# Flood of March 1997 in Southern Ohio

By K. Scott Jackson and Stephen A. Vivian

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## CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

| Multiply | By | To obtain |
|---|---|---|
| foot (ft) | 0.3048 | meter |
| square mile ($mi^2$) | 2.590 | square kilometer |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second |

Temperature is given in degrees Fahrenheit (F), which can be converted to degrees Celsius (C) by the following equation:

$$C = (F - 32)/1.8$$

**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 both the United States and Canada, formerly called Sea Level Datum of 1929.

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*By* K. Scott Jackson and Stephen A. Vivian

## ABSTRACT

Rainfall amounts of up to 12 inches produced by thunderstorms during March 1–2, 1997, resulted in severe flooding throughout much of southern Ohio. Eighteen counties were declared Federal and State disaster areas. Cost estimates of damage in Ohio from the flooding are nearly $180 million. About 6,500 residences and more than 800 businesses were affected by flooding. Nearly 20,000 persons were evacuated, and 5 deaths were attributed to the flooding.

Record peak stage and streamflow were recorded at U.S. Geological Survey (USGS) streamflow-gaging stations on Ohio Brush Creek near West Union and Shade River near Chester. The peak streamflow at these two locations exceeded the estimate of the 100-year-recurrence-interval peak streamflow.

The recurrence intervals of peak streamflow at selected USGS streamflow-gaging stations throughout southern Ohio ranged from less than 2 years to greater than 100 years. The most severe flooding in the State was generally confined to areas within 50 to 70 miles of the Ohio River. Many communities along the Ohio River experienced the worst flooding in more than 30 years.

## INTRODUCTION

Thunderstorms and heavy rains during March 1–2, 1997, in southern Ohio resulted in flooding that caused widespread damage to public and private property. Preliminary cost estimates of the damage for Ohio communities as result of the March 1997 flooding total nearly $180 million (Ohio Governor's Office of Budget and Management, oral commun., 1997).

Record peak stage and peak streamflow were recorded at two USGS streamflow-gaging stations, one on Ohio Brush Creek and the other on Shade River. The peak streamflow at each gaging station exceeded estimates of the 100-year-recurrence-interval peak streamflow. The storms produced heavy rainfall in a band along the Ohio River stretching from western Kentucky to West Virginia, causing floods on many tributaries to the Ohio River. As these and other tributaries drained into the Ohio River, communities along the Ohio River experienced some of the most severe flooding in more than 30 years.

Some of the flooding resulted in tragic consequences in Ohio. The Ohio State Highway Patrol attributed five deaths to the flooding: two in Adams County, and one each in Brown, Pike, and Gallia Counties (fig. 1). These individuals were swept into floodwaters while attempting to drive through flooded roadways (Baird and Dempsey, 1997). Areas of southern Adams and Brown Counties received 10 – 12 inches of rain, which were the largest recorded accumulations during the March 1–2 storms in Ohio. Areas of Athens and Vinton Counties received about 6 inches of rainfall during the storm. Four inches or more of rain fell over most of the counties located along or near the southern border of Ohio. Eighteen counties were declared Federal and State disaster areas, which qualified them for Federal and State disaster assistance: Adams, Athens, Brown, Clermont, Gallia, Hamilton, Highland, Hocking, Jackson, Lawrence, Meigs, Monroe, Morgan, Pike, Ross, Scioto, Vinton, and Washington (fig. 1).

Although the March 1997 flood and the accompanying damages were covered by the news media and by bulletins and real-time data provided by the U.S. Geological Survey (USGS) Internet sites, there was a

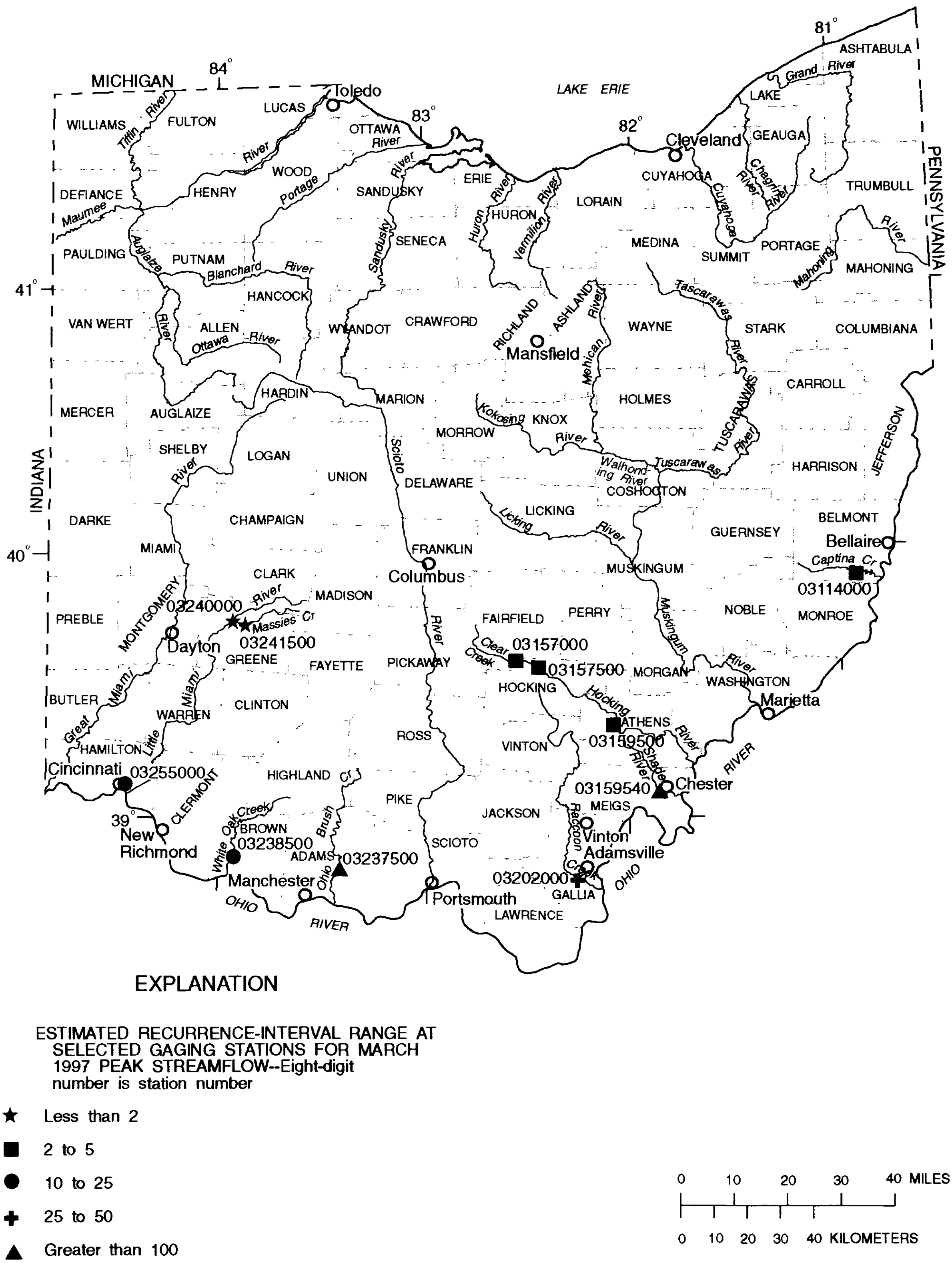



**Figure 1.** Selected streamflow-gaging stations and corresponding recurrence-interval ranges for the March 1997 flood.

need to document the southern Ohio flood and subsequent hydrologic analyses in one publication. Hence, the USGS, in close collaboration with the Ohio Department of Natural Resources (ODNR), began to work in March 1997 to synthesize information on the flood into a single publication.

