# Floods of August and September 2004 in Eastern Ohio: FEMA Disaster Declaration 1556

By Andrew D. Ebner, David E. Straub, and Jonathan D. Lageman

In cooperation with the Ohio Emergency Management Agency

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# Conversion Factors and Abbreviations

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Flow rate | |
| foot per second (ft/s) | 0.3048 | meter per second (m/s) |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second ($m^3/s$) |
| mile per hour (mi/h) | 1.609 | kilometer per hour (km/h) |
| | Pressure | |
| millibar (mb) | 1.0 | hectoPascal (hPa) |

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88), the National Geodetic Vertical Datum of 1929 (NGVD 29), and the U.S. Army Corps of Engineers 1912 Datum (COE 1912), as noted.

Elevation, as used in this report, refers to distance above the vertical datum.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

## Abbreviations

FEMA – Federal Emergency Management Agency
FIS – Flood Insurance Study
GPS – Global Positioning System
GIS – Geographical Information System
NEORSD – Northeast Ohio Regional Sewer District
NGS – National Geodetic Survey
NOAA – National Oceanic and Atmospheric Administration
NWS – National Weather Service
Ohio EMA – Ohio Emergency Management Agency
RTK – Real-Time Kinematic
TIN – Triangulated Irregular Network
USACE – United States Army Corps of Engineers
USGS – U.S. Geological Survey
USC&GS – United States Coast & Geodetic Survey

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# Floods of August and September 2004 in Eastern Ohio: FEMA Disaster Declaration 1556

By Andrew D. Ebner, David E. Straub, and Jonathan D. Lageman

## Abstract

A band of severe thunderstorms at the end of August 2004 and the passage of the remnants of Hurricanes Frances and Ivan during September 2004 caused severe flooding in eastern Ohio during August and September 2004. Record peak streamflow occurred at 12 U.S. Geological Survey (USGS) streamgages. Damages caused by the flooding produced by these storms were severe enough for 21 counties in eastern Ohio to be declared Federal disaster areas. In all, there were 4 storm- or flood-related deaths, 2,563 private structures damaged or destroyed, and an estimated $81 million in damages.

This report describes the meteorological factors that resulted in severe flooding in eastern Ohio during August 27–September 27, 2004, and examines the damages caused by the storms and flooding. Peak-stage, peak-streamflow, and recurrence-interval data are reported for selected USGS streamgages. Flood profiles determined by the USGS are presented for selected streams.

## Introduction

Remnants of Hurricanes Frances and Ivan crossed Ohio during September 2004, resulting in flooding in eastern Ohio and large amounts of rain to the entire eastern United States. The Federal Emergency Management Agency (FEMA) declared 21 counties affected by these storms as disaster areas (FEMA–1556–DR, Ohio, declared on September 19, 2004, with an incident period from August 27 through September 27, 2004). Figure 1 shows the 21 counties that were declared Federal disaster areas and whether they were declared to be eligible for Individual Assistance[1], or Individual Assistance and Public Assistance[2] (Federal Emergency Management Agency, 2007). In many of these counties, several floods occurred during this month-long incident period.

Because of the magnitude of these floods, the U.S. Geological Survey (USGS), in cooperation with the Ohio Emergency Management Agency (Ohio EMA), completed a study to document this historic event. Documentation of flood events can assist Federal, State, and local agencies in making informed decisions on flood-plain management and flood-emergency practices. Flood profiles were developed for Little Stillwater Creek near the Cities of Uhrichsville and Dennison (appendix 1–A), Lisbon Creek near the Village of Lisbon (appendix 1–**B**), Middle Fork Little Beaver Creek near the Villages of Lisbon and Elkton (appendix 1–C), McMahon Creek and Little McMahon Creek near the Village of Neffs (appendix 1–D), the Little Muskingum River near the Village of New Matamoras (appendix 1–E), Wheeler Run near the Village of Woodsfield (appendix 1–F), and Sandy Creek in Brown Township (appendix 1–G) as requested by Ohio EMA.

The disaster declaration is divided into three separate flood events in this report: August 28–29, 2004; September 8–11, 2004; and September 17–22, 2004. This report describes the weather conditions leading to each flood. A general description of each flood also is presented, along with damage estimates.

[1] Individual Assistance is defined as assistance to individuals and households.

[2] Public Assistance is defined as assistance to State and local governments for the repair or replacement of disaster-damaged public facilities.

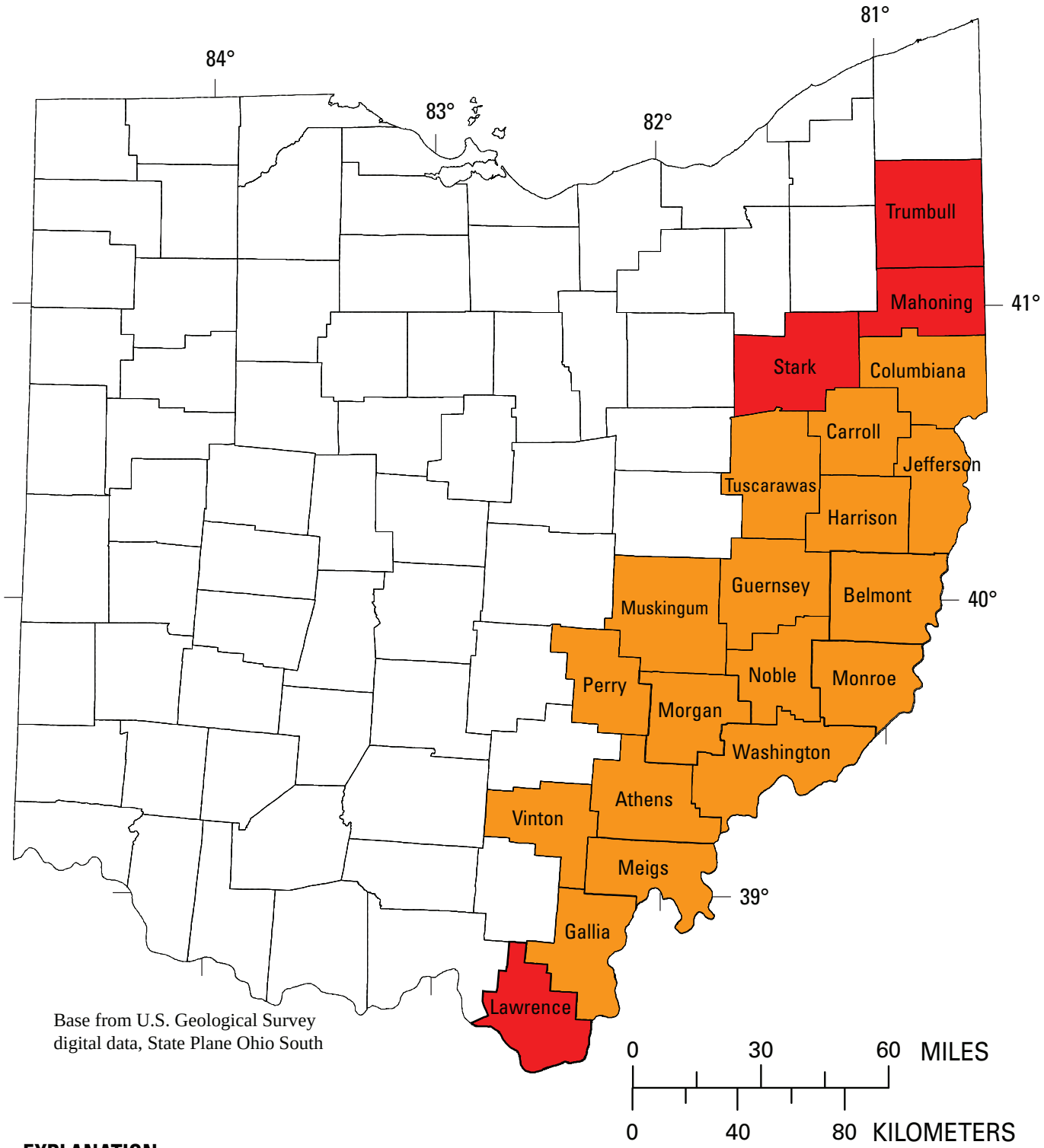



**Figure 1.** Ohio counties declared disaster areas under FEMA declaration 1556 (modified from Federal Emergency Management Agency, 2007).

# Antecedent Climatic Conditions

Unusually wet conditions that preceded the floods in Ohio during August and September 2004 contributed to the severity of the flooding. Climatic conditions prior to the flooding are presented in this section.

**July 2004.** The National Oceanic and Atmospheric Administration (NOAA) divides Ohio into 10 regions based on similar climatological characteristics. Precipitation totals for each region were above normal[3] except for the West Central and South Central Regions. As a whole, the State was 0.52 in. above normal, receiving 4.60 in. of precipitation for the month. Most of the precipitation for the month fell in the second half of the month; the first half of the month was relatively dry. The National Oceanic and Atmospheric Administration (NOAA) divides Ohio into 10 regions based on similar climatological characteristics. The Southeast Region received the most precipitation with 5.51 in., whereas the West Central Region received the least with 3.80 in. (fig. 2A)(Cashell and Kirk, 2004a).

**August 2004.** Precipitation for each region was above normal except for the Southwest and South Central Regions. As a whole, the State was 0.82 in. above normal, receiving 4.26 in.of precipitation for the month. The Northeast Hills Region received the most rainfall with 6.86 in., and the Southwest Region received the least with 3.10 in. (fig. 2B) (Cashell and Kirk, 2004b).

# August 28–29, 2004 Flood

Storms during August 27–28, 2004, led to localized flooding in eastern Ohio during August 28–29, 2004. These storms crossed eastern Ohio following a wetter than normal July and beginning of August (fig. 2A, B). The wet antecedent conditions likely increased the severity of the flooding.

## Storms of August 27–28, 2004

During August 27–28, 2004, predominantly south winds brought moisture-laden air from the Gulf of Mexico into Ohio. This led to high levels of moisture convergence[4], which increases the potential for large rainfall totals during storms. An upper-level trough[5] also was positioned west of Ohio, which allowed air to rise and aid in thunderstorm development.

During the late evening of August 27 and into the early morning of August 28, a cold front associated with a low-pressure system over western Quebec moved slowly southeast over the Great Lakes, northwest of Ohio. This cold front provided a lifting mechanism, causing the moist air coming into the region from the south to rise. Several squall lines[6] formed ahead of this frontal boundary and moved southeast across Ohio during this period, producing wind gusts over 50 mi/h, large hail, and isolated torrential rainfall (Angel and others, 2004a).

Most of the State received less than 0.5 in. of precipitation from these storms; however, isolated thunderstorms dropped more than 7 in. of precipitation on parts of Columbiana County and greater than 3 in. in parts of eastern Stark County (fig. 3). Salem, in Columbiana County, received the most precipitation for the State over the 2-day period of August 27–28, 2004, with 7.13 in. of rain and with an associated recurrence interval of 500–1,000 years. Rainfall intensities and recurrence intervals for selected NWS sites from this storm are listed in table 1.

## General Description of the August 28–29, 2004 Flood

The following sections present information about the flooding that resulted from the August 27–28, 2004 storms. This section contains streamflow and stage data at selected USGS streamgages in the affected counties (fig. 4). The omission from this report of any rivers or communities that experienced flooding is not a reflection of the severity of the flooding or the impact on those communities but rather is due to a lack of available streamflow data.

[3] "Normal" refers to the average value for the period 1951–2000 (Cashell and Kirk, 2004 a,b).

[4] Moisture convergence is defined as a measure of the degree to which moist air is converging into a given area.

[5] An upper-level trough is defined as an elongated region of low pressure at high levels in the atmosphere.

[6] A squall line is defined as a linear band of severe thunderstorms that often forms ahead of or along a cold front. A severe thunderstorm is any thunderstorm that produces wind gusts equal to or greater than 50 knots and (or) hail at least three-quarters of an in. in diameter and (or) produces a tornado (National Weather Service, 2007a).

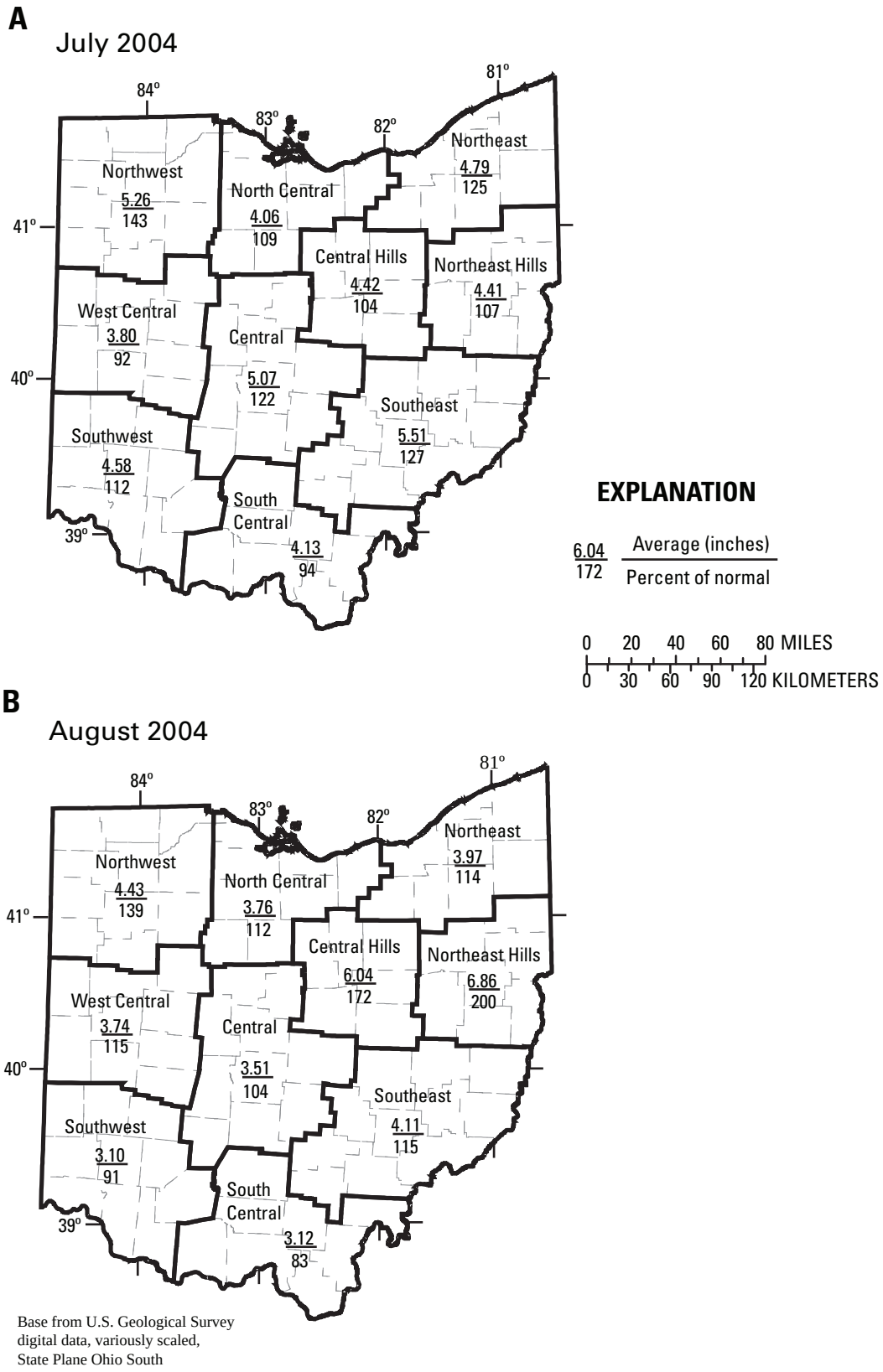



**Figure 2.** Regionally averaged monthly total precipitation and percentage of normal precipitation for the 10 climatic regions of Ohio for A, July and B, August 2004 (modified from Cashell and Kirk, 2004 a,b; "normal" refers to the average value for the period 1951–2000).

