18</u>		
1200	11.69	2,750				1200	45.42	51,400
1800	12.10	3,000	<u>Apr. 13</u>			2400	45.30	50,400
2400	13.11	3,600	0600	42.44	40,200			
			1200	43.28	42,400	<u>Apr. 19</u>		
<u>Apr. 9</u>			1800	43.93	44,300	1200	45.18	49,800
0600	13.95	4,200	2400	44.46	46,000	2400	45.01	48,600
1200	15.14	4,950						
1800	16.78	6,000	<u>Apr. 14</u>			<u>Apr. 20</u>		
2400	18.56	7,150	0600	44.80	47,400	1200	44.84	47,600
			1200	45.08	49,200	2400	44.64	46,300
<u>Apr. 10</u>			1800	45.24	50,000			
0600	20.48	8,500	2400	45.38	51,000	<u>Apr. 21</u>		
1200	22.40	9,950				1200	44.42	45,200
1800	24.38	11,500	<u>Apr. 15</u>			2400	44.20	44,400
2400	26.31	13,500	1200	45.52	52,200			
			2400	45.63	53,100	<u>Apr. 22</u>		
<u>Apr. 11</u>						1200	43.94	43,400
0600	28.31	15,800	<u>Apr. 16</u>			2400	43.66	42,100
1200	30.41	18,500	0800	45.68	53,400			
1800	32.60	21,700	1430	45.69	53,500			
2400	35.18	25,800	2400	45.68	53,400			

(54) 5-0826. English Coulee tributary near Grand Forks, N. Dak.

(Crest-stage station)

Location.--Lat 47°55'05", long 97°10'40", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.4, T.151 N., R.51 W., at bridge on county highway at Powell, 7 miles west of Grand Forks.

Drainage area.--4.68 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 164 cfs Apr. 10 (gage height, 3.08 ft).
1955 to March 1969: Discharge, 130 cfs Mar. 30, 1967 (gage height, 4.91 ft, backwater from ice); gage height, 5.72 ft Mar. 19, 1966 (backwater from ice).

(55) 5-0826.8. Saltwater Coulee tributary near Emerado, N. Dak.

(Crest-stage station)

Location.--Lat 47°53'00", long 97°21'55", at west line sec.19, T.151 N., R.52 W., at bridge on county highway, 2 $\frac{1}{2}$ miles south of Emerado.

Drainage area.--22.0 sq mi.

Gage-height record.--Crest-stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 230 cfs Apr. 10, 1969 (gage height, 6.30 ft).
1955 to March 1969: Discharge, 290 cfs Apr. 12, 1965 (gage height, 6.00 ft); gage height, 7.10 ft Mar. 14, 1966 (backwater from ice).

(56) 5-0827. Saltwater Coulee near Emerado, N. Dak.

(Crest-stage station)

Location.--Lat 47°55'55", long 97°15'40", in NW¼NW¼ sec.1, T.151 N., R.52 W., at bridge on county highway, 0.1 mile south of U.S. Highway 2, and 5½ miles east of Emerado.

Drainage area.--110 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 700 ft and by indirect measurement at 3,500 cfs.

Maxima.--April-May 1969: Discharge, 710 cfs Apr. 10 (gage height, 7.09 ft).
1950, 1955 to March 1969: Discharge, 3,500 cfs April 1950 (gage height, 11.3 ft, according to local residents).

(57) 5-0829. Freshwater Coulee near Emerado, N. Dak.

(Crest-stage station)

Location.--Lat 47°56'00", long 97°14'00", in SW¼ sec.31, T.152 N., R.51 W., at bridge on U.S. Highway 2, 6½ miles east of Emerado.

Drainage area.--31.0 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 190 cfs Apr. 10 (gage height, 6.54 ft, backwater from ice).
1955 to March 1969: Discharge, 1,180 cfs September 1957 and 1965 (gage height, 5.00 ft).
Flood of 1950 reached a stage of 11.5 ft from information by local resident.

Location.--Lat 48°05', long 97°11', in SE $\frac{1}{4}$ sec.10, T.153 N., R.51 W., on downstream side of bridge on State Highway 33, 0.3 mile west of Manvel and 10 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Datum of gage is 799.28 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 3,470 cfs 0300 hours Apr. 13 (gage height, 17.38 ft).

1946 to March 1969: Discharge, 28,000 cfs Apr. 19, 1950 (gage height, 21.5 ft, from floodmarks), from rating curve extended from 4,300 cfs on basis of contracted-opening measurement of peak flow.

Mean discharge, in cubic feet per second, 1907							
Day	April	Day	April	Day	April	Day	April
1.....	0	8....	10	15....	1,710	23....	228
2.....	0	9....	370	16....	1,500	24....	172
3.....	0	10....	764	17....	1,300	25....	128
4.....	.10	11....	1,510	18....	955	26....	100
5.....	.20	12....	3,160	19....	636	27....	80
6.....	.50	13....	3,010	20....	466	28....	64
7.....	1.0	14....	2,030	21....	351	29....	60
				22....	290	30....	56
Monthly mean discharge, in cubic feet per second.....							632
Runoff, in acre-feet							37,590

RED RIVER OF THE NORTH BASIN

265

Turtle River at Manvel, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 13</u>			<u>Apr. 21</u>		
2400	7.01	.86	2400	17.02	2,340	2400	12.64	312
<u>Apr. 7</u>			<u>Apr. 14</u>			<u>Apr. 22</u>		
1200	7.10	.92	0800	16.87	2,060	0800	12.52	296
1800	7.28	.98	1600	16.72	1,940	1600	12.43	284
2400	7.62	1.8	2400	16.57	1,840	2400	12.29	265
<u>Apr. 8</u>			<u>Apr. 15</u>			<u>Apr. 23</u>		
0600	7.92	2.7	0800	16.42	1,750	0800	12.15	244
1200	8.17	3.3	1600	16.29	1,670	1600	11.98	215
1800	8.60	10	2400	16.15	1,590	2400	11.83	186
2400	9.62	50						
<u>Apr. 9</u>			<u>Apr. 16</u>			<u>Apr. 24</u>		
0600	10.27	312	0800	16.03	1,530	0800	11.66	182
1200	10.66	369	1600	15.90	1,470	1600	11.48	166
1800	11.51	477	2400	15.75	1,420	2400	11.33	147
2400	12.66	594						
<u>Apr. 10</u>			<u>Apr. 17</u>			<u>Apr. 25</u>		
0600	13.25	687	0800	15.58	1,350	1200	11.13	127
1200	13.66	757	1600	15.40	1,290	2400	11.00	112
1800	14.05	836	2400	15.23	1,130			
2400	14.53	958				<u>Apr. 26</u>		
<u>Apr. 11</u>			<u>Apr. 18</u>			1500	10.79	96
0600	15.01	1,090	0800	15.02	1,010	2400	10.80	92
1200	15.60	1,320	1600	14.82	905			
1800	16.34	1,790	2400	14.56	772	<u>Apr. 27</u>		
2400	17.07	2,700				1200	10.74	81
<u>Apr. 12</u>			<u>Apr. 19</u>			2400	10.61	65
0600	17.24	3,090	0800	14.25	675			
1200	17.28	3,200	1600	13.95	585	<u>Apr. 28</u>		
1800	17.31	3,280	2400	13.69	525	1200	10.39	64
2400	17.37	3,440				2400	10.18	63
<u>Apr. 13</u>			<u>Apr. 20</u>			<u>Apr. 29</u>		
0300	17.38	3,470	0800	13.45	482	1200	10.00	60
0800	17.32	3,310	1600	13.27	447	2400	9.81	57
1600	17.17	2,790	2400	13.09	410			
			<u>Apr. 21</u>			<u>Apr. 30</u>		
			0800	12.94	362	1200	9.65	56
			1600	12.78	330	2400	9.48	55

Location.--Lat 48°16'10", long 97°22'10", in SE¼ sec.31, T.156 N., R.52 W., on right bank 30 ft upstream from dam in Minto, 150 ft upstream from Great Northern Railway bridge, and 2 blocks east of U.S. Highway 81.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals.
Datum of gage is 806.95 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 3,960 cfs 0230 hours Apr. 12 (gage height, 7.67 ft).

1882, 1897, 1907, 1916, 1944 to March 1969: Discharge, 16,600 cfs Apr. 18, 1950 (gage height, 11.80 ft, from floodmarks), from rating curve extended above 7,200 cfs on basis of contracted-opening measurement of peak flow.

[illegible]

RED RIVER OF THE NORTH BASIN

267

Forest River at Minto, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 13</u>		
2400	1.37	23	0400	4.05	1,220	0600	6.01	2,230
			0600	4.54	1,360	1200	5.50	1,880
<u>Apr. 9</u>			0800	5.38	1,700	1800	5.01	1,630
0800	1.54	59	1000	6.08	2,130	2400	4.60	1,450
1200	1.56	63	1400	6.81	2,750			
1800	1.67	87	1600	6.62	2,570	<u>Apr. 14</u>		
2000	1.76	109	1800	6.79	2,730	0800	4.31	1,410
2400	1.67	87	2400	7.57	3,720	1600	4.08	1,330
						2400	3.84	1,260
<u>Apr. 10</u>			<u>Apr. 12</u>			<u>Apr. 15</u>		
0400	1.53	65	0230	7.67	3,960	1200	3.56	1,100
0600	1.56	72	0600	7.65	3,920	2400	3.35	990
1200	2.11	227	1200	7.37	3,470			
1800	2.68	473	1800	6.82	2,800			
2400	3.58	425	2400	6.32	2,350			

Location.--Lat 48°20'27", long 96°49'02", in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.10, T.156 N., R.48 W., on left bank 20 ft upstream from bridge on U.S. Highway 75 in Argyle, and 14 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph except 1400 hours Apr. 11 to 1500 hours Apr. 12 for which graph was reconstructed on basis of shape of adjacent record and wire-weight gage readings by observer. Datum of gage is 828.53 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 2,530 cfs 2030 hours Apr. 11 (gage height, 15.92 ft, backwater from ice).
1945, 1951 to March 1969: Discharge, 2,590 cfs Apr. 12, 1965 (gage height, 15.29 ft); gage height, 16.00 ft Apr. 3, 1966 (backwater from ice).
Flood of April 1950 reached a stage of 15.25 ft, present datum, from floodmarks (discharge, 2,790 cfs).

[illegible]

RED RIVER OF THE NORTH BASIN

269

Middle River at Argyle, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	2.95		0600	10.05		0800	13.95	1,600
			0700	9.95		1600	13.81	1,520
<u>Apr. 5</u>			1000	11.26		2400	13.60	1,410
1000	2.93		1100	11.21				
1800	3.53		1500	12.26		<u>Apr. 16</u>		
2400	3.64		2400	13.33		1200	13.20	1,240
						2400	12.69	1,090
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
1000	3.70		0500	14.25		1200	12.14	964
2100	4.25		0900	15.39		2400	11.66	874
2400	4.30		1300	15.41				
			2030	15.92		<u>Apr. 18</u>		
<u>Apr. 7</u>			2400	15.67		1200	11.22	804
1000	4.43					2400	10.61	699
1300	4.53		<u>Apr. 12</u>					
1600	4.81		0600	15.28		<u>Apr. 19</u>		
2400	5.12		1200	15.00	2,350	1200	10.06	652
			2400	14.54	1,990	2400	9.49	586
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
1400	6.51		1200	14.27	1,800	1200	8.97	528
1800	6.87		1800	14.09	1,690	2400	8.55	479
2100	7.51		2400	13.97	1,610			
2400	8.22					<u>Apr. 21</u>		
<u>Apr. 9</u>			<u>Apr. 14</u>			1200	8.10	431
0400	9.05		1000	13.86	1,550	2400	7.65	386
0700	9.48		2400	13.94	1,590			
1300	9.92							
1500	10.02							
1800	9.76							
2400	9.68							

Location.--Lat 48°25', long 97°24', in NE¼ sec.13, T.157 N., R.53 W., on right bank 30 ft upstream from Wakeman Avenue Bridge in Grafton and 3.5 miles downstream from South Branch.

Gage-height record.--Water-stage recorder graph. Datum of gage is 807.39 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,990 cfs 1200 hours Apr. 13 (gage height, 18.13 ft).
1932 to March 1969: Discharge, 12,600 cfs Apr. 19, 1950 (gage height, 20.13 ft), from rating curve extended above 9,000 cfs.

Mean discharge, in cubic feet per second, 1969

[illegible]

RED RIVER OF THE NORTH BASIN

271

Park River at Grafton, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 16</u>		
2400	7.67	47	0400	14.38	1,990	0600	16.18	2,610
			0800	15.00	2,200	1200	15.80	2,440
<u>Apr. 9</u>			1200	15.93	2,510	1800	15.36	2,280
1000	7.59	33	1400	17.09	3,160	2200	15.00	2,160
1700	7.74	60	1530	17.48	3,470	2400	14.82	2,100
2400	8.14	152	1600	17.27	3,590			
			2000	17.61	4,060	<u>Apr. 17</u>		
<u>Apr. 10</u>			2400	17.91	4,550	0600	14.31	1,930
0600	8.35	206				1200	13.72	1,730
1000	8.32	198	<u>Apr. 13</u>			1800	13.07	1,530
1400	8.47	234	0600	18.10	4,920	2400	12.30	1,300
1800	8.65	277	1200	18.13	4,990			
2000	8.95	368	2400	18.09	4,900	<u>Apr. 18</u>		
2200	9.34	481				0600	11.58	1,100
2400	9.65	565	<u>Apr. 14</u>			1200	10.91	923
			0600	18.07	4,860	1800	10.48	818
<u>Apr. 11</u>			1200	17.95	4,570	2400	10.22	762
0200	10.00	657	1800	17.77	4,220			
0600	10.74	853	2400	17.54	3,860	<u>Apr. 19</u>		
0900	11.25	996				0700	10.00	717
1200	11.71	1,120	<u>Apr. 15</u>			1200	9.87	693
1500	12.36	1,320	0600	17.31	3,560	2400	9.65	641
1800	12.92	1,480	1200	17.03	3,240			
2100	13.38	1,640	1800	16.79	3,020			
2400	13.87	1,800	2400	16.54	2,820			

(62) 5-0920. Red River of the North at Drayton, N. Dak.

Location.--Lat 48°34'20", long 97°08'50", on line between secs. 24 and 25, T.159 N., R.51 W., on downstream end of east pier of interstate highway bridge, 1½ miles northeast of Drayton and at mile 207.

Drainage area.--34,800 sq mi, approximately (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph except May 14-18. Datum of gage is 755.00 ft above mean sea level of 1929 (Minnesota highway bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-9. Discharge May 14-18 estimated from adjacent records.

Maxima.--April-May 1969: Discharge, 59,000 cfs 1200 hours Apr. 19; gage height, 41.35 ft 0400 hours Apr. 23.

1936-37, 1941 to March 1969: Discharge, 86,500 cfs May 12, 1950 (gage height, 41.58 ft, former site and datum).

Maximum discharge known since 1860, that of May 12, 1950. Flood of April 1897 reached a stage of about 41 ft, at site and datum in use prior to Nov. 30, 1954.

Remarks.--Flow regulated by many lakes and reservoirs on tributaries.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	2,300	36,000	11...	10,500	23,400	21...	52,000	12,500
2...	2,300	34,500	12...	16,800	22,000	22...	50,000	12,300
3...	2,300	33,200	13...	23,600	20,500	23...	48,600	11,800
4...	2,250	32,000	14...	29,000	19,100	24...	46,800	10,800
5...	2,250	31,000	15...	34,000	17,500	25...	45,600	9,900
6...	2,250	29,800	16...	37,800	16,000	26...	44,200	9,090
7...	2,250	28,600	17...	41,600	14,700	27...	41,900	8,450
8...	2,300	27,500	18...	46,700	13,700	28...	40,500	7,970
9...	2,750	26,200	19...	56,600	12,800	29...	39,000	7,590
10...	5,700	25,000	20...	56,000	12,600	30...	36,600	7,230
						31...	--	6,950
Monthly mean discharge, in cubic feet per second							27,480	18,730
Runoff, in acre-feet							1,635,000	1,152,000

RED RIVER OF THE NORTH BASIN

273

Red River of the North at Drayton, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 15</u>			<u>Apr. 23</u>		
2400	11.49	2,300	0800	35.93	33,300	0400	41.35	49,000
			1600	36.64	34,700	1200	41.33	48,500
<u>Apr. 9</u>			2400	37.27	36,200	2400	41.31	48,000
0800	11.65	2,400						
1600	11.94	2,800	<u>Apr. 16</u>			<u>Apr. 24</u>		
2400	12.86	3,800	0800	37.73	37,100	1200	41.26	46,500
			1600	38.32	38,400	2400	41.23	46,000
<u>Apr. 10</u>			2400	38.91	39,800			
0800	14.34	5,100				<u>Apr. 25</u>		
1600	15.65	6,200	<u>Apr. 17</u>			1200	41.18	45,500
2400	17.57	7,800	1200	39.69	41,600	2400	41.17	45,400
			2400	40.19	43,500			
<u>Apr. 11</u>						<u>Apr. 26</u>		
0800	19.80	9,600	<u>Apr. 18</u>			1200	41.11	44,500
1600	21.87	11,300	1200	40.58	46,200	2400	41.01	42,500
2400	23.87	13,400	2400	40.82	51,000			
						<u>Apr. 27</u>		
<u>Apr. 12</u>			<u>Apr. 19</u>			1200	40.95	42,000
0800	25.63	15,400	1200	41.08	59,000	2400	40.90	41,000
1600	27.60	18,000	2400	41.15	57,500			
2400	29.14	20,300				<u>Apr. 28</u>		
			<u>Apr. 20</u>			1200	40.87	40,500
<u>Apr. 13</u>			1200	41.23	56,000	2400	40.82	40,000
0800	30.71	22,900	2400	41.25	54,500			
1600	31.60	24,500				<u>Apr. 29</u>		
2400	32.51	26,300	<u>Apr. 21</u>			1200	40.75	39,000
			1200	41.26	51,500	2400	40.66	38,000
<u>Apr. 14</u>			2400	41.30	50,500			
0800	33.45	28,200				<u>Apr. 30</u>		
1600	34.35	30,000	<u>Apr. 22</u>			1200	40.58	37,500
2400	35.14	31,600	1200	41.31	50,000	2400	40.01	33,400
			2400	41.34	49,500			

(International gaging station)

Drainage area.--348 sq mi.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Cooperation.--This station is one of the international gaging stations maintained by Canada under agreement with the United States.

[illegible]

275

Location.--Lat 49°00'00", long 98°27'15", in SE¼ sec.3, T.1, R.8 W., 1st meridian, on downstream side of bridge on Municipal Road on international boundary, 1.5 miles east of Mowbray.

Gage-height record.--Wire-weight gage read once daily.

Maxima.--April 1969: Daily discharge, 414 cfs Apr. 13, 14 (gage height, 6.35 ft).

1962 to March 1969: Daily discharge, 392 cfs Apr. 24, 1967; gage height, 7.88 ft Mar. 29, 1966 (backwater from ice).

Cooperation.--Records furnished by Inland Waters Branch, Department of Energy, Mines and Resources, Canada.

[illegible]

(International gaging station)

Drainage area.--3,020 sq mi.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Cooperation.--This station is one of the international gaging stations maintained by Canada under agreement with the United States.

Day	April	May	Day	April	May	Day	April	May
1...	18.3	2,970	11...	2,830	1,850	21...	7,230	1,230
2...	19.1	2,840	12...	2,900	1,790	22...	6,550	1,170
3...	21.9	2,700	13...	3,700	1,730	23...	5,860	1,110
4...	29.6	2,570	14...	3,550	1,670	24...	5,130	1,050
5...	56.4	2,440	15...	3,340	1,600	25...	4,460	984
6...	139	2,310	16...	3,100	1,540	26...	4,080	922
7...	292	2,170	17...	2,680	1,480	27...	3,640	860
8...	435	2,040	18...	5,780	1,420	28...	3,430	798
9...	1,630	1,980	19...	8,190	1,360	29...	3,370	736
10...	2,680	1,910	20...	7,850	1,290	30...	3,070	670
						31...	--	612
Monthly mean discharge, in cubic feet per second							3,200	1,610
Runoff, in acre-feet							191,000	98,800

277

Location.--Lat 48°52', long 98°01', in SW¼ sec.10, T.162 N., R.57 W., on right bank 25 ft upstream from county bridge, 3½ miles above mouth, and 6 miles southwest of Walhalla.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,099.48 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 6,000 cfs 2200 hours Apr. 9 (gage height, 12.76 ft).
1957 to March 1969: Discharge, 4,160 cfs Apr. 11, 1960 (gage height, 13.28 ft).

[illegible]

RED RIVER OF THE NORTH BASIN

Little Pembina River near Walhalla, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 11</u>		
2400	6.27	20	2400	12.32	4,500	2400	11.04	2,100
<u>Apr. 8</u>			<u>Apr. 10</u>			<u>Apr. 12</u>		
1400	6.40	24	0300	11.40	2,500	0300	10.46	1,550
1800	6.76	41	0600	11.18	2,250	0900	10.12	1,320
2000	7.45	125	1200	11.24	2,300	1800	10.03	1,270
2200	8.13	314	1400	11.60	2,800	2400	9.72	1,110
2400	8.56	473	1600	12.12	3,800			
			2030	12.50	4,900	<u>Apr. 13</u>		
<u>Apr. 9</u>			2400	12.20	4,100	0400	9.34	941
0600	8.87	654				0800	9.01	809
1200	9.00	805	<u>Apr. 11</u>			1200	8.78	728
1400	9.42	974	0300	11.52	2,700	1800	8.67	660
1600	10.05	1,280	0600	11.04	2,100	2400	8.53	620
1800	11.25	2,350	1030	10.63	1,700			
2000	12.44	4,800	1800	10.98	2,000	<u>Apr. 14</u>		
2200	12.76	6,000	2100	11.14	2,200	0600	8.30	520
						1500	8.00	420
						2400	8.12	450

Location.--Lat 48°55', long 97°55', in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.29, T.163 N., R.56 W., on left bank at downstream side of bridge on State Highway 32, at south edge of Walhalla, and 7 miles downstream from Little Pembina River.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 934 ft (from topographic map).

Maxima.--April-May 1969: Discharge, 8,440 cfs 1400 hours Apr. 20 (gage height, 14.58 ft).

1940, 1942 to March 1969: Discharge, 20,400 cfs Apr. 18, 1950 (gage height, 19.2 ft, former site and datum) from rating curve extended above 7,000 cfs on basis of contracted-opening measurement of peak flow.

Mean discharge, in cubic feet per second, 1905								
Day	April	May	Day	April	May	Day	April	May
1...	24	3,090	11...	5,380	1,960	21...	7,590	1,160
2...	22	2,930	12...	5,000	1,860	22...	6,910	1,130
3...	18	2,760	13...	4,480	1,680	23...	6,370	1,080
4...	22	2,610	14...	4,690	1,600	24...	5,760	1,040
5...	24	2,510	15...	4,290	1,520	25...	5,100	1,000
6...	22	2,360	16...	3,820	1,450	26...	4,660	968
7...	22	2,180	17...	3,480	1,370	27...	4,200	940
8...	210	2,070	18...	3,730	1,320	28...	3,820	901
9...	2,320	1,990	19...	6,260	1,280	29...	3,500	868
10...	4,840	1,930	20...	8,100	1,210	30...	3,220	841
						31...	--	931
Monthly mean discharge, in cubic feet per second							3,596	1,630
Runoff, in acre-feet							214,000	100,200

Pembina River at Walhalla, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 13</u>			<u>Apr. 21</u>		
2400	3.27	50	1200	11.78	4,280	1200	14.29	7,520
			1800	12.12	4,550	2400	14.15	7,260
<u>Apr. 8</u>			2400	12.46	4,800	<u>Apr. 22</u>		
0600	3.96	120				1200	13.91	6,900
1200	4.48	150	<u>Apr. 14</u>			2400	13.59	6,570
1800	5.30	200	0800	12.45	4,790			
2400	7.75	700	1600	12.20	4,610	<u>Apr. 23</u>		
			2400	12.11	4,540	1200	13.43	6,410
<u>Apr. 9</u>			<u>Apr. 15</u>			2400	13.09	6,080
0200	8.40	900	1200	11.75	4,290			
0400	7.70	650	2400	11.40	4,040	<u>Apr. 24</u>		
0500	9.60	1,400				0800	12.90	5,910
0900	8.40	1,250	<u>Apr. 16</u>			1600	12.58	5,620
1800	11.90	3,560	1200	11.06	3,810	2400	12.38	5,440
2400	13.28	4,600	2400	10.78	3,610			
<u>Apr. 10</u>			<u>Apr. 17</u>			<u>Apr. 25</u>		
0300	13.53	4,770	1200	10.41	3,450	0800	12.09	5,180
1200	12.45	4,450	2400	10.23	3,410	1600	11.88	4,990
1800	12.99	5,100				2400	11.71	4,840
2400	13.46	5,580	<u>Apr. 18</u>			<u>Apr. 26</u>		
<u>Apr. 11</u>			0800	10.23	3,440	1200	11.53	4,680
0600	13.38	5,510	1600	10.54	3,750	2400	11.28	4,450
1500	12.88	5,110	2400	11.45	4,600			
1800	13.06	5,260				<u>Apr. 27</u>		
2400	13.42	5,550	<u>Apr. 19</u>			1200	10.99	4,190
			0800	12.92	5,930	2400	10.74	3,990
<u>Apr. 12</u>			1600	13.80	6,780			
0800	12.90	5,130	2400	14.29	7,520	<u>Apr. 28</u>		
1600	12.38	4,740				1200	10.51	3,810
2400	12.30	4,680	<u>Apr. 20</u>			2400	10.32	3,660
			0600	14.45	7,950			
<u>Apr. 13</u>			1400	14.58	8,440			
0600	11.84	4,350	2400	14.48	8,050			

(International gaging station)

Maxima.--April-May 1969: Discharge, 7,360 cfs 1345 hours Apr. 21 (gage height, 21.32 ft); gage height, 21.69 ft Apr. 12 (backwater from ice). 1904-8, 1910-15, 1919 to March 1969: Discharge, 10,700 cfs Apr. 20, 1950 (gage height, 21.58 ft, backwater from ice) from rating curve extended above 5,300 cfs.

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1903								
Day	April	May	Day	April	May	Day	April	May
1...	24	3,550	11...	1,150	2,020	21...	6,670	1,310
2...	22	3,310	12...	4,800	1,930	22...	6,940	1,250
3...	20	3,100	13...	5,230	1,840	23...	6,670	1,220
4...	16	2,900	14...	4,930	1,750	24...	6,350	1,180
5...	16	2,720	15...	4,690	1,670	25...	6,000	1,150
6...	15	2,580	16...	4,540	1,600	26...	5,330	1,120
7...	16	2,450	17...	4,070	1,520	27...	4,610	1,090
8...	17	2,290	18...	3,660	1,460	28...	4,230	1,050
9...	23	2,160	19...	3,220	1,400	29...	3,970	998
10...	44	2,090	20...	3,360	1,360	30...	3,740	957
						31...	--	930
Monthly mean discharge, in cubic feet per second							3,146	1,805
Runoff, in acre-feet							187,200	111,000

RED RIVER OF THE NORTH BASIN

Pembina River at Neche, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 9</u>			<u>Apr. 14</u>			<u>Apr. 19</u>		
2400	7.61	29	0800	20.63	5,140	2400	17.63	3,100
			1600	20.48	4,770			
<u>Apr. 10</u>			2400	20.40	4,550	<u>Apr. 20</u>		
1200	7.64	19				0800	17.85	3,140
2000	8.04	102	<u>Apr. 15</u>			1200	18.18	3,250
2400	8.25	166	0800	20.44	4,660	1600	18.71	3,430
			1600	20.47	4,740	2000	19.43	3,680
<u>Apr. 11</u>			2400	20.48	4,770	2400	20.36	4,290
0800	8.61	210						
1400	8.86	235	<u>Apr. 16</u>			<u>Apr. 21</u>		
1600	11.68	1,580	0800	20.43	4,630	0400	21.06	5,900
1800	16.77	2,700	1600	20.37	4,490	0800	21.26	7,010
2000	17.80	2,960	2400	20.26	4,290	1345	21.32	7,360
2200	18.90	3,250				1800	21.30	7,240
2400	19.71	3,480	<u>Apr. 17</u>			2400	21.22	6,790
			0800	20.12	4,130			
<u>Apr. 12</u>			1600	19.97	4,000	<u>Apr. 22</u>		
0400	21.09	4,140	2400	19.79	3,880	1200	21.18	6,950
0800	21.51	4,820				2400	21.14	6,740
1200	21.60	5,080	<u>Apr. 18</u>					
1715	21.69	5,400	0800	19.49	3,740	<u>Apr. 23</u>		
2000	21.61	5,250	1600	19.11	3,600	1200	21.07	6,680
2400	21.46	5,140	2400	18.63	3,430	2400	21.00	6,420
<u>Apr. 13</u>			<u>Apr. 19</u>			<u>Apr. 24</u>		
0600	21.31	5,290	0800	18.14	3,270	1200	20.96	6,380
1200	21.09	5,290	1600	17.77	3,150	2400	20.89	6,230
1800	20.89	5,250						
2400	20.74	5,180						

Flood of Apr. 18, 1950, is the highest known since settlement of the region (about 1860).

[illegible]

RED RIVER OF THE NORTH BASIN

Tongue River at Akra, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	3.45	20	0800	2.76	46	1200	7.14	518
			1800	2.77	47	2400	7.45	555
<u>Apr. 1</u>			2400	2.46	35			
1200	3.30	14	<u>Apr. 8</u>			<u>Apr. 13</u>		
2400	3.27	13	1200	1.83	21	1200	7.69	586
<u>Apr. 2</u>			2400	1.43	8.9	2400	7.79	599
1000	2.86	8.4				<u>Apr. 14</u>		
2000	3.47	28	<u>Apr. 9</u>			1200	7.83	604
2400	3.47	28	1000	1.44	16	1845	7.85	606
			1800	2.51	55	2400	7.84	605
<u>Apr. 3</u>			2400	1.59	21			
1200	3.19	26	<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	3.09	23	0800	1.04	10	1200	7.82	603
			1200	1.17	14	2400	7.80	600
<u>Apr. 4</u>			1600	2.35	57			
1000	3.01	28	2000	3.14	96	<u>Apr. 16</u>		
2400	3.11	34	2400	4.23	172	1200	7.73	591
						2400	7.65	580
<u>Apr. 5</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
1000	2.82	31	0600	5.39	299	1200	7.51	562
2200	3.25	47	1000	5.99	368	2400	7.31	538
2400	3.19	44	1200	5.99	368			
<u>Apr. 6</u>			2000	6.31	406	<u>Apr. 18</u>		
1000	2.86	41	2400	6.60	441	1200	7.16	520
1800	3.24	56				2400	7.03	505
2400	3.00	46						

(69) 5-1025. Red River of the North at Emerson, Manitoba

(International gaging station)

Location.--Lat 49°00'30", long 97°12'40", in sec.2, T.1, R.2 E., on right bank 1,500 ft downstream from Canadian National Railway bridge in Emerson, three-quarters of a mile downstream from international boundary, 3.6 miles downstream from Pembina River, and at mile 154.3.

Drainage area.--40,200 sq mi, approximately (includes 3,800 sq mi in closed basins).

Gage-height record.--Water-stage recorder graph. Datum of gage is 700.00 ft above mean sea level, datum of 1929, by Geodetic Survey of Canada.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 52,500 cfs 1000 hours Apr. 26 (gage height, 87.61 ft).

1913 to March 1969: Discharge, 95,500 cfs May 13, 1950 (gage height, 90.89 ft).

Remarks.--Flow regulated by many lakes and reservoirs on tributaries.

Cooperation.--This station is one of the international gaging stations maintained by Canada under agreement with the United States.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	2,680	51,400	11...	11,800	35,500	21...	47,500	18,200
2...	2,680	50,400	12...	16,700	33,600	22...	48,000	16,700
3...	2,650	49,300	13...	21,500	31,800	23...	52,100	15,300
4...	2,600	48,200	14...	26,400	30,000	24...	52,200	14,000
5...	2,600	46,400	15...	31,200	28,400	25...	52,200	12,800
6...	2,600	44,600	16...	34,400	26,800	26...	52,400	10,700
7...	2,700	42,700	17...	37,500	25,000	27...	51,000	9,700
8...	2,900	40,900	18...	40,700	23,200	28...	49,500	8,800
9...	4,300	39,100	19...	43,900	21,400	29...	49,000	8,000
10...	7,000	37,300	20...	47,000	19,600	30...	48,500	7,300
						31...	--	6,700
Monthly mean discharge, in cubic feet per second							28,200	27,500
Runoff, in acre-feet							1,680,000	1,690,000

Location.--Lat 48°54'37", long 95°55'18", in SE $\frac{1}{4}$ sec.27, T.163 N., R.41 W., on left bank 300 ft downstream from highway bridge, a quarter of a mile north of Ross, and 2.3 miles downstream from Pine Creek.

Gage-height record.--Water-stage recorder graph except 2400 hours Apr. 8 to 1400 hours Apr. 10 for which graph was reconstructed on basis of shape of adjacent record. Datum of gage is 1,018.44 ft above mean sea level, adjustment of 1928 by Geodetic Survey of Canada.

Maxima---April 1969: Discharge, 3,500 cfs 0500 hours Apr. 20 (gage height, 16.36 ft).
1928 to March 1969: Discharge, 6,560 cfs May 12, 1950 (gage height, 18.25 ft).
Maximum stage known, about 19 ft in 1896.

Mean discharge, in cubic feet per second, 1969

[illegible]

Roseau River at Ross, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 14</u>			<u>Apr. 22</u>		
2400	3.05		1200	15.06	2,910	0600	16.17	3,330
			1800	15.20	3,000	1200	16.19	3,350
<u>Apr. 7</u>			2400	15.34	3,070	2400	16.14	3,300
0600	3.09		<u>Apr. 15</u>			<u>Apr. 23</u>		
1200	3.15		0600	15.46	3,130	1200	16.05	3,230
1500	3.28		1200	15.59	3,200	2400	15.97	3,170
2100	3.73		1800	15.70	3,250			
2400	4.03		2400	15.77	3,270	<u>Apr. 24</u>		
<u>Apr. 8</u>			<u>Apr. 16</u>			1200	15.87	3,090
0300	4.54		0600	15.84	3,300	2400	15.80	3,040
1000	6.00		1200	15.90	3,300	<u>Apr. 25</u>		
1200	6.55		2400	16.04	3,380	1200	15.72	2,990
1300	6.56		<u>Apr. 17</u>			1800	15.74	3,010
1600	7.30		1200	16.15	3,390	2100	15.69	2,970
2100	8.75		1800	16.20	3,390	2400	15.76	3,020
2400	9.43		2400	16.25	3,400	<u>Apr. 26</u>		
<u>Apr. 9</u>			<u>Apr. 18</u>			0300	15.81	3,050
0300	9.75		0600	16.26	3,410	0900	15.72	2,990
1200	10.17		1200	16.28	3,430	1500	15.71	2,990
2400	10.57		2400	16.35	3,490	2400	15.60	2,920
<u>Apr. 10</u>			<u>Apr. 19</u>			<u>Apr. 27</u>		
1200	10.90		1200	16.32	3,460	0900	15.50	
1800	11.16		1700	16.27	3,420	1800	15.39	
2400	11.22		1900	16.30	3,440	2400	15.32	
<u>Apr. 11</u>			2400	16.35	3,490	<u>Apr. 28</u>		
0600	11.38		<u>Apr. 20</u>			0600	15.29	
1800	12.08		0500	16.36	3,500	1500	15.22	
2400	12.44	1,920	1400	16.34	3,480	2400	15.17	
<u>Apr. 12</u>			1800	16.28	3,430	<u>Apr. 29</u>		
0600	12.77	2,020	2400	16.29	3,440	1200	15.13	
1200	13.06	2,110	<u>Apr. 21</u>			2400	15.06	
2400	13.70	2,330	0600	16.25	3,400	<u>Apr. 30</u>		
<u>Apr. 13</u>			1200	16.21	3,360	1200	14.96	
1200	14.25	2,540	1800	16.13	3,300	2100	14.89	
2400	14.71	2,740	2400	16.19	3,350	2400	14.92	

(International gaging station)

Remarks.--This station is one of the international gaging stations maintained by Canada under agreement with the United States.

[illegible]

(72) 5-1134.5. Long Creek tributary No. 2 near Crosby, N. Dak.

(Crest-stage station)

Location.--Lat 48°57'29", long 103°18'57", on east line sec.7, T.163 N., R.97 W., at culverts on county highway 3.4 miles north of junction of State Highways 5 and 42 at Crosby.

Drainage area.--6.69 sq mi, of which 1.11 sq mi is noncontributing.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current meter measurements below 30 cfs and by indirect measurement at 260 cfs.

Maxima.--April 1969: Discharge, 260 cfs Apr. 6 (gage height, 7.07 ft).
1960 to March 1969: Discharge, 43 cfs March 1967 (gage height, 5.29 ft, backwater from ice).

(73) 5-1135.2 Long Creek tributary near Crosby, N. Dak.

(Crest-stage station)

Location.--Lat 48°50'11", long 103°19'19", on north line sec.30, T.162 N. R.97 W., at culverts on county highway, 0.5 mile west of State Highway 42, and 5 miles south of Crosby.

Drainage area.--0.35 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 6 cfs and by indirect measurement at 55 cfs.

Maxima.--April 1969: Discharge, 55 cfs Apr. 6 (gage height, 6.99 ft).
1960 to March 1969: Discharge, 20 cfs June 1965 (gage height, 4.13 ft).

(International gaging station)

1960 to March 1969: Discharge, 3,200 cfs Mar. 27, 1960 (gage height, 14.4 ft. from high-water mark, backwater from ice).

Mean discharge, in cubic feet per second, 1909								
Day	April	May	Day	April	May	Day	April	May
1...	0.50	112	11...	3,820	62	21...	280	27
2...	.20	95	12...	2,950	58	22...	240	24
3...	1.8	85	13...	2,570	53	23...	208	22
4...	2.5	84	14...	2,440	48	24...	183	20
5...	300	89	15...	2,000	45	25...	158	17
6...	1,500	92	16...	1,400	42	26...	135	16
7...	3,400	91	17...	950	36	27...	115	14
8...	4,100	83	18...	600	34	28...	122	12
9...	3,280	73	19...	450	32	29...	107	10
10...	4,260	66	20...	350	29	30...	114	9.1
						31...	---	8.4
Monthly mean discharge, in cubic feet per second							1,201	48.0
Runoff, in acre-feet.....							71,480	2,950

5-1136. Long Creek near Noonan, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 8</u>			<u>Apr. 10</u>			<u>Apr. 12</u>		
2400	14.37	3,690	1200	15.77	4,630	0600	13.34	3,080
			1600	16.23	4,980	1200	13.09	2,940
<u>Apr. 9</u>			1800	16.18	4,940	1800	12.85	2,810
0600	13.86	3,390	2400	15.66	4,550	2400	12.60	2,670
1200	13.47	3,150						
1800	13.50	3,170	<u>Apr. 11</u>			<u>Apr. 13</u>		
2400	13.40	3,110	0600	14.95	4,070	0600	12.43	2,580
			1200	14.52	3,790	1200	12.38	2,550
<u>Apr. 10</u>			1800	14.09	3,520	1800	12.38	2,550
0600	14.16	3,570	2400	13.69	3,280	2400	12.35	2,530

(75) 5-1138. Short Creek below international boundary near
Roche Percee, Saskatchewan

(International gaging station)

Location.--Lat 49°01'42", long 102°51'00", in SW¼ sec.14, T.1, R.7 W.,
2d meridian, 4 miles southwest of Roche Percee and 5 miles upstream
from mouth.

Drainage area.--480 sq mi.

Gage-height record.--Water-stage recorder graph.

Discharge record.--Stage-discharge relation defined by current-meter
measurements.

Maxima.--April 1969: Discharge, 1,700 cfs 0100 hours Apr. 7 (gage height,
14.35 ft).
1960 to March 1969: Discharge, 1,360 cfs Mar. 28, 1960 (gage height,
14.39 ft).

Cooperation.--This station is one of the international gaging stations
maintained by Canada under agreement with the United States.

Short Creek below international boundary near Rocne Percee, Saskatchewan

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0.3	8.....	855	15.....	257	23.....	55.7
2.....	1.3	9.....	606	16.....	240	24.....	47.7
3.....	6.0	10.....	431	17.....	209	25.....	47.1
4.....	4.0	11.....	370	18.....	175	26.....	47.1
5.....	287	12.....	355	19.....	143	27.....	43.8
6.....	1,130	13.....	325	20.....	119	28.....	38.1
7.....	1,400	14.....	290	21.....	89.0	29.....	31.0
				22.....	67.4	30.....	26.2
Monthly mean discharge, in cubic feet per second.....							257
Runoff, in acre-feet							15,270

(76) 5-1140. Souris (Mouse) River near Sherwood, N. Dak.

(International gaging station)

Location.--Lat 48°59'24", long 101°57'28", in NW¼SE¼NE¼ sec.33, T.164 N., R.87 W., on right bank 0.8 mile downstream from international boundary and 16 miles northwest of Sherwood.

Drainage area.--8,940 sq mi, approximately, of which about 5,900 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,604.00 ft above mean sea level, datum of 1929.

Discharge record.--Stage discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-12.

Maxima.--April-May 1969: Discharge 12,400 cfs 2300 hours Apr. 11 (gage height, 24.72 ft, backwater from ice).

1930-31, 1933 to March 1969: Discharge, 7,400 cfs Apr. 28, 1948 (gage height, 23.80 ft).

Maximum stage known, that of Apr. 11, 1969. Flood in 1927 reached a stage of about 22 ft, from information by local residents.

Souris River near Sherwood, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	250	2,180	11...	7,300	828	21...	5,910	374
2...	150	1,960	12...	11,000	742	22...	5,510	331
3...	150	1,750	13...	9,100	706	23...	5,020	297
4...	100	1,560	14...	7,150	674	24...	4,600	270
5...	100	1,400	15...	5,910	632	25...	4,160	250
6...	100	1,250	16...	5,390	580	26...	3,780	232
7...	100	1,130	17...	5,150	514	27...	3,390	216
8...	300	1,050	18...	5,480	480	28...	3,100	197
9...	1,250	996	19...	6,160	470	29...	2,770	173
10...	2,200	926	20...	6,280	422	30...	2,440	163
						31...	--	157
Monthly mean discharge, in cubic feet per second							3,810	739
Runoff, in acre-feet.....							226,700	45,440

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 11</u>		
2400	6.87	150	2400	19.47	1,900	2400	24.71	12,400
<u>Apr. 8</u>			<u>Apr. 10</u>			<u>Apr. 12</u>		
0600	7.36	200	0600	20.29	2,000	1200	24.42	10,800
1200	8.30	200	1200	20.86	2,100	2400	24.18	10,200
1800	10.26	400	1800	21.49	2,500			
2400	12.24	700	2400	22.43	2,700	<u>Apr. 13</u>		
						1200	23.89	9,040
<u>Apr. 9</u>			<u>Apr. 11</u>			2400	23.72	8,110
0600	13.67	1,000	0600	23.23	3,800			
1200	14.85	1,200	1200	24.03	6,800	<u>Apr. 14</u>		
1800	17.33	1,500	1800	24.61	11,000	1200	23.51	7,050
			2300	24.72	12,400	2400	23.36	6,400

(77) 5-1155. Lake Darling near Foxholm, N. Dak.

Location.--Lat 48°27'27", long 101°35'14", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.1, T.157 N., R.85 W., on control structure of Lake Darling Dam, reservoir of Fish and Wildlife Service, on Souris River about 6 miles north of Foxholm, and at mile 82.9 downstream from Canadian border.

Drainage area.--9,450 sq mi, approximately, of which about 6,200 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,577.00 ft above mean sea level, datum of 1929 (Fish and Wildlife Service benchmark).

Maxima.--April-May 1969: Contents, 124,000 acre-ft Apr. 16 (gage height, 22.18 ft).
1936 to March 1969: Contents observed, 130,000 acre-ft Apr. 23, 24, 1943 (gage height, 22.83 ft).

Remarks.--Reservoir is formed by earth dam; storage began in April 1936; dam completed in July 1936. Usable capacity, 108,500 acre-ft between gage heights 0.0 ft (sill of control gates) and 21.0 ft (crest of spillway). Dead storage, 3,500 acre-ft. Water is used during periods of low flow at wildlife refuge downstream. Elevations corrected for wind effect.

Gage height, in feet, and contents, in acre feet, at 2400 hours, 1969

Day	April		May		Day	April		May	
	Gage height	Contents	Gage height	Contents		Gage height	Contents	Gage height	Contents
1	14.48	55,400	21.68	119,000	16	22.14	123,000	19.92	100,000
2	14.56	55,900	21.56	118,000	17	22.06	123,000	19.79	100,000
3	14.59	56,100	21.32	115,000	18	21.99	122,000	19.72	99,500
4	14.64	56,500	21.18	114,000	19	21.96	122,000	19.65	98,800
5	14.79	57,500	20.99	112,000	20	21.99	122,000	19.61	98,500
6	15.12	60,000	20.86	111,000	21	22.04	122,000	19.60	98,400
7	15.37	62,000	20.84	110,000	22	22.03	122,000	19.59	98,300
8	15.76	65,100	20.75	110,000	23	21.99	122,000	19.52	97,700
9	16.32	69,700	20.68	109,000	24	21.98	122,000	19.45	97,000
10	16.84	74,100	20.56	108,000	25	21.99	122,000	19.40	96,600
11	17.46	79,400	20.43	106,000	26	21.98	122,000	19.40	96,600
12	18.53	88,800	20.26	105,000	27	21.96	122,000	19.38	96,400
13	20.40	106,000	20.00	102,000	28	21.91	121,000	19.36	96,200
14	21.61	118,000	19.88	101,000	29	21.86	121,000	19.35	96,200
15	22.08	123,000	19.85	100,000	30	21.77	120,000	19.35	96,200
					31	--	--	19.30	95,700
Change in contents.....							+65,000	--	-24,300

mean discharge, in cubic feet per second, 1908								
Day	April	May	Day	April	May	Day	April	May
1...	0.48	3,640	11...	40	1,620	21...	5,090	763
2...	.48	3,570	12...	200	1,600	22...	5,160	693
3...	.97	3,420	13...	1,020	1,580	23...	5,210	607
4...	2.8	3,280	14...	1,240	1,440	24...	5,160	497
5...	12	3,160	15...	2,130	1,320	25...	5,090	491
6...	42	2,660	16...	4,050	1,240	26...	5,230	342
7...	50	2,090	17...	5,160	1,180	27...	4,850	206
8...	30	1,770	18...	5,360	1,150	28...	4,190	206
9...	35	1,670	19...	5,210	1,120	29...	3,880	165
10...	40	1,630	20...	5,090	974	30...	3,740	98
						31...	--	101
Monthly mean discharge, in cubic feet per second							2,577	1,428
Runoff, in acre-feet.....							153,300	87,830

Souris River near Foxholm, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 11</u>			<u>Apr. 13</u>			<u>Apr. 16</u>		
2400	9.00	40	1800	11.10	1,070	0600	14.85	3,800
			2400	11.22	1,090	1200	15.06	4,100
<u>Apr. 12</u>			<u>Apr. 14</u>			1800	15.31	4,360
1400	8.43	40	0600	11.42	1,150	2400	15.56	4,700
1800	8.50	100	1200	11.58	1,210			
2000	8.60	120	1800	11.94	1,320	<u>Apr. 17</u>		
2000	10.05	896	2400	12.46	1,500	1200	15.80	5,280
2400	10.40	948				2400	15.84	5,380
<u>Apr. 13</u>			<u>Apr. 15</u>			<u>Apr. 18</u>		
0900	10.62	983	0600	12.95	1,770	1200	15.84	5,380
1000	10.78	1,010	1200	13.42	2,070	2400	15.81	5,310
1200	10.92	1,030	1800	13.80	2,330			
			2400	14.46	3,180			

(79) 5-1161. Souris River tributary near Burlington, N. Dak.

(Crest-stage station)

Location.--Lat 48°18'04", long 101°25'13", in SW¼ sec.25, T.156 N.,
R.83 W., at culvert on county highway, 1.8 miles north of Burlington.

Drainage area.--0.13 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 9 cfs and by indirect measurement at 29 cfs.

Maxima.--April-May 1969: Discharge, 3.0 cfs Apr. 5 (gage height, 4.5 ft, from floodmark, backwater from ice).
1959 to March 1969: Discharge, 29 cfs June 1963 (gage height, 8.01 ft).

(80) 5-1162. Des Lacs River tributary near Donnybrook, N. Dak.

(Crest-stage station)

Location.--Lat 48°29'35", long 101°51'20", in NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.24, T.158 N., R.87 W., at culvert in Minneapolis, St. Paul, Sault Ste. Marie Railroad, 1.8 miles southeast of Donnybrook.

Drainage area.--3.82 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 160 cfs Apr. 6 (gage height, 6.79 ft).
1956 to March 1969: Discharge, 135 cfs August 1963 (gage height, 6.40 ft).

(81) 5-1165. Des Lacs River at Foxholm, N. Dak.

Location.--Lat 48°22'14", long 101°34'11", in NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.2, T.156 N., R.85 W., on left bank 200 ft upstream from county highway bridge in Foxholm.

Drainage area.--939 sq mi, of which about 400 sq mi is probably non-contributing.

Gage-height record.--Water-stage recorder graph except portions of Apr. 7-10 which were reconstructed on basis of wire-weight gage readings and floodmarks. Datum of gage is 1,632.98 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-9.

Maxima.--April-May 1969: Discharge, 2,460 cfs 0100 hours Apr. 10 (gage height, 19.82 ft, from floodmark).
1904-06, 1946 to March 1969: Discharge, 2,000 cfs Apr. 4, 1949 (gage height, 18.04 ft, backwater from ice).
Maximum stage known since 1886, that of Apr. 10, 1969, from information by local residents.

Remarks.--Some regulation by a series of wildfowl refuge ponds (combined capacity about 64,000 acre-feet).