## Purpose and Scope

This report describes the flooding in southern Ohio in early March 1997. The meteorologic factors related to the storm are presented. A general description of the flooding, including specific hydrologic information based on data from USGS streamflow gages in the area, is provided. Flood-damage estimates are documented, and a historical perspective of flooding in the area is included.

## Acknowledgments

The authors thank F. Julia Dian of the National Weather Service, Wilmington, Ohio, for her cooperation in providing meteorologic data about the storms and for writing the section of the report "Storms of March 1–2, 1997." The authors also thank Cynthia J. Crecelius of the ODNR, Division of Water, Columbus, Ohio, for compiling flood-damage estimates for the March 1997 floods and writing the section of the report on "Flood Damages." Also appreciated are the efforts of David H. Cashell for coordinating the ODNR contributions to this report.

# METEOROLOGY ASSOCIATED WITH THE FLOOD

The storms of March 1–2, 1997, that affected southern Ohio occurred after a period when precipitation in the area had ranged from 12 to 33 percent below normal[1] during the months of January and February (Cashell, 1997a, b). The floods from the March 1–2 storm may have been even more severe had antecedent precipitation in southern Ohio been closer to normal (if conditions had been wetter).

## Antecedent Conditions

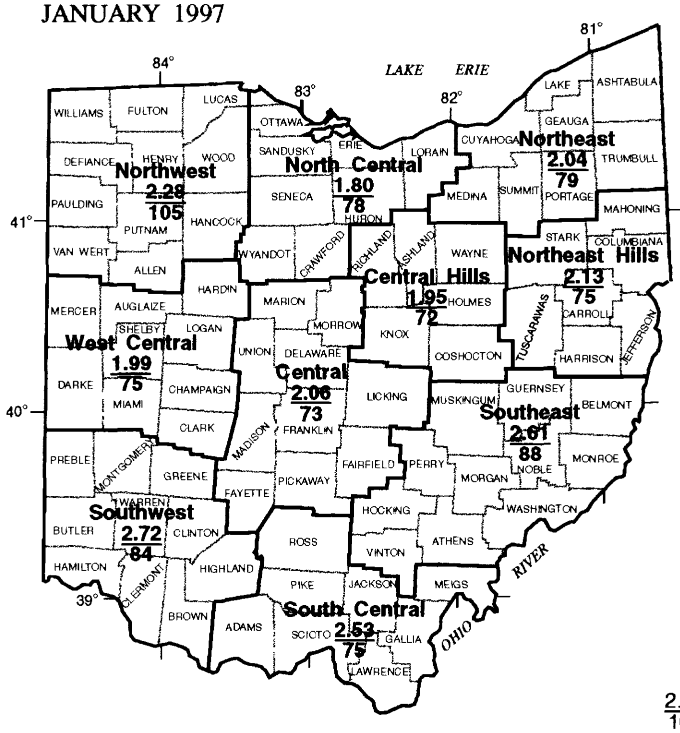
**January 1997**. Precipitation in southern Ohio during January was generally below normal. The National Weather Service (NWS) Divisions[2] along Ohio's southern boundary, the Southwest, South Central, and Southeast, received 84, 75, and 88 percent of the normal precipitation for the month, respectively (fig. 2) (Cashell, 1997a). Temperatures were high enough during January that precipitation was typically in the form of rain. In southern Ohio, the first 3 weeks of January were relatively dry, with only intermittent trace amounts of precipitation. The latter part of the month was much wetter and most areas in southern Ohio received about 1–2 inches of precipitation during this period. During the month, parts of the Southwest and South Central Divisions received about 3 inches of precipitation. The Shawnee State Forest in Scioto County received the most precipitation (4.67 inches) of any location in Ohio during January.

**February 1997**. Precipitation in southern Ohio during February was below normal, with rain being the dominant form. The NWS Southwest, South Central, and Southeast Divisions received 78, 67, and 67 percent of normal precipitation, respectively (fig. 2), (Cashell, 1997b). The greatest accumulations of precipitation in southern Ohio during the month was on February 4–5; typical total accumulations were 0.5 to 1 inch in most areas and some locations received nearly 1.5 inches. The following 3 weeks of February were generally dry, although light precipitation fell on many days. On February 27, areas of southern Ohio received rainfall totaling about 0.25 inch. Light snow cover of 1–2 inches was reported in some areas of southern Ohio during the middle of the month. However, daily high temperatures for the latter half of February in these areas generally were well above freezing (40° to 60° Fahrenheit) and most snow cover had melted.

[1]Normal refers to the average value for the period 1931—80 in National Oceanic and Atmospheric Administration (1981).

[2]A NWS Division is defined as an area within Ohio that has similar climatological characteristics. The NWS calculates Division averages using data from stations that record both temperature and precipitation.

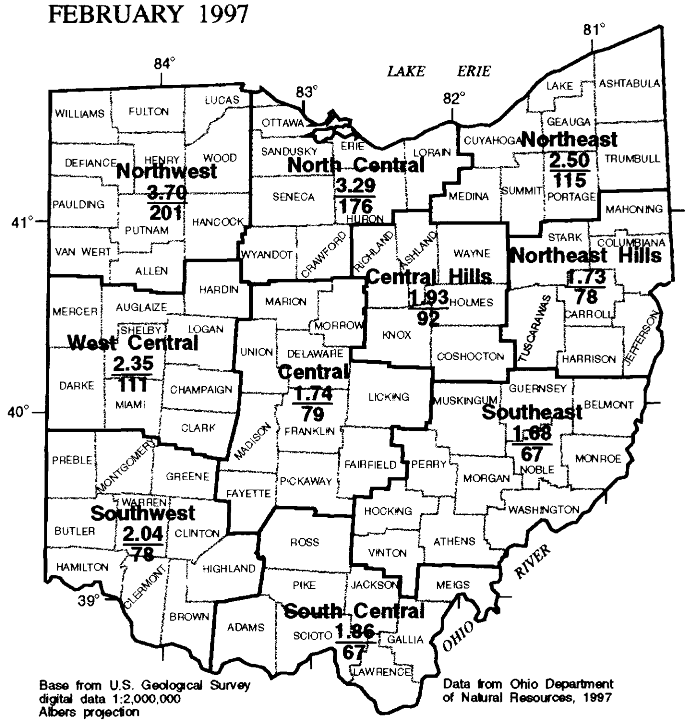
JANUARY 1997




EXPLANATION

2.28 AVERAGE IN INCHES
105 PERCENT OF NORMAL

FEBRUARY 1997




0 10 20 30 40 MILES
0 10 20 30 40 KILOMETERS

**Figure 2.** Regionally averaged monthly total precipitation and percent of normal precipitation by National Weather Service Division, January and February 1997 (from Cashell, 1997a,b).