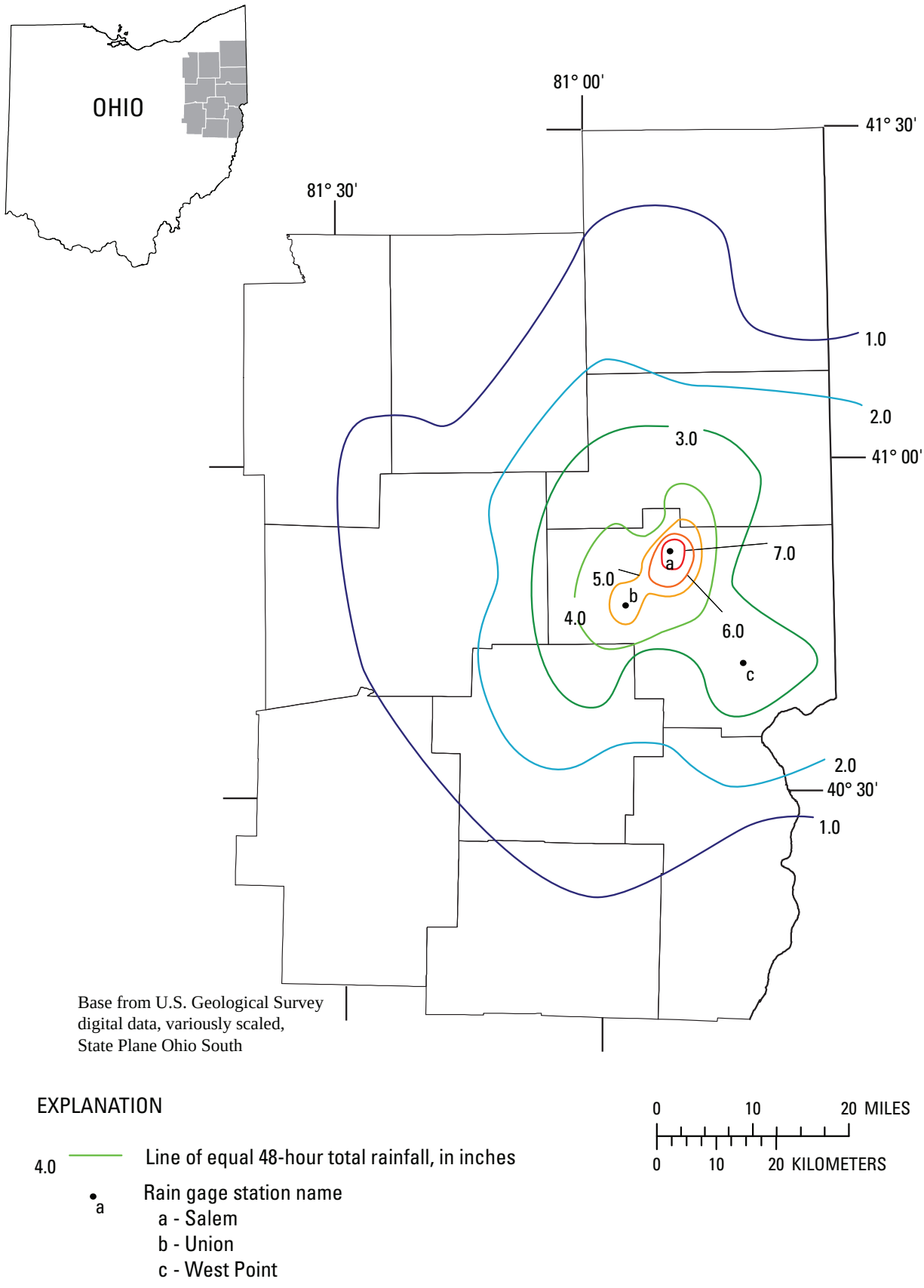


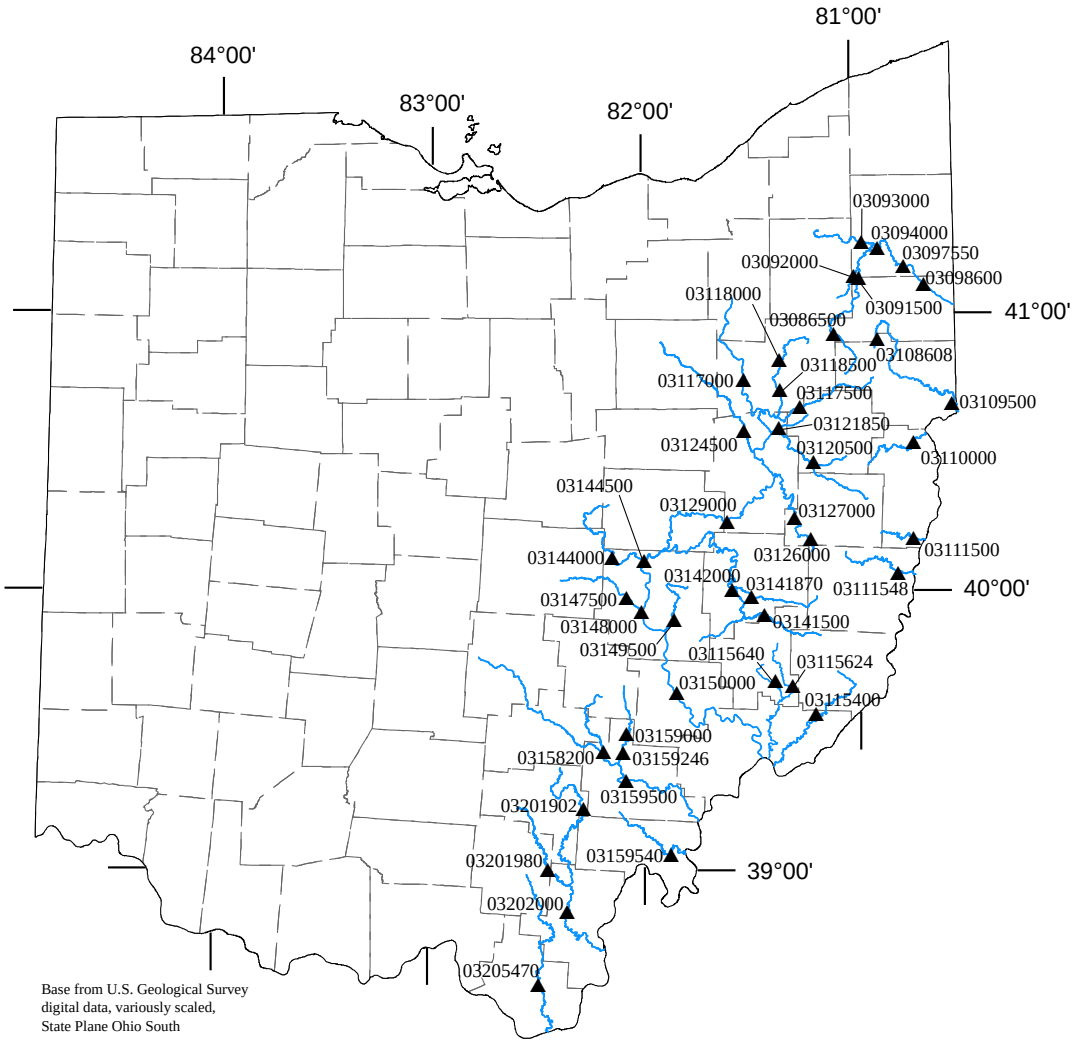

**Figure 3.** Isohyetal map of 48-hour rainfall totals for August 27–28, 2004. Based on data collected at 22 rain gages throughout eastern Ohio (National Weather Service, 2007b; National Oceanic and Atmospheric Administration, 2004a).

**Table 1.** Precipitation totals and recurrence intervals for selected National Weather Service rain gages in Ohio for August 27–28, 2004. Station locations are shown on figure 3.

[Data from National Weather Service, 2007b]

| Station name | County | Dates (2004) | Period (days) | Precipitation (inches) | Recurrence interval[1] (years) |
|---|---|---|---|---|---|
| Salem | Columbiana | August 27–28 | 2 | 7.13 | 500–1000 |
| Union | Columbiana | August 27–28 | 2 | 5.33 | 50–100 |
| West Point | Columbiana | August 27–28 | 2 | 3.88 | 10–25 |

[1]From National Weather Service (2007c).




EXPLANATION

03159500 ▲ Streamgage and number

0 50 100 MILES

0 50 100 KILOMETERS

**Figure 4.** Locations of selected USGS streamgages that are referred to in this report.

### Areal Distribution

The counties listed in table 2 were declared Federal disaster areas (FEMA–1556–DR) as a result of the flooding on August 28–29, 2004. Table 2 also lists the areas affected by flooding and the streams that caused the flooding. Locations of USGS streamgages and stream in the areas flooded are shown on figure 5.

### Flood Stages, Streamflows, and Recurrence Intervals

USGS streamgage records were examined to determine the gages where notable flooding occurred. The peak streamflows for those streams affected by this event were compared to the recurrence intervals for streamflows reported in Koltun and others (2006). For those streamgages that did not have sufficient record to compute a reliable recurrence-interval estimate and so are not reported in Koltun and others (2006), recurrence intervals were estimated by use of Ohio StreamStats (U.S. Geological Survey, 2007). Table 3 lists the peak stage, peak streamflow, and recurrence interval for selected USGS streamgages for August 28–29, 2004. Although the recurrence interval for the rainfall amount at the Salem rain gage was 500–1,000 years, streamgages in Columbiana and Stark Counties show relatively small events (largest recurrence interval of 10–25 years) due to the localized rainfall. Flooding likely occurred on ungaged streams.

## September 8–11, 2004 Flood

Remnants of Hurricane Frances passed over eastern Ohio on September 8–9, resulting in flooding in eastern Ohio during September 8–11, 2004. These storms followed a wetter than normal August for eastern Ohio (fig. 2B). These wet conditions likely increased the severity of flooding that resulted from these storms.

### Storms of September 8–9, 2004

The Atlantic Hurricane Season of 2004 was one of the most devastating seasons on record, with five hurricanes making landfall in the United States. On September 5, 2004, Hurricane Frances made landfall on central Florida's east coast as a category 2 hurricane[7]. Hurricane Frances moved northwest across Florida, into the Gulf of Mexico, and then made landfall again as a tropical storm[8] on September 6 at the eastern end of the Florida panhandle (fig. 6). From northwestern Florida, Frances headed into eastern Alabama, where it weakened into a tropical depression[9] and curved northeastward, steered by the dominant westerly winds on September 7. Early on September 9, centered over West Virginia, the remnants of Hurricane Frances became extratropical[10] and continued to move northeastward across the northeastern United States and southern Canada before dissipating on September 10 over the Gulf of St. Lawrence (Franklin and others, 2006).

The outer rainbands associated with the remnants of Hurricane Frances began to move over southern Ohio in the early morning hours of September 8. A stationary front positioned over southeastern Ohio provided further uplift of these storms, increasing convection and increasing rainfall totals over eastern Ohio. This rain event lasted until the morning of September 9, as the remnants of Hurricane Frances moved off to the northeast.

During September 8–9, 2004, most of eastern Ohio received 4 or more in. of rainfall (fig. 7). More than 8 in. of rain fell in parts of Guernsey and Muskingum Counties. The largest rainfall amount, 8.28 in. in 48 hours, was recorded at the Cambridge rain gage in Guernsey County. Rainfall intensities and recurrence intervals for selected NWS sites from this storm are listed in table 4.

[7] According to the Saffir-Simpson Hurricane Scale: a category 2 hurricane has winds 96–110 mi/h and produces storm surges 6–8 ft above normal (National Hurricane Center, 2007a).

[8] A tropical storm is a tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 39 to 73 mi/h (National Hurricane Center, 2007b).

[9] A tropical depression is a tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 38 mi/h or less (National Hurricane Center, 2007b).

[10] Extratropical is a term used to indicate that a cyclone has lost its "tropical" characteristics, implying that the cyclone no longer receives its energy from latent heat released during condensation but now receives its energy from the temperature contrasts that exist in the mid-latitudes. When a cyclone becomes extratropical, it can still retain hurricane-force winds (National Hurricane Center, 2007b).

**Table 2.** Areas and streams affected by flooding during August 28–29, 2004.

[Data from Angel and others, 2004a]

| County | Stream(s) | Areas | Figure |
|---|---|---|---|
| Carroll | Sandy Creek and its tributaries | Brown Township | 5 |
| Columbiana | Sandy Creek and its tributaries | Kensington | 5 |
| | Middle Branch Sandy Creek | Homeworth | 5 |
| | Bull Creek | Rogers | 5 |
| | Middle Fork Little Beaver Creek | Salem, Leetonia, Lisbon, Elkton, and Williamsport | 5 |
| | Lisbon Creek | Lisbon | 5 |
| | West Fork Little Beaver Creek | Winona | 5 |
| Stark | Sandy Creek and its tributaries | Minerva and Waynesburg | 5 |

