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Floods of 2011 in New York

Scientific Investigations Report 2014–5058

U.S. Department of the Interior
U.S. Geological Survey

Cover. Satellite image of Hurricane Irene, August 28, 2011 (10:30 a.m.), courtesy of the National Aeronautics and Space Administration (NASA).

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By Richard Lumia, Gary D. Firda, and Travis L. Smith

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Conversion Factors, Datum, and Abbreviations

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
gallon (gal)	3.785	cubic decimeter (dm^3)
billion gallons (Bgal)	3.785412×10^6	cubic meters (m^3)
cubic foot (ft^3)	28.32	cubic decimeter (dm^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
million cubic feet (mil ft^3)	0.02832	million cubic meter (mil m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F–32)/1.8

Vertical coordinate information is referenced to either the National Geodetic Vertical Datum of 1929 (NGVD 29) or the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83) and the World Geodetic System 84 (WGS 84).

Barge Canal Datum (BCD) is site specific and there are local conversion factors, in feet, to National Geodetic Vertical Datum of 1929.

Military time (24-hour time) is used in the report.

Elevation, as used in this report, refers to the distance above the National Geodetic Vertical Datum of 1929 (NGVD 29) or the North American Vertical Datum of 1988 (NAVD 88).

Water year is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends. Thus, the year ending September 30, 2011, is called the "2011 water year."

Abbreviations

AEP	annual exceedance probability
FEMA	Federal Emergency Management Agency
HWM	high-water mark
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NWS	National Weather Service
NYCDEP	New York City Department of Environmental Protection
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
RI	recurrence interval
USGS	U.S. Geological Survey

Floods of 2011 in New York

By Richard Lumia, Gary D. Firda, and Travis L. Smith

Abstract

Record rainfall combined with above-average temperatures and substantial spring snowmelt resulted in record flooding throughout New York during 2011. Rainfall totals in eastern New York were the greatest since 1895 and as much as 60 percent above the long-term average within the Catskill Mountains area and the Susquehanna River Basin. This report documents the three largest storms and resultant flooding during the year: (1) spring storm during April and May, (2) Tropical Storm Irene during August, and (3) remnants of Tropical Storm Lee during September. According to the Federal Emergency Management Agency (FEMA), the cost of these three storms exceeded $1 billion in Federal disaster assistance.

A warm and wet spring in northern New York resulted in record flooding at 21 U.S. Geological Survey (USGS) active streamgages during late April to early May with the annual exceedance probabilities (AEPs) of 11 peak discharges equaling or exceeding 1 percent. Nearly 5 inches of rain during late April combined with a rapidly melting snowpack caused widespread flooding throughout northern New York, resulting in many road closures, millions of dollars in damages, and 23 counties declared disaster areas and eligible for public assistance. On May 6, Lake Champlain recorded its highest lake level in over 140 years.

Hurricane Irene entered New York State on August 28 as a tropical storm and traveled up the eastern corridor of the State, leaving a path of destruction and damage never seen in many parts of New York. Thirty-one counties in New York were declared disaster areas with damages of over $1.3 billion dollars and 10 reported deaths. Storm rainfall exceeded 18 inches in the Catskill Mountains area of southeastern New York with many other areas of eastern New York receiving over 7 inches. Catastrophic flooding resulted from the extreme rainfall in many locations, including Schoharie Creek and its tributaries, the eastern Delaware River Basin, the Ausable and Bouquet River Basins in northeastern New York, and several other stream basins throughout southeastern New York. Downstream reaches of the Mohawk River also had substantial flooding. Sixty-two USGS streamgages throughout eastern New York documented record high stream flows and elevations with AEPs of 25 peak discharges equaling or exceeding 1 percent. The USGS streamgage for the Schoharie Creek at Prattsville recorded its greatest peak discharge in 109 years of record at 120,000 cubic feet per second (greater than the 0.2-percent AEP discharge) on August 28. The peak water-surface elevation at the streamgage in Prattsville was 5 feet higher than its previous record in 1996. USGS personnel surveyed 184 high-water marks (HWMs) at 30 locations along an 84-mile reach of Schoharie Creek and compared the elevations to those published by FEMA for the 10-, 2-, 1-, and 0.2-percent AEP floods. Elevations in the lower reaches of the basin exceeded published elevations for the 0.2-percent AEP flood.

Remnants of Tropical Storm Lee brought a third major storm to New York in September 2011. Moisture from Lee began moving into New York on September 7 and intensified over the already saturated Susquehanna River Basin. Most of the rain fell on September 8 with storm totals nearing 13 inches in some areas (12.73 inches at Apalachin in Tioga County). Major disaster declarations were issued for 15 counties in and around central New York, making them eligible for individual or public assistance. Ten USGS streamgages within the Susquehanna River Basin documented record-high stream discharges and elevations on September 8, and all were greater than the 1-percent AEP discharge. USGS personnel surveyed 20 HWMs at 18 locations along a 114-mile reach of the Susquehanna River and compared the elevations to those published by FEMA for the 10-, 2-, 1-, and 0.2-percent AEP floods. Several of the surveyed HWMs exceeded published elevations for the 0.2-percent AEP flood.

Introduction

Major flooding followed three separate storms during 2011 across central and eastern New York State and adjacent states as a result of extreme rainfall, temperatures, and snowpack: (1) April–May spring storm, (2) Tropical Storm Irene in August, and (3) remnants of Tropical Storm Lee in September. Enhanced precipitation from these storms helped to make 2011 New York's wettest year on record (since 1895) with a yearly total precipitation of 54.16 inches (in.) on average across the State (a normal year produces 39.7 in.), according to the National Oceanic and Atmospheric Administration (2011k). It was also the eighth warmest year on record in New York. Historic annual and 2011 annual precipitation over 10 climate divisions of New York (fig. 1; National Oceanic and Atmospheric Administration, 2004) is summarized in table 1. Rainfall totals in the Catskill Mountains area and the Susquehanna River Basin (climate division 2) were the greatest since 1895 and as much as 59 percent above the long-term average.

The winter of 2010–11 had normal precipitation but below normal temperatures, which delayed the melting of more than 16 in. of water in the snowpack in the Adirondack Mountains of northern New York (National Oceanic and Atmospheric Administration, 2011l). The wettest spring on record combined with above-normal temperatures that melted the dense snowpack, resulting in major flooding across northern New York during late April and early May.

The summer of 2011 brought two major tropical storm systems through New York. Hurricane Irene weakened to a tropical storm that moved onshore at New York City and north through eastern New York on August 28 with torrential downpours of as much as 18 in. recorded in less than 24 hours in the Catskill Mountains area. Record flooding throughout much of eastern New York resulted. The remnants of Tropical Storm Lee brought heavy rains again to an already rain-soaked New York in early September. The heaviest rains were centered over the Susquehanna River Basin in south-central New York with over 12 in. recorded in some areas during September 6–9 (with most falling on September 8). Record flooding occurred in the Susquehanna River Basin.

The U.S. Geological Survey (USGS), in cooperation with the Federal Emergency Management Agency (FEMA), conducted this study during 2012–13 to characterize these three storms, document the flooding, and support future flood-mitigation efforts. FEMA calculated the cost of the three storms to be nearly $1 billion in Federal disaster assistance (Federal Emergency Management Agency, 2011a–c) as of February 24, 2014. It should be noted that flood-frequency analyses were done after the annual peak for the 2011 water year was determined by using USGS streamflow data, a log-Pearson type III (LP–III) distribution, and the guidelines of the Interagency Advisory Committee on Water Data (1982). For nonurbanized basins, the results of the LP–III analysis were weighted by the results of the regional flood-frequency analyses for streamgages with unregulated

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/CLIM_DIVS/new_york.gif

Figure 1. Climate divisions of New York. (National Oceanic and Atmospheric Administration, 2004)

Table 1. Annual 2011 and historic precipitation for 10 climate divisions of New York.

[Data from National Oceanic and Atmospheric Administration (2011k) are based on records since 1895; climate-division locations are shown on figure 1; rank is the order from largest to smallest since 1895; all listed trends are upward]

Climate division number	Climate division name	Average annual precipitation (inches)	Previous maximum annual precipitation (inches)	Year of previous maximum	2011 annual precipitation (inches)	Rank of 2011 precipitation	Percent-age of 2011 precipitation above average	Trend of annual precipitation (inches per century)
1	Western Plateau	36.8	49.00	1945	48.94	2	33.0	8.39
2	Eastern Plateau	41.5	57.51	1996	65.92	1	58.8	9.35
3	Northern Plateau	44.2	55.42	1990	56.24	1	27.2	2.28
4	Coastal	44.5	66.37	1983	59.76	3	34.3	8.36
5	Hudson Valley	42.5	56.71	1996	60.26	1	41.8	6.40
6	Mohawk Valley	44.3	57.89	1972	50.06	4	13.0	3.48
7	Champlain Valley	35.2	46.49	1990	53.22	1	51.2	2.45
8	St. Lawrence Valley	36.6	47.42	1954	40.35	20	10.2	1.52
9	Great Lakes	36.2	49.30	1977	45.11	6	24.6	7.73
10	Central Lakes	33.3	46.25	1972	45.32	3	36.1	8.64
	New York State	39.7	50.18	1977	54.16	1	36.4	6.32

streamflows (Lumia and others, 2006). Recurrence intervals at streamgages with substantial urbanization or regulated flows were calculated from statistical analyses of annual peak discharges during the urbanized or regulated period only (through 2011). No adjustments were made for the available storage in reservoirs before or during floods or for changes in regulations or increased urbanization during the period of record. Recurrence intervals at streamgages along the main stem of the Delaware River from Callicoon to Port Jervis were computed by fitting systematic annual peak-discharge data to an LP–III distribution for the period of record (Schopp and Firda, 2008).

Purpose and Scope

This report documents the 2011 flooding in New York State following the (1) April–May spring storm and snowmelt, (2) Tropical Storm Irene in August, and (3) remnants of Tropical Storm Lee in September. The climate and flood data associated with each of these three floods are presented in maps, graphs, and tables that focus on the area where the greatest flooding occurred. The westernmost part of New York State was not affected by substantial flooding in 2011.

The 2011 water year (October 2010 through September 2011) was atypical in that major floods occurred at different times and at different places during the same year. A composite map (fig. 2) shows the drainage basins for active USGS streamgages, which are color coded to reflect the annual exceedance probabilities (AEPs) for the maximum discharges at the streamgages during the three major floods during the 2011 water year. A full-size view of the map on figure 2 can be accessed by the computer link at the end of the figure caption. The AEP values used on figure 2 and throughout this report are given in percentages of the chance of exceedance (for example, the 0.01 AEP is shown as a 1-percent chance AEP). The inverse of the AEP flood was commonly referred to in the past as the flood-recurrence interval (RI). For example, a 1-percent chance AEP flood (a flood having a 1-percent chance of being equaled or exceeded in any given year) is also referred to as a flood with a 100-year recurrence interval. Use of the recurrence interval (RI) to describe a flood magnitude can be misleading because it is often interpreted as the period of time between floods of a given magnitude, but statistically it refers to the likelihood of a flood of a given magnitude in any year. For this reason, the USGS, FEMA, and other agencies have adopted the use of the term AEP for flood-related work. The technical nature of the flood data and the target audience for this report permits the use of both forms of flood-frequency presentation without the danger of creating confusion.

As indicated on figure 2, much of the State experienced major flooding at some time during the 2011 water year. Extreme western New York was one of the few upstate areas spared substantial flooding. Streamgages and numbers shown on figure 2 are listed in appendix 1 (at the end of the report), along with the estimated recurrence interval of each of the three events at the streamgage. The basin color (fig. 2) represents the most extreme of the three events in appendix 1, and a more detailed analysis of each of the events is given below.

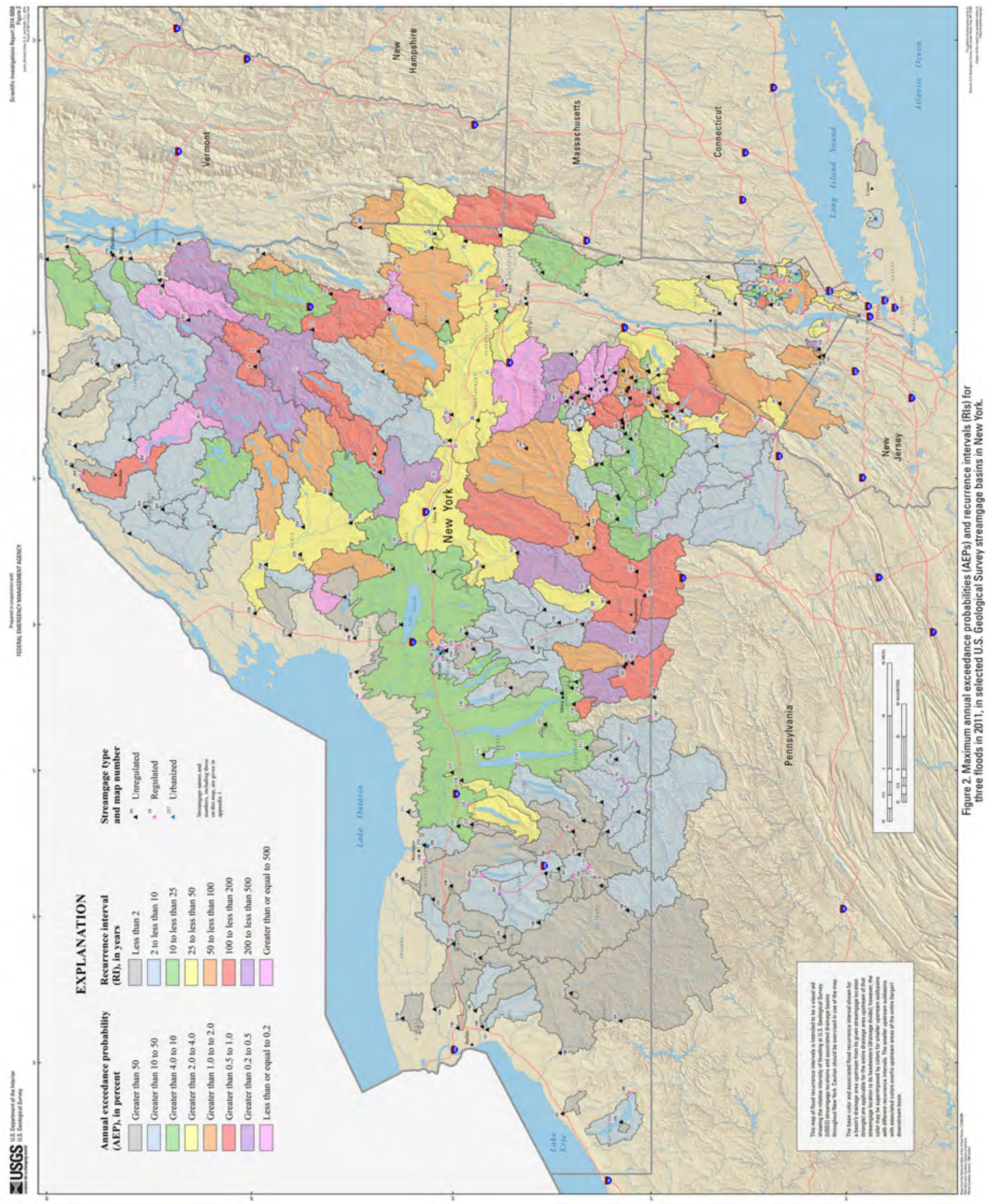

Figure 2. Maximum annual exceedance probabilities and recurrence intervals for three major floods in 2011 in selected U.S. Geological Survey streamgage basins in New York. (Click link to view full-size map of figure 2 at *http://pubs.usgs.gov/sir/2014/5058/*.)

Storm and Floods of April 26–May 9, 2011

Record spring precipitation in 2011 combined with above-average temperatures and a melting snowpack resulted in record flooding on several streams in and around the Adirondack Mountains of northern New York (climate division 3, fig. 1). The greatest flooding occurred from late April to early May in the upper Hudson River, Raquette River, Ausable River, West Canada Creek, and Black River Basins. A slow-moving warm front in west-central New York caused additional flooding in the Finger Lakes region (climate division 10, fig. 1) on April 26–27 and damaged hundreds of roads in several counties. A few tornadoes that were reported in the area on April 27–28 caused localized damage.

The wet spring of 2011 that produced 5 in. of rain during late April in parts of upstate New York, combined with a rapidly melting snowpack from above-normal temperatures, caused widespread flooding of streams throughout northern New York and in other parts of the State. The resulting floods caused many road closures and 23 counties to be declared as Federal disaster areas and generated $60 million in damages (Federal Emergency Management Agency, 2011c). In northern and parts of central New York, record flows were recorded at 17 active streamgages, and record stage was recorded at five lake/reservoir gages during late April to early May. Peak discharges equaled or exceeded the 1-percent AEP discharge at 11 streamgages. Four streamgages on the upper Hudson River recorded their maximum known peak stage and discharge during April 28–29. The peak discharge at the Hudson River at North Creek streamgage recorded its greatest peak stage and discharge in more than 104 years of record (greater than the 0.5-percent AEP or 200-year discharge). Lake Champlain recorded its highest lake level in over 140 years on May 6.

Antecedent Conditions

By the end of March 2011, more than 30 in. of dense snow containing a water equivalent of over 16 in. remained throughout the Adirondack Mountains of northern New York. The distribution of snow-water equivalent in New York for various days in April is shown on figure 3 as modeled radar images (National Oceanic and Atmospheric Administration, 2011l). The National Weather Service (NWS) station at Lake Placid in northern New York indicates that the average air temperature (fig. 4) was above normal during April, and most snow was melted by April 26–27 as maximum temperatures rose to over 70° F (76° F at Lake Placid on April 27).

As the snow melted during April, the runoff increased streamflows throughout northern New York to above normal by April 12 and to much above normal by the time the heavy rains began on April 26. Streamflows during the spring for three USGS streamgages (figs. 5A–C) are representative of antecedent flow conditions in the Adirondack Mountain area prior to the late April rains. The daily flow exceedance statistics for the period of record of each streamgage indicate that the 2011 daily discharges at each site exceeded the 25th percentile during several days in mid- to late April and set record-high daily flows at the Hudson River near Newcomb (fig. 5A) and the Ausable River near Au Sable Forks (fig. 5C). The 2011 daily discharges at the West Branch Oswegatchie River (fig. 5B) were near or above the 25th percentile in mid-April and just above or near the maximum daily flow for the period of record by late April. Photographs of a small stream tributary to the upper Hudson River near North Creek show a torrent that is out of its channel banks on April 20 (fig. 6A) as a result of prestorm snowmelt. More normal flow conditions for this stream are shown on figure 6B.

Precipitation

A warm front moved northward across New York on April 26, bringing warm, humid air (temperatures rose above 70° F) and producing heavy showers and thunderstorms that affected areas mainly north and west of Albany. A series of low-pressure areas moved northeastward along the front, resulting in several rounds of heavy rainfall through April 28. Radar images of precipitation on April 26–29 (fig. 7) show the general track and intensity of the storm as it moved through the State (National Oceanic and Atmospheric Administration, 2011m). The heaviest rains during April 26–28 were concentrated in northern and central New York (fig. 8). Four-day storm totals (table 2) from NOAA weather stations in New York and western Vermont indicate nearly 5 in. of rain at some locations (4.88 in. at Highmarket in Lewis County and 4.52 in. at Lake Placid in Essex County). Rainfall totals decreased to less than 2 in. southeast of the Mohawk River Valley and northwest of the Adirondack Mountains into the St. Lawrence River Valley (fig. 8 (National Oceanic and Atmospheric Administration, 2011a,d)).

The rainfall accumulation at the Lake Placid weather station during April 2011 (fig. 9) was measured as 8.72 in., the greatest April precipitation in nearly 100 years of record at the station (the previous maximum was 6.17 in. in 1967) and 5.87 in. greater than the normal April precipitation (Northeast Region Climate Center, 2013). The maximum 1-day rainfall during April 2011 of 1.90 in. on April 28th is the second greatest 1-day April precipitation on record at Lake Placid; but based on all 1-day maximum precipitation values (all months) for nearly 100 years of record, the 1.90 in. on April 28, 2011, ranks as only the 45th highest, and the recurrence interval of the annual 1-day maximum precipitation (Northeast Region Climate Center, 2013) is less than 2 years (table 3). The 2- and 4-day rainfalls for Lake Placid and two others stations in northern New York during late April 2011 (shown in red on table 3) were generally at recurrence intervals that were respectively larger than the 1-day but less than 25 years (Northeast Region Climate Center, 2010). Saturated soil conditions and snowmelt prior to the storm combined with the late-April rains resulted in major flooding in several parts of northern New York into early May.

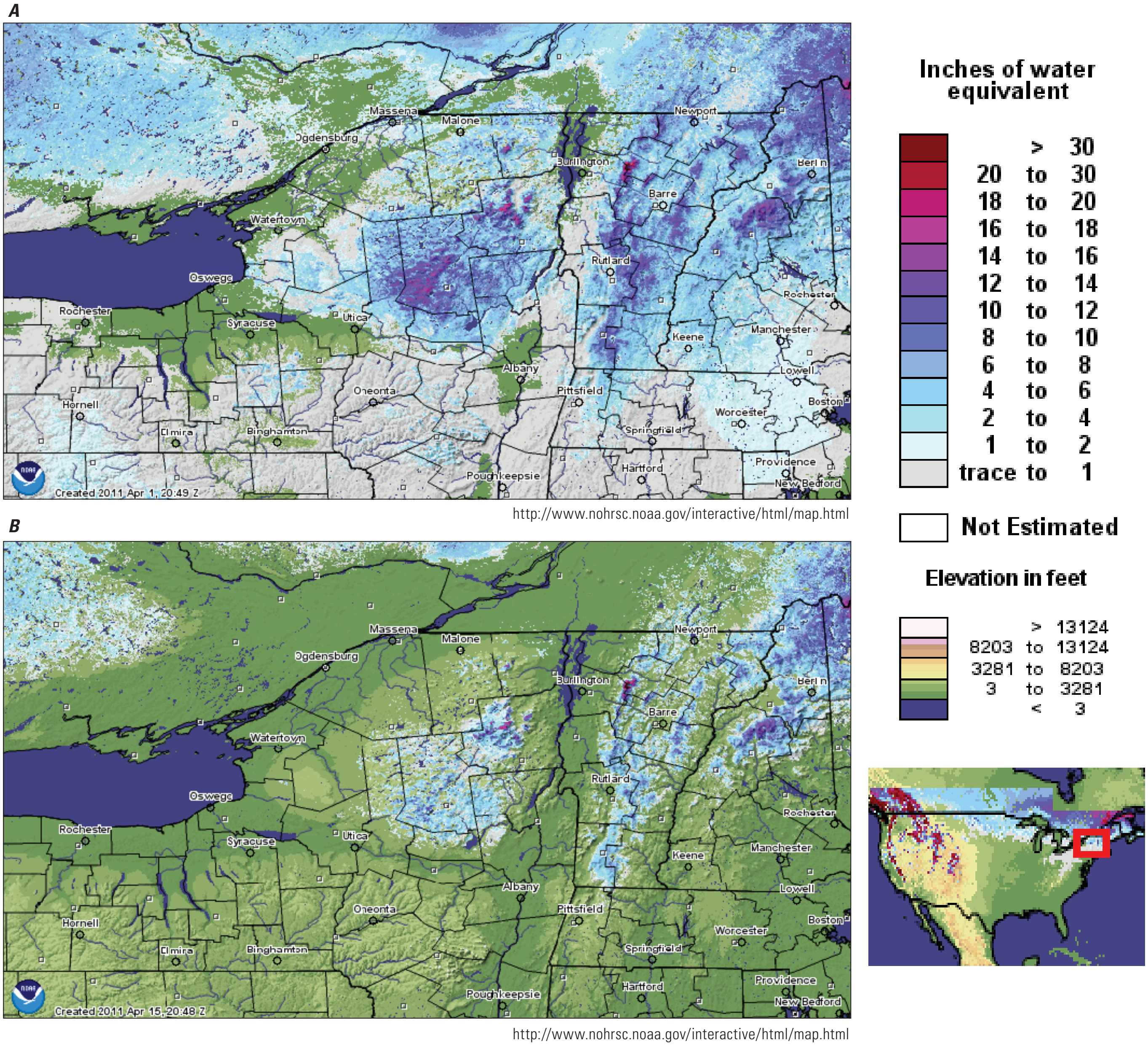

Figure 3. Water equivalent of snow on *A,* April 1, *B,* April 15, *C,* April 26, and *D,* April 29, 2011, in New York and surrounding areas. (National Oceanic and Atmospheric Administration, 2011l; >, greater than; <, less than)

C

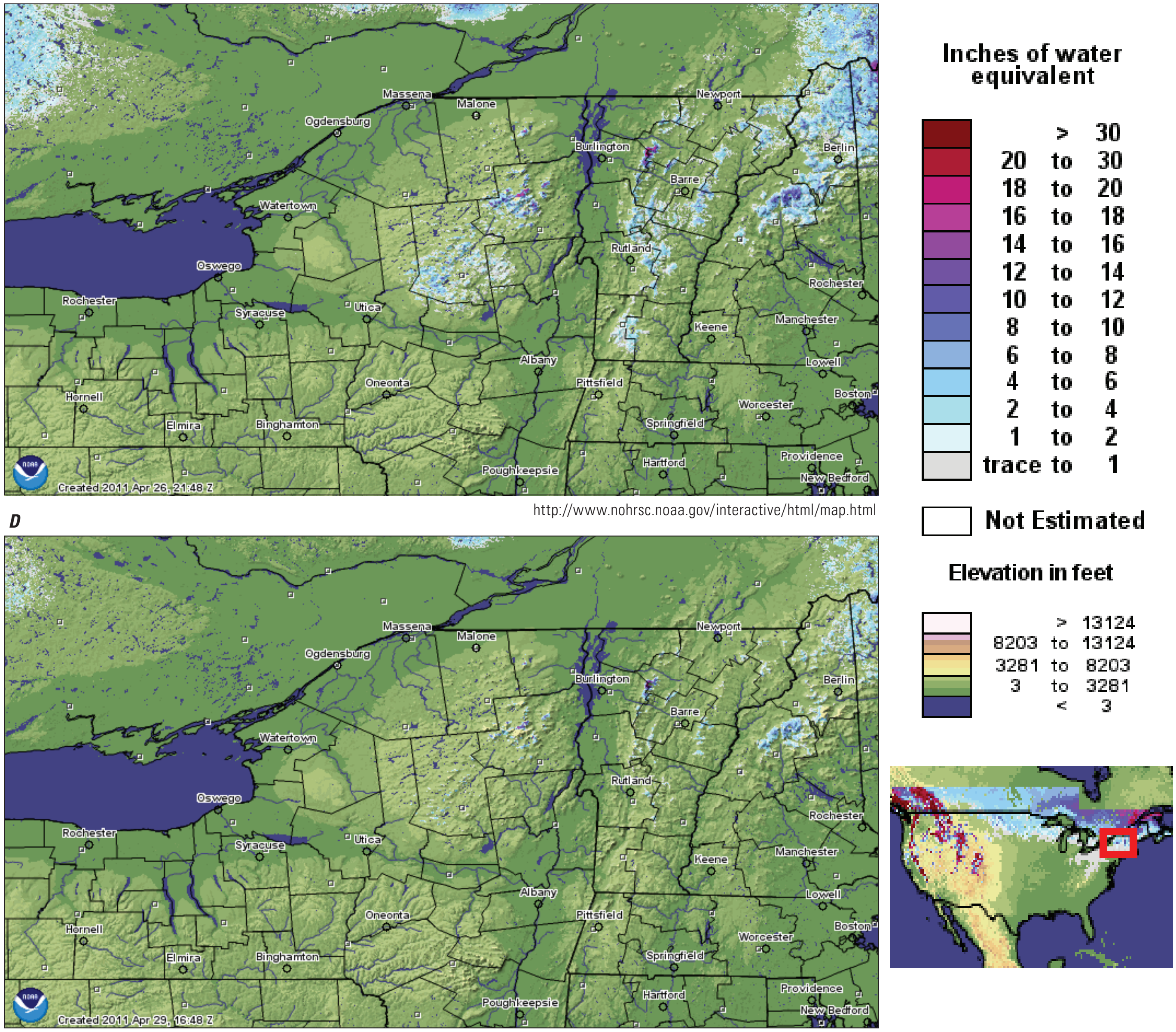

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Figure 3. Water equivalent of snow on *A,* April 1, *B,* April 15, *C,* April 26, and *D,* April 29, 2011, in New York and surrounding areas. (National Oceanic and Atmospheric Administration, 2011l; >, greater than; <, less than)—Continued

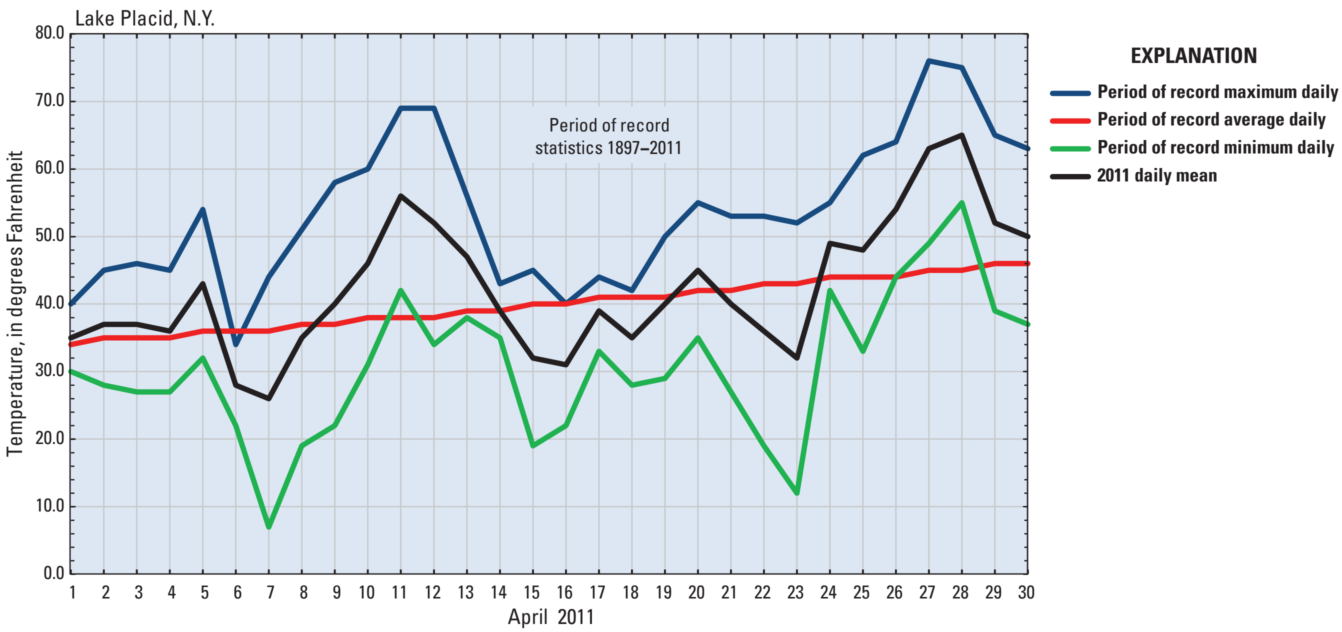


Figure 4. Daily-temperature data at Lake Placid, New York, during April 2011. (National Oceanic and Atmospheric Administration, 2011d)

Flooding

The warm and wet spring of 2011 resulted in record flooding at 17 active streamgages and 5 active lake/reservoir gages during late April to early May (table 4 and fig. 10). Most of the record flows and stages were in northern New York with a few new records set in the central region of the State. Near-record peaks were set at several other streamgages and lake/reservoir sites (table 4 and fig. 10). Many of the maximum flows for the period of record were on regulated streams, indicating that runoff from snowmelt earlier in the month was depleting available storage by the time the heavy rains fell at the end of April. Eleven peak discharges during late April to early May equaled or exceeded the 1-percent AEP (100-year) discharge (table 4). Map numbers (fig. 10) and associated USGS streamgage numbers and names (table 4) are given in appendix 1 at the end of the report. The relation between the two statistical flood-frequency terminologies is shown in appendix 1 and in table 5.

Flood Discharge and Frequency

The most extreme flooding during April–May 2011 occurred on some streams in the upper Hudson and Raquette River Basins, where recorded peak discharges had AEP values less than 0.5 percent (recurrence intervals greater than 200 years). The frequencies of the April–May floods at selected streamgages are shown in a color-coded AEP map of the associated streamgage drainage basins across the State on figure 11. A full-size view of the map on figure 11 can be accessed by the computer link at the end of the figure caption. The most expansive and extreme flooding was in and around the Adirondack Mountains area of northern New York and extended southwest to the Finger Lakes region of west-central New York. Flooding decreased substantially beyond these areas of the State. Record floods were documented at 17 streamgages and 5 lake/reservoir gages with 11 of them having AEP values less than or equal to 1 percent (recurrence intervals greater than or equal to 100 years).

Peak discharges for 50 selected streamgages where the April–May 2011 flood was the maximum for the year, plotted as a function of drainage area (fig. 12), indicate that the spring 2011 peaks were near or above the previous peak discharge of record and the 1-percent AEP (100-year) discharge at several sites. Streamgage numbers shown on figure 12 are plotted at their respective drainage area only for sites with peak discharges exceeding the 1-percent AEP (100-year) flow. Figure 12 also indicates that the April–May flooding was appreciable for streams of all drainage-basin sizes in the affected area. The general relation of peak discharge and drainage area for streamgages on unregulated streams in the affected area is indicated by the solid line plotted on figure 12.

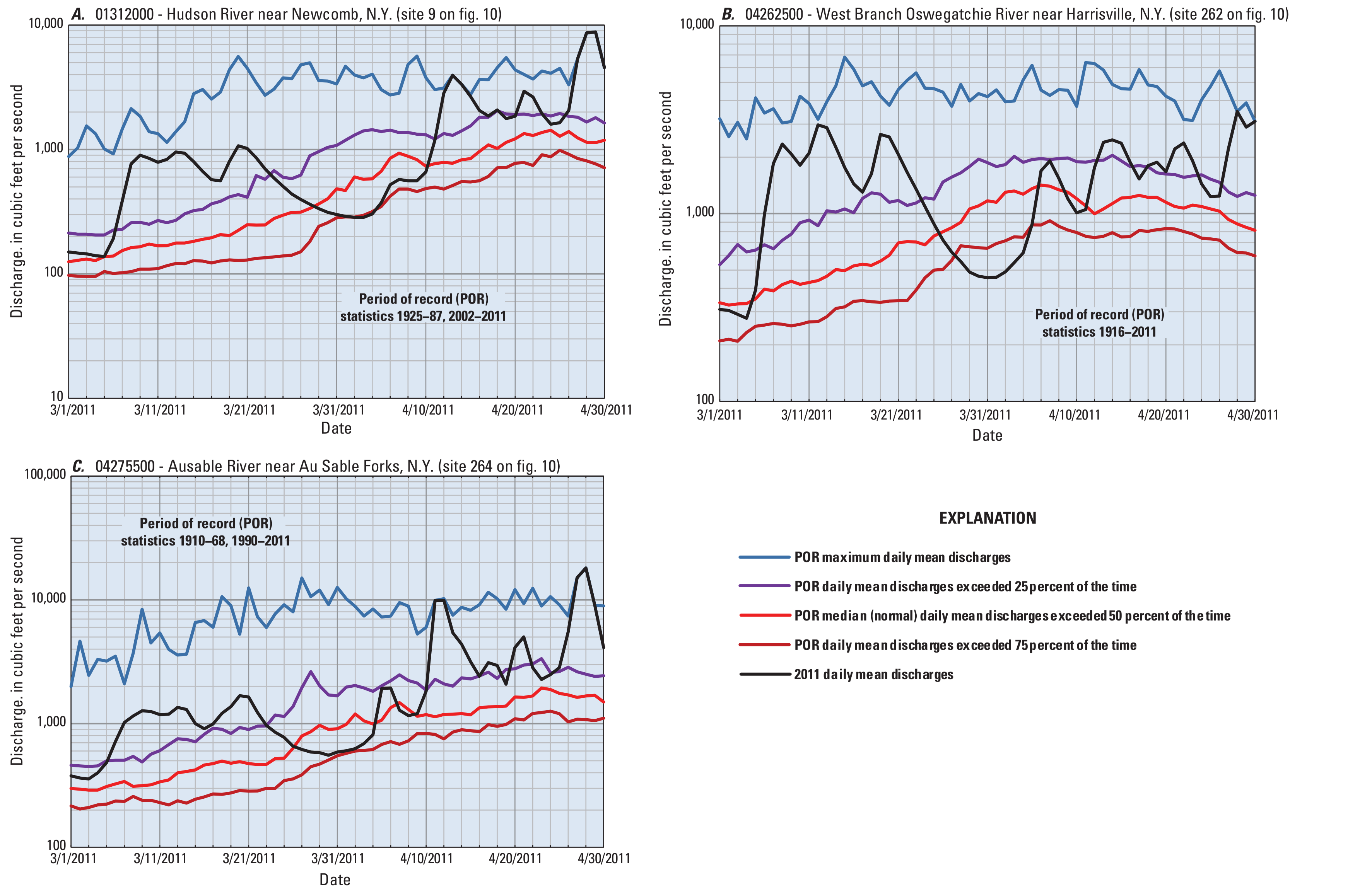


Figure 5. Daily discharge data at U.S. Geological Survey streamgages on the *A,* Hudson River, *B,* West Branch Oswegatchie River, and *C,* Ausable River for March 1–April 30, 2011. (Sites are listed in appendix 1 and shown on figure 10.)

A

B

Figure 6. A small tributary to the upper Hudson River showing flow conditions prior to the storms in *A,* April 2011, and *B,* August 2011. (Photographs courtesy of Greg Lawrence, U.S. Geological Survey)

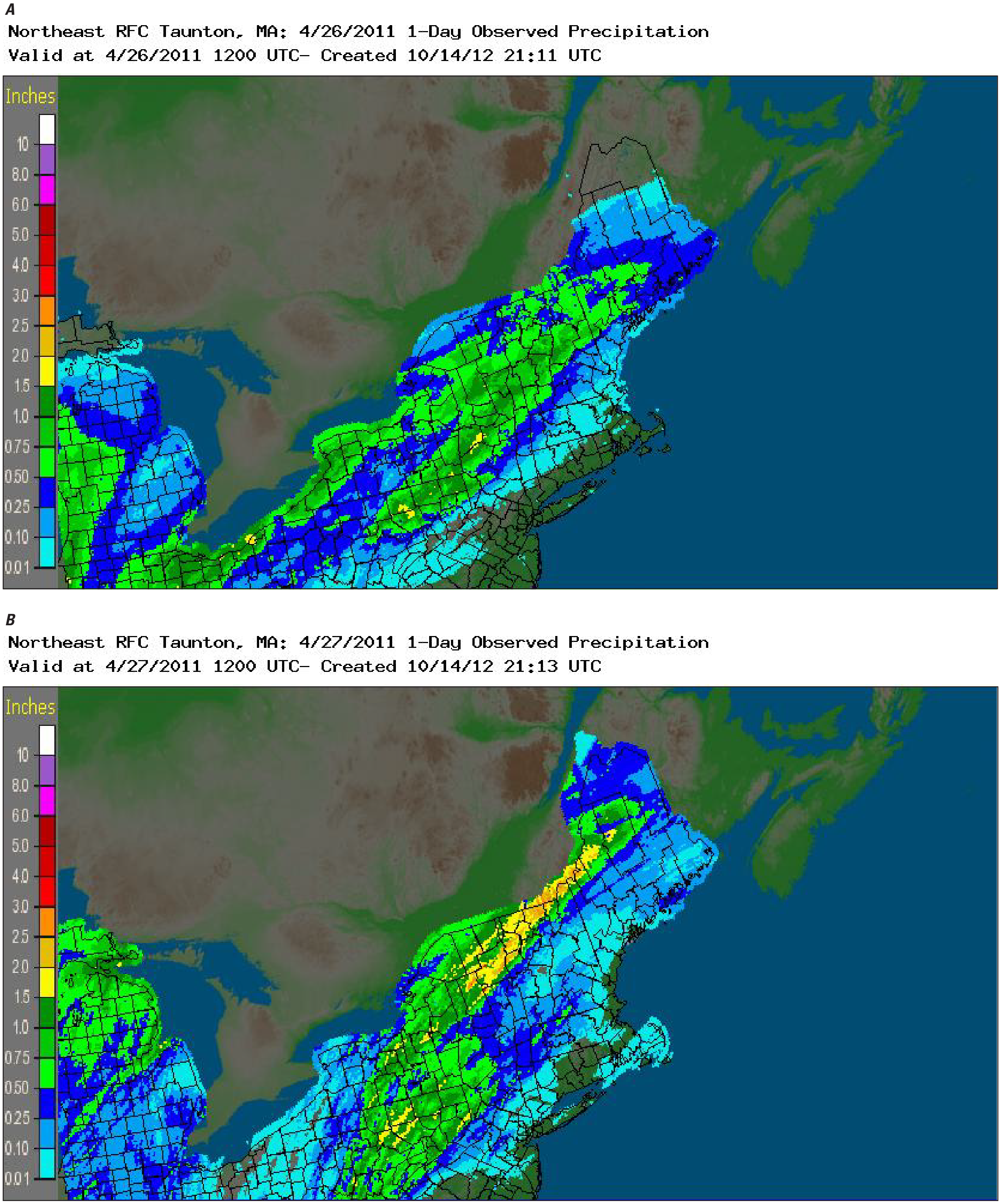
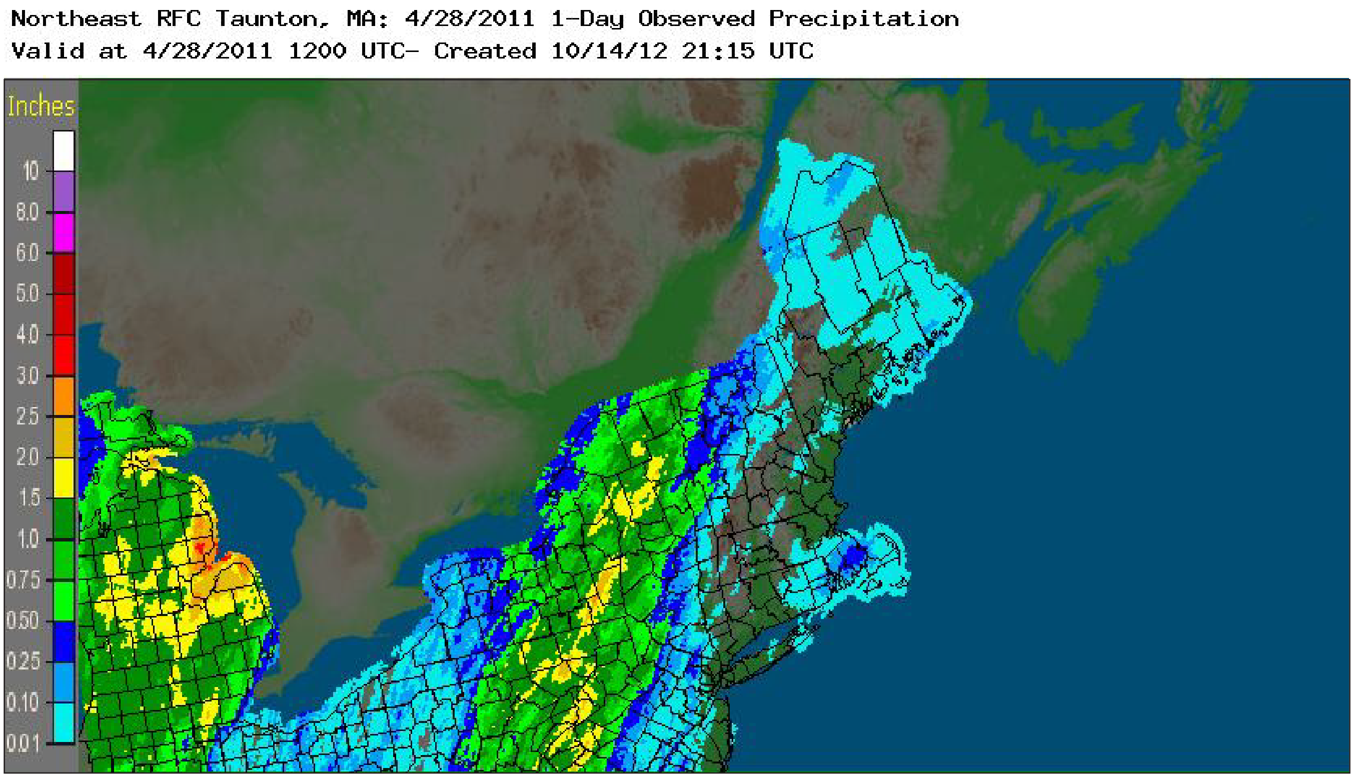


Figure 7. Rainfall amounts for each day during the storm of *A,* April 26, *B,* April 27, *C,* April 28, and *D,* April 29, 2011, for New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011m)

C



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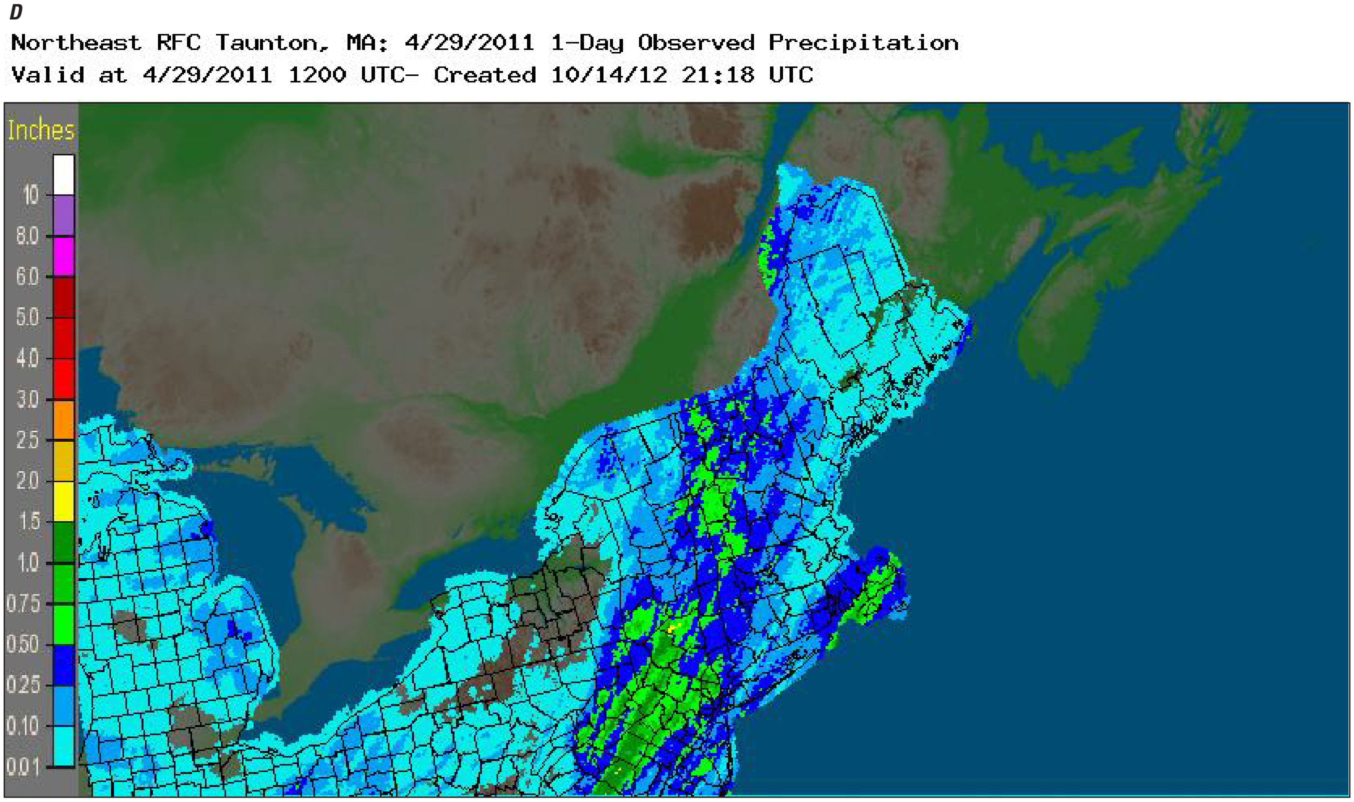

Figure 7. Rainfall amounts for each day during the storm of *A,* April 26, *B,* April 27, *C,* April 28, and *D,* April 29, 2011, for New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011m)—Continued

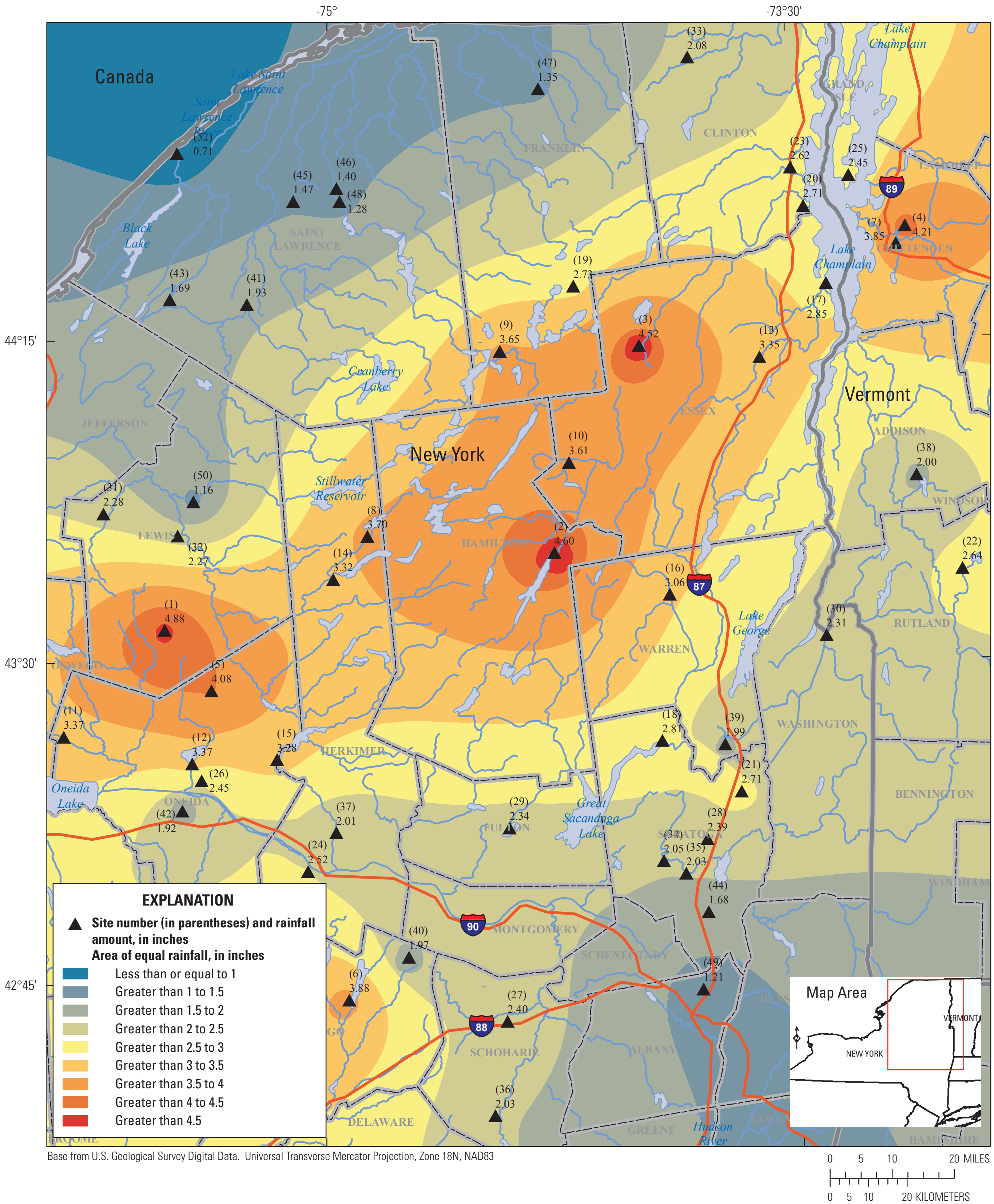

Figure 8. Rainfall totals for the storm of April 26–29, 2011, in New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011a,d; Sites and data are listed in table 2.)

Table 2. Rainfall for the storm of April 26–29, 2011, at selected locations in New York and surrounding areas.

[Data provided by the National Oceanic and Atmospheric Administration (2011a,d); N, north; S, south; E, east; W, west; locations are shown on figure 8]

Site number	Site name	Rainfall (inches)				
		April 26	April 27	April 28	April 29	Total
1	Highmarket, N.Y.	0.65	1.43	1.93	0.87	4.88
2	Indian Lake 2 SE, N.Y.	0.90	1.72	1.23	0.75	4.60
3	Lake Placid 2 S, N.Y.	0.75	1.86	1.90	0.01	4.52
4	Essex Junction 1 N, Vt.	0.57	2.63	0.71	0.30	4.21
5	Boonville, 4 SSW, N.Y.	0.66	1.43	1.90	0.09	4.08
6	Cooperstown, N.Y.	1.00	0.68	1.30	0.90	3.88
7	Burlington International Airport, Vt.	2.74	0.18	0.93	0.00	3.85
8	Big Moose 3 SE, N.Y.	2.00	0.00	1.66	0.04	3.70
9	Tupper Lake Sunmount, N.Y.	0.72	1.30	1.45	0.18	3.65
10	Newcomb, N.Y.	0.50	1.18	1.80	0.13	3.61
11	Camden, N.Y.	0.67	0.96	1.61	0.13	3.37
12	Delta Dam, N.Y.	1.12	1.00	1.25	0.00	3.37
13	Elizabethtown, N.Y.	0.40	1.74	0.93	0.28	3.35
14	Old Forge, N.Y.	0.14	1.28	1.90	0.00	3.32
15	Trenton Falls, N.Y.	0.93	0.90	1.45	0.00	3.28
16	North Creek 5 SE, N.Y.	1.73	0.51	0.45	0.37	3.06
17	Willsboro, N.Y.	0.52	1.58	0.65	0.10	2.85
18	Conklingville Dam, N.Y.	1.12	0.40	0.93	0.36	2.81
19	Saranac Lake Airport, N.Y.	0.62	0.99	1.07	0.05	2.73
20	Gansevoort, N.Y.	1.19	0.13	0.42	0.97	2.71
21	Peru, N.Y.	0.51	1.12	0.34	0.74	2.71
22	Chittenden, Vt.	1.29	0.28	0.22	0.85	2.64
23	Plattsburgh International Airport, N.Y.	0.47	1.05	0.99	0.11	2.62
24	Ilion, N.Y.	0.69	0.50	1.18	0.15	2.52
25	Griffiss Air Force Base, N.Y.	0.84	0.74	0.87	0.00	2.45
26	South Hero, Vt.	1.30	0.33	0.82	0.00	2.45
27	Cobleskill 2 ESE, N.Y.	0.93	0.35	0.84	0.28	2.40
28	Saratoga Springs 4 SW, N.Y.	0.90	0.15	0.35	0.99	2.39
29	Gloversville 7 NW, N.Y.	0.69	0.48	0.93	0.24	2.34
30	Whitehall, N.Y.	0.93	0.20	0.79	0.39	2.31
31	Hooker 12 NNW, N.Y.	0.58	0.77	0.91	0.02	2.28
32	Lowville, N.Y.	0.56	0.80	0.86	0.05	2.27
33	Ellenburg Depot, N.Y.	0.23	0.93	0.61	0.31	2.08
34	Ballston Spa, N.Y.	0.82	0.14	0.70	0.39	2.05
35	Malta, N.Y.	0.87	0.15	0.28	0.73	2.03
36	Lansing Manor, N.Y.	0.65	0.48	0.65	0.25	2.03
37	Little Falls, N.Y.	0.51	0.63	0.83	0.04	2.01
38	Salisbury 2 N, Vt.	0.95	0.34	0.71	0.00	2.00
39	Glens Falls, N.Y.	0.94	0.53	0.36	0.16	1.99
40	Cherry Valley 2 NNE, N.Y.	0.65	1.32	0.00	0.00	1.97
41	Edwards, N.Y.	0.49	0.82	0.58	0.04	1.93
42	Westmoreland 4 N, N.Y.	0.91	0.21	0.78	0.02	1.92
43	Gouverneur 3 NW, N.Y.	0.33	0.80	0.55	0.01	1.69
44	Round Lake 1 SE, N.Y.	0.71	0.15	0.27	0.55	1.68
45	Canton 4 SE, N.Y.	0.19	0.39	0.64	0.25	1.47
46	Hannawa Falls, N.Y.	0.19	0.69	0.37	0.15	1.40
47	Malone, N.Y.	0.12	0.61	0.49	0.13	1.35
48	Colton 1 W, N.Y.	0.17	0.66	0.35	0.10	1.28
49	Albany International Airport, N.Y.	0.71	0.16	0.34	0.00	1.21
50	Beaver Falls, N.Y.	0.63	0.53	0.00	0.00	1.16
51	Massena International Airport, N.Y.	0.55	0.49	0.08	0.00	1.12
52	Ogdensburg, N.Y.	0.08	0.48	0.12	0.03	0.71

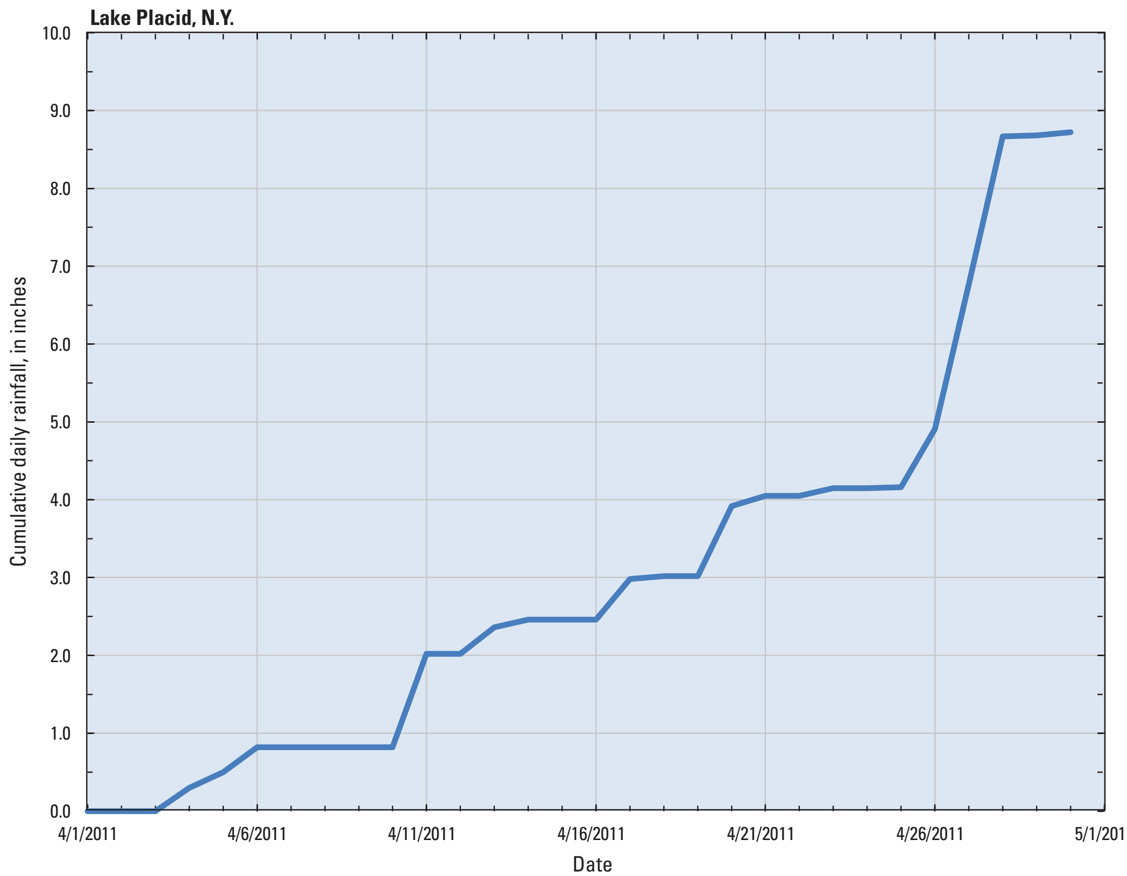

Figure 9. Cumulative daily rainfall during April 1–30, 2011, recorded at Lake Placid, New York. (Site 3 in table 2 and figure 8)

Table 3. Rainfall frequencies for storms of 1-, 2-, and 4-day durations at selected locations in New York.

[April 26–29, 2011, maximum n-day rainfall totals for each site are shown in red. Data from the Northeast Regional Climate Center (2010); locations are shown on figure 8]

Site number	Site name	County	Recurrence interval (years)	Rainfall (inches) for selected duration		
				1-day	2-day	4-day
3	Lake Placid	Essex		1.90		
			2	2.22	2.49	2.81
			5	2.71	3.02	3.37
			10	3.16	3.49	3.86
					3.76	4.52
			25	3.86	4.24	4.63
			50	4.50	4.90	5.31
			100	5.25	5.68	6.09
			200	6.13	6.57	6.99
			500	7.52	7.98	8.39
2	Indian Lake	Hamilton		1.72		
			2	2.22	2.49	2.81
					2.95	
			5	2.71	3.02	3.37
			10	3.16	3.49	3.86
2	Indian Lake	Hamilton				4.60
			25	3.86	4.24	4.63
			50	4.50	4.90	5.31
			100	5.25	5.68	6.09
			200	6.13	6.57	6.99
			500	7.52	7.98	8.39
9	Tupper Lake	Franklin		1.45		
			2	2.22	2.49	2.81
					2.75	3.65
			5	2.71	3.02	3.37
			10	3.16	3.49	3.86
			25	3.86	4.24	4.63
			50	4.50	4.90	5.31
			100	5.25	5.68	6.09
			200	6.13	6.57	6.99
			500	7.52	7.98	8.39

Table 4. Period-of-record peak discharges through March 2011 and peak discharges during the floods of April 26–May 9, 2011, at selected U.S. Geological Survey streamgages in New York.

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in green are reservoir/lake elevation sites (discharge not computed). Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft^3/s)	April 26–May 9, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
				Hudson River Basin									
8	01311992	Arbutus Pond Outlet near Newcomb, N.Y.	1.22	1991–2011	01/09/98	2.37	40	04/29/11	--	2.60	74	1.7	60
9	01312000	Hudson River near Newcomb, N.Y.	192	1926–2011	01/09/98	12.84	11,500	04/29/11	0115	12.59	10,200	<1.0 & >0.5	>100 & <200
10	01314500	Indian Lake near Indian Lake, N.Y.	131	1900–2011	03/28/13	[a]1,656.71	--	04/29/11	0815	[a]1,655.13	--	--	--
11	01315000	Indian River near Indian Lake, N.Y.	132	1913–2011	03/28/13	7.80	3,460	04/29/11	0500	7.83	3,520	<1.0 & >0.5	>100 & <200
12	01315081	Indian River below Lake Abanakee near Indian Lake, N.Y.	195	2005–11	06/29/06	8.07	3,410	04/28/11	--	10.47	--	--	--
13	01315500	Hudson River at North Creek, N.Y.	792	1908–2011	12/31/48	12.14	28,900	04/28/11	2130	13.65	34,900	<0.5 & >0.2	>200 & <500
14	01317000	Schroon River at Riverbank, N.Y.	527	1908–70, 1987–2011	03/21/36	12.18	12,100	04/29/11	1400	10.85	8,650	6.7	15
15	01318500	Hudson River at Hadley, N.Y.	1,664	1922–2011	07/01/49	21.21	42,700	04/29/11	0545	21.32	44,200	1.0	100
16	01321000	Sacandaga River near Hope, N.Y.	491	1912–2011	03/27/13	[b]11.00	32,000	04/28/11	1530	7.83	15,500	33.3	3
17	01323500	Great Sacandaga Lake at Conklingville, N.Y.	1,044	1930–2011	04/21/08	[a]773.58	--	05/01/11	0515	[a]774.47	--	--	--
18	01325000	Sacandaga River at Stewarts Bridge, near Hadley, N.Y.	1,055	1908–1929	03/28/13	[b]12.36	[c]35,500						
				1930–2011	05/03/07	9.78	14,200	05/02/11	1015	10.40	16,500	1.7	60
19	01327750	Hudson River at Fort Edward, N.Y.	2,810	1977–2011	05/03/83	28.34	35,200	04/29/11	1715	31.34	48,800	<0.2	>500
20	01329154	Steele Brook at Shushan, N.Y.	2.85	1979–2011	01/19/96	6.56	149	04/28/11	--	3.34	44	>50.0	<2
21	01329490	Batten Kill below mill at Battenville, N.Y.	396	1923–68, 1987–2011	11/04/27	[b]17.7	21,300	04/29/11	0300	7.41	3,110	>50.0	<2
22	01330000	Glowegee Creek at West Milton, N.Y.	26.0	1949–63, 1991–2011	12/31/48	7.04	1,670	04/28/11	1545	5.33	497	>50.0	<2
23	01331095	Hudson River at Stillwater, N.Y.	3,773	1978–2011	05/04/83	--	[d]44,100	04/29/11	--	--	[c,d]52,000	2.0	50
24	01333500	Little Hoosic River at Petersburg, N.Y.	56.1	1949, 1952–2011	12/31/48	9.4	7,470	04/28/11	1630	3.17	328	>50.0	<2
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	1911–22, 1924–2011	12/31/48	21.15	55,400	04/28/11	2345	6.16	2,860	>50.0	<2
26	01335754	Hudson River above Lock 1 near Waterford, N.Y.	4,605	1888–1929	03/28/13	--	120,000						
				1930–56, 1977–2011	01/01/49	--	118,000	04/29/11	2245	30.87	58,600	12.5	8
27	01335900	Delta Reservoir near Rome, N.Y.	148	1951–2011	06/72, 04/94, 01/98	[e]552.8	--	04/28/11	--	[e]552.3	--	--	--
28	01336000	Mohawk River below Delta Dam, near Rome, N.Y.	152	1928–2011	10/02/45	11.18	8,560	04/28/11	1445	8.78	5,620	6.7	15
29	01342797	Vly Brook near Morehouseville, N.Y.	3.28	1993–2011	10/21/95	11.2	320	04/28/11	--	11.61	361	4.0	25
30	01343060	West Canada Creek near Wilmurt, N.Y.	258	2001–11	06/28/06	13.60	23,200	04/28/11	1200	14.11	25,500	1.0	100
31	01343900	Hinckley Reservoir at Hinckley, N.Y.	372	1914–2011	10/02/45	[e]1,230.2	--	04/28/11	1915	[e]1,230.74	--	--	--
32	01346000	West Canada Creek at Kast Bridge, N.Y.	560	1921–2011	06/29/06	8.29	21,800	04/29/11	0345	8.68	23,400	0.5	200

Table 4. Period-of-record peak discharges through March 2011 and peak discharges during the floods of April 26–May 9, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in green are reservoir/lake elevation sites (discharge not computed). Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	April 26–May 9, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Hudson River Basin—Continued											
33	01347000	Mohawk River near Little Falls, N.Y.	1,342	1928–2011	06/28/06	19.72	35,000	04/29/11	0800	18.11	29,600	2.9	35
34	01348000	East Canada Creek at East Creek, N.Y.	289	1945–96, 1998, 2000, 2003–11	06/28/06	10.99	31,500	04/28/11	1645	6.34	7,260	>50.0	<2
35	01348420	North Creek near Ephratah, N.Y.	6.52	1972–2011	06/28/06	10.06	780	04/28/11	--	4.93	163	>50.0	<2
36	01349150	Canajoharie Creek near Canajoharie, N.Y.	59.7	1993–2011	06/28/06	10.50	5,510	04/28/11	1300	7.34	2,220	>50.0	<2
51	01351500	Schoharie Creek at Burtonsville, N.Y.	886	1940–2011	01/20/96	12.88	81,600	04/28/11	1815	4.52	11,200	>50.0	<2
53	01357500	Mohawk River at Cohoes, N.Y.	3,450	1918–2011	03/06/64	23.15	143,000	04/29/11	0815	18.20	57,600	50.0	2
54	01358000	Hudson River at Green Island, N.Y.	8,090	1946–2011	12/31/48	27.05	181,000	04/29/11	0845	23.02	106,000	33.3	3
		Lake Ontario Basin											
209	04232050	Allen Creek near Rochester, N.Y.	30.1	1960–2011	05/17/74	7.42	3,280	04/27/11	2045	4.32	476	>50.0	<2
213	04232400	Seneca Lake at Watkins Glen, N.Y.	704	1956–2011	04/26/93	[a]448.95	--	05/04/11	0930	[a]447.07	--	--	--
214	04232482	Keuka Lake Outlet near Dresden, N.Y.	207	1965–2011	06/22/72	8.37	4,000	04/27/11	2215	5.82	1,890	33.3	3
216	04233000	Cayuga Inlet near Ithaca, N.Y.	35.2	1937–2011	06/23/72	[b]8.10	4,800	04/28/11	0545	6.22	2,450	20.0	5
219	04233500	Cayuga Inlet (Cayuga Lake) at Ithaca, N.Y.	1,564	1905–25, 1956–2011	04/26/93	[a]386.46	--	05/05/11	1400	[a]385.04	--	--	--
220	04234000	Fall Creek near Ithaca, N.Y.	126	1925–2011	07/08/35	9.52	15,500	04/28/11	1200	3.89	2,190	50.0	2
224	04234500	Canandaigua Lake at Canandaigua, N.Y.	184	1939–2011	06/24/72	[a]692.11	--	04/28/11	0945	[a]690.36	--	--	--
225	04235000	Canandaigua Outlet at Chapin, N.Y.	195	1940–2011	06/24/72	11.08	1,710	04/26/11	2100	6.49	1,320	3.3	30
226	04235250	Flint Creek at Phelps, N.Y.	102	1960–95, 2003–11	03/30/60	5.83	2,940	04/26/11	2315	5.28	3,150	4.0	25
227	04235255	Canandaigua Outlet Tributary near Alloway, N.Y.	2.94	1978–2011	07/05/08	7.04	175	04/26/11	--	6.90	168	2.5	40
229	04235396	Owasco Lake near Auburn, N.Y.	205	1967–2011	06/25/72	[a]716.48	--	04/29/11	0500	[a]713.91	--	--	--
230	04235440	Owasco Outlet at Genesee Street, Auburn, N.Y.	207	1999–2011	04/04/05	8.34	2,730	04/27/11	2015	4.68	1,490	50.0	2
233	04240010	Onondaga Creek at Spencer Street, Syracuse, N.Y.	110	1971–2011	07/03/74	8.73	4,050	04/28/11	0145	6.52	1,540	>50.0	<2
234	04240100	Harbor Brook at Syracuse, N.Y.	10.0	1960–2011	07/03/74	[b]8.34	726	04/26/11	1730	6.11	371	16.7	6
235	04240105	Harbor Brook at Hiawatha Boulevard, Syracuse, N.Y.	12.1	1971–2011	07/03/74	7.91	824	04/26/11	1515	7.63	762	6.7	15
236	04240120	Ley Creek at Park Street, Syracuse, N.Y.	29.9	1973–2011	09/26/75	6.17	1,310	04/26/11	2230	5.02	1,410	1.2	80
237	04240180	Ninemile Creek near Marietta, N.Y.	45.1	1965–2011	06/23/72	8.65	1,030	04/26/11	1645	5.72	661	6.7	15
238	04240300	Ninemile Creek at Lakeland, N.Y.	115	1971–73, 1975–2011	06/23/72	--	[d]2,110	04/27/11	--	--	[d]1,550	16.7	6
239	04240495	Onondaga Lake at Liverpool, N.Y.	285	1970–2011	04/26/93	[a]369.78	--	04/29/11	0145	[a]367.25	--	--	--
240	04242500	East Branch Fish Creek at Taberg, N.Y.	188	1923–95, 2009–11	12/29/84	[b]13.81	21,600	04/28/11	0745	9.95	16,600	1.4	70
241	04243500	Oneida Creek at Oneida, N.Y.	113	1950–2011	10/09/76	15.01	9,110	04/28/11	1215	7.89	1,830	>50.0	<2
244	04249000	Oswego River at Lock 7, Oswego, N.Y.	5,100	1934–2011	03/28/36	13.10	37,500	04/29/11	1230	11.80	30,600	6.7	15

Table 4. Period-of-record peak discharges through March 2011 and peak discharges during the floods of April 26–May 9, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in green are reservoir/lake elevation sites (discharge not computed). Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	April 26–May 9, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Lake Ontario Basin—Continued											
246	042490673	North Branch Grindstone Creek near Altmar, N.Y.	10.1	1976–2011	04/03/05	15.57	565	04/28/11	--	99.34	237	>50.0	<2
247	04249200	North Branch Salmon River at Redfield, N.Y.	82.5	1962–64, 1985, 1987–2011	12/29/84	19.15	13,600	04/29/11	--	19.84	16,700	<0.2	>500
248	04250200	Salmon River at Pineville, N.Y.	238	1985, 1993–2011	12/29/84	16.36	24,800	04/28/11	2400	9.53	4,630	>50.0	<2
249	04250750	Sandy Creek at Adams, N.Y.	137	1958–2011	01/19/96	11.06	7,700	04/28/11	0315	6.66	2,920	>50.0	<2
250	04252500	Black River near Boonville, N.Y.	304	1911–2011	04/18/82, 12/30/84	11.31, 11.41	12,800	04/29/11	0215	10.66	10,500	6.7	15
251	04253300	Sixth Lake near Old Forge, N.Y.	18.6	1911–2011	10/03/45	[a]1,787.1	--	04/29/11	1545	[a]1,786.81	--	--	--
252	04253400	First Lake at Old Forge, N.Y.	53.6	1911–2011	06/17/72	[a]1,707.93	--	05/05/11	2100	[a]1,707.60	--	--	--
253	04254500	Moose River at McKeever, N.Y.	363	1901–70, 1985, 1987–2011	06/03/47	17.45	18,700	04/28/11	2130	15.26	15,900	2.0	50
254	04256000	Independence River at Donnattsburg, N.Y.	88.7	1943–2011	12/30/84	13.34	9,420	04/28/11	2015	8.34	3,080	16.7	6
255	04256040	Tributary to Mill Creek Tributary near Lowville, N.Y.	1.66	1976–86, 1993–2011	03/05/79	13.41	312	04/28/11	--	10.46	103	>50.0	<2
256	04256500	Stillwater Reservoir near Beaver River, N.Y.	171	1908–2011	05/20/69	[a]1,680.08	--	04/29/11	0745	[a]1,680.15	--	--	--
257	04258000	Beaver River at Croghan, N.Y.	291	1931–2011	05/21/69	6.98	5,100	04/29/11	1030	6.70	4,640	2.0	50
258	04258700	Deer River at Deer River, N.Y.	94.8	1957–2011	12/29/84	10.63	17,200	04/28/11	--	5.85	6,430	50.0	2
259	04260500	Black River at Watertown, N.Y.	1,864	1921–2011	01/10/98	16.02	55,500	04/30/11	0815	12.70	36,600	4.0	25
		St. Lawrence River Basin											
260	04260990	Cranberry Lake at Cranberry Lake, N.Y.	140	1923–2011	05/13/71	[a]1,488.25	--	04/30/11	--	[a]1,487.95	--	--	--
261	04262000	Oswegatchie River near Oswegatchie, N.Y.	259	1925–68, 1985, 1988–2011	04/12/47	6.98	4,090	04/28/11	1015	5.89	3,530	10.0	10
262	04262500	West Branch Oswegatchie River near Harrisville, N.Y.	258	1917–2011	01/09/98	10.64	8,700	04/29/11	0930	7.08	3,960	50.0	2
263	04263000	Oswegatchie River near Heuvelton, N.Y.	986	1917–2011	04/06/60	10.36	19,600	05/01/11	0715	6.46	8,770	50.0	2
264	04265000	Grass River at Pyrites, N.Y.	333	1925–77, 1985, 2003–11	11/18/27	13.00	8,300	04/29/11	--	9.51	4,600	50.0	2
265	04265100	Elm Creek near Hermon, N.Y.	32.6	1959–2011	04/06/74	9.07	1,270	04/29/11	--	7.26	705	33.3	3
266	04265432	Grass River at Chase Mills, N.Y.	598	2004–11	09/18/05	7.53	10,300	04/29/11	1700	6.83	6,930	50.0	2
267	04266500	Raquette River at Piercefield, N.Y.	721	1909–2011	04/27/93	12.04	8,630	05/01/11	0430	13.40	10,400	<0.5 & >0.2	>200 & <500
268	04267500	Raquette River at South Colton, N.Y.	937	1953–2002, 2011	05/11/71	9.80	9,720	04/29/11	0330	11.27	12,800	<0.2	>500
269	04268000	Raquette River at Raymondville, N.Y.	1,125	1944–2011	04/05/74	8.40	13,000	05/04/11	1945	8.72	14,100	1.0	100
270	04268200	Plum Brook near Grantville, N.Y.	43.9	1959–2011	03/30/63	6.94	1,920	--	--	<4.20	<290	>50.0	<2
271	04268800	West Branch St. Regis River near Parishville, N.Y.	171	1959–2011	12/29/84	7.37	5,960	04/28/11	2015	5.21	3,200	25.0	4

Table 4. Period-of-record peak discharges through March 2011 and peak discharges during the floods of April 26–May 9, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

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Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft^3/s)	April 26–May 9, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		St. Lawrence River Basin—Continued											
272	04269000	St. Regis River at Brasher Center, N.Y.	612	1911–2011	04/06/37	12.82	16,800	04/29/11	1445	9.81	7,180	50.0	2
274	04270000	Salmon River at Chasm Falls, N.Y.	132	1926–82, 1987–2011	04/01/98	5.43	3,540	04/28/11	2400	4.34	2,220	25.0	4
275	04270200	Little Salmon River at Bombay, N.Y.	92.2	1959–98, 2002–11	03/31/98	13.27	3,420	04/27/11	1045	5.59	604	>50.0	<2
276	04270700	Trout River at Trout River, N.Y.	107	1960–2011	07/05/96	9.42	6,980	04/27/01	--	4.18	1,340	>50.0	<2
		Lake Champlain Basin											
278	04271815	Little Chazy River near Chazy, N.Y.	50.3	1990–2011	11/10/96	10.40	2,750	04/28/11	1715	6.17	938	33.3	3
279	04273500	Saranac River at Plattsburgh, N.Y.	608	1903–30, 1944–2011	11/09/96	12.11	14,400	04/28/11	1430	9.54	8,760	11.1	9
280	04273700	Salmon River at South Plattsburgh, N.Y.	63.3	1960–86, 1990–2011	11/09/96	7.56	4,200	04/28/11	1215	5.08	1,610	20.0	5
281	04273800	Little Ausable River near Valcour, N.Y.	67.8	1992–2011	06/27/98	13.78	7,210	04/28/11	1515	3.32	1,110	33.3	3
282	04274000	West Branch Ausable River near Lake Placid, N.Y.	116	1920–68, 1983–2011	09/22/38	12.20	10,800	04/28/11	--	11.88	10,200	1.2	80
283	04275000	East Branch Ausable River at Au Sable Forks, N.Y.	198	1925–2011	11/09/96	15.22	23,900	04/28/11	1400	11.48	14,400	5.0	20
284	04275500	Ausable River near Au Sable Forks, N.Y.	446	1911–68, 1990–2011	11/09/96	13.83	37,400	04/28/11	1545	11.60	25,100	2.9	35
285	04276500	Bouquet River at Willsboro, N.Y.	270	1924–68, 1980, 1985, 1987–2011	11/09/96	10.93	12,300	04/27/11	1415	9.22	8,500	10.0	10
286	04276842	Putnam Creek east of Crown Point Center, N.Y.	51.6	1990–2011	06/17/05	7.71	3,140	04/28/11	1500	6.50	838	>50.0	<2
287	04278000	Lake George at Rogers Rock, N.Y.	233	1913–2011	04/09/36	[a]321.15	--	04/28/11	0645	[a]320.41	--	--	--
288	04279085	Lake Champlain north of Whitehall, N.Y.	725	1998–2011	04/28/01	[a,f]101.80	--	05/09/11	1400	[a,f]103.57	--	--	--
289	04280450	Mettawee River near Middle Granville, N.Y.	167	1990–2011	12/17/00	13.47	13,100	04/28/11	2000	6.63	2,070	>50.0	<2
290	04295000	Richelieu River (Lake Champlain) at Rouses Point, N.Y.	8,277	1869, 1871–2011	05/04/1869	[a]102.1	--	05/06/11	0715	[a]103.20	--	--	--

[a]Elevation in feet above National Geodetic Vertical Datum of 1929.

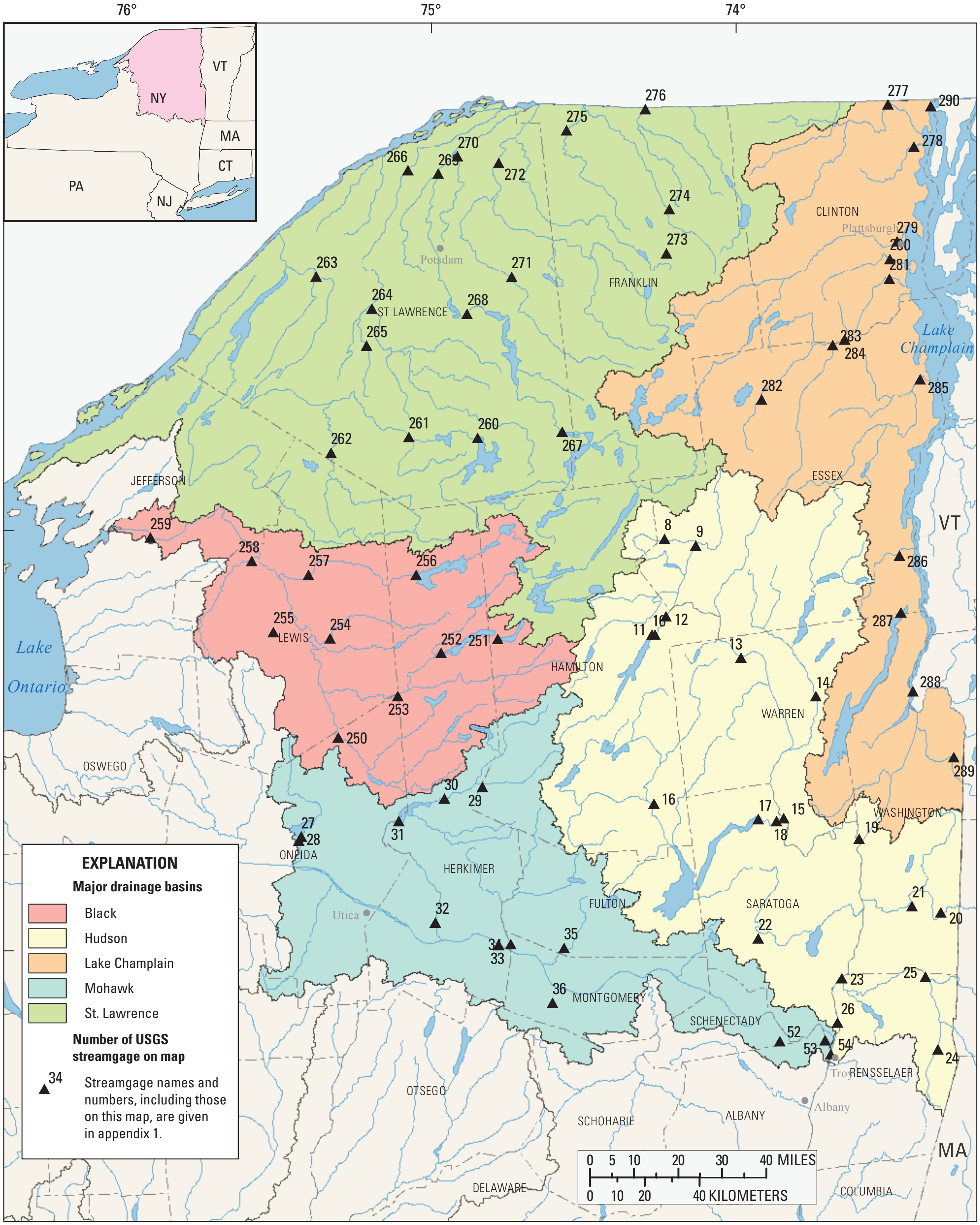
[b]At former site or datum.

[c]Estimated.

[d]Daily discharge.

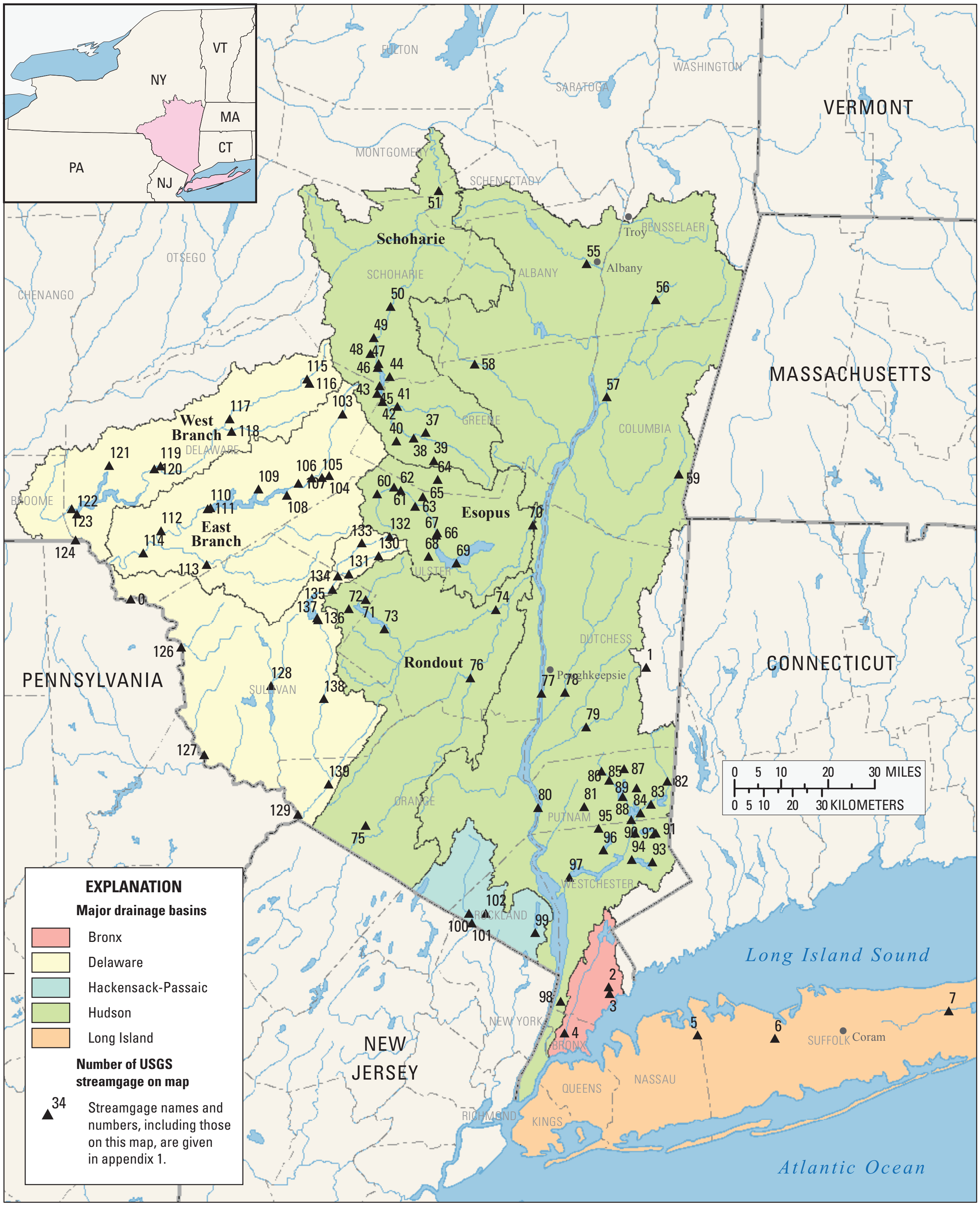
[e]Elevation in feet above Barge Canal Datum.

[f]Affected by seiche.



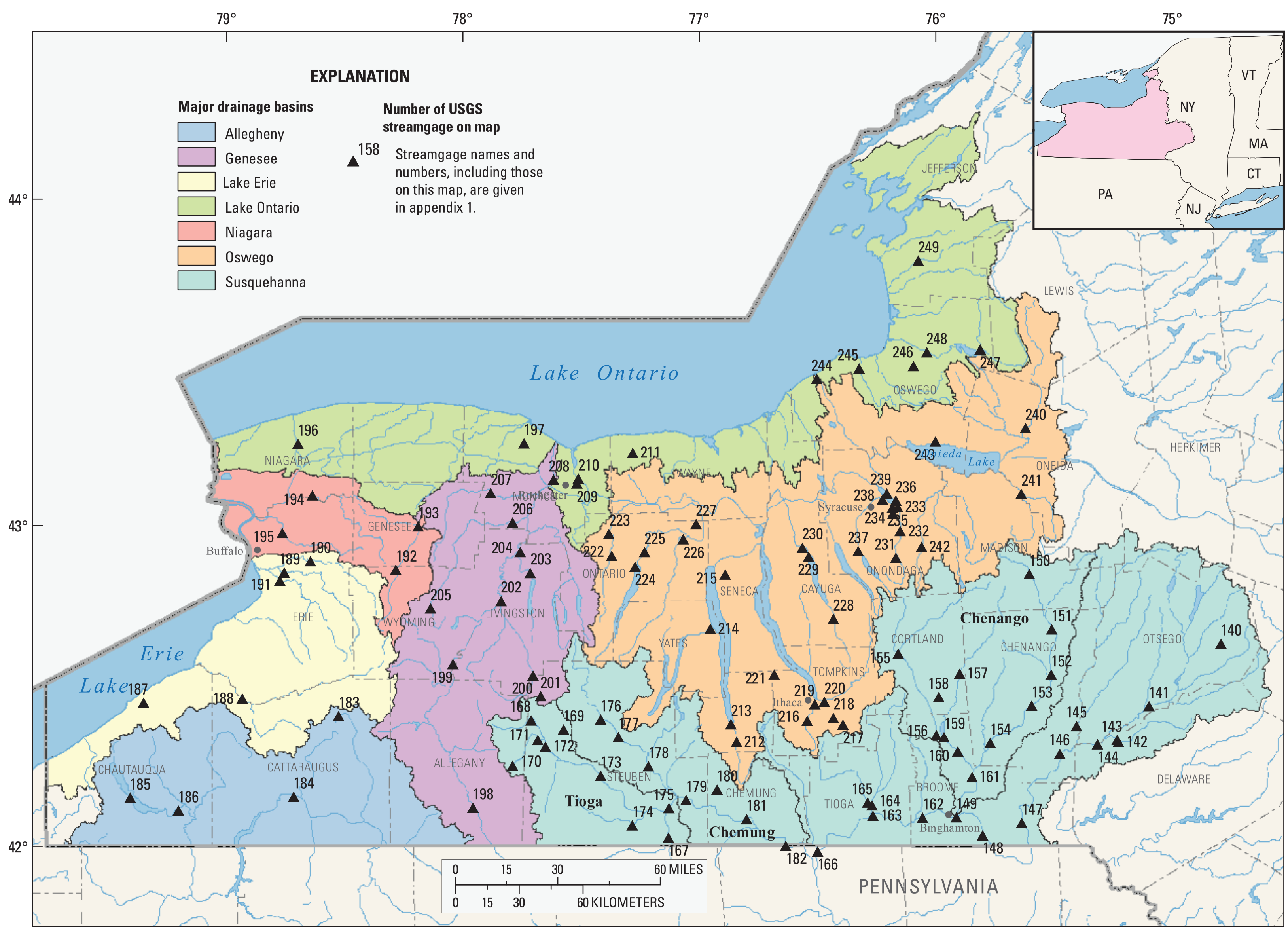
Base from the National Atlas of the United States, 1:2,000,000
Web Mercator Auxiliary Sphere projection,
World Geodetic System, 1984 datum

Figure 10. Locations of selected U.S. Geological Survey streamgages and major drainage basins in New York.



Base from the National Atlas of the United States, 1:2,000,000
Web Mercator Auxiliary Sphere projection,
World Geodetic System, 1984 datum

Figure 10. Locations of selected U.S. Geological Survey streamgages and major drainage basins in New York.—Continued



Base from the National Atlas of the United States, 1:2,000,000
Web Mercator Auxiliary Sphere projection,
World Geodetic System, 1984 datum

Figure 10. Locations of selected U.S. Geological Survey streamgages and major drainage basins in New York.—Continued

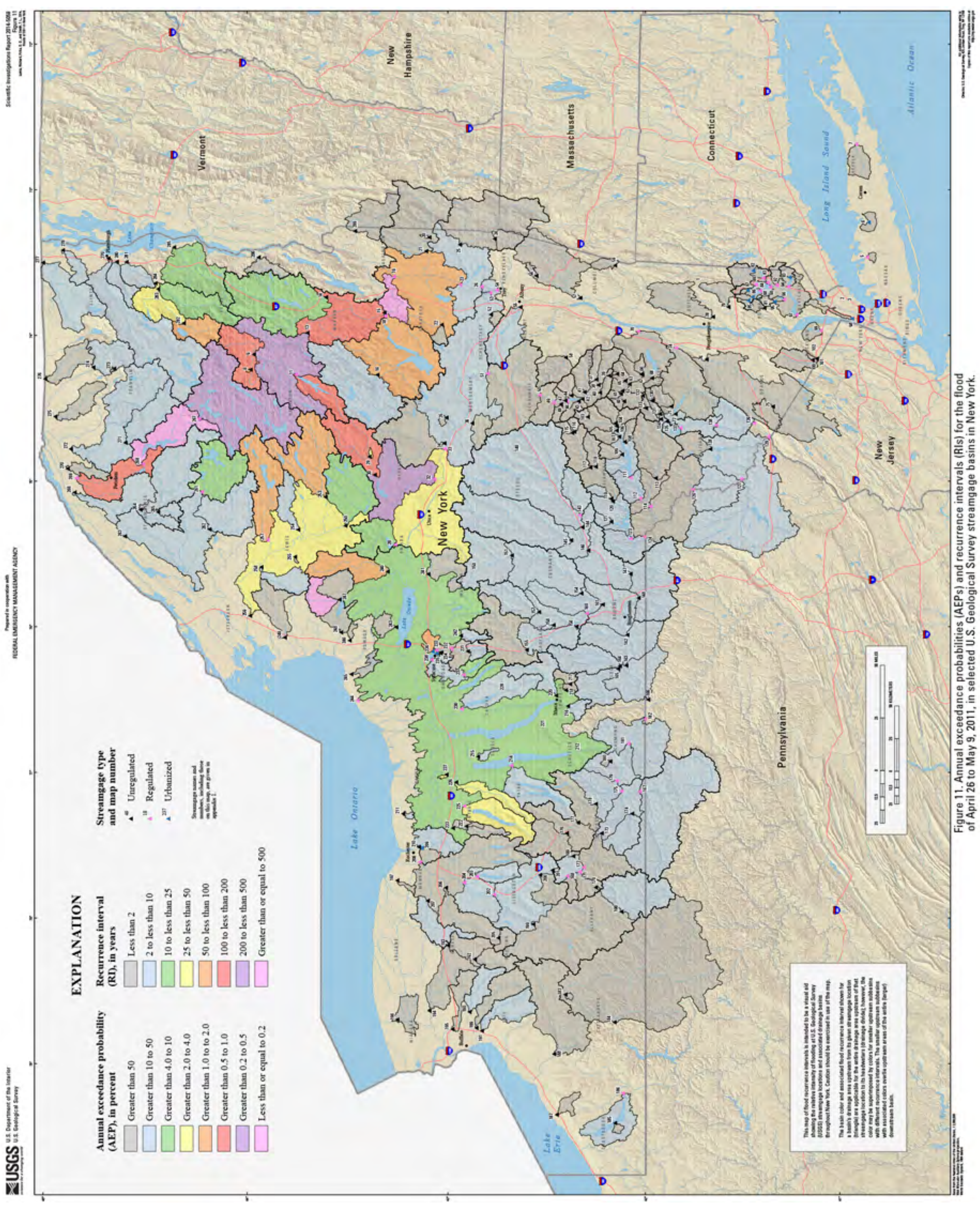


Figure 11. Annual exceedance probabilities and recurrence intervals for the flood of April 26–May 9, 2011, in selected U.S. Geological Survey streamgage basins in New York. (Click link to view full-size map of figure 11 at *http://pubs.usgs.gov/sir/2014/5058/*.)

Table 5. T-year recurrence interval with corresponding annual exceedance probability and P-percent chance annual exceedance probability for flood-frequency flows.

T-year recurrence interval	Annual exceedance probability	P-percent chance annual exceedance probability
2	0.5	50
5	0.2	20
10	0.1	10
25	0.04	4
50	0.02	2
100	0.01	1
200	0.005	0.5
500	0.002	0.2

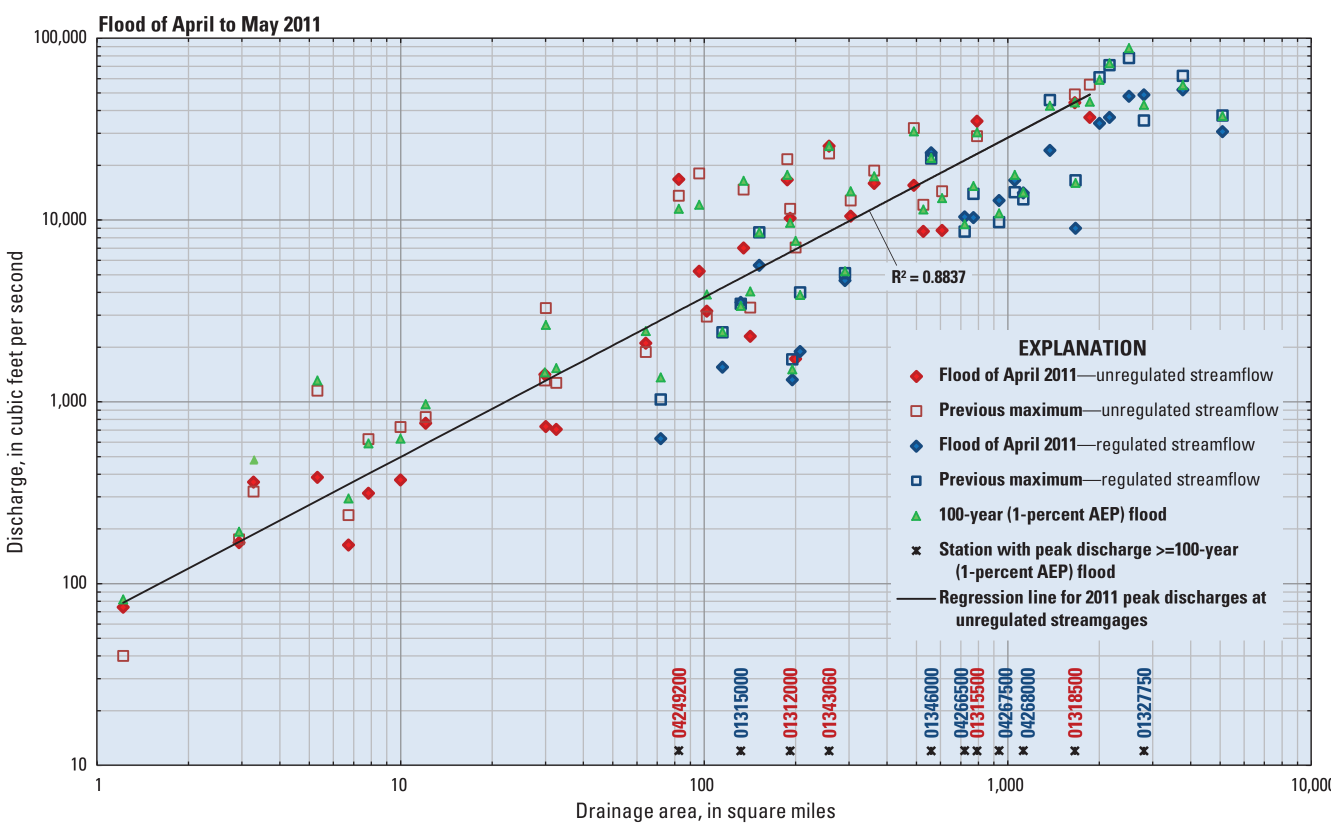


Figure 12. Peak discharges for the flood of April 26–May 9, 2011, previous maximum known discharges, and 1-percent annual exceedance probability (100-year) discharges at selected streamgages, as a function of drainage area. (Sites are listed in appendix 1 and shown on figure 10; ≥, greater than or equal to; AEP, annual exceedance probability)

The upper Hudson River Basin was particularly hard hit by the April flooding. Of the seven streamgages on the main stem of the Hudson River (fig. 10 and appendix 1) at or upstream from Green Island (near Troy), the four most upstream streamgages recorded peaks less than a 1-percent AEP (>100-year) flow (fig. 13). The Hudson River at North Creek streamgage (01315500) recorded its greatest stage and discharge since record collection began in 1908 (the April peak stage of 13.65 ft was 1.51 ft higher than that of 12.14 ft during the previous record flood on December 31, 1948).