## Storms of March 1–2, 1997

*By* F. Julia Dian[3]

During the evening of February 28, 1997, a low-pressure center was established over the Upper Midwest region of the United States, with a stationary front extending southeast from the low to the Tennessee- Kentucky border. A cold front extended south from the low into Texas. The stationary front remained near this position until just after midnight on March 1, when it began to move north towards the Ohio River.

The former stationary front moved north as a warm front and slowed (nearly stalling) over central Ohio by the afternoon of March 1. Although the warm front moved out of the southern Ohio/northern Kentucky area, several boundaries of unstable air remained over northern Kentucky. As typically happens with a surface low-pressure and frontal system with these characteristics, warm, moisture-laden southerly air was pumped into the "warm sector" (the region ahead of the cold front and south of the warm front) from the Gulf of Mexico. This warm and moist air interacted with the boundaries of unstable air and triggered thunderstorms.

What caused these storms to produce such heavy rains was that the frontal system slowed dramatically and strong, persistent southerly winds continued to pump warm air into northern Kentucky and southern Ohio, sustaining the thunderstorms. The extremely slow movement of the cold front kept the thunderstorms over the Ohio Valley for nearly 36 hours. If the cold front had moved faster, it would have pushed the thunderstorms more quickly to the east, and rainfall amounts would have been much less.

What resulted on March 1–2, 1997, was a broad area of thunderstorms that produced as much as nearly 12 inches of rain in some areas of southern Ohio. The 48-hour total rainfall for this storm is shown in figure 3. The storm produced rainfall over the southern half of the State, the heaviest rain being concentrated to the south and east of a line generally extending from Cincinnati to Bellaire, Ohio.

# GENERAL DESCRIPTION OF THE FLOOD

The water levels in many streams in southern Ohio rose rapidly in response to the heavy rainfall. At the USGS streamflow-gaging station on Ohio Brush Creek near West Union (03237500)[4] in Adams County, the water level rose nearly 19 feet in 12 hours. The water level in the Ohio River was also observed to rise rapidly as a result of the storms; such a rise is generally uncommon in a large river. The USGS gaging station on the Ohio River at Portsmouth, Kentucky (03217200, across the river from Portsmouth, Ohio), recorded a water-level increase of about 14.3 feet during a 12-hour period. The gaging station on the Ohio River at Cincinnati (03255000) recorded a water-level rise of about 10.6 feet in a 12-hour period.

A factor contributing to the rapid rise of the Ohio River is that the heaviest rainfall during the March 1–2, 1997, storms was concentrated in a relatively narrow band along the Ohio River. Thus, a large amount the runoff produced by the storms was downstream from most of the U.S. Army Corps of Engineers flood-control reservoirs on major tributaries to the Ohio River.

## Areal Distribution of the Flood

Severe flooding within Ohio was generally confined to stream reaches within 50 to 70 miles of the Ohio River. The most severe flooding in Ohio was in Adams, Brown, Gallia, Meigs, Lawrence, and Scioto Counties. Less severe flooding occurred in counties farther north, away from the Ohio River. Floodwaters draining from southern Ohio watersheds and from basins in Kentucky and West Virginia also produced flooding along the Ohio River. Ohio communities that border the Ohio River from Marietta downstream to Cincinnati were affected by floodwaters. Two communities along the Ohio River that were particularly hard hit by the flooding were Manchester and New Richmond, Ohio (figs. 4 and 5).

Communities along the Ohio River in Kentucky, Indiana, and Illinois also experienced flooding as a result of the March 1997 storms. In Kentucky, the worst flooding was generally located within a 40- to 50-mile-wide band running approximately parallel to and south of the Ohio River (Kevin J. Ruhl, U.S. Geological Survey, written commun., April 1997). The city of Falmouth, Ky., at the confluence of the South Fork and main stem of the Licking River, was devastated by floodwaters; hundreds were left homeless and four deaths were attributed to the flooding (Kevin J. Ruhl, U.S. Geological Survey, written commun., April 1997).

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[3]National Weather Service, Wilmington, Ohio

[4] USGS streamflow-gaging stations are assigned station numbers on the basis of a downstream-order system in which the order of listing is in a downstream direction along the main stream.

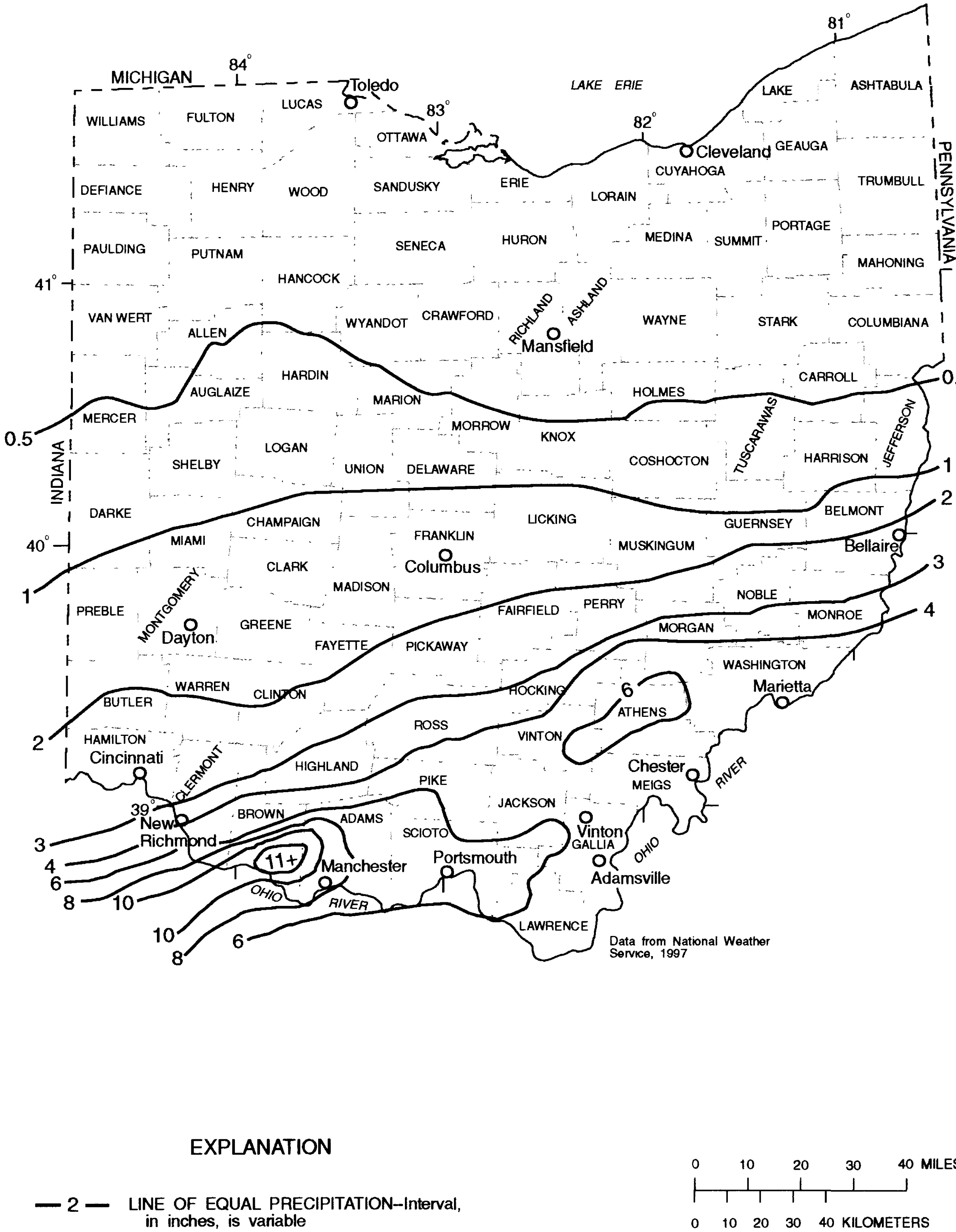


**Figure 3.** Isolines of total accumulated precipitation for the 48-hour period of March 1-2, 1997.

Columbus Dispatch/Eric Albrecht
(reproduction with permission)