RED RIVER OF THE NORTH BASIN

Des Lacs River at Foxholm, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	6.0	50	11...	1,640	80	21...	109	68
2...	6.5	54	12...	1,230	80	22...	94	66
3...	10	58	13...	917	79	23...	83	65
4...	40	64	14...	669	77	24...	72	63
5...	200	72	15...	480	73	25...	65	61
6...	700	79	16...	325	72	26...	61	60
7...	1,680	80	17...	219	72	27...	61	56
8...	1,690	81	18...	174	72	28...	58	52
9...	2,160	82	19...	149	71	29...	52	50
10...	2,220	82	20...	128	70	30...	49	49
						31...	--	47
Monthly mean discharge, in cubic feet per second							512	67.3
Runoff, in acre-feet							30,440	4,140

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 11</u>		
2400	6.81	100	1200	18.09	1,660	1800	16.89	1,550
			1800	17.92	1,600	2400	16.31	1,400
<u>Apr. 5</u>			2400	18.15	1,740			
0800	6.68	100				<u>Apr. 12</u>		
1200	7.00	120	<u>Apr. 9</u>			1200	15.43	1,220
1800	9.06	300	0600	18.68	1,950	2400	14.65	1,070
2400	10.56	400	1200	19.30	2,200			
			1800	19.64	2,390	<u>Apr. 13</u>		
<u>Apr. 6</u>			2400	19.82	2,460	1200	13.63	908
0600	11.52	500				2400	12.67	782
1200	12.43	630	<u>Apr. 10</u>					
1800	14.15	900	0100	19.82	2,460	<u>Apr. 14</u>		
2400	15.69	1,130	0600	19.71	2,420	1200	11.72	666
			1200	19.35	2,290	2400	10.79	562
<u>Apr. 7</u>			1800	18.55	2,040			
0600	16.99	1,400	2400	17.90	1,840	<u>Apr. 15</u>		
1200	18.79	1,900				1200	10.01	481
1700	19.17	1,980	<u>Apr. 11</u>			2400	9.10	394
2400	18.58	1,800	0600	17.59	1,750			
			1200	17.31	1,660	<u>Apr. 16</u>		
<u>Apr. 8</u>						1200	8.27	324
0600	18.29	1,720				2400	7.35	258

(82) 5-1165.5. Fuller Coulee at Foxholm, N. Dak.

(Crest-stage station)

Location.--Lat 48°21'45", long 101°34'00", in NE¼SW¼ sec.2, T.156 N.,
R.85 W., at culvert on U.S. Highway 52, 0.4 mile southeast of Foxholm.

Drainage area.--12.8 sq mi, of which about 6.9 sq mi is noncontributing.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 222 cfs Apr. 6 (gage height, 5.65 ft).
1955 to March 1969: Discharge, 140 cfs Mar. 29, 1955 (gage height, 4.73 ft).

(83) 5-1172. Souris River tributary No. 2 near Burlington, N. Dak.

(Crest-stage station)

Location.--Lat 48°15'17", long 101°22'48", in NW¼NW¼ sec.17, T.155 N.,
R.83 W., at culvert on county highway, 2.6 miles southeast of
Burlington.

Drainage area.--2.04 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 89 cfs Apr. 5 (gage height, 5.01 ft).
1960 to March 1969: Discharge, 148 cfs June 1963 (gage height, 7.42 ft).

Location.--Lat 48°14'45", long 101°22'15", in NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.17, T.155 N., R.83 W., on right bank 180 ft downstream from county highway bridge, 3 $\frac{1}{2}$ miles west of Minot, 7 miles downstream from Des Lacs River, and at mile 124.1 downstream from Canadian border.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,545.75 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 6,020 cfs 1700 hours Apr. 19 (gage height, 20.36 ft).

1904, 1906-17, 1919 to March 1969: Discharge, 12,000 cfs Apr. 20, 1904 (gage height, 21.9 ft at site in Minot), from rating curve extended above 8,100 cfs.

Maximum stage known at present site, about 23 ft in April 1904. Maximum stage known in Minot at least 3 ft higher than 1904 peak, in 1881, according to Apr. 20, 1904 issue of Minot Daily Optic. This peak probably occurred in 1882.

Remarks.--Flow regulated since 1936 by Lake Darling and several smaller reservoirs (combined capacity, about 248,000 acre-feet).

Day	April	May	Day	April	May	Day	April	May
1...	21	4,280	11...	2,920	1,830	21...	5,460	1,110
2...	19	4,190	12...	2,760	1,760	22...	5,410	906
3...	19	4,100	13...	2,500	1,720	23...	5,380	772
4...	21	3,990	14...	2,300	1,680	24...	5,310	622
5...	150	3,880	15...	2,120	1,610	25...	5,280	507
6...	700	3,710	16...	2,240	1,510	26...	5,330	492
7...	1,390	3,360	17...	3,450	1,420	27...	5,550	358
8...	1,600	2,770	18...	4,880	1,360	28...	5,100	204
9...	2,270	2,270	19...	5,760	1,310	29...	4,710	181
10...	2,900	1,960	20...	5,570	1,270	30...	4,430	151
						31...	--	110
Monthly mean discharge, in cubic feet per second							3,185	1,787
Runoff, in acre-feet							189,500	109,900

RED RIVER OF THE NORTH BASIN

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Souris (Mouse) River above Minot, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 16</u>		
2400	4.43	28	1200	14.91	1,520	0600	13.46	2,060
			2400	15.74	1,900	1200	13.78	2,150
<u>Apr. 5</u>			<u>Apr. 9</u>			1800	14.41	2,370
0600	4.68	67	1200	16.19	2,230	2400	15.24	2,700
1200	5.24	100	2400	16.67	2,710	<u>Apr. 17</u>		
1800	7.35	180				0600	16.07	3,050
2400	9.10	500	<u>Apr. 10</u>			1200	16.76	3,380
<u>Apr. 6</u>			0600	16.86	2,820	1800	17.72	3,880
0300	9.46	540	1200	16.97	2,920	2400	18.41	4,260
0600	9.33	510	1700	17.04	2,990	<u>Apr. 18</u>		
0900	9.15	480	2400	17.01	2,980	0600	19.09	4,630
1200	9.25	500	<u>Apr. 11</u>			1200	19.60	4,910
1500	10.00	650	1200	16.81	2,930	1800	19.99	5,150
1800	11.50	910	2400	16.49	2,840	2400	20.22	5,380
2100	12.68	1,150	<u>Apr. 12</u>			<u>Apr. 19</u>		
2400	13.57	1,350	1200	16.02	2,770	0600	20.29	5,570
<u>Apr. 7</u>			2400	15.46	2,660	1200	20.34	5,880
0600	13.84	1,400	<u>Apr. 15</u>			1700	20.36	6,020
1200	13.67	1,360	2400	13.44	2,050	2400	20.33	5,810
1800	13.86	1,400						
2400	14.22	1,480						

Location.--Lat 48°09'35", long 100°43'45", in NW¼SW¼ sec.17, T.154 N., R.78 W., on left bank 2.7 miles north of Verendrye, 7½ miles southwest of (19 miles upstream from) mouth of Wintering River, and at mile 210.5 downstream from Canadian border.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,464.87 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge 5,960 cfs 1130 hours Apr. 30 (gage height, 17.05 ft).

1937 to March 1969: Discharge, about 4,200 cfs Apr. 8, 1949 (gage height, 17.7 ft, from high-water mark, backwater from ice).

Remarks.--Flow regulated by reservoirs on the Souris and Des Lacs Rivers (combined capacity about 248,000 acre-feet).

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	8.5	5,590	11...	2,950	3,780	21...	2,540	1,520
2...	9.7	5,120	12...	2,900	3,560	22...	2,630	1,440
3...	25	4,800	13...	2,850	3,300	23...	2,820	1,380
4...	60	4,630	14...	2,800	2,980	24...	3,500	1,230
5...	60	4,540	15...	2,930	2,590	25...	4,420	1,030
6...	241	4,410	16...	2,890	2,340	26...	5,210	870
7...	1,120	4,280	17...	2,830	2,060	27...	5,520	740
8...	2,300	4,150	18...	2,720	1,850	28...	5,680	624
9...	2,600	4,040	19...	2,590	1,720	29...	5,820	575
10...	2,650	3,940	20...	2,530	1,610	30...	5,890	498
						31...	--	410
Monthly mean discharge, in cubic feet per second							2,703	2,632
Runoff, in acre-feet							160,800	161,900

Souris (Mouse) River near Verendrye, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 23</u>			<u>Apr. 28</u>		
2400	4.08	65	2400	15.49	3,040	1200	16.99	5,680
						2400	17.00	5,720
<u>Apr. 6</u>			<u>Apr. 24</u>			<u>Apr. 29</u>		
0600	4.23	76	1200	15.98	3,560	1200	17.03	5,860
1200	4.56	131	2400	16.17	3,820	2400	17.02	5,820
1800	5.72	363						
2400	8.38	722	<u>Apr. 25</u>			<u>Apr. 30</u>		
			1200	16.55	4,480	1130	17.05	5,960
<u>Apr. 7</u>			2400	16.74	4,920	2400	17.02	5,820
0600	10.56	899						
1200	12.55	1,000	<u>Apr. 26</u>			<u>May 1</u>		
1800	13.77	1,350	1200	16.87	5,280	1200	16.96	5,580
2400	14.83	1,720	2400	16.90	5,370	2400	16.90	5,370
<u>Apr. 8</u>			<u>Apr. 27</u>			<u>May 2</u>		
0600	15.42	2,090	1200	16.95	5,540	1200	16.81	5,100
1200	15.84	2,480	2400	16.97	5,620	2400	16.74	4,920
1800	15.85	2,490						
2400	16.00	2,580						

(86) 5-1205. Wintering River near Karlsruhe, N. Dak.

Location.--Lat 48°10'14", long 100°32'20", on line between secs.10 and 11, T.154 N., R.77 W., on left bank 30 ft upstream from highway bridge, 4 miles upstream from mouth, and 7 miles northeast of Karlsruhe.

Drainage area.--705 sq mi, of which about 420 sq mi is noncontributing.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,480 ft from river-profile map.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 4-12.

Maxima.--April-May 1969: Discharge, 1,480 cfs 1150 hours Apr. 11 (gage height, 10.12 ft, backwater from ice).

1937 to March 1969: Discharge, 3,000 cfs Apr. 7, 1949, by velocity-area studies (gage height, 12.0 ft, channel choked by packed snow).

Remarks.--Flow regulated by Fish and Wildlife Service dam on Cottonwood and

Wintering River near Karlsruhe, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	May	Day	April	May	Day	April	May
1...	0	54	11...	920	32	21...	194	15
2...	0	48	12...	1,170	30	22...	164	15
3...	0	42	13...	1,080	27	23...	144	14
4...	.50	42	14...	864	24	24...	131	13
5...	1.2	45	15...	684	22	25...	117	12
6...	2.0	45	16...	524	21	26...	101	11
7...	3.8	40	17...	403	20	27...	90	10
8...	15	37	18...	338	20	28...	77	10
9...	35	34	19...	293	18	29...	63	9.2
10...	270	32	20...	238	17	30...	56	8.8
						31...	--	8.4
Monthly mean discharge, in cubic feet per second							266	25.0
Runoff, in acre-feet							15,820	1,540

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 9</u>			<u>Apr. 11</u>			<u>Apr. 13</u>		
2400	6.98	76	0700	7.97	510	0600	8.76	1,130
			0900	9.53	1,080	1200	8.67	1,080
<u>Apr. 10</u>			1150	10.12	1,480	2400	8.49	970
0600	6.77	68	1200	10.09	1,450			
1000	6.60	63	1800	9.49	1,150	<u>Apr. 14</u>		
1200	7.74	200	2400	9.16	1,040	1200	8.28	855
1700	8.34	631				2400	8.12	775
2400	7.34	340	<u>Apr. 12</u>					
			0600	9.03	1,180	<u>Apr. 15</u>		
<u>Apr. 11</u>			1200	8.96	1,200	1200	7.91	680
0500	7.19	304	2400	8.82	1,170	2400	7.71	599

Location.--Lat 48°30'20", long 100°26'04", in SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.14, T.158 N., R.76 W., on left bank 200 ft upstream from Nelson bridge, 8 miles east of Bantry, 18 miles upstream from Willow Creek, and at mile 284.8 downstream from Canadian border.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,427.56 ft above mean sea level, datum of 1929, Emerson-Crookston Supplementary Adjustment of 1941.

Maxima.--April-May 1969: Discharge 5,660 cfs 2200 hours May 4 (gage height, 13.80 ft).

1937 to March 1969: Discharge, 4,760 cfs Apr. 13, 1949 (gage height, 13.76 ft, from floodmark).

Remarks.--Flow regulated by reservoirs on Souris, Des Lacs, and Wintering Rivers (combined capacity, about 249,000 acre-feet).

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1969								
Day	April	May	Day	April	May	Day	April	May
1...	2.8	4,620	11...	450	4,060	21...	2,990	2,550
2...	3.5	4,940	12...	905	3,980	22...	2,970	2,450
3...	4.6	5,110	13...	1,070	3,790	23...	2,940	2,330
4...	35	5,300	14...	1,200	3,640	24...	2,880	2,190
5...	30	5,430	15...	1,380	3,530	25...	2,730	2,060
6...	25	5,140	16...	1,630	3,330	26...	2,580	2,020
7...	20	4,920	17...	2,110	3,260	27...	2,510	1,990
8...	20	4,560	18...	2,510	3,130	28...	2,910	1,860
9...	22	4,260	19...	2,730	2,910	29...	3,420	1,810
10...	100	4,140	20...	2,800	2,710	30...	3,970	1,720
						31...	--	1,620
Monthly mean discharge, in cubic feet per second							1,565	3,399
Runoff, in acre-feet							93,120	209,000

RED RIVER OF THE NORTH BASIN

Souris (Mouse) River near Bantry, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 9</u>			<u>Apr. 14</u>			<u>May 2</u>		
2400	4.26	40	1200	10.72	1,190	1200	13.75	4,910
			2400	11.12	1,290	2400	13.76	5,080
<u>Apr. 10</u>			<u>Apr. 15</u>			<u>May 3</u>		
0600	4.74	60	1200	11.45	1,380	1200	13.76	5,120
1200	4.89	70	2400	11.73	1,460	2400	13.74	5,120
1800	5.70	120						
2400	6.78	210	<u>Apr. 16</u>			<u>May 4</u>		
			1200	12.13	1,610	1200	13.74	5,180
<u>Apr. 11</u>			2400	12.54	1,850	1800	13.79	5,470
0600	7.70	310				2200	13.80	5,660
1200	8.40	390	<u>Apr. 29</u>			2400	13.79	5,610
1800	9.44	530	2400	13.33	3,670			
2400	10.26	730				<u>May 5</u>		
			<u>Apr. 30</u>			1200	13.75	5,420
<u>Apr. 12</u>			1200	13.44	3,970	2400	13.72	5,280
0600	10.69	880	2400	13.59	4,280			
1200	10.66	920				<u>May 6</u>		
1800	10.54	950	<u>May 1</u>			1200	13.68	5,090
2400	10.45	1,010	1200	13.69	4,660	2400	13.68	5,090
			2400	13.74	4,870			
<u>Apr. 13</u>						<u>May 7</u>		
1200	10.33	1,070				1200	13.64	4,910
2400	10.47	1,130				2400	13.61	4,780

Location.--Lat 48°35'20", long 100°26'30", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.23, T.159 N., R.76 W., on left bank 50 ft downstream from bridge on county road, $1\frac{1}{2}$ miles upstream from Snake Creek, and 7 miles west of Willow City.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,430 ft (from topographic map).

Maxima.--April 1969: Discharge 5,900 cfs 0700 hours Apr. 12 (gage height, 16.76 ft).
1957 to March 1969: Discharge, 1,190 cfs Apr. 9, 1960 (gage height, 14.03 ft).

A discharge of 1,340 cfs occurred Apr. 20, 1956 at site 1½ miles downstream below Snake Creek (computed from rating curve extended above 1,220 cfs.

[illegible]

RED RIVER OF THE NORTH BASIN

Willow Creek near Willow City, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 9</u>			<u>Apr. 11</u>			<u>Apr. 12</u>		
2400	10.88	120	0600	15.27	2,430	2400	16.48	4,520
			1200	15.96	4,150			
<u>Apr. 10</u>			1800	16.49	5,730	<u>Apr. 13</u>		
0400	11.06	120	2400	16.67	5,870	1200	16.23	3,900
1600	10.39	120				2400	16.01	3,400
1800	10.69	200	<u>Apr. 12</u>					
2000	11.45	300	0700	16.76	5,900	<u>Apr. 14</u>		
2200	13.00	800	1200	16.70	5,250	1200	15.75	2,890
2400	14.18	1,180	1800	16.60	4,850	2400	15.66	2,710

(89) 5-1235.1. Deep River near Upham, N. Dak.

Location.--Lat 48°35'03", long 100°51'44", in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.22, T.159 N., R.79 W., 0.8 mile downstream from Little Deep River and 6.3 miles west of Upham.

Drainage area.--975 sq mi, of which 605 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,430 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 8-10.

Maxima.--April 1969: Discharge, 6,760 cfs 1600 hours Apr. 12 (gage height, 18.18 ft).

1958 to March 1969: Discharge, 580 cfs Apr. 5, 1960 (gage height, 10.90 ft).

Flood in April 1951 reached a stage of about 16 ft, from information by a local resident.

RED RIVER OF THE NORTH BASIN

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Deep River near Upham, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8.....	30	15.....	2,710	23.....	457
2.....	0	9.....	110	16.....	2,100	24.....	374
3.....	0	10.....	650	17.....	1,660	25.....	292
4.....	0	11.....	3,350	18.....	1,280	26.....	223
5.....	0	12.....	5,700	19.....	933	27.....	171
6.....	0	13.....	5,050	20.....	648	28.....	143
7.....	0	14.....	3,740	21.....	634	29.....	127
				22.....	542	30.....	119
Monthly mean discharge, in cubic feet per second.....							1,035
Runoff, in acre-feet							61,570

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 12</u>		
2400	3.55	0	0300	8.93	130	0600	17.53	4,910
			0800	9.37	200	1200	17.88	5,840
<u>Apr. 8</u>			1200	10.95	450	1600	18.18	6,760
1400	3.58	0	1500	12.40	800	2400	17.93	5,990
1500	7.00	0	1800	13.38	1,230			
1600	9.08	0	2400	14.01	1,500	<u>Apr. 13</u>		
1700	9.80	5				1200	17.54	4,940
1800	10.06	100	<u>Apr. 11</u>			2400	17.27	4,340
2400	10.10	115	0300	14.21	1,600			
			0600	15.23	2,170	<u>Apr. 14</u>		
<u>Apr. 9</u>			0900	16.38	3,060	1200	16.92	3,730
1400	9.73	100	1200	17.01	3,880	2400	16.47	3,150
1700	9.91	120	1800	17.32	4,440			
2400	9.10	110	2400	17.36	4,530	<u>Apr. 15</u>		
						1200	15.95	2,680
						2400	15.49	2,340

(90) 5-1235.2. Egg Creek near Glenburn, N. Dak.

(Crest-stage station)

Location.--Lat 48°29'15", long 101°24'15", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.21, T.158 N., R.83 W., at culvert on county highway 8 $\frac{1}{2}$ miles west of Glenburn.

Drainage area.--20.9 sq mi, of which 13.9 sq mi is probably noncontributing.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 50 cfs and by indirect measurement at 165 cfs.

Maxima.--April-May 1969: Discharge, 165 cfs April (gage height, 5.19 ft).
1955 to March 1969: Discharge, 75 cfs April 1956 (gage height, 4.59 ft).

(91) 5-1235.4. Egg Creek near Ruthville, N. Dak.

(Crest-stage station)

Location.--Lat 48°26'25", long 101°17'55", in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.8, T.157 N., R.82 W., at bridge on U.S. Highway 83, 4.7 miles north of Ruthville.

Drainage area.--108.4 sq mi, of which 82.0 sq mi is probably noncontributing.

Gage-height record.--Crest-stage only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 260 cfs and extended above by logarithmic plotting.

Maxima.--April-May 1969: Discharge, 600 cfs April (gage height, 4.28 ft);
gage height, 4.70 ft Apr. 5 (backwater from ice).
1955 to March 1969: Discharge, 430 cfs June 1963 (gage height, 2.62 ft, former datum).

(92) 5-1235.6. Egg Creek tributary near Deering, N. Dak.

(Crest-stage station)

Location.--Lat 48°22'15", long 101°09'10", in SE $\frac{1}{4}$ sec.32, T.157 N., R.81 W., at culvert on county highway, 5 miles southwest of Deering.

Drainage area.--4.25 sq mi, of which 0.75 sq mi is probably noncontributing.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April-May 1969: Discharge, 14 cfs April (gage height, 4.75 ft, backwater from snow).

1955 to March 1969: Discharge, 25 cfs June 1963 (gage height, 2.77 ft).

(93) 5-1235.8. Egg Creek near Deering, N. Dak.

(Crest-stage station)

Location.--Lat 48°20'35", long 101°07'20", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.7, T.156 N., R.81 W., at culvert on county highway 5 miles southwest of Deering.

Drainage area.--132.0 sq mi, of which 91.2 sq mi is probably noncontributing.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 100 cfs and extended above by indirect measurement at 430 cfs.

Maxima.--April-May 1969: Discharge, 430 cfs April (gage height, 7.50 ft).

1955 to March 1969: Discharge, 118 cfs March 1963 (gage height, 5.42 ft).

Location.--Lat 48°21'18", long 100°49'19", on west line of sec.10, T.156 N., R.79 W., on right downstream wingwall of bridge, 2 miles downstream from Hay Coulee, 3.5 miles upstream from North Lake, and 6 miles northeast of Granville.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,478.14 ft above mean sea level, datum of 1929 (levels by Bureau of Reclamation).

Maxima.--April 1969: Discharge 1,710 cfs 1400 hours Apr. 10 (gage height, 7.28 ft).
1957 to March 1969: Discharge, 258 cfs Mar. 28, 1960 (gage height, 5.44 ft).

[illegible]

Egg Creek near Granville, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 11</u>		
2400	2.86	0	1800	6.34	892	1000	6.90	1,370
			2400	6.55	1,060	1600	6.76	1,240
<u>Apr. 8</u>						1800	6.82	1,300
1900	3.24	0	<u>Apr. 10</u>			2400	6.74	1,230
2000	4.21	0	0400	6.64	1,140			
2200	6.86	10	0800	6.90	1,370	<u>Apr. 12</u>		
2400	7.21	20	1200	7.26	1,690	1200	6.60	1,100
			1400	7.28	1,710	2400	6.42	956
<u>Apr. 9</u>			1600	7.24	1,680			
0600	8.10	700	2000	7.14	1,590	<u>Apr. 13</u>		
1200	6.27	836	2400	7.04	1,500	1200	6.28	844
						2400	6.17	756

(95) 5-1237. Cutbank Creek at North Lake Outlet near Granville, N. Dak.

Location.--Lat 48°23'10", long 100°46'00", on south line of sec.29, T.157 N., R.78 W., on right downstream wingwall of bridge, 9 miles northeast of Granville and 13.5 miles east of Deering.

Drainage area.--534 sq mi, of which about 290 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph except Apr. 11-13. Datum of gage is 1,477.25 ft above mean sea level, datum of 1929 (levels by Bureau of Reclamation).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Discharge Apr. 11-13 estimated from adjacent record and records for Egg Creek near Granville.

Maxima.--April 1969: Discharge, 339 cfs 1500 hours Apr. 14 (gage height, 3.78 ft).
1957 to March 1969: Discharge, 1.0 cfs Apr. 13, 1960 (gage height, 0.62 ft).

Remarks.--Flow affected by storage in Buffalo Lodge Lake and North Lake.

Cutbank Creek at North Lake Outlet near Granville, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8.....	0	15.....	308	23.....	149
2.....	0	9.....	0	16.....	278	24.....	138
3.....	0	10.....	0	17.....	259	25.....	116
4.....	0	11.....	10	18.....	242	26.....	93
5.....	0	12.....	50	19.....	212	27.....	97
6.....	0	13.....	200	20.....	191	28.....	99
7.....	0	14.....	334	21.....	169	29.....	90
				22.....	160	30.....	79
Monthly mean discharge, in cubic feet per second.....							109
Runoff, in acre-feet							6,490

(96) 5-1239. Boundary Creek near Landa, N. Dak.

Location.--Lat 48°48'46", long 100°51'46", at west line of sec.26, T.162 N., R.79 W., on right bank 80 ft downstream from bridge on county road 5 miles upstream from mouth and 6 miles southeast of Landa.

Drainage area.--230 sq mi, of which about 60 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,420.03 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1-9.

Maxima.--April 1969: Discharge, 3,580 cfs 1630 hours Apr. 9 (gage height, 12.70 ft).
1958 to March 1969: Discharge, 660 cfs Mar. 30, 1960 (gage height, 10.22 ft).

RED RIVER OF THE NORTH BASIN

315

Boundary Creek near Landa, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8....	30	15....	562	23....	83
2.....	0	9....	2,150	16....	458	24....	68
3.....	0	10....	2,690	17....	369	25....	57
4.....	0	11....	1,320	18....	263	26....	51
5.....	0	12....	964	19....	180	27....	45
6.....	0	13....	779	20....	152	28....	38
7.....	1.0	14....	652	21....	125	29....	42
				22....	102	30....	31
Monthly mean discharge, in cubic feet per second.....							374
Runoff, in acre-feet							22,240

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 9</u>			<u>Apr. 11</u>		
2400	7.39	7.0	0800	11.86	2,040	0300	11.48	1,520
			1000	12.23	2,670	0600	11.38	1,420
<u>Apr. 8</u>			1300	12.15	2,530	1200	11.18	1,270
0500	7.44	5.0	1600	12.65	3,480	2400	10.85	1,080
0800	7.81	13	1630	12.70	3,580			
1500	7.50	17	1900	12.40	2,980	<u>Apr. 12</u>		
1800	8.79	67	2400	12.61	3,400	0600	10.65	985
2400	8.30	80				1200	10.51	929
			<u>Apr. 10</u>			1800	10.57	953
<u>Apr. 9</u>			0300	12.59	3,360	2400	10.42	897
0400	7.81	88	1200	12.22	2,660			
0500	8.91	300	1800	12.02	2,300	<u>Apr. 13</u>		
0600	10.86	1,080	2400	11.73	1,840	1200	10.01	763
						2400	9.78	694

(International gaging station)

Remarks.--Flow regulated by dams on Souris River and tributaries (combined capacity, about 321,000 acre-feet).

Mean discharge, in cubic feet per second, 1901								
Day	April	May	Day	April	May	Day	April	May
1...	20	5,020	11...	1,600	5,050	21...	5,240	4,430
2...	19	4,860	12...	2,330	5,100	22...	6,200	4,350
3...	18	4,810	13...	2,900	5,080	23...	6,200	4,230
4...	14	4,770	14...	3,620	5,020	24...	6,000	4,120
5...	12	4,730	15...	4,320	4,940	25...	5,760	4,030
6...	10	4,760	16...	4,910	4,800	26...	5,600	3,960
7...	6.0	4,800	17...	5,240	4,760	27...	5,460	3,850
8...	8.0	4,860	18...	5,040	4,710	28...	5,360	3,670
9...	250	4,980	19...	4,860	4,580	29...	5,260	3,570
10...	850	5,060	20...	4,960	4,530	30...	5,150	3,510
						31...	--	3,350
Monthly mean discharge, in cubic feet per second							3,241	4,525
Runoff, in acre-feet							192,800	278,300

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Location.--Lat 47°40'25", long 92°54'00", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.20, T.60 N., R.20 W., on left bank 1,000 ft upstream from highway bridge, 0.6 mile downstream from East Branch Sturgeon River, and 11 $\frac{1}{2}$ miles north of Chisholm.

Gage-height record.---Water-stage recorder graph, except 1200 hours Apr. 28 to 0400 hours Apr. 29 for which graph was reconstructed on basis of shape of adjacent record. Datum of gage is 1306.7 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 2,200 cfs 0400 hours April 15 (gage height, 5.55 ft).
1942 to March 1969: Discharge 3,630 cfs May 7, 1950 (gage height, 6.41 ft).

[illegible]

LAKE OF THE WOODS BASIN

Sturgeon River near Chisholm, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 9</u>			<u>Apr. 13</u>			<u>Apr. 17</u>		
2400	2.67	446	0300	4.77	1,609	0600	4.85	1,665
			0600	4.81	1,637	1200	4.72	1,574
<u>Apr. 10</u>			1200	4.90	1,700	2400	4.50	1,420
0600	2.72	465	1400	4.97	1,749			
1200	2.85	518	1800	5.12	1,856	<u>Apr. 18</u>		
1800	3.07	619	2400	5.26	1,968	1200	4.26	1,276
2400	3.20	683				2400	4.07	1,162
			<u>Apr. 14</u>					
<u>Apr. 11</u>			0600	5.34	2,032	<u>Apr. 19</u>		
0600	3.27	718	1500	5.43	2,104	1200	3.88	1,048
0800	3.30	733	2000	5.50	2,160	2400	3.73	962
1200	3.62	901	2400	5.53	2,187			
1300	3.57	874				<u>Apr. 20</u>		
1600	3.68	934	<u>Apr. 15</u>			1200	3.61	896
2100	3.88	1,048	0400	5.55	2,205	2400	3.59	884
2400	3.92	1,072	1200	5.49	2,152			
			2000	5.45	2,120	<u>Apr. 21</u>		
<u>Apr. 12</u>			2400	5.42	2,096	1200	3.54	857
0300	3.94	1,084				2400	3.48	825
0800	3.98	1,108	<u>Apr. 16</u>					
1500	4.30	1,300	0300	5.38	2,064	<u>Apr. 22</u>		
1800	4.46	1,396	1200	5.23	1,944	1200	3.42	793
2100	4.62	1,504	1800	5.12	1,856	2400	3.38	773
2400	4.70	1,560	2400	4.99	1,763			

Location.--Lat 48°24', long 93°34', in NW $\frac{1}{4}$ sec.9, T.68 N., R.25 W., on left bank 100 ft downstream from highway bridge at town of Littlefork, 0.3 mile downstream from bridge on State Highway 217, 1 $\frac{1}{2}$ miles upstream from Beaver Creek, and 18 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,073.06 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 20,600 cfs 1200 hours Apr. 17 (gage height, 32.61 ft).
1910-17, 1929 to March 1969: Discharge, 25,000 cfs Apr. 18, 1916, May 11, 1950 (gage height, 37.00 ft).

Mean discharge, in cubic feet per second, 1900							
Day	April	Day	April	Day	April	Day	April
1.....	305	8....	640	15....	18,600	23....	7,820
2.....	300	9....	1,820	16....	20,000	24....	7,000
3.....	298	10....	3,500	17....	20,600	25....	6,200
4.....	300	11....	6,700	18....	19,700	26....	5,570
5.....	310	12....	9,110	19....	17,500	27....	5,190
6.....	320	13....	13,400	20....	13,900	28....	4,770
7.....	360	14....	16,800	21....	10,400	29....	4,280
				22....	8,770	30....	3,820
Monthly mean discharge, in cubic feet per second.....							7,609
Runoff, in inches							4.91

Little Fork River at Littlefork, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 7</u>			<u>Apr. 13</u>			<u>Apr. 18</u>		
2400	9.20		1400	26.73		0400	32.28	20,200
			1600	28.13		0800	32.11	20,000
<u>Apr. 8</u>			1700	28.28		1200	31.91	19,800
0800	9.50		1900	28.63		1800	31.55	19,400
1600	10.18		2100	29.19		2400	31.13	18,900
2400	11.13		2200	28.98				
			2400	28.76	16,000	<u>Apr. 19</u>		
<u>Apr. 9</u>						0600	30.63	18,300
0800	12.43		<u>Apr. 14</u>			1300	29.96	17,500
1500	13.72		0200	28.75	16,000	2400	28.64	15,900
2400	15.31		0600	28.96	16,300			
			1000	29.23	16,600	<u>Apr. 20</u>		
<u>Apr. 10</u>			1800	29.74	17,200	1100	26.95	14,100
0900	16.64		2400	30.16	17,700	1800	25.80	12,800
1800	18.35					2400	24.86	11,900
2400	19.47		<u>Apr. 15</u>					
			0600	30.56	18,200	<u>Apr. 21</u>		
<u>Apr. 11</u>			1300	30.99	18,700	0600	23.96	11,000
0600	19.95		2400	31.55	19,400	1600	22.88	9,940
1200	20.33					2400	22.24	9,370
1800	20.83		<u>Apr. 16</u>					
2400	21.75		1100	32.05	20,000	<u>Apr. 22</u>		
			1800	32.32	20,300	0800	21.73	8,920
<u>Apr. 12</u>			2400	32.48	20,500	1600	21.32	8,580
0600	22.37					2400	20.92	8,260
1200	22.75		<u>Apr. 17</u>					
1800	23.73		0600	32.57	20,600	<u>Apr. 23</u>		
2400	24.61		1200	32.61	20,600	0800	20.57	7,980
			1600	32.57	20,600	1200	20.37	7,820
<u>Apr. 13</u>			2000	32.53	20,600	2000	19.99	7,520
0600	25.92		2400	32.42	20,400	2400	19.82	7,400
1100	26.92							

Location.--Lat 48°12', long 93°48', in sec.35, T.155 N., R.25 W., on left bank at village of Big Falls, 700 ft downstream from falls, 0.3 mile downstream from bridge on U. S. Highway 71, and 4 3/4 miles upstream from Sturgeon River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,144.71 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 13,300 cfs 0300 hours Apr. 16 (gage height, 15.79 ft).
1910-12, 1929 to March 1969: Discharge, 14,800 cfs May 8, 9, 1950; gage height, 17.08 ft May 8, 1950.

Mean discharge, in cubic feet per second, 1900							
Day	April	Day	April	Day	April	Day	April
1.....	338	8....	540	15....	12,500	23....	4,940
2.....	333	9....	760	16....	13,100	24....	4,520
3.....	328	10....	1,270	17....	11,800	25....	4,110
4.....	325	11....	2,010	18....	10,200	26....	3,760
5.....	330	12....	3,450	19....	8,540	27....	3,480
6.....	340	13....	6,100	20....	7,010	28....	3,200
7.....	400	14....	10,800	21....	5,940	29....	2,980
				22....	5,360	30....	2,780
Monthly mean discharge, in cubic feet per second.....							4,385
Runoff, in inches							3.35

LAKE OF THE WOODS BASIN

Big Fork River at Big Falls, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 10</u>			<u>Apr. 13</u>			<u>Apr. 17</u>		
2400	7.63		1400	11.23		0400	15.08	12,400
			1600	12.17		1600	14.35	11,600
<u>Apr. 11</u>			1900	12.31		2400	13.90	11,000
0600	7.91		2000	12.42	9,320			
1000	7.94		2400	12.93	9,900	<u>Apr. 18</u>		
1200	7.79					0800	13.43	10,500
1400	7.78		<u>Apr. 14</u>			1800	12.78	9,730
1600	7.45		0400	13.45	10,500	2400	12.44	9,340
1800	7.45		0800	13.63	10,700			
2400	7.69		1200	13.65	10,700	<u>Apr. 19</u>		
			1600	13.79	10,900	0600	12.10	8,950
<u>Apr. 12</u>			2000	14.01	11,100	1400	11.63	8,410
0600	7.93		2400	14.33	11,500	1800	11.38	8,120
0800	7.99					2400	11.04	7,730
1000	7.90		<u>Apr. 15</u>					
1400	8.52		0400	14.65	11,900	<u>Apr. 20</u>		
1600	7.67		1000	15.11	12,500	0600	10.71	7,350
2000	8.22		1600	15.46	12,900	1800	10.11	6,660
2200	8.17		2400	15.75	13,200	2400	9.85	6,360
2400	8.44							
			<u>Apr. 16</u>			<u>Apr. 21</u>		
<u>Apr. 13</u>			0300	15.79	13,300	0600	9.65	6,130
0200	8.56		1000	15.74	13,200	1400	9.40	5,840
0400	8.89		1600	15.58	13,000	2400	9.18	5,590
0800	9.23		2000	15.44	12,900			
1000	10.18		2400	15.26	12,600	<u>Apr. 22</u>		
1200	9.94					1000	9.01	5,400
						2400	8.79	5,140

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Location.--Lat 48°38'04", long 93°54'47", in sec.36, T.160 N., R.26 W., on left bank at Manitou Rapids, 3½ miles east of Manitou Post Office, and 4 miles west of Indus.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,062.48 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 58,300 cfs 0630 hours Apr. 18 (gage height, 18.37 ft).
1929 to March 1969: Discharge, 71,600 cfs May 12, 1950 (gage height, 21.04 ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

Rainy River at Manitou Rapids, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 14</u>			<u>Apr. 19</u>		
2400	6.43	13,100	0400	13.37	35,500	0400	18.02	56,700
			1000	14.53	40,600	1200	17.80	55,600
<u>Apr. 9</u>			1200	14.79	41,400	1800	17.58	54,500
0600	6.69	13,800	1600	15.13	43,300	2400	17.34	53,400
1200	6.88	14,300	2000	15.37	44,300			
1400	6.96	14,600	2400	15.58	45,200	<u>Apr. 20</u>		
2400	7.59	16,300				0600	17.08	52,100
			<u>Apr. 15</u>			1600	16.59	49,900
<u>Apr. 10</u>			0400	15.74	46,000	2400	16.17	48,000
1000	8.01	17,500	1200	15.97	47,000			
1400	8.26	18,200	1800	16.17	48,000	<u>Apr. 21</u>		
2000	8.79	19,700	2400	16.70	50,400	0800	15.75	46,000
2400	9.06	20,500				1400	15.37	44,300
			<u>Apr. 16</u>			2400	15.00	42,700
<u>Apr. 11</u>			0600	17.03	51,900			
0400	9.23	21,000	1600	17.53	54,300	<u>Apr. 22</u>		
1400	9.67	22,300	2400	17.86	55,900	1000	14.58	40,800
2000	10.04	23,400				1600	14.41	40,100
2400	10.25	24,100	<u>Apr. 17</u>			2400	14.19	39,100
			0800	18.05	56,800			
<u>Apr. 12</u>			1200	18.11	57,100	<u>Apr. 23</u>		
0400	10.38	24,500	1600	18.19	57,500	0800	14.00	38,300
1600	10.80	25,800	2200	18.33	58,100	1600	13.78	37,300
2400	11.14	27,000	2400	18.32	58,100	2400	13.56	36,300
<u>Apr. 13</u>			<u>Apr. 18</u>			<u>Apr. 24</u>		
0800	11.47	28,100	0200	18.34	58,200	0800	13.37	35,500
1600	11.82	29,300	0630	18.37	58,300	2400	13.05	34,200
2000	12.10	30,300	1200	18.31	58,000			
2400	12.74	32,900	2000	18.18	57,400			
			2400	18.11	57,100			

Location.--Lat 48°32'10", long 94°33'05", in NE $\frac{1}{4}$ sec.1, T.158 N., R.31 W., on left bank 20 ft upstream from bridge on State Highway 72, 1.2 miles downstream from North Branch Rapid River, and 12 miles south of Baudette.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,093.92 ft above mean sea level, datum of 1929 (Minnesota Highway Department bench mark).

Maxima.--April 1969: Discharge, 5,500 cfs 0900 hours Apr. 14 (gage height, 17.86 ft).

1957 to March 1969: Discharge, 5,160 cfs (revised) May 24, 1962 (gage height, 17.13 ft).

Flood of May 11, 1950 reached stage of 21.1 ft (discharge, about 8,500 cfs).

[illegible]

LAKE OF THE WOODS BASIN

Rapid River near Baudette, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 14</u>		
2400	3.39		2000	13.30		0900	17.86	5,500
			2200	13.54		1800	17.82	5,480
<u>Apr. 7</u>			2400	13.64		2400	17.79	5,460
0900	3.41					<u>Apr. 15</u>		
1200	3.47		<u>Apr. 11</u>			0600	17.75	5,440
1800	3.85		0200	13.66		1200	17.72	5,430
2400	4.15		0700	13.60		2400	17.71	5,420
			1300	14.17				
<u>Apr. 8</u>			1800	14.82		<u>Apr. 16</u>		
0600	4.49		2100	14.98		1200	17.57	5,360
1200	4.89		2400	15.20		2400	17.30	5,240
1600	5.44							
2000	6.14		<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	6.76		0300	15.35		1200	16.92	5,060
			0600	15.40		2400	16.44	4,860
<u>Apr. 9</u>			1000	15.29				
0400	7.19		1200	15.54		<u>Apr. 18</u>		
0800	8.13		1400	15.48		1200	15.83	4,610
1200	8.60		1500	15.53		2400	15.16	4,340
1400	9.00		1600	16.17				
1700	9.04		1800	16.40		<u>Apr. 19</u>		
1800	10.24		2200	16.43		1200	14.50	4,080
2000	10.89		2400	16.51		2400	13.90	3,840
2200	11.22							
2400	11.33		<u>Apr. 13</u>			<u>Apr. 20</u>		
			0200	16.61		1200	13.31	3,600
<u>Apr. 10</u>			1200	17.24		2400	12.76	3,380
0200	11.31		1800	17.66				
0800	11.05		2400	17.78	5,460	<u>Apr. 21</u>		
1200	11.51					1200	12.25	3,180
1300	12.08		<u>Apr. 14</u>			2400	11.77	2,990
1600	12.70		0600	17.85	5,500			

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Location.--Lat 47°23'20", long 93°22'50", in NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.27, T.57 N., R.24 W., on left bank 125 ft upstream from highway bridge, 1 $\frac{1}{2}$ miles downstream from outlet of Lawrence Lake and 5 miles north of Taconite.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-3.

1967 to March 1969: Daily discharge, 1,020 cfs Apr. 22, 23, 1967; gage height, 7.96 ft Apr. 23, 1967.

[illegible]

PRAIRIE RIVER BASIN

Prairie River near Taconite, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	4.21	275	0200	7.59	901	1000	11.80	3,250
			0700	7.67	923	1300	11.81	3,260
<u>Apr. 9</u>			1300	7.99	998	2100	11.78	3,240
0400	4.38	299	1700	8.11	1,030	2400	11.76	3,220
0800	4.52	318	2400	8.40	1,130			
1400	4.86	369				<u>Apr. 18</u>		
1900	5.18	421	<u>Apr. 13</u>			0300	11.73	3,200
2400	5.36	450	0700	8.64	1,260	1700	11.62	3,130
			1200	8.82	1,380	2400	11.51	3,060
<u>Apr. 10</u>			1900	9.25	1,640			
0500	5.45	465	2400	9.62	1,870	<u>Apr. 19</u>		
0900	5.56	484				0700	11.38	2,980
1200	5.70	510	<u>Apr. 14</u>			1600	11.24	2,890
1900	6.26	618	0500	9.88	2,040	2400	11.07	2,780
2200	6.42	648	1400	10.35	2,330			
2400	6.45	654	2400	10.77	2,590	<u>Apr. 20</u>		
						0800	10.91	2,680
<u>Apr. 11</u>			<u>Apr. 15</u>			1600	10.75	2,580
0200	6.51	664	1000	11.10	2,800	2400	10.61	2,490
0700	6.63	686	2000	11.36	2,960			
1100	6.88	737	2400	11.46	3,030	<u>Apr. 21</u>		
1300	7.01	788				0800	10.44	2,390
1700	7.25	819	<u>Apr. 16</u>			2400	10.13	2,200
2200	7.48	872	0400	11.51	3,060			
2400	7.57	894	1400	11.68	3,170			
			2400	11.74	3,210			

Location.--Lat $47^{\circ}06'40''$, long $93^{\circ}15'50''$, in SE $\frac{1}{4}$ sec.33, T.54 N., R.23 W., on left bank 75 ft upstream from highway bridge, $1\frac{1}{4}$ miles south of Warba, $3\frac{3}{4}$ miles northwest of Swan River, and 22 miles upstream from mouth.

Gage-height record.--Digital recorder tape punched at 15-minute intervals except 1200 hours to 1600 hours Apr. 11 for which graph was reconstructed on basis of readings before and after this period. Datum of gage is 1,259.80 ft above mean sea level (Minnesota State Highway Department bench mark).

Maxima.--April 1969: Discharge, 1,360 cfs 2300 hours Apr. 15 (gage height, 9.33 ft); gage height, 9.74 ft 1145 hours Apr. 12 (backwater from ice).
1954 to March 1969: Discharge, 1,080 cfs Apr. 17, 1965 (gage height, 9.49 ft, backwater from ice); gage height, 9.53 ft Apr. 16, 1965 (backwater from ice).

Mean discharge, in cubic feet per second, 1969

[illegible]

SWAN RIVER BASIN

Swan River near Warba, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 11</u>			<u>Apr. 18</u>		
2400	4.74		1800	9.22		1200	9.08	1,180
			2000	9.31		2400	9.02	1,130
<u>Apr. 5</u>			2400	9.47		<u>Apr. 19</u>		
1200	4.81		<u>Apr. 12</u>			0800	8.99	1,110
2400	4.93		1000	9.71		1200	8.97	1,090
<u>Apr. 6</u>			1200	9.74		2400	8.92	1,060
1200	5.06		1600	9.69		<u>Apr. 20</u>		
2400	5.24		1800	9.69		1200	8.88	1,030
<u>Apr. 7</u>			2400	9.59		2400	8.86	1,010
1200	5.44		<u>Apr. 13</u>			<u>Apr. 21</u>		
2400	5.86		1200	9.41		1200	8.82	984
<u>Apr. 8</u>			2400	9.27		2400	8.79	964
0600	6.05		<u>Apr. 14</u>			<u>Apr. 22</u>		
1000	6.17		1200	9.24	1,300	0600	8.77	951
2400	6.73		2400	9.26	1,310	1200	8.75	938
<u>Apr. 9</u>			<u>Apr. 15</u>			2400	8.68	898
0800	7.01		1200	9.30	1,340	<u>Apr. 23</u>		
1000	7.07		2300	9.33	1,360	0800	8.64	880
2400	7.54		2400	9.32	1,360	1800	8.56	848
<u>Apr. 10</u>			<u>Apr. 16</u>			2400	8.52	834
1200	7.85		1600	9.30	1,340	<u>Apr. 24</u>		
1600	7.98		2000	9.28	1,320	0200	8.51	830
2000	8.06		2400	9.27	1,320	0400	8.48	821
2400	8.21		<u>Apr. 17</u>			1400	8.40	797
<u>Apr. 11</u>			1200	9.21	1,270	1600	8.38	792
1000	8.64		2400	9.15	1,230	2400	8.32	775

Location.--Lat $46^{\circ}47'$, long $93^{\circ}20'$, in sec.25, T.50 N., R.24 W., on right bank 600 ft downstream from Sandy River, three quarters of a mile northwest of Libby, and at mile 1,106 upstream from Ohio River.

Gage-height record.--Water-stage recorder graph except 2400 hours Mar. 31 to 0600 hours Apr. 1, for which graph was reconstructed on basis of shape of adjacent record. Datum of gage is 1,204.55 ft above mean sea level, adjustment of 1912.

Maxima.--April 1969: Discharge, 9,080 cfs 2200 hours Apr. 20 (gage height, 16.46 ft).
1930 to March 1969: Discharge, 16,000 cfs May 17, 1950 (gage height, 20.02 ft).

Remarks.--Flow regulated by powerplants and Winnibigoshish, Leech, Pokegama, and Sandy Lakes.

[illegible]

Mississippi River below Sandy River near Libby, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 10</u>			<u>Apr. 17</u>			<u>Apr. 23</u>		
2400	10.44	4,700	1200	15.45	8,080	0800	16.13	8,720
			2400	15.68	8,280	1200	16.08	8,670
<u>Apr. 11</u>						1700	16.02	8,610
0400	10.52	4,740	<u>Apr. 18</u>			2400	15.92	8,510
1200	10.68	4,840	1200	15.90	8,490			
2200	11.00	5,020	1800	16.02	8,610	<u>Apr. 24</u>		
2400	11.06	5,060	2400	16.13	8,720	0700	15.82	8,410
						1800	15.66	8,260
<u>Apr. 12</u>			<u>Apr. 19</u>			2400	15.56	8,170
0200	11.12	5,100	0600	16.22	8,810			
1200	11.35	5,230	1200	16.29	8,890	<u>Apr. 25</u>		
2400	11.79	5,490	1800	16.35	8,960	0600	15.44	8,070
			2400	16.39	9,000	1200	15.33	7,970
<u>Apr. 13</u>						1300	15.31	7,960
1200	12.20	5,750	<u>Apr. 20</u>			1400	15.35	7,990
2400	12.66	6,050	0600	16.41	9,020	1600	15.40	8,030
			1800	16.45	9,060	1800	15.42	8,050
<u>Apr. 14</u>			2200	16.46	9,080	2400	15.40	8,030
1200	13.13	6,360	2400	16.46	9,080			
2400	13.60	6,690				<u>Apr. 26</u>		
			<u>Apr. 21</u>			0600	15.36	8,000
<u>Apr. 15</u>			0200	16.45	9,060	1200	15.29	7,940
1200	14.12	7,050	0800	16.44	9,050	1800	15.20	7,870
1800	14.36	7,230	1600	16.43	9,040	2400	15.10	7,790
2400	14.56	7,380	2400	16.38	8,990			
<u>Apr. 16</u>			<u>Apr. 22</u>					
0600	14.74	7,520	0800	16.33	8,930			
1200	14.91	7,640	1600	16.28	8,880			
2400	15.20	7,870	2400	16.20	8,790			

Location.--Lat 46°32'26", long 93°42'26", in W $\frac{1}{2}$ sec.24, T.47 N., R.27 W., at upstream side of highway bridge at north edge of Aitkin, 1 mile downstream from Mud River and at mile 1,055.9 upstream from Ohio River.

Gage-height record.--Water-stage recorder graph for river channel. Datum of gage is 1,182.41 ft above mean sea level, datum of 1929 (levels by Corps of Engineers). For the diversion channel a graph was constructed on the basis of once or twice-daily wire-weight gage readings. Datum of the gage is 1,182.02 ft above mean sea level, datum of 1929.

Remarks.--Slight regulation by powerplants and by Winnibigoshish, Leech, Pokegama, and Sandy Lakes. Water diverted at medium and high stages into Aitkin diversion channel $6\frac{1}{2}$ miles above station, bypasses station and returns to river $15\frac{1}{2}$ miles below station. Diversion began Apr. 2, 1955. These records include flow in diversion channel.

