HYDROLOGIC INVESTIGATIONS ATLAS HA 735–B
Schaap, B.D., and Harvey, C.A., Delineation of Flooding within the Upper Mississippi River Basin, 1993—Flood of June 29–September 18, 1993, in Iowa City and Vicinity, Iowa

INTRODUCTION

During the spring, summer, and fall of 1993, record flooding disrupted business and transportation and caused widespread property damage and personal hardship in parts of Iowa, Illinois, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. In an effort to document the 1993 flooding, the U.S. Geological Survey (USGS) is publishing a series of reports collectively known as Circular 1120, *Floods in the upper Mississippi River Basin, 1993*. Also, hydrologic atlases such as this one are being published for Davenport, Iowa City, and Des Moines, Iowa; Jefferson City and St. Louis, Missouri; and Kansas City, Kansas and Missouri.

This hydrologic atlas describes the flooding that occurred from June 29 through September 18, 1993, along the Iowa River in Iowa City and vicinity. Flooding in Iowa City threatened the water treatment plants of the City of Iowa City and the University of Iowa. Some streets were closed for more than 2 months, and businesses, homes, and University buildings were damaged. The 1993 flood elevations and inundated areas are presented and compared to those estimated by the Federal Emergency Management Agency [(FEMA) 1978b, 1985a–b, 1987a, 1988a] for the 100-year flood.

DESCRIPTION OF THE AREA

Iowa City is in east-central Iowa. The drainage basin for the Iowa River at the USGS streamflow-gaging station at Iowa City is entirely within the State of Iowa (fig. 1), and much of it is used for agriculture. The headlands are in an area of low relief typical of north-central Iowa, characterized by many ponds and marshes with no drainage outlets. Farther downstream, the topography varies from gently to steeply rolling hills, and the drainage system is more developed.

Coralville Dam (fig. 2), which is about 4 miles (mi) north of Iowa City, has regulated the flow of the Iowa River since September 17, 1958. Since then, considerable development has occurred near the southern part of Coralville Reservoir and downstream from the dam along the Iowa River, especially in Coralville and Iowa City (fig. 2).

The primary tributaries to the Iowa River in the Iowa City area are Rapid Creek and Clear Creek. Rapid Creek joins the Iowa River about 2.3 river mi downstream from Coralville Dam and upstream of Coralville. Clear Creek joins the Iowa River about 5.5 river mi downstream of Coralville Dam and within the city limits of Coralville.

CLIMATIC CONDITIONS

In early June 1993, a weather pattern that was characterized by a strong low-pressure system developed over the Western United States, and a corresponding large high-pressure system developed over the Southeastern United States. The jet stream dipped south over the Western United States and flowed northeasterly across the upper Midwest. The high-pressure system to the southeast blocked the eastward movement of storms, thus creating a convergence zone between the flow of warm, moist air from the Gulf of Mexico and the much cooler and drier air from Canada, which resulted in thunderstorms. As a result, the upper Midwest within this convergence zone was deluged with rain, while the Southeastern and Eastern United States from Alabama to Vermont, under the influence of the high-pressure system, was very hot and dry. Slight movements in the atmospheric pattern determined the timing and location of the excessive rainfall throughout the upper Midwest (Wahl and others, 1993, p. 2–3).