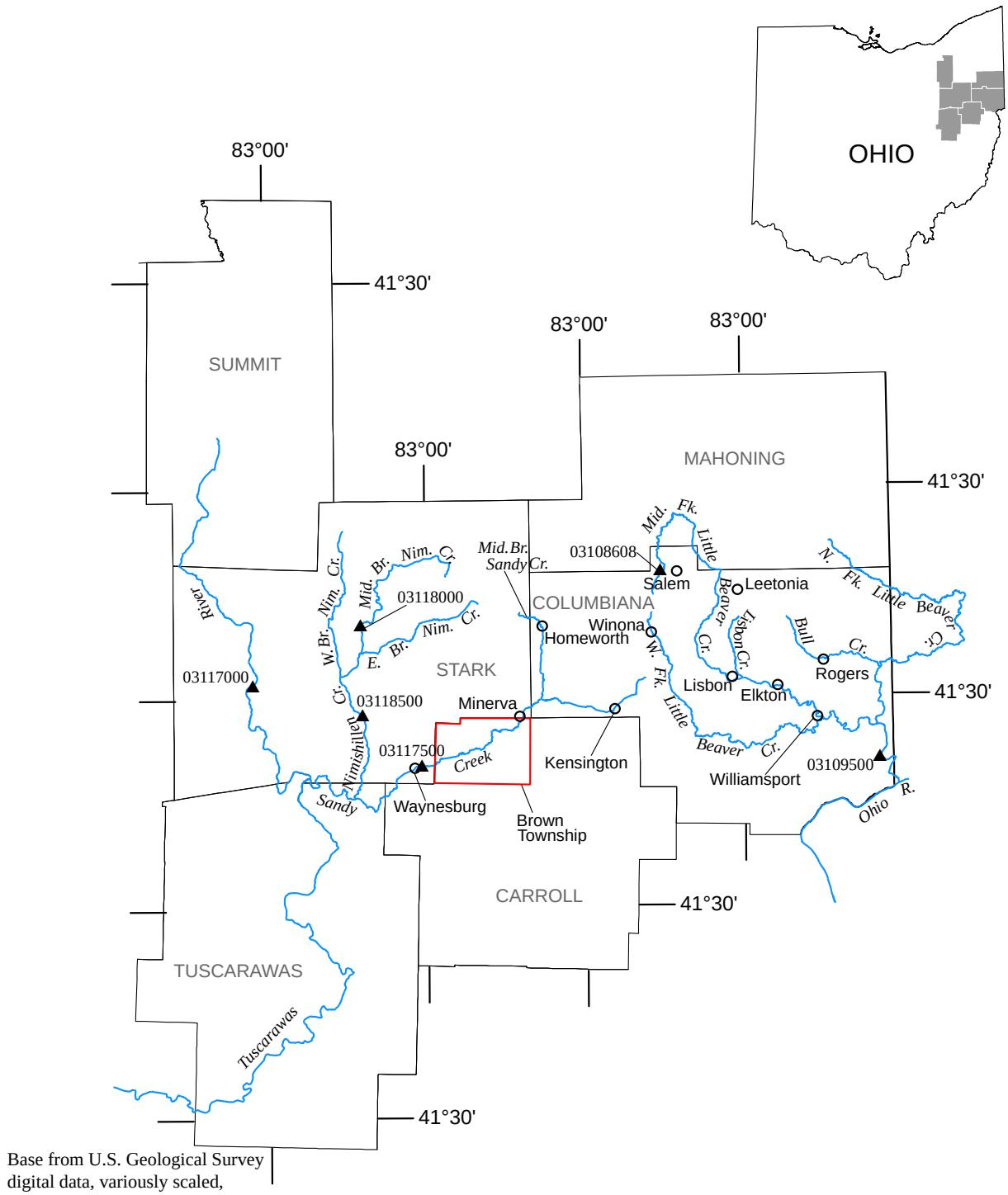



**Figure 5.** Selected areas of eastern Ohio affected by flooding during August 28–29, 2004.

**Table 3.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, August 28–29, 2004.

[mi², square miles; ft, feet (above gage datum); ft³/s, cubic feet per second; <, less than; N/A, not available; thick lines separate dates of maximum peak]

| Permanent station number | Stream and place of determination | Drainage area (mi²) | Gage datum (ft) (COE 1912) | Period of systematic record (water years)[a] | Maximum prior to August 28, 2004 | | | Maximum during August 28–September 2, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft³/s) | Date | Stage (ft) | Streamflow (ft³/s) | |
| 03108608 | Middle Fork Little Beaver Creek near Salem | 1.68 | N/A[b] | 5 | 2003 | 60.44 | 340 | 8/28/2004 | 61.86 | 428 | 10–25[c] |
| 03109500 | Little Beaver Creek near East Liverpool | 496 | 702.77 | 92 | 1941 | 17.40 | 25,000 | 8/28/2004 | 12.31 | 11,500 | 2–5[d] |
| 03118000 | Middle Branch Nimishillen Creek at Canton | 43.1 | 1,046.6 | 66 | 1959 | 6.50[e] | 2,470 | 8/28/2004 | 2.47 | 116 | < 2[d] |
| 03118500 | Nimishillen Creek at North Industry | 175 | 976.72 | 85 | 2003 | 14.18 | 9,310 | 8/28/2004 | 5.77 | 1,970 | < 2[d] |
| 03117000 | Tuscarawas River at Massillon | 518 | 916 | 68 | 1969 | 16.43 | 10,700 | 8/29/2004 | 3.23 | 828 | < 2[d] |
| 03117500 | Sandy Creek at Waynesburg | 253 | 955 | 68 | 1959 | 10.05 | 15,000 | 8/29/2004 | 7.80 | 4,300 | 2–5[d] |

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

[b] Gage datum is based on an arbitrary datum.

[c] Based on frequency estimates from Ohio StreamStats (U.S. Geological Survey, 2007).

[d] Based on weighted estimates from Koltun and others (2006).

[e] A peak stage of 6.63 ft occurred in the 2003 water year, but is associated with a peak discharge of only 1,630 ft³/s.

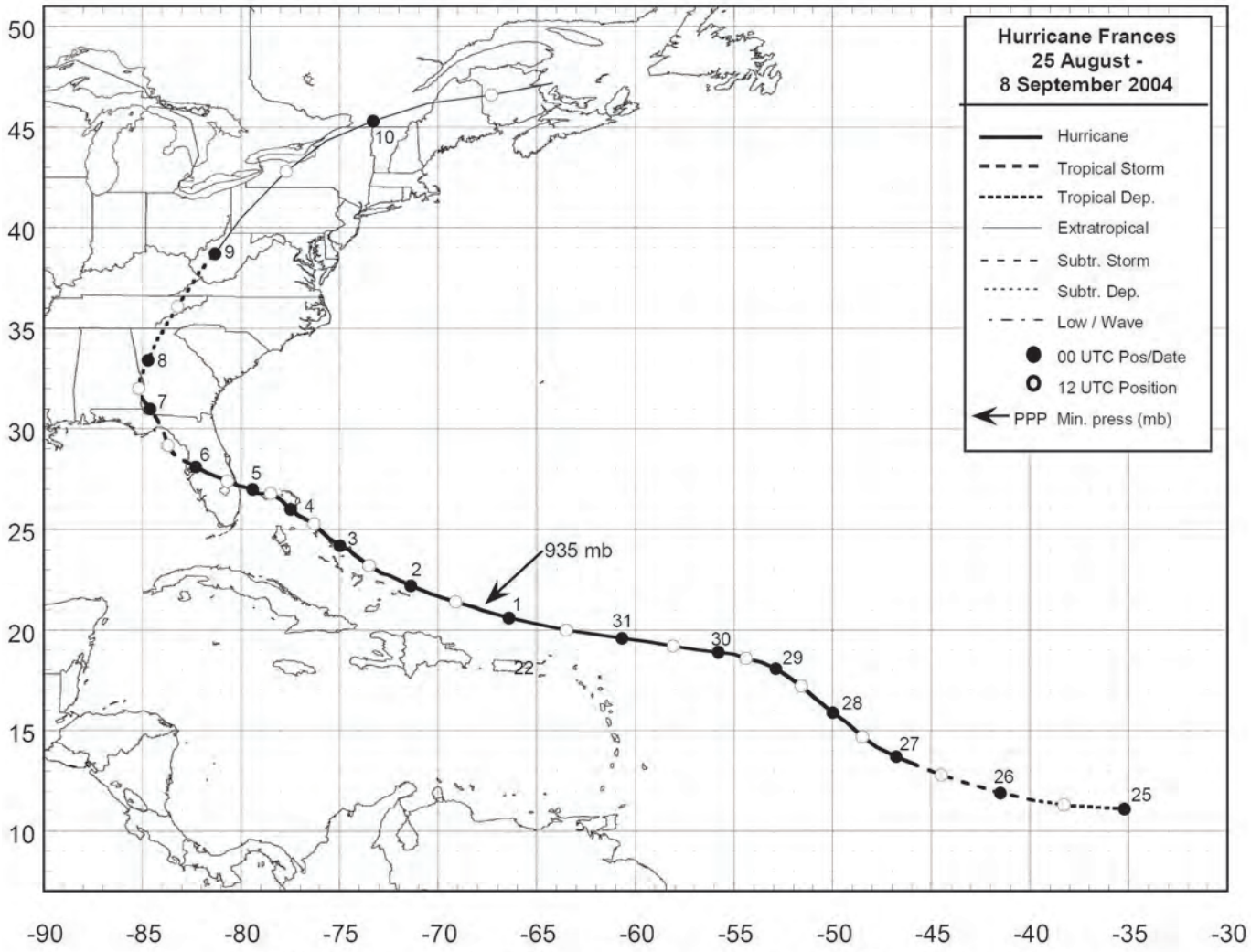
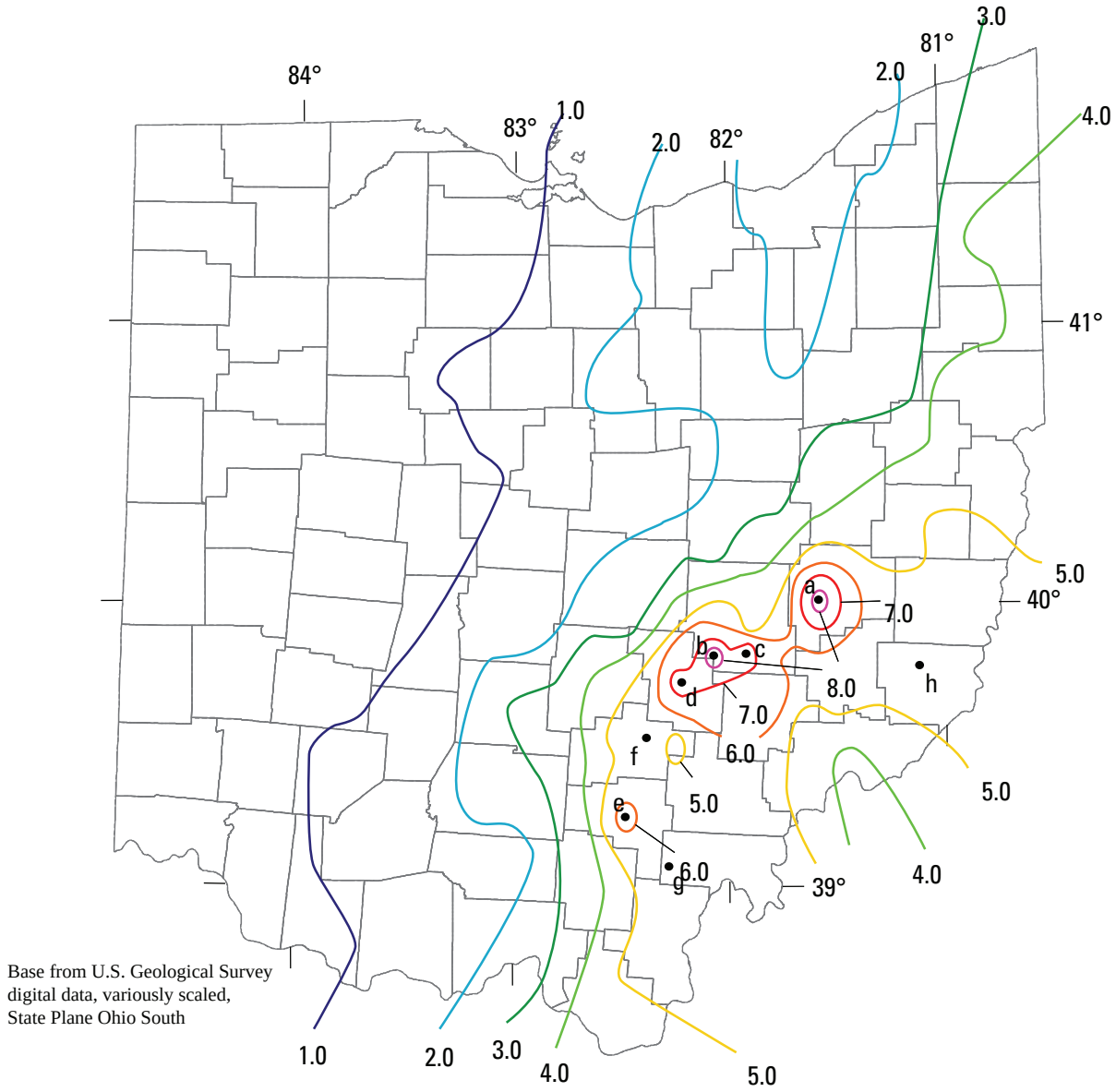



**Figure 6.** Best track positions for the eye of Hurricane Frances for August 25–September 10, 2004 (reproduced from Beven, 2004). (Tropical Dep., Tropical Depression; Subtr. Storm, Subtropical Storm; Subtr. Dep., Subtropical Depression; UTC, Coordinated Universal Time; mb, millibars).




EXPLANATION

4.0 Line of equal 48-hour total rainfall, in inches

a Rain gage station name

- a - Cambridge
- b - Roseville
- c - Philo 3 SW
- d - New Lexington 2 NW
- e - McArthur
- f - Logan
- g - Salem Center 2 E
- h - Woodsfield 2 N

0 50 100 MILES

0 50 100 KILOMETERS

**Figure 7.** Isohyetal map of 48-hour rainfall totals in Ohio for September 8–9, 2004. Based on data collected at 130 rain gages throughout Ohio (National Oceanic and Atmospheric Administration, 2004b).

**Table 4.** Precipitation totals and recurrence intervals for selected National Weather Service rain gages in Ohio for September 8–9, 2004. Station locations are shown on figure 7.

[Data from National Oceanic and Atmospheric Administration, 2004b]

| Station name | County | Dates (2004) | Period (hours) | Precipitation (inches) | Recurrence interval[1] (years) |
|---|---|---|---|---|---|
| Cambridge | Guernsey | September 8–9 | 48 | 8.28 | 200–500 |
| Roseville | Muskingum | September 8–9 | 48 | 8.03 | 200–500 |
| Philo 3 SW | Muskingum | September 8–9 | 48 | 7.55 | 200–500 |
| New Lexington 2 NW | Perry | September 8–9 | 48 | 7.45 | 100–200 |
| McArthur | Vinton | September 8–9 | 48 | 6.27 | 100–200 |
| Logan | Hocking | September 8–9 | 48 | 5.95 | 50–100 |
| Salem Center 2 E | Meigs | September 8–9 | 48 | 5.66 | 50–100 |
| Woodsfield 2 N | Monroe | September 8–9 | 48 | 5.50 | 50–100 |

[1]From National Weather Service (2007c).

## General Description of the September 8–11, 2004, Flood

The following sections present information about the flooding during September 8–11, 2004, that resulted from the September 8–9, 2004 storms. This section contains streamflow and stage data at selected USGS streamgages in the affected counties (fig. 4). The omission from this report of any rivers or communities that experienced flooding is not a reflection of the severity of the flooding or the impact on those communities but rather is due to a lack of available streamflow data.

### Areal Distribution

The counties listed in table 5 were declared Federal disaster areas (FEMA–1556–DR) as a result of flooding of September 8–11, 2004. Table 5 also lists the areas affected by flooding and the streams that caused the flooding. Locations of USGS streamgages and streams in the areas flooded are shown in figures 8–13.

### Flood Stages, Streamflows, and Recurrence Intervals

USGS streamgage records were examined to determine which gages were most affected by these storms. The peak streamflows for those streams affected by this event were compared to the recurrence intervals for streamflows that are reported in Koltun and others (2006). For gages that do not have sufficient record to compute a reliable recurrence-interval estimate and so are not reported in Koltun and others (2006), recurrence intervals were estimated by use of Ohio StreamStats (U.S. Geological Survey, 2007). Table 6 lists the peak stage, peak streamflow, and recurrence-interval range for selected USGS streamgages for September 8–11, 2004. For those stations on regulated rivers, a recurrence interval is not given. Record peak streamflow occurred on Yellow Creek near Hammondsville (station 03110000), Huff Run at Mineral City (station 03121850), Stillwater Creek at Tippecanoe (station 03127000), Leatherwood Creek near Kipling (station 03141870), and Salt Creek near Chandlersville (station 03149500). The recurrence intervals of greater than 500 years estimated for Salt Creek near Chandlersville (station 03149500) and Huff Run at Mineral City (station 03121850) were the largest recurrence intervals estimated at USGS streamgages for August 28 – September 22, 2004.