[illegible]

MISSISSIPPI RIVER MAIN STEM

Mississippi River at Aitkin, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 13</u>			<u>Apr. 22</u>		
2400	10.00		1200	14.62	5,790	1200	17.25	7,640
			1800	14.77	5,850	1600	17.28	7,680
<u>Apr. 5</u>			2400	14.87	5,890	2400	17.28	7,680
1200	10.20		<u>Apr. 14</u>			<u>Apr. 23</u>		
2400	10.56		1200	15.11	6,010	0800	17.29	7,700
<u>Apr. 6</u>			2400	15.28	6,090	1200	17.30	7,710
1200	10.90		<u>Apr. 15</u>			1400	17.32	7,740
2400	11.36		1200	15.45	6,180	1900	17.32	7,740
<u>Apr. 7</u>			2400	15.56	6,240	2400	17.32	7,740
1200	11.71		<u>Apr. 16</u>			<u>Apr. 24</u>		
1800	12.05		1200	15.75	6,350	0500	17.31	7,720
2400	12.34		1800	15.84	6,400	1200	17.29	7,700
<u>Apr. 8</u>			2400	15.90	6,440	2400	17.26	7,660
0600	12.56		<u>Apr. 17</u>			<u>Apr. 25</u>		
1200	12.69		0600	15.98	6,490	1200	17.21	7,590
1800	12.82		1200	16.11	6,580	2400	17.11	7,460
2400	12.92		1800	16.18	6,630	<u>Apr. 26</u>		
<u>Apr. 9</u>			2400	16.24	6,670	1200	17.03	7,360
0600	12.97		<u>Apr. 18</u>			1400	17.00	7,320
1900	12.96		0600	16.32	6,720	2400	16.75	7,040
2400	12.96		1800	16.44	6,810	<u>Apr. 27</u>		
<u>Apr. 10</u>			2400	16.49	6,840	1000	16.65	6,960
0500	12.95		<u>Apr. 19</u>			2400	16.50	6,850
1200	12.91		0600	16.54	6,880	<u>Apr. 28</u>		
1800	12.92		1200	16.65	6,960	1300	16.32	6,720
2400	13.02	5,220	2400	16.74	7,030	2400	16.13	6,590
<u>Apr. 11</u>			<u>Apr. 20</u>			<u>Apr. 29</u>		
0600	13.17	5,270	1200	16.85	7,150	1100	15.92	6,450
1800	13.47	5,370	2000	16.94	7,250	2400	15.65	6,290
2400	13.59	5,420	2400	17.01	7,340	<u>Apr. 30</u>		
<u>Apr. 12</u>			<u>Apr. 21</u>			1300	15.35	6,120
0600	13.75	5,470	0400	17.06	7,400	2400	15.10	6,000
1200	13.92	5,530	1200	17.15	7,510			
2400	14.27	5,650						

Mississippi River Diversion near Aitkin, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 13</u>			<u>Apr. 22</u>		
2400	9.37		1200	14.67	4,870	1600	17.57	6,630
			2400	15.02	5,080	2400	17.58	6,640
<u>Apr. 5</u>			<u>Apr. 14</u>			<u>Apr. 23</u>		
1200	9.77		1200	15.14	5,150	0800	17.59	6,640
2400	10.20		2400	15.35	5,280	1200	17.58	6,640
<u>Apr. 6</u>			<u>Apr. 15</u>			1400	17.58	6,640
1200	10.70		1200	15.54	5,390	1900	17.56	6,620
2400	11.27		2400	15.72	5,500	2400	17.55	6,620
<u>Apr. 7</u>			<u>Apr. 16</u>			<u>Apr. 24</u>		
1200	11.94		1200	15.90	5,610	0500	17.54	6,610
1800	12.19		1800	16.00	5,670	1200	17.49	6,580
2400	12.27		2400	16.11	5,740	2400	17.39	6,510
<u>Apr. 8</u>			<u>Apr. 17</u>			<u>Apr. 25</u>		
0600	12.23		0600	16.19	5,780	1200	17.33	6,470
1200	12.05		1200	16.27	5,830	2400	17.17	6,370
1800	11.93		1800	16.39	5,900	<u>Apr. 26</u>		
2400	11.91		2400	16.47	5,950	1200	17.03	6,290
<u>Apr. 9</u>			<u>Apr. 18</u>			1400	16.99	6,260
0600	11.90		0600	16.57	6,010	2400	16.87	6,190
1900	12.02		1800	16.75	6,120	<u>Apr. 27</u>		
2400	12.10		2400	16.82	6,160	1000	16.69	6,080
<u>Apr. 10</u>			<u>Apr. 19</u>			2400	16.52	5,980
0500	12.20		0600	16.89	6,200	<u>Apr. 28</u>		
1200	12.37		1200	16.97	6,250	1400	16.30	5,850
1800	12.55		2400	17.14	6,350	2400	16.07	5,710
2400	12.68		<u>Apr. 20</u>			<u>Apr. 29</u>		
<u>Apr. 11</u>			1200	17.24	6,420	1000	15.87	5,590
0600	12.87		2000	17.30	6,460	2400	15.55	5,400
1800	13.19		2400	17.36	6,490	<u>Apr. 30</u>		
2400	13.37	4,090	<u>Apr. 21</u>			1400	15.21	5,200
<u>Apr. 12</u>			0400	17.37	6,500	2400	14.97	5,050
0600	13.57	4,210	1200	17.47	6,570			
1200	13.77	4,330	2400	17.50	6,580			
2400	14.07	4,510						

Location.--Lat $46^{\circ}39'$, long $94^{\circ}53'$, in sec.32, T.137 N., R.33 W., on right bank 200 ft upstream from highway bridge, 0.2 mile north of Nimrod, and 0.7 mile upstream from Cat River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals. Datum of gage is 1,313.27 ft above mean sea level, datum of 1929 (levels by Wadena County Highway Department from Minnesota Highway Department bench mark).

Maxima.--April 1969: Discharge, 2,200 cfs 1900 hours Apr. 15 (gage height, 5.26 ft).

Remarks.--Flow affected by natural storage in many lakes.

[illegible]

CROW WING RIVER BASIN

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Crow Wing River at Nimrod, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	4.21		1000	4.77	1,760	0600	5.22	2,170
			1400	4.87	1,850	1800	5.25	2,200
<u>Apr. 7</u>			1800	5.06	2,020	1900	5.26	2,200
0600	4.08		2200	5.15	2,100	2000	5.25	2,200
0800	4.05		2400	5.16	2,110	2400	5.25	2,200
1000	3.80							
1400	3.64		<u>Apr. 11</u>			<u>Apr. 16</u>		
1600	3.67		0200	5.16	2,110	1200	5.24	2,180
2200	3.89		0400	5.17	2,120	2400	5.20	2,130
2400	3.92	1,030	0800	5.18	2,130			
			1800	5.22	2,170	<u>Apr. 17</u>		
<u>Apr. 8</u>			2400	5.21	2,160	1200	5.16	2,080
0400	4.01	1,100				2400	5.11	2,020
1000	4.07	1,150	<u>Apr. 12</u>					
1400	4.17	1,240	0600	5.19	2,140	<u>Apr. 18</u>		
2000	4.37	1,410	1400	5.18	2,130	1200	5.05	1,930
2400	4.44	1,470	1800	5.20	2,150	2400	4.99	1,870
			2400	5.19	2,140			
<u>Apr. 9</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
0600	4.49	1,510	1200	5.19	2,140	1200	4.94	1,810
1400	4.64	1,650	2400	5.17	2,120	2400	4.87	1,740
2000	4.86	1,840						
2400	4.93	1,910	<u>Apr. 14</u>			<u>Apr. 20</u>		
			1200	5.18	2,130	1200	4.82	1,700
<u>Apr. 10</u>			2400	5.20	2,150	2400	4.80	1,680
0400	4.92	1,900						
0800	4.75	1,740						

Location.--Lat 46°18'18", long 94°22'38", in SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.30, T.133 N., R.29 W., on left bank at Minnesota Power and Light Company, Sylvan Dam, 4.9 miles southeast of Pillager, and approximately 3.6 miles above mouth.

Discharge record.---Discharge computed by Minnesota Power and Light Company.
Three check measurements made by Geological Survey.

Remarks.--Flow partly regulated by powerplants and Gull Lake. Records prior to Oct. 1, 1968 in files of Geological Survey.

Mean discharge, in cubic feet per second, 1969

[illegible]

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Location.--Lat 45°51'40", long 94°21'30", in lot 2, sec.20, T.39 N., R.32 W., at plant of Minnesota Power and Light Company, 4 miles northwest of Royalton, and 4.5 miles downstream from Swan River, and at mile 956 upstream from Ohio River.

Gage-height record.---Headwater and tailwater gages read hourly by company employees. Readings not reported to Geological Survey.

Maxima.--April 1969: Daily discharge, 32,400 cfs Apr. 14.
1924 to March 1969: Daily discharge, 37,700 cfs Apr. 16, 1965.

Mean discharge, in cubic feet per second, 1969

[illegible]

Location.--Lat $45^{\circ}33'35''$, long $94^{\circ}14'00''$, in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.8, T.124 N., R.28 W., on right bank half a mile northwest of Waite Park, 3 miles west of St. Cloud, and 5 miles upstream from mouth.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 1,034.95 ft above mean sea level, adjustment of 1912.

Maxima.--April 1969: Discharge, 5,300 cfs 1815 hours Apr. 11 (gage height, 7.96 ft).
1909-13, 1929 to March 1969: Discharge, 9,100 cfs Apr. 13, 1965 (gage height, 10.68 ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

SAUK RIVER BASIN

341

Sauk River near St. Cloud, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
2400	3.56		1200	7.05	4,120	1200	7.81	5,100
			2400	7.39	4,560	2400	7.74	5,010
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 14</u>		
1200	3.49		1200	7.66	4,910	1200	7.63	4,870
1800	3.64		2400	7.83	5,130	2400	7.55	4,760
2400	3.80							
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
1200	3.67		1200	7.93	5,260	1200	7.47	4,660
1800	3.88		1815	7.96	5,300	2400	7.36	4,520
2400	4.14		2400	7.96	5,300			
<u>Apr. 7</u>			<u>Apr. 12</u>			<u>Apr. 16</u>		
1200	4.25		0400	7.96	5,300	2400	7.10	4,180
2400	4.81		1200	7.92	5,250	<u>Apr. 17</u>		
			2400	7.86	5,170	2400	6.80	3,810
<u>Apr. 8</u>								
1200	5.64							
2400	6.34	3,260						

(111) Mississippi River at St. Cloud, Minn.

(Miscellaneous site)

Location.--Lat $45^{\circ}35'14''$, long $94^{\circ}10'08''$, in $S\frac{1}{2}$ sec.35, T.125 N., R.28 W., at bridge on State Highway 152, at St. Cloud.

Gage-height record.--Occasional readings obtained by Northern States Power Co. at site of hydro-plant dam 3 miles downstream. Hydro-plant operation discontinued prior to 1969. Elevations are in feet above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 42,900 cfs Apr. 14 (elevation, 982.6 ft pool, 968.8 ft tailwater).

1965 to March 1969: Elevation, 984.9 ft pool, 971.2 ft tailwater, Apr. 14, 1965.

Cooperation.--Elevations and previous maxima furnished by Northern States Power Co. and the Corps of Engineers.

JOHNSON CREEK BASIN

(112) 5-2723. Johnson Creek near St. Augusta, Minn.

(Crest-stage station)

Location.--Lat $45^{\circ}27'49''$, long $94^{\circ}09'19''$, in $NW\frac{1}{4}SW\frac{1}{4}$ sec.13, T.123 N., R.28 W., at bridge on County Highway 7, 1.0 mile south of St. Augusta, and 3.3 miles above mouth.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 532 cfs Apr. 7 (gage height, 14.23 ft).

1964 to March 1969: Discharge, 682 cfs Apr. 12, 1965 (gage height, 14.77 ft).

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Location.--Lat 45°20'02", long 93°40'00", in NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.23, T.33 N., R.27 W., on right bank at upstream side of highway bridge, 4 miles east of Big Lake and 4 miles downstream from St. Francis River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 899.60 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 5,980 cfs 2100 hours Apr. 10 (gage height, 10.08 ft).
1911-17, 1931 to March 1969: Discharge, 7,360 cfs Apr. 16, 1965 (gage height, 10.86 ft).

[illegible]

Elk River near Big Lake, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 12</u>		
2400	2.46	635	0600	7.95	3,460	0600	9.64	5,290
			1200	8.87	4,310	1200	9.48	5,060
<u>Apr. 5</u>			1800	9.34	4,870	1800	9.28	4,790
1200	2.49	645	2400	9.63	5,280	2400	9.07	4,530
1800	2.76	743						
2400	2.84	771	<u>Apr. 10</u>			<u>Apr. 13</u>		
			0600	9.82	5,560	1200	8.60	4,030
<u>Apr. 6</u>			1200	9.97	5,800	2400	8.14	3,610
1200	2.92	800	1800	10.02	5,880			
2400	3.21	908	2100	10.08	5,980	<u>Apr. 14</u>		
			2200	10.08	5,980	1200	7.69	3,260
<u>Apr. 7</u>			2400	10.06	5,950	2400	7.25	2,960
1200	3.49	1,010						
2400	4.02	1,210	<u>Apr. 11</u>					
			0600	10.05	5,930			
<u>Apr. 8</u>			1200	9.99	5,830			
1200	4.90	1,600	1800	9.91	5,710			
2400	6.55	2,510	2400	9.79	5,520			

MISSISSIPPI RIVER MAIN STEM

(114) 5-2755. Mississippi River at Elk River, Minn.
(Gaging station, discontinued 1956)

Location.--Lat 45°18', long 93°34', in SE $\frac{1}{4}$ sec. 34, T.33 N., R.26 W., fourth principal meridian, on left bank in town of Elk River, and at mile 884.6 above Ohio River.

Drainage area.--14,500 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 847.92 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 48,100 cfs Apr. 13 (gage height, 14.28 ft)
1915 to March 1969: Discharge, 62,000 cfs Apr. 16, 1965 (gage height, 17.20 ft, from floodmark).

Cooperation.--Gage-height record furnished by Corps of Engineers.

(115) South Fork Crow River at Hutchinson, Minn.

(Miscellaneous site)

Location.--Lat $44^{\circ}53'44''$, long $94^{\circ}22'08''$, in $SE\frac{1}{4}SW\frac{1}{4}$ sec.31, T.117 N., R.29 W., at State Highways 15 and 22 in Hutchinson, and 6.2 miles upstream from McCuen Creek.

Drainage area.--462 sq mi.

Gage-height record.--Occasional readings of pool and tailwater gages during flood. Elevations are in feet above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 3,100 cfs Apr. 9 (elevation, 1,041.9 ft pool, 1,038.0 ft tailwater).
1965 to March 1969: Discharge, 4,670 cfs Apr. 11, 1965 (elevation, 1,044.10 ft pool, 1,040.44 ft tailwater).

Cooperation.--Elevations furnished by the Corps of Engineers.

(116) 5-2790. South Fork Crow River near Mayer, Minn.

Location.--Lat $44^{\circ}54'20''$, long $93^{\circ}53'05''$, in $SW\frac{1}{4}SW\frac{1}{4}$ sec.30, T.117 N., R.25 W., near center of span on downstream side of bridge on State Highway 7, 1.3 miles north of Mayer, 4.3 miles southwest of Watertown, and 16 miles upstream from confluence with North Fork.

Drainage area.--1,170 sq mi, approximately.

Gage-height record.--Graph constructed on basis of once or twice daily outside gage readings by observer, several engineer's readings and floodmark. Datum of gage is 926.00 ft above mean sea level (levels by Hennepin County Park Board Survey).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-4.

Maxima.--April 1969: Discharge, 9,770 cfs 1000 hours Apr. 11 (gage height, 16.48 ft, from floodmark).
1934 to March 1969: Discharge, 16,100 cfs Apr. 13, 1965 (gage height, 19.23 ft, from floodmark).

South Fork Crow River near Mayer, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	1,400	8....	6,650	15....	5,980	23....	2,630
2.....	1,500	9....	8,120	16....	5,430	24....	2,380
3.....	1,800	10....	9,370	17....	4,960	25....	2,210
4.....	2,600	11....	9,660	18....	4,560	26....	2,050
5.....	3,800	12....	9,040	19....	4,140	27....	2,000
6.....	5,020	13....	8,050	20....	3,650	28....	1,950
7.....	5,900	14....	6,820	21....	3,280	29....	1,920
				22....	2,950	30....	1,850
Monthly mean discharge, in cubic feet per second.....							4,389
Runoff, in inches							4.19

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	8.28		1200	13.73	5,930	1200	16.08	9,060
			2400	14.00	6,200	2400	15.79	8,580
<u>Apr. 2</u>			<u>Apr. 8</u>			<u>Apr. 13</u>		
1200	8.45		1200	14.32	6,550	1200	15.46	8,090
2400	8.72		2400	14.93	7,300	2400	15.02	7,430
<u>Apr. 3</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
1200	9.07		1200	15.48	8,120	1200	14.52	6,780
2400	9.44		2400	16.00	8,920	2400	14.10	6,310
<u>Apr. 4</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
1200	9.95		1200	16.29	9,420	1200	13.77	5,970
2400	10.47	3,210	2400	16.45	9,720	2400	13.48	5,680
<u>Apr. 5</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
1200	11.30	3,790	1000	16.48	9,770	2400	12.98	5,180
2400	12.10	4,400	2400	16.30	9,440			
<u>Apr. 6</u>						<u>Apr. 17</u>		
1200	12.88	5,090				2400	12.50	4,750
2400	13.32	5,520						

(117) South Fork Crow River at Delano, Minn.

(Miscellaneous site)

Location.--Lat $45^{\circ}02'32''$, long $93^{\circ}47'22''$, in $NE\frac{1}{4}SE\frac{1}{4}$ sec.11, T.118 N., R.25 W., at bridge in Delano.

Gage-height record.--Occasional gage readings during high water by Weather Bureau observer. Datum of gage is 904.85 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 9,680 cfs Apr. 11, 12 (gage height, 15.10 ft). 1965 to March 1969: Gage height, 18.40 ft Apr. 13, 1965.

Cooperation.--Gage-height records furnished by the Corps of Engineers and the U.S. Weather Bureau.

(118) 5-2800. Crow River at Rockford, Minn.

Location.--Lat $45^{\circ}05'15''$, long $93^{\circ}44'00''$, in sec.29, T.119 N., R.24 W., on right bank at Rockford, 150 ft downstream from bridge on State Highway 55 and 1 mile downstream from confluence of North and South Forks.

Drainage area.--2,520 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 893.65 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1, 2.

Maxima.--April 1969: Discharge, 15,100 cfs 1700 hours Apr. 13 (gage height, 16.48 ft). 1909-17, 1929 to March 1969: Discharge, 22,400 cfs Apr. 16, 1965 (gage height, 1927 ft, from floodmark).

Crow River at Rockford, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	2,400	8....	8,300	15....	14,100	23....	8,120
2.....	2,300	9....	9,730	16....	13,100	24....	7,500
3.....	2,820	10....	11,400	17....	12,200	25....	6,900
4.....	3,470	11....	13,100	18....	11,400	26....	6,390
5.....	4,460	12....	14,400	19....	10,700	27....	6,080
6.....	5,680	13....	15,000	20....	10,000	28....	5,860
7.....	6,990	14....	14,800	21....	9,370	29....	5,580
				22....	8,740	30....	5,280
Monthly mean discharge, in cubic feet per second.....							8,539
Runoff, in inches							3.78

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 31</u>			<u>Apr. 6</u>			<u>Apr. 12</u>		
2400	6.39		1200	9.45	5,640	1200	16.19	14,500
			2400	10.07	6,290	2400	16.39	14,900
<u>Apr. 1</u>			<u>Apr. 7</u>			<u>Apr. 13</u>		
1200	6.31		1200	10.72	7,000	1700	16.48	15,100
2400	6.04		2400	11.32	7,660	2400	16.47	15,000
<u>Apr. 2</u>			<u>Apr. 8</u>			<u>Apr. 14</u>		
1300	6.11		1200	11.90	8,300	1200	16.33	14,800
2000	6.02		2400	12.49	8,950	2400	16.22	14,500
2400	6.05	2,660						
<u>Apr. 3</u>			<u>Apr. 9</u>			<u>Apr. 15</u>		
0700	6.19	2,770	1200	13.14	9,730	1200	15.98	14,100
1200	6.21	2,790	2400	13.80	10,500	2400	15.73	13,600
2400	6.50	3,020						
<u>Apr. 4</u>			<u>Apr. 10</u>			<u>Apr. 16</u>		
1200	7.04	3,450	1200	14.45	11,500	1200	15.45	13,100
2400	7.64	3,950	2400	15.01	12,300	2400	15.19	12,600
			<u>Apr. 11</u>					
<u>Apr. 5</u>			1200	15.48	13,100			
0900	7.95	4,220	2400	15.84	13,800			
2400	8.95	5,140						

(119) Rum River at West Point, Minn.

(Miscellaneous site)

Location.--Lat $45^{\circ}33'$, long $93^{\circ}24'$, in $SE\frac{1}{4}SE\frac{1}{4}$ sec.36, T.36 N., R.25 W., at bridge on State Highway 47 at West Point, and 8 miles west of Cambridge.

Gage-height record.--Occasional staff gage readings during flood. Datum of staff gage is 899.94 ft above mean sea level, datum of 1929. Datum of crest-stage gage is 921.90 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 8,900 cfs Apr. 10 (gage height, 29.15 ft).
1958 to March 1969: Discharge, 10,800 cfs Apr. 16, 1965 (gage height, 29.38 ft).

Cooperation.--Gage-height readings and previous maxima furnished by Corps of Engineers.

(120) Rum River at Isanti, Minn.

(Miscellaneous site)

Location.--Lat $45^{\circ}29'$, long $93^{\circ}16'$, in $W\frac{1}{2}$ sec.30, T.35 N., R.23 W., at bridge on County Road 5, 0.8 mile west of Isanti.

Gage-height record.--Occasional chain gage readings during flood. Datum of gage is 891.13 ft above mean sea level, datum of 1929. Crest-stage datum is 898.87 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 9,100 cfs Apr. 13 (elevation, 907.46 ft, from crest-stage gage).
1958 to March 1969: Discharge, 9,400 cfs Apr. 19, 1965 (elevation, 907.60 ft, from crest-stage gage).

Cooperation.--Gage readings furnished by Corps of Engineers.

Location.--Lat 45°19'40", long 93°22'20", in SE¹/₄ sec.19, T.33 N., R.24 W., on left bank at upstream side of highway bridge, 4 miles south of St. Francis and 15 3/4 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Datum of gage is 861.12 ft above mean sea level, adjustment of 1912.

Maxima.---April 1969: Discharge, 10,100 cfs 2000 hours Apr. 13 (gage height, 11.63 ft).
1929 to March 1969: Discharge, 10,100 cfs Apr. 20, 1965 (gage height, 11.57 ft).

Remarks.--Occasional regulation by Ogechie (also controls Mille Lacs Lake) and Onamia Lakes.

[illegible]

RUM RIVER BASIN

351

Rum River near St. Francis, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u> 2400	4.45	1,340	<u>Apr. 10</u> 2400	8.70	6,270	<u>Apr. 15</u> 2400	10.80	8,980
<u>Apr. 5</u> 1100	4.56	1,440	<u>Apr. 11</u> 1900	10.06	7,960	<u>Apr. 16</u> 1800	10.25	8,210
2400	4.85	1,720	2000	10.28	8,250	2000	10.03	7,950
			2400	10.52	8,590	2400	9.91	7,950
<u>Apr. 6</u> 0400	4.89	1,760	<u>Apr. 12</u> 1200	11.11	9,410	<u>Apr. 17</u> 2400	9.18	6,940
0900	4.86	1,730	2400	11.44	9,880			
2400	5.20	2,080				<u>Apr. 18</u> 2400	8.48	5,960
<u>Apr. 7</u> 2400	5.62	2,520	<u>Apr. 13</u> 1200	11.59	10,100	<u>Apr. 19</u> 2400	7.83	5,110
			2000	11.63	10,100			
<u>Apr. 8</u> 2400	6.07	3,020	2400	11.62	10,100	<u>Apr. 20</u> 2400	7.33	4,480
<u>Apr. 9</u> 1200	6.37	3,350	<u>Apr. 14</u> 1200	11.53	10,000			
1800	6.57	3,570	2400	11.34	9,740			
2400	6.86	3,910						

Location.--Lat 45°07'36", long 93°17'48", in SW $\frac{1}{4}$ sec.12, T.119 N., R.21 W., on right bank half a mile downstream from Coon Creek, 1 $\frac{1}{2}$ miles downstream from hydroelectric plant of Northern States Power Co. at Coon Rapids, 6 $\frac{1}{2}$ miles downstream from Anoka, and at mile 864.8 upstream from Ohio River.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 805.02 ft above mean sea level, adjustment of 1912.

Maxima.--April 1969: Discharge, 72,500 cfs 0215 hours Apr. 14 (gage height, 16.84 ft).
1931 to March 1969: Discharge, 91,000 cfs Apr. 17, 1965 (gage height, 19.53 ft).

Remarks.--Flow slightly regulated by six reservoirs on headwaters; total usable capacity, 1,640,600 acre ft.

[illegible]

MISSISSIPPI RIVER MAIN STEM

353

Mississippi River near Anoka, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	4.96	11,700	1200	8.53	25,700	1200	16.26	69,100
			2400	9.38	29,900	2400	16.58	71,000
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 13</u>		
1400	5.64	14,200	1200	10.60	36,000	1200	16.75	72,000
2400	5.71	14,400	2400	11.42	40,300	2400	16.83	72,500
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
0600	5.73	14,500	1200	12.29	45,200	0215	16.84	72,500
0800	5.88	15,100	2400	13.40	51,900	1200	16.80	72,300
2400	6.00	15,500				2400	16.75	72,000
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
1400	6.60	17,800	1200	14.13	56,300	1200	16.63	71,300
1800	7.33	20,700	2400	14.79	60,200	2400	16.41	70,000
2400	7.37	20,800	<u>Apr. 11</u>			<u>Apr. 16</u>		
<u>Apr. 6</u>			1200	15.42	64,000	1200	16.13	68,300
0800	7.42	21,000	2400	15.89	66,800	2400	15.79	66,200
2400	7.93	23,100						

(123) 5-2900. Little Minnesota River near Peever, S. Dak.

Location.--Lat $45^{\circ}36'05''$, long $96^{\circ}52'18''$, in SW $\frac{1}{4}$ sec.13, T.125 N., R.50 W., on right bank 2 miles northwest of town of Browns Valley, Minn., $3\frac{1}{4}$ miles upstream from proposed Lake Traverse diversion, 5.3 miles northeast of Peever, $7\frac{1}{4}$ miles downstream from Jorgenson River, and 8 miles upstream from Big Stone Lake.

Drainage area.--447 sq mi.

Gage-height record.--Water-stage recorder graph except 1700 hours Apr. 6 to 0900 hours Apr. 7 for which graph was reconstructed on basis of high-water mark in gage well and adjacent record. Altitude of gage is 1,000 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-4.

Maxima.--April 1969: Discharge, 3,270 cfs 2200 hours Apr. 6 (gage height, 11.31 ft, from floodmark).

1939 to March 1969: Discharge, 4,730 cfs Apr. 8, 1952 (gage height, 12.16 ft); gage height, 13.35 ft Mar. 25, 1943 (from floodmark, backwater from ice).

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0.9	8....	2,880	15....	1,010	23....	295
2.....	2.9	9....	2,910	16....	830	24....	251
3.....	47	10....	2,480	17....	688	25....	208
4.....	1,090	11....	1,980	18....	574	26....	173
5.....	1,370	12....	1,640	19....	480	27....	161
6.....	2,100	13....	1,380	20....	407	28....	176
7.....	2,690	14....	1,240	21....	376	29....	168
				22....	337	30....	147

Monthly mean discharge, in cubic feet per second..... 936

Runoff, in inches..... 2.34

Runoff, in acre-feet..... 55,700

MINNESOTA RIVER BASIN

355

Little Minnesota River near Peever, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 6</u>			<u>Apr. 11</u>		
2400	2.15		0600	7.89	1,660	0500	8.30	2,110
			1100	7.97	1,690	1200	8.07	1,980
<u>Apr. 1</u>			1300	8.15	1,770	1800	7.82	1,870
1200	2.18		1600	9.00	2,160	2400	7.62	1,780
2400	2.27		2200	11.31	3,270			
			2400	11.00	3,100	<u>Apr. 12</u>		
<u>Apr. 2</u>						0600	7.34	1,660
1200	2.33		<u>Apr. 7</u>			0900	7.25	1,620
2400	2.64		0500	10.02	2,610	1200	7.28	1,630
			1100	9.68	2,460	2000	7.24	1,610
<u>Apr. 3</u>			1600	10.06	2,630	2400	7.10	1,550
1200	3.05		1700	10.07	2,640			
1500	3.45		2100	10.61	2,900	<u>Apr. 13</u>		
1700	4.73		2300	10.66	2,930	0300	6.94	1,480
2200	4.36		2400	10.52	2,860	0900	6.74	1,340
2400	8.65					1900	6.65	1,340
			<u>Apr. 8</u>			2400	6.59	1,310
<u>Apr. 4</u>			0600	10.17	2,680			
0100	9.15		0900	10.01	2,660	<u>Apr. 14</u>		
0200	8.25		1200	10.07	2,780	1200	6.43	1,240
0500	5.97		1400	10.08	2,890	1800	6.35	1,210
1200	5.93	832	1900	10.42	3,170	2400	6.16	1,120
2000	9.79	2,510	2400	10.21	3,060			
2400	9.45	2,360				<u>Apr. 15</u>		
			<u>Apr. 9</u>			0400	6.03	1,060
<u>Apr. 5</u>			0500	9.96	2,940	2400	5.72	928
0900	6.17	928	1100	10.06	2,980			
1200	5.68	738	1300	9.89	2,900	<u>Apr. 16</u>		
1300	5.70	745	2400	9.73	2,790	1200	5.46	824
1700	7.06	1,280				2400	5.27	745
2300	8.02	1,710	<u>Apr. 10</u>					
2400	8.02	1,710	0500	9.56	2,700	<u>Apr. 17</u>		
			1400	8.93	2,390	2400	4.96	631
			2400	8.53	2,210			

(124) 5-2910. Whetstone River near Big Stone City, S. Dak.

Location.--Lat $45^{\circ}17'32''$, long $96^{\circ}29'14''$, in $SE\frac{1}{4}NW\frac{1}{4}$ sec.18, T.121 N., R.46 W., on right bank 20 ft downstream from highway bridge, $1\frac{1}{2}$ miles west of Big Stone City, and $4\frac{1}{2}$ miles upstream from Big Stone Lake.

Drainage area.--389 sq mi.

Gage-height record.--Water-stage recorder graph except 1800 hours Apr. 5 to 1600 hours Apr. 6, 0200 hours to 0700 hours Apr. 8, for which graph was reconstructed on basis of adjacent record, high-water mark and records for stations on nearby streams. Datum of gage is 996.96 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-6.

Maxima.--April 1969: Discharge, 6,870 cfs 0400 hours Apr. 8 (gage height, 14.32 ft, from floodmark).

1910-12, 1931 to March 1969: Discharge, 5,710 cfs Apr. 8, 1952 (gage height, 13.64 ft, from floodmark); gage height, 13.95 ft Apr. 11, 1947.

Maximum stage known, about 26 ft in June 1919, present site and datum, from information by local resident.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	2.2	8.....	6,090	15.....	862	23.....	201
2.....	2.2	9.....	4,550	16.....	595	24.....	174
3.....	2.5	10.....	2,820	17.....	460	25.....	161
4.....	3.5	11.....	1,970	18.....	387	26.....	141
5.....	50	12.....	1,550	19.....	337	27.....	142
6.....	1,200	13.....	1,270	20.....	288	28.....	152
7.....	4,710	14.....	1,090	21.....	277	29.....	151
				22.....	243	30.....	137

Monthly mean discharge, in cubic feet per second.....	1,000
Runoff, in inches.....	2.87
Runoff, in acre-feet.....	59,541

MINNESOTA RIVER BASIN

357

Whetstone River near Big Stone City, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	2.37		0100	13.10	5,650	1000	6.79	1,070
			0600	12.52	5,120	2000	6.85	1,100
<u>Apr. 3</u>			1200	11.67	4,350	2400	6.80	1,080
1200	2.42		1800	11.34	4,070			
2400	2.48		2400	10.72	3,580	<u>Apr. 15</u>		
						1200	6.17	840
<u>Apr. 4</u>			<u>Apr. 10</u>			2400	5.69	687
1200	2.59		0600	10.10	3,080			
2400	2.63		1200	9.62	2,740	<u>Apr. 16</u>		
			1800	9.17	2,430	1200	5.39	597
<u>Apr. 5</u>			2100	9.22	2,460	2400	5.04	500
1200	2.57		2400	9.12	2,390			
2400	4.45					<u>Apr. 17</u>		
			<u>Apr. 11</u>			0800	4.87	458
<u>Apr. 6</u>			0600	9.05	2,340	1100	4.91	468
1200	7.20		1200	8.35	1,880	1800	4.81	442
2000	8.55		1800	7.98	1,680	2400	4.77	432
2400	8.75	2,140	2100	7.87	1,620			
			2400	7.84	1,600	<u>Apr. 18</u>		
<u>Apr. 7</u>						1200	4.55	378
0600	10.60	3,480	<u>Apr. 12</u>			2400	4.47	359
1200	12.47	5,070	0600	7.89	1,630			
1800	13.17	5,720	1000	7.71	1,530	<u>Apr. 19</u>		
2200	14.17	6,720	1400	7.77	1,560	1200	4.37	338
2400	14.02	6,570	2400	7.57	1,450	2400	4.25	313
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
0400	14.32	6,870	1200	7.21	1,260	1700	4.07	279
1200	13.15	5,700	2400	6.88	1,110	2400	4.07	279
1500	13.12	5,670						
1700	13.36	5,910						
1900	13.26	5,810						
2100	13.34	5,890						
2300	12.97	5,520						
2400	13.09	5,640						

Location.--Lat 45°17'44", long 96°26'38", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.16, T.121 N., R.46 W., on left bank 400 ft downstream from bridge on U.S. Highway 12 and 1,300 ft downstream from dam at outlet of Big Stone Lake, at Ortonville.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 956.38 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 2,550 cfs 1130 hours Apr. 13 (gage height, 12.09 ft).
1938 to March 1969: Discharge, 3,060 cfs Apr. 13, 1952 (gage height, 12.92 ft).

Remarks.--Flow partly regulated by dam at Big Stone Lake.

Mean discharge, in cubic feet per second, 1969							
Day	April	Day	April	Day	April	Day	April
1.....	109	8....	1,200	15....	2,450	23....	1,870
2.....	103	9....	1,700	16....	2,290	24....	1,940
3.....	99	10....	2,030	17....	2,150	25....	1,830
4.....	111	11....	2,300	18....	2,070	26....	1,760
5.....	123	12....	2,440	19....	1,980	27....	1,750
6.....	344	13....	2,540	20....	1,970	28....	1,650
7.....	759	14....	2,530	21....	1,950	29....	1,500
				22....	1,840	30....	1,370
Monthly mean discharge, in cubic feet per second.....							1,559
Runoff, in acre-feet.....							92,740

MINNESOTA RIVER BASIN

359

Minnesota River at Ortonville, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 13</u>		
2400	3.06	116	0600	9.76	1,090	1130	12.09	2,550
			1200	10.00	1,210	2400	12.08	2,550
<u>Apr. 5</u>			1800	10.16	1,290			
1200	3.10	116	2400	10.23	1,330	<u>Apr. 14</u>		
2400	3.60	148				1200	12.09	2,550
			<u>Apr. 9</u>			1600	12.08	2,550
<u>Apr. 6</u>			0600	10.70	1,610	2000	11.98	2,490
0400	3.71	153	1200	10.93	1,750	2400	11.96	2,480
0800	5.10	278	1800	11.07	1,850			
1600	5.92	376	2400	11.15	1,900	<u>Apr. 15</u>		
2000	7.25	555				1200	11.92	2,460
2400	7.54	598	<u>Apr. 10</u>			1600	11.90	2,450
			1200	11.35	2,130	1800	11.73	2,360
<u>Apr. 7</u>			2400	11.57	2,170	2000	11.85	2,420
0600	8.01	678				2400	11.81	2,400
0800	7.55	597	<u>Apr. 11</u>					
1200	8.29	734	1200	11.80	2,320	<u>Apr. 16</u>		
1400	8.95	866	2400	11.93	2,400	0800	11.77	2,380
1800	8.78	832				1200	11.61	2,300
2400	9.46	997	<u>Apr. 12</u>			1600	11.41	2,200
			1200	11.99	2,440	2400	11.34	2,170
			2400	12.05	2,480			
						<u>Apr. 17</u>		
						1400	11.27	2,140
						1800	11.35	2,180
						2400	11.25	2,125

(126) 5-2930. Yellow Bank River near Odessa, Minn.

Location.--Lat $45^{\circ}13'35''$, long $96^{\circ}21'12''$, in $SE\frac{1}{4}SE\frac{1}{4}$ sec.1, T.120 N., R.46 W., on left bank 150 ft downstream from highway bridge, $2\frac{1}{2}$ miles southwest of Odessa, and $4\frac{1}{2}$ miles upstream from mouth.

Drainage area.--398 sq mi.

Gage-height record.--Water-stage recorder graph except 1600 hours Apr. 8 to 1600 hours Apr. 10 and 1600 hours Apr. 22 to 1200 hours Apr. 24 for which graph was reconstructed on basis of fragmentary gage-height record, high-water mark in gage well and records for nearby stations. Digital recorder tape punched at 15-minute intervals from 1200 hours Apr. 1-29. Datum of gage is 953.34 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-8.

Maxima.--April 1969: Discharge, 6,970 cfs 1200 hours Apr. 9 (gage height, 19.07 ft, from floodmark).

1939 to March 1969: Discharge, 6,260 cfs Apr. 4, 1952 (gage height, 17.06 ft); gage height, 17.98 ft Mar. 25, 1943 (from floodmark, backwater from ice).

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	10	8....	2,500	15....	1,510	23....	374
2.....	13	9....	6,640	16....	1,100	24....	338
3.....	16	10....	5,810	17....	870	25....	304
4.....	20	11....	4,820	18....	725	26....	274
5.....	30	12....	2,910	19....	638	27....	254
6.....	40	13....	2,080	20....	535	28....	244
7.....	100	14....	1,800	21....	495	29....	234
				22....	445	30....	220

Monthly mean discharge, in cubic feet per second.....	1,178
Runoff, in inches.....	3.30
Runoff, in acre-feet.....	70,110

MINNESOTA RIVER BASIN

361

Yellow Bank River near Odessa, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	3.75		0800	6.76		1200	11.65	2,820
			0900	8.05		1800	10.94	2,530
<u>Apr. 4</u>			1000	11.17		2400	10.55	2,370
1200	3.83		1100	13.62				
2400	3.93		1200	15.32		<u>Apr. 13</u>		
			1400	16.89		0900	10.00	2,150
<u>Apr. 5</u>			1600	17.40	5,620	1800	9.41	1,910
0600	3.96		2400	18.50	6,360	2400	9.34	1,890
1300	3.89							
1500	4.02		<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	4.14		0600	18.86	6,740	0600	9.25	1,850
			1200	19.07	6,970	1700	8.95	1,730
<u>Apr. 6</u>			1800	18.70	6,560	2100	8.99	1,750
0600	4.17		2400	18.35	6,230	2400	8.94	1,730
1200	4.14							
1800	4.53		<u>Apr. 10</u>			<u>Apr. 15</u>		
2400	4.81		0600	18.06	6,010	0600	8.68	1,640
			1200	17.70	5,780	1200	8.35	1,520
<u>Apr. 7</u>			1800	17.26	5,540	1800	7.94	1,380
0800	4.87		2400	17.38	5,610	2400	7.58	1,250
1500	4.72							
1600	5.30		<u>Apr. 11</u>			<u>Apr. 16</u>		
1700	6.70		0600	17.16	5,490	0600	7.41	1,190
1800	7.85		1200	16.35	5,040	1200	7.10	1,080
2000	8.16		1800	14.50	4,110	2400	6.68	954
2400	7.74		2400	13.56	3,680			
						<u>Apr. 17</u>		
						2400	6.04	785

MINNESOTA RIVER BASIN

(127) 5-2940. Pomme de Terre River at Appleton, Minn.

Location.--Lat 45°12'10", long 96°01'20", in SW¹₄NW¹₄ sec.14, T.120 N., R.43 W., on left bank at Appleton, 60 ft upstream from bridge on U. S. Highway 59 and State Highway 119, and 8 miles upstream from mouth.

Drainage area.--905 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 978.00 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-10.

Maxima.--April 1969: Discharge, 5,520 cfs 1300 hours Apr. 11 (gage height, 13.78 ft); gage height, 14.58 ft 2100 hours Apr. 9 (backwater from ice).
1931 to March 1969: Discharge, 5,050 cfs Apr. 8, 1952 (gage height, 10.13 ft, site and datum then in use).

Remarks.--Flow affected by lakes above station.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	3.3	8....	43	15....	3,000	23....	1,280
2.....	3.8	9....	2,310	16....	2,580	24....	1,160
3.....	5.4	10....	4,940	17....	2,210	25....	1,100
4.....	6.5	11....	5,210	18....	1,870	26....	1,040
5.....	7.7	12....	3,840	19....	1,670	27....	1,020
6.....	11	13....	3,650	20....	1,580	28....	974
7.....	15	14....	3,390	21....	1,520	29....	930
				22....	1,410	30....	842

Monthly mean discharge, in cubic feet per second..... 1,587
Runoff, in inches..... 1.96
Runoff, in acre-feet..... 94,460

MINNESOTA RIVER BASIN

363

Pomme de Terre River at Appleton, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
2400	3.84		0900	4.28		0600	13.41	5,230
			1600	4.52		1200	13.47	5,280
<u>Apr. 1</u>			2200	4.46		1300	13.78	5,520
0900	3.84		2400	4.50		1800	13.46	5,270
1300	3.98					2400	12.60	4,580
2400	3.88		<u>Apr. 8</u>			<u>Apr. 12</u>		
			0600	4.47		0600	11.97	4,090
<u>Apr. 2</u>			1200	4.73		1200	11.47	3,700
1200	3.90		2300	5.48		1900	11.19	3,490
1600	4.00		2400	6.28		2400	11.28	3,560
2400	3.94		<u>Apr. 9</u>			<u>Apr. 13</u>		
			0100	6.40		0800	11.51	3,730
<u>Apr. 3</u>			0200	5.84		1600	11.41	3,660
0800	3.81		0600	6.18		2400	11.26	3,540
1200	4.06		1200	9.18		<u>Apr. 14</u>		
1700	4.23		1500	13.88		1200	11.03	3,380
2400	4.09		1800	14.53		1800	10.96	3,330
<u>Apr. 4</u>			1900	14.50		2400	10.81	3,230
0800	4.07		2100	14.58		<u>Apr. 15</u>		
1500	4.17		2400	14.40		1200	10.45	2,990
2400	4.09		<u>Apr. 10</u>			2400	10.14	2,790
<u>Apr. 5</u>			0600	13.34		<u>Apr. 16</u>		
1000	4.06		0900	12.96		1200	9.81	2,580
1600	4.29		1200	13.30		2400	9.51	2,380
2400	4.17		1500	13.75		<u>Apr. 17</u>		
<u>Apr. 6</u>			2400	13.52	5,320	1200	9.25	2,210
0900	4.14					2400	8.95	2,030
1500	4.43							
2400	4.30							

(128) 5-3000. Lac qui Parle River near Lac qui Parle, Minn.

Location.--Lat 45°00', long 95°55', in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.27, T.118 N., R.42 W., on right bank 40 ft downstream from highway bridge and half a mile southwest of village of Lac qui Parle.

Drainage area.--983 sq mi.

Gage-height record.--Water-stage recorder graph Apr. 1-9. The graph for Apr. 10-18 was reconstructed on basis of once-daily or more wire-weight gage readings and high-water mark in gage well. Digital recorder tape punched at 15-minute intervals Apr. 19-30. Datum of gage is 951.98 ft above mean sea level (Minnesota Highway Department bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-8.

Maxima.--April 1969: Discharge, 17,100 cfs 1100 hours Apr. 10 (gage height, 18.94 ft).

1910-14, 1931 to March 1969: Discharge, 11,100 cfs Apr. 6, 1952 (gage height, 18.18 ft); gage height, 19.37 ft Apr. 9, 1965 (from floodmark, backwater from ice).

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	7.0	8....	850	15....	6,220	23....	1,610
2.....	7.5	9....	9,960	16....	5,100	24....	1,400
3.....	15	10....	16,000	17....	4,300	25....	1,190
4.....	20	11....	14,200	18....	3,550	26....	1,020
5.....	35	12....	11,800	19....	2,910	27....	930
6.....	60	13....	9,400	20....	2,450	28....	892
7.....	250	14....	7,600	21....	2,110	29....	830
				22....	1,850	30....	762

Monthly mean discharge, in cubic feet per second..... 3,578

Runoff, in inches..... 4.06

Runoff, in acre-feet..... 212,900

MINNESOTA RIVER BASIN

365

Lac qui Parle River near Lac qui Parle, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 12</u>		
2400	1.80		0100	7.00	2,110	1200	17.17	12,000
			0700	16.45	10,300	2400	16.53	10,500
<u>Apr. 5</u>			0800	15.41	8,350			
1200	1.81		0900	16.01	9,430	<u>Apr. 13</u>		
2400	1.96		1200	16.27	9,960	1200	16.00	9,410
			1800	17.50	12,800	2400	15.38	8,300
<u>Apr. 6</u>			2400	18.26	15,100			
1200	2.01					<u>Apr. 14</u>		
1800	2.48		<u>Apr. 10</u>			2400	14.38	6,900
2400	2.53		0300	18.57	16,000			
			0600	18.74	16,500	<u>Apr. 15</u>		
<u>Apr. 7</u>			1100	18.94	17,100	2400	13.04	5,540
0800	2.93		1500	18.66	16,300			
1400	3.59		1700	18.61	16,100	<u>Apr. 16</u>		
1800	3.49		2100	18.02	14,400	2400	11.78	4,660
2400	3.79		2400	18.25	15,000			
						<u>Apr. 17</u>		
<u>Apr. 8</u>			<u>Apr. 11</u>			2400	10.54	3,930
0600	6.05		0300	18.51	15,800			
1000	5.50		0600	18.40	15,500			
1800	7.00		1200	17.76	13,600			
2400	8.60	2,910	1600	17.84	13,800			
			2400	17.47	12,800			

Location.--Lat 45°01'17", long 95°52'05", in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.24, T.118 N., R.42 W., on left bank 200 ft downstream from dam at Lac qui Parle Outlet, 2.4 miles northeast of village of Lac qui Parle, and 3.5 miles west of Watson.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 900.00 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 29,400 cfs 1800 hours Apr. 12 (gage height, 39.75 ft).
1942 to March 1969: Discharge, 19,700 cfs Apr. 10, 1952 (gage height, 37.98 ft, from floodmark).

Remarks.--Part of flow from 2,050 square miles of Chippewa River basin at times diverted into Minnesota River above station. Some regulation by Big Stone, Lac qui Parle and Marsh Lakes.

[illegible]

Minnesota River near Lac qui Parle, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
2400	20.76		0600	30.80		1200	39.55	28,200
			1200	31.14		2400	39.26	26,600
<u>Apr. 5</u>			1400	30.93		<u>Apr. 14</u>		
2400	20.77		2000	31.69		1200	38.99	25,100
			2400	32.25	3,700	2400	38.76	23,900
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
0800	20.77		1200	34.59	6,070	1200	38.51	22,500
1200	21.66		2400	36.51	12,100	2400	38.25	21,100
1800	21.72		<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	22.66		0600	37.48	17,300	1200	38.00	19,900
<u>Apr. 7</u>			1200	38.34	21,600	2400	37.77	18,700
1200	22.84		1800	38.98	25,100	<u>Apr. 17</u>		
1800	23.52		2400	39.33	27,000	2400	37.36	16,700
2400	25.33		<u>Apr. 12</u>			<u>Apr. 18</u>		
<u>Apr. 8</u>			0600	39.57	28,300	2400	36.99	14,800
0800	25.93		1200	39.70	29,100			
1000	27.28		1800	39.75	29,400			
1200	27.84		2400	39.70	29,100			
1800	29.09							
2400	30.42							

(130) 5-3034.5 Hassel Creek near Clontarf, Minn.

(Crest-stage station)

Location.--Lat $45^{\circ}24'05''$, long $95^{\circ}34'15''$, in NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.4, T.122 N., R.39 W., at culvert on State Highway 29, a quarter mile above Lake Hassel, and $5\frac{1}{4}$ miles east of Clontarf.

Drainage area.--4.03 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 130 cfs and by indirect measurements at 220 cfs and 313 cfs.

Maxima.--April 1969: Discharge, 190 cfs Apr. 7 (gage-height, 12.62 ft, backwater from ice).

1962 to March 1969: Discharge, 177 cfs July 19, 1962 (gage height, 11.92 ft).

(131) 5-3045. Chippewa River near Milan, Minn.

Location.--Lat $45^{\circ}06'39''$, long $95^{\circ}47'57''$, in $SE\frac{1}{4}SE\frac{1}{4}$ sec.16, T.119 N., R.41 W., on right bank 800 ft upstream from bridge on State Highway 40, 2.0 miles upstream from small tributary, and $5\frac{1}{2}$ miles east of Milan.

Drainage area.--1,870 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 959.69 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-8.

Maxima.--April 1969: Discharge, 11,400 cfs 2230 hours Apr. 9 (gage height, 15.45 ft).

1937 to March 1969: Discharge, 6,930 cfs Apr. 9, 1952 (gage height, 12.12 ft); gage height, 12.29 ft Apr. 7, 1952 (backwater from ice).

Remarks.--Flow regulated by several small lakes above gage.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	55	8....	3,600	15....	6,010	23....	2,120
2.....	61	9....	8,750	16....	5,200	24....	1,980
3.....	66	10....	10,100	17....	4,610	25....	1,850
4.....	73	11....	9,840	18....	3,970	26....	1,750
5.....	80	12....	9,400	19....	3,340	27....	1,750
6.....	150	13....	7,680	20....	2,910	28....	1,990
7.....	780	14....	6,720	21....	2,570	29....	1,950
				22....	2,310	30....	1,820

Monthly mean discharge, in cubic feet per second..... 3,450

Runoff, in inches..... 2.06

Runoff, in acre-feet..... 205,300

Chippewa River near Milan, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	2.68		1500	9.72		1200	14.11	9,450
			1800	11.16		2400	13.36	8,480
<u>Apr. 5</u>			1900	11.06				
1700	2.82		2400	11.46	6,440	<u>Apr. 13</u>		
2400	2.85					1200	12.61	7,620
			<u>Apr. 9</u>			2400	12.02	7,000
<u>Apr. 6</u>			1200	13.26	8,360			
0500	2.93		1800	14.63	10,200	<u>Apr. 14</u>		
2000	4.31		2230	15.45	11,400	1200	11.59	6,570
2400	4.49		2400	15.29	11,100	2400	11.23	6,740
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
0600	5.40		1600	14.20	9,580	1200	10.82	5,890
1200	7.03		2400	14.31	9,730	2400	10.38	5,530
1800	8.82							
2400	9.71		<u>Apr. 11</u>			<u>Apr. 16</u>		
			1200	14.30	9,720	1200	9.95	5,190
<u>Apr. 8</u>			2400	14.61	10,200	2400	9.58	4,890
0500	10.29							
0600	10.76					<u>Apr. 17</u>		
0830	10.03					1200	9.25	4,630
1400	10.70					2400	8.84	4,300

(132) 5-3052. Spring Creek near Montevideo, Minn.

(Crest-station station)

Location.--Lat $44^{\circ}58'40''$, long $95^{\circ}43'00''$, in $SW\frac{1}{4}SW\frac{1}{4}$ sec.32, T.118 N., R.40 W., at culvert on State Highway 29, $1\frac{1}{4}$ miles above mouth, and $2\frac{1}{4}$ miles north of Montevideo.

Drainage area.--16.3 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 150 cfs and by indirect measurement at 430 cfs.

Maxima.--April 1969: Discharge, 463 cfs Apr. 7 (gage height, 17.94 ft).

1959 to March 1969: Discharge, 492 cfs July 19, 1962 (gage height, 18.22 ft).