**Figure 4.** Ohio River floodwaters in Manchester, Ohio, March 7, 1997.

Jamie Sabau
(reproduced with permission)

**Figure 5.** Ohio River floodwaters in New Richmond, Ohio, March 4, 1997.

## Flood Stages, Streamflows, Recurrence Intervals, and High-Water Marks

Peak-stage and peak-streamflow data from the March 1997 flooding are listed in table 1 for selected USGS streamflow-gaging stations in southern Ohio. Also listed for each gaging station are the record peak stage and peak streamflow prior to the March 1997 flooding, and the estimate of the 100-year-recurrence-interval peak streamflow. The 100-year peak streamflow is the instantaneous peak streamflow with a 1 percent chance of being equaled or exceeded in any given year. Estimates of the 100-year peak streamflow in table 1 (unless otherwise noted) were obtained from the most recently published USGS report for estimating flood-peak streamflows (Koltun and Roberts, 1990), which is based on data collected through water year[5] 1987.

Ranges of recurrence intervals that bracket the estimated recurrence interval associated with the peak streamflow are included in table 1 to provide an indication of the relative magnitude of the March 1997 flooding at each of the gaging stations. The location and corresponding recurrence-interval range for the streamflow-gaging stations listed in table 1 are shown on figure 1.

Peak streamflows for the March 1997 flood at the streamflow-gaging stations were determined by use of standard USGS techniques (Rantz and others, 1982). USGS personnel were able to obtain direct measurements of the streamflow at most of the gaging stations in southern Ohio during the March 1997 flood. At one gaging station, an indirect determination of the peak streamflow was made by use of the slope-area method (Benson and Dalrymple, 1967; Dalrymple and Benson, 1967).

Record peak stage and peak streamflow occurred during the March 1997 floods at two streamflow-gaging stations:

**Ohio Brush Creek near West Union** (03237500, Adams County) — The peak streamflow and corresponding stage at the USGS gaging station on Ohio Brush Creek near West Union, Ohio, were the highest recorded since the gaging station was established (in water year 1927). The March 1997 peak streamflow of 77,700 $ft^3/s$ was greater than the estimated 100-year peak-streamflow value and, therefore, is considered to have been greater than a 100-year flood.

On Sunday morning, March 2, 1997, the water level was high enough that highway officials closed the State Route 125 bridge over Ohio Brush Creek (about 6 miles east of West Union) because of concerns about the structural integrity of the bridge (fig. 6). By the afternoon, the water level had dropped, and officials reopened the highway. USGS field personnel were able to obtain a direct measurement of the streamflow from the State Route 125 bridge (fig. 7).

**Shade River near Chester** (03159540, Meigs County) — The peak stage and peak streamflow for the March 1997 flood were the highest recorded since the gaging station was established (in water year 1966). The March 1997 peak streamflow of 15,600 $ft^3/s$ exceeded the estimated 100-year peak-streamflow value and, therefore, is considered to have been greater than the 100-year flood.

During the March 1997 flood on the Shade River, all roads leading to the gaging station were inundated, and no direct measurement of streamflow could be made. Therefore, the slope-area indirect method of peak-streamflow determination (Benson and Dalrymple, 1967; Dalrymple and Benson, 1967) was used to determine the peak streamflow at this gaging station. The indirect measurement site was approximately 4,100 feet upstream from the gaging station.

Major flooding occurred at other streams in southern Ohio. Selected locations are discussed in the following paragraphs:

**Raccoon Creek at Adamsville** (03202000, Gallia County) — The March 1997 peak streamflow of 16,500 $ft^3/s$ on Raccoon Creek at the USGS streamflow-gaging station was the largest streamflow since May 1968. The recurrence interval corresponding to the March 1997 peak streamflow is estimated to be greater than 25 years but less than 50 years. Historic log cabins at the recreated 1800's village along the bank of Raccoon Creek at The Bob Evans Farms property in Adamsville were damaged by the floodwaters (figs. 8 and 9).

**White Oak Creek near Georgetown** (03238500, Brown County) — The March 1997 streamflow of 17,900 $ft^3/s$ at the USGS streamflow-gaging station White Oak Creek near Georgetown (fig. 10) was the largest streamflow since July 1980 (19,500 $ft^3/s$). The March 1997 flood was the second largest streamflow

[5] A water year is the 12-month period from October 1 through September 30 and is designated by the calendar year in which it ends.

AP/WIDE WORLD PHOTOS (reproduced with permission)

**Figure 6.** Floodwater of Ohio Brush Creek (Adams County, Ohio) splashing onto the State Route 125 bridge during the morning of March 2, 1997, looking downstream to the south.

**Figure 7.** U.S. Geological field crew making a streamflow measurement on the State Route 125 bridge over Ohio Brush Creek (Adams County, Ohio) during the afternoon of March 2, 1997, looking to the southeast.

**Table 1.** Peak stages and peak streamflows at selected U.S. Gelogical Survey streamflow-gaging stations in southern Ohio, March 1997.

[Abbreviations: $mi^2$. square miles; $ft^3/s$, cubic feet per second; --, not available; <, less than; >, greater than. Source: Recurrence-interval data from Koltun and Roberts (1990) unless otherwise noted]