**Table 5.** Areas and streams affected by flooding during September 8–11, 2004.

[Data from Angel and others, 2004b]

| County | Stream(s) | Areas | Figure |
|---|---|---|---|
| Athens | Sunday Creek | Trimble | 8 |
| Belmont | McMahon Creek | Glencoe, Neffs, and Bellaire | 9 |
| | Little McMahon Creek | Neffs | 9 |
| | Wheeling Creek and its tributaries | Lafferty, Bannock, Crabapple, Maynard, Barton, Lansing, Wolfhurst, and Colerain | 9 |
| | Captina Creek and its tributaries | Bethesda and Powhatan Point | 9 |
| | Ohio River and its tributaries | Shadyside, Yorkville, and Dilles Bottom | 9 |
| | Leatherwood Creek | Baileys Mills | 10 |
| Carroll | Sandy Creek | Brown Township | 11 |
| | Indian Fork and its tributaries | Carrollton | 11 |
| | Conotton Creek | Sherrodsville | 11 |
| Columbiana | Middle Branch Sandy Creek | Homeworth | 11 |
| | Middle Fork Little Beaver Creek | Salem, Lisbon, Leetonia, and Elkton | 12 |
| | Lisbon Creek | Lisbon | 12 |
| | Ohio River and its tributaries | Wellsville | 12 |
| Gallia | Data not available | Countywide | 13 |
| Guernsey | Wills Creek | Cambridge | 10 |
| | Data not available | Central and northern parts of the county | 10 |
| Harrison | Conotton Creek | Jewett | 11 |
| | Piney Fork | Hopedale | 11 |
| Jefferson | Short Creek | Adena, Dillonvale, Connorville, and Rayland | 11 |
| | Little Short Creek | Glen Robbins | 11 |
| | North Fork Yellow Creek | Irondale | 11 |
| | Salt Run | Irondale | 11 |
| | Wolf Run | Wolf Run | 11 |
| | Ohio River and its tributaries | Toronto | 11 |
| | Data not available | Smithfield | 11 |
| Lawrence | Data not available | Countywide | 13 |
| Mahoning | Yellow Creek and its tributaries | Poland | 12 |
| | Mahoning River and its tributaries | Beloit, Youngstown, and Campbell | 12 |
| | Mill Creek | Youngstown and Boardman | 12 |
| | Sandy Creek | Hanoverton to Kensington | 11 |
| Meigs | Shade River | Chester | 8 |

**Table 5.** Areas and streams affected by flooding during September 8–11, 2004. —Continued

[Data from Angel and others, 2004b]

| County | Stream(s) | Areas | Figure |
|---|---|---|---|
| Monroe | Sunfish Creek | Woodsfield, Cameron, Lewisville, and Clarington | 10 |
| | Wheeler Run | Woodsfield | 10 |
| | Little Muskingum River | Jericho | 10 |
| | Ohio River and its tributaries | Sardis and Hannibal | 10 |
| Morgan | Data not available | Countywide | 10 |
| Muskingum | Brush Creek | Duncan Falls | 10 |
| | Slat Creek | Duncan Falls | 10 |
| | Muskingum River | Zanesville | 10 |
| | Licking River | Zanesville | 10 |
| | Data not available | New Concord | 10 |
| Noble | West Fork Duck Creek | Caldwell and Belle Valley | 10 |
| | East Fork Duck Creek | East Union | 10 |
| Stark | Sandy Creek | Minerva and Waynesburg | 11 |
| | Nimishillen Creek | widespread | 11 |
| Trumbull | Walnut Creek | Cortland | 12 |
| | Mahoning River | Widespread | 12 |
| | Little Yankee Creek | Hubbard | 12 |
| | Mud Run | Hubbard | 12 |
| Tuscarawas | Huff Run | Mineral City | 11 |
| | Stillwater Creek | Dennison and Uhrichsville | 11 |
| | Little Stillwater Creek | Dennison and Uhrichsville | 11 |
| | Tributaries of Tuscarawas River | Newcomerstown | 11 |
| Vinton | Data not available | Countywide | 10 |
| Washington | West Fork Duck Creek | Aurelius Township from Macksburg to Elba | 10 |
| | East Fork Duck Creek | Lower Salem | 10 |
| | Little Muskingum River | New Matamoras | 10 |
| | Ohio River and its tributaries | New Matamoras | 10 |