Location.--Lat 44°56'00", long 95°44'00", in NW¹/₄NW¹/₄ sec.19, T.117 N., R.40 W., on right bank 100 ft upstream from bridge on U.S. Highway 212 at Montevideo, and 400 ft downstream from Chippewa River.

Gage-height record.---Digital recorder tape punched at 15-minute intervals, except 2000 hours Apr. 12 to 0800 hours Apr. 13 for which graph was constructed on basis of adjacent record and reconstructed on high-water mark in gage well. Datum of gage is 909.12 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 35,100 cfs 2400 hours Apr. 12 (gage height, 21.68 ft, from floodmark).
1909 to March 1969: Discharge, 24,500 cfs Apr. 10, 1952 (gage height, 20.02 ft, from floodmark).

Mean discharge, in cubic feet per second, 1969

[illegible]

Minnesota River at Montevideo, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	3.58		1200	14.14	5,950	1200	20.93	31,700
			2400	15.07	8,100	2400	20.59	30,100
<u>Apr. 5</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
1400	3.43		0600	15.41	9,280	1200	20.23	28,500
2400	3.74		1800	15.80	10,700	2400	19.92	27,100
<u>Apr. 6</u>			2400	16.19	12,100	<u>Apr. 16</u>		
1400	3.81		<u>Apr. 11</u>			2400	19.19	24,000
2400	6.33		0600	16.85	14,500	<u>Apr. 17</u>		
<u>Apr. 7</u>			1800	18.99	23,200	2400	18.49	21,100
0400	7.07		2400	20.15	28,200	<u>Apr. 18</u>		
1200	7.70		<u>Apr. 12</u>			2400	17.84	18,300
2400	9.93	2,860	0600	20.92	31,600	<u>Apr. 19</u>		
<u>Apr. 8</u>			1800	21.53	34,400	2400	17.23	15,900
1200	11.33	3,700	2400	21.68	35,100	<u>Apr. 20</u>		
1600	12.61	4,470	<u>Apr. 13</u>			2400	16.86	14,500
2400	13.14	4,800	1200	21.54	34,500			
			2400	21.27	33,200			

(134) Minnesota River at Granite Falls, Minn.

(Miscellaneous site)

Location.--Lat 44°48'20", long 95°32'36", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.34, T.116 N., R.39 W.,
at bridge on U. S. Highway 212 in Granite Falls.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments.

Maxima.--April 1969: Discharge, 43,400 cfs Apr. 13 (elevation, 895.49 ft
above mean sea level, datum of 1929). Elevation in pool above dam,
910.25 ft Apr. 13.

Cooperation.--Elevation in pool above dam furnished by Corps of Engineers.

(135) 5-3112. North Branch Yellow Medicine River near Ivanhoe, Minn.

(Crest-stage station)

Location.--Lat $44^{\circ}27'30''$, long $96^{\circ}21'20''$, in NW $\frac{1}{4}$ sec.2, T.111 N., R.46 W., at culvert on State Highway 19, $5\frac{1}{4}$ miles west of Ivanhoe.

Drainage area.--15.2 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 510 cfs and by indirect measurements at 700 cfs and 940 cfs.

Maxima.--April 1969: Discharge, 940 cfs Apr. 7 (gage height, 18.70 ft).
1960 to March 1969: Discharge, 540 cfs June 15, 1967 (gage height, 14.17 ft, from downstream gage).

(136) 5-3112.5 North Branch Yellow Medicine River tributary near Wilno, Minn.

(Crest-stage station)

Location.--Lat $44^{\circ}33'10''$, long $96^{\circ}16'40''$, in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.33, T.133 N., R.45 W., at culvert on U.S. Highway 75, $1\frac{1}{2}$ miles above mouth, and $4\frac{1}{2}$ miles northwest of Wilno.

Drainage area.--0.33 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 12 cfs and by indirect measurements at 28 cfs and 50 cfs.

Maxima.--April 1969: Discharge, 54 cfs Apr. 4 (gage height, 10.47 ft); gage height, 11.69 ft Apr. 4 (backwater from ice).
1960 to March 1969: Discharge, 56 cfs July 26, 1968 (gage height, 10.64 ft).

(137) 5-3113. North Branch Yellow Medicine River tributary
near Porter, Minn.

(Crest-stage station)

Location.--Lat $44^{\circ}35'40''$, long $96^{\circ}16'40''$, in $E\frac{1}{2}$ sec.16, T.113 N., R.45 W., at
culvert on U.S. Highway 75, $6\frac{1}{4}$ miles southwest of Porter.

Drainage area.--1.46 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Theoretical fall-stage-discharge relation defined by
computer analysis.

Maxima.--April 1969: Discharge, 212 cfs Apr. 7 (gage height, 16.57 ft);
gage height, 17.61 Apr. 3 (backwater from ice).
1960 to March 1969: Discharge, 247 cfs Apr. 10, 1962 (gage height,
16.79 ft, backwater from ice).

Location.--Lat 44°33'50", long 95°59'50", in SE $\frac{1}{4}$ sec.26, T.113 N., R.43 W., on downstream side of bridge on State Highway 68, 0.5 mile northwest of Minneota, and 6 miles upstream from confluence with North Branch Yellow Medicine River.

Gage-height record.--Graph constructed on the basis of twice daily or more wire-weight gage readings by observer, and miscellaneous engineers' readings. Gage read hourly 2000 hours Apr. 6 to 1700 hours Apr. 10. Datum of gage is 1,150.00 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,430 cfs 1700 hours Apr. 8 (gage height, 13.41 ft).
1960 to March 1969: Discharge, 1,830 cfs Apr. 6, 1960 (gage height, 11.10 ft).

[illegible]

MINNESOTA RIVER BASIN

375

South Branch Yellow Medicine River at Minneota, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	5.05		0100	12.85		0800	9.38	991
			0200	12.45		1200	9.27	942
<u>Apr. 2</u>			0300	12.60		2400	9.10	865
1200	5.38		1000	12.35	3,000			
2400	5.61		1700	13.41	4,430	<u>Apr. 13</u>		
			1800	13.41	4,430	1200	8.99	816
<u>Apr. 3</u>			2400	13.13	4,000	2400	8.89	774
1200	5.95							
2400	6.82		<u>Apr. 9</u>			<u>Apr. 14</u>		
			0600	12.78	3,480	1200	8.73	714
<u>Apr. 4</u>			1000	12.68	3,360	2400	8.58	664
0600	7.38		1600	12.45	3,040			
1200	7.98		2400	11.88	2,570	<u>Apr. 15</u>		
1800	8.72					1200	8.37	604
2400	9.68		<u>Apr. 10</u>			2400	8.05	514
			1200	10.95	1,900			
<u>Apr. 5</u>			1300	11.00	1,930	<u>Apr. 16</u>		
0800	10.98		1500	10.72	1,750	1200	7.73	428
2400	11.52		1700	10.85	1,830	2400	7.49	372
			2400	10.65	1,700			
<u>Apr. 6</u>						<u>Apr. 17</u>		
0800	11.36		<u>Apr. 11</u>			1200	7.27	329
2400	12.45		0600	10.30	1,480	2400	7.11	300
			1200	10.05	1,330			
<u>Apr. 7</u>			1600	9.85	1,220			
0500	13.00		2400	9.69	1,140			
1500	11.56							
2200	11.74							
2400	12.37							

(139) 5-3135. Yellow Medicine River near Granite Falls, Minn.

Location.--Lat 44°43', long 95°31', in sec.35, T.115 N., R.39 W., on right bank 50 ft downstream from highway bridge, 6 miles upstream from mouth, and 8 miles south of town of Granite Falls.

Drainage area.--653 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 971.59 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-8.

Maxima.--April 1969: Discharge, 17,200 cfs 0500 hours Apr. 10 (gage height, 14.90 ft).

1931 to March 1969: Discharge, 11,800 cfs June 18, 1957 (gage height, 12.41 ft).

Flood in June 1919 reached a stage of 17.5 ft, from information by local residents.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	31	8....	1,300	15....	5,060	23....	1,440
2.....	32	9....	11,900	16....	4,280	24....	1,260
3.....	35	10....	16,400	17....	3,620	25....	1,090
4.....	40	11....	12,900	18....	3,070	26....	941
5.....	46	12....	9,630	19....	2,650	27....	876
6.....	70	13....	7,730	20....	2,240	28....	844
7.....	280	14....	6,190	21....	1,930	29....	802
				22....	1,660	30....	724

Monthly mean discharge, in cubic feet per second..... 3,302
 Runoff, in inches..... 5.64
 Runoff, in acre-feet..... 196,500

Yellow Medicine River near Granite Falls, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	2.84		0200	4.80		1800	11.00	9,030
			0800	4.98		2400	10.74	8,540
<u>Apr. 5</u>			1200	5.65				
0800	2.73		1800	6.34		<u>Apr. 13</u>		
1000	2.80		2400	7.22	2,970	1200	10.28	7,710
1200	2.74					2400	9.86	6,960
2100	3.21		<u>Apr. 9</u>					
2400	3.08		0400	9.00	5,490	<u>Apr. 14</u>		
			0600	11.00	9,030	1200	9.38	6,140
<u>Apr. 6</u>			1000	12.85	12,700	2400	9.02	5,520
0800	2.89		1300	13.20	13,500			
1000	3.05		1500	13.82	14,800	<u>Apr. 15</u>		
1200	2.98		2400	14.82	17,000	1200	8.72	5,030
2000	3.58					2400	8.48	4,650
2200	3.56		<u>Apr. 10</u>					
2400	3.60		0500	14.90	17,200	<u>Apr. 16</u>		
			1200	14.64	16,600	1200	8.22	4,260
<u>Apr. 7</u>			2400	13.92	15,000	2400	7.99	3,940
1000	3.57							
2400	4.92		<u>Apr. 11</u>			<u>Apr. 17</u>		
			1200	12.92	12,900	1200	7.76	3,620
			2400	11.92	10,800	2400	7.51	3,300

(140) 5-3149. Redwood River at Ruthton, Minn.

(Crest-stage station)

Location.--Lat 44°10'50", long 96°06'10", in NW¹₄NW¹₄ sec.11, T.108 N., R.44 W.,
at culvert on State Highway 23, 0.1 mile northeast of Ruthton.

Drainage area.--5.90 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments below 320 cfs and by indirect measurements at 500 cfs and 728 cfs.

Maxima.--April 1969: Discharge, 728 cfs Apr. 8 (gage height, 18.19 ft).
1959 to March 1969: Discharge, 472 cfs July 4, 1962 (gage height,
16.09 ft).

(141) 5-3150. Redwood River at Marshall, Minn.

Location.--Lat $44^{\circ}27'05''$, long $95^{\circ}47'13''$, in $SE\frac{1}{4}NW\frac{1}{4}$ sec.4, T.111 N., R.41 W., on downstream side of highway bridge on Fourth Street in Marshall, and 10 miles upstream from Threemile Creek.

Drainage area.--307 sq mi.

Gage-height record.--Graph drawn on basis of twice-daily or more wire-weight gage reading and crest-stage gage on river channel. Datum of gage is 1,144.88 ft above mean sea level, datum of 1929. Graph drawn on basis of once-daily or more readings on staff gage or reference point and crest-stage gage on diversion channel. Datum of gage is 1,100.00 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Discharge record.--Stage-discharge relations defined by current-meter measurements. Backwater from ice, Apr. 1-7 on river channel, Apr. 1-9 on diversion channel.

Maxima.--April 1969: Discharge, 5,450 cfs 1000 hours Apr. 10 (includes flow in diversion channel).

River channel: Discharge, 1,610 cfs 0900 hours Apr. 9 (gage height, 7.62 ft).

Diversion channel: Discharge, 4,440 cfs 1000 hours Apr. 10 (gage height, 78.45 ft).

1940 to March 1969: Discharge, 5,370 cfs June 17, 1957 (gage height, 10.14 ft); gage height, 11.05 ft Apr. 6, 1951 (from floodmark).

Remarks.--Water diverted at medium and high stages into diversion channel 3 miles above station, bypasses station and returns to river 1 mile below station. Diversion began Mar. 18, 1964. These records include flow in diversion channel.

Unknown amount of natural diversion into Cottonwood River basin at extremely high stages.

Redwood River at Marshall, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	23	8....	2,780	15....	1,590	23....	490
2.....	20	9....	4,760	16....	1,350	24....	454
3.....	23	10....	4,530	17....	1,170	25....	443
4.....	53	11....	2,950	18....	930	26....	414
5.....	240	12....	2,440	19....	799	27....	410
6.....	519	13....	2,160	20....	676	28....	397
7.....	1,240	14....	1,870	21....	598	29....	367
				22....	534	30....	332

Monthly mean discharge, in cubic feet per second..... 1,152
 Runoff, in inches..... 4.19
 Runoff, in acre-feet..... 68,550

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	1.43		0600	5.50	1,090	1200	3.99	664
			1200	5.92	1,160	2400	3.89	657
<u>Apr. 4</u>			1800	6.23	1,240			
1200	1.49		2400	6.40	1,300	<u>Apr. 13</u>		
2400	1.84					1200	3.81	638
			<u>Apr. 9</u>			2400	3.73	645
<u>Apr. 5</u>			0600	6.98	1,440			
0800	1.91		0900	7.62	1,610	<u>Apr. 14</u>		
1200	2.05		1200	7.22	1,510	1200	3.60	635
1800	2.55		1800	6.31	1,290	2400	3.51	613
2400	2.48		2400	5.92	1,160			
						<u>Apr. 15</u>		
<u>Apr. 6</u>			<u>Apr. 10</u>			1200	3.44	590
0600	2.38		1200	5.30	1,000	2400	3.40	581
1200	2.52		2400	4.82	881			
1800	2.90					<u>Apr. 16</u>		
2400	3.43		<u>Apr. 11</u>			1200	3.32	558
			1200	4.46	785	2400	3.32	558
<u>Apr. 7</u>			2400	4.13	709			
1200	3.47					<u>Apr. 17</u>		
1800	3.92					1200	3.14	504
2400	4.81	869				2400	3.07	481

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Redwood River Diversion at Marshall, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
2400	73.92		0600	77.08		1200	75.69	1,790
			1200	77.31		2400	75.56	1,680
<u>Apr. 4</u>			2000	77.66		<u>Apr. 13</u>		
1200	74.48		2400	77.60		1200	75.33	1,500
2400	74.99					2400	75.18	1,390
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	75.35		0600	77.46		1200	74.96	1,230
<u>Apr. 6</u>			1200	77.55	3,760	2400	74.80	1,120
1200	75.54		2400	77.78				
2400	76.33		<u>Apr. 10</u>			<u>Apr. 15</u>		
<u>Apr. 7</u>			0600	77.90	3,880	1200	74.61	1,000
0500	76.80		0800	78.00	3,980	2400	74.40	875
1000	76.43		1000	78.45	4,440	<u>Apr. 16</u>		
1600	77.00		1200	78.28	4,260	1200	74.23	782
2000	77.63		1600	77.00	2,980	2400	74.10	710
2400	77.51		2000	76.74	2,720			
			2400	76.60	2,590	<u>Apr. 17</u>		
			<u>Apr. 11</u>			0800	74.02	670
			0600	76.41	2,420	1100	74.06	690
			1200	76.08	2,120	2400	73.81	565
			1800	75.84	1,910			
			2400	75.74	1,830			

(142) 5-3152. Prairie Ravine near Marshall, Minn.

(Crest-stage station)

Location.--Lat 44°29'44", long 95°47'48", in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.20, T.112 N., R.41 W.,
at culvert on U.S. Highway 59, 2.7 miles north of Marshall.

Gage-height record.--Crest stages only.

Discharge record.--Discharge obtained from indirect measurements.

Maxima.--April 1969: Discharge, 221 cfs Apr. 7 (gage height, 9.96 ft); gage
height, 11.0 ft Apr. 6 (backwater from ice).

1959 to March 1969: Discharge, 75 cfs Mar. 28, 1962 (gage height,
7.62 ft, backwater from ice).

(143) 5-3165. Redwood River near Redwood Falls, Minn.

Location--Lat $44^{\circ}31'25''$, long $95^{\circ}10'20''$, in $SE\frac{1}{4}NE\frac{1}{4}$ sec.9, T.112 N., R.36 W., on right bank 20 ft upstream from highway bridge, 3 miles west of town of Redwood Falls, and 8.5 miles upstream from mouth.

Drainage area--697 sq mi.

Gage-height record--Water-stage recorder graph. Datum of gage is 972.33 ft above mean sea level, datum of 1929.

Discharge record--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 3-8.

Maxima--April 1969: Discharge, 14,100 cfs 1200 hours Apr. 9 (gage height, 14.58 ft).
1909-14, 1930 to March 1969: Discharge, 19,700 cfs June 18, 1957 (gage height, 15.92 ft, from floodmark).

Remarks--Natural discharge affected by unknown amount of interbasin flow between Yellow Medicine, Redwood and Cottonwood River basins during extreme floods.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	100	8....	5,000	15....	3,860	23....	1,300
2.....	120	9....	13,200	16....	3,380	24....	1,140
3.....	160	10....	11,200	17....	2,960	25....	1,000
4.....	280	11....	8,720	18....	2,540	26....	878
5.....	600	12....	6,450	19....	2,200	27....	858
6.....	1,200	13....	4,960	20....	1,910	28....	897
7.....	2,500	14....	4,270	21....	1,710	29....	806
				22....	1,490	30....	722

Monthly mean discharge, in cubic feet per second..... 2,880
Runoff, in inches..... 4.61
Runoff, in acre-feet..... 171,400

Redwood River near Redwood Falls, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 6</u>			<u>Apr. 10</u>		
2400	2.36		1500	4.95		1200	13.32	11,200
			1700	5.38		2400	12.55	9,800
<u>Apr. 3</u>			1800	5.12				
1100	2.37		2200	5.59		<u>Apr. 11</u>		
2200	3.04		2300	7.17		1200	11.90	8,740
2400	3.04		2400	6.98		2400	11.08	7,600
<u>Apr. 4</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
0300	3.01		0400	6.66		1200	10.10	6,370
1200	3.21		1000	6.94		2400	9.35	5,470
1300	3.57		1100	7.73				
1800	3.78		1400	7.50		<u>Apr. 13</u>		
2100	3.81		1600	8.44		1200	8.89	4,930
2400	3.78		1800	7.44		2400	8.46	4,500
			2000	7.67				
<u>Apr. 5</u>			2400	7.11		<u>Apr. 14</u>		
0900	3.51					1200	8.21	4,260
1100	3.90		<u>Apr. 8</u>			2400	8.01	4,070
1200	3.80		0400	7.63				
1400	4.41		0600	7.49		<u>Apr. 15</u>		
1700	4.94		0700	7.60		1200	7.81	3,880
1800	4.80		1000	7.45	3,540	2400	7.54	3,620
1900	5.15		1400	8.67	4,710			
2000	5.07		1600	10.12	6,390	<u>Apr. 16</u>		
2400	5.21		1800	11.78	8,550	1200	7.27	3,370
			2400	13.60	11,800	2400	7.07	3,180
<u>Apr. 6</u>			<u>Apr. 9</u>			<u>Apr. 17</u>		
1000	5.00		0600	14.33	13,400	2400	6.55	2,750
1100	4.89		1200	14.58	14,100			
1200	4.89		1800	14.28	13,300			
1300	5.13		2400	13.91	12,500			

(144) 5-3167. Spring Creek near Sleepy Eye, Minn.

(Crest-stage station)

Location.--Lat $44^{\circ}24'15''$, long $94^{\circ}44'55''$, in $NE\frac{1}{4}SE\frac{1}{4}$ sec.24, T.111 N., R.33 W., at culvert on county highway, $3\frac{3}{4}$ miles above mouth, and $7\frac{1}{2}$ miles north of Sleepy Eye.

Drainage area.--30.0 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 100 cfs and by indirect measurements at 149 cfs, 416 cfs, and 740 cfs.

Maxima.--April 1969: Discharge, 683 cfs Apr. 6 (gage height, 15.93 ft).
1959 to March 1969: Discharge, 930 cfs Apr. 10, 1965 (gage height, 17.79 ft).

(145) 5-3167.70 Minnesota River at New Ulm, Minn.

Location.--Lat $44^{\circ}19'29''$, long $94^{\circ}27'09''$, in $NE\frac{1}{4}NE\frac{1}{4}$ sec.20, T.110 N., R.30 W., on left bank 30 ft downstream from bridge on U. S. Highway 14 and State Highway 15, 0.9 mile northeast of New Ulm Post Office, 6.1 miles upstream from Cottonwood River, and at mile 146.8 upstream from Mississippi River.

Drainage area.--9,540 sq mi, approximately.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 778.72 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-4. Backwater from Cottonwood River, Apr. 5-12.

Maxima.--April 1969: Discharge, 58,000 cfs 1700 hours Apr. 15 (gage height, 30.65 ft).

Sediment concentrations: Daily, 355 mg/l Apr. 4.

Sediment loads: Daily, 34,200 tons Apr. 13.

1967 to March 1969: Discharge, 7,220 cfs 0015 hours Oct. 23, 1968 (gage height, 20.58 ft, backwater from Cottonwood River); gage height, 21.88 ft Oct. 20, 1968, backwater from Cottonwood River.

Floods of Apr. 27, 1881, Apr. 13, 1952 and Apr. 12, 1965 reached stages of 29.17 ft, 27.75 ft and 28.00 ft, respectively, from information by Corps of Engineers.

Minnesota River at New Ulm, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	2,100	8.....	7,700	15.....	56,900	23.....	24,400
2.....	2,250	9.....	11,000	16.....	55,600	24.....	22,100
3.....	2,500	10.....	21,500	17.....	50,400	25.....	20,300
4.....	2,900	11.....	38,900	18.....	44,400	26.....	18,600
5.....	3,220	12.....	49,100	19.....	38,600	27.....	17,100
6.....	4,150	13.....	51,500	20.....	34,200	28.....	15,800
7.....	5,510	14.....	53,200	21.....	30,500	29.....	14,700
				22.....	27,300	30.....	14,100
Monthly mean discharge, in cubic feet per second.....							24,680
Runoff, in inches							2.89

Suspended sediment discharge, April 1969

Day	Mean concentration (mg/l)	Tons per day	Day	Mean concentration (mg/l)	Tons per day
1.....	41	232	16.....	186	27,900
2.....	63	383	17.....	119	16,200
3.....	123	830	18.....	88	10,500
4.....	355	2,780	19.....	65	6,770
5.....	256	2,230	20.....	47	4,340
6.....	170	1,900	21.....	38	3,130
7.....	110	1,640	22.....	32	2,360
8.....	92	1,910	23.....	32	2,110
9.....	81	2,410	24.....	26	1,550
10.....	122	7,080	25.....	25	1,370
11.....	195	20,500	26.....	33	1,660
12.....	220	29,200	27.....	42	1,940
13.....	246	34,200	28.....	45	1,920
14.....	194	27,900	29.....	37	1,470
15.....	186	28,600	30.....	38	1,450
Total load for month (tons).....					246,465
Load per square mile for month (tons).....					26

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Minnesota River at New Ulm, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 10</u>			<u>Apr. 18</u>		
2400	11.56		1200	27.52	21,600	1200	28.40	44,400
			2400	28.17	24,200	2400	27.87	41,200
<u>Apr. 2</u>			<u>Apr. 11</u>			<u>Apr. 19</u>		
1200	11.96		1200	28.79	38,700	1200	27.43	38,600
2400	12.44		2400	29.44	42,500	2400	26.92	36,100
<u>Apr. 3</u>			<u>Apr. 12</u>			<u>Apr. 20</u>		
1200	12.96		1200	29.76	49,600	1200	26.53	34,200
2400	14.08		2400	29.73	49,400	2400	26.14	32,200
<u>Apr. 4</u>			<u>Apr. 13</u>			<u>Apr. 21</u>		
1200	15.24		1200	29.60	51,600	1200	25.75	30,500
2400	16.25		2400	29.52	51,100	2400	25.32	28,800
<u>Apr. 5</u>			<u>Apr. 14</u>			<u>Apr. 22</u>		
1200	17.12	3,230	1200	29.85	53,100	1200	24.97	27,400
2400	17.77	3,620	2400	30.29	55,700	2400	24.57	25,800
<u>Apr. 6</u>			<u>Apr. 15</u>			<u>Apr. 23</u>		
1200	18.84	4,150	1400	30.63	57,900	1200	24.22	24,400
2400	19.89	4,880	1700	30.65	58,000	2400	23.91	23,100
			2400	30.45	56,600			
<u>Apr. 7</u>			<u>Apr. 16</u>			<u>Apr. 24</u>		
1200	21.06	5,470	1200	30.27	55,600	1200	23.67	22,200
2400	22.21	6,570	2400	29.89	53,300	2400	23.40	21,100
<u>Apr. 8</u>			<u>Apr. 17</u>			<u>Apr. 25</u>		
1200	23.41	7,610	1200	29.43	50,600	1200	23.19	20,300
2400	24.58	9,420	2400	28.91	47,500	2400	22.99	19,500
<u>Apr. 9</u>								
1200	25.61	10,900						
2400	26.64	13,600						

(146) 5-3168. Cottonwood River tributary near Balaton, Minn.

(Crest-stage station)

Location.--Lat $44^{\circ}14'20''$, long $95^{\circ}57'20''$, in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.19, T.109 N., R.42 W., at culvert on U.S. Highway 14, $\frac{1}{4}$ miles west of Balaton.

Drainage area.--0.50 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 25 cfs and by indirect measurement at 73 cfs.

Maxima.--April 1969: Discharge, 106 cfs Apr. 6 (gage height, 7.74 ft, backwater from ice); gage height, 8.41 ft Apr. 4 (backwater from ice).
1959 to March 1969: Discharge, 73 cfs July 19, 1963 (gage height, 6.74 ft).

(147) Cottonwood River near Lamberton, Minn.

(Miscellaneous site)

Location.--Lat $44^{\circ}14'20''$, long $95^{\circ}14'41''$, on line between secs.13 and 24, T.109 N., R.37 W., at bridge on U.S. Highway 14, one mile east of Lamberton.

Gage-height record.--Occasional observations from reference point and staff gage readings during flood. Elevations are in feet above mean sea level, datum of 1929.

Discharge record.--Discharge obtained from current-meter measurement near peak.

Maxima.--April 1969: Discharge, 8,720 cfs Apr. 8 (elevation, 1,062.33 ft).

Cooperation.--Gage-height readings furnished by Corps of Engineers.

(148) Cottonwood River at Springfield, Minn.

(Miscellaneous site)

Location.--Lat $44^{\circ}14'16''$, long $94^{\circ}58'26''$, in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.19, T.109 N., R.34 W., at bridge in Springfield.

Gage-height record.--Staff gage readings obtained during flood by the Corps of Engineers. Gage readings are in feet above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 20,500 cfs Apr. 8 (elevation, 1,019.17 ft).

Cooperation.--Maximum elevation furnished by Corps of Engineers.

(149) 5-3170. Cottonwood River near New Ulm, Minn.

Location.--Lat $44^{\circ}17'40''$, long $94^{\circ}26'40''$, in N $\frac{1}{2}$ sec.33, T.110 N., R.30 W., on left bank 600 ft upstream from highway bridge, 1.8 miles south of New Ulm, and 2 miles upstream from mouth.

Drainage area.--1,280 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 799.09 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1, 2.

Maxima.--April 1969: Discharge, 28,700 cfs 0100 hours Apr. 10 (gage height, 19.15 ft).

Sediment concentrations: Daily, 1,350 mg/l Apr. 9.

Sediment loads: Daily, 98,000 tons Apr. 9.

1909-13, 1931 to March 1969: Discharge, 26,000 cfs Apr. 8, 1965 (gage height, 20.86 ft, from floodmark, backwater from ice).

Remarks.--Some regulation by dam at Cottonwood Lake and several other small lakes above station.

Cottonwood River near New Ulm, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	850	8....	22,000	15....	6,900	23....	2,340
2.....	1,200	9....	27,100	16....	6,240	24....	2,070
3.....	2,090	10....	24,200	17....	5,440	25....	1,880
4.....	4,300	11....	18,200	18....	4,600	26....	1,700
5.....	6,350	12....	13,600	19....	3,980	27....	1,630
6.....	9,660	13....	10,000	20....	3,480	28....	1,730
7.....	13,600	14....	7,910	21....	3,040	29....	1,800
				22....	2,660	30....	1,690

Monthly mean discharge, in cubic feet per second..... 7,075
 Runoff, in inches..... 6.17
 Runoff, in acre-feet..... 421,000

Suspended sediment discharge, April 1969

Day	Mean concentration (mg/l)	Tons per day	Day	Mean concentration (mg/l)	Tons per day
1.....	120	275	16.....	500	8,420
2.....	240	778	17.....	448	7,170
3.....	598	3,760	18.....	454	5,640
4.....	1,120	13,000	19.....	458	4,920
5.....	920	15,800	20.....	510	4,790
6.....	935	24,400	21.....	682	5,600
7.....	864	32,400	22.....	680	4,880
8.....	1,210	71,900	23.....	495	3,130
9.....	1,350	98,000	24.....	394	2,200
10.....	1,070	69,900	25.....	302	1,530
11.....	977	48,000	26.....	350	1,610
12.....	817	30,000	27.....	340	1,500
13.....	684	18,500	28.....	335	1,560
14.....	650	13,900	29.....	300	1,460
15.....	584	10,900	30.....	326	1,490

Total load for month (tons)..... 507,413
 Load per square mile for month (tons)..... 396

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Cottonwood River near New Ulm, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 13</u>		
2400	6.50	1,640	1600	15.26	14,000	1200	13.91	9,950
			2400	16.06	16,700	2400	13.46	8,710
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 14</u>		
0200	6.62	1,700	0700	17.00	20,100	1200	13.11	7,820
1400	7.05	1,910	1400	17.83	23,300	2400	12.87	7,290
1800	8.02	2,450	2400	18.49	26,000			
2400	9.03	3,060				<u>Apr. 15</u>		
<u>Apr. 4</u>			<u>Apr. 9</u>			1200	12.66	6,860
0300	9.25	3,190	0500	18.85	27,500	2400	12.50	6,570
0600	10.00	3,700	1700	18.58	26,300			
1300	10.83	4,460	1900	18.93	27,800	<u>Apr. 16</u>		
2000	11.48	5,190	2400	19.00	28,100	2400	12.10	5,920
2400	11.63	5,370				<u>Apr. 17</u>		
<u>Apr. 5</u>			<u>Apr. 10</u>			2400	11.47	4,960
0600	12.00	5,820	0100	19.15	28,700			
1300	12.30	6,240	0400	18.38	25,500	<u>Apr. 18</u>		
2400	13.05	7,680	1700	17.77	23,100	2400	10.85	4,250
			2400	17.23	21,000			
<u>Apr. 6</u>			<u>Apr. 11</u>			<u>Apr. 19</u>		
0600	13.43	8,630	0300	17.00	20,100	2400	10.25	3,710
1200	13.87	9,840	1200	16.45	18,100			
2400	14.43	11,400	2400	15.79	15,800	<u>Apr. 20</u>		
<u>Apr. 7</u>			<u>Apr. 12</u>			2400	9.70	3,260
1200	15.03	13,200	1000	15.26	14,000			
1300	15.42	14,500	2400	14.46	11,500			

(150) Little Cottonwood River at Searles, Minn.

(Miscellaneous site)

Location.--Lat $44^{\circ}14'19''$, long $94^{\circ}26'04''$, in $NE\frac{1}{4}NE\frac{1}{4}$ sec.21, T.109 N., R.30 W., at bridge on State Highway 15, $3/4$ mile north of Searles.

Discharge record.--Discharge obtained on the following days by current-meter measurements.

Date	Discharge, in cfs
Apr. 4, 1969	953
Apr. 7, 1969	2,310
Apr. 10, 1969	2,100

(151) 5-3175. Minnesota River at Judson, Minn.

(Miscellaneous site)

Location.--Lat $44^{\circ}12'00''$, long $94^{\circ}11'36''$, in $E\frac{1}{2}$ sec.33, T.109 N., R.28 W., on highway bridge a quarter of a mile northeast of Judson, and 11 miles upstream from Blue Earth River.

Drainage area.--11,200 sq mi, approximately.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 64,000 cfs Apr. 13 (elevation, 788.6 ft, datum of 1929).

1938 to March 1969: Discharge, 58,000 cfs Apr. 9, 1965 (elevation, 787.6 ft).

Maximum elevation known, 790.5 ft Apr. 25, 1881.

Cooperation.--Elevations and previous maximums furnished by the Corps of Engineers.

5-3195. Watonwan River near Garden City, Minn.
(Gaging station, discontinued 1945)

Location.--Lat $44^{\circ}02'45''$, long $94^{\circ}11'38''$, in $SW\frac{1}{4}NE\frac{1}{4}$ sec.28, T.107 N., R.28 W., on upstream side of highway bridge, 1.5 miles west of Garden City, 5 miles downstream from Perch Creek, and 7.3 miles upstream from mouth.

Drainage area.--812 sq mi.

Gage-height record.--Chain gage readings. Datum of gage is 900.0 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 11,800 cfs Apr. 9 (gage height, 20.07 ft).
1940-45, 1953 to March 1969: Discharge, 19,000 cfs Apr. 7, 1965 (gage height, 24.11 ft, from floodmark, present datum).

Cooperation.--Gage heights furnished by Corps of Engineers.

(152) 5-3200. Blue Earth River near Rapidan, Minn.

Location.--Lat $44^{\circ}05'44''$, long $94^{\circ}06'33''$, in $SE\frac{1}{4}SE\frac{1}{4}$ sec.6, T.107 N., R.27 W., on left bank 0.2 mile downstream from abandoned powerplant of Northern States Power Co., 2 miles west of Rapidan, $3\frac{1}{2}$ miles downstream from Watonwan River, and $7\frac{3}{4}$ miles upstream from LeSueur River.

Drainage area.--2,430 sq mi, approximately.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 808.80 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 21,100 cfs 1400 hours Apr. 10 (gage height, 13.54 ft).
1909-10, 1939-45, 1949 to March 1969: Discharge, 43,100 cfs Apr. 9, 1965 (gage height, 21.36 ft, from floodmark).

Blue Earth River near Rapidan, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	7,720	8....	17,000	15....	10,200	23....	4,950
2.....	7,600	9....	20,100	16....	9,310	24....	4,410
3.....	7,950	10....	20,900	17....	8,770	25....	3,970
4.....	8,980	11....	19,700	18....	8,410	26....	3,620
5.....	10,900	12....	16,600	19....	7,880	27....	3,430
6.....	12,600	13....	13,700	20....	7,180	28....	3,430
7.....	14,500	14....	11,500	21....	6,400	29....	3,460
				22....	5,620	30....	3,300

Monthly mean discharge, in cubic feet per second..... 9,470

Runoff, in inches..... 4.35

Runoff, in acre-feet..... 563,500

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 11</u>		
2400	8.76	9,920	1200	11.82	16,900	0600	13.27	20,400
			2400	12.64	18,900	1200	12.99	19,700
<u>Apr. 5</u>						1800	12.71	19,100
1200	9.20	10,900	<u>Apr. 9</u>			2400	12.42	18,400
2400	9.59	11,700	0600	12.96	19,700			
			1200	13.23	20,300	<u>Apr. 12</u>		
<u>Apr. 6</u>			1800	13.31	20,500	1200	11.70	16,600
1200	9.92	12,500	2400	13.38	20,700	2400	11.04	15,000
2400	10.39	13,500						
			<u>Apr. 10</u>			<u>Apr. 13</u>		
<u>Apr. 7</u>			0600	13.43	20,800	1200	10.45	13,700
1200	10.81	14,500	1200	13.50	21,000	2400	9.93	12,500
2400	11.18	15,400	1400	13.54	21,100			
			1800	13.52	21,000	<u>Apr. 14</u>		
			2400	13.44	20,800	1200	9.47	11,500
						2400	9.14	10,800

(153) 5-3203. Cobb River tributary near Mapleton, Minn.

(Crest-stage station)

Location. Lat $44^{\circ}01'05''$, long $93^{\circ}57'30''$, in $SW\frac{1}{4}NE\frac{1}{4}$ sec.4, T.106 N., R.26 W., at culvert on State Highway 22, 1.0 mile above mouth, and 6.3 miles north of Mapleton.

Drainage area.--7.25 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 100 cfs and by indirect measurements at 258 cfs, 359 cfs, and 526 cfs.

Maxima.--April 1969: Discharge, 120 cfs Apr. 4 (gage height, 15.56 ft).
1959 to March 1969: Discharge, 526 cfs May 21, 1960 (gage height, 22.24 ft).

(154) 5-3205. Le Sueur River near Rapidan, Minn.

Location.--Lat $44^{\circ}06'40''$, long $94^{\circ}02'28''$, in SW $\frac{1}{4}$ sec.35, T.108 N., R.27 W., on right bank 600 ft downstream from highway bridge, 1.8 miles northeast of Rapidan, and 2.3 miles upstream from mouth.

Drainage area.--1,100 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 775.76 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Mar. 19-23.

Maxima.--March-April 1969: Discharge, 10,900 cfs 1300 hours Mar. 27 (gage height, 12.75 ft).

1939-45, 1949 to February 1969: Discharge, 24,700 cfs Apr. 8, 1965 (gage height, 22.10 ft, from floodmark); gage height, 22.72 ft May 22, 1960 (from floodmark).

Mean discharge, in cubic feet per second, 1969

Day	March	April	Day	March	April	Day	March	April
1...		4,180	11...		5,170	21...	500	2,140
2...		4,410	12...		4,560	22...	1,050	1,920
3...		5,310	13...		3,860	23...	2,000	1,730
4...		6,940	14...		3,250	24...	5,180	1,560
5...		7,630	15...		3,230	25...	8,840	1,420
6...		7,410	16...		3,320	26...	10,400	1,300
7...		6,460	17...		3,280	27...	10,700	1,280
8...		5,760	18...		2,960	28...	10,300	1,250
9...		5,510	19...	160	2,680	29...	7,590	1,170
10...		5,470	20...	200	2,410	30...	6,100	1,090
						31...	5,640	

Monthly mean discharge, in cubic feet per second...	3,622
Runoff, in inches.....	3.67
Runoff, in acre-feet.....	215,500

MINNESOTA RIVER BASIN

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Le Sueur River near Rapidan, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
Mar. 18			Mar. 25			Apr. 2		
2400	2.44		1800	11.87	9,560	0600	7.90	4,260
			2400	12.17	10,000	1400	7.84	4,190
Mar. 19						1800	8.20	4,620
2400	2.59		Mar. 26			2400	8.53	5,020
			0900	12.69	10,800			
Mar. 20			1800	12.35	10,300	Apr. 3		
1200	3.15		2400	12.40	10,400	1300	8.60	5,100
2400	4.50					1800	8.95	5,540
Mar. 21			Mar. 27			2400	9.41	6,130
0700	5.10		0400	12.41	10,400			
1000	4.05		1300	12.75	10,900	Apr. 4		
1800	5.27		1800	12.68	10,800	1200	10.08	7,010
2400	5.60		2400	12.58	10,600	2100	10.41	7,470
						2400	10.48	7,570
Mar. 22			Mar. 28					
0600	5.85		0900	12.60	10,700	Apr. 5		
1200	6.00		1700	12.24	10,100	0600	10.55	7,670
1800	5.73		2400	11.92	9,630	1200	10.52	7,630
2400	5.98					2400	10.51	7,610
Mar. 23			Mar. 29					
0800	6.34		0600	11.50	9,000	Apr. 6		
1300	6.75		1300	9.96	6,850	1000	10.47	7,560
1600	7.69		1700	9.59	6,370	1800	10.25	7,250
2000	7.52	3,800	2400	9.53	6,290	2400	10.09	7,030
2400	7.63	3,940						
Mar. 24			Mar. 30			Apr. 7		
0600	8.02	4,400	1200	9.34	6,040	1200	9.62	6,410
1200	8.57	5,060	2400	9.34	6,040	2400	9.31	6,000
1800	9.22	5,890						
2400	9.89	6,760	Mar. 31			Apr. 8		
			1200	9.28	5,960	0600	9.13	5,770
Mar. 25			2400	8.19	4,610	1200	9.13	5,770
0600	11.00	8,300				2400	9.02	5,630
1200	11.59	9,140	Apr. 1					
			0600	7.88	4,240			
			1600	7.65	3,960			
			2400	7.90	4,260			

(155) 5-3250. Minnesota River at Mankato, Minn.

Location.--Lat $44^{\circ}10'10''$, long $94^{\circ}00'15''$, in sec.7, T.108 N., R.26 W., on left bank at downstream side of Main Street Bridge in Mankato, 1.8 miles downstream from Blue Earth River and at mile 106.4 upstream from Mississippi River.

Drainage area.--14,900 sq mi, approximately.

Gage-height record.--Digital recorder tape punched at 15-minute intervals except for periods, Apr. 1-2 and Apr. 23-26. For the period Apr. 1-2, graph constructed on the basis of once or twice-daily wire-weight gage readings and for the period Apr. 23-26, record was obtained from graphic water-stage recorder. Datum of gage is 747.92 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 76,700 cfs 1415 hours Apr. 12 (gage height, 27.07 ft).

Sediment concentrations: Daily, 1,500 mg/l Apr. 9.

Sediment loads: Daily, 227,000 tons Apr. 9.

1903 to March 1969: Discharge, 94,100 cfs Apr. 10, 1965 (gage height, 29.09 ft).

Maximum stage known, 29.9 ft Apr. 26, 1881, from floodmark, present site and datum (discharge, 90,000 cfs).

Minnesota River at Mankato, Minn.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	15,200	8.....	45,700	15.....	74,400	23.....	36,600
2.....	15,800	9.....	61,000	16.....	75,500	24.....	32,100
3.....	17,200	10.....	70,000	17.....	72,700	25.....	28,200
4.....	20,800	11.....	74,200	18.....	67,100	26.....	25,600
5.....	25,800	12.....	76,200	19.....	60,600	27.....	24,100
6.....	30,800	13.....	75,400	20.....	53,900	28.....	22,700
7.....	36,400	14.....	73,000	21.....	48,200	29.....	21,500
				22.....	42,400	30.....	20,300

Monthly mean discharge, in cubic feet per second..... 44,780
 Runoff, in inches..... 3.35
 Runoff, in acre-feet..... 2,664,000

Suspended sediment discharge, April 1969

Day	Mean concentration (mg/l)	Tons per day	Day	Mean concentration (mg/l)	Tons per day
1.....	411	16,900	16.....	335	68,300
2.....	501	21,400	17.....	262	51,400
3.....	627	29,100	18.....	201	36,400
4.....	768	43,100	19.....	175	28,600
5.....	777	54,100	20.....	170	24,700
6.....	742	61,700	21.....	166	21,600
7.....	883	86,800	22.....	244	27,900
8.....	1,320	163,000	23.....	149	14,700
9.....	1,380	227,000	24.....	106	9,190
10.....	894	169,000	25.....	118	8,980
11.....	796	159,000	26.....	132	9,120
12.....	593	122,000	27.....	121	7,870
13.....	624	127,000	28.....	109	6,680
14.....	570	112,000	29.....	98	5,690
15.....	397	79,700	30.....	100	5,480

Total load for month (tons)..... 1,798,410
 Load per square mile for month (tons)..... 121

MINNESOTA RIVER BASIN

Minnesota River at Mankato, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 6</u>			<u>Apr. 13</u>		
2400	14.41	15,200	1200	19.36	30,700	1200	26.89	75,700
			2400	19.82	33,300	2400	26.63	74,000
<u>Apr. 1</u>			<u>Apr. 7</u>			<u>Apr. 14</u>		
0900	14.27	15,000	1200	20.38	36,200	1200	26.40	72,700
1200	14.54	15,400	2400	21.08	40,400	2400	26.44	72,900
2000	14.30	15,000						
2400	14.48	15,300	<u>Apr. 8</u>			<u>Apr. 15</u>		
			1200	21.91	45,200	1200	26.63	74,300
<u>Apr. 2</u>			2400	23.17	53,000	2400	26.85	75,700
0600	14.71	15,100						
1700	14.75	15,800	<u>Apr. 9</u>			<u>Apr. 16</u>		
2400	15.08	16,400	1800	25.09	65,400	1200	26.84	75,900
			2000	25.09	65,400	2400	26.65	74,600
<u>Apr. 3</u>			2400	25.29	66,700			
0400	15.32	16,800				<u>Apr. 17</u>		
1400	15.48	17,100	<u>Apr. 10</u>			1200	26.36	72,900
2400	16.17	18,600	1200	25.93	70,000	2400	25.94	70,100
			2400	26.42	73,200			
<u>Apr. 4</u>			<u>Apr. 11</u>			<u>Apr. 18</u>		
1200	16.96	20,800	1200	26.79	74,700	1200	25.45	67,100
2400	17.72	23,400	2400	26.80	74,800	2400	24.96	63,900
<u>Apr. 5</u>			<u>Apr. 12</u>			<u>Apr. 19</u>		
1200	18.35	25,800	1415	27.07	76,700	2400	23.89	57,100
2400	18.92	28,600	2400	26.99	76,200	<u>Apr. 20</u>		
						2400	22.91	50,900

(156) 5-3300. Minnesota River near Jordan, Minn.
(Formerly published as Minnesota River near Carver)

Location.--Lat $44^{\circ}41'35''$, long $93^{\circ}38'30''$, in NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.7, T.114 N., R.23 W., on left bank $1\frac{1}{2}$ miles northwest of Jordan and at mile 39.4 upstream from Mississippi River.

Drainage area.--16,200 sq mi, approximately.

Gage-height record.--Digital recorder tape punched at 15-minute intervals except for Apr. 1-6 when graph was constructed on basis of twice-daily chain-gage readings. Datum of gage is 690.00 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 84,600 cfs 0700 hours Apr. 14 (gage height, 32.85 ft).
1934 to March 1969: Discharge, 117,000 cfs Apr. 11, 1965; gage height, 34.37 ft Apr. 12, 1965 (backwater from Mississippi River).

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	24,400	8....	33,600	15....	83,500	23....	46,300
2.....	23,100	9....	38,300	16....	82,100	24....	40,100
3.....	22,900	10....	48,300	17....	81,600	25....	35,200
4.....	23,700	11....	64,000	18....	79,400	26....	31,200
5.....	25,100	12....	76,000	19....	74,900	27....	28,600
6.....	27,200	13....	82,300	20....	68,900	28....	26,500
7.....	30,400	14....	84,500	21....	61,600	29....	25,000
				22....	53,500	30....	23,900

Monthly mean discharge, in cubic feet per second..... 48,200
Runoff, in inches..... 3.32
Runoff, in acre-feet..... 2,868,000

Minnesota River near Jordan, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 15</u>			<u>Apr. 23</u>		
2400	25.04	28,900	1200	32.73	83,600	1200	28.07	46,300
			2400	32.62	82,600	2400	27.60	43,000
<u>Apr. 7</u>			<u>Apr. 16</u>			<u>Apr. 24</u>		
1200	25.38	30,400	1200	32.57	82,100	1200	27.15	40,000
2400	25.73	32,100	2400	32.54	81,900	2400	26.73	37,500
<u>Apr. 8</u>			<u>Apr. 17</u>			<u>Apr. 25</u>		
1200	26.03	33,600	1200	32.52	81,700	1200	26.34	35,100
2400	26.37	35,600	2400	32.44	81,000	2400	25.97	32,900
<u>Apr. 9</u>			<u>Apr. 18</u>			<u>Apr. 26</u>		
1200	26.82	38,000	1200	32.29	79,600	1200	25.64	31,200
2400	27.45	42,000	2400	32.05	77,200	2400	25.31	29,600
<u>Apr. 10</u>			<u>Apr. 19</u>			<u>Apr. 27</u>		
1200	28.32	48,000	1200	31.75	75,000	1200	25.12	28,600
2400	29.35	55,800	2400	31.39	72,100	2400	24.91	27,600
<u>Apr. 11</u>			<u>Apr. 20</u>			<u>Apr. 28</u>		
1200	30.41	64,300	1200	30.99	68,900	1200	24.70	26,500
2400	31.27	71,200	2400	30.56	65,500	2400	24.52	25,600
<u>Apr. 12</u>			<u>Apr. 21</u>			<u>Apr. 29</u>		
1200	31.91	76,300	1200	30.08	61,600	1200	24.37	25,000
2400	32.31	79,800	2400	29.56	57,500	2400	24.22	24,400
<u>Apr. 13</u>			<u>Apr. 22</u>			<u>Apr. 30</u>		
1200	32.60	82,400	1200	29.07	53,600	1200	24.09	23,900
2400	32.78	84,000	2400	28.56	49,700	2400	23.98	23,400
<u>Apr. 14</u>								
0700	32.85	84,600						
1200	32.84	84,600						
2400	32.82	84,400						

Location.--Lat 44°56'40", long 93°05'20", in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.6, T.28 N., R.22 W., on left bank in St. Paul, 300 ft upstream from Robert Street Bridge, 6 miles downstream from Minnesota River, and at mile 839.3 upstream from Ohio River.

Gage-height record.--Water-stage recorder graph except 0100 hours Apr. 15 to 1200 hours Apr. 16 for which graph was reconstructed on basis of adjacent record and high-water mark in gage house.

Discharge record.--Stage-fall-discharge relation defined by current-meter measurements. Fall used as a factor in computing discharge May 28-31.

Remarks.--Sewage from Minneapolis and St. Paul diverted to a sewage disposal plant, thence to river below station. Figures of discharge do not include this diversion which is insignificant during the flood.

Mean discharge, in cubic feet per second, 1969								
Day	April	May	Day	April	May	Day	April	May
1...	32,400	65,500	11...	99,400	49,000	21...	122,000	33,900
2...	33,000	63,400	12...	119,000	47,200	22...	113,000	33,700
3...	34,400	61,500	13...	137,000	45,200	23...	104,000	32,900
4...	37,700	59,700	14...	148,000	43,700	24...	96,600	31,600
5...	39,800	58,100	15...	155,000	42,100	25...	89,600	30,500
6...	45,000	56,600	16...	153,000	40,100	26...	83,400	29,600
7...	49,800	55,100	17...	148,000	38,500	27...	78,400	28,800
8...	57,400	53,600	18...	144,000	37,000	28...	73,600	26,300
9...	68,300	52,200	19...	138,000	35,800	29...	70,800	24,200
10...	82,200	50,700	20...	132,000	34,700	30...	68,000	23,900
						31...	--	22,100
Monthly mean discharge, in cubic feet per second							91,740	42,170
Runoff, in inches.....							2.78	1.32

(158) 5-3385. Snake River near Pine City, Minn.

Location.--Lat 45°50'30", long 92°56'00", in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.26, T.39 N., R.21 W., on left bank at site of former powerplant and dam, half a mile downstream from Cross Lake and 1 $\frac{1}{2}$ miles northeast of Pine City.

Drainage area.--958 sq mi.

Gage-height record.--Digital recorder tape punched at 15-minute intervals.
Datum of gage is 919.00 ft above mean sea level, datum of 1929.

Discharge record.---Stage-discharge relation defined by current-meter measurements.

