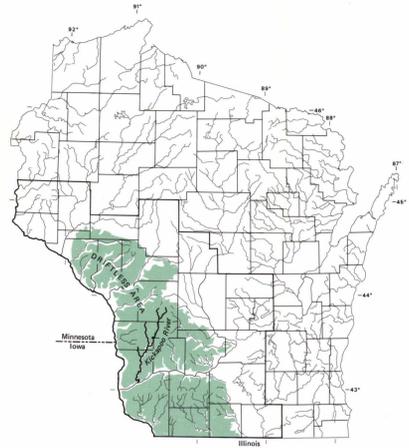


## INTRODUCTION

The Kickapoo River Valley in southwestern Wisconsin had a devastating flood during July 1-5, 1978. The flash flooding, caused by intense storms, resulted in flood elevations that equaled or exceeded the largest recorded since the 1850's. Extensive damages included 2 people dead, over 1,000 destroyed or damaged farm structures, 125 dead livestock, crop losses to more than 11,000 farmers, 182 damaged businesses, and more than 100 damaged or destroyed bridges, culverts, and sections of roadways. Total damages have been estimated to be \$10 million. Of the total, \$8.71 million occurred on the main stem of the Kickapoo River and \$1.29 million in tributary areas.

This study is part of the State and National effort to obtain accurate measurement of flood characteristics from unusual hydrologic events. Interpretation of the collected data will provide a sounder basis for designing culverts, bridges, and drainage systems; for planning use of flood-prone lands; and for establishing flood-insurance rates. Summaries of the hydrologic and hydraulic characteristics of large floods are useful in improving the accuracy of estimated flood discharges and profiles.



## PHYSICAL SETTING

The Kickapoo River basin, representative of the unglaciated "Driftless Area" of southwestern Wisconsin, occupies 766 mi<sup>2</sup>. This basin, highly susceptible to flash flooding, is characterized by steep slopes (30 to 40 percent), rounded ridges, and steep narrow valleys. The width of the valley averages between 0.25 and 0.50 mi. The widest part, just downstream from Soldiers Grove, is about 1.0 mi. The flood plain of the Kickapoo River during a 100-year flood from La Farge to Steuben includes approximately 10,500 acres.

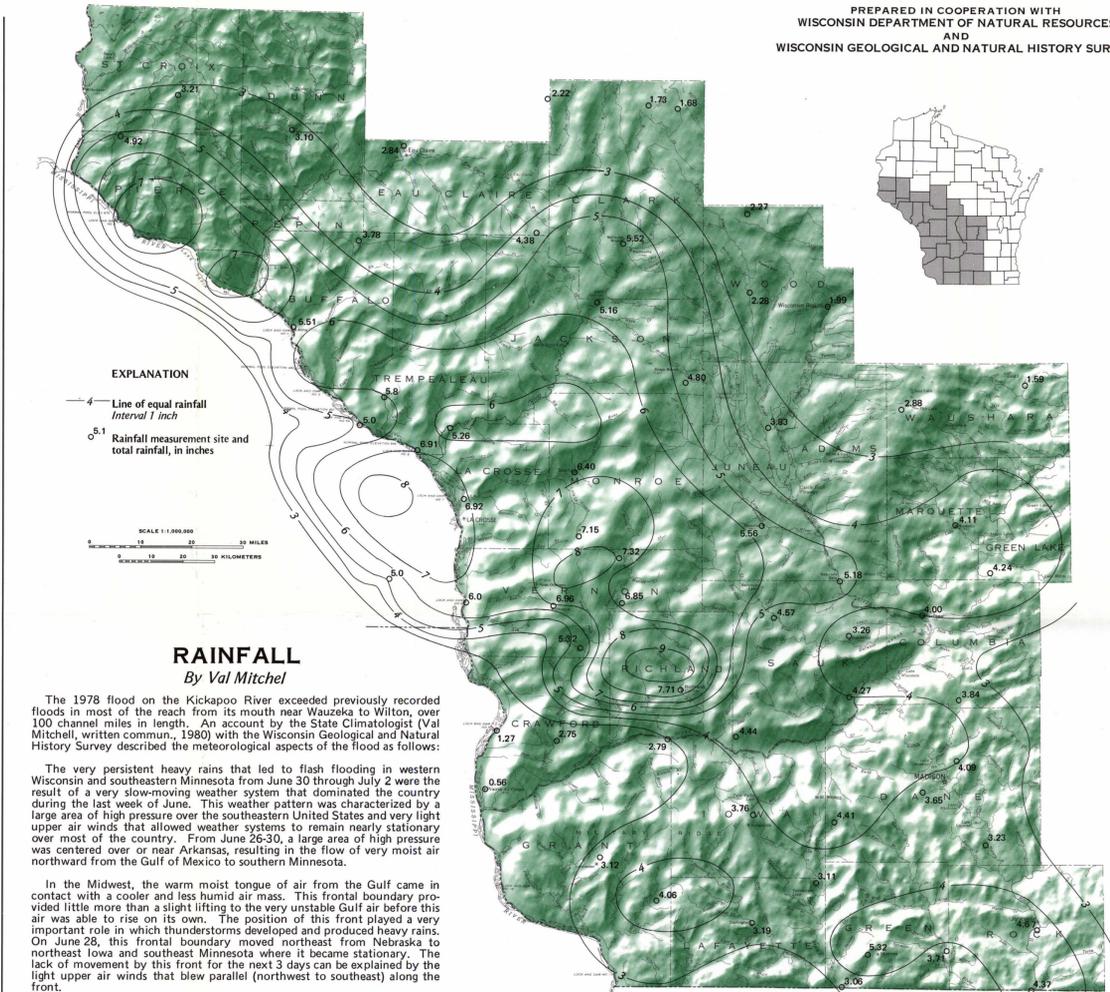
The basin has 43 towns and villages in 4 counties (Crawford, Monroe, Richland, and Vernon). Most of the basin is in Crawford and Vernon Counties. Busse (1979) reports that land use is approximately 40 percent wooded, 25 percent cropland, 25 percent pasture, 2 percent wetland, and 8 percent urban. The population is approximately 26,000.