The wettest November–June period in 121 years of Iowa records was followed by July 1993, the wettest month recorded in Iowa (National Oceanic and Atmospheric Administration, 1993b). The locations of selected precipitation stations within or near the drainage basin of the Iowa River at Iowa City streamflow-gaging station are shown in figure 1. For June, July, and August, 1993, all of these stations recorded more than 100 percent of normal rainfall (table 1). Each of these stations recorded more than 200 percent of normal rainfall for at least one of these months and rainfall at the Cedar Rapids Airport was 414 percent of normal for the month of July (National Oceanic and Atmospheric Administration, 1993a,b,c). Of the many different storms that contributed to the flooding in the Iowa City area, two are of special importance. The Iowa River at Iowa City was already above flood stage when runoff from the July 4–6 storm raised the water level of Coralville Reservoir above the level of the emergency spillway. Rainfall from that storm was more than 2 inches (in.) over the southeastern third of Iowa and exceeded 4 in. in a 50- to 100-mile-wide band from south-central to east-central Iowa (Wahl and others, 1993). In August, the rains continued and on August 9–10, more than 1 in. of rain fell on most of the basin with 3.60 in. of rain recorded in Iowa City and 5.14 in. of rain reported at the Cedar Rapids Airport (National Oceanic and Atmospheric Administration, 1993c). Although the discharge of the Iowa River below the Coralville Dam was well below earlier levels (fig. 3), the discharges of the flooding Clear Creek and Rapid Creek led to the highest elevation and the largest discharge ever recorded at the Iowa River at Iowa City gaging station since Coralville Dam was built (table 2).

FLOOD DISCHARGES

Maximum discharges and stages at selected streamflow-gaging stations are listed in table 2. The rate of discharge of a stream is the volume of flow that passes a specific location in a given period of time. Floods are described in terms of discharge as well as elevation because changes in the river channel can affect the relationship between water-surface elevation and discharge. As flooding continues, erosion may widen or deepen the river channel so that a greater discharge might be associated with a lower water-surface elevation. This may affect the interpretation of the timing of the maximum water-surface elevations.

Discharges at Iowa River streamflow-gaging stations upstream from Coralville Reservoir, downstream from Coralville Reservoir, and at Iowa City are shown in figure 3. Most of the difference between the discharge of the Iowa River below Coralville Dam and the Iowa River at Iowa City is from Rapid Creek and Clear Creek. The heavy rains of August 9–10 (table 1) fell on the saturated drainage basins of these small tributaries and caused the rapid increase in the discharge of the Iowa River at Iowa City on August 10.

Table 1. Precipitation recorded during June through August 1993 within or near the drainage basin of the Iowa River at Iowa City streamflow-gaging station

[in., inches; —, not available. Data from National Oceanic and Atmospheric Administration (1993a, 1993b, 1993c). Percent of normal is percent of normal precipitation from 1961–1990.]

Period of rainfall	National Oceanic and Atmospheric Administration precipitation station (fig. 1)															
	Belle Plaine		Britt		Cedar Rapids Airport		Clarion		Eldora		Iowa City		Marshalltown		Williamsburg	
	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal	Rain (in.)	Percent of normal
Month of June	9.46	**203**	10.11	**228**	8.80	**193**	9.44	**207**	10.22	**209**	10.75	**237**	8.16	**172**	6.72	**141**
July 4–6	1.24	—	.10	—	5.55	—	.32	—	1.18	—	4.02	—	1.85	—	5.71	—
July 8–11	3.92	—	2.69	—	2.34	—	4.89	—	3.59	—	1.59	—	6.38	—	1.62	—
July 17–19	3.99	—	1.57	—	1.89	—	2.85	—	1.15	—	0.13	—	2.70	—	0.65	—
July 22–24	.79	—	.15	—	2.62	—	.22	—	.51	—	3.77	—	0.41	—	2.85	—
Month of July	12.96	**294**	7.19	**165**	17.03	**414**	9.75	**222**	8.21	**181**	13.40	**273**	13.64	**316**	12.10	**273**
August 9–10	1.82	—	.11	—	5.14	—	1.92	—	1.07	—	3.60	—	0.85	—	1.18	—
August 14–19	4.49	—	2.62	—	4.10	—	3.17	—	7.32	—	4.58	—	6.21	—	2.76	—
August 28–30	2.59	—	1.58	—	1.77	—	3.21	—	2.08	—	1.69	—	2.65	—	1.65	—
Month of August	13.69	**296**	5.88	**166**	13.09	**326**	11.60	**314**	13.74	**328**	12.33	**280**	14.71	**317**	10.74	**234**

Table 2. Summary of maximum stages and discharges at selected streamflow-gaging stations at Iowa City, Iowa, and vicinity

[mi^2, square miles; ft, feet above gage datum; ft^3/s, cubic feet per second; >, greater than. Data from Southard and others (1994), O'Connell and others (1991), and Federal Emergency Management Agency (FEMA)(1976, 1978a, 1981, 1987b.)]