| Station name and number | Drainage area ($mi^2$) | Period of historical and systematic record (water years)[1] | Peak values for period of record prior to March 1997 | | | Peak values for March 1997 | | Estimated 100-year peak streamflow ($ft^3/s$) | Estimated recurrence-interval range for March 1997 peak streamflow (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Date | Stage (feet above gage datum) | Streamflow ($ft^3/s$) | Stage (feet above gage datum) | Streamflow ($ft^3/s$) | | |
| Captina Creek at Armstrong Mills (03114000) | 134 | 1927 - 35<br>1959 - current | 08/11/80 | 17.48 | 21,900 | 10.51 | 7,160 | 20,000 | 2 - 5 |
| Clear Creek near Rockbridge (03157000) | 89.0 | 1940 - current | 07/22/48 | 17.68 | 16,000 | 10.22 | 3,590 | 10,700 | 2 - 5 |
| Hocking River at Enterprise (03157500) | 459 | 1907<br>1932 - current | 03/--/07 | 22.00 | 36,000 | 15.14 | 9,060 | 31,800 | 2 - 5 |
| Hocking River at Athens (03159500) | 943 | 1907<br>1916 - current | 03/--/07 | 27.00 | 50,000 | 22.46 | 17,400 | 42,000 | 2 - 5 |
| Shade River near Chester (03159540) | 156 | 1966 - current | 05/25/68 | 27.39 | 8,170 | 31.38 | 15,600 | 8,830 | >100 |
| Raccoon Creek at Adamsville (03202000) | 595 | 1916 - 35[2]<br>1937[2]<br>1939 - 85[2]<br>1939 - current | 05/28/68[2] | 28.69[2] | 20,000[2] | 29.11 | 16,500 | 19,600 | 25 - 50 |
| Ohio Brush Creek near West Union (03237500) | 387 | 1927 - 35<br>1941 - current | 03/10/64 | 27.91 | 59,200 | 31.15 | 77,700 | 55,500 | >100 |
| White Oak Creek near Georgetown (03238500) | 218 | 1924 - 35<br>1940 - current | 03/10/64 | 14.64 | 22,400 | 9.32 | 17,900 | 24,500 | 10 - 25 |
| Little Miami River near Oldtown (03240000) | 129 | 1953 - current | 01/21/59 | 12.20 | 14,800 | 5.25 | 1,220 | 16,000 | < 2 |

**Table 1.** Peak stages and peak streamflows at selected U.S. Geological Survey streamflow-gaging stations in southern Ohio, March 1997—Continued

[Abbreviations; $mi^2$, square miles; $ft^3/s$, cubic feet per second: –, not available; <, less than; >, greater than. Source: Recurrence-interval data from Koltun and Roberts (1990) unless otherwise noted]

| Station name and number | Drainage area ($mi^2$) | Period of historical and systematic record (water years)[1] | Peak values for period of record prior to March 1997 | | | Peak values for March 1997 | | Estimated 100-year peak streamflow ($ft^3/s$) | Estimated recurrence-interval range for March 1997 peak streamflow (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Date | Stage (feet above gage datum) | Streamflow ($ft^3/s$) | Stage (feet above gage datum) | Streamflow ($ft^3/s$) | | |
| Massies Creek at Wilberforce (03241500) | 63.2 | 1953 - current | 01/21/59<br>03/04/63 | 11.25<br>11.25 | 7,300<br>7,300 | 5.41 | 584 | 8,610 | < 2 |
| Ohio River at Cincinnati (03255000) | 76,580 | 1773<br>1792 - 1793<br>1832<br>1847<br>1858-1975 | 01 26/37 | 80.0 | 894,000 | 64.48 | 625,000 | 767,000[3] | 10 - 25 |

[1]A water year is the 12-month period from October 1 through September 30 and is designated by the calendar year in which it ends.

[2] Prior to July 8, 1984, streamflow-gaging station located 1.7 miles upstream with a drainage area of 585 $mi^2$.

[3] From Hannum (1976).

**Figure 8.** Floodwaters of Raccoon Creek, prior to the peak streamflow, surrounding historic log cabins at The Bob Evans Farm in Adamsville, Ohio, March 2, 1997, looking to the northeast, flow direction from the left to right.

**Figure 9.** The Wickline and Post Office log cabins being swept off their foundations by Racoon Creek floodwaters at The Bob Evans Farm in Adamsville, Ohio, March 4, 1997, looking downstream to the southwest.

**Figure 10.** White Oak Creek floodwaters piling up on the piers at the State Route 221 bridge near Georgetown, Ohio, March 2, 1997, looking to the northeast.

recorded at this location since the peak streamflow of 22,400 $ft^3/s$ in March 1964. The recurrence interval for the March 1997 peak streamflow is estimated to be greater than 10 years but less than 25 years.

**Ohio River at Cincinnati** (03255000, Hamilton County) — The March 1997 peak streamflow of 625,000 $ft^3/s$ was the largest streamflow at the Ohio River at Cincinnati USGS streamflow-gaging station since March 1964. The recurrence interval corresponding to the March 1997 peak streamflow is estimated to be greater than 10 years but less than 25 years. Many low-lying areas along the Ohio River in the Cincinnati area – the most densely populated part of southern Ohio – were inundated during the March 1997 flood (fig. 11).

Shortly after the floodwaters receded in southern Ohio, personnel from the Ohio Department of Natural Resources, Division of Water obtained high-water marks for selected streams. The high-water marks were initially identified and flagged in the field, and third-order-accuracy surveys were made at a later date to determine elevations of the high-water marks. These data (table 2) were collected to document water-surface elevations along various streams.

## Flood Damages

*By* Cynthia J. Crecelius[6]

The human impact of the March 1997 flooding in southern Ohio was appreciable. Nearly 20,000 people were evacuated during the flooding, and 5 people lost their lives. The fatalities were in Adams, Brown, Pike, and Gallia Counties. The Ohio Emergency Management Agency (OEMA) reported that 93 roads were closed as a result of the flooding on March 2, 1997. OEMA estimated that on March 5, 1997, 1200 residents of southern Ohio were without natural gas, 2032 were without electricity, and 1785 were without telephone service. OEMA also reported that 37 boil-water advisories were in effect for various southern Ohio communities, owing to potential contamination of water supplies by floodwaters on March 6, 1997.

Preliminary estimates prepared by the Ohio Governor's Office of Budget and Management indicate that the economic impact of the March 1997 flood

[6] Ohio Department of Natural Resources, Columbus, Ohio.

The Cincinnati Enquirer/ Ernest Coleman
(reproduced with permission)

**Figure 11.** Flooding of the Ohio River at Cincinnati, Ohio, March 5, 1997, looking upstream to the east.

on Ohio communities may approach $180 million. The following breakdown of the estimates (based upon information from the Ohio Emergency Management Agency, May 1997) supports this determination: Individual Assistance, $12 million, Public Assistance, $45 million; Small Business Administration Loans (Businesses, Homes, Churches), $98 million; Agriculture, $8 million; Mitigation, $12 million; and State-agency expenditures, $5 million.

### Effect of Floods on Public Infrastructure

The March 1997 flood resulted in about $42 million damage to public infrastructure (such as roads, bridges, water-control facilities, public buildings, public utilities, and parks and recreation facilities) in southern Ohio. Infrastructure damage by county and State agency is summarized in table 3. Additionally, several publicly owned and maintained dams were damaged as a result of the flooding in the area (table 4).

### Effect of Floods on Private Property

Many residences and businesses in southern Ohio also were affected during the March 1997 floods. The effects of the March 1997 flooding on residential structures are summarized in table 5; in all, more than 6,500 residences were damaged. The Small Business Administration's preliminary estimates indicate that about 833 business/commercial structures incurred damage during the floods in southern Ohio (Ohio Emergency Management Agency, written commun., May 1997). In addition, many privately owned dams were damaged (table 6).

