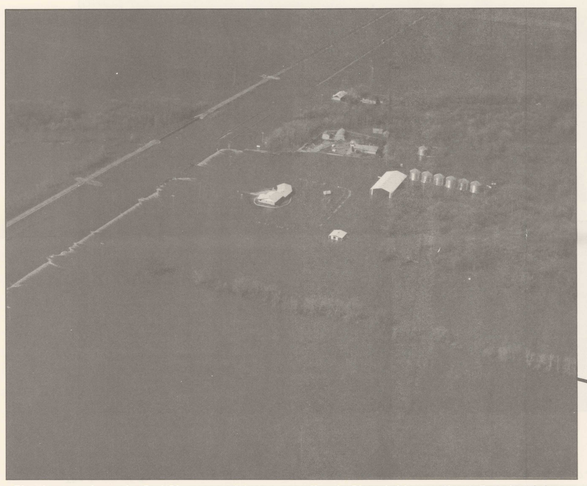
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
U. S. ARMY CORPS OF ENGINEERS, ST. PAUL DISTRICT

SHEET 1 OF 2
WATER–RESOURCES INVESTIGATIONS 80–1176
OPEN–FILE REPORT

Ineffective agricultural levee south of Highway 317 on Minnesota side of the Red River. View is looking downstream (north)



Floodwaters from the Red River engulf farms near Marais River bridge on North Dakota Highway 54. Ring dikes are effective in protecting some of the buildings. Photo date is April 27, 1979

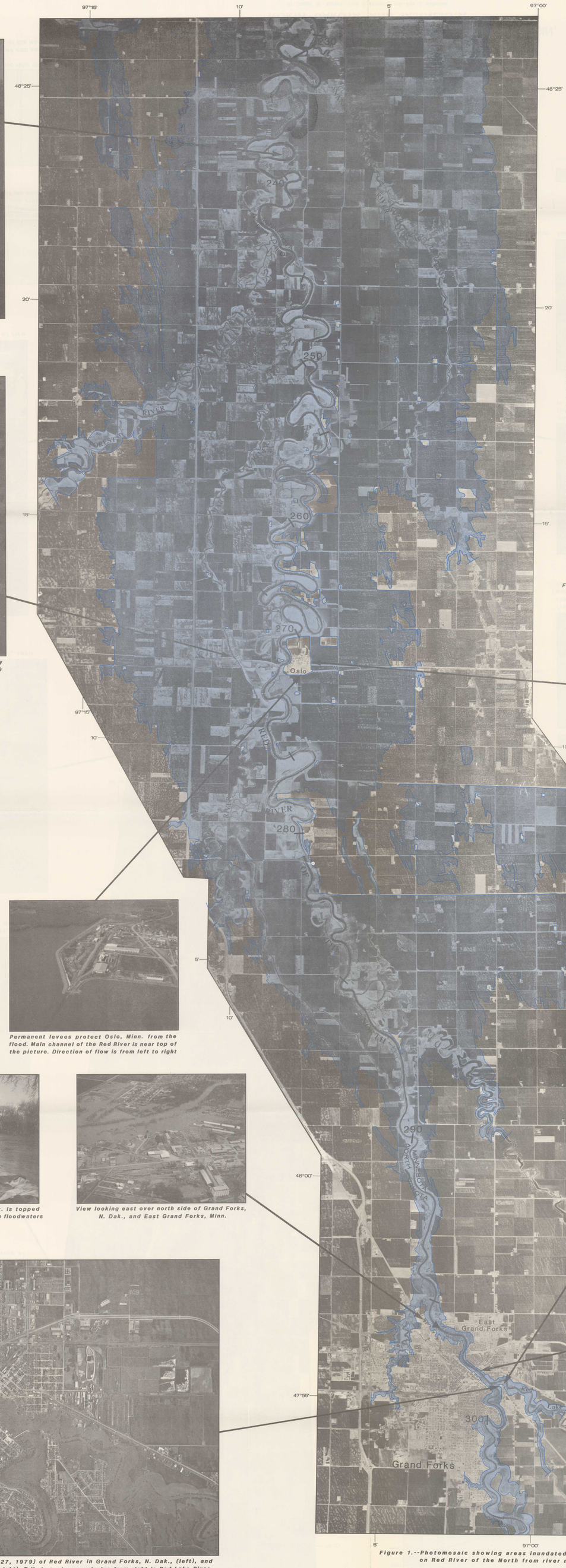


Figure 1.--Photomosaic showing areas inundated April 27, 1979, on Red River of the North from river mile 304 to 228