Station number (fig. 2)	Station name	Drainage area (mi^2)	Gage datum (feet above sea level)	Flood data: Flood of June 29–September 18, 1993: Date (month/day)	Maximum stage (ft)	Maximum discharge (ft^3/s)	Recurrence interval (years)	Prior to 1993 flood: Date (month/year)	Maximum stage (ft)	Maximum discharge (ft^3/s)	FEMA study 100-year flood discharge (ft^3/s)
05453100	Iowa River at Marengo	2,794	720.52	7/19	20.31	[1]38,000	[2]90	[3]3/60	19.21	30,800	44,300
05453520	Iowa River below Coralville Dam near Coralville	3,115	600.00	7/19	63.95	[1]25,800	>100[4, 5](1.7)	[4]7/69	[4]59.96	[4]13,000	21,000
05454000	Rapid Creek near Iowa City	25.3	673.72	8/10	15.61	[1]6,700	[2]35	[3]5/65	14.10	6,100	9,000
05454300	Clear Creek near Coralville	98.1	647.48	7/06	14.74	6,760	[2]20	6/90	16.36	10,200	12,000
05454500	Iowa River at Iowa City	3,271	617.27	8/10	28.52	28,200	>100[4, 5](1.3)	6/1851	[6, 7, 8]34.3	[6, 7]70,000	25,000
								7/69	[8, 9]23.93	[9]15,000	

[1] Maximum discharge for 1993 exceeds the previous maximum known discharge.
[2] Based on information from Eash (in press).
[3] Date of maximum discharge. Maximum stage was at a different time.
[4] Based on information from U.S. Army Corps of Engineers (Hydraulics Branch, oral commun., 1994).
[5] Ratio of flood discharge to that of the 100-year flood.
[6] Estimated.
[7] Before Coralville Dam began affecting flow (September 17, 1958).
[8] Converted to present gage datum.
[9] After Coralville Dam began affecting flow (September 17, 1958)

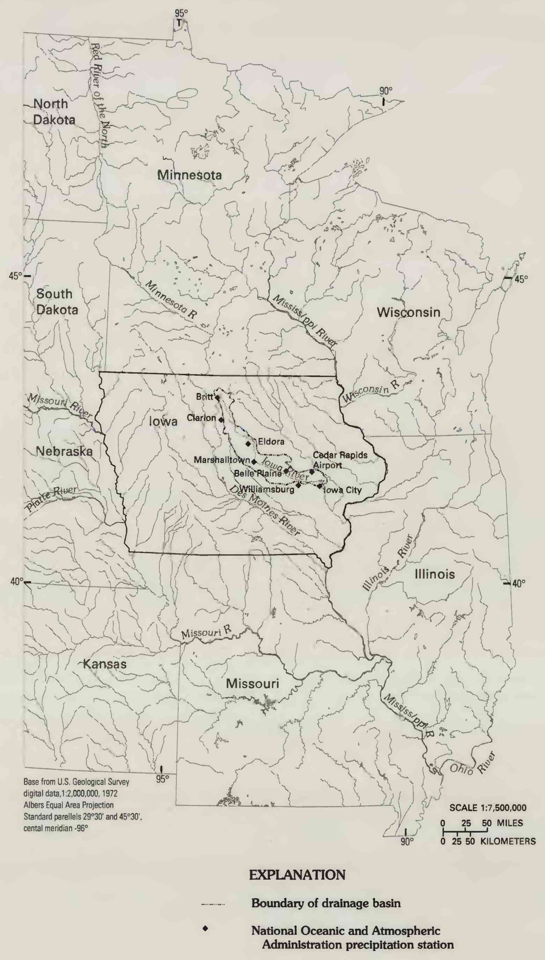

Figure 1. Location of the drainage basin of the Iowa River upstream from the Iowa River at Iowa City streamflow-gaging station and selected National Oceanic and Atmospheric Administration precipitation stations.