Maxima -- April 1969: Discharge, 10,200 cfs 2015 hours Apr. 12 (gage height, 9.08 ft).

1913-17, 1951 to March 1969: Discharge, 11,500 cfs Apr. 18, 1965 (gage height, 9.56 ft).

A discharge measurement of 12,500 cfs was made May 9, 1950.

Mean discharge, in cubic feet per second, 1969

[illegible]

ST. CROIX RIVER BASIN

403

Snake River near Pine City, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u> 2400	3.99	742	<u>Apr. 9</u> 2400	8.22	7,920	<u>Apr. 14</u> 2400	8.82	9,530
<u>Apr. 4</u> 2400	4.23	946	<u>Apr. 10</u> 1200 2400	8.46 8.69	8,600 9,190	<u>Apr. 15</u> 2400	8.60	8,960
<u>Apr. 5</u> 1200 2400	4.37 4.67	1,060 1,380	<u>Apr. 11</u> 1200 2400	8.84 8.97	9,580 9,920	<u>Apr. 16</u> 2400	8.29	8,150
<u>Apr. 6</u> 1200 2400	4.92 5.42	1,690 2,310	<u>Apr. 12</u> 1200 2015 2400	9.03 9.08 9.08	10,100 10,200 10,200	<u>Apr. 17</u> 2400	7.93	7,240
<u>Apr. 7</u> 1200 2400	5.85 6.55	2,960 4,200	<u>Apr. 13</u> 2400	9.01	10,000	<u>Apr. 18</u> 2400	7.55	6,320
<u>Apr. 8</u> 2400	7.52	6,160				<u>Apr. 19</u> 2400	7.17	5,500
						<u>Apr. 20</u> 2400	6.80	4,770

Location.--Lat 45°24'30", long 92°38'45", in NW $\frac{1}{4}$ sec.30, T.34 N., R.18 W., on left bank 1,800 ft downstream from powerplant of Northern States Power Co., in St. Croix Falls, and at mile 52.2.

Gage-height record.--Digital recorder punched at 15-minute intervals. Datum of gage is 690.47 ft above mean sea level, adjustment of 1912.

Maxima.--April 1969: Discharge, 41,600 cfs 0100 hours Apr. 13 (gage height, 19.19 ft).
1902 to March 1969: Discharge, 54,900 cfs May 8, 1950 (gage height, 25.19 ft).

Remarks.--Flow affected by powerplant upstream.

Mean discharge, in cubic feet per second, 1969

[illegible]

ST. CROIX RIVER BASIN

405

St. Croix River at St. Croix Falls, Wis.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 10</u>			<u>Apr. 16</u>		
2400	4.00	6,950	0600	15.22	32,600	1200	17.54	37,800
			1200	15.65	33,600	2400	17.02	36,600
<u>Apr. 5</u>			1800	16.00	34,400			
0800	4.02	7,010	2400	16.36	35,200	<u>Apr. 17</u>		
1000	5.00	9,500				1200	16.34	35,100
1400	4.75	8,900	<u>Apr. 11</u>			2400	15.55	33,400
2000	4.73	8,850	0600	16.66	35,800			
2400	5.16	9,880	1200	16.96	36,500	<u>Apr. 18</u>		
			1800	17.30	37,300	1200	14.69	31,400
<u>Apr. 6</u>			2400	17.53	37,800	2400	13.92	29,700
0200	5.54	10,800						
1000	5.68	11,200	<u>Apr. 12</u>			<u>Apr. 19</u>		
1200	7.32	14,800	0600	17.86	38,500	1200	12.88	27,400
1800	7.21	14,600	1200	18.15	39,200	2400	12.08	25,600
2400	7.57	15,400	1800	18.26	39,400			
			2400	18.51	40,000	<u>Apr. 20</u>		
<u>Apr. 7</u>			<u>Apr. 13</u>			1200	11.49	24,200
0800	7.99	16,400	0100	19.19	41,600	2400	10.74	22,500
1600	8.41	17,300	0200	18.87	40,800			
2400	9.13	18,900	0600	18.69	40,500	<u>Apr. 21</u>		
			1200	18.68	40,400	1200	9.73	20,300
<u>Apr. 8</u>			1800	18.75	40,600	2400	9.23	19,200
0600	9.98	20,800	2400	18.74	40,600			
1200	11.20	23,600				<u>Apr. 22</u>		
1800	12.13	25,700	<u>Apr. 14</u>			1200	8.56	17,600
2400	12.46	26,400	0600	18.65	40,400	2400	7.95	16,200
			1200	18.55	40,100			
<u>Apr. 9</u>			1800	18.48	40,000	<u>Apr. 23</u>		
0600	13.25	28,200	2400	18.39	39,800	1200	7.41	15,000
1200	13.82	29,400				2400	6.95	14,000
1800	14.58	31,200	<u>Apr. 15</u>					
2400	14.81	31,700	0800	18.18	39,300	<u>Apr. 24</u>		
			1600	18.03	39,000	1200	6.55	13,100
			2400	17.82	38,400	2400	6.15	12,200

ST. CROIX RIVER BASIN

(160) St. Croix River at Prescott, Wis.

(Miscellaneous site)

Location.--Lat 44°44'56", long 92°48'12", in sec.9, T.26 N., R.20 W., at bridge on U.S. Highway 10, 600 ft upstream from Mississippi River, and 500 ft north of Chicago, Burlington and Quincy Railroad bridge in Prescott.

Gage-height record.--Floodmark and gage heights are those for Mississippi River at Prescott, Wis. Datum of gage is 600.00 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Discharge record.--Discharge obtained on the following days by current-meter measurements.

Date	Discharge, in cfs
Apr. 1, 1969	2,920
Apr. 11, 1969	27,100
Apr. 16, 1969	38,400
Apr. 24, 1969	19,100
Apr. 29, 1969	16,500

Location.--Lat 44°44'45", long 92°48'00", in sec.9, T.26 N., R.20 W., on left bank at Prescott, 200 ft downstream from St. Croix River, 300 ft south of Chicago, Burlington & Quincy Railroad bridge, 800 ft south of bridge on U.S. Highway 10, and at mile 811.4 upstream from Ohio River. Auxiliary water-stage recorder 10.7 miles downstream from base gage.

Gage-height record.--Base gage: Digital water-stage recorder tape punched at hour intervals. Datum of gage is 600.00 ft above mean sea level, adjustment of 1912 (levels by Corps of Engineers).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Fall was not a factor for computing the discharge during the period included in this report.

Remarks.--Some regulation by reservoirs, navigation dams, and powerplants at low and medium stages.

[illegible]

Location.--Lat 44°37'45", long 91°58'10", in SW 1/4 sec. 21, T. 25 N., R. 13 W., on left bank at Durand, 75 ft downstream from highway bridge and 9.5 miles downstream from Red Cedar River.

Gage-height record.--Digital recorder tape punched at sixty-minute intervals.
Datum of gage is 694.59 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 53,600 cfs 1600 Apr. 10 (gage height, 12.46 ft).
1928 to March 1969: Discharge, 123,000 cfs Apr. 2, 1967 (gage height, 16.93 ft).
Maximum stage known, 18.4 ft Sept. 12, 1884.

Remarks.--Flow partly regulated by powerplants, Moose Lake, Lake Chippewa, Rest Lake, Flambeau Flowage, and Lake Wissota on Chippewa and Flambeau Rivers, and Birch, Cedar, Bear, and Long Lakes on upper Red Cedar River.

[illegible]

CHIPPEWA RIVER BASIN

409

Chippewa River at Durand, Wis.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
2400	5.17	14,100	0400	10.23	35,100	1000	11.27	42,700
			0800	10.69	37,200	2000	10.67	38,400
<u>Apr. 5</u>			1200	11.09	39,600	2400	10.23	35,700
0600	5.25	14,400	1600	11.50	42,200			
1200	5.44	14,900	1800	11.70	43,700	<u>Apr. 14</u>		
1800	5.62	15,500	2000	11.86	45,200	0800	9.15	29,800
2400	5.96	16,800	2200	12.01	47,200	1600	9.13	29,600
			2400	12.12	49,200	2400	8.90	28,600
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 15</u>		
0800	6.55	19,200	0400	12.29	51,900	0600	8.19	25,800
1600	6.81	20,200	0800	12.39	52,900	1200	7.78	24,100
2400	7.11	21,400	1200	12.44	53,400	2400	7.62	23,500
			1600	12.46	53,600			
<u>Apr. 7</u>			2000	12.44	53,400	<u>Apr. 16</u>		
0400	7.49	23,000	2400	12.39	52,900	1200	7.33	22,300
0800	7.91	24,600				2400	7.02	21,100
1600	8.04	25,200	<u>Apr. 11</u>					
2400	8.46	26,800	0800	12.27	51,700	<u>Apr. 17</u>		
<u>Apr. 8</u>			1600	12.15	50,500	0600	6.64	19,600
0600	8.80	28,200	2400	12.06	49,600	1200	6.35	18,400
1200	8.99	29,000				2400	6.25	18,000
1800	9.14	29,700	<u>Apr. 12</u>					
2200	9.44	31,200	0800	11.99	48,900	<u>Apr. 18</u>		
2400	9.68	32,400	1600	11.88	47,800	1000	5.89	16,600
			2400	11.66	45,800	2400	5.63	15,500

(163) Mississippi River at Lock and Dam 4 near Alma, Wis.

(Miscellaneous site)

Location.--Lat $44^{\circ}20'$, long $91^{\circ}56'$, in sec.2, T.21 N., R.13 W., at Lock and Dam 4 in Alma, and at mile 752.87 above Ohio River.

Gage-height record.--Peak stages from pool and tailwater water-stage recorder graphs. Datum of gage is at mean sea level, adjustment of 1912.

Discharge record.--Corps of Engineers stage-discharge relation and two current-meter measurements made by Geological Survey.

Maxima.--April 1969: Discharge, 214,000 cfs Apr. 17, 18 (elevations, 674.20 ft pool, 673.60 ft tailwater).
1935 to March 1969: Discharge, 256,000 cfs Apr. 19, 1965 (elevations, 676.45 ft pool, 675.78 ft tailwater).

Cooperation.--Records furnished by Corps of Engineers.

Location.--Lat 44°03'20", long 91°38'15", in sec.23, T.107 N., R.7 W., on right bank at Winona pumping station in Winona, 9½ miles upstream from Trempealeau River and at mile 725.7 upstream from the Ohio River. Auxiliary digital water-stage recorder at navigation dam 5A in sec.9, T.107 N., R.7 W., 2.7 miles upstream.

Gage-height record.--Base gage: Digital water-stage recorder tape punched at hour intervals except 0800 hours Apr. 18 to 1000 hours Apr. 22 when graph was constructed on basis of hourly gage readings by Winona water plant employees and floodmark. Datum of gage is 639.64 ft above mean sea level, datum of 1929.

Discharge record.--Stage-fall-discharge relation affected by changes in slope and defined by current-meter measurements. Fall was a factor in computing discharge May 31.

Remarks.--Some regulation by reservoirs, navigation dams, and powerplants at low and medium stages. Flood flow not materially affected by artificial storage.

[illegible]

(165) 5-3835. Mississippi River at La Crosse, Wis.
(Gaging station, discontinued 1955)

Location.--Lat 43°48'45", long 91°15'25", in sec.31, T.16 N., R.7 W., on left bank 1,300 ft upstream from highway bridge at La Crosse, 0.4 mile downstream from La Crosse River, and at mile 697.8 above Ohio River.

Drainage area.--62,800 sq mi, approximately.

Gage-height record.--Gage reading on and near peak. Datum of gage is 626.32 ft above mean sea level, adjustment of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 214,000 cfs Apr. 20 (gage height, 15.7 ft).
1929 to March 1969: Discharge, 278,000 cfs Apr. 22, 1965 (gage height, 17.96 ft, from floodmark).

Flood of June 19, 1880 reached a stage of 16.5 ft, present datum, from floodmark. Maximum stage known, 17.96 ft Apr. 22, 1965, from floodmark.

Cooperation.--Gage heights for 1969 flood furnished by Corps of Engineers.

(166) Mississippi River at Lansing, Iowa

(Miscellaneous site)

Location.--NE $\frac{1}{4}$ sec.29, T.99 N., R.03 W., at bridge on State Highway 9 at Lansing.

Drainage area.--66,280 sq mi.

Discharge record.--Discharge obtained by current-meter measurement near peak.

Maxima.--April 1969: Discharge, 205,000 cfs Apr. 22 (elevation, 631.14 ft above mean sea level, adjustment of 1912).
1880 to March 1969: Discharge, 272,000 cfs Apr. 24, 1965 (elevation, 634.8 ft above mean sea level, adjustment of 1912); discharge obtained by current-meter measurement near peak.

Location.--Lat 43°01'30", long 91°10'20", in SE¼SE¼ sec.22, T.95 N., R.3 W., on right bank in city park at north end of Main Street in McGregor, 2.6 miles upstream from Wisconsin River, 4.3 miles downstream from Yellow River, and at mile 633.4 from Ohio River. Auxiliary gage located at site 14.1 miles upstream in tailwater of Dam 9.

Gage-height record.--Water-stage recorder graph. Datum of gage is 605.30 ft above mean sea level, adjustment of 1912, and auxiliary gage is 600.00 ft.

Maxima.--April-May 1969: Daily discharge 215,000 cfs Apr. 22. Gage height 21.57 ft 1200 hrs Apr. 22.

1936 to March 1969: Daily discharge 276,000 cfs Apr. 24, 1965 (gage height, 25.38 ft 0400 hrs Apr. 24, 1965).

Prior to 1936: Gage height about 21.0 ft June 1880.

[illegible]

WISCONSIN RIVER BASIN

(168) Wisconsin River at Bridgeport, Wisconsin
(Miscellaneous Site--Corps of Engineers gage)

Location--Lat 43°00'10", long 91°03'07", at northwest corner NE¼ sec.14, T.6 N., R. 6W., on right bank 200 feet upstream from bridge on U.S. Highway 18 and 5.1 miles upstream from Mississippi River.

Drainage area--11,700 sq mi.

Gage-height record--(By USGS) Occasional readings of chain gage and staff gages during discharge measurements. Variable backwater effect during high Mississippi River stages.

Discharge record--Occasional high-stage measurements to define Wisconsin River contribution to Mississippi River flow.

Remarks--Date, gage-height, and discharge of 1969 measurements are:

	(ft.)	(cfs)
April 9	22.20	22,700
April 15	25.49	41,100
April 23	26.47	17,500
April 28	24.47	14,400

(169) Mississippi River at Dubuque, Iowa

Location.--Lat 42°29', long 90°38', on right bank at the foot of Fourth Street in Dubuque, adjacent to and on the downstream side of the right abutment of the Illinois Central Railroad Bridge and at mile 579.9 above the Ohio River.

Drainage area.--81,600 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 584.95 ft above mean sea level, datum of 1929, 585.47 ft, datum of 1912.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Relation only applicable for discharges above 100,000 cfs.

Maxima.--April 1969: Daily discharge 230,000 cfs, Apr. 23. Gage height 23.11 ft, 2230 hrs. Apr. 23.

1965 to March 1969: Discharge 304,000 cfs, 0030 hrs Apr. 26, 1956 (gage height, 26.71 ft).

Remarks.--Current-meter measurements for Apr. 1969 furnished by Corps of Engineers. Gage-height record furnished by U.S. Weather Bureau.

Mean gage height, in feet, and discharge,
in cubic feet per second, April 1969

Day	Gage height	Discharge
15	18.10	149,000
16	19.14	165,000
17	20.09	179,000
18	20.89	192,000
19	21.45	202,000
20	22.00	211,000
21	22.52	220,000
22	22.90	226,000
23	23.10	230,000
24	23.08	229,000
25	22.90	226,000
26	22.60	221,000
27	22.24	215,000
28	21.80	208,000
29	21.23	198,000
30	20.57	187,000

Mean gage height, in feet, and discharge, in cubic feet per second, 1969							
Day	April		May		Day	April	
	Gage height	Dis-charge	Gage height	Dis-charge		Gage height	Dis-charge
1	12.66	83,900	20.04	202,000	16	16.40	146,000
2	13.15	90,900	19.56	193,000	17	17.21	159,000
3	13.26	91,600	19.04	185,000	18	18.01	173,000
4	13.25	91,600	18.44	175,000	19	18.60	181,000
5	13.37	94,000	17.80	165,000	20	19.13	192,000
6	13.66	99,800	17.22	156,000	21	19.79	203,000
7	13.81	101,000	16.76	149,000	22	20.56	214,000
8	13.79	102,000	16.44	144,000	23	21.01	222,000
9	13.77	102,000	16.16	139,000	24	21.30	228,000
10	13.83	103,000	15.99	136,000	25	21.47	231,000
11	14.01	106,000	15.82	133,000	26	21.50	231,000
12	14.29	111,000	15.65	131,000	27	21.44	230,000
13	14.67	117,000	15.45	127,000	28	21.28	224,000
14	15.11	124,000	15.22	124,000	29	20.96	219,000
15	15.67	134,000			30	20.54	211,000
					31	--	--
Monthly mean discharge, in cubic feet per second.....							153,900
Runoff, in inches.....							2.01

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Location.--Lat 40°23'35", long 91°22'25", in SE¼SW¼ sec.30, T.65 N., R.4 W., near right bank in tailwater at downstream end of new lock below dam and powerplant of Union Electric Co. at Keokuk, 2.8 miles upstream from Des Moines River and at mile 364.2 upstream from Ohio River.

Gage-height record.--Water-stage recorder. Datum of gage is 477.41 ft above mean sea level, datum of 1929 (levels by Corps of Engineers); 477.83 ft above mean sea level, adjustment of 1912; 477.34 ft above mean gulf level; and 484.65 ft above Memphis datum. Jan. 1, 1878, to May 1913, staff gage at Galland (formerly Nashville), 8 miles upstream; zero of gage was set to low-water mark of 1864, or 497.94 ft above mean sea level, adjustment of 1912.

Flood of June 6, 1851, reached a stage of 21.0 ft, present site and datum; estimated as 13.5 ft at Galland (discharge, 360,000 cfs).

Mean discharge, in cubic feet per second, 1909								
Day	April	May	Day	April	May	Day	April	May
1...	130,500	246,500	11...	150,900	173,800	21...	216,300	128,300
2...	132,500	241,800	12...	152,300	168,900	22...	224,000	124,300
3...	136,100	232,800	13...	154,600	166,300	23...	232,400	122,000
4...	137,900	223,600	14...	158,400	162,700	24...	239,700	120,500
5...	138,800	214,000	15...	160,300	158,700	25...	248,400	117,400
6...	137,200	206,000	16...	165,400	153,700	26...	253,200	114,200
7...	140,800	199,000	17...	174,000	150,300	27...	250,700	110,800
8...	146,800	192,700	18...	188,400	145,300	28...	244,500	108,600
9...	148,500	185,900	19...	195,800	139,000	29...	247,200	102,400
10...	149,000	181,400	20...	204,800	134,700	30...	250,100	98,400
						31...	---	92,500
Monthly mean discharge, in cubic feet per second							183,650	158,600
Runoff, in inches							1.72	1.54

(172) West Fork Des Moines River at outlet of
Talcot Lake near Dundee, Minn.

(Miscellaneous site)

Location.--Lat $43^{\circ}53'$, long $95^{\circ}26'$, near center of sec.20, T.105 N., R.38 W.,
at outlet of Talcot Lake, $3\frac{1}{4}$ miles northeast of Dundee.

Gage-height record.--Occasional staff gage readings during the flood. Datum
of gage is 1,395.32 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments.

Maxima.--April 1969: Discharge, 8,730 cfs Apr. 9, 1969 (gage height,
12.48 ft).

Remarks.--Regulation by Talcot Lake other than natural storage was nullified
at peak as control structure experienced practically total submergence.

(173) West Fork Des Moines River at Windom, Minn.

(Miscellaneous site)

Location.--Lat $43^{\circ}55'$, long $95^{\circ}07'$, on line between secs.25 and 36, T.105 N.,
R.36 W., at bridge on State Highway 62 in Windom.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments.

Maxima.--April 1969: Discharge, 15,000 cfs 0400 hours Apr. 11 (elevation,
1,352.8 ft above mean sea level, datum of 1929).

Flood of Apr. 8, 1965 reached an elevation of 1,351.4 ft.

Cooperation.--Maximum elevation for 1969 flood furnished by Siouxland
Engineering Company of Windom.

(174) 5-4758. West Fork Des Moines River tributary near Jackson, Minn.

(Crest-stage station)

Location.--Lat $43^{\circ}41'40''$, long $95^{\circ}01'30''$, in NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.27, T.103 N., R.35 W., at culvert on county highway, three-quarters of a mile above mouth, and $5\frac{1}{2}$ miles north of Jackson.

Drainage area.--1.42 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage discharge relation defined by current-meter measurements below 7 cfs and by indirect measurements at 23 cfs and 77 cfs.

Maxima.--April 1969: Discharge, 77 cfs Apr. 6 (gage height, 15.55 ft); gage height, 17.57 ft Apr. 4 (backwater from ice).

1960 to March 1969: Discharge, 69 cfs Mar. 28, 1962 (gage height, 16.34 ft, backwater from ice).

(175) 5-4759. West Fork Des Moines River tributary near Lakefield, Minn.

(Crest-stage station)

Location.--Lat $43^{\circ}40'30''$, long $95^{\circ}03'20''$, in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.32, T.103 N., R.35 W., at culvert on county highway 19, $1\frac{1}{2}$ miles above mouth, and $5\frac{3}{4}$ miles east of Lakefield.

Drainage area.--4.52 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 50 cfs and by indirect measurements at 119 cfs and 221 cfs.

Maxima.--April 1969: Discharge, 221 cfs Apr. 7 (gage height, 8.76 ft).

1960 to March 1969: Discharge, 119 cfs June 9, 1963 (gage height, 7.00 ft).

Location.--Lat 43°37'10", long 94°59'10", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.24, T.102 N., R.35 W., on right bank in storage room of city powerplant in Jackson.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,287.75 ft
above mean sea level, datum of 1929.

Maxima.---April 1969: Discharge, 15,700 cfs 1600 hours Apr. 11 (gage height, 19.45 ft).

1909-13, 1930 to March 1969: Discharge, 9,530 cfs Apr. 9, 1965; gage height, 18.62 ft Apr. 6, 1965 (from floodmark, backwater from ice).

[illegible]

DES MOINES RIVER BASIN

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West Fork Des Moines River at Jackson, Minn.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 7</u>			<u>Apr. 15</u>		
2400	5.25		1200	14.33		1200	17.32	9,910
			1800	15.14		2400	17.09	9,370
<u>Apr. 1</u>			2400	15.34	6,130	<u>Apr. 16</u>		
1200	5.35					2400	16.55	8,240
2400	5.76		<u>Apr. 8</u>			<u>Apr. 17</u>		
			0600	15.63	6,600	2400	16.04	7,270
<u>Apr. 2</u>			1200	16.09	7,360	<u>Apr. 18</u>		
1200	6.05		1800	16.96	9,080	2400	15.54	6,450
2400	6.35		2400	17.49	10,300	<u>Apr. 19</u>		
<u>Apr. 3</u>						2400	15.13	5,820
1200	6.62		<u>Apr. 9</u>			<u>Apr. 20</u>		
2400	8.00		1200	18.02	11,700	2400	14.76	5,350
			2400	18.55	13,100	<u>Apr. 21</u>		
<u>Apr. 4</u>			<u>Apr. 10</u>			2400	14.36	4,880
1200	9.70		1200	18.89	14,100	<u>Apr. 22</u>		
2000	10.49		2400	19.23	15,100	1200	14.08	4,570
2400	10.55					2400	13.75	4,260
<u>Apr. 5</u>			<u>Apr. 11</u>			<u>Apr. 23</u>		
1200	10.26		1200	19.41	15,600	1200	13.41	3,950
2000	11.50		1600	19.45	15,700	2400	13.21	3,770
2400	11.74		2400	19.42	15,600	<u>Apr. 24</u>		
<u>Apr. 6</u>			<u>Apr. 12</u>			2400	13.01	3,590
0800	11.90		1200	19.27	15,200			
1200	11.60		2400	18.98	14,300			
1800	12.06		<u>Apr. 13</u>					
2400	12.92		1200	18.64	13,400			
			2400	18.27	12,300			
<u>Apr. 7</u>			<u>Apr. 14</u>					
0300	13.11		1200	17.91	11,400			
0400	13.71		2400	17.63	10,700			
0900	13.72							

(177) 5-4761. Story Brook near Petersburg, Minn.

(Crest-stage station)

Location.--Lat $43^{\circ}32'20''$, long $94^{\circ}59'40''$, in $SW\frac{1}{4}NW\frac{1}{4}$ sec.24, T.101 N., R.35 W., at bridge on U.S. Highway 71, 3 miles above mouth, and 4 miles west of Petersburg.

Drainage area.--25.2 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,500 cfs and by indirect measurement at 2,110 cfs.

Maxima.--April 1969: Discharge, 1,790 cfs Apr. 6 (gage height, 12.50 ft); gage height, 16.54 ft Apr. 5 (backwater from ice).
1960 to March 1969: Discharge, 2,110 cfs July 4, 1962 (gage height, 12.77 ft).

423

Location.--Lat 43°24'00", long 94°50'40", in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.10, T.99 N., R.34 W., on right bank in city park, 1,200 ft downstream from bridge on State Highway 9 at Estherville, 2.5 miles upstream from Brown Creek, and at mile 404.2 upstream from mouth of Des Moines River.

Gage-height record.--Digital water-stage recorder except Apr. 10-17. Graph reconstructed from daily outside staff gage readings Apr. 10-17. Datum of gage is 1,247.55 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 16,000 cfs Apr. 12 (gage height, 17.68 ft, from floodmark).
1951 to March 1969: Discharge, 10,800 cfs June 8, 1953 (gage height, 15.53 ft); maximum gage height, 15.61 ft Apr. 10, 1965.

[illegible]

DES MOINES RIVER BASIN

West Fork Des Moines River at Estherville, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	4.37		0600	12.62	5,530	0300	17.68	16,000
			1200	12.78	5,710	0600	17.67	16,000
<u>Apr. 3</u>			1800	12.84	5,770	1200	17.65	15,900
1200	4.50		2400	12.98	5,930	1800	17.58	15,700
1800	4.94					2400	17.48	15,300
2400	5.64	1,300	<u>Apr. 8</u>			<u>Apr. 13</u>		
			0600	13.66	6,790	0600	17.37	14,900
<u>Apr. 4</u>			1200	14.08	7,370	1200	17.22	14,400
0600	6.38	1,600	1800	14.32	7,730	1800	17.06	13,900
1200	7.09	1,920	2400	14.80	8,500	2400	16.87	13,200
1800	7.83	2,250						
2400	8.42	2,520	<u>Apr. 9</u>			<u>Apr. 14</u>		
			0600	15.48	9,810	1200	16.51	12,100
<u>Apr. 5</u>			1200	15.99	10,800	2400	16.17	11,300
0600	8.79	2,710	1800	16.32	11,600			
1200	9.07	2,850	2400	16.56	12,300	<u>Apr. 15</u>		
1800	9.97	3,380				1200	15.81	10,500
2400	10.30	3,610	<u>Apr. 10</u>			2400	15.56	9,970
			0600	16.82	13,100			
<u>Apr. 6</u>			1200	17.02	13,700	<u>Apr. 16</u>		
0600	10.21	3,550	1800	17.20	14,400	1200	15.27	9,390
1200	11.08	4,160	2400	17.35	14,900	2400	14.93	8,730
1800	11.69	4,650						
2400	12.13	5,020	<u>Apr. 11</u>			<u>Apr. 17</u>		
			0600	17.47	15,300	1200	14.59	8,140
			1200	17.57	15,600	2400	14.25	7,620
			1800	17.63	15,900			
			2400	17.67	16,000			

(179) West Fork Des Moines River near Emmetsburg, Iowa
(Miscellaneous Site)

Location--Lat $43^{\circ}08'$, long $94^{\circ}43'$, in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.23, T.96 N., R.33 W., at U.S. Highway 18 bridge 1 mile northwest of Emmetsburg and at mile 380.6 above mouth of Des Moines River (U.S. Geological Survey profile).

Drainage area--1,671 sq mi.

Gage-height record--High-water mark elevation in feet above mean sea level, datum of 1929.

Discharge record--Peak discharge measurement with current meter.

Maxima--April 1969: Discharge, 16,100 cfs Apr. 12 (elevation, 1210.5 ft).
No prior record at site.

Location.--Lat 42°43'10", long 94°13'10", in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.1, T.91 N., R.29 W., on left bank 5 ft downstream from First Avenue bridge in city of Humboldt, about 700 ft below dam, 3.9 miles upstream from confluence with East Fork Des Moines River, and at mile 334.3 upstream from mouth of Des Moines River.

Gage-height record.--Digital water-stage recorder except Apr. 13-19 when graph based on once-daily or more frequent wire-weight gage readings were used. Datum of gage is 1,053.54 ft above mean sea level, datum 1929.

Maxima.--April 1969: Discharge, 18,000 cfs Apr. 14 (gage height, 15.40 ft).
1965 to March 1969: Discharge, 14,400 cfs Apr. 8, 1965 (gage height, 13.90 ft).
Flood of June 23, 1947, reached a stage of 12.2 ft (discharge, 11,000 cfs).

[illegible]

DES MOINES RIVER BASIN

427

West Fork Des Moines River at Humboldt, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 8</u>			<u>Apr. 14</u>		
2400	6.46	2,680	1200	8.95	5,830	0600	15.27	17,700
			2400	9.04	5,960	1200	15.35	17,900
<u>Apr. 3</u>						2000	15.40	18,000
0600	6.43	2,650	<u>Apr. 9</u>			2400	15.38	18,000
1200	6.70	2,940	1200	9.13	6,100			
1800	6.90	3,160	2400	9.20	6,200	<u>Apr. 15</u>		
2400	7.14	3,430				0600	15.31	17,800
			<u>Apr. 10</u>			1200	15.22	17,600
<u>Apr. 4</u>			1200	9.48	6,620	1800	15.12	17,400
0600	7.61	4,000	2400	9.82	7,130	2400	14.99	17,000
1200	7.95	4,450						
1800	7.84	4,300	<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	7.82	4,280	0600	10.08	7,520	0600	14.85	16,700
			1200	10.38	8,020	1200	14.70	16,400
<u>Apr. 5</u>			1800	10.81	8,770	1800	14.53	16,100
0600	7.97	4,470	2400	11.34	9,700	2400	14.33	15,700
1200	8.17	4,730						
1800	8.34	4,950	<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	8.48	5,130	0600	12.02	11,000	1200	13.97	14,900
			1200	12.83	12,700	2400	13.58	14,200
<u>Apr. 6</u>			1800	13.55	14,100			
1200	8.67	5,410	2400	14.02	15,000	<u>Apr. 18</u>		
2400	8.81	5,620				1200	13.21	13,400
			<u>Apr. 13</u>			2400	12.81	12,600
<u>Apr. 7</u>			0400	14.32	15,600			
1200	8.89	5,740	0800	14.56	16,100	<u>Apr. 19</u>		
2400	8.92	5,780	1200	14.76	16,500	1200	12.38	11,800
			1800	14.98	17,000	2400	12.11	11,100
			2400	15.14	17,400			

(181) 5-4769. East Fork Des Moines River tributary near Dunnell, Minn.

(Crest-stage station)

Location.--Lat 43°35'00", long 94°46'25", in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.2, T.101 N., R.33 W., at bridge on State Highway 4, a half mile above mouth, and 1 $\frac{1}{2}$ miles north of Dunnell.

Drainage area.--7.88 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 410 cfs and by indirect measurement at 2,200 cfs.

Maxima.--April 1969: Discharge, 421 cfs Apr. 6 (gage height, 13.71 ft).
1960 to March 1969: Discharge, 2,200 cfs July 4, 1962 (gage height, 16.15 ft).

(182) 5-4790. East Fork Des Moines River at Dakota City, Iowa
(Published as "near Hardy" 1940-54)

Location.--Lat 42°43'25", long 94°11'30", in NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.6, T.91 N., R.28 W., on right bank 50 ft upstream from old mill dam, in city park at east edge of Dakota City, 500 ft upstream from county highway bridge, 0.6 mile downstream from bridge on State Highway 3, 3.4 miles upstream from confluence with West Fork Des Moines River and at mile 333.8 upstream from mouth of Des Moines River.

Drainage area.--1,308 sq mi.

Gage-height record.--Digital water-stage recorder. Datum of gage is 1,038.71 ft above mean sea level, datum of 1929.

Discharge record.--Stage discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 5,990 cfs Apr. 9 (gage height, 16.21 ft).
1940 to March 1969: Discharge, 17,400 cfs June 21, 1954 (gage height, 24.02 ft).

Remarks.--Flood of Sept. 1938 reached a stage of 17.4 ft (discharge, 22,000 cfs) and flood of June 21, 1954 reached a stage of 16.95 ft, from flood-mark, (discharge, 18,800 cfs) site and datum then in use near Hardy, Iowa.

DES MOINES RIVER BASIN

429

East Fork Des Moines River at Dakota City, Iowa

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	3,770	8....	5,560	15....	4,580	23....	2,620
2.....	3,480	9....	5,890	16....	4,410	24....	2,390
3.....	3,210	10....	5,890	17....	4,240	25....	2,190
4.....	3,700	11....	5,480	18....	4,190	26....	2,040
5.....	4,190	12....	5,060	19....	3,870	27....	1,930
6.....	4,650	13....	4,870	20....	3,520	28....	1,820
7.....	5,060	14....	4,750	21....	3,180	29....	1,730
				22....	2,890	30....	1,640
Monthly mean discharge, in cubic feet per second.....							3,760
Runoff, in inches							3.21

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 5</u>			<u>Apr. 9</u>		
2400	13.48	3,440	1200	14.35	4,180	1200	16.12	5,890
			2400	14.62	4,420	2400	16.21	5,990
<u>Apr. 3</u>			<u>Apr. 6</u>			<u>Apr. 10</u>		
0600	13.23	3,240	1200	14.87	4,640	1200	16.14	5,910
1200	13.11	3,150	2400	15.13	4,890	2400	15.96	5,720
2400	13.12	3,160						
<u>Apr. 4</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
0200	13.13	3,160	1200	15.29	5,050	1200	15.73	5,490
0400	13.54	3,490	2400	15.49	5,250	2400	15.48	5,240
0600	13.67	3,600						
1200	13.84	3,730	<u>Apr. 8</u>			<u>Apr. 12</u>		
1800	14.00	3,860	1200	15.83	5,590	1200	15.28	5,040
2400	14.13	3,980	2400	16.03	5,790	2400	15.17	4,930

Location.--Lat 42°30'25", long 94°12'00", in NW¹SW¹₄ sec.19, T.89 N., R.28 W., on right bank 400 ft upstream from Soldier Creek, 1,800 ft downstream from Illinois Central Railroad bridge in Fort Dodge, 2,000 ft downstream from Lizard Creek, and at mile 314.6.

Gage-height record.--Digital water-stage recorder. Datum of gage is 969.38 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 22,900 cfs Apr. 15 (gage height, 12.83 ft).
1905-6, 1913-27, 1946 to March 1969: Discharge, 35,600 cfs Apr. 8,
1965 (gage height, 17.79 ft).
Maximum stage known, 19.62 ft June 23, 1947, from floodmark (discharge,
34,000 cfs).

[illegible]

DES MOINES RIVER BASIN

431

Des Moines River at Fort Dodge, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 8</u>			<u>Apr. 14</u>		
2400	7.61	8,430	1200	9.37	13,000	0600	12.65	22,400
			2400	9.47	13,300	1200	12.77	22,700
<u>Apr. 4</u>						1800	12.81	22,800
0300	7.90	9,150	<u>Apr. 9</u>			2400	12.82	22,900
0600	8.68	11,100	1200	9.52	13,400			
0900	9.02	12,000	2400	9.54	13,500	<u>Apr. 15</u>		
1600	9.16	12,400				0145	12.83	22,900
2400	9.08	12,200	<u>Apr. 10</u>			1200	12.76	22,700
			1200	9.64	13,800	2400	12.63	22,300
<u>Apr. 5</u>			2400	9.66	13,800			
1200	9.09	12,200	<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	9.16	12,400	1200	9.77	14,100	1200	12.50	21,900
			2400	10.05	14,900	2400	12.17	20,900
<u>Apr. 6</u>						<u>Apr. 17</u>		
0600	9.26	12,700	<u>Apr. 12</u>			1200	11.93	20,200
1200	9.16	12,400	0600	10.40	15,900	2400	11.96	20,300
2400	9.28	12,700	1200	10.70	16,700			
			1800	11.13	17,900	<u>Apr. 18</u>		
<u>Apr. 7</u>			2400	11.52	19,000	1200	11.68	19,500
1200	9.27	12,700				2400	11.32	18,500
2400	9.32	12,900	<u>Apr. 13</u>					
			0600	11.87	20,000			
			1200	12.17	20,900			
			1800	12.33	21,400			
			2400	12.49	21,900			

Location.--Lat 48°17'04", long 103°34'21", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.5, T.155 N., R.100 W., on left bank 37 ft downstream from center line of highway, 1 mile downstream from Cow Creek, 4 miles upstream from Camp Creek, 10 miles northeast of Williston, and 13 miles upstream from mouth.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals.

Maxima.--April 1969: Discharge, 4,380 cfs 0545 hours Apr. 4 (gage height, 12.43 ft).
1955 to March 1969: Discharge, 6,910 cfs Mar. 27, 1960 (gage height, 13.57 ft).

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1907							
Day	April	Day	April	Day	April	Day	April
1.....	383	8....	776	15....	104	23....	63
2.....	596	9....	413	16....	109	24....	62
3.....	2,090	10....	261	17....	108	25....	61
4.....	3,620	11....	190	18....	93	26....	70
5.....	2,460	12....	154	19....	79	27....	69
6.....	2,150	13....	132	20....	72	28....	77
7.....	1,210	14....	114	21....	70	29....	66
				22....	66	30....	64
Monthly mean discharge, in cubic feet per second							526
Runoff, in acre-feet							31,300

LITTLE MUDDY CREEK BASIN

433

Little Muddy Creek below Cow Creek near Williston, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 9</u>		
2400	8.64	322	1600	11.83	3,350	0800	8.29	439
			2400	11.46	2,800	1600	8.07	371
<u>Apr. 1</u>						2400	7.90	322
0600	8.64	322	<u>Apr. 5</u>					
1500	8.65	335	0400	11.33	2,630	<u>Apr. 10</u>		
1800	8.84	392	1000	11.30	2,590	0800	7.75	272
2400	9.29	556	1400	11.03	2,250	1600	7.64	245
			1600	11.25	2,520	2400	7.54	222
<u>Apr. 2</u>			2000	10.99	2,200			
0800	8.83	512	2400	11.22	2,490	<u>Apr. 11</u>		
1400	8.76	484				0800	7.45	196
1800	9.04	598	<u>Apr. 6</u>			1600	7.38	182
2400	9.50	825	0600	11.45	2,790	2400	7.31	169
			1200	10.94	2,140			
<u>Apr. 3</u>			1800	10.48	1,670	<u>Apr. 12</u>		
0600	9.88	1,200	2400	10.18	1,420	0800	7.26	157
1000	10.46	1,650				1600	7.23	152
1400	11.39	2,710	<u>Apr. 7</u>			2400	7.19	145
1800	11.56	2,940	0600	9.99	1,350			
2000	11.48	2,830	1200	9.83	1,230	<u>Apr. 13</u>		
2400	11.91	3,480	1800	9.59	1,060	1200	7.12	133
			2400	9.38	928	2400	7.05	121
<u>Apr. 4</u>								
0200	12.23	4,010	<u>Apr. 8</u>			<u>Apr. 14</u>		
0400	12.37	4,270	0800	9.13	847	1200	7.01	115
0545	12.43	4,380	1600	8.87	710	2400	6.96	107
1000	12.28	4,100	2400	8.57	572			

Location.--Lat 48°23', long 102°46', in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.36, T.157 N., R.94 W., 35 ft upstream from bridge on county highway, a quarter of a mile east of White Earth.

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,070.00 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 2,040 cfs 0330 hours Apr. 6 (gage height, 17.58 ft).

1955 to March 1969: Discharge, 2,300 cfs Mar. 28, 1960 (gage height, 18.02 ft. backwater from ice).

Flood of 1929 reached a stage of 21.8 ft (former site and datum) from information by local residents.

Mean discharge, in cubic feet per second, 1969

[illegible]

WHITE EARTH RIVER BASIN

435

White Earth River at White Earth, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 3</u>			<u>Apr. 6</u>		
2400	4.25	52	1700	13.54	1,000	1630	15.45	1,580
			2100	13.60	1,010	2000	16.47	1,780
<u>Apr. 1</u>			2400	13.85	1,060	2400	17.26	1,960
0600	4.62	65						
1300	4.82	72	<u>Apr. 4</u>			<u>Apr. 7</u>		
1700	5.00	80	0300	14.00	1,090	0300	17.47	2,020
2400	5.50	105	0900	12.86	908	1200	16.98	1,900
			1600	11.73	734	2400	15.69	1,630
<u>Apr. 2</u>			2000	12.43	840			
0800	5.43	104	2400	13.35	986	<u>Apr. 8</u>		
1200	5.73	121				0600	15.01	1,490
1500	6.05	140	<u>Apr. 5</u>			1200	14.44	1,380
1800	7.13	216	0300	13.86	1,050	2400	13.64	1,220
2000	7.90	283	1200	12.53	855			
2100	8.85	376	1800	14.01	1,190	<u>Apr. 9</u>		
2215	9.85	496	2000	15.31	1,500	0800	12.80	1,050
2245	9.55	496	2400	17.15	1,940	1600	11.80	882
2330	9.98	520				2400	11.50	835
2400	10.47	577	<u>Apr. 6</u>					
			0330	17.58	2,040	<u>Apr. 10</u>		
<u>Apr. 3</u>			0900	16.46	1,780	0800	10.71	717
0400	12.21	799	1400	15.48	1,590	1400	10.04	625
0900	12.99	912	1500	15.59	1,610	2400	9.66	576

(Hydrologic bench mark station)

Maxima.--April 1969: Discharge, about 1,100 cfs 0030 hours Apr. 6 (gage height, 10.03 ft).
1967 to March 1969: Discharge, 290 cfs Mar. 22, 1967 (gage height, 7.90 ft, backwater from ice).

Mean discharge, in cubic feet per second, 1969

[illegible]

BEAR DEN CREEK BASIN

437

Bear Den Creek near Mandaree, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 6</u>		
2400	4.29		1600	4.31	305	2400	4.50	355
			2400	4.26	290			
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 7</u>		
0200	4.29	115	0600	4.18	270	0600	4.05	235
0600	4.54	190	1100	3.89	190	1200	3.75	155
1200	4.72	265	1400	4.11	250	2400	3.74	150
2400	4.56	195	1700	4.96	460			
<u>Apr. 2</u>			1900	5.66	600	<u>Apr. 8</u>		
1400	4.37	130	2400	6.71	770	1200	3.58	115
1600	4.42	150				2400	3.49	95
1800	5.08	490	<u>Apr. 6</u>			<u>Apr. 9</u>		
2100	5.92	650	0030	10.03	1,100	1200	3.29	55
2400	7.12	840	0130	9.67	1,090	2000	3.26	48
			0145	8.52	1,060	2300	3.47	88
<u>Apr. 3</u>			0200	7.62	985	2400	3.37	67
0400	6.41	735	0230	6.22	830			
0800	5.58	590	0330	5.00	580	<u>Apr. 10</u>		
1200	5.15	505	0800	4.45	340	0600	3.20	39
2400	5.04	480	1200	4.00	225	1600	3.05	24
			2200	4.65	425	2400	3.05	24
<u>Apr. 4</u>								
1000	4.63	380						

Location.--Lat 48°03', long 102°08', in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.29, T.153 N., R.89 W., on left bank 800 ft downstream from bridge on county highway 6 miles northwest of Parshall.

Gage-height record.--Water-stage recorder graph.

Maxima.--April 1969: Discharge, 2,270 cfs 2300 hours Apr. 6 (gage height, 7.57 ft from recorder graph, 7.60 ft from floodmarks).
1966 to March 1969: Discharge, 458 cfs July 1, 1966 (gage height, 5.52 ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

SHELL CREEK BASIN

439

Shell Creek near Parshall, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 9</u>		
2400	4.48	8.1	1500	6.14	206	0800	6.32	946
			1700	6.70	580	1630	6.11	806
<u>Apr. 2</u>			2030	7.02	1,110	1900	6.15	830
1330	4.23	5.1	2400	6.75	1,320	2400	6.03	758
1900	4.53	9.1						
2400	4.79	13	<u>Apr. 6</u>			<u>Apr. 10</u>		
			0830	6.42	1,030	0800	5.73	595
<u>Apr. 3</u>			1200	6.55	1,140	1600	5.32	418
0430	4.96	17	1600	6.83	1,390	2000	5.54	506
0900	5.18	23	2000	7.37	2,000	2400	5.44	466
1100	5.06	22	2300	7.57	2,270			
2400	5.45	39	2400	7.55	2,240	<u>Apr. 11</u>		
						1300	5.01	306
<u>Apr. 4</u>			<u>Apr. 7</u>			1600	4.94	285
1200	5.38	44	0900	7.16	1,740	2100	4.98	297
1500	5.58	64	1100	7.20	1,790	2400	5.02	309
1600	5.89	112	1630	7.04	1,600			
1700	5.84	119	2400	6.85	1,410	<u>Apr. 12</u>		
2200	6.16	180				0100	5.00	303
2400	6.16	180	<u>Apr. 8</u>			1200	4.64	206
			1200	6.68	1,250	2400	4.54	186
<u>Apr. 5</u>			2400	6.60	1,180			
0800	5.90	150						

Location.--Lat 47°14', long 102°46', in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.6, T.143 N., R.95 W., on left bank 50 ft downstream from bridge on State Highway 22, 0.4 mile north of Manning.

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,156.55 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 1,060 cfs 0300 hours Apr. 4 (gage height, 14.48 ft).

1968 to March 1969: Discharge, 420 cfs Mar. 2, 1968 (gage height, 10.44 ft. backwater from ice).

[illegible]

KNIFE RIVER BASIN

441

Knife River at Manning, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 7</u>		
2400	7.38	225	0300	14.48	1,060	0300	10.88	625
			0900	14.08	1,010	0600	9.82	508
<u>Apr. 1</u>			1200	13.50	940	1130	9.05	423
0700	8.00	282	1500	12.75	850	1800	9.85	511
1200	8.75	358	1800	12.29	795	2000	9.96	524
1500	9.57	445	2100	11.75	730	2400	9.52	475
1800	10.44	544	2400	11.45	694			
2200	11.07	614				<u>Apr. 8</u>		
2400	11.10	617	<u>Apr. 5</u>			0300	8.81	397
			0400	10.88	626	0600	8.13	329
<u>Apr. 2</u>			0800	9.91	519	1200	7.25	245
0600	11.32	642	1200	9.10	430	1400	7.17	237
1100	11.38	650	1500	8.59	376	2100	7.52	269
1400	11.30	646	1800	9.02	421	2400	7.40	258
1600	11.92	726	2100	9.57	482			
1800	12.75	838	2400	9.79	506	<u>Apr. 9</u>		
2200	13.41	923				0600	6.76	200
2400	13.31	917	<u>Apr. 6</u>			1200	6.16	151
			0300	9.83	509	2400	5.71	119
<u>Apr. 3</u>			0800	10.22	552			
0300	13.37	924	1200	10.68	603	<u>Apr. 10</u>		
0800	13.87	984	1600	11.39	698	1200	5.41	101
1530	14.13	1,020	2100	12.28	792	2400	5.01	77
1800	13.97	996	2400	11.87	743			
2400	14.40	1,050						

Location.--Lat 47°06', long 102°03', in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.23, T.142 N., R.90 W., on right bank 60 ft upstream from Mercer County highway bridge 13.5 miles south of Golden Valley.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,915.18 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 980 cfs 0500 hours Apr. 4 (gage height, 17.25 ft).
1968 to March 1969: Discharge, 191 cfs Mar. 5, 1968 (gage height, 7.20 ft).

[illegible]

KNIFE RIVER BASIN

443

Elm Creek near Golden Valley, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 8</u>		
2400	5.02	64	1000	16.15	880	0500	8.32	264
			1400	15.10	786	1100	8.65	288
<u>Apr. 1</u>			1800	13.95	693	1800	8.10	249
0600	4.76	54	2100	12.65	589	2000	7.10	179
1200	4.60	48	2400	11.50	497	2400	6.35	133
1500	5.23	35						
1700	5.85	104	<u>Apr. 5</u>			<u>Apr. 9</u>		
1900	6.85	163	0300	10.35	412	0600	6.00	112
2400	7.60	214	0700	9.38	346	1200	5.82	102
			1000	8.70	291	1800	5.82	102
<u>Apr. 2</u>			1400	7.90	235	2400	5.45	84
0300	7.80	228	1800	8.58	283			
1000	7.45	204	2100	9.55	351	<u>Apr. 10</u>		
1500	7.95	238	2400	10.55	426	0800	5.00	63
1700	9.00	312				1400	4.65	50
1900	9.50	347	<u>Apr. 6</u>			2400	4.57	47
2400	10.00	387	0200	11.55	501			
			0500	12.50	577	<u>Apr. 11</u>		
<u>Apr. 3</u>			1100	13.16	630	1200	4.29	37
0300	10.95	458	1600	11.95	533	2400	4.20	34
0600	11.90	529	2000	10.85	450			
1100	12.35	565	2400	11.55	501	<u>Apr. 12</u>		
1500	12.16	550				1200	4.20	33
1900	12.70	593	<u>Apr. 7</u>			2400	4.10	30
2200	13.30	641	0400	12.60	585			
2400	14.50	737	1100	13.86	686	<u>Apr. 13</u>		
			1500	12.80	601	1200	4.00	26
<u>Apr. 4</u>			1700	11.50	497	2400	3.88	22
0100	15.55	826	1900	10.30	408			
0300	16.90	948	2100	9.20	326	<u>Apr. 14</u>		
0500	17.25	980	2400	8.55	280	1200	3.85	21
						2400	3.75	18

Location.--Lat 47°09', long 102°03', in SE¼ sec.34, T.143 N., R.90 W., on left bank 6 ft downstream from highway bridge, 4½ miles downstream from Elm Creek, and 9 miles south of Golden Valley.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,847.13 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 5,410 cfs 1730 hours Apr. 4 (gage height, 22.67 ft, backwater from ice).

1943-44, 1947 to March 1969: Discharge, 10,900 cfs Apr. 16, 1950 (gage height, 26.37 ft, backwater from ice).

Flood of Mar. 26, 27, 1943, reached a stage of 26.7 ft, from flood-mark (discharge, 11,500 cfs). The flood in 1943 was the only major flood in period 1903-49, according to local residents.