The water equivalent of snow in the Adirondack Mountains combined with high rainfall totals throughout northern New York during April resulted in large volumes of runoff (the amount of water discharged from a drainage basin and passing a specific location during a given amount of time) for several days. The maximum volumes of runoff for the periods of record for 1-, 3-, and 7-consecutive days (n-days), expressed as the mean of daily mean discharges over an n-day period, at four streamgages—Hudson River at North Creek (01315500), Raquette River at Piercefield (04266500) and at South Colton (04267500), and Ausable River near Au Sable Forks (04275500)—are shown on figures 14A–D, respectively. The graphs also show the 10-, 2-, and 1-percent AEP n-day discharges, the 10-year moving average, and a trend line for each site. The n-day runoffs during late April and early May 2011 were 20 to 40 percent greater than the previous maximum n-day runoffs at Hudson River at North Creek (01315500) over the 104-year period of record and significantly exceeded the 1-percent AEP (100-year) n-day discharges (fig. 14A). The maximum 7-day runoff from April 26 to May 2, 2011, was more than 6 in. over the entire 792 square-mile (mi^2) drainage basin. No significant trend is indicated since record collection began in 1908. The Raquette River at Piercefield (04266500) and at South Colton (04267500) n-day runoffs during the April–May flood also exceeded the previous record n-day runoffs (figs. 14B–C). These streamgages represent large drainage basins (721 and 937 mi^2) that are regulated by upstream reservoirs, lakes, and ponds. The maximum 1-, 3-, and 7-consecutive-day mean discharges during April–May 2011 exceeded the 1-percent AEP (100-year) n-day discharge at each Raquette River gage. Runoff from the April–May 2011 flood at the Ausable River

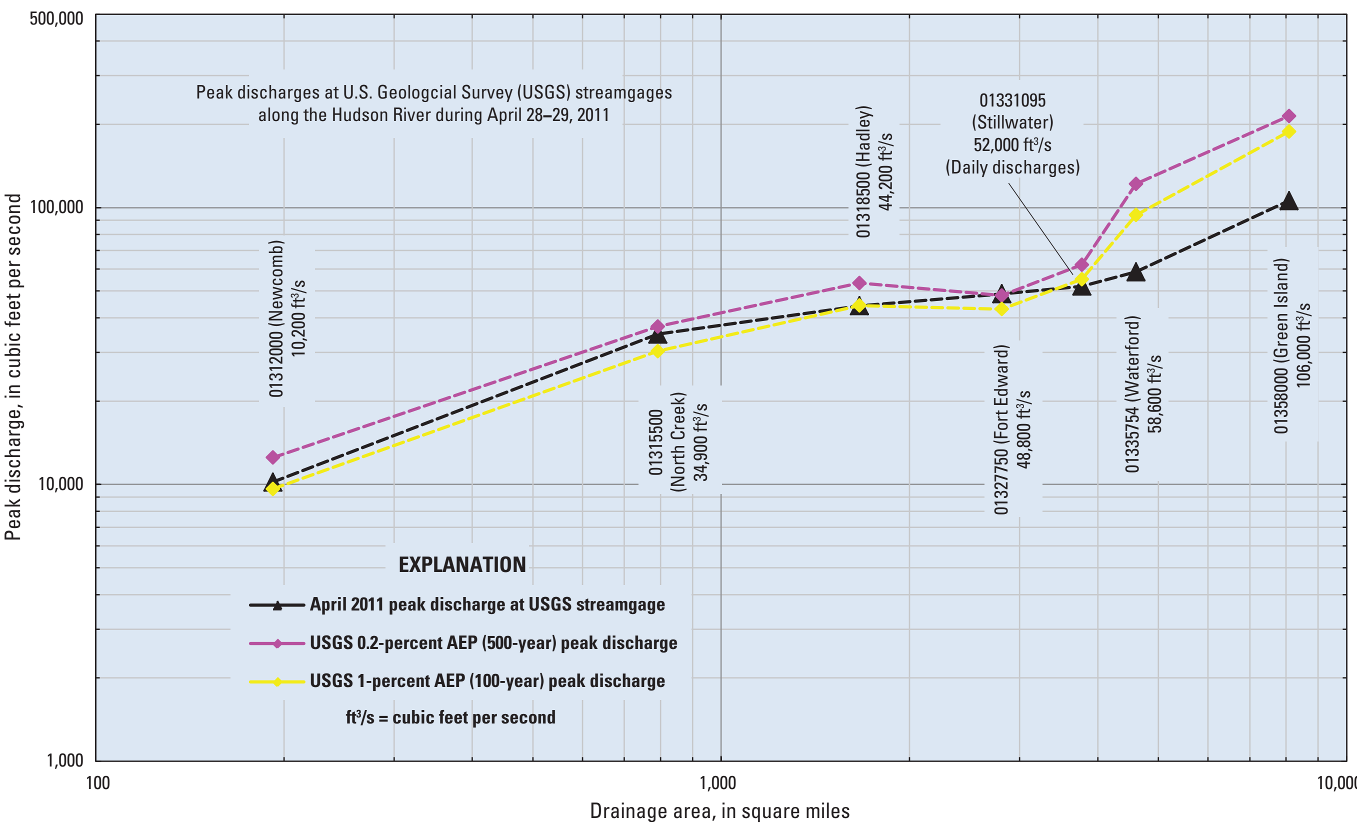


Figure 13. Peak discharges for the floods of April 26–May 9, 2011, and 1- and 0.2-percent annual exceedance probability (AEP) (100- and 500-year) discharges at seven U.S. Geological Survey (USGS) streamgages on the Hudson River, as a function of drainage area. (Sites are listed in appendix 1 and shown on figure 10.)

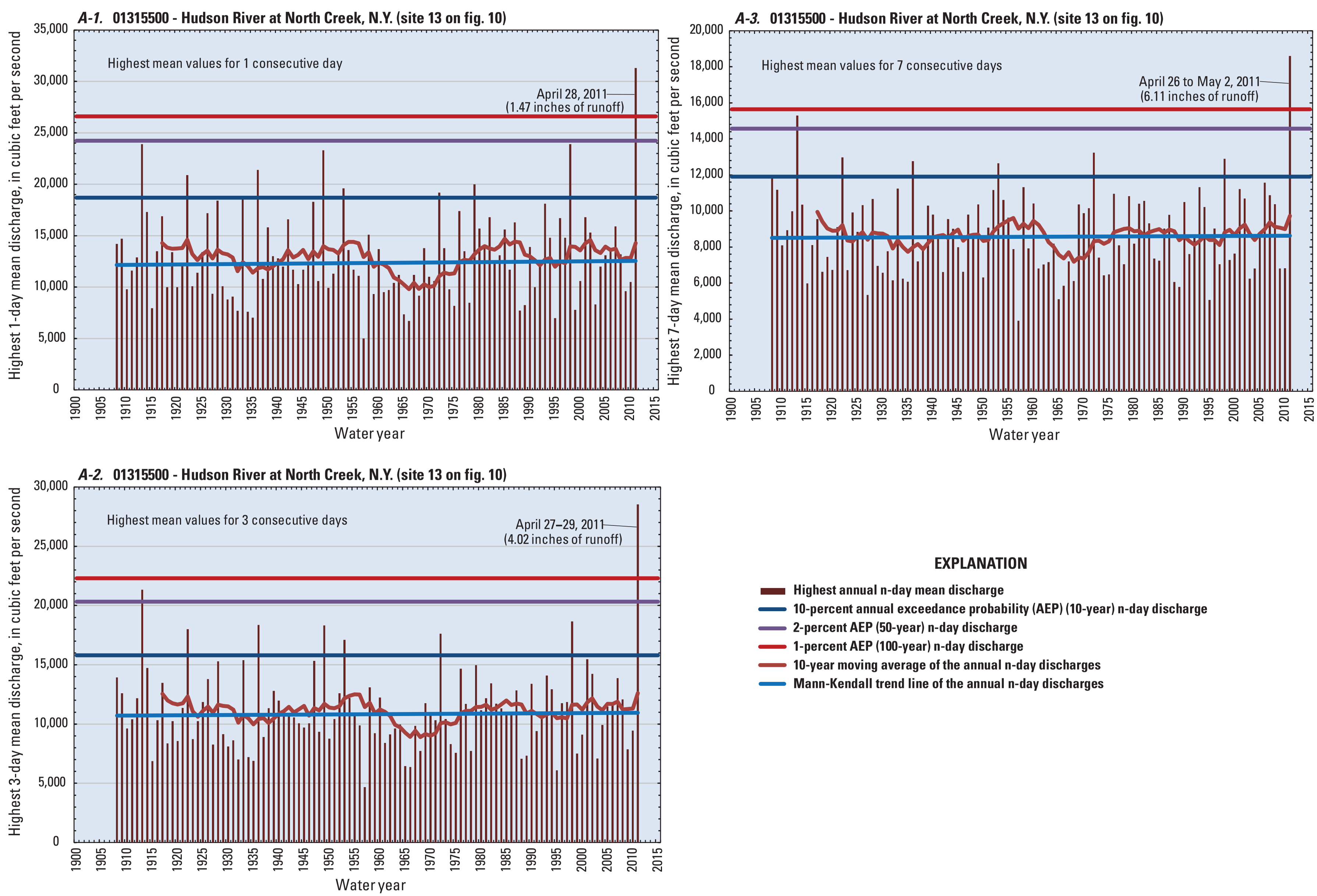


Figure 14. Highest 1-, 3-, and 7-consecutive daily mean discharges, selected n-day frequencies, and trend-analysis data for the streamgages *A,* Hudson River at North Creek, *B,* Raquette River at Piercefield, *C,* Raquette River at South Colton, and *D,* Ausable River near Au Sable Forks, New York. (Sites are listed in appendix 1 and shown on figure 10.)

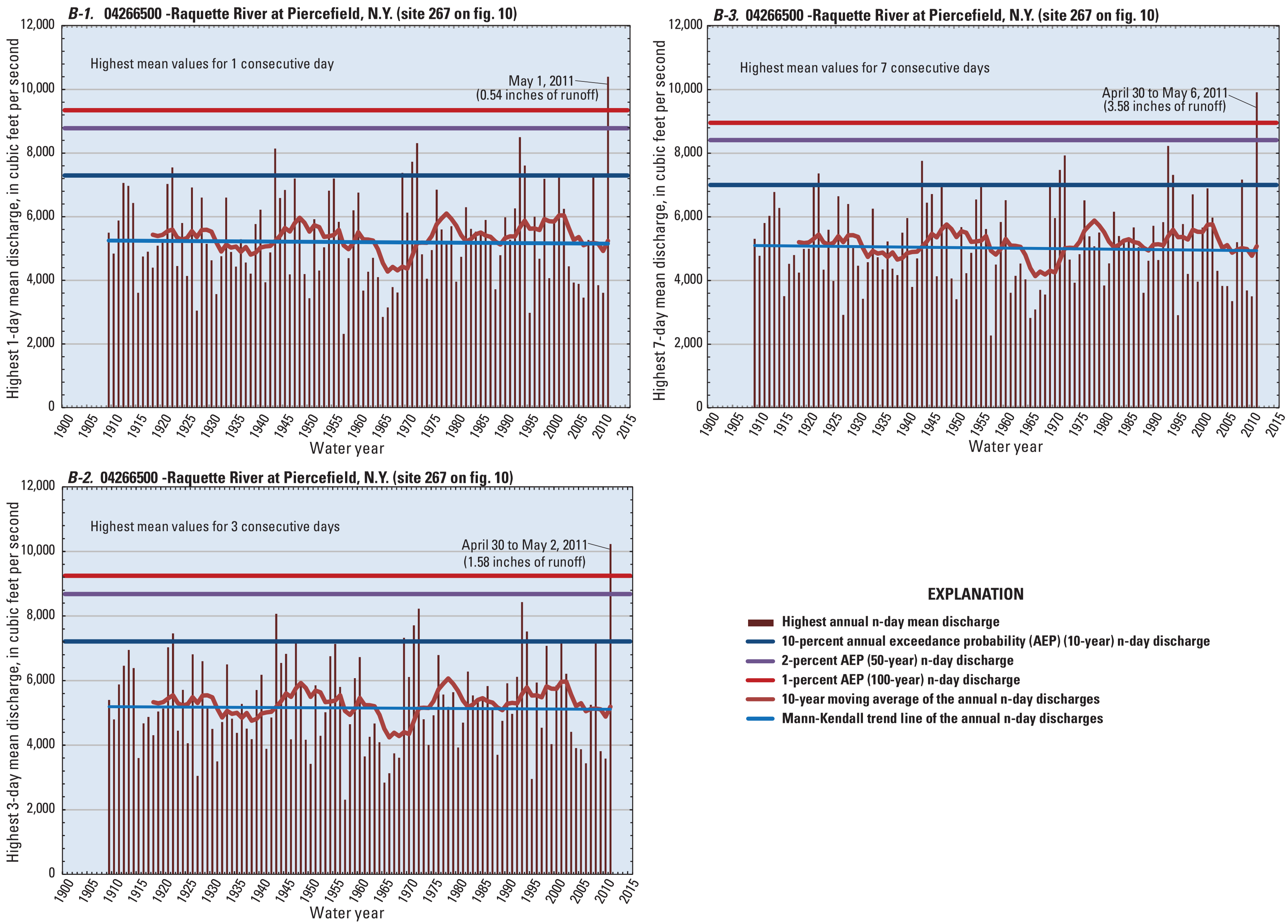


Figure 14. Highest 1-, 3-, and 7-consecutive daily mean discharges, selected n-day frequencies, and trend-analysis data for the streamgages *A,* Hudson River at North Creek, *B,* Raquette River at Piercefield, *C,* Raquette River at South Colton, and *D,* Ausable River near Au Sable Forks, New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

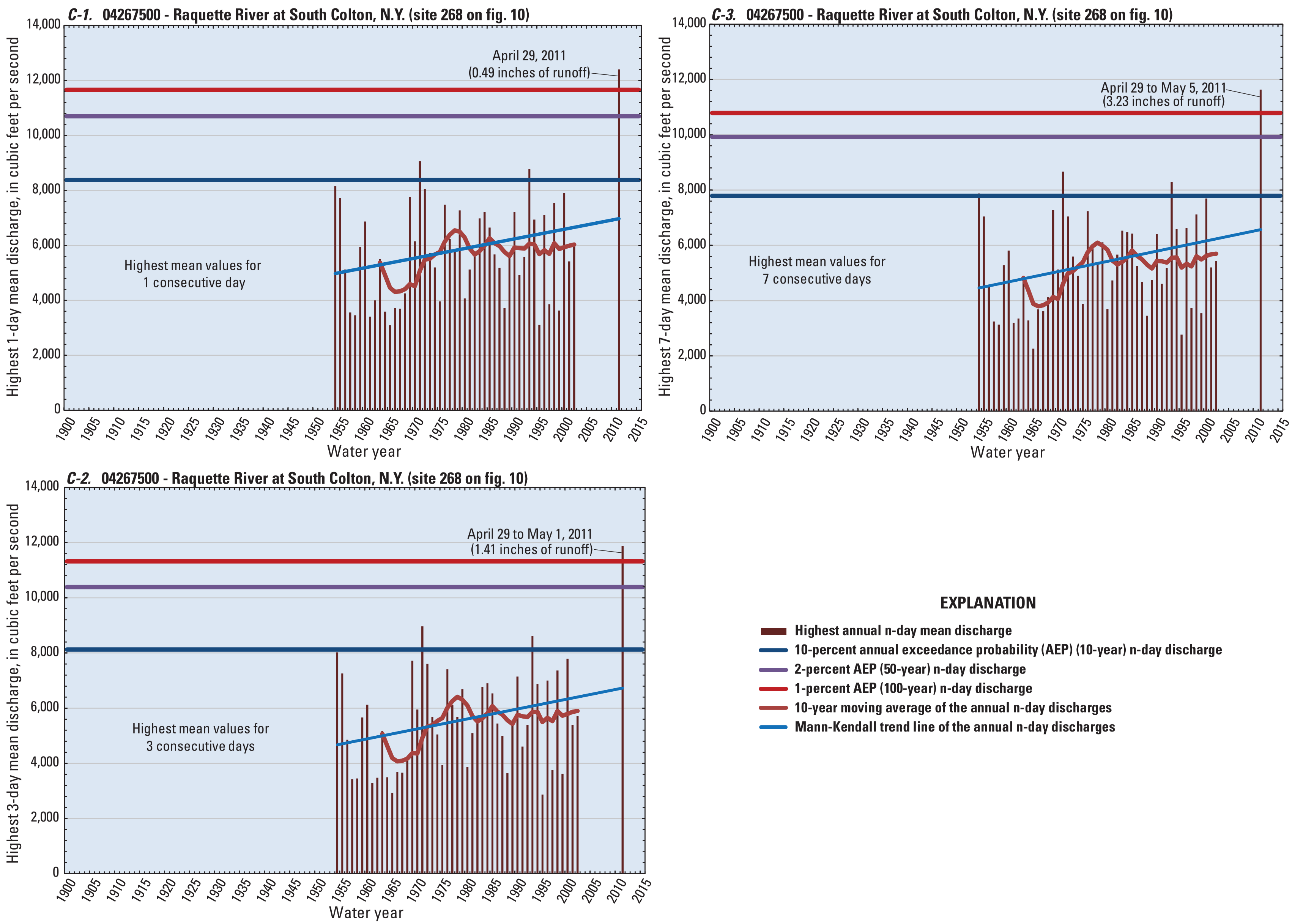


Figure 14. Highest 1-, 3-, and 7-consecutive daily mean discharges, selected n-day frequencies, and trend-analysis data for the streamgages *A,* Hudson River at North Creek, *B,* Raquette River at Piercefield, *C,* Raquette River at South Colton, and *D,* Ausable River near Au Sable Forks, New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

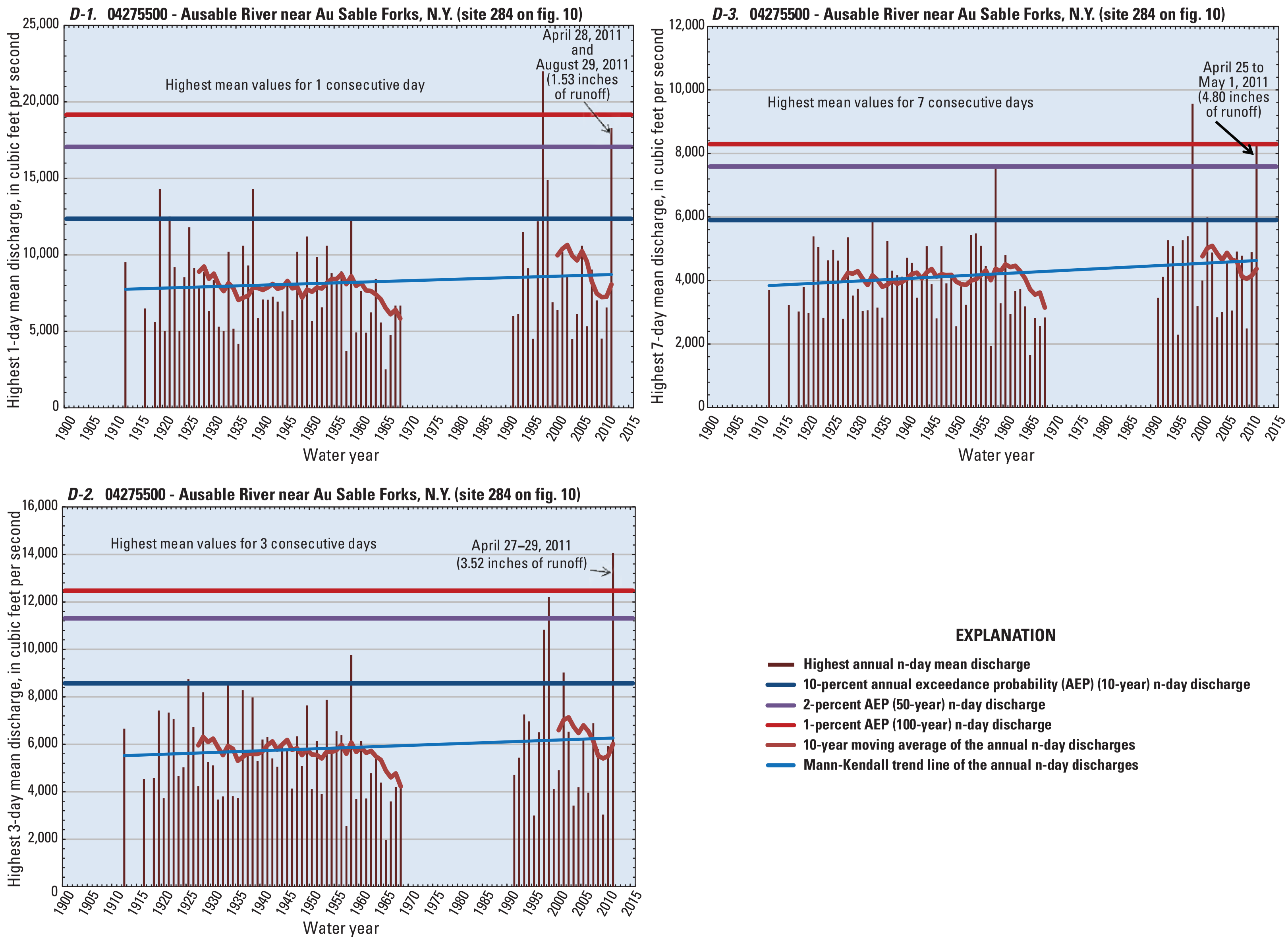


Figure 14. Highest 1-, 3-, and 7-consecutive daily mean discharges, selected n-day frequencies, and trend-analysis data for the streamgages *A,* Hudson River at North Creek, *B,* Raquette River at Piercefield, *C,* Raquette River at South Colton, and *D,* Ausable River near Au Sable Forks, New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

near Au Sable Forks (04275500) was the second largest for 1- and 7-day periods but the greatest 3-day runoff for the period of record (fig. 14D). A large flood that peaked on November 9, 1996, exceeded 1- and 7-day runoff of the 2011 flood. The maximum 3-consecutive-day mean flow (for April 27–29, 2011) at the Ausable River streamgage exceeded the 1-percent AEP (100-year) n-day flow.

An analysis of annual peak discharges at 13 selected USGS streamgages throughout northern New York indicates that the April–May 2011 peak discharges exceeded the 1-percent AEP (100-year) discharge, and many were peaks of record (figs. 15A–M). The streamgages on Indian River near Indian Lake (01315000 just downstream from Indian Lake) recorded the greatest stage and discharge since record collection began in 1913 and exceeded the 1-percent AEP (100-year) peak discharge (fig. 15B). Other peak flows of note during the April–May 2011 flood include those at the Hudson River at North Creek (01315500), which exceeded the previous maximum in December 1948 (fig. 15C) by 25 percent (greater than the 0.5-percent AEP or 200-year discharge, table 4); Sacandaga River at Stewart's Bridge near Hadley (01325000), which recorded its greatest stage and discharge since regulation at Great Sacandaga Lake began in 1930 (fig. 15E); West Canada Creek at Kast Bridge (01346000), where the largest flow since 1913 was recorded (fig. 15H); and three streamgages on the Raquette River (at Piercefield (04266500), South Colton (04267500), and Raymondville (04268000)), where each recorded maximum stage and discharge exceeded or equaled the 1-percent AEP (100-year) flow (figs. 15K–M).

Trends in annual peak flow and n-day runoff were tested by using the Mann-Kendall trend test, a nonparametric test that is resistant to the effects of a small number of unusual values (outliers) and is well suited for variables that exhibit skewness around the general relation. The test is applicable to data that are not serially correlated. Correlation was tested by using methods by Lorentz and others (2011), but no correlation was detected. The strength of the monotonic relation between time and peak discharge is represented by the tau value and level of significance (p-value) (Helsel and Hirsch, 1992, 2002). Significance levels (p-values) of 0.05 and 0.10 were used in these analyses. The median of the slopes for the pairs of data used in each analysis was calculated by using the Thiel-Sen slope estimator (Lorenz and others, 2011).

Results of the trend tests are presented in table 6 for 55 selected streamgages with substantial flooding during 2011 and are shown on graphs for n-day mean discharges (figs. 14A–D) and annual peaks (figs. 15A–M). Trend data for the period of record (long-term trend) and for short-term record (most recent 30 years through 2011 or shorter if less data are available) are reported in table 6 and shown on figures 15A–M. Of the 55 selected sites in table 6, 41 had annual peak discharges with long periods of record (32 to 108 years), of which 12 sites (29 percent) had a significant upward trend (p-value less than or equal to 0.10), and only 2 sites had a statistically significant downward trend. Short-term trends computed at 42 of the 55 selected sites for the most recent 30 years or less (13–30 years) indicate that 14 sites (33 percent) had statistically significant upward trends (p-values less than or equal to 0.10), and no sites had significant downward trends.

The general increase in trends in the annual peak discharge could be caused by climate change, increasing urbanization, or other changes and could affect future water management, infrastructure design, flood planning and management, and other practices. Data trends also indicate that annual peak discharges may not be stationary, as currently presumed in standard flood-frequency analyses (Walter and Vogel, 2010). Underlying components to nonstationary peak flows need to be identified and (or) removed for valid assessment of flood frequencies. A study of trends in peak discharges at 1,312 USGS streamgages throughout the northeastern United States by Walter and Vogel (2010) suggests that in 10 years, at sites exhibiting trends, a 10-year storm frequency is reduced, on average, to a 6.1-year storm frequency; a 25-year storm frequency to a 13.8-year storm frequency; and a 100-year storm frequency to a 48.5-year storm frequency. This analysis, as well as similar analyses of trends in peak discharges, indicate that flows in New York streams need more detailed evaluations, especially if nonstationarity continues to affect many streamgages.

Flood AEP flows computed for the Hudson River at North Creek (01315500) starting after the first 10 years of record (1908–17) and recomputed after each additional year of record through 2011 (maximum discharge for the year occurred on April 28) illustrate the effect of individual annual peak discharges on the magnitude of the AEP flow over time (fig. 16). The 10-year moving average and the computed trend line for the "moving" 1-percent AEP (100-year) flood-frequency values show almost no trend (slightly downward) at this site during its 104-year period of record.

Antecedent conditions, precipitation, runoff patterns, and basin characteristics all play a role in determining the peak water-surface elevation and discharge at a streamgage. Discharge hydrographs for selected streamgages throughout the flooded areas for April 25–May 1, 2011, are shown on figures 17–18. The graphs on figure 17 compare hydrographs at selected streamgages within a basin and include the 1-percent AEP (100-year) discharge for each site; the plots show the magnitude, frequency, and timing of flows at each location. The Raquette River plots (fig. 17I) show data for April 27–May 3 (slower basin-response time as a result of upstream lakes, ponds, and reservoirs). One of the hydrograph plots of note shows the Hudson River streamgages at Fort Edward (01327750) and Waterford (01335754) with the hydrograph of the intervening Hoosic River near Eagle Bridge streamgage (01334500) (fig. 17C). The Fort Edward streamgage recorded a peak discharge greater than the 500-year flood (less than the 0.2-percent AEP discharge), whereas the Hoosic River, which enters the Hudson River downstream from Fort Edward, recorded a "low" peak discharge with a recurrence interval of less than 2 years (greater than

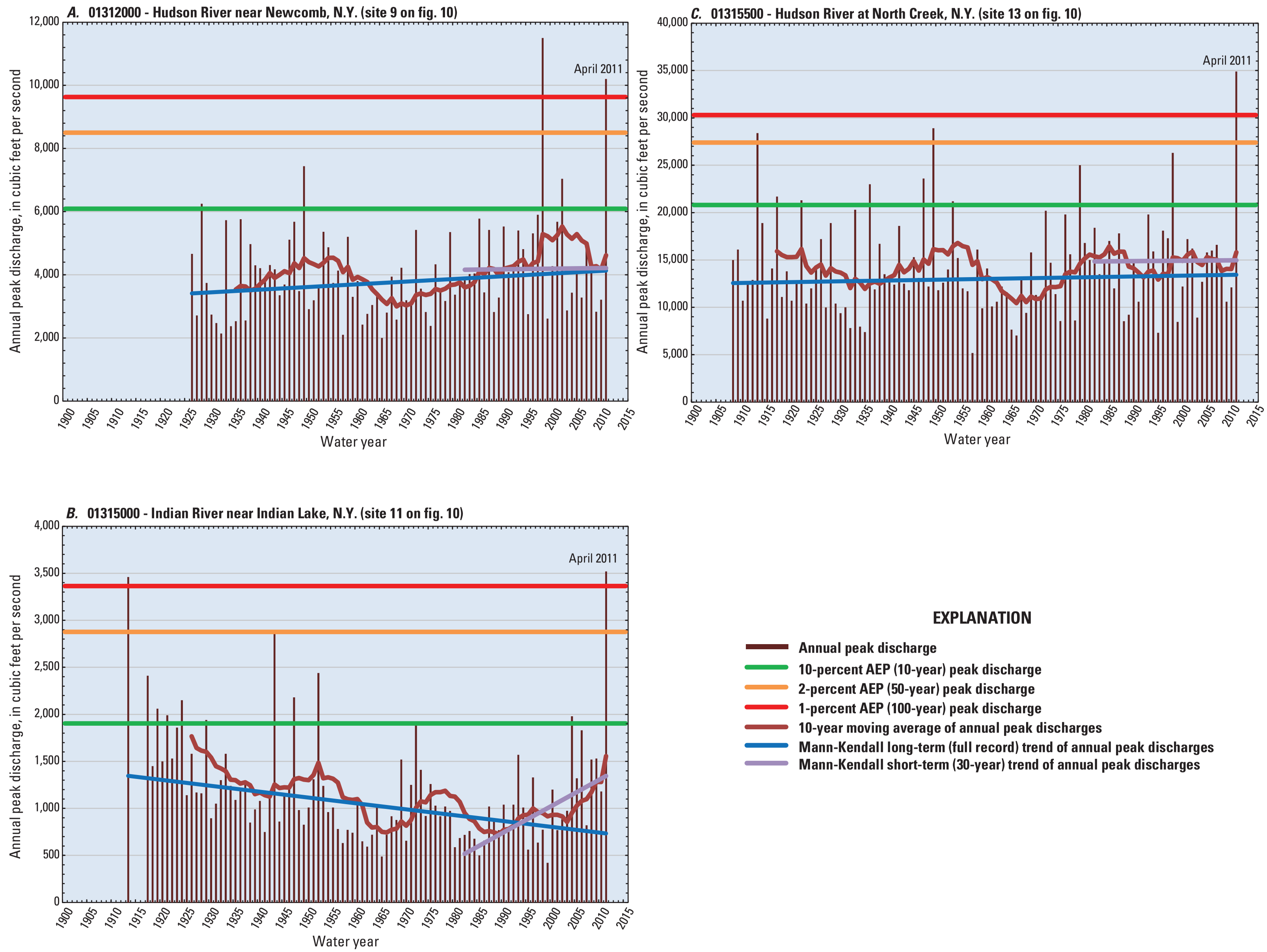


Figure 15. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)

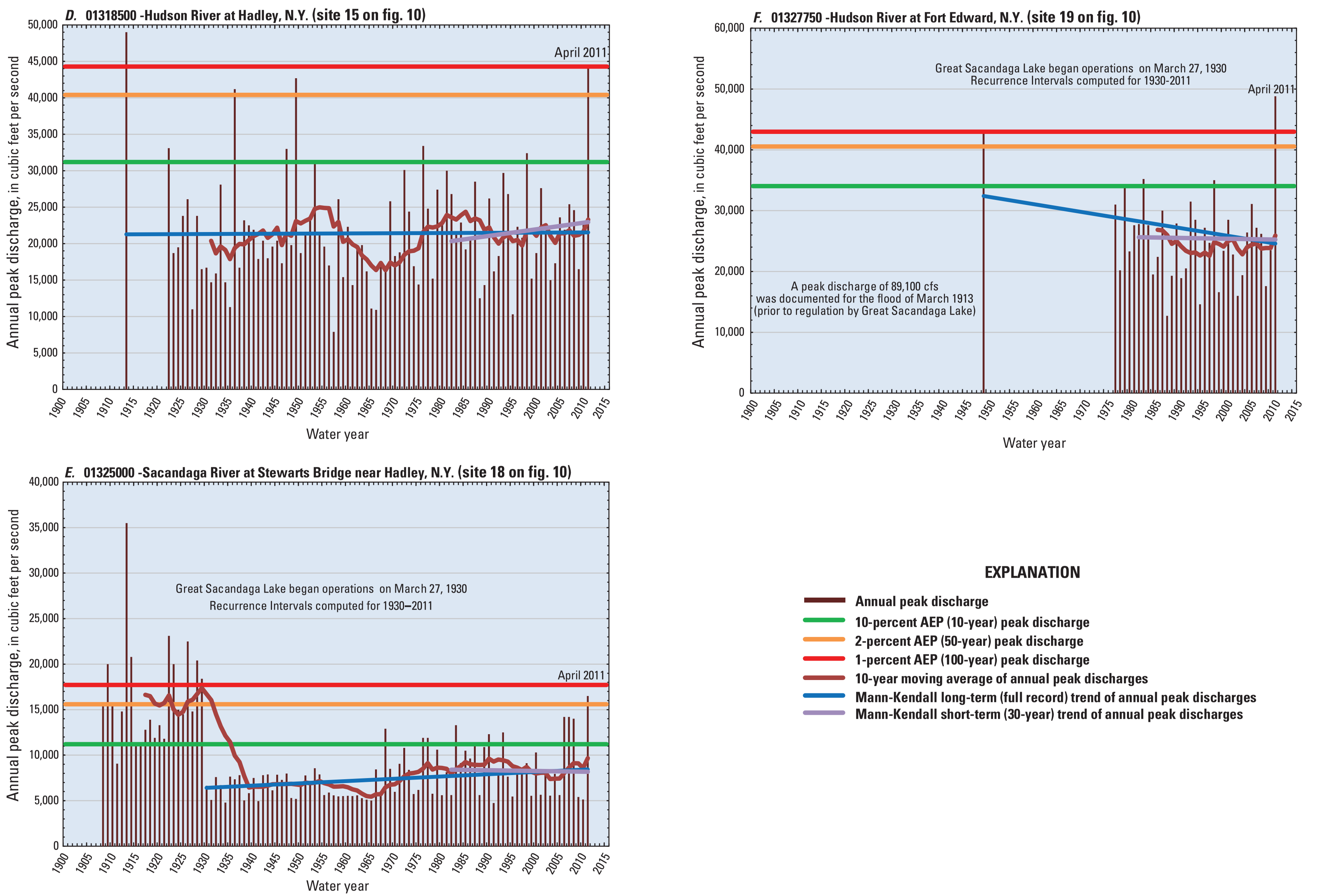
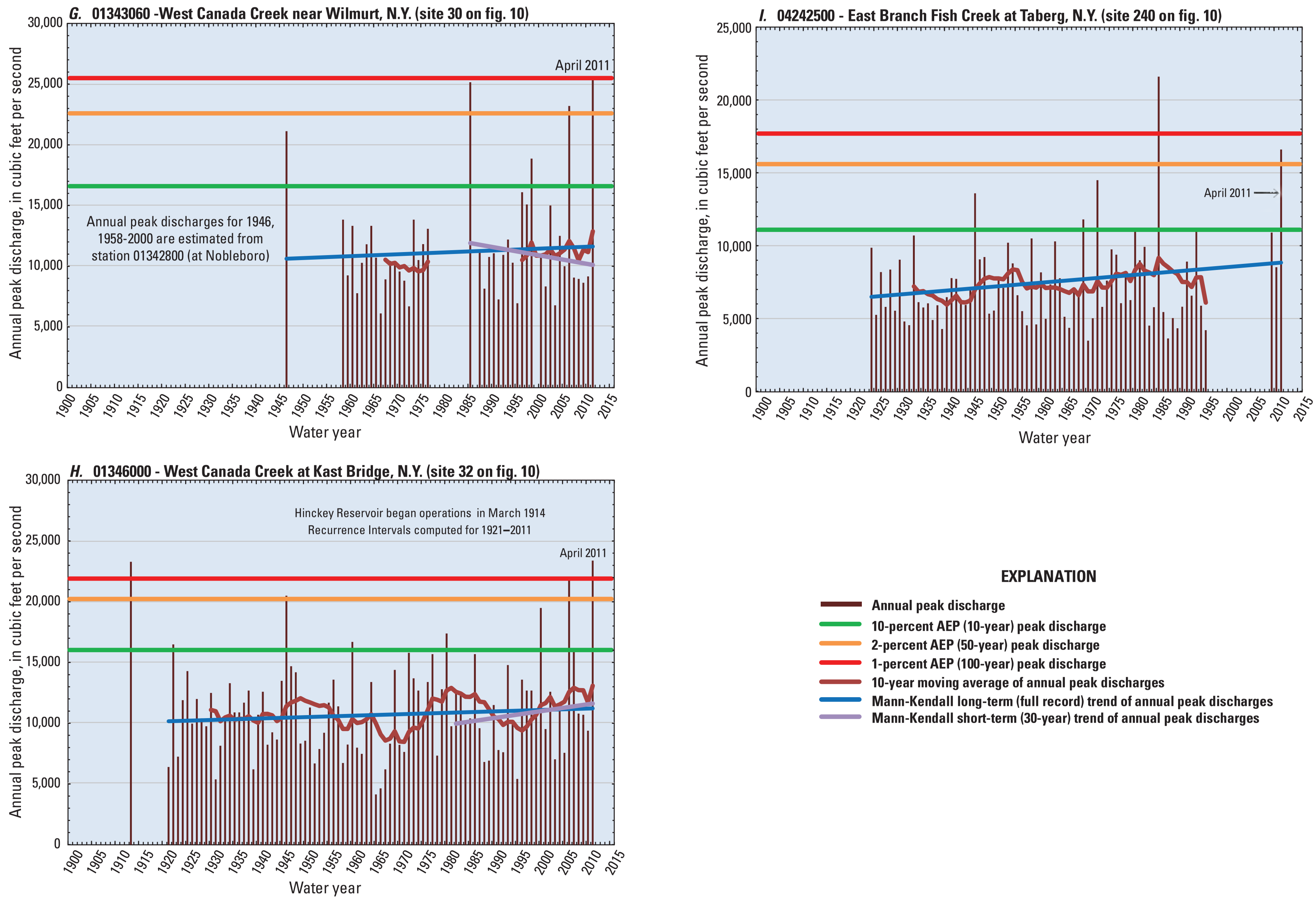


Figure 15. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued



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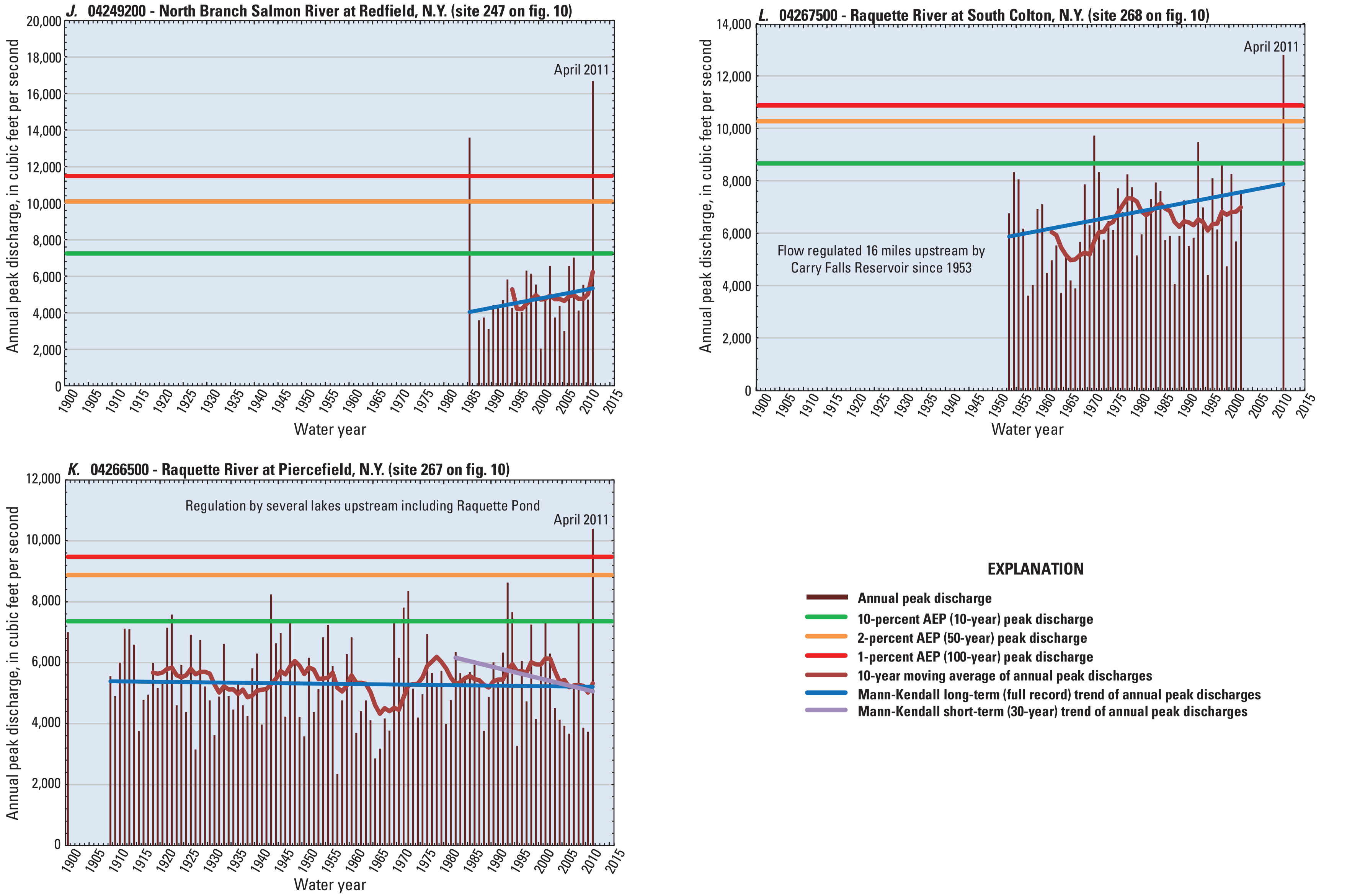


Figure 15. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

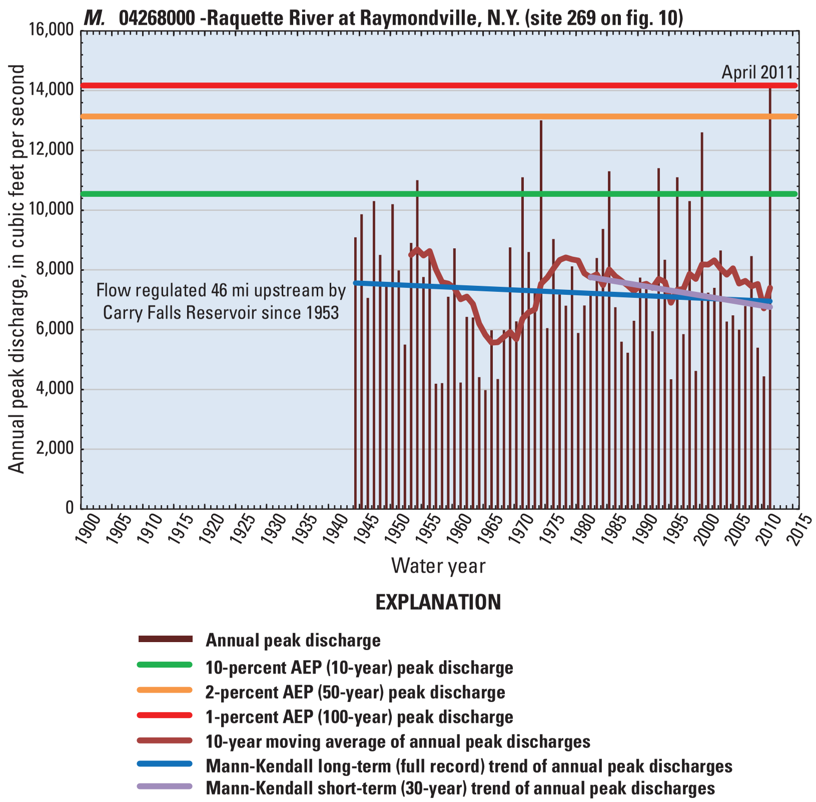


Figure 15. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

Table 6. Trend tests for annual peak discharges at selected U.S. Geological Survey streamgages in New York for the period of record and the most recent 30 years or less (through 2011).

[The Mann-Kendall statistical trend test was used for these analyses. Trends are plotted on figures 15, 32, and 57; **bold blue** indicates a significant upward trend (p-value ≤ 0.05); **bold red** indicates a significant downward trend (p-value ≤ 0.05; **bold green** indicates an upward trend (p-value > 0.05 and ≤ 0.10); latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); sites in pink have a significant degree of upstream regulation; ft³/s, cubic feet per second; mi², square miles; >, greater than; ≤, less than or equal to; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude	Longitude	Period of record	Long-term trend (>30 years): Years of peak discharges	Long-term: Median of peak discharges (ft³/s)	Long-term: Kendall's Tau	Long-term: Slope (ft³/s)/year	Long-term: p-value	Short-term trend (most recent 30 years or less): Years of peak discharges	Short-term: Median of peak discharges (ft³/s)	Short-term: Kendall's Tau	Short-term: Slope (ft³/s)/year	Short-term: p-value
9	01312000	Hudson River near Newcomb, N.Y.	192	43.96667	-74.13194	1926–2011	86	3,770	0.109	8.5	0.139	30	4,185	0.009	1.8	0.957
11	01315000	Indian River near Indian Lake, N.Y.	132	43.75639	-74.26750	1913–2011	**99**	**1,040**	**-0.261**	**-6.2**	**0.000**	**30**	**932**	**0.414**	**28.5**	**0.001**
13	01315500	Hudson River at North Creek, N.Y.	792	43.70083	-73.98389	1908–2011	104	13,000	0.032	8.5	0.631	30	14,900	0.005	4.2	0.986
15	01318500	Hudson River at Hadley, N.Y.	1,664	43.31889	-73.84472	1913–2011	99	21,400	0.008	2.6	0.906	30	21,650	0.078	90.0	0.556
18	01325000	Sacandaga River at Stewarts Bridge near Hadley, N.Y.	1,055	43.31139	-73.86778	1930–2011	**82**	**7,425**	**0.223**	**25.0**	**0.003**	30	8,290	-0.048	-7.8	0.721
19	01327750	Hudson River at Fort Edward, N.Y.	2,810	43.26944	-73.59639	1949, 1977–2011	**36**	**28,500**	**-0.497**	**-126.3**	**0.000**	30	25,450	-0.012	-13.3	0.943
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	42.93861	-73.37750	1911–2011	**101**	**11,897**	**0.243**	**50.9**	**0.000**	30	14,250	0.177	130.0	0.175
30	01343060	West Canada Creek near Wilmurt, N.Y.	258	43.36611	-74.95806	1946, 1958–76, 1984–2011	45	11,123	0.046	15.6	0.588	25	11,005	-0.048	-69.0	0.739
32	01346000	West Canada Creek at Kast Bridge, N.Y.	560	43.06889	-74.98861	1921–2011	91	10,700	0.060	11.8	0.401	30	10,800	0.103	57.1	0.432
35	01348420	North Creek near Ephratah, N.Y.	6.52	43.00778	-74.56500	1975–2011	37	290	0.149	2.7	0.200					
37	01349700	East Kill near Jewett Center, N.Y.	35.6	42.24917	-74.30306	1956, 1996–2011						**16**	**6,023**	**0.187**	**36.3**	**0.043**
38	01349705	Schoharie Creek near Lexington, N.Y.	96.8	42.23694	-74.34056	1999–2011						13	12,200	0.115	505.0	0.625
39	01349711	West Kill below Hunter Brook near Spruceton, N.Y.	4.97	42.18500	-74.27722	1998–2011						14	508	0.077	27.0	0.743
40	01349810	West Kill near West Kill, N.Y.	27.0	42.23028	-74.39333	1996–2011						16	2,740	-0.067	-44.7	0.753
41	01349950	Batavia Kill at Red Falls near Prattsville, N.Y.	68.6	42.30833	-74.39028	1996–2011						16	5,235	-0.033	-22.5	0.893
42	01350000	Schoharie Creek at Prattsville, N.Y.	237	42.31944	-74.43694	1904–2011	**108**	**14,850**	**0.145**	**57.7**	**0.027**	**30**	**16,550**	**0.241**	**413.0**	**0.064**
46	01350101	Schoharie Creek at Gilboa, N.Y.	316	42.39722	-74.45083	1976–2011	36	15,200	0.138	268.8	0.241					
49	01350180	Schoharie Creek at North Blenheim, N.Y.	358	42.46583	-74.46250	1971–2011	41	17,100	0.082	147.2	0.459					
50	01350355	Schoharie Creek at Breakabeen, N.Y.	444	42.53694	-74.41083	1976–2011	36	19,550	0.095	190.7	0.421					
51	01351500	Schoharie Creek at Burtonsville, N.Y.	886	42.80000	-74.26333	1940–2011	**72**	**21,450**	**0.207**	**194.7**	**0.010**	30	27,750	0.172	569.2	0.187
58	01361500	Catskill Creek at Oak Hill, N.Y.	95.8	42.40528	-74.15139	1911–80, 1987–2011	**95**	**4,690**	**0.333**	**44.4**	**0.000**					
62	01362200	Esopus Creek at Allaben, N.Y.	63.7	42.11694	-74.38056	1964–2011	48	3,705	0.144	39.4	0.152	**30**	**3,410**	**0.230**	**91.1**	**0.077**
65	01362370	Stony Clove Creek below Ox Clove at Chichester, N.Y.	30.9	42.10194	-74.31083	1997–2011						15	4,270	0.086	85.5	0.692
74	01367500	Rondout Creek at Rosendale, N.Y.	383	41.84306	-74.08639	1951–2011	**61**	**13,100**	**0.153**	**78.3**	**0.084**	**30**	**13,350**	**0.269**	**175.0**	**0.038**
76	01371500	Wallkill River at Gardiner, N.Y.	695	41.68611	-74.16556	1925–2011	**87**	**11,100**	**0.245**	**55.0**	**0.001**	**30**	**11,900**	**0.287**	**214.3**	**0.027**
81	01374250	Peekskill Hollow Creek at Tompkins Corners, N.Y.	14.9	41.38833	-73.81306	1975–2011	**37**	**472**	**0.228**	**11.8**	**0.048**					
100	01387400	Ramapo River at Ramapo, N.Y.	86.9	41.14028	-74.16889	1980–2011	32	2,430	0.129	29.0	0.307					
101	01387420	Ramapo River at Suffern, N.Y.	93.0	41.11833	-74.16056	1980–2011	32	2,810	0.093	29.8	0.466					

Table 6. Trend tests for annual peak discharges at selected U.S. Geological Survey streamgages in New York for the period of record and the most recent 30 years or less (through 2011).—Continued

[The Mann-Kendall statistical trend test was used for these analyses. Trends are plotted on figures 15, 32, and 57; **bold blue** indicates a significant upward trend (p-value ≤ 0.05); **bold red** indicates a significant downward trend (p-value ≤ 0.05; **bold green** indicates an upward trend (p-value > 0.05 and ≤ 0.10); latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); sites in pink have a significant degree of upstream regulation; ft³/s, cubic feet per second; mi², square miles; >, greater than; ≤, less than or equal to; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude	Longitude	Period of record	Long-term trend (>30 years): Years of peak discharges	Median of peak discharges (ft³/s)	Kendall's Tau	Slope (ft³/s)/year	p-value	Short-term trend (most recent 30 years or less): Years of peak discharges	Median of peak discharges (ft³/s)	Kendall's Tau	Slope (ft³/s)/year	p-value
102	01387450	Mahwah River near Suffern, N.Y.	12.3	41.14083	-74.11694	1959–2011	**53**	**580**	**0.154**	**5.0**	**0.105**	30	613	0.048	3.1	0.721
104	01413398	Bush Kill near Arkville, N.Y.	46.7	42.15083	-74.60167	1996–2011						16	2,915	0.083	26.1	0.685
105	01413408	Dry Brook at Arkville, N.Y.	82.2	42.14667	-74.62361	1996–2011						16	6,160	0.000	-0.7	1.000
106	01413500	East Branch Delaware River at Margaretville, N.Y.	163	42.14472	-74.65389	1937–2011	75	6,120	0.079	20.0	0.321	**30**	**5,830**	**0.253**	**138.0**	**0.052**
133	01434025	Biscuit Brook above Pigeon Brook at Frost Valley, N.Y.	3.72	41.99583	-74.50000	1984–2011						28	307	-0.061	-1.7	0.664
140	01497805	Little Elk Creek near Westford, N.Y.	3.73	42.63361	-74.79583	1978–2011	**34**	**112**	**0.244**	**1.9**	**0.044**					
144	01500500	Susquehanna River at Unadilla, N.Y.	982	42.32139	-75.31694	1935–2011	77	13,700	-0.063	-20.0	0.418	**30**	**13,750**	**0.251**	**166.7**	**0.054**
145	01502500	Unadilla River at Rockdale, N.Y.	520	42.37778	-75.40639	1930–2011	82	8,965	0.064	14.1	0.400	30	9,320	0.156	91.4	0.232
146	01502632	Susquehanna River at Bainbridge, N.Y.	1,610	42.29139	-75.47667	1988–2011						**24**	**24,200**	**0.250**	**450.8**	**0.092**
147	01502731	Susquehanna River at Windsor, N.Y.	1,820	42.07472	-75.63806	1988–2011						**24**	**26,900**	**0.257**	**527.5**	**0.082**
148	01503000	Susquehanna River at Conklin, N.Y.	2,232	42.03528	-75.80333	1913–2011	99	30,700	-0.074	-38.9	0.278	**30**	**29,350**	**0.248**	**490.0**	**0.054**
154	01507000	Chenango River at Greene, N.Y.	593	42.32444	-75.77167	1937–2011	75	8,860	0.063	15.0	0.423	**30**	**8,895**	**0.232**	**161.3**	**0.074**
162	01513500	Susquehanna River at Vestal, N.Y.	3,941	42.09083	-76.05639	1935–2011	77	53,000	-0.031	-27.9	0.692	**30**	**52,950**	**0.235**	**728.6**	**0.072**
163	01513831	Susquehanna River at Owego, N.Y.	4,216	42.09722	-76.26667	1988–2011						**24**	**58,750**	**0.399**	**1,477.8**	**0.007**
165	01514801	Catatonk Creek near Owego, N.Y.	151	42.13833	-76.28972	1988–2011						24	3,735	0.167	46.0	0.264
166	01515000	Susquehanna River near Waverly, N.Y.	4,773	41.98472	-76.50139	1936–2011	76	64,100	0.015	22.7	0.854	30	65,800	0.195	730.0	0.134
216	04233000	Cayuga Inlet near Ithaca, N.Y.	35.2	42.39306	-76.54528	1935–2011	77	1,330	-0.041	-2.8	0.601	30	1,615	0.198	44.0	0.129
240	04242500	East Branch Fish Creek at Taberg, N.Y.	188	43.30111	-75.62167	1924–95, 2009–11	**75**	**7,665**	**0.177**	**26.9**	**0.015**					
247	04249200	North Branch Salmon River at Redfield, N.Y.	82.5	43.54222	-75.81417	1985–2011						27	4,700	0.168	50.0	0.226
267	04266500	Raquette River at Piercefield, N.Y.	721	44.23472	-74.57222	1909–2011	103	5,300	-0.024	-1.8	0.717	30	5,610	-0.113	-38.2	0.392
268	04267500	Raquette River at South Colton, N.Y.	937	44.51167	-74.88333	1953–2002, 2011	**51**	**6,870**	**0.244**	**34.6**	**0.007**					
269	04268000	Raquette River at Raymondville, N.Y.	1,125	44.83889	-74.97917	1944–2011	68	7,255	-0.048	-9.1	0.564	30	7,255	-0.067	-34.3	0.617
282	04274000	West Branch Ausable River near Lake Placid, N.Y.	116	44.31111	-73.91667	1920–68, 1983–2011	78	3,710	0.050	4.0	0.487	30	3,500	-0.138	-43.7	0.302
283	04275000	East Branch Ausable River at Au Sable Forks, N.Y.	198	44.43889	-73.68194	1925–2011	87	6,300	0.021	2.9	0.778	30	6,450	-0.124	-56.2	0.344
284	04275500	Ausable River near Au Sable Forks, N.Y.	446	44.45139	-73.64306	1911–68, 1990–2011	80	11,200	0.074	14.4	0.274					
285	04276500	Bouquet River at Willsboro, N.Y.	270	44.35833	-73.39722	1924–68, 1985–2011	72	5,177	0.076	10.7	0.299	30	4,600	0.026	12.8	0.868
289	04280450	Mettawee River near Middle Granville, N.Y.	167	43.46389	-73.28472	1977–2011	**35**	**5,929**	**-0.287**	**-56.9**	**0.016**					

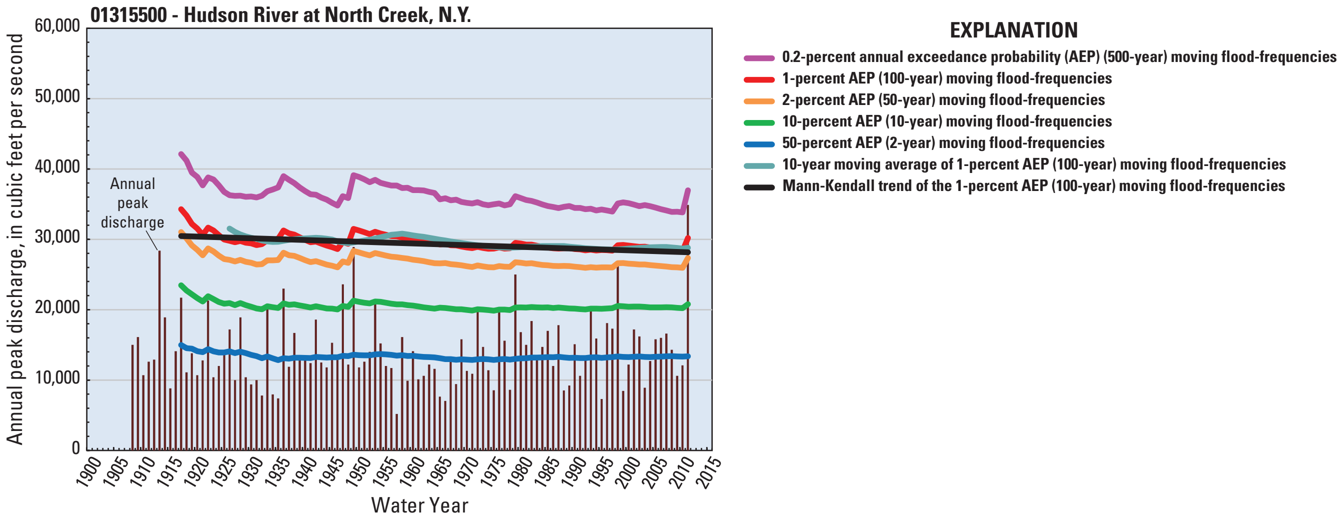


Figure 16. Annual peak discharges, moving flood frequencies, and trends of the moving 1-percent AEP (100-year) discharges through 2011 at the Hudson River at North Creek, New York, streamgage. (Site 13 on figure 10)

50-percent AEP discharge) (table 4). Major flooding on the Hoosic River could have led to catastrophic conditions on the Hudson River near Waterford and farther downstream. Figures 18A–C show discharge hydrographs for three sites in the flooded areas, as well as available hydrographs for previous high flows at each site. Selected flood frequencies and a list of the largest four peak discharges at each streamgage are included for comparison. The peak discharges for previous floods were overlaid on those for the April–May flood for hydrograph-shape comparisons.

The stage or water level of a stream determines which home, business, or roadway becomes inundated during a flood. The magnitude, frequency, and duration of flood stages are all important conditions for flood-plain and water-resource managers or planners to consider. To help evaluate these conditions in flooded areas during the late April to early May 2011 storm, stage hydrographs for selected streamgages show the stream stage (converted to National Geodetic Vertical Datum of 1929 (NGVD 29)) along with stage frequencies (horizontal color-coded range bars) and stage-frequency durations (figs. 19A–D). For example, the stream stage at the Hudson River at North Creek (01315500) remained above the 0.5-percent AEP (200-year) stage for about 18 hours during April 28–29 and above the 1-percent AEP (100-year) stage for more than 24 hours (fig. 19A). The Raquette River at South Colton (04267500) was above the 0.2-percent AEP (500-year) flood stage for about 32 hours during April 29–30 and above the 1-percent AEP (100-year) stage for more than 2 days (fig. 19D). Other than stages documented at streamgages in table 4, the USGS did not survey the elevations of high-water marks (HWMs) (maximum flood stages) at ungaged locations for this flood. However, 17 HWMs were surveyed by the New York State Department of Environmental Conservation (NYSDEC) along the upper Hudson River from Lake Luzerne downstream to Mechanicville following the April–May, 2011, flood (table 7 and fig. 20).

Effects of Reservoirs

The April–May flood discharges along reaches of several streams in areas in northern New York were affected by one or more lakes or reservoirs within the basins. Data for Indian Lake, Great Sacandaga Lake, and Hinckley Reservoir (Hudson River Basin); Sixth Lake, First Lake, and Stillwater Reservoir (Black River-Lake Ontario Basin); and Lake Champlain (St. Lawrence River Basin), indicate that all reservoirs exceeded their usable capacity during the flood (table 8).

Water-surface elevations and change in contents (volume of water in a reservoir or lake computed on the basis of a level pool and does not include bank storage) indicate that appreciable amounts of runoff were stored during the flood that may have helped mitigate downstream flooding. Indian Lake and Great Sacandaga Lake in the upper Hudson River Basin each stored nearly 9 in. of runoff at the time of their maximum lake levels; prior to spilling, they stored 6.20 and 3.69 in., respectively. Stillwater Reservoir, in the Black River Basin, stored almost 6 in. of runoff; prior to spilling, it stored 4.79 in. New maximum water-surface elevations were recorded during the April–May flood at Great Sacandaga Lake (82 years of record), Hinckley Reservoir (98 years of record), and Stillwater Reservoir (104 years of record).

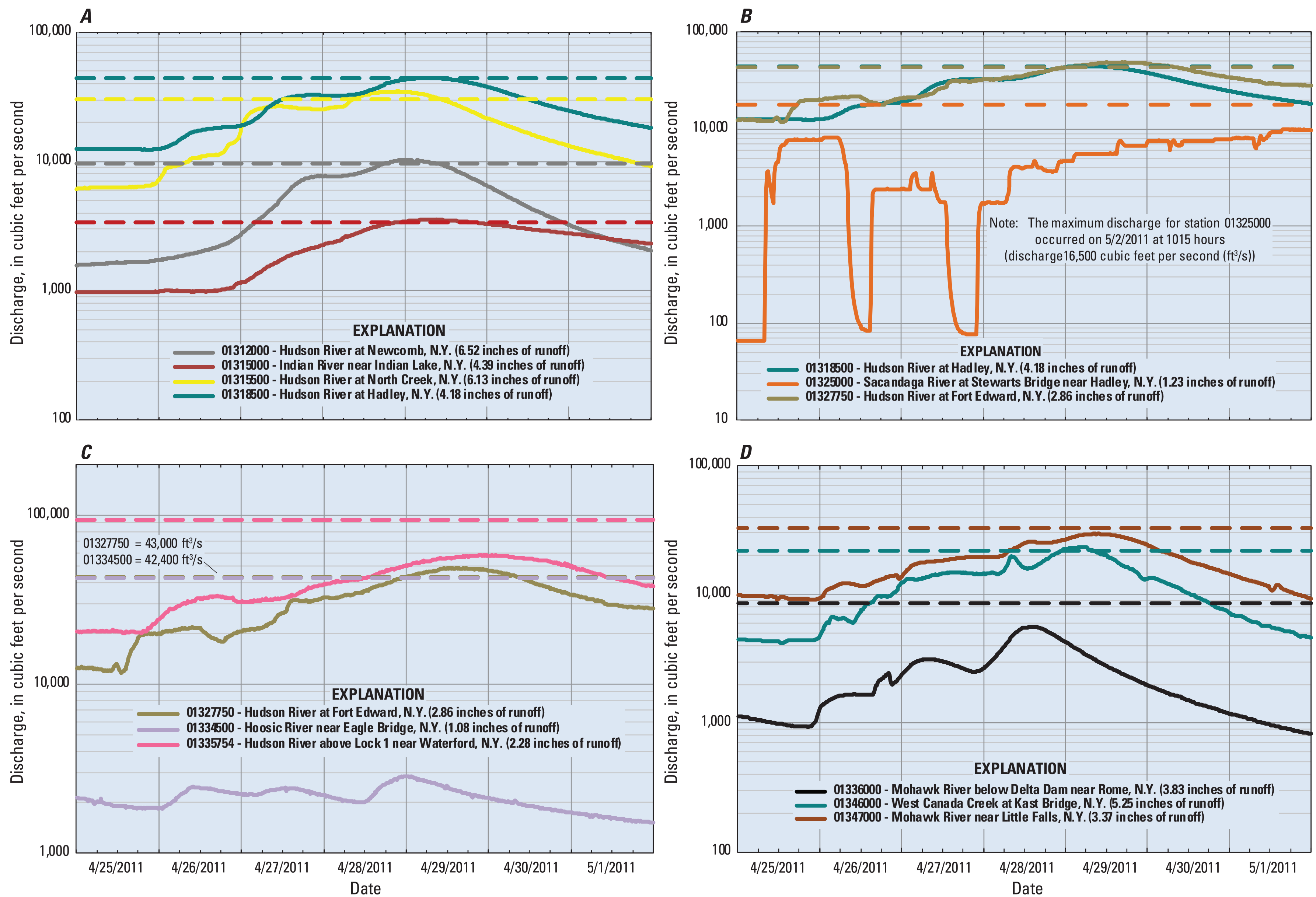


Figure 17. Discharge hydrographs for April 25–May 1, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A–C*, Hudson, *D–H*, Mohawk, and *I*, Raquette River Basins in New York. (One-percent annual exceedance probabilities are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)

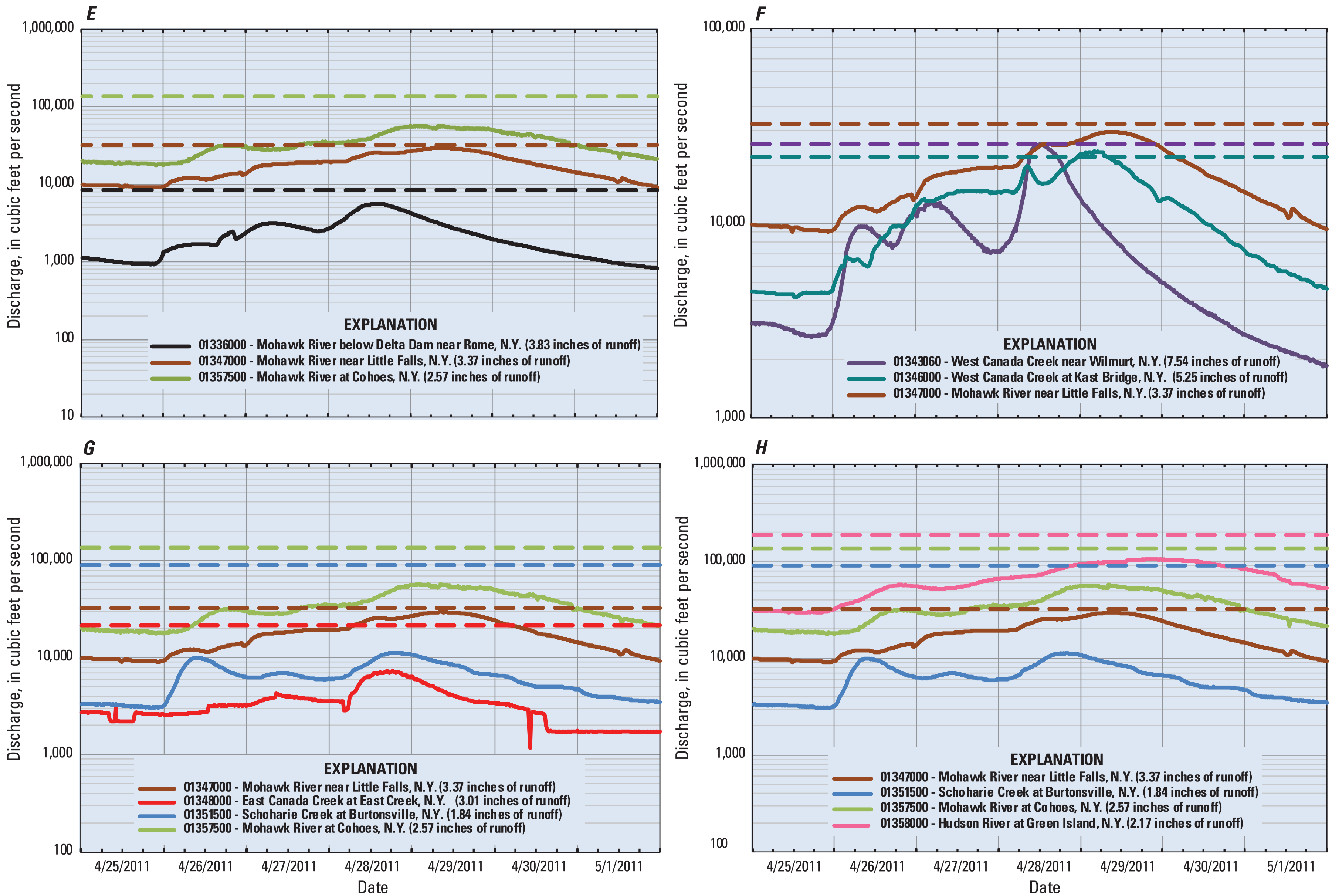


Figure 17. Discharge hydrographs for April 25–May 1, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A–C*, Hudson, *D–H*, Mohawk, and *I*, Raquette River Basins in New York. (One-percent annual exceedance probabilities are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)—Continued

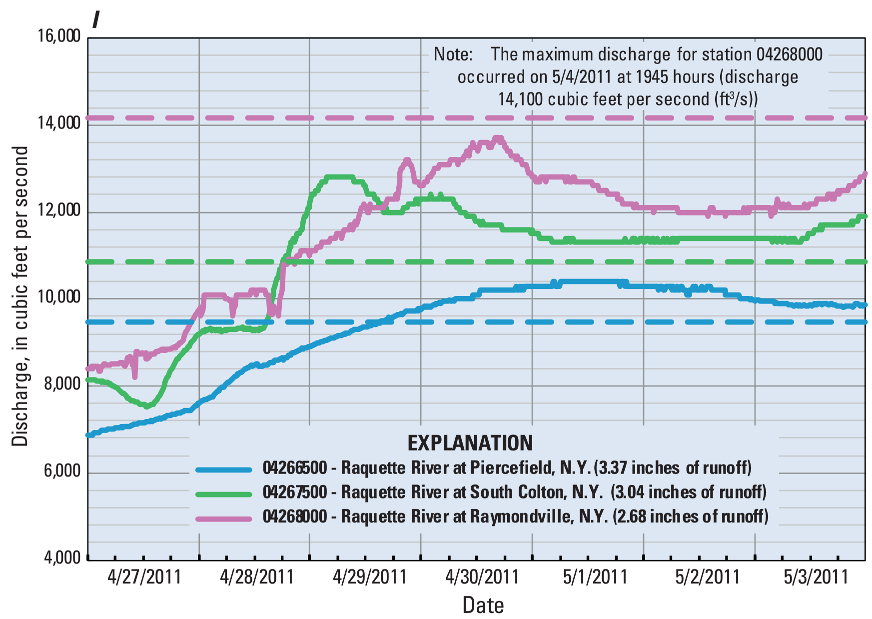


Figure 17. Discharge hydrographs for April 25–May 1, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A–C*, Hudson. *D–H*, Mohawk. and *I*, Raquette River Basins in New York. (One-percent annual exceedance probabilities are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)—Continued

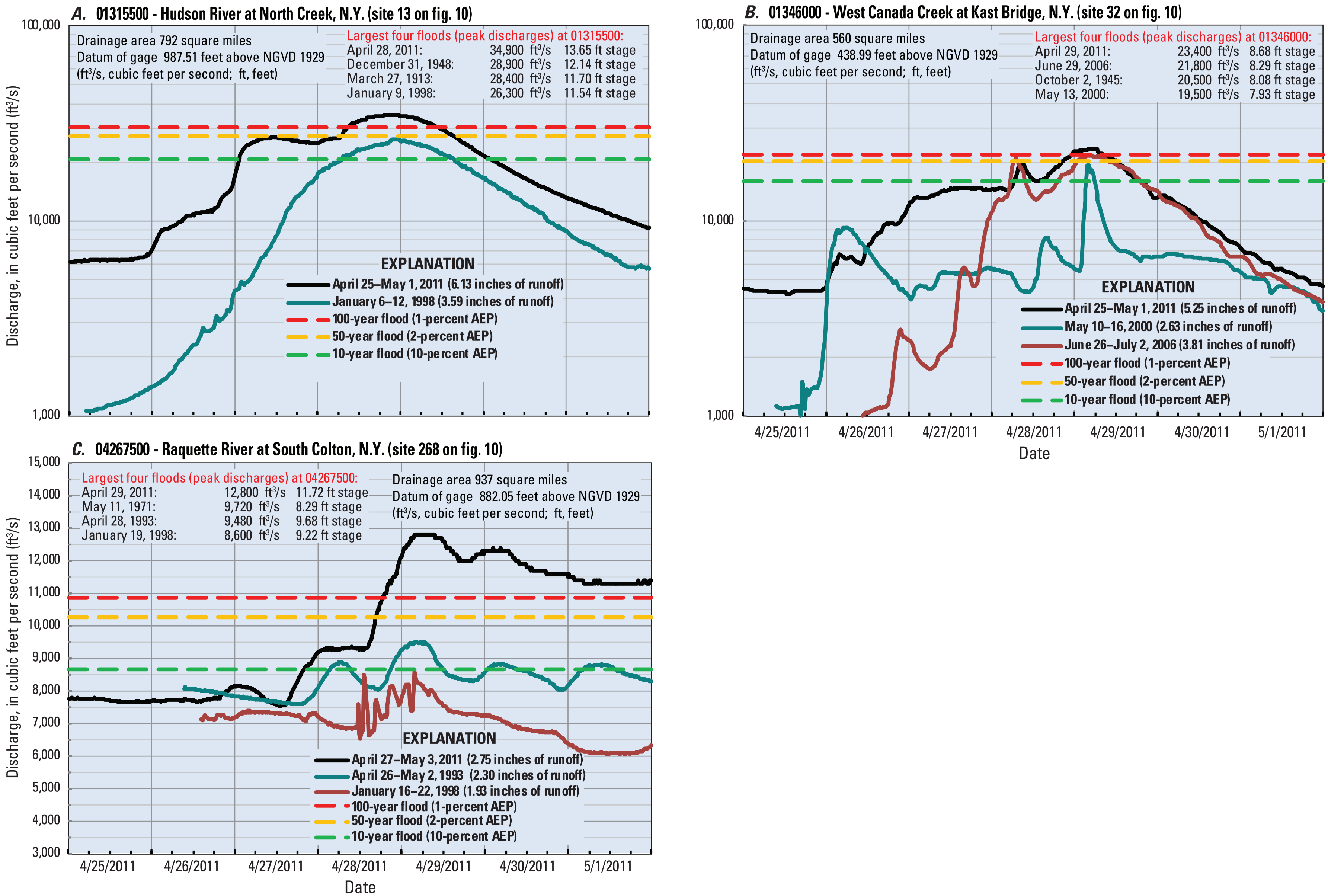


Figure 18. Discharge hydrographs for April 25–May 1, 2011, for selected previous floods, selected flood frequencies, and a list of the largest four floods for the streamgages *A,* Hudson River at North Creek., *B,* West Canada Creek at Kast Bridge, and *C,* Raquette River at South Colton, New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)

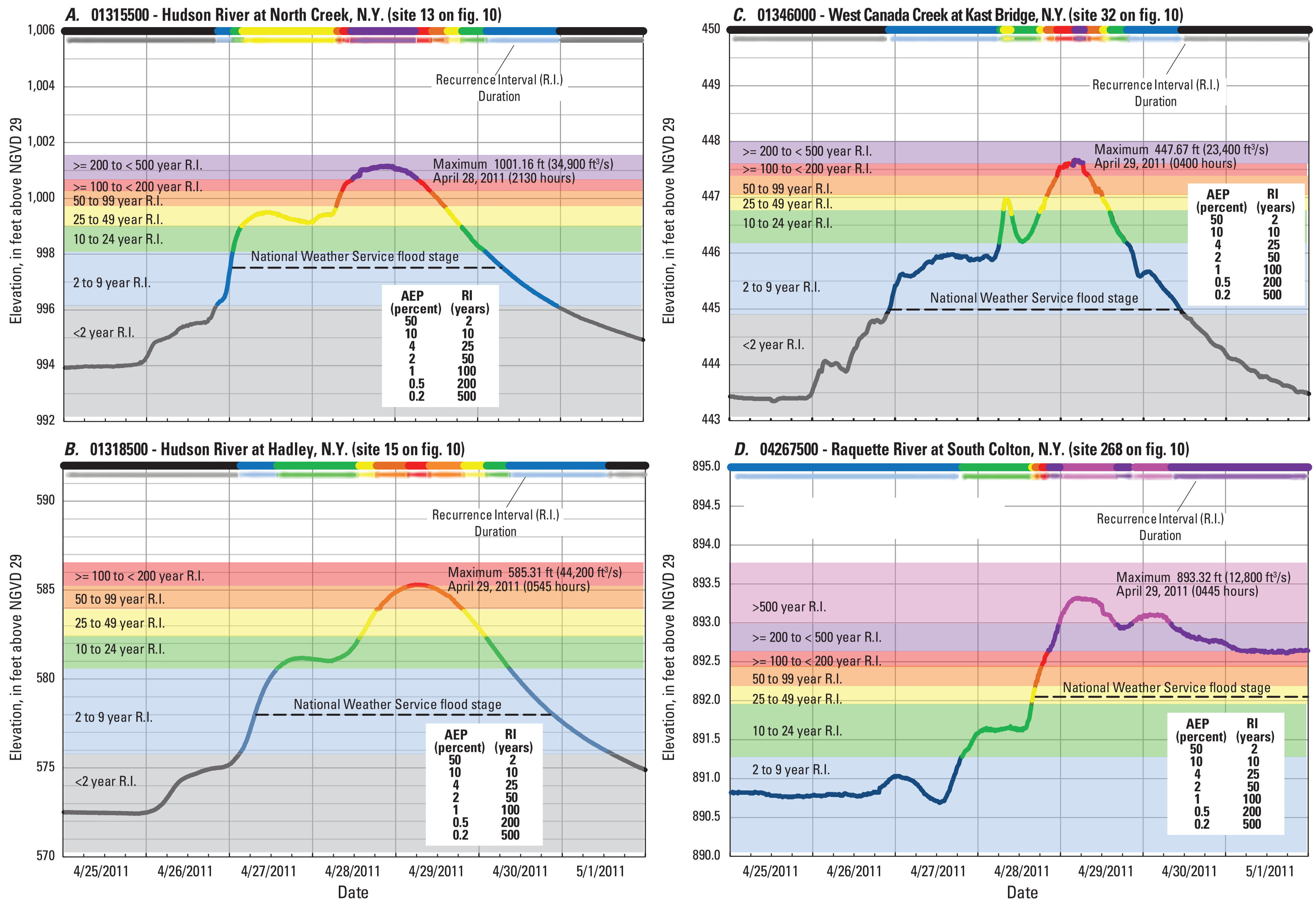


Figure 19. Stage hydrographs for April 25 to May 1, 2011, stage frequencies, and stage-frequency durations for the streamgages *A,* Hudson River at North Creek, *B,* Hudson River at Hadley, *C,* West Canada Creek at Kast Bridge, and *D,* Raquette River at South Colton, New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD 29, National Geodetic Vertical Datum of 1929; ≥, greater than or equal to; <, less than; ft³/s, cubic feet per second; AEP, annual exceedance probability)

Table 7. High-water marks collected by the New York State Department of Environmental Conservation at 17 selected sites along the upper Hudson River in New York during the flood of April 26–29, 2011.

[Latitude, longitude, and elevation are from the New York State Department of Environmental Conservation (NYSDEC, written commun., 2012); HWM ID, high-water-mark identification; latitude and longitude in decimal degrees, North American Datum of 1983 (NAD 83); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); locations are shown in fig. 20]

Site number	NYSDEC HWM ID	Site name	Latitude	Longitude	Elevation
1	DEC29	Hudson River at Lake Luzerne, N.Y.	43.31440	-73.83815	561.21
2	DEC17	Hudson River downstream of Lake Luzerne, N.Y.	43.30702	-73.83315	558.72
3	DEC16	Hudson River downstream of Lake Luzerne, N.Y.	43.28788	-73.82533	558.13
4	DEC15	Hudson River at Corinth, N.Y.	43.24923	-73.83503	554.95
5	DEC13	Hudson River upstream of Glens Falls, N.Y.	43.26414	-73.68142	291.72
6	DEC12	Hudson River upstream of Glens Falls, N.Y.	43.26464	-73.67522	287.77
7	DEC01	Hudson River downstream of Fort Edward, N.Y.	43.23162	-73.59443	128.50
8	DEC03	Hudson River downstream of Fort Edward, N.Y.	43.22495	-73.60682	128.45
9	DEC02	Hudson River downstream of Fort Edward, N.Y.	43.22945	-73.58921	127.95
10	DEC11	Hudson River upstream of Fort Miller, N.Y.	43.16892	-73.58586	122.56
11	DEC10	Hudson River at Thomson, N.Y.	43.12993	-73.58549	109.76
12	DEC09	Hudson River at Schuylerville, N.Y.	43.09989	-73.57406	95.74
13	DEC08	Hudson River downstream of Schuylerville, N.Y.	43.03111	-73.59301	93.17
14	DEC07	Hudson River upstream of Bemis Heights, N.Y.	42.99070	-73.61535	91.27
15	DEC06	Hudson River at Stillwater, N.Y.	42.94069	-73.64781	89.36
16	DEC05	Hudson River at Stillwater, N.Y.	42.93714	-73.65689	81.78
17	DEC04	Hudson River at Mechanicville, N.Y.	42.91829	-73.67601	74.90

Inflows to each lake and reservoir were computed and are plotted with outflows, elevations, and spillway elevations on figures 21A–F. Lake elevations only are shown for Lake Champlain (fig. 21G). Most of the reservoirs attenuated or significantly reduced the resulting peak outflows to downstream reaches of each stream. For example, the maximum estimated daily inflow to Sacandaga Reservoir was 26,600 cubic feet per second (ft^3/s) on April 28, whereas the maximum daily outflow was 12,300 ft^3/s on May 3 (fig. 21B), and the maximum daily inflow to Stillwater Reservoir was 4,540 ft^3/s on April 28, with a maximum daily outflow of 3,200 ft^3/s on April 29 (fig. 21F). Inflows to Sacandaga Reservoir were estimated by a drainage-area adjustment of daily discharge data for upstream streamgage Sacandaga River near Hope (01321000), which accounts for 47 percent of the drainage area to the reservoir (1,044 mi^2).

The USGS New York Water Science Center operates two gages on Lake Champlain, one at the south end of the lake just north of Whitehall (04279085) and the other at the north end near the outlet of the lake at Rouses Point (04295000). The maximum lake stage (103.20 ft relative to NGVD 29) recorded at the Rouses Point gage on May 6 was the highest in 141 years of record (normal for May 6 is 98.8 ft) and the highest documented stage since at least 1827 (previous maximum stage was 102.1 ft in 1869). The daily mean lake stages at Rouses Point were above 100 ft from April 13 to June 17, 2011, (normally about 98.2 ft) and above 102 ft from April 28 to June 4, 2011 (normally at 98.3 ft). The USGS also operates a gage on Lake Champlain at Burlington, Vermont (04294500), and water-surface elevations for each of the three lake gages during April 1–May 31, 2011, are plotted on figure 21G. Winds and seiche caused different lake levels at specific times at each of the three gages.

Flood Damage

A state of emergency was declared by officials in several towns in New York during the severe flooding of April–May 2011, and the President of the United States declared 23 counties Federal disaster areas on June 10, 2011 (fig. 22; Federal Emergency Management Agency, 2011c). Hundreds of residents that live near the flooded areas, including many along the Hudson River, the Ausable River, and Saranac River, were asked to evacuate their homes because of the flooding. Several roads and bridges were damaged or destroyed throughout the flooded areas. The damage was not confined to northern areas: many counties in central and western New York, including Onondaga, Oneida, Otsego, Yates, Chemung,

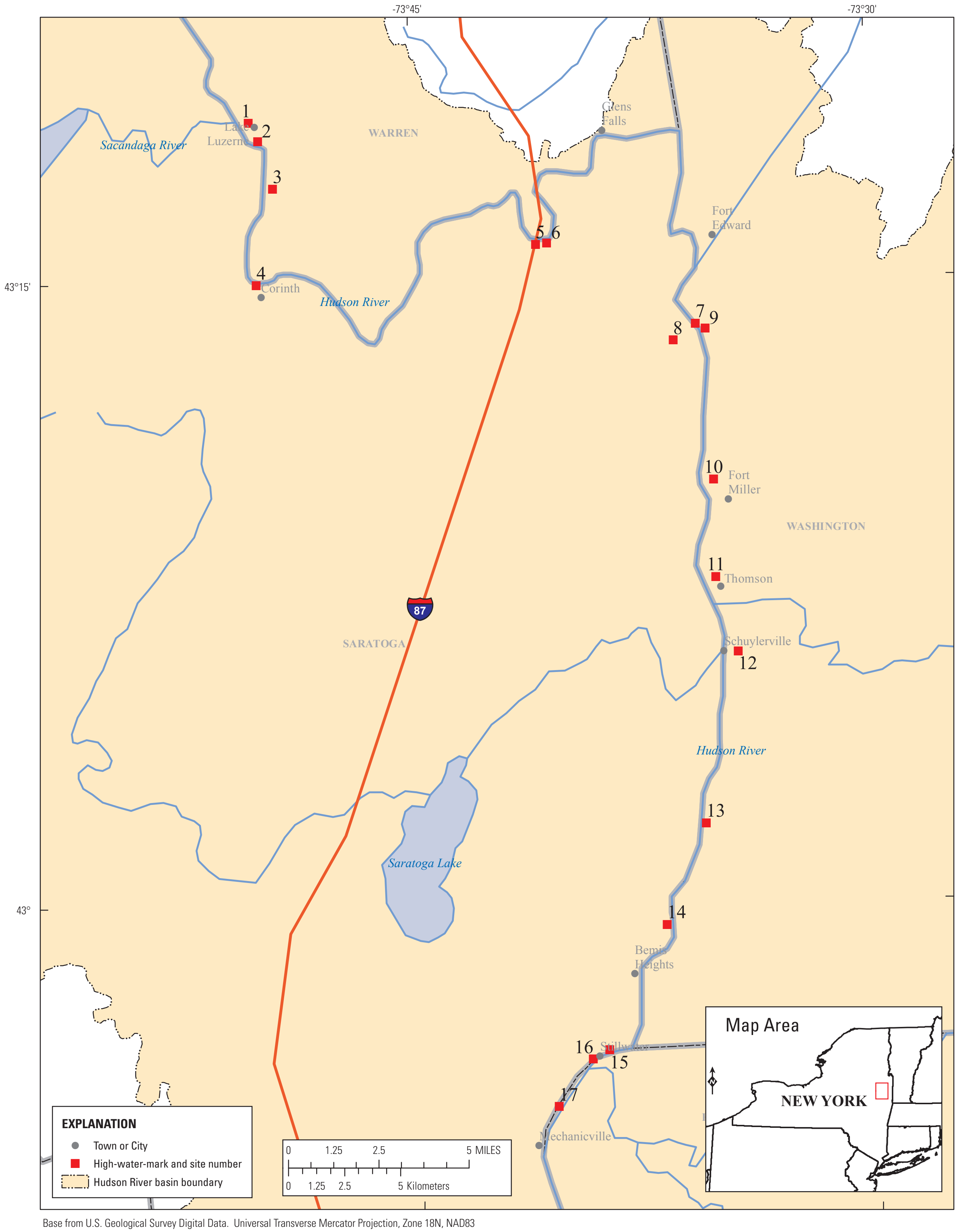


Figure 20. Locations of high-water marks collected for the flood of April 26–29, 2011, at selected sites along the upper Hudson River from Lake Luzerne to Mechanicville, New York.

Table 8. Data for six lakes and reservoirs in northern New York for the floods of April–May 2011.

[mi^2, square miles; ft, feet; mil ft^3, million cubic feet; in., inches; USGS, U.S. Geological Survey; locations are shown on figure 10]

Map number	Station number and name	Drainage area (mi^2)	[a]Dates of runoff	[b]Water-surface elevation (ft)	Contents (mil ft^3)	Percentage of usable capacity	Change in contents (mil ft^3)	[c]Runoff stored (in.)	[b]Spillway elevation (ft)	Usable capacity (mil ft^3)
10	01314500 Indian Lake near Indian Lake, N.Y.[d]	131	4/5	1,640.29	2,779.78	59.5		6.20	1,651.29	4,668.0
			4/29	1,655.13	5,446.17	116.7	2,666.39	8.76		
17	01323500 Great Sacandaga Lake at Conklingville, N.Y. (USGS reservoir gage)	1,044	4/4	755.37	20,970.00	70.1		3.69	771.00	29,920.0
			5/1	774.47	41,820.00	139.8	20,850.00	8.60		
31	01343900 Hinckley Reservoir at Hinckley, N.Y. (USGS reservoir gage)	372	4/4	[e]1,213.01	2,084.89	62.8		1.43	[e]1,225.00	3,320.0
			4/28	[e]1,230.74	4,124.40	124.2	2,039.51	2.36		
251	04253300 Sixth Lake near Old Forge, N.Y.[d]	18.6	4/1	1,779.94	109.50	36.9		4.33	1,786.00	296.6
			4/29	1,786.81	322.53	108.7	213.03	4.93		
252	04253400 First Lake at Old Forge, N.Y.[d]	53.6	4/1	1,703.40	423.19	47.3		3.79	1,707.00	895.6
			5/5	1,707.60	973.07	108.7	549.88	4.42		
256	04256500 Stillwater Reservoir near Beaver River, N.Y.[d]	171	4/4	1,671.34	2,721.39	58.9		4.79	1,679.30	4,623.0
			4/29	1,680.15	4,969.48	107.5	2,248.09	5.66		

[a]From minimum elevation at start of storm runoff to maximum elevation.

[b]Elevation in feet above National Geodetic Vertical Datum of 1929 unless otherwise footnoted.

[c]First runoff value at each site is just prior to spillage; second runoff value is at maximum elevation.

[d]Records furnished by Hudson River-Black River Regulating District.

[e]Elevation in feet above Barge Canal Datum.

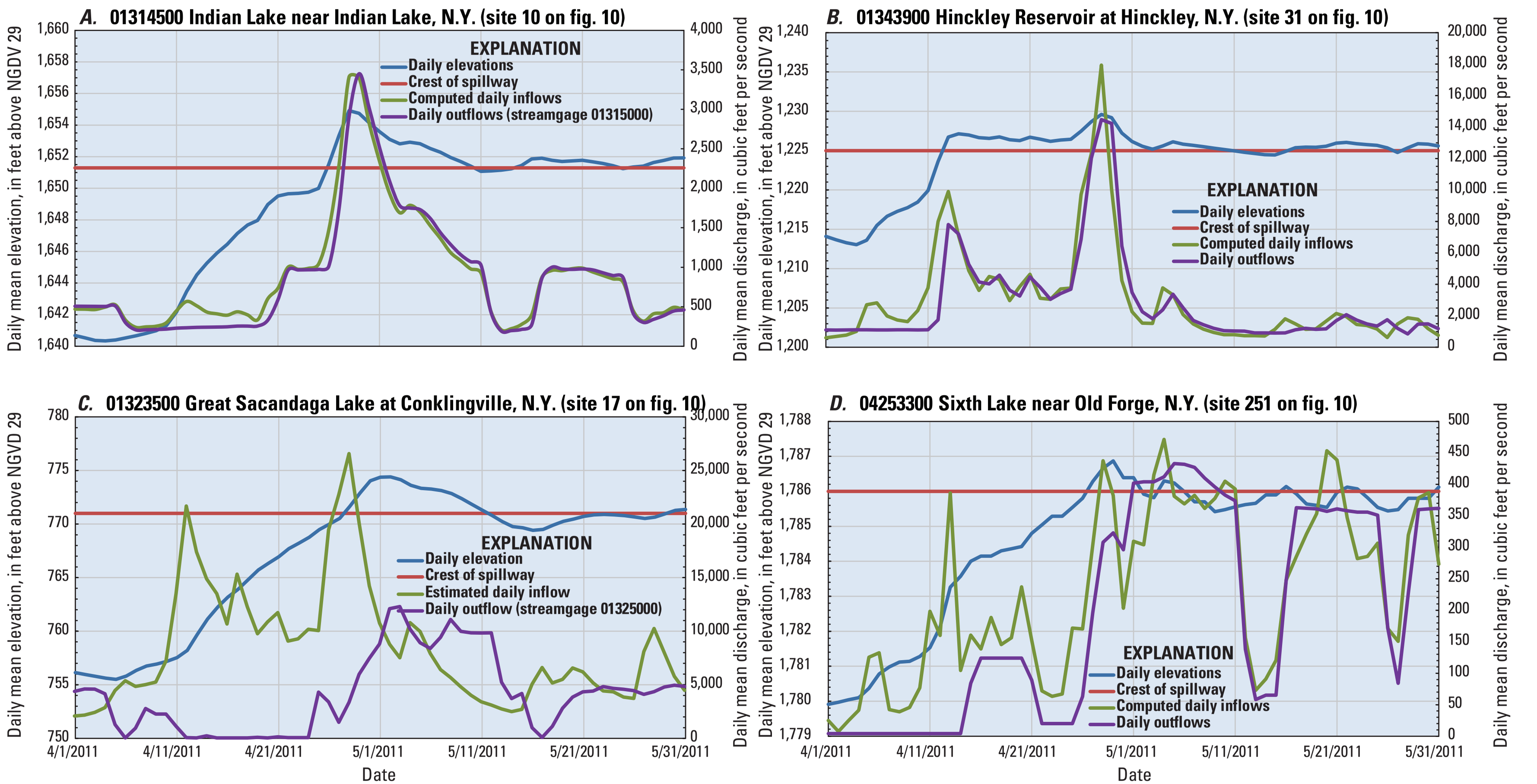


Figure 21. Daily inflows, outflows, and water-surface elevations relative to National Geodetic Vertical Datum of 1929 (NGVD 29) at selected lakes and reservoirs in northern New York, April 1–May 31, 2011. (Sites are listed in appendix 1 and shown on figure 10.)

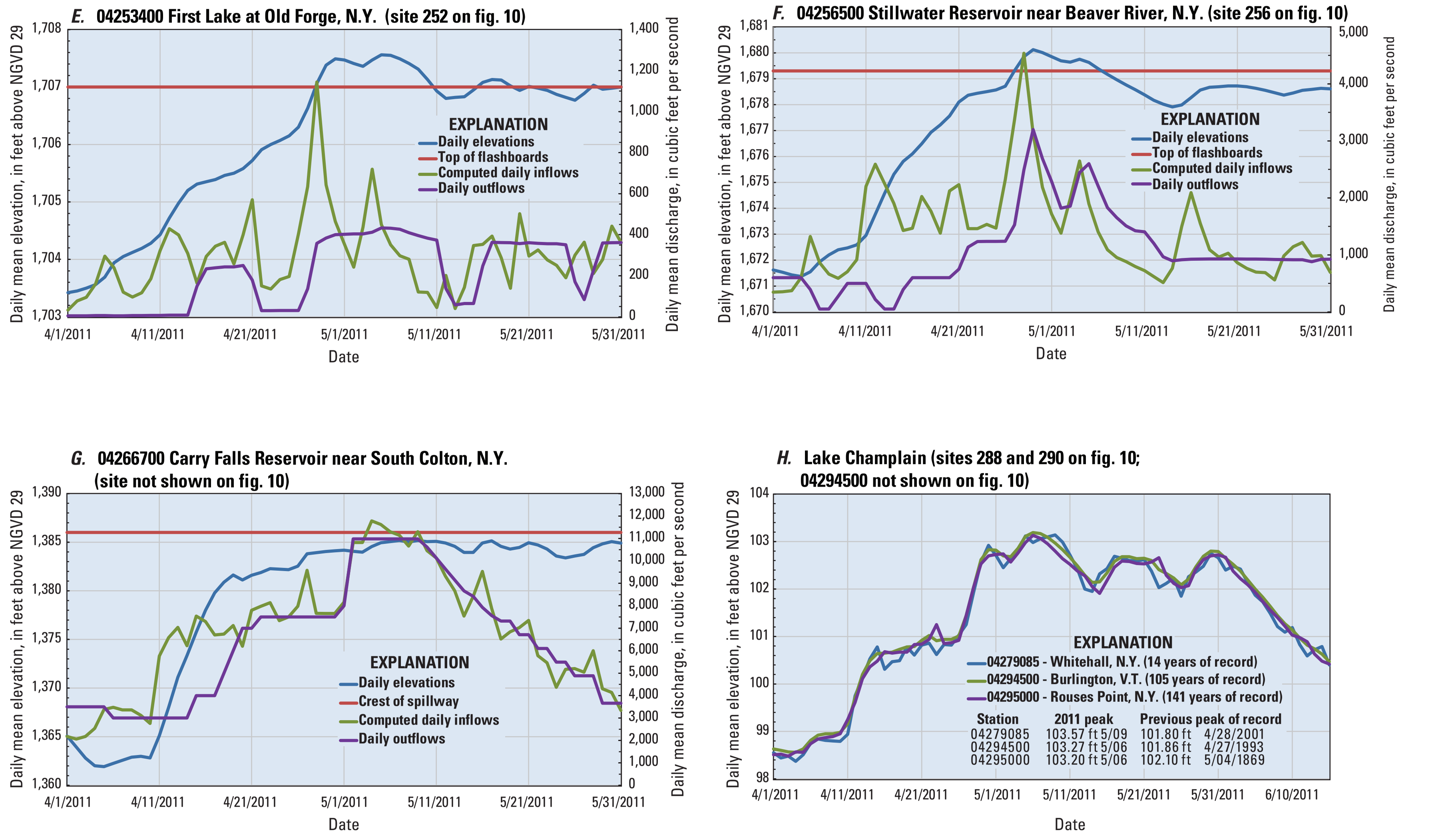


Figure 21. Daily inflows, outflows, and water-surface elevations relative to National Geodetic Vertical Datum of 1929 (NGVD 29) at selected lakes and reservoirs in northern New York, April 1–May 31, 2011. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

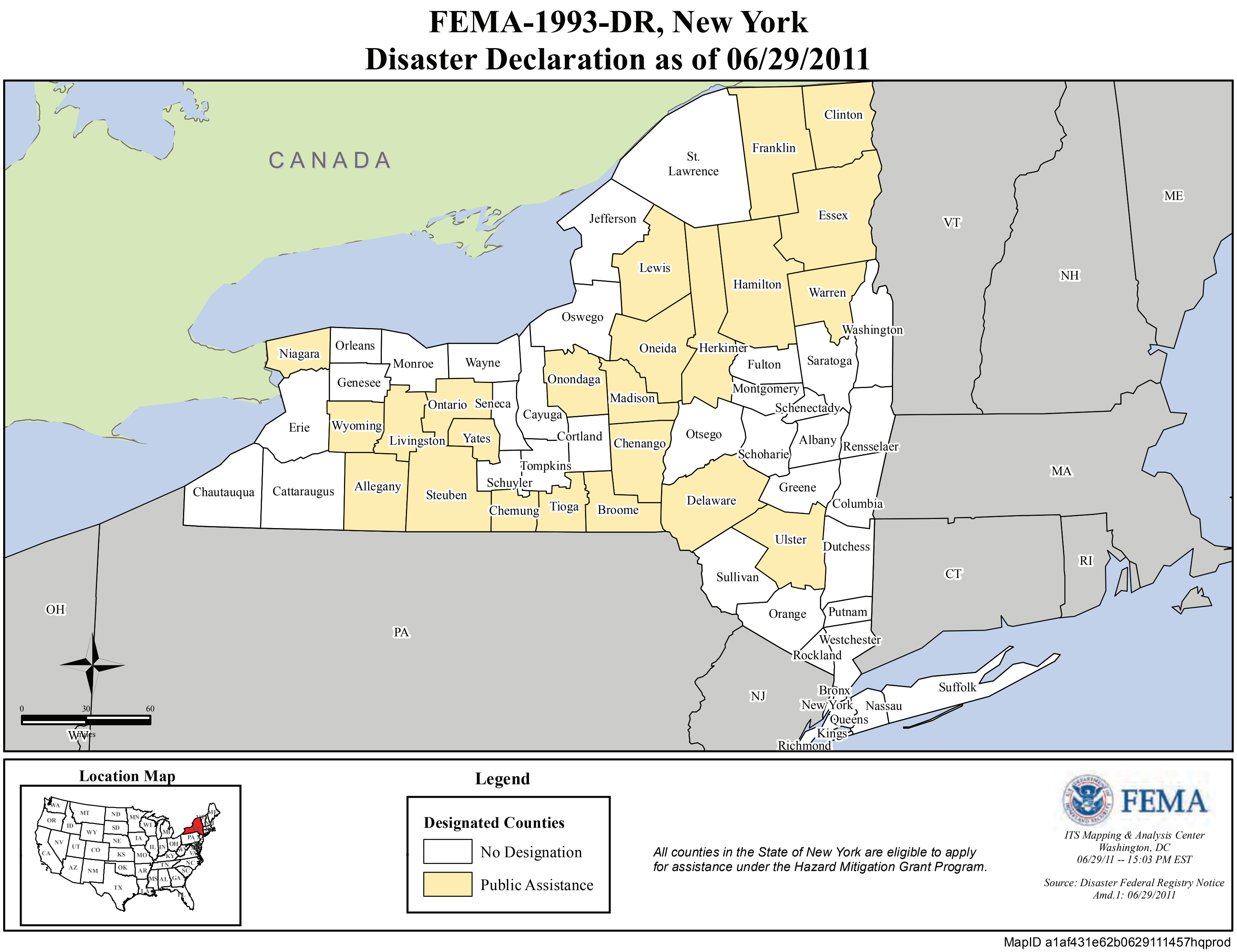


Figure 22. Counties of New York that were declared major disaster areas following the flooding of April 26–May 9, 2011. (From Federal Emergency Management Agency, 2011c)

Tioga, Chenango, and Broome Counties, were affected as a result of flash floods on April 26–27. Severe storms in those areas produced tornadoes as reported in Oneida, Chemung, Tompkins, Steuben, and Chenango Counties. Several buildings were damaged, and many trees uprooted. Delaware and Rockland Counties in southeastern New York also incurred damage (National Oceanic and Atmospheric Administration, 2011n).

As the storm moved northeastward on April 27–28, many areas reported flooding of roadways, houses, bridges, and riverside camps. Flooding along the Hudson River in the North Creek area caused the closing of several roads as evacuations began. School districts in Indian Lake, Long Lake, and Johnsburg were closed on April 29 as a result of the flooding. The widespread flooding caused damage along West Canada Creek, Ausable River, Bouquet River, Raquette River, and downstream reaches of the Hudson River to parts of Fort Edward and Schuylerville, where one family had to be rescued from their Schuyler Island home. The New York State Canal Corporation (NYSCC) delayed opening of the New York State Canal System because of high waters and flows. The above-normal snowpack and rainfall within the Lake Champlain Basin caused record flooding accompanied by winds and seiche, which created problems in Whitehall and many other areas along the lakeshore. Many roads, hundreds of homes, and several businesses were damaged, and ferry services at several locations were delayed or closed during the flooding, which continued well into May. In Jefferson County, flooding along the Black River resulted in the death of a 67-year old man who drowned after his canoe overturned near Dexter (National Oceanic and Atmospheric Administration, 2011n). The April–May 2011 flood required nearly $60 million in Federal disaster assistance (through April 4, 2013) to be disbursed for damages throughout many flooded areas of New York (Federal Emergency Management Agency, 2013b).

Storm and Floods of August 28–29, 2011 (Tropical Storm Irene)

Remnants of Hurricane Irene entered New York State on August 28 as a tropical storm and traveled up the eastern corridor of the State, leaving an unprecedented path of destruction in many parts of New York. Thirty-one counties in New York were declared Federal disaster areas with damages of over $1.3 billion dollars and 10 deaths reported (Federal Emergency Management Agency, 2011a). Storm rainfall exceeded 18 in. in the Catskill Mountains area of southeastern New York with many other areas of eastern New York receiving over 7 in. Catastrophic flooding resulted from the extreme rainfall in many locations, including Schoharie Creek and its tributaries, the eastern Delaware River Basin, the Ausable and Bouquet River Basins in northeastern New York, and several other stream basins throughout southeastern New York. Downstream reaches of the Mohawk River also had substantial flooding. The USGS surveyed 184 HWMs at 30 locations along an 84-mile (mi) reach of Schoharie Creek and compared the elevations to those published by FEMA at those locations for the 10-, 2-, 1-, and 0.2-percent AEP floods.