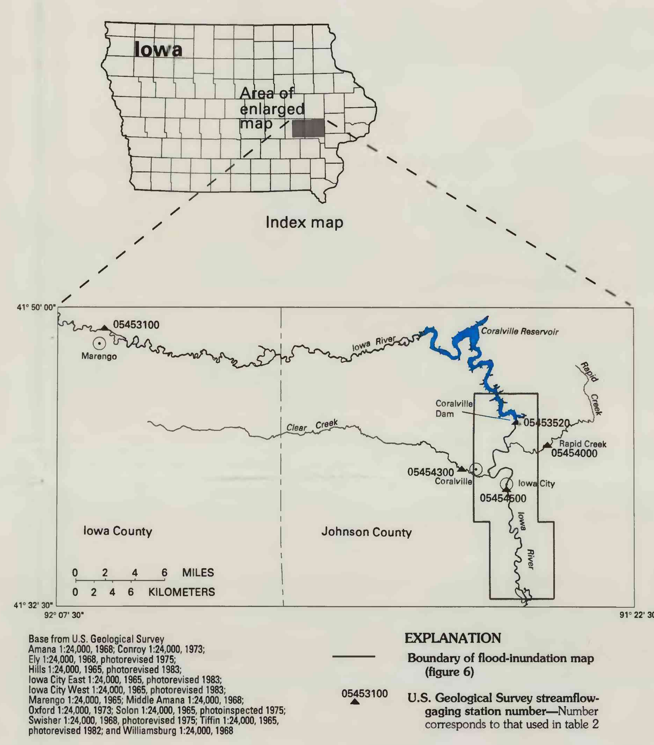

Figure 2. Location of U.S. Geological Survey streamflow-gaging stations and boundary of flood-inundation map.

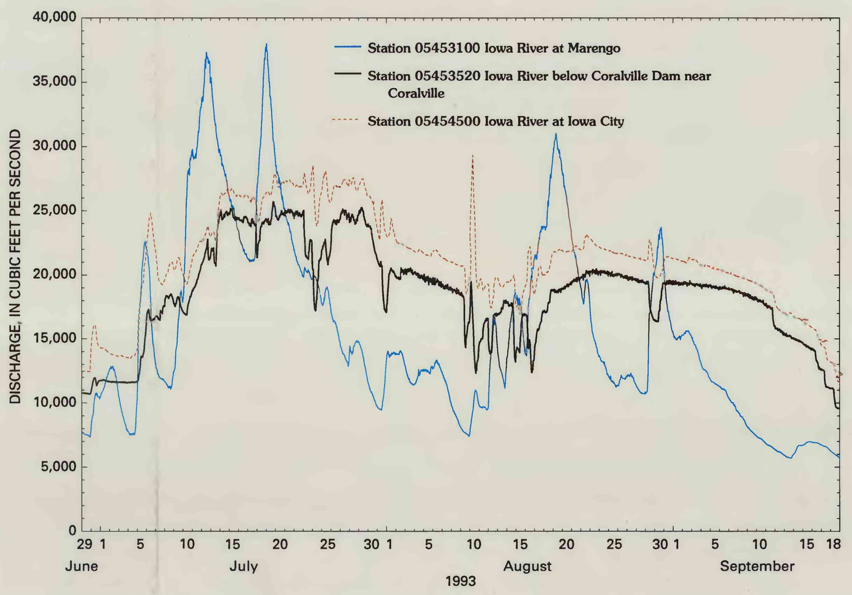

Figure 3. Discharge at U.S. Geological Survey streamflow-gaging stations on the Iowa River at Iowa City and vicinity, June 29–September 18, 1993.