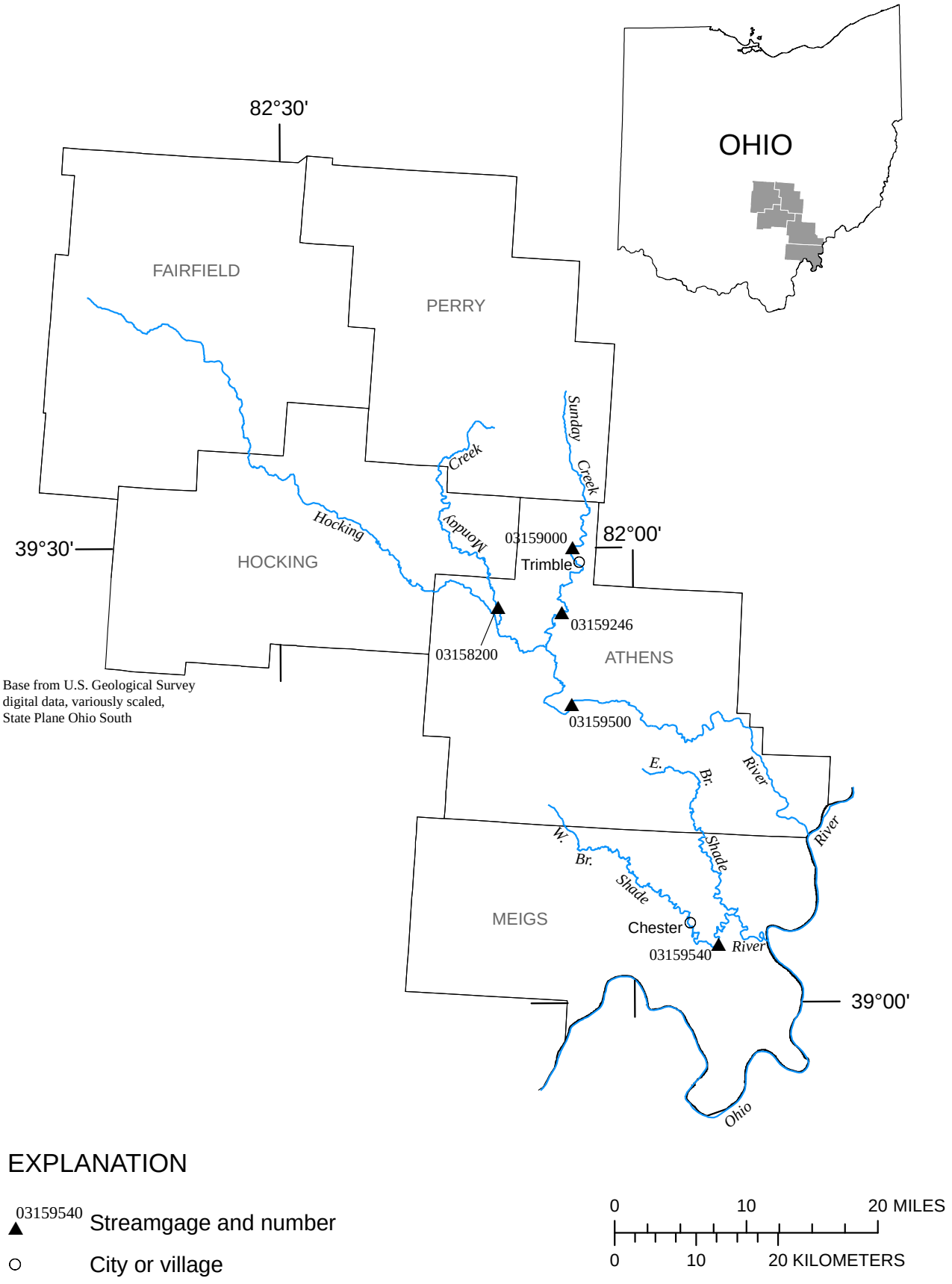



**Figure 8.** Selected areas of southeastern Ohio affected by flooding during September 8–11, 2004.

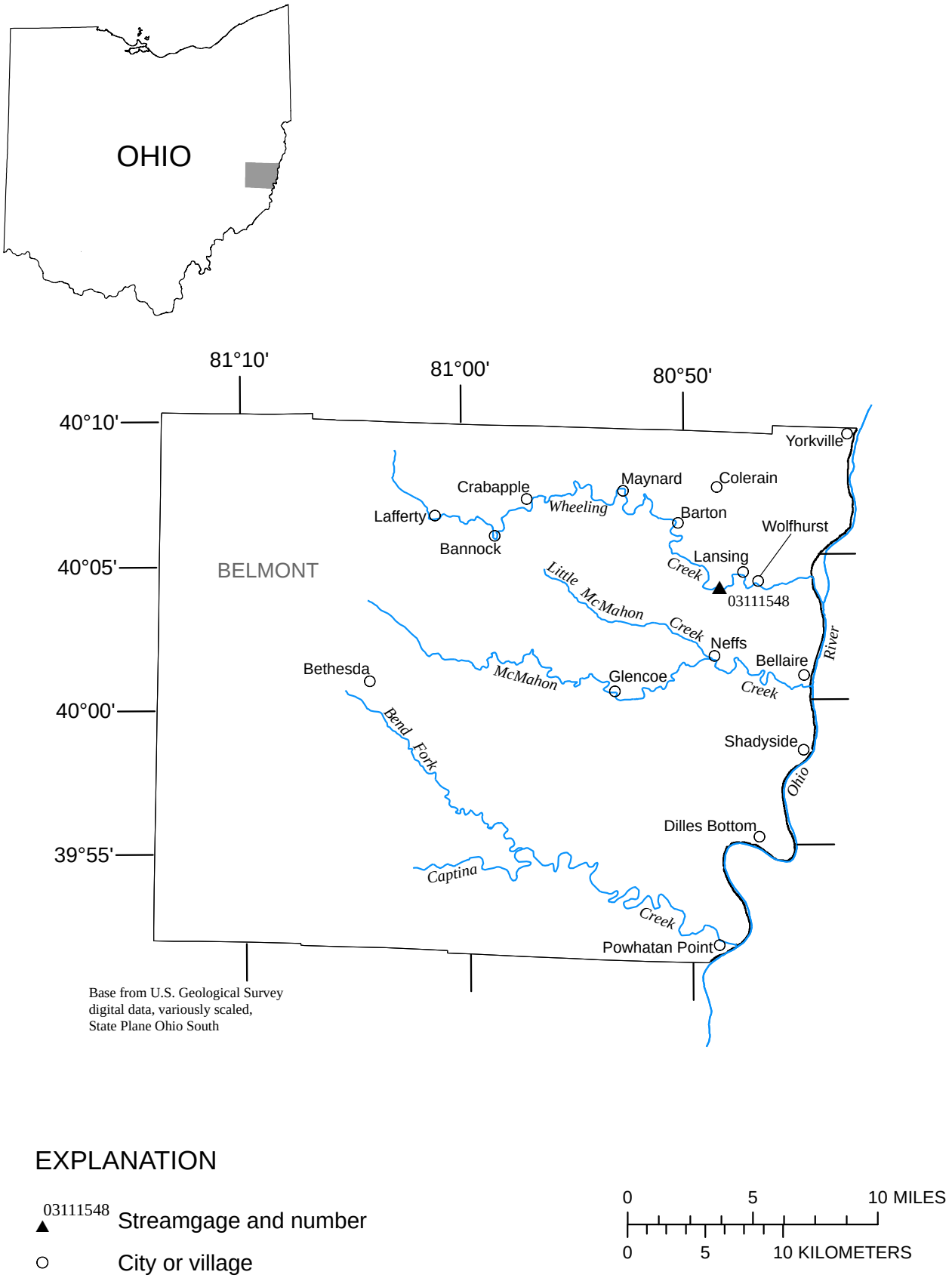



**Figure 9.** Selected areas in central and eastern Belmont County affected by flooding during September 8–11, 2004.

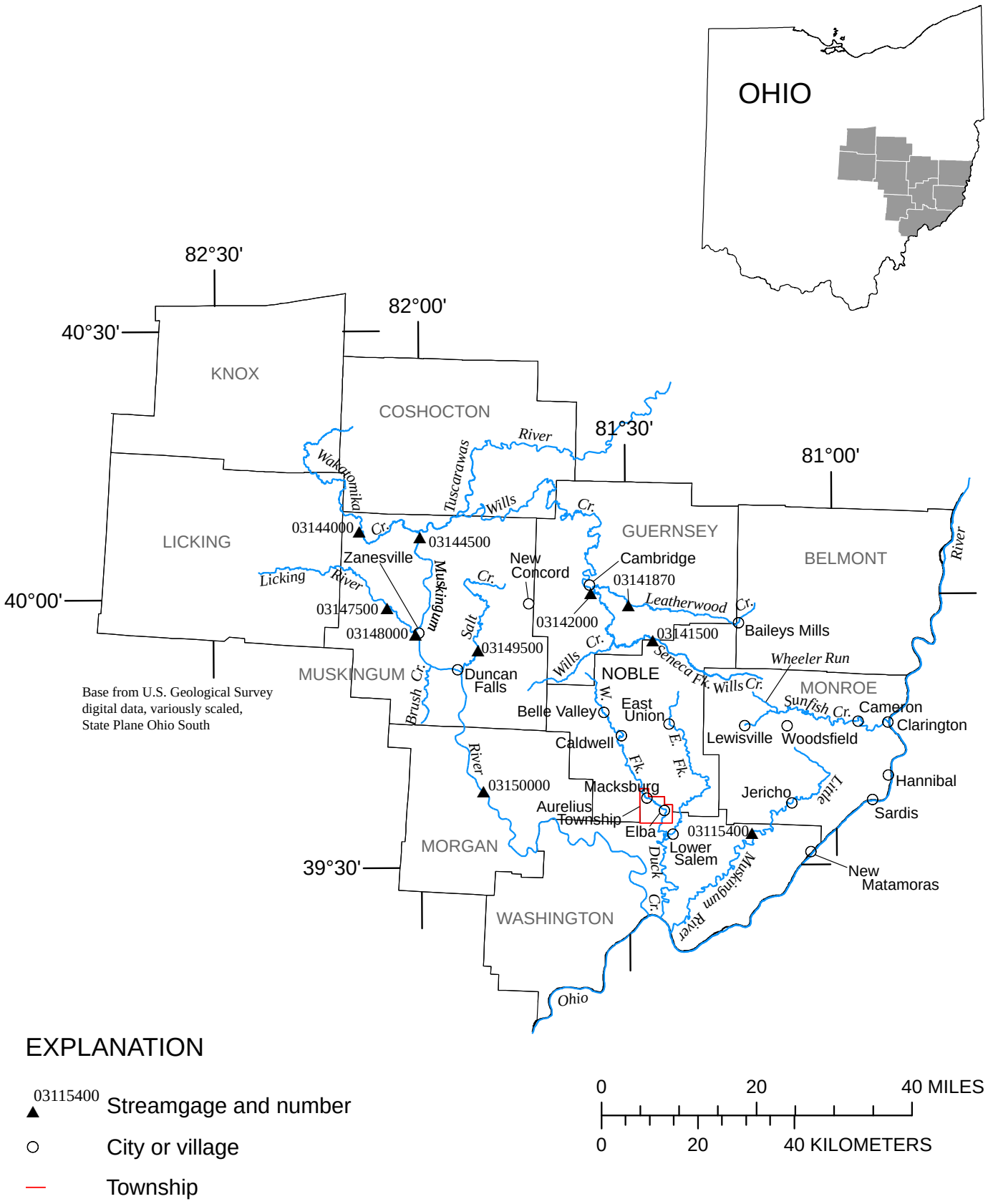



**Figure 10.** Selected areas of central eastern Ohio affected by flooding during September 8–11, 2004.

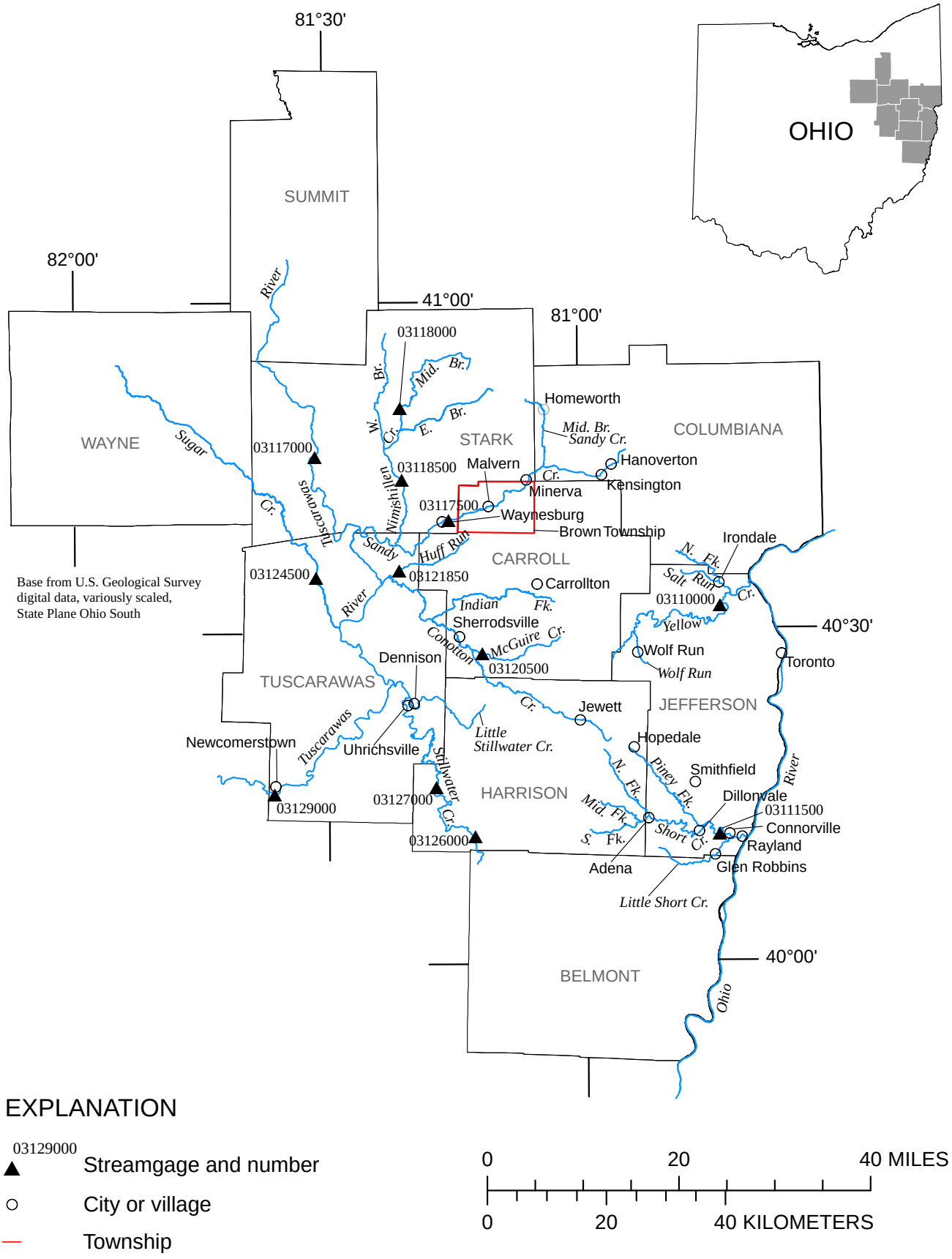



**Figure 11.** Selected areas of eastern Ohio affected by flooding during September 8–11, 2004.

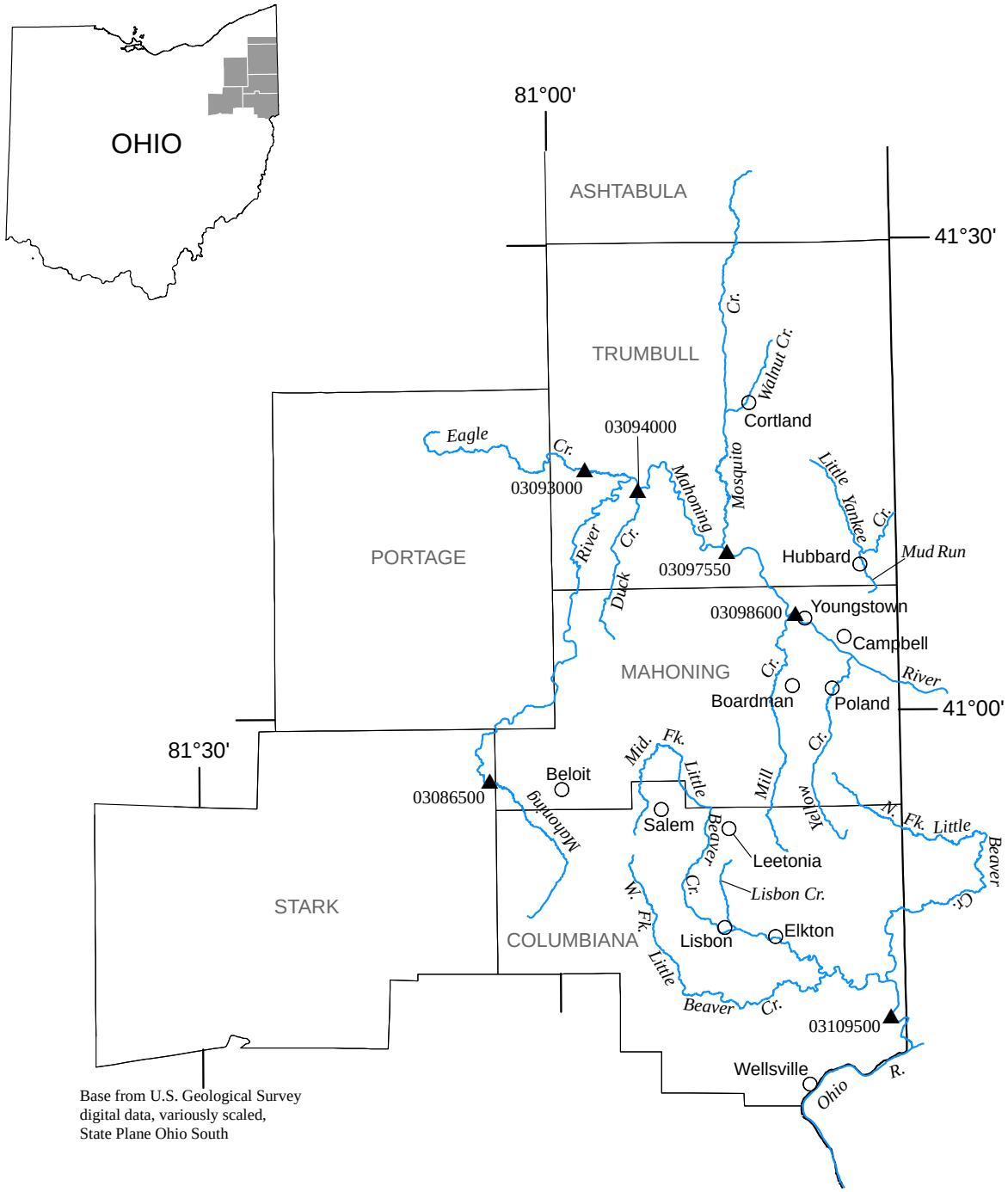



**Figure 12.** Selected areas of northeastern Ohio affected by flooding during September 8–11, 2004.

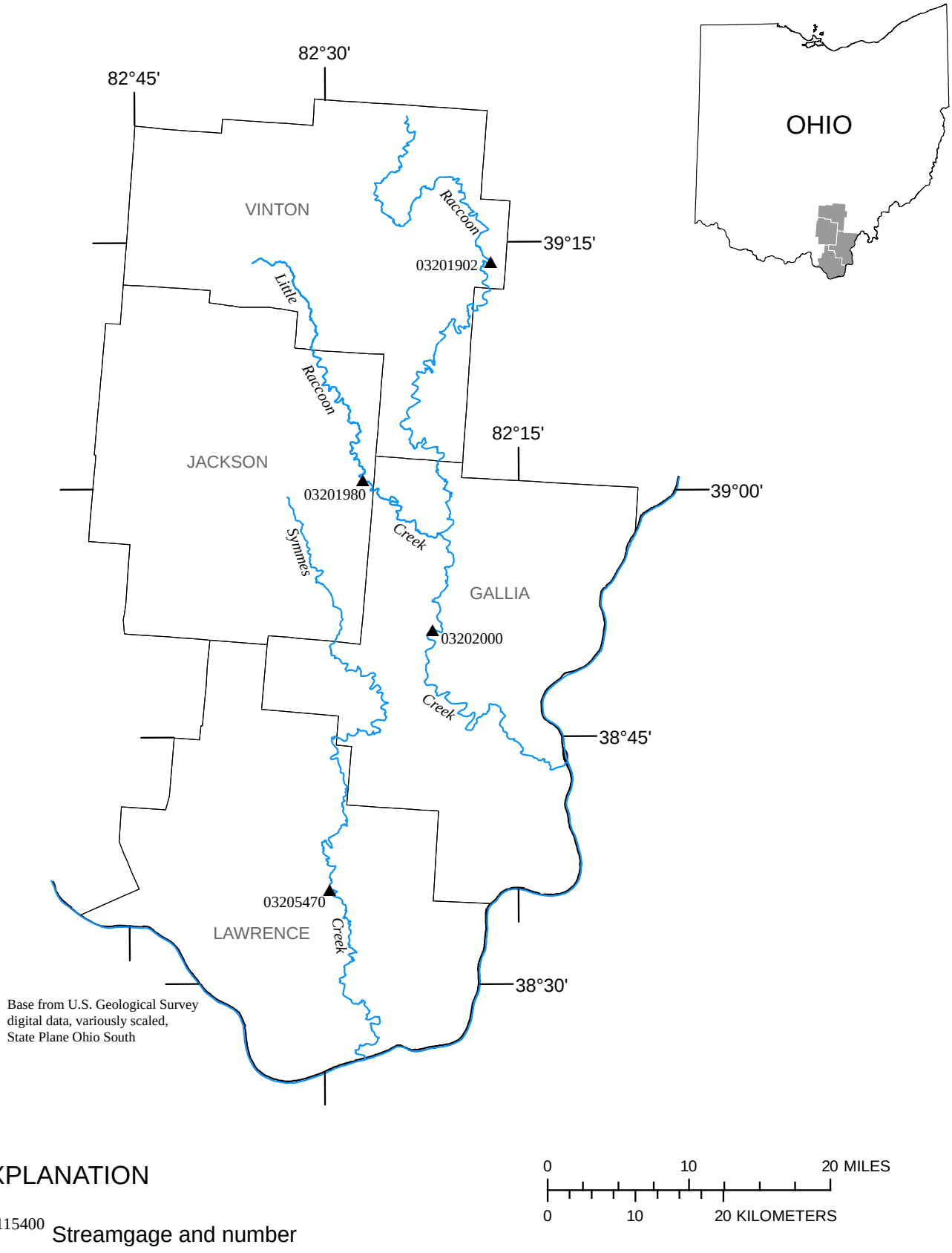



**Figure 13.** Selected areas of southern Ohio affected by flooding during September 8–11, 2004.

**Table 6.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 8–11, 2004.

[mi², square miles; ft, feet (above gage datum); ft³/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi²) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 8, 2004 | | | Maximum during September 8–11, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft³/s) | Date | Stage (ft) | Streamflow (ft³/s) | |
| 03141500 | Seneca Fork below Senecaville Dam near Senecaville | 118 | 799[b] | 68 | 1998 | 9.51 | 977 | 9/8/2004 | 9.09 | N/A | N/A |
| 03149500 | Salt Creek near Chandlersville | 75.7 | 681.71[b] | 19 | 1940 | 15.06 | 5,240 | 9/8/2004 | 22.26 | 13,500 | > 500[c] |
| 03086500 | Mahoning River at Alliance | 89.2 | 1,037.3[d] | 66 | 1959 | 9.11 | 9,740 | 9/9//2004 | 8.09 | 7,380 | 50–100[c] |
| 03094000 | Mahoning River at Leavittsburg | 575 | 871.25[d] | 67 | 1959 | 19.37[e] | 20,300 | 9/9/2004 | 10.91 | 4,690 | N/A |
| 03097550 | Mahoning River at Ohio Edison Power Plant at Niles | 854 | 843.08[b] | 19 | 2003 | 15.42 | 13,000 | 9/9/2004 | 11.78 | 8,470 | N/A |
| 03098600 | Mahoning River below West Ave at Youngstown | 978 | 824.10[b] | 19 | 2003 | 17.49 | 15,800 | 9/9/2004 | 14.29 | 12,600 | N/A |
| 03109500 | Little Beaver Creek near East Liverpool | 496 | 702.77[d] | 92 | 1941 | 17.40 | 25,000 | 9/9/2004 | 16.48 | 22,300 | 25–50[c] |
| 03110000 | Yellow Creek near Hammondsville | 147 | 692.10[b] | 66 | 1952 | 12.17 | 9,580 | 9/9/2004 | 12.98 | 10,500 | 100–500[c] |
| 03111500 | Short Creek near Dillonvale | 123 | 676.10[b] | 65 | 1990 | 12.27 | 8,200 | 9/9/2004 | 11.41 | 6,530 | 25–50[c] |
| 03111548 | Wheeling Creek below Blaine | 97.7 | 699.11[b] | 25 | 1998 | 8.21 | 5,470 | 9/9/2004 | 9.86 | 5,350 | 10–25[c] |
| 03115400 | Little Muskingum River at Bloomfield | 210 | 645.99[b] | 32 | 1998 | 30.78 | 32,300 | 9/9/2004 | 27.63 | 17,600 | 25–50[c] |
| 03117000 | Tuscarawas River at Massillon | 518 | 916d | 68 | 1969 | 16.43 | 10,700 | 9/9/2004 | 7.63 | 2,670 | < 2[c] |
| 03118000 | Middle Branch Nimishillen Creek at Canton | 43.1 | 1,046.60[d] | 66 | 1959 | 6.50[f] | 2,470 | 9/9/2004 | 5.47 | 592 | < 2[c] |
| 03118500 | Nimishillen Creek at North Industry | 175 | 976.72[d] | 85 | 2003 | 14.18 | 9,310 | 9/9/2004 | 8.98 | 4,280 | 2–5[c] |