## Historical Perspective

Floods on the Ohio River and its tributaries within Ohio are not uncommon. Most of the major flooding in the past on the Shade River, Raccoon Creek, and Ohio Brush Creek has been part of widespread flooding and has generally coincided with floods on the Ohio River. Damage that resulted from the March 1997 flood was mainly in towns along the Ohio River and, to a lesser extent, to dwellings that were in the flood plain of the smaller tributaries. Although hydrologically significant, past floods of the Shade River, Raccoon Creek, and Ohio Brush Creek have not produced as much damage as compared to

**Table 2.** Elevation of high-water marks at selected locations in southern Ohio for the March 1997 flooding

[Data collected and compiled by the Ohio Department of Natural Resources. Division of Water]

| Community | County | Stream | Latitude | Longitude | Elevation (in feet above sea level) | Description and location of high-water mark |
|---|---|---|---|---|---|---|
| Village of Rarden | Scioto | Scioto Brush Creek | 38° 55′ 22″ | 83° 14′ 44″ | 615.9 | Mud line on front door of Rarden Volunteer Fire Department building |
| Village of Rarden | Scioto | Scioto Brush Creek | 38° 55′ 02″ | 83° 14′ 45″ | 612.9 | Debris line near Hazelbaker Hill Road Bridge |
| Village of Otway | Scioto | Scioto Brush Creek | 38° 51′ 46″ | 83° 11′ 25″ | 592.8 | Mud line on covered bridge over Scioto Brush Creek |
| Village of Lawshe | Adams | West Fork Ohio Brush Creek | 38° 56′ 22″ | 83° 28′ 28″ | 617.8 | Debris on bridge over West Fork at Lawshe |
| Village of Blue Creek | Adams | Mill Creek | 38° 46′ 36″ | 83° 20′ 10″ | 653.7 | Mud line on Knauff's Grocery and Restaurant, State Route 125 |
| Village of Blue Creek | Adams | Churn Creek | 38° 46′ 37″ | 83° 20′ 07″ | 653.6 | Mud line on barn adjacent to Churn Creek at State Route 125 |
| Village of Blue Creek | Adams | South Fork Scioto Brush Creek | 38° 46′ 44″ | 83° 19′ 31″ | 645.5 | Mud line on side of former Pentecostal Church |
| Village of Blue Creek | Adams | South Fork Scioto Brush Creek | 38° 47′ 15″ | 83° 19′ 09″ | 645.4 | Mud line on large metal machinery building |
| Village of Wamsley | Adams | South Fork Scioto Brush Creek | 38° 49′ 37″ | 83° 17′ 03″ | 614.9 | Debris on electric pole along South Fork Scioto Brush Creek, State Route 348 |
| Village of Burlingham | Meigs | West Branch Shade River | 39° 09′ 59″ | 82° 01′ 18″ | 667.1 | Mud line on general store along river, U.S. Route 33 |
| Village of Chester | Meigs | Shade River | 39° 06′ 00″ | 81° 55′ 16″ | 621.7 | Mud line on sycamore tree at side of County Road 36 |
| Village of Chester | Meigs | Shade River | 39° 05′ 12″ | 81° 55′ 31″ | 621.2 | Mud line on Ashland Oil service station building |

**Table 2.** Elevation of high-water marks at selected locations in southern Ohio for the March 1997 flooding—Continued

[Data collected and compiled by the Ohio Department of Natural Resources. Division of Water]

| Community | County | Stream | Latitude | Longitude | Elevation (in feet above sea level) | Description and location of high-water mark |
|---|---|---|---|---|---|---|
| Village of Langsville | Meigs | Leading Creek | 39° 02′ 44″ | 82° 11′ 10″ | 549.2 | Mud line in the By-the-Way Store at west end of village |
| Village of Langsville | Meigs | Leading Creek | 39° 02′ 50″ | 82° 10′ 53″ | 546.3 | Mud line on welcome sign at east end of village |
| Village of Rutland | Meigs | Little Leading Creek | 39° 02′ 20″ | 82° 07′ 47″ | 577.1 | Mud line on Joe's Country Market |
| Village of Rutland | Meigs | Little Leading Creek | 39° 02′ 08″ | 82° 07′ 44″ | 576.2 | Mud line on side of house along Rutland Road |
| Village of Rutland | Meigs | Little Leading Creek | 39° 02′ 26″ | 82° 07′ 50″ | 577.2 | Mud line on office door of Uniroyal business along Main Street |
| Village of Rutland | Meigs | Little Leading Creek | 39° 02′ 43″ | 82° 07′ 49″ | 581.1 | Mud line on storefront at intersection of Main Street and Salem Street |
| Village of Vinton | Gallia | Raccoon Creek | 38° 58′ 44″ | 82° 20′ 18″ | 612.2 | Mud line on side panel of picnic shelter in park |
| Village of Vinton | Gallia | Raccoon Creek | 38° 58′ 34″ | 82° 20′ 19″ | 612.0 | Mud line on front door of Colony Video store along State Route 160 |
| Village of Vinton | Gallia | Raccoon Creek | 38° 58′ 31″ | 82° 20′ 27″ | 611.5 | Mud line on side of former church at corner of Clay & Cherry Streets |
| Village of Vinton | Gallia | Raccoon Creek | 38° 58′ 35″ | 82° 20′ 28″ | 612.2 | Postmaster's high-water observation at base of flagpole |
| Village of Vinton | Gallia | Raccoon Creek | 38° 58′ 34″ | 82° 20′ 35″ | 611.5 | Mud line on side of house along Jackson Street |

**Table 3.** Infrastructure-damage estimates related to the March 1997 flooding in southern Ohio

[All figures in dollars; Damage estimates provided by the Ohio Emergency Management Agency, Department of Public Safety. Abbreviations: ODOT, Ohio Department of Transportation; ODNR, Ohio Department of Natural Resources; ONG, Ohio National Guard]

| County or State of Ohio Agency | Debris removal | Emergency protectitve measures | Roads and bridges | Water-control facilities | Public buildings, facilities, equipment | Public utilities | Parks and recreation | Total dollars |
|---|---|---|---|---|---|---|---|---|
| Adams | 1,000,000 | 0 | 10,000,000 | 0 | 0 | 1,000,000 | 0 | 12,000,000 |
| Athens | 50,000 | 0 | 500,000 | 0 | 0 | 0 | 0 | 550,000 |
| Brown | 134,000 | 124,000 | 2,095,000 | 0 | 57,000 | 487,000 | 75,000 | 2,972,000 |
| Clermont | 205,000 | 45,000 | 1,630,000 | 0 | 60,000 | 375,000 | 0 | 2,315,000 |
| Gallia | 50,000 | 40,000 | 1,050,000 | 0 | 0 | 10,000 | 15,000 | 1,165,000 |
| Hamilton | 274,000 | 85,000 | 1,900,000 | 0 | 230,000 | 80,000 | 73,000 | 2,642,000 |
| Highland | 41,500 | 5,000 | 55,000 | 0 | 2,000 | 4,000 | 8,500 | 116,000 |
| Hocking | 42,000 | 0 | 568,000 | 2,000 | 0 | 1,200 | 0 | 613,200 |
| Jackson | 40,000 | 20,000 | 400,000 | 0 | 360,000 | 900,000 | 780,000 | 2,500,000 |
| Lawrence | 43,000 | 72,000 | 2,300,000 | 5,000 | 38,000 | 0 | 0 | 2,458,000 |
| Meigs | 10,000 | 16,000 | 2,300,000 | 0 | 30,000 | 100,000 | 0 | 2,456,000 |
| Monroe | 36,000 | 0 | 1,200,000 | 31,000 | 20,000 | 50,000 | 0 | 1,337,000 |
| Morgan | 11,200 | 0 | 55,400 | 0 | 0 | 0 | 0 | 66,600 |
| Pike | 77,700 | 70,000 | 418,200 | 0 | 2,500 | 18,000 | 0 | 586,400 |
| Ross | 32,300 | 30,400 | 128,000 | 0 | 0 | 15,000 | 0 | 205,700 |
| Scioto | 450,000 | 57,000 | 1,832,000 | 0 | 0 | 476,000 | 25,000 | 2,840,000 |
| Vinton | 40,000 | 8,000 | 960,000 | 0 | 20,000 | 0 | 15,000 | 1,043,000 |
| Washington | 0 | 0 | 797,000 | 0 | 6,000 | 85,000 | 1,000 | 889,000 |
| ODOT | 1,050,000 | 0 | 165,000 | 0 | 0 | 0 | 0 | 1,215,000 |
| ODNR | 0 | 0 | 350,000 | 10,000 | 35,000 | 3,000 | 965,000 | 1,363,000 |
| ONG | 0 | 3,000,000 | 0 | 0 | 0 | 0 | 0 | 3,000,000 |
| Total dollars | 3,586,000 | 3,572,400 | 28,703,600 | 48,000 | 860,500 | 3,604,200 | 1,957,500 | 42,332,900 |