FLOOD ELEVATIONS

The elevation of a flood at a streamflow-gaging station is commonly stated in terms of gage height or stage, which is the elevation of the water surface above a selected gage datum. From June 29 to September 18, 1993, the stage of the Iowa River at Iowa City streamflow-gaging station (station 05454500) equalled or exceeded 22 feet (ft), which is defined by the National Weather Service (Mike Longnecker, National Weather Service, written commun., 1995) as the flood stage at that station. The maximum water-surface elevations that occurred between July 19 and August 10 along the Iowa River within the study area are shown in figure 4.

The maximum Coralville Reservoir water-surface elevation of 716.71 ft occurred on July 24 (U.S. Army Corps of Engineers, 1994). Figure 5 shows that the level of the Coralville Reservoir was above the elevation of the emergency spillway for nearly a month. During this time, the ability to control the flow from the reservoir was reduced. The maximum water-surface elevation at the Iowa River below Coralville Dam was recorded on July 19 (table 2).

Between Coralville Dam and the confluence of Clear Creek and the Iowa River at about river mile 77.8, the maximum water-surface elevations probably occurred on July 19. The maximum water-surface elevation at the confluence of the Iowa River and Clear Creek was measured on August 10 (City of Coralville, Engineering Department, written commun., 1993). Downstream from Clear Creek, the maximum elevations along the Iowa River probably occurred on August 10. At the Iowa River at Iowa City streamflow-gaging station, the maximum elevation was recorded on August 10.

Maximum stages recorded at USGS and U.S. Army Corps of Engineers (COE) gages in Iowa City and vicinity have been converted to elevations and are reported on the flood-inundation map to the nearest hundredth of a foot (fig. 6). At ungaged locations, the maximum stages were determined by the USGS, the Cities of Coralville and Iowa City, and eyewitness accounts by the public. Maximum stages determined by the USGS were based on physical evidence. The City of Coralville reported the maximum elevation of the water surface at the 1st Avenue Bridge, and the City of Iowa City reported the maximum elevations at the Park Road Bridge, the Iowa City water-treatment plant, and the Iowa City pollution control plant. At four sites, reliable accounts by eyewitnesses indicated that the maximum elevations were higher than the observed physical evidence. The City of Iowa City determined the elevations at those sites where maximum stages were determined by the USGS or eyewitness accounts. In figure 6, elevations for the ungaged locations are reported to the nearest tenth of a foot.