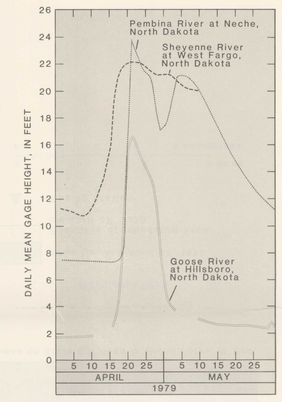


Figure 2.--Stage hydrographs at selected locations on North Dakota tributaries to the Red River of the North

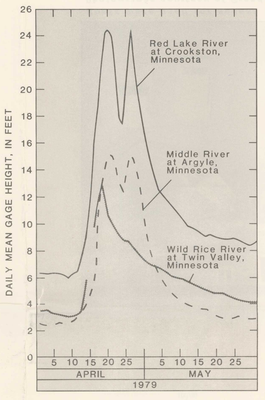


Figure 3.--Stage hydrographs at selected locations on Minnesota tributaries to the Red River of the North

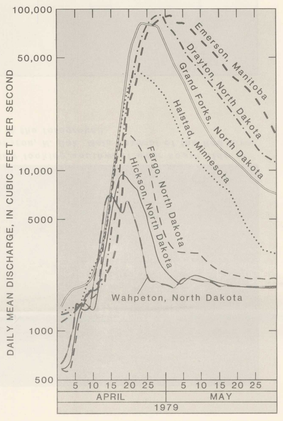


Figure 6.--Discharge hydrographs at gaging stations located on main stem of Red River of the North

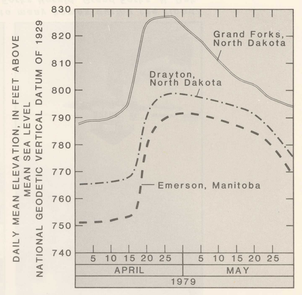


Figure 4.--Stage hydrographs at gaging stations located on main stem of Red River of the North from river mile 154 to 296

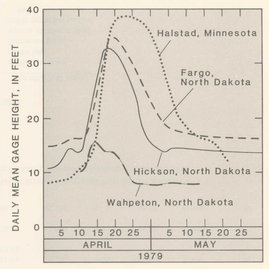


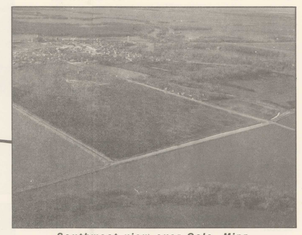
Figure 5.--Stage hydrographs at gaging stations located on main stem of Red River of the North from river mile 375 to 549

Permanent levees protect Oslo, Minn. from the flood. Main channel of the Red River is near top of the picture. Direction of flow is from left to right

Earthen levee in Grand Forks, N. Dak. is topped with sandbags and plastic to contain the floodwaters

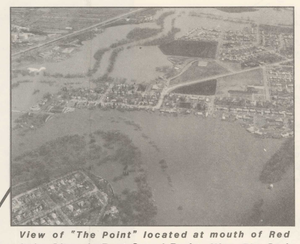
View looking east over north side of Grand Forks, N. Dak., and East Grand Forks, Minn.

Aerial photograph (April 27, 1979) of Red River in Grand Forks, N. Dak., (left), and East Grand Forks, Minn., (right). Tributary stream entering from right is Red Lake River. Direction of flow is toward the top of photograph



Southwest view over Oslo, Minn.

View of flooding in residential area in south Grand Forks, N. Dak.



View of "The Point" located at mouth of Red Lake River in East Grand Forks, Minn. The Red River of the North is in the foreground

The Red River is confined between business districts of Grand Forks, N. Dak., (upper right) and East Grand Forks, Minn., (lower left). View is looking upstream (south)

Four homes lost to floodwaters in Riverside Park area of Grand Forks, N. Dak.