HISTORICAL FLOOD OF MARCH, 1961 AT GAYS MILLS—View looking west (photo courtesy of Madison Newspapers Incorporated)

## HISTORY OF FLOODING

Floods on the Kickapoo River are not unusual. The valley has an average of one destructive flood per year. Long-term streamflow records from the U.S. Geological Survey gaging stations on the Kickapoo River at Steuben (No. 05410500) and Gays Mills (No. 05410000) show floods during all seasons of the year. Major damaging floods occurred in 1912, 1917, 1935, 1951, 1956, 1961, 1965, 1966, and in July 1978. The July 1978 flood is the greatest known at the five gaging stations in the 100-mi reach between La Farge and Wauzeka.



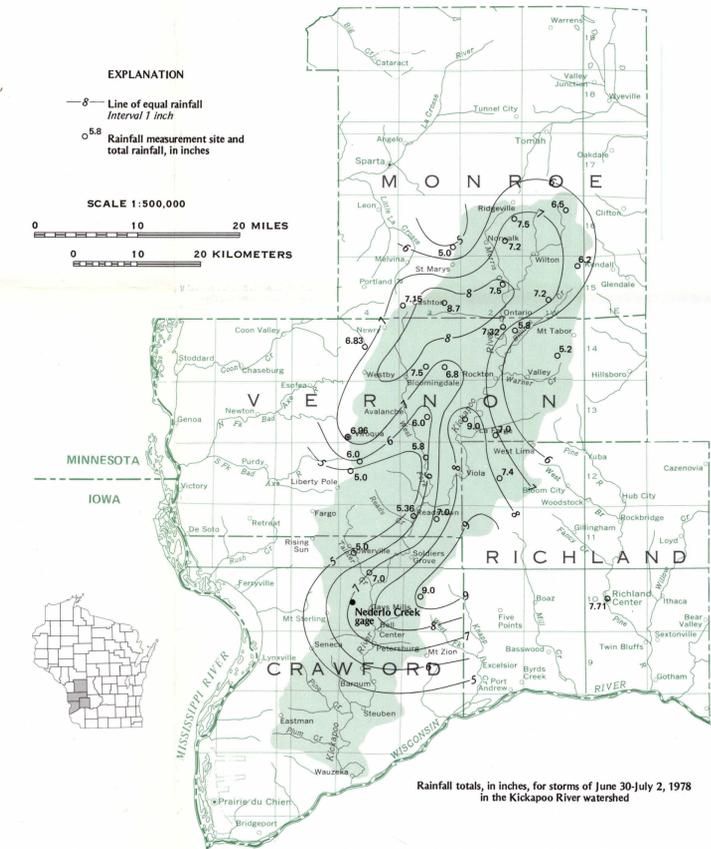
## RAINFALL By Val Mitchell

The 1978 flood on the Kickapoo River exceeded previously recorded floods in most of the reach from its mouth near Wauzeka to Wilton, over 100 channel miles in length. An account by the State Climatologist (Val Mitchell, written commun., 1980) with the Wisconsin Geological and Natural History Survey described the meteorological aspects of the flood as follows:

The very persistent heavy rains that led to flash flooding in western Wisconsin and southeastern Minnesota from June 30 through July 2 were the result of a very slow-moving weather system that dominated the country during the last week of June. This weather pattern was characterized by a large area of high pressure over the southeastern United States and very light upper air winds that allowed weather systems to remain nearly stationary over most of the country. From June 26-30, a large area of high pressure was centered over or near Arkansas, resulting in the flow of very moist air northward from the Gulf of Mexico to southern Minnesota.

In the Midwest, the warm moist tongue of air from the Gulf came in contact with a cooler and less humid air mass. This frontal boundary provided little more than a slight lifting to the very unstable Gulf air before this air was able to rise on its own. The position of this front played a very important role in which thunderstorms developed and produced heavy rains. On June 28, this frontal boundary moved northeast from Nebraska to northeast Iowa and southeast Minnesota where it became stationary. The lack of movement by this front for the next 3 days can be explained by the light upper air winds that blew parallel (northwest to southeast) along the front.

Rainfall totals, in inches, for storms of June 30-July 2, 1978 in southwestern Wisconsin and southeastern Minnesota



Rainfall totals, in inches, for storms of June 30-July 2, 1978 in the Kickapoo River watershed

For 3 days, June 30-July 2, heavy thunderstorms developed along this stationary front. Although the storms moved to the southeast at 25 to 35 mi/h, periodic development maintained the heaviest rainfall near the Wisconsin-Minnesota border. Some of these storms were very intense with many cloud tops of over 50,000 ft above sea level.

In one case, a severe thunderstorm on the evening of July 1 produced three tornadoes, damaging property in Vernon County, Wis. As is usually the case with intense thunderstorms, these storms produced heavy localized rainfall, creating large differences in observed precipitation over short distances. The high variability in the observed precipitation totals from the numerous thunderstorms that occurred in 3 days makes the analysis of the rainfall pattern and the determination of the amount of water that fell over an area such as the Kickapoo River basin difficult.

The map at the left shows the precipitation totals (June 30-July 2) in a portion of the Kickapoo basin. The data were obtained from a survey taken July 3 of individuals who had rain gages and from established weather substations in the survey area. The large variability of precipitation over a short distance can be seen on this map in the Ontario area. An established substation 1 mi south-southeast of the city of Ontario recorded 7.32 in. of rain while at Wildcat State Park, approximately a mile away, total rainfall was observed at only 5.8 in. Both readings should be reliable. Also, from the map, it can be seen that at least three maxima in the survey area occurred; one of over 8 in., surrounding the Cashton area, a 9-in. maximum northwest of La Farge, and a large area which received over 9 in. between Soldiers Grove and Richland Center. In all cases, the precipitation reported in this area equaled or exceeded 5 in. The largest single total reported by an individual with a rain gage was 9.5 in., 4 mi northwest of La Farge. It is possible that much heavier rainfall occurred but was not measured accurately by a rain gage. Some individuals west of Cashton that did not have rain gages estimated they received 11 to 12 in.

At La Farge, where rainfall is measured hourly, the La Farge rainfall records show that most of the rain fell in at least five separate periods. On June 30, between 1 and 3 a.m. CST, 0.73 in. of rain fell; between 7 and 9 p.m., 1.25 in.; and between 10 and 12 p.m., 1.37 in. On July 1, rain continued steadily from the previous day until it intensified about 4 a.m., when between 4 and 5 a.m., 0.73 in. fell and again between 7 and 11 p.m., 1.43 in. fell. Rain fell on July 2, but unfortunately, it was not measured at La Farge.

From the La Farge hourly rainfall data, it can be shown that no single period of precipitation was very unusual. On an hourly time scale, rainfalls like these occur in southwestern Wisconsin about once every 2 years. It was the persistence of these rains that made June 30-July 2 an exceptional case.

## FLOOD OF JULY 1-5, 1978 ON THE KICKAPOO RIVER, SOUTHWESTERN WISCONSIN

BY  
P.E. HUGHES, J.S. HANNUKSELA,  
AND W.J. DANCHUK  
1981

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## PEAK DISCHARGES

The table summarizes available peak discharges during the July 1-5, 1978, flood and the previously recorded maximum discharges for the Kickapoo River at the six gaging sites from La Farge to Wauzeka.