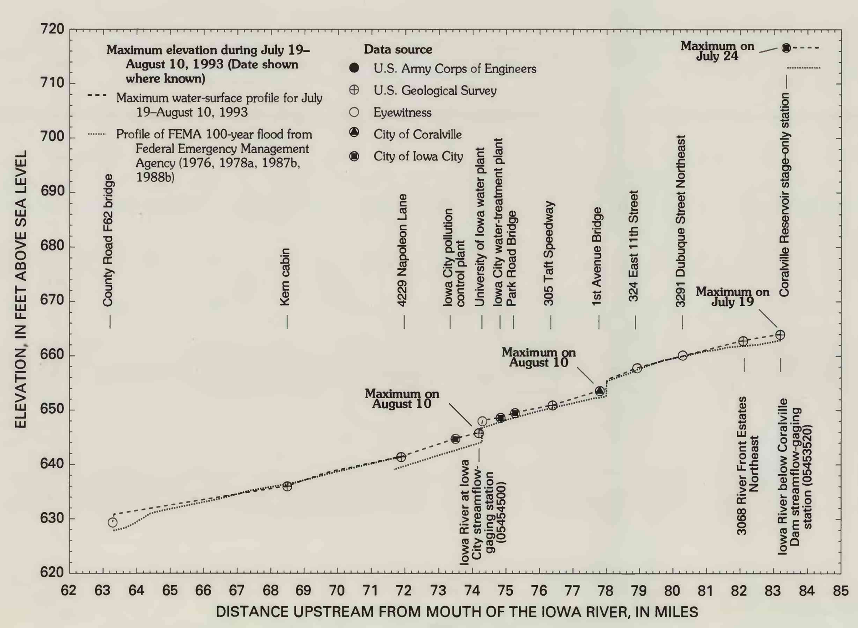

Figure 4. Profile of maximum water-surface elevations along the Iowa River, July 19–August 10, 1993, and profile of FEMA 100-year flood.

INUNDATED AREA

The areas inundated in 1993 are shown in figure 6. Flood extent was determined by combining several sources of information. Aerial photographs taken July 20, 1993, for the COE were used to draw flood-extent boundaries. These boundaries were adjusted where the differences between the July 20 elevations and the 1993 maximum water-surface elevations were significant and in areas where the edge of the floodwaters was obscured by buildings or vegetation. These adjustments were based on comparisons of the 1993 water-surface elevations to the elevations on the 1:24,000 topographic base maps and more detailed elevation maps from the COE, observations during and after the flood, and eyewitness accounts.

In some places, the flood-inundation line is shown to cross back and forth across topographic contour lines of different elevations because the topography has changed since the base maps were published (fig. 6).

FLOOD-RECURRENCE INTERVAL

The recurrence interval is the long-run average number of years between occurrences of annual-maximum flood peaks that exceed a given magnitude. The magnitude may be expressed in terms of peak discharge or peak stage (water-surface elevation). The recurrence interval also is the reciprocal of the annual probability or chance of occurrence of a flood exceeding the given magnitude. For example, a flood magnitude having a recurrence interval of 100 years (the 100-year flood) has a 1-percent chance (0.01 probability) of being exceeded in any given year. Recurrence intervals do not imply regularity of occurrence: the 100-year flood might be exceeded in consecutive years or might not occur at all for over 100 years.

Recurrence intervals for selected maximum elevations and discharges are statistics that can change and should become more reliable as more data are collected and used in the computations. Long-term climatic changes and physical changes in the basin can alter the recurrence interval for a specified discharge. Examples of these basin changes include, but are not limited to, extensive urbanization, implementation of agricultural conservation practices, installation of drainage systems, and construction of reservoirs.

The maximum discharges during the flood of 1993 at the Iowa River below Coralville Dam and the Iowa River at Iowa City streamflow-gaging stations had recurrence intervals greater than 100 years (table 2). A comparison of the flood inundation boundaries to the FEMA 100-year flood boundaries (fig. 6) and of the profile of maximum water-surface elevations to the FEMA 100-year flood profile (fig. 4) also indicates that the 1993 flood was greater than a 100-year flood for the Iowa River in Iowa City and vicinity.

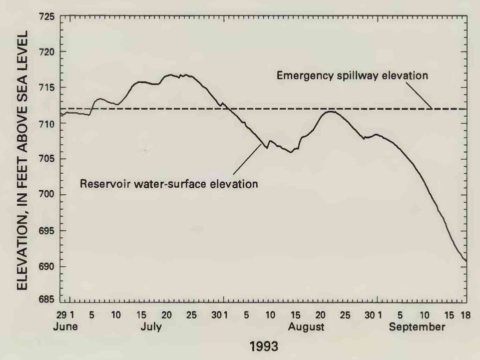

Figure 5. Water-surface elevation for Coralville Reservoir, June 29–September 18, 1993. (Data from U.S. Army Corps of Engineers files.)

FEDERAL EMERGENCY MANAGEMENT AGENCY 100-YEAR FLOOD INFORMATION

The 100-year flood boundary, as determined by FEMA (1978b, 1985a–b, 1987a, 1988a), is presented in figure 6. The 100-year flood boundary outlines those areas expected to be inundated during a 100-year flood. The outlined areas do not include those areas protected by flood-prevention measures, such as dikes, levees, or other structures which may fail or be overtopped during larger floods. The FEMA 100-year flood boundary may be of interest to many people because it is the basis for flood-insurance rates. It also may affect local zoning ordinances and qualification for home and business loans.