[illegible]

Knife River near Golden Valley, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 5</u>			<u>Apr. 10</u>		
2400	9.03	512	0400	21.63	4,760	1800	9.15	840
			0800	21.00	4,410	2400	8.79	768
<u>Apr. 1</u>			1200	20.20	4,050			
0600	9.13	526	1500	19.75	3,880	<u>Apr. 11</u>		
1000	8.90	489	1900	19.20	3,670	0600	8.43	696
1600	9.43	572	2400	18.78	3,510	1200	8.02	625
2100	10.08	676				1800	7.58	560
2400	10.68	800	<u>Apr. 6</u>			2400	7.18	500
			0200	18.73	3,500			
<u>Apr. 2</u>			1100	19.02	3,610	<u>Apr. 12</u>		
0300	11.35	938	1500	18.74	3,500	0800	6.85	452
0700	12.20	1,110	1900	18.21	3,300	1400	6.95	466
1200	13.05	1,310	2400	17.60	3,090	2000	6.78	442
1400	13.85	1,510				2400	6.60	417
1700	13.12	1,880	<u>Apr. 7</u>					
2000	16.90	2,500	0300	17.41	3,020	<u>Apr. 13</u>		
2400	17.97	2,930	0900	17.49	3,060	0600	6.27	374
			1700	16.91	2,860	1200	5.88	324
<u>Apr. 3</u>			2000	16.54	2,730	1800	5.69	301
0400	18.68	3,250	2400	15.89	2,540	2400	5.46	273
1000	19.18	3,490						
1100	20.50	3,560	<u>Apr. 8</u>			<u>Apr. 14</u>		
1230	21.45	3,700	0500	15.19	2,350	0800	5.30	254
1430	20.45	3,840	1200	14.79	2,270	1600	5.16	239
1630	22.25	3,990	1900	14.51	2,220	2400	5.05	228
2400	21.58	4,710	2400	14.03	2,050			
						<u>Apr. 15</u>		
<u>Apr. 4</u>			<u>Apr. 9</u>			1200	4.88	211
0200	21.58	4,710	0600	13.17	1,780	2400	4.70	193
0500	21.80	4,830	1200	12.36	1,550			
0800	22.10	5,030	1800	11.65	1,380	<u>Apr. 16</u>		
1200	22.50	5,290	2400	11.10	1,240	1200	4.55	178
1730	22.67	5,410				2400	4.44	167
2100	22.50	5,290	<u>Apr. 10</u>					
2400	22.20	5,110	0600	10.43	1,100	<u>Apr. 17</u>		
			1200	9.71	952	1200	4.35	158
						2400	4.25	149

Location.--Lat 47°17', long 101°55', in SW $\frac{1}{4}$ sec.14, T.144 N., R.89 W., on right bank 250 ft downstream from Northern Pacific Railway bridge in Zap and 9 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph except Apr. 19-30 when once-daily wire-weight gage readings were used. Datum of gage is 1,819.39 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 5,360 cfs 1900 hours Apr. 6 (gage height, 20.27 ft).

1924, 1946 to March 1969: Discharge, 6,130 cfs Apr. 7, 1952 (gage height, 20.03 ft); gage height, maximum stage known occurred in about 1902, from ice jam. Floods of February 1913 and March 1943 reached a stage of about 20 ft and 19.5 ft respectively, from information by local residents.

[illegible]

KNIFE RIVER BASIN

447

Spring Creek near Zap, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 9</u>		
2400	6.85	86	2400	18.85	3,330	2400	8.96	497
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 10</u>		
0600	7.20	98	0900	19.06	3,640	0600	8.40	432
1200	7.37	106	1300	19.00	3,600	1200	7.94	383
2100	7.62	120	2100	19.43	4,050	1800	7.67	359
2400	8.10	156	2400	19.42	4,040	2400	7.41	333
<u>Apr. 2</u>			<u>Apr. 6</u>			<u>Apr. 11</u>		
0300	8.20	162	0400	19.39	4,410	0600	7.05	303
1000	7.35	102	1400	20.17	5,230	1200	6.82	287
1200	7.65	122	1900	20.27	5,360	1800	6.62	270
1800	7.80	132	2400	19.99	5,010	2400	6.42	254
2000	9.30	264						
2200	10.61	421	<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	11.41	556	0400	19.82	4,820	0800	6.13	234
			1000	20.04	5,070	1600	5.88	214
<u>Apr. 3</u>			1600	19.65	4,650	2400	5.73	206
0130	12.51	792	2000	19.09	4,090			
0300	13.24	990	2400	18.23	3,510	<u>Apr. 13</u>		
0430	12.31	750				0800	5.53	191
0600	14.40	1,400	<u>Apr. 8</u>			1600	5.35	178
0900	14.34	1,380	0400	17.24	2,950	2400	5.20	172
1200	14.53	1,450	0800	16.34	2,490			
1500	15.55	1,830	1200	15.21	1,970	<u>Apr. 14</u>		
2000	16.64	2,290	1600	13.99	1,550	0800	5.07	163
2400	17.59	2,730	2000	13.11	1,310	1600	4.92	154
			2400	12.30	1,100	2400	4.77	148
<u>Apr. 4</u>			<u>Apr. 9</u>			<u>Apr. 15</u>		
0600	18.36	3,080	0600	11.12	844	0800	4.64	140
0900	18.68	3,240	1200	10.19	681	2000	4.46	130
1500	18.71	3,260	1800	9.58	583	2400	4.49	131

Location.--Lat 47°17', long 101°37', in SE¼ sec.18, T.144 N., R.86 W., on right bank at upstream side of highway bridge, half a mile south of Hazen and 2 miles upstream from Antelope Creek.

Gage-height record.--Water-stage recorder graph except Apr. 13-30 when graph based on once-daily wire-weight gage readings was used. Datum of gage is 1,712.35 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 11,800 cfs 1000 hours Apr. 7 (gage height, 24.75 ft).
1938 to March 1969: Discharge, 35,300 cfs June 24, 1966 (gage height, 27.01 ft).
Floods in 1943, 1950, 1952 and 1966 are the only major floods known since 1884.

Remarks.--Some regulation by Lake Ilo (capacity, 7,130 acre-ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

KNIFE RIVER BASIN

449

Knife River at Hazen, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 8</u>		
2400	12.41	559	0600	23.08	8,170	2400	22.85	7,420
			1200	23.52	8,680			
<u>Apr. 1</u>			1800	23.96	9,220	<u>Apr. 9</u>		
1200	12.91	669	2400	24.16	9,480	0300	22.00	6,830
1800	13.36	885				0600	20.66	6,030
2400	13.70	970	<u>Apr. 5</u>			0900	19.48	5,320
			0800	24.36	9,900	1200	18.45	4,700
<u>Apr. 2</u>			1800	24.16	9,120	1500	17.67	4,300
1200	14.27	1,570	2400	24.23	9,160	1800	17.00	3,970
1800	14.84	2,690				2100	16.36	3,650
2400	15.84	3,740	<u>Apr. 6</u>			2400	15.81	3,400
			1200	24.39	9,420			
<u>Apr. 3</u>			1900	24.34	9,280	<u>Apr. 10</u>		
0230	17.00	4,280	2400	24.55	9,850	0600	14.85	2,970
0400	17.42	4,460				1200	13.96	2,600
0600	18.40	4,920	<u>Apr. 7</u>			1800	13.18	2,290
0745	19.23	5,320	0600	24.63	10,800	2400	12.46	2,040
0800	18.65	5,000	1000	24.75	11,800			
0900	17.27	4,280	1300	24.74	11,800	<u>Apr. 11</u>		
1000	16.95	4,180	1800	24.54	10,500	0500	12.00	1,880
1030	16.96	4,230	2400	24.35	9,550	0900	11.57	1,720
1200	17.21	4,400				1400	11.13	1,580
1400	18.02	4,860	<u>Apr. 8</u>			1900	10.76	1,470
1600	19.40	5,650	0800	24.19	8,870	2400	10.46	1,380
1800	20.41	6,290	1200	24.01	8,420			
2230	21.92	7,340	1600	23.79	8,140	<u>Apr. 12</u>		
2400	22.31	7,610	2000	23.49	7,870	1200	9.75	1,160
						2400	9.13	1,010

Location.--Lat 46°42', long 101°28', in SW¼ sec.7, T.137 N., R.85 W., on right bank 450 ft downstream from county highway bridge, 2 miles downstream from Hailstone Creek, 3 miles southeast of Almont, and 12 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,864 ft (by barometer).

Maxima.--April 1969: Discharge, 4,760 cfs 1730 hours Apr. 7 (gage height, 24.80 ft).

1946 to March 1969: Discharge, 20,200 cfs Apr. 17, 1950 (gage height, 30.7 ft, from floodmark) from rating curve extended above 2,300 cfs on basis of slope-area measurement of peak flow.

Mean discharge, in cubic feet per second, 1955							
Day	April	Day	April	Day	April	Day	April
1.....	160	8....	3,240	15....	153	23....	31
2.....	460	9....	1,740	16....	122	24....	27
3.....	1,430	10....	1,000	17....	99	25....	23
4.....	2,510	11....	528	18....	82	26....	21
5.....	2,830	12....	322	19....	66	27....	22
6.....	3,360	13....	244	20....	53	28....	20
7.....	4,580	14....	184	21....	41	29....	17
				22....	34	30....	16
Monthly mean discharge, in cubic feet per second.....							780
Runoff, in acre-feet							46,440

HEART RIVER BASIN

451

Big Muddy Creek near Almont, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 5</u>			<u>Apr. 9</u>		
2400	5.81	100	0400	20.82	2,740	1600	15.70	1,460
			0800	20.58	2,770	2400	14.72	1,260
<u>Apr. 1</u>			1400	20.59	2,780			
0600	6.06	110	2400	21.45	3,060	<u>Apr. 10</u>		
1200	6.70	150				0800	13.89	1,110
1800	8.40	200	<u>Apr. 6</u>			1600	12.75	912
2400	9.27	230	0300	21.49	3,070	2400	11.52	723
			1000	21.95	3,230			
<u>Apr. 2</u>			1400	21.90	3,220	<u>Apr. 11</u>		
0600	9.37	250	2400	23.73	4,090	1200	9.89	506
1200	9.63	300				2400	8.77	377
1800	11.13	500	<u>Apr. 7</u>					
2400	14.08	900	0800	24.77	4,730	<u>Apr. 12</u>		
			1200	24.65	4,660	1200	8.22	319
<u>Apr. 3</u>			1730	24.80	4,760	2400	7.73	273
0500	15.32	1,100	2400	24.33	4,440			
0700	15.15	1,150				<u>Apr. 13</u>		
1200	15.82	1,300	<u>Apr. 8</u>			1200	7.42	245
1800	17.58	1,750	0600	23.15	3,770	2400	7.03	212
2400	19.38	2,200	1200	21.50	3,080			
			1800	20.25	2,680	<u>Apr. 14</u>		
<u>Apr. 4</u>			2400	19.38	2,410	1200	6.79	193
0800	20.40	2,540				2400	6.02	140
1600	20.10	2,510	<u>Apr. 9</u>					
2400	20.82	2,740	0800	17.59	1,940			

Location.--Lat 46°36'37", long 101°22'54", in NW¼NW¼SW¼ sec.9, T.136 N., R.85 W., on right bank 20 ft downstream from bridge on State Highway 31, 1 mile downstream from Big Muddy Creek, and 10 miles north of Lark.

Gage-height record.--Water-stage recorder graph except portions of Apr. 1, 14, 15, 16 when gage heights were estimated from fragmentary record. Datum of gage is 1,802.83 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 12,700 cfs 1030 hours Apr. 4 (gage height, 17.59 ft, backwater from ice).
1947 to March 1969: Discharge, 29,200 cfs Apr. 17, 1950 (gage height, 20.70 ft) from rating curve extended above 11,000 cfs on basis of contracted-opening measurement of peak flow.

Mean discharge, in cubic feet per second, 1969

[illegible]

HEART RIVER BASIN

453

Heart River near Lark, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 8</u>		
2400	7.84	639	0600	17.22	11,900	1400	14.47	8,520
			1030	17.59	12,700	1800	14.00	8,010
<u>Apr. 1</u>			1600	17.20	11,800	2400	13.45	7,470
0700	7.90	660	2000	16.65	10,700			
1100	8.40	940	2400	16.44	10,400	<u>Apr. 9</u>		
1500	9.08	1,310				0800	13.05	7,170
2000	9.93	1,950	<u>Apr. 5</u>			1600	12.57	6,560
2400	10.31	2,260	0800	15.95	10,000	2400	12.05	5,860
			1600	15.40	9,400			
<u>Apr. 2</u>			2200	15.95	10,400	<u>Apr. 10</u>		
0400	10.55	2,480	2400	16.42	11,300	0800	11.62	5,320
0430	9.97	2,040				1600	11.28	4,920
0600	10.78	2,700	<u>Apr. 6</u>			2400	11.01	4,600
1200	11.00	2,890	0400	16.63	11,800			
1300	12.52	4,610	0900	16.28	11,100	<u>Apr. 11</u>		
1530	10.72	2,820	1500	15.68	9,900	0800	10.52	4,060
1800	11.30	3,340	1800	15.82	10,200	1600	9.98	3,520
2200	12.50	4,590	2100	16.50	11,500	2400	9.51	3,080
2400	12.28	4,350	2400	16.88	12,300			
						<u>Apr. 12</u>		
<u>Apr. 3</u>			<u>Apr. 7</u>			0800	9.11	2,730
0400	13.40	5,860	0400	17.07	12,500	1600	8.73	2,420
0900	13.05	5,420	0800	16.78	12,100	2400	8.51	2,260
1200	13.70	6,320	1700	15.70	9,940			
1500	14.65	7,700	2400	15.48	9,720	<u>Apr. 13</u>		
1900	15.54	8,960				1200	8.12	1,970
2400	16.25	10,000	<u>Apr. 8</u>			2400	7.82	1,760
			0800	15.10	9,230			

Location.--Lat 46°50'02", long 100°58'27", in NW¼NE¼ sec.25, T.139 N., R.82 W., on left bank near downstream wingwall of bridge on county highway 3 miles west of Mandan, and 4 miles downstream from Sweetbriar Creek.

Gage-height record.--Water-stage recorder graph except Apr. 16-20 when a graph, based on hydrographers readings, was used. Datum of gage is 1,638.70 ft above mean sea level, datum of 1929, and 1,632.03 ft above Northern Pacific Railway datum.

Maxima.--April 1969: Discharge, 18,800 cfs 1900 hours Apr. 7 (gage height, 20.55 ft); gage height, 22.84 ft Apr. 4 (backwater from ice). 1924, 1929-33, 1938 to March 1969: Discharge, about 30,500 cfs Apr. 19, 1950 (gage height, 23.64 ft); gage height, 25.75 ft Apr. 4, 1952 (ice jam).

Mean discharge, in cubic feet per second, 1969

[illegible]

HEART RIVER BASIN

455

Heart River near Mandan, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 4</u>			<u>Apr. 9</u>		
2400	7.82	450	0800	21.58	9,740	1600	15.87	10,200
			1000	22.84	15,200	2400	15.02	8,950
<u>Apr. 1</u>			1600	22.16	14,000			
0600	8.32	568	2400	22.03	13,700	<u>Apr. 10</u>		
1200	8.63	654				0800	14.50	8,250
2400	8.75	690	<u>Apr. 5</u>			1600	13.68	7,210
			1000	22.24	14,100	2400	13.07	6,500
<u>Apr. 2</u>			1300	21.39	14,200			
1200	9.00	1,070	1600	21.54	14,100	<u>Apr. 11</u>		
1600	9.27	1,709	1800	20.39	13,700	0800	12.63	6,030
1800	10.17	1,860	2000	19.44	13,600	1600	12.28	5,660
2000	12.32	2,540	2400	18.37	13,400	2400	11.75	5,130
2200	14.96	2,970						
2400	15.64	3,180	<u>Apr. 6</u>			<u>Apr. 12</u>		
			0400	18.26	13,400	0800	11.25	4,660
<u>Apr. 3</u>			1200	18.86	14,700	1600	10.70	4,170
0100	13.41	2,730	1800	19.68	16,400	2400	10.30	3,830
0200	15.35	3,220	2400	20.05	17,700			
0300	16.52	3,280				<u>Apr. 13</u>		
0500	15.51	3,080	<u>Apr. 7</u>			0800	9.80	3,440
0600	16.49	3,260	0600	20.45	18,600	1600	9.42	3,160
0800	15.91	3,120	1900	20.55	18,800	2400	9.05	2,910
0900	19.36	3,760	2400	20.35	18,300			
1500	19.81	3,880				<u>Apr. 14</u>		
2000	20.48	4,030	<u>Apr. 8</u>			0800	8.71	2,680
2100	18.10	3,540	0600	19.85	17,300	1600	8.45	2,520
2400	19.83	3,900	1200	18.85	15,300	2400	8.25	2,400
			1800	18.18	14,000			
<u>Apr. 4</u>			2400	17.68	13,100	<u>Apr. 15</u>		
0300	20.85	6,930				1200	7.90	2,190
0500	21.48	9,240	<u>Apr. 9</u>			2400	7.53	1,990
0700	19.61	8,000	0800	16.87	11,700			

Location.--Lat 46°47'40", long 100°39'25", in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.9, T.138 N., R.79 W., on left bank 75 ft downstream from bridge on county highway, 4 miles upstream from Hay Creek, 6.3 miles west of Menoken, and 6.4 miles east of Bismarck.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals.
Datum of gage is 1,638.61 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,040 cfs 0715 hours Apr. 10 (gage height, 16.68 ft).
1947 to March 1969: Discharge, 6,750 cfs Apr. 18, 1950 (gage height, 17.07 ft).

[illegible]

APPLE CREEK BASIN

457

Apple Creek near Menoken, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
2400	4.55	4.0	0600	15.52	1,630	0800	14.17	1,120
			1200	15.74	1,860	1600	13.87	1,050
<u>Apr. 6</u>			1800	16.09	2,390	2400	13.55	983
0800	4.74	12	2400	16.41	3,260			
1200	4.50	9.0				<u>Apr. 15</u>		
1600	5.21	20	<u>Apr. 10</u>			0800	13.22	949
2000	6.37	46	0400	16.58	3,680	1600	12.84	885
2400	8.10	122	0715	16.68	4,040	2400	12.45	822
			1200	16.59	3,720			
<u>Apr. 7</u>			1800	16.53	3,520	<u>Apr. 16</u>		
0400	8.93	236	2400	16.42	3,170	0800	12.09	785
0800	8.57	211				1600	11.74	730
1400	7.70	158	<u>Apr. 11</u>			2400	11.38	678
2000	9.29	261	0600	16.28	3,020			
2200	10.39	347	1200	16.10	2,520	<u>Apr. 17</u>		
2400	11.33	433	1800	15.93	2,190	1200	10.78	615
			2400	15.75	1,930	2400	10.26	554
<u>Apr. 8</u>								
0200	12.14	628	<u>Apr. 12</u>			<u>Apr. 18</u>		
0600	13.02	753	0800	15.52	1,630	1200	9.86	508
1000	13.60	846	1600	15.35	1,510	2400	9.53	475
1400	14.06	922	2400	15.22	1,440			
1800	14.53	1,010				<u>Apr. 19</u>		
2200	15.05	1,120	<u>Apr. 13</u>			1200	9.22	440
2400	15.27	1,180	0800	15.02	1,330	2400	8.90	408
			1600	14.73	1,230			
			2400	14.44	1,150			

Location.--Lat 46°05', long 101°20', in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.17, T.130 N., R.85 W., on right bank 300 ft downstream from unnamed tributary, 1 mile upstream from bridge on N. D. Highway 31, 7 miles upstream from mouth, and 19 miles south of Raleigh.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1890.81 ft above mean sea level, datum of 1929.

Maxima.--April-May 1969: Discharge, 5,860 cfs 0300 hours Apr. 3 (gage height, 11.30 ft).
1939, 1962 to March 1969: Discharge, 6,000 cfs Mar. 15, 1966 (gage height, 12.32 ft, backwater from ice).
Maximum stage known, about 18 ft Apr. 18, 1950, (discharge about 45,000 cfs, on basis of slope-area measurement 5 miles upstream).

Mean discharge, in cubic feet per second, 1965								
Day	April	May	Day	April	May	Day	April	May
1...	2,550	51	11...	695	48	21...	121	30
2...	4,850	53	12...	554	45	22...	103	30
3...	5,150	49	13...	442	42	23...	92	28
4...	4,130	54	14...	361	40	24...	80	24
5...	2,300	59	15...	293	39	25...	70	24
6...	1,670	60	16...	233	37	26...	66	23
7...	1,580	61	17...	193	34	27...	61	22
8...	1,240	59	18...	160	32	28...	56	21
9...	1,140	55	19...	144	30	29...	50	20
10...	874	52	20...	134	29	30...	50	19
						31...	--	24
Monthly mean discharge, in cubic feet per second							981	38.5
Runoff, in acre-feet							58,400	2,370

Cedar Creek near Raleigh, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 30</u>			<u>Apr. 2</u>			<u>Apr. 4</u>		
2400	6.28	1,390	0600	10.33	4,720	0100	10.72	5,160
			1400	10.10	4,470	0700	10.34	4,730
<u>Apr. 1</u>			1800	10.52	4,930	1200	9.72	4,070
0400	6.65	1,600	2400	11.04	5,550	1800	9.10	3,460
0600	6.72	1,640				2400	8.69	3,090
1000	7.03	1,830	<u>Apr. 3</u>			<u>Apr. 5</u>		
1200	7.39	2,070	0300	11.30	5,860	0600	8.17	2,660
1400	7.80	2,360	0600	11.03	5,540	1200	7.61	2,230
1600	8.45	2,880	1200	10.56	4,970	1800	7.15	1,900
1800	8.95	3,320	1800	10.22	4,600	2400	6.91	1,760
2100	9.90	4,250	2400	10.65	5,080			
2400	10.61	5,030						

(195) 6-3540. Cannonball River at Breien, N. Dak.

Location.--Lat 46°23', long 100°56', in sec.36, T.134 N., R.82 W., on right bank 600 ft upstream from bridge on State Highway 6, 950 ft downstream from Louise Creek, and 0.5 mile south of Breien.

Drainage area.--4,100 sq mi, approximately.

Gage-height record.--Water-stage recorder graph except Mar. 28 to Apr. 5 when once- or twice-daily wire-weight gage readings were used. Datum of gage is 1,676.54 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 16,900 cfs 1730 hours Apr. 4 (gage height, 13.91 ft).

1906-8, 1912-18, 1922, 1924, 1928 to March 1969: Discharge, 94,800 cfs Apr. 19, 1950 (gage height, 22.30 ft, from floodmarks), from rating curve extended above 16,000 cfs on basis of slope-area and contracted-opening measurement of peak flow.

Remarks.--Daily discharges for Mar. 21-31 are listed below.

Mar. 21	50	Mar. 25	3,500	Mar. 29	2,900
22	1,000	26	4,000	30	2,550
23	2,200	27	4,500	31	2,150
24	3,400	28	3,700		

Cannonball River at Breien, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	2,790	8....	3,870	15....	904	23....	327
2.....	9,620	9....	3,120	16....	765	24....	305
3.....	14,300	10....	2,520	17....	635	25....	284
4.....	16,100	11....	1,840	18....	537	26....	270
5.....	10,100	12....	1,470	19....	478	27....	257
6.....	6,520	13....	1,260	20....	430	28....	243
7.....	5,530	14....	1,090	21....	390	29....	227
				22....	355	30....	214
Monthly mean discharge, in cubic feet per second.....							2,892
Runoff, in acre-feet							172,100

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Mar. 31</u>			<u>Apr. 3</u>			<u>Apr. 6</u>		
2400	5.05	2,120	2400	13.80	16,000	2400	8.82	5,870
<u>Apr. 1</u>			<u>Apr. 4</u>			<u>Apr. 7</u>		
0600	5.15	2,200	0600	13.67	15,600	0600	8.55	5,520
1200	5.62	2,580	1200	13.82	16,400	1200	8.70	5,710
1800	6.31	3,200	1730	13.91	16,900	1800	8.58	5,560
2400	7.38	4,210	2400	13.49	15,100	2400	7.92	4,760
<u>Apr. 2</u>			<u>Apr. 5</u>			<u>Apr. 8</u>		
0600	8.76	5,710	0600	12.08	11,300	0800	7.14	3,930
1200	11.75	10,600	1200	11.00	9,340	1600	6.80	3,590
1800	13.03	13,200	1800	10.33	8,300	2400	6.65	3,440
2400	13.18	13,700	2400	9.81	7,440			
<u>Apr. 3</u>			<u>Apr. 6</u>			<u>Apr. 9</u>		
0600	13.05	13,600	0600	9.27	6,530	0800	6.32	3,140
1200	13.04	13,700	1200	9.32	6,540	1600	6.19	3,020
1800	13.55	14,900	1800	9.20	6,370	2400	6.15	2,990

461

Location.--Lat 46°15', long 100°14', on line between secs. 17 and 18, T.132 N., R.76 W., on left bank 60 ft downstream from bridge on U.S. Highway 83, 0.7 mile south of railway station in Linton, and 1 mile upstream from Spring Creek.

Gage-height record.--Water-stage recorder graph. Graph reconstructed from engineers readings from 1400 hours Apr. 6 to 1400 hours Apr. 17. Datum of gage is 1,690.55 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 5,160 cfs 0730 hours Apr. 9 (gage height, 16.7 ft).

1943, 1950 to March 1969: Discharge, 9,800 cfs Apr. 8, 1952 (gage height, 17.50 ft).

[illegible]

Beaver Creek at Linton, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
2400	4.25	9.4	2000	13.30	1,470	2400	14.24	2,070
			2400	14.00	1,720			
<u>Apr. 4</u>			<u>Apr. 8</u>			<u>Apr. 12</u>		
0600	4.39	17	0600	15.12	2,280	0600	13.77	1,860
1200	4.74	28	1200	15.50	2,540	1200	13.32	1,680
1800	5.60	62	1800	16.00	3,180	1800	12.85	1,510
2400	7.47	198	2400	16.48	4,390	2400	12.39	1,350
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
0600	8.53	338	0730	16.70	5,160	0600	11.96	1,210
1000	8.82	392	1200	16.62	4,870	1200	11.56	1,090
1500	8.67	399	1800	16.42	4,260	1800	11.12	970
1900	9.18	474	2400	16.20	3,730	2400	10.70	865
2400	9.51	527						
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 14</u>		
0400	9.65	552	0600	16.07	3,480	1200	10.05	720
1100	9.30	493	1200	16.05	3,440	2400	9.53	616
1700	9.72	565	1800	16.03	3,400			
2100	10.08	631	2400	15.86	3,150	<u>Apr. 15</u>		
2400	10.52	719				1200	9.07	527
			<u>Apr. 11</u>			2400	8.65	455
<u>Apr. 7</u>			0600	15.55	2,820	<u>Apr. 16</u>		
0400	11.38	918	1200	15.15	2,550	1200	8.31	402
1000	11.93	1,060	1800	14.72	2,310	2400	8.02	359
1600	12.65	1,270						

463

Location.--Lat 42°52', long 97°24', between sec.18, T.93 N., R.55 W., and sec.13, T.93 N., R.56 W., on downstream end of left pier of Meridian Highway Bridge on U.S. Highway 81 in Yankton, 8.3 miles upstream from James River, 5.3 miles downstream from Gavins Point Dam, and at mile 805.8.

Gage-height record.--Digital water-stage recorder record. No gage-height record Apr. 9-17 when water was below intakes. Datum of gage is 1,139.68 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 33,600 cfs 1330 hours Apr. 25 (gage height, 21.67 ft).
1930 to March 1969: Discharge, 480,000 cfs Apr. 13, 1952; gage height, 35.5 ft Apr. 13, 14, 1952.
Maximum stage known, 50.5 ft Apr. 5, 1881 (ice jam), present datum.

Mean discharge, in cubic feet per second, 1969							
Day	April	Day	April	Day	April	Day	April
1.....	27,800	8....	12,300	15....	20,000	23....	32,400
2.....	23,300	9....	6,000	16....	22,500	24....	32,400
3.....	18,300	10....	6,000	17....	25,000	25....	32,800
4.....	18,000	11....	8,000	18....	26,700	26....	31,400
5.....	17,900	12....	12,000	19....	29,400	27....	31,300
6.....	17,800	13....	15,000	20....	31,600	28....	32,600
7.....	18,000	14....	17,500	21....	32,000	29....	33,000
				22....	32,300	30....	33,000
Monthly mean discharge, in cubic feet per second.....							23,200
Runoff, in acre-feet.....							1,381,000

Location.--Lat 47°33'29", long 98°51'45", in NW¼NW¼NW¼ sec.17, T.147 N., R.64 W., on left bank at downstream side of county highway bridge and 2.5 miles northwest of Grace City.

Gage-height record.--Water-stage recorder graph.

Maxima.--April 1969: Discharge, 3,100 cfs 1400 hours Apr. 13 (gage height, 12.00 ft).

Mean discharge, in cubic feet per second, 1969

[illegible]

James River near Grace City, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 9</u>			<u>Apr. 11</u>			<u>Apr. 14</u>		
2400	10.12	380	2400	11.42	2,100	1200	11.78	2,860
						2400	11.43	2,590
<u>Apr. 10</u>			<u>Apr. 12</u>			<u>Apr. 15</u>		
0600	10.63	500	1000	11.68	2,770	1200	11.13	2,400
1200	10.87	520	1400	11.56	2,680	2400	10.80	2,220
1800	10.98	580	2000	11.43	2,590			
2400	10.92	600	2400	11.50	2,640	<u>Apr. 16</u>		
						1200	10.52	2,060
<u>Apr. 11</u>			<u>Apr. 13</u>			2400	10.25	1,900
0600	10.83	750	0800	11.78	2,860			
1200	10.83	850	1400	12.00	3,100			
1800	11.25	1,670	2400	11.90	2,980			

(199) 6-4690. Jamestown Reservoir near Jamestown, N. Dak.

Location.--Lat 46°56'03", long 98°42'38", in NW¼NW¼ sec.24, T.140 N., R.64 W., on right bank 800 ft north of glory hole on west end of Jamestown Dam on James River, 1.9 miles north of Jamestown Post Office, and 4 miles upstream from Pipestem Creek.

Drainage area.--1,760 sq mi, approximately, of which about 1,010 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is at mean sea level, datum of 1929.

Maxima.--April 1969: Contents, 102,750 acre-feet Apr. 30 (elevation, 1,443.56 ft).

1953 to March 1969: Contents, 70,530 acre-feet Apr. 6, 1966 (elevation, 1,439.90 ft).

Remarks.--Reservoir is formed by earth-fill dam, completed Oct. 1, 1953. Closure made May 7, 1953, and filling of dead storage started. Gates initially closed Feb. 8, 1954. Usable capacity, 229,470 acre-ft between elevations 1,400 ft (sill of outlet) and 1,454 ft (crest of spillway). Dead storage below elevation 1,400 ft, 820 acre-ft. Maximum design pool, 389,600 acre-ft (elevation, 1,464.4 ft). Figures given herein represent total contents based on capacity table dated Oct. 1, 1965. Reservoir is used for flood control and municipal supply.

Jamestown Reservoir near Jamestown, N. Dak.

Elevation, in feet, and contents in acre-feet, at 2400 hours, 1969

Day	Elevation	Contents	Day	Elevation	Contents	Day	Elevation	Contents
1	1429.23	27,740	11	1431.35	32,330	21	1442.77	95,340
2	1429.23	27,740	12	1431.72	33,200	22	1442.99	97,350
3	1429.22	27,720	13	1432.01	33,880	23	1443.07	98,100
4	1429.22	27,720	14	1432.99	36,350	24	1443.13	98,670
5	1429.23	27,740	15	1435.05	42,220	25	1443.18	99,150
6	1429.26	27,810	16	1437.49	53,040	26	1443.33	100,570
7	1429.36	28,010	17	1439.60	68,190	27	1443.52	102,370
8	1429.73	28,770	18	1441.07	80,220	28	1443.54	102,560
9	1430.37	30,130	19	1441.93	87,720	29	1443.55	102,660
10	1430.89	31,270	20	1442.47	92,610	30	1443.56	102,750
Change in contents.....							--	+75,010

(200) 6-4695. Pipestem Creek near Buchanan, N. Dak.

Location.--Lat 47°03'59", long 98°55'07", on north line sec.4, T.141 N., R.65 W., on left bank 30 ft downstream from bridge on county highway and 4½ miles west of Buchanan.

Drainage area.--758 sq mi, of which about 460 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph except portions of Apr. 7, 8, 10-12 when graph was reconstructed using once-daily wire-weight readings and engineers notes. Datum of gage is 1,467.10 ft above mean sea level, datum of 1929.

Discharge.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 7-11.

Maxima.--April 1969: Discharge, 6,080 cfs 2100 hours Apr. 10 (gage height, 12.08 ft).
1950 to March 1969: Discharge, 4,480 cfs Apr. 17, 1950 (gage height, 10.77 ft); gage height, 11.89 ft Apr. 9, 1950 (backwater from ice).

JAMES RIVER BASIN

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Pipestem Creek near Buchanan, N. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8....	90	15....	1,300	23....	152
2.....	0	9....	710	16....	1,010	24....	126
3.....	0	10....	3,920	17....	808	25....	106
4.....	0	11....	4,620	18....	599	26....	94
5.....	0	12....	3,160	19....	440	27....	86
6.....	0	13....	2,160	20....	335	28....	72
7.....	1.0	14....	1,700	21....	250	29....	72
				22....	191	30....	67
Monthly mean discharge, in cubic feet per second.....							736
Runoff, in acre-feet							43,780

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 13</u>		
2400	5.64	2.0	0600	10.85	2,320	0600	10.30	2,260
			1200	11.78	4,230	1200	10.17	2,110
<u>Apr. 8</u>			1500	12.04	4,880	1800	10.14	2,070
0300	6.36	4.0	1900	11.65	4,920	2400	10.05	1,980
0600	6.42	4.0	2100	12.08	6,080			
1200	6.31	4.0	2400	11.87	5,500	<u>Apr. 14</u>		
1300	7.26	50				1200	9.67	1,680
1900	8.30	220	<u>Apr. 11</u>			2400	9.38	1,480
2400	8.61	300	0600	11.59	4,750			
			1200	11.48	4,470	<u>Apr. 15</u>		
<u>Apr. 9</u>			1800	11.48	4,470	1200	9.08	1,300
0600	8.78	340	2400	11.32	4,090	2400	8.79	1,140
1200	8.38	440						
1800	9.85	960	<u>Apr. 12</u>			<u>Apr. 16</u>		
2400	10.68	1,910	1200	10.83	3,050	1200	8.51	995
			2400	10.47	2,460	2400	8.32	908

Location.--Lat 46°53'22", long 98°40'58", in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.6, T.139 N., R.63 W., on left bank 100 ft upstream from Interstate 94 bridge at southeast corner of Jamestown and 3 miles downstream from Pipestem Creek.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,373.27 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 6,330 cfs 1800 hours Apr. 11 (gage height, 16.94 ft).
1928-33, 1938-39, 1943 to March 1969: Discharge, 6,390 cfs May 13, 1950 (gage height, 15.82 ft, site and datum then in use).

Remarks.--Flow regulated by Arrowwood and Jim Lakes and Jamestown Reservoir (combined capacity, 246,000 acre-ft).

[illegible]

JAMES RIVER BASIN

469

James River at Jamestown, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 9</u>			<u>Apr. 11</u>			<u>Apr. 14</u>		
2400	8.38	560	1800	16.94	6,330	1200	13.62	2,640
			2400	16.78	5,980	2400	12.88	2,280
<u>Apr. 10</u>			<u>Apr. 12</u>			<u>Apr. 15</u>		
0600	9.73	980	0600	16.56	5,560	1200	12.11	1,960
1200	11.03	1,440	1200	16.33	5,170	2400	11.27	1,660
1800	12.64	2,200	1800	15.92	4,580			
2400	14.40	3,130	2400	15.62	4,200	<u>Apr. 16</u>		
<u>Apr. 11</u>			<u>Apr. 13</u>			1200	10.49	1,430
0600	15.90	4,550	1200	14.98	3,580	2400	9.94	1,290
1400	16.77	5,960	2400	14.36	3,100			
1500	16.82	6,060						

Location.--Lat 46°21'20", long 98°18'15", at northeast corner of sec.11, T.133 N., R.61 W., on left bank 80 ft downstream from bridge on State Highway 13, half a mile west of La Moure, and 12 miles upstream from Cottonwood Creek.

Gage-height.--Digital-recorder tape punched at 15-minute intervals.
Datum of gage is 1,290.00 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 6,800 cfs 1400 hours Apr. 14 (gage height, 16.17 ft).

1950 to March 1969: Discharge, 5,730 cfs May 16, 1950 (gage height, 15.34 ft).

A long-time local resident says flood of May 16, 1950 was the highest since 1882, with stage in either 1942 or 1943 being almost as high owing to large ice jam.

[illegible]

JAMES RIVER BASIN

471

James River at La Moure, N. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 8</u>			<u>Apr. 13</u>			<u>Apr. 18</u>		
2400	7.95	264	0600	14.70	3,600	2400	14.15	3,550
			1200	14.94	4,200			
<u>Apr. 9</u>			1800	15.23	4,800	<u>Apr. 19</u>		
0400	8.32	474	2400	15.64	5,600	0800	13.89	3,350
0800	8.75	775				1600	13.54	3,050
1200	9.19	1,120	<u>Apr. 14</u>			2400	13.15	2,850
1600	9.72	1,330	0200	15.82	6,000			
2000	10.34	1,470	0600	16.01	6,300	<u>Apr. 20</u>		
2400	10.82	1,560	1000	16.08	6,500	0800	12.68	2,550
			1400	16.17	6,800	1600	12.13	2,250
<u>Apr. 10</u>			1800	16.13	6,600	2400	11.57	2,000
0400	11.07	1,600	2400	16.07	6,400			
0800	11.20	1,620				<u>Apr. 21</u>		
1200	11.37	1,660	<u>Apr. 15</u>			0800	11.04	1,800
1600	11.64	1,700	0600	16.02	6,300	1600	10.54	1,600
2000	11.89	1,750	1200	15.96	6,200	2400	10.12	1,480
2400	12.15	1,790	1800	15.88	6,000			
			2400	15.83	5,800	<u>Apr. 22</u>		
<u>Apr. 11</u>						0800	9.76	1,380
0600	12.47	1,840	<u>Apr. 16</u>			1600	9.44	1,320
1200	12.77	1,870	0800	15.70	5,600	2400	9.20	1,140
1800	13.11	1,920	1600	15.58	5,300			
2400	13.47	1,970	2400	15.42	5,000	<u>Apr. 23</u>		
						0800	9.03	1,000
<u>Apr. 12</u>			<u>Apr. 17</u>			1600	8.92	916
0600	13.79	2,000	0800	15.26	4,800	2400	8.84	852
1200	14.04	2,150	1600	15.07	4,600			
1800	14.26	2,600	2400	14.86	4,250	<u>Apr. 24</u>		
2400	14.47	3,100				0800	8.74	775
			<u>Apr. 18</u>			1600	8.66	715
			0800	14.66	4,000	2400	8.64	700
			1600	14.41	3,800			

Location.--Lat 45°37'05", long 98°19'30", in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec.29, T.125 N., R.62 W., on left bank 10 ft downstream from highway bridge, three quarters of a mile northwest of Columbia, 2 $\frac{1}{2}$ miles upstream from Chicago and North Western Railway Co. bridge, 3 $\frac{1}{2}$ miles upstream from Elm River, and 9 miles downstream from Sand Lake.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,274.54 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 4,670 cfs 2400 hours Apr. 22 (gage height, 17.09 ft); daily reverse flow, 1,750 cfs Apr. 11 (backwater from Elm River).

1945 to March 1969: Discharge, 5,420 cfs May 24, 25, 1950 (gage height, 16.89 ft from graph based on gage readings); daily reverse flow, 1,860 cfs Apr. 8, 1952 (backwater from Elm River).

Remarks.--Frequent backwater and occasional reverse flow caused by Elm River;
negative figures indicate reverse flow.

Mean discharge, in cubic feet per second, 1969

[illegible]

JAMES RIVER BASIN

473

James River at Columbia, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 6</u>			<u>Apr. 15</u>			<u>Apr. 23</u>		
2400	6.48		2400	16.24		1200	17.06	4,570
						2400	17.02	4,440
<u>Apr. 7</u>			<u>Apr. 16</u>			<u>Apr. 24</u>		
1200	7.35		2400	16.35		0600	16.99	4,350
2400	8.45					1200	16.83	3,880
<u>Apr. 8</u>			<u>Apr. 17</u>			1800	16.74	3,640
1200	9.51		2400	16.44		2400	16.77	3,720
2400	10.94					<u>Apr. 25</u>		
<u>Apr. 9</u>			<u>Apr. 18</u>			0600	16.81	3,830
1200	12.48		2400	16.57		1200	16.74	3,640
2400	13.64					1800	16.65	3,420
<u>Apr. 10</u>			<u>Apr. 19</u>			2400	16.51	3,120
1200	14.42		2400	16.63		<u>Apr. 26</u>		
2400	15.65					0600	16.40	2,910
<u>Apr. 11</u>			<u>Apr. 20</u>			1200	16.32	2,770
2400	16.39		1200	16.79		1700	16.29	2,710
<u>Apr. 12</u>			2400	16.90	4,080	2400	16.49	3,080
2400	16.43					<u>Apr. 27</u>		
<u>Apr. 13</u>			<u>Apr. 21</u>			0600	16.71	3,570
2400	16.38		1200	16.96	4,260	1200	16.86	3,970
			1800	17.01	4,410	1400	16.88	4,020
<u>Apr. 14</u>			2400	17.03	4,480	1800	16.84	3,910
2400	16.16					2400	16.78	3,750
			<u>Apr. 22</u>					
			1200	17.06	4,570			
			2400	17.09	4,670			

(204) 6-4710.5 Elm River tributary near Leola, S. Dak.

(Crest-stage station)

Location.--NE $\frac{1}{4}$ sec.3, T.127 N., R.66 W., at culvert on county highway, 12 $\frac{1}{2}$ miles northeast of Leola.

Drainage area.--14.7 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 160 cfs and by flow-through culvert measurement at 418 cfs.

Maxima.--April 1969: Discharge, not determined Apr. 8 (gage height, 11.0 ft).
1956 to March 1969: Discharge, 418 cfs May 3, 1964 (gage height, 8.62 ft).

(205) 6-4712. Maple River at North Dakota-South Dakota State line

Location.--Lat 45°56'20", long 98°27'10", in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.33, T.129 N., R.62 W., on left bank 0.4 mile upstream from State line, 8 miles northeast of Frederick, S. Dak., and 15 $\frac{1}{2}$ miles upstream from mouth.

Drainage area.--750 sq mi, approximately, of which about 270 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,365 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-11.

Maxima.--April 1969: Discharge, 5,930 cfs 2200 hours Apr. 11 (gage height, 15.22 ft); gage height, 16.05 ft 0200 hours Apr. 11 (backwater from ice).
1956 to March 1969: Discharge, 2,620 cfs Mar. 16, 1966 (gage height, 12.43 ft).

Maple River at North Dakota-South Dakota State line

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8....	50	15....	1,480	23....	264
2.....	0	9....	250	16....	940	24....	218
3.....	0	10....	1,200	17....	700	25....	182
4.....	0	11....	5,500	18....	552	26....	154
5.....	0	12....	5,120	19....	447	27....	147
6.....	5.0	13....	3,030	20....	383	28....	120
7.....	20	14....	2,070	21....	335	29....	100
				22....	296	30....	86
Monthly mean discharge, in cubic feet per second.....							788
Runoff, in acre-feet.....							46,910

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 14</u>		
1200	4.74		0200	16.05		1200	10.59	2,080
2400	7.06		1200	15.62		2400	9.98	1,780
			2000	15.20	5,910			
<u>Apr. 8</u>			2200	15.22	5,930	<u>Apr. 15</u>		
1200	6.13		2400	15.18	5,890	0800	9.57	1,600
2200	7.02					1200	9.38	1,510
2400	6.92		<u>Apr. 12</u>			2400	8.56	1,150
			0600	14.99	5,660			
<u>Apr. 9</u>			1200	14.68	5,290	<u>Apr. 16</u>		
0300	6.85		1800	14.12	4,640	0600	8.24	1,030
1200	7.84		2400	13.43	3,900	1200	7.97	930
2400	8.61					1800	7.70	835
			<u>Apr. 13</u>			2400	7.54	781
<u>Apr. 10</u>			0600	12.83	3,380			
1000	8.05		1200	12.21	2,970			
1600	9.84		1800	11.65	2,630			
1700	11.94		2400	11.18	2,370			
1800	13.23							
2400	15.82							

(206) 6-4713.5 Maple River at Frederick, S. Dak.

(Crest-stage station)

Location.--NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.11, T.127 N., R.64 W., at dam on Maple River in City Park at west edge of Frederick.

Drainage area.--552 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 6,000 cfs Apr. 11 (gage height, 13.2 ft); gage height, 14.3 ft Apr. 11 (backwater from ice jam).

1956 to March 1969: Discharge, 3,000 cfs Mar. 17, 1962 (gage height, 12.70 ft).

(207) 6-4714. Willow Creek tributary near Leola, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.11, T.126 N., R.66 W., at culvert on former State Highway 10, 8 $\frac{3}{4}$ miles northeast of Leola.

Drainage area.--3.74 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 120 cfs.

Maxima.--April 1969: Discharge, not determined Apr. 8 (gage height, 4.81 ft).

1956 to March 1969: Discharge, 33 cfs May 3, 1964 (gage height, 2.58 ft).

(208) 6-4714.5 Willow Creek tributary near Barnard, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.11, T.126 N., R.65 W., at culvert on former State Highway 10, 6 $\frac{1}{2}$ miles west of Barnard.

Drainage area.--0.18 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 10 cfs.

Maxima.--April 1969: Discharge, not determined Apr. 9 (gage height, 4.93 ft).
1956 to March 1969: Discharge, 20 cfs Apr. 5, 1960 (gage height, 2.59 ft, backwater from ice).

(209) 6-4715. Elm River at Westport, S. Dak.

Location.--Lat 45°39'20", long 98°29'50", in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.12, T.125 N., R.64 W., on right bank 12 ft downstream from highway bridge, half a mile north of Westport, three-quarters of a mile upstream from Chicago, Milwaukee, St. Paul and Pacific Railroad bridge, 9 $\frac{1}{2}$ miles downstream from Willow Creek, and 30 $\frac{1}{2}$ miles upstream from mouth.

Drainage area.--1,680 sq mi, approximately, of which about 540 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,309.3 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-9.

Maxima.--April 1969: Discharge, 12,600 cfs 1000 hours Apr. 10 (gage height, 22.11 ft).
1945 to March 1969: Discharge, 7,520 cfs Apr. 8, 1952 (gage height, 20.10 ft, from floodmark).

JAMES RIVER BASIN

Elm River at Westport, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	40	8....	1,500	15....	3,710	23....	532
2.....	50	9....	7,000	16....	2,740	24....	468
3.....	60	10....	11,900	17....	1,990	25....	383
4.....	50	11....	10,100	18....	1,560	26....	322
5.....	40	12....	11,100	19....	1,230	27....	282
6.....	60	13....	8,180	20....	968	28....	242
7.....	400	14....	5,220	21....	776	29....	233
				22....	632	30....	195
Monthly mean discharge, in cubic feet per second.....							2,399
Runoff, in acre-feet.....							142,700

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 6</u>			<u>Apr. 10</u>			<u>Apr. 13</u>		
2400	6.61		1000	22.11	12,600	1800	18.43	7,270
			1200	22.00	12,400	2400	17.69	6,380
<u>Apr. 7</u>			1600	22.03	12,400			
1200	6.70		2000	21.74	11,900	<u>Apr. 14</u>		
2400	9.85		2400	21.21	11,100	0600	17.03	5,690
						1200	16.41	5,150
<u>Apr. 8</u>			<u>Apr. 11</u>			1800	15.82	4,680
1400	10.85		0600	20.36	9,930	2400	15.30	4,310
1800	14.62		1200	19.92	9,390			
2400	16.28		1800	20.15	9,810	<u>Apr. 15</u>		
			2400	20.84	11,200	0600	14.82	3,970
<u>Apr. 9</u>						1200	14.39	3,680
1200	18.68		<u>Apr. 12</u>			2400	13.59	3,200
1600	20.21		0700	21.12	11,700			
2200	20.83		1200	20.99	11,500	<u>Apr. 16</u>		
2400	21.00	10,800	1800	20.63	10,700	1200	12.75	2,740
			2400	20.16	9,820	2400	11.89	2,310
<u>Apr. 10</u>								
0200	21.27	11,200	<u>Apr. 13</u>					
0600	21.49	11,600	0600	19.75	9,120			
			1200	19.17	8,250			

(210) 6-4720. James River near Stratford, S. Dak.
(Gaging station, discontinued 1968)

Location--Lat $45^{\circ}14'30''$, long $98^{\circ}23'30''$, in $NE\frac{1}{4}NE\frac{1}{4}NE\frac{1}{4}$ sec.3, T.120 N., R.63 W., on right bank 30 ft downstream from highway bridge, $6\frac{3}{4}$ miles southwest of Stratford, and $8\frac{3}{4}$ miles upstream from Mud Creek.

Drainage area--9,990 sq mi, approximately, of which about 3,920 sq mi is probably noncontributing.

Maxima--April 1969: Discharge, not determined Apr. 19 (gage height, 18.18 ft).

1950 to March 1968: Discharge, 5,580 cfs May 14 or 15, 1950, estimated on basis of records at site $20\frac{1}{2}$ miles upstream; gage height, 18.13 ft Apr. 19, 20, 1952.

(211) 6-4722.5 Mud Creek tributary No. 2 near Groton, S. Dak.

(Crest-stage station)

Location-- $SE\frac{1}{4}$ sec.21, T.123 N., R.60 W., at culvert on U.S. Highway 12, $2\frac{3}{4}$ miles east of Groton.

Drainage area--60.0 sq mi.

Gage-height record--Crest stages only.

Discharge record--Stage-discharge relation defined by current-meter measurements below 260 cfs.

Maxima--April 1969: Discharge, 310 cfs Apr. 8 (gage height, 5.60 ft).

1956 to March 1969: Discharge, 272 cfs Mar. 12, 1966 (gage height, 5.54 ft).

Location.--Lat 45°16'13", long 98°17'16", in NW¹/₄NW¹/₄NW¹/₄ sec.27, T.121 N., R.62 W., near right bank at downstream side of highway bridge, 3¹/₄ miles south of Stratford and 13 3/4 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,270 ft (from topographic map).

Maxima.--April 1969: Discharge, 1,180 cfs 0600 hours Apr. 10 (gage height, 7.92 ft).
1955 to March 1969: Discharge, 637 cfs Mar. 28, 1962 (gage height, 10.53 ft, site and datum then in use).