EXPLANATION

- Area flooded April 27, 1979
- Boundary of inundated area on April 27, 1979
- Gaging station

0 1 2 3 MILES
0 1 2 3 4 KILOMETERS

FLOOD OF APRIL–MAY 1979 IN RED RIVER OF THE NORTH BASIN, NORTH DAKOTA AND MINNESOTA

By Donald W. Ericson, Oren O. Holmen, and Vito J. Latkovich

1980

FLOOD OF APRIL–MAY 1979 IN RED RIVER OF THE NORTH BASIN, NORTH DAKOTA AND MINNESOTA

The flood of April-May 1979 on the Red River of the North has been described as the flood of the century. At most locations between Halstad, Minn., and the international boundary at Emerson, Manitoba, flood peaks were either the highest of record or the highest of this century. The destructive flood inundated over 1 million acres of valuable farm land and caused damages exceeding 114 million dollars. In some areas downstream from Grand Forks, N. Dak., the width of the Red River exceeded 10 miles as compared to its normal width of 200 to 500 feet. Severe flooding also occurred on several tributary streams in North Dakota and Minnesota causing peak flows that exceeded previous maximums of record.

This report presents two photomosaics showing extent of flooding on April 27, 1979, (near the peak) along a 150 river-mile reach of the Red River from Grand Forks, N Dak., to the international boundary. The report also includes flood data from gaging stations, stage and discharge hydrographs, flood profiles, and photographs. The information should assist individuals, organizations, and government agencies involved in evaluating the effects of flooding on the economic development of the valley, in formulating flood-plain zoning regulations, and in designing improvements to reduce hazards and minimize damages from future floods.

The Red River is formed by the confluence of the Otter Tail and Bois de Sioux Rivers at Wahpeton, N. Dak., and Breckenridge, Minn., and flows northward to Lake Winnipeg in Manitoba, Canada. From Lake Winnipeg, the water drains to Hudson Bay via the Nelson River.

The Red River of the North basin, as used in this report, refers only to that part of the basin located within the United States. The Red River is the common boundary between North Dakota and Minnesota. At the point where the Red River crosses the international boundary at Pembina, N. Dak., and Emerson, Manitoba, it drains an area of approximately 40,200 mi², of which 3,800 mi² are closed basins. The basin landscape was formed by glacial advances and retreats in the past 70,000 years and is generally considered flat and featureless. The greatest relief is found in the headwaters of several tributary streams. Along the main stem of the Red River, the basin is very flat from deposition of sediment by Glacial Lake Agassiz which covered the area. The average gradient of the Red River between Breckenridge, Minn., and the international boundary is approximately 0.5 foot per mile. The flattest gradient is near the international boundary where the river drops only 0.2 foot per mile.

The Red River basin has several characteristics that make it susceptible to destructive flooding. The main channel is under-sized in relation to the floodplain, for the floodplain is formed by the bed of Lake Agassiz rather than the regime of the Red River. Because of the small gradient of the main channel and the flatness of adjacent land, vast areas are subject to inundation when flood flows exceed the capacity of the main channel. The orientation of the river from south to north can also contribute to flooding in the spring. Some years as the spring thaw progresses slowly northward in the basin, peak runoff from several of the tributary streams will coincide with the flood crest moving downstream on the Red River and increase peak discharges significantly. Ice jams may also cause localized stage increases immediately upstream from obstruction in the channel.

The longest history of known floods in the Red River basin in the United States is at Grand Forks, N. Dak., where flood data have been collected since 1882. There have been major floods at Grand Forks in 1882, 1893, 1897, 1950, 1965, 1966, 1969, 1978, and 1979 (fig. 12). The 1979 peak discharge at Grand Forks was exceeded only by the peak in 1897. Historical information indicates there also were notable floods in 1826, 1852, and 1861. Major flood peaks for the period of record at three other main stem gaging stations are given in figures 11, 13, and 14.