**Table 6.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 8–11, 2004. —Continued

[mi², square miles; ft, feet (above gage datum); ft³/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi²) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 8, 2004 | | | Maximum during September 8–11, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft³/s) | Date | Stage (ft) | Streamflow (ft³/s) | |
| 03121850 | Huff Run at Mineral City | 12.3 | 886.98[b] | 9 | 2000 | 5.16 | 1,090 | 9/9/2004 | 5.82 | 1,860 | > 500[g] |
| 03126000 | Stillwater Creek at Piedmont | 122 | 872[d] | 68 | 1998 | 10.75 | 3,770 | 9/9/2004 | 11.98 | 1,520 | N/A |
| 03141870 | Leatherwood Creek near Kipling | 69.5 | 790[b] | 6 | 2002 | 12.06 | 1,240 | 9/9/2004 | 15.45 | 5,300 | 25–50[g] |
| 03144000 | Wakatomika Creek near Frazeysburg | 140 | 748.12[d] | 71 | 1979 | 14.07 | 16,800 | 9/9/2004 | 5.91 | 2,430 | < 2[c] |
| 03144500 | Muskingum River at Dresden | 5,993 | 693.15[d] | 86 | 1913 | 46.00 | 228,000 | 9/9/2004 | 15.63 | N/A | N/A |
| 03148000 | Muskingum River at Zanesville | 6,850 | 667[b] | 17 | 1952 | N/A | 80,900 | 9/9/2004 | 15.98 | N/A | N/A |
| 03150000 | Muskingum River at McConnelsville | 7,422 | 650.31[d] | 79 | 1913 | 33.50 | 270,000 | 9/9/2004 | 11.71 | 45,900 | < 2[c] |
| 03158200 | Monday Creek at Doanville | 114 | 650[h] | 9 | 1998 | 19.42 | 5,130 | 9/9/2004 | 17.26 | 2,960 | 2–5[g] |
| 03159000 | Sunday Creek at Glouster | 104 | 665.23[c] | 60 | 1907 | 22.00 | N/A | 9/9/2004 | 16.42 | N/A | N/A |
| 03159246 | Sunday Creek below Millfield | 126 | 670h | 4 | 2003 | 9.10 | 1,880 | 9/9/2004 | 22.73 | 3,690 | N/A |
| 03159540 | Shade River near Chester | 156 | 576.91[c] | 41 | 1997 | 31.44 | 15,600 | 9/9/2004 | 21.55 | 4,760 | 2–5[c] |
| 03201980 | Little Raccoon Creek near Ewington | 118 | 799[d] | 9 | 2000 | 15.83 | 8,450 | 9/9/2004 | 10.51 | 803 | < 2[g] |
| 03202000 | Raccoon Creek at Adamsville | 585 | 570.04[c] | 83 | 1968 | 28.69 | 20,000 | 9/9/2004 | 15.40 | 4,140 | < 2[c] |
| 03205470 | Symmes Creek at Aid | 302 | 590[c] | 6 | 2001 | 23.56 | 7,100 | 9/9/2004 | 17.68 | 3,060 | < 2[g] |
| 03093000 | Eagle Creek at Phalanx Station | 97.6 | 887.14[c] | 77 | 1959 | 13.12 | 6,700 | 9/10/2004 | 10.65 | 1,360 | < 2[c] |

**Table 6.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 8–11, 2004. —Continued

[mi$^2$, square miles; ft, feet (above gage datum); ft$^3$/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi$^2$) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 8, 2004 | | | Maximum during September 8–11, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft$^3$/s) | Date | Stage (ft) | Streamflow (ft$^3$/s) | |
| 03117500 | Sandy Creek at Waynesburg | 253 | 955[d] | 68 | 1959 | 10.05 | 15,000 | 9/10/2004 | 9.00 | 7,970 | 25–50[c] |
| 03120500 | McGuire Creek near Leesville | 48.3 | 915[c] | 65 | 1940 | 7.88 | 740 | 9/10/2004 | 6.57 | 558 | N/A |
| 03127000 | Stillwater Creek at Tippecanoe | 282 | 849[d] | 68 | 1963 | 17.29[i] | 4,410 | 9/10/2004 | 17.64 | 4,740 | N/A |
| 03129000 | Tuscarawas River at Newcomerstown | 2,443 | 780[d] | 84 | 1913 | 21.50 | 83,000 | 9/10/2004 | 9.8 | 14,100 | < 2[c] |
| 03142000 | Wills Creek at Cambridge | 406 | 772.34[c] | 72 | 1998 | 26.91 | 11,400 | 9/10/2004 | 24.93 | 9,110 | N/A |
| 03159500 | Hocking River at Athens | 943 | 611.26[d] | 94 | 1907 | 27.00 | 50,000 | 9/10/2004 | 19.91 | 13,300 | 2–5[c] |
| 03201902 | Raccoon Creek near Bolins Mills | 205 | 680[h] | 5 | 1985 | 14.50[j] | 3,130 | 9/10/2004 | 14.83 | 2,990 | N/A |
| 03124500 | Sugar Creek at Strasburg | 311 | 896.24[d] | 53 | 1935 | 12.70 | 19,700 | 9/11/2004 | 5.02 | 1,590 | N/A |
| 03147500 | Licking River below Dillon Dam near Dillon Falls | 742 | 700[b] | 68 | 1959 | 32.46[k] | 47,000 | 9/11/2004 | 9.07 | N/A | N/A |

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

[b] NGVD 1929.

[c] Based on weighted estimates from Koltun and others (2006).

[d] COE 1912.

[e] A peak stage of 24.00 ft occurred in water year 1913 but there is no associated peak discharge.

[f] A peak stage of 6.63 ft occurred in water year 2003 but is associated with a peak discharge of only 1,630 ft$^3$/s.

[g] Based on frequency estimates from Ohio StreamStats (U.S. Geological Survey, 2007).

[h] From topographic map.

[i] A peak stage of 17.69 ft occurred in water year 1998 but is associated with a peak discharge of only 3,770 ft$^3$/s.

[j] A peak stage of 14.91 ft occurred in water year 2003 but is associated with a peak discharge of only 2,530 ft$^3$/s.

[k] A peak stage of 37.00 ft occurred in water year 1913 but is associated with a peak discharge of only 39,000 ft$^3$/s.

# September 17–22, 2004 Flood

Remnants of Hurricane Ivan passed over eastern Ohio on September 17–18, resulting in flooding in eastern Ohio during September 17–22, 2004. These storms affected areas that had just been flooded by heavy rains from Hurricane Frances. The wet conditions left from Hurricane Frances likely increased the severity of flooding that resulted from these storms.

## Storms of September 17–18, 2004

On September 16, 2004, Hurricane Ivan made landfall on the Gulf Coast at the Alabama–Florida border as a category 3 hurricane[11]. It then moved northeast into Alabama (fig. 14). As Hurricane Ivan moved northeast on the evening of September 16, winds decreased and it was classified as a tropical storm over central Alabama. As winds continued to decrease in the early morning of September 17, Ivan was classified as a tropical depression over northeast Alabama. Ivan continued to move northeast across Tennessee and Virginia before it became extratropical over the Delmarva Peninsula on the afternoon of September 18. The remaining path of Ivan, before its dissipation over eastern Texas, is described in detail in Franklin and others (2006) and is not relevant to flooding in Ohio.

The outer rainbands associated with the remnants of Hurricane Ivan began to move over southern Ohio on the evening of September 16, with heavier rains beginning in southern Ohio in the early morning of September 17. Similar to the stationary front over southeastern Ohio at the time remnants of Hurricane Frances passed over Ohio, a cold front moving southeast across southeastern Ohio provided further uplift of these storms, increasing convection and increasing rainfall totals over eastern Ohio. This rain event lasted until the late morning of September 18, as the remnants of Hurricane Ivan moved off to the east.

During September 17–18, 2004, most of eastern Ohio received 2–5 in. of rainfall (fig. 15). More than 6 in. of rain fell in parts of Monroe and Washington counties. The largest rainfall amount, 6.75 in. in 48 hours, was recorded at the Woodsfield rain gage in Monroe County. Rainfall intensities and recurrence intervals for selected NWS sites from this storm are listed in table 7.

## General Description of the September 17–22, 2004 Flood

The following sections present information about the flooding during September 17–22, 2004, that resulted from the September 17–18, 2004 storms. This section will discuss streamflow and stage data at selected USGS streamgages in the affected counties (fig. 4). The omission from this report of any rivers or communities that experienced flooding is not a reflection of the severity of the flooding or the impact on those communities but rather is due to lack of available streamflow data.

### Areal Distribution

The counties listed in table 8 were declared Federal disaster areas (FEMA–1556–DR) as a result of the flooding during September 17–22, 2004. Table 8 also lists the areas affected by the flooding and the streams that caused the flooding. Locations of USGS streamgages and streams in the areas flooded are shown in figures 16–18.

[11] According to the Saffir-Simpson Hurricane Scale: a category 3 hurricane has winds 111–130 mi/h and storm surges 9–12 ft above normal (National Hurricane Center, 2007a).

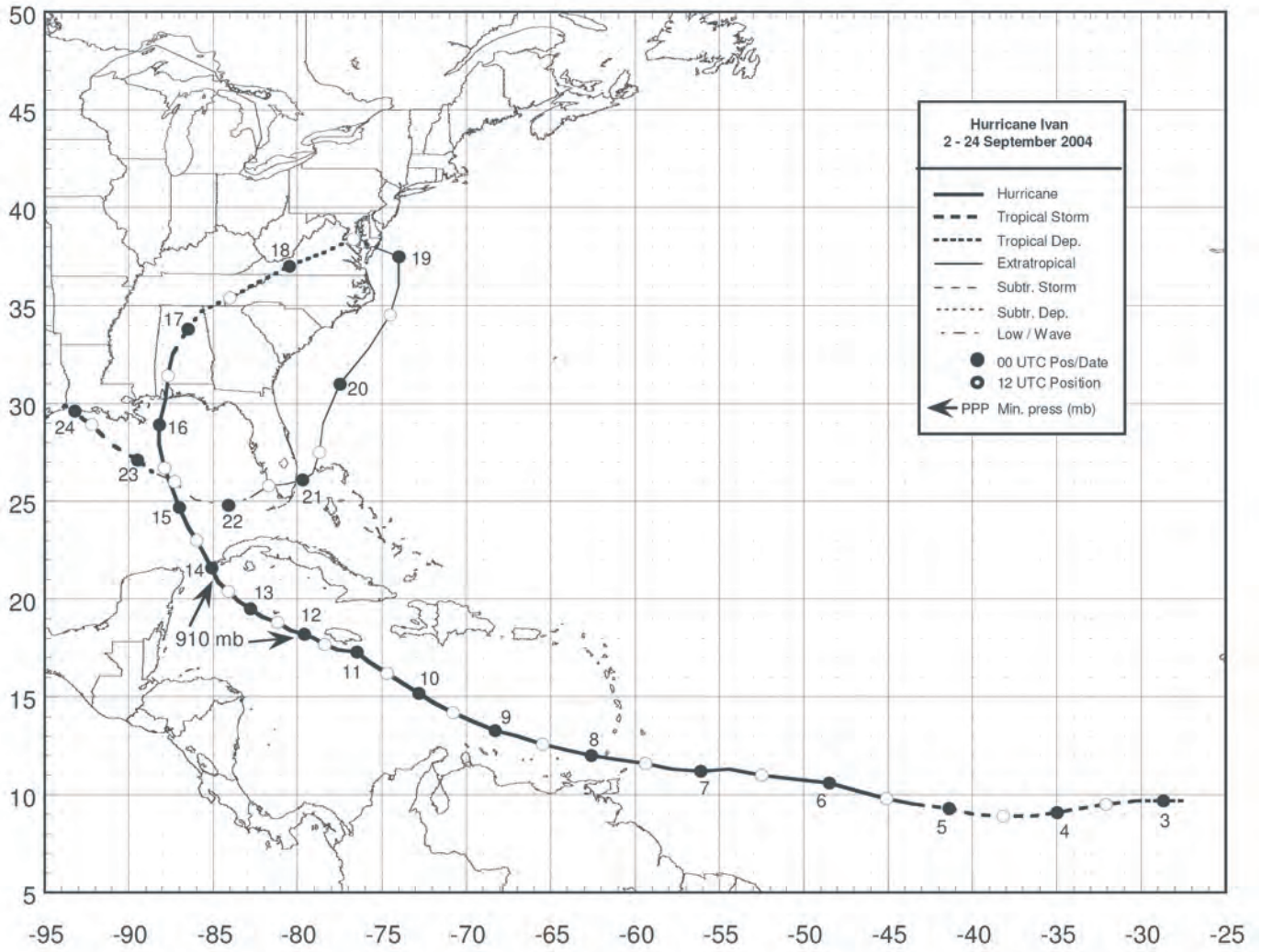
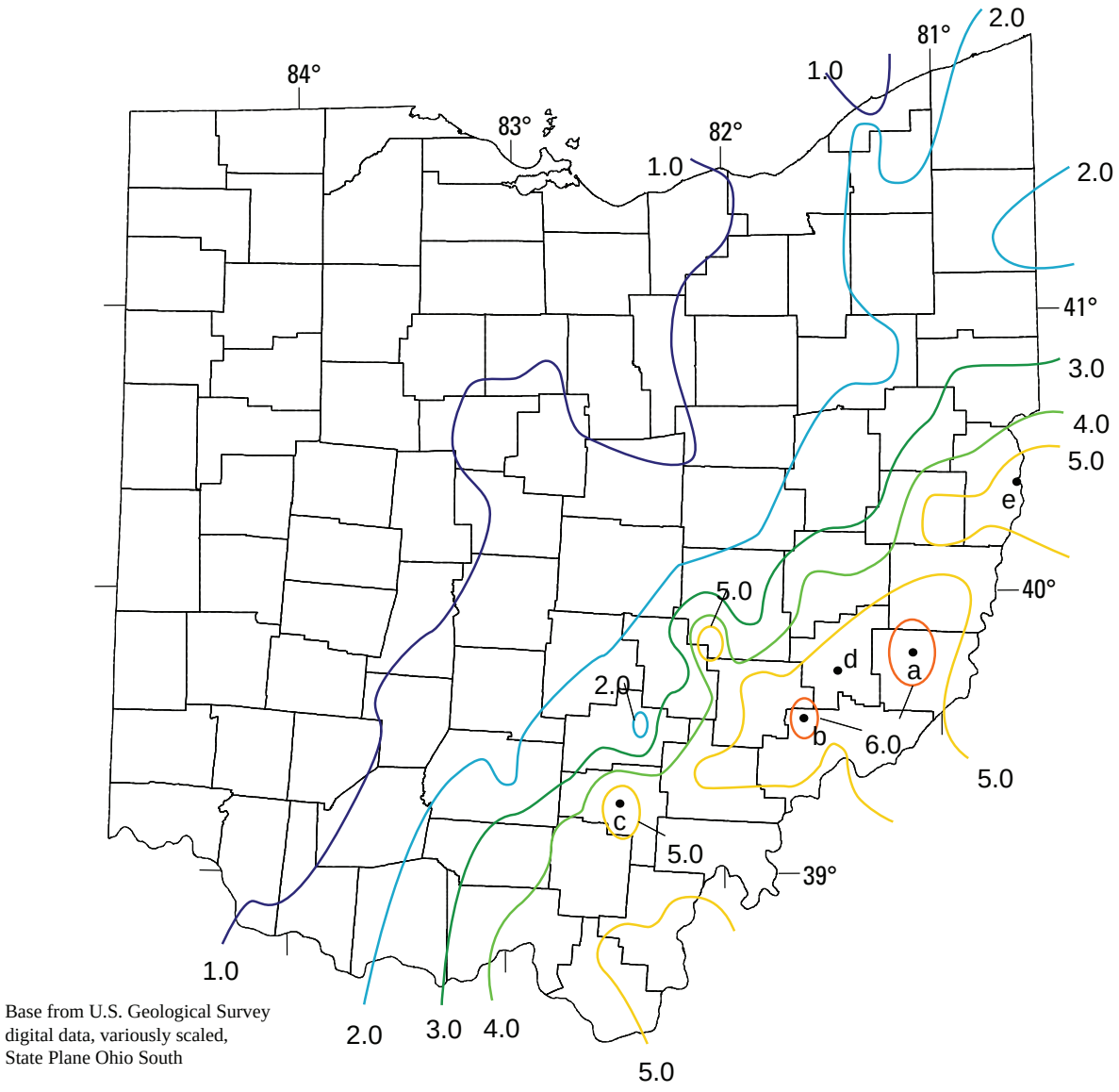



**Figure 14.** Best track positions for the eye of Hurricane Ivan for September 3–24, 2004 (reproduced from Stewart, 2005). (Tropical Dep., Tropical Depression; Subtr. Storm, Subtropical Storm; Subtr. Dep., Subtropical depression; UTC, Universal Coordinated Time; mb, millibars).