On August 28, Tropical Storm Irene moved inland and north through New York bringing torrential rains, which resulted in catastrophic flooding and damage to many areas of eastern New York. Record storm rainfall totals were reported at several NWS stations in the Catskill Mountains area. Record stream stages and discharges were recorded at 62 streamgages throughout eastern New York, and peak discharges at 25 of the streamgages exceeded the 1-percent AEP discharge with 6 sites in the Schoharie Creek Basin exceeding the 0.2-percent AEP discharge. Reservoir inflow, outflow, and stage data in and around the Catskill Mountains area indicate that some floodwaters were stored, but most reservoir water elevations exceeded those of their spillways on August 28.

Antecedent Conditions

Precipitation during June–July 2011 in eastern New York was generally below normal in the Lake Champlain Valley, normal in the lower Hudson River Valley, and slightly above normal in the Catskill Mountains area of southeastern New York. The relatively normal rainfalls of early summer were in stark contrast to the excessive precipitation to come in August.

Streamflows in eastern New York were normal at the beginning of August. Discharges at three streamgages (figs. 23A–C) in the most heavily flooded areas are representative of antecedent-flow conditions prior to the arrival of Tropical Storm Irene on August 28. A few storms with 1 to 2 in. of rain during mid-August saturated the soils and caused streamflows in the Catskill Mountains area to increase to more than the 25th percentile of their long-term daily flows and remain high as Tropical Storm Irene approached (figs. 23A–B). The Ausable River at Au Sable Forks (04275500) is a tributary to Lake Champlain in northeastern New York, and flow was normal to slightly above normal prior to the arrival of Tropical Storm Irene (fig. 23C).

Precipitation

Tropical Storm Irene (formerly Hurricane Irene) made its ninth and final landfall along the eastern seaboard over New York City on August 28, 2011, with a massive circulation covering the entire northeastern United States. As the storm moved north-northeast through New York on August 28–29, rainfall totals exceeded 18 in. in some areas of the Catskill Mountains of southeastern New York (18.12 in. at Maplecrest) with many other areas of eastern New York receiving over 7 in. (table 9; National Oceanic and Atmospheric Administration, 2011b, c, e, g; New York City Department of Environmental Protection, written commun., 2012). Over 10 in. of rain was reported in the higher elevations of the

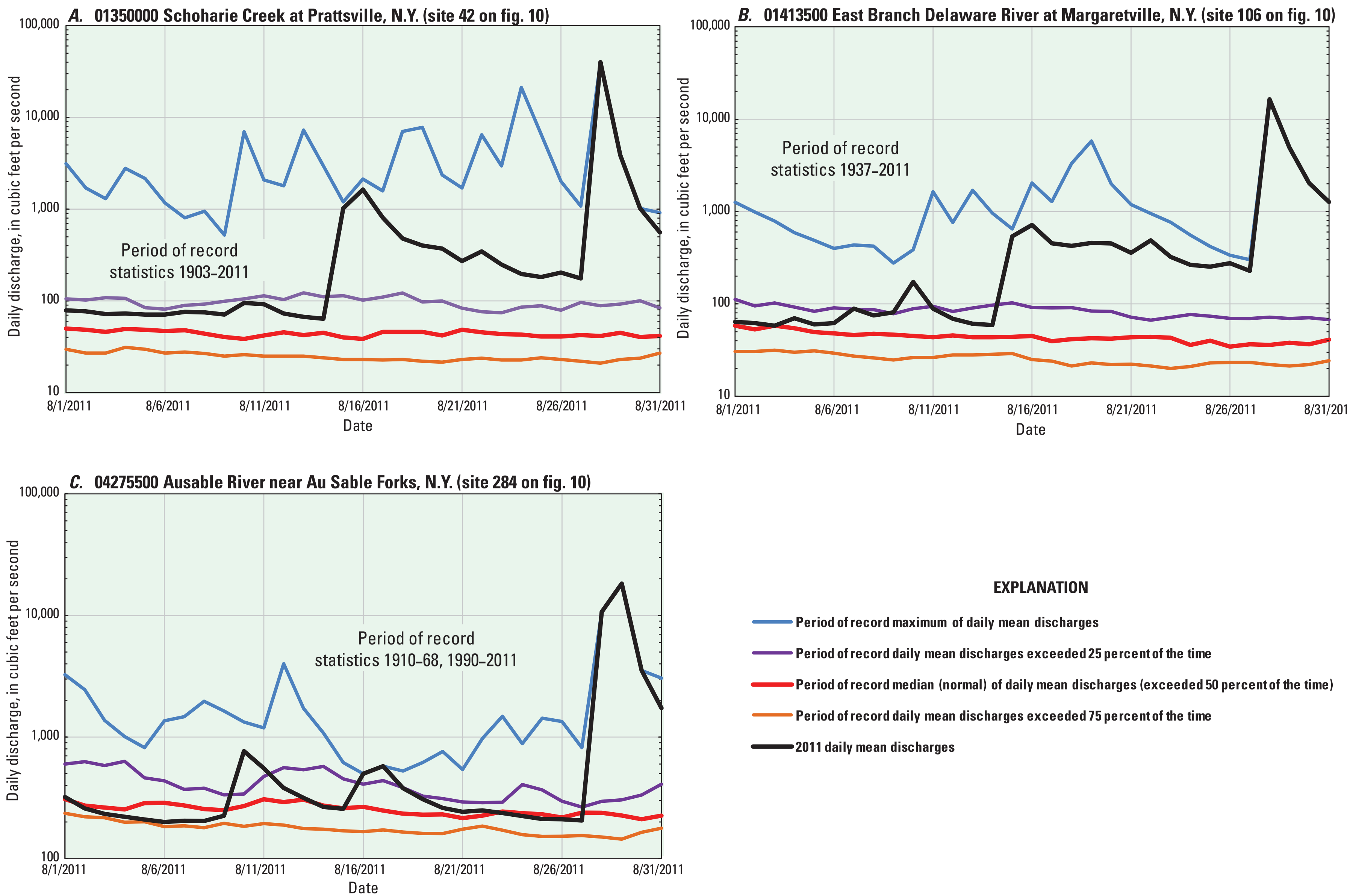


Figure 23. Daily discharge data for the streamgages *A*, Schoharie Creek at Prattsville, *B*, East Branch Delaware River at Margaretville, and *C*, Ausable River at Au Sable Forks, New York, for August 1–31, 2011. (Sites are listed in appendix 1 and shown on figure 10.)

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
1	Maplecrest, N.Y.	18.12	0.00	18.12
2	East Jewett, N.Y.	6.15	6.70	12.85
3	Sky View Lake 1 N, N.Y.	5.20	6.80	12.00
4	Tannersville 2 SE , N.Y.	11.60	0.00	11.60
5	Slide Mountain, N.Y.	8.62	2.91	11.53
6	Winnisook Club at Winnisook Lake near Frost Valley, N.Y.	10.56	0.00	10.56
7	Delanson 2 NE, N.Y.	1.73	8.55	10.28
8	Platte Cove, N.Y.	5.13	4.88	10.01
9	Burlington, Conn.	7.45	2.05	9.50
10	Thomaston Dam, Conn.	7.14	2.17	9.31
11	Bakersville, Conn.	5.62	2.79	8.41
12	Rhinebeck 4 SE, N.Y.	4.20	4.07	8.27
13	Mohonk Lake, N.Y.	8.21	0.00	8.21
14	Woodbridge 6 S, N.Y.	5.15	2.94	8.09
15	Torrington, Conn.	4.93	2.90	7.83
16	West Point, N.Y.	4.39	3.37	7.76
17	Poughkeepsie 7 NNW, N.Y.	4.44	3.31	7.75
18	Norfork 2 SW, Conn.	5.69	2.02	7.71
19	Granville Dam, Mass.	3.90	3.78	7.68
20	Walden 1 SES, N.Y.	6.65	0.89	7.54
21	Sussex 2 NW, N.J.	6.44	0.89	7.33
22	Batavia Kill near Ashland, N.Y.	7.31	0.00	7.31
23	Barkhamsted, Conn.	5.00	2.31	7.31
24	Midland Park, N.J.	0.00	7.20	7.20
25	Plattsburgh 3 S, N.Y.	3.45	3.52	6.97
26	Rock Hill 3 SW, N.Y.	4.95	1.94	6.89
27	Noxen, Pa.	4.96	1.89	6.85
28	Alcove Dam, N.Y.	2.46	4.35	6.81
29	Yorktown Heights 1 W, N.Y.	6.35	0.30	6.65
30	Elizabethtown, N.Y.	0.60	6.01	6.61
31	West Otis, Mass.	2.75	3.84	6.59
32	Cairo 4 NW, N.Y.	3.47	3.04	6.51
33	Danby Four Corners, Vt.	1.91	4.60	6.51
34	Woodcliff Lake, N.J.	6.51	0.00	6.51
35	Worthington, Mass.	2.80	3.65	6.45
36	Lansing Manor, N.Y.	3.50	2.90	6.40
37	South Lincoln, Vt.	0.99	5.36	6.35
38	Millbrook 3 W, N.Y.	0.77	5.57	6.34
39	Bloomingburg 2 SW, N.Y.	6.19	0.00	6.19
40	Harrison, N.Y.	6.16	0.00	6.16
41	Port Jervis, N.Y.	4.38	1.69	6.07

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
42	Poughkeepsie Dutchess County Airport, N.Y.	5.95	0.00	5.95
43	New Milford, N.J.	5.92	0.00	5.92
44	Valatie 1 N, N.Y.	1.93	3.93	5.86
45	Sandy Hook, N.J.	0.00	5.80	5.80
46	Whitehall, N.Y.	1.20	4.60	5.80
47	Gouldsboro, Pa.	4.62	1.03	5.65
48	Susquehanna, Pa.	4.12	1.52	5.64
49	Chittenden, Vt.	0.67	4.96	5.63
50	Buskirk, N.Y.	1.26	4.36	5.62
51	Clinton Corners, N.Y.	5.60	0.00	5.60
52	Conklingville Dam, N.Y.	0.00	5.50	5.50
53	NYCDEP Property on Red Hill near Denning, N.Y.	5.13	0.33	5.46
54	Chazy Miner, N.Y.	0.00	5.44	5.44
55	Dalton, Mass.	2.36	3.00	5.36
56	Ellensburg Depot, N.Y.	5.20	0.11	5.31
57	Mineola, N.Y.	1.34	3.96	5.30
58	Stanfordville, Conn.	2.40	2.88	5.28
59	Putnam Lake, Conn.	5.26	0.01	5.27
60	Ruoff Farm near Chichester, N.Y.	5.26	0.00	5.26
61	Richfield Springs 1 ESE, N.Y.	0.93	4.31	5.24
62	Dannemora, N.Y.	3.30	1.90	5.20
63	Westchester County Airport, N.Y.	5.18	0.00	5.18
64	Sunderland 2, Vt.	1.00	4.16	5.16
65	Cobleskill 2 ESE, N.Y.	2.60	2.55	5.15
66	Friendsville 7 NE, Pa.	2.85	2.27	5.12
67	Lenox Dale, Mass.	2.63	2.39	5.02
68	Merriman Dam (Rondout) near Lackawack, N.Y.	5.01	0.00	5.01
69	NYCDEP Property near New Kingston, N.Y.	4.98	0.00	4.98
70	Claryville, N.Y.	3.12	1.76	4.88
71	Liberty I NE, N.Y.	4.10	0.77	4.87
72	North Adams Harriman Airport, Mass.	4.85	0.00	4.85
73	Norwich, N.Y.	1.23	3.60	4.83
74	Hawley 4 NE, Pa.	3.78	1.03	4.81
75	Montrose 6 SSW, Pa.	2.34	2.46	4.80
76	Moscow, N.Y.	3.94	0.85	4.79
77	Miele Farm near Bovina, N.Y.	4.79	0.00	4.79
78	Hawley, Pa.	4.73	0.01	4.74
79	Lake Luzerne, N.Y.	1.18	3.52	4.70
80	Windsor, N.Y.	2.40	2.30	4.70
81	Albany International Airport, N.Y.	4.69	0.00	4.69
82	Rutland, Vt.	1.37	3.16	4.53

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
83	Salisbury 2 N, Vt.	4.08	0.43	4.51
84	Honesdale, Pa.	4.07	0.38	4.45
85	Windsor 8 SE, N.Y.	2.41	2.00	4.41
86	Centerport, N.Y.	4.09	0.30	4.39
87	Pittsfield Municipal Airport, Mass.	4.33	0.00	4.33
88	South Kortright W, N.Y.	2.18	2.15	4.33
89	Ashokan Dam near Boiceville, N.Y.	4.31	0.00	4.31
90	Hampton, Conn.	2.18	2.07	4.25
91	Saratoga Springs 4 SW, N.Y.	4.23	0.01	4.24
92	Pleasant Mount 1 W, Pa.	3.00	1.19	4.19
93	New Hartford 1 S, N.Y.	0.58	3.57	4.15
94	South Hero, Vt.	4.02	0.12	4.14
95	Prattsville Airport near Prattsville, N.Y.	4.10	0.00	4.10
96	Morris, N.Y.	1.65	2.42	4.07
97	Gloversville 7 NW, N.Y.	1.15	2.89	4.04
98	Round Lake 1 SE, N.Y.	1.66	2.35	4.01
99	New York Central Park Tower, N.Y.	3.99	0.00	3.99
100	Aldenville, N.Y.	3.35	0.63	3.98
101	West Hazleton, Pa.	3.14	0.82	3.96
102	NYCDEP Property near West Delhi, N.Y.	3.96	0.00	3.96
103	Endicott 3 SSE, N.Y.	2.90	1.05	3.95
104	Hancock 1 W, N.Y.	1.80	2.15	3.95
105	Callicoon Center, N.Y.	3.05	0.88	3.93
106	Indian Lake 2 SW, N.Y.	0.03	3.74	3.77
107	Binghamton 2 SW, N.Y.	2.06	1.70	3.76
108	Glenburn 1 ESE, Pa.	3.15	0.60	3.75
109	Cornwall, Vt.	0.86	2.88	3.74
110	Binghamton 1 ENE, N.Y.	2.02	1.71	3.73
111	Prompton, Pa.	3.39	0.30	3.69
112	Bainbridge, N.Y.	1.62	2.06	3.68
113	Glens Falls Airport, N.Y.	3.67	0.00	3.67
114	Melrose 1 NE, N.Y.	3.65	0.00	3.65
115	North Creek 5 SE, N.Y.	0.82	2.83	3.65
116	Unadillla 2 N, N.Y.	1.71	1.94	3.65
117	Walton 2, N.Y.	1.50	2.15	3.65
118	Chenango Forks 1 SE, N.Y.	1.64	2.01	3.65
119	Bronx, N.Y.	3.63	0.00	3.63
120	Schoharie Dam near Gilboa, N.Y.	3.62	0.00	3.62
121	New York La Guardia Airport, N.Y.	3.62	0.00	3.62
122	Hazleton 1 NNE, Pa.	1.89	1.67	3.56
123	Hazleton, Pa.	2.84	0.72	3.56

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
124	Essex Junction 1 N, Vt.	0.67	2.87	3.54
125	East Sidney, N.Y.	1.87	1.62	3.49
126	Lawton, N.Y.	2.34	1.11	3.45
127	Vernon, N.Y.	0.37	3.08	3.45
128	Jermyn, Pa.	2.95	0.47	3.42
129	Burlington International Airport, Vt.	3.38	0.00	3.38
130	Honesdale, Pa.	3.08	0.30	3.38
131	Sherburne, N.Y.	1.35	2.03	3.38
132	North Brookfield, N.Y.	0.60	2.77	3.37
133	Norwich 5 W, N.Y.	0.94	2.41	3.35
134	Pepacton Dam near Downsville, N.Y.	3.33	0.01	3.34
135	Deposit, N.Y.	2.07	1.23	3.30
136	Hop Bottom, Pa.	2.51	0.77	3.28
137	Oneonta 7 NE, N.Y.	1.47	1.77	3.24
138	Tunkhannock, Pa.	2.60	0.59	3.19
139	Oneonta 1 ENE, N.Y.	1.82	1.36	3.18
140	Maryland 6 SW, N.Y.	1.47	1.59	3.06
141	Cannonsville Dam, N.Y.	3.05	0.00	3.05
142	Tupper Lake Sunmount, N.Y.	0.00	3.04	3.04
143	Munnsville 2 SW, N.Y.	0.54	2.46	3.00
144	Smyrna 2 WNW, N.Y.	1.20	1.75	2.95
145	Big Bend Club on Hunter Road near Claryville, N.Y.	2.91	0.01	2.91
146	Morrisville 6 SW, N.Y.	0.85	2.02	2.87
147	Morrisville, N.Y.	0.80	2.02	2.82
148	Newcomb, N.Y.	0.67	2.13	2.80
149	Greene, N.Y.	1.80	0.94	2.74
150	Le Raysville, Pa.	1.75	0.99	2.74
151	Greater Binghamton Airport, N.Y.	2.71	0.00	2.71
152	Overton, N.Y.	1.89	0.79	2.68
153	Apalachin 3 ESE, N.Y.	1.39	1.19	2.58
154	Canastota 1 S, N.Y.	0.49	2.09	2.58
155	Whitney Point 2 SSE, N.Y.	1.32	1.23	2.55
156	Apalachin 3 SE, N.Y.	1.98	0.55	2.53
157	Bridgewater 4 SSE, N.Y.	0.45	2.07	2.52
158	Orwell, Pa.	1.44	1.08	2.52
159	Bridgeport Sikorsky Airport, Conn.	2.50	0.00	2.50
160	Forest City, N.Y.	2.31	0.18	2.49
161	Chittenango 2 ESE, N.Y.	0.36	2.09	2.45
162	Durhamville 4 NNW, Pa.	0.33	2.11	2.44
163	Cazenovia 3 SE, N.Y.	0.54	1.84	2.38
164	Towanda, Pa.	1.42	0.96	2.38

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
165	Earlville, N.Y.	0.74	1.62	2.36
166	New York JFK International Airport, N.Y.	2.34	0.00	2.34
167	Riverhead Research Farm, N.Y.	2.33	0.00	2.33
168	Westmoreland 4 N, N.Y.	0.43	1.83	2.26
169	Rome 5 SSE, N.Y.	0.42	1.83	2.25
170	Candor 3 NE, N.Y.	0.91	1.31	2.22
171	Berkshire 2 ENE, N.Y.	1.22	0.98	2.20
172	Holland Patent 2 WSW, N.Y.	0.37	1.81	2.18
173	Candor 2 SE, N.Y.	1.01	1.14	2.15
174	Cooperstown, N.Y.	2.10	0.04	2.14
175	Oquago Retreat Center at Perch Lake near Andes, N.Y.	2.12	0.00	2.12
176	Owego 3 ENE, N.Y.	1.00	1.12	2.12
177	Monroeton, Pa.	1.44	0.63	2.07
178	Whitney Point Dam, N.Y.	0.92	1.14	2.06
179	Cortland, N.Y.	0.98	1.07	2.05
180	Big Moose 3 SE, N.Y.	1.75	0.29	2.04
181	Old Forge, N.Y.	0.40	1.62	2.02
182	Highmarket, N.Y.	0.01	1.95	1.96
183	Boonville 4 SSW, N.Y.	0.32	1.62	1.94
184	East Smithfield, N.Y.	1.35	0.56	1.91
185	Tully 2 WSW, N.Y.	0.46	1.44	1.90
186	Owego 3 WSW, N.Y.	1.00	0.85	1.85
187	Van Etten, N.Y.	1.14	0.71	1.85
188	Slaterville Spring 1 S, N.Y.	0.70	1.12	1.82
189	Marathon 1 NW, N.Y.	0.73	1.07	1.80
190	Newark Valley, N.Y.	1.00	0.80	1.80
191	Sylvania 3 SSW, Pa.	1.15	0.65	1.80
192	Powell, Pa.	1.11	0.68	1.79
193	Boonville 8 E, N.Y.	0.24	1.53	1.77
194	Equinunk, Pa.	1.21	0.55	1.76
195	Cincinnatus, N.Y.	0.90	0.80	1.70
196	New London Lock 22, N.Y.	0.36	1.34	1.70
197	Smith Valley 2 SE, N.Y.	0.67	0.96	1.63
198	East Ithaca 5 E, N.Y.	0.70	0.92	1.62
199	Roseville 6 ENE, Pa.	1.07	0.55	1.62
200	White Haven, Pa.	1.15	0.46	1.61
201	Chemung, N.Y.	1.03	0.56	1.59
202	Columbia Cross Roads, Pa.	1.07	0.52	1.59
203	Griffiss Air Force Base, N.Y.	0.42	1.12	1.54
204	De Witt 1 WSW, N.Y.	0.30	1.23	1.53
205	Troy, Pa.	0.92	0.56	1.48

Table 9. Rainfall for the storm of August 28–29, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012); N, north; S, south; E, east; W, west; locations are shown on figure 25]

Site number	Site name	Rainfall (inches)		
		August 28	August 29	Total
206	Canton, Pa.	1.07	0.40	1.47
207	Groton 3 SSW, N.Y.	0.66	0.75	1.41
208	Groton 1 NW, N.Y.	0.61	0.79	1.40
209	Freeville 3 N, N.Y.	0.61	0.78	1.39
210	Hooker 12 NNW, N.Y.	0.00	1.35	1.35
211	Mecklenburg 4 SW, N.Y.	0.53	0.82	1.35
212	Odessa 3 ENE, N.Y.	0.80	0.53	1.33
213	Freeville 2 NE, N.Y.	0.69	0.63	1.32
214	Hunts Corners, N.Y.	0.80	0.50	1.30
215	Locke 2 W, N.Y.	0.50	0.77	1.27
216	Southport 4 SSW, N.Y.	0.87	0.38	1.25
217	Elmira 1 ESE, N.Y.	0.82	0.42	1.24
218	Copenhagen, N.Y.	0.00	1.23	1.23
219	Lowville, N.Y.	0.26	0.95	1.21
220	Elmira, N.Y.	0.82	0.37	1.19
221	Camden, N.Y.	0.24	0.93	1.17
222	Elmira 1 WNW, N.Y.	0.79	0.38	1.17
223	West Elmira 1 SSE, N.Y.	0.71	0.46	1.17
224	Beaver Falls, N.Y.	1.16	0.00	1.16
225	Horseheads 1 W, N.Y.	0.68	0.38	1.06
226	Auburn, N.Y.	0.20	0.78	0.98
227	Brewerton Lock 23, N.Y.	0.03	0.95	0.98
228	Camillus 1 W, N.Y.	0.05	0.90	0.95
229	Burnett 1 ESE, N.Y.	0.34	0.58	0.92
230	Big Flats 1 W, N.Y.	0.57	0.34	0.91
231	South Corning 5 S, N.Y.	0.67	0.21	0.88
232	Dundee 6 ESE, N.Y.	0.49	0.36	0.85
233	Dundee 6 E, N.Y.	0.33	0.50	0.83
234	Catlin, N.Y.	0.52	0.24	0.76
235	Watkins Glen 5 NW, N.Y.	0.31	0.44	0.75
236	Erin, N.Y.	0.36	0.36	0.72
237	Liverpool 4 NNW, N.Y.	0.02	0.65	0.67
238	Baldwinsville, N.Y.	0.03	0.61	0.64
239	Corning, N.Y.	0.33	0.25	0.58
240	Bath, N.Y.	0.09	0.12	0.21
241	Waterloo, N.Y.	0.00	0.08	0.08
242	Bently Creek, N.Y.	0.04	0.00	0.04
243	Jasper, N.Y.	0.00	0.04	0.04
244	Hornell, N.Y.	0.00	0.01	0.01

Catskill Mountains with East Jewett receiving 12.85 in. Radar images of total daily precipitation on August 28–29 (fig. 24) show the general track and intensity of the storm moving from the New York City area north over Lake Champlain (National Oceanic and Atmospheric Administration, 2011m). The eastern slopes of the Adirondack Mountains to Lake Champlain in northeastern New York received nearly 7 in. of rain during the storm. The distribution of the total 2-day rainfalls (fig. 25) details the extreme amounts in eastern New York compared to the total rainfall in areas west of the Catskill and Adirondack Mountains, which received minimal rainfall during the event.

Record rainfall intensities were measured at some weather stations including Tannersville in the Catskill Mountain area, where 11.60 in. fell in less than 24 hours (National Oceanic and Atmospheric Administration, 2011i). Accumulated hourly rainfalls plotted on figure 26 for several weather stations in eastern New York show that most of their total storm rainfall occurred in less than 24 hours. Rainfall-frequency data were compiled for four weather stations in eastern New York and one in western Vermont (table 10) for 6-, 12-, and 24-hour rainfall totals (Northeast Regional Climate Center, 2010). Rainfall totals at Tannersville, N.Y., for the three durations, were each equal to or greater than the 0.5-percent AEP (200-year recurrence interval) rainfall. August 2011 was the wettest August statewide and throughout eastern New York since at least 1895 (National Oceanic and Atmospheric Administration, 2011k). The lower Hudson River Valley averaged 12.04 in. of rain in August 2011, which is more than 8 in. above normal for the month.

Flooding

The heavy rains from Tropical Storm Irene over eastern New York resulted in record flooding at 60 active streamgages and two lake/reservoir gages during late August 2011. The prior peak discharge of record, peak discharges during the August 28–29, 2011 flood, and flood frequencies for 154 selected USGS streamgages are presented in table 11 (locations shown in fig. 10).

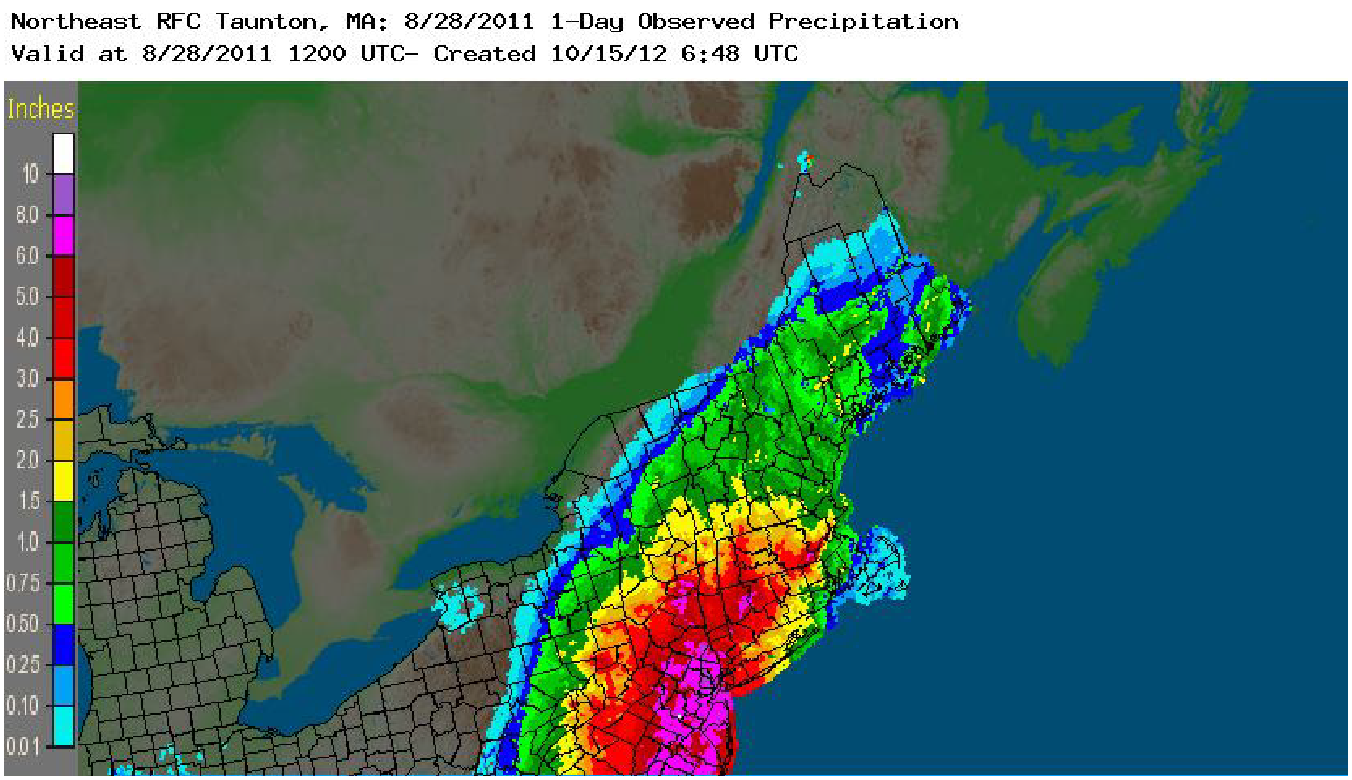
Flood Discharge and Frequency

The record floods at many streamgages from Tropical Storm Irene resulted in extreme flood frequencies in many areas of eastern New York as indicated by the associated drainage-basin color code shown on figure 27. A full-size view of the map on figure 27 can be accessed by the computer link at the end of the figure caption. The most extreme flooding was in and around the eastern Catskill Mountains area of southeastern New York and the eastern slopes of the Adirondack Mountains into the Champlain Valley. West of these areas, flooding was substantially less. Record floods were documented at 60 streamgages and two lake/reservoir gages, with 25 of them having AEP values equal to or less than 1 percent (greater than or equal to 100 years). Peak discharges plotted as a function of drainage area (fig. 28) for 94 streamgages where the August 2011 floods were the maximum for the year indicate that the August 2011 flood was near or exceeded both the previous peak discharge of record and the 1-percent AEP (100-year) discharge for most of the selected sites. The documented August 2011 flows span a wide range of basin sizes (fig. 28).

The Schoharie Creek Basin was particularly hard hit by the August flooding. Three of the six streamgages on Schoharie Creek recorded peak discharges that were nearly equal to or greater than the 0.2-percent AEP (500-year) flood discharge (fig. 29). On August 28, 2011, the streamgage at Schoharie Creek at Prattsville (01350000) recorded its highest stage (24.38 ft) and discharge (120,000 ft^3/s) since record collection began in 1903 (5.0 ft higher than that during the previous peak of record, 19.39 ft on January 19, 1996). The 2011 peak discharges at the Schoharie Creek streamgages were 1.5 to 2.3 times greater than those recorded during the January 1996 flood. Reaches of the Mohawk River downstream from the confluence with Schoharie Creek also had substantial flooding. Other streams throughout eastern New York with long periods of record (75–101 years)—including Catskill Creek, Esopus Creek, Rondout Creek, Ramapo River, East Branch Delaware River, Ausable River (East Branch, West Branch, and main stem), and Bouquet River—all had record flooding during August 28–29, 2011 (table 11).

The heavy rainfall during a relatively short time interval in late August 2011 resulted in large volumes of runoff (the amount of water discharged from a drainage basin and passing a specific location during a given amount of time) in many parts of eastern New York. Similar to the analysis done for the April–May flood, the August 2011 maximum 1-, 3-, and 7-consecutive-day runoff, expressed as the mean of daily mean discharges over an n-day period, was calculated for five streamgages in the Catskill Mountains area (figs. 30A–E); Schoharie Creek at Prattsville (01350000), Schoharie Creek at Burtonsville (01351500), Esopus Creek at Allaben (01362200), Esopus Creek at Coldbrook (01362500), and East Branch Delaware River at Margaretville (01413500).

The maximum 1-day mean flow for the Schoharie Creek at Prattsville (01350000) (August 28, 2011; 40,000 ft^3/s) was the largest 1-day flow in 104 years of record (50 percent higher than the previous 1-day maximum flow recorded in 1955) and significantly exceeded the 1-percent AEP (100-year) 1-day discharge (fig. 30A–1); the 3-day flow (August 28–30) was the second largest, and the 7-day flow the 4th largest during the period of record. The extreme 1-day runoff and the progressively less notable 3- and 7-day runoffs are indicative of the intensity of the rainfall in this basin. A similar pattern of n-day runoff was observed at the other four streamgages (figs. 30B–E), but the August maximum 3-day runoff was still the largest of record at Schoharie Creek at Burtonsville (01351500), Esopus Creek at Allaben (01362200), and East Branch Delaware River at Margaretville (01413500) and the



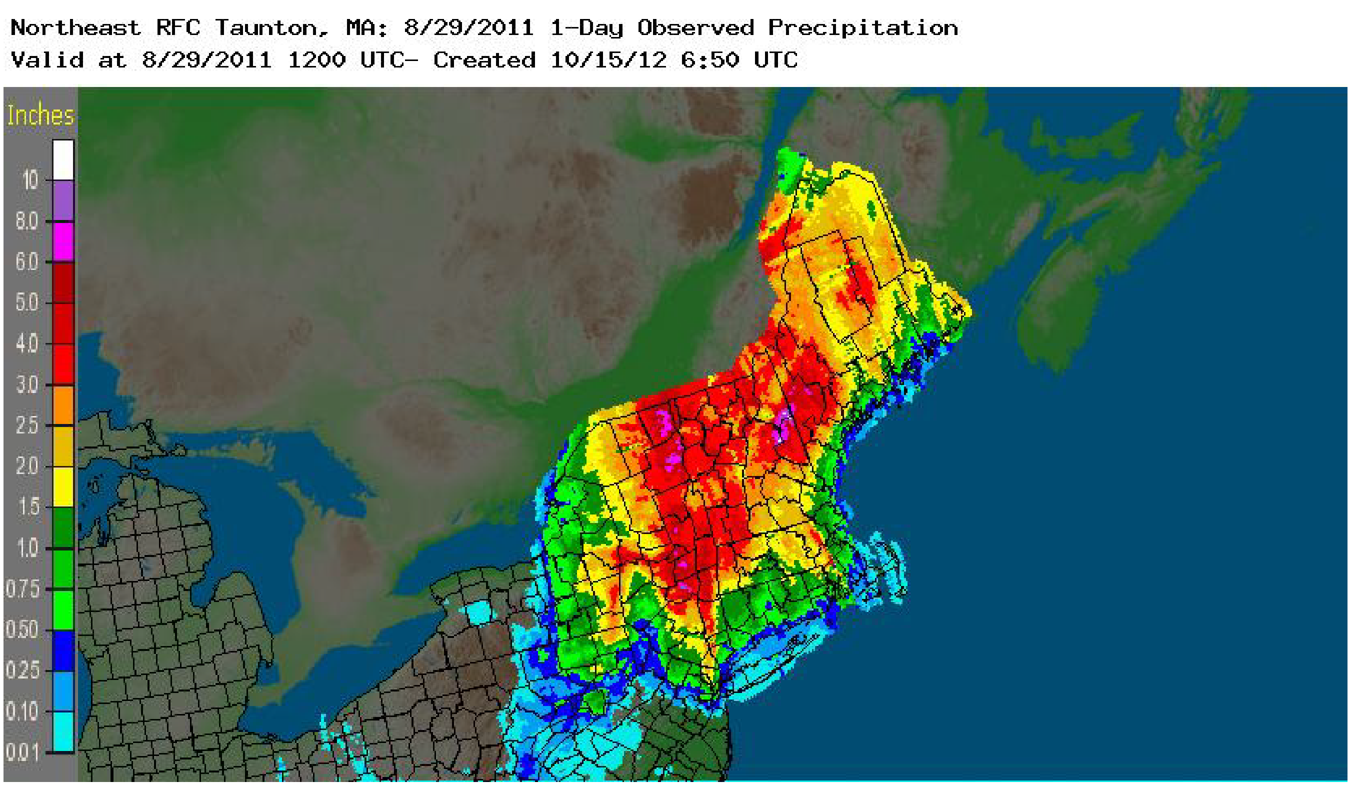
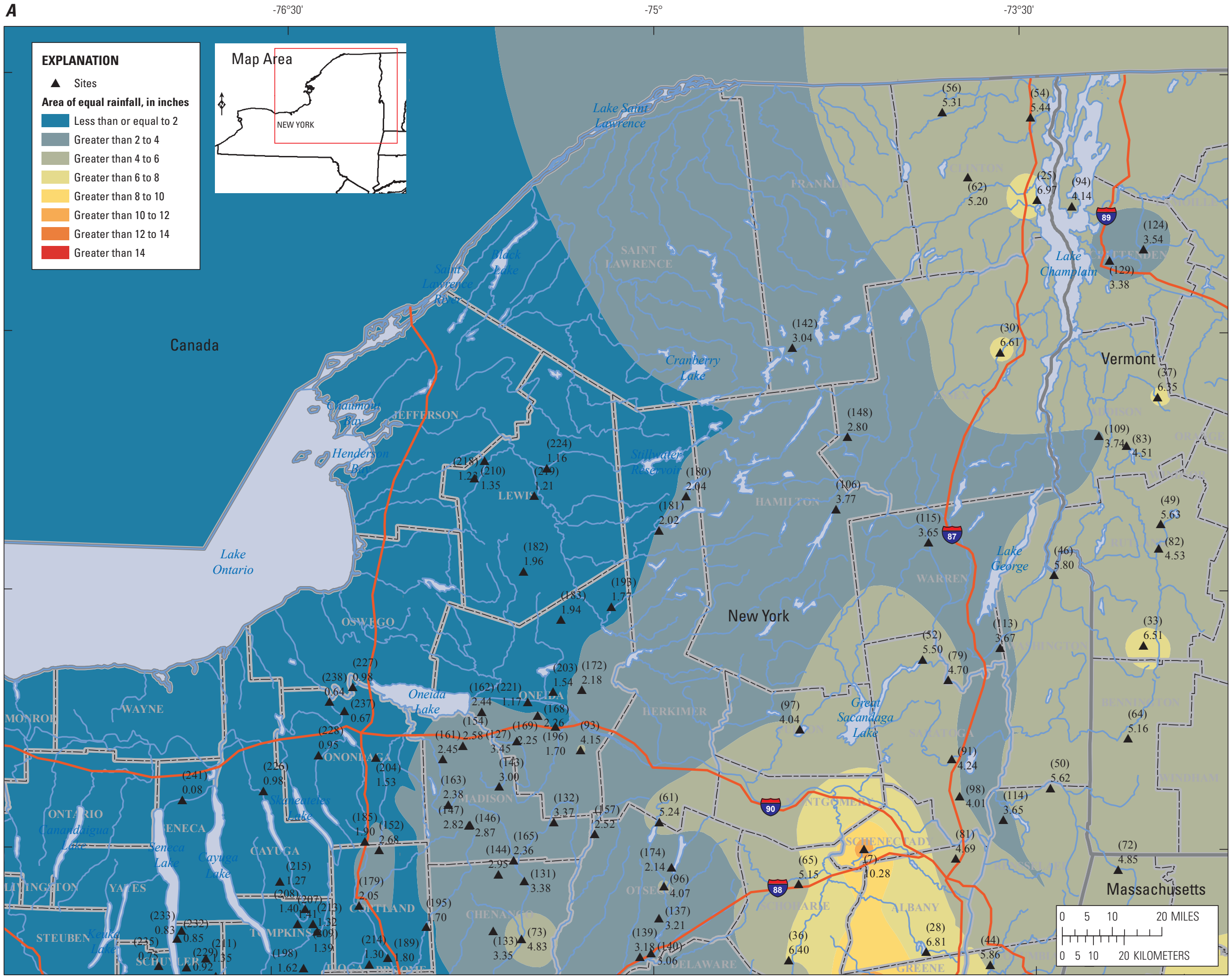
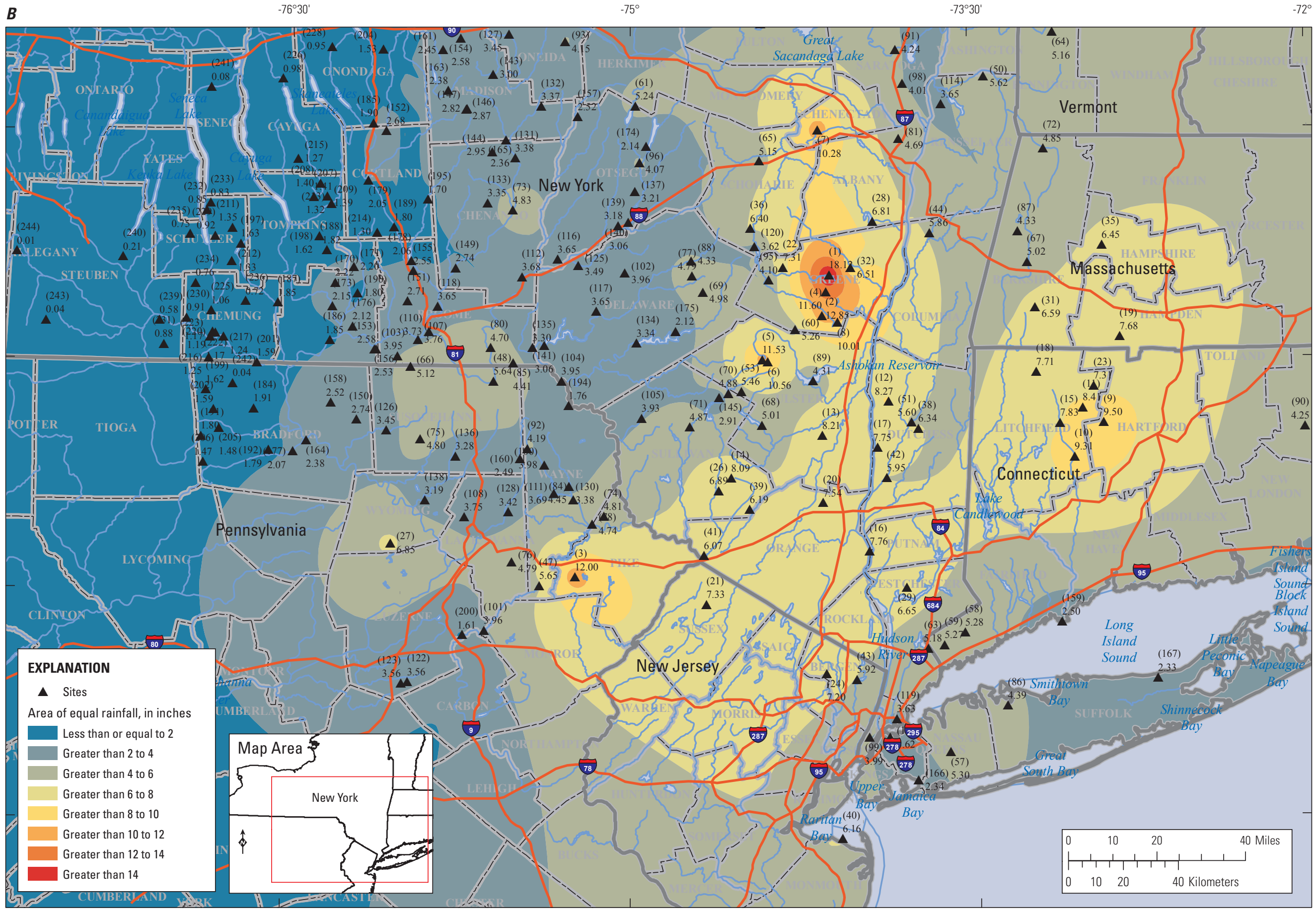


Figure 24. Daily rainfall totals during August 28–29, 2011, for New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011m)



Base from U.S. Geological Survey Digital Data. Universal Transverse Mercator Projection, Zone 18N, NAD83

Figure 25. Rainfall totals for the storm of August 28–29, 2011, in *A,* north, and *B,* south areas of New York and surrounding areas. (National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012) Sites and data are listed in table 9.)



Base from U.S. Geological Survey Digital Data. Universal Transverse Mercator Projection, Zone 18N, NAD83

Figure 25. Rainfall totals for the storm of August 28–29, 2011, in *A,* north, and *B,* south areas of New York and surrounding areas. (National Oceanic and Atmospheric Administration (2011b, c, e, g; written commun., 2012), and New York City Department of Environmental Protection (NYCDEP, written commun., 2012) Sites and data are listed in table 9.)—Continued

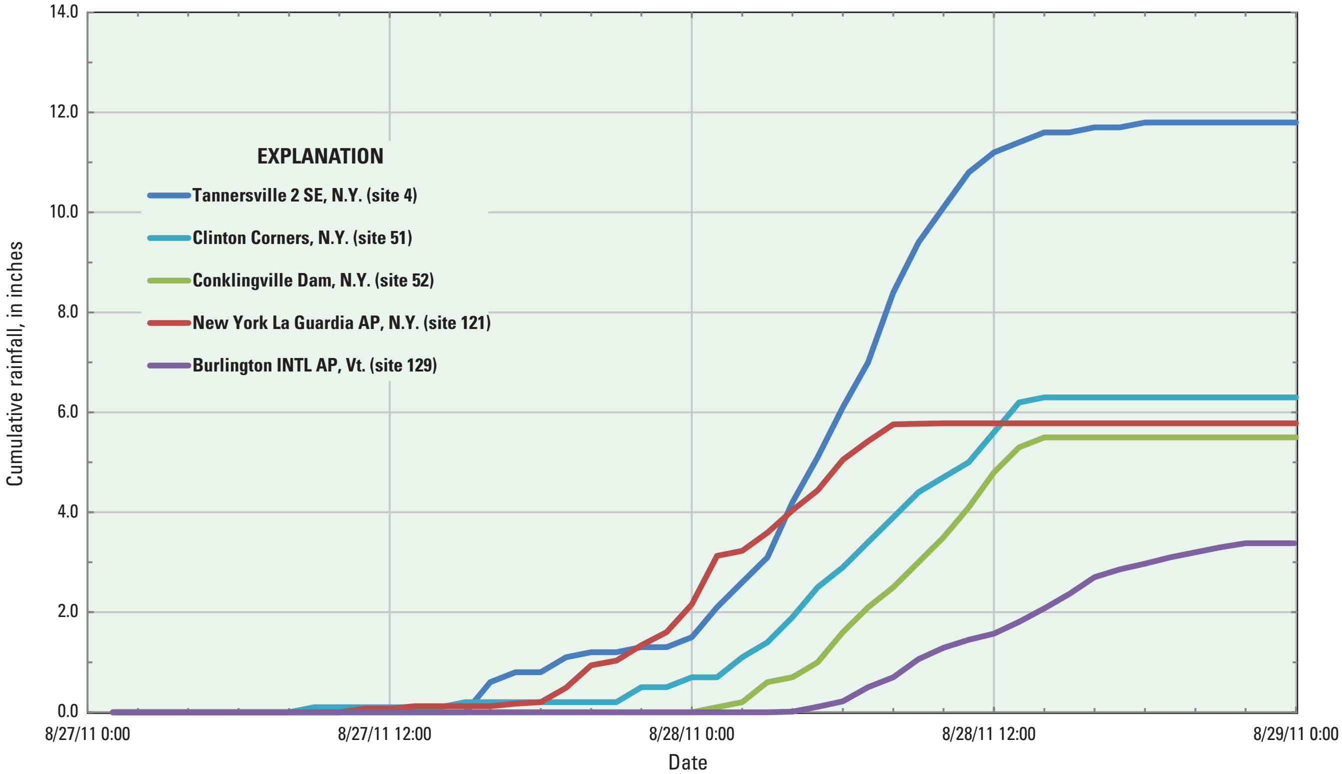


Figure 26. Cumulative hourly rainfall during August 27–29, 2011, recorded at five weather stations in New York and Vermont. (Data from National Oceanic and Atmospheric Administration, 2011i; Sites are listed in table 9 and locations are shown on figure 25.)

largest 7-day runoff of record for the last two streamgages. Slightly upward trends in flood runoffs at the Prattsville streamgage are indicated since record collection began in 1908. Runoffs at the East Branch Delaware River at Margaretville streamgage (01413500) reached record high values during late August to early September for the maximum 1-, 3-, and 7-consecutive-day mean discharges (fig. 30E). The 1- and 3-day runoffs exceeded the 1-percent AEP (100-year) runoffs, whereas the 7-day runoff (August 28–September 3) was slightly less than the 2-percent AEP (50-year) runoff. The Margaretville streamgage also recorded slightly upward trends in runoffs during its 75 years of record.

The 7-day (August 27–September 2, 2011) storm runoff (table 12), which is color-coded in inches over streamgage basins in the eastern half of New York (fig. 31), indicate the greatest runoffs were in and around the Catskill Mountains with lesser amounts extending to the eastern slopes of the Adirondack Mountains and into the Champlain Valley. Storm runoff at streamgages affected by substantial regulation in the basin was adjusted for storage if data on reservoir contents were available. A full-size view of the map on figure 31 can be accessed by the computer link at the end of the figure caption.

Annual peak discharges at 30 selected streamgages in eastern New York (figs. 32A–AD) indicate that the August 2011 peak generally far exceeded the previous annual peak at most sites. The August 2011 peak discharge exceeded the 1-percent AEP (100-year) discharge at 24 of the 30 selected streamgages (figs. 32A–AD). All August 2011 peaks at selected streamgages within the Schoharie Creek Basin (figs. 32C–L) set new peaks of record and exceeded the 1-percent AEP (100-year) discharge, most by a substantial amount.

Several of the records for streamgages in the Schoharie Creek Basin indicated a significant upward trend in annual peak discharges (figs. 32C–L, table 6). The record peak discharge for the Catskill Creek at Oak Hill (01361500) streamgage exceeded the 1-percent AEP (100-year) discharge, and the annual peaks for the period 1911–2011 show a significant (p-value 0.000) positive trend (fig. 32M, table 6). Although Rondout Reservoir is upstream from the Rondout Creek at Rosendale (01367500) streamgage, the August 2011 stage (26.96 ft) and discharge (36,500 ft^3/s) are maximums for the period of record. Since the Rondout Reservoir began operation in 1950, the annual peak long-term (1951–2011) and short-term (1982–2011) trends at the Rosendale streamgage have been upward (p-values 0.084 and 0.038, respectively).

Table 10. Rainfall frequencies for storms of 6-, 12- and 24-hour durations at selected locations in New York and Vermont.

[Maximum rainfall during August 28–29, 2011, for selected durations are shown in red. Data from the Northeast Regional Climate Center, 2010; locations are shown on figure 25]

Site number	Site name	County	Recurrence interval (years)	Rainfall for selected duration (inches)		
				6-hour	12-hour	24-hour
4	Tannersville, N.Y.	Greene	2	2.07	2.58	3.21
			5	2.59	3.24	4.04
			10	3.07	3.86	4.82
			25	3.85	4.86	6.09
			50	4.58	5.80	7.28
			100	5.44	6.90	8.70
				6.30		
			200	6.47	8.24	10.41
					9.70	11.60
			500	8.12	10.40	13.21
51	Clinton Corners, N.Y.	Dutchess	2	2.17	2.70	3.34
			5	2.75	3.40	4.20
				3.00		
			10	3.30	4.07	4.99
						6.20
			25	4.18	5.15	6.27
					5.50	
			50	5.00	6.14	7.46
			100	5.99	7.34	8.88
			200	7.17	8.76	10.57
			500	9.09	11.08	13.31
52	Conklingville Dam, N.Y.	Saratoga	2	1.81	2.17	3.42
			5	2.27	2.71	4.28
			10	2.69	3.19	5.08
				3.20		5.50
			25	3.36	3.98	6.37
			50	4.00	4.70	7.56
					5.30	
			100	4.73	5.53	8.98
			200	5.62	6.54	10.67
			500	7.03	8.14	13.41
121	New York	Queens	2	2.28	2.79	3.42
	La Guardia Airport, N.Y.			2.64		
			5	2.87	3.51	4.28
			10	3.41	4.17	5.08
					4.93	5.78
			25	4.27	5.25	6.37
			50	5.07	6.22	7.56
			100	6.02	7.40	8.98
			200	7.15	8.79	10.67
			500	8.97	11.04	13.41
129	Burlington, Vt.	Chittenden		1.41		
			2	1.63	1.91	2.22
			5	2.03	2.36	2.70
					2.75	
			10	2.41	2.77	3.13
						3.38
			25	3.01	3.41	3.80
			50	3.55	4.00	4.41
			100	4.20	4.69	5.12
			200	4.98	5.50	5.95
			500	6.19	6.78	7.26

Table 11. Period-of-record peak discharges through July 2011 and peak discharges during the flood of August 28–29, 2011, at selected U.S. Geological Survey streamgages in New York.

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Period-of-record peak discharge: Date	Period-of-record peak discharge: Stage (ft)	Period-of-record peak discharge: Discharge (ft³/s)	August 26–29, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Housatonic River Basin											
1	01199477	Stony Brook near Dover Plains, N.Y.	1.93	1976–2011	04/04/87	6.40	601	08/28/11	--	6.51	[a]620	2.2	45
		Mamaroneck River Basin											
2	01300800	Mamaroneck River at Winfield Avenue at Mamaroneck, N.Y.	14.5	1972, 1983–87, 2009–11	06/19/72	11.6	2,590	08/28/11	--	11.99	2,800	2.9	35
3	01301000	Mamaroneck River at Mamaroneck, N.Y.	23.4	1944–89, 1999, 2009–11	09/26/75	10.15	3,700	08/28/11	--	10.92	3,970	2.5	40
		Bronx River Basin											
4	01302020	Bronx River at New York Botanical Garden at Bronx, N.Y.	38.4	2007–11	04/16/07	6.05	3,460	08/28/11	1915	5.19	2,710	--	--
		Streams on Long Island											
5	01303500	Cold Spring Brook at Cold Spring Harbor, N.Y.	7.30	1951–2011	01/21/79	1.99	181	08/28/11	0945	3.76	73	16.7	6
6	01304000	Nissequoque River near Smithtown, N.Y.	27.0	1944–2011	01/22/79	3.22	952	08/28/11	0700	1.17	128	33.3	3
7	01304500	Peconic River at Riverhead, N.Y.	75.0	1943–2011	01/30/78	1.20	225	08/28/11	1300	0.62	60	>50.0	<2
		Hudson River Basin											
8	01311992	Arbutus Pond Outlet near Newcomb, N.Y.	1.22	1991–2011	04/29/11	2.60	74	08/28/11	--	1.68	12	>50.0	<2
9	01312000	Hudson River near Newcomb, N.Y.	192	1926–2011	01/09/98	12.84	11,500	08/29/11	2115	7.64	3,870	50.0	2
13	01315500	Hudson River at North Creek, N.Y.	792	1908–2011	04/28/2011	13.65	34,900	08/29/11	2115	7.49	9,410	>50.0	<2
14	01317000	Schroon River at Riverbank, N.Y.	527	1908–70, 1987–2011	03/21/36	12.18	12,100	08/31/11	0530	6.57	3,500	>50.0	<2
15	01318500	Hudson River at Hadley, N.Y.	1,664	1922–2011	04/29/11	21.32	44,200	08/28/11	2330	10.50	17,200	>50.0	<2
16	01321000	Sacandaga River near Hope, N.Y.	491	1912–2011	03/27/13	[b]11.00	32,000	08/28/11	2230	7.13	12,100	50.0	2
18	01325000	Sacandaga River at Stewarts Bridge, near Hadley, N.Y.	1,055	1908–29	03/28/13	[b]12.36	[a]35,500						
				1930–2011	05/02/11	10.40	16,500	08/28/11	1300	5.38	4,060	>50.0	<2
19	01327750	Hudson River at Fort Edward, N.Y.	2,810	1977–2011	04/29/11	31.34	48,800	08/29/11	0245	25.38	21,300	>50.0	<2
20	01329154	Steele Brook at Shushan, N.Y.	2.85	1979–2011	01/19/96	6.56	149	08/29/11	--	6.75	155	10.0	10
21	01329490	Batten Kill below mill at Battenville, N.Y.	396	1923–68, 1987–2011	11/04/27	[b]17.7	21,300	08/29/11	0845	14.27	15,200	3.3	30
22	01330000	Glowegee Creek at West Milton, N.Y.	26.0	1949–63, 1991–2011	12/31/48	7.04	1,670	08/28/11	1900	7.09	1,480	5.0	20
23	01331095	Hudson River at Stillwater, N.Y.	3,773	1978–2011	04/29/11	--	[a,c]52,000	08/29/11	--	--	[a,c]32,000	50.0	2
24	01333500	Little Hoosic River at Petersburg, N.Y.	56.1	1949, 1952–2011	12/31/48	9.4	7,470	08/28/11	1600	9.07	5,700	2.5	40
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	1911–22, 1924–2011	12/31/48	21.15	55,400	08/29/11	0030	19.24	44,300	<1.0 & >0.5	>100 & <200

Table 11. Period-of-record peak discharges through July 2011 and peak discharges during the flood of August 28–29, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft^3/s)	August 26–29, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
				Hudson River Basin—Continued									
26	01335754	Hudson River above Lock 1 near Waterford, N.Y.	4,605	1888–1929	03/28/13	--	120,000						
				1930–56, 1977–2011	01/01/49	--	118,000	08/29/11	1815	34.60	75,500	3.3	30
32	01346000	West Canada Creek at Kast Bridge, N.Y.	560	1921–2011	04/29/11	8.68	23,400	08/28/11	1515	4.88	5,980	>50.0	<2
33	01347000	Mohawk River near Little Falls, N.Y.	1,342	1928–2011	06/28/06	19.72	35,000	08/28/11	1915	13.60	16,400	>50.0	<2
34	01348000	East Canada Creek at East Creek, N.Y.	289	1945–96, 1998, 2000, 2003–11	06/28/06	10.99	31,500	08/28/11	2215	4.88	3,440	>50.0	<2
35	01348420	North Creek near Ephratah, N.Y.	6.52	1972–2011	06/28/06	10.06	780	08/28/11	--	11.2	[a]1,800	<0.2	>500
36	01349150	Canajoharie Creek near Canajoharie, N.Y.	59.7	1993–2011	06/28/06	10.50	5,510	08/28/11	2015	10.76	5,850	4.0	25
37	01349700	East Kill near Jewett Center, N.Y.	35.6	1965–74, 1987, 1996–2011	01/19/96	17.00	13,500	08/28/11	--	25.65	28,400	<0.2	>500
38	01349705	Schoharie Creek near Lexington, N.Y.	96.8	1999–2011	09/16/99	[a]16.5	23,000	08/28/11	1000	22.87	40,500	<0.2	>500
39	01349711	West Kill below Hunter Brook near Spruceton, N.Y.	4.97	1998–2011	09/16/99	4.32	2,080	08/28/11	0820	5.23	4,320	<0.2	>500
40	01349810	West Kill near West Kill, N.Y.	27.0	1996–2011	01/19/96	[b]11.06	6,500	08/28/11	0830	19.03	19,100	<0.2	>500
41	01349950	Batavia Kill at Red Falls near Prattsville, N.Y.	68.6	1996–2011	09/17/99	10.08	16,800	08/28/11	--	20.0	44,200	<0.2	>500
42	01350000	Schoharie Creek at Prattsville, N.Y.	237	1903–2011	01/19/96	19.39	52,800	08/28/11	1200	24.38	120,000	<0.2	>500
43	01350035	Bear Kill near Prattsville, N.Y.	25.7	1999–2011	09/18/04	8.06	2,580	08/28/11	1300	8.11	2,620	12.5	8
44	01350080	Manor Kill at West Conesville near Gilboa, N.Y.	32.4	1987–2011	01/19/96	10.20	5,050	08/28/11	0945	11.92	6,590	1.7	60
45	01350100	Schoharie Reservoir near Grand Gorge, N.Y.	315	1928–2011	01/19/96	[d]1,136.68	--	08/28/11	1300	[d]1,137.73	--	--	--
46	01350101	Schoharie Creek at Gilboa, N.Y.	316	1976–2011	01/19/96	30.60	70,800	08/28/11	--	40.52	111,000	<1.0 & >0.5	>100 & <200
47	01350120	Platter Kill at Gilboa, N.Y.	10.9	1976–2011	01/19/96	6.7	1,370	08/28/11	1230	7.51	1,750	2.0	50
48	01350140	Mine Kill near North Blenheim, N.Y.	16.2	1975–2011	01/19/96	5.20	2,550	08/28/11	1100	6.26	2,290	6.7	15
49	01350180	Schoharie Creek at North Blenheim, N.Y.	358	1971–2011	01/19/96	17.16	75,600	08/28/11	1415	22.00	[e]119,000	<0.5 & >0.2	>200 & <500
50	01350355	Schoharie Creek at Breakabeen, N.Y.	444	1976–2011	01/19/96	20.51	88,000	08/28/11	1600	22.37	134,000	<0.5 & >0.2	>200 & <500
51	01351500	Schoharie Creek at Burtonsville, N.Y.	886	1940–2011	01/20/96	12.88	81,600	08/29/11	--	17.46	128,000	0.2	500
52	01356190	Lisha Kill northwest of Niskayuna, N.Y.	15.6	1994–97, 2001–11	01/19/96	5.22	662	08/28/11	1600	4.78	1,030	6.7	15
53	01357500	Mohawk River at Cohoes, N.Y.	3,450	1918–2011	03/06/64	23.15	143,000	08/29/11	1300	21.86	117,000	3.3	30
54	01358000	Hudson River at Green Island, N.Y.	8,090	1946–2011	12/31/48	27.05	181,000	08/29/11	1515	27.05	181,000	1.7	60
55	01359528	Normans Kill at Albany, N.Y.	168	1980–84, 1992–2011	09/17/99	13.50	11,800	08/28/11	--	14.15	13,200	2.2	45
56	01360640	Valatie Kill near Nassau, N.Y.	9.48	1991–2011	06/06/00	6.18	856	08/28/11	1445	6.52	914	6.7	15

Table 11. Period-of-record peak discharges through July 2011 and peak discharges during the flood of August 28–29, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated lake gage or streamgage. Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft^3/s)	August 26–29, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
				Hudson River Basin—Continued									
57	01361000	Kinderhook Creek at Rossman, N.Y.	329	1906–14, 1928–68, 1984, 1988–2011	12/31/48	20.8	29,800	08/29/11	--	11.81	15,000	6.7	15
58	01361500	Catskill Creek at Oak Hill, N.Y.	95.8	1911–77, 1980, 1987–2011	04/04/87	16.6	15,400	08/28/11	--	18.0	21,000	<0.5 & >0.2	>200 & <500
59	01362100	Roeliff Jansen Kill near Hillsdale, N.Y.	27.5	1958–2011	06/30/73	9.78	3,280	08/28/11	--	7.80	2,220	6.7	15
60	013621955	Birch Creek at Big Indian, N.Y.	12.5	1999–2011	04/02/05	7.12	1,130	08/28/11	1145	7.18	1,460	14.3	7
61	01362197	Bushnellsville Creek at Shandaken, N.Y.	11.4	1951, 1956, 1972–87, 1994–2011	04/02/05	12.52	2,700	08/28/11	--	12.6	2,750	2.0	50
62	01362200	Esopus Creek at Allaben, N.Y.	63.7	1964–2011	04/02/05	14.44	21,700	08/28/11	0915	16.34	29,300	<1.0 & >0.5	>100 & <200
63	0136230002	Woodland Creek above mouth at Phoenicia, N.Y.	20.6	2003–11	04/02/05	10.65	8,600	08/28/11	0630	10.00	6,690	6.7	15
64	01362342	Hollow Tree Brook at Lanesville, N.Y.	1.95	1998–2011	10/01/10, 12/01/10	4.56, 4.55	396	08/28/11	1420	5.89	487	6.7	15
65	01362370	Stony Clove Creek below Ox Clove at Chichester, N.Y.	30.9	1997–2011	10/01/10	9.32	13,200	08/28/11	0900	9.61	14,300	1.2	80
66	01362497	Little Beaver Kill at Beechford near Mount Tremper, N.Y.	16.5	1998–2011	06/26/06	8.71	2,820	08/28/11	1100	8.35	2,530	6.7	15
67	01362500	Esopus Creek at Coldbrook, N.Y.	192	1932–2011	03/21/80	21.94	65,300	08/28/11	1200	23.34	75,800	1.4	70
68	01363382	Bush Kill below Maltby Hollow Brook at West Shokan, N.Y.	16.2	2001–11	10/01/10	7.82	4,420	08/28/11	1130	12.30	6,240	2.2	45
69	01363400	Ashokan Reservoir at Ashokan, N.Y.–West Basin	256	1913–2011	04/03/05	[d]594.84	--	08/28/11	1400	[d]595.92	--	--	--
		–East Basin			03/31/51	[d]592.23	--	08/28/11	2400	[d]590.58	--	--	--
70	01364500	Esopus Creek at Mount Marion, N.Y.	419	1971–2011	04/03/05	26.46	30,500	08/28/11	1615	25.39	25,200	2.5	40
71	01365000	Rondout Creek near Lowes Corners, N.Y.	38.3	1937–2011	07/22/38	[b]8.20	7,600	08/28/11	0815	10.63	8,200	3.3	30
72	01365500	Chestnut Creek at Grahamsville, N.Y.	20.9	1939–87, 1999–2011	10/15/55	7.02	4,640	08/28/11	0945	4.75	2,600	12.5	8
73	01366400	Rondout Reservoir at Lackawack, N.Y.	95.4	1951–2011	04/03/05	[d]842.77	--	08/28/11	1700	[d]841.95	--	--	--
74	01367500	Rondout Creek at Rosendale, N.Y.	383	1927–43	08/27/28	[b]21.90	27,300						
				1944–2011	10/16/55	36.8	35,800	08/28/11	1700	26.96	36,500	1.0	100
75	01368500	Rutgers Creek at Gardnerville, N.Y.	59.7	1944–68, 1984, 1987–90, 1993–2011	08/19/55	12.38	6,850	08/28/11	--	12.0	4,940	2.5	40
76	01371500	Wallkill River at Gardiner, N.Y.	695	1925–2011	10/16/55	19.81	30,800	08/28/11	1930	18.92	30,300	1.1	90

Table 11. Period-of-record peak discharges through July 2011 and peak discharges during the flood of August 28–29, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

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Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	August 26–29, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Hudson River Basin—Continued											
77	01372058	Hudson River below Poughkeepsie, N.Y.	11,740	1992–2011	12/11/92	[d]6.82	--	08/28/11	1135	[d]7.96	--	--	--
78	01372500	Wappinger Creek near Wappingers Falls, N.Y.	181	1929–2011	08/19/55	19.60	18,600	08/29/11	0015	15.29	11,900	2.9	35
79	01372800	Fishkill Creek at Hopewell Junction, N.Y.	57.3	1958–75, 1984, 1987–2011	04/16/07	11.03	4,160	08/28/11	--	10.28	3,420	4.0	25
80	01374019	Hudson River at South Dock at West Point, N.Y.	12,596	1991–2011	12/11/92	[d]6.79	--	08/28/11	1045	[d]7.65	--	--	--
81	01374250	Peekskill Hollow Creek at Tompkins Corners, N.Y.	14.9	1975–2011	09/16/99	6.01	2,000	08/28/11	--	6.68	2,770	1.0	100
82	0137449480	East Branch Croton River near Putnam Lake, N.Y.	62.1	1996–2011	03/07/11	11.64	2,650	08/29/11	0645	10.46	2,020	16.7	6
83	01374505	East Branch Croton River at Brewster, N.Y.	81.2	1994–2011	03/08/11	8.30	3,810	08/28/11	0945	7.83	3,130	5.0	20
84	01374531	East Branch Croton River near Croton Falls, N.Y.	86.4	1994–2011	03/08/11	6.78	2,590	08/28/11	1100	8.63	3,720	1.7	60
85	01374559	West Branch Croton River at Richardsville, N.Y.	11.0	1996–2011	09/17/99	4.88	1,290	08/28/11	1430	5.01	807	11.1	9
86	01374581	West Branch Croton River below dam near Kent Cliffs, N.Y.	22.4	2002–11	04/16/07	9.54	1,750	08/28/11	1700	9.08	1,570	10.0	10
87	01374598	Horse Pound Brook near Lake Carmel, N.Y.	3.94	1997–2011	09/16/99	4.61	1,070	08/28/11	0950	3.38	348	20.0	5
88	0137462010	West Branch Croton River near Carmel, N.Y.	42.9	1994–2011	04/16/07	5.58	1,740	08/28/11	2330	5.88	1,970	6.7	15
89	01374654	Middle Branch Croton River near Carmel, N.Y.	13.7	1996–2011	09/17/99	5.97	756	08/28/11	1515	5.35	558	16.7	6
90	01374701	West Branch Croton River near Croton Falls, N.Y.	80.4	1994–2011	04/17/07	7.51	2,720	08/29/11	0315	7.07	2,650	4.0	25
91	01374781	Titicus River below June Road at Salem Center, N.Y.	12.9	2007–11	04/16/07	6.34	1,400	08/28/11	1000	6.6	1,550	--	--
92	01374821	Titicus River at Purdys Station, N.Y.	23.8	1994–2011	03/07/11	8.68	2,150	08/28/11	1330	8.75	2,190	2.9	35
93	01374890	Cross River near Cross River, N.Y.	17.1	1996–2011	03/07/11	6.96	1,080	08/28/11	1045	6.46	895	12.5	8
94	01374901	Cross River at Katonah, N.Y.	29.9	1994–2011	03/07/11	7.71	2,070	08/28/11	1330	7.04	1,730	5.0	20
95	01374930	Muscoot River at Baldwin Place, N.Y.	13.5	1996–2011	09/16/99	9.42	1,020	08/28/11	1600	8.46	761	10.0	10
96	01374941	Muscoot River below dam at Amawalk, N.Y.	19.7	1994–2011	04/17/07	12.64	1,440	08/29/11	1030	11.57	565	10.0	10
97	01375000	Croton River at New Croton Dam, near Croton-On-Hudson, N.Y.	378	1934–2011	10/16/55	18.44	45,400	08/28/11	1445	13.21	22,600	1.7	60
98	01376500	Saw Mill River at Yonkers, N.Y.	25.6	1944–89, 1993–95, 1999, 2003–11	04/16/07	9.00	1,840	08/28/11	--	9.61	1,740	2.2	45
		Hackensack River Basin											
99	01376800	Hackensack River at West Nyack, N.Y.	30.7	1959–2011	09/16/99	11.21	1,740	08/28/11	1800	11.50	1,740	4.0	25
		Passaic River Basin											
100	01387400	Ramapo River at Ramapo, N.Y.	86.9	1936, 1980–2011	04/05/84	13.82	10,700	08/28/11	1300	15.75	13,700	1.2	80
101	01387420	Ramapo River at Suffern, N.Y.	93.0	1980–2011	04/05/84	15.38	12,300	08/28/11	1345	18.88	14,700	1.4	70
102	01387450	Mahwah River near Suffern, N.Y.	12.3	1959–2011	11/08/77	9.91	1,840	08/28/11	1045	10.66	3,700	<0.5 & >0.2	>200 & <500

Table 11. Period-of-record peak discharges through July 2011 and peak discharges during the flood of August 28–29, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

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Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Period-of-record peak discharge: Date	Period-of-record peak discharge: Stage (ft)	Period-of-record peak discharge: Discharge (ft^3/s)	August 26–29, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
				Delaware River Basin									
103	01413088	East Branch Delaware River at Roxbury, N.Y.	13.5	2000–11	03/23/10	6.65	524	08/28/11	1615	7.73	866	25.0	4
104	01413398	Bush Kill near Arkville, N.Y.	46.7	1996, 1998–2011	01/19/96	--	7,600	08/28/11	1015	16.26	13,800	<1.0 & >0.5	>100 & <200
105	01413408	Dry Brook at Arkville, N.Y.	82.2	1997–2011	04/02/05	13.86	11,100	08/28/11	--	17.1	24,600	<1.0 & >0.5	>100 & <200
106	01413500	East Branch Delaware River at Margaretville, N.Y.	163	1937–2011	01/19/96	14.88	25,800	08/28/11	1115	15.97	35,500	<1.0 & >0.5	>100 & <200
107	01414000	Platte Kill at Dunraven, N.Y.	34.9	1942–62, 1996–2011	01/19/96	9.60	5,690	08/28/11	0930	7.09	2,760	16.7	6
108	01414500	Mill Brook near Dunraven, N.Y.	25.2	1937–2011	01/19/96	12.56	5,380	08/28/11	--	10.26	4,110	5.0	20
109	01415000	Tremper Kill near Andes, N.Y.	33.2	1937–2011	10/01/10	8.51	5,900	08/28/11	0930	5.66	1,730	33.3	3
110	01416900	Pepacton Reservoir near Downsville, N.Y.	372	1954–2011	04/03/05	[d]1,283.68	--	08/29/11	0500	[d]1,282.76	--	--	--
111	01417000	East Branch Delaware River at Downsville, N.Y.	372	1942–54	11/26/50	[b]14.52	23,900						
				1955–2011	09/18/04	12.08	20,200	08/29/11	0500	10.00	12,400	10.0	10
112	01417500	East Branch Delaware River at Harvard, N.Y.	458	1935–54	09/22/38	[b]16.93	31,400						
				1955–67, 1978–2011	06/28/06	16.61	22,100	08/29/11	0930	13.33	13,900	10.0	10
113	01420500	Beaver Kill at Cooks Falls, N.Y.	241	1914–2011	06/28/06	20.55	62,400	08/28/11	1430	15.60	30,300	6.7	15
114	01421000	East Branch Delaware River at Fishs Eddy, N.Y.	784	1913–54	08/24/33	[b]20.60	53,300						
				1955–2011	06/28/06	21.43	77,400	08/28/11	1600	16.04	44,400	6.7	15
115	01421610	West Branch Delaware River at Hobart, N.Y.	15.5	2001–11	10/01/10	3.10	910	08/28/11	1415	3.22	995	11.1	9
116	01421618	Town Brook southeast of Hobart, N.Y.	14.3	1998–2011	07/04/99	7.54	4,400	08/28/11	0815	6.46	2,460	11.1	9
117	01421900	West Branch Delaware River upstream from Delhi, N.Y.	134	1937–70, 1972–74, 1996–2011	01/19/96	[b]9.8	[a]13,000	08/28/11	1930	12.53	8,860	3.3	30
118	01422500	Little Delaware River near Delhi, N.Y.	49.8	1938–70, 1972–74, 1996–2011	01/19/96	8.51	6,100	08/28/11	1315	6.64	2,560	33.3	3
119	01422747	East Brook east of Walton, N.Y.	24.7	1999–2011	06/28/06	9.95	7,110	08/28/11	1615	5.88	1,900	33.3	3
120	01423000	West Branch Delaware River at Walton, N.Y.	332	1951–2011	06/28/06	16.85	28,600	08/29/11	0315	13.66	16,000	14.3	7
121	0142400103	Trout Creek near Trout Creek, N.Y.	20.2	1953–67, 1996–2011	06/27/06	6.99	4,350	08/28/11	1315	6.05	1,940	20.0	5
123	01425000	West Branch Delaware River at Stilesville, N.Y.	456	1953–63	01/22/59	[b]9.01	17,500						
				1964–2011	06/28/06	17.72	33,100	08/28/11	1345	8.18	676	>50.0	<2
124	01426500	West Branch Delaware River at Hale Eddy, N.Y.	595	1913–63	03/22/48	15.69	28,900						
				1964–2011	06/28/06	19.10	43,400	08/28/11	1615	9.97	9,760	33.3	3

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				Delaware River Basin—Continued									
125	01427207	Delaware River at Lordville, N.Y.	1,590	2006–11	06/28/06	28.87	126,000	08/28/11	2000	18.78	55,300	--	--
126	01427510	Delaware River at Callicoon, N.Y.	1,820	1976–2011	06/28/06	20.38	144,000	08/28/11	2215	12.90	62,000	20.0	5
127	01428500	Delaware River above Lackawaxen River near Barryville, N.Y.	2,020	1941–63	08/19/55	26.40	130,000						
				1964–2011	06/28/06	28.97	151,000	08/29/11	0200	16.60	60,600	25.0	4
128	01432900	Mongaup River at Mongaup Valley, N.Y.	76.6	2003–11	04/03/05	13.47	7,630	08/28/11	1230	11.00	5,010	25.0	4
129	01434000	Delaware River at Port Jervis, N.Y.	3,070	1905–63	08/19/55	23.91	233,000						
				1964–2011	06/28/06	21.47	189,000	08/29/11	0445	14.02	83,000	25.0	4
130	0143400680	East Branch Neversink River northeast of Denning, N.Y.	8.93	1991–2011	09/16/99	6.96	3,070	08/28/11	0930	8.75	5,580	<0.5 & >0.2	>200 & <500
131	01434017	East Branch Neversink River near Claryville, N.Y.	22.9	1992–2011	10/01/10	12.63	5,590	08/28/11	1100	13.61	7,650	1.7	60
132	01434021	West Branch Neversink River near Frost Valley, N.Y.	0.77	1991–2011	10/01/10	3.86	262	08/28/11	0600	4.76	344	2.0	50
133	01434025	Biscuit Brook above Pigeon Brook at Frost Valley, N.Y.	3.72	1984–2011	04/04/87	[b]3.37	815	08/28/11	--	[b]6.37	[a]1,500	1.2	80
134	01434498	West Branch Neversink River at Claryville, N.Y.	33.8	1992–2011	04/02/05	12.73	9,570	08/28/11	0745	15.38	11,600	2.2	45
135	01435000	Neversink River near Claryville, N.Y.	66.6	1938–49, 1951–2011	11/25/50	15.0	23,400	08/28/11	0815	14.64	20,900	1.7	60
136	01435900	Neversink Reservoir near Neversink, N.Y.	92.5	1953–2011	04/03/05	[d]1,443.66	--	08/28/11	1500	[d]1,443.24	--	--	--
137	01436000	Neversink River at Neversink, N.Y.	92.6	1942–53	11/25/50	[b]11.23	22,300						
				1954–2011	04/03/05	12.99	12,300	08/28/11	1445	11.30	10,200	2.9	35
138	01436690	Neversink River at Bridgeville, N.Y.	171	1993–2011	04/03/05	21.25	25,900	08/28/11	2100	18.02	16,800	4.0	25
139	01437500	Neversink River at Godeffroy, N.Y.	307	1938–53	11/26/50	11.79	24,500						
				1954–2011	08/19/55	12.49	33,000	08/28/11	1215	12.05	28,800	1.7	60
				Susquehanna River Basin									
143	01500000	Ouleout Creek at East Sidney, N.Y.	103	1941–49, 1950–2011	04/07/60	6.19	4,000	08/28/11	1200	3.72	1,200	>50.0	<2
144	01500500	Susquehanna River at Unadilla, N.Y.	982	1939–2011	06/29/06	17.72	35,100	08/29/11	1030	9.76	10,300	>50.0	<2
146	01502632	Susquehanna River at Bainbridge, N.Y.	1,610	1988–2011	06/29/06	27.05	58,700	08/29/11	2000	12.72	16,600	>50.0	<2
148	01503000	Susquehanna River at Conklin, N.Y.	2,232	1913–2011	06/28/06	25.02	76,800	08/28/11	1545	16.34	39,400	25.0	4
161	01512500	Chenango River near Chenango Forks, N.Y.	1,483	1913–2011	07/08/35	20.3	96,000	08/28/11	2030	5.94	6,180	>50.0	<2
166	01515000	Susquehanna River near Waverly, N.Y.	4,773	1936–2011	03/18/36, 06/29/06	[a,b]21.4, 22.52	128,000	08/29/11	0445	11.91	47,900	>50.0	<2

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		St. Lawrence River Basin											
267	04266500	Raquette River at Piercefield, N.Y.	721	1909–2011	05/01/2011	13.40	10,400	08/31/11	1845	6.96	2,080	>50.0	<2
268	04267500	Raquette River at South Colton, N.Y.	937	1953–2002, 2011	04/29/11	11.27	12,800	08/29/11	1800	5.60	2,980	>50.0	<2
271	04268800	West Branch St. Regis River near Parishville, N.Y.	171	1959–2011	12/29/84	7.37	5,960	08/29/11	0930	2.76	957	>50.0	<2
272	04269000	St. Regis River at Brasher Center, N.Y.	612	1911–2011	04/06/37	12.82	16,800	08/29/11	1515	8.05	3,200	>50.0	<2
274	04270000	Salmon River at Chasm Falls, N.Y.	132	1926–82, 1987–2011	04/01/98	5.43	3,540	08/29/11	1245	2.88	880	>50.0	<2
275	04270200	Little Salmon River at Bombay, N.Y.	92.2	1959–98, 2002–11	03/31/98	13.27	3,420	08/29/11	0815	6.43	810	>50.0	<2
		Lake Champlain Basin											
278	04271815	Little Chazy River near Chazy, N.Y.	50.3	1990–2011	11/10/96	10.40	2,750	08/29/11	2100	9.25	1,840	5.0	20
279	04273500	Saranac River at Plattsburgh, N.Y.	608	1903–30, 1944–2011	11/09/96	12.11	14,400	08/29/11	0230	8.62	7,050	25.0	4
280	04273700	Salmon River at South Plattsburgh, N.Y.	63.3	1960–86, 1990–2011	11/09/96	7.56	4,200	08/29/11	0245	6.01	2,480	6.7	15
281	04273800	Little Ausable River near Valcour, N.Y.	67.8	1992–2011	06/27/98	13.78	7,210	08/29/11	1115	4.14	2,240	11.1	9
282	04274000	West Branch Ausable River near Lake Placid, N.Y.	116	1920–68, 1983–2011	09/22/38	12.20	10,800	08/28/11	--	13.65	14,200	<0.5 & >0.2	>200 & <500
283	04275000	East Branch Ausable River at Au Sable Forks, N.Y.	198	1925–2011	11/09/96	15.22	23,900	08/28/11	2220	18.51	31,500	<0.2	>500
284	04275500	Ausable River near Au Sable Forks, N.Y.	446	1911–68, 1990–2011	11/09/96	13.83	37,400	08/28/11	2315	15.54	46,500	<0.2	>500
285	04276500	Bouquet River at Willsboro, N.Y.	270	1924–68, 1980, 1985, 1987–2011	11/09/96	10.93	12,300	08/29/11	--	12.35	16,000	<0.5 & >0.2	>200 & <500
286	04276842	Putnam Creek east of Crown Point Center, N.Y.	51.6	1990–2011	06/17/05	7.71	3,140	08/28/11	1630	8.93	4,130	1.7	60
287	04278000	Lake George at Rogers Rock, N.Y.	233	1913–2011	04/09/36	[d]321.15	--	08/29/11	0245	[d]320.24	--	--	--
288	04279085	Lake Champlain north of Whitehall, N.Y.	725	1998–2011	05/09/11	[d,f]103.57	--	08/29/11	1700	[d,f]98.81	--	--	--
289	04280450	Mettawee River near Middle Granville, N.Y.	167	1990–2011	12/17/00	13.47	13,100	08/28/11	2245	15.04	16,800	1.4	70
290	04295000	Richelieu River (Lake Champlain) at Rouses Point, N.Y.	8,277	1869, 1871–2011	05/06/2011	[d]103.20	--	09/03/11	0100	[d]97.89	--	--	--

[a]Estimated.

[b]At former site or datum.

[c]Daily discharge.

[d]Elevation in feet above National Geodetic Vertical Datum of 1929.

[e]From New York Power Authority.

[f]Affected by seiche.

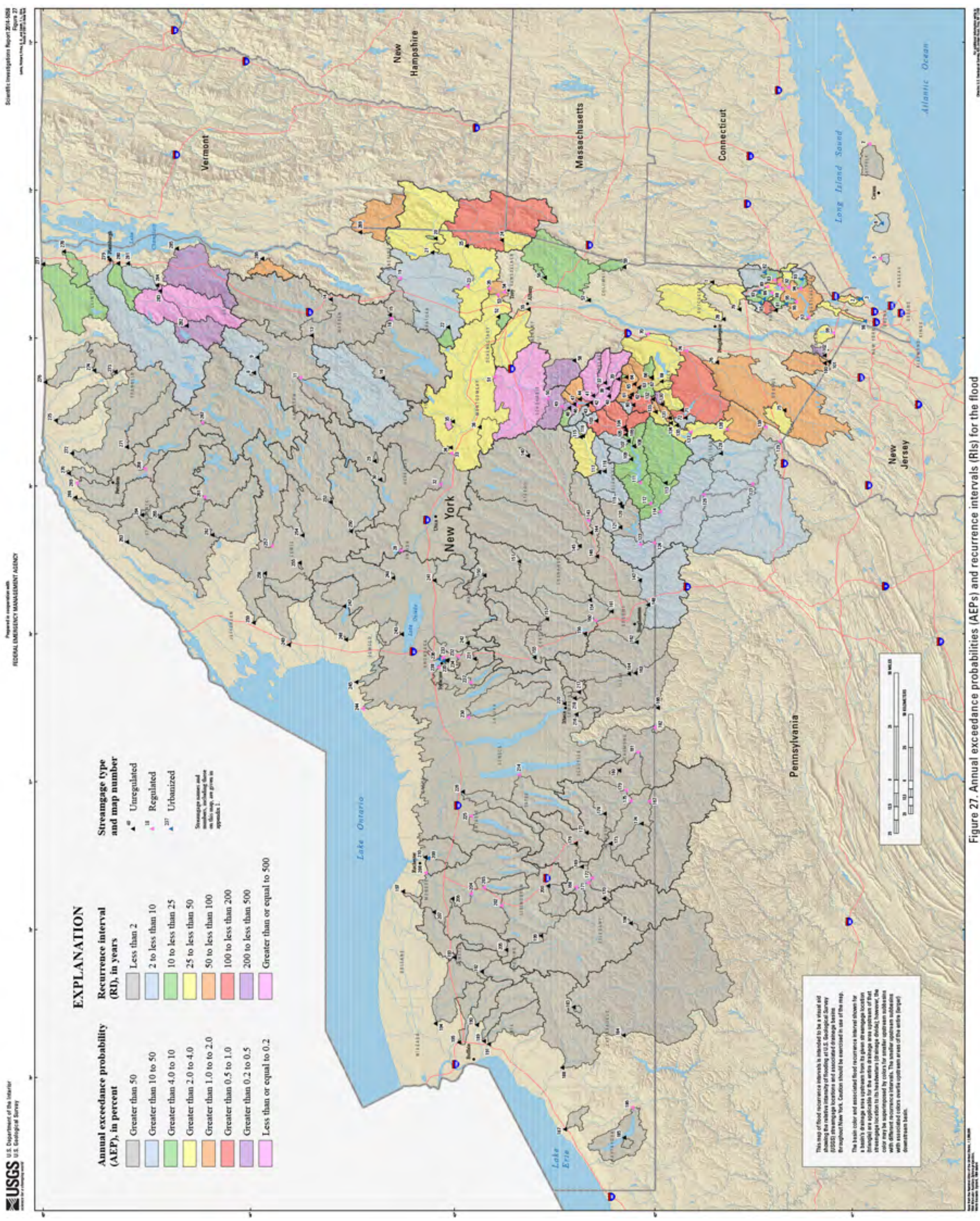


Figure 27. Annual exceedance probabilities and recurrence intervals for the flood of August 28–29, 2011, in selected U.S. Geological Survey streamgage basins in New York. (Click link to view full-size map of figure 27 at *http://pubs.usgs.gov/sir/2014/5058/*.)

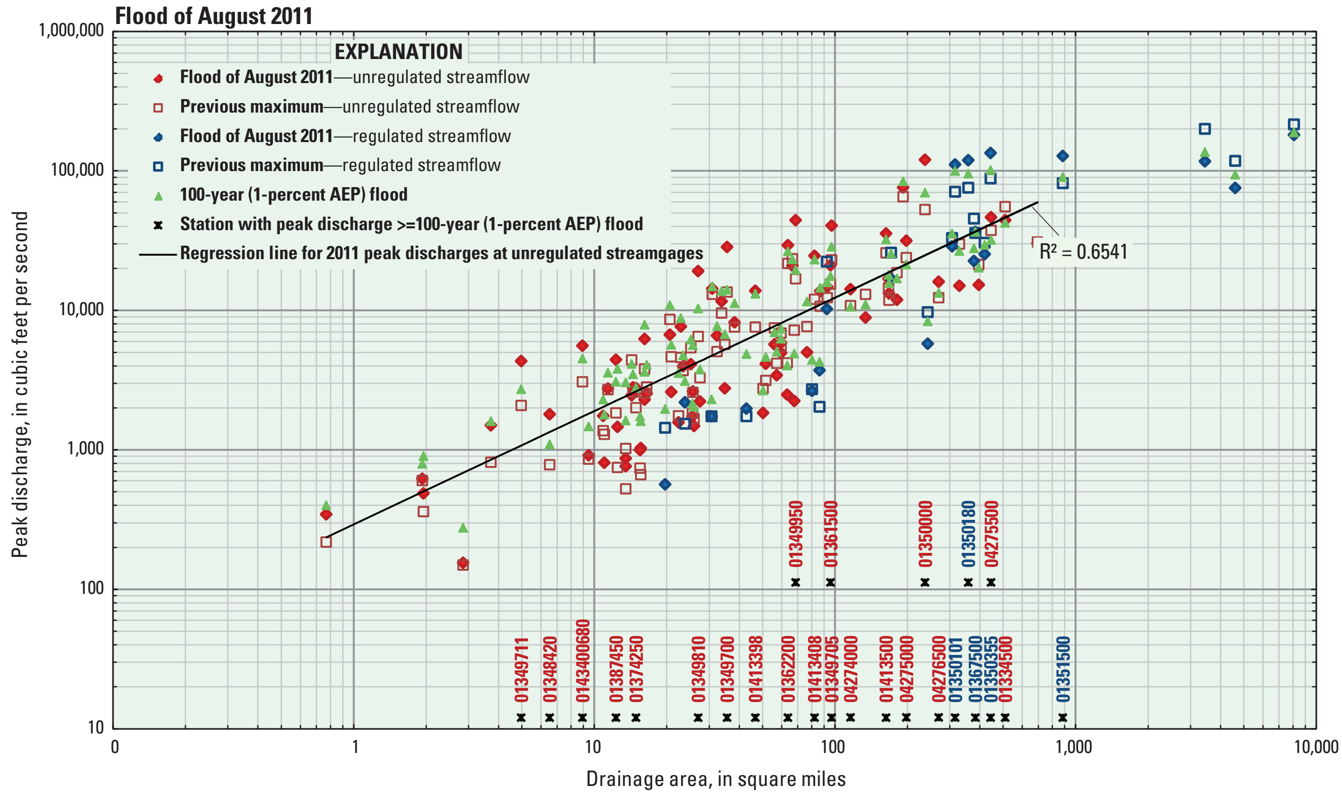


Figure 28. Peak discharges for the flood of August 28–29, 2011, previous maximum known discharges, and 1-percent annual exceedance probability (100-year) discharges at selected streamgages, as a function of drainage area at selected sites in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; ≥, greater than or equal to)

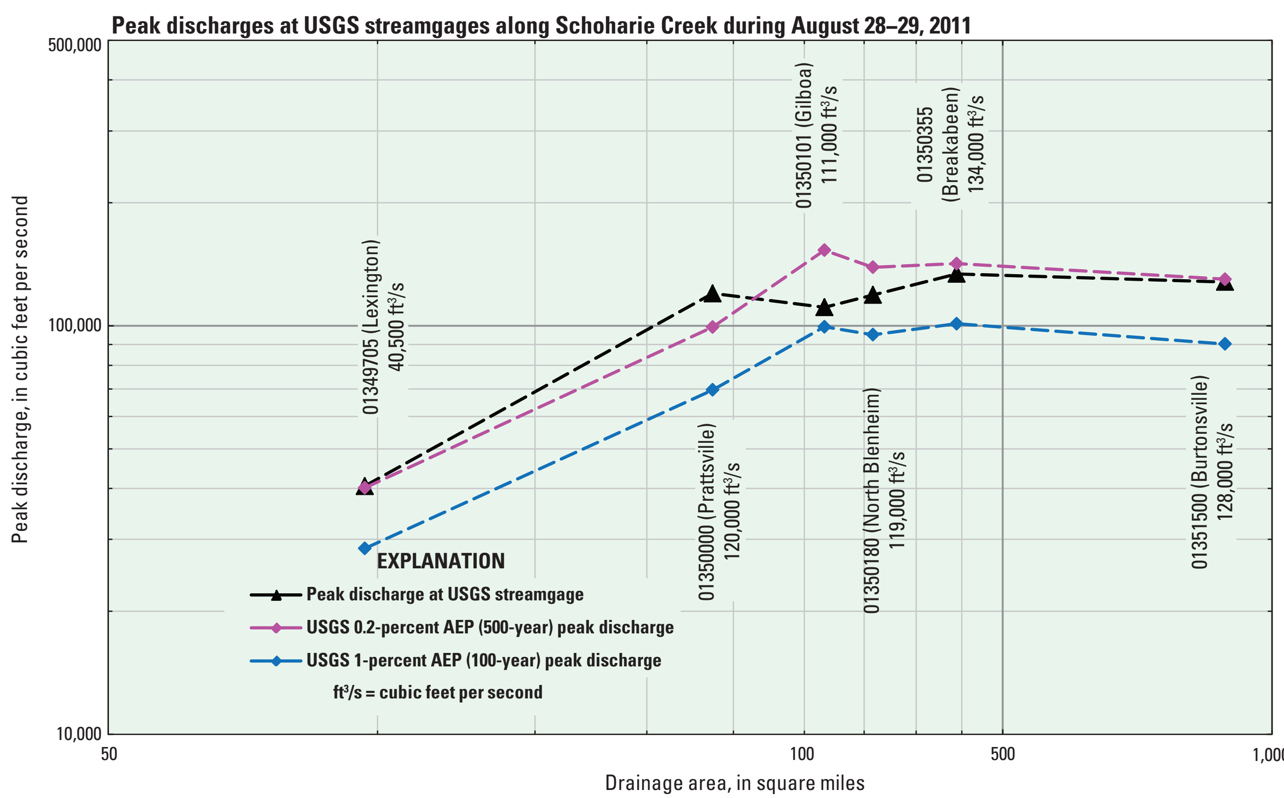


Figure 29. Peak discharges for the flood of August 28–29, 2011, and 1- and 0.2-percent annual exceedance probability (100- and 500-year) discharges at six U.S. Geological Survey streamgages on Schoharie Creek, New York, as a function of drainage area. (Sites are listed in appendix 1 and shown on figure 10. USGS, U.S. Geological Survey; AEP, annual exceedance probability)

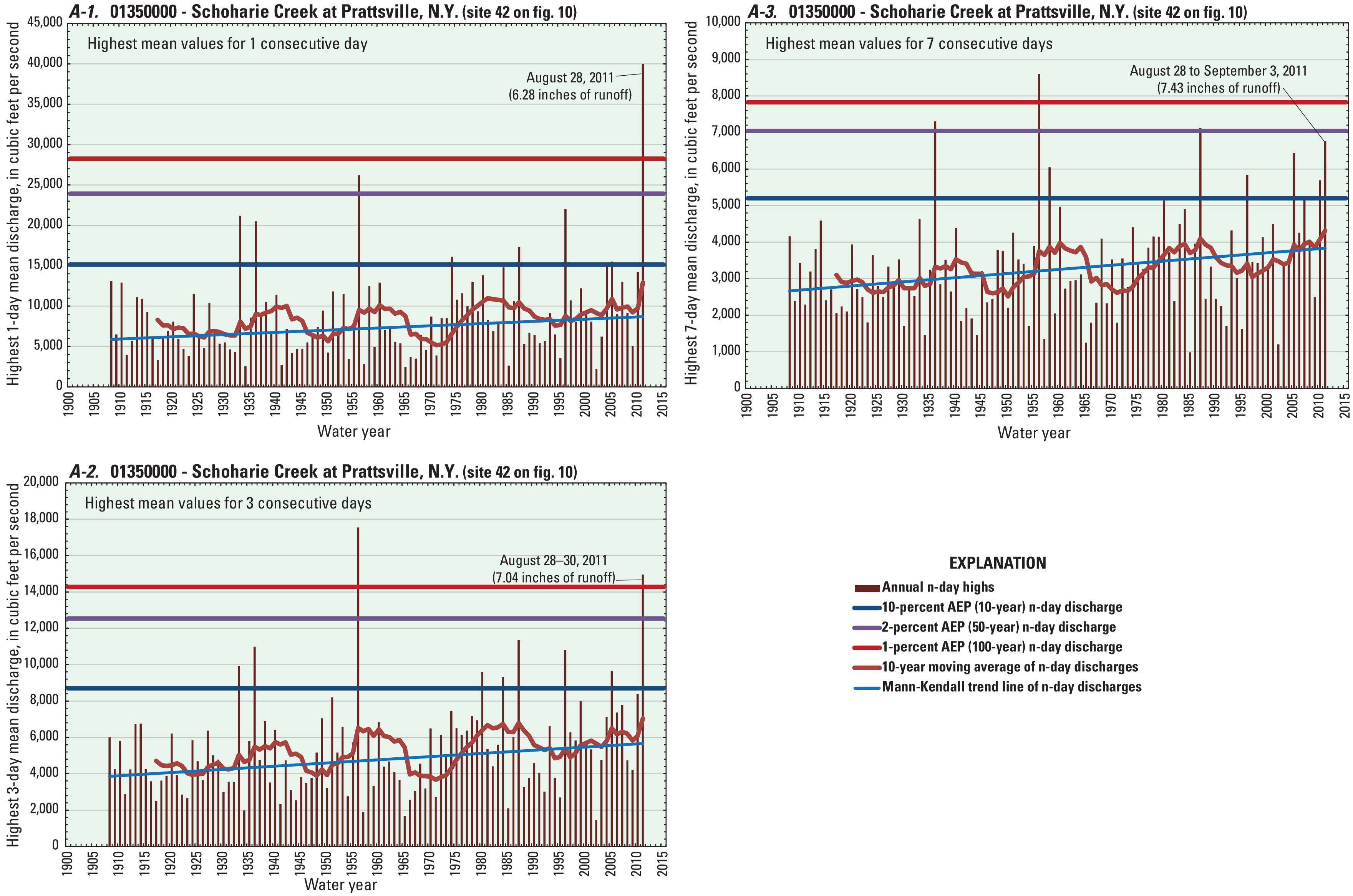


Figure 30. Highest 1-, 3-, and 7-consecutive day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)

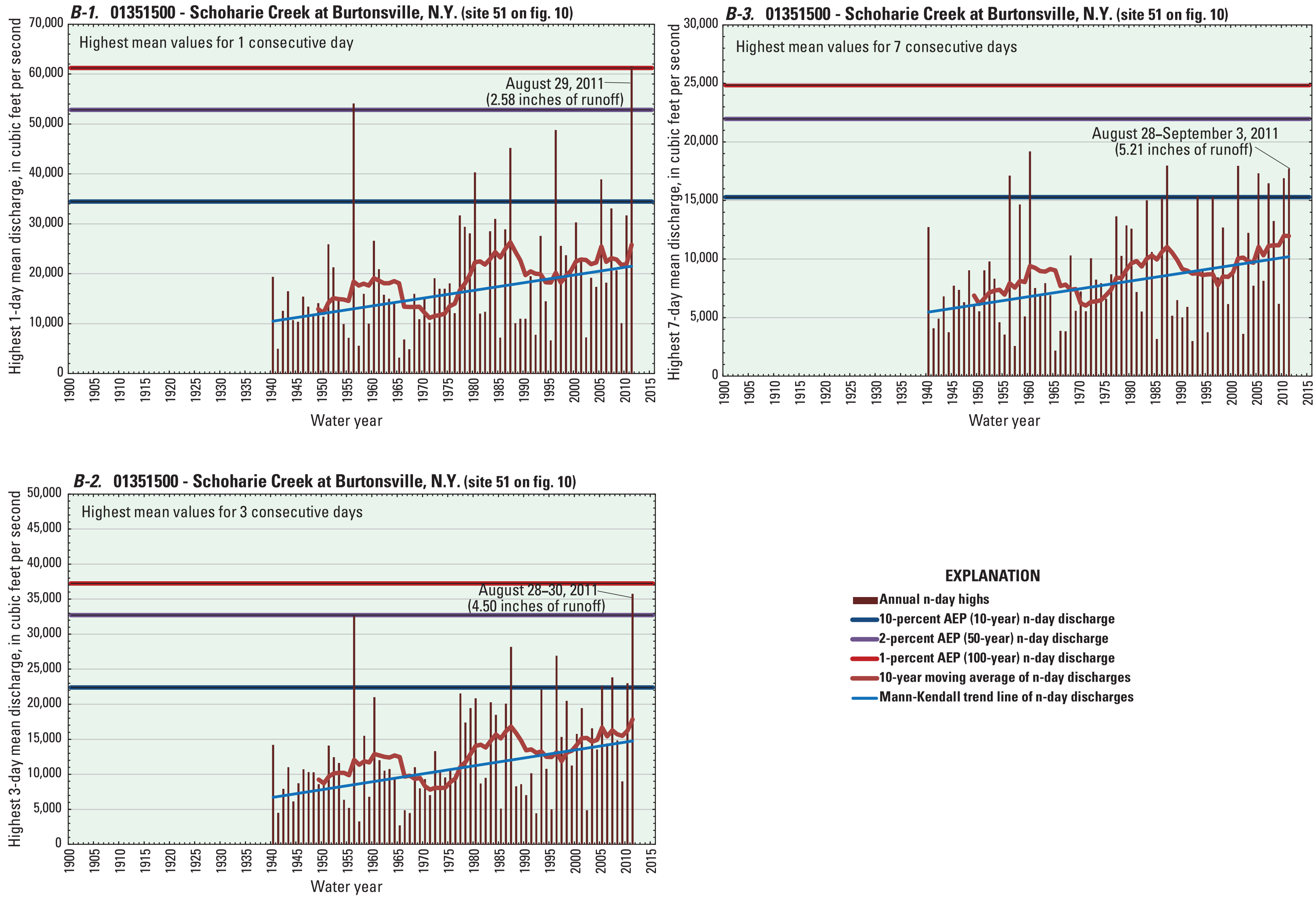


Figure 30. Highest 1-, 3-, and 7-consecutive day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

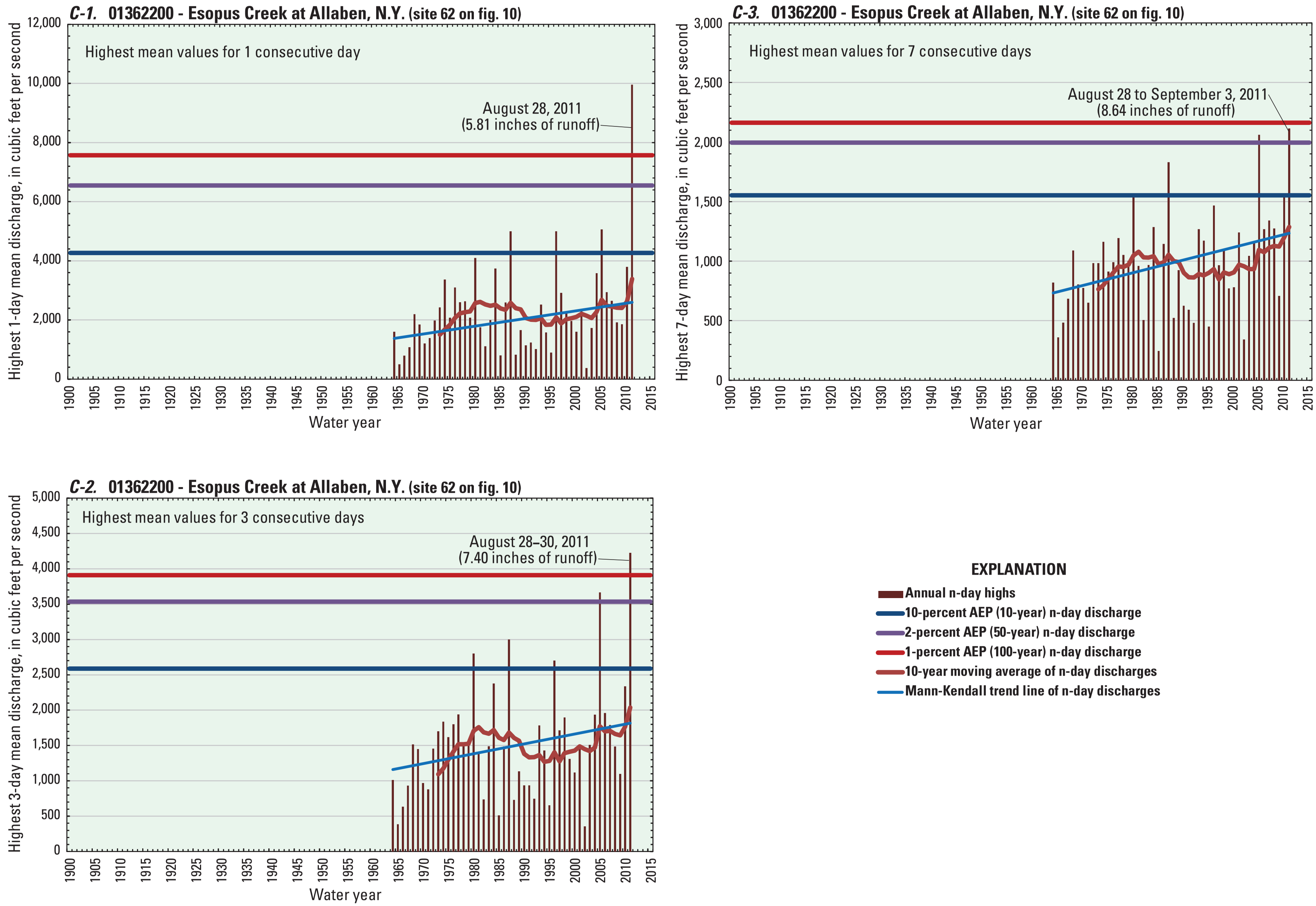


Figure 30. Highest 1-, 3-, and 7-consecutive day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

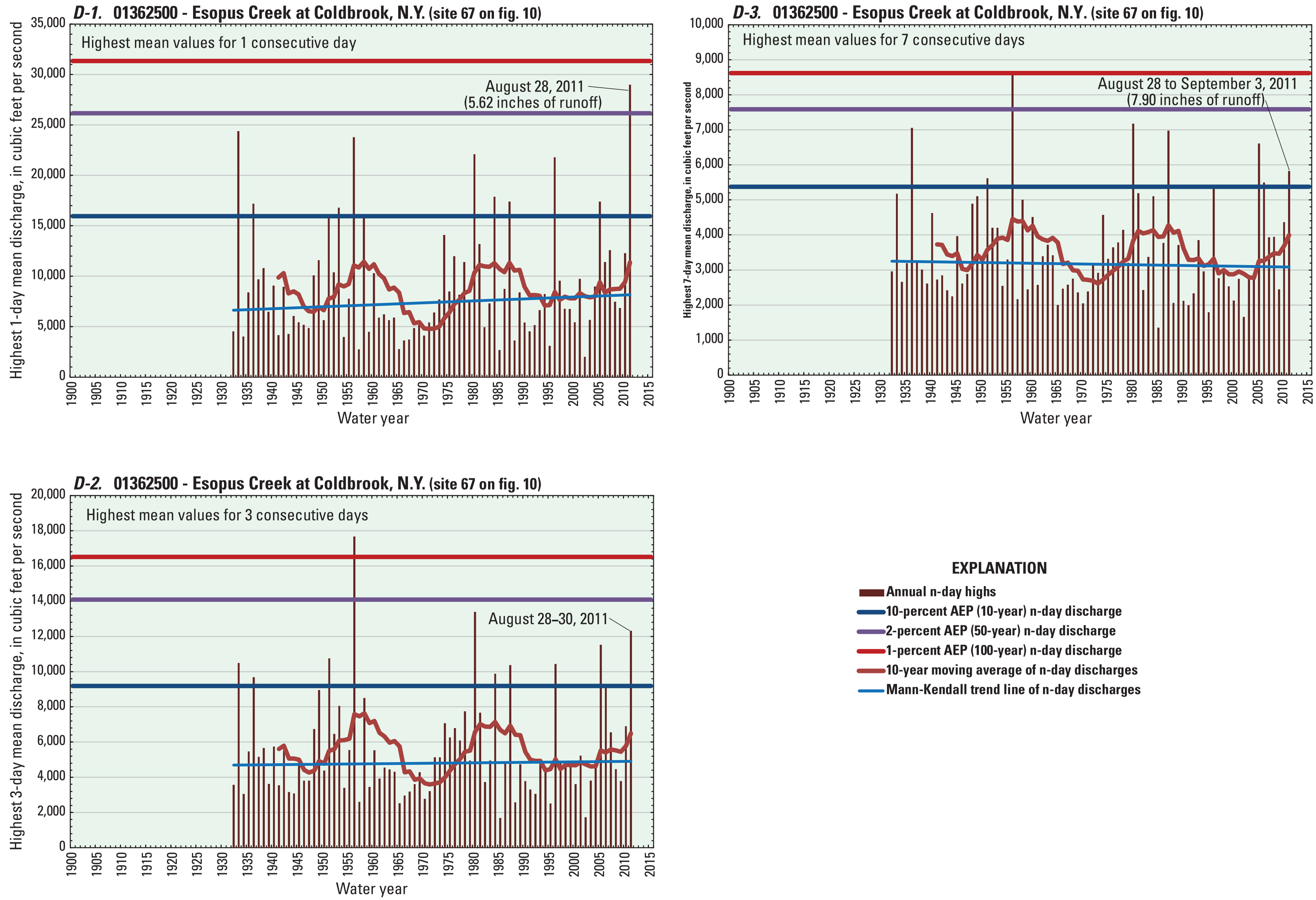


Figure 30. Highest 1-, 3-, and 7-consecutive day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

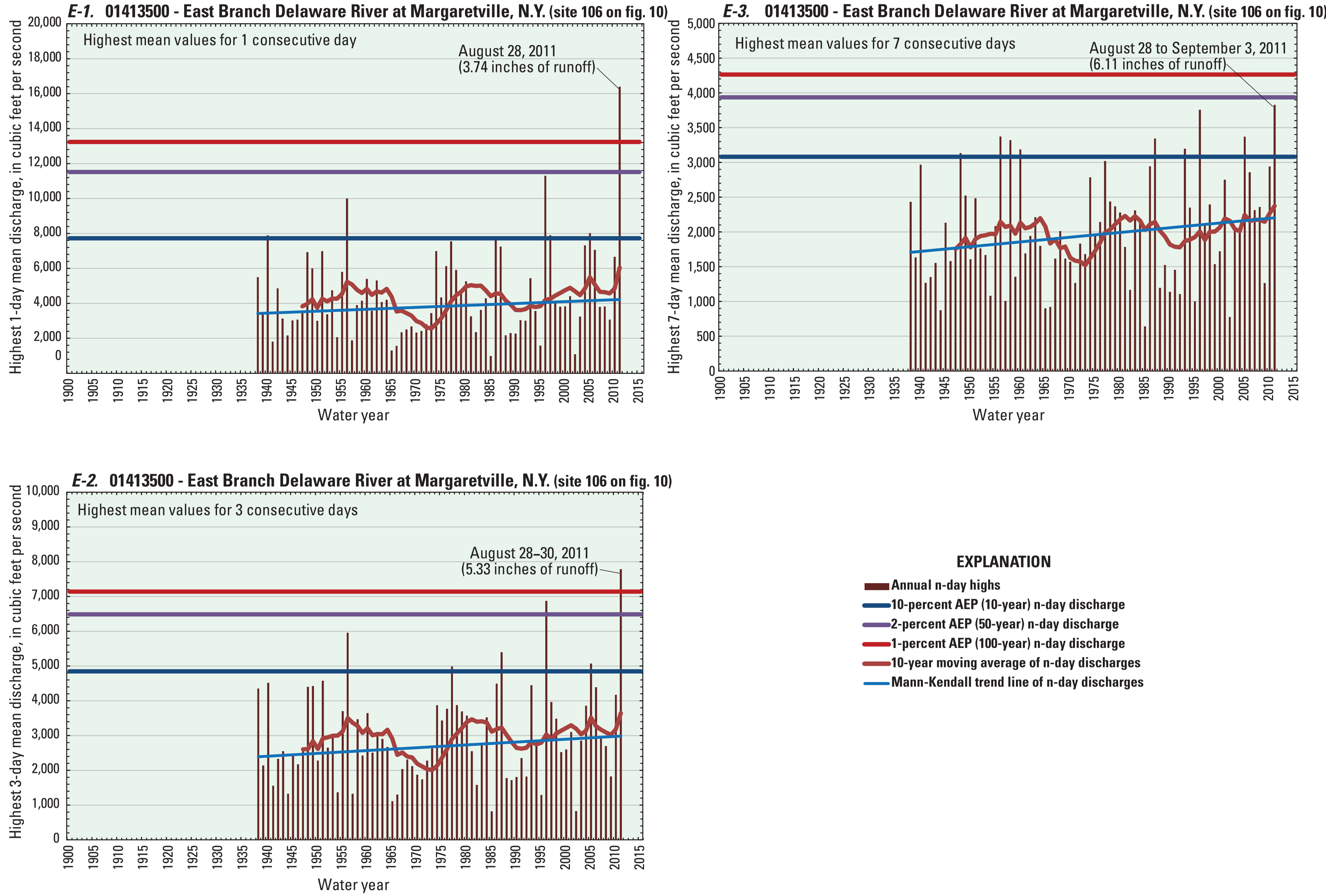


Figure 30. Highest 1-, 3-, and 7-consecutive day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability)—Continued

Table 12. Total storm runoff and selected statistics for August 27 to September 2, 2011, at selected U.S. Geological Survey streamgages in New York.

[Latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83); mi², square miles; runoffs for sites in pink have been adjusted for storage in upstream reservoirs; runoffs in red are greater than or equal to the median storm runoff for selected sites in listed basins; locations are shown on figures 10 and 31]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude	Longitude	Storm runoff (inches)	Basin median storm runoff (inches)	Basin mean storm runoff (inches)	Number of selected basin sites
		Upper Hudson River Basin					**1.54**	**1.80**	**12**
9	01312000	Hudson River near Newcomb, N.Y.	192	43.96667	-74.13194	**1.68**			
11	01315000	Indian River near Indian Lake, N.Y.	132	43.75639	-74.26750	**1.37**			
13	01315500	Hudson River at North Creek, N.Y.	792	43.70083	-73.98389	**1.41**			
15	01318500	Hudson River at Hadley, N.Y.	1,664	43.31889	-73.84472	**1.27**			
16	01321000	Sacandaga River near Hope, N.Y.	491	43.35278	-74.27083	**1.47**			
18	01325000	Sacandaga River at Stewarts Bridge near Hadley, N.Y.	1,055	43.31139	-73.86778	**1.75**			
19	01327750	Hudson River at Fort Edward, N.Y.	2,810	43.26944	-73.59639	**1.48**			
21	01329490	Batten Kill below mill at Battenville, N.Y.	396	43.10861	-73.42222	**3.20**			
22	01330000	Glowegee Creek at West Milton, N.Y.	26.0	43.03056	-73.92778	**1.57**			
23	01331095	Hudson River at Stillwater, N.Y.	3,773	42.93556	-73.65222	**1.50**			
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	42.93861	-73.37750	**3.20**			
26	01335754	Hudson River above Lock 1 near Waterford, N.Y.	4,605	42.82917	-73.66667	**1.73**			
		Upper Mohawk River Basin					**0.99**	**1.24**	**6**
28	01336000	Mohawk River below Delta Dam near Rome, N.Y.	152	43.26444	-75.43667	**0.40**			
30	01343060	West Canada Creek near Wilmurt, N.Y.	258	43.36611	-74.95806	**1.25**			
32	01346000	West Canada Creek at Kast Bridge, N.Y.	560	43.06889	-74.98861	**1.02**			
33	01347000	Mohawk River near Little Falls, N.Y.	1,342	43.01472	-74.77972	**0.96**			
34	01348000	East Canada Creek at East Creek, N.Y.	289	43.01667	-74.74111	**0.91**			
36	01349150	Canajoharie Creek near Canajoharie, N.Y.	59.7	42.87611	-74.60333	**2.92**			
		Schoharie Creek Basin					**7.38**	**7.14**	**14**
37	01349700	East Kill near Jewett Center, N.Y.	35.6	42.24917	-74.30306	**11.13**			
38	01349705	Schoharie Creek near Lexington, N.Y.	96.8	42.23694	-74.34056	**7.82**			
39	01349711	West Kill below Hunter Brook near Spruceton, N.Y.	4.97	42.18500	-74.27722	**12.17**			
40	01349810	West Kill near West Kill, N.Y.	27.0	42.23028	-74.39333	**10.83**			
41	01349950	Batavia Kill at Red Falls near Prattsville, N.Y.	68.6	42.30833	-74.39028	**9.29**			
42	01350000	Schoharie Creek at Prattsville, N.Y.	237	42.31944	-74.43694	**8.10**			
43	01350035	Bear Kill near Prattsville, N.Y.	25.7	42.33806	-74.45194	**3.46**			
44	01350080	Manor Kill at West Conesville near Gilboa, N.Y.	32.4	42.37694	-74.41333	**4.00**			
46	01350101	Schoharie Creek at Gilboa, N.Y.	316	42.39722	-74.45083	**6.99**			
47	01350120	Platter Kill at Gilboa, N.Y.	10.9	42.40611	-74.44750	**3.79**			
48	01350140	Mine Kill near North Blenheim, N.Y.	16.2	42.42889	-74.47333	**2.89**			
49	01350180	Schoharie Creek at North Blenheim, N.Y.	358	42.46583	-74.46250	**7.76**			
50	01350355	Schoharie Creek at Breakabeen, N.Y.	444	42.53694	-74.41083	**6.44**			
51	01351500	Schoharie Creek at Burtonsville, N.Y.	886	42.80000	-74.26333	**5.29**			
		Lower Mohawk River Basin					**2.18**	**2.18**	**2**
52	01356190	Lisha Kill northwest of Niskayuna, N.Y.	15.6	42.78361	-73.85722	**2.06**			
53	01357500	Mohawk River at Cohoes, N.Y.	3,450	42.78528	-73.70806	**2.30**			
		Lower Hudson River Basin					**4.38**	**5.07**	**22**
54	01358000	Hudson River at Green Island, N.Y.	8,090	42.75222	-73.68944	**2.00**			
56	01360640	Valatie Kill near Nassau, N.Y.	9.48	42.55194	-73.59194	**2.85**			
60	013621955	Birch Creek at Big Indian, N.Y.	12.5	42.10889	-74.45222	**4.19**			
62	01362200	Esopus Creek at Allaben, N.Y.	63.7	42.11694	-74.38056	**8.48**			
63	0136230002	Woodland Creek above mouth at Phoenicia, N.Y.	20.6	42.07972	-74.33444	**9.35**			
64	01362342	Hollow Tree Brook at Lanesville, N.Y.	1.95	42.14222	-74.26528	**7.72**			
65	01362370	Stony Clove Creek below Ox Clove at Chichester, N.Y.	30.9	42.10194	-74.31083	**8.43**			
66	01362497	Little Beaver Kill at Beechford near Mount Tremper, N.Y.	16.5	42.01944	-74.26667	**4.61**			

Table 12. Total storm runoff and selected statistics for August 27 to September 2, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83); mi², square miles; runoffs for sites in pink have been adjusted for storage in upstream reservoirs; runoffs in red are greater than or equal to the median storm runoff for selected sites in listed basins; locations are shown on figures 10 and 31]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude	Longitude	Storm runoff (inches)	Basin median storm runoff (inches)	Basin mean storm runoff (inches)	Number of selected basin sites
		Lower Hudson River Basin—Continued							
67	01362500	Esopus Creek at Coldbrook, N.Y.	192	42.01417	-74.27083	**7.89**			
68	01363382	Bush Kill below Maltby Hollow Brook at West Shokan, N.Y.	16.2	41.96556	-74.29333	**6.95**			
70	01364500	Esopus Creek at Mount Marion, N.Y.	419	42.03778	-73.97250	**5.80**			
71	01365000	Rondout Creek near Lowes Corners, N.Y.	38.3	41.86639	-74.48750	**5.28**			
72	01365500	Chestnut Creek at Grahamsville, N.Y.	20.9	41.84500	-74.53972	**3.01**			
74	01367500	Rondout Creek at Rosendale, N.Y.	383	41.84306	-74.08639	**4.82**			
76	01371500	Wallkill River at Gardiner, N.Y.	695	41.68611	-74.16556	**4.58**			
78	01372500	Wappinger Creek near Wappingers Falls, N.Y.	181	41.65306	-73.87306	**3.60**			
82	0137449480	East Branch Croton River near Putnam Lake, N.Y.	62.1	41.44722	-73.55583	**3.70**			
85	01374559	West Branch Croton River at Richardsville, N.Y.	11.0	41.47056	-73.76056	**4.07**			
86	01374581	West Branch Croton River below dam near Kent Cliffs, N.Y.	22.4	41.44972	-73.73694	**4.00**			
87	01374598	Horse Pound Brook near Lake Carmel, N.Y.	3.94	41.47583	-73.68944	**2.74**			
93	01374890	Cross River near Cross River, N.Y.	17.1	41.26000	-73.60167	**3.61**			
95	01374930	Muscoot River at Baldwin Place, N.Y.	13.5	41.33806	-73.76861	**3.78**			
		Passaic River Basin					**7.67**	**7.67**	**2**
100	01387400	Ramapo River at Ramapo, N.Y.	86.9	41.14028	-74.16889	**7.40**			
101	01387420	Ramapo River at Suffern, N.Y.	93.0	41.11833	-74.16056	**7.95**			
		Delaware River Basin					**3.88**	**4.28**	**33**
103	01413088	East Branch Delaware River at Roxbury, N.Y.	13.5	42.29167	-74.55972	**3.49**			
104	01413398	Bush Kill near Arkville, N.Y.	46.7	42.15083	-74.60167	**5.88**			
105	01413408	Dry Brook at Arkville	82.2	42.14667	-74.62361	**5.87**			
106	01413500	East Branch Delaware River at Margaretville, N.Y.	163	42.14472	-74.65389	**6.03**			
107	01414000	Platte Kill at Dunraven, N.Y.	34.9	42.13306	-74.69583	**3.63**			
108	01414500	Mill Brook near Dunraven, N.Y.	25.2	42.10611	-74.73083	**5.04**			
109	01415000	Tremper Kill near Andes, N.Y.	33.2	42.12000	-74.81889	**2.64**			
111	01417000	East Branch Delaware River at Downsville, N.Y.	372	42.07500	-74.97667	**4.50**			
112	01417500	East Branch Delaware River at Harvard, N.Y.	458	42.02444	-75.11917	**4.35**			
113	01420500	Beaver Kill at Cooks Falls, N.Y.	241	41.94639	-74.98000	**3.64**			
114	01421000	East Branch Delaware River at Fishs Eddy, N.Y.	784	41.97306	-75.17444	**3.88**			
115	01421610	West Branch Delaware River at Hobart, N.Y.	15.5	42.37139	-74.66944	**2.53**			
116	01421618	Town Brook southeast of Hobart, N.Y.	14.3	42.36111	-74.66250	**4.08**			
117	01421900	West Branch Delaware River upstream from Delhi, N.Y.	134	42.28028	-74.90750	**3.01**			
118	01422500	Little Delaware River near Delhi, N.Y.	49.8	42.25222	-74.90194	**3.01**			
119	01422747	East Brook East of Walton, N.Y.	24.7	42.17278	-75.12167	**3.12**			
120	01423000	West Branch Delaware River at Walton, N.Y.	332	42.16611	-75.14028	**2.78**			
121	0142400103	Trout Creek near Trout Creek, N.Y.	20.2	42.17361	-75.27972	**2.08**			
123	01425000	West Branch Delaware River at Stilesville, N.Y.	456	42.07472	-75.39639	**2.39**			
124	01426500	West Branch Delaware River at Hale Eddy, N.Y.	595	42.00306	-75.38389	**2.40**			
126	01427510	Delaware River at Callicoon, N.Y.	1,820	41.75667	-75.05778	**3.00**			
127	01428500	Delaware River above Lackawaxen River near Barryville, N.Y.	2,020	41.50889	-74.98611	**2.95**			
128	01432900	Mongaup River at Mongaup Valley, N.Y.	76.6	41.66806	-74.78083	**2.81**			
129	01434000	Delaware River at Port Jervis, N.Y.	3,070	41.37056	-74.69778	**2.75**			
130	0143400680	East Branch Neversink River northeast of Denning, N.Y.	8.93	41.96694	-74.44833	**8.54**			

Table 12. Total storm runoff and selected statistics for August 27 to September 2, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83); mi^2, square miles; runoffs for sites in pink have been adjusted for storage in upstream reservoirs; runoffs in red are greater than or equal to the median storm runoff for selected sites in listed basins; locations are shown on figures 10 and 31]

Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Latitude	Longitude	Storm runoff (inches)	Basin median storm runoff (inches)	Basin mean storm runoff (inches)	Number of selected basin sites
		Delaware River Basin—Continued							
131	01434017	East Branch Neversink River near Claryville, N.Y.	22.9	41.92528	-74.54056	**6.60**			
132	01434021	West Branch Neversink River at Winnisook Lake near Frost Valley, N.Y.	0.77	42.01111	-74.41472	**6.92**			
133	01434025	Biscuit Brook above Pigeon Brook at Frost Valley, N.Y.	3.72	41.99583	-74.50000	**4.63**			
134	01434498	West Branch Neversink River at Claryville, N.Y.	33.8	41.92028	-74.57500	**6.29**			
135	01435000	Neversink River near Claryville, N.Y.	66.6	41.89000	-74.59028	**5.69**			
137	01436000	Neversink River at Neversink, N.Y.	92.6	41.82000	-74.63583	**5.71**			
138	01436690	Neversink River at Bridgeville, N.Y.	171	41.63778	-74.61722	**5.50**			
139	01437500	Neversink River at Godeffroy, N.Y.	307	41.44111	-74.60222	**5.37**			
		Susquehanna River Basin					**0.98**	**0.87**	**13**
144	01500500	Susquehanna River at Unadilla, N.Y.	982	42.32139	-75.31694	**1.38**			
145	01502500	Unadilla River at Rockdale, N.Y.	520	42.37778	-75.40639	**1.09**			
146	01502632	Susquehanna River at Bainbridge, N.Y.	1,610	42.29139	-75.47667	**1.36**			
147	01502731	Susquehanna River at Windsor, N.Y.	1,820	42.07472	-75.63806	**1.38**			
148	01503000	Susquehanna River at Conklin, N.Y.	2,232	42.03528	-75.80333	**1.62**			
151	01505000	Chenango River at Sherburne, N.Y.	263	42.67861	-75.51083	**0.36**			
154	01507000	Chenango River at Greene, N.Y.	593	42.32444	-75.77167	**0.50**			
155	01509000	Tioughnioga River at Cortland, N.Y.	292	42.60278	-76.15972	**0.15**			
157	01510000	Otselic River at Cincinnatus, N.Y.	147	42.54111	-75.90000	**0.18**			
161	01512500	Chenango River near Chenango Forks, N.Y.	1,483	42.21806	-75.84861	**0.31**			
162	01513500	Susquehanna River at Vestal, N.Y.	3,941	42.09083	-76.05639	**1.06**			
163	01513831	Susquehanna River at Owego, N.Y.	4,216	42.09722	-76.26667	**0.98**			
166	01515000	Susquehanna River near Waverly, N.Y.	4,773	41.98472	-76.50139	**0.98**			
		Lake Ontario Basin					**0.13**	**0.13**	**1**
249	04250750	Sandy Creek near Adams, N.Y.	137	43.81333	-76.07500	**0.13**			
		Black River Basin					**0.53**	**0.53**	**3**
250	04252500	Black River near Boonville, N.Y.	304	43.51167	-75.30694	**0.61**			
254	04256000	Independence River at Donnattsburg, N.Y.	88.7	43.74722	-75.33472	**0.46**			
259	04260500	Black River at Watertown, N.Y.	1,864	43.98556	-75.92500	**0.53**			
		St. Lawrence River Basin					**0.50**	**0.56**	**7**
262	04262500	West Branch Oswegatchie River near Harrisville, N.Y.	258	44.18556	-75.33111	**0.43**			
263	04263000	Oswegatchie River near Heuvelton, N.Y.	986	44.59944	-75.37917	**0.37**			
266	04265432	Grass River at Chase Mills, N.Y.	598	44.84667	-75.07806	**0.49**			
271	04268800	West Branch St. Regis River near Parishville, N.Y.	171	44.59861	-74.73750	**0.67**			
272	04269000	St. Regis River at Brasher Center, N.Y.	612	44.86361	-74.77917	**0.60**			
274	04270000	Salmon River at Chasm Falls, N.Y.	132	44.75611	-74.21917	**0.84**			
275	04270200	Little Salmon River at Bombay, N.Y.	92.2	44.94000	-74.55667	**0.50**			
		Lake Champlain Basin					**2.08**	**2.14**	**9**
277	04271500	Great Chazy River at Perry Mills, N.Y.	243	45.00000	-73.50139	**1.49**			
278	04271815	Little Chazy River near Chazy, N.Y.	50.3	44.90222	-73.41556	**2.08**			
279	04273500	Saranac River at Plattsburgh, N.Y.	608	44.68167	-73.47167	**0.87**			
280	04273700	Salmon River at South Plattsburgh, N.Y.	63.3	44.64000	-73.49528	**1.49**			
281	04273800	Little Ausable River near Valcour, N.Y.	67.8	44.59417	-73.49667	**1.03**			
284	04275500	Ausable River near Au Sable Forks, N.Y.	446	44.45139	-73.64306	**3.03**			
285	04276500	Bouquet River at Willsboro, N.Y.	270	44.35833	-73.39722	**2.39**			
286	04276842	Putnam Creek east of Crown Point Center, N.Y.	51.6	43.94250	-73.46417	**3.35**			
289	04280450	Mettawee River near Middle Granville, N.Y.	167	43.46389	-73.28472	**3.49**			

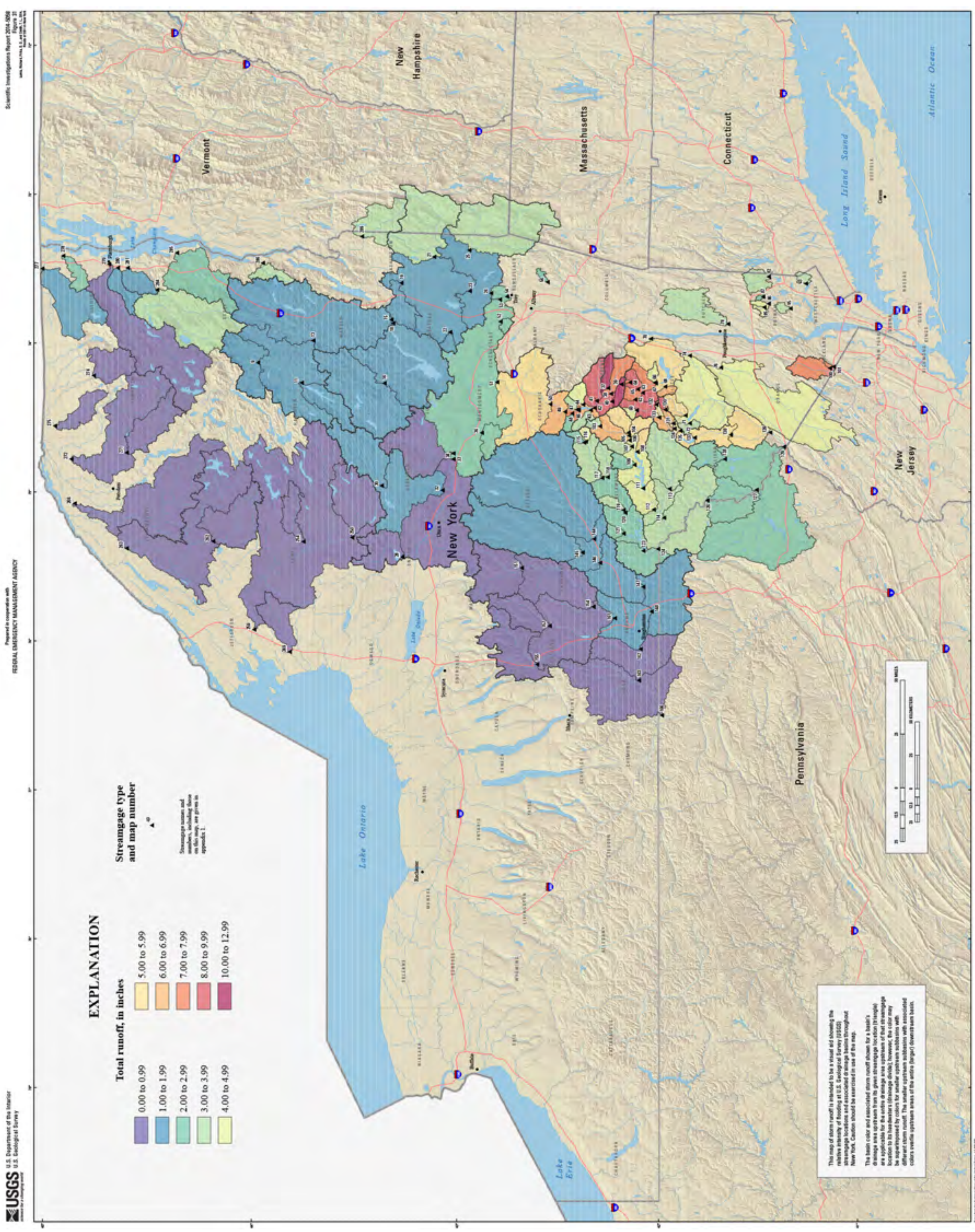


Figure 31. Total storm runoff, in inches, for August 27–September 2, 2011, at selected streamgage basins in New York and vicinity. (Click link to view full-size map of figure 31 at *http://pubs.usgs.gov/sir/2014/5058/*.)

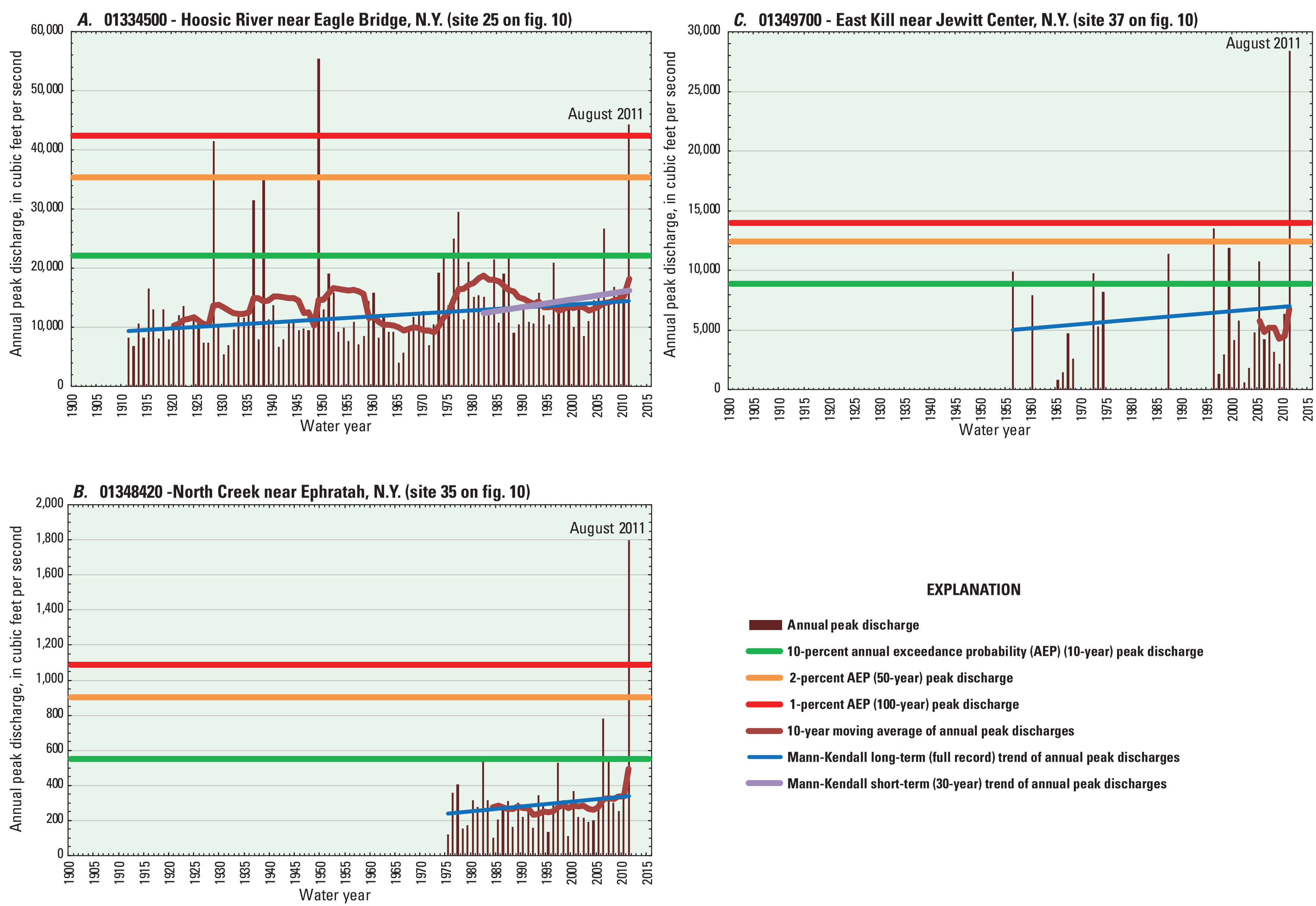


Figure 32. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and trend data is given in table 6.)

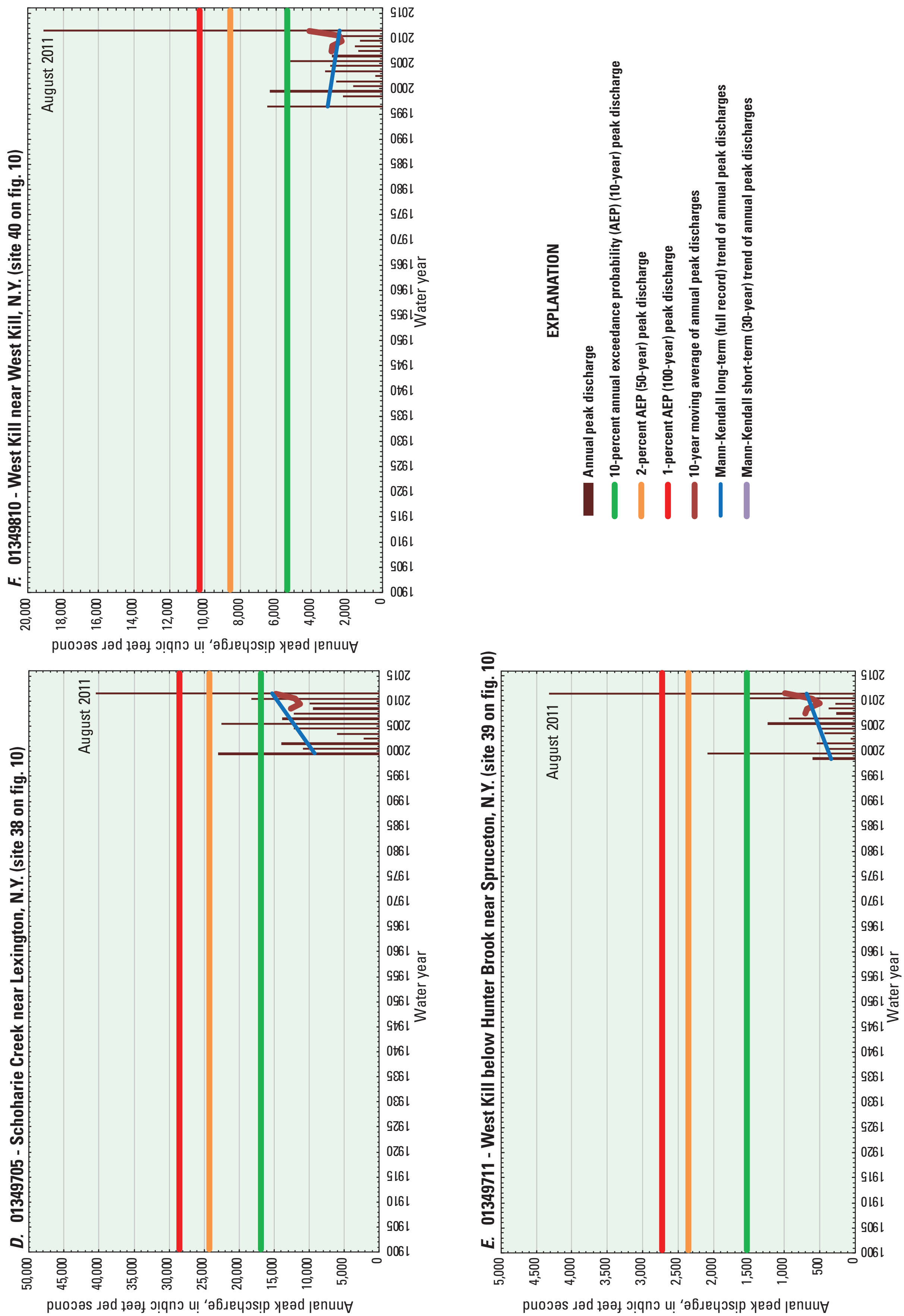


Figure 32.—Continued

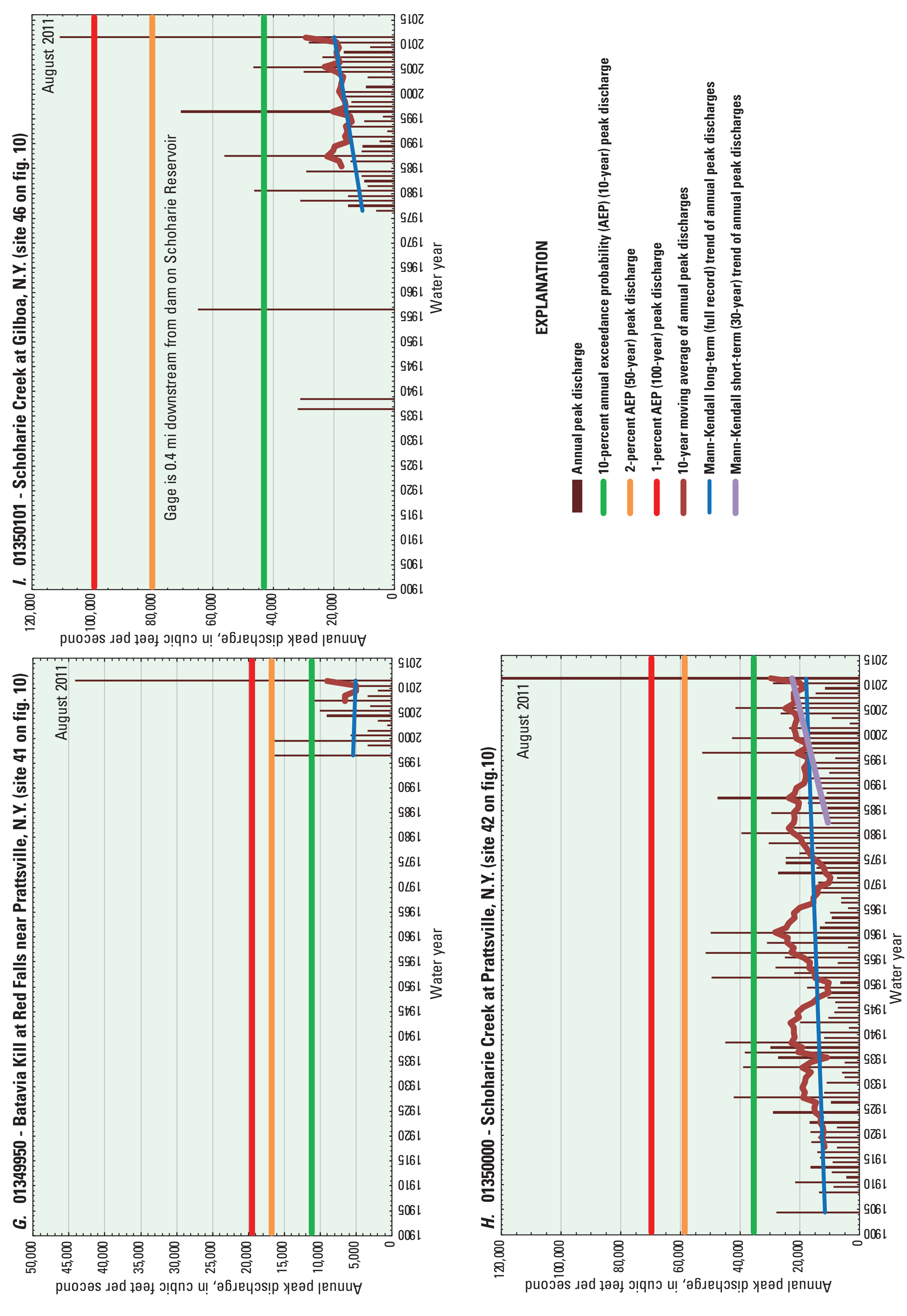
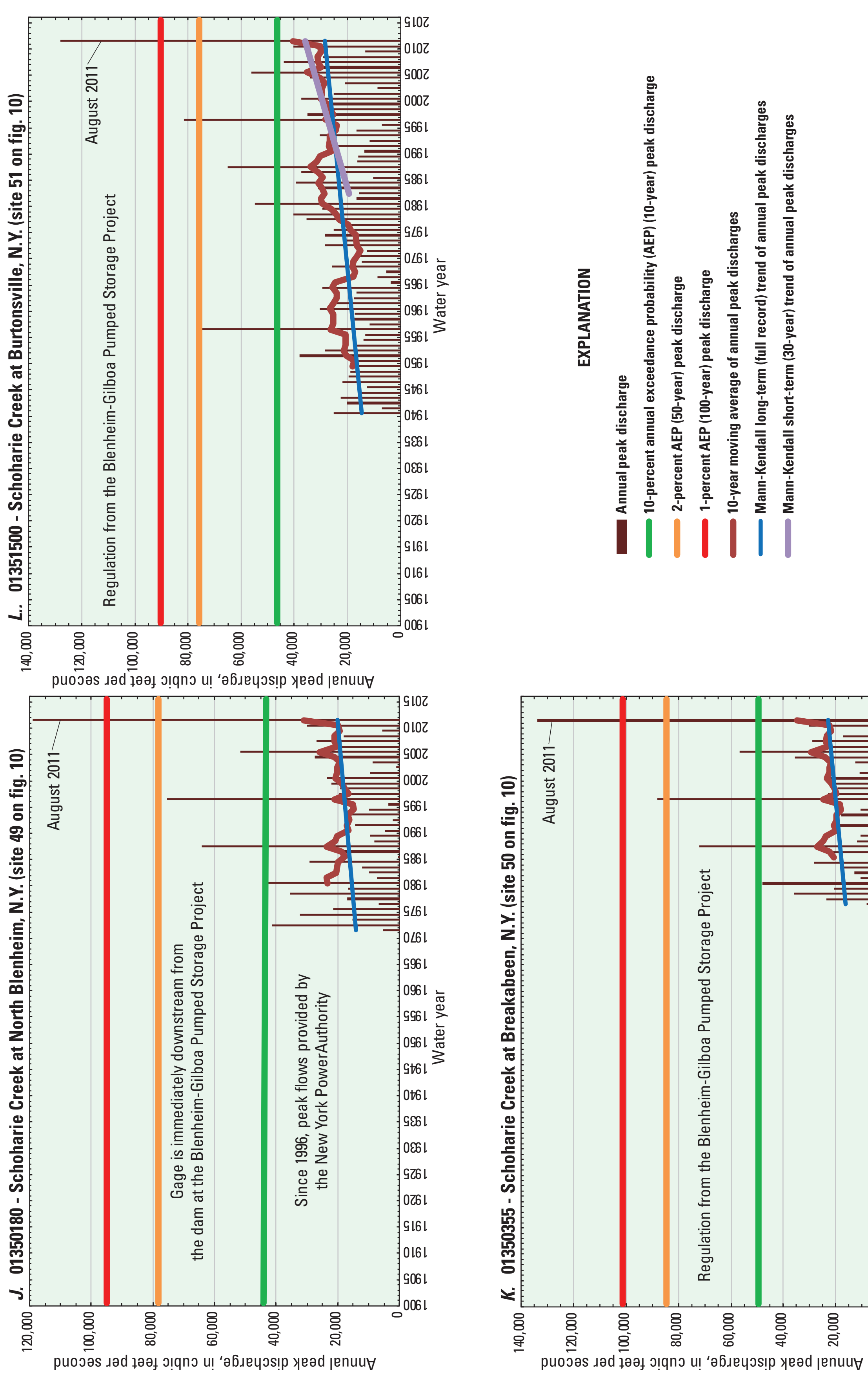


Figure 32.—Continued



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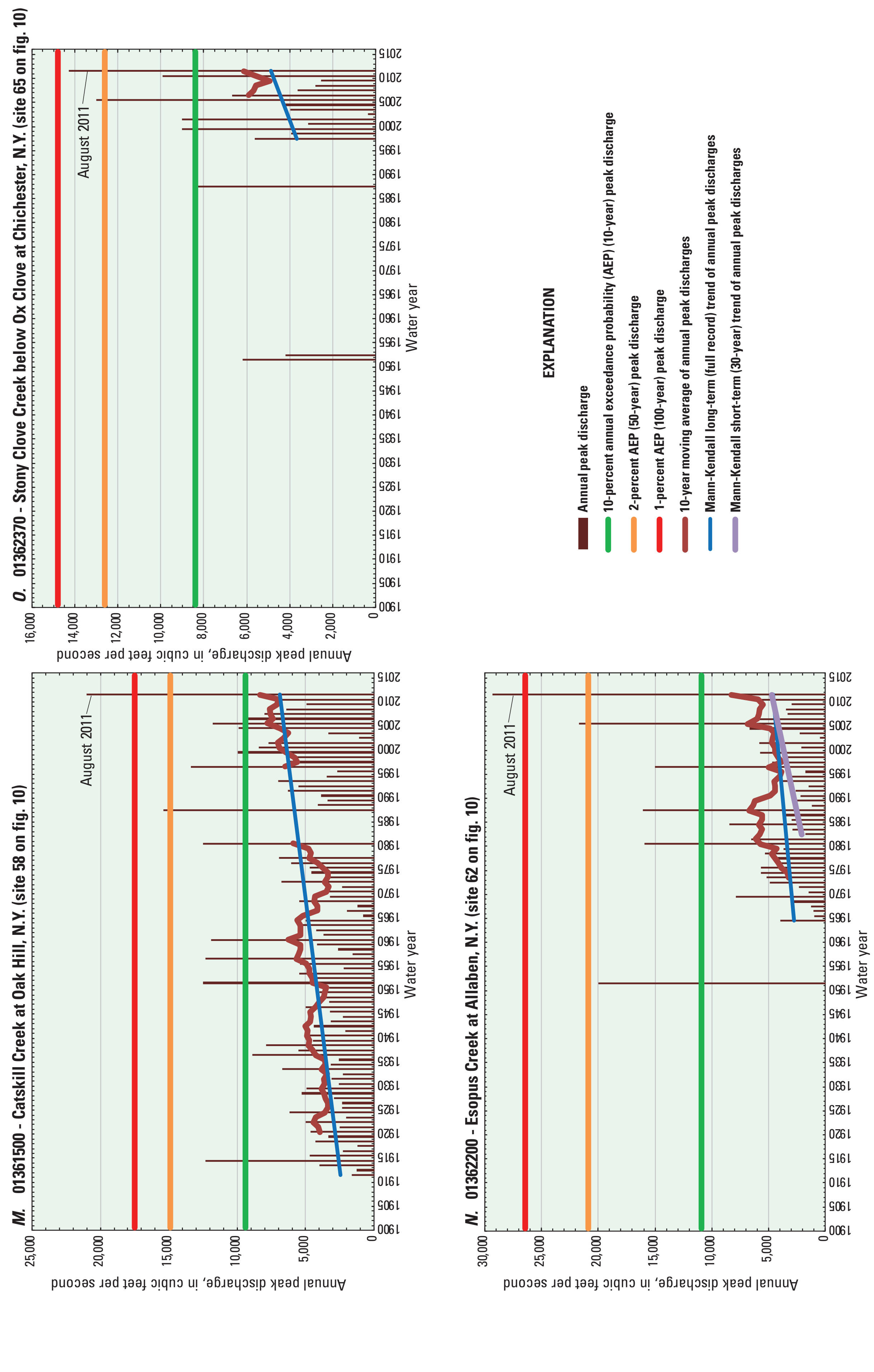

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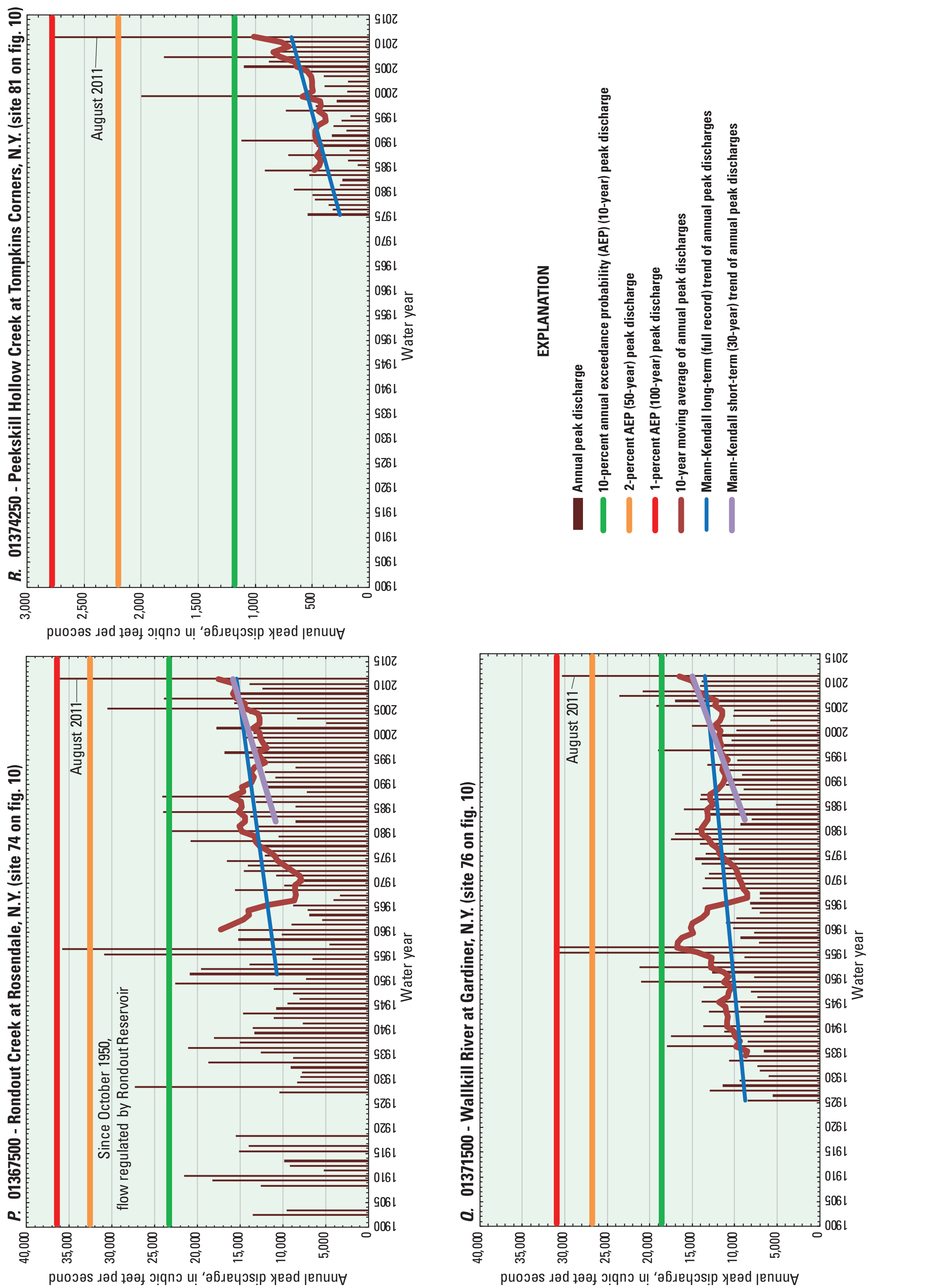

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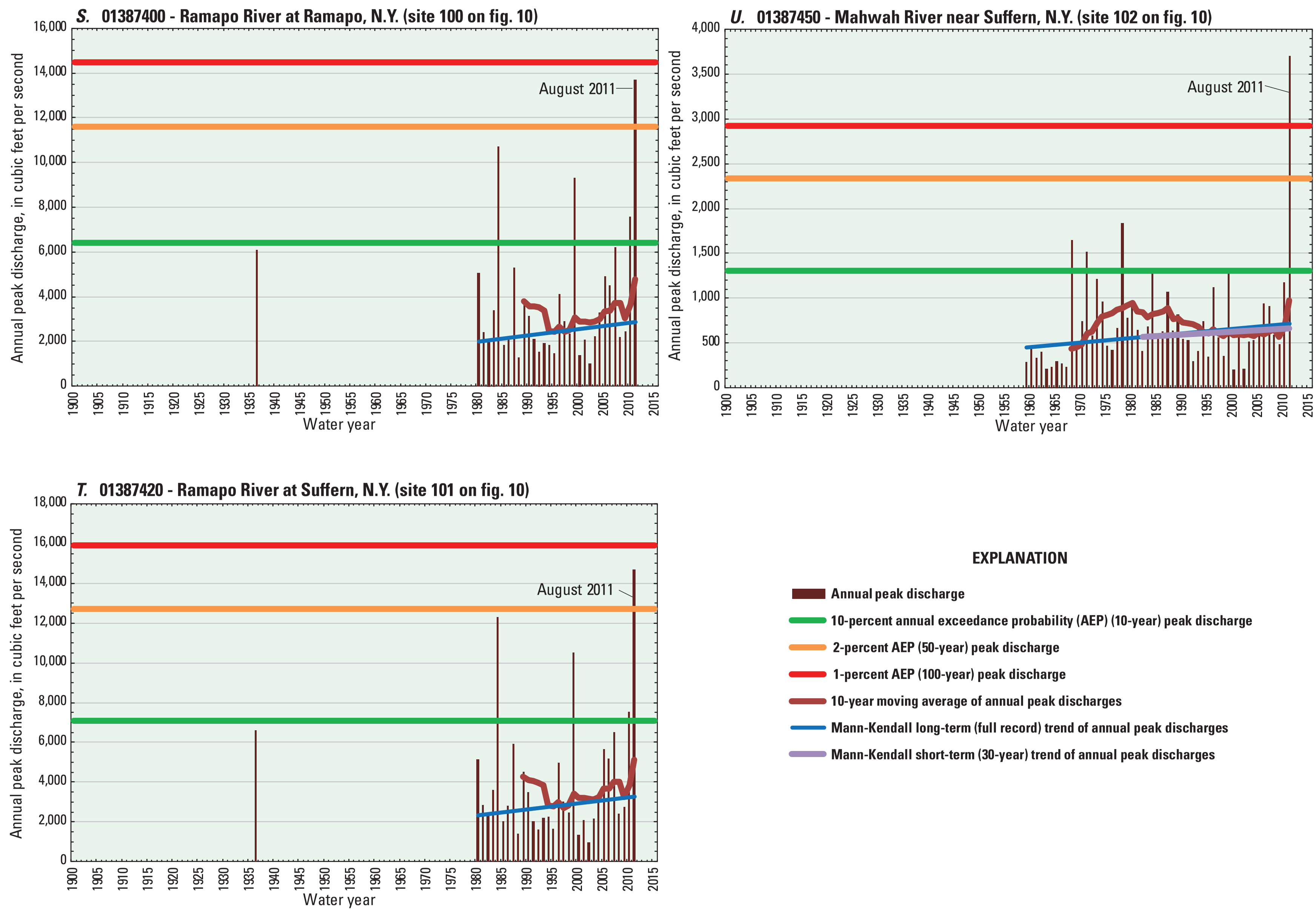

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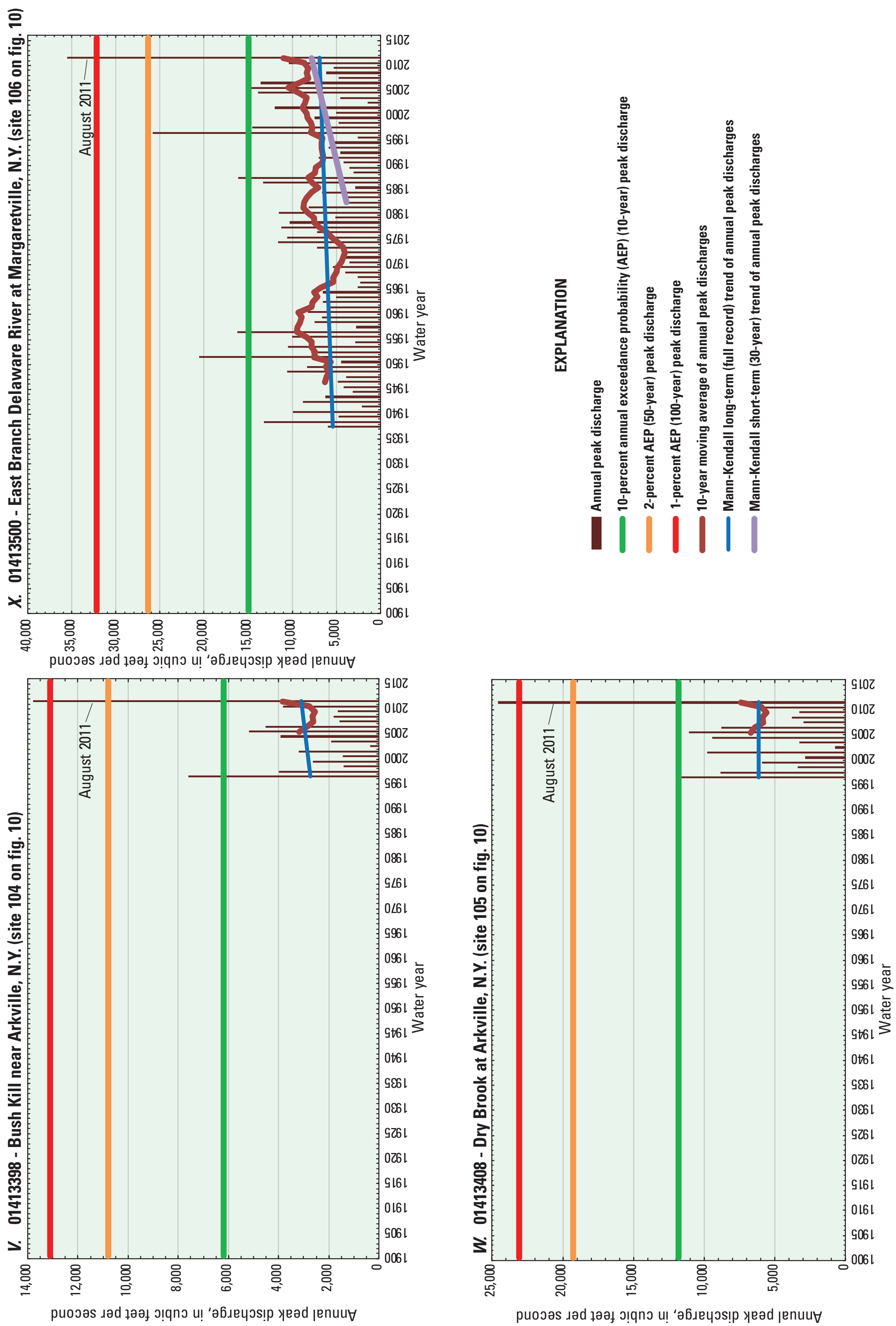

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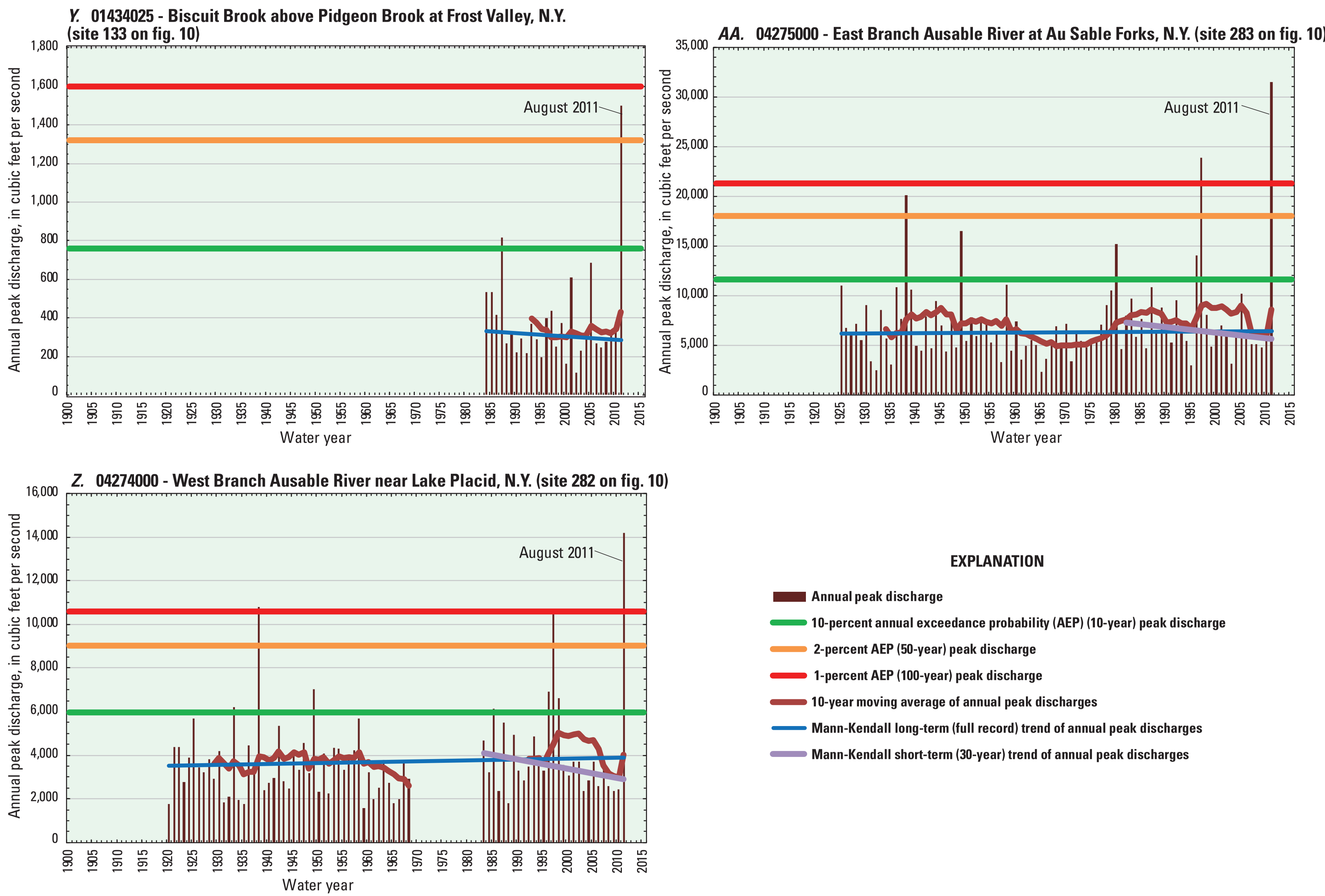

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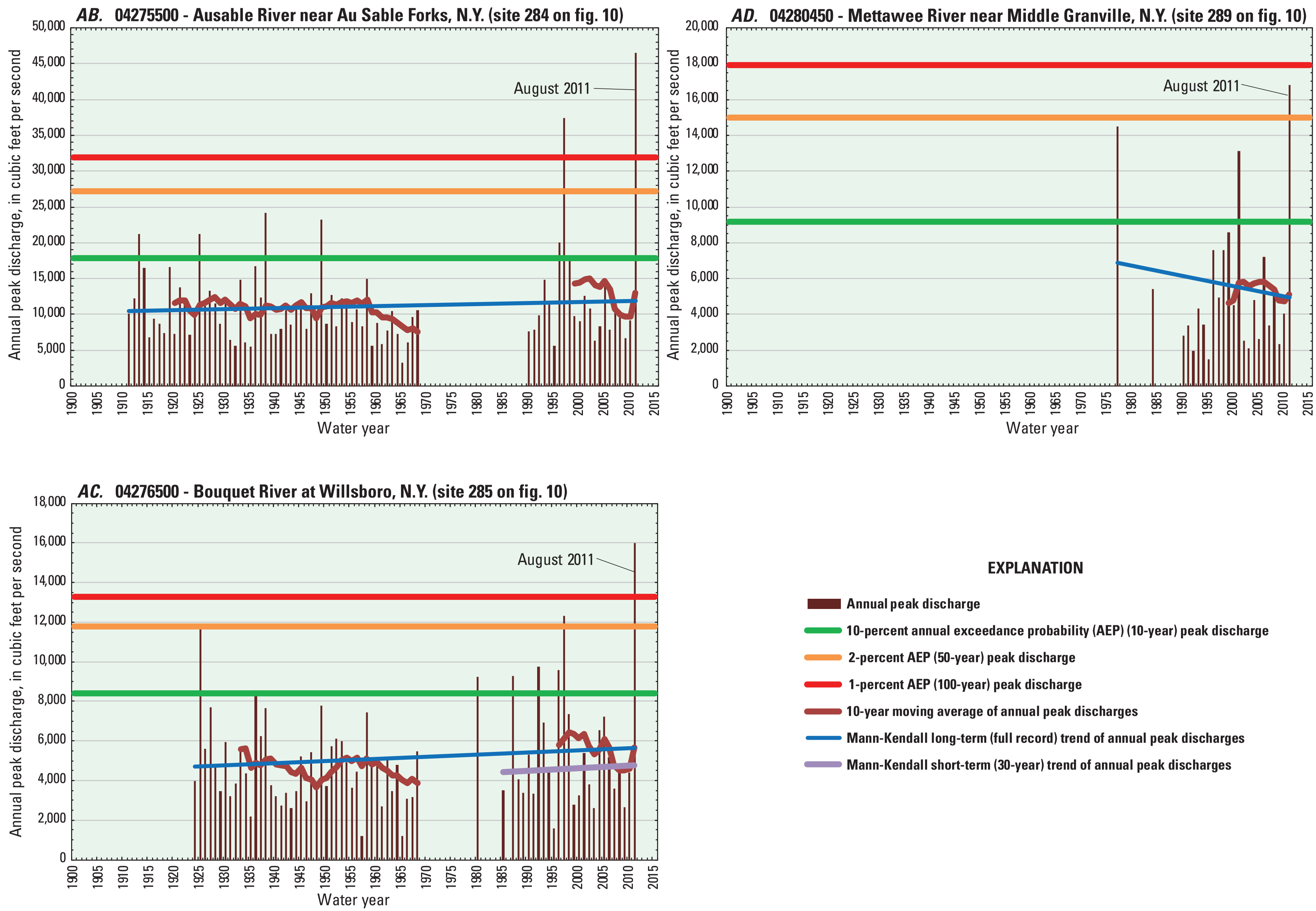

Figure 32.—Continued

The record peak discharge of 35,500 ft^3/s for the East Branch Delaware River at Margaretville (01413500) streamgage on August 28 was 1.4 times greater than the previous peak of record (25,800 ft^3/s on January 19, 1996; fig. 32X, table 11). The annual peak discharges at Margaretville had a statistically significant (p-value 0.052) short-term (1982–2011) positive trend, but the long-term (1937–2011) trend was small and not significant (table 6). August 28 flooding in the Ausable and Bouquet River Basins (Lake Champlain Basin) set record peak discharges far exceeding the 1-percent AEP (100-year) flows (figs. 32Z–AC, table 11) and the previous peak of record in November 1996. Annual peak flows do not have significant trends at these four streamgages (figs. 32Z–AC, table 6).

The effects of the August 2011 peak flow and previous annual peak discharges on flood frequencies over time are illustrated on figures 33A–C. Updated flood-frequency values were re-calculated annually following the first 10 years of peak-discharge record and plotted in a continuous line as each year of peak-discharge record was added to the computations. The 10-year moving average and the computed trend line for the moving 1-percent AEP (100-year) flood-frequency values show a statistically significant increase (p-value 0.000) for Schoharie Creek at Prattsville (01350000) and Burtonsville (01351500) (figs. 33A–B). The graphs for Burtonsville (fig. 33B) and East Branch Delaware River at Margaretville (01413500) (fig. 33C) indicate that the 1996 flood at each streamgage was previously computed (in 1996) to be a 1-percent AEP (100-year) flood but has been reduced to nearly a 2-percent AEP (50-year) flood as a result of recomputations that included the 1997–2011 flood peaks. The maximum discharge at each site for 2011 occurred on August 28 or 29.

Antecedent conditions, precipitation, runoff patterns, and basin characteristics all play a role in determining the peak water-surface elevation and discharge at a streamgage. Discharge hydrographs for selected streamgages for August 27–September 2, 2011, compare the magnitude, relative frequency, and timing of flows at each location (figs. 34–35). In some cases, unit (15-minute) discharge data are missing because of equipment malfunction or damage to the streamgage that houses the equipment. The Schoharie Creek hydrographs (fig. 34C) from five streamgages indicate that each peak discharge exceeded the 1-percent AEP flow and that reservoir and flood-plain storage had some effect on timing and attenuation of flows throughout the basin during the flood. The Mohawk River upstream from Schoharie Creek had less flooding than flows downstream from the confluence (figs. 34D–G), and flooding could have been worse if two major tributaries (East and West Canada Creeks) had contributed more than the minor flows (less than 50-percent AEP or 2-year peak discharges) (table 11) recorded during late August (figs. 34D and F). Peak discharges on August 28, 2011, on several streams in the East Branch Delaware River Basin (upstream from Pepacton Reservoir) exceeded the 1-percent AEP (100-year) discharge (fig. 34K), whereas the West Branch Delaware River Basin had minimal flooding (table 11). Tropical Storm Irene caused moderate to significant flooding (25- to 80-year floods) in the Neversink River Basin (tributary to the Delaware River) in southeastern New York (figs. 34L–M, table 11), whereas heavy rains on August 28–29 over the Ausable and Bouquet River Basins in northeastern New York caused record flooding with some peak flows exceeding the 0.5-percent AEP (200-year) discharge. The East Branch Ausable River (04275000) peaked at nearly the same time as the main stem Ausable River (04275500) near Au Sable Forks (fig. 34P), whereas the time of the peak discharge on the West Branch Ausable River (04274000) is unknown because the streamgage does not record continuous streamflow.

Unit discharge hydrographs for August 27–September 2, 2011, for 14 sites in the flooded areas, hydrographs for previous high flows at each site, selected flood frequencies, and a list of the greatest four peak discharges at each streamgage allow comparisons of hydrograph shape and the relative magnitude and frequency of each flood (figs. 35A–N). The peak discharges for previous floods were overlaid on those for the August 2011 flood to allow hydrograph-shape comparisons. The January 1996 flood hydrographs (previous peaks of record) are included with each of the five Schoharie Creek plots (figs. 35A–E) for comparison. The differences between the 1996 and 2011 peak stages at the Schoharie Creek sites ranged from 1.86 ft (01350355 at Breakabeen) to 9.92 ft (01350101 at Gilboa). The large range in differences is a result of variable hydraulic conditions found at each gaged location along Schoharie Creek during each flood. The spikes on the hydrographs for the Mohawk River at Cohoes (01357500) streamgage (fig. 35F) are somewhat unique (see the 1964 and 1996 hydrographs in fig. 35F); the spikes result from releases from upstream ice jams that caused a temporary surge of water (discharge) at the Cohoes streamgage. The peak discharges and volumes of flow are correct, but the surges of water at high flows produce a nonhomogeneous annual peak dataset. Enhanced peak discharges occur often and are treated as the normal condition of the dataset, and flood frequencies are computed accordingly. For comparison, hydrographs and associated peak discharges during periods of upstream release of ice jams (where data were readily available) were adjusted to reflect the "normal" flow conditions (without surges) at the Cohoes streamgage. Flood-frequency analyses were recomputed and indicate the adjusted 1-percent AEP (100-year) value to be lower, resulting in higher frequencies for flood peaks. Most hydrographs at a given site on figure 35 have similar shapes, but their differences depend on the time of year for each flood (reflecting antecedent base-flow conditions, snowmelt, and storm rainfall patterns and intensities).

The magnitude, frequency, and duration of flood stages for 11 streamgages in the Catskill Mountains area of New York are shown on figure 36. The stage hydrograph, selected stage frequencies (horizontal color-coded range bars), and frequency durations (color-coded lines at the top of the plot) for the Schoharie Creek at Prattsville (01350000) indicate that the stage rose nearly 21 ft on August 28 and remained above the 0.2-percent AEP (500-year) flood stage for about 3 hours and above the 1-percent AEP (100-year) stage for about 6 hours (fig. 36A). The stage on August 28 increased

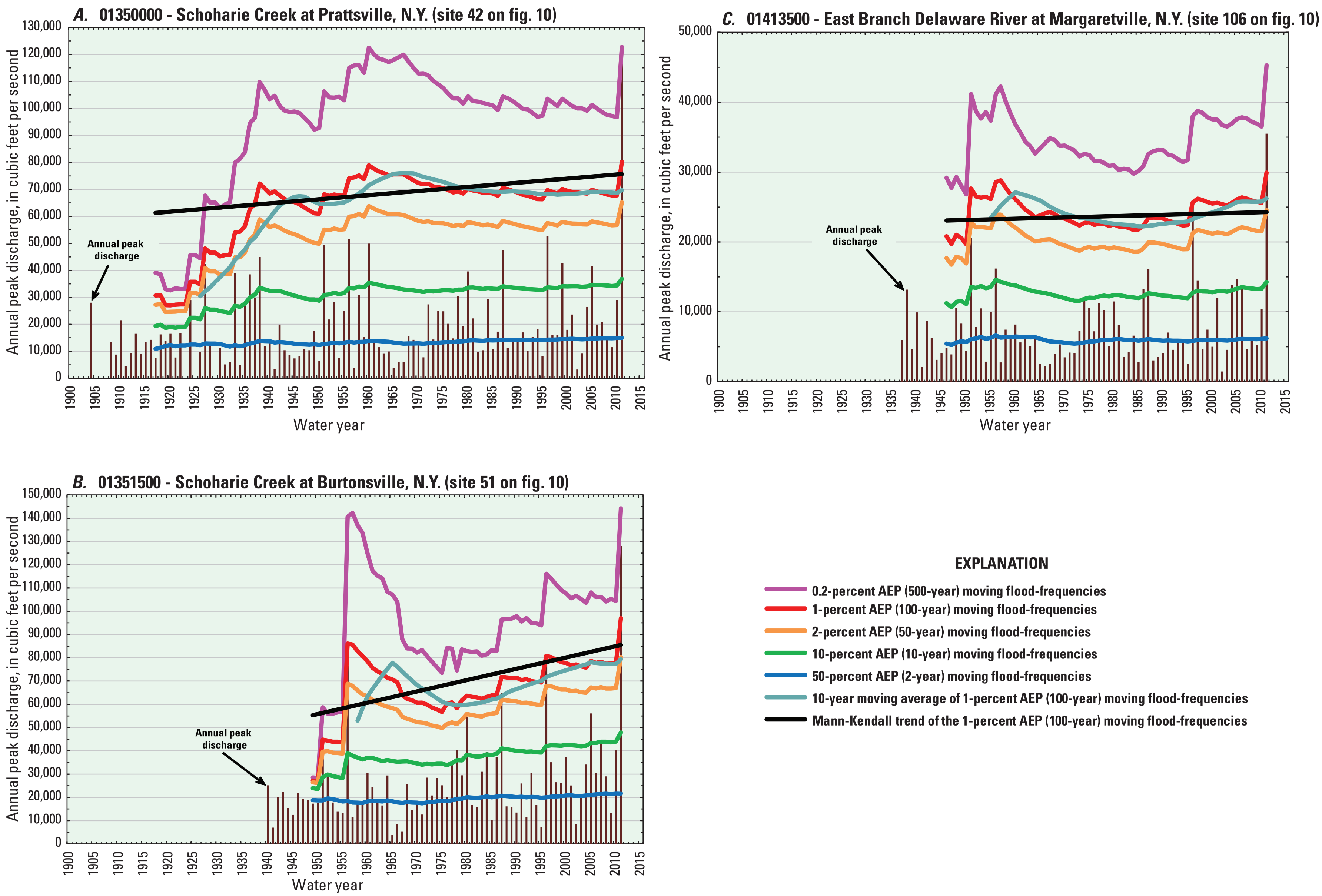

Figure 33. Annual peak discharges, moving flood frequencies, and trends of the moving 1-percent annual exceedance probability (AEP) (100-year) discharges through 2011 at *A,* Schoharie Creek at Prattsville, *B,* Schoharie Creek at Burtonsville, and *C,* East Branch Delaware River at Margaretville, New York. (Sites are listed in appendix 1 and shown on figure 10.)

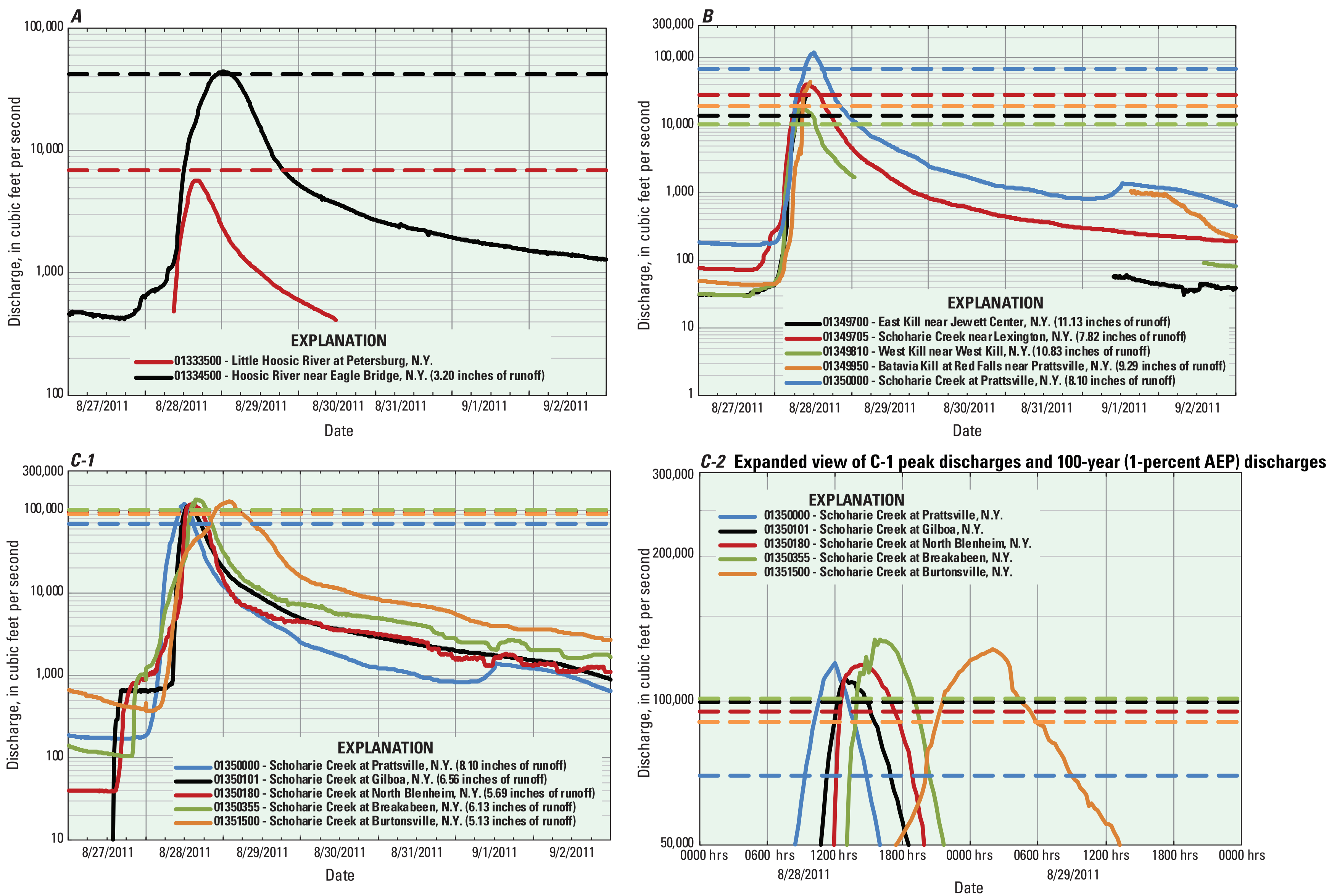

Figure 34. Discharge hydrographs for August 27–September 2, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A*, Hoosic River, *B–G*, Schoharie Creek/Mohawk River, *H–J*, Lower Hudson River/Ramapo River, *K–M*, Delaware River/Neversink River, and *N–Q*, Lake Champlain, Basins, New York. (One-percent annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10. hrs, hours)

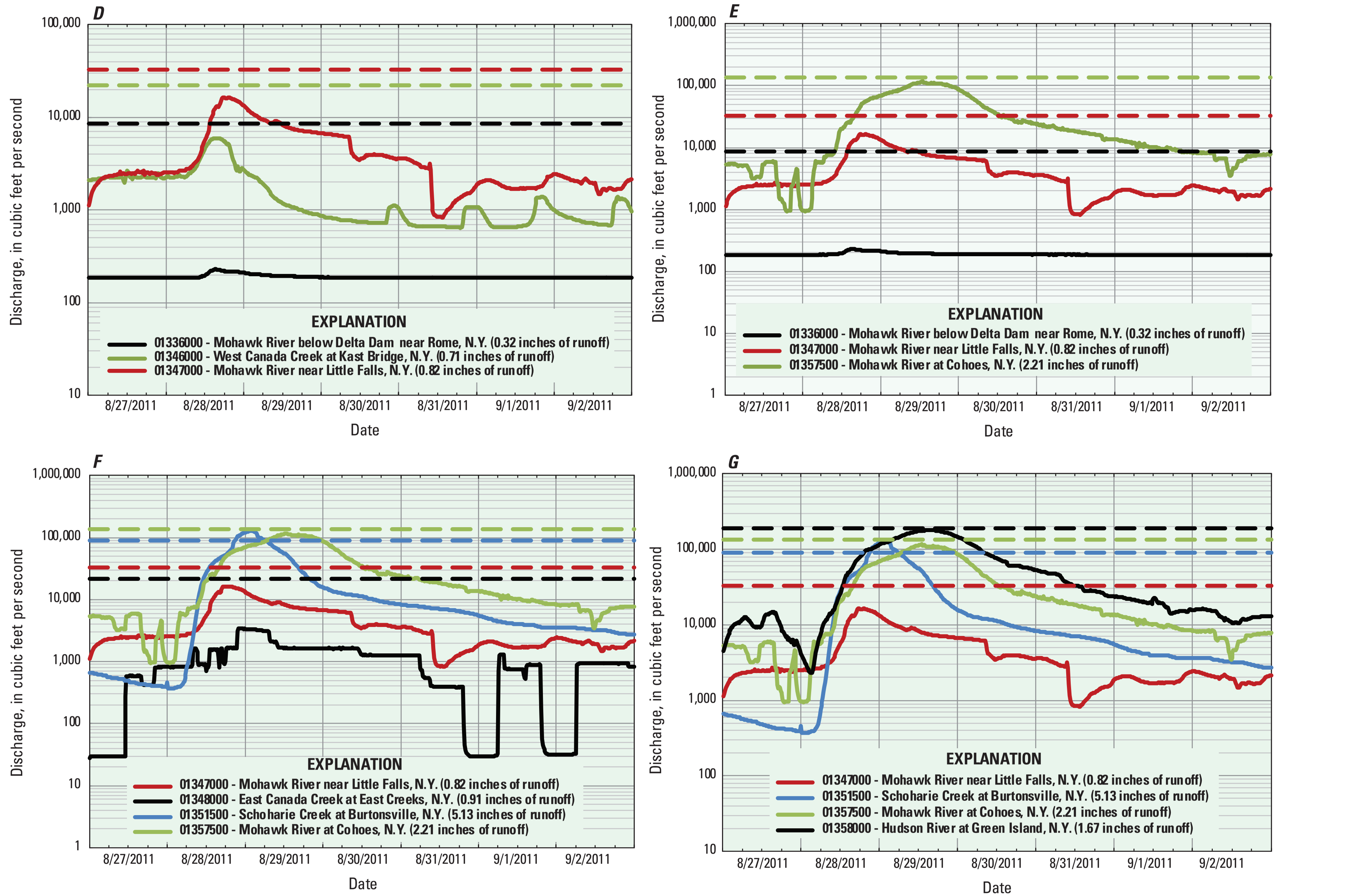

Figure 34. Discharge hydrographs for August 27–September 2, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A*, Hoosic River, *B–G*, Schoharie Creek/Mohawk River, *H–J*, Lower Hudson River/Ramapo River, *K–M*, Delaware River/Neversink River, and *N–Q*, Lake Champlain, Basins, New York. (One-percent annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10. hrs, hours)—Continued

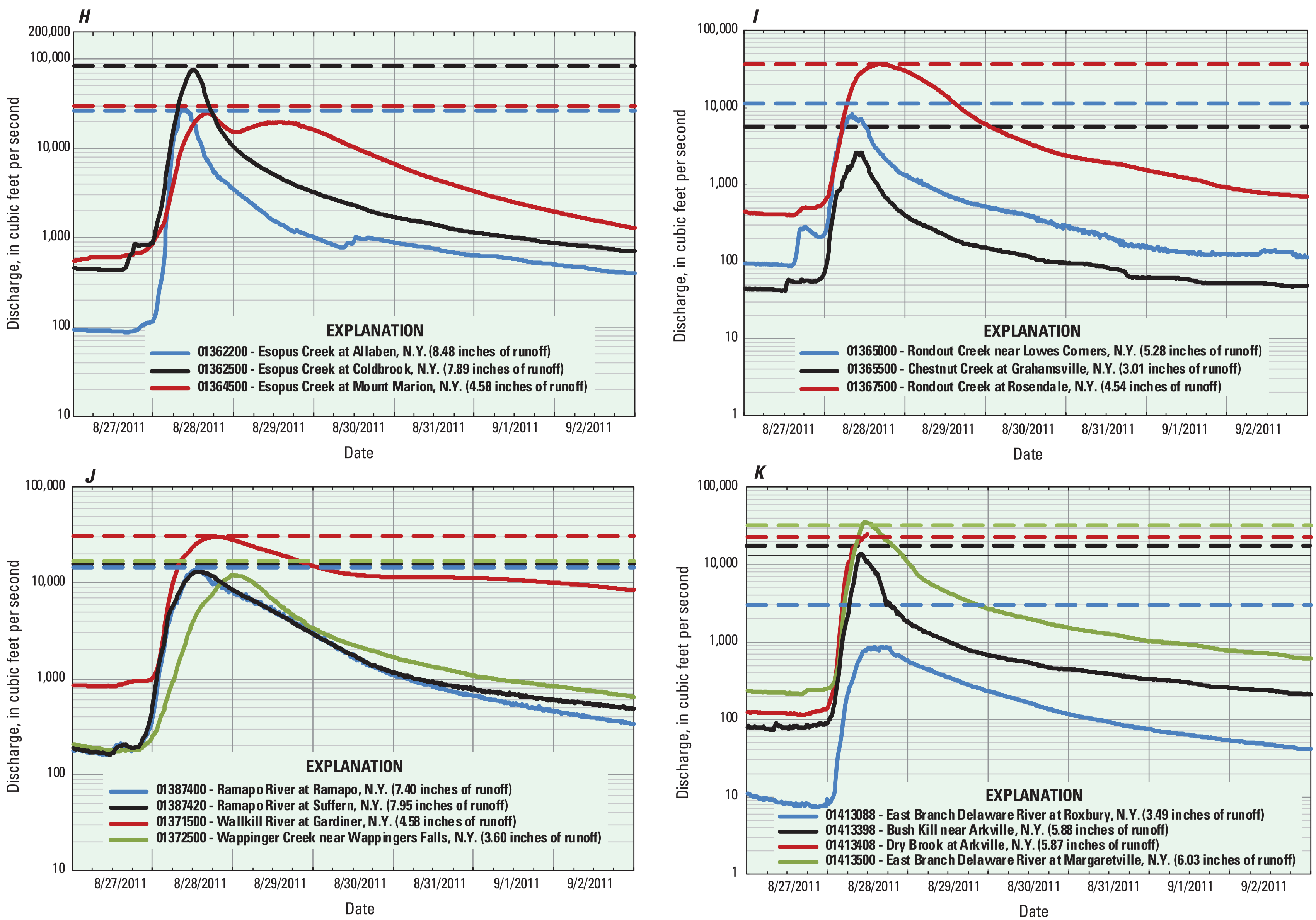

Figure 34. Discharge hydrographs for August 27–September 2, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A*, Hoosic River, *B–G*, Schoharie Creek/Mohawk River, *H–J*, Lower Hudson River/Ramapo River, *K–M*, Delaware River/Neversink River, and *N–Q*, Lake Champlain, Basins, New York. (One-percent annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10. hrs, hours)—Continued

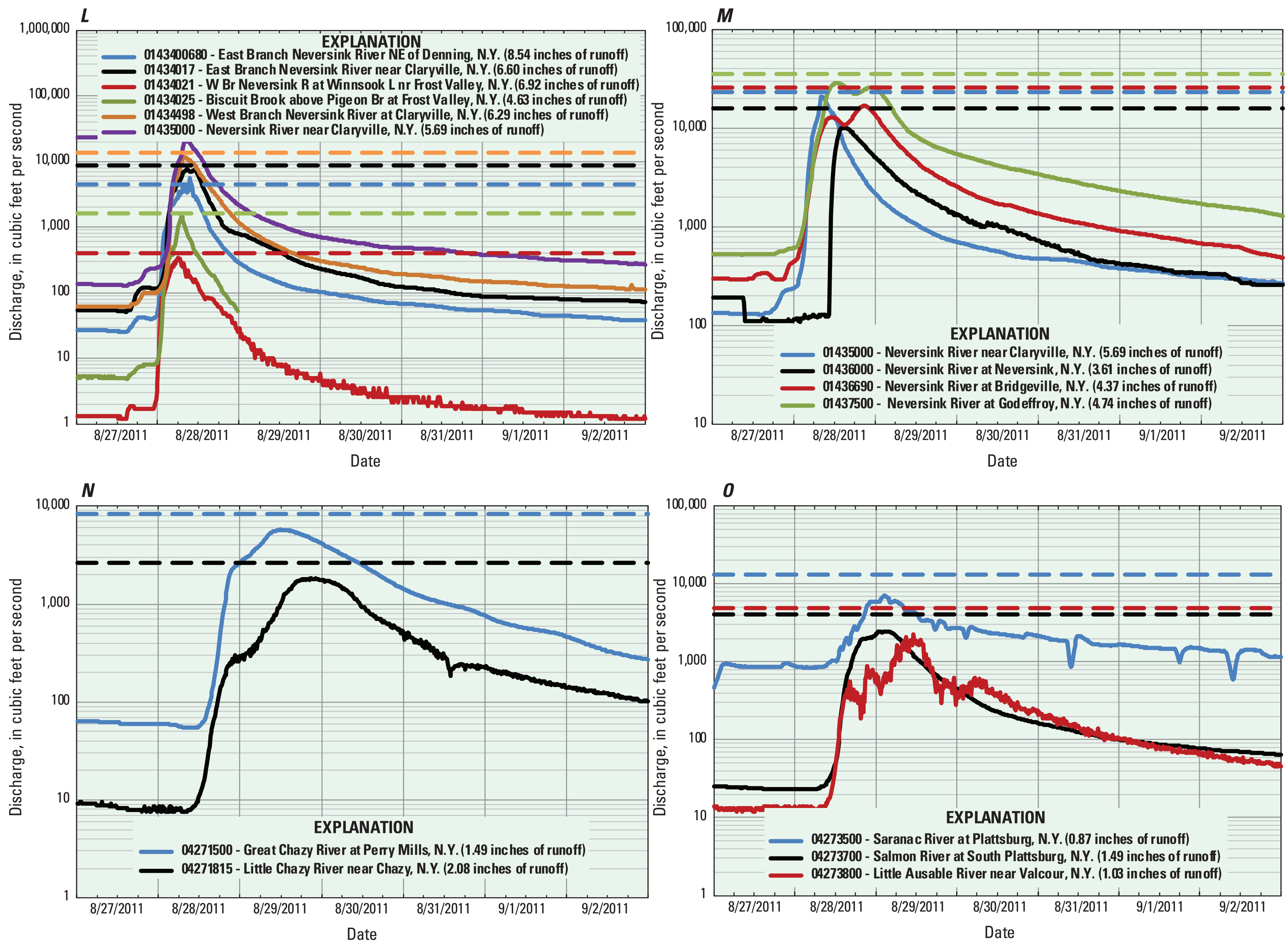

Figure 34. Discharge hydrographs for August 27–September 2, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A*, Hoosic River, *B–G*, Schoharie Creek/Mohawk River, *H–J*, Lower Hudson River/Ramapo River, *K–M*, Delaware River/Neversink River, and *N–Q*, Lake Champlain, Basins, New York. (One-percent annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10. hrs, hours)—Continued

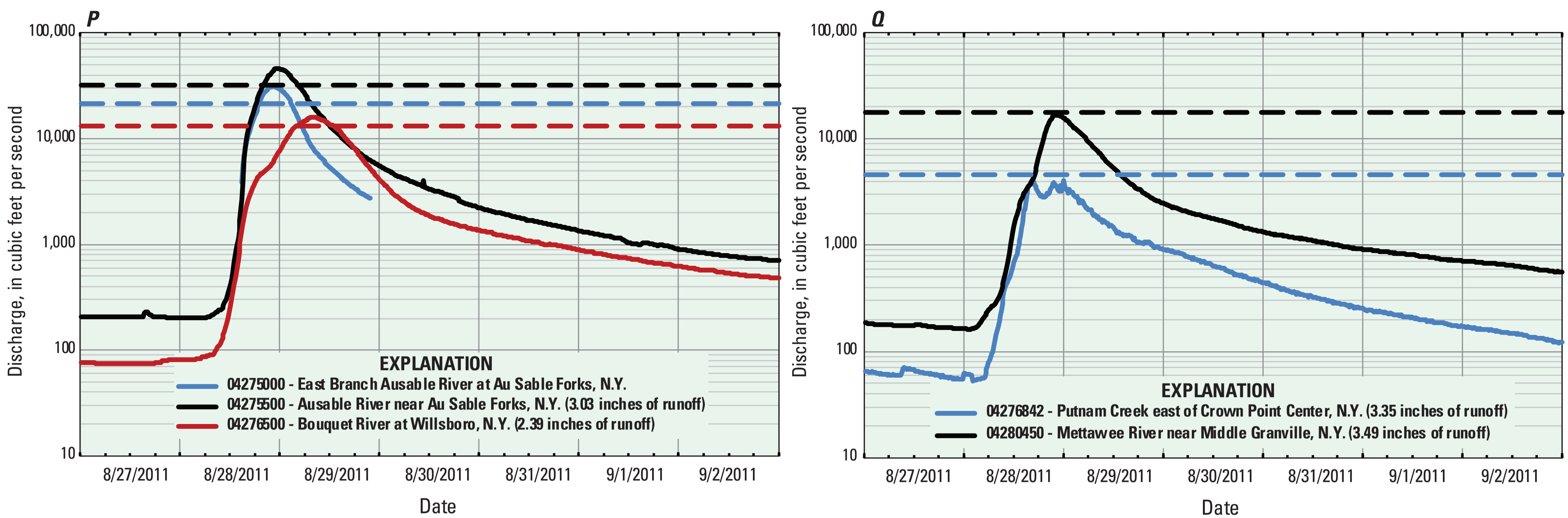

Figure 34. Discharge hydrographs for August 27–September 2, 2011, and 1-percent annual exceedance probabilities for selected streamgages in the *A,* Hoosic River, *B–G,* Schoharie Creek/Mohawk River, *H–J,* Lower Hudson River/Ramapo River, *K–M,* Delaware River/Neversink River, and *N–Q,* Lake Champlain, Basins, New York. (One-percent annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10. hrs, hours)—Continued

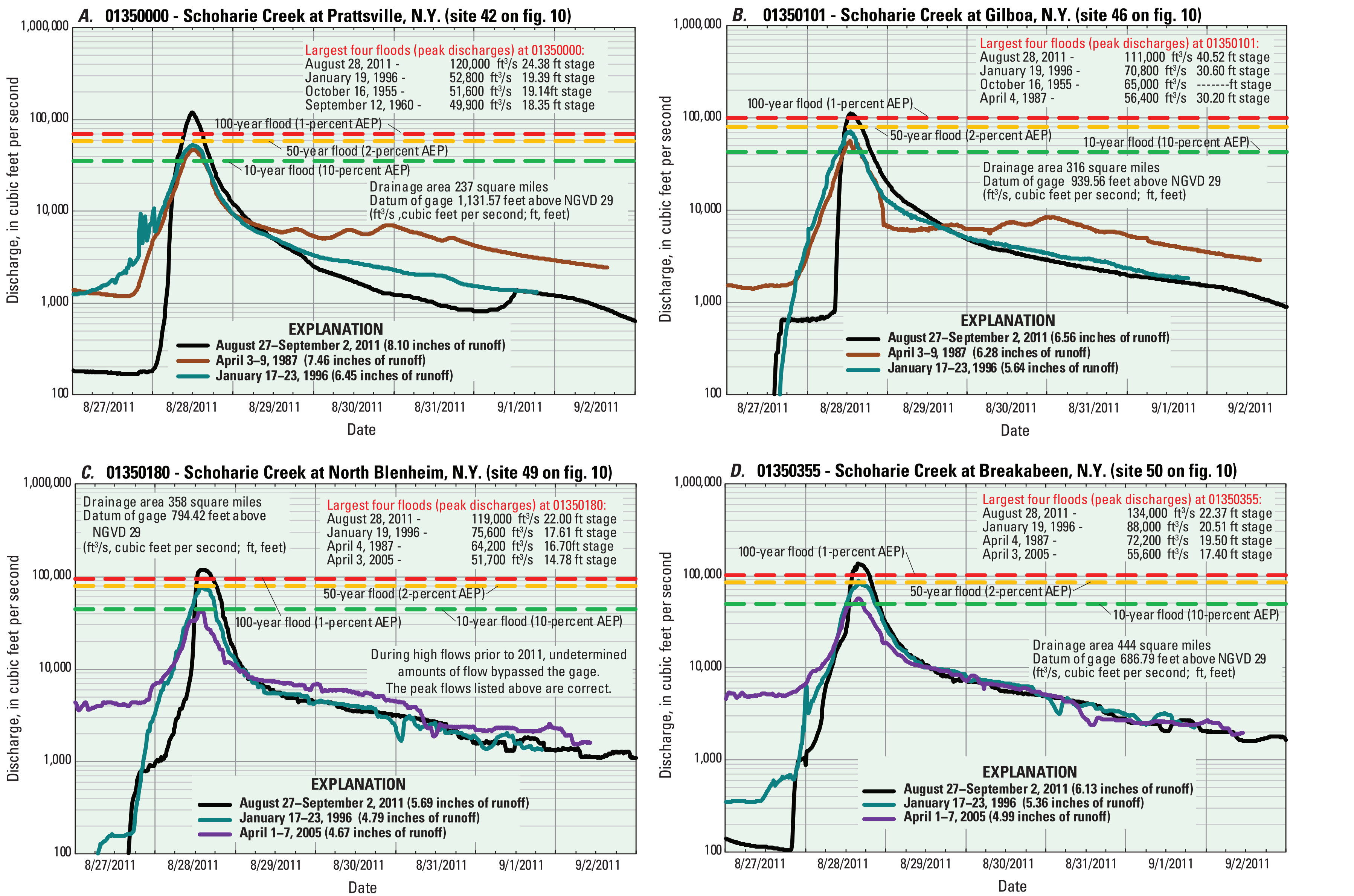

Figure 35. Discharge hydrographs for August 27–September 2, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)

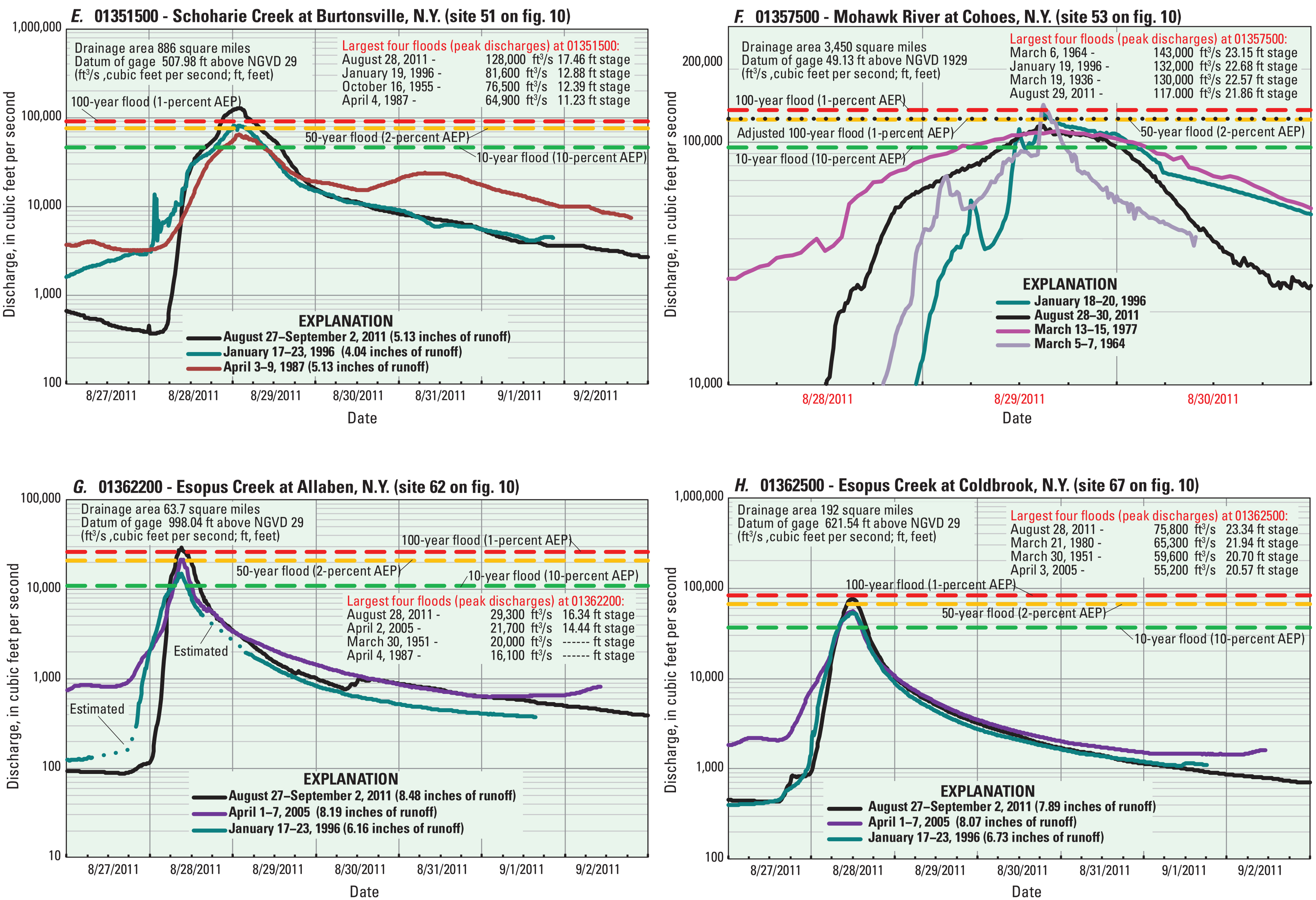

Figure 35. Discharge hydrographs for August 27–September 2, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)—Continued