The maximum peak of record at main stem gaging stations located upstream from Halstad, Minn., were during the 1897 or 1969 flood. In the reach from Halstad, Minn., to Dayton, N. Dak., the maximums of record occurred during the 1897 or 1979 flood, and near the international boundary the largest flood was in 1950.

The April-May flood was caused by run-off from melting snow and rain. Rivers and streams remained low until a warming trend developed during the second week in April, triggering a rapid melting of the snowpack. Temperatures were in the fifties by April 16, and in the southern part of the basin, the Red River at Fargo, N. Dak., crested on April 19. Temperatures continued warm and in the next few days most of the snow cover melted in the central and northern parts of the basin. Flooding was aggravated by excessive precipitation on several occasions during the snowmelt period. The precipitation, generally in the form of warm rain, contributed additional runoff and accelerated melting of the snowpack.

The area inundated by floodwaters on April 27, 1979, along the main stem of the Red River from Grand Forks, N. Dak., to the international boundary is delineated on the photomosaics on sheets 1 and 2. The photomosaic in figure 1 of sheet 1 covers the Red River from river mile 304 to 228, and figure 10 of sheet 2 is for the reach from river mile 228 to 154. The inundated area was determined from aerial photographs taken April 27, 1979, when the flood crest was located between Grand Forks and Drayton, N. Dak. On April 27, the river stage at Grand Forks had receded more than 0.2 foot from the peak. The river crested at Drayton on April 28 only 0.04 foot above the stage on April 27. The flood crest reached Emerson, Manitoba, on May 1 and was about 1 foot higher than the stage on April 27. The flooded area delineated between Grand Forks and Drayton should be only slightly smaller than the actual area flooded at the time of the peak. Near the international boundary, however, the inundated area increased significantly when the flood crest reached the area.

The photomosaics have not been corrected for possible distortions caused by camera tilt or minor changes of altitude during the flight. Such distortions will cause errors in the linear scale of the photomosaics, but they have no affect on boundaries of the flooded areas.

Minor undulations in the Red River flood plain complicated delineation of the flood boundaries in areas such as that shown on the aerial photograph in figure 8. The scale of the photomosaics precludes outlining the numerous interconnected fingers of water lacing the flood boundary in these areas. Instead, a meandering boundary was drawn that enclosed most of the flooded area, but did exclude some of the smaller interconnecting channels and pockets of standing water. Within the flooded area, boundaries are delineated around islands and areas ringed by dikes only when they exceeded several acres. It was apparent on some of the aerial photographs that several agricultural dikes had just recently been breached, but much of the land they were protecting had not yet been flooded. One or two days after the aerial photographs were taken, there were probably several additional sections of land inundated as dikes eroded and increasing amounts of water flowed through the breached areas.

The boundaries of the flooded area on April 27, 1979, reflect channel and floodplain conditions existing at that time. As these conditions change, either during or between flood events, there will be a corresponding change in the boundaries of the area inundated by future floods similar in magnitude to the 1979 flood. During the 1979 flood, temporary dikes were constructed and heights were raised on some of the existing emergency levees constructed during previous floods. As the crest of the flood approached, many roads were overtopped and some sections of roadfill were washed away. Most of the agricultural levees were overtopped also and large washouts were common. In addition to the changes in the roads, dikes, and levees as the existing networks are rebuilt, there will also be natural changes in the river channel and flood plain.

FLOOD HEIGHT

The height of a flood at a gaging station generally is stated in terms of gage height or stage, which is the height of the water surface in feet above an arbitrary datum plane. Gage heights for gaging stations can be converted to elevations above mean sea level, National Geodetic Vertical Datum of 1929, by adding the gage height to the appropriate datum of the gage.

FLOOD DISCHARGE

The discharge of a stream is the volume of water that passes a given location within a given period of time. Discharge in this report is expressed in units of cubic feet per second. Peak discharge is the maximum discharge during a flood, and it usually occurs near the time of maximum height. Some streams have reaches that are subject to variable backwater caused by ice jams or high stages on a nearby stream. The variable backwater can cause the peak stage to occur when the discharge is not at a maximum.