**Table 4.** Damages and (or) extreme flow conditions at publicly owned dams during the March 1997 flooding in southern Ohio
[Data complied by the Ohio Department of Natural Resources, Division of Water]

| Name | County | Latitude | Longitude | Comments |
|---|---|---|---|---|
| Lake White Dam | Pike | 39° 06′ 24″ | 83° 00′ 30″ | Overtopped[1]; downstream slope erosion[2] |
| Pike Lake Dam | Pike | 39° 09′ 34″ | 83° 13′ 08″ | Overtopped; downstream slope erosion |
| Stewart Lake Dam | Ross | 39° 13′ 03″ | 82° 57′ 40″ | Flow through the emergency spillway |
| Roosevelt Lake Dam | Scioto | 38° 43′ 33″ | 83° 10′ 24″ | Overtopped; downstream slope erosion |
| Turkey Creek Lake Dam | Scioto | 38° 44′ 00″ | 83° 11′ 22″ | Flow through the emergency spillway |
| Bear Creek Lake Dam | Scioto | 38° 46′ 52″ | 83° 10′ 35″ | Erosion at the spillway outlet |
| Pond Lick Lake Dam | Scioto | 38° 41′ 51″ | 83° 10′ 10″ | Erosion at the spillway outlet |
| Lake Alma Dam | Vinton | 39° 08′ 40″ | 82° 31′ 05″ | Overtopped; downstream slope erosion |

[1]Overtopped: Flow over the top of the dam embankment crest.
[2]Downstream slope erosion: Removal of soil from the downstream dam embankment.

the Ohio River floods probably because of the sparseness of development.

**Ohio Brush Creek near West Union** – The March 1997 peak stage of 31.15 feet at the gaging station on Ohio Brush Creek near West Union, in Adams County, surpassed the previous peak stage (27.91 feet) that occurred on March 10, 1964, by more than 3 feet. A major flood also occurred on the Ohio River in 1964, and Adams County residents along the Ohio River were forced to evacuate. According to the March 12, 1964, issue of "The People's Defender," a West Union newspaper, more than 175 families were affected by the Ohio Brush Creek flooding and more than 300 individuals sought emergency housing in local school buildings. State Route 52, in southern Adams County along the Ohio River, was closed because of the flooding of the Ohio River in 1964 and 1997.

Backwater caused by the Ohio River has contributed to flooding on Ohio Brush Creek. During the 1937 Ohio River flood (the peak of record at many Ohio River gaging stations), the gaging station on Ohio Brush Creek near West Union had been temporarily discontinued because of funding restrictions. Connell Moore, Jr., a lifelong Adams County resident who lived adjacent to Ohio Brush Creek in 1937, stated that the flooding in Ohio Brush Creek was due to backwater caused by the Ohio River. He recalls that his father, Connell Moore, Sr., who was employed by the USGS as a gaging station observer on Ohio Brush Creek from 1940 to 1970, was able to row a boat and touch the bottom of the old State Route 348 bridge that crosses Ohio Brush Creek at the station. The deck of the old State Route 348 bridge, which is no longer in service, was submerged by the flooded Ohio Brush Creek in March 1997.

**Raccoon Creek at Adamsville** – The village of Adamsville was originally established adjacent to Raccoon Creek in 1800, although residents began to relocate to the vicinity of Rio Grande in the 1870's as a result of recurring flooding. This left only a few dwellings in the community of Adamsville. Beginning in 1971, The Bob Evans Farm moved log cabins from various locations in southeastern Ohio to Adamsville in order to recreate an 1800's village. Two of these cabins (the Wickline and the Post Office) were swept away by the 1997 flood (fig. 9).

The largest flood of record at the USGS streamflow-gaging station Raccoon Creek at Adamsville occurred in May 1968. Late spring rains produced flooding that forced the evacuation of homes and businesses in the town of Vinton, about 12 miles upstream from Adamsville. The peak stage of the May 1968 flood at the gaging station was 28.69 feet and, according to an issue of the "Gallipolis Daily Tribune" dated May 27, 1968, the State Route 35 bridge (currently State Route 588) over Raccoon Creek at Adamsville was under water for the first time since construction in 1952.

**Table 5.** Preliminary assessments of damage to residential structures related to the March 1997 flooding in southern Ohio

[Estimates and classification criteria provided by the Ohio Emergency Management Agency, Department of Public Safety]

| County | Damage assessments (in numbers of structures) | | |
|---|---|---|---|
| | Destroyed[1] / Major[2] | Minor[3] | Affected[4] |
| Adams | 292 | 159 | 158 |
| Athens | 37 | 7 | 18 |
| Brown | 261 | 27 | 7 |
| Clermont | 511 | 0 | 0 |
| Gallia | 153 | 32 | 29 |
| Hamilton | 358 | 35 | 187 |
| Highland | 3 | 0 | 0 |
| Hocking | 4 | 6 | 83 |
| Jackson | 156 | 24 | 9 |
| Lawrence | 246 | 201 | 28 |
| Meigs | 82 | 24 | 28 |
| Monroe | 2 | 8 | 1 |
| Morgan | 0 | 0 | 0 |
| Pike | 60 | 310 | 194 |
| Ross | 4 | 23 | 97 |
| Scioto | 300 | 1,500 | 800 |
| Vinton | 41 | 26 | 6 |
| Washington | 20 | 8 | 7 |
| Totals | 2,530 | 2,390 | 1,652 |

[1]Flood depth more than 4 feet above structure's first floor and (or) structure is uninhabitable or not repairable.
[2]Flood depth less than 4 feet above structure's first floor and (or) structure is uninhabitable without major repair.
[3]Flood depth between 1 to 4 feet above structure's first floor, utility damage and minor repair needed.
[4]Flood depth generally less than 1 foot above structure's first floor, no utility damage.