EXPLANATION

4.0 Line of equal 48-hour total rainfall, in inches

a Rain gage station name
- a - Woodsfield 2 N
- b - Beverly STP
- c - McArthur
- d - Caldwell 3 SE
- e - Steubenville

0 50 100 MILES

0 50 100 KILOMETERS

**Figure 15.** Isohyetal map of 48-hour rainfall totals in Ohio for September 17–18, 2004. Based on data collected at 129 rain gages throughout Ohio (National Oceanic and Atmospheric Administration, 2004b).

**Table 7.** Precipitation totals and recurrence intervals for selected National Weather Service rain gages in Ohio for September 17–18, 2004. Station locations are shown on figure 15.

[Data from National Oceanic and Atmospheric Administration, 2004b]

| Station name | County | Period (hours) | Precipitation (inches) | Recurrence interval[1] (years) |
|---|---|---|---|---|
| Woodsfield 2 N | Monroe | 48 | 6.75 | 200–500 |
| Beverly STP | Washington | 48 | 6.39 | 100–200 |
| McArthur | Vinton | 48 | 5.99 | 50–100 |
| Caldwell 3 SE | Noble | 48 | 5.74 | 50–100 |
| Steubenville | Jefferson | 48 | 5.49 | 50–100 |

[1]From National Weather Service (2007c).

**Table 8.** Areas and streams affected by flooding during September 17–22, 2004.

[Data from Angel and others, 2004b]

| County | Stream(s) | Areas | Figure |
|---|---|---|---|
| Athens | Sunday Creek | Widespread | 16 |
| | Shade River | Widespread | 24 |
| Belmont | McMahon Creek | Neffs | 27 |
| | Little McMahon Creek | Neffs | 17 |
| | Wheeling Creek | Bridgeport, Brookside, and Lansing | 17 |
| | Captina Creek | Powhatan Point | 17 |
| | *Data not available* | St. Clairsville | 17 |
| Columbiana | Little Beaver Creek and its tributaries | Salem, Leetonia, Lisbon, and Summitville | 18 |
| | Lisbon Creek | Lisbon | 18 |
| | Ohio River and its tributaries | East Liverpool and Wellsville | 18 |
| | Sandy Creek | Kensington | 18 |
| | Middle Branch Sandy Creek | Homeworth | 18 |
| Gallia | Raccoon Creek | Widespread | 16 |
| | Little Raccoon Creek | Widespread | 16 |
| | Symmes Creek | Widespread | 16 |
| Guernsey | Leatherwood Creek | Quaker City | 17 |
| | Wills Creek and its tributaries | Winterset | 17 |
| Harrison | Conotton Creek | Scio and Bowerston | 18 |
| | Short Creek and its tributaries | Cadiz | 18 |
| Jefferson | Ohio River and its tributaries | Brilliant, Mingo Junction, Steubenville, Toronto, Empire, and Stratton | 18 |

**Table 8.** Areas and streams affected by flooding during September 17–22, 2004. —Continued

[Data from Angel and others, 2004b]

| County | Stream(s) | Areas | Figure |
|---|---|---|---|
| Lawrence | Symmes Creek | Widespread | 16 |
| Mahoning | Tributary of the Mahoning River | Beloit | 18 |
| Meigs | Shade River | Widespread | 16 |
| | Ohio River and its tributaries | Racine and Pomeroy | 16 |
| Morgan | Muskingum River and its tributaries | Widespread | 17 |
| Monroe | Sunfish Creek | Woodsfield and Clarington | 17 |
| | Wheeler Run | Woodsfield | 17 |
| | Ohio River and its tributaries | Hannibal, Duffy, and Sardis | 17 |
| Muskingum | Salt Creek | Duncan Falls | 17 |
| | Muskingum River | Duncan Falls | 17 |
| Noble | Buffalo Creek and its tributaries | Sarahsville | 17 |
| | Seneca Fork Wills Creek and its tributaries | Batesville | 17 |
| | West Fork Duck Creek | Caldwell | 17 |
| Perry | Sunday Creek | Widespread | 16 |
| Trumbull | *Data not available* | Widespread | 18 |
| Vinton | Raccoon Creek | Widespread | 16 |
| | Little Raccoon Creek | Widespread | 16 |
| Washington | Duck Creek | Macksburg, Elba, and Lower Salem | 17 |
| | Little Muskingum River | New Matamoras, Wingett Run, and Bloomfield | 17 |
| | Ohio River and its tributaries | New Matamoras, Marietta, and Belpre | 17 |