The 1979 peak discharge data at gaging stations in the Red River of the North basin are listed in table 1. In addition to the record-setting peaks at some of the gaging stations on the Red River, new maximums of record were also recorded on the tributary streams – Wild Rice, Sheyenne, Rush, and Goose Rivers in North Dakota, and Marsh and Clearwater Rivers in Minnesota.

Stage hydrographs of the 1979 flood at gaging stations located on the main stem of the Red River and selected tributary streams in North Dakota and Minnesota are shown in figures 2-5. Discharge hydrographs of the 1979 flood (fig. 6) are also included for stations on the main stem of the Red River.

RECURRENCE INTERVALS

The recurrence interval of a flood is the average time interval in which a flood of a given size is exceeded as an annual maximum. If a 1,000 ft³/s flood at a gaging station has a recurrence interval of 25 years, this means that over a long period of time the annual maximum peak will exceed 1,000 ft³/s at intervals averaging 25 years in length. Frequencies of floods also may be given in term of their probabilities of occurrence, which is virtually the reciprocal of the recurrence interval for floods exceeding the 10-year event. In the preceding example, the 1,000 ft³/s flood with a 25-year recurrence interval would have a 1/25 or 4 percent chance of being exceeded in any given year. Recurrence intervals for most of the 1979 peak discharges are listed in table 1.

FLOOD PROFILES

The profile of the maximum water-surface elevation along the Red River from Wahpeton, N. Dak., to Emerson, Manitoba, during the 1979 flood is shown in figure 7. The profile was constructed from high-water marks determined by the Corps of Engineers, St. Paul District, and peak stages recorded at U.S. Geological Survey gaging stations. Straight line interpolation was used between points of known elevations. The river-mile distance used in this report were determined by the Corps of Engineers and are measured from the mouth of the river. For comparison with the 1969 flood, selected points of known elevations for that flood are plotted as closed circles on the profile.

There has been considerable dike, levee, and floodwall construction in the Red River basin. The Corps of Engineers has constructed permanent levees and flood walls in several cities and towns near or adjacent to the Red River. During extreme floods, such as in 1979, emergency levees are constructed and temporary levees left in place from previous floods are raised to prevent overtopping. Heavy equipment is generally used to place material used in emergency construction, but when equipment is not available or access is not adequate, sandbags are used. The Corps of Engineers used over 4 million sandbags in the 1979 flood in addition to those used by communities and private individuals.

A number of farmsteads within the flood plain have been encircled with dikes to protect them from flooding. Many of these ring dikes effectively reduced or eliminated flooding in 1979, but some were overtopped or had weak sections that gave way. In recent years, farmers in some areas also have constructed levees to prevent flooding of agricultural land. Most of the agricultural levees were overtopped by the 1979 flood.

Cost of flood damages sustained during the 1979 flood exceeded 114 million dollars according to the Corps of Engineers. The largest damages occurred in rural areas where losses were over 84 million dollars. In addition to damages from extensive flooding of croplands, farmers also suffered damages to their homes, farm buildings, machinery, stored grain, and livestock. The rural network of roads also sustained considerable damage. Roads were overtopped by the flood water, sections of road grade were washed out or badly eroded and many culverts and small bridges were damaged or washed out.

ACKNOWLEDGEMENTS

All uncredited photographs in this report were taken by the U.S. Army Corps of Engineers, St. Paul District. Data for the Red River of the North at Emerson, Manitoba gaging station was furnished by the Water Survey of Canada, Winnipeg, Manitoba.

ADDITIONAL INFORMATION

Supporting data and computations relative to this report and additional information pertaining to floods in the Red River of the North basin may be obtained at the district offices of the U.S. Geological Survey located in Bismarck, N.Dak., and St. Paul, Minn., and from the following reports:

Anderson, D.B., and Schwab, H.H., 1970, Floods of April-May 1969 in upper midwestern United States: U.S. Geological Survey open-file report, 555 p.

U.S. Army Corps of Engineers, St. Paul District, 1979, Red River of the North and Souris River, Post Flood Report: 73 p.

Lindskov, K.L., 1975, Data Summary of June-July 1975 floods in eastern North Dakota and northwestern Minnesota: U.S. Geological Survey Open-file Report 75-565, 15 p.