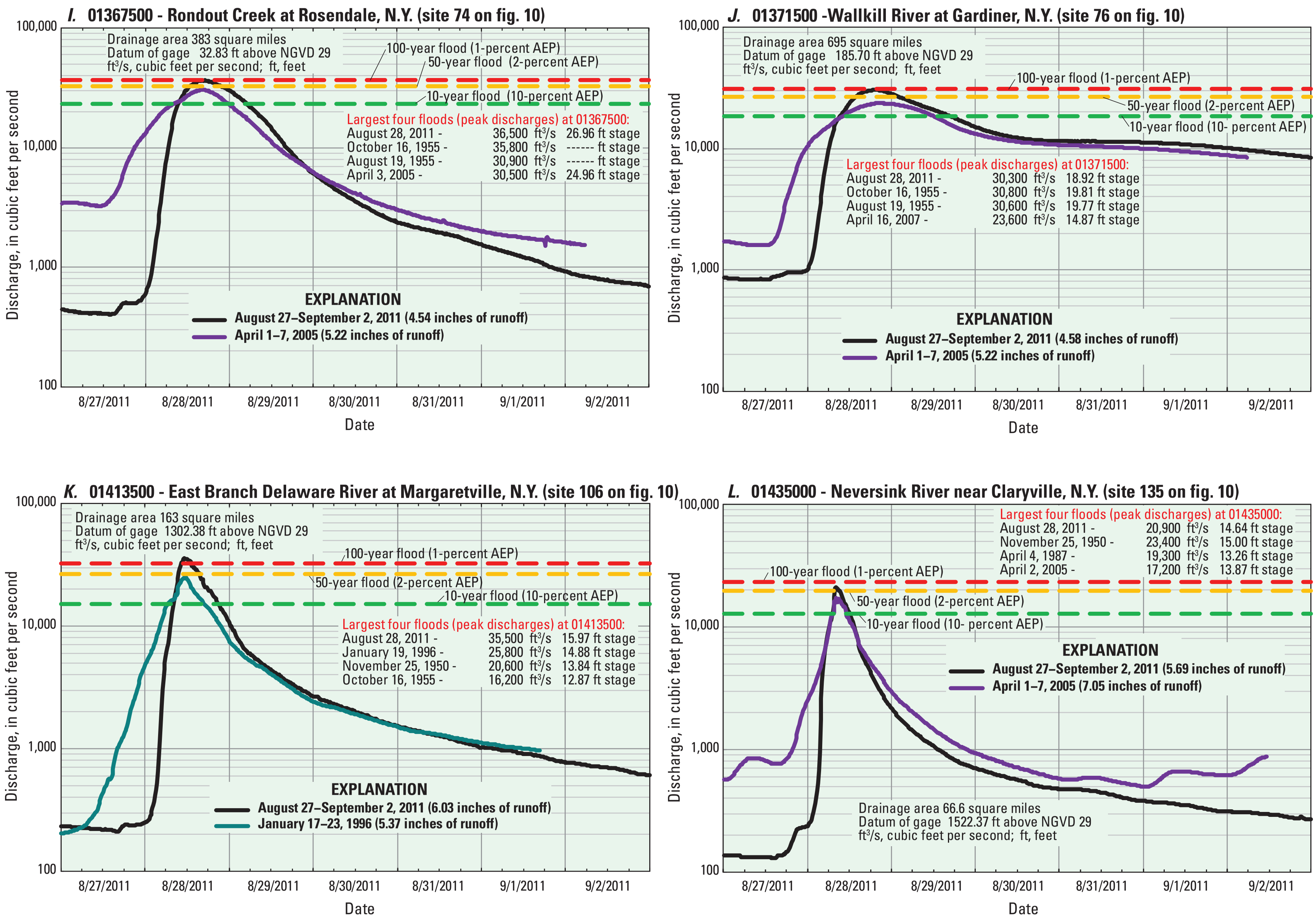

Figure 35. Discharge hydrographs for August 27–September 2, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)—Continued

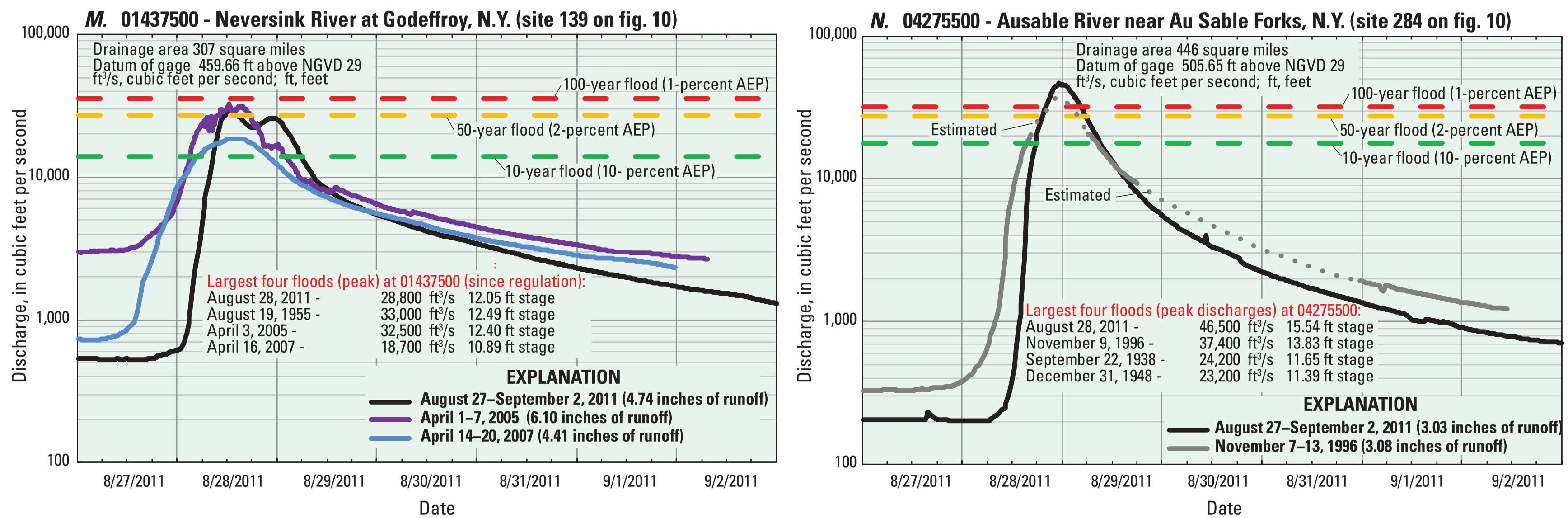

Figure 35. Discharge hydrographs for August 27–September 2, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)—Continued

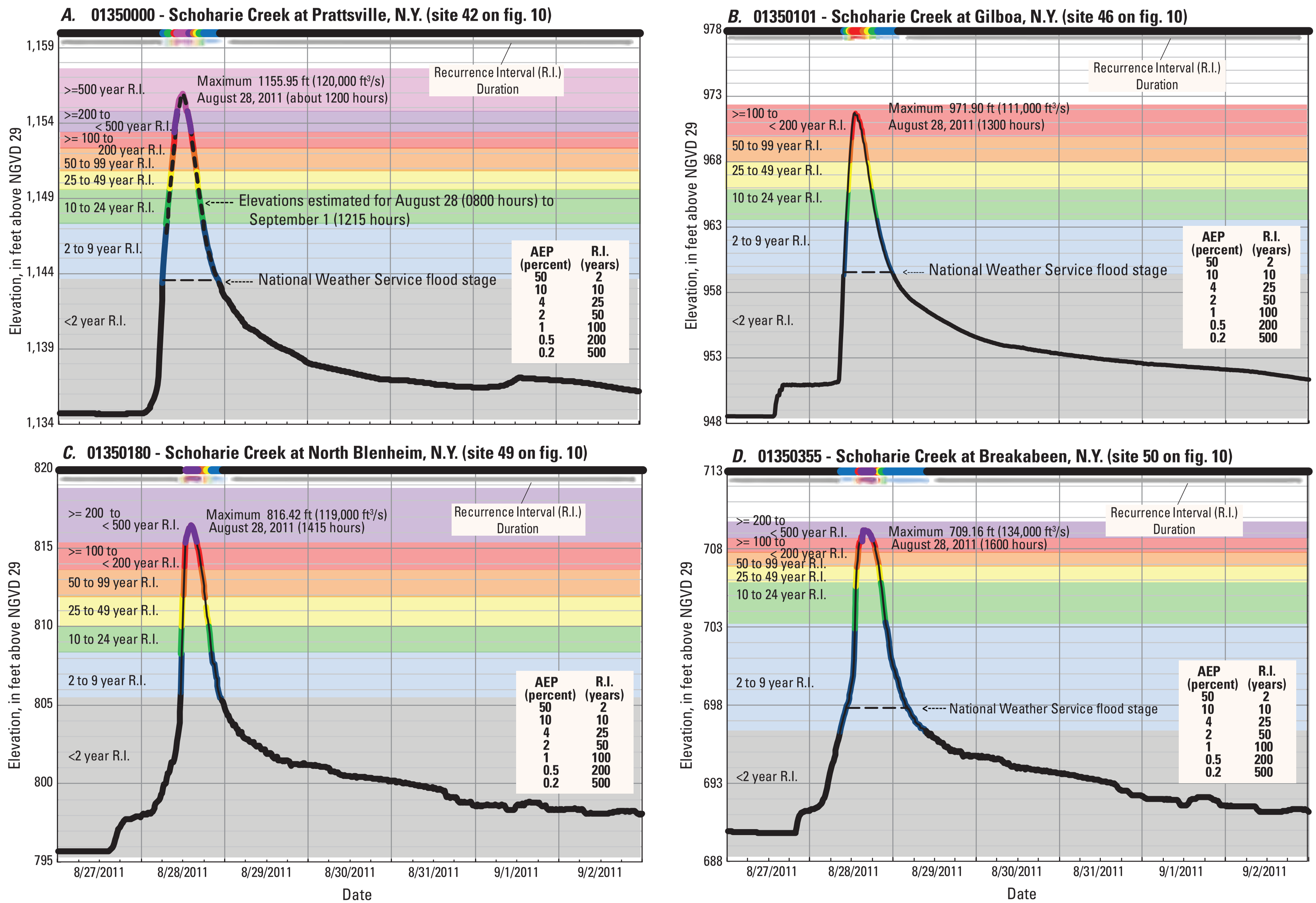

Figure 36. Stage hydrographs for August 27–September 2, 2011, stage frequencies, and stage-frequency durations for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD 29, National Geodetic Vertical Datum of 1929; AEP, annual exceedance probability; <, less than; ≥, greater than or equal to; ft^3/s, cubic feet per second)

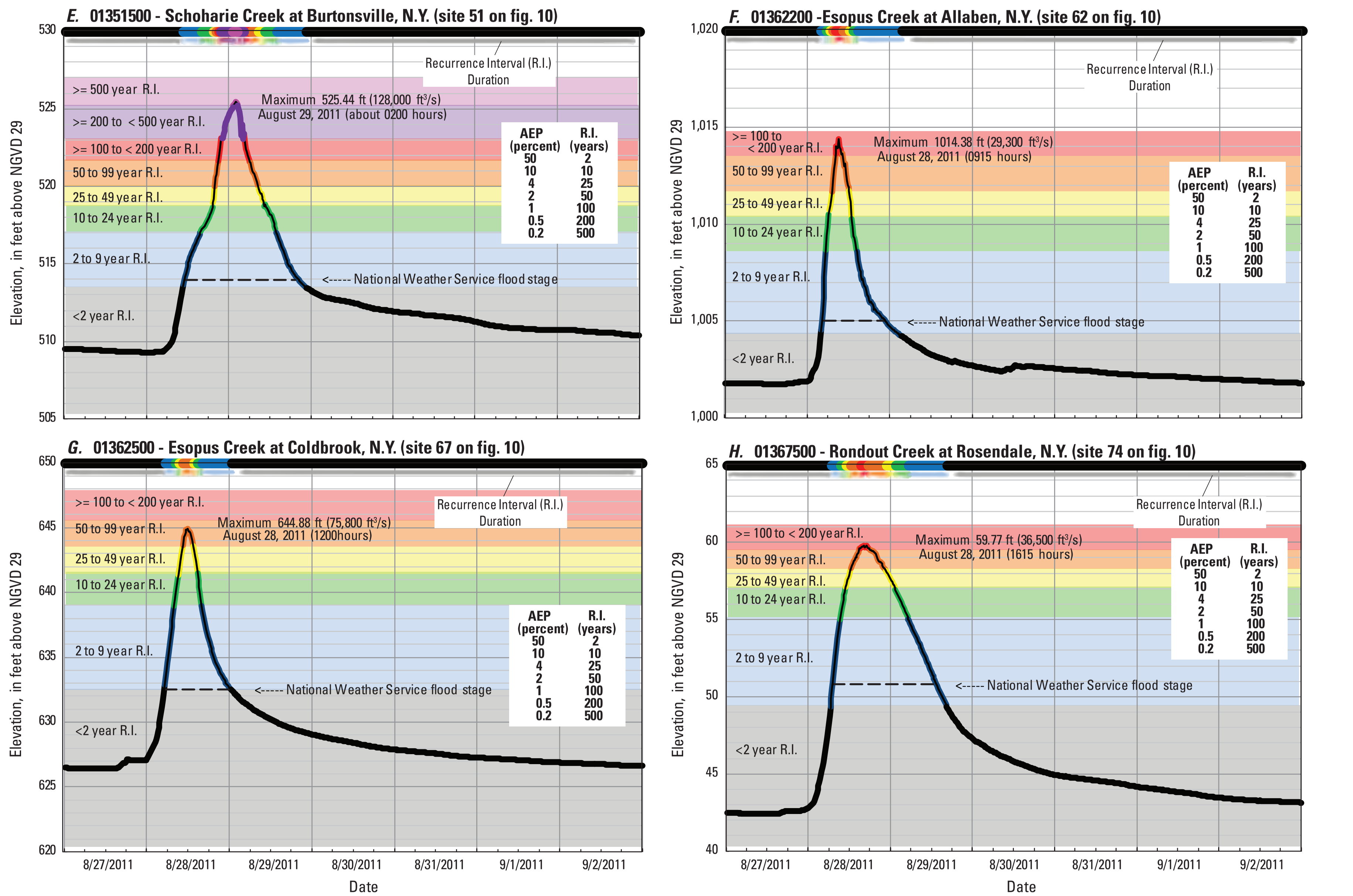

Figure 36. Stage hydrographs for August 27–September 2, 2011, stage frequencies, and stage-frequency durations for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD, National Geodetic Vertical Datum of 1929; AEP, annual exceedance probability; <, less than; ≥, greater than or equal to; ft³/s, cubic feet per second)—Continued

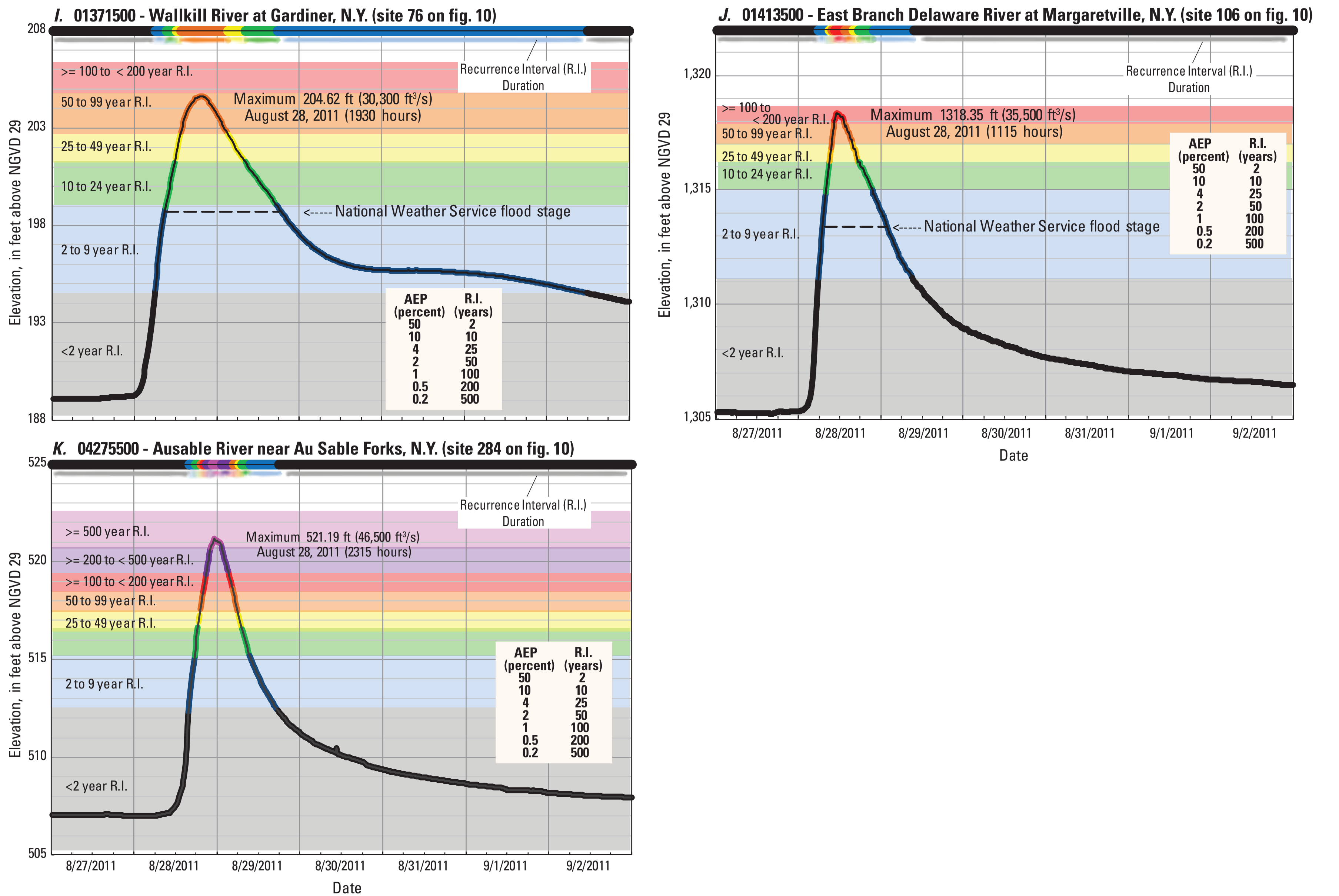

Figure 36. Stage hydrographs for August 27–September 2, 2011, stage frequencies, and stage-frequency durations for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD, National Geodetic Vertical Datum of 1929; AEP, annual exceedance probability; <, less than; ≥, greater than or equal to; ft³/s, cubic feet per second)—Continued

from a low level at 2:00 a.m. to the 50-percent AEP (2-year) stage at 6:00 a.m., peaked at about 12:00 p.m., and receded to below the 50-percent AEP (2-year) stage before the end of the day. In contrast, the much wider stage hydrograph for the Wallkill River at Gardiner (01371500) streamgage indicates that the stage on August 28 rose about 15.5 ft over 20 hours, peaking at 204.62 ft (90-year flood), and remained above the 50-percent AEP (2-year) stage for over 5 days (fig. 36I, table 11). In northern New York, the water level at the Ausable River near Au Sable Forks (04275500) remained above the 1-percent AEP (100-year) stage for about 9 hours, above the 0.5-percent AEP (200-year) stage for 7 hours, and above the 0.2-percent (500-year) stage for nearly 4 hours (fig. 36K).

Flood Profiles of Schoharie Creek

The devastating flooding along Schoharie Creek prompted a more detailed evaluation of the flood stages throughout the length of its reach. HWMs were identified and their elevations measured along an 84-mi reach of Schoharie Creek from the headwaters (near Hunter) to the mouth (near Fort Hunter) to allow documentation and evaluation of the extent and severity of the August 28, 2011, flood. A total of 184 HWMs were surveyed at 30 sites to define a general flood profile along the creek (fig. 37); for reference, the figure also shows approximate stream-bottom elevations, locations of major communities, streamgages (locations shown in fig. 38), and generalized FEMA flood-profile data (shown only to give the approximate locations where published FEMA studies were done).

After the August 2011 flood, the USGS flagged and surveyed 184 HWMs along Schoharie Creek (mostly at bridge crossings) and at 7 streamgages (figs. 37–38). Elevations of HWMs were surveyed upstream and downstream from the structure, when possible, and were rated subjectively by field personnel as “excellent,” “good,” “fair,” or “poor,” according to the guidelines by Benson and Dalrymple (1967). HWM elevations (relative to the North American Vertical Datum of 1988 (NAVD 88)) from the August 28 flood were compared with flood-profile elevations published in FEMA flood-insurance studies (Federal Emergency Management Agency, 1989, 2008, 2012a) for selected AEPs and with HWMs from the floods of April 1987 and January 1996 (Lumia, 1998) (table 13, fig. 39). Figure 39 also shows geometry for selected bridges (low chord and top of road elevations) obtained from field surveys or from published FEMA flood-insurance studies.

August 2011 flood elevations were higher than those of April 1987 and January 1996 throughout the study reach (table 13, fig. 39). Flood elevations on August 28 ranged from 0.6 ft (at Hunter) to 11.1 ft (at Mill Point) higher than the January 1996 flood. From Hunter to Jewett (sites 1–5, figs. 39A–E), the August 2011 HWM elevations in these upper reaches of Schoharie Creek were generally between the 10- and 2-percent AEP (10- and 50-year) flood elevations published by FEMA in the most recent flood-insurance study. At Lexington (sites 6–7, figs. 39F–G), 2011 peak elevations were generally greater than the FEMA 1-percent AEP (100-year) elevations, except for those upstream from the State Route 42 bridge (site 7, fig. 39G), where they were at the 2-percent AEP (50-year) elevations. The August 2011 elevations at Mosquito Point (site 8, fig. 39H) were higher than the FEMA 1-percent AEP (100-year) elevations upstream from the bridge at County Road 2 but lower than the 2-percent AEP (50-year) elevations downstream from the bridge. In Prattsville (site 9, fig. 39I), August 2011 HWM elevations at 19 locations surveyed at the State Route 23 bridge were generally greater than the 1-percent AEP (100-year) FEMA elevations but a few feet lower than the published 0.2-percent AEP (500-year) elevations. No FEMA studies are available for Schoharie Reservoir (site 10, fig. 39J) downstream to Boucks Island in Fultonham (site 17, fig. 39Q). Site number 14 (fig. 39N) shows HWMs at State Route 30 in North Blenheim, near the old covered bridge (built in 1855), which unfortunately was destroyed on August 28 as the floodwater rose 5.3 ft higher than the previous maximum elevation during the January 1996 flood (fig. 40). FEMA studies are available for Middleburg (site 18, fig. 39R) to Esperance (site 24, fig. 39X), and the August 2011 peak elevations were generally at or greater than the FEMA 0.2-percent AEP (500-year) elevations published in the most recent flood-insurance studies. FEMA flood-insurance studies are not available for Burtonsville (site 25, fig. 39Y) downstream to the mouth of Schoharie Creek at the Mohawk River near Fort Hunter (site 30, figs. 39A–D).

HWM elevations were surveyed by FEMA (Federal Emergency Management Agency, 2011e) at 72 locations following the August 2011 flood in the Delaware and lower Hudson River Basins (table 14, fig. 41A) and by the NYSCC (New York State Canal Corporation, written commun., 2012) at 13 locations on the Mohawk River from Randall (lock 13) to Vischer Ferry (lock 7) (table 15, fig. 41B). Elevations of the August 2011 HWMs on the Mohawk River ranged from 1.4 to 7.4 ft higher than HWM elevations for the June 2006 flood (table 15) at the same locations.

Coastal Flooding in Extreme Southeastern New York and Long Island

Tropical Storm Irene battered coastal areas in the southeastern corner of New York and Long Island on August 28. High-water elevations were recorded at USGS tide gages, and elevations of sea-level HWMs measured by other agencies (McCallum and others, 2012) indicate that the storm surge generally ranged from 3.2 ft (Suffolk County) to nearly 10 ft (Nassau County) above NAVD 88 (table 16, fig. 42). One HWM surveyed by the USGS was about 20.8 ft above NAVD 88 in Nassau County, but the accuracy of the measurement is unclear (possible wave runup). FEMA (Federal Emergency Management Agency, 2011d) documented coastal peak water elevations in five counties in and around New York City and western Long Island (table 17, fig. 43). The FEMA peak water elevations ranged from 4.1 ft (Richmond County) to 14.1 ft (Nassau County) above NAVD 88.

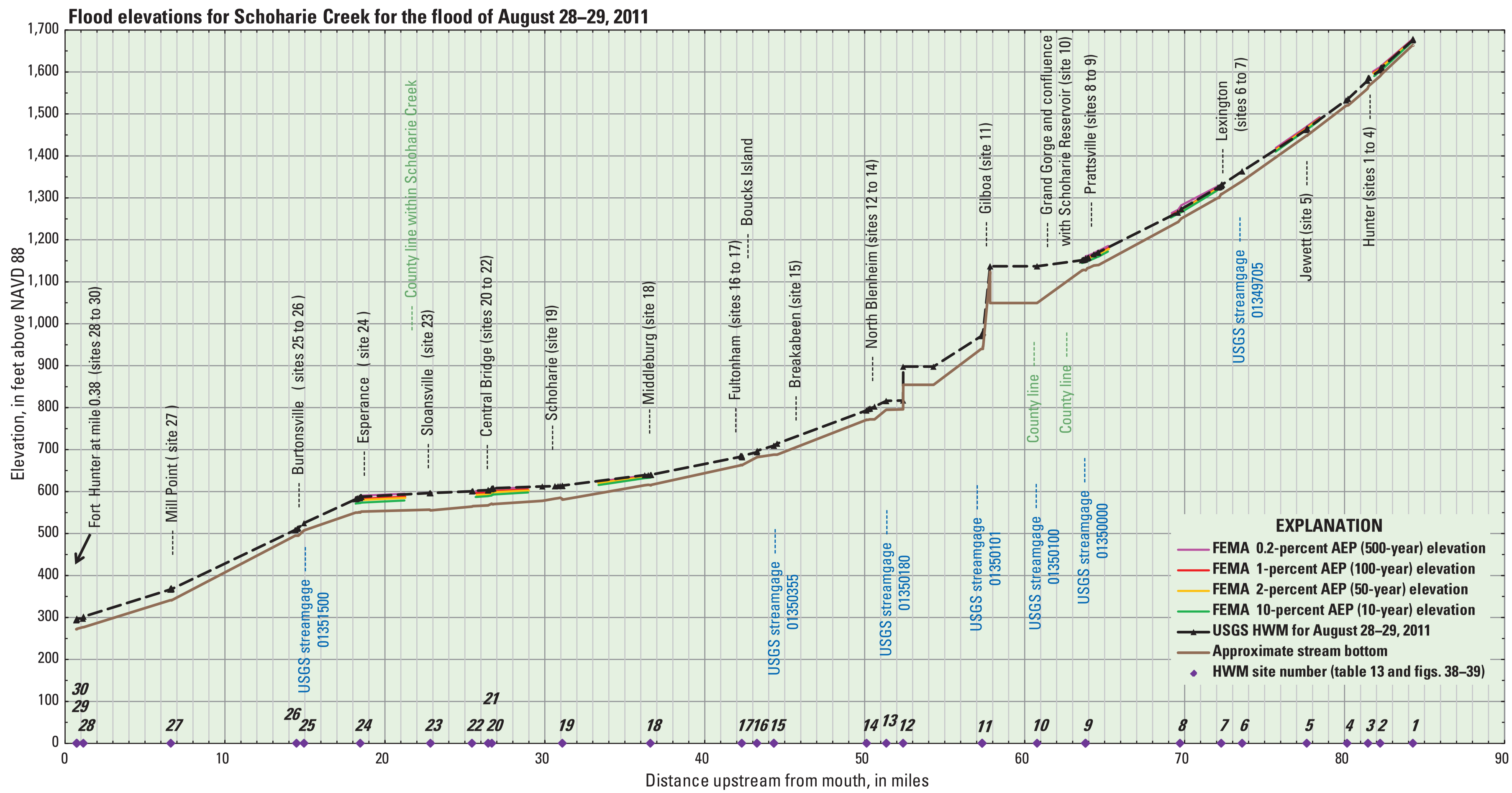

Figure 37. A generalized profile of Schoharie Creek for the flood of August 28–29, 2011, with the elevations of high-water marks, approximate Federal Emergency Management Agency (FEMA) flood profiles, approximate stream-bottom elevations, and locations of local communities and U.S. Geological Survey (USGS) streamgages in New York. (Data are given in table 13, and site locations are shown on figure 38. Detailed flood elevations are shown on figure 39; USGS streamgages are listed in appendix 1 and shown on figure 10. NAVD 88, North American Vertical Datum of 1988; AEP, annual exceedance probability; HWM, high-water mark)

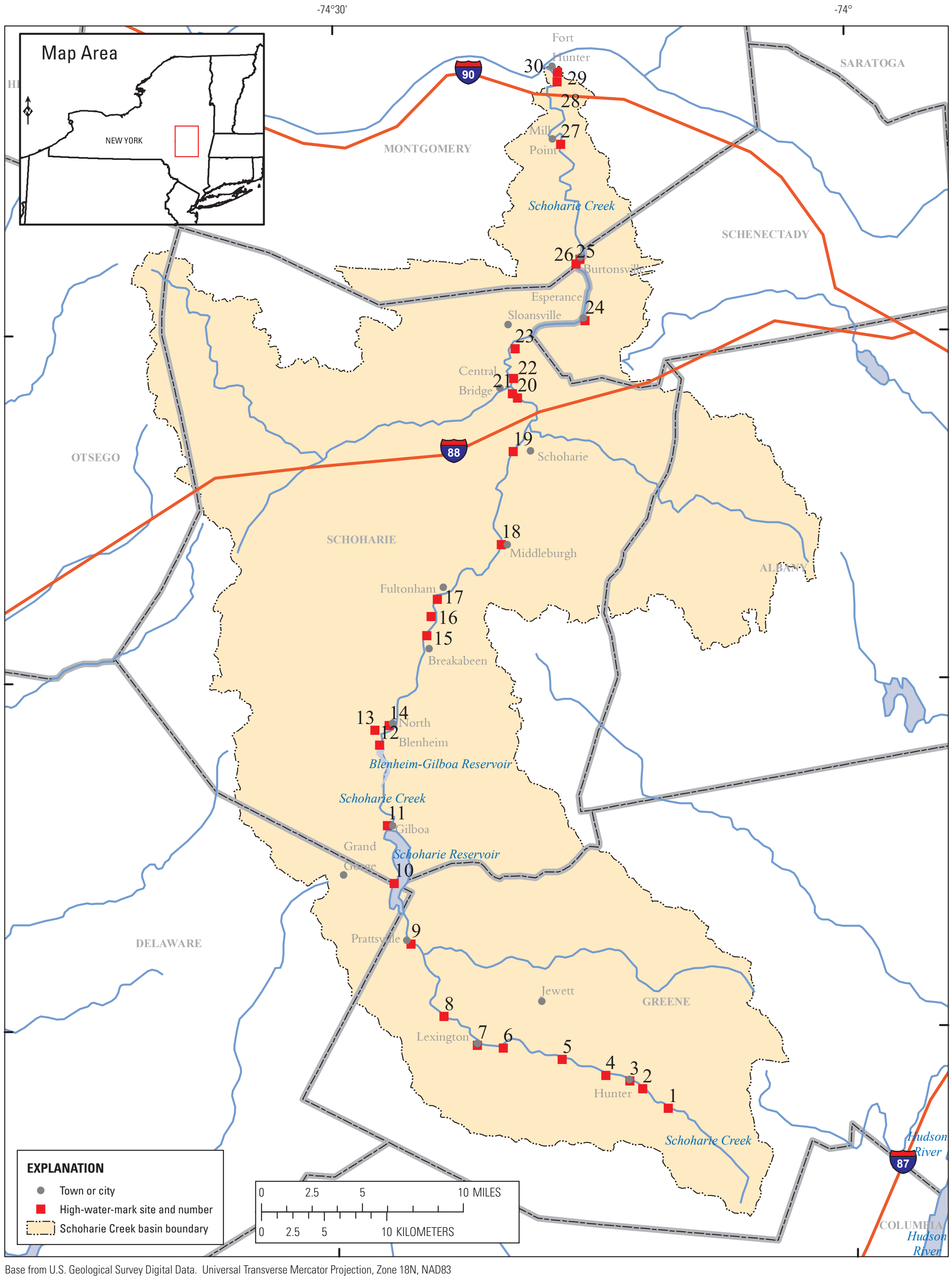

Figure 38. Locations of high-water-mark sites selected for the flood of August 28–29, 2011, along Schoharie Creek from Hunter to Fort Hunter, New York.

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1989, 2008, 2012a); HWM ID, high-water-mark identification; HWM, high-water mark; --, no data available; high-water-mark location—USRB, upstream right bank; USLB, upstream left bank; DSRB, downstream right bank; DSLB, downstream left bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; F, fair; P, poor; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of January 19–20, 1996, from Lumia, 1998; elevation data for the flood of April 4–5, 1987, from Zembrzuski and Evans, 1989; locations are shown on figures 37–39]

Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
1		84.269	State Route 214 bridge at Hunter, N.Y. (Greene County)											
	1–1	84.283	USRB–On ground–Wash line	P	42.19242	-74.18156	1,678.99	1,673.9	1,676.9	1,677.9	1,680.0	--	1,675.82	1,663.0
	1–2	84.270	USLB–On ground–Debris line	F	42.19217	-74.18186	1,677.13	1,673.8	1,676.6	1,677.6	1,679.7	1,671.38	1,675.22	1,664.1
	1–3	84.288	USLB–On ground–Debris line	F	42.19225	-74.18231	1,677.25	1,674.0	1,677.0	1,678.0	1,680.2	1,671.38	--	1,663.1
	1–4	84.256	DSRB–On ground–Wash line	P	42.19264	-74.18228	1,676.95	1,673.5	1,676.1	1,677.1	1,678.5	1,670.42	1,674.77	1,664.0
	1–5	84.259	DSLB–On ground–Debris line	F	42.19233	-74.18272	1,675.62	1,673.6	1,676.2	1,677.2	1,678.6	1,669.93	1,674.45	1,664.1
2		82.233	County Road 83 bridge at Hunter, N.Y. (Greene County)											
	2–1	82.330	USRB–On ground–Debris line	G	42.20669	-74.20608	1,610.98	1,605.1	1,612.0	1,612.9	1,615.3	--	--	1,595.0
	2–2	82.328	USRB–On ground–Debris line	G	42.20669	-74.20611	1,610.69	1,605.0	1,611.9	1,612.8	1,615.2	--	--	1,594.9
	2–3	82.273	USLB–On Dolan's Lake building–Mud line	G	42.20664	-74.20733	1,610.43	1,604.0	1,611.3	1,612.1	1,614.1	--	--	1,593.1
	2–4	82.274	USLB–On tree–Mud line	P	42.20683	-74.20719	1,609.65	1,604.0	1,611.3	1,612.1	1,614.1	1,605.86	1,605.84	1,593.1
	2–5	82.283	USRB–On basement window of 7729 Main Street–Seed line	G	42.20719	-74.20678	1,609.16	1,604.2	1,611.6	1,612.2	1,614.4			1,593.1
	2–6	82.227	DSLB–On ground–Debris line	F	42.20733	-74.20819	1,605.92	1,602.1	1,606.7	1,608.2	1,612.1	1,604.19	1,604.17	1,590.3
	2–7	82.229	DSLB–On ground–Debris line	P	42.20731	-74.20822	1,604.18	1,602.1	1,606.7	1,608.2	1,612.1	--	--	1,590.3
3		81.470	Bridge Street bridge at Hunter, N.Y. (Greene County)											
	3–1	81.544	USRB–On ground–Debris line	F	42.21247	-74.21842	1,586.10	1,580.4	1,589.8	1,591.8	1,595.6	--	--	1,567.7
	3–2	81.542	USRB–On ground–Debris line	F	42.21250	-74.21844	1,586.11	1,580.4	1,589.8	1,591.8	1,595.6	1,583.24	1,582.45	1,567.7
	3–3	81.498	USRB–On barn interior wall–Seed line	G	42.21261	-74.21897	1,585.94	1,579.7	1,589.2	1,591.3	1,594.9	--	--	1,565.8
	3–4	81.487	USRB–On ground–Debris line	P	42.21308	-74.21908	1,586.51	1,579.5	1,589.1	1,591.2	1,594.8	--	--	1,565.1
	3–5	81.438	DSRB–On screen door of shed behind 7997 Main Street–Seed line	G	42.21372	-74.21989	1,579.18	1,574.1	1,578.8	1,580.5	1,584.8	1,576.78	1,577.11	1,560.0
4		80.161	Deming Road bridge at Hunter, N.Y. (Greene County)											
	4–1	80.227	USLB–On ground–Debris line	F	42.21664	-74.24167	1,536.11	1,534.0	1,539.6	1,541.3	1,543.8	--	--	1,520.5
	4–2	80.225	USLB–On ground–Debris line	F	42.21667	-74.24169	1,536.29	1,534.0	1,539.6	1,541.3	1,543.8	1,533.92	1,533.95	1,520.5
	4–3	80.106	DSRB–On ground–Debris line	F	42.21711	-74.24406	1,532.72	1,531.8	1,534.2	1,535.4	1,538.0	1,532.12	1,531.53	1,519.8
	4–4	80.097	DSRB–On ground–Debris line	F	42.21714	-74.24422	1,532.63	1,531.5	1,534.0	1,535.0	1,537.7	1,532.06	1,531.61	1,519.9
5		77.634	Carr Road bridge at Jewett, N.Y. (Greene County)											
	5–1	77.674	USRB–On ground–Debris line	P	42.22836	-74.28344	1,465.51	1,463.2	1,467.1	1,468.2	1,470.9	1,461.19	1,462.99	1,448.9
	5–2	77.657	USRB–On ground–Debris line	F	42.22836	-74.28381	1,465.45	1,463.2	1,467.0	1,468.1	1,470.6	--	--	1,448.1

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1989, 2008, 2012a); HWM ID, high-water-mark identification; HWM, high-water mark; --, no data available; high-water-mark location—USRB, upstream right bank; USLB, upstream left bank; DSRB, downstream right bank; DSLB, downstream left bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; F, fair; P, poor; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of January 19–20, 1996, from Lumia, 1998; elevation data for the flood of April 4–5, 1987, from Zembrzuski and Evans, 1989; locations are shown on figures 37–39]

Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet)							
							Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	5–3	77.653	USRB–On ground–Debris line	G	42.22839	-74.28386	1,465.54	1,463.1	1,466.9	1,468.0	1,470.5	1,461.71	1,462.99	1,447.9
	5–4	77.610	DSRB–On ground–Debris line	F	42.22856	-74.28478	1,462.45	1,462.1	1,464.9	1,466.2	1,469.2	1,459.33	1,460.68	1,447.8
	5–5	77.604	DSRB–On ground–Debris line	F	42.22856	-74.28486	1,461.81	1,462.0	1,464.8	1,466.1	1,469.1	--	--	1,447.8
6/01349705		73.600	Streamgage at Lexington, N.Y. (Greene County)											
	6–1	73.600	USLB–On ground–Wash line	P	42.23694	-74.34050	1,363.46	1,353.8	1,357.9	1,359.8	1,364.1	--	--	1,340.0
	6–2	73.600	USLB–On ground–Wash line	F	42.23694	-74.34053	1,363.55	1,353.8	1,357.9	1,359.8	1,364.1	--	--	1,340.0
	6–3	73.600	USLB–On ground–Wash line	F	42.23694	-74.34058	1,363.33	1,353.8	1,357.9	1,359.8	1,364.1	--	--	1,340.0
	6–4	73.600	LB–Recorded	E	42.23694	-74.34056	1,362.10	1,353.8	1,357.9	1,359.8	1,364.1	--	--	1,340.0
7		72.294	State Route 42 bridge at Lexington, N.Y. (Greene County)											
	7–1	72.350	USLB–On ground–Wash line	G	42.23917	-74.36525	1,331.81	1,324.9	1,331.8	1,332.9	1,335.8	--	--	1,309.9
	7–2	72.348	USLB–On ground–Wash line	G	42.23917	-74.36528	1,331.86	1,324.9	1,331.8	1,332.9	1,335.8	--	--	1,309.9
	7–3	72.335	USRB–On ground behind house at 3936 State Route 42–Debris line	G	42.24006	-74.36469	1,331.87	1,324.8	1,331.8	1,332.8	1,335.8	1,326.52	--	1,309.6
	7–4	72.333	USRB–On ground behind house at 3936 State Route 42–Debris line	G	42.24008	-74.36472	1,331.92	1,324.7	1,331.8	1,332.8	1,335.8	1,326.99	1,325.95	1,309.5
	7–5	72.337	USLB–On ground–Wash line	F	42.23919	-74.36558	1,331.61	1,324.8	1,331.8	1,332.8	1,335.8	--	--	1,309.7
	7–6	72.318	USRB–On shed behind 3926 State Route 42–Mud line	G	42.24006	-74.36508	1,331.31	1,324.6	1,331.6	1,332.6	1,335.4	--	--	1,309.1
	7–7	72.307	USRB–On basement window of 3926 State Route 42–Mud line	F	42.24017	-74.36522	1,331.25	1,324.2	1,331.3	1,332.2	1,335.1	--	--	1,308.8
	7–8	72.292	DSLB–On ground–Wash line	P	42.23972	-74.36628	1,328.68	1,324.0	1,327.6	1,329.2	1,332.9	--	--	1,308.6
	7–9	72.290	DSLB–On ground–Debris line	P	42.23972	-74.36631	1,329.06	1,324.0	1,327.6	1,329.2	1,332.9	--	--	1,308.6
	7–10	72.282	DSLB–On ground–Debris line	G	42.23981	-74.36644	1,328.77	1,323.9	1,327.6	1,329.1	1,332.9	--	--	1,308.6
	7–11	72.292	DSRB–On ground–Debris line	G	42.24056	-74.36544	1,329.79	1,324.0	1,327.6	1,329.2	1,332.9	--	--	1,308.6
	7–12	72.282	DSRB–On ground–Debris line	G	42.24053	-74.36569	1,328.96	1,323.9	1,327.6	1,329.1	1,332.9	1,324.71	1,324.29	1,308.6
	7–13	72.269	DSLB–On ground–Wash line	P	42.23992	-74.36667	1,328.36	1,323.8	1,327.6	1,329.1	1,332.9	--	--	1,308.5
	7–14	72.267	DSLB–On ground–Wash line	P	42.23994	-74.36667	1,328.27	1,323.8	1,327.6	1,329.1	1,332.9	--	--	1,308.5
	7–15	72.199	DSRB–On front porch of 38 County Road 13A–Seed line	G	42.24133	-74.36694	1,326.16	1,321.9	1,324.7	1,325.6	1,328.6	--	--	1,303.0
	7–16	72.157	DSRB–On front window of 59 County Road 13A–Mud line	E	42.24167	-74.36761	1,325.33	1,321.0	1,323.8	1,325.1	1,328.3	--	--	1,300.0

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1989, 2008, 2012a); HWM ID, high-water-mark identification; HWM, high-water mark; --, no data available; high-water-mark location—USRB, upstream right bank; USLB, upstream left bank; DSRB, downstream right bank; DSLB, downstream left bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; F, fair; P, poor; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of January 19–20, 1996, from Lumia, 1998; elevation data for the flood of April 4–5, 1987, from Zembrzuski and Evans, 1989; locations are shown on figures 37–39]

Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	7–17	72.093	DSRB–On side window of 91 County Road 13A–Mud line	E	42.24228	-74.36856	1,325.06	1,319.0	1,322.9	1,324.6	1,328.2	--	--	1,300.5
	7–18	72.089	DSRB–On front window of 80 County Road 13A–Mud line	E	42.24275	-74.36822	1,324.80	1,319.0	1,322.9	1,324.6	1,328.2	--	--	1,300.3
8		69.718	County Road 2 (Mosquito Point) bridge at Prattsville, N.Y. (Greene County)											
	8–1	69.799	USLB–On door of home on Fuller Road–Mud line	G	42.25978	-74.39739	1,273.21	1,265.9	1,270.1	1,272.1	1,282.3	1,268.01	1,267.62	1,250.9
	8–2	69.794	USLB–On storm door of home on Fuller Road–Mud line	G	42.25986	-74.39742	1,273.20	1,265.9	1,270.1	1,272.1	1,282.3	--	--	1,250.8
	8–3	69.587	DSRB–On ground–Debris line	F	42.26219	-74.40014	1,265.10	1,261.9	1,265.8	1,267.2	1,271.1	--	1,266.77	1,242.2
	8–4	69.570	DSRB–On ground–Debris line	G	42.26244	-74.40031	1,264.83	1,261.8	1,265.7	1,267.1	1,271.1	--	1,266.33	1,242.3
9		63.798	State Route 23 bridge at Prattsville, N.Y. (Greene County)											
	9–1	64.613	USRB–On front door of 14438 State Route 23–Mud line	G	42.31231	-74.42875	1,170.20	1,159.9	1,165.2	1,167.8	1,173.4	--	--	1,139.9
	9–2	64.594	USRB–On window of 1452 State Route 23–Mud line	F	42.31242	-74.42900	1,169.17	1,159.9	1,165.2	1,167.8	1,173.4	--	--	1,139.9
	9–3	64.567	USRB–On siding of Prattsville Methodist Church–Seed line	G	42.31283	-74.42953	1,169.26	1,159.6	1,165.2	1,167.8	1,173.4	--	--	1,139.9
	9–4	64.329	USRB–On front door to Sheriff's Office/Town Hall–Mud line	E	42.31375	-74.43206	1,165.42	1,155.2	1,161.0	1,162.9	1,168.1	--	--	1,138.9
	9–5	63.999	USRB–On window of Prattsville Reformed Church–Mud line	E	42.31697	-74.43550	1,158.09	1,150.4	1,156.8	1,158.0	1,163.0	--	--	1,133.0
	9–6	63.978	USRB–On front door of unit 2, 14634 State Route 23–Mud line	G	42.31719	-74.43558	1,157.44	1,149.7	1,155.9	1,156.9	1,162.0	--	1,150.78	1,133.0
	9–7	63.923	USRB–On window of Moore's Motel 14672 State Route 23–Mud line	F	42.31781	-74.43506	1,156.16	1,148.4	1,155.4	1,156.6	1,161.8	--	1,151.66	1,132.3
	9–8	63.920	USRB–On window of Moore's Motel 14672 State Route 23–Mud line	E	42.31789	-74.43506	1,156.20	1,148.4	1,155.4	1,156.6	1,161.8	1,151.65	1,149.17	1,132.3
9/01350000	9–9	63.817	Streamgage at Prattsville, N.Y. (USLB–Seed line, gage destroyed) (Greene County)	G	42.31942	-74.43697	1,156.07	1,148.0	1,155.1	1,156.0	1,161.1	--	--	1,127.3
9/01350000	9–10	63.817	Streamgage at Prattsville, N.Y. (USLB–Mud line, gage destroyed) (Greene County)	E	42.31944	-74.43694	1,155.34	1,148.0	1,155.1	1,156.0	1,161.1	1,150.35	1,149.33	1,127.3

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1989, 2008, 2012a); HWM ID, high-water-mark identification; HWM, high-water mark; --, no data available; high-water-mark location—USRB, upstream right bank; USLB, upstream left bank; DSRB, downstream right bank; DSLB, downstream left bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; F, fair; P, poor; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of January 19–20, 1996, from Lumia, 1998; elevation data for the flood of April 4–5, 1987, from Zembrzuski and Evans, 1989; locations are shown on figures 37–39]

Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	9–11	63.776	DSRB–On tan house at 22 County Road 7–Mud line	G	42.32000	-74.43550	1,153.06	1,147.3	1,151.4	1,153.0	1,157.1	1,150.28	--	1,127.8
	9–12	63.723	DSRB–On green house County Road 7–Mud line	E	42.32080	-74.43520	1,152.29	1,146.6	1,150.2	1,151.8	1,155.5	1,149.14	--	1,128.1
	9–13	63.696	DSRB–On white house with green trim County Road 7–Mud line	G	42.32120	-74.43510	1,152.80	1,146.0	1,149.1	1,150.2	1,154.0	--	--	1,128.4
	9–14	63.677	DSRB–On garage of house at 50 County Road 7–Seed line	G	42.32150	-74.43510	1,152.50	1,145.8	1,148.9	1,150.1	1,153.8	--	--	1,128.1
	9–15	63.652	DSRB–On yellow house County Road 7–Mud line	F	42.32180	-74.43500	1,152.13	1,145.4	1,148.6	1,150.0	1,153.6	--	--	1,127.8
	9–16	63.635	DSRB–On brown house with white trim County Road 7–Mud line	G	42.32200	-74.43490	1,151.68	1,145.1	1,148.3	1,149.8	1,153.4	--	--	1,127.8
	9–17	63.615	DSRB–On white and green house County Road 7–Mud line	G	42.32230	-74.43460	1,151.57	1,145.0	1,148.2	1,149.8	1,153.3	--	--	1,128.0
	9–18	63.599	DSRB–On white trailer home County Road 7–Mud line	E	42.32250	-74.43440	1,151.39	1,144.9	1,148.2	1,149.7	1,153.3	--	--	1,127.0
	9–19	63.584	DSRB–On brown house County Road 7–Mud line	E	42.32270	-74.43390	1,151.30	1,144.8	1,148.1	1,149.5	1,153.3	--	--	1,126.9
10/01350100		60.777	Streamgage at Schoharie Reservoir near Grand Gorge, N.Y. (Schoharie County)											
	10–1	60.777	LB–Recorded	E	42.35583	-74.44500	1,137.13	--	--	--	--	1,136.08	1,135.09	1,049.4
	10–2	60.777	LB–On Shandaken Tunnel intake house–Seed line	E	42.35586	-74.44500	1,137.12	--	--	--	--	1,136.02	--	
	10–3	60.777	LB–On Shandaken Tunnel intake house–Seed line	E	42.35586	-74.44500	1,137.14	--	--	--	--	--	--	
	10–4	60.777	LB–On Shandaken Tunnel intake house–Seed line	E	42.35589	-74.44500	1,137.15	--	--	--	--	--	--	
11		57.345	State Route 990V bridge at Gilboa, N.Y. (Schoharie County)											
	11–1	57.407	USLB–On ground–Debris line	G	42.39719	-74.45114	980.47	--	--	--	--	--	--	
	11–2	57.402	USLB–On ground–Debris line	G	42.39728	-74.45117	980.78	--	--	--	--	--	--	
	11–3	57.390	USLB–On ground–Debris line	F	42.39740	-74.45097	979.59	--	--	--	--	--	--	
11/01350101	11–4	57.386	Streamgage at Gilboa, N.Y. (USLB–Debris line, gage destroyed) (Schoharie County)	F	42.39742	-74.45083	979.48	--	--	--	--	969.56	969.16	946.0
	11–5	57.386	USLB–On ground–Debris line	F	42.39744	-74.45089	978.98	--	--	--	--			
	11–6	57.384	USLB–On ground–Debris line	F	42.39744	-74.45083	977.67	--	--	--	--	971.20	968.20	
	11–7	57.316	DSLB–On ground–Debris line	F	42.39839	-74.45014	971.07	--	--	--	--	970.24	966.55	940.0
	11–8	57.286	DSLB–On ground–Debris line	G	42.39883	-74.45000	970.56	--	--	--	--	--	--	

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Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet)							
							Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
12		52.405	Blenheim-Gilboa Lower Reservoir and Dam at North Blenheim, N.Y. (Schoharie County)											
	12–1	52.405	Recorded–furnished by New York Power Authority	E	42.45503	-74.45825	897.79	--	--	--	--	895.00	889.70	854.5
13/01350180		51.350	Streamgage at North Blenheim, N.Y. (Schoharie County)											
	13–1	51.350	LB–On stair railing–Seed line	E	42.46582	-74.46250	816.27	--	--	--	--	--	--	794.9
	13–2	51.350	LB–On stair railing–Seed line	E	42.46581	-74.46250	816.26	--	--	--	--	--	--	
	13–3	51.350	LB–Recorded	E	42.46583	-74.46250	815.92	--	--	--	--	811.53	810.62	
14		50.123	State Route 30 bridge at North Blenheim, N.Y. (Schoharie County)											
	14–1	50.616	USLB–On window of 1823 State Route 30–Mud line	E	42.46911	-74.44875	802.78	--	--	--	--	--	--	
	14–2	50.345	USLB–On door of shed behind 1872 State Route 30–Mud line	F	42.47069	-74.44425	798.16	--	--	--	--	--	--	
	14–3	50.307	USLB–On exterior wall of 1878 State Route 30–Mud line	G	42.47111	-74.44372	797.56	--	--	--	--	794.24	791.55	
	14–4	50.218	USLB–On exterior wall of 1886 State Route 30–Mud line	F	42.47125	-74.44283	796.86	--	--	--	--	791.59	790.85	
	14–5	50.102	DSLB–On door of 103 Bear Ladder Road–Mud line	E	42.47203	-74.44283	793.36	--	--	--	--	--	--	
	14–6	50.114	DSRB–On ground–Debris line	F	42.47325	-74.44083	793.51	--	--	--	--	789.26	787.73	771.0
15		44.326	State Route 30 bridge at Breakabeen, N.Y. (Schoharie County)											
	15–1	44.525	USRB–On wall in shed in front of 2887 State Route 30–Seed line	G	42.53364	-74.41175	714.42	--	--	--	--	707.54	706.36	
	15–2	44.525	USRB–On window of shed in front of 2887 State Route 30–Mud line	G	42.53364	-74.41167	714.46	--	--	--	--	707.58	707.10	
	15–3	44.320	DSLB–On ground–Debris line	F	42.53767	-74.41031	709.59	--	--	--	--	--	--	
15/01350355	15–4	44.318	Streamgage at Breakabeen, N.Y. (DSLB–Seed line in gage house) (Schoharie County)	E	42.53764	-74.41022	709.51	--	--	--	--	707.25	706.22	688.0
16		43.265	State Route 30 bridge near Max V. Shaul State Park, Fultonham, N.Y. (Schoharie County)											
	16–1	43.278	USLB–On ground–Debris line	P	42.54756	-74.40736	697.41	--	--	--	--	694.40	693.78	682.0
	16–2	43.259	DSRB–On ground–Debris line	P	42.54944	-74.40556	695.28	--	--	--	--	693.06	688.99	
	16–3	43.269	USRB–On ground–Debris line	P	42.54953	-74.40522	693.87	--	--	--	--	693.08	--	

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

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Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
17		42.313	State Route 30 bridge near Boucks Island at Fultonham, N.Y. (Schoharie County)											
	17–1	42.333	USRB–On ground–Debris line	P	42.55968	-74.40097	685.21	--	--	--	--	682.18	680.82	663.0
	17–2	42.341	USLB–On trailer–Landward of overtopped levee–Seed line	E	42.56110	-74.40165	681.84	--	--	--	--	--	--	
	17–3	42.301	DSRB–On ground just landward of levee–Debris line	P	42.56012	-74.40045	684.91	--	--	--	--	--	678.24	
	17–4	42.246	DSRB–On white house 320 feet landward of levee–Mud line	G	42.55978	-74.39925	685.81	--	--	--	--	681.08	679.07	
	17–5	42.307	DSLB–On ground–Debris line	P	42.56115	-74.40085	683.52	--	--	--	--	--	--	
	17–6	42.305	DSLB–On tree (about 6.7 feet above ground)–Seed line	F	42.56127	-74.40088	683.51	--	--	--	--	--	--	
18		36.604	State Routes 30/145 bridge at Middleburgh, N.Y. (Schoharie County)											
	18–1	36.657	USLB–On generator near Department of Public Works building (about 0.8 feet above ground)–Seed line	G	42.59882	-74.33835	640.30	634.1	636.6	637.7	640.2	636.23	635.31	616.0
	18–2	36.623	USRB–On window of café (about 5.6 feet above ground)–Mud line	E	42.59905	-74.33598	639.79	633.9	636.3	637.4	640.0	636.04	635.00	614.8
	18–3	36.603	DSRB–On window of Subway restaurant (about 3.5 feet above ground)–Mud line	G	42.59945	-74.33573	639.79	633.2	635.9	637.1	639.9	635.49		615.3
	18–4	36.472	DSRB–On window of house at 128 River Street (about 7.8 feet above ground)–Mud line	G	42.60157	-74.33533	639.40	632.7	635.4	636.6	639.3	635.70	634.61	616.1
	18–5	36.250	DSRB–On window of Middleburgh Reformed Church (about 5.9 feet above ground)–Mud line	G	42.60475	-74.33750	639.21	631.8	634.7	635.8	638.4	635.80	633.62	615.1
19		31.098	Bridge Street bridge at Schoharie, N.Y. (Schoharie County)											
	19–1	31.098	USLB–On truss of bridge–Mud line	G	42.66547	-74.32623	614.31	603.0	609.6	609.8	613.1	608.08	606.74	580.7
	19–2	31.098	DSRB–On window of cedar house Bridge Street–Mud line	E	42.66528	-74.32553	614.01	602.8	609.4	609.6	613.0	--	604.56	580.8
	19–3	31.091	DSLB–On window of white house Bridge Street (about 6.6 feet above ground)–Seed line	G	42.66572	-74.32647	613.33	602.5	608.6	609.0	612.8	--	604.05	581.0
	19–4	31.106	DSRB–On window of 221 Main Street (about 4.6 feet above ground)–Mud line	G	42.66077	-74.31622	614.17	603.1	609.7	609.9	613.2	--	--	582.0

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Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	19–5	30.962	DSRB–On window of 256 Main Street (about 5.6 feet above ground)–Mud line	G	42.66237	-74.31365	613.49	602.2	605.8	607.6	612.0	--	--	585.4
	19–6	30.830	DSRB–On door of Schoharie County Courthouse (about 4.6 feet above ground)–Mud line	E	42.66358	-74.31148	613.18	601.9	605.4	607.3	611.9	607.28	--	584.1
	19–7	30.636	DSRB–On window of Exxon Mobil gas station (about 7.2 feet above ground)–Mud line	G	42.66603	-74.30952	613.00	601.2	605.1	607.0	611.8	--	--	583.1
	19–8	30.636	DSRB–On window of Exxon Mobil gas station (about 7.1 feet above ground)–Mud line	G	42.66603	-74.30952	612.90	601.2	605.1	607.0	611.8	--	--	583.1
	19–9	29.848	DSRB–On announcers' booth at Little League field (about 2.1 feet above second floor)–Seed line	G	42.67723	-74.30468	612.39	600.2	604.1	606.2	610.9	605.66	601.72	578.0
20		26.695	Interstate 88 bridge at Central Bridge, N.Y. (Schoharie County)											
	20–1	26.799	USLB–On house at 175 Karkerdorf Road (about 6.6 feet above ground)–Seed line	E	42.70407	-74.32170	608.18	593.1	598.6	601.6	606.9	--	--	570.2
	20–2	26.777	USLB–On white building (about 10.4 feet above ground)–Mud line	E	42.70435	-74.32188	607.88	592.9	598.3	601.2	606.6	600.47	597.98	569.8
	20–3	26.786	USLB–On ground–Debris line	P	42.70402	-74.32255	607.04	593.0	598.4	601.4	606.8	--	--	569.9
	20–4	26.725	USRB–On ground–Debris line	F	42.70575	-74.31762	608.10	592.7	598.0	601.0	606.4	--	--	569.8
	20–5	26.723	USRB–On ground–Debris line	F	42.70577	-74.31753	607.99	592.7	598.0	601.0	606.4	--	--	569.8
	20–6	26.682	DSRB–On riprap–Debris line	P	42.70677	-74.31885	606.66	590.6	595.3	598.0	604.5	--	596.36	571.2
	20–7	26.682	DSRB–On tree (about 5.1 feet above ground)–Debris line	P	42.70652	-74.31997	606.68	590.6	595.3	598.0	604.5	598.17		571.2
	20–8	26.676	DSRB–On tree (about 3.3 feet above ground)–Seed line	F	42.70677	-74.31930	606.59	590.5	595.2	597.9	604.2	597.72	595.91	571.1
	20–9	26.674	DSRB–On tree (about 5.3 feet above ground)–Debris line	P	42.70660	-74.31990	605.96	590.5	595.2	597.9	604.2	--	--	571.1
21		26.462	State Route 7 bridge at Central Bridge, N.Y. (Schoharie County)											
	21–1	26.468	USLB–On first floor window (about 6.5 feet above ground)–Mud line	G	42.70722	-74.32658	603.98	589.5	594.0	597.0	603.8	596.38	594.64	567.3
	21–2	26.466	USLB–On window of house at 3676 State Route 7 (about 5.1 feet above ground)–Mud line	E	42.70683	-74.32875	603.42	589.3	593.7	596.9	603.7	--	--	567.3

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Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	21–3	26.453	DSLB–On window of house at 3693 State Route 7 (about 5.0 feet above ground)–Mud line	E	42.70739	-74.32725	602.80	589.0	593.2	596.7	601.9	--	593.88	567.1
	21–4	26.453	DSLB–On building (about 5.8 feet above ground)–Seed line	E	42.70719	-74.32839	603.59	589.0	593.2	596.7	601.9	595.26	594.07	567.1
22		25.451	Railroad bridge at Central Bridge, N.Y. (Schoharie County)											
	22–1	25.500	USRB–On rafters of pole barn (about 13.9 feet above ground)–Seed line	E	42.71798	-74.32542	601.87	586.7	592.0	596.0	601.2	594.31	592.75	565.2
	22–2	25.451	DSRB–On truss of bridge (about 2.2 feet above railroad track)–Mud line	E	42.71783	-74.32728	600.63	586.6	591.3	594.0	600.2	592.09	590.71	564.1
	22–3	25.449	DSRB–On steel beam of bridge–Mud line	E	42.71789	-74.32731	600.68	586.5	591.2	593.5	599.8	--	--	564.1
23		22.848	Junction Road (County Road 27) bridge at Sloansville, N.Y. (Schoharie County)											
	23–1	22.849	USRB–On upstream edge of road–Debris line	G	42.73947	-74.32357	596.48	582.0	588.2	591.0	597.6	588.32	586.09	555.3
	23–2	22.849	USRB–On bridge girder (about 10.4 feet above bridge deck)–Mud line	E	42.74248	-74.32697	596.64	582.0	588.2	591.0	597.6	--	586.17	555.3
	23–3	22.849	USRB–On bridge girder (about 10.6 feet above bridge deck)–Mud line	E	42.74260	-74.32702	596.59	582.0	588.2	591.0	597.6	--	--	555.3
	23–4	22.849	USRB–On bridge girder (about 10.3 feet above bridge deck)–Mud line	E	42.74248	-74.32697	596.47	582.0	588.2	591.0	597.6	--	--	555.3
	23–5	22.799	DSLB–On window of house at 1142 State Route 30A (over 10 feet above ground)–Seed line	E	42.74440	-74.32738	596.43	581.7	587.9	590.6	597.5	587.82	584.87	557.0
24		18.460	State Route 20 bridge at Esperance, N.Y. (Schoharie and Schenectady Counties)											
	24–1	18.544	USRB–On tree–Seed line	G	42.75942	-74.25525	587.75	573.6	580.0	582.9	590.1	--	--	552.3
	24–2	18.523	USRB–On ground–Debris line	G	42.75969	-74.25508	587.59	573.5	579.9	582.8	590.0	--	--	552.2
	24–3	18.513	USRB–On ground–Debris line	G	42.75981	-74.25494	587.48	573.3	579.8	582.7	589.9	579.66	--	552.1
	24–4	18.489	USLB–On house at 178 State Route 20 (about 2.6 feet above ground)–Mud line	G	42.76056	-74.25739	587.63	573.1	579.4	582.2	589.6	--	--	551.0
	24–5	18.473	USLB–On Allstate Insurance building at 180 State Route 20 (about 2.9 feet above ground)–Mud line	E	42.76064	-74.25700	587.43	573.0	579.2	582.1	589.4	--	--	550.5
	24–6	18.466	USLB–On house at 182 State Route 20 (about 4.2 feet above ground)–Mud line	E	42.76072	-74.25686	587.09	573.0	579.1	582.0	589.3	--	--	550.2

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Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	24–7	18.436	DSLB–On window of Esperance Town Hall (about 6.0 feet above ground)–Mud line	G	42.76125	-74.25628	585.01	572.8	578.9	581.5	587.7	--	--	550.2
	24–8	18.455	DSRB–On ground–Debris line	G	42.76069	-74.25419	584.62	572.9	579.0	581.6	587.7	--	--	550.1
	24–9	18.384	DSLB–On house at 102 Charleston Road (about 4.2 feet above ground)–Mud line	G	42.76200	-74.25592	585.50	572.3	578.6	581.1	587.1	577.81	575.34	550.8
	24–10	18.413	DSRB–On ground–Debris line	F	42.76125	-74.25411	584.39	572.6	578.7	581.2	587.6	--	--	550.7
	24–11	18.284	DSLB–On ground–Debris line	F	42.76325	-74.25494	584.55	572.1	578.2	580.8	586.8	576.82	576.44	550.0
	24–12	18.267	DSLB–On ground–Debris line	F	42.76347	-74.25472	583.90	572.0	578.1	580.7	586.6	--	--	550.0
	24–13	18.233	DSLB–On ground–Debris line	F	42.76394	-74.25450	583.15	571.9	578.0	580.5	586.2	579.66	577.34	550.0
	24–14	18.199	DSLB–On ground–Debris line	F	42.76447	-74.25442	582.55	571.7	577.9	580.2	586.1	--	--	550.0
	24–15	18.170	DSLB–On ground–Debris line	F	42.76483	-74.25419	581.83	571.3	577.7	580.0	586.0	--	--	550.0
25/01351500	25–1	14.941	Streamgage at Burtonsville, N.Y. (USRB–Seed line in gage house) (Schenectady County)	E	42.80000	-74.26333	524.95	--	--	--	--	520.37	518.72	507.6
26		14.479	County Road 160/102 bridge at Burtonsville, N.Y. (Montgomery County)											
	26–1	14.591	USLB–On ground in front of house at 126 Colyer Road–Debris line	G	42.80347	-74.25947	513.40	--	--	--	--	--	--	
	26–2	14.536	USLB–On ground across from house at 112 Colyer Road–Debris line	F	42.80422	-74.25917	511.51	--	--	--	--	509.43	--	
	26–3	14.527	USLB–On ground across from house at 112 Colyer Road–Debris line	F	42.80436	-74.25914	511.38	--	--	--	--	508.97	508.68	
	26–4	14.428	DSRB–On house at 112 Island Road (about 2.2 feet above ground)–Seed line	E	42.80550	-74.25753	508.86	--	--	--	--	508.22	507.42	
	26–5	14.386	DSRB–On ground near brown storage shed of house at 114 Island Road–Debris line	F	42.80600	-74.25700	508.47	--	--	--	--	--	--	
27		6.619	State Route 161 bridge at Mill Point, N.Y. (Montgomery County)											
	27–1	6.670	USRB–On wall inside house at 775 Youngs Creek Road (about 4.5 feet above ground)–Seed line	E	42.88623	-74.27737	367.49	--	--	--	--	--	--	
	27–2	6.653	USRB–On I-beam in garage basement (about 6.8 feet above floor)–Seed line	E	42.88647	-74.27725	367.57	--	--	--	--	--	--	
	27–3	6.661	USLB–On ground–Debris line	P	42.88693	-74.27877	369.80	--	--	--	--	358.71	356.36	

Table 13. Peak water-surface elevations at 30 high-water-mark sites, including seven U.S. Geological Survey streamgages, along the Schoharie Creek in New York during the floods of August 28–29, 2011, January 19–20, 1996, and April 4–5, 1987, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1989, 2008, 2012a); HWM ID, high-water-mark identification; HWM, high-water mark; --, no data available; high-water-mark location—USRB, upstream right bank; USLB, upstream left bank; DSRB, downstream right bank; DSLB, downstream left bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; F, fair; P, poor; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of January 19–20, 1996, from Lumia, 1998; elevation data for the flood of April 4–5, 1987, from Zembrzuski and Evans, 1989; locations are shown on figures 37–39]

Site number and streamgage number	HWM ID	Miles above mouth	Site or streamgage along Schoharie Creek and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for August 28–29, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for January 19–20, 1996	Peak water-surface elevation for April 4–5, 1987	Stream-bottom elevation
	27–4	6.644	USLB–On ground–Debris line	P	42.88717	-74.27863	370.17	--	--	--	--	359.48	--	
	27–5	6.616	DSRB–On ground–Debris line	F	42.88693	-74.27668	366.80	--	--	--	--	--	--	
	27–6	6.604	DSRB–On ground–Debris line	F	42.88695	-74.27628	366.54	--	--	--	--	356.20	--	
	27–7	6.595	DSLB–On ground–Debris line	P	42.88788	-74.27813	369.37	--	--	--	--	--	--	
	27–8	6.578	DSRB–On tree (about 7.0 feet above ground)–Debris line	P	42.88758	-74.27662	366.45	--	--	--	--	356.32	354.93	
28		1.146	Interstate 90 (New York State Thruway) bridge at Fort Hunter, N.Y. (Montgomery County)											
	28–1	1.161	USLB–On ground–Debris line	F	42.93108	-74.28042	302.24	--	--	--	--	297.28	--	277.0
	28–2	1.161	USLB–On ground–Debris line	P	42.93105	-74.28077	302.19	--	--	--	--	297.54	--	
	28–3	1.125	DSLB–On tree (about 7.4 feet above ground)–Debris line	F	42.93193	-74.27957	297.37	--	--	--	--	293.42	--	
	28–4	1.116	DSLB–On tree (about 5.2 feet above ground)–Debris line	F	42.93202	-74.28020	297.39	--	--	--	--	293.41	292.83	
29		0.748	State Route 5S bridge at Fort Hunter, N.Y. (Montgomery County)											
	29–1	0.748	USRB–On bridge–Debris line	F	42.93772	-74.27987	297.55	--	--	--	--	292.32	291.93	273.0
30		0.731	Abandoned railroad bridge at Fort Hunter, N.Y. (Montgomery County)											
	30–1	0.737	USRB–On tree (about 0.8 feet above ground)–Seed line	P	42.93782	-74.28002	295.87	--	--	--	--	--	--	
	30–2	0.735	USRB–On ground–Wash line	P	42.93785	-74.28005	296.45	--	--	--	--	290.71	--	
	30–3	0.732	USLB–On ground–Wash line	P	42.93667	-74.28165	296.15	--	--	--	--	--	--	272.0
	30–4	0.725	DSRB–On ground–Wash line	P	42.93800	-74.28022	295.06	--	--	--	--	290.12	289.18	
	30–5	0.714	DSLB–On guy wire (about 4.7 feet above ground)–Debris line	P	42.93705	-74.28175	294.41	--	--	--	--	--	--	
	30–6	0.712	DSLB–On tree/brush (about 5.0 feet above ground)–Debris line	P	42.93697	-74.28193	294.44	--	--	--	--	290.24	--	
	30–7	0.712	DSLB–On tree/brush (about 5.1 feet above ground)–Debris line	P	42.93712	-74.28172	293.87	--	--	--	--	--	--	
	30–8	0.706	DSLB–On tree (about 4.9 feet above ground)–Debris line	P	42.93697	-74.28207	293.64	--	--	--	--	--	291.04	
	30–9	0.705	DSLB–On trailer (about 5.1 feet above ground)–Mud line	E	42.93692	-74.28217	293.54	--	--	--	--	--	--	

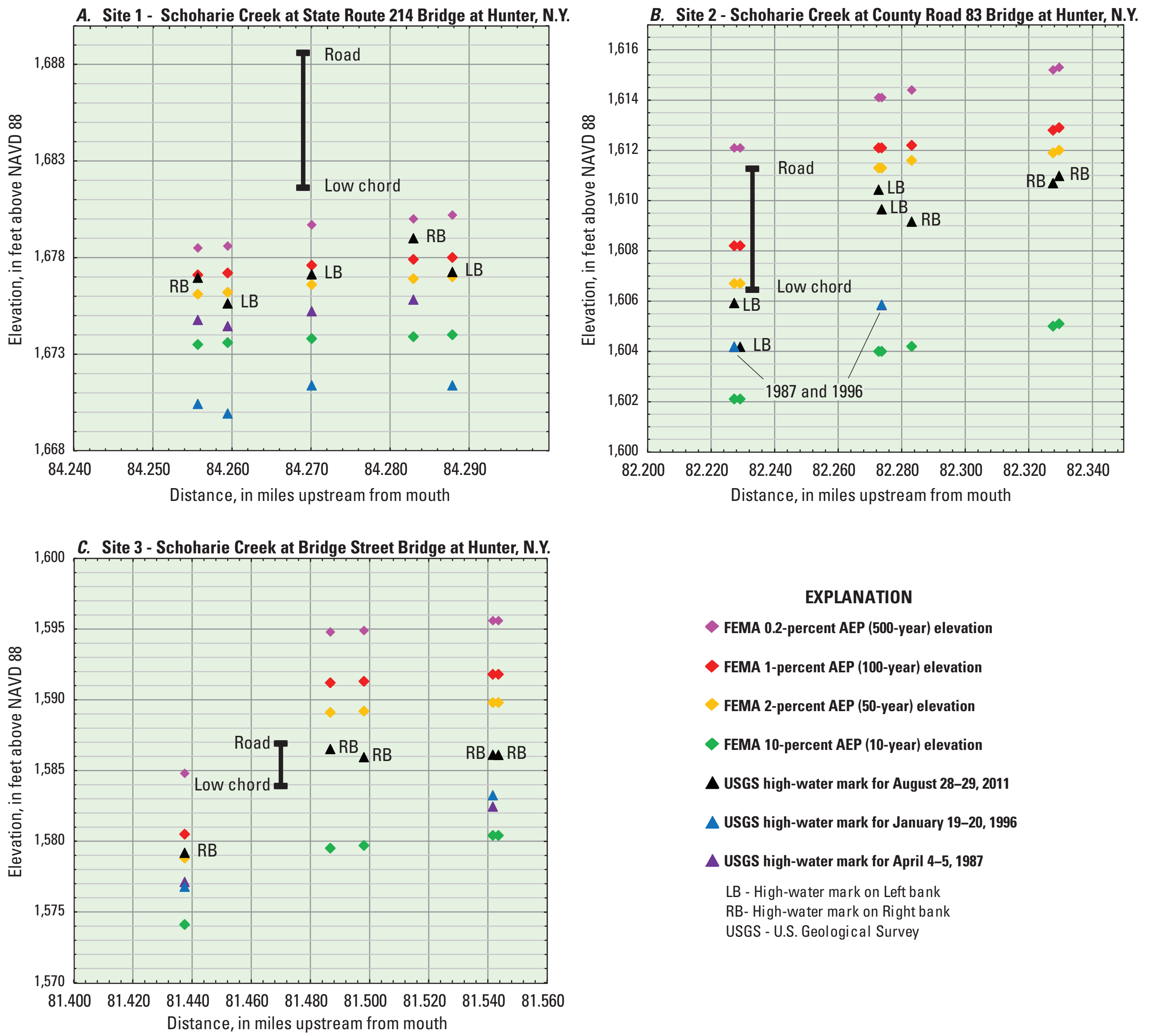


Figure 39. Peak water-surface elevations of Schoharie Creek (as indicated by high-water marks) at 30 sites from Hunter to Fort Hunter, New York, during the flood of August 28–29, 2011, and annual exceedance probability (AEP) elevations from published Federal Emergency Management Agency (FEMA) profiles. (Site data are given in table 13 and locations are shown on figure 38. NAVD 88, North American Vertical Datum of 1988)

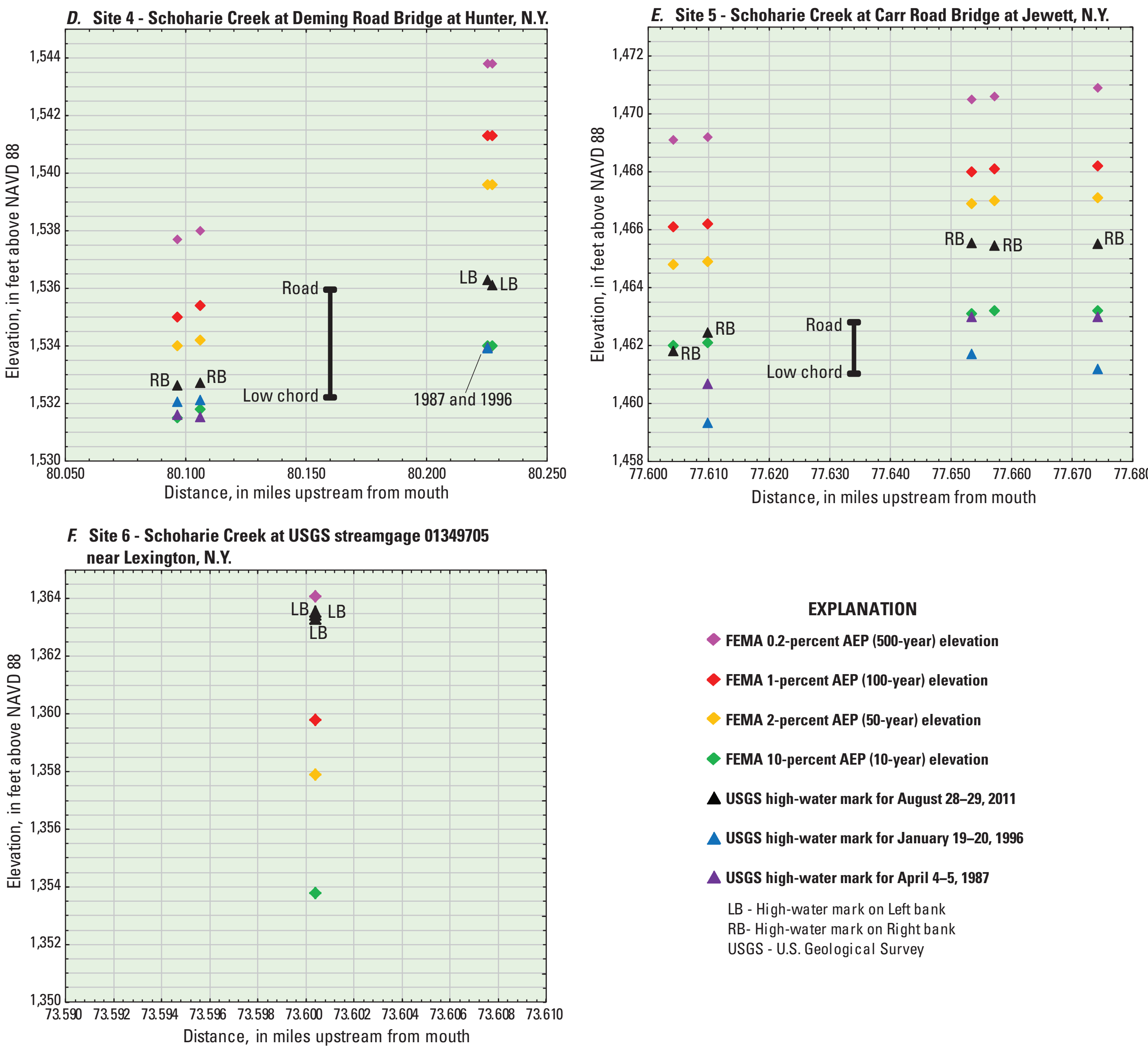


Figure 39.—Continued

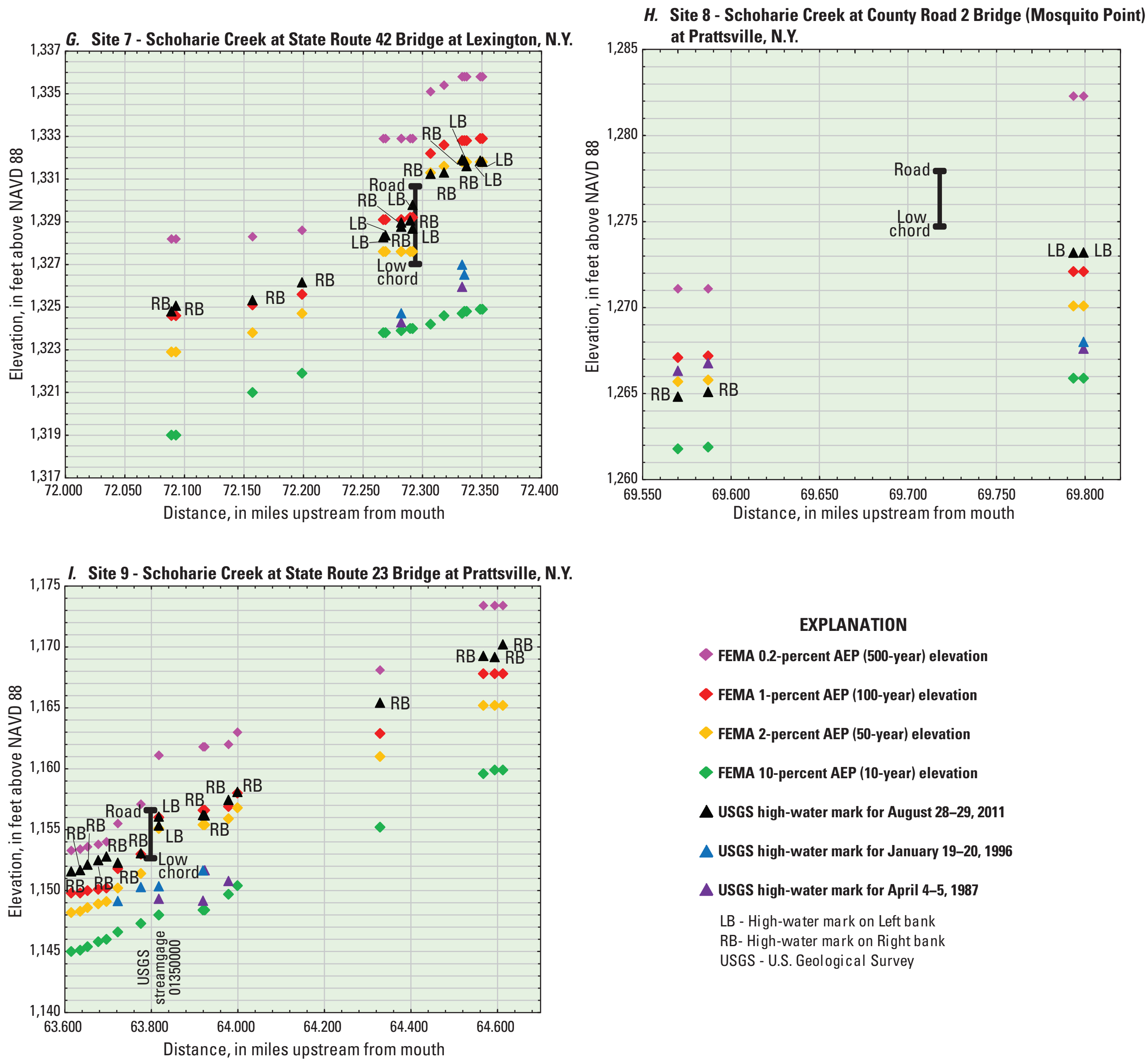


Figure 39.—Continued

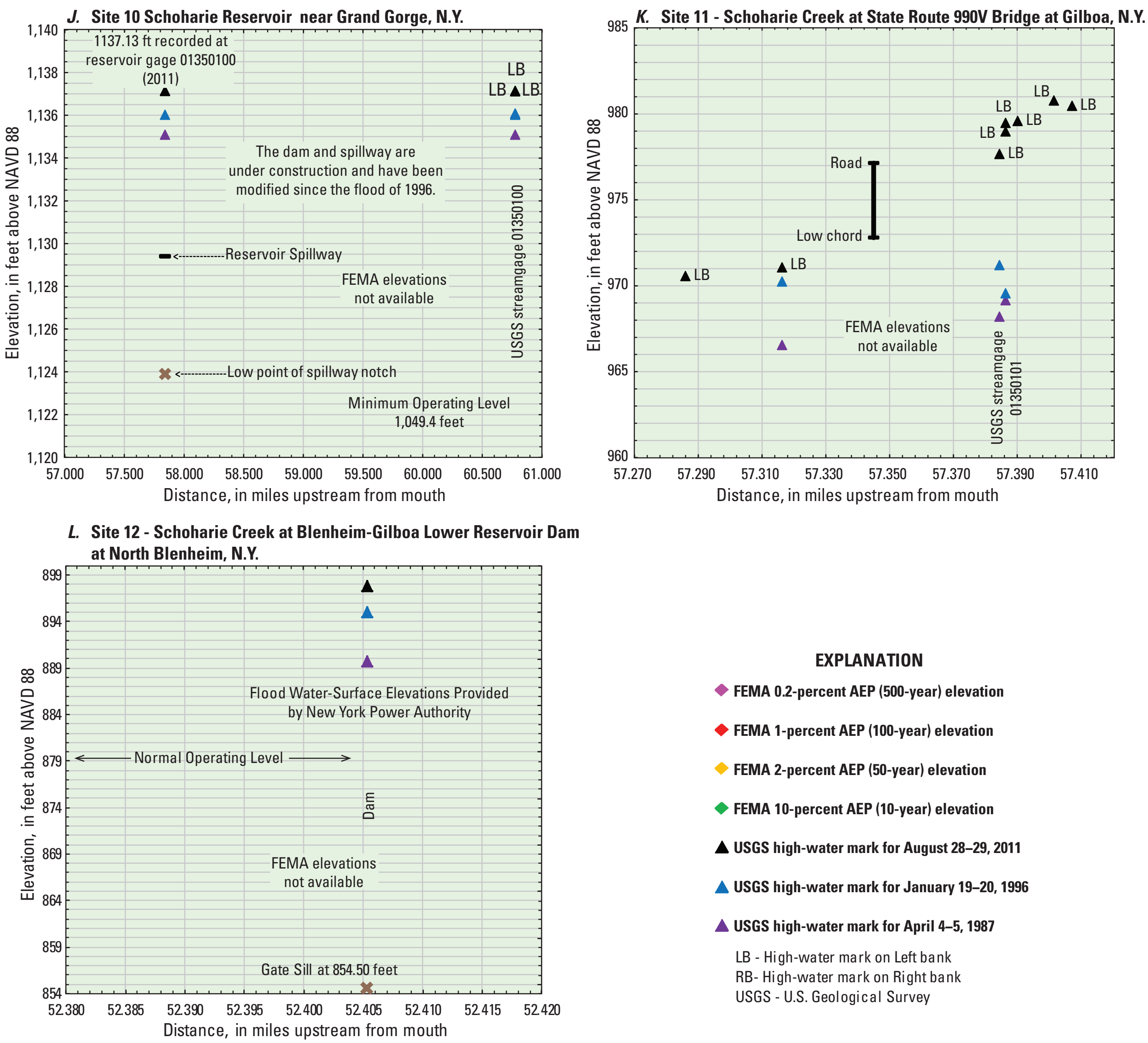


Figure 39.—Continued

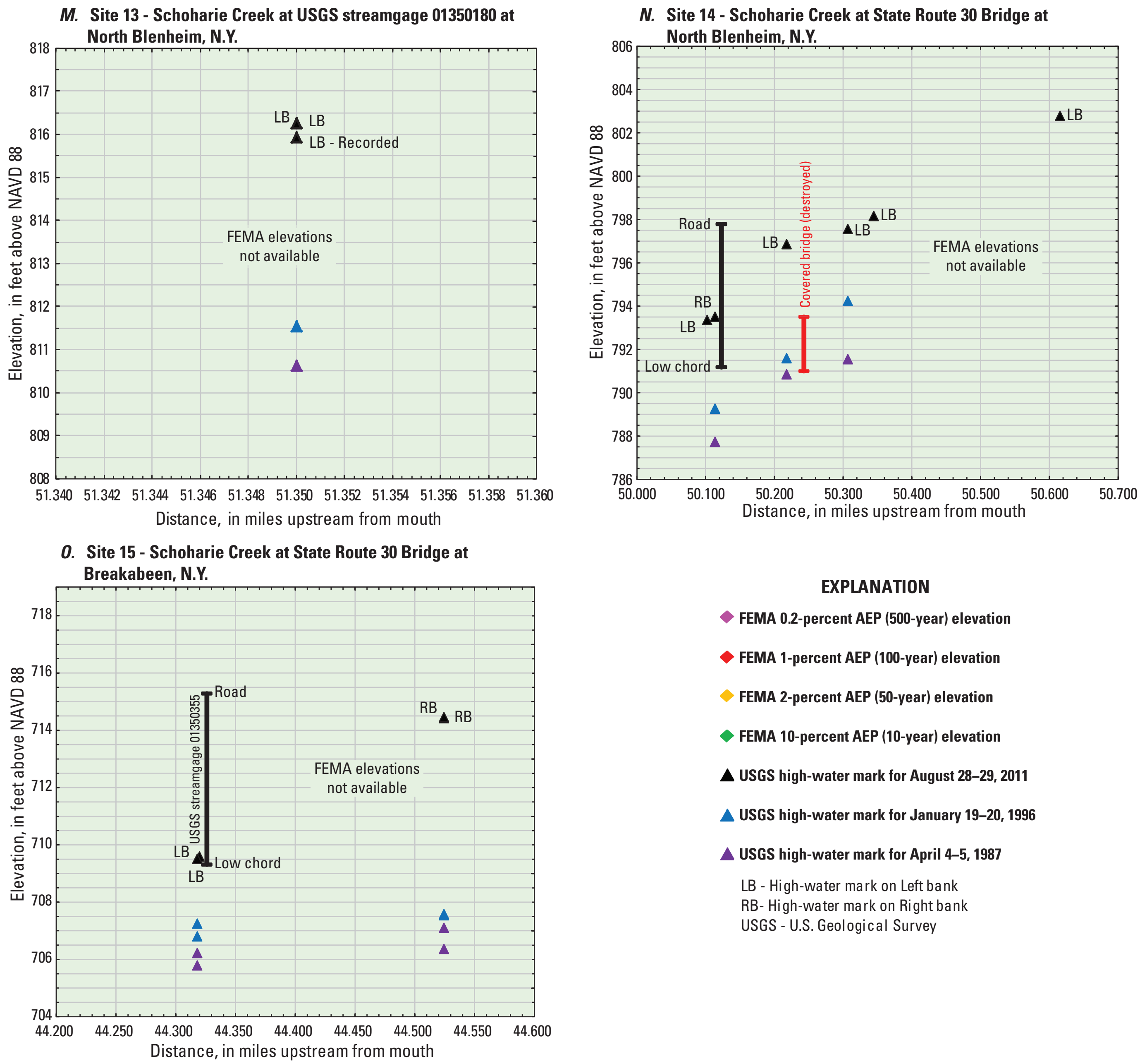


Figure 39.—Continued

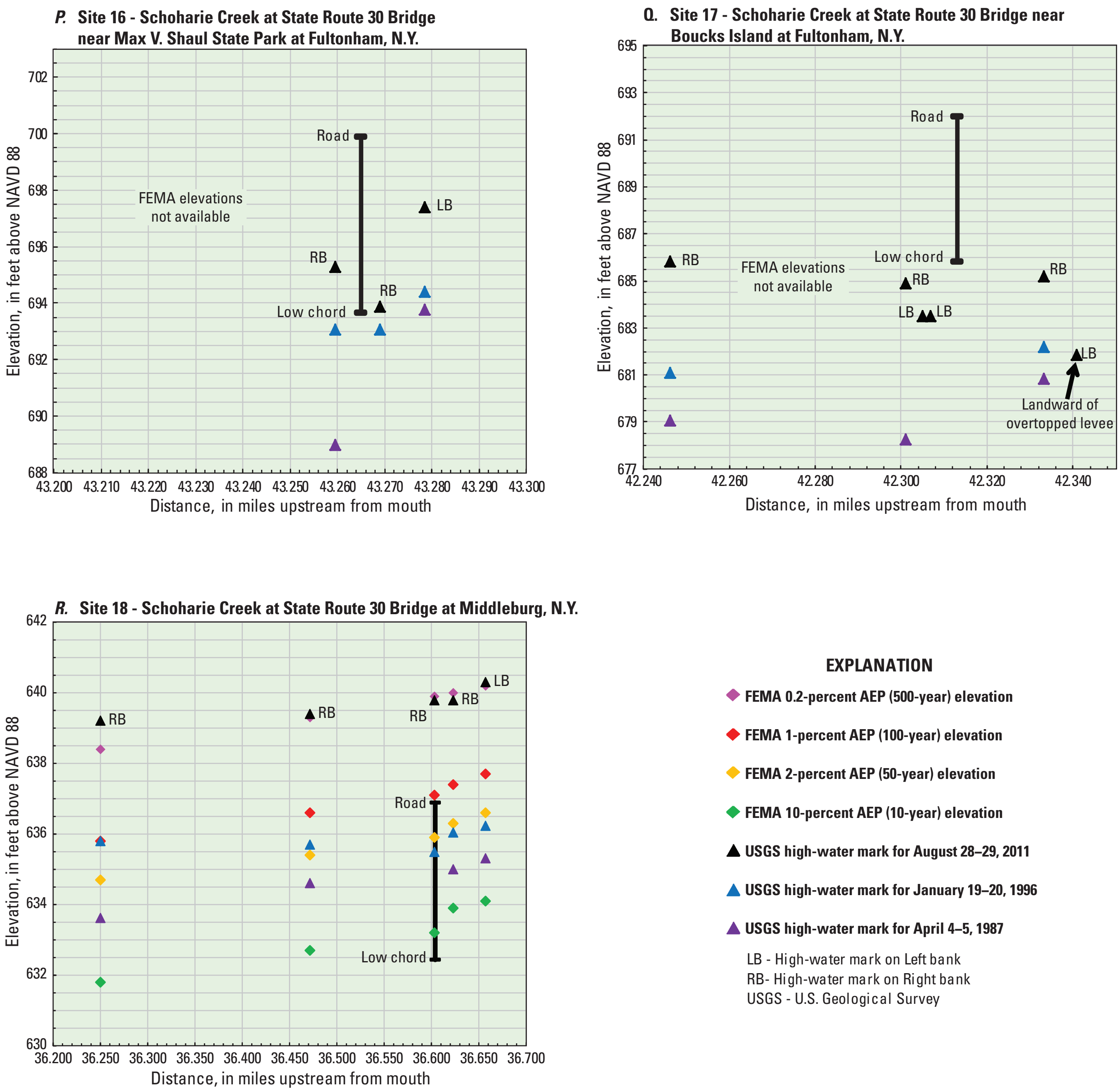


Figure 39.—Continued

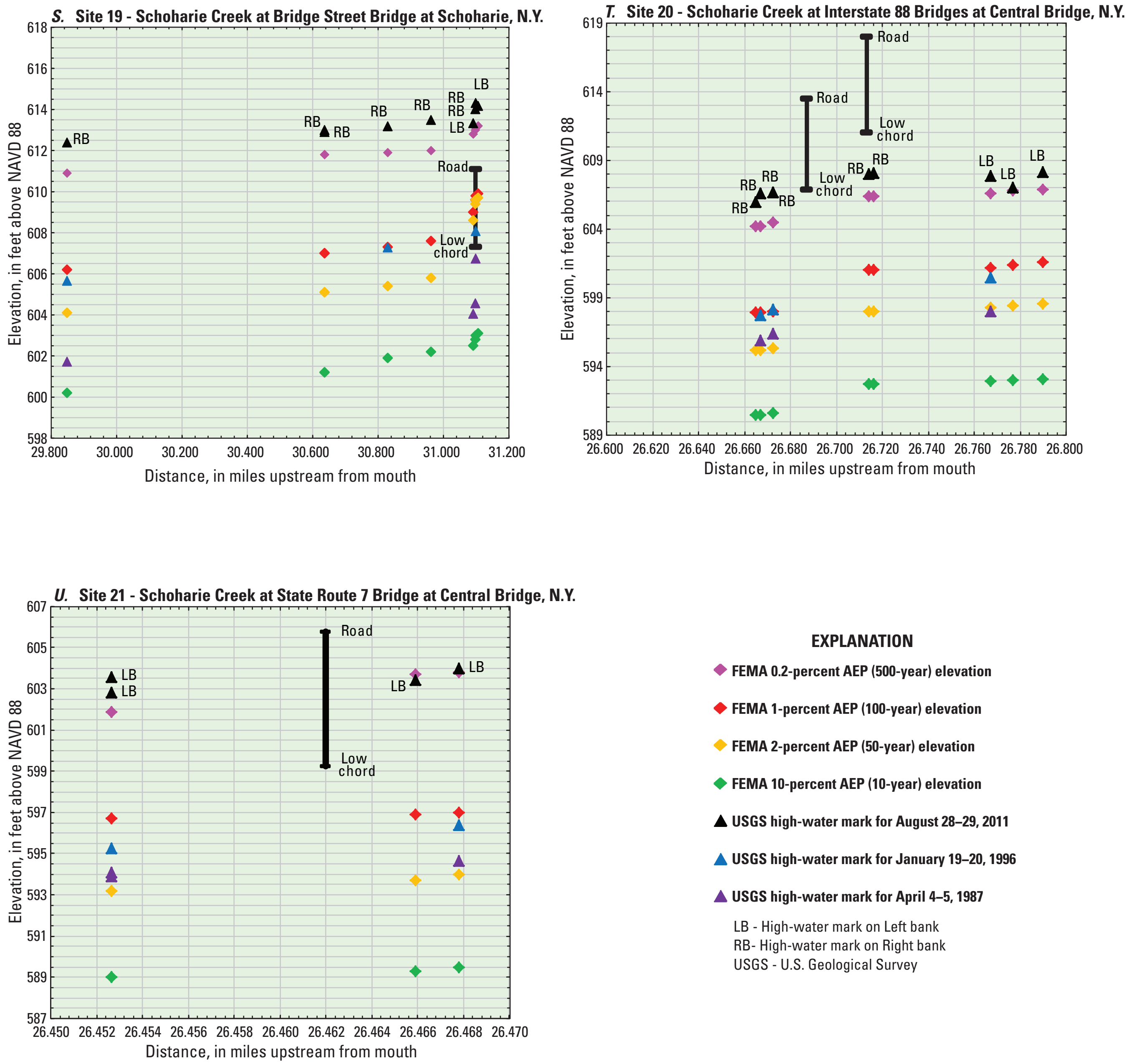


Figure 39.—Continued

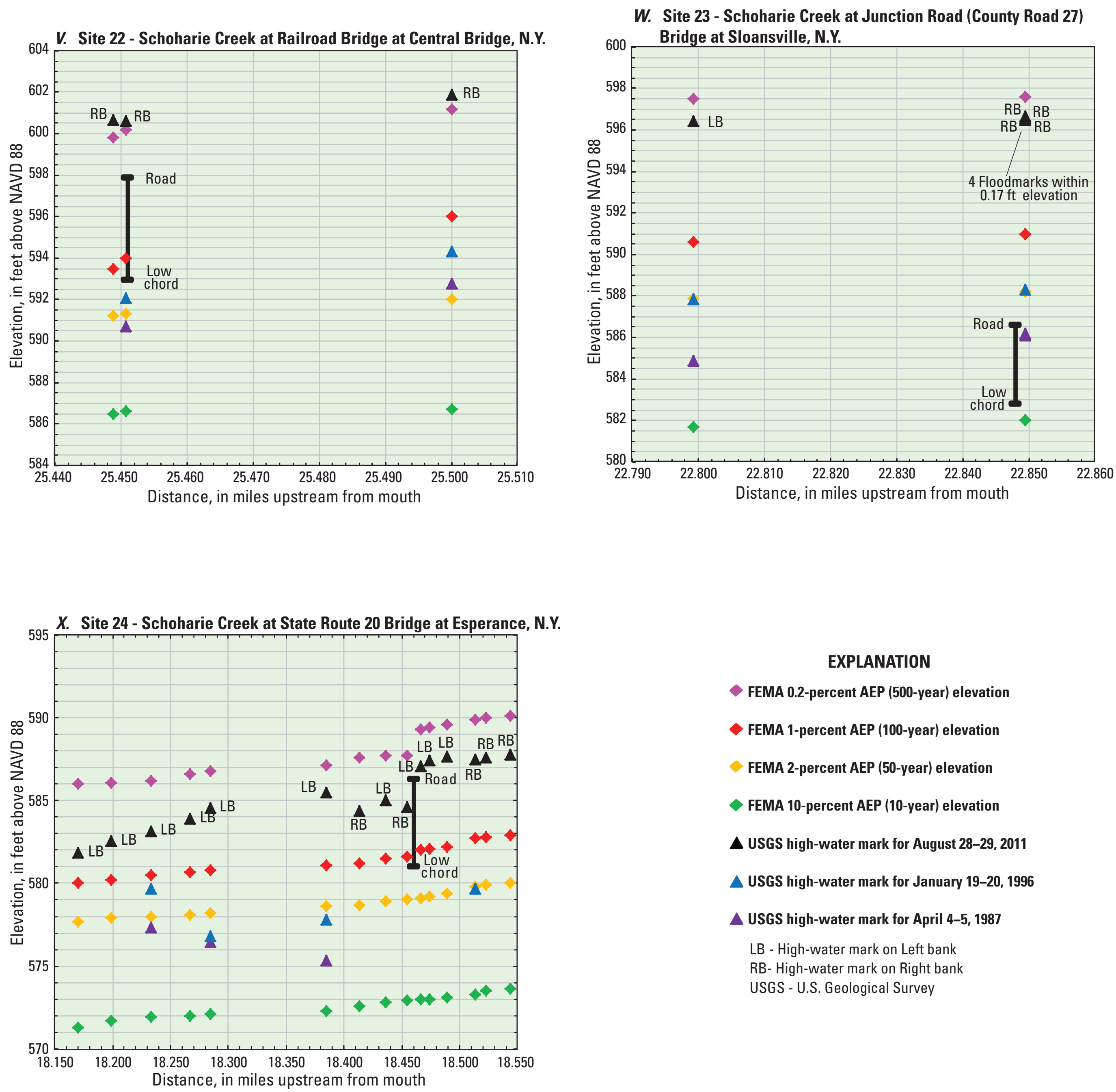


Figure 39.—Continued

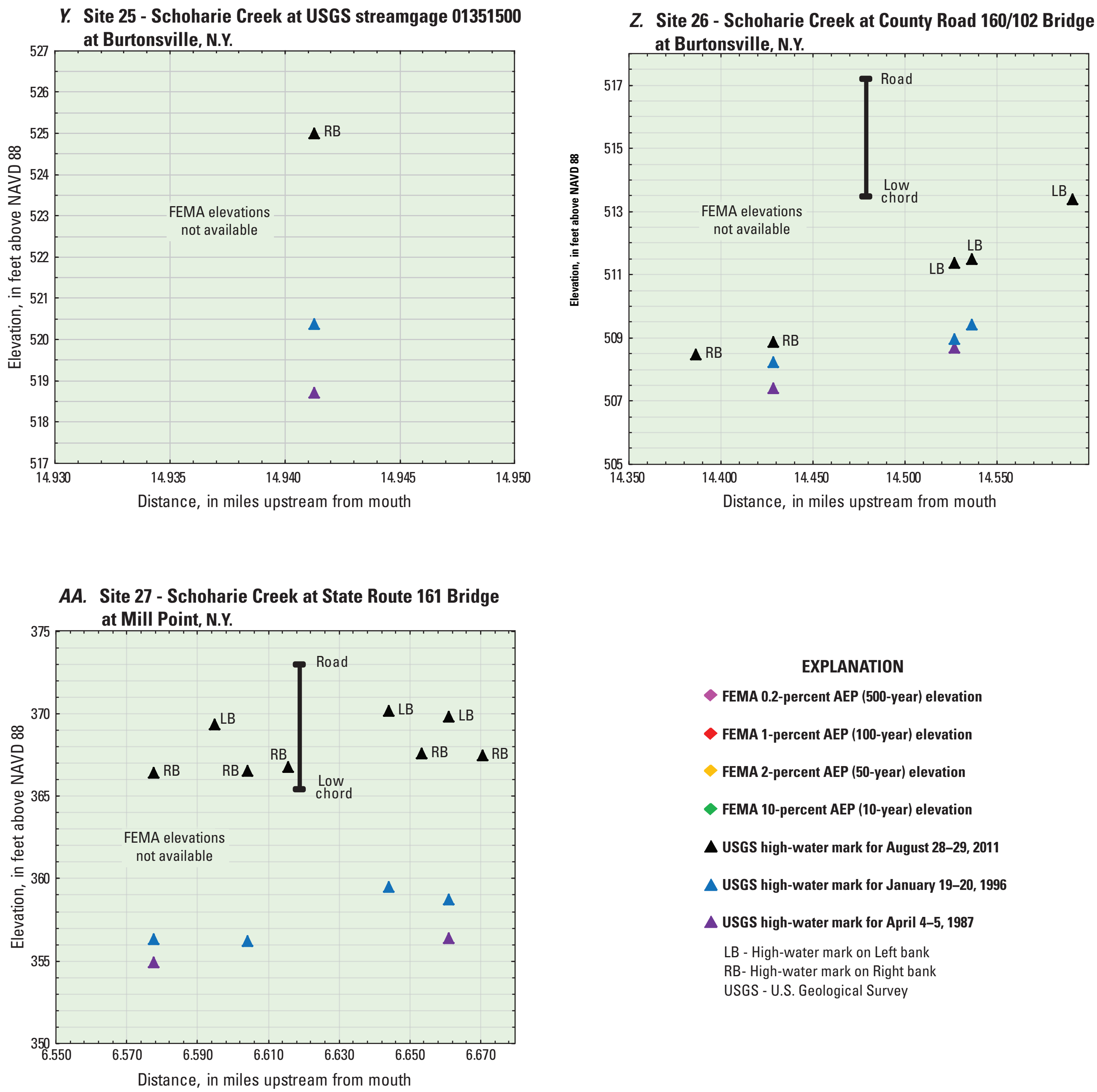


Figure 39.—Continued

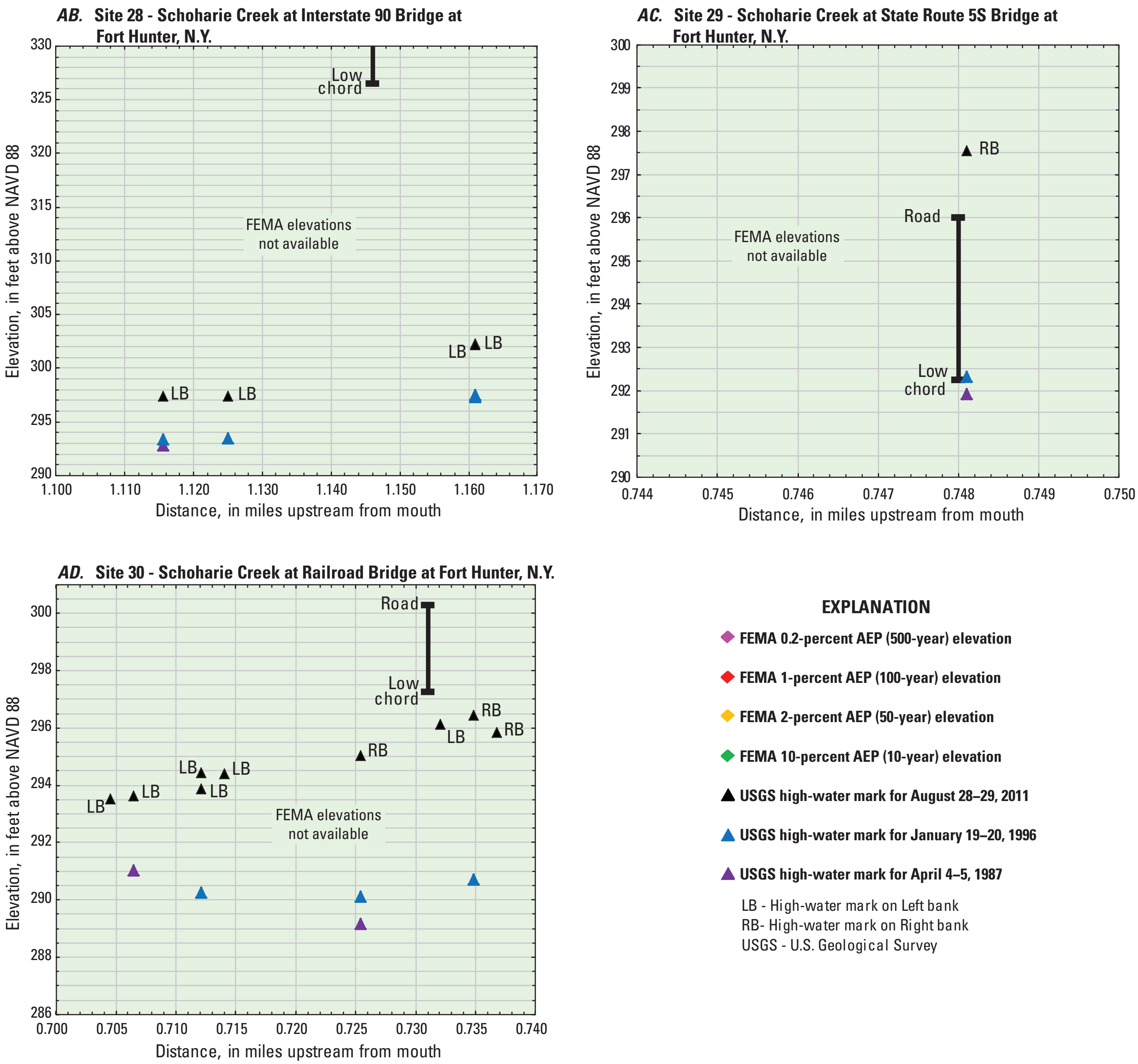


Figure 39.—Continued

Covered Bridge – North Blenheim, N.Y.