The recurrence interval, as applied to floods, is the average number of years within which a given flood peak will be equaled or exceeded once. It is inversely related to the chance of a flood of a given discharge being equaled or exceeded in any 1 year. Thus, a 20-year flood would have 1 chance in 20 of being equaled or exceeded in any year, and a 100-year flood would have 1 chance in 100 of being equaled or exceeded in any year. Three streamflow gaging stations (La Farge, Gays Mills, and Steuben) having a streamflow gaging station record of sufficient length to allow frequency analyses show that the 1978 flood has a recurrence interval equal to or greater than 100 years. At La Farge, the 1978 peak discharge of 14,300 ft<sup>3</sup>/s has a recurrence interval greater than 100 years, and at Gays Mills the estimated 1978 peak discharge of 15,000 ft<sup>3</sup>/s has a recurrence interval of approximately 100 years. The 1978 peak discharge of 16,500 ft<sup>3</sup>/s at Steuben also has a recurrence interval greater than 100 years.

It is emphasized that recurrence intervals are average figures—the average number of years that will elapse between floods that equal or exceed a given magnitude. The fact that a major flood occurs does not reduce the probability of a flood as great or greater in the next year, next month, or next week.

River mile	Datum (NGVD)	Drainage area (mi <sup>2</sup> )	Period of record	Date	Gage height (ft)	Maximum flood previously known		Maximum during present flood		Comments			
						Discharge (ft <sup>3</sup> /s)	Time or date of high water (month)	Discharge (ft <sup>3</sup> /s)	Time or date of high water (month)				
68.65	782.00	266	1938-78	2/9/66	13.7	9910	37.3	1600	14.9	14,300	53.8	greater than the 100-yr flood	
								7/1/78	14.76	13,500	50.7	measurement shortly after crest	
58.75	700.00	340	1960-78	3/28/61	61.0	3810	11.2	7/1/78	16.0	13,600	40.0	approximates the 100-yr flood	
46.02	700.00	530	1938-39	3/2/65	25.8	4240	8.0	7/2/78	36.5	14,300	27.0	approximates the 100-yr flood	
34.38	686.75	616	1964-78	2/10/68	16.0	10,600	17.2	7/3/78	18.2	15,000	24.4	equal to the 100-yr flood	
17.25	657.82	690	1933-78	3/28/61	12.3	10,800	52.9	9/30	14.8	16,500	24.9	greater than the 100-yr flood	
								7/3/78	44.6	18,300	23.8	maximum discharge during flood measurement shortly after crest	
2.80	600.00	768						7/3/78	1600	44.5	16,100		

Flood discharge summary for the Kickapoo River, July 1-3, 1978

## FLOODED AREAS

Flood boundaries were delineated from aerial photographs (scale 1" = 1,500') taken by the Wisconsin Department of Natural Resources on July 5. The delineation was verified by field inspection and comparison with large-scale topographic maps.

The area covered by the photomosaic is shown on the following sheets. The photomosaic (scale 1" = 1,500') shows the area flooded by the main river only; tributaries are shown only at their junction with the Kickapoo River and flood boundaries are not continued beyond the Kickapoo River backwater. The extent of flooding was for the most part clearly visible and discernable on the aerial photographs. Cloud cover prevented the Wisconsin Department of Natural Resources from obtaining aerial photography coverage of the upper one-third of the Kickapoo River until 3 days after the flood crest. It was therefore necessary to use the 1978 flood profile and topographic maps to assist in the flood-boundary delineation. However, flooding may have extended beyond the flood outline in some areas or may include areas within the flood outline that were not flooded. The 1978 flood profile, along with the six earlier historic flood profiles, is shown for the reach identified on each photomosaic sheet.

## FLOOD PROFILES

High water marks were identified for 44 locations in the 100-mi reach of the Kickapoo River from Wauzeka to Wilton. At each location several marks were established and elevations were determined by leveling to bench marks and are referenced to the National Geodetic Vertical Datum of 1929. The average elevation at each location is shown on the following sheets. Plotted with the 1978 profile are six earlier historic flood profiles as compiled by the U.S. Army Corps of Engineers, St. Paul District.

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## ACKNOWLEDGMENTS

The Wisconsin Department of Natural Resources provided funding, furnished the aerial photography, and assisted in locating and leveling of the floodmarks. Val Mitchell, State Climatologist, of the Wisconsin Geological and Natural History Survey, provided the meteorological analysis. Historic flood profiles before 1978 and "ordinary low water surface, 1938" were furnished by the U.S. Army Corps of Engineers, St. Paul District.