[illegible]

JAMES RIVER BASIN

481

Mud Creek near Stratford, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 7</u>			<u>Apr. 10</u>		
2400	2.68	0.74	1200	6.50	335	0600	7.92	1,180
			1700	6.88	397	1200	7.91	1,160
<u>Apr. 6</u>			2100	6.87	395	1800	7.89	1,140
0900	2.65	.50	2400	6.84	388	2400	7.87	1,110
1600	2.78	2.2						
1800	3.78	73	<u>Apr. 8</u>			<u>Apr. 11</u>		
2000	3.81	76	0600	6.81	382	1200	7.86	1,090
2300	3.63	61	1000	6.83	386	2400	7.83	1,050
2400	3.83	77	1600	7.04	438			
			2000	7.17	480	<u>Apr. 12</u>		
<u>Apr. 7</u>			2400	7.40	578	1200	7.78	982
0200	4.33	121				2400	7.73	912
0400	5.02	183	<u>Apr. 9</u>					
0600	5.76	254	0600	7.68	844	<u>Apr. 13</u>		
0800	6.28	311	1200	7.82	1,040	1200	7.67	832
			1800	7.87	1,110	2400	7.62	768
			2400	7.90	1,150			

Location.--Lat 45°00'02", long 98°28'57", in SE¹₄SW¹₄ sec.25, T.118 N., R.64 W., on right bank 900 ft upstream from highway bridge, half a mile east of Ashton, 6 miles upstream from Snake Creek, and 14 miles upstream from Turtle Creek.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,244.4
ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 5,680 cfs 0600 hours Apr. 24 (gage height, 20.63 ft); gage height, 21.17 ft 0500 hours Apr. 13 (backwater from Snake Creek); daily reverse flow, 2,100 cfs Apr. 9 (backwater from Snake Creek).
1945 to March 1969: Discharge, 5,170 cfs May 18, 19, 1950; gage height, 19.59 ft Apr. 23, 24, 1952; daily reverse flow, 1,500 cfs Apr. 10, 1952 (backwater from Snake Creek).

Mean discharge, in cubic feet per second, 1969

[illegible]

JAMES RIVER BASIN

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James River at Ashton, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 9</u>			<u>Apr. 18</u>		
2400	3.70		0600	17.93		1200	18.54	
			1200	18.47		1600	18.53	
<u>Apr. 3</u>			1800	18.88		2400	18.63	
1000	3.63		2400	19.18				
1400	3.99		<u>Apr. 10</u>			<u>Apr. 19</u>		
1800	5.96		1200	19.55		1200	18.91	
2400	5.56		1800	19.71		2400	19.31	
<u>Apr. 4</u>			2400	19.96		<u>Apr. 20</u>		
1200	5.81		<u>Apr. 11</u>			1200	19.63	
1800	6.08		0800	20.28		2400	19.91	5,030
2400	5.18		1600	20.55		<u>Apr. 21</u>		
<u>Apr. 5</u>			2400	20.81		1200	20.14	5,240
1000	5.90		<u>Apr. 12</u>			1600	20.21	5,300
1400	6.08		0800	20.98		1800	20.25	5,340
1600	7.09		1600	21.10		2400	20.33	5,410
2000	7.76		2400	21.16		<u>Apr. 22</u>		
2400	7.66		<u>Apr. 13</u>			0600	20.39	5,460
<u>Apr. 6</u>			0500	21.17		1200	20.45	5,520
0600	8.47		1200	21.14		1800	20.50	5,560
1200	10.09		2400	21.04		2400	20.53	5,590
1800	11.73		<u>Apr. 14</u>			<u>Apr. 23</u>		
2400	12.85		1200	20.84		1200	20.59	5,640
<u>Apr. 7</u>			2400	20.60		2400	20.62	5,670
0600	13.62		<u>Apr. 15</u>			<u>Apr. 24</u>		
1200	14.38		1200	20.31		0600	20.63	5,680
1800	15.16		2400	19.99		1200	20.62	5,670
2400	15.77		<u>Apr. 16</u>			2400	20.62	5,670
<u>Apr. 8</u>			1200	19.64		<u>Apr. 25</u>		
0600	16.22		2400	19.27		1200	20.61	5,660
1200	16.57		<u>Apr. 17</u>			1600	20.61	5,660
1800	16.81		1200	18.95		2000	20.57	5,620
2400	17.29		2400	18.71		2400	20.58	5,630

(214) 6-4735. South Fork Snake Creek near Athol, S. Dak.
(Formerly published as West Branch Snake Creek near Athol)

Location (revised).--Lat 45°03'04", long 98°44'14", in SE¼NE¼ sec.11, T.118 N., R.66 W., on left bank at upstream side of highway bridge, 3 miles downstream from Perry Creek and 7½ miles northwest of Athol.

Drainage area.--1,820 sq mi, approximately, of which about 730 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,316.05 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-7.

Maxima.--April 1969: Discharge, 6,810 cfs 1600 hours Apr. 7; gage height, 19.15 ft Apr. 7 (backwater from ice).

1950 to March 1969: Discharge, about 2,200 cfs Apr. 9, 1952 (gage height, 16.42 ft, backwater from ice).

Mean discharge, in cubic feet per second, 1969

Mean discharge, in cubic feet per second, 1901							
Day	April	Day	April	Day	April	Day	April
1.....	0	8....	5,510	15....	417	23....	74
2.....	0	9....	3,130	16....	327	24....	63
3.....	0	10....	1,960	17....	260	25....	54
4.....	.10	11....	1,460	18....	205	26....	48
5.....	.10	12....	1,080	19....	176	27....	42
6.....	800	13....	794	20....	149	28....	40
7.....	4,500	14....	571	21....	120	29....	37
				22....	95	30....	33
Monthly mean discharge, in cubic feet per second.....							732
Runoff, in acre-feet.....							43,530

South Fork Snake Creek near Athol, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 7</u>			<u>Apr. 9</u>		
2400	8.30		0600	18.07		0600	16.92	3,580
			1200	18.61		1200	16.51	3,080
<u>Apr. 6</u>			1400	19.15		1800	16.05	2,620
0300	8.35		1500	18.98	6,710	2400	15.66	2,310
0400	10.52		1600	19.03	6,810			
0600	13.87		1800	18.95	6,650	<u>Apr. 10</u>		
1000	15.66		2400	18.78	6,320	0600	15.39	2,100
1100	16.00					1200	15.18	1,940
1400	15.74		<u>Apr. 8</u>			1800	15.00	1,820
1700	16.82		0600	18.64	6,070	2400	14.83	1,690
2400	16.72		1200	18.46	5,760			
			1800	17.95	4,960	<u>Apr. 11</u>		
			2400	17.40	4,200	1200	14.45	1,450
						2400	14.09	1,240

(215) 6-4737. Snake Creek near Ashton, S. Dak.

Location (revised).--Lat 45°01'50", long 98°34'26", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.17, T.118 N., R.64 W., on right bank 7 ft downstream from highway bridge, 700 ft downstream from South Fork Snake Creek, 4 $\frac{1}{2}$ miles northwest of Ashton, and 21 $\frac{1}{2}$ miles upstream from mouth.

Drainage area.--2,620 sq mi, approximately, of which about 850 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph except Apr. 1-7. Gage heights for Apr. 3-5, 7 based on once-daily wire-weight gage readings. Altitude of gage is 1,265 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-7.

Maxima.--April 1969: Discharge, 6,980 cfs 2400 hours Apr. 10 (gage height, 17.21 ft).

1955 to March 1969: Discharge, 1,210 cfs Mar. 20, 1966 (gage height, 13.69 ft).

JAMES RIVER BASIN

Snake Creek near Ashton, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8.....	4,950	15.....	1,700	23.....	374
2.....	0	9.....	5,030	16.....	1,310	24.....	324
3.....	0	10.....	5,780	17.....	1,020	25.....	292
4.....	0	11.....	6,650	18.....	807	26.....	259
5.....	0	12.....	5,040	19.....	640	27.....	266
6.....	200	13.....	3,400	20.....	561	28.....	254
7.....	600	14.....	2,300	21.....	478	29.....	228
				22.....	423	30.....	196
Monthly mean discharge, in cubic feet per second.....							1,436
runoff, in acre-feet.....							85,450

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 7</u>			<u>Apr. 10</u>			<u>Apr. 12</u>		
2400	14.89	1,750	0400	16.58	4,110	1200	16.83	4,980
			0800	16.84	5,020	1800	16.71	4,540
<u>Apr. 8</u>			1200	17.10	6,260	2400	16.58	4,110
0400	15.86	2,630	1600	17.19	6,840			
0800	16.43	4,170	2400	17.21	6,980	<u>Apr. 13</u>		
1300	16.83	5,990				0800	16.41	3,630
1900	16.94	6,710	<u>Apr. 11</u>			1600	16.21	3,140
2400	16.91	6,450	0600	17.20	6,900	2400	16.03	2,760
			1200	17.18	6,770			
<u>Apr. 9</u>			1800	17.12	6,390	<u>Apr. 14</u>		
0600	16.82	5,630	2400	17.07	6,100	0800	15.81	2,400
1200	16.71	4,860				1600	15.57	2,150
1800	16.62	4,340	<u>Apr. 12</u>			2400	15.30	1,950
2400	16.58	4,110	0600	16.96	5,540			

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Location.--Lat 44°36'25", long 99°13'55", in SW¼SW¼ sec.11, T.113 N., R.70 W., near right bank on downstream side of highway bridge, a quarter of a mile downstream from nearest tributary, 6½ miles north of Ree Heights, and 13 3/4 miles upstream from Lake Louise dam.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,615 ft (from topographic map).

Maxima.--April 1969: Discharge, 990 cfs 0800 hours Apr. 5 (gage height, 9.33 ft).
1959 to March 1969: Discharge, 842 cfs Mar. 30, 1960 (gage height, 9.18 ft); gage height, 9.57 ft Mar. 14, 1966 (backwater from ice).

Mean discharge, in cubic feet per second, 1969

[illegible]

Wolf Creek near Ree Heights, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 6</u>		
2400	6.61		0400	9.28	955	2100	8.53	581
			0800	9.33	990	2300	8.49	565
<u>Apr. 2</u>			1200	9.28	955	2400	8.41	535
2400	7.70		1600	9.15	872			
			1900	9.02	799	<u>Apr. 7</u>		
<u>Apr. 3</u>			2100	9.04	810	0100	8.47	558
1200	8.08		2400	9.00	788	0200	8.42	539
2400	8.51	573				0500	8.44	546
			<u>Apr. 6</u>			0700	8.36	517
<u>Apr. 4</u>			0400	8.86	719	0900	8.15	450
0400	8.59	604	1000	8.84	710	1200	7.81	365
1000	8.52	577	1200	8.61	612	1400	7.95	397
1600	8.84	710	1400	8.48	561	1600	7.91	387
2000	9.01	793	1700	8.42	539	1800	7.84	372
2400	9.16	878	1900	8.51	573	2100	7.94	395
						2400	8.03	417

(217) 6-4738. Matter Creek tributary near Orient, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.1, T.115 N., R.69 W., at culvert on county highway
6 3/4 miles southeast of Orient.

Drainage area.--5.41 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments.

Maxima.--April 1969: Discharge, 400 cfs Apr. 3 (gage height, 9.01 ft).
1956 to March 1969: Discharge, 325 cfs Mar. 30, 1960 (gage height,
7.41 ft); gage height, 7.90 ft Mar. 13, 1966 (backwater from ice).

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(218) 6-4738.2 Shaefer Creek near Orient, S. Dak.

(Crest-stage station)

Location.--NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.17, T.115 N., R.68 W., on downstream side of bridge on county highway, 8 $\frac{1}{2}$ miles southeast of Orient.

Drainage area.--45.1 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 700 cfs and extended by logarithmic plotting.

Maxima.--April 1969: Discharge, 1,280 cfs Apr. 3 (gage height, 5.98 ft).
1956 to March 1969: Discharge, 870 cfs Mar. 30, 1960 (gage height, 5.12 ft).

(219) 6-4738.5 Shaefer Creek tributary near Orient, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ sec.34, T.115 N., R.68 W., at culvert on State Highway 45, 13 miles southeast of Orient.

Drainage area.--6.08 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 350 cfs Apr. 3 (gage height, 7.98 ft).
1956 to March 1969: Discharge, 221 cfs Mar. 30, 1960 (gage height, 6.12 ft).

(220) 6-4738.8 Shaefer Creek tributary near Miller, S. Dak.

(Crest-stage station)

Location.--NE $\frac{1}{4}$ sec.10, T.114 N., R.68 W., at culvert on State Highway 45, 13 miles north of Miller.

Drainage area.--5.75 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 170 cfs.

Maxima.--April 1969: Discharge, 245 cfs Apr. 3 (gage height, 6.40 ft).
1956 to March 1969: Discharge, 120 cfs Mar. 30, 1960, June 15, 1967 (gage height, 4.61 ft).

(221) 6-4740. Turtle Creek near Tulare, S. Dak.

Location.--Lat 44°44', long 98°35', in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.25, T.115 N., R.65 W., on left bank at downstream side of highway bridge, 4 miles west of Tulare and 9 miles downstream from Wolf Creek.

Drainage area.--1,120 sq mi, approximately.

Gage-height record.--Water-stage recorder graph except 1800 hours Apr. 5 to 1600 hours Apr. 11. Reconstructed graph based on water-surface reading below reference point on Apr. 6, 7, 9. Altitude of gage is 1,300 ft (by barometer).

Discharge record.--Stage-discharge relation defined by current-meter measurements below 3,900 cfs. Backwater from ice, Apr. 3-6.

Maxima.--April 1969: Discharge, about 6,000 cfs Apr. 5; gage height, 18.51 ft Apr. 5 (backwater from ice).
1953-56, 1965 to March 1969: Discharge, 1,980 cfs Mar. 16, 1966 (gage height, 12.10 ft, from floodmark).

JAMES RIVER BASIN

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Turtle Creek near Tulare, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0.96	8....	2,950	15....	533	23....	226
2.....	3.8	9....	2,380	16....	446	24....	212
3.....	4.0	10....	1,950	17....	386	25....	184
4.....	250	11....	1,440	18....	313	26....	175
5.....	5,500	12....	1,070	19....	304	27....	155
6.....	5,000	13....	830	20....	293	28....	135
7.....	4,110	14....	656	21....	269	29....	106
				22....	241	30....	78
Monthly mean discharge, in cubic feet per second.....							1,007
Runoff, in acre-feet.....							59,900

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u> 1400	4.53	3.0	<u>Apr. 9</u> 1330	12.68	2,370	<u>Apr. 17</u> 1100	8.11	386
<u>Apr. 4</u> 1730	10.18	414	<u>Apr. 11</u> 1700	11.00	1,340	<u>Apr. 21</u> 1330	7.16	277
<u>Apr. 5</u> 1130	17.94	5,410	<u>Apr. 13</u> 1400	9.76	809	<u>Apr. 25</u> 1030	6.61	202
<u>Apr. 7</u> 1530	14.52	3,870	<u>Apr. 15</u> 1230	8.84	521			

Location (revised).--Lat 44°45'52", long 98°42'13", in NW¼NW¼ sec.19, T.115 N., R.65 W., at downstream side of center piling of bridge on State Highway 26, 3 3/4 miles upstream from Cottonwood Lake and 9 1/4 miles south of Zell.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,320 ft (from topographic map).

Maxima.--April 1969: Discharge, 2,210 cfs 0330 hours Apr. 5 (gage height, 12.41 ft).
1959 to March 1969: Discharge, 1,250 cfs Mar. 14, 1966 (gage height, 10.28 ft).

Mean discharge, in cubic feet per second, 1900							
Day	April	Day	April	Day	April	Day	April
1.....	0.06	8....	827	15....	66	23....	15
2.....	.20	9....	517	16....	54	24....	13
3.....	15	10....	335	17....	41	25....	12
4.....	855	11....	206	18....	34	26....	11
5.....	1,750	12....	131	19....	28	27....	9.8
6.....	1,130	13....	96	20....	24	28....	8.8
7.....	1,010	14....	78	21....	20	29....	7.8
				22....	17	30....	6.7
Monthly mean discharge, in cubic feet per second.....							244
Runoff, in acre-feet.....							14,520

JAMES RIVER BASIN

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Medicine Creek near Zell, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 4</u>			<u>Apr. 6</u>		
2400	3.68		1600	11.00	1,540	1100	9.94	1,040
			1800	11.22	1,640	1500	10.03	1,080
<u>Apr. 3</u>			2100	11.59	1,810	2100	9.86	1,000
0600	3.85		2400	12.06	2,040	2400	9.92	1,030
1400	4.26							
2100	5.60		<u>Apr. 5</u>			<u>Apr. 7</u>		
2400	5.56	57	0200	12.26	2,130	0400	9.98	1,060
			0330	12.41	2,210	1200	9.88	1,010
<u>Apr. 4</u>			0400	12.14	2,080	1900	9.81	978
0100	5.74	67	0800	11.68	1,860	2400	9.81	978
0500	5.45	52	1200	11.35	1,700			
1000	5.28	44	1500	11.00	1,540	<u>Apr. 8</u>		
1100	7.62	276	1900	11.07	1,570	0400	9.77	959
1200	9.60	881	2400	10.79	1,440	0800	9.66	909
1400	10.59	1,340				1200	9.52	844
						1800	9.25	724
						2400	8.98	618

(223) 6-4745. Turtle Creek at Redfield, S. Dak.

Location.--Lat 44°53'00", long 98°30'45", in SW¼SE¼ sec.3, T.116 N., R.64 W., near center of span at downstream side of bridge on U. S. Highway 281 at north edge of Redfield, and 6 3/4 miles upstream from mouth.

Drainage area.--1,540 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,259.3 ft above mean sea level, datum of 1929.

Discharge record.--Stage discharge relation defined by current-meter measurements. Backwater from ice, Apr. 5, 6.

Maxima.--April 1969: Discharge, 7,660 cfs 0630 hours Apr. 7 (gage height, 15.94 ft).

1945 to March 1969: Discharge, 6,420 cfs Apr. 10, 1952 (gage height, 15.51 ft).

JAMES RIVER BASIN

Turtle Creek at Redfield, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0.42	8....	5,080	15....	872	23....	328
2.....	1.3	9....	3,750	16....	724	24....	299
3.....	.89	10....	2,910	17....	621	25....	268
4.....	.89	11....	2,230	18....	546	26....	241
5.....	500	12....	1,700	19....	476	27....	202
6.....	3,800	13....	1,280	20....	433	28....	188
7.....	7,120	14....	1,050	21....	397	29....	163
				22....	361	30....	138
Monthly mean discharge, in cubic feet per second.....							1,189
Runoff, in acre-feet.....							70,770

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 4</u>			<u>Apr. 7</u>			<u>Apr. 9</u>		
2400	2.05		0600	15.85	7,570	0600	12.17	3,980
			0630	15.94	7,660	1200	11.89	3,730
<u>Apr. 5</u>			1200	15.71	7,430	1800	11.66	3,520
1200	2.19		1800	15.26	6,980	2400	11.43	3,320
1600	7.86		2400	14.51	6,230			
2400	10.81					<u>Apr. 10</u>		
			<u>Apr. 8</u>			0600	11.20	3,110
<u>Apr. 6</u>			0600	13.77	5,490	1200	10.94	2,880
1200	12.80		1200	13.27	4,990	1800	10.73	2,710
1800	13.66		1800	12.85	4,600	2400	10.51	2,540
2400	14.95	6,670	2400	12.45	4,240			

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Location.--Lat $44^{\circ}55'10''$, long $98^{\circ}25'50''$, in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.28, T.117 N., R.63 W., on right bank just downstream from highway bridge, $4\frac{1}{2}$ miles northeast of Redfield and $5\frac{1}{4}$ miles downstream from Turtle Creek.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,236.3 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 7,310 cfs 0800 hours Apr. 13 (gage height, 24.93 ft).
1950 to March 1969: Discharge, 6,100 cfs Apr. 11, 1952 (gage height, 22.12 ft).

[illegible]

JAMES RIVER BASIN

James River near Redfield, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 2</u>			<u>Apr. 10</u>			<u>Apr. 17</u>		
2400	4.34		0600	23.76	6,420	1200	21.92	5,660
			1200	23.87	6,490	2400	21.41	5,020
<u>Apr. 3</u>			2400	24.03	6,610	<u>Apr. 18</u>		
2400	6.38		<u>Apr. 11</u>			1200	20.92	4,830
			1200	24.30	6,800	2400	20.54	4,680
<u>Apr. 4</u>			2400	24.56	7,010	<u>Apr. 19</u>		
2400	7.07		<u>Apr. 12</u>			0600	20.44	4,650
<u>Apr. 5</u>			1200	24.80	7,200	1800	20.44	4,650
2400	9.35		2400	24.91	7,290	2400	20.55	4,740
<u>Apr. 6</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
1200	14.30		0800	24.93	7,310	1200	20.81	4,930
2400	18.79		1800	24.88	7,270	2400	21.15	5,200
<u>Apr. 7</u>			2400	24.80	7,200	<u>Apr. 21</u>		
1200	21.78		<u>Apr. 14</u>			1200	21.43	5,410
2400	22.61	5,290	1200	24.60	7,040	2400	21.72	5,660
<u>Apr. 8</u>			1800	24.42	6,900	<u>Apr. 22</u>		
0600	22.49	5,130	2400	24.25	6,770	1200	21.96	5,880
1200	22.49	5,130	<u>Apr. 15</u>			2400	22.15	6,040
1800	22.53	5,190	0600	24.08	6,650	<u>Apr. 23</u>		
2400	22.61	5,290	1200	23.89	6,510	1200	22.27	6,160
<u>Apr. 9</u>			2400	23.45	6,210	2400	22.35	6,230
0600	22.89	5,600	<u>Apr. 16</u>			<u>Apr. 24</u>		
1200	23.20	5,930	1200	22.96	5,880	1000	22.40	6,270
1800	23.46	6,160	2400	22.46	5,550	1800	22.37	6,260
2400	23.64	6,320				2400	22.35	6,250

497

Location.--Lat 44°56'15", long 98°19'45", in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.20, T.117 N., R.62 W., on left bank 8 ft downstream from highway bridge, 400 ft downstream from small tributary, 4 1/3 miles north of Frankfort, and 7 miles upstream from mouth.

Gage-height record.--Water-stage recorder graph except 2000 hours Apr. 9 to 1000 hours Apr. 11, and other short periods when clock stopped intermittently. Reconstructed graph based on range lines and trend of recorded graph. Datum of gage is 1,253.19 ft above mean sea level, datum of 1929 (Bureau of Reclamation bench mark).

Maxima.--April 1969: Discharge, 465 cfs 1500 hours Apr. 7 (gage height, 8.81 ft).
1955 to March 1969: Discharge, 772 cfs Mar. 29, 1962 (gage height, 9.16 ft).

[illegible]

JAMES RIVER BASIN

Dry Run near Frankfort, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 5</u>			<u>Apr. 7</u>			<u>Apr. 10</u>		
1200	5.61		1500	8.81	465	0600	8.34	332
1800	5.95		1800	8.77	452	1200	8.38	341
2400	6.25		2400	8.68	421	1800	8.44	354
						2400	8.51	372
<u>Apr. 6</u>			<u>Apr. 8</u>			<u>Apr. 11</u>		
0500	6.17		0600	8.60	397	0600	8.58	389
0700	6.51		1200	8.54	382	1200	8.59	393
0900	6.95		1800	8.46	361	1500	8.59	393
1200	7.24		2400	8.41	348	1800	8.59	393
1600	7.72					2400	8.57	389
2000	8.16		<u>Apr. 9</u>			<u>Apr. 12</u>		
2400	8.41	348	0600	8.37	338	0800	8.54	382
			1200	8.33	328	1600	8.51	372
<u>Apr. 7</u>			1800	8.31	322	2400	8.46	361
0400	8.58	389	2400	8.31	322			
0800	8.68	421						
1200	8.77	452						

(226) 6-4760. James River at Huron, S. Dak.

Location.--Lat $44^{\circ}21'49''$, long $98^{\circ}11'56''$, in SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.6, T.110 N., R.61 W., on right bank 15 ft upstream from city dam at Huron, 135 ft downstream from Chicago and North Western Railway Co. bridge, and 165 ft upstream from bridge on U.S. Highway 14.

Drainage area.--16,800 sq mi, approximately, of which about 4,790 sq mi is probably noncontributing.

Gage-height record.--Digital water-stage recorder. Datum of gage is 1,223.44 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 9,000 cfs 0200 hours Apr. 13 (gage height, 16.70 ft).

1928-32, 1943 to March 1969: Discharge, 6,250 cfs Apr. 2, 1962; gage height, 15.80 ft Apr. 1, 2, 1962.

Stage known, 19.8 ft between Apr. 11 and 13, 1881, from U.S. Weather Bureau publication. Flood of Mar. 22, 1922, reached a stage of 16.5 ft.

JAMES RIVER BASIN

499

James River at Huron, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	59	8....	5,750	15....	8,440	23....	5,650
2.....	68	9....	7,060	16....	8,080	24....	5,770
3.....	122	10....	8,240	17....	7,610	25....	5,940
4.....	455	11....	8,830	18....	7,110	26....	5,970
5.....	1,180	12....	8,940	19....	6,630	27....	5,980
6.....	2,170	13....	8,930	20....	6,180	28....	5,920
7.....	3,860	14....	8,780	21....	5,810	29....	5,930
				22....	5,650	30....	5,920
Monthly mean discharge, in cubic feet per second.....							5,568
Runoff, in acre-feet.....							331,300

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 1</u>			<u>Apr. 4</u>			<u>Apr. 7</u>		
2400	8.08	68	1200	8.91	464	1200	13.85	3,730
			2400	9.45	665	2400	14.87	5,060
<u>Apr. 2</u>			<u>Apr. 5</u>			<u>Apr. 8</u>		
1200	8.11	78	1200	10.75	1,210	1200	15.29	5,660
1500	8.15	95	2400	11.50	1,610	2400	15.65	6,280
1800	8.28	162						
2400	8.55	310	<u>Apr. 6</u>					
			1200	12.32	2,190			
			2400	13.02	2,820			

Location.--Lat 44°09'20", long 98°26'10", in NE¹/₄NE¹/₄ sec.19, T.108 N., R.63 W., on left bank 5 ft downstream from highway bridge, 4 miles southwest of Alpena, 7 miles upstream from Chicago, Milwaukee, St. Paul and Pacific Railroad bridge, and 10½ miles upstream from interlink with Cain Creek.

Gage-height record.--Water-stage recorder graph except for Apr. 3, 4 for which graph was drawn on basis of once-daily wire-weight gage readings. Altitude of gage is 1,315 ft (by barometer).

Maxima.--April 1969: Discharge, 2,220 cfs 0900 hours Apr. 5 (gage height, 12.92 ft); gage height, 13.00 ft Apr. 4 (backwater from ice).
1950 to Mar. 1969: Discharge, 2,240 cfs Mar. 28, 1960 (gage height, 13.35 ft); gage height, 14.1 ft Mar. 28, 1950 (backwater from ice), from graph based on gage readings.

[illegible]

JAMES RIVER BASIN

501

Sand Creek near Alpena, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 8</u>		
1200	3.91		0600	12.90	2,190	0600	10.67	352
2400	4.87		0900	12.92	2,220	1200	10.72	365
			1200	12.84	2,090	1800	10.72	365
<u>Apr. 2</u>			1800	12.67	1,840	2400	10.60	335
1200	5.21		2400	12.49	1,600			
2400	5.99					<u>Apr. 9</u>		
			<u>Apr. 6</u>			0600	10.40	288
<u>Apr. 3</u>			0600	12.27	1,350	1200	10.26	255
0400	6.03		1200	12.02	1,110	1800	10.15	231
1100	5.92		1800	11.72	866	2400	10.08	216
1800	8.10		2400	11.36	626			
2400	10.50					<u>Apr. 10</u>		
<u>Apr. 4</u>			<u>Apr. 7</u>			0600	9.95	191
0600	13.00		0600	11.12	490	1200	9.78	161
1200	12.72		1200	11.00	440	1800	9.68	145
1600	12.90		1800	10.98	434	2400	9.60	134
2200	12.73		2400	10.83	392			
2400	12.76	1,970						

Location.--Lat 43°58'45", long 98°04'05", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.20, T.106 N., R.60 W., on right bank 5 ft downstream from highway bridge, 3 3/4 miles southeast of Forestburg, 4 $\frac{1}{2}$ miles downstream from Chicago, Milwaukee, St. Paul and Pacific Railroad bridge, and 5 $\frac{1}{4}$ miles downstream from Sand Creek.

Drainage area.--18,600 sq mi, approximately, of which about 4,790 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph except Apr. 7, for which graph was drawn on basis of daily wire-weight gage readings. Altitude of gage is 1,205 ft (by barometer).

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-6.

Maxima.--April 1969: Discharge, 12,500 cfs 2000 hours Apr. 9 (gage height, 17.16 ft).

1950 to March 1969: Discharge, 12,000 cfs Mar. 31, 1962 (gage height, 16.40 ft).

Floods in Mar. 1920 and Mar. 1922 reached a stage of about 18 ft, from information by local residents.

Mean discharge, in cubic feet per second, 1969

[illegible]

James River near Forestburg, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 5</u>			<u>Apr. 8</u>			<u>Apr. 10</u>		
2400	9.90		0600	15.36	4,410	0400	17.13	12,200
			1200	15.91	5,620	1400	17.13	12,200
<u>Apr. 6</u>			1800	16.28	6,870	2400	17.08	12,100
0300	10.16		2400	16.63	8,630			
0600	10.44					<u>Apr. 11</u>		
1200	10.78		<u>Apr. 9</u>			1200	17.03	11,900
1800	11.37		0400	16.80	9,700	2400	16.96	11,600
2400	12.24	2,160	0700	16.90	10,400			
			1000	16.98	11,000	<u>Apr. 12</u>		
<u>Apr. 7</u>			1300	17.05	11,600	1200	16.88	11,300
0600	12.91	2,480	1700	17.13	12,200	2400	16.78	10,900
1200	13.59	2,840	2000	17.16	12,500			
1800	14.24	3,260	2200	17.16	12,500	<u>Apr. 13</u>		
2400	14.80	3,740	2400	17.14	12,300	1200	16.71	10,800
						2400	16.63	10,600

(229) 6-4771.5 Rock Creek near Fulton, S. Dak.

Location.--Lat 43°45'39", long 97°54'25", in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec.3, T.103 N., R.59 W., near right bank at downstream side of highway bridge, 9 miles northwest of Fulton and 10 miles upstream from mouth.

Drainage area.--270 sq mi, approximately.

Gage-height record.--Water-stage recorder graph except Apr. 6-8, for which a graph was drawn on basis of partial recorder record and floodmark. Datum of gage is 1,232.08 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice, Apr. 1-6.

Maxima.--April 1969: Discharge, 2,040 cfs about 0200 hours Apr. 7 (gage height, 10.21 ft, from floodmark).

1966 to March 1969: Discharge, 625 cfs June 17, 1967 (gage height, 7.22 ft), from rating curve extended above 300 cfs by logarithmic plotting.

JAMES RIVER BASIN

Rock Creek near Fulton, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	0	8....	1,560	15....	114	23....	27
2.....	0	9....	1,320	16....	90	24....	20
3.....	10	10....	859	17....	79	25....	16
4.....	80	11....	474	18....	68	26....	13
5.....	280	12....	273	19....	60	27....	12
6.....	1,000	13....	182	20....	52	28....	12
7.....	1,840	14....	137	21....	42	29....	11
				22....	34	30....	10
Monthly mean discharge, in cubic feet per second.....							289
Runoff, in acre-feet.....							17,200

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 5</u>			<u>Apr. 9</u>		
2400	4.48		1900	7.50		0600	9.05	1,420
			2400	8.68		1200	8.88	1,330
<u>Apr. 3</u>						2400	8.38	1,100
1200	4.64		<u>Apr. 6</u>			<u>Apr. 10</u>		
1800	6.98		0900	8.76		1200	7.75	846
2000	8.03		1200	9.02		2400	7.11	645
2400	7.92		2400	10.12	1,980			
<u>Apr. 4</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
0200	7.98		0200	10.21	2,040	1200	6.45	459
1000	6.98		0600	10.08	1,960	2400	5.93	344
1300	6.60		1200	9.84	1,830			
1500	6.98		2400	9.52	1,650	<u>Apr. 12</u>		
2400	8.38					1200	5.54	268
			<u>Apr. 8</u>			2400	5.25	215
<u>Apr. 5</u>			1200	9.34	1,560	<u>Apr. 13</u>		
0600	8.33		2400	9.14	1,460	1800	4.97	167
						2400	4.90	156

505

Location.--Lat 43°46', long 98°15', in SW¼SW¼ sec.26, T.104 N., R.62 W., near center of span on downstream side of highway bridge, 4½ miles north of Mount Vernon, 5¼ miles downstream from West Firesteel Creek, and 12 miles northwest of Mitchell.

Gage-height record.--Wire-weight gage read once daily. Graph for Apr. 1-22 drawn on basis of once-daily gage readings and crest-stage gage marks. Altitude of gage is 1,310 ft (from topographic map).

Maxima.--April 1969: Discharge, 6,610 cfs about 2200 hours Apr. 4 (gage height, 15.34 ft); gage height, 17.12 ft Apr. 3 (backwater from ice).
1950 to March 1969: Discharge, 5,780 cfs Mar. 28, 1960 (gage height, 15.13 ft); gage height, 16.85 ft Mar. 31, 1962 (backwater from ice).

Mean discharge, in cubic feet per second, 1969							
Day	April	Day	April	Day	April	Day	April
1.....	50	8....	736	15....	100	23....	25
2.....	200	9....	527	16....	89	24....	26
3.....	2,500	10....	360	17....	75	25....	24
4.....	5,820	11....	255	18....	60	26....	21
5.....	4,090	12....	215	19....	50	27....	17
6.....	1,950	13....	188	20....	41	28....	15
7.....	1,030	14....	134	21....	32	29....	12
				22....	28	30....	11
Monthly mean discharge, in cubic feet per second.....							623
Runoff, in acre-feet.....							37,100

JAMES RIVER BASIN

Firesteel Creek near Mount Vernon, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 1</u>			<u>Apr. 4</u>			<u>Apr. 7</u>		
0100	3.95		0600	14.68	5,580	1200	8.35	1,010
1200	6.00		1200	14.65	5,540	2400	7.82	832
1800	6.42		1800	14.88	5,880			
2400	6.14		2200	15.34	6,610	<u>Apr. 8</u>		
			2400	15.02	6,090	1200	7.48	740
<u>Apr. 2</u>						2400	7.04	630
1600	5.50		<u>Apr. 5</u>					
1800	5.70		0600	14.00	4,680	<u>Apr. 9</u>		
2400	7.63		1200	13.20	3,820	1200	6.58	522
			1800	12.70	3,410	2400	6.18	435
<u>Apr. 3</u>			2400	11.92	2,790			
0600	10.25							
1200	13.00		<u>Apr. 6</u>					
1900	17.12		0600	11.17	2,270			
2100	15.15		1200	10.43	1,860			
2400	14.85	5,840	1800	9.85	1,590			
			2400	9.22	1,340			

(231) 6-4780. James River near Mitchell, S. Dak.

Location.--Lat 43°41'35", long 97°57'55", in NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.30, T.103 N., R.59 W., near left bank at downstream side of bridge on Interstate 90, a quarter of a mile downstream from Firesteel Creek and 3 miles southeast of Mitchell.

Drainage area.--19,800 sq mi, approximately, of which about 4,790 sq mi is probably noncontributing.

Gage-height record.--Water-stage recorder graph except Apr. 1, 4, 9-30. A graph based on once-daily wire-weight gage readings was used Apr. 4, 9-11, 13-18, 22-26, 29. Datum of gage is 1,198.00 ft above mean sea level, datum of 1929 (South Dakota Department of Highways bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements; affected by ice, Apr. 1-4. Discharge for periods of no gage-height record estimated on basis of six discharge measurements, weather records, and records for nearby stations.

Maxima.--April 1969: Discharge, 13,800 cfs 1400 hours Apr. 11 (gage height, 18.32 ft).

1953-58, 1965 to March 1969: Discharge, 2,750 cfs Mar. 23, 1966 (gage height, 12.98 ft).

JAMES RIVER BASIN

507

James River near Mitchell, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	100	8....	6,100	15....	11,000	23....	6,820
2.....	150	9....	9,570	16....	10,500	24....	6,500
3.....	650	10....	12,800	17....	10,000	25....	6,100
4.....	1,800	11....	13,200	18....	9,530	26....	6,350
5.....	3,790	12....	12,800	19....	8,940	27....	6,720
6.....	4,670	13....	12,400	20....	8,510	28....	6,600
7.....	5,330	14....	11,700	21....	8,150	29....	6,150
				22....	7,490	30....	5,900
Monthly mean discharge, in cubic feet per second.....							7,340
Runoff, in acre-feet.....							437,000

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
2400	5.70		1200	16.11	5,380	0600	18.22	13,200
			1800	16.11	5,380	1400	18.32	13,800
<u>Apr. 3</u>			2400	16.17	5,520	1600	18.20	13,200
1200	7.10					2000	18.14	12,800
2400	9.85		<u>Apr. 8</u>			2400	18.14	12,800
			1200	16.30	5,900			
<u>Apr. 4</u>			1800	16.48	6,380	<u>Apr. 12</u>		
1200	11.25		2400	16.83	7,400	0600	18.18	13,000
1800	12.10					1200	18.14	12,800
2400	13.47	2,630	<u>Apr. 9</u>			2400	18.06	12,400
			0600	17.16	8,480			
<u>Apr. 5</u>			1200	17.48	9,640	<u>Apr. 13</u>		
0600	14.65	3,500	1800	17.70	10,600	0600	18.02	12,200
1200	15.11	3,940	2400	17.92	11,700	1200	18.10	12,600
1800	15.37	4,200				2400	18.00	12,200
2400	15.54	4,410	<u>Apr. 10</u>					
			0600	18.10	12,600	<u>Apr. 14</u>		
<u>Apr. 6</u>			1200	18.18	13,000	0600	17.93	11,800
1200	15.66	4,580	2400	18.21	13,200	1200	17.90	11,700
2400	15.99	5,120				2400	17.80	11,200

(232) 6-4782.6 North Branch Dry Creek near Parkston, S. Dak.

(Crest-stage station)

Location.--NE $\frac{1}{4}$ sec.29, T.99 N., R.59 W., at bridge on county highway,
7 $\frac{1}{2}$ miles southeast of Parkston.

Drainage area.--37.0 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter
measurements below 900 cfs and extended by logarithmic plotting.

Maxima.--April 1969: Discharge, 3,200 cfs Apr. 8 (gage height,
10.28 ft).
1956 to March 1969: Discharge, 1,540 cfs July 14, 1962 (gage
height, 8.76 ft).

(233) 6-4782.8 South Branch Dry Creek near Parkston, S. Dak.

(Crest-stage station)

Location.--NW $\frac{1}{4}$ sec.33, T.99 N., R.59 W., at bridge on county highway,
8 $\frac{1}{4}$ miles southeast of Parkston.

Drainage area.--17.1 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter
measurements below 400 cfs and extended by logarithmic plotting.

Maxima.--April 1969: Discharge, 650 cfs Apr. 8 (gage height, 6.52 ft).
1956 to March 1969: Discharge, 920 cfs Mar. 27, 1960 (gage
height, 7.37 ft).

(234) 6-4783. Dry Creek near Parkston, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ sec.21, T.99 N., R.59 W., at bridge on county highway, 8 $\frac{1}{2}$ miles southeast of Parkston.

Drainage area.--76.8 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 2,000 cfs and by slope-area measurement at 4,210 cfs.

Maxima.--April 1969: Discharge, 1,500 cfs Apr. 8 (gage height, 9.08 ft).
1956 to March 1969: Discharge, 4,210 cfs Mar. 27, 1960 (gage height, 12.70 ft).

(235) 6-4785. James River near Scotland, S. Dak.

Location.--Lat 43°11'00", long 97°37'55", in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec.30, T.97 N., R.57 W., on left bank 50 ft upstream from highway bridge, 500 ft upstream from Dawson Creek, and 5 miles northeast of Scotland.

Drainage area.--21,550 sq mi, approximately, of which about 4,790 sq mi is probably noncontributing.

Gage-height record. Digital water-stage recorder record. Datum of gage is 1,168.51 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice or downstream tributaries, Apr. 1-10.

Maxima.--April 1969: Discharge, 14,000 cfs 1000 hours to 2100 hours Apr. 13 (gage height, 18.55 ft).
1928 to March 1969: Discharge, 15,200 cfs Apr. 3, 1962 (gage height, 18.74 ft).

Remarks.--Occasional backwater caused by Dawson Creek; reverse flow occurred for part of May 15, 1961, from information by local residents.

James River near Scotland, S. Dak.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	1,600	8....	6,030	15....	13,200	23....	8,970
2.....	3,000	9....	6,200	16....	12,600	24....	8,310
3.....	3,940	10....	7,410	17....	12,000	25....	7,600
4.....	4,290	11....	10,600	18....	11,500	26....	6,980
5.....	4,830	12....	12,900	19....	11,100	27....	6,470
6.....	5,220	13....	13,900	20....	10,500	28....	6,140
7.....	5,480	14....	13,700	21....	10,000	29....	5,910
				22....	9,520	30....	5,750
Monthly mean discharge, in cubic feet per second.....							8,190
Runoff, in acre-feet.....							487,200

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 1</u>			<u>Apr. 8</u>			<u>Apr. 13</u>		
0100	8.31		1200	16.01		1800	18.55	14,000
1200	9.99					2100	18.55	14,000
2400	12.85		<u>Apr. 9</u>			2400	18.53	13,900
			1200	15.93				
<u>Apr. 2</u>			<u>Apr. 10</u>			<u>Apr. 14</u>		
1200	13.97		1200	16.55		1200	18.49	13,700
			2400	16.85	8,160	2400	18.43	13,500
<u>Apr. 3</u>			<u>Apr. 11</u>			<u>Apr. 15</u>		
1200	14.31		0600	17.23	9,520	2400	18.29	12,900
<u>Apr. 4</u>			1200	17.58	10,600	<u>Apr. 16</u>		
1200	14.54		1800	17.92	11,800	2400	18.15	12,400
<u>Apr. 5</u>			2400	18.16	12,600	<u>Apr. 17</u>		
1200	15.16		<u>Apr. 12</u>			2400	18.00	11,800
<u>Apr. 6</u>			1200	18.21	12,800	<u>Apr. 18</u>		
1200	15.50		2400	18.47	13,700	2400	17.85	11,200
<u>Apr. 7</u>			<u>Apr. 13</u>			<u>Apr. 19</u>		
1200	15.71		1000	18.55	14,000	2400	17.74	10,900
			1400	18.55	14,000			

Location.--Lat 43°25'00", long 97°12'10", in NE¼ sec.10, T.99 N., R.54 W., near midstream at downstream side of highway bridge, 3½ miles northwest of Parker and 12 miles upstream from confluence with East Fork Vermillion River.

Gage-height record.--Wire-weight gage and crest-stage gage read once or twice daily. Graph for Apr. 1-23 drawn on basis of wire-weight gage readings. Altitude of gage is 1,540 ft (from topographic map).

Maxima.--April 1969: Discharge, 3,760 cfs 2300 hours Apr. 6 (gage height, 12.00 ft); gage height, 12.30 ft Apr. 4 (backwater from ice).
1961 to March 1969: Discharge, 4,340 cfs Mar. 28, 1962 (gage height, 12.33 ft).

Mean discharge, in cubic feet per second, 1969							
Day	April	Day	April	Day	April	Day	April
1.....	100	8....	1,770	15....	254	23....	44
2.....	400	9....	1,740	16....	186	24....	40
3.....	550	10....	1,300	17....	141	25....	38
4.....	1,200	11....	918	18....	113	26....	34
5.....	2,000	12....	628	19....	94	27....	29
6.....	2,700	13....	460	20....	79	28....	24
7.....	2,140	14....	362	21....	64	29....	21
				22....	52	30....	19
Monthly mean discharge, in cubic feet per second.....							583
Runoff, in acre-feet.....							34,700

West Fork Vermillion River near Parker, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 9</u>		
0600	3.72		1200	11.22		0600	10.23	1,780
1200	5.30		2400	11.16	2,480	1200	10.15	1,740
2400	7.85					1800	10.06	1,700
			<u>Apr. 6</u>			2400	9.90	1,620
<u>Apr. 2</u>			0900	10.97	2,300			
0600	8.25		1200	11.13	2,450	<u>Apr. 10</u>		
1200	8.19		1800	11.50	2,900	0600	9.47	1,440
2400	8.12		2300	12.00	3,760	1200	9.03	1,270
			2400	11.82	3,400	1800	8.72	1,150
<u>Apr. 3</u>						2400	8.48	1,060
0600	8.12		<u>Apr. 7</u>					
1000	8.95		0600	10.80	2,150	<u>Apr. 11</u>		
1400	8.72		1200	10.49	1,940	0600	8.26	988
1800	9.55		2400	10.29	1,820	1200	8.05	914
2400	10.48					1800	7.88	854
			<u>Apr. 8</u>			2400	7.64	770
<u>Apr. 4</u>			1000	10.02	1,680			
0600	11.30		2000	10.35	1,850			
1500	12.30		2400	10.31	1,830			
2400	11.83							

(237) 6-4788. Saddlerock Creek near Canton, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.23, T.97 N., R.50 W., at bridge on county highway, 9 3/4 miles southwest of Canton.

Drainage area.--14.8 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, about 700 cfs Apr. 8 (gage height, 8.80 ft, backwater from ice).

1956 to March 1969: Discharge, 945 cfs June 12, 1965 (gage height, 8.81 ft).

VERMILLION RIVER BASIN

513

(238) 6-4788.2 Saddlerock Creek tributary near Beresford, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.16, T.97 N., R.50 W., at culvert on U. S. Highway 77,
9 $\frac{1}{2}$ miles north of Beresford.

Drainage area.--2.32 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 40 cfs and extended by logarithmic plotting.

Maxima.--April 1969: Discharge, 32 cfs Apr. 8 (gage height, 4.53 ft).
1956 to March 1969: Discharge, 97 cfs June 12, 1965 (gage height, 6.79 ft).

(239) 6-4788.4 Saddlerock Creek near Beresford, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ sec.14, T.97 N., R.51 W., at bridge on county highway,
9 $\frac{3}{4}$ miles northwest of Beresford.

Drainage area.--26.3 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 900 cfs Apr. 8 (gage height, 8.39 ft).
1956 to March 1969: Discharge, 1,480 cfs June 12, 1965 (gage height, 9.80 ft).

Location.--Lat 42°59'20", long 96°57'50", in SW¼NW¼ sec.2, T.94 N., R.52 W., on left bank 40 ft downstream from bridge on State Highway 19, 3½ miles downstream from Frog Creek, 7¼ miles southeast of Wakonda, and 16½ miles downstream from Turkey Ridge Creek.

Gage-height record.--Digital water-stage recorder record. Datum of gage is 1,150.9 ft above mean sea level (levels by Corps of Engineers).

Maxima.--April 1969: Discharge, 9,880 cfs 1400 hours Apr. 8 (gage height, 16.22 ft); gage height, 17.17 ft Apr. 6 (stage-discharge relation affected by levee breaks).

1945 to March 1969: Discharge, 8,660 cfs Mar. 31, 1962 (includes 7,160 cfs bypass flow from levee breaks); gage height, 16.94 ft Apr. 1, 1960.

[illegible]

VERMILLION RIVER BASIN

515

Vermillion River near Wakonda, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 6</u>			<u>Apr. 9</u>		
2400	9.98		0700	17.17		1800	15.81	8,440
			2400	16.36		2400	15.73	8,190
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 10</u>		
2400	12.61		2400	16.38	9,800	0600	15.62	7,860
<u>Apr. 3</u>			<u>Apr. 8</u>			1200	15.52	7,560
2400	16.56		1400	16.22	9,880	1800	15.42	7,260
<u>Apr. 4</u>			1800	16.17	9,700	2400	15.33	6,990
2400	16.95		2400	16.06	9,310	<u>Apr. 11</u>		
<u>Apr. 5</u>			<u>Apr. 9</u>			0600	15.24	6,720
2400	17.01		0600	15.97	9,000	1200	15.15	6,450
			1200	15.91	8,790	1800	15.06	6,180
						2400	14.96	5,880

BIG SIOUX RIVER BASIN

(241) 6-4792. Big Sioux River near Ortley, S. Dak.

(Crest-stage station, discontinued Apr. 6, 1969)

Location.--NW $\frac{1}{4}$ sec.34, T.121 N., R.52 W., at bridge on county highway,
7 $\frac{3}{4}$ miles southeast of Ortley and 9 $\frac{1}{2}$ miles southeast of Waubay.

Drainage area.-- 53.8 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter
measurements.

Maxima.--April 1969: Stage and discharge unknown. Site destroyed by
flood.

1956 to March 1969: Discharge, 950 cfs July 1, 1962 (gage height,
5.73 ft).

BIG SIOUX RIVER BASIN

(242) 6-4792.4 Big Sioux River tributary No. 2 near Summit, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.30, T.121 N., R.51 W., at culvert on U. S. Highway 81,
5 $\frac{3}{4}$ miles southwest of Summit and 11 $\frac{1}{2}$ miles southeast of Waubay.

Drainage area.--0.26 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 20 cfs and by flow-through-culvert measurement at 38 cfs.

Maxima.--April 1969: Discharge, 40 cfs Apr. 6 (gage height, 4.32 ft).
1956 to March 1969: Discharge, 53 cfs July 1, 1962 (gage height, 5.16 ft).

(243) 6-4792.6 Big Sioux River tributary No. 3 near Summit, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ sec.25, T.121 N., R.52 W., at culvert on county highway,
6 $\frac{1}{2}$ miles southwest of Summit, and 11 $\frac{1}{2}$ miles southeast of Waubay.

Drainage area.--6.60 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 490 cfs.

Maxima.--April 1969: Discharge, 800 cfs Apr. 6 (gage height, 10.11 ft).
1956 to March 1969: Discharge, 600 cfs May 24, 1965 (gage height, 6.15 ft).

517

Location.--Lat 44°56'30", long 97°08'50", in SW¼SW¼NW¼ sec.13, T.117 N., R.53 W., on right bank 20 ft downstream from highway bridge, 1 mile downstream from inlet-outlet to Lake Kampeska, 2½ miles northwest of Watertown, and 7½ miles upstream from Willow Creek.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,710 ft (from river-profile map).

Maxima.--April 1969: Discharge, about 1,750 cfs 0930 hours Apr. 8 (gage height, 11.40 ft).
1945 to March 1969: Discharge, 2,220 cfs Apr. 9, 1952; gage height, 10.35 ft Apr. 4, 1952 (backwater from ice).