In 1937, Raccoon Creek peaked at 25.20 feet, almost 4 feet less than the March 1997 flood. The January 26, 1937, issue of the "Gallipolis Daily Tribune" reported the Raccoon Creek flood as "smashing all records for height and devastation." The 1937 flood on Raccoon Creek was 4.1 feet higher than the previous peak stage (21.10 feet), which had been recorded at the gaging station in April 1920.

**Shade River near Chester** – The gaging station on the Shade River near Chester is situated in a remote area of eastern Meigs County (fig. 1). The March 1997 peak stage of 31.38 feet exceeded the previous record of 27.39 feet, which was established May 25, 1968. The flood of 1968 affected much of southern Ohio, and it was reported in the May 24, 1968, edition of the "Daily Sentinel" (a Pomeroy newspaper) that thousands of southern Ohio residents were forced to evacuate their homes. It also was reported that the flood caused the closure of all major highways in Meigs County. Another flood that occurred in February 14, 1966, on the Shade River resulted in the closure of major highways in Meigs County. The peak stage of the February 1966 flood was 24.67 feet, 6.71 feet less than in 1997.

**Table 6.** Damages and (or) extreme flow conditions at privately owned dams during the March 1997 flooding in southern Ohio
[Data complied by the Ohio Department of Natural Resources, Division of Water]

| Name | County | Latitude | Longitude | Comments |
|---|---|---|---|---|
| Thomas Pond Dam | Adams | 38° 48′ 38″ | 83° 20′ 33″ | Overtopped[1] and completely breached[2] |
| Laycock Farm Pond No. 1 Dam | Adams | 38° 54′ 51″ | 83° 29′ 01″ | Overtopped; downstream slope erosion[3] |
| Wagon Wheel Lake Dam | Brown | 38° 56′ 00″ | 84° 00′ 32″ | Overtopped; downstream slope erosion |
| Russellville Reservoir Dam | Brown | 38° 53′ 14″ | 83° 46′ 52″ | Overtopped; severe emergency spillway erosion |
| Jackson Lake Dam | Jackson | 39° 06′ 02″ | 82° 47′ 22″ | Overtopped; severe downstream slope erosion |
| Cecil Hollow Dam | Lawrence | 38° 35′ 40″ | 82° 41′ 20″ | Overtopped and breached[4] |
| Kerns Hollow Impoundment | Lawrence | 38° 40′ 30″ | 82° 40′ 20″ | Overtopped; downstream slope erosion |
| Cave Lake Dam | Pike | 39° 05′ 30″ | 83° 19′ 12″ | Flow through the emergency spillway |
| Long's Retreat Lake Dam | Pike | 39° 05′ 18″ | 83° 19′ 00″ | Flow through the emergency spillway |
| Green Acres Levee | Pike | 39° 07′ 30″ | 82° 59′ 00″ | Overtopped and breached |
| Lake Frasure Dam | Scioto | 38° 55′ 17″ | 83° 02′ 57″ | Overtopped; damage to principal spillway |

[1]Overtopped: Flow over the top of the dam embankment crest.
[2]Completely breached: Formation of an opening or breakthrough of the dam embankment.
[3]Downstream slope erosion: Removal of soil from the downstream dam embankment.
[4]Breached: Formation of an opening of the dam embankment from the crest to the downstream toe of the dam.

**Ohio River at Cincinnati** – Floods on the Ohio River have been numerous and have been documented since 1773. The January 1937 flood resulted in a record peak stage of 80.0 feet at the Ohio River at Cincinnati gaging station, surpassing the March 1997 peak stage by more than 15 feet. The 1937 flood caused an estimated $32 million in damage (1937 dollars) and forced approximately 50,000 people from their homes (McNutt, 1995). Floodwaters toppled nine fuel tanks in the Mill Creek valley, spilling about 135,000 gallons of gasoline. The gasoline ignited, resulting in a fire that covered an area 1 mile long by 3.5 miles wide.

Legislation had been enacted in 1936 authorizing the U.S. Army Corps of Engineers (COE) to construct flood-control projects throughout the Ohio River Basin, and the 1937 flood spurred an acceleration of the effort. The U.S. Army COE currently manages 78 flood-control projects in the Ohio River Basin, 55 of which are located in the stream system upstream from Cincinnati. In addition, the construction of the Mill Creek barrier dam, which was completed in 1948, provides additional flood protection for Cincinnati from Ohio River backwater.

The gage on the Ohio River at Cincinnati has recorded stages in excess of 60 feet eight times since 1937, but this level was last exceeded in 1964 when the river reached a stage of 66.20 feet, almost 2 feet higher than the peak stage of 64.48 feet in 1997. In 1964, there were 34 flood-control reservoirs operating upstream from Cincinnati. The U.S. Army COE estimates that the 55 flood-control projects currently in place helped to reduce the March 1997 peak stage at Cincinnati by about 2.5 feet (Steven Holmstrum, U.S. Army Corps of Engineers, written commun., 1997).

## SUMMARY

Storms that produced heavy rains during March 1–2, 1997, resulted in severe flooding in southern Ohio. Widespread damages to private and public property occurred throughout the area. The following 18 counties in southern Ohio were declared Federal and State disaster areas: Adams, Athens, Brown, Clermont, Gallia, Hamilton, Highland, Hocking, Jackson, Lawrence, Meigs, Monroe, Morgan, Pike, Ross, Scioto, Vinton, and Washington. Preliminary estimates of the cost of the flood damage are set at nearly $180 million. Nearly 20,000 persons were evacuated and about 6,500 residences and 833 businesses were affected. Five deaths were attributed to the flooding, all of the fatalities the result of attempts to drive through flooded roads.

Record peak stage and peak streamflow were recorded at two USGS streamflow-gaging stations, Ohio Brush Creek near West Union (Adams County) and Shade River near Chester (Meigs County). The peak streamflows at both locations exceeded estimates of 100-year-recurrence-interval peak streamflow. The peak streamflow and the corresponding water level at the USGS gaging station on Ohio Brush Creek near West Union, Ohio, were the highest recorded since the gaging station began operation (in water year 1927). The peak stage and peak streamflow for the Shade River near Chester gaging station also were the highest since the station began operation (in water year 1966). The peak streamflow at the Shade River near Chester was determined by use of an indirect method (slope-area computation) because all roads leading to the gaging station were inundated during the flood.

The largest accumulations of rainfall in Ohio for the March 1–2, 1997, storms were recorded in southern Adams and Brown Counties and ranged from 10 to 12 inches. Parts of Athens and Vinton Counties received about 6 inches of rainfall during the storm. Generally, rainfall amounts of 4 or more inches fell on most of the counties along or near the southern border of Ohio.

The most severe flooding within the state of Ohio was observed in streams located within 50 to 70 miles north of the Ohio River. Recurrence intervals at selected USGS streamflow-gaging stations throughout southern Ohio ranged from less than 2 years to greater than 100 years. The streamflow-gaging stations where floods having higher recurrence-interval floods occurred were on Ohio River tributaries in counties that border the Ohio River. These tributaries drain into the Ohio River, resulting in the flooding of many communities along the Ohio River and some of the worst flooding in over 30 years.

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