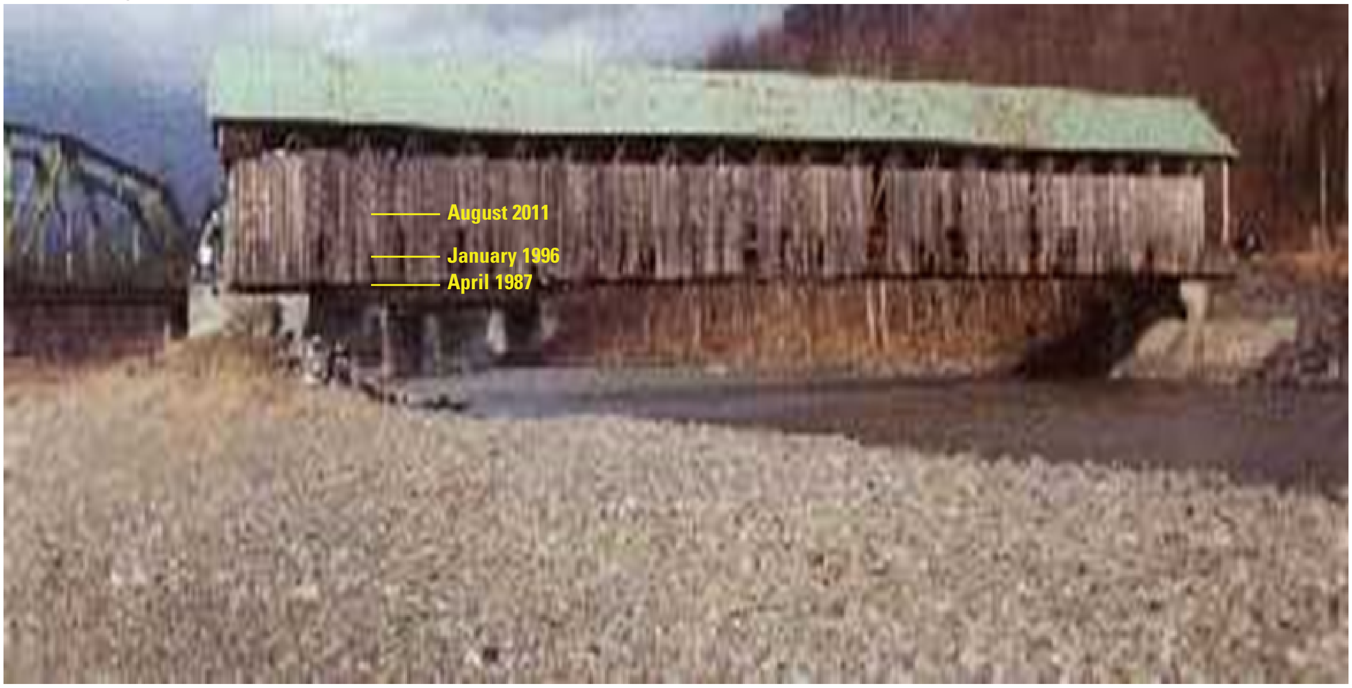


Figure 40. The covered bridge over Schoharie Creek in North Blenheim, New York, with the maximum elevations of the August 28, 2011, flood and two previous floods.

Effects of Reservoirs

Unlike the April–May flood, which had prolonged high flow prior to the major flooding that limited available storage, data for seven reservoirs in east-central and southeastern New York (table 18, figs. 44A–G) indicate that reservoir storage mitigated a moderate to a substantial amount of downstream flooding from Tropical Storm Irene. For six of the reservoirs, water level and release data were provided by the New York City Department of Environmental Protection (written commun., 2012).

The water levels in six of the seven reservoirs (except Cannonsville Reservoir) exceeded their spillway elevations during August 28–29. The highest water-surface elevations of record were documented (table 11) for Schoharie Reservoir (86 years of record) and the West Basin of the Ashokan Reservoir (99 years of record). Schoharie Reservoir, just downstream from Prattsville, stored over 1.3 in. of upstream runoff during 10 hours on August 28, and the Ashokan Reservoir (East and West Basins) in the Esopus Creek Basin stored about 4.0 in. of upstream runoff. Most of the reservoirs attenuated or substantially reduced outflows. For example, the maximum computed hourly inflow to Schoharie Reservoir (fig. 44A) was 137,000 ft^3/s on August 28, whereas the maximum outflow was 111,000 ft^3/s, nearly a 20-percent reduction. The peak inflow to Ashokan Reservoir was 99,900 ft^3/s on August 28, whereas the maximum hourly outflow to Esopus Creek was only 20,900 ft^3/s on August 29, nearly an 80-percent reduction (fig. 44C). Inflows to Ashokan Reservoir were estimated by a drainage-area adjustment of hourly discharge data for two upstream streamgages (Esopus Creek at Coldbrook (01362500) and Bush Kill at West Shokan (01363382)), which together account for 81 percent of the drainage area to the reservoir (256 mi^2). A similar procedure was used to compute inflows to Rondout Reservoir (fig. 44D) from upstream streamgages at Rondout Creek near Lowes Corners (01365000) and Chestnut Creek at Grahamsville (01365500), which together account for 62 percent of the reservoir's drainage area (95.4 mi^2). Much of the outflow from Rondout Reservoir was attenuated by storage; the estimated peak hourly inflow was 15,700 ft^3/s, and the maximum outflow was 5,560 ft^3/s (fig. 44D). Similar analyses for the Pepacton Reservoir on the East Branch Delaware River, the Cannonsville Reservoir on the West Branch Delaware River, and the Neversink Reservoir on a tributary to the main stem of the Delaware River indicate that outflows were reduced by about 80-, 64-, and 65-percent, respectively (figs. 44E–G).

The National Resources Conservation Service (NRCS) maintains three flood-control dams in the headwaters of the Batavia Kill, a major tributary to Schoharie Creek. These dams are designed to detain the runoff from the 1-percent chance AEP (100-year recurrence interval) storm and have auxiliary spillways to pass flows that exceed the design storm. On August 28, the auxiliary spillways at all three dams were flowing, but the reservoirs retained a substantial amount of runoff before spilling (Peter Wright, National Resource Conservation Service, oral commun., 2013).

Table 14. High-water marks collected by the Federal Emergency Management Agency at 72 selected sites in the Delaware and lower Hudson River Basins in New York for the flood of August 28–29, 2011.

[Latitude, longitude, and elevation are from the Federal Emergency Management Agency (FEMA, 2011e); HWM ID, high-water-mark identification; latitude and longitude in decimal degrees, North American Datum of 1983 (NAD 83); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); locations are shown on figure 41A]

Site number	FEMA HWM ID	Site name	Latitude	Longitude	Elevation
1	D1_27	West Kill upstream of West Kill, N.Y.	42.20580	-74.38117	1,496.4
2	D1_26	West Kill at West Kill, N.Y.	42.20702	-74.38361	1,485.8
3	D3_15	Manor Kill upstream of Conesville, N.Y.	42.38603	-74.36465	1,392.8
4	D3_14	Manor Kill upstream of Conesville, N.Y.	42.38717	-74.36779	1,388.5
5	D3_13	Manor Kill upstream of Conesville, N.Y.	42.38734	-74.36964	1,386.5
6	D3_12	Manor Kill upstream of Conesville, N.Y.	42.38746	-74.36999	1,387.2
7	D2_10	Esopus Creek downstream of Oliverea, N.Y.	42.07359	-74.46014	1,374.3
8	D2_11	Bushnellsville Creek downstream of Bushnellsville, N.Y.	42.14593	-74.41097	1,345.3
9	D1_15	Esopus Creek at Allaben, N.Y.	42.11736	-74.38231	1,017.9
10	D1_14	Esopus Creek at Allaben, N.Y.	42.11747	-74.38120	1,015.7
11	D1_13	Esopus Creek at Allaben, N.Y.	42.11723	-74.38087	1,015.5
12	D1_12	Stony Clove Creek at Phoenicia, N.Y.	42.08476	-74.31706	828.0
13	D1_24	Esopus Creek at Phoenicia, N.Y.	42.08293	-74.31563	822.1
14	D1_25	Esopus Creek at Phoenicia, N.Y.	42.08322	-74.31556	820.9
15	D1_7	Esopus Creek at Phoenicia, N.Y.	42.08312	-74.31396	813.7
16	D1_6	Esopus Creek at Phoenicia, N.Y.	42.08317	-74.31419	815.2
17	D1_8	Esopus Creek at Phoenicia, N.Y.	42.08357	-74.31358	813.2
18	D1_11	Esopus Creek downstream of Phoenicia, N.Y.	42.08206	-74.30620	795.2
19	D1_10	Esopus Creek downstream of Phoenicia, N.Y.	42.08166	-74.30608	794.1
20	D1_9	Esopus Creek downstream of Phoenicia, N.Y.	42.08101	-74.30558	791.0
21	D1_22	Esopus Creek downstream of Phoenicia, N.Y.	42.07472	-74.30095	776.9
22	D1_23	Esopus Creek downstream of Phoenicia, N.Y.	42.07451	-74.30061	777.2
23	D1_20	Beaver Kill at Mount Tremper, N.Y.	42.04719	-74.27635	702.6
24	D1_21	Beaver Kill at Mount Tremper, N.Y.	42.04706	-74.27646	701.2
25	D1_3	Esopus Creek at Mount Tremper, N.Y.	42.04558	-74.27912	698.0
26	D1_4	Esopus Creek at Mount Tremper, N.Y.	42.04535	-74.27970	696.9
27	D1_5	Esopus Creek at Mount Tremper, N.Y.	42.04442	-74.28108	696.0
28	D1_17	Esopus Creek at Mount Tremper, N.Y.	42.04132	-74.27914	694.9
29	D1_18	Esopus Creek at Mount Tremper, N.Y.	42.04081	-74.27913	691.3
30	D1_19	Esopus Creek at Mount Tremper, N.Y.	42.04026	-74.27916	692.1
31	D1_1	Esopus Creek at Boiceville, N.Y.	42.00714	-74.26854	630.0
32	D1_2	Esopus Creek at Boiceville, N.Y.	42.00685	-74.26772	630.0
33	D2_26	Maltby Hollow Brook upstream of West Shokan, N.Y.	41.97146	-74.30275	785.7
34	D2_27	Bush Kill at West Shokan, N.Y.	41.97018	-74.27791	619.3
35	D1_16	Kenozia Lake near Ashokan, N.Y.	41.99302	-74.16762	694.5
36	D2_13	Rondout Creek upstream of Lowes Corners, N.Y.	41.86774	-74.48515	894.6
37	D2_12	Rondout Creek upstream of Lowes Corners, N.Y.	41.86700	-74.48574	890.1
38	D2_14	Rondout Creek at Lowes Corners, N.Y.	41.86445	-74.50440	850.9
39	D2_15	Rondout Creek at Lowes Corners, N.Y.	41.86414	-74.50410	851.9
40	D3_18	East Branch Delaware River at Roxbury, N.Y.	42.28433	-74.56630	1,476.5

Table 14. High-water marks collected by the Federal Emergency Management Agency at 72 selected sites in the Delaware and lower Hudson River Basins in New York for the flood of August 28–29, 2011.—Continued

[Latitude, longitude, and elevation are from the Federal Emergency Management Agency (FEMA, 2011e); HWM ID, high-water-mark identification; latitude and longitude in decimal degrees, North American Datum of 1983 (NAD 83); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); locations are shown on figure 41A]

Site number	FEMA HWM ID	Site name	Latitude	Longitude	Elevation
41	D3_17	East Branch Delaware River at Roxbury, N.Y.	42.28418	-74.56635	1,475.6
42	D3_16	East Branch Delaware River at Roxbury, N.Y.	42.28406	-74.56647	1,475.4
43	D2_7	East Branch Delaware River upstream of Margaretville, N.Y.	42.16095	-74.62281	1,342.9
44	D2_5	Dry Brook upstream of Arkville, N.Y.	42.12422	-74.57103	1,538.2
45	D2_6	Dry Brook upstream of Arkville, N.Y.	42.13049	-74.57738	1,500.3
46	D2_4	Dry Brook upstream of Arkville, N.Y.	42.14119	-74.60493	1,399.0
47	D2_9	Bush Kill at Fleischmanns, N.Y.	42.15495	-74.52707	1,515.9
48	D2_8	Bush Kill at Fleischmanns, N.Y.	42.15500	-74.54066	1,485.5
49	D2_3	East Branch Delaware River at Margaretville, N.Y.	42.14925	-74.64571	1,324.6
50	D2_2	East Branch Delaware River at Margaretville, N.Y.	42.14812	-74.64552	1,327.1
51	D3_10	East Branch Delaware River at Margaretville, N.Y.	42.14278	-74.65203	1,317.1
52	D2_1	Tremper Kill downstream of Andes, N.Y.	42.14412	-74.80129	1,371.0
53	D3_7	West Branch Delaware River at Delhi, N.Y.	42.28157	-74.90637	1,364.0
54	D3_8	West Branch Delaware River at Delhi, N.Y.	42.28134	-74.90666	1,363.6
55	D3_9	West Branch Delaware River at Delhi, N.Y.	42.28122	-74.90667	1,363.6
56	D3_11	West Branch Delaware River at Delhi, N.Y.	42.27879	-74.91233	1,361.3
57	D3_6	West Branch Delaware River downstream of Delhi, N.Y.	42.26674	-74.92113	1,348.7
58	D3_3	West Branch Delaware River at Hamden, N.Y.	42.19558	-74.98873	1,271.5
59	D3_4	West Branch Delaware River at Hawleys, N.Y.	42.17505	-75.01785	1,256.5
60	D3_5	West Branch Delaware River at Hawleys, N.Y.	42.17499	-75.01787	1,255.3
61	D3_1	West Branch Delaware River at Walton, N.Y.	42.16830	-75.13471	1,205.3
62	D3_2	West Branch Delaware River at Walton, N.Y.	42.16822	-75.13478	1,204.7
63	D2_22	East Branch Neversink River downstream of Ladleton, N.Y.	41.93744	-74.52519	1,801.4
64	D2_21	East Branch Neversink River downstream of Ladleton, N.Y.	41.93544	-74.52876	1,797.6
65	D2_20	East Branch Neversink River upstream of Claryville, N.Y.	41.92522	-74.55094	1,703.5
66	D2_25	West Branch Neversink River upstream of Claryville, N.Y.	41.96126	-74.54168	1,830.9
67	D2_24	West Branch Neversink River upstream of Claryville, N.Y.	41.95846	-74.54369	1,822.2
68	D2_23	West Branch Neversink River upstream of Claryville, N.Y.	41.94216	-74.57444	1,708.4
69	D2_19	Neversink River downstream of Claryville, N.Y.	41.90172	-74.58047	1,576.2
70	D2_18	Neversink River downstream of Claryville, N.Y.	41.89317	-74.58569	1,546.5
71	D2_17	Neversink River downstream of Claryville, N.Y.	41.89235	-74.58870	1,541.7
72	D2_16	Neversink River downstream of Claryville, N.Y.	41.89204	-74.58882	1,543.4

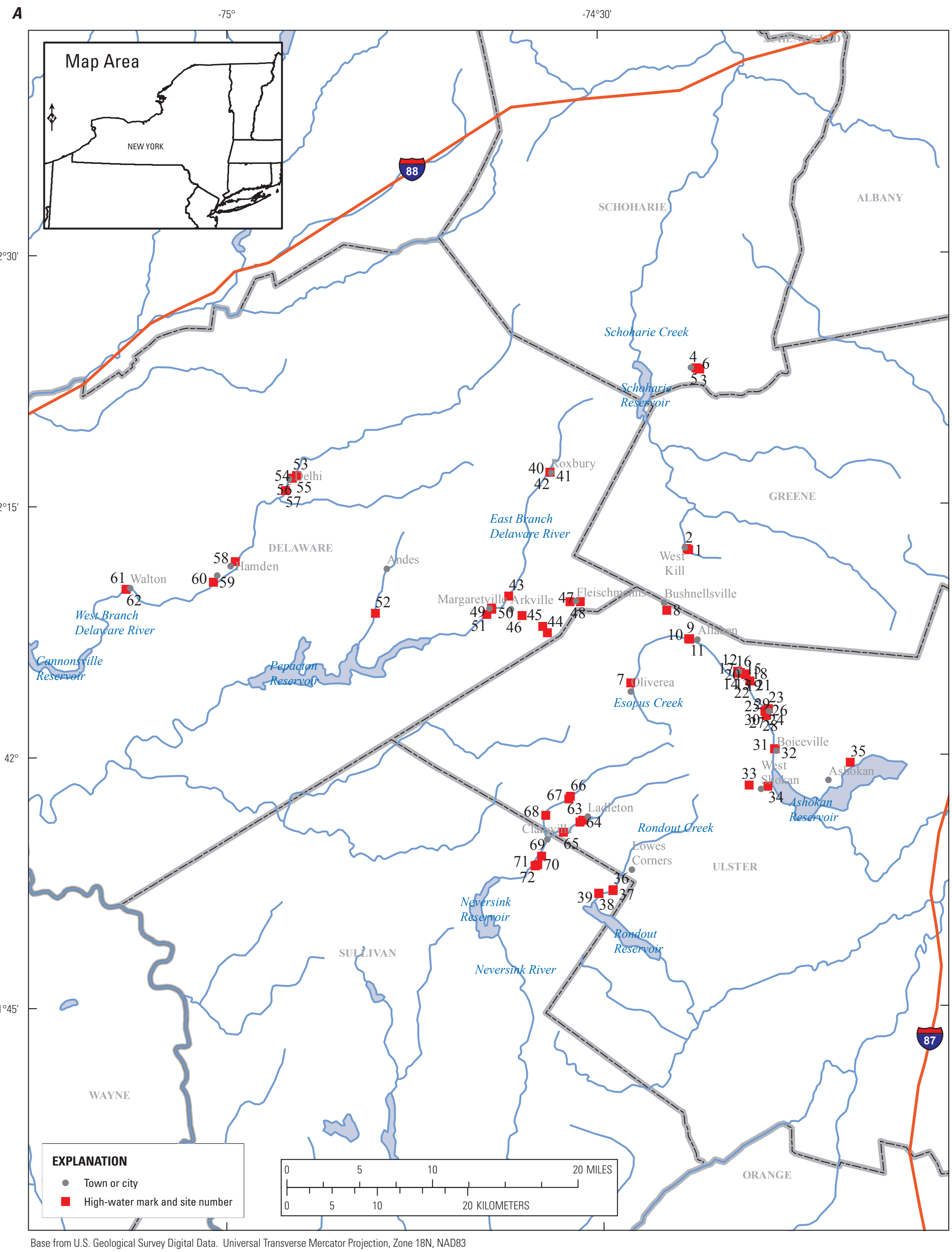


Figure 41. The locations of high-water marks collected *A,* by Federal Emergency Management Agency at 72 selected sites in the Delaware and lower Hudson River Basins and *B,* by the New York State Canal Corporation at 13 sites along the main-stem Mohawk River for the flood of August 28–29, 2011.

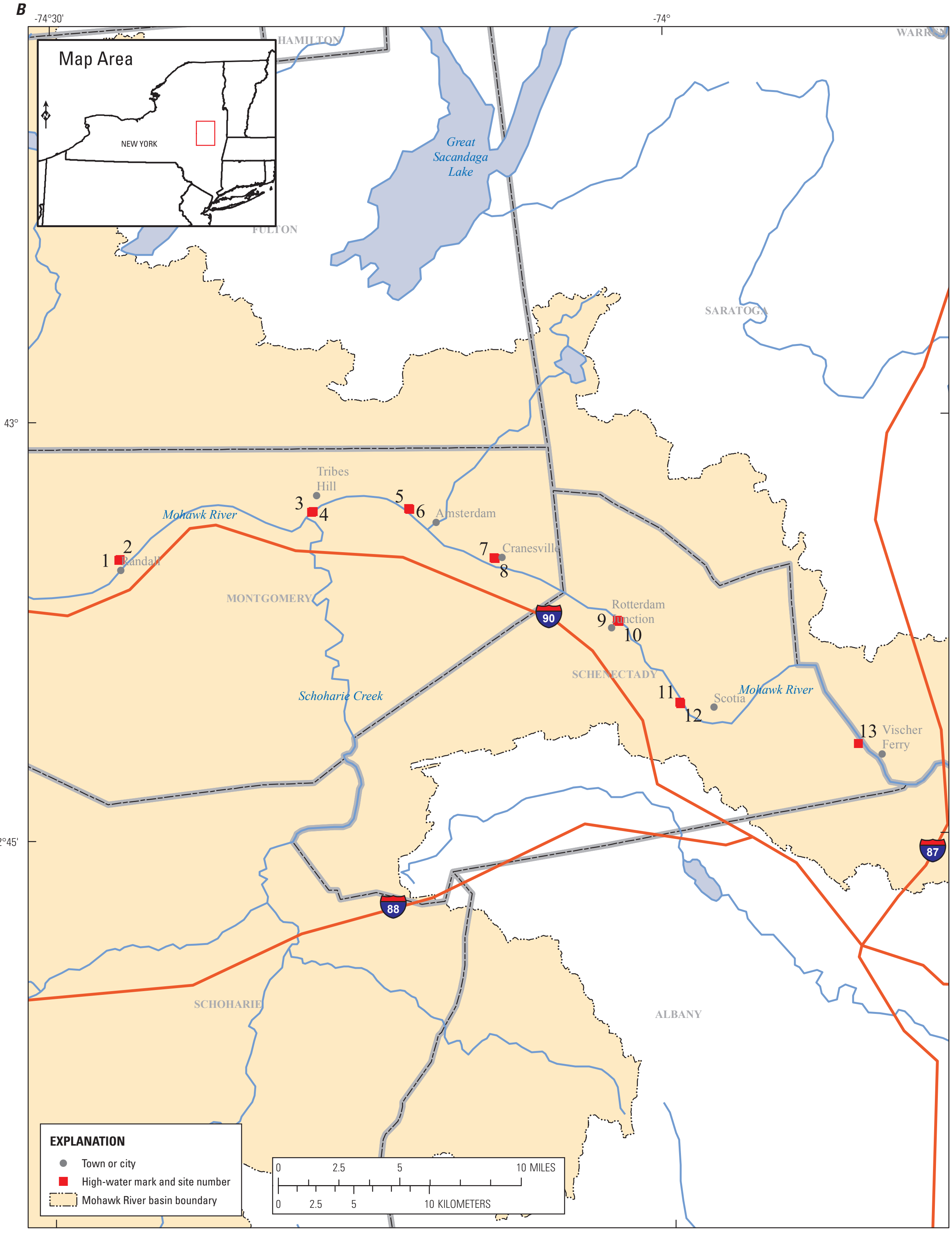


Figure 41. The locations of high-water marks collected *A,* by Federal Emergency Management Agency at 72 selected sites in the Delaware and lower Hudson River Basins and *B,* by the New York State Canal Corporation at 13 sites along the main-stem Mohawk River for the flood of August 28–29, 2011.—Continued

Table 15. High-water marks collected along the Mohawk River in New York by the New York State Canal Corporation at 13 selected sites for the flood of August 28–29, 2011, and by the U.S. Geological Survey at 8 selected sites for the flood of June 26–29, 2006.

[High-water-mark elevations are from the New York State Canal Corporation (NYSCC, written commun., 2012); latitude and longitude in decimal degrees, North American Datum of 1983 (NAD 83); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for flood of June 26–29, 2006, from Suro and others, 2009; --, no data available; locations are shown on figure 41B]

Site number	Site name	Latitude	Longitude	August 28–29, 2011 elevation	June 26–29, 2006 elevation
1	Mohawk River at Erie Canal Lock 13 (upstream cabin) at Randall, N.Y.	42.91738	-74.44602	292.10	--
2	Mohawk River at Erie Canal Lock 13 (downstream cabin) at Randall, N.Y.	42.91791	-74.44501	290.85	--
3	Mohawk River at Erie Canal Lock 12 (upstream cabin) at Tribes Hill, N.Y.	42.94548	-74.28921	288.60	287.20
4	Mohawk River at Erie Canal Lock 12 (downstream cabin) at Tribes Hill, N.Y.	42.94588	-74.28806	285.27	[a]279.20
5	Mohawk River at Erie Canal Lock 11 (upstream cabin) at Amsterdam, N.Y.	42.94703	-74.21051	280.44	273.03
6	Mohawk River at Erie Canal Lock 11 (downstream cabin) at Amsterdam, N.Y.	42.94642	-74.20962	276.44	272.68
7	Mohawk River at Erie Canal Lock 10 (upstream cabin) at Cranesville, N.Y.	42.91720	-74.14145	270.20	263.42
8	Mohawk River at Erie Canal Lock 10 (downstream cabin) at Cranesville, N.Y.	42.91680	-74.14030	264.54	262.91
9	Mohawk River at Erie Canal Lock 9 (upstream cabin) at Rotterdam Junction, N.Y.	42.87905	-74.04162	253.86	248.82
10	Mohawk River at Erie Canal Lock 9 (downstream cabin) at Rotterdam Junction, N.Y.	42.87848	-74.04062	250.86	247.12
11	Mohawk River at Erie Canal Lock 8 (upstream cabin) at Scotia, N.Y.	42.82966	-73.99186	236.64	--
12	Mohawk River at Erie Canal Lock 8 (downstream cabin) at Scotia, N.Y.	42.82890	-73.99114	232.47	--
13	Mohawk River at Erie Canal Lock 7 (upstream staff gage) at Vischer Ferry, N.Y.	42.80365	-73.84758	216.83	--

[a]Downstream 180 feet and landward 180 feet from downstream cabin.

The USGS New York Water Science Center operates two gages on Lake Champlain, one at the south end of the lake just north of Whitehall (04279085) and the other at the north end near the outlet of the lake at Rouses Point (04295000). The drainage areas at the two gages are 725 and 8,277 mi^2, respectively. The maximum lake level (97.89 ft) at Rouses Point on September 3 was nearly 1 ft lower than the maximum at Whitehall on August 29. The USGS also operates a gage on Lake Champlain at Burlington, Vermont (04294500); lake elevations at the three gages during August 20 to September 5 were substantially different (fig. 45A).Wind speed and direction during August 27–30, combined with substantial inflows to the lake, caused the large differences between lake levels at the ends of the lake (figs. 45A–B). On August 28, the lake level at the north end (Rouses Point) was lowered by nearly 1 ft as a result of the strong north winds. At nearly the same time, the level at the south end of the lake rose about 3 ft in a few hours as the water was pushed southward into the narrow lake channel near Whitehall. A second rise on August 29 (as winds shifted to the west) reflects major inflows from Mettawee and Poultney Rivers, which enter from the east side of the lake at a point where the lake is narrow. These rivers produced record or near-record floods on August 28–29. Winds and seiche also caused variable lake levels during other specific times at each of the three lake gages (fig. 45A).

Flood Damage

Hurricane Irene, which became Tropical Storm Irene when it made landfall in the Northeast, caused widespread destruction and 56 deaths along its path from the Caribbean Sea northward to New England during August 21–30, 2011. Damages throughout the United States from Irene are estimated to be nearly $16 billion, making it the seventh costliest storm in the United States (Avila and Cangialosi, 2011).

Hurricane Irene entered New York State on August 28 as a tropical storm and traveled up the eastern corridor of the State, leaving a path of destruction and damage never before seen in many parts of New York. Thirty-one counties in New York were declared disaster areas (fig. 46) on August 31, 2011, with damages and subsequent distribution of Federal disaster assistance of nearly $600 million (as of February 24, 2014); 10 deaths were reported (Federal Emergency Management Agency, 2011a). More than 33,000 citizens in New York registered for individual Federal assistance, and 74 Disaster Resource Centers were created during the recovery period (New York State, 2012). More than one million people in New York were left without power during and after the storm.

Table 16. Peak storm-tide data for Hurricane Irene at U.S. Geological Survey tide gages and at selected coastal sites in New York for August 28, 2011.

[Latitude and longitude in decimal degrees, NAD 83 (North American Datum of 1983); NAVD 88, North American Vertical Datum of 1988; GMT, Greenwich Mean Time; --, not applicable; data from McCallum and others, 2012; locations are shown on figure 42]

Site number	Internal site identification number	County	Latitude	Longitude	Site type	Type of data recorded	Peak storm-tide elevation (feet above NAVD 88)	Peak storm-tide date and time (GMT)
				Peak storm-tide data at U.S. Geological Survey permanent monitoring sites				
1	01302050	Queens	40.75583	-73.74639	Real-time streamgage	Riverine	9.46	8/28/2011 13:15:00
2	01302250	Nassau	40.86622	-73.71020	Real-time-tide gage	Storm tide	9.48	8/28/2011 13:30:00
3	01302600	Nassau	40.88856	-73.63800	Real-time-tide gage	Storm tide	9.30	8/28/2011 13:30:00
4	01302845	Nassau	40.90511	-73.59319	Real-time-tide gage	Storm tide	9.13	8/28/2011 14:24:00
5	01303500	Nassau	40.85722	-73.46389	Real-time streamgage	Riverine	9.14	8/28/2011 13:45:00
6	01304057	Suffolk	40.96286	-73.14317	Real-time-tide gage	Storm tide	8.88	8/28/2011 14:06:00
7	01304705	Suffolk	40.93333	-72.22500	Real-time streamgage	Riverine	7.67	8/28/2011 14:45:00
8	01309225	Suffolk	40.66927	-73.35567	Real-time-tide gage	Storm tide	5.27	8/28/2011 12:30:00
9	01310521	Nassau	40.62760	-73.57541	Real-time-tide gage	Storm tide	7.35	8/28/2011 11:36:00
10	01310740	Nassau	40.59344	-73.58374	Real-time-tide gage	Storm tide	7.07	8/28/2011 11:18:00
11	01311143	Nassau	40.60883	-73.65611	Real-time-tide gage	Storm tide	7.75	8/28/2011 11:48:00
12	01311145	Nassau	40.59316	-73.73736	Real-time-tide gage	Storm tide	7.43	8/28/2011 11:18:00
13	01311850	Queens	40.61733	-73.75791	Real-time-tide gage	Storm tide	7.52	8/28/2011 12:24:00
14	01311875	Queens	40.57372	-73.88514	Real-time-tide gage	Storm tide	7.58	8/28/2011 11:30:00
15	01374019	Putnam	41.38620	-73.95514	Real-time streamgage	Riverine	7.65	8/28/2011 14:45:00
16	01376269	Rockland	41.04319	-73.89606	Real-time streamgage	Riverine	7.56	8/28/2011 13:30:00
				Poststorm high-water marks obtained by the U. S. Geological Survey				
17	HWM–NY–KIN–001	Kings	40.58026	-74.01005	--	--	9.50	8/28/2011
18	HWM–NY–KIN–002	Kings	40.70473	-73.98951	--	--	6.74	8/28/2011
19	HWM–NY–NAS–001	Nassau	40.64742	-73.46229	--	--	6.68	8/28/2011
20	HWM–NY–NAS–002	Nassau	40.58396	-73.63749	--	--	20.77	8/28/2011
21	HWM–NY–NAS–003	Nassau	40.88760	-73.56374	--	--	8.40	8/28/2011
22	HWM–NY–QUE–001	Queens	40.76184	-73.85864	--	--	8.23	8/28/2011
23	HWM–NY–QUE–002	Queens	40.64572	-73.83648	--	--	7.20	8/28/2011
24	HWM–NY–RIC–001	Richmond	40.59436	-74.06024	--	--	7.84	8/28/2011
25	HWM–NY–RIC–002	Richmond	40.50200	-74.23027	--	--	8.59	8/28/2011
26	HWM–NY–SUF–001	Suffolk	41.01207	-72.55773	--	--	6.92	8/28/2011
27	HWM–NY–SUF–002	Suffolk	40.84913	-72.50310	--	--	5.57	8/28/2011
28	HWM–NY–SUF–003	Suffolk	40.99074	-72.47138	--	--	5.12	8/28/2011
29	HWM–NY–SUF–004	Suffolk	40.63473	-73.20216	--	--	5.17	8/28/2011
30	HWM–NY–SUF–005	Suffolk	40.75018	-73.01311	--	--	4.33	8/28/2011

Table 16. Peak storm-tide data for Hurricane Irene at U.S. Geological Survey tide gages and at selected coastal sites in New York for August 28, 2011.—Continued

[Latitude and longitude in decimal degrees, NAD 83 (North American Datum of 1983); NAVD 88, North American Vertical Datum of 1988; GMT, Greenwich Mean Time; --, not applicable; data from McCallum and others, 2012; locations are shown on figure 42]

Site number	Internal site identification number	County	Latitude	Longitude	Site type	Type of data recorded	Peak storm-tide elevation (feet above NAVD 88)	Peak storm-tide date and time (GMT)
Temporary continuous-record gages deployed by the U. S. Geological Survey								
31	403836073154801	Suffolk	40.64328	-73.26334	Real-time water level	Storm tide	3.43	8/28/2011 13:30:00
32	SSS–NY–KIN–001WL	Kings	40.58000	-74.01161	Water level	Storm tide	8.10	8/28/2011 12:53:00
33	SSS–NY–KIN–002WL	Kings	40.70458	-73.98832	Water level	Storm tide	6.22	8/28/2011 13:19:00
34	SSS–NY–NAS–001WL	Nassau	40.87791	-73.53057	Water level	Storm tide	8.20	8/28/2011 14:54:30
35	SSS–NY–NAS–004WL	Nassau	40.58275	-73.64068	Water level	Storm tide	9.72	8/28/2011 11:13:00
36	SSS–NY–NAS–005WL	Nassau	40.64733	-73.46234	Water level	Storm tide	6.24	8/28/2011 13:13:00
37	SSS–NY–QUE–001WL	Queens	40.76229	-73.85828	Water level	Storm tide	8.03	8/28/2011 13:52:30
38	SSS–NY–QUE–002WL	Queens	40.64533	-73.83638	Water level	Storm tide	7.04	8/28/2011 13:16:30
39	SSS–NY–RIC–001WL	Richmond	40.59388	-74.05985	Water level	Storm tide	8.86	8/28/2011 12:33:30
40	SSS–NY–RIC–003WL	Richmond	40.50188	-74.23034	Water level	Storm tide	8.36	8/28/2011 11:52:30
41	SSS–NY–SUF–001WL	Suffolk	41.01259	-72.55828	Water level	Storm tide	6.94	8/28/2011 15:35:30
42	SSS–NY–SUF–002WL	Suffolk	40.96438	-72.86320	Water level	Storm tide	8.05	8/28/2011 15:35:00
43	SSS–NY–SUF–003WL	Suffolk	40.94617	-73.07227	Water level	Storm tide	7.54	8/28/2011 15:13:30
44	SSS–NY–SUF–004WL	Suffolk	40.78712	-72.75025	Water level	Storm tide	5.93	8/28/2011 13:33:30
45	SSS–NY–SUF–005WL	Suffolk	40.91608	-72.63774	Water level	Storm tide	4.10	8/28/2011 15:09:00
46	SSS–NY–SUF–006WL	Suffolk	40.84887	-72.50285	Water level	Storm tide	6.13	8/28/2011 11:57:00
47	SSS–NY–SUF–008WL	Suffolk	40.89331	-72.50300	Water level	Storm tide	3.94	8/28/2011 15:05:30
48	SSS–NY–SUF–009WL	Suffolk	41.00197	-72.29030	Water level	Storm tide	3.72	8/28/2011 13:37:30
49	SSS–NY–SUF–011WL	Suffolk	40.90048	-73.35304	Water level	Storm tide	8.09	8/28/2011 15:05:00
50	SSS–NY–SUF–014WL	Suffolk	40.99070	-72.47074	Water level	Storm tide	4.99	8/28/2011 15:59:00
51	SSS–NY–SUF–015WL	Suffolk	41.10104	-72.36144	Water level	Storm tide	4.41	8/28/2011 14:06:00
52	SSS–NY–SUF–017WL	Suffolk	40.64316	-73.15750	Water level	Storm tide	9.32	8/28/2011 10:55:30
53	SSS–NY–SUF–018WL	Suffolk	40.63473	-73.20216	Water level	Storm tide	6.33	8/28/2011 11:40:30
54	SSS–NY–SUF–019WL	Suffolk	40.65932	-73.26486	Water level	Storm tide	3.16	8/28/2011 13:18:30
55	SSS–NY–SUF–021WL	Suffolk	40.74918	-73.01338	Water level	Storm tide	4.37	8/28/2011 15:15:00
56	SSS–NY–SUF–022WL	Suffolk	40.68523	-73.27990	Water level	Storm tide	4.52	8/28/2011 13:35:30
National Oceanic and Atmospheric Administration tide gages								
57	8510560	Suffolk	41.04830	-71.96000	Real-time-tide gage	Storm tide	4.08	8/28/2011 13:12:00
58	8518750	New York	40.70060	-74.01420	Real-time-tide gage	Storm tide	6.70	8/28/2011 12:42:00
59	8519483	Richmond	40.63670	-74.14170	Real-time-tide gage	Storm tide	7.26	8/28/2011 12:42:00

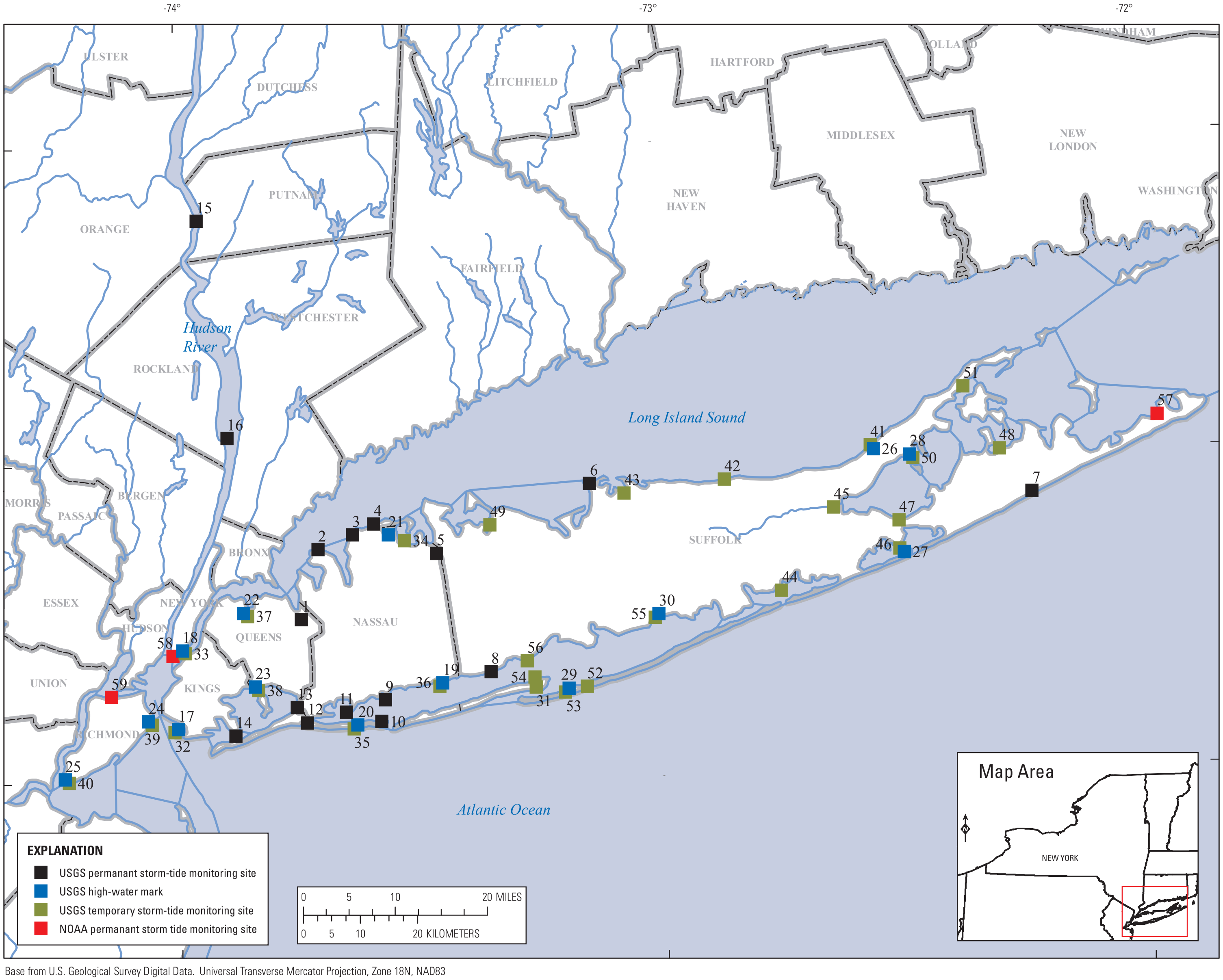
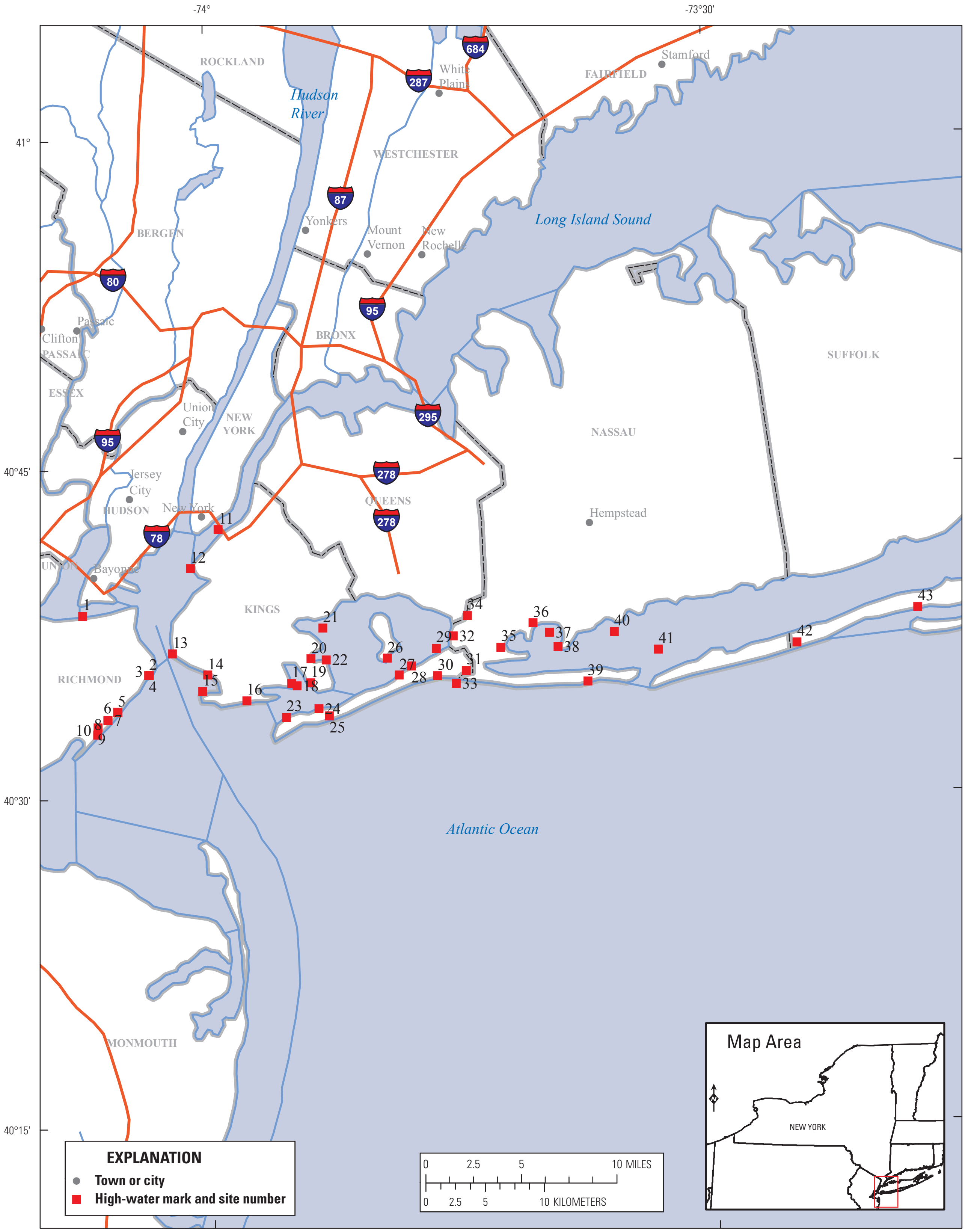


Figure 42. The locations of high-water marks and peak water-surface elevations recorded by the U.S. Geological Survey at coastal areas in New York City and Long Island, New York, for the flood of August 28, 2011.

Table 17. High-water marks collected by the Federal Emergency Management Agency at 43 selected coastal sites in Richmond, Kings, Queens, Nassau, and Suffolk Counties, New York, for the flood of August 28–29, 2011.

[Latitude, longitude, and elevation are from the Federal Emergency Management Agency (FEMA, 2011d); HWM ID, high-water-mark identification; latitude and longitude in decimal degrees, North American Datum of 1983 (NAD 83); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); locations are shown on figure 43]

Site number	FEMA HWM ID	County–borough (neighborhood/area) or town (village/hamlet)	Latitude	Longitude	Elevation
1	005–CNY–01–003	Richmond–Staten Island (Port Richmond), N.Y.	40.63990	-74.12555	6.7
2	005–CNY–01–006	Richmond–Staten Island (Arrochar), N.Y.	40.59416	-74.05983	6.2
3	005–CNY–01–005	Richmond–Staten Island (Arrochar), N.Y.	40.59432	-74.06004	8.9
4	005–CNY–01–004	Richmond–Staten Island (Arrochar), N.Y.	40.59407	-74.06039	9.0
5	005–CNY–01–010	Richmond–Staten Island (Midland Beach), N.Y.	40.56647	-74.09160	6.1
6	005–CNY–01–008	Richmond–Staten Island (Midland Beach), N.Y.	40.56671	-74.09190	10.3
7	005–CNY–01–012	Richmond–Staten Island (New Dorp Beach), N.Y.	40.56046	-74.10139	5.8
8	005–CNY–01–011	Richmond–Staten Island (New Dorp Beach), N.Y.	40.56046	-74.10139	5.6
9	005–CNY–01–015	Richmond–Staten Island (Oakwood), N.Y.	40.55486	-74.11153	4.1
10	005–CNY–01–013	Richmond–Staten Island (Oakwood), N.Y.	40.54972	-74.11204	12.0
11	005–CNY–03–012	Kings–Brooklyn (Dumbo), N.Y.	40.70453	-73.98950	8.0
12	005–CNY–03–010	Kings–Brooklyn (Red Hook), N.Y.	40.67513	-74.01783	6.8
13	005–CNY–03–009	Kings–Brooklyn (Fort Hamilton), N.Y.	40.61060	-74.03650	8.5
14	005–CNY–03–007	Kings–Brooklyn (Bath Beach), N.Y.	40.59414	-74.00169	9.6
15	005–CNY–03–006	Kings–Brooklyn (Sea Gate), N.Y.	40.58175	-74.00683	7.9
16	005–CNY–03–005	Kings–Brooklyn (Brighton Beach), N.Y.	40.57428	-73.96312	10.2
17	005–CNY–03–003	Kings–Brooklyn (Gerritsen Beach), N.Y.	40.58705	-73.91803	5.5
18	005–CNY–03–004	Kings–Brooklyn (Plumb Beach), N.Y.	40.58515	-73.91273	6.7
19	005–CNY–02–002	Kings–Brooklyn (Marine Park), N.Y.	40.58736	-73.89929	7.7
20	005–CNY–02–003	Kings–Brooklyn (Bergen Beach), N.Y.	40.60536	-73.89844	5.3
21	005–CNY–02–004	Kings–Brooklyn (Canarsie), N.Y.	40.62894	-73.88639	6.1
22	005–CNY–02–001	Kings–Brooklyn (Floyd Bennet Field), N.Y.	40.60469	-73.88345	6.0
23	005–CNY–02–010	Queens–Queens (Breezy Point), N.Y.	40.56153	-73.92385	7.9
24	005–CNY–02–012	Queens–Queens (Roxbury), N.Y.	40.56744	-73.89128	6.8
25	005–CNY–02–011	Queens–Queens (Roxbury), N.Y.	40.56212	-73.88091	10.6
26	005–CNY–02–006	Queens–Queens (Broad Channel), N.Y.	40.60524	-73.82235	6.0
27	005–CNY–02–014	Queens–Queens (Hammels), N.Y.	40.59233	-73.81091	7.7
28	005–CNY–02–015	Queens–Queens (Arverne), N.Y.	40.59914	-73.79866	6.5
29	005–CNY–02–017	Queens–Queens (Bayswater), N.Y.	40.61252	-73.77358	6.3
30	005–CNY–02–016	Queens–Queens (Edgemere), N.Y.	40.59154	-73.77270	10.4
31	005–CNY–02–020	Queens–Queens (Far Rockaway), N.Y.	40.59514	-73.74402	6.9
32	005–CNY–02–018	Nassau–Hempstead (Inwood), N.Y.	40.62159	-73.75647	6.8
33	005–CNY–02–025	Nassau–Hempstead (Atlantic Beach), N.Y.	40.58571	-73.75410	11.1
34	005–CNY–02–019	Nassau–Hempstead (Woodmere), N.Y.	40.63697	-73.74214	6.7
35	005–CNY–02–021	Nassau–Hempstead (Lawrence), N.Y.	40.61256	-73.70908	6.7
36	005–CNY–02–022	Nassau–Hempstead (Hewlett Harbor), N.Y.	40.63056	-73.67668	6.3
37	005–CNY–02–023	Nassau–Hempstead (Oceanside), N.Y.	40.62342	-73.66040	7.4
38	005–CNY–02–027	Nassau–Hempstead (Island Park), N.Y.	40.61242	-73.65222	6.5
39	005–CNY–02–028	Nassau–Hempstead (Lido Beach), N.Y.	40.58586	-73.62305	14.1
40	005–CNY–02–024	Nassau–Hempstead (Baldwin Harbor), N.Y.	40.62312	-73.59589	6.8
41	005–CNY–02–029	Nassau–Hempstead (Jones Island), N.Y.	40.60912	-73.55185	6.0
42	005–CNY–02–030	Suffolk–Babylon (West Gilgo Beach), N.Y.	40.61299	-73.41391	10.9
43	005–CNY–02–031	Suffolk–Babylon (Oak Beach), N.Y.	40.63820	-73.29280	5.5



Base from U.S. Geological Survey Digital Data. Universal Transverse Mercator Projection, Zone 18N, NAD83

Figure 43. The locations of 43 high-water marks in selected coastal areas in New York City and on Long Island, New York, for the flood of August 28, 2011.

Table 18. Data for seven reservoirs in southeastern New York for the flood of August 28–29, 2011.

[mi^2, square miles; h, hours; ft, feet; mil ft^3, million cubic feet; in., inches; USGS, U.S. Geological Survey; locations are shown on figure 10]

Map number	Station number and name	Drainage area (mi^2)	[a]Dates of runoff	Time (h)	[b]Water-surface elevation (ft)	Contents (mil ft^3)	Percentage of usable capacity	Change in contents (mil ft^3)	[c]Runoff stored (in.)	[b]Spillway elevation (ft)	Usable capacity (mil ft^3)
45	01350100 Schoharie Reservoir near Grand Gorge, N.Y. (USGS reservoir gage)	315	8/28	0200	1,117.86	2,060	78.7		0.76	1,124.5	2,618
			8/28	1300	1,137.73	3,032	115.8	972	1.33		
69	01363400 Ashokan Reservoir at Ashokan, N.Y.–West Basin[d]	256	8/28	0100	589.97	6,279	99.7		0.05	590.0	6,307
			8/28	1400	595.92	7,151	113.4	872	[e]1.47		
69	01363400 Ashokan Reservoir at Ashokan, N.Y.–East Basin[d]	256	8/28	0100	582.79	9,837	91.2		1.59	587.1	10,785
			8/28	2400	590.58	11,570	106.9	1,733	[e]2.91		
73	01366400 Rondout Reservoir at Lackawack, N.Y.[d]	95.4	8/28	0100	836.16	6,344	95.1		1.56	840.0	6,690
			8/28	1700	841.95	6,870	102.6	525	2.37		
110	01416900 Pepacton Reservoir near Downsville, N.Y.[d]	372	8/28	0100	1,273.98	17,757	94.8		1.14	1,280.0	18,741
			8/29	0500	1,282.76	19,899	106.2	2,141	2.48		
122	01424997 Cannonsville Reservoir near Stilesville, N.Y.[d]	454	8/28	0100	1,139.33	10,824	84.6		No spillage	1,150.0	12,794
			8/29	2300	1,147.33	12,387	96.8	1,563	1.48		
136	01435900 Neversink Reservoir near Neversink, N.Y.[d]	92.5	8/28	0100	1,433.57	4,327	92.6		1.60	1,440.0	4,671
			8/28	1500	1,443.24	4,958	106.1	631	2.93		

[a]From minimum elevation at start of storm runoff to maximum elevation.

[b]Elevation in feet above National Geodetic Vertical Datum of 1929.

[c]First runoff value at each site is just prior to spillage, second runoff value is at maximum elevation.

[d]Records furnished by New York City Department of Environmental Protection.

[e]As a result of reservoir configuration and timing of inflows, the maximum combined runoff stored in the West and East Basins of Ashokan Reservoir was 3.99 inches at 2300 hours on August 28, 2011.

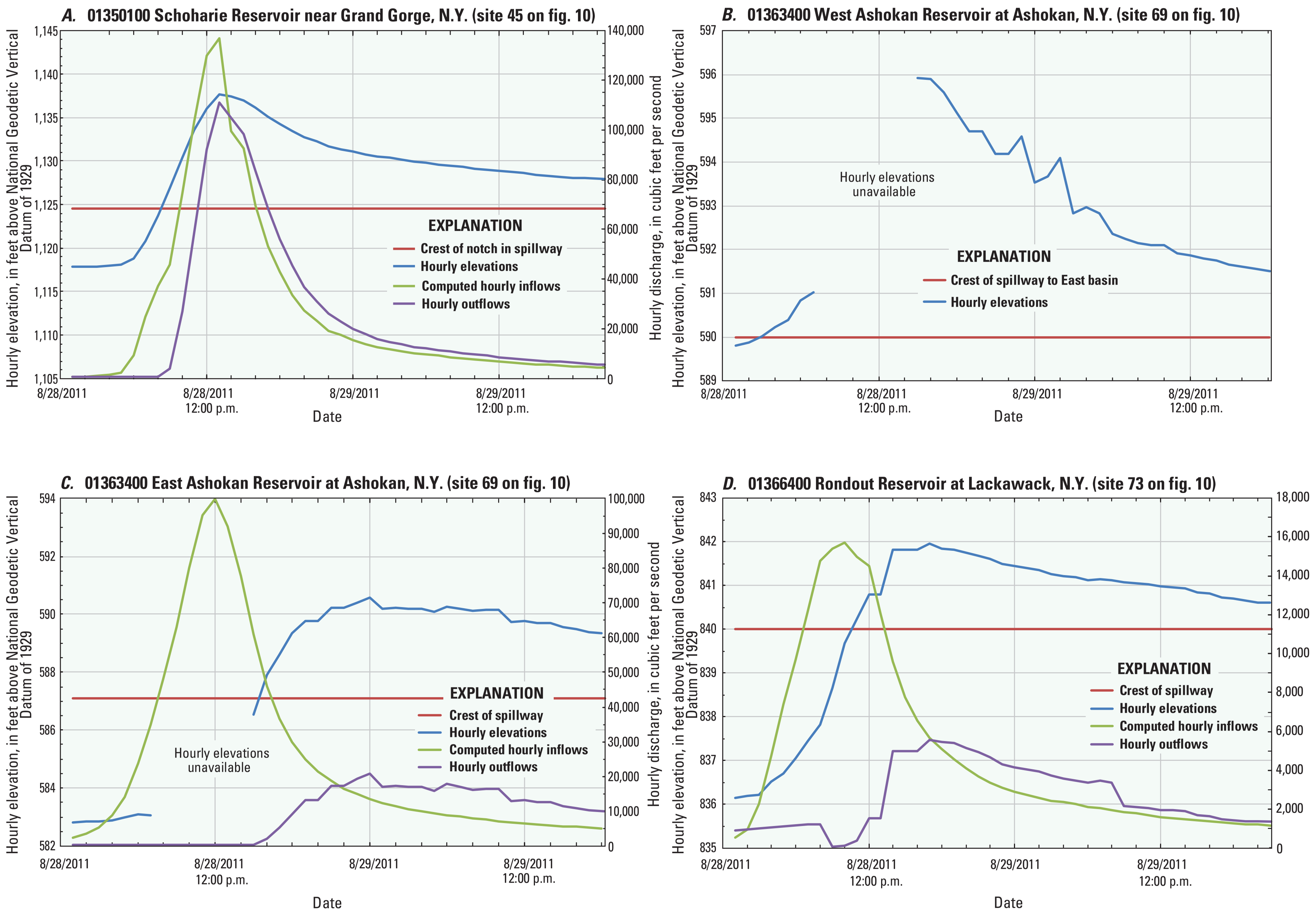


Figure 44. Hourly inflows, outflows, and water-surface elevations at selected reservoirs in southeastern New York, August 28–29, 2011. (Data are given in table 18 and locations are shown on figure 10.)

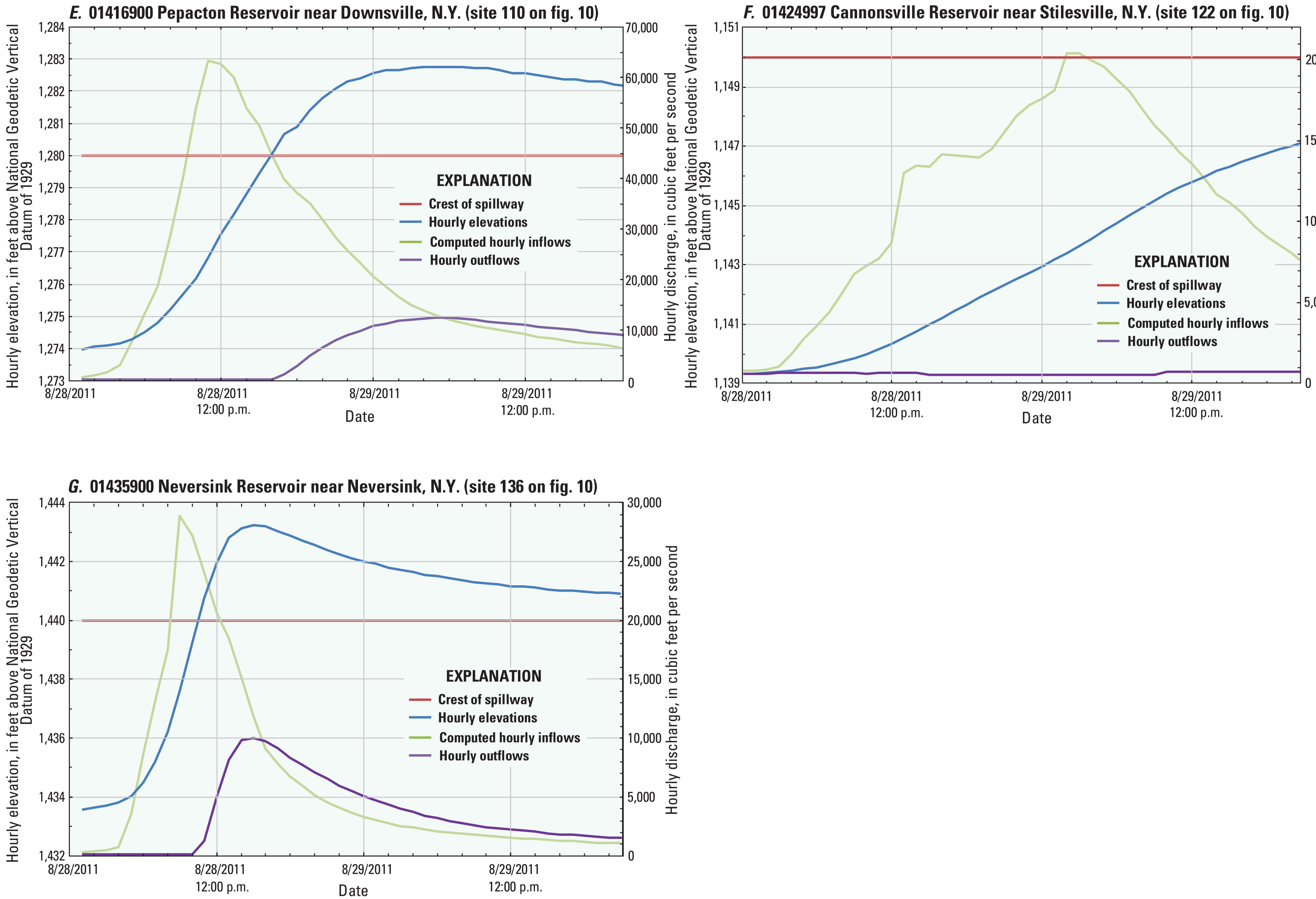


Figure 44. Hourly inflows, outflows, and water-surface elevations at selected reservoirs in southeastern New York, August 28–29, 2011. (Data are given in table 18 and locations are shown on figure 10.)—Continued

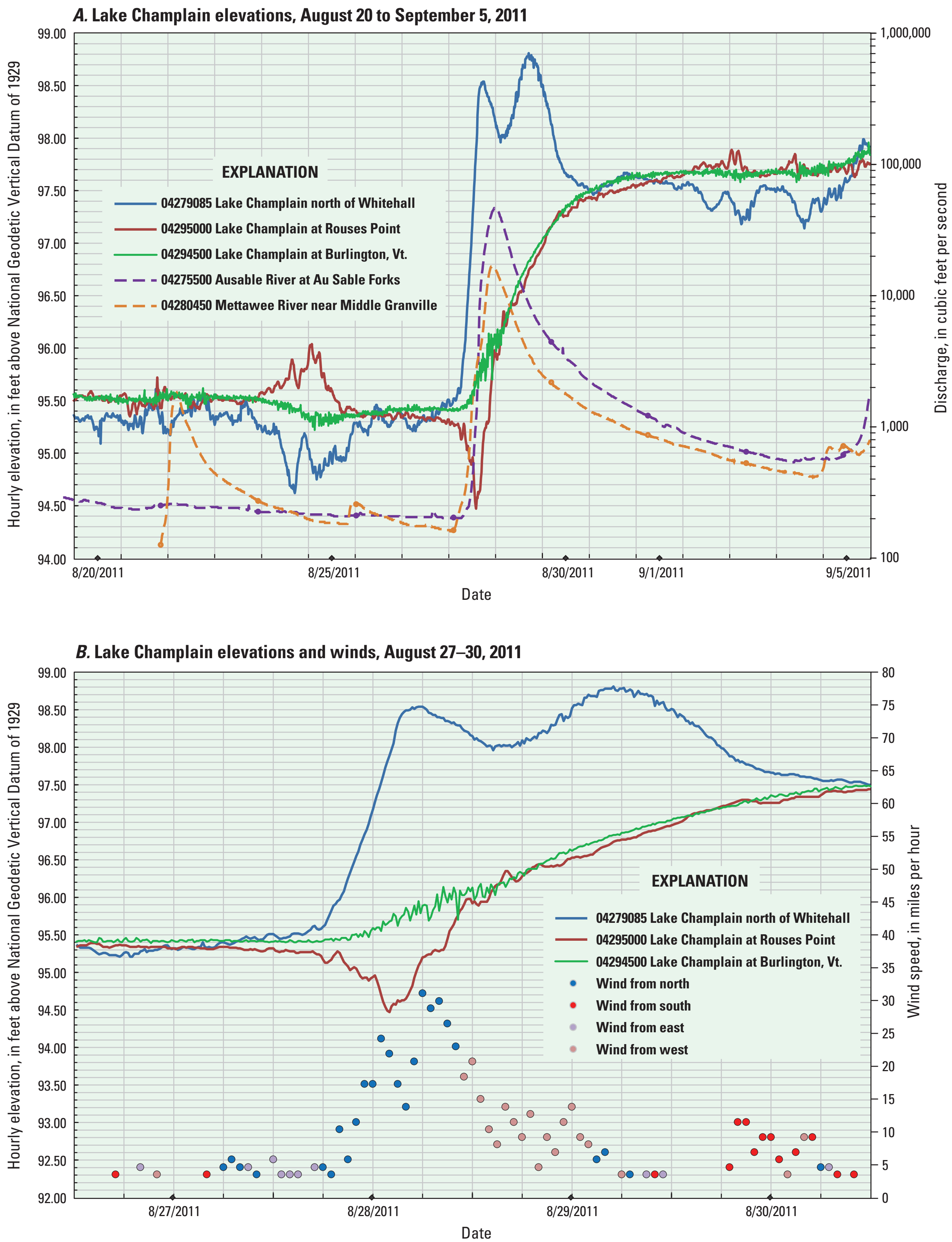


Figure 45. Water-surface elevations at three lake gages on Lake Champlain and *A,* inflows from two tributaries, and *B,* wind direction and speed, for late August to early September 2011. (All gages are in New York unless otherwise specified; locations are shown on figure 10)

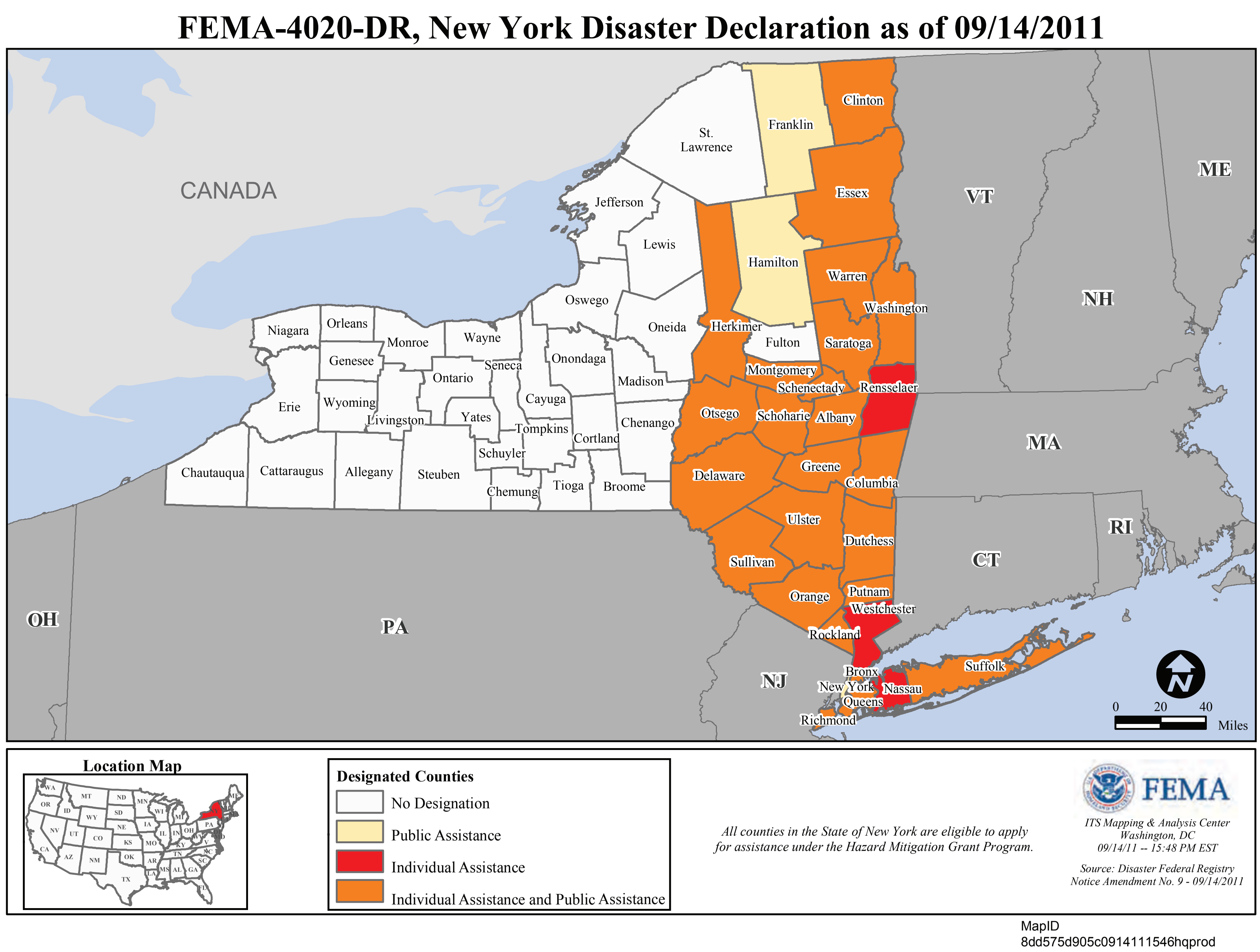


Figure 46. The counties of New York that were declared major disaster areas following the flooding of August 28–29, 2011. (From Federal Emergency Management Agency (FEMA), 2011a)

Communities along Schoharie Creek were particularly hard hit. Local officials estimated that about one-third of homes and businesses in the village of Schoharie were destroyed as a result of the flooding. Similar destruction occurred within other villages (Prattsville, Middleburg, Esperance, and many others) along the creek. Other streams in parts of the Catskill Mountains area, southeastern New York, the eastern Adirondack Mountains, and areas west of Lake Champlain also incurred major damage. Many farms sustained damage during the flood, and New York received a Federal relief fund to help farmers cope with the destruction. The State's transportation-system infrastructure also sustained major damage, totaling $297 million (New York State, 2012). The New York State Department of Transportation (NYSDOT) reopened more than 80 percent of closed roads and bridges within 10 days of the storm and received the Award of Merit from the American Council of Engineering Companies of New York for its response to Tropical Storm Irene. Several other restoration and flood-mitigation programs were initiated following the most destructive and costly disaster in New York to date (New York State, 2012).

Storm and Floods of September 7–11, 2011 (Tropical Storm Lee)

Tropical Storm Lee was the 12th named storm of the 2011 Atlantic hurricane season. Lee made landfall near the mouth of the Mississippi River on September 2 and slowly traveled north-northeast along the western Appalachian Mountains, where its remnants entered New York near Binghamton in the south-central part of the State on September 7. The remnants of Lee were able to pull moisture from Hurricane Katia in the south-southeast far off the Atlantic coast and, as a result, left over 12 in. of rain in parts of the State during September 7–8. Major flooding resulted from the extreme rainfall in many locations, especially along the Susquehanna River and its tributaries as well as several other streams in east-central to southeast New York, including the Wallkill River, which was still recovering from flooding caused by Tropical Storm Irene. The USGS surveyed 20 HWMs at 18 locations along a 114-mi reach of the Susquehanna River and compared the elevations to those published by FEMA for the 10-, 2-, 1-, and 0.2-percent AEP (10-, 50-, 100-, and 500-year) floods.

Remnants of Tropical Storm Lee reached south-central New York on September 7, 2011. The heaviest rains were centered over the already saturated Susquehanna River Basin in south-central New York with over 12 in. recorded in some areas during September 7–9 (and most falling on September 8). Flooding in the lower reaches of the Susquehanna River exceeded the record levels of 2006 by more than 4 ft (Tioga County). Ten streamgages in the Susquehanna River Basin recorded new maximum discharges and elevations on September 8, each greater than the 1-percent AEP discharge. The stage-frequency plot for the Susquehanna River near Waverly (01515000) streamgage shows that the water-surface elevation remained above the 1-percent AEP (100-year) flood elevation for nearly 24 hours during September 8–9. The peak discharge at Waverly (167,000 ft^3/s) was the largest in 76 years (the previous maximum was 128,000 ft^3/s in 1936 and 2006). Major disaster declarations were made for 15 counties in and around central New York with about $1 billion in estimated damages (Federal Emergency Management Agency, 2011b).

Antecedent Conditions

The heavy rains from the remnants of Tropical Storm Lee moved over south-central New York on September 7–8, 2011, only 10 days after Tropical Storm Irene had saturated the area with several inches of rain. Soil moisture increased further in early September as 1 to 2 in. of rain fell over the area during September 5–6.

Streamgages in the Susquehanna River Basin and other areas of south-central New York indicated flows that were already far above normal at the beginning of September; these flows were representative of antecedent conditions prior to the arrival of Lee on September 7 (figs. 47A–D). At each of the streamgages, daily mean flows remained above their 25th percentiles during late August through at least mid-September. The high flows prior to the early-September storm combined with the extreme rainfalls of Tropical Storm Lee during September 8–9 led to record floods on the Susquehanna River and some of its tributaries.

Precipitation

Tropical Storm Lee's large circulation, covering much of the mid-Atlantic region of the United States, pulled moisture north from Hurricane Katia, which had formed over the Atlantic Ocean (fig. 48, Masters, 2011). Rainfall from Lee exceeded 20 in. in some areas along its path from Louisiana to New England (fig. 49, Brown, 2011). Radar images of 1-day total rainfall (fig. 50) indicate that more than 10 in. fell in the Susquehanna River Basin during September 6–9, 2011 (National Oceanic and Atmospheric Administration, 2011m). Precipitation gages in south-central New York and adjacent parts of Pennsylvania recorded totals of nearly 13 in. of rain during the storm (table 19) with most of the rain falling on September 8 (10.40 in. at Apalachin, N.Y.); nine stations reported rainfall totals greater than 10 in. The greatest rainfall in the region was over south-central New York near Binghamton, which received about 10 to 12 in. of rain during the storm (fig. 51). Southeastern New York also received substantial amounts of rain (6–8 in.), causing streams like the Wallkill River to rise to nearly 5 ft above flood stage. Beyond central and southeastern New York, rainfall from Lee diminished greatly, with western New York receiving less than 1 in. (National Oceanic and Atmospheric Administration, 2011f, h).

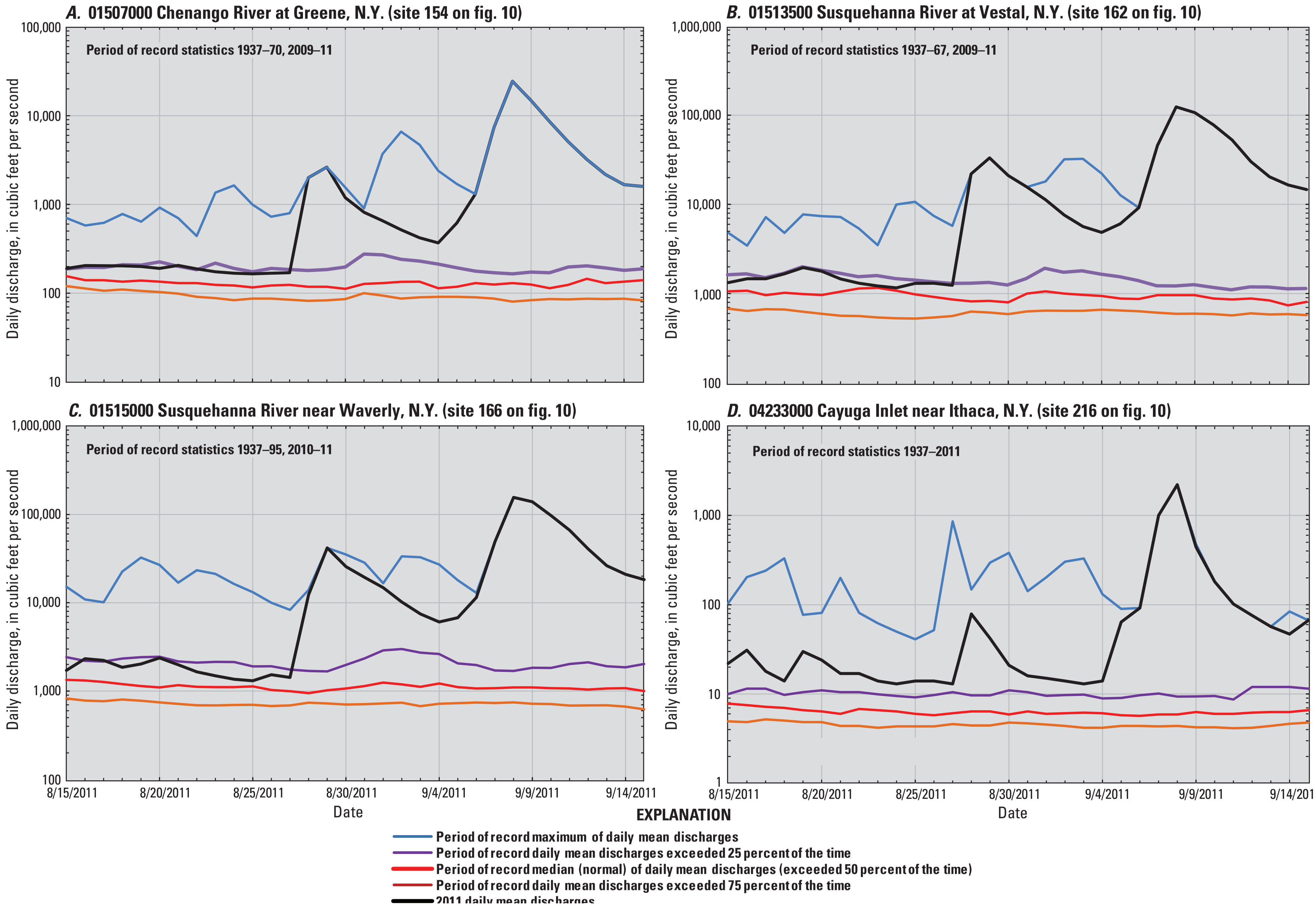


Figure 47. Daily discharge data for the streamgages *A,* Chenango River at Greene, *B,* Susquehanna River at Vestal, *C,* Susquehanna River near Waverly, and *D,* Cayuga Inlet near Ithaca, New York, for August 15–September 15, 2011. (Sites are listed in appendix 1 and shown on figure 10.)

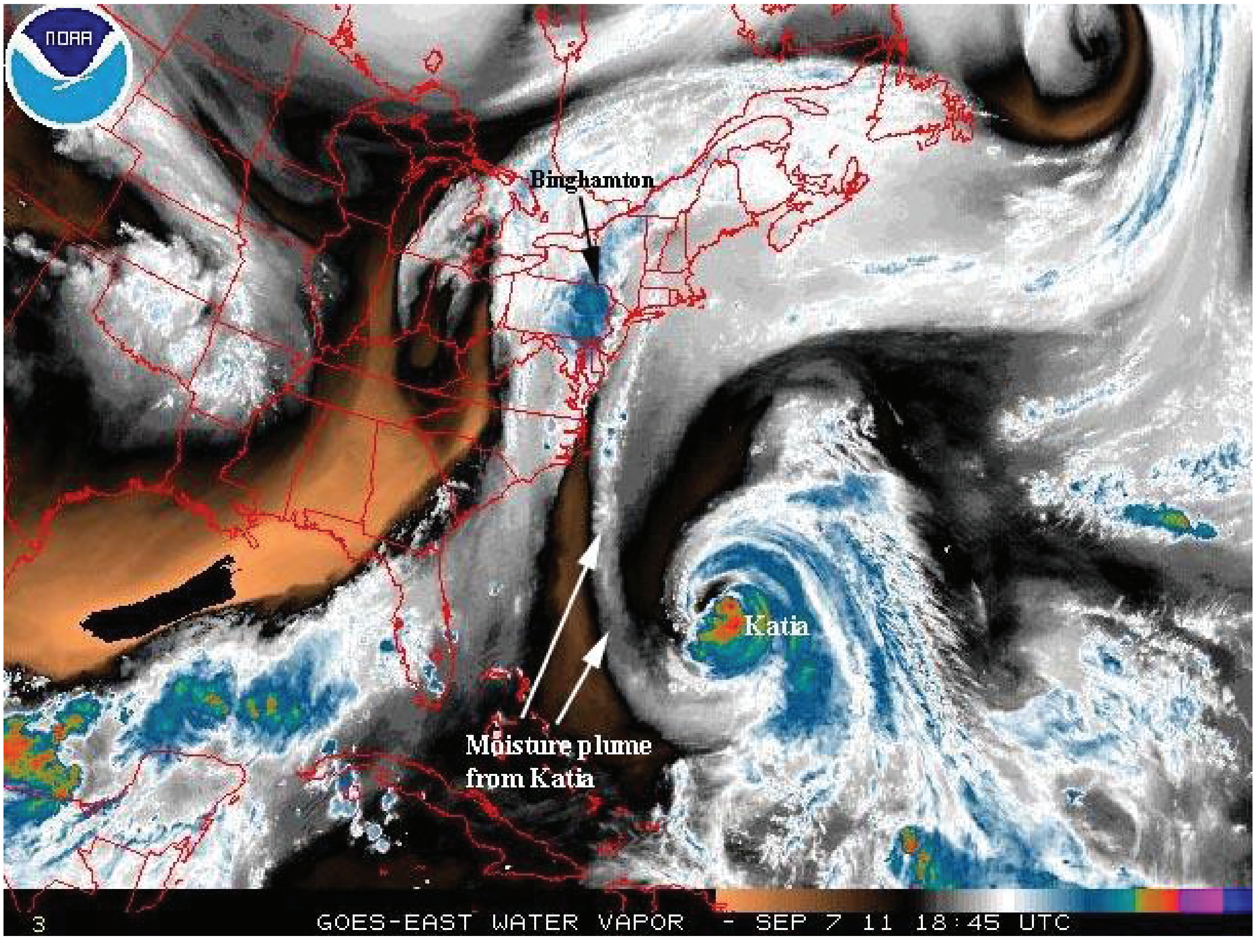


Figure 48. Moisture from the remnants of Tropical Storm Lee and Hurricane Katia on September 7, 2011. (From Masters, 2011)

Record rainfall intensities were set at Binghamton, where 8.70 in. fell in less than 24 hours (National Oceanic and Atmospheric Administration, 2011j). Accumulated hourly rainfalls at three weather stations in south-central to east-central New York indicate that most of the total storm rain fell in less than 24 hours, mostly on September 7, 2011 (fig. 52). Rainfall-frequency data at the three climate stations (table 20) and maximum 3-, 6-, 12-, and 24-hour rainfall during September 7–8, 2011 (shown in red), indicate that the intensities of rainfall were notable at Binghamton and Ithaca but not at Albany. Rainfall intensity at Binghamton for the 12- and 24-hour durations exceeded the 100- and 200-year recurrence intervals, respectively, and was nearly a 500-year, 24-hour storm (8.87 in.). At Ithaca, rainfall intensities for a 24-hour period were at about the 25-year recurrence interval. The durations of rainfall totals at Albany were less than 2 years.

September 2011 was the wettest September throughout south-central New York (climate division 2 in fig. 1) since at least 1895, averaging 11.60 in. of rain for the month, nearly 8 in. above normal (National Oceanic and Atmospheric Administration, 2011k). Total rainfall during August and September 2011 (20.99 in.) in south-central New York was the greatest 2-month late-summer total on record (since 1895), mostly from Tropical Storm Irene in August and Lee in September. The previous maximum total for August and September was 13.86 in. in 1977.

Flooding

The heavy rains from the remnants of Tropical Storm Lee, especially in south-central New York, resulted in record streamflows at 10 active streamgages in the Susquehanna River Basin and 2 other streamgages in the Cayuga Lake Basin (Finger Lake tributary to Lake Ontario) during early September 2011 (table 21, fig. 10). Flooding in the lower reaches of the Susquehanna River in New York exceeded the record levels of 2006 by more than 4 ft, and peak discharges exceeded the 1-percent AEP flow.

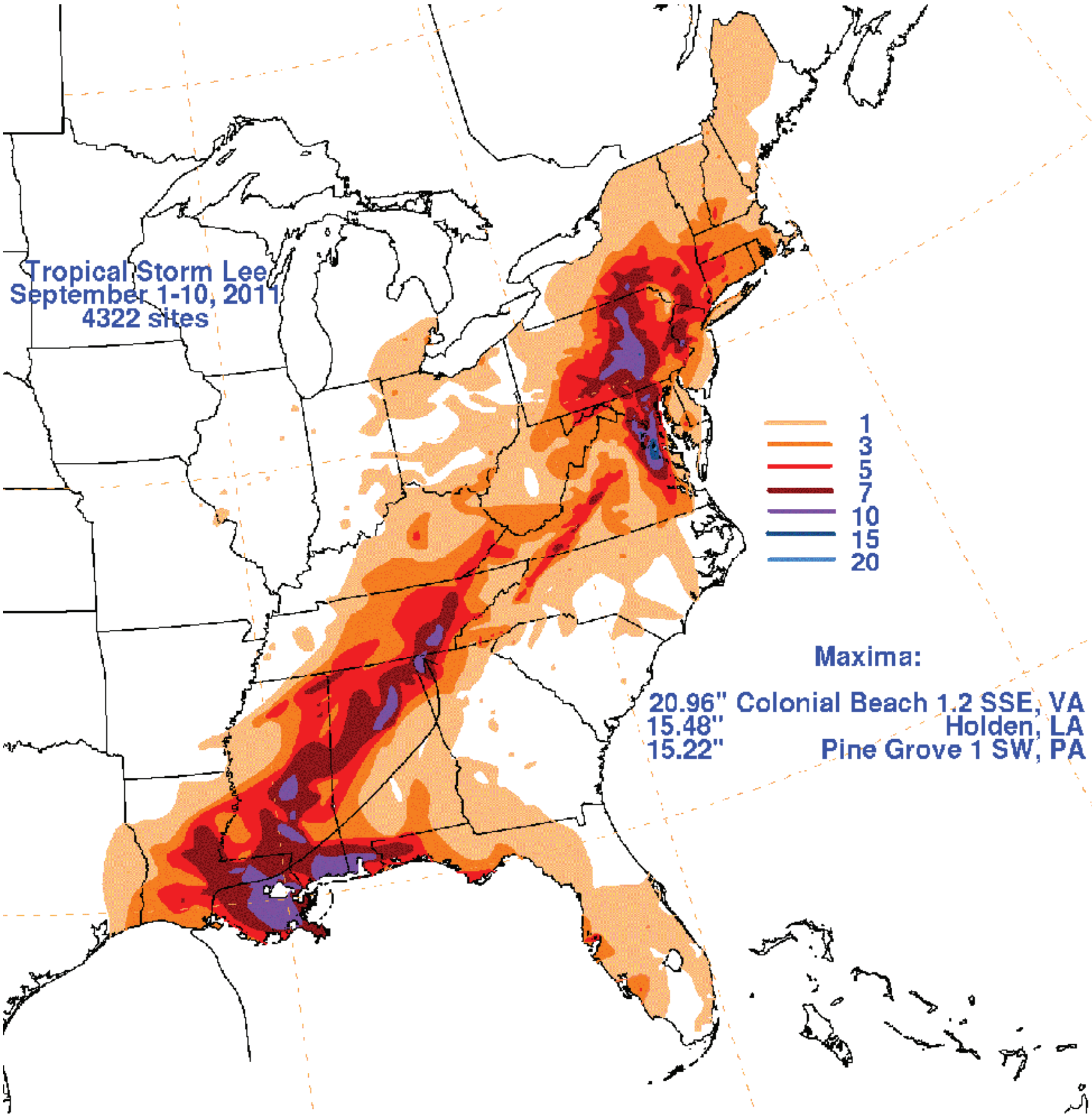
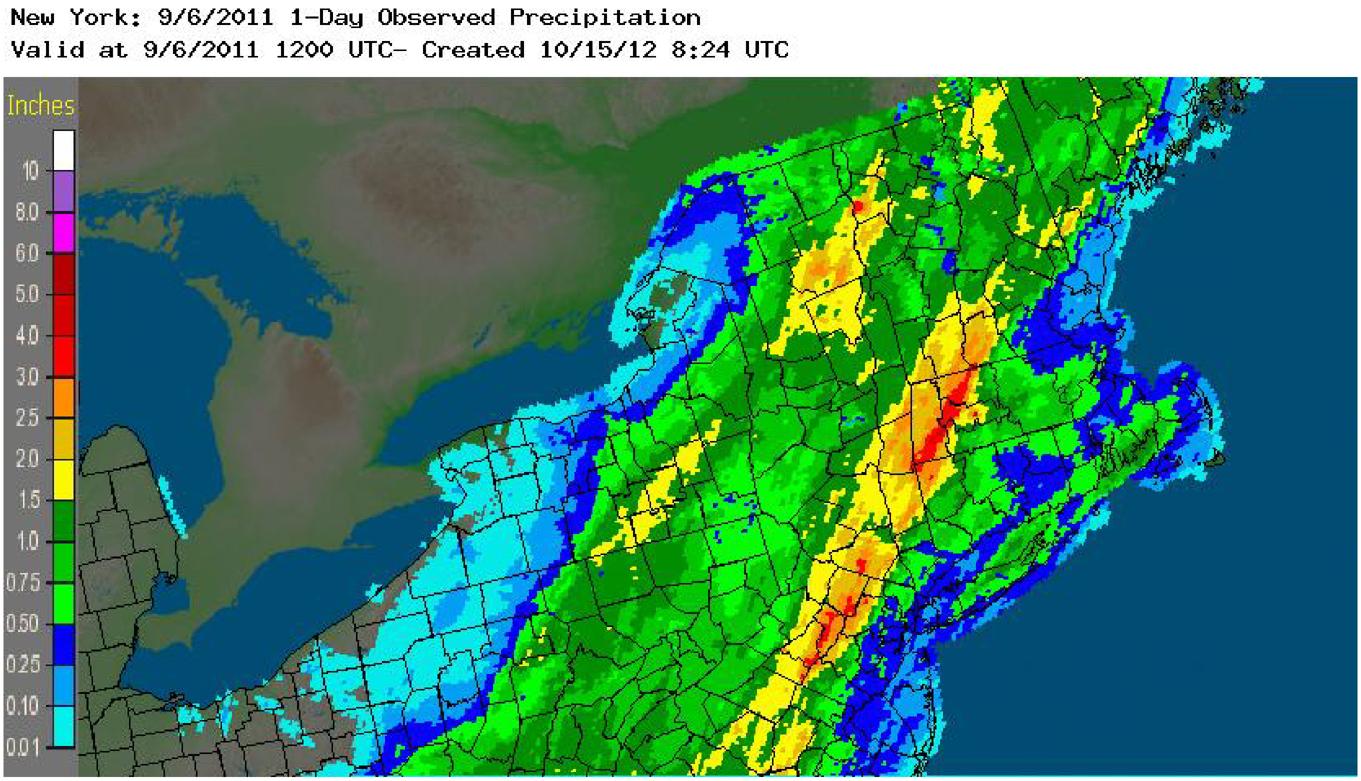


Figure 49. Rainfall totals in inches from Tropical Storm Lee and its remnants during September 1–10, 2011. (From Brown, 2011)

A



B

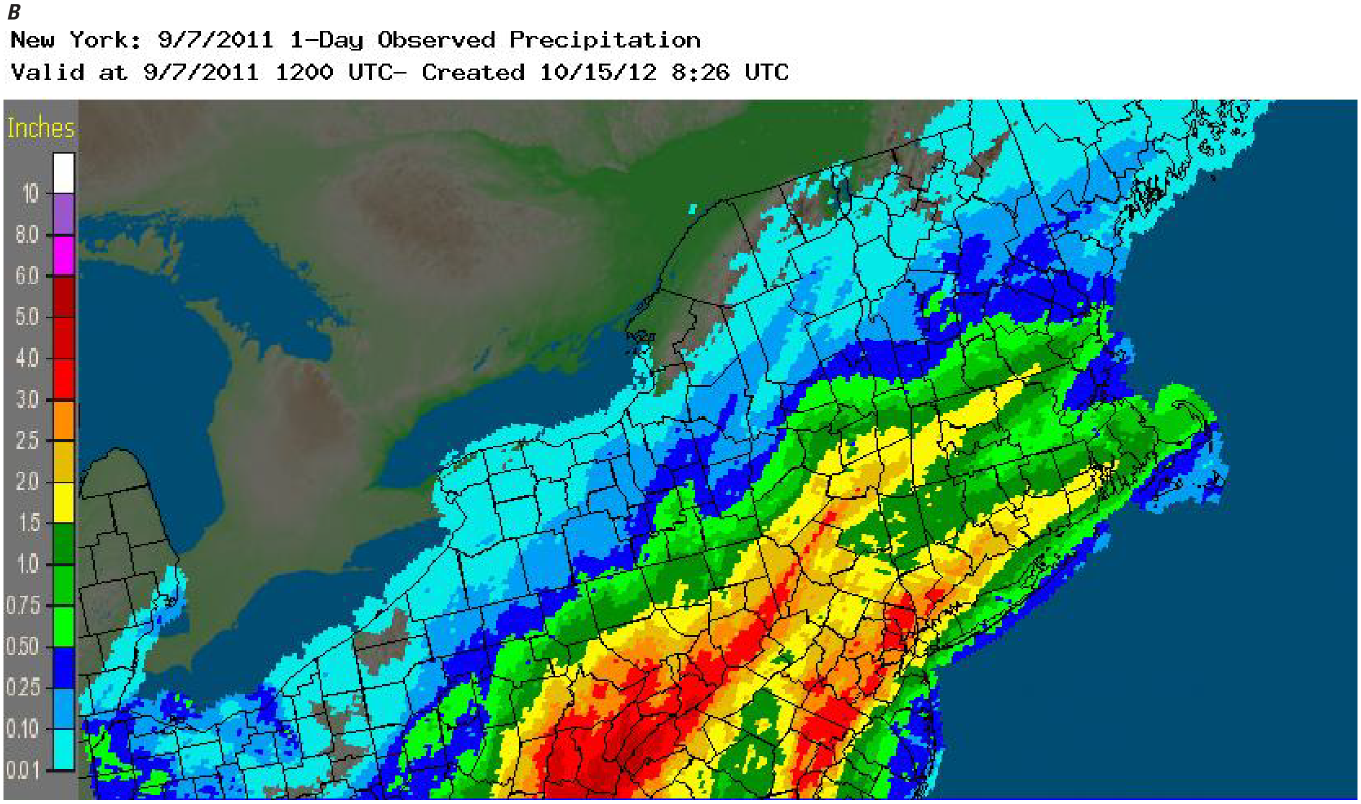
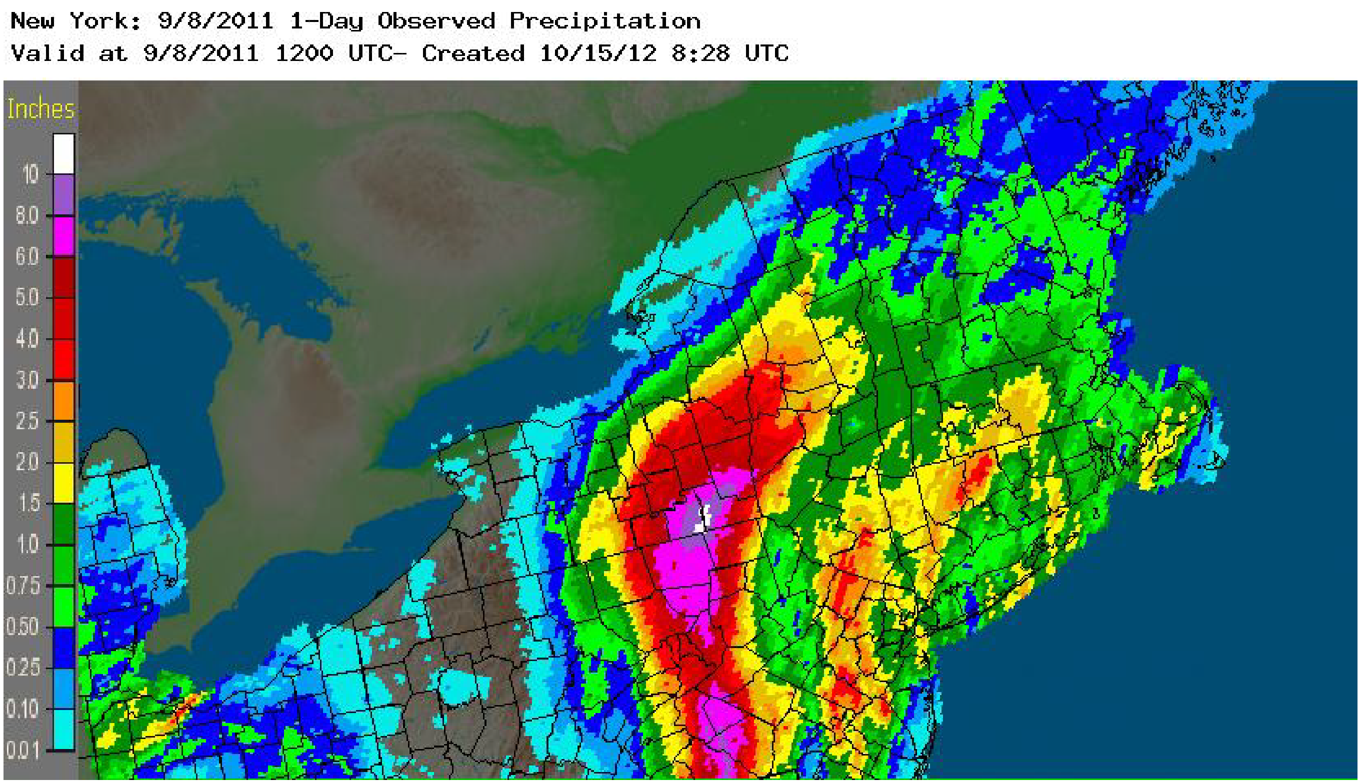


Figure 50. Daily rainfall totals from the remnants of Tropical Storm Lee during *A,* September 6, *B,* September 7, *C,* September 8, and *D,* September 9, 2011, for New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011m)

C



D

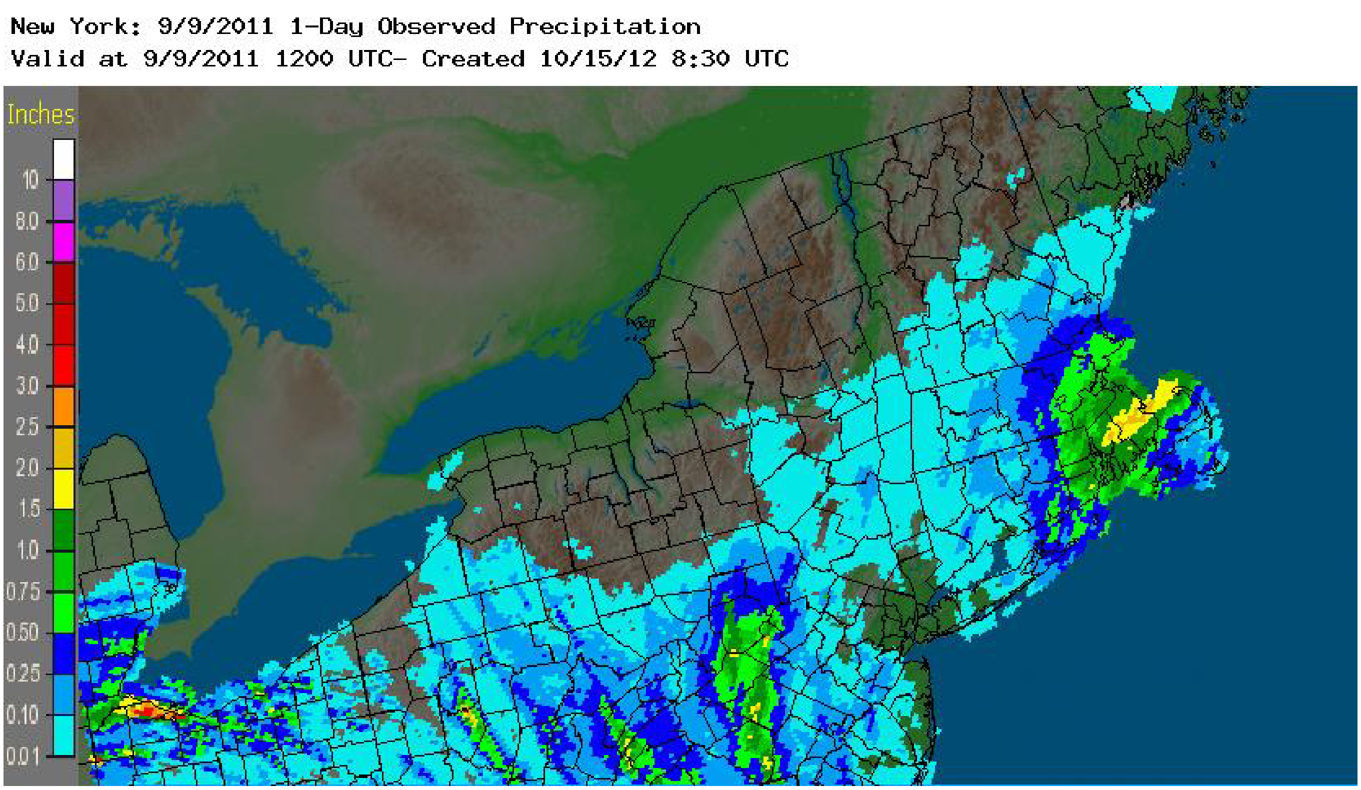


Figure 50. Daily rainfall totals from the remnants of Tropical Storm Lee during *A,* September 6, *B,* September 7, *C,* September 8, and *D,* September 9, 2011, for New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011m)—Continued

Table 19. Rainfall for the storm of September 5–9, 2011, at selected locations in New York and surrounding areas.