The FEMA flood-boundary information is published in map form for individual cities and counties within the study area. The FEMA maps were prepared by different contractors at different times on a variety of base maps and were published at different scales. For this hydrologic atlas, the 100-year flood boundary was created by combining information from the appropriate city and county maps. The FEMA maps may be revised as changes in the area of interest and in the drainage basins occur. These changes can affect the flow of floodwaters and be reflected in future FEMA maps. For official FEMA information, one should examine individual FEMA maps, including any that may have been published since this hydrologic atlas was published.

The FEMA (1976, 1978a, 1987b, 1988b) 100-year flood profile is shown on figure 4. From about river mile 71.67 to 72.04, the boundary between Iowa City and Johnson County is in the middle of the Iowa River. For this stretch of the river, the Iowa City profile (Federal Emergency Management Agency, 1976) is about 2 ft lower than the Johnson County profile (Federal Emergency Management Agency, 1987b) and the FEMA boundary to the west is lower than to the east. The FEMA 100-year flood discharges (1976, 1978a, 1987b, 1988b) are included in table 2.

ADDITIONAL INFORMATION

Additional information pertaining to the 1993 floods in the Midwest can be found in USGS Circular 1120, *Floods in the upper Mississippi River Basin, 1993*. This report is published as individual chapters (1120–A, 1120–B, 1120–C, etc.) which provide data and findings on the magnitude and frequency of maximum discharges, precipitation, water-quality characteristics, effects of reservoir storage on flood maximums, effects of inundation on ground-water quality, flood-discharge volumes, transport of sediment, assessment of sediment deposited on flood plains, stream-channel scour at selected bridges, and documentation of geomorphologic changes.

Information also is available from the U.S. Army Corps of Engineers, Rock Island District, the engineering departments of Coralville, Iowa City, and Johnson County, and the Iowa Department of Transportation.

CONVERSION FACTORS AND VERTICAL DATUM

Multiply inch-pound unit	by	To obtain metric unit
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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_____1987a, Flood insurance rate map for Johnson County, Iowa: Baltimore, Md., community 190882, panels 0080 C and 0130 C, scale 1:12,000.

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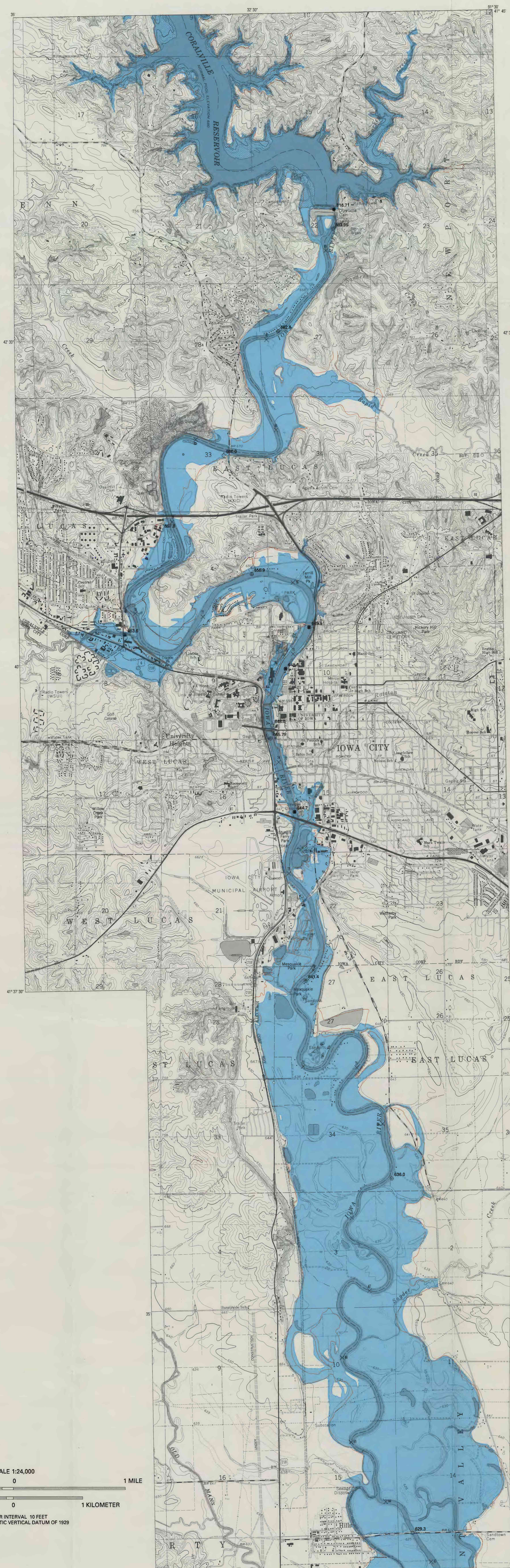