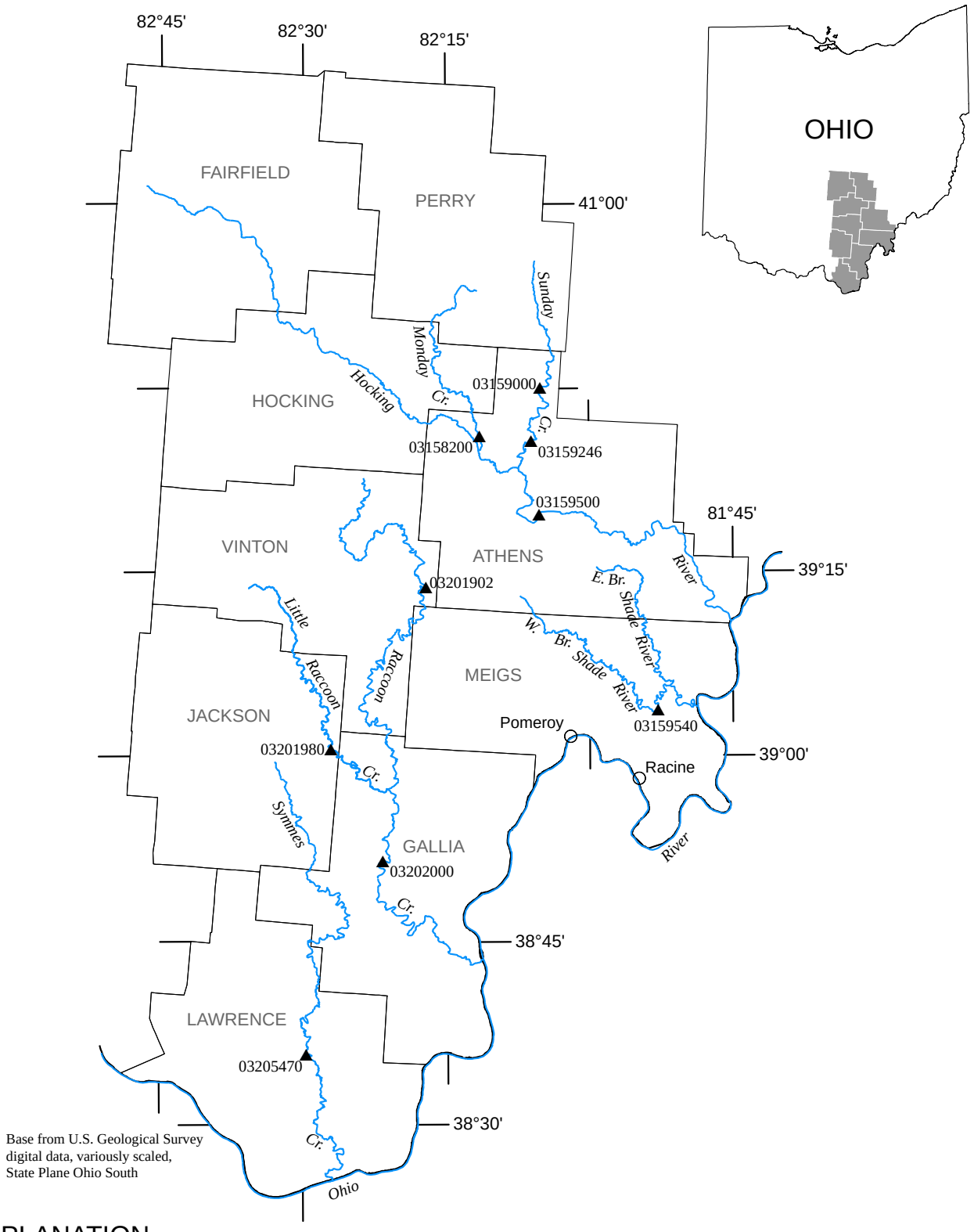



**Figure 16.** Selected areas of southeastern Ohio affected by flooding during September 17–22, 2004.

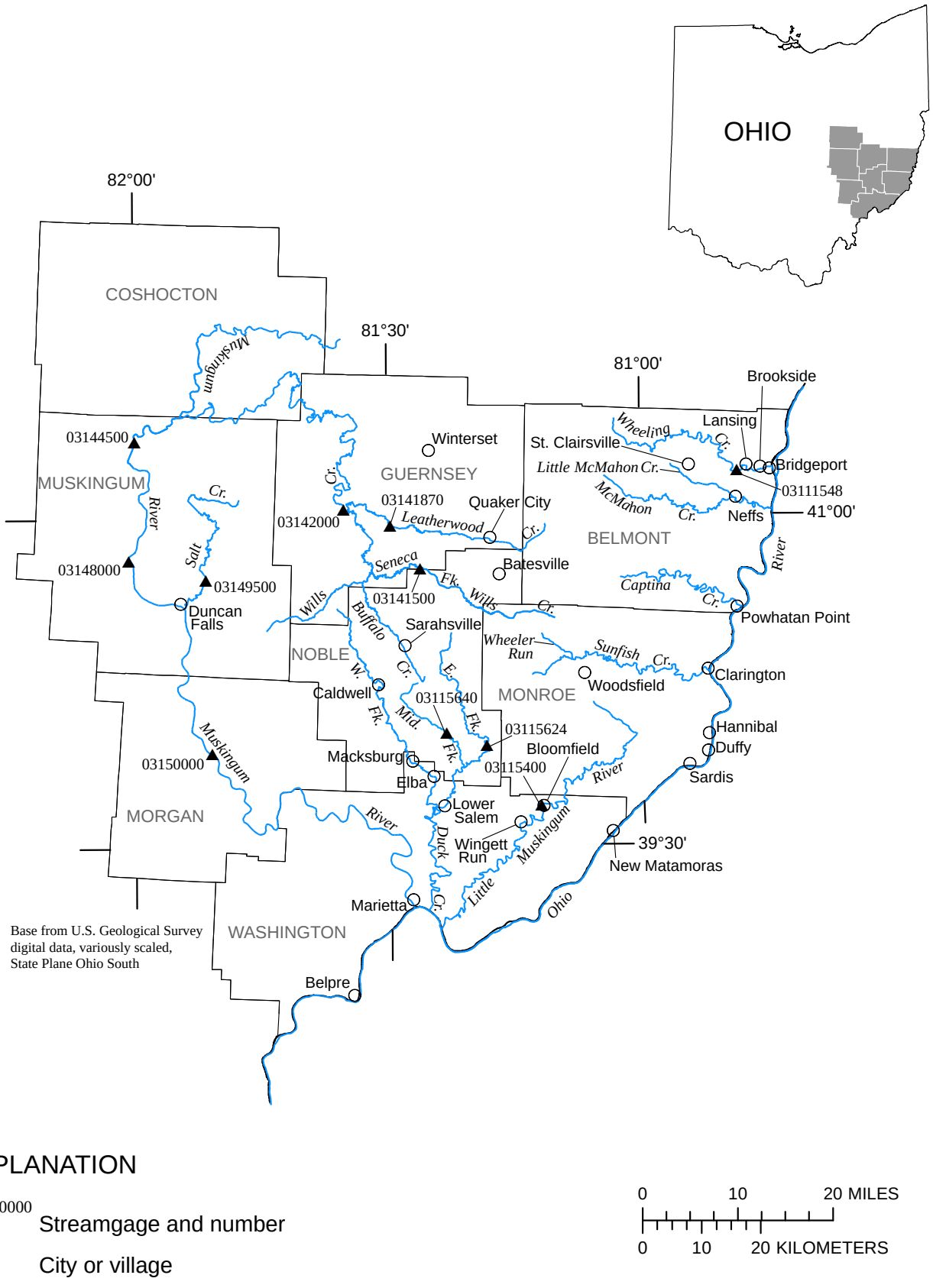



**Figure 17.** Selected areas of eastern Ohio affected by flooding during September 17–22, 2004.

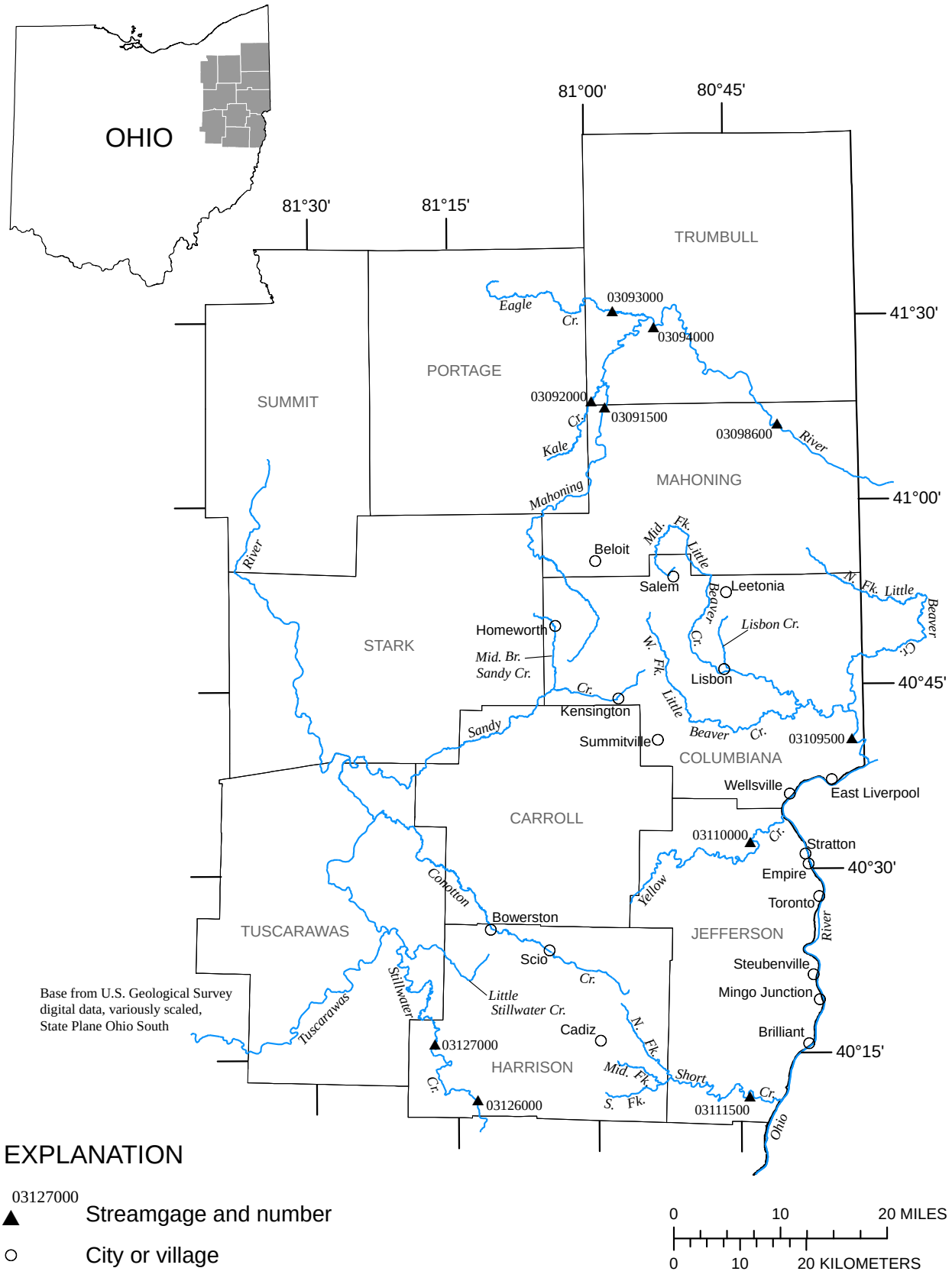



**Figure 18.** Selected areas of northeastern Ohio affected by flooding during September 17–22, 2004.

### Flood Stages, Streamflows, and Recurrence Intervals

USGS streamgage records were examined to determine which streams were most affected by these storms. The peak streamflows for those streams affected by this event were compared to the recurrence intervals for streamflows that are reported in Koltun and others (2006). For streamgages that did not have sufficient record to compute a reliable recurrence-interval estimate and so are not reported in Koltun and others (2006), recurrence intervals were estimated by use of Ohio StreamStats (U.S. Geological Survey, 2007). Table 9 lists the peak stage, peak streamflow, and recurrence-interval range for selected USGS streamgages for September 17–22, 2004. For those stations on regulated rivers, a recurrence interval is not given. Record peak streamflow occurred at Short Creek near Dillonvale (station 03111500), Wheeling Creek below Blaine (station 03111548), Little Muskingum River at Bloomfield (station 03114500), East Fork Duck Creek near Road Fork (station 03115624), Middle Fork Duck Creek at Middlesburg (station 03115640), Seneca Fork below Senecaville Dam near Senecaville (station 03141500), Leatherwood Creek near Kipling (station 03141870), and Sunday Creek below Millfield (station 03159246). The recurrence intervals equal to or greater than 500 years estimated for Short Creek near Dillonvale (station 03111500), Little Muskingum River at Bloomfield (station 03115400), East Fork Duck Creek near Road Fork (station 03115624), Middle Fork Duck Creek at Middleburg (station 03115640), and Leatherwood Creek near Kipling (station 03141870) were the largest recurrence intervals estimated at USGS streamgages for August 28–September 22, 2004.

## Flood and Storm Damages Associated with FEMA-1556-DR

Although it was not possible to determine an exact value of the damages caused by the flooding, Ohio EMA was able to obtain some estimates of the extent of the damage. According to the Ohio EMA (Kay Phillips, written commun., 2007), flooding for the period August 27–September 27, 2004, resulted in four deaths and damage to or destruction of 2,563 private properties. Damages to public property were estimated to be $45 million. FEMA approved more than $52 million of assistance to aid in the repair of both public and private properties. The Small Business Administration approved an additional $28.7 million in loans to aid with repair of local businesses affected by the flooding.

Tables 10 and 11 list the extent of the damages to private and public property. Table 10 lists the estimated damages incurred to private property (Individual Assistance). Table 11 indicates estimated damages to public properties such as city and county buildings, roadways, vehicles, certain utilities, and other publicly owned property.

**Table 9.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 17–22, 2004.

[mi², square miles; ft, feet (above gage datum); ft³/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi²) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 17, 2004 | | | Maximum during September 17–22, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft³/s) | Date | Stage (ft) | Streamflow (ft³/s) | |
| 03092000 | Kale Creek near Pricetown | 21.9 | 914.7[b] | 42 | 1959 | 8.52 | 3,890 | 9/17/2004 | 5.29 | N/A | N/A |
| 03098600 | Mahoning River below West Ave at Youngstown | 978 | 824.10[c] | 19 | 2003 | 17.49 | 15,800 | 9/17/2004 | 14.25 | 12,600 | N/A |
| 03109500 | Little Beaver Creek near East Liverpool | 496 | 702.77[b] | 92 | 1941 | 17.40 | 25,000 | 9/17/2004 | 13.87 | 15,200 | 5–10[d] |
| 03111500 | Short Creek near Dillonvale | 123 | 676.10[c] | 65 | 1990 | 12.27 | 8,200 | 9/17/2004 | 12.65 | 9,110 | 500[d] |
| 03111548 | Wheeling Creek below Blaine | 97.7 | 699.11[c] | 25 | 2004 | 9.86 | 5,350 | 9/17/2004 | 12.54 | 8,500 | 50–100[d] |
| 03141500 | Seneca Fork below Senecaville Dam near Senecaville | 118 | 799[b] | 68 | 1998 | 9.51 | 977 | 9/17/2004 | 9.88 | 1,030 | N/A |
| 03149500 | Salt Creek near Chandlersville | 75.7 | 681.71[c] | 19 | 2004 | 22.26 | 13,500 | 9/17/2004 | 16.2 | 3,740 | 2–5[d] |
| 03150000 | Muskingum River at McConnelsville | 7,422 | 650.31[b] | 79 | 1913 | 33.50 | 270,000 | 9/17/2004 | 9.82 | 34,000 | < 2[d] |
| 03159000 | Sunday Creek at Glouster | 104 | 665.23[e] | 60 | 1907 | 22.00 | N/A | 9/17/2004 | 17.59 | N/A | N/A |
| 03093000 | Eagle Creek at Phalanx Station | 97.6 | 887.14[c] | 77 | 1959 | 13.12 | 6,700 | 9/18/2004 | 11.7 | 2,030 | < 2[d] |
| 03094000 | Mahoning River at Leavittsburg | 575 | 871.25[b] | 67 | 1959 | 19.37[f] | 20,300 | 9/18/2004 | 11.62 | 5,240 | N/A |
| 03110000 | Yellow Creek near Hammondsville | 147 | 692.10[c] | 66 | 2004 | 12.98 | 10,500 | 9/18/2004 | 11.81 | 8,530 | 50–100[d] |
| 03115400 | Little Muskingum River at Bloomfield | 210 | 645.99[c] | 32 | 1998 | 30.78 | 32,300 | 9/18/2004 | 32.16 | 41,600 | > 500[d] |
| 03115624 | East Fork Duck Creek near Road Fork | 61.3 | N/A[g] | 5 | 2003 | 92.48 | 2,100 | 9/18/2004 | 103.50 | 12,450 | > 500[h] |

**Table 9.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 17–22, 2004. —Continued

[mi$^2$, square miles; ft, feet (above gage datum); ft$^3$/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi$^2$) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 17, 2004 | | | Maximum during September 17–22, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft$^3$/s) | Date | Stage (ft) | Streamflow (ft$^3$/s) | |
| 03115640 | Middle Fork Duck Creek at Middleburg | 20.5 | N/A[g] | 5 | 2003 | 93.98 | 1,750 | 9/18/2004 | 99.38 | 5,460 | > 500[h] |
| 03126000 | Stillwater Creek at Piedmont | 122 | 872[b] | 68 | 1998 | 10.75 | 3,770 | 9/18/2004 | 11.86 | N/A | N/A |
| 03141870 | Leatherwood Creek near Kipling | 69.5 | 790[c] | 6 | 2004 | 15.45 | 5,300 | 9/18/2004 | 17.21 | 10,100 | > 500[h] |
| 03144500 | Muskingum River at Dresden | 5,993 | 693.15[b] | 86 | 1913 | 46.00 | 228,000 | 9/18/2004 | 15.47 | N/A | N/A |
| 03148000 | Muskingum River at Zanesville | 6,850 | 667[c] | 17 | 1952 | N/A | 80,900 | 9/18/2004 | 15.3 | N/A | N/A |
| 03158200 | Monday Creek at Doanville | 114 | 650[i] | 9 | 1998 | 19.42 | 5,130 | 9/18/2004 | 16.69 | 2,660 | 2–5[h] |
| 03159246 | Sunday Creek below Millfield | 126 | 670[i] | 4 | 2004 | 22.73 | 3,690 | 9/18/2004 | 24.48 | 4,440 | N/A |
| 03159500 | Hocking River at Athens | 943 | 611.26[b] | 94 | 1907 | 27.00 | 50,000 | 9/18/2004 | 20.79 | 14,400 | 2–5[d] |
| 03159540 | Shade River near Chester | 156 | 576.91[c] | 41 | 1997 | 31.44 | 15,600 | 9/18/2004 | 30.04 | 11,100 | 50–100[d] |
| 03201902 | Raccoon Creek near Bolins Mills | 205 | 680[i] | 5 | 1985 | 14.50 | 3,130 | 9/18/2004 | 17.05 | 5,000 | N/A |
| 03201980 | Little Raccoon Creek near Ewington | 118 | 799[b] | 9 | 2000 | 15.83 | 8,450 | 9/18/2004 | 15.18 | 6,270 | 25–50[h] |
| 03205470 | Symmes Creek at Aid | 302 | 590[c] | 6 | 2001 | 23.56 | 7,100 | 9/18/2004 | 23.44 | 6,510 | 2–5[h] |
| 03127000 | Stillwater Creek at Tippecanoe | 282 | 849[b] | 68 | 2004 | 17.64[j] | 4,740 | 9/19/2004 | 17.42 | N/A | N/A |
| 03142000 | Wills Creek at Cambridge | 406 | 772.34[c] | 72 | 1998 | 26.91 | 11,400 | 9/19/2004 | 22.88 | 7,360 | N/A |

**Table 9.** Peak stages, peak streamflows, and estimated recurrence-interval ranges at selected USGS streamgages in Ohio, September 17–22, 2004. —Continued

[mi$^2$, square miles; ft, feet (above gage datum); ft$^3$/s, cubic feet per second; <, less than; >, greater than; N/A, not available; thick lines separate dates of max. peak]

| Permanent station number | Stream and place of determination | Drainage area (mi$^2$) | Gage datum (ft) | Period of systematic record (water years)[a] | Maximum prior to September 17, 2004 | | | Maximum during September 17–22, 2004 | | | Estimated recurrence-interval range (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water year[a] | Stage (ft) | Streamflow (ft$^3$/s) | Date | Stage (ft) | Streamflow (ft$^3$/s) | |
| 03202000 | Raccoon Creek at Adamsville | 585 | 570.04[c] | 83 | 1968 | 28.69 | 20,000 | 9/20/2004 | 20.18 | 6,910 | 2–5[d] |
| 03091500 | Mahoning River at Pricetown | 273 | 905[b] | 77 | 1937 | 15.01 | 6,770 | 9/22/2004 | 6.51 | 1,850 | N/A |

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

[b] COE 1912.

[c] NGVD 1929.

[d] Based on weighted estimates from Koltun and others (2006).

[e] NAVD 1988.

[f] A peak stage of 24.00 ft occurred in water year 1913 but there is no associated peak discharge.

[g] Gage datum is based on an arbitrary datum.

[h] Based on frequency estimates from Ohio StreamStats (U.S. Geological Survey, 2007).

[i] From topographic map.

[j] A peak stage of 17.69 ft occurred in water year 1998 but is associated with a peak discharge of only 3,770 ft$^3$/s.

**Table 10.** Damage estimates for Individual Assistance associated with Federal Emergency Management Agency disaster declaration FEMA–1556–DR.

[Source: Kay Phillips, Ohio Emergency Management Agency, written commun., 2007]

| County | Structures damaged[1] | Structures destroyed[2] | Deaths |
|---|---|---|---|
| Athens | 124 | 28 | 0 |
| Belmont | 200 | 31 | 0 |
| Carroll | 130 | 0 | 0 |
| Columbiana | 99 | 19 | 0 |
| Gallia | 6 | 1 | 0 |
| Guernsey | 30 | 0 | 3 |
| Harrison | 137 | 9 | 0 |
| Jefferson | 451 | 4 | 0 |
| Lawrence | 8 | 3 | 0 |
| Mahoning | 310 | 0 | 0 |
| Meigs | 54 | 1 | 0 |
| Monroe | 11 | 6 | 0 |
| Morgan | 39 | 0 | 0 |
| Muskingum | 116 | 0 | 0 |
| Noble | 80 | 1 | 0 |
| Perry | 190 | 3 | 0 |
| Stark | 29 | 0 | 0 |
| Trumbull | 139 | 0 | 0 |
| Tuscarawas | 254 | 0 | 1 |
| Vinton | 29 | 2 | 0 |
| Washington | 18 | 1 | 0 |

[1] Properties that received damage considered to be repairable.

[2] Properties that were considered to be a total loss.

**Table 11.** Damage estimates for Public Assistance associated with Federal Emergency Management Agency disaster declaration FEMA–1556–DR.

[Source: Kay Phillips, Ohio Emergency Management Agency, written commun., 2007]

| County | Estimated damages |
|---|---|
| Athens | $386,000 |
| Belmont | $14,775,000 |
| Carroll | $275,000 |
| Columbiana | $6,649,000 |
| Gallia | $669,600 |
| Guernsey | $4,034,000 |
| Harrison | $1,130,200 |
| Jefferson | $2,571,000 |
| Meigs | $2,513,000 |
| Monroe | $3,448,200 |
| Morgan | $658,800 |
| Muskingum | $739,900 |
| Noble | $1,141,600 |
| Perry | $533,500 |
| Tuscarawas | $222,700 |
| Vinton | $65,000 |
| Washington | $5,207,000 |

## Summary

A band of severe thunderstorms near the end of August 2004, followed by the remnants of Hurricanes Frances and Ivan during the middle of September 2004, brought intense rains to eastern Ohio, resulting in flooding throughout much of the area from August 27 through September 27, 2004. From August 27 through August 28, localized thunderstorms affected a small area of eastern Ohio, with parts of Columbiana County receiving more than 7 in. of rain during that 48-hour period. From September 8 through September 9, 2004, as remnants of Hurricane Frances passed over eastern Ohio, rain was widespread across the region. Parts of Guernsey County received more than 8 in. of rainfall in this 48-hour period. From September 17 through September 18, as remnants of Hurricane Ivan passed over eastern Ohio, rain was widespread across the region. Parts of Monroe County received more than 6.5 in. of rain during this 48-hour period.

Floods with recurrence intervals of 500 years or greater occurred at seven USGS streamgages throughout eastern Ohio during August 28–September 27. These stations were: Salt Creek near Chandlersville (station 03149500), Huff Run at Mineral City (station 03121850), Short Creek near Dillonvale (station 03111500), Little Muskingum River at Bloomfield (station 03115400), East Fork Duck Creek near Road Fork (station 03115624), Middle Fork Duck Creek at Middleburg (station 03115640), and Leatherwood Creek near Kipling (station 03141870). Record peak streamflow occurred at 12 USGS streamgages.

In all, 21 counties in eastern Ohio were declared Federal disaster areas (FEMA–1556–DR) as a result of the storms and flooding from August 27 through September 27, 2004. Four storm- or flood-related fatalities were reported, and an economic impact of nearly $81 million was estimated by the Ohio EMA.

## Acknowledgments

Special thanks are extended to Kay Phillips of Ohio EMA for her help in providing damage estimates for the counties affected by this flood. Thanks also to Jeff Smith of the Ohio Geographically Referenced Information Program (OGRIP) for providing Ohio Statewide Imagery Program (OSIP) data used to make certain figures in this report.

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