[Data provided by the National Oceanic and Atmospheric Administration (2011f,h) and Community Collaborative Rain, Hail & Snow Network; Sept., September; N, north; S, south; E, east; W, west; SUNY-ESF, State University of New York College of Environmental Science and Forestry; locations are given on figure 51]

Site number	Site name	Rainfall (inches)					
		Sept. 5	Sept. 6	Sept. 7	Sept. 8	Sept. 9	Total
1	Apalachin 2 ESE, N.Y.	0.65	0.76	0.87	10.40	0.05	12.73
2	Laporte, Pa.	1.29	0.93	1.98	7.82	0.25	12.27
3	Apalachin 3 ESE, N.Y.	0.66	0.73	0.69	9.70	0.05	11.83
4	Endicott 5 SSE, N.Y.	0.85	0.66	1.02	8.90	0.03	11.46
5	Dushore, Pa.	1.09	0.82	1.59	7.36	0.14	11.00
6	Vestal 3 SSE, N.Y.	0.81	0.73	1.02	7.91	0.02	10.49
7	Owego 3 WSW, N.Y.	0.41	1.03	0.54	8.35	0.00	10.33
8	Candor 2 SE, N.Y.	2.48	1.12	0.61	6.11	0.00	10.32
9	Waverly, N.Y.	0.20	1.05	0.84	8.00	0.00	10.09
10	Binghamton 2 SW, N.Y.	0.78	0.68	1.30	7.17	0.02	9.95
11	Greater Binghamton Airport, N.Y.	0.55	0.39	7.49	1.41	0.00	9.84
12	Whitney Point 2 SSE , N.Y.	0.63	0.87	0.24	7.12	0.70	9.56
13	Canton, Pa.	0.32	1.55	1.93	5.39	0.03	9.22
14	Greene, N.Y.	0.73	0.72	0.40	7.26	0.00	9.11
15	Towanda 1 S, Pa.	0.66	1.03	1.19	6.02	0.03	8.93
16	Smyrna 2 WNW, N.Y.	2.20	1.49	0.26	4.65	0.06	8.66
17	Whitney Point Dam, N.Y.	0.53	0.85	0.31	6.75	0.00	8.44
18	Phoenicia 2 SW, N.Y.	1.36	1.53	3.49	1.86	0.06	8.30
19	Sherburne 4 NNE, N.Y.	0.92	1.21	0.31	5.80	0.00	8.24
20	Berkshire 2 ENE, N.Y.	0.27	1.31	0.78	5.84	0.03	8.23
21	Unadilla 2 N, N.Y.	1.17	0.72	0.60	5.46	0.07	8.02
22	Bloomingburg 2 SW, N.Y.	0.35	2.31	1.99	2.35	0.98	7.98
23	Owego 3 ENE, N.Y.	0.33	0.86	0.47	6.17	0.00	7.83
24	Covington 2 WSW, Pa.	0.79	1.57	1.00	4.29	0.00	7.65
25	Candor 3 NE, N.Y.	0.25	1.49	0.48	5.38	0.00	7.60
26	New Milford 5 W, Pa.	0.56	0.55	1.50	4.78	0.18	7.57
27	Norwich, N.Y.	0.72	0.76	0.31	5.72	0.06	7.57
28	Norwich 6 NE, N.Y.	0.96	0.80	0.38	5.39	0.02	7.55
29	Southport 4 SSW, N.Y.	0.24	1.66	0.99	4.62	0.00	7.51
30	Bridgewater 4 SSE, N.Y.	1.21	1.05	0.18	5.03	0.03	7.50
31	Elmira 1 ESE, N.Y.	0.32	1.63	0.51	4.98	0.00	7.44
32	Slide Mountain, N.Y.	1.14	1.91	2.83	1.40	0.04	7.32
33	Chemung, N.Y.	0.27	1.41	0.83	4.75	0.03	7.29
34	Maryland 6 SW, N.Y.	0.95	0.97	0.57	4.73	0.06	7.28
35	Walton 2, N.Y.	2.22	0.81	0.75	3.12	0.36	7.26
36	Elmira, N.Y.	0.32	1.87	0.47	4.56	0.01	7.23
37	Oneonta, N.Y.	0.80	1.19	0.61	4.52	0.05	7.17
38	Willet 2 E, N.Y.	0.18	1.02	0.27	5.68	0.02	7.17
39	Rock Hill 3 SW, N.Y.	1.12	2.17	2.01	1.70	0.06	7.06
40	Slaterville Springs 1 S, N.Y.	0.12	1.73	0.42	4.75	0.02	7.04
41	Elmira 3 E, N.Y.	0.44	1.31	1.39	3.87	0.00	7.01

Table 19. Rainfall for the storm of September 5–9, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011f,h) and Community Collaborative Rain, Hail & Snow Network; Sept., September; N, north; S, south; E, east; W, west; SUNY-ESF, State University of New York College of Environmental Science and Forestry; locations are given on figure 51]

Site number	Site name	Rainfall (inches)					
		Sept. 5	Sept. 6	Sept. 7	Sept. 8	Sept. 9	Total
42	Oneonta 1 ENE, N.Y.	0.88	1.17	0.91	4.00	0.02	6.98
43	West Elmira 1 SSE, N.Y.	0.33	1.66	0.45	4.51	0.01	6.96
44	Norwich 5 W, N.Y.	0.43	0.79	0.26	5.42	0.02	6.92
45	Freeville 2 NE, N.Y.	0.32	1.72	0.29	4.52	0.02	6.87
46	Cornell University, Ithaca, N.Y.	0.26	1.83	0.32	4.43	0.01	6.85
47	Newfield 3 S, N.Y.	0.21	1.72	0.38	4.45	0.01	6.77
48	Freeville 1 NE, N.Y.	0.06	2.02	0.60	4.02	0.03	6.73
49	East Ithaca 5 E, N.Y.	0.15	1.49	0.34	4.62	0.02	6.62
50	Freeville 4 W, N.Y.	0.21	1.77	0.29	4.33	0.02	6.62
51	Ithaca 13 E, N.Y.	1.32	0.17	3.94	1.19	0.00	6.62
52	Worcester 4 SSW, N.Y.	0.96	0.96	1.00	3.00	0.60	6.52
53	Arkville 2 W, N.Y.	0.93	1.42	2.34	1.79	0.02	6.50
54	Groton 3 SSW, N.Y.	0.15	1.65	0.30	4.35	0.01	6.46
55	Delhi 2 NNE, N.Y.	2.31	0.86	1.70	1.50	0.08	6.45
56	East Jewett, N.Y.	1.03	1.38	2.06	1.81	0.16	6.44
57	East Sidney, N.Y.	0.90	0.70	0.70	3.95	0.17	6.42
58	Tioga Hammond Dam, Pa.	0.22	1.44	0.58	4.12	0.00	6.36
59	Mecklenburg 4 SW, N.Y.	0.07	1.57	0.26	4.40	0.00	6.30
60	Marathon 1 NW, N.Y.	0.24	1.45	0.30	4.25	0.01	6.25
61	Susquehannna, Pa.	0.44	0.51	1.79	3.36	0.14	6.24
62	Enfield 1 ENE, N.Y.	0.10	1.26	0.22	4.50	0.00	6.08
63	Sherburne, N.Y.	0.15	1.24	0.21	4.44	0.03	6.07
64	Hartwick, N.Y.	0.38	0.87	0.51	4.21	0.04	6.01
65	Liberty 1 NE, N.Y.	0.53	1.30	2.18	1.65	0.19	5.85
66	Cooperstown, N.Y.	0.71	0.87	2.62	1.58	0.00	5.78
67	Groton 1 NW, N.Y.	0.29	1.44	0.24	3.71	0.00	5.68
68	Deposit, N.Y.	0.56	0.52	1.41	3.14	0.04	5.67
69	Cowanesque Dam, Pa.	0.24	1.47	0.76	3.15	0.00	5.62
70	Elmira Corning Regional Airport, N.Y.	1.66	0.17	3.26	0.43	0.00	5.52
71	Lansing Manor, N.Y.	1.08	0.99	2.18	1.20	0.02	5.47
72	Windsor 8 SE, N.Y.	0.42	0.53	1.38	3.04	0.07	5.44
73	Corning, N.Y.	0.21	1.70	0.29	3.23	0.00	5.43
74	Cairo 4 NW, N.Y.	0.71	1.24	2.25	1.16	0.00	5.36
75	Callicoon Center, N.Y.	0.80	0.92	2.51	1.00	0.09	5.32
76	Lansing 9 N, N.Y.	0.44	0.90	0.25	3.73	0.00	5.32
77	Lindley 2 N, N.Y.	0.00	1.80	0.42	3.10	0.00	5.32
78	Big Flats 1 W, N.Y.	0.16	1.72	0.75	2.62	0.00	5.25
79	Westmoreland 4 N, N.Y.	0.10	1.48	0.30	3.24	0.04	5.16
80	Trenton Falls, N.Y.	0.54	1.21	0.41	2.95	0.00	5.11
81	Richfield Springs 1 ESE, N.Y.	0.84	0.87	0.32	3.02	0.02	5.07
82	Locke 2 W, N.Y.	0.09	0.99	0.26	3.67	0.00	5.01

Table 19. Rainfall for the storm of September 5–9, 2011, at selected locations in New York and surrounding areas.—Continued

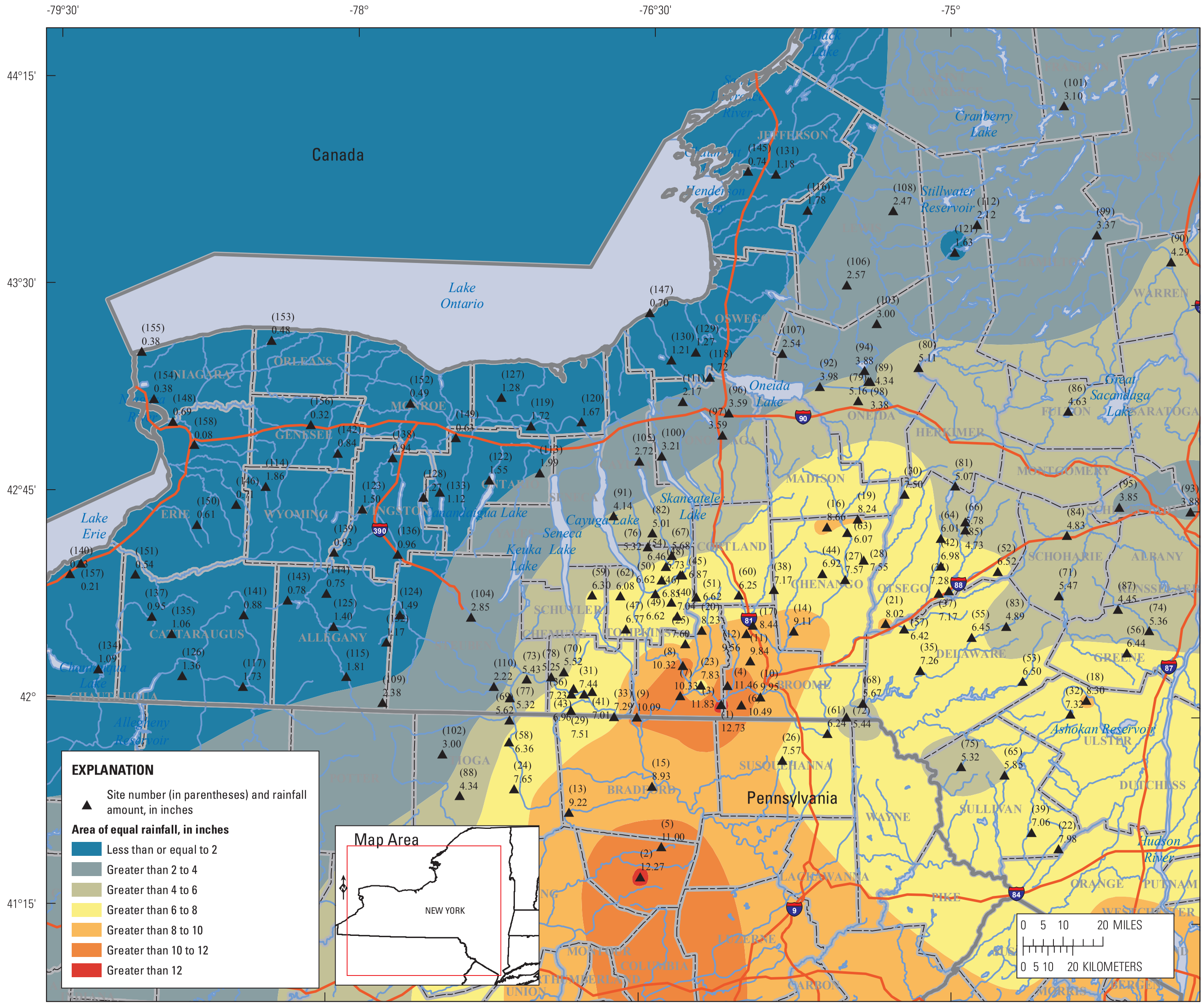
[Data provided by the National Oceanic and Atmospheric Administration (2011f,h) and Community Collaborative Rain, Hail & Snow Network; Sept., September; N, north; S, south; E, east; W, west; SUNY-ESF, State University of New York College of Environmental Science and Forestry; locations are given on figure 51]

Site number	Site name	Rainfall (inches)					
		Sept. 5	Sept. 6	Sept. 7	Sept. 8	Sept. 9	Total
83	South Kortright 1 W, N.Y.	0.78	0.91	1.48	1.68	0.04	4.89
84	Cobleskill 2 ESE, N.Y.	0.45	1.10	0.78	2.47	0.03	4.83
85	Cooperstown, N.Y.	0.53	0.50	2.10	1.35	0.25	4.73
86	Gloversville 7 NW, N.Y.	1.28	0.88	0.34	2.13	0.00	4.63
87	Schoharie, N.Y.	0.20	1.30	0.90	1.85	0.20	4.45
88	Wellsboro 4 SW, Pa.	0.34	1.32	0.91	1.73	0.04	4.34
89	Rome Griffiss Airfield, N.Y.	1.17	0.13	2.97	0.07	0.00	4.34
90	North Creek 5 SE, N.Y.	0.97	2.20	0.12	0.98	0.02	4.29
91	Aurora Research Farm, N.Y.	0.15	0.87	0.19	2.73	0.20	4.14
92	New London Lock 22, N.Y.	0.25	0.83	0.17	2.70	0.03	3.98
93	Albany International Airport, N.Y.	0.92	0.82	1.76	0.38	0.00	3.88
94	Delta Dam, N.Y.	0.20	0.90	0.28	2.50	0.00	3.88
95	Delanson 2 NE, N.Y.	0.55	0.91	0.98	1.29	0.12	3.85
96	Syracuse Hancock International Airport, N.Y.	0.94	0.00	2.58	0.07	0.00	3.59
97	SUNY-ESF, Syracuse, N.Y.	0.07	0.55	0.26	2.71	0.00	3.59
98	Griffiss Air Force Base, N.Y.	0.38	0.92	0.30	1.78	0.00	3.38
99	Indian Lake 2 SW, N.Y.	0.47	1.72	0.07	1.11	0.00	3.37
100	Skaneateles, N.Y.	0.17	0.56	0.19	2.27	0.02	3.21
101	Tupper Lake Sunmount, N.Y.	1.80	0.78	0.05	0.45	0.02	3.10
102	Sabinsville 3 SE, Pa.	0.04	0.52	1.01	1.33	0.10	3.00
103	Boonville 4 SSW, N.Y.	0.22	0.80	0.11	1.87	0.00	3.00
104	Bath, N.Y.	0.20	0.58	0.20	1.86	0.01	2.85
105	Auburn, N.Y.	0.34	0.70	0.17	1.51	0.00	2.72
106	Highmarket, N.Y.	1.05	0.52	0.02	0.98	0.00	2.57
107	Camden, N.Y.	0.18	0.77	0.05	1.54	0.00	2.54
108	Lowville, N.Y.	1.82	0.24	0.01	0.40	0.00	2.47
109	Whitesville, N.Y.	0.55	0.50	0.21	1.11	0.01	2.38
110	Addison, N.Y.	0.64	1.07	0.31	0.20	0.00	2.22
111	Baldwinsville, N.Y.	0.44	0.46	0.07	1.20	0.00	2.17
112	Big Moose 3 SE, N.Y.	0.11	0.37	0.60	1.04	0.00	2.12
113	Geneva Research Farm, N.Y.	0.28	0.65	0.22	0.84	0.00	1.99
114	Attica 7 SW, N.Y.	0.81	0.80	0.11	0.14	0.00	1.86
115	Wellsville, N.Y.	0.74	0.48	0.09	0.40	0.10	1.81
116	Hooker 12 NNW, N.Y.	1.30	0.19	0.05	0.24	0.00	1.78
117	Olean, N.Y.	1.03	0.16	0.18	0.12	0.24	1.73
118	Brewerton Lock 23, N.Y.	0.21	0.43	0.08	1.00	0.00	1.72
119	Newark, N.Y.	0.31	0.47	0.47	0.47	0.00	1.72
120	Clyde Lock 26, N.Y.	0.13	0.60	0.10	0.84	0.00	1.67
121	Old Forge, N.Y.	0.23	0.92	0.48	0.00	0.00	1.63
122	Canandaigua 3 S, N.Y.	0.40	0.43	0.20	0.52	0.00	1.55
123	Mount Morris 2 W, N.Y.	0.66	0.60	0.09	0.15	0.00	1.50

Table 19. Rainfall for the storm of September 5–9, 2011, at selected locations in New York and surrounding areas.—Continued

[Data provided by the National Oceanic and Atmospheric Administration (2011f,h) and Community Collaborative Rain, Hail & Snow Network; Sept., September; N, north; S, south; E, east; W, west; SUNY-ESF, State University of New York College of Environmental Science and Forestry; locations are given on figure 51]

Site number	Site name	Rainfall (inches)					
		Sept. 5	Sept. 6	Sept. 7	Sept. 8	Sept. 9	Total
124	Hornell Almond Dam, N.Y.	0.37	0.29	0.17	0.62	0.04	1.49
125	Angelica, N.Y.	0.77	0.20	0.06	0.23	0.14	1.40
126	Allegany State Park, N.Y.	1.03	0.11	0.14	0.03	0.05	1.36
127	Webster 2 NE, N.Y.	1.06	0.00	0.17	0.05	0.00	1.28
128	Hemlock, N.Y.	0.50	0.38	0.10	0.29	0.00	1.27
129	Palermo 2 SSE, N.Y.	0.23	0.09	0.08	0.81	0.06	1.27
130	Fulton, N.Y.	0.15	0.15	0.10	0.81	0.00	1.21
131	Watertown, N.Y.	0.92	0.09	0.01	0.15	0.01	1.18
132	Alfred, N.Y.	0.45	0.15	0.18	0.34	0.05	1.17
133	Honeoye, N.Y.	0.47	0.22	0.18	0.25	0.00	1.12
134	Jamestown 4 ENE, N.Y.	0.70	0.05	0.17	0.00	0.17	1.09
135	Little Valley, N.Y.	0.57	0.27	0.20	0.00	0.02	1.06
136	Dansville, N.Y.	0.21	0.34	0.17	0.22	0.02	0.96
137	New Albion 2, N.Y.	0.52	0.05	0.12	0.01	0.25	0.95
138	Avon, N.Y.	0.60	0.12	0.05	0.17	0.00	0.94
139	Portageville, N.Y.	0.43	0.02	0.35	0.10	0.03	0.93
140	Fredonia, N.Y.	0.65	0.08	0.11	0.00	0.09	0.93
141	Franklinville, N.Y.	0.02	0.48	0.13	0.11	0.14	0.88
142	Pavilion, N.Y.	0.61	0.05	0.09	0.09	0.00	0.84
143	Rushford, N.Y.	0.36	0.07	0.23	0.04	0.08	0.78
144	Silver Springs 3 N, N.Y.	0.44	0.16	0.06	0.09	0.00	0.75
145	Watertown Airport, N.Y.	0.69	0.00	0.05	0.00	0.00	0.74
146	Wales, N.Y.	0.51	0.10	0.10	0.00	0.00	0.71
147	Oswego East, N.Y.	0.28	0.02	0.22	0.18	0.00	0.70
148	North Tonawanda, N.Y.	0.53	0.04	0.00	0.11	0.01	0.69
149	Victor 2 NW, N.Y.	0.00	0.32	0.09	0.22	0.00	0.63
150	Colden 1 W, N.Y.	0.48	0.03	0.08	0.02	0.00	0.61
151	Perrysburg, N.Y.	0.42	0.00	0.00	0.12	0.00	0.54
152	Rochester International Airport, N.Y.	0.38	0.00	0.11	0.00	0.00	0.49
153	Lyndonville, N.Y.	0.14	0.23	0.00	0.04	0.07	0.48
154	Niagara Falls International Airport, N.Y.	0.32	0.00	0.02	0.04	0.00	0.38
155	Youngstown 2 NE, N.Y.	0.32	0.00	0.01	0.02	0.03	0.38
156	Batavia, N.Y.	0.20	0.04	0.06	0.02	0.00	0.32
157	Dunkirk Chautauqua Airport, N.Y.	0.02	0.02	0.06	0.01	0.10	0.21
158	Buffalo Niagara International Airport, N.Y.	0.01	0.01	0.05	0.00	0.01	0.08



Base from U.S. Geological Survey Digital Data. Universal Transverse Mercator Projection, Zone 18N, NAD83

Figure 51. Rainfall totals for the storm of September 6–9, 2011, in New York and surrounding areas. (From National Oceanic and Atmospheric Administration, 2011f,h; Sites and data are listed in table 19.)

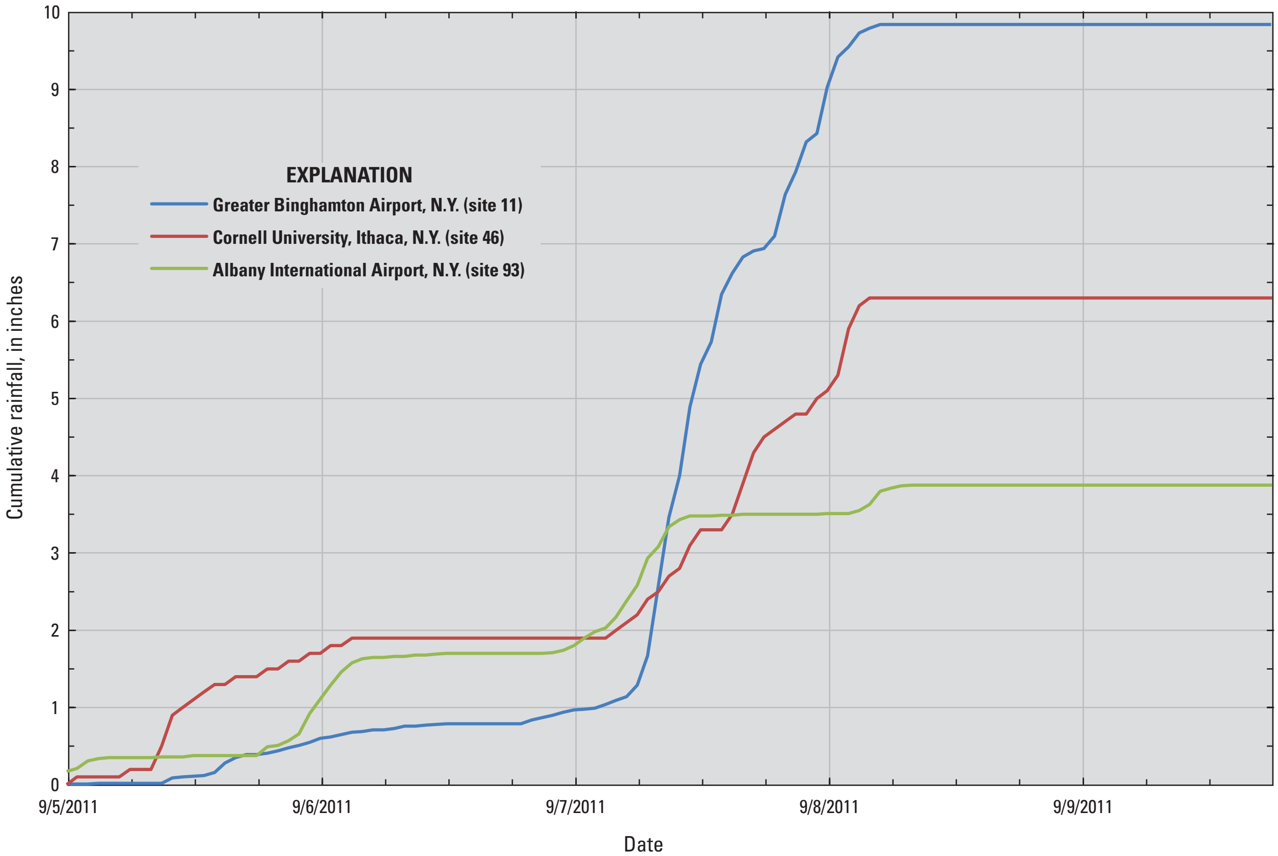


Figure 52. Cumulative hourly rainfall during September 5–9, 2011, recorded at three weather stations in south-central New York. (From National Oceanic and Atmospheric Administration, 2011j; Sites are listed in table 19 and locations are shown on figure 51.)

Flood Discharge and Frequency

The flood frequencies at selected streamgages are indicated by the color codes of their associated drainage basins (fig. 53). A full-size view of the map on figure 53 can be accessed by the computer link at the end of the figure caption. The most extreme flooding was along and around the Susquehanna River from Oneonta through Binghamton to Waverly in south-central New York but decreased substantially north and west of these areas.

Record flood discharges were documented at 10 streamgages in the Susquehanna River Basin (table 21), and 10 sites in the flooded areas had AEP values equal to or less than 1 percent (recurrence intervals equal to or greater than 100 years). Peak discharges plotted as a function of drainage area for the September 2011 flood at 43 selected streamgages at which the September 2011 flood was the maximum for the year (fig. 54) indicate that many peaks were near or above the previous peak discharge of record and the 1-percent AEP (100-year) discharge. Streamgage numbers are plotted at their respective drainage area for sites with peak discharges exceeding their 1-percent AEP (100-year) flows; however, flooding affected streams of all drainage basin sizes. A generally strong relation of peak discharge and drainage area for streamgages on unregulated streams is indicated by the solid line (fig. 54). Most unregulated streamgages shown are in the Susquehanna River Basin.

Of the seven streamgages on the Susquehanna River with computed flood frequencies, the five most downstream recorded peak discharges were equal to or greater than the 1-percent AEP (100-year) flood (fig. 55) on September 8, but each peak was less than the 0.2-percent AEP (500-year) discharge. The Susquehanna River near Waverly (01515000) streamgage recorded its greatest stage (26.67 ft) and discharge (167,000 ft^3/s) since record collection began in 1936; the stage was about 4.2 ft higher than that during the previous record flood on June 29, 2006. The 2011 peak discharges at the Susquehanna River streamgages near Waverly and at Owego were about 1.3 times greater than those recorded during the June 2006 flood, whereas recorded peaks at four upstream gages on the Susquehanna River (Unadilla, Bainbridge, Windsor, and Conklin) were less than those during 2006 (table 21). Flooding occurred on other streams south of the eastern Finger Lakes and within the Mohawk River Basin (upstream from the confluence with Schoharie Creek), the Wallkill River, and several tributaries to the lower Hudson River (fig. 53), but the magnitudes were not as great as those on streams in south-central New York.

Table 20. Rainfall frequencies for storms of 3-, 6-, 12-, and 24-hour durations at selected locations in south-central and east-central New York.

[Maximum rainfall totals for selected durations during September 8–9, 2011, are shown in red; Data from the Northeast Regional Climate Center, 2010); locations are shown on figure 51]

Site number	Site name	County	Recurrence interval (years)	Rainfall (inches) for selected duration			
				3-hour	6-hour	12-hour	24-hour
11	Greater Binghamton Airport	Broome	2	1.46	1.74	2.05	2.39
			5	1.84	2.19	2.56	2.97
			10	2.21	2.62	3.04	3.49
				2.33			
			25	2.79	3.29	3.81	4.34
			50	3.34	3.94	4.53	5.12
					4.15		
			100	3.99	4.69	5.37	6.04
						5.77	
			200	4.77	5.59	6.37	7.12
							8.70
			500	6.03	7.04	7.98	8.87
46	Cornell University, Ithaca	Tompkins		1.10	1.50		
			2	1.43	1.70	2.01	2.34
			5	1.78	2.13	2.50	2.91
						2.70	
			10	2.11	2.52	2.96	3.43
			25	2.64	3.15	3.70	4.27
							4.30
			50	3.12	3.74	4.38	5.04
			100	3.71	4.43	5.18	5.95
			200	4.39	5.25	6.12	7.02
			500	5.49	6.57	7.65	8.75
93	Albany International Airport	Albany		0.76	1.31	1.74	1.80
			2	1.51	1.82	2.18	2.59
			5	1.90	2.28	2.71	3.18
			10	2.26	2.71	3.19	3.72
			25	2.84	3.39	3.97	4.58
			50	3.39	4.03	4.69	5.37
			100	4.03	4.78	5.53	6.29
			200	4.80	5.67	6.53	7.37
			500	6.04	7.10	8.13	9.11

The several inches of rain that fell in the flooded areas resulted in large volumes of runoff (the amount of water discharged from a drainage basin and passing a specific location during a given amount of time) occurring during a relatively short period of time in early September. The maximum consecutive 1-, 3-, and 7-day mean discharges during the period of record at two streamgages on the Susquehanna River were among the highest of record at Conklin (01503000) (fig. 56A) and the highest of record near Waverly (01515000) (fig. 56B). The maximum 1-day (September 8) and 3-day (September 8–10) mean discharges at Susquehanna River at Conklin (01503000) were the second largest in 98 years of record (2006 flows were larger) and were equal to the 1-percent AEP (100-year) n-day discharges (fig. 56A). The maximum consecutive 7-day mean discharge (September 7–13) at Conklin was less than the 2-percent AEP (50-year) 7-day discharge. The maximum 1-day (September 8), 3-day (September 8–10), and 7-day (September 7–13) mean discharges at the Susquehanna River near Waverly streamgage (01515000) were the highest for the station's period of record (fig. 56B). The 1- and 3-day discharges exceeded the 1-percent AEP (100-year) discharge, whereas the maximum 7-day discharge (September 7–13) was slightly less than the 2-percent AEP (50-year) 7-day discharge. The 7-day volume of water passing the Waverly streamgage (which averaged 82,100 ft^3/s and totaled 371.4 billion gallons) would fill 562,000 Olympic-sized swimming pools and cover the entire State of Rhode Island or the five boroughs of New York City with 1.5 and 5.9 ft of water, respectively. No significant trends in computed flood volumes are indicated at the Conklin or Waverly streamgages since record collection began in 1914 and 1938, respectively.

Annual peak discharges at 12 selected streamgages in the flooded areas indicate that the September 2011 peak flow was the greatest or second greatest for the period of record (table 21, figs. 57A–L). The September 2011 peak discharges exceeded the 1-percent AEP (100-year) discharges for most of the selected streamgages and many by a wide margin. A couple of tributaries (figs. 57A, J) in the Susquehanna River Basin and three streamgages on the lower reaches of the main stem from Vestal to Waverly (figs. 57H, I, and K) recorded their greatest stages and discharges of record (some with data collected since the 1930s) with a few peak discharges exceeding the 0.5-percent AEP (200-year) flow (table 21). Annual short-term trend lines for peak discharges during the most recent 24–30 years at most of the selected streamgages in the Susquehanna River Basin were significantly upward (figs. 57A–L, table 6); however, with the exception of Little Elk Creek near Westford (01497805, fig. 57A), a station with 34 years of record, long-term trends (more than 30 years of record) were not pronounced and not statistically significant (p-value greater than 0.10). Outside the Susquehanna River Basin, the September 2011 peak discharge (7,190 ft^3/s) at Cayuga Inlet near Ithaca (04233000) was the greatest of record, which began in 1935 (fig. 57L).

Table 21. Period-of-record peak discharges through August 2011 and peak discharges during the flood of September 7–11, 2011, at selected U.S. Geological Survey streamgages in New York.

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated streamgage. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	September 7–11, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Hudson River Basin											
9	01312000	Hudson River near Newcomb, N.Y.	192	1926–2011	01/09/98	12.84	11,500	09/08/11	2030	4.95	1,560	>50.0	<2
11	01315000	Indian River near Indian Lake, N.Y.	132	1913–2011	04/29/11	7.83	3,520	09/07/11	2000	2.34	333	>50.0	<2
13	01315500	Hudson River at North Creek, N.Y.	792	1908–2011	04/28/2011	13.65	34,900	09/08/11	1345	6.80	7,230	>50.0	<2
14	01317000	Schroon River at Riverbank, N.Y.	527	1908–70, 1987–2011	03/21/36	12.18	12,100	09/08/11	2045	6.71	3,640	>50.0	<2
15	01318500	Hudson River at Hadley, N.Y.	1,664	1922–2011	04/29/11	21.32	44,200	09/08/11	1800	8.98	13,400	>50.0	<2
16	01321000	Sacandaga River near Hope, N.Y.	491	1912–2011	03/27/13	[a]11.00	32,000	09/08/11	0315	7.19	12,400	50.0	2
18	01325000	Sacandaga River at Stewarts Bridge, near Hadley, N.Y.	1,055	1908–29	03/28/13	[a]12.36	[b]35,500						
				1930–2011	05/02/11	10.40	16,500	09/08/11	0545	2.52	848	>50.0	<2
19	01327750	Hudson River at Fort Edward, N.Y.	2,810	1977–2011	04/29/11	31.34	48,800	09/08/11	1115	24.49	16,900	>50.0	<2
20	01329154	Steele Brook at Shushan, N.Y.	2.85	1979–2011	08/29/11	6.75	155	09/07/11	--	3.83	59	>50.0	<2
21	01329490	Batten Kill below mill at Battenville, N.Y.	396	1923–68, 1987–2011	11/04/27	[a]17.7	21,300	09/08/11	1730	9.38	6,690	50.0	2
22	01330000	Glowegee Creek at West Milton, N.Y.	26.0	1949–63, 1991–2011	12/31/48	7.04	1,670	09/07/11	1930	6.28	957	33.3	3
23	01331095	Hudson River at Stillwater, N.Y.	3,773	1978–2011	04/29/11	--	[b,c]52,000	09/08/11	--	--	[b,c]20,000	>50.0	<2
24	01333500	Little Hoosic River at Petersburg, N.Y.	56.1	1949, 1952–2011	12/31/48	9.4	7,470	09/07/11	--	8.30	4,570	6.7	15
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	1911–22, 1924–2011	12/31/48	21.15	55,400	09/07/11	1800	14.05	20,600	12.5	8
26	01335754	Hudson River above Lock 1 near Waterford, N.Y.	4,605	1888–1929	03/28/13	--	120,000						
				1930–56, 1977–2011	01/01/49	--	118,000	09/08/11	--	--	[b,c]32,000	>50.0	<2
28	01336000	Mohawk River below Delta Dam, near Rome, N.Y.	152	1928–2011	10/02/45	11.18	8,560	09/07/11	2000	2.75	520	>50.0	<2
29	01342797	Vly Brook near Morehouseville, N.Y.	3.28	1993–2011	04/28/11	11.6	361	09/07/11	--	9.44	140	50.0	2
30	01343060	West Canada Creek near Wilmurt, N.Y.	258	2001–11	04/28/11	14.11	25,500	09/08/11	0345	10.51	11,500	50.0	2
31	01343900	Hinckley Reservoir at Hinckley, N.Y.	372	1914–2011	04/28/11	[d]1,230.74	--	09/09/11	1800	[d]1,226.58	--	--	--
32	01346000	West Canada Creek at Kast Bridge, N.Y.	560	1921–2011	04/29/11	8.68	23,400	09/07/11	2345	7.33	16,400	10.0	10
33	01347000	Mohawk River near Little Falls, N.Y.	1,342	1928–2011	06/28/06	19.72	35,000	09/08/11	0430	18.20	29,800	2.9	35
34	01348000	East Canada Creek at East Creek, N.Y.	289	1945–96, 1998, 2000, 2003–11	06/28/06	10.99	31,500	09/08/11	0700	7.34	11,000	25.0	4
35	01348420	North Creek near Ephratah, N.Y.	6.52	1972–2011	08/28/11	11.2	[b]1,800	09/07/11	--	6.57	268	50.0	2
36	01349150	Canajoharie Creek near Canajoharie, N.Y.	59.7	1993–2011	08/28/11	10.76	5,850	09/08/11	0545	10.23	5,170	10.0	10
37	01349700	East Kill near Jewett Center, N.Y.	35.6	1965–74, 1987, 1996–2011	08/28/11	25.65	28,400	09/07/11	0900	8.70	3,300	50.0	2
38	01349705	Schoharie Creek near Lexington, N.Y.	96.8	1999–2011	08/28/11	22.87	40,500	09/07/11	0715	10.05	11,400	50.0	2
39	01349711	West Kill below Hunter Brook near Spruceton, N.Y.	4.97	1998–2011	08/28/11	5.23	4,320	09/07/11	0500	2.85	409	>50.0	<2

Table 21. Period-of-record peak discharges through August 2011 and peak discharges during the flood of September 7–11, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated streamgage. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	September 7–11, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
				Hudson River Basin—Continued									
40	01349810	West Kill near West Kill, N.Y.	27.0	1996–2011	08/28/11	19.03	19,100	09/07/11	0600	8.17	3,270	33.3	3
41	01349950	Batavia Kill at Red Falls near Prattsville, N.Y.	68.6	1996–2011	08/28/11	20.0	44,200	09/07/11	0845	6.07	5,570	33.3	3
42	01350000	Schoharie Creek at Prattsville, N.Y.	237	1903–2011	08/28/2011	24.38	120,000	09/07/11	1015	13.85	22,900	25.0	4
43	01350035	Bear Kill near Prattsville, N.Y.	25.7	1999–2011	08/28/11	8.11	2,620	09/07/11	0915	8.10	2,560	12.5	8
44	01350080	Manor Kill at West Conesville near Gilboa, N.Y.	32.4	1987–2011	08/28/11	11.92	6,590	09/07/11	0945	5.50	1,950	33.3	3
45	01350100	Schoharie Reservoir near Grand Gorge, N.Y.	315	1928–2011	08/28/11	[e]1,137.73	--	09/07/11	1100	[e]1,131.85	--	--	--
46	01350101	Schoharie Creek at Gilboa, N.Y.	316	1976–2011	08/28/11	[a]40.52	111,000	09/07/11	1115	21.04	27,200	25.0	4
47	01350120	Platter Kill at Gilboa, N.Y.	10.9	1976–2011	08/28/11	7.5	1,750	09/07/11	--	--	b700	14.3	7
48	01350140	Mine Kill near North Blenheim, N.Y.	16.2	1975–2011	01/19/96	5.20	2,550	09/07/11	0815	6.09	2,070	10.0	10
49	01350180	Schoharie Creek at North Blenheim, N.Y.	358	1971–2011	08/28/11	22.00	f119,000	09/07/11	1345	9.66	[f]17,500	50.0	2
50	01350355	Schoharie Creek at Breakabeen, N.Y.	444	1976–2011	08/28/11	22.37	134,000	09/07/11	1300	11.85	21,600	50.0	2
51	01351500	Schoharie Creek at Burtonsville, N.Y.	886	1940–2011	08/28/11	17.46	128,000	09/07/11	2245	9.33	47,400	10.0	10
52	01356190	Lisha Kill northwest of Niskayuna, N.Y.	15.6	1994–97, 2001–11	08/28/11	4.78	1,030	09/07/11	1430	3.35	478	50.0	2
53	01357500	Mohawk River at Cohoes, N.Y.	3,450	1918–2011	03/06/64	23.15	143,000	09/08/11	1500	20.51	93,300	11.1	9
54	01358000	Hudson River at Green Island, N.Y.	8,090	1946–2011	12/31/48, 08/29/11	27.05	181,000	09/08/11	1930	24.13	134,000	14.3	7
55	01359528	Normans Kill at Albany, N.Y.	168	1980–84, 1992–2011	08/28/11	14.15	13,200	09/07/11	0945	6.67	2,410	>50.0	<2
56	01360640	Valatie Kill near Nassau, N.Y.	9.48	1991–2011	08/28/11	6.52	914	09/07/11	1000	5.70	642	25.0	4
57	01361000	Kinderhook Creek at Rossman, N.Y.	329	1906–14, 1928–68, 1984, 1988–2011	12/31/48	20.8	29,800	09/08/11	1815	10.89	13,000	10.0	10
60	013621955	Birch Creek at Big Indian, N.Y.	12.5	1999–2011	08/28/11	7.18	1,460	09/07/11	0515	5.52	631	50.0	2
61	01362197	Bushnellsville Creek at Shandaken, N.Y.	11.4	1951, 1956, 1972–87, 1994–2011	08/28/11	12.6	2,750	09/07/11	--	7.17	497	50.0	2
62	01362200	Esopus Creek at Allaben, N.Y.	63.7	1964–2011	08/28/11	16.34	29,300	09/07/11	0530	8.18	5,730	33.3	3
63	0136230002	Woodland Creek above mouth at Phoenicia, N.Y.	20.6	2003–11	04/02/05	10.65	8,600	09/07/11	0400	8.08	2,160	50.0	2
64	01362342	Hollow Tree Brook at Lanesville, N.Y.	1.95	1998–2011	08/28/11	5.89	487	09/07/11	0450	4.29	[b]190	33.3	3
65	01362370	Stony Clove Creek below Ox Clove at Chichester, N.Y.	30.9	1997–2011	08/28/11	9.61	14,300	09/07/11	0500	6.02	3,570	>50.0	<2
66	01362497	Little Beaver Kill at Beechford near Mount Tremper, N.Y.	16.5	1998–2011	06/26/06	8.71	2,820	09/07/11	0645	6.46	1,260	50.0	2
67	01362500	Esopus Creek at Coldbrook, N.Y.	192	1932–2011	08/28/11	23.34	75,800	09/07/11	0645	14.21	20,500	33.3	3
68	01363382	Bush Kill below Maltby Hollow Brook at West Shokan, N.Y.	16.2	2001–11	08/28/11	12.30	6,240	09/08/11	0530	2.30	752	>50.0	<2

Table 21. Period-of-record peak discharges through August 2011 and peak discharges during the flood of September 7–11, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

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Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft³/s)	September 7–11, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Hudson River Basin—Continued											
70	01364500	Esopus Creek at Mount Marion, N.Y.	419	1971–2011	04/03/05	26.46	30,500	09/08/11	1100	23.66	18,000	11.1	9
71	01365000	Rondout Creek near Lowes Corners, N.Y.	38.3	1937–2011	08/28/11	10.63	8,200	09/08/11	0715	4.05	2,080	>50.0	<2
72	01365500	Chestnut Creek at Grahamsville, N.Y.	20.9	1939–87, 1999–2011	10/15/55	7.02	4,640	09/07/11	0330	4.06	1,640	33.3	3
74	01367500	Rondout Creek at Rosendale, N.Y.	383	1927–43	08/27/28	[a]21.90	27,300						
				1944–2011	08/28/11	26.96	36,500	09/08/11	1230	20.30	18,100	25.0	4
76	01371500	Wallkill River at Gardiner, N.Y.	695	1925–2011	10/16/55	19.81	30,800	09/08/11	1545	17.67	27,500	1.7	60
78	01372500	Wappinger Creek near Wappingers Falls, N.Y.	181	1929–2011	08/19/55	19.60	18,600	09/08/11	2045	11.47	6,870	11.1	9
79	01372800	Fishkill Creek at Hopewell Junction, N.Y.	57.3	1958–75, 1984, 1987–2011	04/16/07	11.03	4,160	09/08/11	--	6.28	856	50.0	2
81	01374250	Peekskill Hollow Creek at Tompkins Corners, N.Y.	14.9	1975–2011	08/28/11	6.68	2,770	09/08/11	--	5.10	1,200	10.0	10
82	0137449480	East Branch Croton River near Putnam Lake, N.Y.	62.1	1996–2011	03/07/11	11.64	2,650	09/09/11	0630	9.27	1,470	33.3	3
83	01374505	East Branch Croton River at Brewster, N.Y.	81.2	1994–2011	03/08/11	8.30	3,810	09/08/11	0900	6.83	1,940	14.3	7
84	01374531	East Branch Croton River near Croton Falls, N.Y.	86.4	1994–2011	08/28/11	8.63	3,720	09/08/11	0845	6.50	2,430	6.7	15
85	01374559	West Branch Croton River at Richardsville, N.Y.	11.0	1996–2011	09/17/99	4.88	1,290	09/08/11	1200	3.76	425	33.3	3
86	01374581	West Branch Croton River below dam near Kent Cliffs, N.Y.	22.4	2002–11	04/16/07	9.54	1,750	09/09/11	0600	4.02	276	>50.0	<2
87	01374598	Horse Pound Brook near Lake Carmel, N.Y.	3.94	1997–2011	09/16/99	4.61	1,070	09/08/11	0710	2.64	136	50.0	2
88	0137462010	West Branch Croton River near Carmel, N.Y.	42.9	1994–2011	08/28/11	5.88	1,970	09/08/11	0145	1.38	37	>50.0	<2
89	01374654	Middle Branch Croton River near Carmel, N.Y.	13.7	1996–2011	09/17/99	5.97	756	09/08/11	1945	4.31	298	50.0	2
90	01374701	West Branch Croton River near Croton Falls, N.Y.	80.4	1994–2011	04/17/07	7.51	2,720	09/08/11	0930	5.53	1,140	25.0	4
91	01374781	Titicus River below June Road at Salem Center, N.Y.	12.9	2007–11	08/28/11	6.6	1,550	09/08/11	0600	5.88	1,190	--	--
92	01374821	Titicus River at Purdys Station, N.Y.	23.8	1994–2011	08/28/11	8.75	2,190	09/08/11	1115	7.58	1,520	6.7	15
93	01374890	Cross River near Cross River, N.Y.	17.1	1996–2011	03/07/11	6.96	1,080	09/08/11	0945	5.95	723	20.0	5
94	01374901	Cross River at Katonah, N.Y.	29.9	1994–2011	03/07/11	7.71	2,070	09/08/11	1115	6.49	1,470	10.0	10
95	01374930	Muscoot River at Baldwin Place, N.Y.	13.5	1996–2011	09/16/99	9.42	1,020	09/08/11	1445	6.53	325	50.0	2
96	01374941	Muscoot River below dam at Amawalk, N.Y.	19.7	1994–2011	04/17/07	12.64	1,440	09/08/11	2130	10.99	338	25.0	4
97	01375000	Croton River at New Croton Dam, near Croton-On-Hudson, N.Y.	378	1934–2011	10/16/55	18.44	45,400	09/08/11	1515	10.25	11,700	10.0	10
98	01376500	Saw Mill River at Yonkers, N.Y.	25.6	1944–90, 1993–95, 1999, 2003–11	04/16/07	9.00	1,840	09/08/11	--	6.64	819	25.0	4

Table 21. Period-of-record peak discharges through August 2011 and peak discharges during the flood of September 7–11, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

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Map number	Streamgage number	Streamgage name	Drainage area (mi^2)	Period-of-record peak discharge: Period of record	Date	Stage (ft)	Discharge (ft^3/s)	September 7–11, 2011, peak discharge: Date	Time (h)	Stage (ft)	Discharge (ft^3/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Hackensack River Basin											
99	01376800	Hackensack River at West Nyack, N.Y.	30.7	1959–2011	09/16/99, 08/28/11	11.21, 11.50	1,740	09/08/11	0930	7.93	843	33.3	3
		Passaic River Basin											
100	01387400	Ramapo River at Ramapo, N.Y.	86.9	1936, 1980–2011	08/28/11	15.75	13,700	09/08/11	1245	8.23	3,670	33.3	3
101	01387420	Ramapo River at Suffern, N.Y.	93.0	1980–2011	08/28/11	18.88	14,700	09/08/11	0400	10.23	4,100	33.3	3
		Delaware River Basin											
103	01413088	East Branch Delaware River at Roxbury, N.Y.	13.5	2000–11	08/28/11	7.73	866	09/07/11	1445	6.63	519	50.0	2
104	01413398	Bush Kill near Arkville, N.Y.	46.7	1996, 1998–2011	08/28/11	16.26	13,800	09/07/11	0730	9.31	2,830	50.0	2
105	01413408	Dry Brook at Arkville, N.Y.	82.2	1997–2011	08/28/11	17.1	24,600	09/07/11	--	--	[b]5,600	50.0	2
106	01413500	East Branch Delaware River at Margaretville, N.Y.	163	1937–2011	08/28/11	15.97	35,500	09/07/11	1000	11.79	11,200	20.0	5
107	01414000	Platte Kill at Dunraven, N.Y.	34.9	1942–62, 1996–2011	01/19/96	9.60	5,690	09/08/11	0630	6.90	2,580	20.0	5
108	01414500	Mill Brook near Dunraven, N.Y.	25.2	1937–2011	01/19/96	12.56	5,380	09/08/11	0600	6.34	1,920	33.3	3
109	01415000	Tremper Kill near Andes, N.Y.	33.2	1937–2011	10/01/10	8.51	5,900	09/07/11	0930	5.54	1,610	50.0	2
110	01416900	Pepacton Reservoir near Downsville, N.Y.	372	1954–2011	04/03/05	[c]1,283.68	--	09/08/11	0800	[c]1,282.98	--	--	--
111	01417000	East Branch Delaware River at Downsville, N.Y.	372	1942–54	11/26/50	[a]14.52	23,900						
				1955–2011	09/18/04	12.08	20,200	09/08/11	1145	10.98	15,600	6.7	15
112	01417500	East Branch Delaware River at Harvard, N.Y.	458	1935–54	09/22/38	[a]16.93	31,400						
				1955–67, 1978–2011	06/28/06	16.61	22,100	09/07/11	2145	14.73	17,100	5.0	20
113	01420500	Beaver Kill at Cooks Falls, N.Y.	241	1914–2011	06/28/06	20.55	62,400	09/07/11	0830	13.64	21,500	16.7	6
114	01421000	East Branch Delaware River at Fishs Eddy, N.Y.	784	1913–54	08/24/33	[a]20.60	53,300						
				1955–2011	06/28/06	21.43	77,400	09/08/11	1145	15.59	35,200	16.7	6
115	01421610	West Branch Delaware River at Hobart, N.Y.	15.5	2001–11	08/28/11	3.22	995	09/07/11	1115	3.08	897	14.3	7
116	01421618	Town Brook southeast of Hobart, N.Y.	14.3	1998–2011	07/04/99	7.54	4,400	09/07/11	0745	6.00	1,890	25.0	4
117	01421900	West Branch Delaware River upstream from Delhi, N.Y.	134	1937–70, 1972–74, 1996–2011	01/19/96	[a]9.8	[b]13,000	09/07/11	1745	11.01	7,010	10.0	10
118	01422500	Little Delaware River near Delhi, N.Y.	49.8	1938–70, 1972–74, 1996–2011	01/19/96	8.51	6,100	09/07/11	1045	7.06	3,240	14.3	7
119	01422747	East Brook east of Walton, N.Y.	24.7	1999–2011	06/28/06	9.95	7,110	09/08/11	0615	6.75	2,750	14.3	7
120	01423000	West Branch Delaware River at Walton, N.Y.	332	1951–2011	06/28/06	16.85	28,600	09/08/11	0600	14.40	18,500	10.0	10
121	0142400103	Trout Creek near Trout Creek, N.Y.	20.2	1953–67, 1996–2011	06/27/06	6.99	4,350	09/08/11	0330	6.47	2,960	5.0	20
122	01424997	Cannonsville Reservoir near Stilesville, N.Y.	454	1963–2011	06/29/06	[c]1,158.00	--	09/09/11	0800	[c]1,156.02	--	--	--

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		Delaware River Basin—Continued											
123	01425000	West Branch Delaware River at Stilesville, N.Y.	456	1953–63	01/22/59	[a]9.01	17,500						
				1964–2011	06/28/06	17.72	33,100	09/08/11	2200	12.93	13,800	10.0	10
124	01426500	West Branch Delaware River at Hale Eddy, N.Y.	595	1913–63	03/22/48	15.69	28,900						
				1964–2011	06/28/06	19.10	43,400	09/08/11	1045	14.71	22,200	5.0	20
125	01427207	Delaware River at Lordville, N.Y.	1,590	2006–11	06/28/06	28.87	126,000	09/08/11	1530	20.56	67,600	--	--
126	01427510	Delaware River at Callicoon, N.Y.	1,820	1976–2011	06/28/06	20.38	144,000	09/08/11	1715	14.34	76,000	11.1	9
127	01428500	Delaware River above Lackawaxen River near Barryville, N.Y.	2,020	1941–63	08/19/55	26.40	130,000						
				1964–2011	06/28/06	28.97	151,000	09/08/11	2030	18.61	73,600	14.3	7
128	01432900	Mongaup River at Mongaup Valley, N.Y.	76.6	2003–11	04/03/05	13.47	7,630	09/08/11	1015	9.03	3,260	50.0	2
129	01434000	Delaware River at Port Jervis, N.Y.	3,070	1905–63	08/19/55	23.91	233,000						
				1964–2011	06/28/06	21.47	189,000	09/08/11	2115	15.11	96,000	16.7	6
130	0143400680	East Branch Neversink River northeast of Denning, N.Y.	8.93	1991–2011	08/28/11	8.75	5,580	09/07/11	0415	4.37	842	>50.0	<2
131	01434017	East Branch Neversink River near Claryville, N.Y.	22.9	1992–2011	08/28/11	13.61	7,650	09/07/11	0515	8.50	2,070	>50.0	<2
132	01434021	West Branch Neversink River near Frost Valley, N.Y.	0.77	1991–2011	08/28/11	4.76	344	09/07/11	0320	1.94	86	>50.0	<2
133	01434025	Biscuit Brook above Pigeon Brook at Frost Valley, N.Y.	3.72	1984–2011	08/28/11	[a]6.37	[b]1,500	09/07/11	--	--	380	50.0	2
134	01434498	West Branch Neversink River at Claryville, N.Y.	33.8	1992–2011	08/28/11	15.38	11,600	09/07/11	0430	10.82	4,740	33.3	3
135	01435000	Neversink River near Claryville, N.Y.	66.6	1938–49, 1951–2011	11/25/50	15.0	23,400	09/07/11	0500	10.81	5,620	50.0	2
136	01435900	Neversink Reservoir near Neversink, N.Y.	92.5	1953–2011	04/03/05	[c]1,443.66	--	09/07/11	0800	[c]1,442.14	--	--	--
137	01436000	Neversink River at Neversink, N.Y.	92.6	1942–53	11/25/50	[a]11.23	22,300						
				1954–2011	04/03/05	12.99	12,300	09/07/11	0830	8.08	5,990	10.0	10
138	01436690	Neversink River at Bridgeville, N.Y.	171	1993–2011	04/03/05	21.25	25,900	09/07/11	1330	14.05	9,250	16.7	6
139	01437500	Neversink River at Godeffroy, N.Y.	307	1938–53	11/26/50	11.79	24,500						
				1954–2011	08/19/55	12.49	33,000	09/07/11	1515	9.92	12,400	14.3	7
		Susquehanna River Basin											
140	01497805	Little Elk Creek near Westford, N.Y.	3.73	1978–2011	06/28/06	19.89	333	09/08/11	--	22.00	740	<0.2	>500
141	01498620	Susquehanna River southwest of Oneonta, N.Y.	678	1988–91, 2009–11	03/23/10	10.67	11,900	09/08/11	1500	16.03	22,400	--	--
142	01499500	East Sidney Lake at East Sidney, N.Y.	103	1949–2011	06/30/06	[c]1,204.35	--	09/11/11	1030	[c]1,190.62	--	--	--
143	01500000	Ouleout Creek at East Sidney, N.Y.	103	1941–49, 1950–2011	04/07/60	6.19	4,000	09/11/11	1900	4.13	1,520	>50.0	<2
144	01500500	Susquehanna River at Unadilla, N.Y.	982	1939–2011	06/29/06	17.72	35,100	09/08/11	2115	16.34	29,700	1.7	60

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		Susquehanna River Basin—Continued											
145	01502500	Unadilla River at Rockdale, N.Y.	520	1930–33, 1937–2011	06/28/06	13.96	20,200	09/08/11	1045	14.22	21,100	1.0	100
146	01502632	Susquehanna River at Bainbridge, N.Y.	1,610	1988–2011	06/29/06	27.05	58,700	09/08/11	2130	26.20	51,700	1.1	90
147	01502731	Susquehanna River at Windsor, N.Y.	1,820	1988–2011	06/29/06	24.27	55,900	09/08/11	1845	24.21	55,400	<1.0 & >0.5	>100 & <200
148	01503000	Susquehanna River at Conklin, N.Y.	2,232	1913–2011	06/28/06	25.02	76,800	09/08/11	1145	23.94	72,100	<1.0 & >0.5	>100 & <200
149	01503500	Susquehanna River at Binghamton, N.Y.	2,283	1988–90, 2006, 2010–11	06/28/06	[b]25.2	--	09/08/11	1500	25.73	--	--	--
150	01503980	Chenango River at Eaton, N.Y.	24.3	1964–65, 1967–2011	04/02/05	8.25	2,780	09/08/11	--	8.05	2,150	3.3	30
151	01505000	Chenango River at Sherburne, N.Y.	263	1938–2011	06/28/06	11.35	11,400	09/08/11	0815	11.64	10,900	1.7	60
152	01505031	Chenango River at Norwich, N.Y.	329	2010–11	01/25/10	8.14	4,430	09/10/11	--	11.58	8,500	--	--
153	01505810	Chenango River at Oxford, N.Y.	458	2009–11	03/09/09	16.01	6,650	09/08/11	0800	21.76	14,100	--	--
154	01507000	Chenango River at Greene, N.Y.	590	1937–2011	06/28/06	21.16	27,100	09/08/11	1015	21.09	26,900	0.5	200
155	01509000	Tioughnioga River at Cortland, N.Y.	292	1939–2011	04/03/05	14.07	14,200	09/08/11	2100	9.88	5,970	50.0	2
156	01509520	Tioughnioga River at Lisle, N.Y.	453	1988–2011	04/02/05	10.38	19,800	09/08/11	0630	10.02	13,800	12.5	8
157	01510000	Otselic River at Cincinnatus, N.Y.	147	1939–64, 1970–2011	12/30/42	10.67	8,390	09/08/11	1000	9.63	6,740	12.5	8
158	01510610	Merrill Creek Tributary near Texas Valley, N.Y.	5.32	1976–81, 1983–2011	01/19/96	6.64	[b]1,150	09/08/11	--	2.18	502	50.0	2
159	01511000	Whitney Point Lake at Whitney Point, N.Y.	257	1942–2011	04/05/05	[c]1,005.76	--	09/11/11	1100	[c]998.30	--	--	--
160	01511500	Tioughnioga River at Itaska, N.Y.	730	1930–41	07/08/35	16.61	61,100						
				1942–2011	02/26/61	11.15	22,600	09/08/11	1030	9.53	15,400	11.1	9
161	01512500	Chenango River near Chenango Forks, N.Y.	1,483	1913–2011	07/08/35	20.3	96,000	09/08/11	1200	14.93	49,500	2.5	40
162	01513500	Susquehanna River at Vestal, N.Y.	3,941	1937–2011	06/28/06	33.66	119,000	09/08/11	1130	35.26	129,000	<1.0 & >0.5	>100 & <200
163	01513831	Susquehanna River at Owego, N.Y.	4,216	1988–96, 1999–2011	06/29/06	35.90	127,000	09/08/11	1500	39.62	159,000	<0.5 & >0.2	>200 & <500
164	01514000	Owego Creek near Owego, N.Y.	185	1930–2011	07/08/35	11.50	23,500	09/08/11	0615	13.05	17,600	1.7	60
165	01514801	Catatonk Creek near Owego, N.Y.	151	1988–2011	01/20/96	14.83	10,900	09/08/11	--	17.13	15,700	<0.5 & >0.2	>200 & <500
166	01515000	Susquehanna River near Waverly, N.Y.	4,773	1936–2011	03/18/36, 06/29/06	[a,b]21.4, 22.52	128,000	09/08/11	1615	26.67	167,000	<1.0 & >0.5	>100 & <200
181	01530332	Chemung River at Elmira, N.Y.	2,162	1988–2011	01/20/96	18.51	71,000	09/08/11	1000	6.56	13,900	>50.0	<2
182	01531000	Chemung River at Chemung, N.Y.	2,506	1904–78	06/23/72	31.62	189,000						
				1979–2011	01/20/96	19.71	77,800	09/08/11	0715	14.70	41,100	50.0	2

Table 21. Period-of-record peak discharges through August 2011 and peak discharges during the flood of September 7–11, 2011, at selected U.S. Geological Survey streamgages in New York.—Continued

[Map numbers in red indicate a new maximum stage and (or) discharge recorded at the associated streamgage. Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites. At regulated sites with periods of record longer than 10 years prior to regulation, the peak discharge for the unregulated period is given. Sites in green are stream/reservoir/lake elevation sites (discharge not computed). Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time. Annual exceedance probabilities and recurrence intervals in orange at sites in pink were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008). mi², square miles; ft, feet; ft³/s, cubic feet per second; h, hours; <, less than; >, greater than; &, and; --, no data available; locations are shown on figure 10]

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Period-of-record peak discharge				September 7–11, 2011, peak discharge					
				Period of record	Date	Stage (ft)	Discharge (ft³/s)	Date	Time (h)	Stage (ft)	Discharge (ft³/s)	Annual exceedance probability (percent)	Recurrence interval (years)
		Lake Ontario Basin											
212	04232200	Catharine Creek at Montour Falls, N.Y.	41.1	1976–77, 1987–2011	11/08/96	8.48	[b]4,700	09/08/11	--	5.11	528	>50.0	<2
216	04233000	Cayuga Inlet near Ithaca, N.Y.	35.2	1937–2011	06/23/72	[a]8.10	4,800	09/08/11	0315	9.82	7,190	1.0	100
217	04233286	Sixmile Creek at Brooktondale, N.Y.	27.0	2003–11	04/02/05	5.20	4,100	09/08/11	0230	5.38	4,470	6.7	15
218	04233300	Sixmile Creek at Bethel Grove, N.Y.	39.0	1996–2011	01/19/96	9.78	6,200	09/08/11	0315	8.98	5,080	10.0	10
219	04233500	Cayuga Inlet (Cayuga Lake) at Ithaca, N.Y.	1,564	1905–25, 1956–2011	04/26/93	[e]386.46	--	09/08/11	0500	[e]384.02	--	--	--
220	04234000	Fall Creek near Ithaca, N.Y.	126	1925–2011	07/08/35	9.52	15,500	09/08/11	0930	5.21	4,310	25.0	4
228	04235299	Owasco Inlet below Aurora Street at Moravia, N.Y.	106	2010–11	01/25/10	9.30	3,010	09/08/11	0430	8.59	2,510	>50.0	<2
233	04240010	Onondaga Creek at Spencer Street, Syracuse, N.Y.	110	1971–2011	07/03/74	8.73	4,050	09/07/11	1745	7.18	1,960	50.0	2
234	04240100	Harbor Brook at Syracuse, N.Y.	10.0	1960–2011	07/03/74	[a]8.34	726	09/07/11	2000	4.83	254	50.0	2
235	04240105	Harbor Brook at Hiawatha Boulevard, Syracuse, N.Y.	12.1	1971–2011	07/03/74	7.91	824	09/07/11	1800	6.27	493	50.0	2
236	04240120	Ley Creek at Park Street, Syracuse, N.Y.	29.9	1973–2011	04/26/11	5.02	1,410	09/07/11	2315	4.19	994	14.3	7
237	04240180	Ninemile Creek near Marietta, N.Y.	45.1	1965–2011	06/23/72	8.65	1,030	09/07/11	1900	3.49	182	>50.0	<2
238	04240300	Ninemile Creek at Lakeland, N.Y.	115	1971–73, 1975–2011	06/23/72	--	[d]2,110	09/08/11	--	--	[d]616	>50.0	<2
239	04240495	Onondaga Lake at Liverpool, N.Y.	285	1970–2011	04/26/93	[e]369.78	--	09/08/11	0830	[e]364.33	--	--	--
240	04242500	East Branch Fish Creek at Taberg, N.Y.	188	1923–95, 2009–11	12/29/84	[a]13.81	21,600	09/07/11	2300	5.70	1,240	>50.0	<2
241	04243500	Oneida Creek at Oneida, N.Y.	113	1950–2011	10/09/76	15.01	9,110	09/08/11	0600	15.55	6,380	10.0	10
244	04249000	Oswego River at Lock 7, Oswego, N.Y.	5,100	1934–2011	03/28/36	13.10	37,500	09/09/11	0215	7.19	13,200	>50.0	<2
248	04250200	Salmon River at Pineville, N.Y.	238	1985, 1993–2011	12/29/84	16.36	24,800	09/07/11	1715	6.47	824	>50.0	<2
		Black River Basin											
250	04252500	Black River near Boonville, N.Y.	304	1911–2011	04/18/82, 12/30/84	11.31, 11.41	12,800	09/08/11	2030	8.38	4,050	>50.0	<2
253	04254500	Moose River at McKeever, N.Y.	363	1901–70, 1985, 1987–2011	06/03/47	17.45	18,700	09/08/11	1700	7.00	3,530	>50.0	<2

[a]At former site or datum.

[b]Estimated.

[c]Daily discharge.

[d]Elevation in feet above Barge Canal Datum.

[e]Elevation in feet above NGVD 29.

[f]From New York Power Authority.

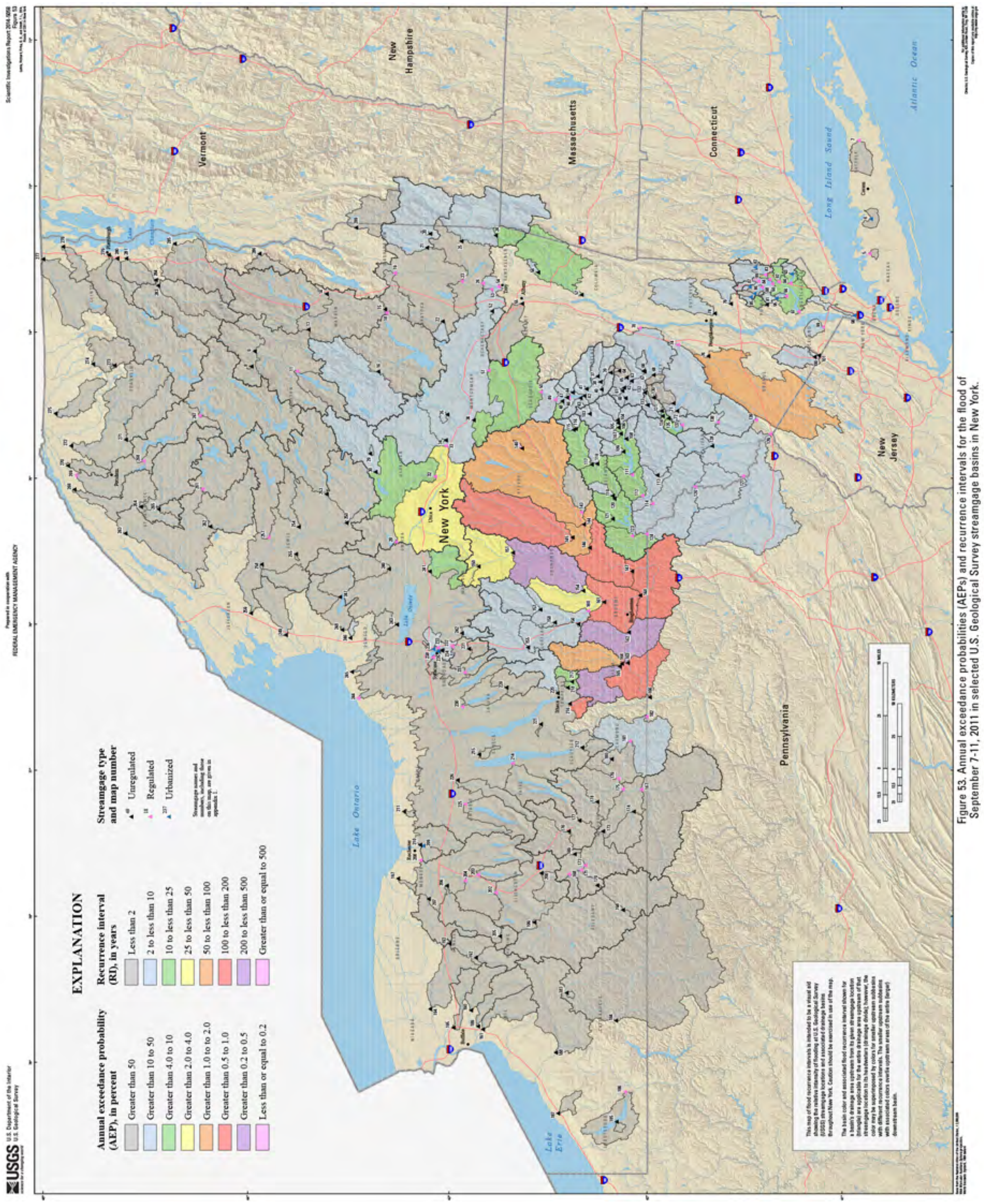

Figure 53. Annual exceedance probabilities and recurrence intervals for the flood of September 7–11, 2011, in selected U.S. Geological Survey streamgage basins in New York. (Click link to view full-size map of figure 53 at *http://pubs.usgs.gov/sir/2014/5058/*.)

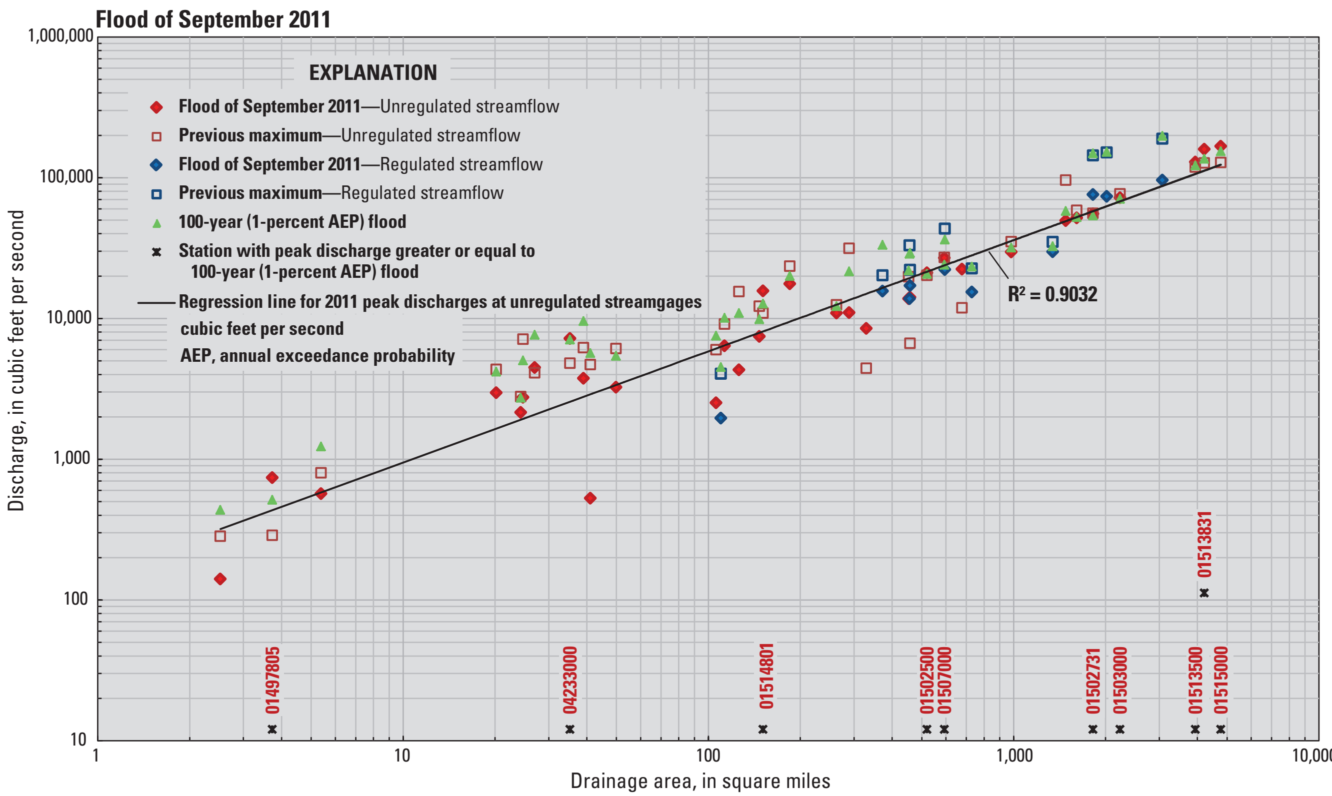

Figure 54. Peak discharges for the flood of September 8–9, 2011, previous maximum known discharges, and 1-percent annual exceedance probability (100-year) discharges at selected streamgages as a function of drainage area in New York. (Sites are listed in appendix 1 and shown on figure 10.)

Flood AEP flows computed for first 10 years of record (1935–44) for the Susquehanna River at Vestal (01513500) streamgage and recomputed for each additional year of record through 2011 (the maximum discharge for the year occurred on September 8) illustrate the effects of individual annual peak discharges on the magnitudes of the AEP flows over time (fig. 58). The 10-year moving average and trend line for the moving 100-year (1-percent AEP) flood-frequency discharges indicate a slightly downward trend at Vestal over its entire 77-year period of record, but the 10-year moving average of the 100-year moving frequency curve indicates a slightly upward trend over the past 25 years.

Discharge hydrographs for selected streamgages throughout the flooded areas for September 5–11, 2011, compare the magnitudes, relative frequencies, and timings of flows during September 5–11, 2011 (figs. 59A–L). Some unit (15-minute) discharge data are missing because of equipment malfunction or damage to the streamgage housing the equipment. Discharges at seven streamgages on the Susquehanna River (figs. 59A–C) peaked near or above their respective 1-percent AEP (100-year) discharges on September 8 with consistent hydrograph shape and timing. The Chenango River (figs. 59D–E) enters the Susquehanna River just upstream from Vestal, and peak flows coincided with those along the main stem of the Susquehanna River.

The remnants of Tropical Storm Lee produced the third flood along the Mohawk River in 2011. The flows from the headwaters of the Mohawk River below Delta Dam near Rome (01336000) were minor during Tropical Storm Lee, but inflows from West Canada Creek (01346000) and other tributaries increased flows at Little Falls (01347000) to the 35-year (2.8-percent AEP) flood (fig. 59F). Because inflows from East Canada Creek (01348000), Schoharie Creek (01351500), and the upper Hudson River were minor, downstream flooding remained less than the 10-percent AEP (10-year) flood at the Mohawk River at Cohoes (01357500) and the Hudson River at Green Island (01358000) streamgages (figs. 59G–I).

Discharge hydrographs for selected streamgages in the Susquehanna River Basin for September 5–11, 2011, and for previous floods during 2005–06 compare flow magnitude and frequency, hydrograph shape, and antecedent conditions (figs. 60A–F). The peak discharges for previous floods were overlaid on that for the September flood to allow hydrograph-shape comparisons, which are similar except for the much higher base flows prior to the April 2005 flood (figs. 60C–E). Discharge hydrographs for the Mohawk River at Little Falls

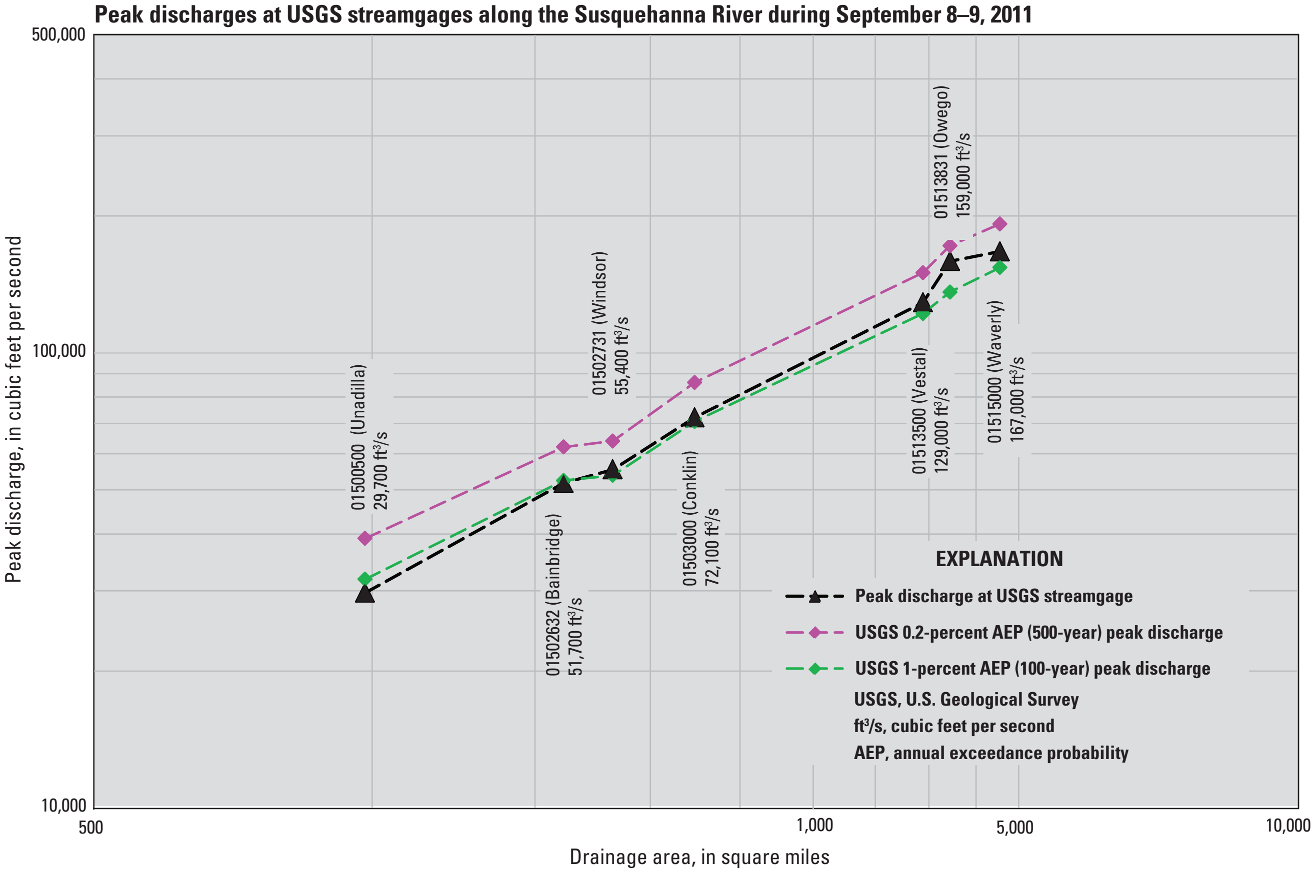

Figure 55. Peak discharges for the flood of September 8–9, 2011, and 1- and 0.2-percent annual exceedance probability (100- and 500-year) discharges at seven U.S. Geological Survey streamgages on the Susquehanna River as a function of drainage area in New York. (Sites are listed in appendix 1 and shown on figure 10.)

(01347000) and at Cohoes (01357500) (figs. 60G–I) are much wider for the spring floods of April 2011 and March 1977 because snowmelt sustained high base flows prior to the maximum discharge. The September 2011 hydrographs also indicate high antecedent flows as a result of runoffs from Tropical Storm Irene a week earlier. As discussed earlier, an additional 1-percent AEP (100-year) discharge at Cohoes is included to reflect the adjustment of annual peaks for releases from upstream ice jams (fig. 60I): the March 1964 peak flow (which was greater than the 1-percent AEP or 100-year discharge) would have been closer to the 10-percent AEP (10-year) discharge if not for the surge of water from the upstream ice-jam release.

Stage-frequency hydrographs for five selected streamgages in the Susquehanna River Basin indicate that stream stage at Susquehanna River at Conklin (01503000) rose nearly 16 ft in about 30 hours during September 7–8 and remained above the 1-percent AEP (100-year) flood stage for about 12 hours and above the 2-percent AEP (50-year) stage for about 26 hours (fig. 61A). The stage at the Conklin streamgage remained above the NWS flood stage for nearly 5 days. The stages at the Susquehanna River at Vestal (01513500) (fig. 61D) and near Waverly (01515000) (fig. 61E) peaked at or near their 0.5-percent AEPs (200-year) stage, and the water levels rose 25.5 and 20.6 ft., respectively, in about 30 hours.

Flood Profiles of the Susquehanna River

The severe flooding along the Susquehanna River prompted a more detailed evaluation of the flood stages throughout the length of its reach. The elevations of 20 HWMs were surveyed at 18 sites along a 114-mi reach of the Susquehanna River (fig. 62) from Unadilla, N.Y., to Athens, Pennsylvania (just south of the New York–Pennsylvania border) to enable the documentation and evaluation of the extent and severity of the September 2011 flood. The HWMs were surveyed where marks had previously been documented following the June 2006 flood (Suro and others, 2009). Descriptions of the HWMs from the September 2011 and June 2006 floods, FEMA AEP water-surface elevations, and other pertinent information are summarized in table 22; a map showing the locations of the HWM sites in the Susquehanna River Basin is given on figure 63.

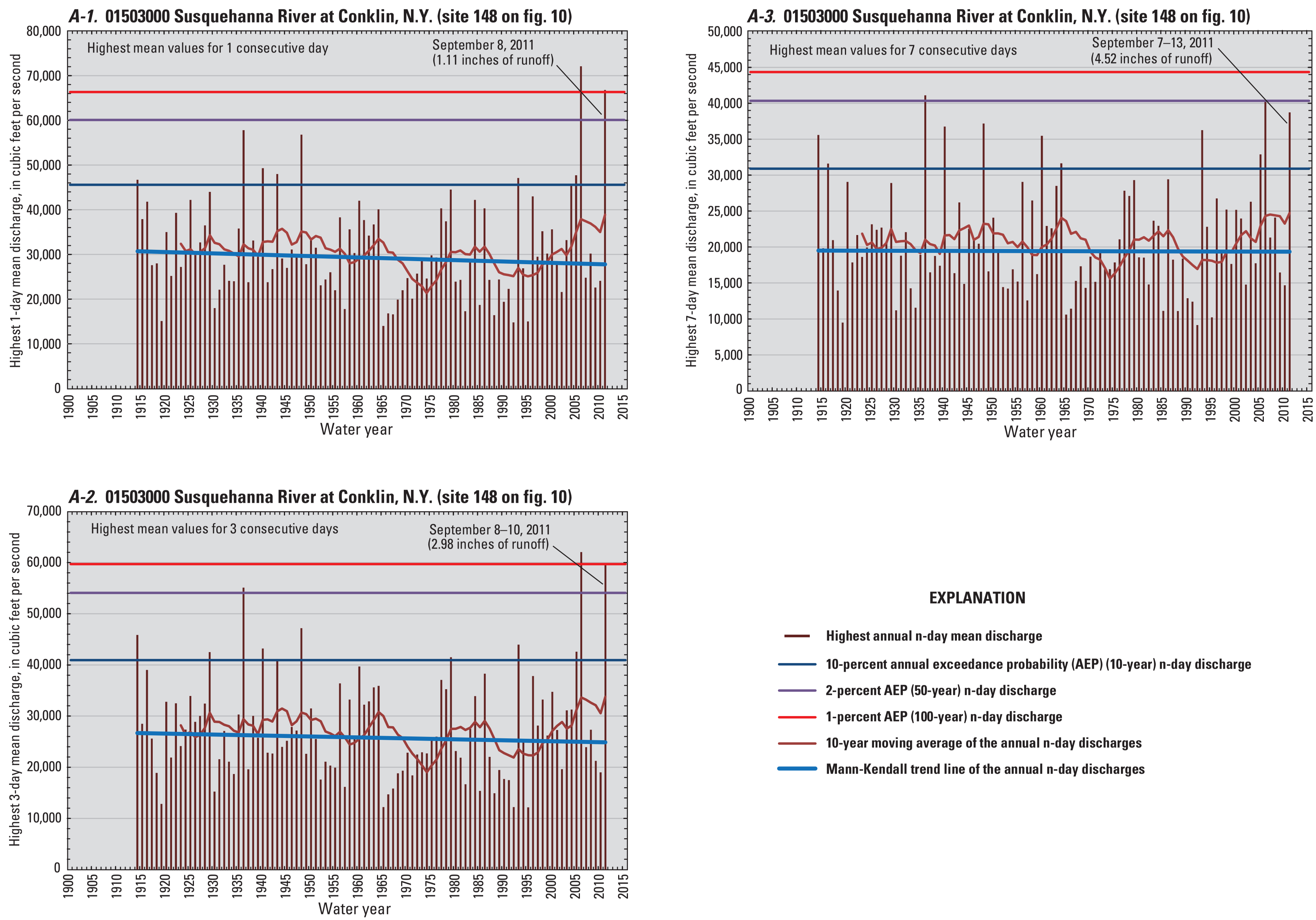

Figure 56. Highest 1-, 3-, and 7-consecutive-day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)

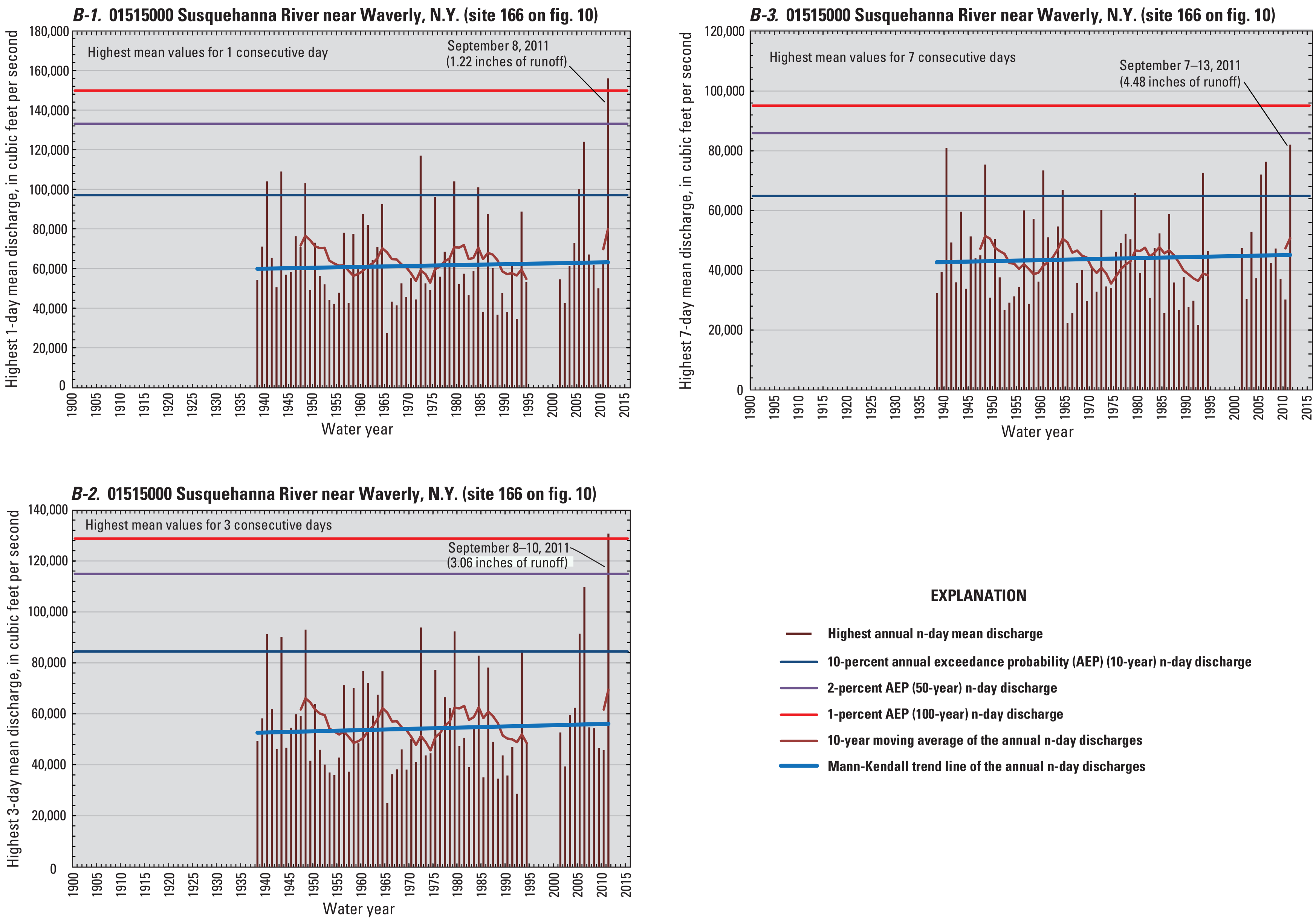

Figure 56. Highest 1-, 3-, and 7-consecutive-day mean discharges, selected n-day frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

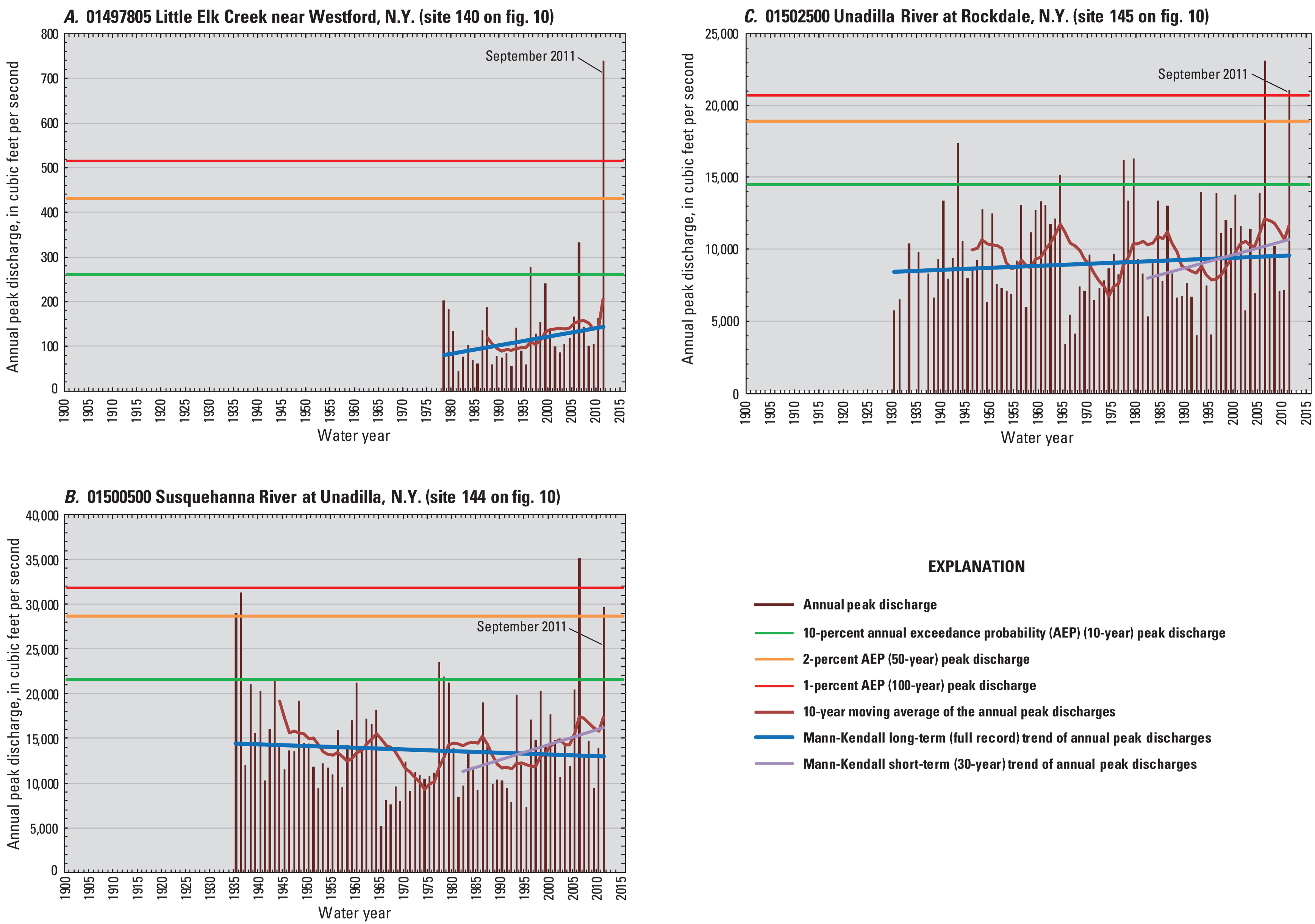

Figure 57. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)

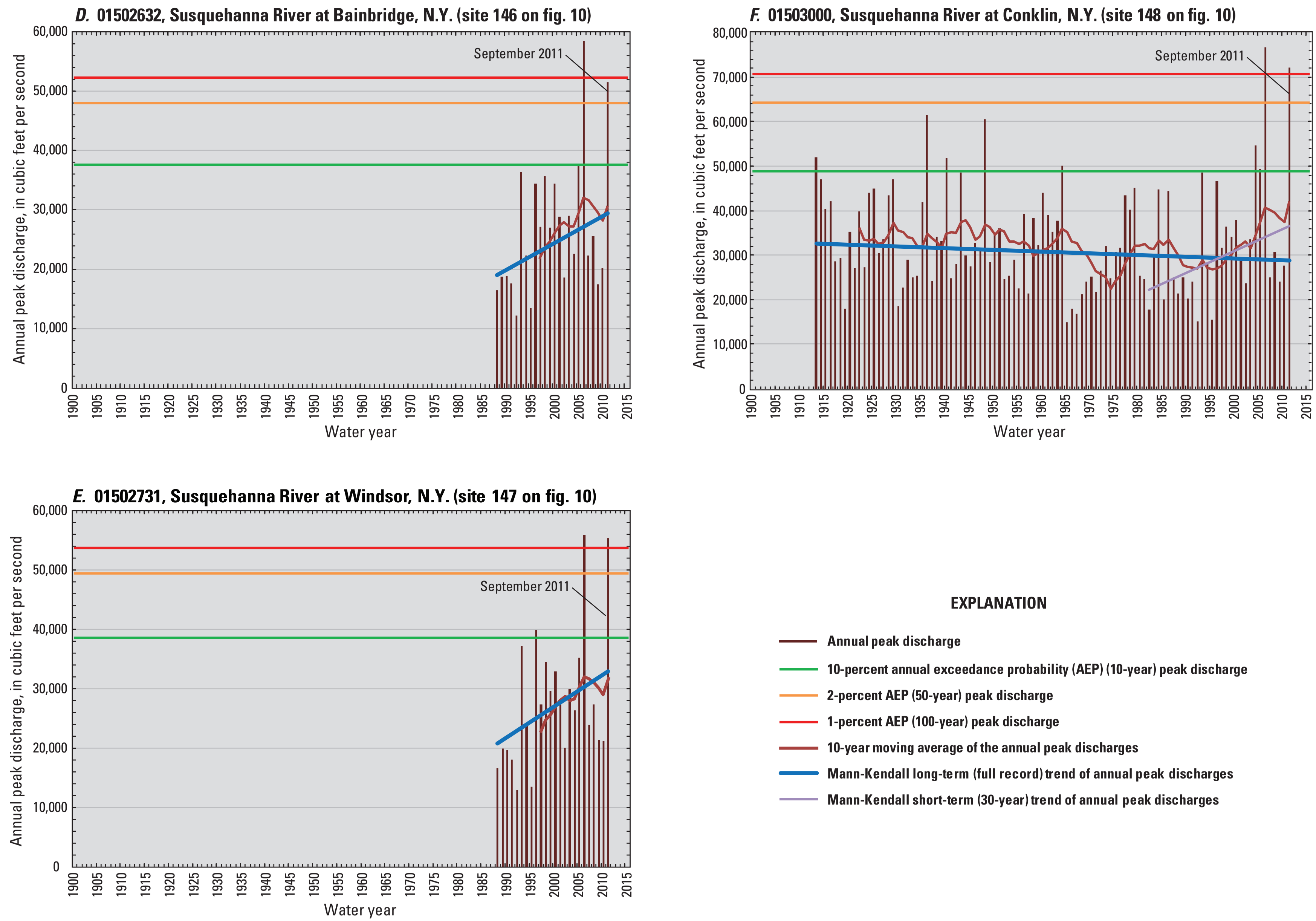

Figure 57. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

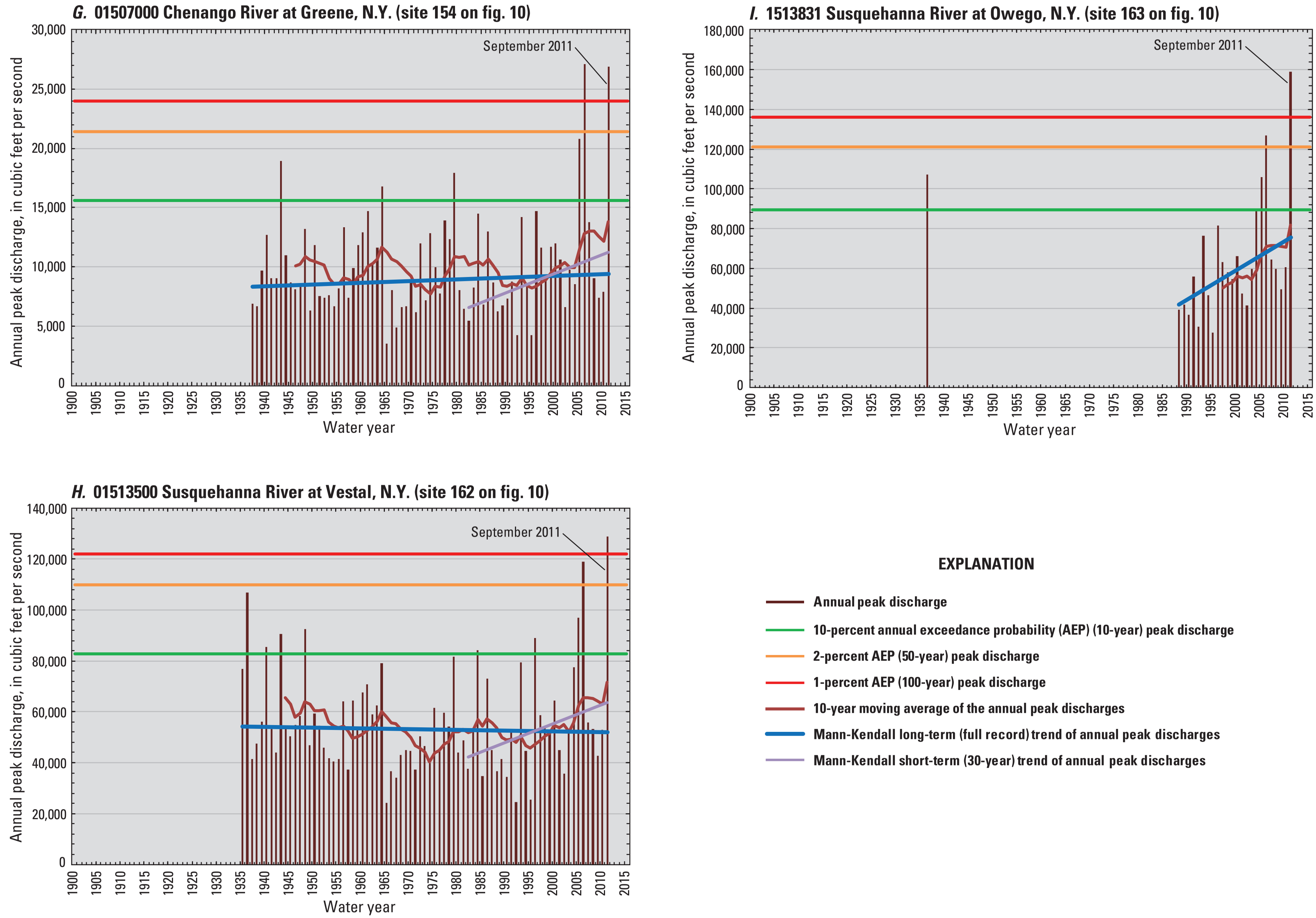

Figure 57. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

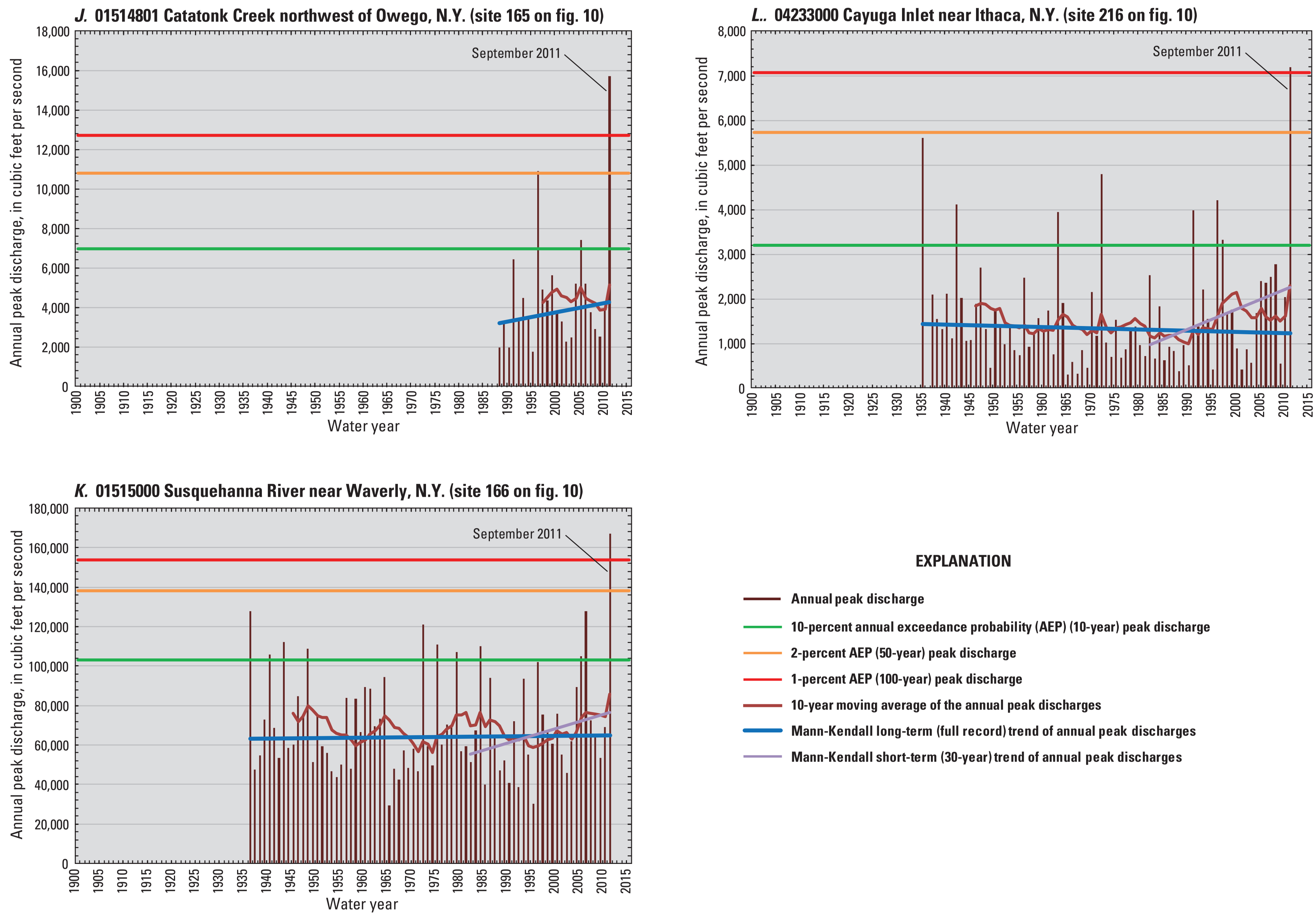

Figure 57. Annual peak discharges through 2011, selected flood frequencies, and trend-analysis data for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10.)—Continued

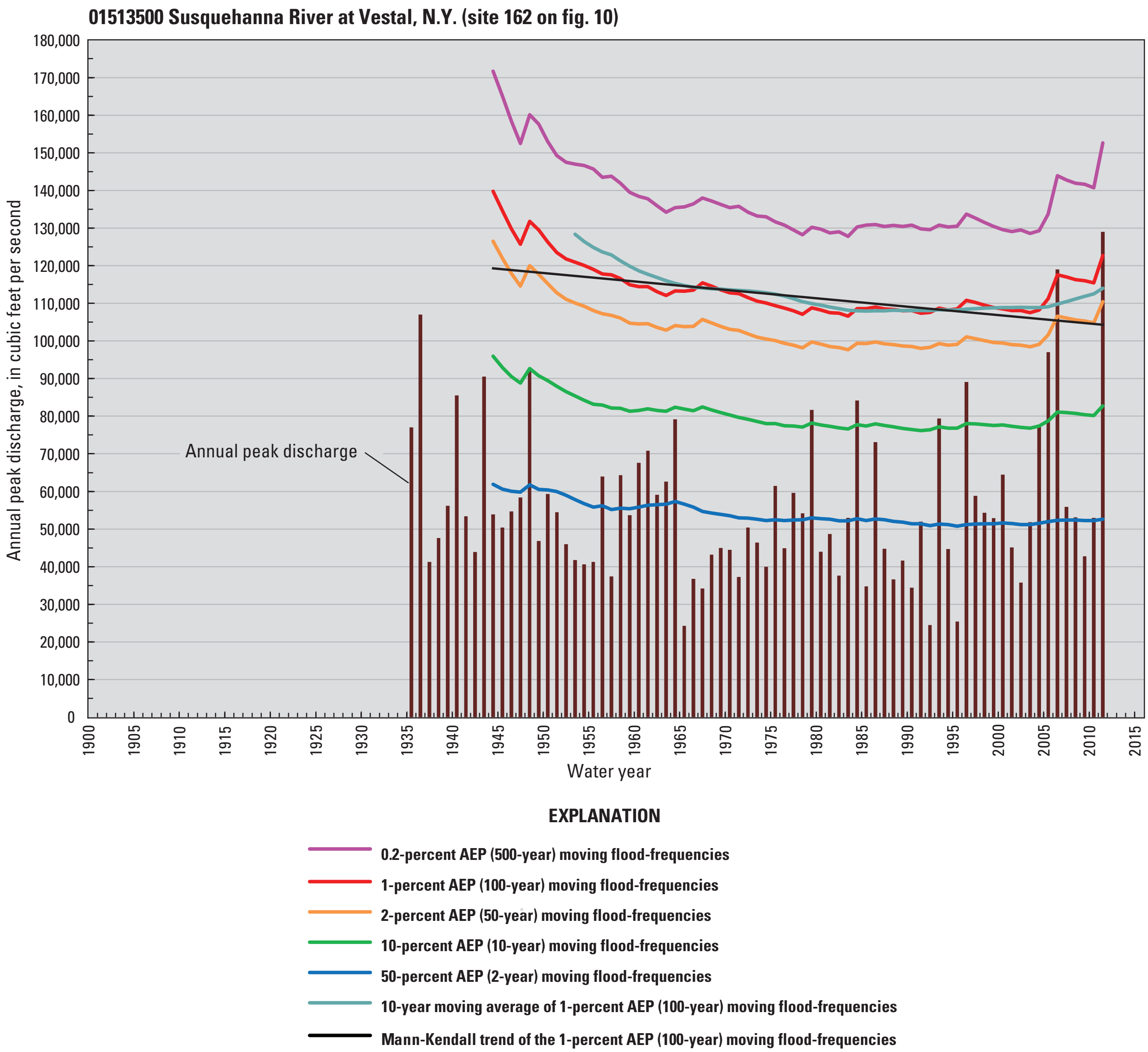

Figure 58. Annual peak discharges, moving flood frequencies, and trends of the moving 1-percent annual exceedance probability (AEP) (100-year) discharges through 2011 at the Susquehanna River at Vestal, New York streamgage. (Site is listed in appendix 1 and shown on figure 10.)