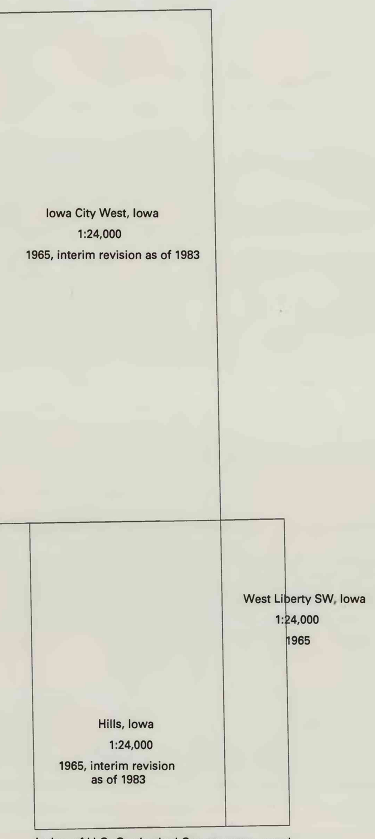
EXPLANATION

- Area inundated by flood of June 29–September 18, 1993
- Boundary of area inundated by flood of June 29–September 18, 1993
- Boundary of Federal Emergency Management Agency (FEMA) 100-year flood
- Boundary of study area

Water-surface elevation measurement sites—Number is maximum water-surface elevation for flood of June 29–September 18, 1993, in feet. Datum is sea level

- 716.71 U.S. Army Corps of Engineers
- 663.95 U.S. Geological Survey
- 660.0 Eyewitness
- 653.6 City of Coralville
- 649.5 City of Iowa City

× 76 **River-mile marker**—Number is number of river miles upstream from mouth of Iowa River



Index of U.S. Geological Survey maps used to produce the flood-inundation base map

Base from U.S. Geological Survey
Iowa City West, Iowa,1:24,000 1965,
interim revision1983; Hills, Iowa,1:24,000 1965,
interim revision as of 1983;
West Liberty SW, Iowa,1:24,000 1965
Boundary of FEMA 100-year flood from
Federal Emergency Management Agency
(1978b, 1985a–b, 1987a, 1988a)

SCALE 1:24,000
1 0 1 MILE
1 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 6. Boundary of area inundated by flood of June 29–September 18, 1993, Federal Emergency Managment Agency (FEMA) 100-year flood boundary, and maximum water-surface elevations at selected sites.

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1996

DELINEATION OF FLOODING WITHIN THE UPPER MISSISSIPPI RIVER BASIN, 1993—FLOOD OF JUNE 29–SEPTEMBER 18, 1993, IN IOWA CITY AND VICINITY, IOWA

By
Bryan D. Schaap and Craig A. Harvey
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