[illegible]

BIG SIOUX RIVER BASIN

Big Sioux River at Watertown, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
2400	5.11		1200	10.57		1200	9.64	1,140
			2400	10.42	1,550	2400	9.50	1,080
<u>Apr. 4</u>			<u>Apr. 10</u>			<u>Apr. 14</u>		
2400	5.37		0200	10.42	1,550	2400	9.19	961
<u>Apr. 5</u>			0900	10.37	1,520			
2400	5.61		1400	10.35	1,510	<u>Apr. 15</u>		
			1800	10.33	1,500	1200	9.09	921
<u>Apr. 6</u>			2400	10.28	1,470	1800	9.02	893
2400	6.61					2400	8.94	861
<u>Apr. 7</u>			<u>Apr. 11</u>			<u>Apr. 16</u>		
0800	9.31		1200	10.19	1,420	1200	8.79	801
1600	9.76		2400	10.03	1,340	2400	8.65	748
2400	10.62		<u>Apr. 12</u>			<u>Apr. 17</u>		
<u>Apr. 8</u>			1200	9.90	1,260	1000	8.51	698
1400	11.31	1,680	2400	9.76	1,200	2400	8.35	645
2400	10.74					<u>Apr. 18</u>		
						2400	8.07	566

(245) 6-4797.5 Peg Munky Run near Estelline, S. Dak.

(Crest-stage station)

Location.--N $\frac{1}{2}$ sec.29, T.113 N., R.50 W., at bridge on State Highway 28,
2 $\frac{1}{2}$ miles east of Estelline.

Drainage area.--25.4 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments below 150 cfs and by slope-area measurement at 1,080 cfs.

Maxima.--April 1969: Discharge, 1,480 cfs Apr. 8 (gage height, 7.25 ft).

1956 to March 1969: Discharge, 1,540 cfs May 24, 1965 (gage
height, 7.29 ft).

BIG SIOUX RIVER BASIN

519

(246) 6-4798. North Deer Creek near Estelline, S. Dak.

(Crest-stage station)

Location.--SE $\frac{1}{4}$ sec.35, T.112 N., R.50 W., at bridge on U. S. Highway 77,
9 $\frac{3}{4}$ miles southeast of Estelline.

Drainage area.--48.3 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 3,550 cfs Apr. 8 (gage height, 8.45 ft).
1956 to March 1969: Discharge, 590 cfs July 4, 1962 (gage height,
7.61 ft).

(247) 6-4799. Sixmile Creek tributary near Brookings, S. Dak.

(Crest-stage station)

Location.--NW $\frac{1}{4}$ sec.35, T.111 N., R.49 W., at bridge on county highway,
7 $\frac{1}{2}$ miles northeast of Brookings.

Drainage area.--9.42 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 120 cfs and by slope-area measurement at 595 cfs.

Maxima.--April 1969: Discharge, about 1,000 cfs Apr. 8 (gage height,
9.08 ft, backwater from ice).
1956 to March 1969: Discharge, 820 cfs July 4, 1965 (gage height,
6.68 ft).

(248) 6-4799.5 Deer Creek near Brookings, S. Dak.

(Crest-stage station)

Location.--SW $\frac{1}{4}$ sec.29, T.111 N., R.48 W., at bridge on county highway,
9 $\frac{3}{4}$ miles northeast of Brookings.

Drainage area.--4.21 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 300 cfs and extended by logarithmic plotting.

Maxima.--April 1969: Discharge, not determined Apr. 8 (gage height, 7.72 ft).
1956 to March 1969: Discharge, 194 cfs June 7, 1961 (gage height,
5.83 ft).

521

Maxima.--April 1969: Discharge, 33,900 cfs 0800 hours to 0900 hours Apr. 9 (gage height, 14.77 ft).
1953 to March 1969: Discharge, 10,600 cfs Mar. 29, 1962 (gage height, 12.95 ft).

[illegible]

BIG SIOUX RIVER BASIN

Big Sioux River near Brookings, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 14</u>		
1200	4.44		1200	14.71	33,000	0800	11.60	5,150
2400	5.10		1600	14.59	31,000	1600	11.51	4,880
			2000	14.44	28,700	2400	11.37	4,530
<u>Apr. 6</u>			2400	14.22	25,700			
1200	5.70					<u>Apr. 15</u>		
1800	7.24		<u>Apr. 10</u>			0800	11.22	4,170
2400	8.42		0300	14.06	23,700	1600	11.07	3,840
			0600	13.89	21,700	2400	10.94	3,560
<u>Apr. 7</u>			0900	13.74	20,000			
0600	8.99		1200	13.60	18,500	<u>Apr. 16</u>		
1200	10.03		1600	13.41	16,500	0800	10.83	3,340
1800	11.92		2000	13.23	14,800	1600	10.72	3,130
2400	12.97	12,600	2400	13.07	13,400	2400	10.61	2,920
<u>Apr. 8</u>			<u>Apr. 11</u>			<u>Apr. 17</u>		
0300	13.18	14,300	0400	12.97	12,600	0800	10.51	2,740
0600	13.52	17,700	0800	12.83	11,500	1600	10.42	2,580
0900	13.83	21,000	1200	12.69	10,500	2400	10.30	2,400
1200	14.02	23,200	2000	12.52	9,370			
1500	14.14	24,700	2400	12.41	8,710	<u>Apr. 18</u>		
1800	14.26	26,200				2400	9.99	2,060
2100	14.43	28,600	<u>Apr. 12</u>					
2400	14.54	30,200	1200	12.15	7,300	<u>Apr. 19</u>		
			2400	11.95	6,400	2400	9.65	1,830
<u>Apr. 9</u>			<u>Apr. 13</u>			<u>Apr. 20</u>		
0400	14.69	32,600	1200	11.80	5,800	2400	9.37	1,690
0800	14.77	33,900	2400	11.65	5,300			
0900	14.77	33,900						

523

Location.--Lat 43°47'25", long 96°44'45", in NW¼NW¼ sec.29, T.104 N., R.49 W., on left bank at downstream side of highway bridge, a quarter of a mile downstream from confluence of divided channels, 1 3/4 miles upstream from nearest tributary, and 3 miles southwest of Dell Rapids.

Gage-height record.--Water-stage recorder graph. Doubtful gage-height record Apr. 8-11 for which a graph was drawn based on wire-weight gage readings. Datum of gage is 1,455.99 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 41,300 cfs 1930 hours Apr. 9 (gage height, 16.47 ft).
1948 to March 1969: Discharge, 18,400 cfs Mar. 30, 1962 (gage height, 15.14 ft).

[illegible]

BIG SIOUX RIVER BASIN

Big Sioux River near Dell Rapids, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 7</u>			<u>Apr. 10</u>		
2400	4.21		1600	13.57	8,380	0200	16.35	37,400
			2000	14.40	12,500	0600	16.40	38,900
<u>Apr. 4</u>			2200	14.58	13,800	1000	16.34	37,000
1200	5.00		2400	14.60	14,000	1200	16.30	35,800
2400	6.57					1500	16.28	35,200
			<u>Apr. 8</u>			1600	16.23	33,800
<u>Apr. 5</u>			0300	14.50	13,200	2100	16.09	30,300
1200	5.51		0600	14.62	14,200	2400	16.00	28,300
2400	7.57		1200	15.12	18,200			
			1700	15.55	21,900	<u>Apr. 11</u>		
<u>Apr. 6</u>			2400	15.90	26,400	0700	15.79	24,700
0400	7.40					1200	15.64	22,800
1100	7.96		<u>Apr. 9</u>			2400	15.16	18,100
1600	9.65		0300	16.02	28,700			
1900	11.93		0600	16.12	31,000	<u>Apr. 12</u>		
2400	12.31	4,840	0900	16.23	33,800	1200	14.73	14,400
			1100	16.33	36,700	2400	14.34	11,600
<u>Apr. 7</u>			1500	16.39	38,600			
0300	12.58	5,280	1700	16.36	37,700	<u>Apr. 13</u>		
0800	12.79	5,720	1800	16.39	38,600	1200	14.06	10,100
1000	12.83	5,810	1930	16.47	41,300	2400	13.82	9,000
1300	13.10	6,550	2100	16.38	38,300			
			2200	16.34	37,000	<u>Apr. 14</u>		
			2400	16.32	36,400	1200	13.58	7,940
						2400	13.37	7,060

525

Location.--Lat 43°32'35", long 96°48'30", in NW¼NW¼ sec.23, T.101 N., R.50 W., on left bank at downstream side of bridge on U. S. Highway 16, 600 ft upstream from nearest tributary, 2½ miles upstream from mouth, and 4 miles west of Sioux Falls.

Gage-height record.--Water-stage recorder graph except April 1-3 for which graph was drawn based on once-daily wire-weight gage readings. Datum of gage is 1,415.29 ft above mean sea level, datum of 1929 (levels by Corps of Engineers).

1948 to March 1969: Discharge, 29,400 cfs June 17, 1957 (gage height, 17.78 ft), from rating curve extended above 8,100 cfs on basis of slope-area measurement of peak flow.

[illegible]

BIG SIOUX RIVER BASIN

Skunk Creek near Sioux Falls, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 6</u>			<u>Apr. 8</u>		
2400	3.00		1300	8.62	3,680	0700	10.55	5,860
			1600	9.65	4,820	1700	9.84	5,020
<u>Apr. 4</u>			1800	11.08	6,560	2000	9.79	4,970
0400	4.70		1900	11.87	7,670	2400	9.54	4,690
1200	7.18		2100	12.67	8,860			
2400	10.15		2200	12.86	9,140	<u>Apr. 9</u>		
			2300	13.16	9,590	0600	8.95	4,040
<u>Apr. 5</u>			2400	13.24	9,710	1200	8.49	3,550
0100	10.59					1900	7.98	3,070
0400	10.43		<u>Apr. 7</u>			2400	7.53	2,670
1400	8.70		0100	12.99	9,340			
1500	8.95		0300	12.80	9,050	<u>Apr. 10</u>		
1600	8.21		0500	12.55	8,680	0800	6.77	2,050
2400	9.47	4,620	0700	12.44	8,510	1200	6.51	1,870
			1000	11.94	7,770	1700	6.27	1,700
<u>Apr. 6</u>			1300	11.12	6,620	2200	6.10	1,590
0400	9.68	4,850	1400	10.80	6,190	2400	6.03	1,540
0600	9.49	4,640	1700	10.29	5,550			
0900	8.63	3,690	1900	10.16	5,390	<u>Apr. 11</u>		
1200	8.48	3,540	2400	10.59	5,920	1200	5.71	1,340
						2400	5.49	1,190
						<u>Apr. 12</u>		
						2400	5.25	1,050

527

Location.--Lat 43°36'25", long 96°37'55", in NE¼SE¼ sec.30, T.102 N., R.48 W., on left bank 130 ft upstream from Great Northern Railway bridge, 2 3/4 miles northwest of Brandon, and 7 miles upstream from Split Rock Creek.

Gage-height record.--Digital water-stage recorder record except April 10-12 for which graph was drawn on basis of floodmarks. Datum of gage is 1,283.38 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 36,800 cfs 1600 hours to 1800 hours
Apr. 10 (gage height, 24.56 ft, from floodmark).
1959 to March 1969: Discharge, 17,100 cfs Mar. 31, 1962 (gage
height, 19.93 ft).

[illegible]

BIG SIOUX RIVER BASIN

Big Sioux River near Brandon, S. Dak.

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 3</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
1300	4.60	113	0600	16.88	9,070	0600	23.82	32,800
2000	5.13	246	0900	17.78	10,900	1200	23.35	30,400
2400	5.40	331	1300	18.27	12,100	1800	22.86	28,000
			1800	18.33	13,500	2400	22.35	25,400
<u>Apr. 4</u>			2200	18.19	11,900			
0400	5.75	438	2400	18.16	11,800	<u>Apr. 12</u>		
0800	5.84	471				0600	21.83	22,900
1000	5.87	481	<u>Apr. 8</u>			1200	21.35	20,900
1600	7.14	986	0400	18.72	13,200	1500	21.08	19,800
2000	8.70	1,660	1100	18.60	12,900	2000	21.40	21,100
2400	9.53	2,080	1800	18.83	13,500	2400	20.93	19,200
			2400	19.01	13,900			
<u>Apr. 5</u>			<u>Apr. 9</u>			<u>Apr. 13</u>		
0300	10.07	2,340	0600	19.37	14,800	0600	19.98	16,400
0600	10.99	2,800	0800	19.55	15,300	1200	19.46	15,100
0800	11.44	3,030	1200	20.81	18,800	1800	19.04	14,000
1200	11.90	3,290	1800	22.64	26,900	2400	18.72	13,200
1800	12.51	3,680	2400	23.87	33,000	<u>Apr. 14</u>		
2400	13.11	4,160				0600	18.40	12,400
<u>Apr. 6</u>			<u>Apr. 10</u>			1200	18.11	11,700
0300	13.31	4,340	0400	24.18	34,700	1800	17.85	11,100
1000	13.66	4,690	0800	24.38	35,800	2400	17.60	10,500
1600	13.96	5,020	1200	24.49	36,400			
2100	15.06	6,390	1600	24.56	36,800	<u>Apr. 15</u>		
2400	15.50	6,980	1800	24.56	36,800	1200	17.10	9,500
			2400	24.24	35,100	2400	16.39	8,280

(253) 6-4828.7 Little Beaver Creek tributary near Canton, S. Dak.

(Crest-stage station)

Location.--NE $\frac{1}{4}$ sec.4, T.97 N., R.49 W., at culvert on county highway,
4 miles southwest of Canton.

Drainage area.--0.22 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter
measurements below 30 cfs.

Maxima.--April 1969: Discharge, not determined Apr. 8 (gage height,
4.91 ft Apr. 8, backwater from ice).

1956 to March 1969: Discharge, not determined; gage height,
3.54 ft June 25, 1968.

(254) 6-4829.5 Mound Creek near Hardwick, Minn.

(Crest-stage station)

Location.--Lat 43°48'20", long 96°12'50", in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.15, T.104 N., R.45 W.,
at culvert on county highway, 2 $\frac{1}{4}$ miles northwest of Hardwick.

Drainage area.--2.77 sq mi.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments below 50 cfs and by indirect measurements at 99 cfs and 274 cfs.

Maxima.--April 1969: Discharge, 274 cfs Apr. 7 (gage height, 11.54 ft).

1959 to March 1969: Discharge, 106 cfs Apr. 3, 1960 (gage height,
10.49 ft).

(255) 6-4830. Rock River at Luverne, Minn.
(Gaging station, discontinued 1914)

Location.--Lat $43^{\circ}39'15''$, long $96^{\circ}12'03''$, in $SW\frac{1}{4}NE\frac{1}{4}$ sec.11, T.102 N., R.45 W.,
at bridge in Luverne.

Drainage area.--440 sq mi.

Gage-height record.--Occasional measurements from reference point. Datum of
reference point is 1,450.03 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measure-
ments below 13,900 cfs and extended above by logarithmic plotting.

Maxima.--April 1969: Discharge, 19,500 cfs 0500 hours Apr. 8 (elevation,
1,439.39 ft).
1911-1914: Discharge, 11,600 cfs June 13, 1914 (elevation, 1,437.78 ft).

Location.--Lat 43°26'13", long 96°09'58", in NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.33, T.100 N., R.45 W., on right bank at upstream side of dam on north side of city park in Rock Rapids, a third of a mile upstream from Tom Creek, half a mile northeast of junction of U.S. Highway 75 and State Highway 9, and 42.8 miles upstream from mouth (U.S. Geological Survey river profile).

Gage-height record.--Digital water stage recorder. Datum of gage is 1,331.55 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 29,000 cfs 1330 hours Apr. 8 (gage height, 10.23 ft, in gage well, 10.93 ft, from outside floodmark).
1959 to March 1969: Discharge, 16,400 cfs March 29, 1962 (gage height, 9.56 ft).

[illegible]

BIG SIOUX RIVER BASIN

Rock River at Rock Rapids, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 6</u>			<u>Apr. 10</u>		
0000	1.27		0800	5.94	7,390	0400	7.90	12,900
0800	1.31		0900	6.03	7,600	0800	7.32	11,300
1600	1.63		1000	6.50	8,730	1200	6.93	10,300
2000	1.69		1100	6.70	9,210	1600	6.68	9,700
2400	1.77		1300	7.03	10,000	2000	6.35	8,880
			1500	7.78	11,900	2400	5.79	7,480
<u>Apr. 2</u>			1700	8.64	14,000			
1000	1.77		1900	9.02	15,000	<u>Apr. 11</u>		
2000	1.85		2100	9.08	15,200	0400	5.23	6,080
2400	1.87		2400	9.43	16,000	0800	4.76	4,970
						1200	4.33	3,990
<u>Apr. 3</u>			<u>Apr. 7</u>			1600	4.09	3,470
1000	1.89		0600	9.45	16,100	2000	3.99	3,260
1500	2.00		0800	9.47	16,200	2400	3.94	3,150
1800	2.26		1200	9.66	16,700			
2000	2.40		1400	9.64	16,700	<u>Apr. 12</u>		
2100	2.29		1800	9.76	17,800	0600	3.86	2,990
2400	2.34		2000	9.84	21,300	1200	3.72	2,710
			2200	9.86	22,500	1800	3.64	2,550
<u>Apr. 4</u>			2400	9.90	24,300	2400	3.61	2,490
0500	2.35							
0600	2.30		<u>Apr. 8</u>			<u>Apr. 13</u>		
1200	2.48		0800	9.74	22,200	0600	3.59	2,450
1400	2.69		1200	10.08	26,700	1200	3.46	2,210
2000	3.25		1330	10.23	29,000	1800	3.36	2,030
2400	3.61	2,300	1400	10.13	27,400	2400	3.32	1,960
			1600	10.19	28,400			
<u>Apr. 5</u>			1800	9.82	23,300	<u>Apr. 14</u>		
0200	3.67	2,410	2000	9.53	19,800	0600	3.29	1,900
0700	3.56	2,210	2200	9.49	19,400	1200	3.25	1,830
0800	3.57	2,230	2400	9.48	19,300	1800	3.20	1,740
1000	4.07	3,190				2400	3.16	1,670
1200	4.44	3,940	<u>Apr. 9</u>					
1400	4.94	5,040	0200	9.50	19,500	<u>Apr. 15</u>		
1600	5.01	5,190	0600	9.29	18,000	1200	3.11	1,590
1730	6.55	8,850	0800	9.57	20,200	2400	3.05	1,490
1830	6.25	8,130	1000	9.67	21,300			
2200	7.02	10,000	1600	9.79	22,900	<u>Apr. 16</u>		
2400	6.97	9,880	1800	9.68	21,500	1200	3.00	1,410
			2000	9.41	18,800	2400	2.94	1,310
<u>Apr. 6</u>			2200	9.04	16,900			
0400	6.44	8,590	2400	8.72	15,600			
0600	6.10	7,770						

BIG SIOUX RIVER BASIN

533

(257) Little Rock River near Little Rock, Iowa
(Miscellaneous Site)

Location.--Lat 43° 29', long 95-57' in NE¼ sec.3, T.99N., R.43 W., downstream side Highway 9 bridge, 1 mile southwest of town of Little Rock and at mile 63.78 upstream of mouth Rock River (U.S. Geological Survey profile).

Drainage area.--134 sq mi.

Gage-height record.--High-water mark elevation above mean level, datum of 1929, from Soil Conservation Service bench mark.

Discharge record.--Peak discharge only by indirect measurement.

Maxima.--April 1969: Discharge 9,100 cfs April 6 at elevation 1435.02 ft.

(258) Little Rock River at George, Iowa
(Miscellaneous Site)

Location.--Lat 43°20', long 96°00' at southeast corner sec. 2, T.98 N., R.44 W., at downstream side of bridge at south edge of George and at mile 48.70 upstream of mouth Rock River (U.S. Geological Survey profile).

Drainage area.--195 sq mi.

Gage-height record.--High-water mark elevation above mean sea level datum of 1929 from Soil Conservation Service bench mark.

Discharge record.--Peak discharge only by indirect measurement.

Maxima.--April 1969: Discharge 10,200 cfs April 6, at elevation 1355.98 ft.

(259) 6.4834.6 Otter Creek near Ashton, Iowa
(Crest-stage Station)

Location.--Lat 43°20', long 95°46' in SE¼ sec.2, T.98 N., R.42 W.,
at bridge 2 miles northeast of Ashton.

Drainage area.--88.0 sq mi.

Gage-height record.--Crest stages only. Datum of gage is 1448.21 feet above
mean sea level, datum of 1929, from Soil Conservation Service bench
mark.

Discharge record.--Stage-discharge relation defined by current meter and
indirect measurements below 17,000 cfs.

Maxima.--April 1969: Discharge 4,900 cfs April 6 (gage height 10.77 ft.)
1952 to March 1969: Discharge 17,400, June 7, 1953 (gage height
12.16 ft.).

(260) Otter Creek near Matlock, Iowa
(Miscellaneous Site)

Location.--Lat 43°15', long 96°00' in NE¼ sec.12, T.97 N., R.44 W., at
downstream side bridge 2 miles west of Matlock.

Drainage area.--179 sq mi.

Gage-height record.--High-water mark elevation above mean sea level, datum
of 1929 from Soil Conservation Service bench mark.

Discharge record.--Peak discharge only by indirect measurement.

Maxima.--April 1969. Discharge 8,510 cfs April 6-7 at elevation 1360.46 ft.

(261) Little Rock River near George, Iowa
(Miscellaneous Site)

Location.--Lat $43^{\circ}18'$, long $96^{\circ}04'$ at southeast corner sec.17, T.98 N., R.44 W., at downstream side bridge 4 miles southwest of George and 700 feet downstream of Otter Creek and at mile 42.06 upstream of mouth Rock River (U.S. Geological Survey profile).

Drainage area.--416 sq mi.

Gage-height record.--High-water mark elevation above mean level datum of 1929 from Soil Conservation Service bench mark.

Discharge record.--Peak discharge only by indirect measurement.

Maxima.--April 1969: Discharge 14,600 cfs April 7 at elevation 1323.69 ft.

(262) Little Rock River near Doon, Iowa
(Miscellaneous Site)

Location.--Lat $43^{\circ}16'$, long $96^{\circ}12'$ at northwest corner NE $\frac{1}{4}$ sec.31, T.98 N., R.45 W., 2.2 miles upstream from mouth and $1\frac{1}{2}$ miles southeast of Doon at downstream side of bridge and at mile 27.90 upstream of mouth Rock River (U.S. Geological Survey profile).

Drainage area.--470 sq mi.

Gage-height record.--High-water mark elevation above mean sea level datum of 1929 from Corps of Engineers bench mark.

Discharge record.--Stage-discharge relation defined by current meter measurements below 12,500 cfs.

Maxima.--April 1969: Discharge 14,300 cfs April 7 at elevation 1271.63 ft.

Remarks.--Twelve of 15 discharge measurements furnished by Corps of Engineers.

(263) 6-4835. Rock River near Rock Valley, Iowa

Location.--Lat 43°12'05", long 96°20'15", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.25, T.97 N., R.47 W., on downstream side of bridge on U.S. Highway 18, 1.8 miles west of Rock Valley, and at mile 15.9.

Drainage area.--1,600 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,211.81 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 1,2.

Maxima.--April 1969: Discharge, 40,400 cfs 0700 hours to 0800 hours Apr. 7 (gage height, 17.32 ft).
1948 to March 1969: Discharge, 28,400 cfs Mar. 30, 1962 (gage height, 16.91 ft).
1897: Gage height, 17.0 ft (discharge unknown) from information by State Highway Commission.

Mean discharge, in cubic feet per second, 1969

[illegible]

Rock River near Rock Valley, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 8</u>		
0000	5.53		0300	14.77	12,900	0130	17.03	33,900
0700	5.44		0600	14.96	13,700	0330	17.04	34,100
1200	5.44		1200	15.14	14,600	0500	16.95	32,400
1500	5.56		1400	15.14	14,600	0600	17.00	33,300
1700	5.97		1600	15.12	14,500	0700	16.96	32,600
1900	6.70		1800	15.15	14,600	0900	17.00	33,300
2100	7.67		2000	15.25	15,200	1300	16.80	29,900
2400	8.06		2200	15.46	16,300	1600	16.67	28,100
			2400	15.82	18,800	1800	16.65	27,800
<u>Apr. 2</u>						2000	16.65	27,800
0200	8.06		<u>Apr. 6</u>			2400	16.84	30,500
0400	8.02		0300	16.36	24,400			
1000	7.54		0600	16.11	21,600	<u>Apr. 9</u>		
1200	7.47		0700	16.04	20,900	0100	16.86	30,900
1400	7.47		0900	16.04	20,900	0400	16.76	29,300
1800	7.74		1100	16.18	22,400	0800	16.45	25,400
2100	7.86		1400	16.04	20,900	1200	16.16	22,200
2400	7.89		1600	15.88	19,300	1500	15.98	20,300
<u>Apr. 3</u>			1900	15.78	18,400	1800	15.90	19,500
0300	7.89	1,330	2100	15.94	19,900	2100	15.93	19,800
0800	7.82	1,290	2400	16.42	25,000	2400	15.98	20,300
1100	7.86	1,320						
1300	7.97	1,380	<u>Apr. 7</u>			<u>Apr. 10</u>		
1500	8.20	1,520	0300	16.87	31,000	0200	15.98	20,300
1700	8.92	2,030	0600	17.24	38,500	0400	15.92	19,700
1900	10.16	3,140	0700	17.32	40,400	0700	15.72	18,000
2100	10.88	3,940	0800	17.32	40,400	1300	15.23	15,000
2400	11.36	4,540	1200	17.20	37,500	1900	14.75	12,800
			1400	17.10	35,300	2400	14.50	11,800
<u>Apr. 4</u>			1500	17.15	36,400			
0300	11.85	5,190	1600	17.10	35,300	<u>Apr. 11</u>		
0600	12.35	5,920	1700	17.15	36,400	0600	14.12	10,400
0900	12.65	6,410	1900	17.07	34,700	1200	13.74	9,090
1200	12.98	7,060	2030	17.12	35,700	1800	13.32	7,900
1500	13.46	8,250	2200	17.02	33,700	2400	12.78	6,640
1700	13.87	9,540	2400	17.10	35,300			
1900	14.15	10,500				<u>Apr. 12</u>		
2200	14.40	11,400				0700	12.27	5,790
2400	14.55	12,000				1100	12.04	5,460
						1300	12.00	5,400
						1700	11.82	5,150
						2400	11.52	4,750

BIG SIOUX RIVER BASIN

Rock River near Rock Valley, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 13</u>			<u>Apr. 15</u>			<u>Apr. 17</u>		
0600	11.25	4,400	1200	9.92	2,900	1200	9.17	2,230
1200	11.07	4,160	1800	9.83	2,820	2400	8.98	2,070
1800	10.92	3,980	2400	9.72	2,720			
2400	10.77	3,800				<u>Apr. 18</u>		
			<u>Apr. 16</u>			1200	8.78	1,920
<u>Apr. 14</u>			1200	9.55	2,560	2400	8.56	1,760
1200	10.41	3,400	2400	9.38	2,410			
2400	10.19	3,170						

539

Location.--Lat 42°49'40", long 96°33'50", in W½ sec.31, T.93 N., R.48 W., on left bank at west edge of Akron, three-quarters of a mile downstream from State Highway 48, and 2 3/4 miles upstream from Union Creek.

Gage-height record.--Digital water-stage recorder record. Datum of gage is 1,118.90 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 80,800 cfs 1700 hours Apr. 9 (gage height, 22.99 ft).
1928 to March 1969: Discharge, 54,300 cfs Mar. 31, 1962 (gage height, 22.08 ft).

[illegible]

BIG SIOUX RIVER BASIN

Big Sioux River at Akron, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 6</u>			<u>Apr. 10</u>		
1200	7.58		0600	18.95	15,400	1200	22.61	66,400
1800	9.80		1200	19.79	17,900	1600	22.56	65,400
2400	11.32	3,680	1800	20.39	21,600	2000	22.51	64,400
			2400	21.10	32,100	2400	22.46	63,500
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 11</u>		
0600	12.06	4,130	0600	21.67	42,500	0600	22.35	61,500
1200	12.42	4,340	1400	22.06	51,500	1200	22.28	60,200
1400	12.76	4,550	1600	22.03	50,700	1800	22.23	59,300
1800	12.44	4,350	2000	22.24	56,200	2400	22.17	58,300
2200	13.98	5,440	2400	22.47	62,800			
2400	13.90	5,370				<u>Apr. 12</u>		
<u>Apr. 3</u>			<u>Apr. 8</u>			0600	22.09	57,000
0600	13.36	4,950	0600	22.63	67,600	1200	21.82	52,900
1200	12.61	4,460	1000	22.71	70,000	1800	21.53	48,900
1400	12.44	4,350	1400	22.72	70,400	2400	21.31	46,000
1800	12.97	4,680	1800	22.76	71,800			
2400	14.07	5,520	2400	22.81	73,600	<u>Apr. 13</u>		
<u>Apr. 4</u>			<u>Apr. 9</u>			0600	21.07	42,900
0600	15.02	6,510	0400	22.85	75,200	1200	20.82	39,700
1200	15.90	7,750	0800	22.88	76,400	1800	20.53	36,100
1800	16.60	9,190	1200	22.92	78,000	2400	20.26	33,000
2400	16.96	10,100	1700	22.99	80,800	<u>Apr. 14</u>		
			2000	22.97	79,600	0600	20.00	30,200
<u>Apr. 5</u>			2400	22.89	75,300	1200	19.79	28,100
0600	17.00	10,200	<u>Apr. 10</u>			1800	19.57	26,100
1200	17.04	10,300	0400	22.79	71,400	2400	19.35	24,200
1800	17.29	10,900	0800	22.68	68,200			
2400	17.98	12,600						

(265) 6-4860. Missouri River at Sioux City, Iowa

Location---Lat $42^{\circ}29'10''$, long $96^{\circ}24'45''$, in NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.16, T.29 N., R.9 E., sixth principal meridian, on right bank on upstream side of bridge on U.S. Highway 77 at Sioux City, 2.0 miles downstream from Big Sioux River, and at mile 732.3.

Drainage area---314,600 sq mi, approximately.

Gage-height record---Water-stage recorder graph. No gage-height record Apr. 26. Datum of gage is 1,076.96 ft above mean sea level, datum of 1929.

Discharge record---Stage-discharge relation defined by current-meter measurements.

Maxima---April 1969: Discharge, 77,700 cfs Apr. 10 (gage height, 7.58 ft).
1928 to March 1969: Discharge, 441,000 cfs Apr. 14, 1952 (gage height, 24.28 ft).

Remarks---Flow partly regulated by upstream main-stem reservoirs.

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	36,500	8.....	47,800	15.....	57,600	23.....	54,000
2.....	40,300	9.....	65,800	16.....	56,100	24.....	52,400
3.....	36,800	10.....	76,400	17.....	54,000	25.....	49,200
4.....	34,500	11.....	73,700	18.....	51,400	26.....	47,500
5.....	38,900	12.....	68,800	19.....	52,300	27.....	42,000
6.....	40,200	13.....	66,000	20.....	55,200	28.....	39,500
7.....	34,200	14.....	61,100	21.....	58,400	29.....	40,400
				22.....	56,500	30.....	41,700

Monthly mean discharge, in cubic feet per second..... 50,970
Runoff, in inches..... 0.18
Runoff, in acre-feet..... 3,033,000

Location.--Lat 42°58'40", long 96°00'00", in NE $\frac{1}{4}$ sec.11, T.94 N., R.44 W., on left bank at downstream side of Chicago and North Western Railway Co. bridge at east edge of Alton, 22 miles upstream from confluence with West Floyd River and at mile 51.6.

Gage-height record.--Digital water-stage recorder. Datum of gage is 1,269.55 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 8,510 cfs 0300 hours Apr. 4 (gage height, 17.78 ft).
1955 to March 1969: Discharge, 12,200 cfs Mar. 28, 1962 (gage height, 18.35 ft).
1953: Discharge, about 45,500 cfs (determined by Corps of Engineers).

[illegible]

FLOYD RIVER BASIN

543

Floyd River at Alton, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 3</u>			<u>Apr. 6</u>		
0400	8.67	178	1800	15.64	2,460	0700	17.07	4,800
0600	8.70	181	2100	15.89	2,730	0800	17.07	4,800
1000	8.88	202	2200	15.98	2,820	1400	16.58	3,740
1200	9.10	231	2400	16.45	3,460	2000	16.46	3,530
1400	9.57	294				2400	16.58	3,740
1600	10.40	429	<u>Apr. 4</u>			<u>Apr. 7</u>		
1800	11.65	688	0300	17.78	8,510	0200	16.62	3,810
2000	11.86	740	0600	17.65	7,600	0500	16.54	3,670
2200	12.00	775	1100	17.73	8,160	0900	16.54	3,670
2400	12.06	790	1300	17.67	7,740	1600	16.34	3,350
			1500	17.56	6,970	1900	16.17	3,110
<u>Apr. 2</u>			1800	17.49	6,600	2400	15.73	2,630
0800	12.17	815	2400	17.47	6,500			
1000	12.22	828	<u>Apr. 5</u>			<u>Apr. 8</u>		
1200	12.30	848	0300	17.40	6,100	0600	15.07	2,060
1400	12.45	891	0500	17.28	5,580	1400	13.95	1,500
1600	12.81	1,000	0800	17.03	4,680	1700	13.67	1,380
2000	13.06	1,090	1300	16.45	3,520	2400	13.11	1,160
2400	13.40	1,210	1500	16.31	3,310			
			1900	16.33	3,340	<u>Apr. 9</u>		
<u>Apr. 3</u>			2200	16.29	3,280	0500	12.47	951
0200	13.53	1,270	2400	16.42	3,480	0900	11.91	792
0400	13.56	1,280				1200	11.57	705
0700	13.52	1,260	<u>Apr. 6</u>			2400	10.70	515
0900	13.36	1,200	0300	16.78	4,120			
1300	13.65	1,320	0600	17.01	4,620			
1400	13.82	1,390						

Location---Lat 42°55'15", long 96°10'30", in NE $\frac{1}{4}$ sec.32, T.94 N., R.45 W., on right bank at downstream side of county road bridge 0.2 miles west of U.S. Highway 75, 2.2 miles northeast of Struble, 14 miles upstream from confluence with Floyd River and at mile 39.3.

Gage-height record.--Digital water-stage recorder. Datum of gage is 1,239.40 ft above mean sea level (State Highway Commission benchmark).

Maxima.--April 1969: Discharge, 4,380 cfs 0415 hours Apr. 4 (gage height, 14.90 ft in well, 15.4 ft, from outside gage).
1955 to March 1969: Discharge, 8,060 cfs Mar. 28, 1962 (gage height, 15.63 ft).

[illegible]

FLOYD RIVER BASIN

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West Branch Floyd River near Struble, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 4</u>			<u>Apr. 6</u>		
1200	9.95		0400	14.89	4,350	1030	14.25	2,780
1400	10.61		0415	14.90	4,380	1600	14.18	2,680
1600	11.85		0600	14.89	4,350	1900	14.22	2,740
1800	13.18		1200	14.81	4,090	2100	14.20	2,710
2000	13.73		1400	14.77	3,960	2400	14.11	2,590
2200	13.88		1600	14.72	3,800			
2400	14.00		1800	14.69	3,710	<u>Apr. 7</u>		
			2100	14.65	3,580	0400	14.03	2,490
<u>Apr. 2</u>			2400	14.61	3,450	0900	14.25	2,780
0200	14.05					1000	14.28	2,810
0800	14.06		<u>Apr. 5</u>			1200	14.23	2,750
1000	14.06		0300	14.55	3,260	1400	14.13	2,620
1200	14.08		0600	14.47	3,060	1600	13.91	2,380
1500	14.02		0900	14.38	2,940	1800	13.53	2,100
2000	14.18		1200	14.27	2,800	2100	12.65	1,620
2200	14.12		1400	14.15	2,640	2400	11.73	1,230
2400	14.11		1600	14.03	2,490			
			1900	14.19	2,700	<u>Apr. 8</u>		
<u>Apr. 3</u>			2100	14.26	2,790	0200	11.15	1,040
0900	14.05		2200	14.26	2,790	0400	10.71	925
1200	14.08		2400	14.20	2,710	0600	10.30	822
1400	14.07					0900	9.70	686
1800	14.65		<u>Apr. 6</u>			1200	9.22	590
2130	14.89		0300	14.11	2,590	1500	8.85	519
2400	14.82	4,120	0500	14.11	2,590	1800	8.45	448
			0800	14.18	2,680	2400	8.11	394

(268) 6-6005. Floyd River at James, Iowa

Location.--Lat $42^{\circ}34'30''$, long $96^{\circ}18'45''$, in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec.30, T.90 N., R.46 W., on right pier at downstream side of highway bridge at James, 15.1 miles downstream from West Branch Floyd River and at mile 9.0.

Drainage area.--882 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,102.59 ft above mean sea level, datum of 1929.

Discharge record.---Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 17,300 cfs 0400 hours Apr. 5 (gage height, 21.54 ft).

1935 to March 1969: Discharge, 71,500 cfs June 8, 1953 (gage height, 25.3 ft, from floodmark).

Mean discharge, in cubic feet per second, 1969

[illegible]

FLOYD RIVER BASIN

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Floyd River at James, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 4</u>			<u>Apr. 8</u>		
0400	11.03	1,200	0900	19.26	6,950	0500	18.53	9,000
0800	11.48	1,300	1200	19.87	8,510	0700	18.40	8,800
1000	11.78	1,380	1600	20.68	11,600	0900	18.28	8,620
1100	11.88	1,410	1800	20.99	13,400	1100	18.11	8,360
1200	12.03	1,450	2000	21.14	14,400	1200	18.02	8,230
1400	12.54	1,590	2100	21.21	14,800	1300	17.88	8,060
1600	13.24	1,810	2400	21.20	14,800	1600	17.33	7,400
1800	13.97	2,090				1800	17.07	7,080
1900	14.24	2,200	<u>Apr. 5</u>			1900	17.01	7,010
2000	14.40	2,270	0100	21.24	15,000	2000	16.78	6,780
2400	14.80	2,450	0200	21.32	15,600	2100	16.42	6,430
			0300	21.48	16,800	2400	15.79	5,860
<u>Apr. 2</u>			0400	21.54	17,300			
0100	14.88	2,490	0500	21.52	17,200	<u>Apr. 9</u>		
0200	15.06	2,570	0800	21.53	17,300	0200	15.37	5,480
0400	15.66	2,860	1100	21.41	16,600	0400	14.93	5,090
0600	16.09	3,080	1800	20.92	14,700	0600	14.47	4,730
0700	16.24	3,170	2400	20.51	13,000	0800	14.08	4,460
0900	16.82	3,580				1100	13.47	4,030
1100	17.09	3,790	<u>Apr. 6</u>			1500	12.68	3,520
1500	17.49	4,110	0600	19.98	11,800	2000	11.91	3,090
1600	17.54	4,150	1200	19.45	10,700	2400	11.31	2,760
2400	17.84	4,440	1600	19.17	10,100			
			1800	19.08	9,960	<u>Apr. 10</u>		
<u>Apr. 3</u>			2000	19.02	9,840	0300	10.88	2,520
0400	17.97	4,570	2400	18.95	9,700	0700	10.31	2,220
0800	17.89	4,490				1000	9.95	2,040
1000	17.90	4,500	<u>Apr. 7</u>			1200	9.74	1,950
1200	17.99	4,590	0200	18.97	9,740	1600	9.41	1,800
1300	17.99	4,590	0600	18.99	9,780	2000	9.12	1,690
1800	17.85	4,450	0800	18.98	9,760	2400	8.87	1,590
2000	17.81	4,410	1000	18.97	9,740			
2100	17.83	4,430	1500	18.91	9,620	<u>Apr. 11</u>		
2400	18.05	4,670	2400	18.66	9,190	0600	8.53	1,450
						1200	8.27	1,350
<u>Apr. 4</u>						1800	8.07	1,270
0300	18.45	5,230				2100	8.01	1,240
0700	18.85	6,000				2400	7.89	1,200

(269) 6-6035.3 Little Sioux River near Spafford, Minn.

(Crest-stage station)

Location.--Lat $43^{\circ}36'08''$, long $95^{\circ}15'27''$, in $NE\frac{1}{4}NE\frac{1}{4}$ sec.34, T.102 N., R.37 W., at bridge on county highway, 1.6 miles below Jackson County ditch No. 11, and 5.8 miles east of Spafford.

Gage-height record.--Crest stages only.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 2,040 cfs Apr. 6 (gage height, 10.03 ft).
1962 to March 1969: Discharge, 2,700 cfs Apr. 6, 1965 (gage height, 11.08 ft, backwater from ice).

(270) 6-6051. Little Sioux River at Spencer, Iowa
(Gaging station discontinued 1942)

Location.--Lat $43^{\circ}08'$, long $95^{\circ}08'$, in sec.18, T.96 N., R.36 W., at bridge on U.S. Highways 18 and 71 at Spencer, 3/4 mile downstream from Ocheyedan River, and at mile 160.3 (U.S. Geological Survey profile).

Drainage area.--990 sq mi.

Gage-height record.--Peak stage from flood marks after 1942. Datum of gage was 1294.54 ft above mean sea level, datum of 1929.

Discharge record.--From rating curve defined by current meter measurements.

Maxima.--April 1969: Discharge 16,700 cfs Apr. 8 (gage height 16.1 ft).
1936 to March 1969: Discharge 30,000 cfs June 8, 1953 (gage height 20.20 ft from flood mark).

Remarks.--Peak stage and four discharge measurements made during 1969 flood furnished by Corps of Engineers.

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Location.--(Revised) Lat 43°01'06", long 95°02'34", in SW¹₄NE¹₄ sec.25, T.95 N., R.36 W., on left bank 5 ft downstream from county highway bridge, 0.4 mile northwest of Gillett Grove, 0.9 mile above Elk Creek, and at mile 146.1 (U.S. Geological Survey river profile).

Gage-height record.--Digital water-stage recorder. Datum of gage is 1,266.84 ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 15,900 cfs 1030 hours Apr. 8 (gage height, 17.78 ft).

1958 to March 1969: Discharge, 20,200 cfs Apr. 7, 1965 (gage height, 18.67 ft).

Flood of June 9, 1953 reached a stage of 17.87 ft, from floodmark (discharge, about 24,000 cfs).

[illegible]

LITTLE SIOUX RIVER BASIN

Little Sioux River at Gillett Grove, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 5</u>			<u>Apr. 10</u>		
2400	9.91		0600	15.08	7,860	0600	16.43	11,600
			1200	15.33	8,430	1200	16.07	10,600
<u>Apr. 2</u>			2400	15.43	8,670	1800	15.71	9,700
0600	10.19					2400	15.37	8,890
1200	10.27		<u>Apr. 6</u>			<u>Apr. 11</u>		
1800	10.66		0600	15.63	9,150	0600	15.10	8,240
2400	10.89	2,050	1200	16.04	10,100	1200	14.85	7,700
			1800	16.38	11,000	1800	14.65	7,300
<u>Apr. 3</u>			2400	16.51	11,400	2400	14.46	6,920
0600	11.03	2,140				<u>Apr. 12</u>		
1200	11.13	2,210	<u>Apr. 7</u>			1200	14.04	6,080
1800	11.37	2,390	1200	16.63	11,700	2400	13.66	5,460
2400	11.95	2,900	1800	16.84	12,400			
			2400	17.18	13,500	<u>Apr. 13</u>		
<u>Apr. 4</u>						1200	13.33	4,930
0600	12.60	3,640	<u>Apr. 8</u>			2400	13.04	4,460
1200	13.41	4,820	0400	17.51	14,900			
1800	14.16	6,020	1030	17.78	15,900	<u>Apr. 14</u>		
2400	14.70	7,100	1800	17.58	15,100	1200	12.82	4,150
			2400	17.44	14,600	2400	12.61	3,850
			<u>Apr. 9</u>					
			1200	17.14	13,700			
			2400	16.75	12,400			

(272) 6-6063. Mill Creek near Cherokee, Iowa
(Corps of Engineers gage)

Location.--Lat $42^{\circ}07'$, long $95^{\circ}33'$, in $SE\frac{1}{4}NE\frac{1}{4}$ sec.15, T.92 N., R.40 W., on downstream handrail of bridge on U.S. Highway 59, $1\frac{3}{4}$ miles north of Cherokee, 2.7 miles upstream from mouth and at mile 93.3 above mouth of Little Sioux River (U.S. Geological Survey profile).

Drainage area.--292 sq mi.

Gage-height record.--Wire-weight gage readings daily or more often. Datum of gage is 1,179.89 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 7,300 cfs Apr. 6 (gage height, 10.9 ft).
1953: Discharge, 11,500 cfs June 8 (gage height, 14.30 ft).
1965: Discharge, 10,400 cfs Apr. 6 (gage-height, 13.4 ft).

Remarks.--Data for flood of April 1969 furnished by Corps of Engineers.
Gaging-station records not published.

(273) Little Sioux River at Cherokee, Iowa
(Corps of Engineers gage)

Location.--Lat $42^{\circ}46'$, long $95^{\circ}32'$, in $NE\frac{1}{4}NE\frac{1}{4}$ sec.26, T.92 N., R.40 W., on Iowa Highways 3 and 5 bridge in Cherokee, $1\frac{1}{2}$ miles downstream from Mill Creek and at mile 89.1 (U.S. Geological Survey profile).

Drainage area.--2,173 sq mi.

Gage-height record.--Wire-weight gage on downstream side of bridge. Datum of gage is 1,154.11 ft above mean sea level, datum of 1929.

Discharge record.--Defined by current-meter measurements.

Maxima.--April 1969: Discharge, 21,000 cfs Apr. 7 (gage height, 24.24 ft).
April 1965: Discharge, 33,700 cfs Apr. 6 (gage height, 25.6 ft, from floodmark).

Remarks.--Data for flood of April 1969 furnished by Corps of Engineers.
Gaging-station records not published.

Location.--Lat 42°28'20", long 95°47'50", in NE₄NW₄ sec.1, T.88 N., R.43 W., on right bank 10 ft upstream from bridge on State Highway 31, 0.2 mile upstream from Bacon Creek, 0.5 mile west of Correctionville, 0.8 mile downstream from Pierson Creek, and at mile 56.0 (U.S. Geological Survey river profile).

Gage-height record.--Digital water-stage record. Datum of gage is 1,096.49
ft above mean sea level, datum of 1929.

Maxima.--April 1969: Discharge, 21,000 cfs 1000 hours to 1200 hours Apr. 8 (gage height, 23.61 ft).
1918 to March 1969: Discharge, 29,800 cfs Apr. 7, 1965 (gage height, 25.86 ft).
1891: Gage height, 29.34 ft (discharge unknown, may have been affected by failure of dam on Bacon Creek).

[illegible]

LITTLE SIOUX RIVER BASIN

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Little Sioux River at Correctionville, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 1</u>			<u>Apr. 6</u>			<u>Apr. 12</u>		
0500	13.73	2,950	0200	22.31	16,300	0600	22.22	16,000
0700	13.98	3,100	0400	22.41	16,600	1200	22.05	15,400
1300	15.60	4,180	0600	22.47	16,800	1800	21.81	14,600
1600	17.08	5,350	0800	22.48	16,900	2400	21.55	13,700
1800	17.70	5,900	1800	22.29	16,200			
2000	18.02	6,190	2000	22.28	16,200	<u>Apr. 13</u>		
2200	18.09	6,260	2400	22.36	16,500	0600	21.27	12,700
2400	18.06	6,230				1200	20.98	11,800
			<u>Apr. 7</u>			1800	20.68	11,000
<u>Apr. 2</u>			0400	22.55	17,100	2400	20.46	10,500
0800	17.52	5,740	0600	22.60	17,300			
1000	17.44	5,670	0800	22.71	17,700	<u>Apr. 14</u>		
1400	17.41	5,640	1300	23.03	18,800	0600	20.22	9,740
1800	17.46	5,680	2400	23.35	20,000	1200	20.00	9,210
2200	17.63	5,840				1800	19.81	8,810
2400	17.68	5,880	<u>Apr. 8</u>			2400	19.65	8,490
			0600	23.45	20,400			
<u>Apr. 3</u>			0800	23.57	20,900	<u>Apr. 15</u>		
0200	17.69	5,890	1000	23.61	21,000	0600	19.47	8,120
0600	17.58	5,790	1200	23.61	21,000	1200	19.33	7,830
1200	17.32	5,560	1600	23.51	20,600	2400	19.00	7,250
1400	17.28	5,520	2400	23.22	19,500			
1500	17.31	5,550				<u>Apr. 16</u>		
1800	18.42	6,750	<u>Apr. 9</u>			1200	18.71	6,740
2000	18.83	7,350	0800	22.98	18,600	2400	18.42	6,260
2100	18.88	7,420	1600	22.83	18,100			
2400	18.80	7,310	2000	22.79	18,000	<u>Apr. 17</u>		
			2400	22.78	17,900	1200	18.12	5,930
<u>Apr. 4</u>						1800	17.99	5,760
0200	18.75	7,240	<u>Apr. 10</u>			2400	17.89	5,650
0400	18.77	7,270	0600	22.80	18,000			
1800	19.46	8,340	1200	22.89	18,300	<u>Apr. 18</u>		
2400	19.64	8,630	1800	22.96	18,600	0600	17.82	5,570
			2400	22.98	18,600	1200	17.78	5,510
<u>Apr. 5</u>						2400	17.55	5,340
0600	20.09	9,380	<u>Apr. 11</u>			<u>Apr. 19</u>		
1800	21.53	13,500	0600	22.89	18,300	1200	17.26	5,150
2200	21.98	15,100	1200	22.76	17,900	2400	16.97	4,940
2400	22.17	15,800	1800	22.59	17,300			
			2400	22.42	16,700			

Little Sioux River at Correctionville, Iowa

Gage height, in feet, and discharge, in cubic feet per second,
at indicated time, 1969

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
<u>Apr. 20</u>			<u>Apr. 21</u>			<u>Apr. 22</u>		
1200	16.76	4,810	2400	16.16	4,430	2400	15.27	3,910
2400	16.59	4,690						
			<u>Apr. 22</u>			<u>Apr. 23</u>		
<u>Apr. 21</u>			0600	15.98	4,320	1200	14.80	3,640
1200	16.43	4,590	1200	15.77	4,180	1800	14.61	3,550
1800	16.32	4,520				2400	14.42	3,440

REFERENCES CITED

- Anderson, D. B. and Burmeister, I. L., 1970, Floods of March-May 1965 in upper Mississippi River basin: U.S. Geol. Survey Water-Supply Paper 1850-A. (in press)
- Department of the Army, St. Paul district Corps of Engineers, 1969, After action report 1969 spring floods, upper Mississippi River basin, Red River of the North basin, and Souris River basin, 435 p.
- Matthai, H. F., 1968, Missouri River basin below Sioux City, Iowa, magnitude and frequency of floods: U.S. Geol. Survey Water-Supply Paper 1680, 491 p.
- Patterson, J. L., 1966, Missouri River basin above Sioux City, Iowa, magnitude and frequency of floods: U.S. Geol. Survey Water-Supply Paper 1679, 471 p.
- Patterson, J. L. and Gamble, C. R., 1968, Hudson Bay and upper Mississippi River basins, magnitude and frequency of floods: U.S. Geol. Survey Water-Supply Paper 1678, 546 p.
- Schwob, H. H., 1966, Little Sioux River basin floods: U.S. Geol. Survey open-file report, 60 p.
- Wiitala, S. W., 1965, St. Lawrence River basin, magnitude and frequency of floods: U.S. Geol. Survey Water-Supply Paper 1677, 357 p.

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