Peak water-surface elevations for the September 2011 and June 2006 floods on the Susquehanna River were compared with flood-profile elevations (10-, 50-, 100-, and 500-year) published in FEMA flood-insurance studies (Federal Emergency Management Agency, 1976a, b, 1977, 1979, 1987, 1988, 1992, 1998, 2010, 2012b) (table 22 and fig. 64). The elevations of the HWMs relative to NAVD 88 indicate that the September 2011 flood elevations along the Susquehanna River were lower than those during 2006 in the upper reaches (Unadilla to Conklin, figs. 64A–E) by as much as 1.38 ft (Unadilla). Flood elevations downstream from Binghamton, N.Y. to Athens, Pa. (figs. 64F–R), however, were higher in 2011 than 2006 by as much as 4.41 ft (in the town of Nichols in Tioga County). The September 2011 HWMs in upstream study areas indicated elevations that ranged from less than the FEMA 2-percent AEP (50-year) elevation (at Bainbridge, fig. 64B) to 1.3 ft higher than the FEMA 0.2-percent AEP (500-year) elevation (at Windsor and Conklin, figs. 64C–D). Farther downstream, the September 2011 elevations were as much as 4.55 ft higher than the FEMA 1-percent AEP (100-year) flood elevations from Binghamton to Tioga (figs. 64G–N) and exceeded the FEMA 0.2-percent AEP (500-year) elevations by as much as 1.45 ft (site 15 at Nichols, fig. 64O). No additional elevations of HWMs along the Susquehanna River were surveyed by the USGS or other agencies.

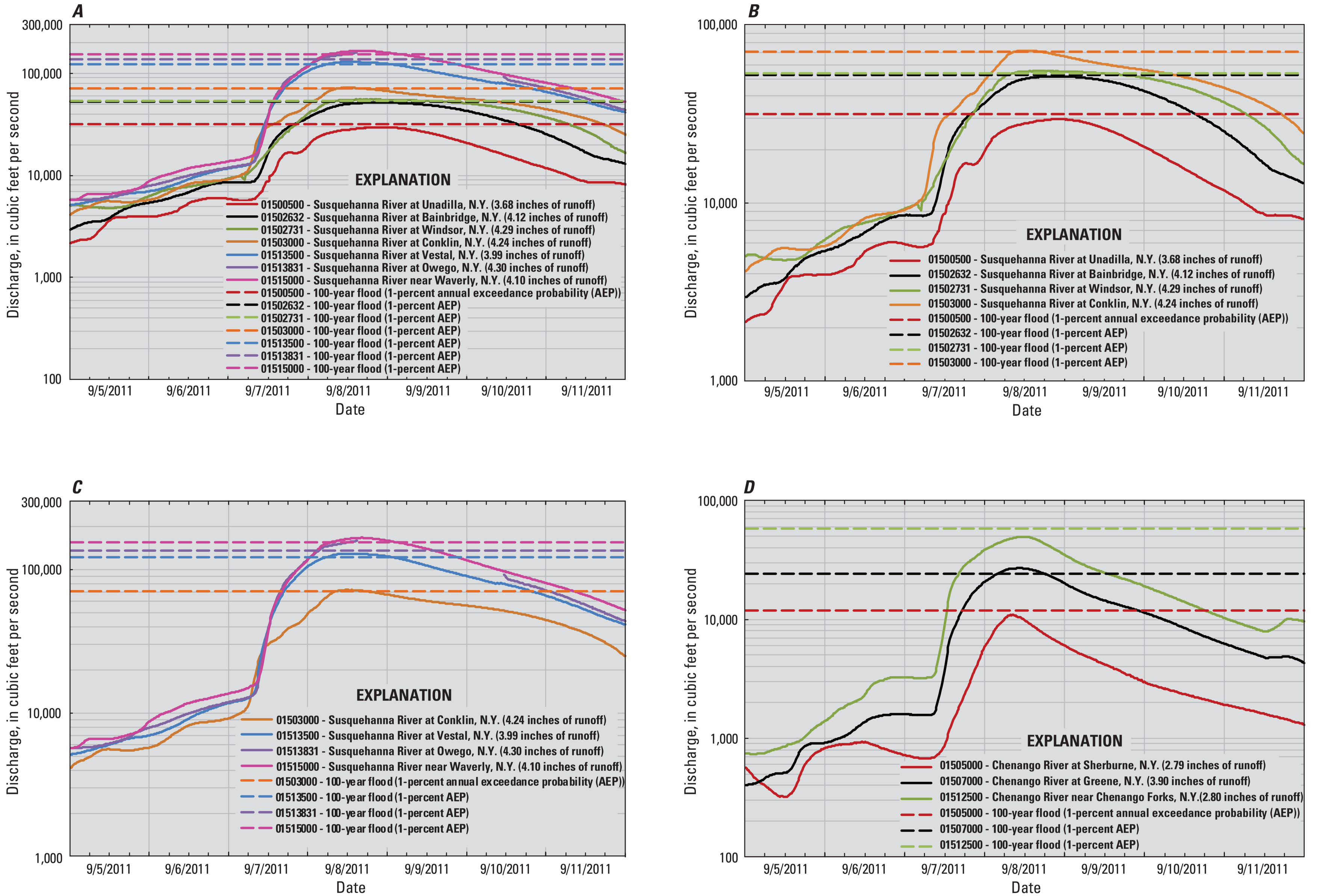

Figure 59. Discharge hydrographs for September 5–11, 2011, and 1-percent annual exceedance probabilities for selected streamgages on the Susquehanna, Chenango, and Mohawk Rivers, New York. (Annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)

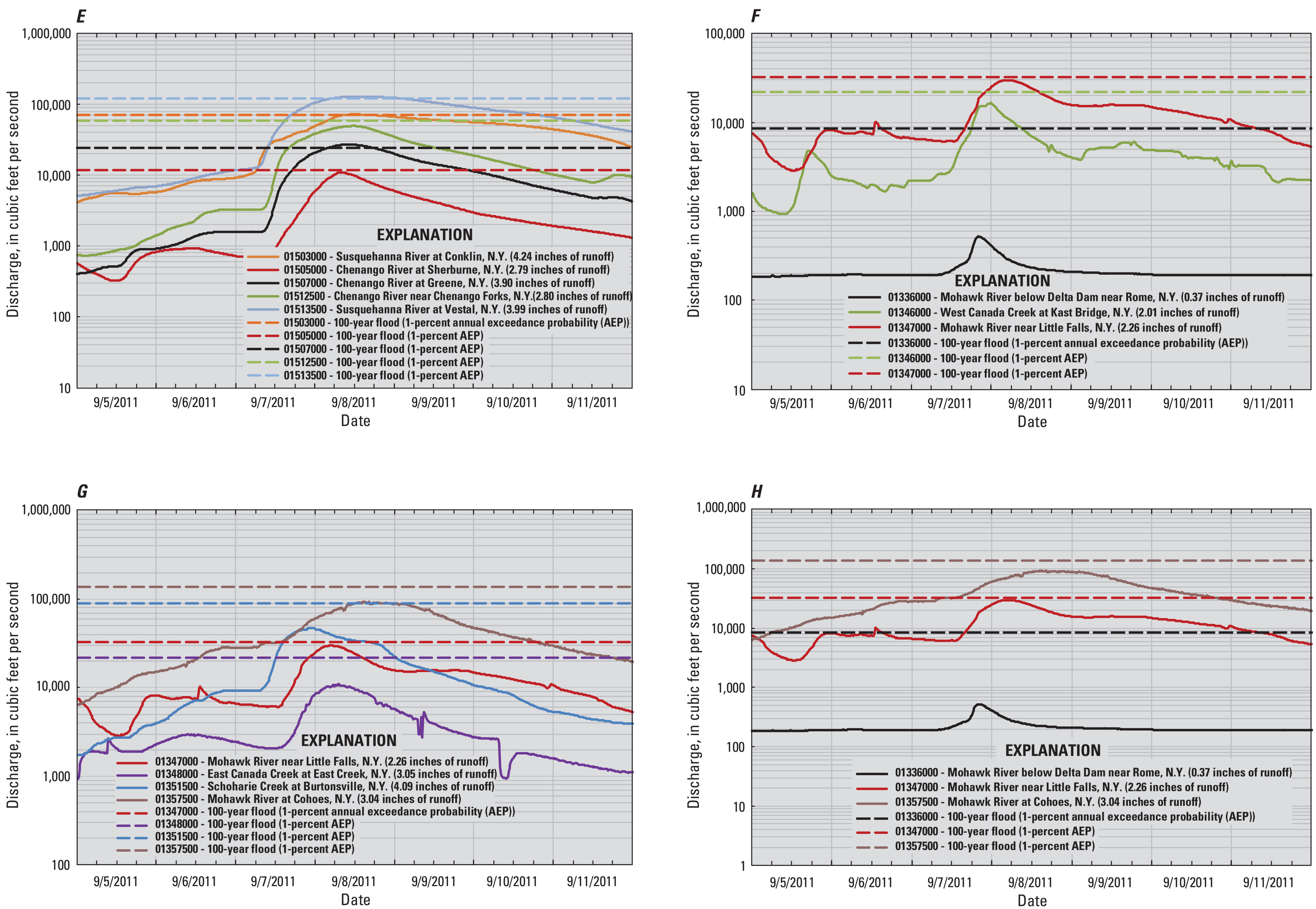

Figure 59. Discharge hydrographs for September 5–11, 2011, and 1-percent annual exceedance probabilities for selected streamgages on the Susquehanna, Chenango, and Mohawk Rivers, New York. (Annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)—Continued

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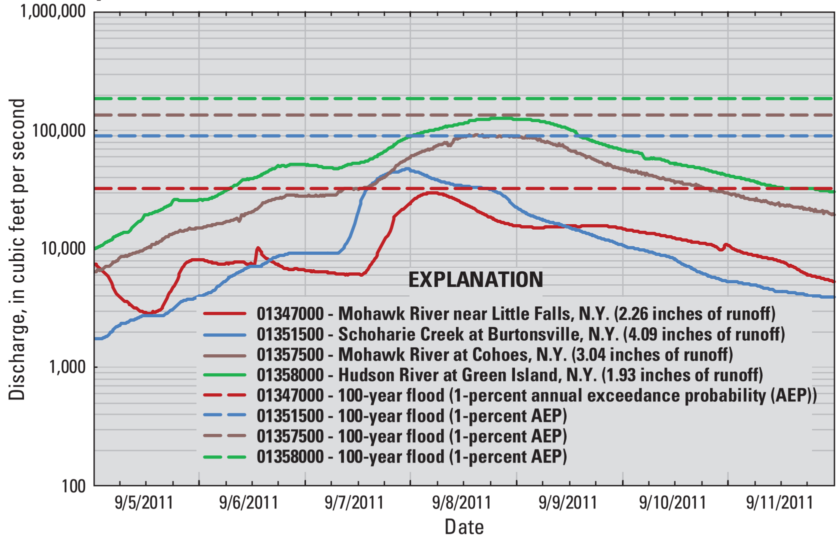


Figure 59. Discharge hydrographs for September 5–11, 2011, and 1-percent annual exceedance probabilities for selected streamgages on the Susquehanna, Chenango, and Mohawk Rivers, New York. (Annual exceedance probabilities (AEPs) are shown as color-coded dashed lines for each site; sites are listed in appendix 1 and shown on figure 10.)—Continued

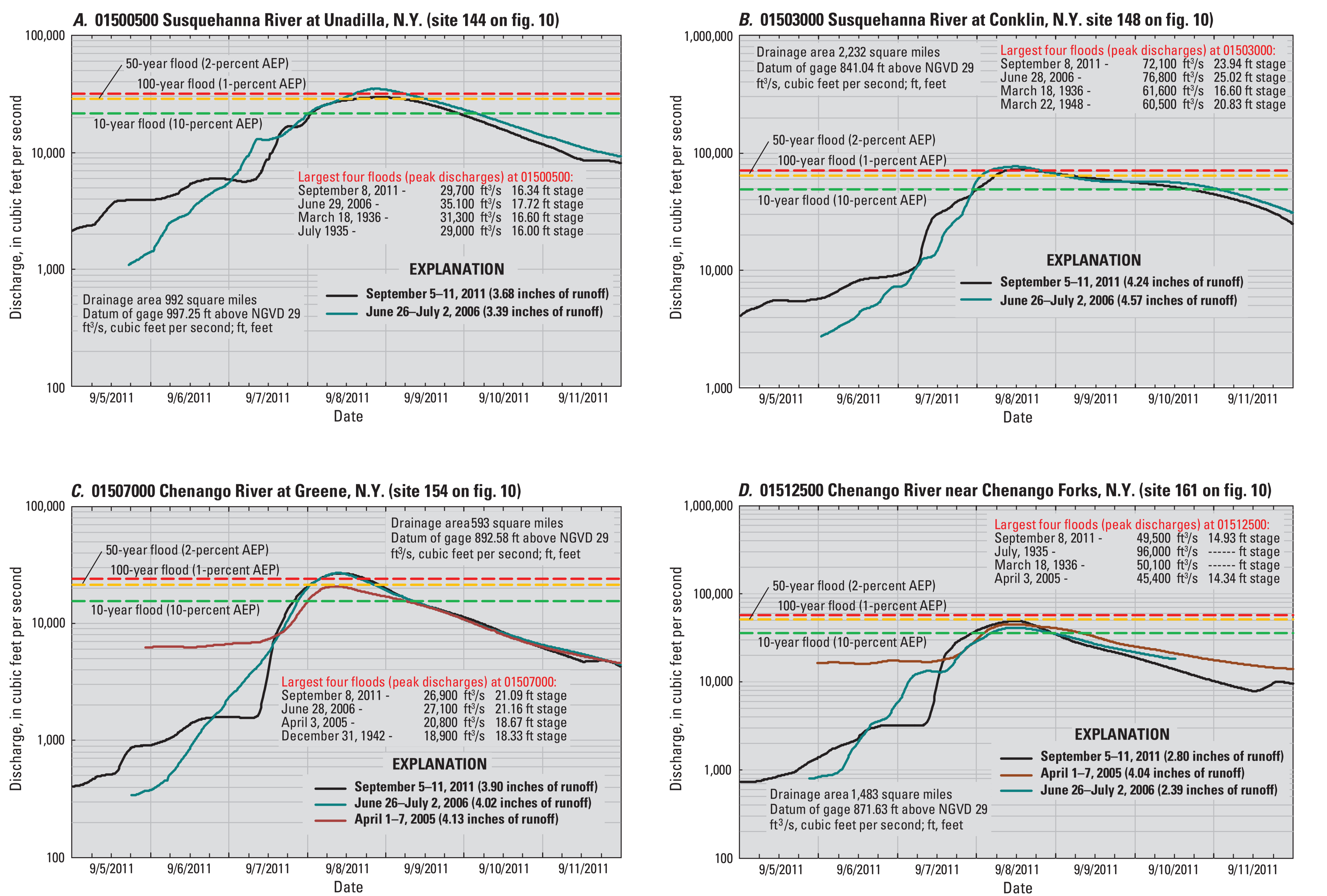


Figure 60. Discharge hydrographs for September 5–11, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)

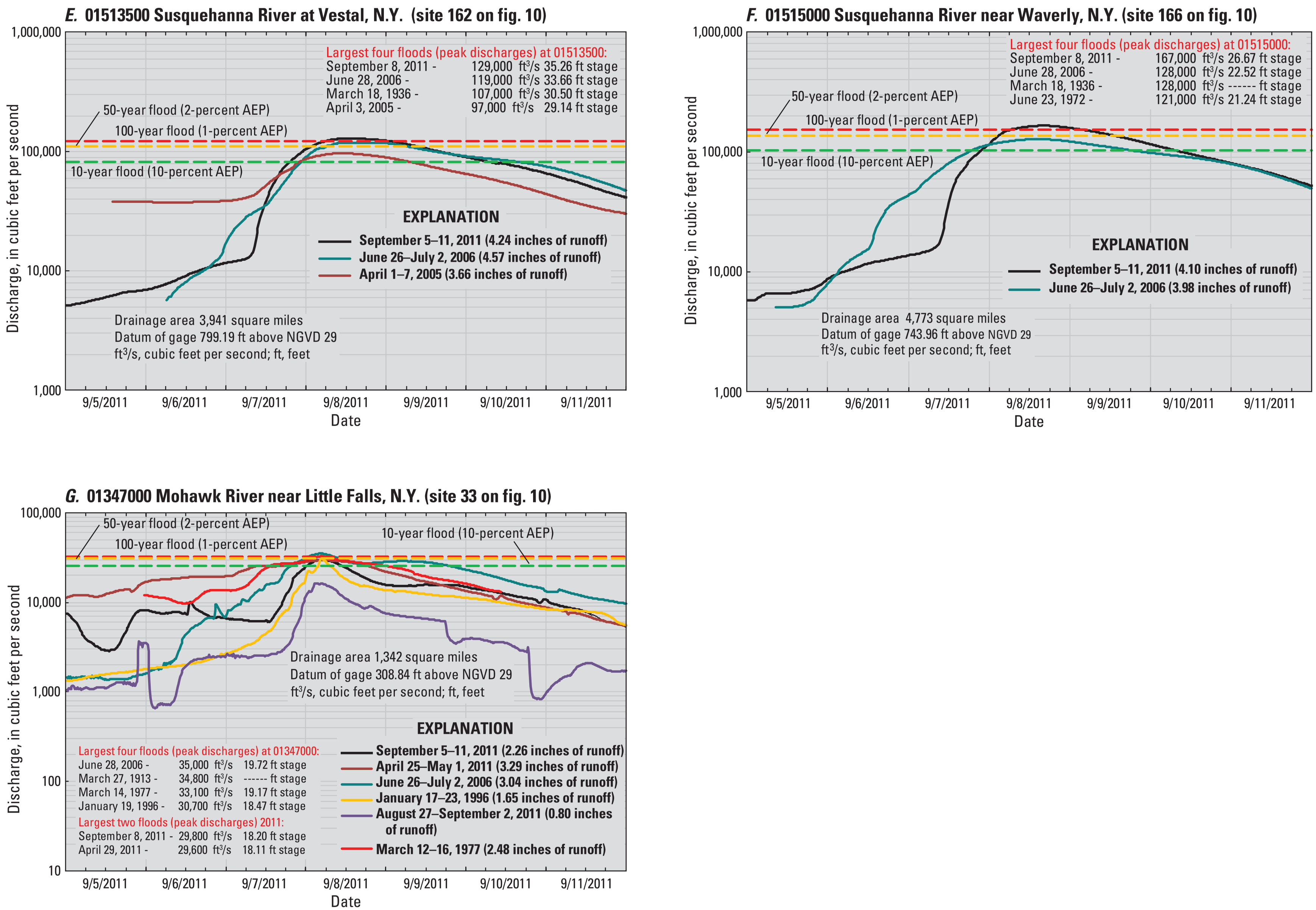


Figure 60. Discharge hydrographs for September 5–11, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929)—Continued

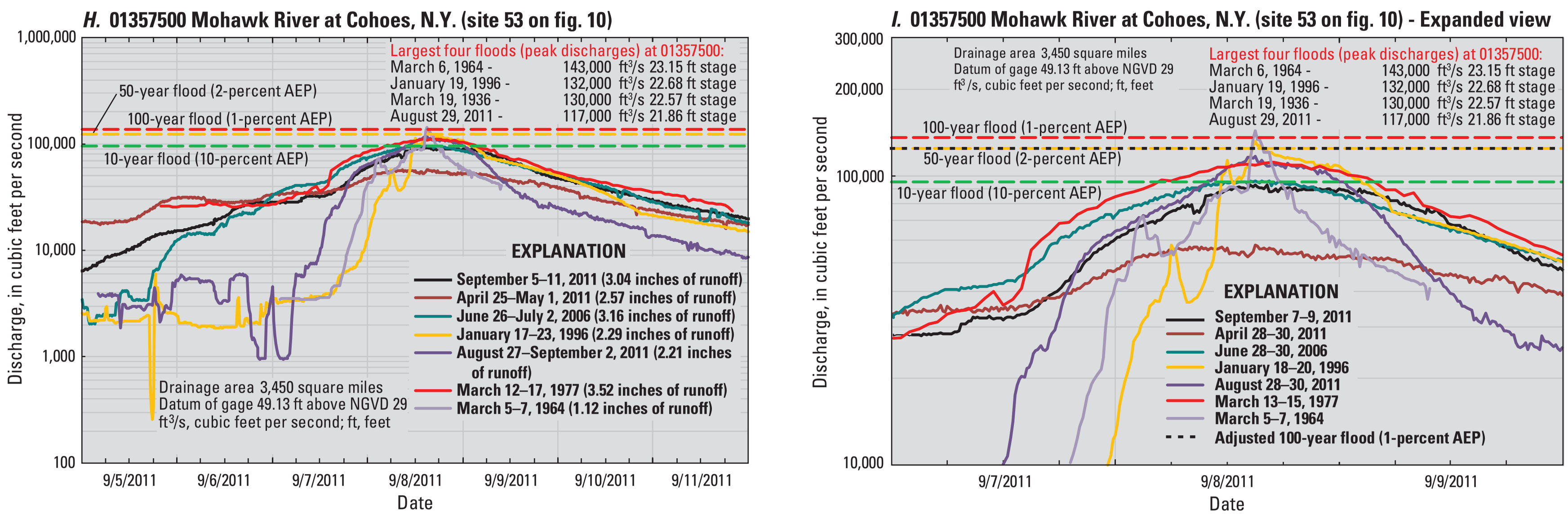


Figure 60. Discharge hydrographs for September 5–11, 2011, selected previous floods, selected flood frequencies, and a list of the largest four floods for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. AEP, annual exceedance probability; NGVD 29, National Geodetic Vertical Datum of 1929) —Continued

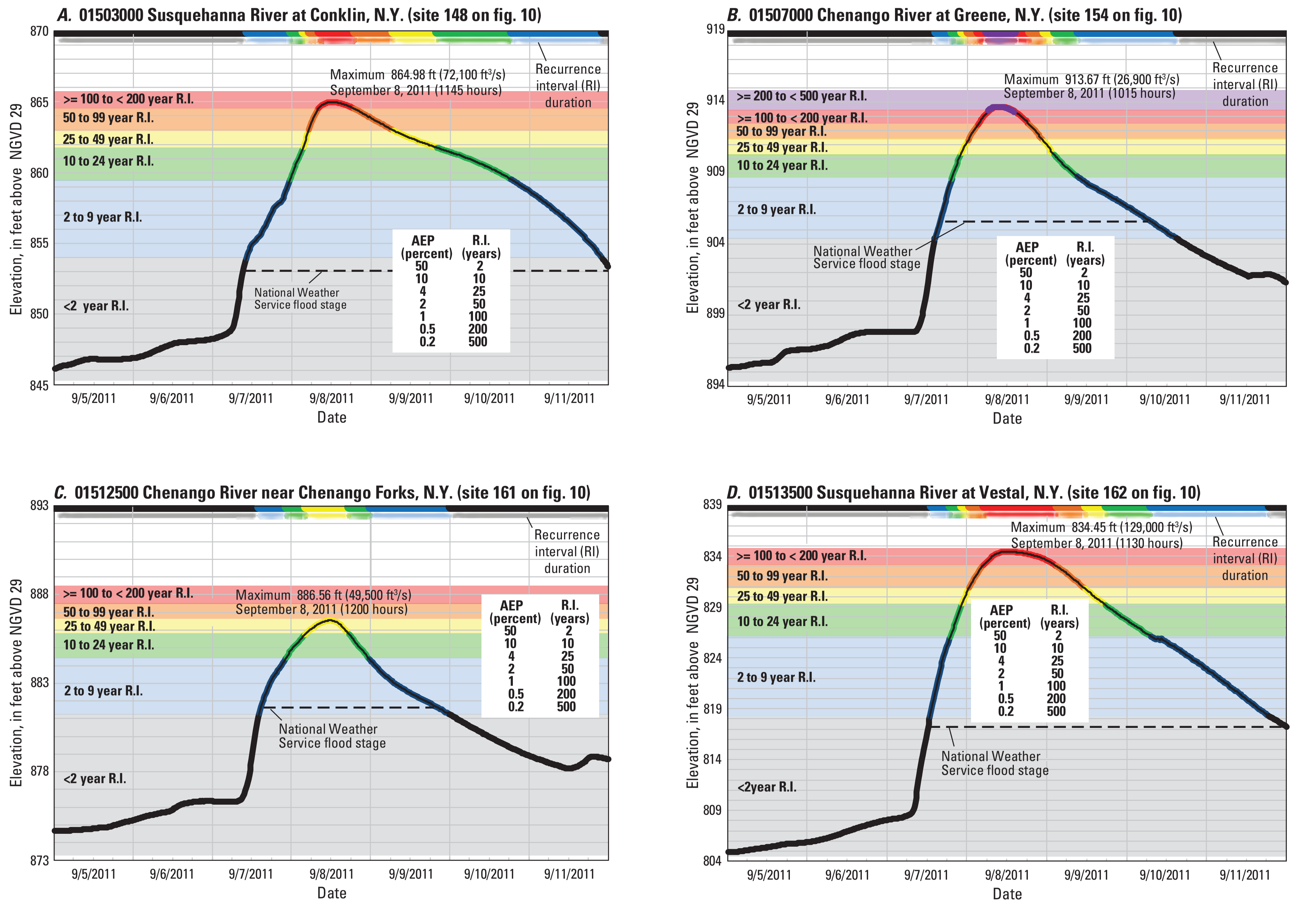


Figure 61. Stage hydrographs for September 5–11, 2011, stage frequencies, and stage-frequency durations for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD 29, National Geodetic Vertical Datum of 1929; AEP, annual exceedance probability; ≥, greater than or equal to; <, less than; ft³/s, cubic feet per second)

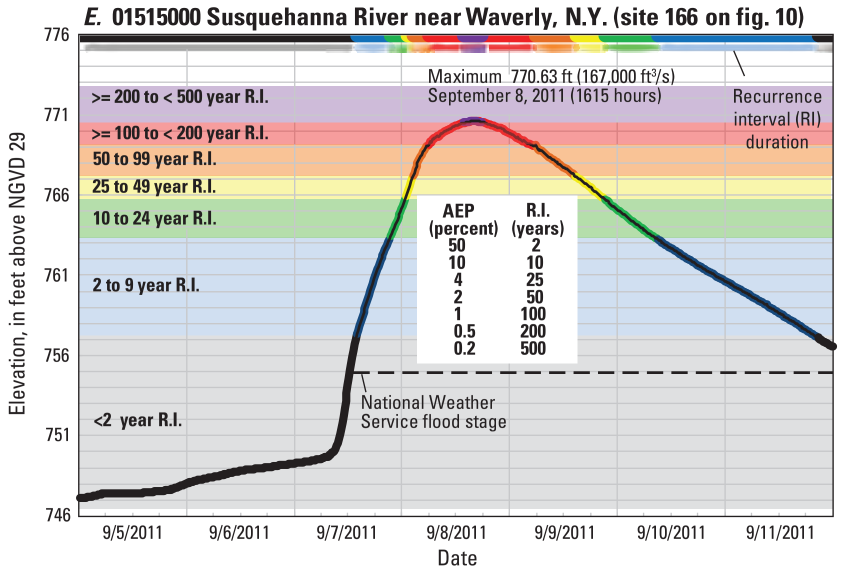


Figure 61. Stage hydrographs for September 5–11, 2011, stage frequencies, and stage-frequency durations for selected streamgages in New York. (Sites are listed in appendix 1 and shown on figure 10. NGVD 29, National Geodetic Vertical Datum of 1929; AEP, annual exceedance probability; ≥, greater than or equal to; <, less than; ft^3/s, cubic feet per second)—Continued

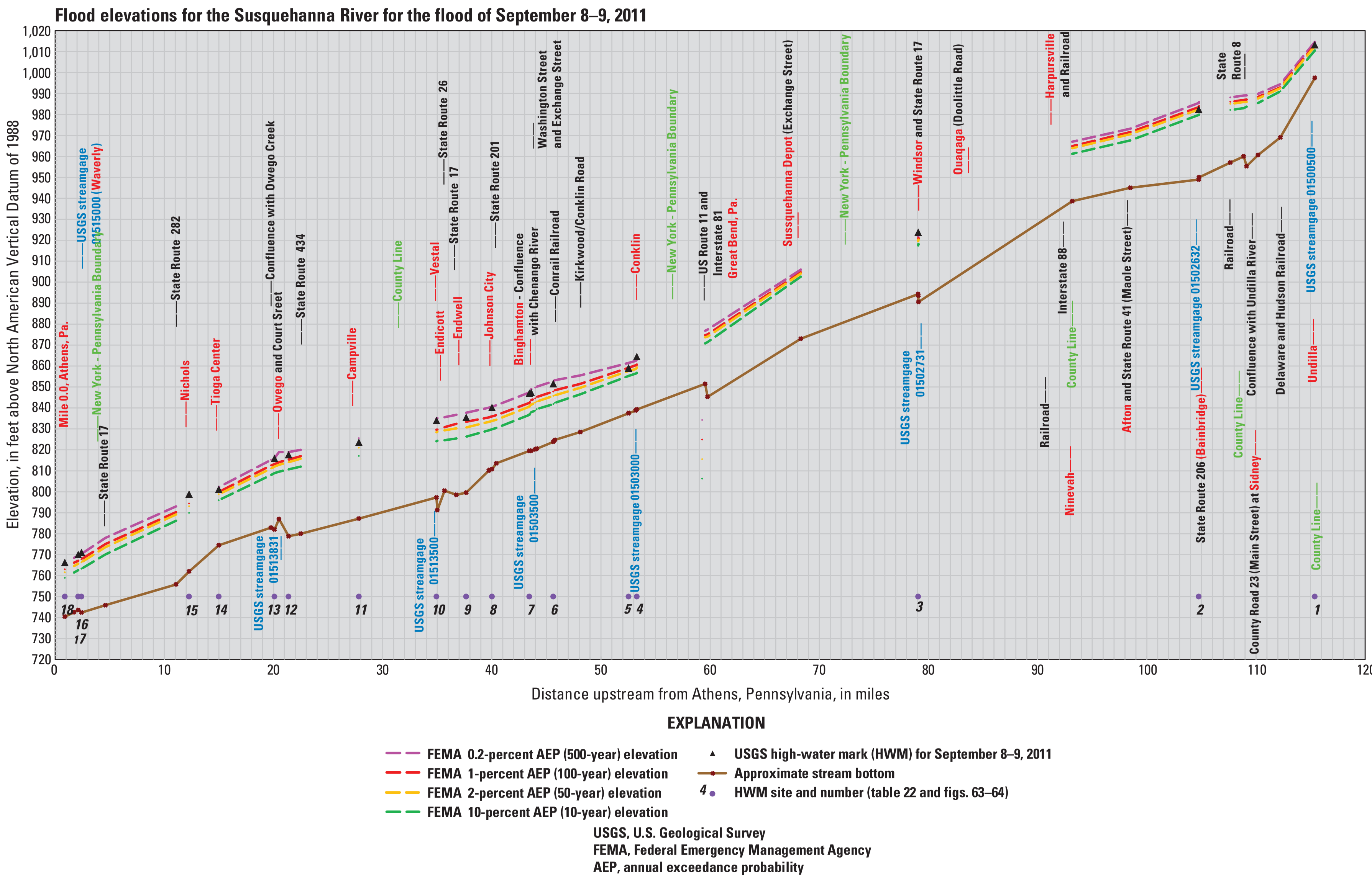


Figure 62. A generalized profile of the Susquehanna River for the flood of September 8–9, 2011, with the elevations of high-water marks, approximate Federal Emergency Management Agency flood profiles, approximate stream-bottom elevations, and locations of local communities and U.S. Geological Survey streamgages in New York. (Data are given in table 22, site locations are shown on figure 63, and detailed flood elevations are shown on figure 64.)

Table 22. Peak water-surface elevations at 18 high-water-mark sites, including 8 U.S. Geological Survey streamgages, along the Susquehanna River in New York during the floods of September 8–9, 2011, and June 28–29, 2006, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.

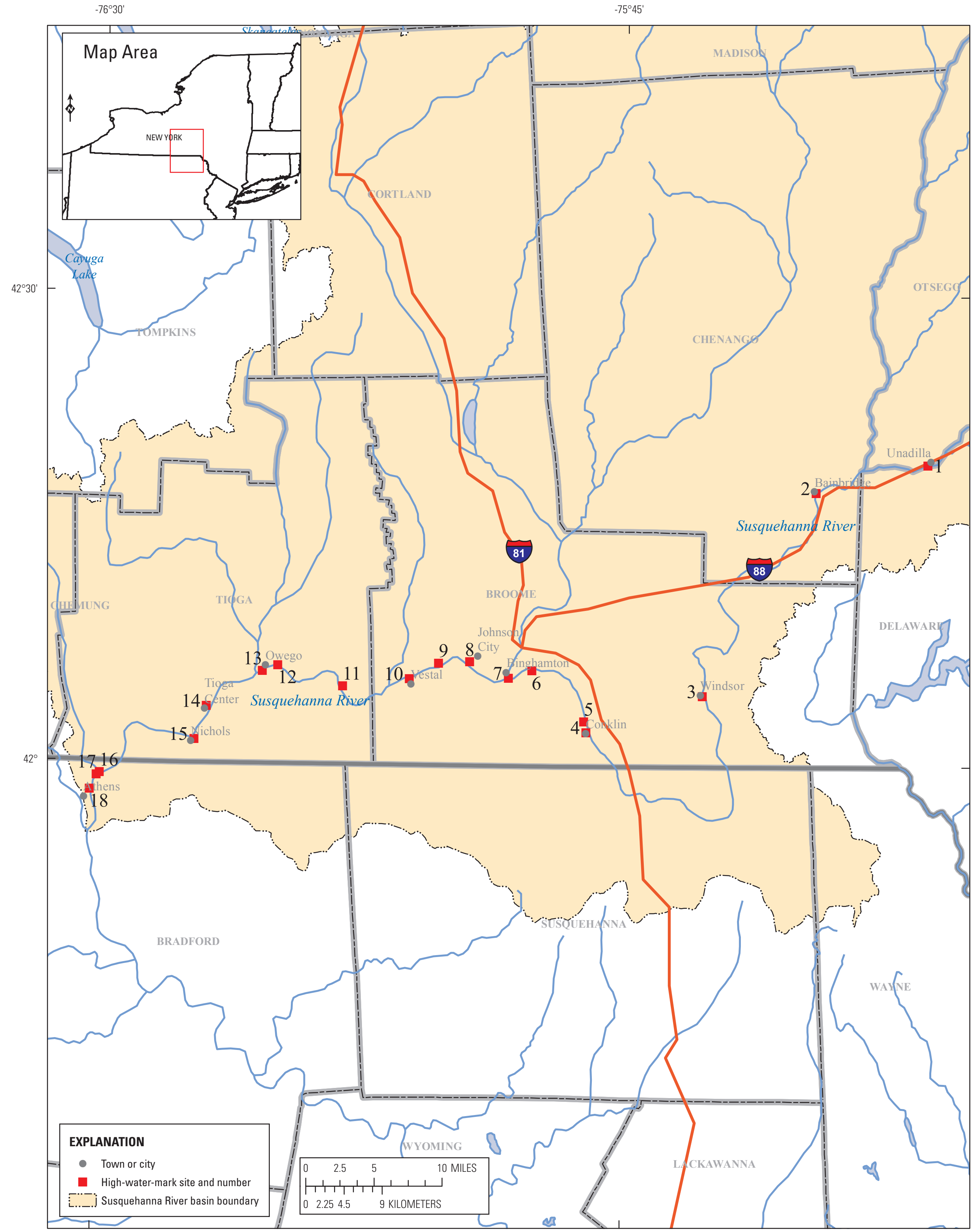
[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1976a, 1976b, 1977, 1979, 1987, 1988, 1992, 1998, 2010, 2012b); HWM ID, high-water-mark identification; --, no data available; high-water-mark location—RB, right bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of June 28–29, 2006, from Suro and others, 2009; locations are shown on figure 63]

Site number or streamgage number	HWM ID	Miles above Athens, Pa.	Site or streamgage along Susquehanna River and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet)						
							Peak water-surface elevation for September 8–9, 2011	10-percent AEP (10-year) flood	2-percent AEP (50-year) flood	1-percent AEP (100-year) flood	0.2-percent AEP (500-year) flood	Peak water-surface elevation for June 28–29, 2006	Stream-bottom elevation
1/01500500	1–1	115.388	RB–Streamgage at Unadilla–Recorded Village of Unadilla, Otsego County, N.Y.	E	42.32139	-75.31667	1,013.20	1,010.51	1,012.61	1,013.31	1,014.61	1,014.58	997.4
2/01502632	2–1	104.760	RB–Streamgage at Bainbridge–Recorded Village of Bainbridge, Chenango County, N.Y.	E	42.29139	-75.47639	982.35	979.8	982.4	983.5	985.5	983.20	948.9
3/01502731	3–1	79.072	RB–Streamgage at Windsor–Recorded Village of Windsor, Broome County, N.Y.	E	42.07472	-75.63778	923.74	918.1	920.2	921.0	922.4	923.80	893.5
4/01503000	4–1	53.283	LB–Streamgage at Conklin–Recorded Town of Conklin, Broome County, N.Y.	E	42.03528	-75.80306	864.46	856.8	859.3	860.7	863.2	865.54	839.3
5	5–1	52.534	LB–On wall of garage of house at 1288 Conklin Road (4.0 feet above floor)–Mud line	G	42.04669	-75.80653	859.04	855.3	857.7	859.2	861.5	859.81	837.5
	5–2	52.534	LB–On house at 1282 Conklin Road (7.0 feet above floor)–Mud line Town of Conklin, Broome County, N.Y.	G	42.04669	-75.80653	858.88	855.3	857.7	859.2	861.5	859.81	837.5
6	6–1	45.634	LB–On patio door of house at 21 Richmond Avenue (6.2 feet above floor)–Mud line City of Binghamton, Broome County, N.Y.	G	42.10022	-75.88156	851.52	841.8	845.7	847.8	852.7	851.52	823.8
7/01503500	7–1	43.612	LB–Streamgage at Binghamton–Recorded	E	42.09250	-75.91472	847.31	837.9	841.5	843.7	848.9	846.23	819.5
	7–2	43.446	RB–On basement window of house at 6 Front Street (5.2 feet above ground)–Mud line City of Binghamton, Broome County, N.Y.	E	42.09253	-75.91867	846.95	836.7	840.6	842.4	847.4	845.80	819.5
8	8–1	40.021	RB–On front window of house at 517 Grand Avenue (6.0 feet above ground)–Mud line Village of Johnson City, Broome County, N.Y.	E	42.10933	-75.97042	840.14	829.8	833.8	836.0	840.6	838.93	810.8
9	9–1	37.654	RB–On front window of abandoned Tanfastic tanning salon (3606)–Mud line Town of Union, Broome County, N.Y.	E	42.10744	-76.01469	835.46	826.3	830.7	833.4	837.7	--	799.6

Table 22. Peak water-surface elevations at 18 high-water-mark sites, including 8 U.S. Geological Survey streamgages, along the Susquehanna River in New York during the floods of September 8–9, 2011, and June 28–29, 2006, and corresponding elevations for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods.—Continued

[AEP, annual exceedance probability; AEP and stream-bottom elevations are from the Federal Emergency Management Agency (1976a, 1976b, 1977, 1979, 1987, 1988, 1992, 1998, 2010, 2012b); HWM ID, high-water-mark identification; --, no data available; high-water-mark location—RB, right bank; LB, left bank; high-water-mark ratings—E, excellent; G, good; recorded, logged by streamgage instruments; latitude and longitude in decimal degrees (North American Datum of 1983 (NAD 83)); elevation in feet above North American Vertical Datum of 1988 (NAVD 88); elevation data for the flood of June 28–29, 2006, from Suro and others, 2009; locations are shown on figure 63]

Site number or streamgage number	HWM ID	Miles above Athens, Pa.	Site or streamgage along Susquehanna River and HWM location and description	HWM rating	Latitude	Longitude	Elevation (feet): Peak water-surface elevation for September 8–9, 2011	Elevation (feet): 10-percent AEP (10-year) flood	Elevation (feet): 2-percent AEP (50-year) flood	Elevation (feet): 1-percent AEP (100-year) flood	Elevation (feet): 0.2-percent AEP (500-year) flood	Elevation (feet): Peak water-surface elevation for June 28–29, 2006	Elevation (feet): Stream-bottom elevation
10/01513500	10–1	34.934	LB–Streamgage at Vestal–Recorded Town of Vestal, Broome County, N.Y.	E	42.09083	-76.05611	833.98	824.1	828.4	829.6	834.9	832.38	797.3
11	11–1	27.824	RB–On window of house at 191 Kinney Road (5.2 feet above ground)–Mud line Town of Owego, Tioga County, N.Y.	E	42.08225	-76.15119	823.55	817.1	821.0	822.4	825.6	821.27	787.2
12	12–1	21.387	RB–On window of building at 596 5th Avenue (4.0 feet above ground)–Mud line Village of Owego, Tioga County, N.Y.	E	42.10375	-76.24444	817.64	810.7	814.1	815.4	819.0	814.27	778.8
13/01513831	13–1	20.095	RB–Streamgage at Owego–On door of pump house (gage house) (5.4 feet above ground)–Mud line Village of Owego, Tioga County, N.Y.	E	42.09722	-76.26639	815.91	808.9	812.0	813.2	816.0	812.00	782.0
14	14–1	14.986	RB–On bridge girder of State Route 17C over Pipe Creek–Mud line Town of Tioga, Tioga County, N.Y.	G	42.05931	-76.34522	801.14	796.0	798.8	799.9	802.2	--	774.5
15	15–1	12.271	LB–At State Route 17 bridge over Wappasening Creek (4.5 feet above ground)–Mud line Town of Nichols, Tioga County, N.Y.	E	42.02403	-76.36231	798.85	789.9	793.1	794.4	797.4	794.44	762.0
16	16–1	2.413	LB–On garage of house at 179 Riverside Drive (2.5 feet above ground)–Mud line Township of Athens, Bradford County, Pa.	E	41.98694	-76.49667	771.04	763.3	766.4	767.8	770.4	766.90	742.4
17/01515000	17–1	2.111	LB–Streamgage near Waverly–Recorded Township of Athens, Bradford County, Pa.	E	41.98472	-76.50111	770.04	762.6	765.7	767.1	769.6	765.89	743.6
18	18–1	0.888	LB–On garage window of house at 815 Riverside Drive (6.0 feet above ground)–Mud line Township of Athens, Bradford County, Pa.	E	41.96931	-76.51031	766.26	758.9	761.6	763.0	765.6	762.45	740.4



Base from U.S. Geological Survey Digital Data. Universal Transverse Mercator Projection, Zone 18N, NAD83

Figure 63. Locations of high-water-mark sites selected for the flood of September 8–9, 2011 along the Susquehanna River from Unadilla, New York to Athens, Pennsylvania. (Data are given in table 22 and detailed flood elevations are shown on figure 64.)

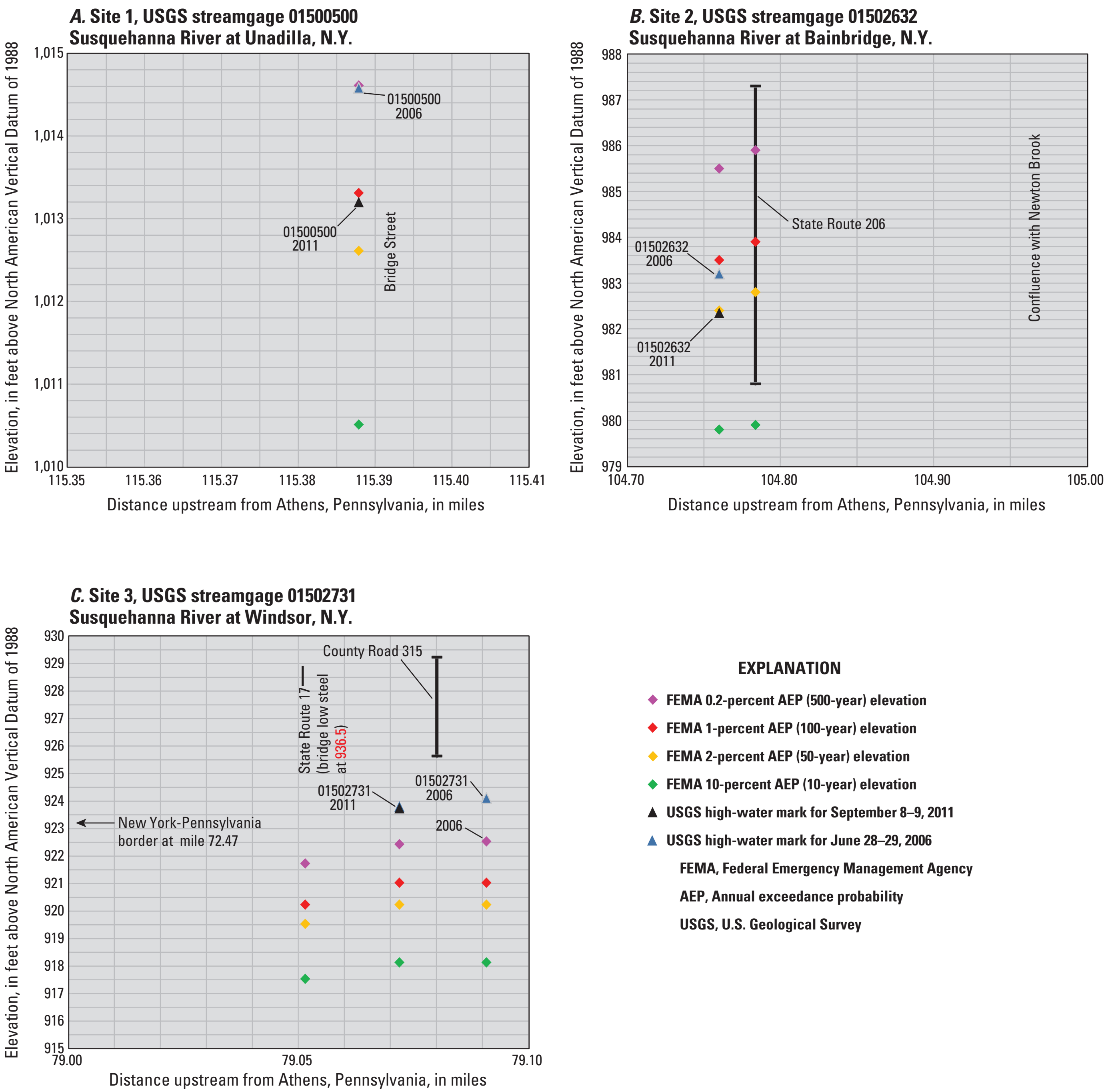


Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)

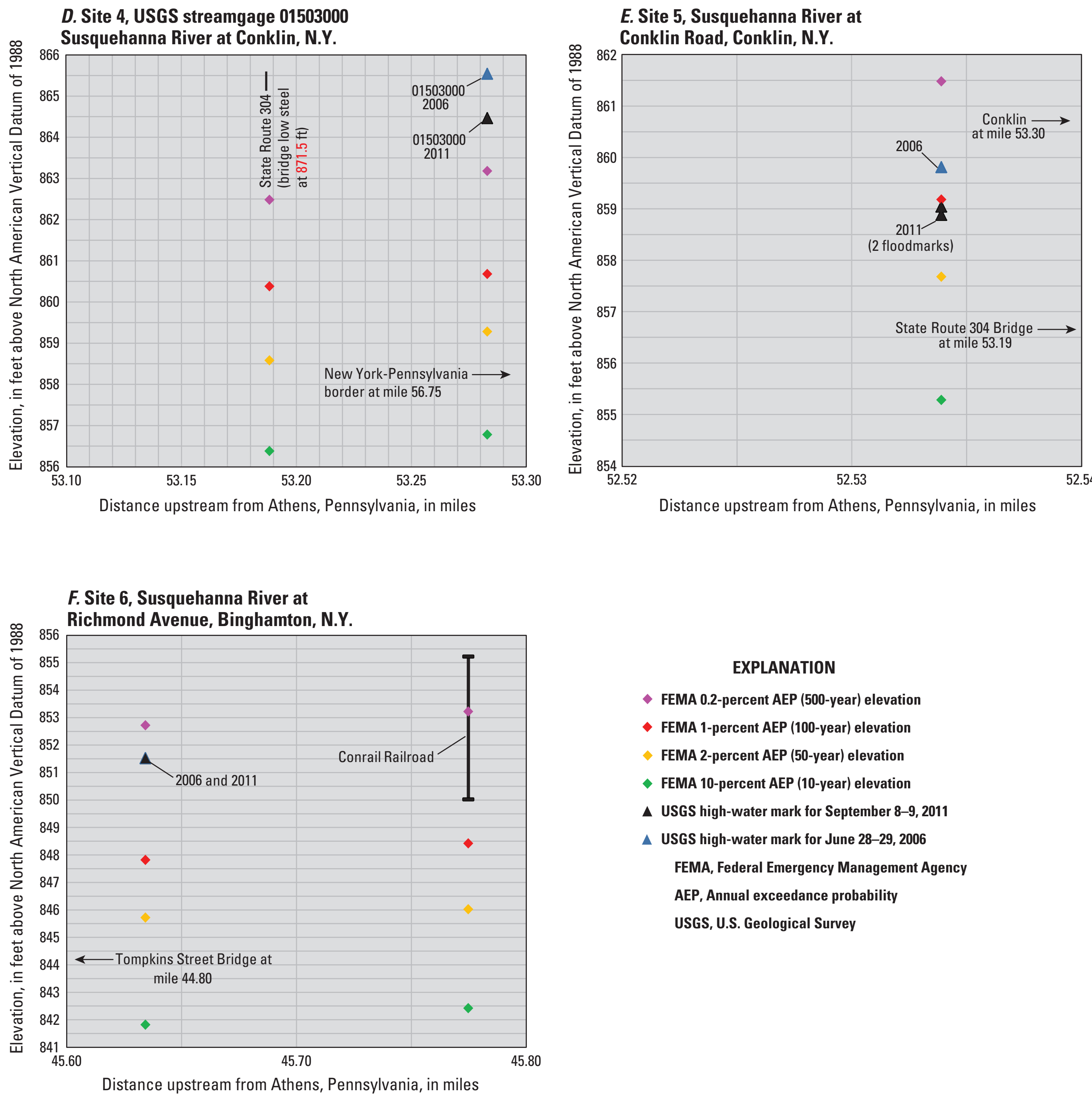


Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency (FEMA) flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)—Continued

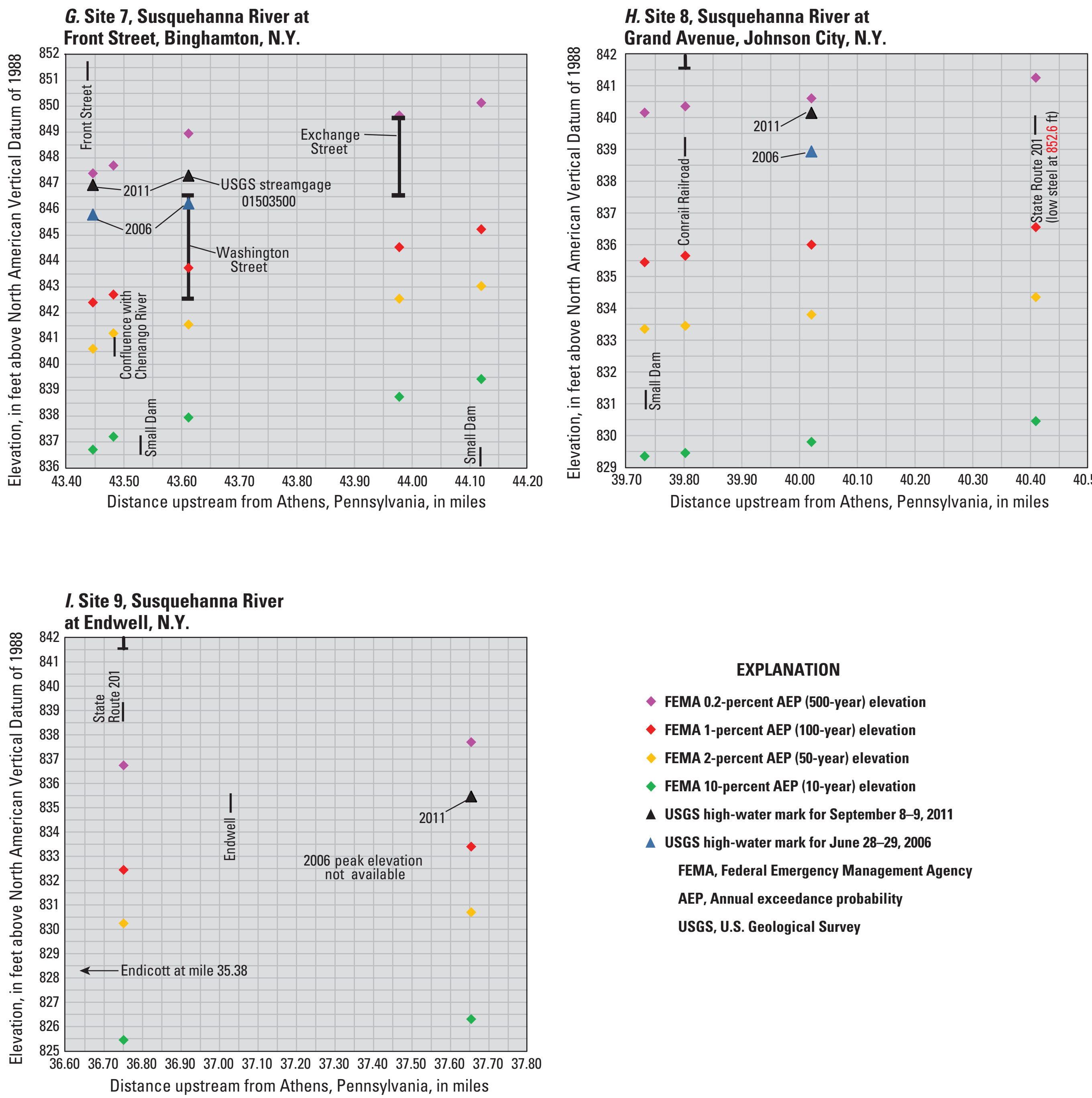


Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency (FEMA) flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)—Continued

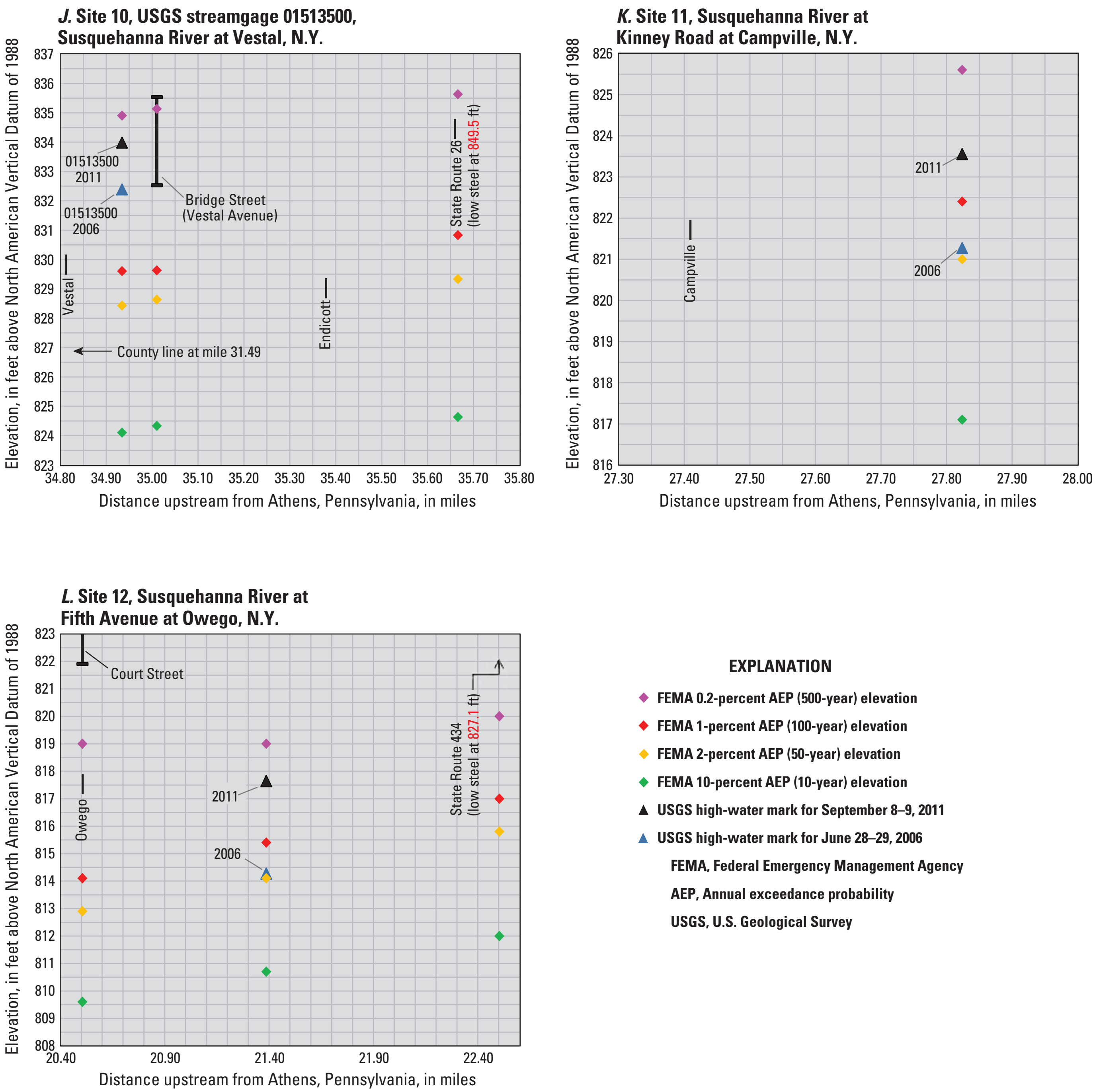
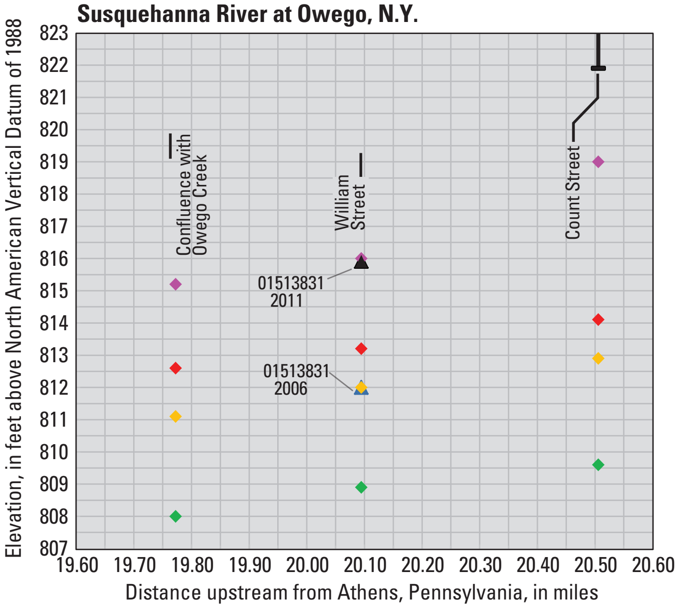
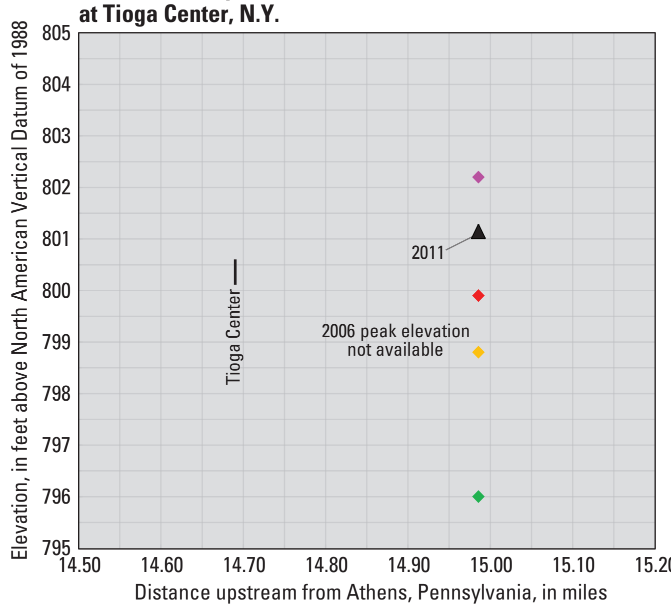


Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency (FEMA) flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)—Continued

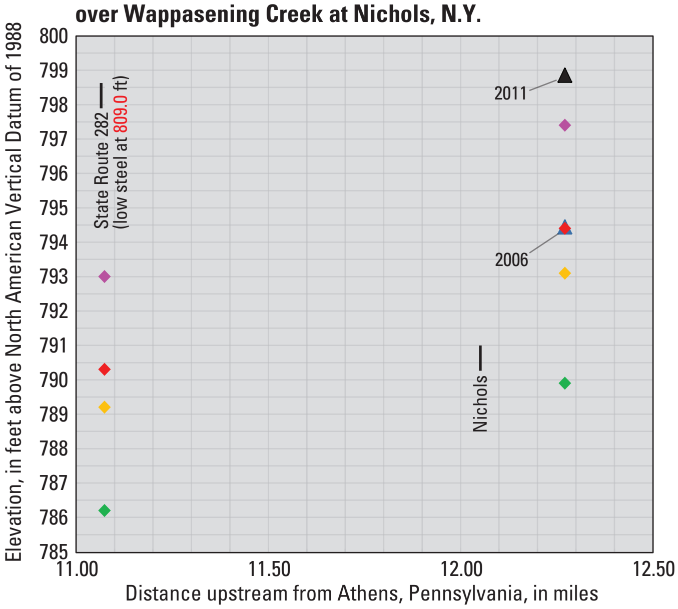
***M.* Site 13, USGS streamgage 01513831 Susquehanna River at Owego, N.Y.**



***N.* Site 13, Susquehanna River at State Route 17C at Tioga Center, N.Y.**



***O.* Site 15, Susquehanna River at State Route 17 over Wappasening Creek at Nichols, N.Y.**



EXPLANATION

- ◆ FEMA 0.2-percent AEP (500-year) elevation
- ◆ FEMA 1-percent AEP (100-year) elevation
- ◆ FEMA 2-percent AEP (50-year) elevation
- ◆ FEMA 10-percent AEP (10-year) elevation
- ▲ USGS high-water mark for September 8–9, 2011
- ▲ USGS high-water mark for June 28–29, 2006

FEMA, Federal Emergency Management Agency
AEP, Annual exceedance probability
USGS, U.S. Geological Survey

Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency (FEMA) flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)—Continued

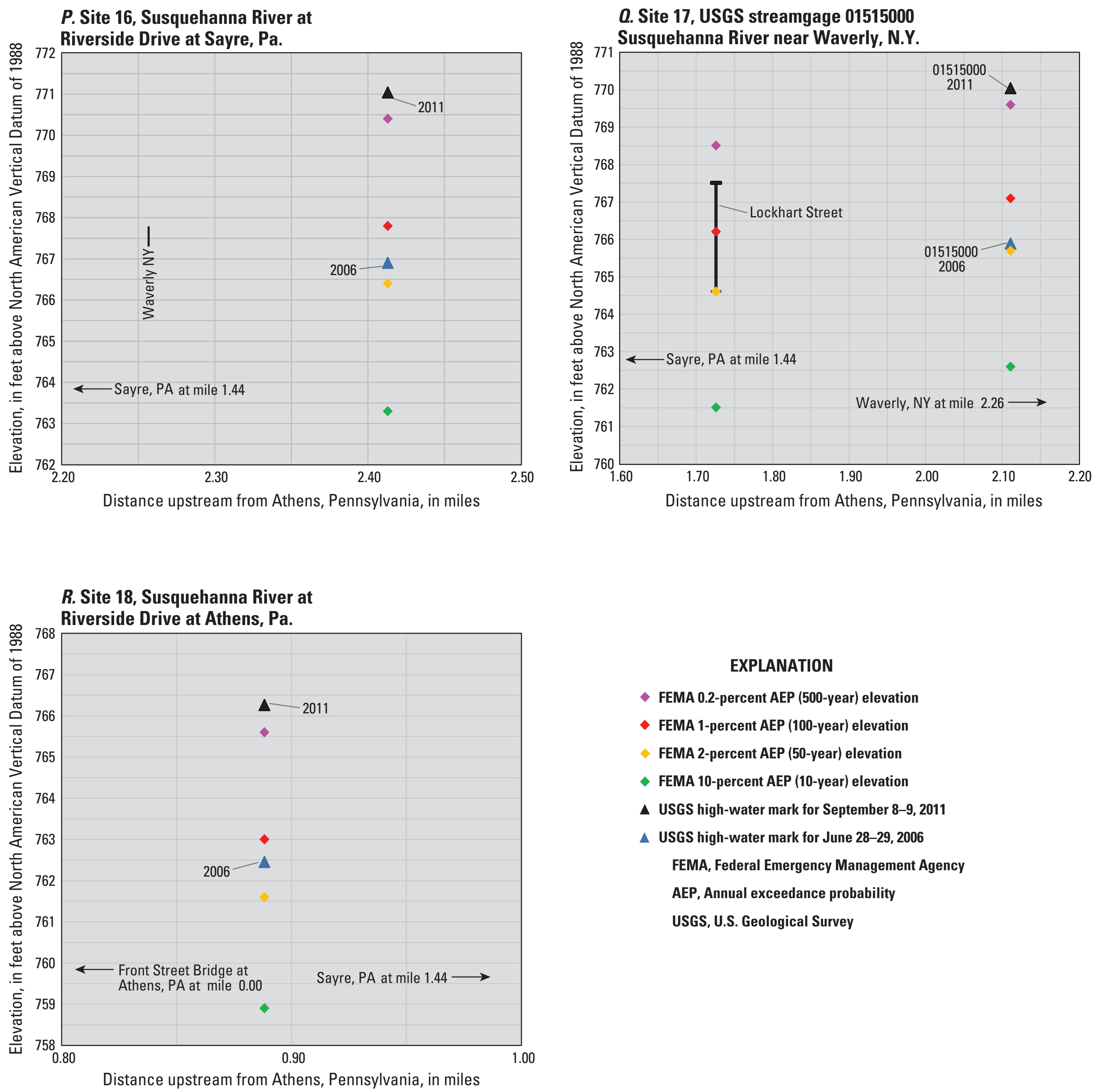


Figure 64. Peak water-surface elevations of the Susquehanna River at 18 sites from Unadilla, New York, to Athens, Pennsylvania, during the flood of September 8–9, 2011, and Federal Emergency Management Agency (FEMA) flood elevations for selected frequencies. (Data are given in table 22 and locations are shown on figure 63.)—Continued

Effects of Reservoirs

Flows during the September 2011 flood, particularly in the upper reaches of the Susquehanna River, were affected by two tributary reservoirs (East Sidney Lake and Whitney Point Lake, figs. 65A–B). Water-surface elevations, changes in reservoir contents, and inches of runoff stored during September 5–11 are given in table 23 and show that substantial amounts of storm runoff were stored in each of the lakes up to the time of their maximum stage.

East Sidney Lake at East Sidney (01499500) is on Ouleout Creek 4.4 mi upstream from its confluence with the Susquehanna River just upstream from Unadilla; this lake was built as a flood-control reservoir in 1950 and has a contributing area of 103 mi^2, or about 12 percent of the drainage area of the Susquehanna River above its confluence with the creek. The lake crested on September 11, 2011, after storing 789 million cubic feet (3.30 in.) of runoff over 1 week (fig. 65A, table 23). The lake rose 40 ft during the runoff period, with the peak elevation (1,190.62 ft) remaining 12.38 ft below the crest of the dam spillway (1,203.0 ft) or about 65 percent of full capacity before levels receded. The maximum water level (1,190.62 ft) on September 11, 2011, was almost 14 ft lower than the record water level of 1,204.35 ft during the flood of June 30, 2006 (the only time the lake had spilled during its 57-year history; Suro and others, 2009). Hourly inflows to East Sidney Lake were estimated from hourly lake elevations (01499500), lake-capacity data provided by the U.S. Army Corps of Engineers, and hourly outflows recorded at streamgage 01500000 (Ouleout Creek at East Sidney). The estimated peak inflow of about 8,400 ft^3/s occurred on September 8 at 7:00 a.m. with minimal controlled outflow (26 ft^3/s) at the time.

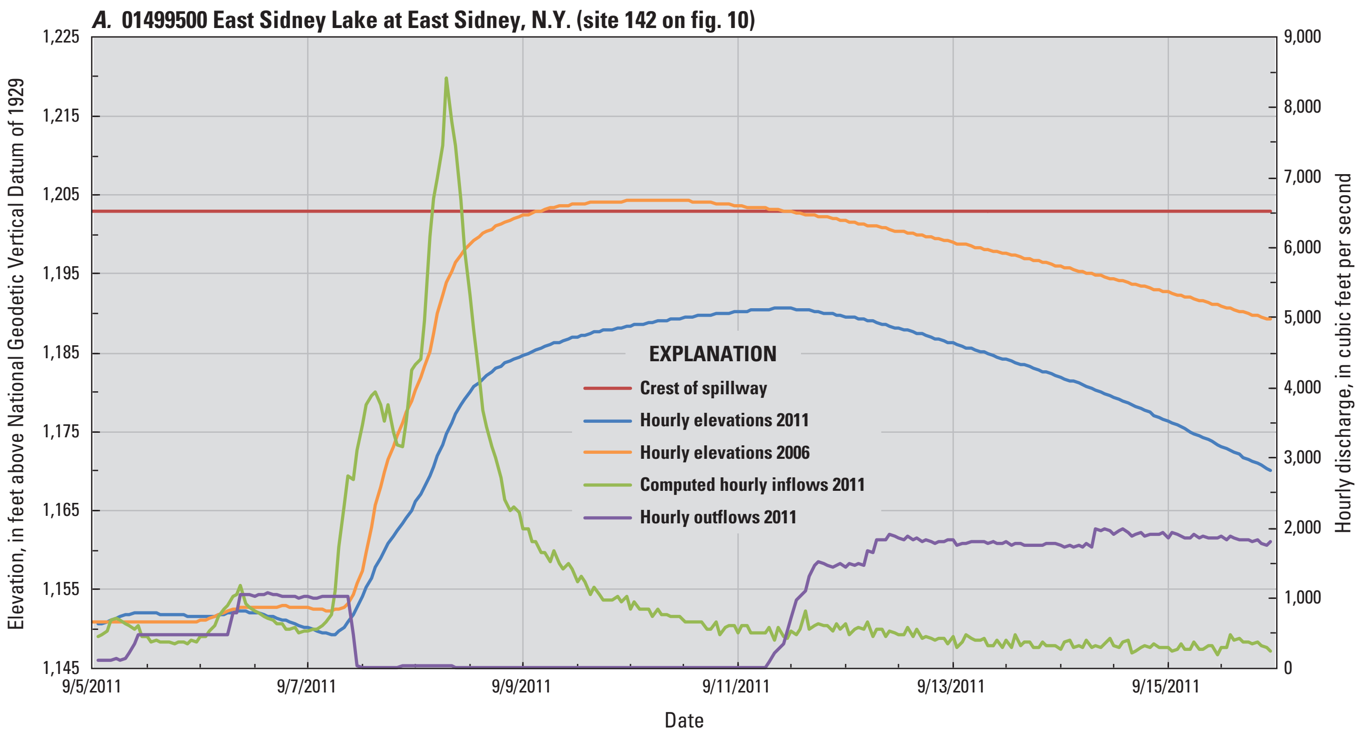
Whitney Point Lake at Whitney Point (01511000) controls runoff from 257 mi^2 (99.6 percent) of the Otselic River drainage area just upstream of its confluence with the Tioughnioga River. The Tioughnioga River is a tributary to the Chenango River, which drains to the Susquehanna River at Binghamton, N.Y. Discharges recorded at the Otselic River at Cincinnatus (01510000) (fig. 65B) represent 57 percent of the total inflow to Whitney Point Lake, which rose 25 ft and crested on September 11 at 998.30 ft, storing 1,852 million cubic feet (3.11 in.) of runoff during September 5–11 but remaining 11.7 ft below its spillway elevation (1,010.0 ft) and at about 64 percent of its usable capacity. The maximum water level recorded at Whitney Point Lake during its 70 years of operation was 1,005.76 ft on April 5, 2005. The lake stage peaked at 999.57 ft during the June 2006 flood (Suro and others, 2009).

In addition to the major dams that are maintained by the U.S. Army Corps of Engineers, the NRCS maintains 27 flood-control reservoirs on tributaries to the Susquehanna River upstream from the confluence with the Chemung River just south of Sayre, Pa. Twenty of these reservoirs are located in Broome County, N.Y. Most are designed to control runoff from a 1-percent chance AEP (100-year) storm, and each has auxiliary spillways, which pass flows that exceed the design storm. On September 8, 19 of the 20 reservoirs in Broome County overtopped their spillways for the first time since their construction in the 1960s and 1970s (Peter Wright, National Resources Conservation Service, oral commun., 2013).

Flood Damage

Tropical Storm Lee caused over $1.6 billion in damages with 18 fatalities along its path from the Gulf of Mexico to New England (Federal Emergency Management Agency, 2011b). Fifteen counties in New York were declared disaster areas on September 13, 2011 (fig. 66). Flood damages had cost nearly $300 million in Federal disaster assistance as of February 24, 2014 (Federal Emergency Management Agency, 2011b) and are ongoing at the time this report was published. In Binghamton, the flood waters spilled over a levee that had protected the city since the 1940s. The flooding inundated 25,000 homes and businesses along the Susquehanna River and its tributaries, and 30,000 people were evacuated. Hundreds of roads and bridges were flooded, and dozens of both were destroyed (National Oceanic and Atmospheric Administration, 2012).

Communities in the lower reaches of the Susquehanna River in New York were particularly hard hit by Lee, which inundated many areas for the first time since the 1930s, when levees had been constructed. More than 20,000 residents were evacuated in Broome County as the flood waters overtopped the levees in Binghamton by a few tenths of a foot, and the downtown area was closed off. Much of the Village of Owego was inundated (The Owego Pennysaver, 2011), and several roads, including Interstate 88 (blocked by a mudslide) and New York State Route 17, were closed. Estimates of damage in the flooded areas were more than $500 million each in Broome and Tioga Counties, and two deaths were related to the storm (National Oceanic and Atmospheric Administration, 2012). Damages and costs in New York from the remnants of Tropical Storm Lee exceeded those from the June 2006 flood, and several restoration and flood-mitigation programs were initiated as a result of the storm. Selected photographs of flooding from the remnants of Tropical Storm Lee, as well as the April–May and August floods during 2011, are presented in appendix 2 at the end of the report. A detailed discussion on the selection, accuracy, and documentation of HWMs with example photographs is given in appendix 3 at the end of the report.



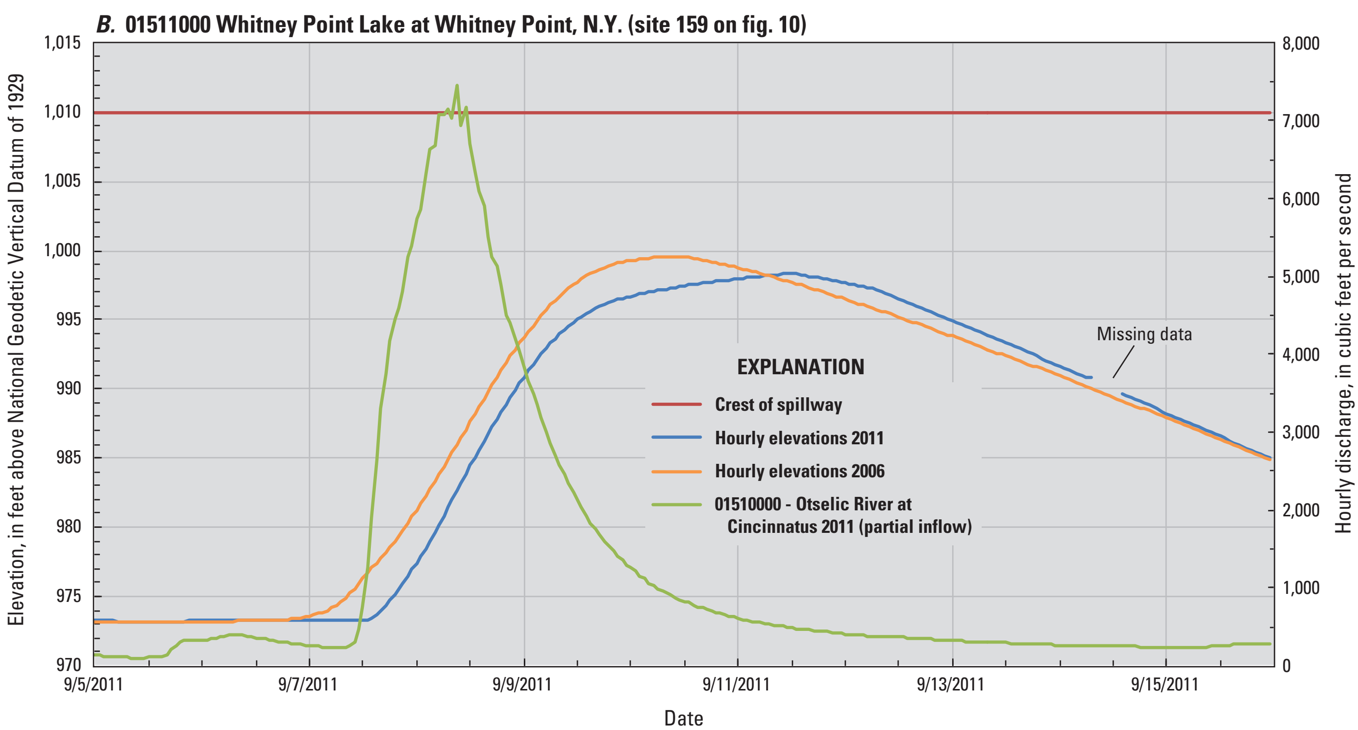


Figure 65. Hourly inflows, outflows, and water-surface elevations at *A,* East Sidney Lake and *B,* Whitney Point Lake with hourly discharges at the Otselic River at Cincinnatus streamgage in New York for September 5–15, 2011. (Data are given in table 23 and locations are shown on figure 10.)

Table 23. Data for two lakes in the Susquehanna River Basin in New York for the flood of September 5–11, 2011.

[mi^2, square miles; h, hours; ft, feet; mil ft^3, million cubic feet; in., inches; locations are shown in fig. 10]

Map number	Streamgage number and name	Drainage area (mi^2)	[a]Dates of runoff	Time (h)	[b]Water-surface elevation (ft)	Contents (mil ft^3)	Percentage of usable capacity	Change in contents (mil ft^3)	Runoff stored (in.)	[b]Spillway elevation (ft)	Usable capacity (mil ft^3)
142	0149950 East Sidney Lake at East Sidney, N.Y.	103	9/5	0100	1,150.58	129	9.1			1,203.0	1,424
			9/11	1030	1,190.62	918	64.4	789	3.30		
159	01511000 Whitney Point Lake at Whitney Point, N.Y.	257	9/5	1100	973.20	565	15.0			1,010.0	3,765
			9/11	1100	998.30	2,417	64.2	1,852	3.10		

[a]From minimum elevation at start of storm runoff to maximum elevation.

[b]Elevation in feet above National Geodetic Vertical Datum of 1929.

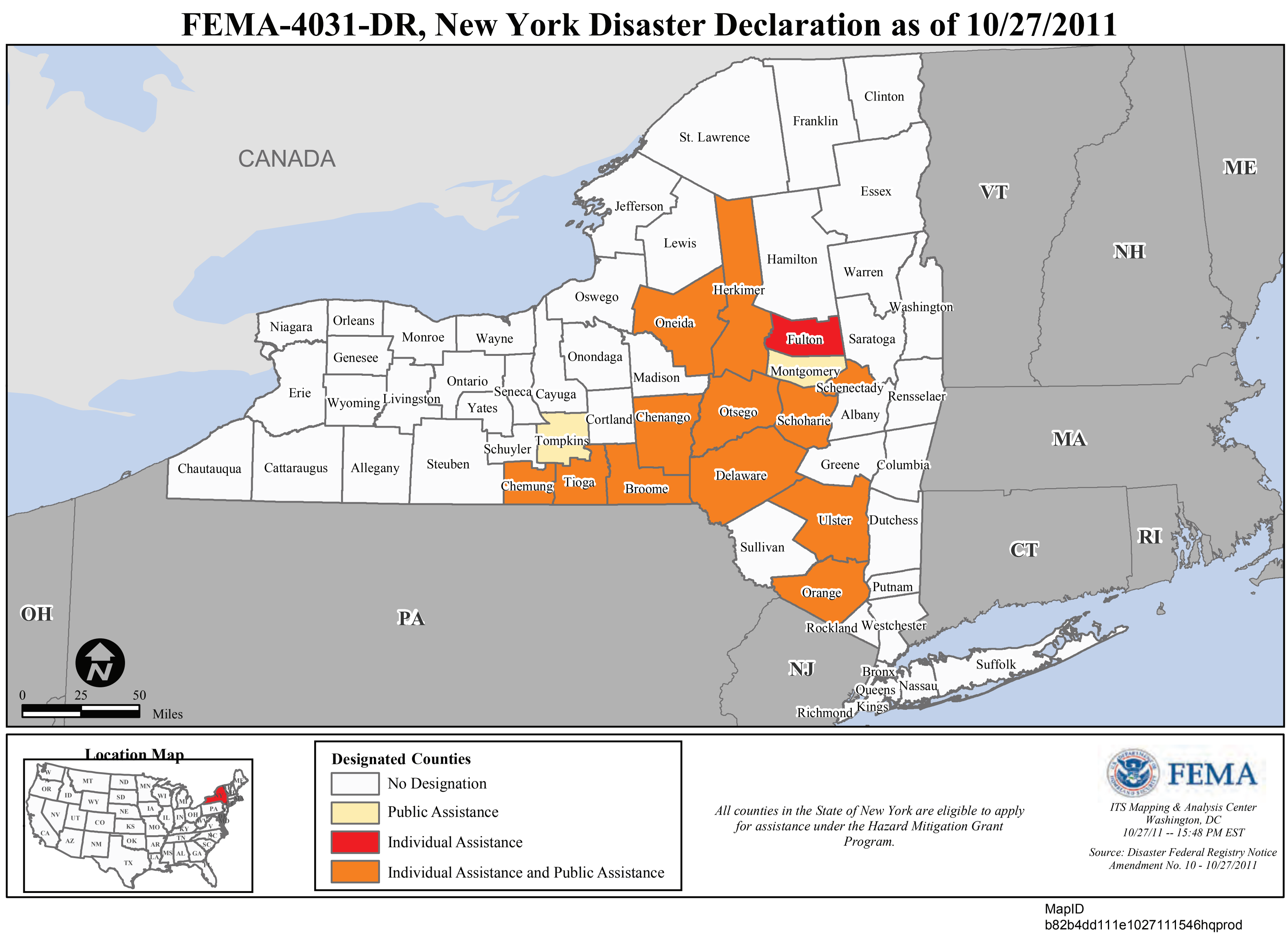


Figure 66. The counties of New York that were declared major disaster areas following the flooding of September 8–9, 2011. (From Federal Emergency Management Agency, 2011b)

Summary

Three major floods occurred during 2011 in central, eastern, and northern New York State as a result of extreme rainfall and warm springtime temperatures that caused rapid melting of a thick snowpack: (1) spring storm during April and May, (2) Tropical Storm Irene during late August, and (3) remnants of Tropical Storm Lee in early September. These events caused 2011 rainfall totals in eastern New York to be the greatest since 1895 and were as much as 60 percent above the long-term averages for areas within the Catskill Mountains area and the Susquehanna River Basin. The winter of 2010–11 delivered normal quantities of precipitation, but below-normal temperatures delayed the melting of more than 16 in. of the water equivalent of snow in the Adirondack Mountains of northern New York. The wettest spring on record combined with above-normal temperatures melted the dense snowpack and resulted in major flooding across northern New York during late April and early May. The summer of 2011 brought two major tropical-storm systems through New York. Hurricane Irene weakened to a tropical storm that moved onshore at New York City, travelling north through eastern New York on August 28 with torrential downpours of up to 18 in. recorded in less than 24 hours in the Catskill Mountains area. The result was record flooding throughout much of eastern New York. The remnants of Tropical Storm Lee brought heavy rains again to an already rain-soaked New York in early September. The heaviest rains were centered over the Susquehanna River Basin in south-central New York with rainfall totaling more than 12 in. in some areas during September 6–9. Record flooding occurred within the Susquehanna River Basin and in other areas of south-central New York. The U.S. Geological Survey (USGS), in cooperation with the Federal Emergency Management Agency (FEMA), conducted this study to characterize and document the three storms.

The very warm and wet spring of 2011 in northern New York resulted in record flooding at 21 USGS active streamgages during late April and early May, with 11 peak discharges equaling or exceeding the 1-percent annual exceedance probability (AEP) (100-year) discharges at those streamgages. Four streamgages on the upper Hudson River recorded their maximum peak stage and discharge on April 28–29, including the Hudson River at North Creek, which had its greatest flood in more than 104 years of record (greater than the 0.5-percent AEP discharge). Nearly 5 in. of rain during late April, combined with a rapidly melting snowpack, caused widespread flooding of streams throughout northern New York and in some parts of the Finger Lakes region. Many road closures along with millions of dollars in damages resulted in 23 counties being declared disaster areas and eligible for public assistance. On May 6, Lake Champlain recorded its highest lake level in over 140 years at Rouses Point.

On August 28, Tropical Storm Irene moved inland and north through New York bringing torrential rains that resulted in catastrophic flooding and damage to many areas of eastern New York. Record rainfall totals (over 18 in. at some locations) were reported at several National Weather Service stations in the Catskill Mountains area. Record stages and discharges were recorded at 62 lake gages and streamgages throughout eastern New York. Areas especially hard hit by this storm were the Schoharie Creek Basin, the eastern Delaware River Basin, the Ausable and Bouquet River Basins in northeastern New York, and several other basins throughout southeastern parts of the State. Peak discharges exceeded their 1-percent AEP (100-year) discharges at 25 streamgages and their respective 0.2-percent AEP (500-year) discharges at 6 sites in the Schoharie Creek Basin. The USGS surveyed 184 high water marks (HWMs) at 30 locations along an 84-mile reach of Schoharie Creek. Elevations of the HWMs in the lower reaches of the basin exceeded those published by FEMA for their respective 0.2-percent AEP (500-year) floods. Storage in several reservoirs in and around the Catskill Mountains area mitigated flooding, but most reservoirs exceeded their capacity on August 28. Thirty-one counties in the State were declared disaster areas with damages of over $1.3 billion and 10 deaths reported as a result of Tropical Storm Irene.

Remnants of Tropical Storm Lee reached south-central New York in early September. The heaviest rains were centered over the already saturated Susquehanna River Basin in south-central New York with over 12 in. recorded in some areas during September 7–9. Flooding in the lower reaches of the Susquehanna River exceeded levels recorded in June 2006, the previous flood of record, by more than 4 ft (Tioga County). Ten streamgages in the Susquehanna River Basin measured record peak discharges on September 8 that exceeded their 1-percent AEP (100-year) discharges. The Susquehanna River near Waverly remained above the 1-percent AEP (100-year) elevation for nearly 24 hours during September 8–9, and the peak discharge (167,000 ft^3/s) was the largest in at least 76 years (the previous maximum was 128,000 ft^3/s in 1936 and 2006). The USGS surveyed 20 HWMs at 18 locations along a 114-mi reach of the Susquehanna River. The elevations of the HWMs exceeded the published FEMA 0.2-percent AEP (500-year) elevations at many locations and the 1-percent AEP (100-year) elevations at other sites. Major disaster declarations were issued for 15 counties in and around central New York, making them eligible for individual or public assistance.

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Appendix 1. Map Numbers, U.S. Geological Survey Streamgage Numbers and Names, and Selected Flood Information Used in the Study

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.

[mi², square miles; ddmmss, degrees, minutes, seconds; decimal degrees North American Datum of 1983 (NAD 83); RI, recurrence interval; <, less than; >, greater than; ≥, greater than or equal to; ≤, less than or equal to; --, no data available; site and basin locations are shown on figures 2 and 10]

Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Housatonic River Basin									
1	01199477	Stony Brook near Dover Plains, N.Y.	1.93	414238	733718	41.71056	-73.62167	--	45	--	45
		Mamaroneck River Basin									
2	01300800	Mamaroneck River at Winfield Avenue at Mamaroneck, N.Y.[1]	14.5	405808	734412	40.96889	-73.73667	--	35	--	35
3	01301000	Mamaroneck River at Mamaroneck, N.Y.[1]	23.4	405715	734404	40.95417	-73.73444	--	40	--	40
		Bronx River Basin									
4	01302020	Bronx River at New York Botanical Garden at Bronx, N.Y.[1]	38.4	405144.3	735227.8	40.86231	-73.87439	--	--	--	--
		Streams on Long Island									
5	01303500	Cold Spring Brook at Cold Spring Harbor, N.Y.[2]	7.30	405126	732748	40.85722	-73.46333	<2	6	<2	6
6	01304000	Nissequoque River near Smithtown, N.Y.[1]	27.0	405058	731327	40.84944	-73.22417	<2	3	<2	3
7	01304500	Peconic River at Riverhead, N.Y.[2]	75.0	405449	724112	40.91361	-72.68667	<2	<2	<2	<2
		Upper Hudson River Basin									
8	01311992	Arbutus Pond Outlet near Newcomb, N.Y.	1.22	435856	741409	43.98222	-74.23583	60	<2	<2	60
9	01312000	Hudson River near Newcomb, N.Y.	192	435800	740755	43.96667	-74.13194	100 to <200	2	<2	100 to <200
10	01314500	Indian Lake near Indian Lake, N.Y.[3]	131	434520	741635	43.75556	-74.27639	--	--	--	--
11	01315000	Indian River near Indian Lake, N.Y.[2]	132	434523	741603	43.75639	-74.26750	100 to <200	<2	<2	100 to <200
12	01315081	Indian River below Lake Abanakee near Indian Lake, N.Y.[2]	195	434755.4	741346.3	43.79872	-74.22953	--	--	--	--
13	01315500	Hudson River at North Creek, N.Y.	792	434203	735902	43.70083	-73.98389	200 to <500	<2	<2	200 to <500
14	01317000	Schroon River at Riverbank, N.Y.	527	433634	734417	43.60944	-73.73806	15	<2	<2	15
15	01318500	Hudson River at Hadley, N.Y.	1,664	431908	735041	43.31889	-73.84472	100	<2	<2	100
16	01321000	Sacandaga River near Hope, N.Y.	491	432110	741615	43.35278	-74.27083	3	2	2	3
17	01323500	Great Sacandaga Lake at Conklingville, N.Y.[3]	1,044	431857	735539	43.31583	-73.92750	--	--	--	--
18	01325000	Sacandaga River at Stewarts Bridge near Hadley, N.Y.[2]	1,055	431841	735204	43.31139	-73.86778	60	<2	<2	60
19	01327750	Hudson River at Fort Edward, N.Y.[2]	2,810	431610	733547	43.26944	-73.59639	≥500	<2	<2	≥500
20	01329154	Steele Brook at Shushan, N.Y.	2.85	430535	731938	43.09306	-73.32722	<2	10	<2	10
21	01329490	Batten Kill below mill at Battenville, N.Y.	396	430631	732520	43.10861	-73.42222	<2	30	2	30
22	01330000	Glowegee Creek at West Milton, N.Y.	26.0	430150	735540	43.03056	-73.92778	<2	20	3	20
23	01331095	Hudson River at Stillwater, N.Y.[2]	3,773	425608	733908	42.93556	-73.65222	50	2	<2	50
24	01333500	Little Hoosic River at Petersburg, N.Y.	56.1	424550	732016	42.76389	-73.33778	<2	40	15	40
25	01334500	Hoosic River near Eagle Bridge, N.Y.	510	425619	732239	42.93861	-73.37750	<2	100 to <200	8	100 to <200
26	01335754	Hudson River above Lock 1 near Waterford, N.Y.[2]	4,605	424945	734000	42.82917	-73.66667	8	30	<2	30
		Upper Mohawk River Basin									
27	01335900	Delta Reservoir near Rome, N.Y.[3]	148	431629	752543	43.27472	-75.42861	--	--	--	--
28	01336000	Mohawk River below Delta Dam near Rome, N.Y.[2]	152	431552	752612	43.26444	-75.43667	15	<2	<2	15
29	01342797	Vly Brook near Morehouseville, N.Y.	3.28	432334	744959	43.39278	-74.83306	25	<2	2	25
30	01343060	West Canada Creek near Wilmurt, N.Y.	258	432158	745729	43.36611	-74.95806	100	<2	2	100

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

[mi², square miles; ddmmss, degrees, minutes, seconds; decimal degrees North American Datum of 1983 (NAD 83); RI, recurrence interval; <, less than; >, greater than; ≥, greater than or equal to; ≤, less than or equal to; --, no data available; site and basin locations are shown on figures 2 and 10]

Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Upper Mohawk River Basin—Continued									
31	01343900	Hinckley Reservoir at Hinckley, N.Y.[3]	372	431841	750630	43.31139	-75.10833	--	--	--	--
32	01346000	West Canada Creek at Kast Bridge, N.Y.[2]	560	430408	745919	43.06889	-74.98861	200	<2	10	200
33	01347000	Mohawk River near Little Falls, N.Y.[2]	1,342	430053	744647	43.01472	-74.77972	35	<2	35	35
34	01348000	East Canada Creek at East Creek, N.Y.	289	430100	744428	43.01667	-74.74111	<2	<2	4	4
35	01348420	North Creek near Ephratah, N.Y.	6.52	430028	743354	43.00778	-74.56500	<2	≥500	2	≥500
36	01349150	Canajoharie Creek near Canajoharie, N.Y.	59.7	425234	743612	42.87611	-74.60333	<2	25	10	25
		Schoharie Creek Basin									
37	01349700	East Kill near Jewett Center, N.Y.	35.6	421457	741811	42.24917	-74.30306	<2	≥500	2	≥500
38	01349705	Schoharie Creek near Lexington, N.Y.	96.8	421413	742026	42.23694	-74.34056	<2	≥500	2	≥500
39	01349711	West Kill below Hunter Brook near Spruceton, N.Y.	4.97	421106	741638	42.18500	-74.27722	<2	≥500	<2	≥500
40	01349810	West Kill near West Kill, N.Y.	27.0	421349	742336	42.23028	-74.39333	<2	≥500	3	≥500
41	01349950	Batavia Kill at Red Falls near Prattsville, N.Y.	68.6	421830	742325	42.30833	-74.39028	<2	≥500	3	≥500
42	01350000	Schoharie Creek at Prattsville, N.Y.	237	421910	742613	42.31944	-74.43694	<2	≥500	4	≥500
43	01350035	Bear Kill near Prattsville, N.Y.	25.7	422017	742707	42.33806	-74.45194	<2	8	8	8
44	01350080	Manor Kill at West Conesville near Gilboa, N.Y.	32.4	422237	742448	42.37694	-74.41333	<2	60	3	60
45	01350100	Schoharie Reservoir near Grand Gorge, N.Y.[3]	315	422121	742642	42.35583	-74.44500	--	--	--	--
46	01350101	Schoharie Creek at Gilboa, N.Y.[2]	316	422350	742703	42.39722	-74.45083	<2	100 to <200	4	100 to <200
47	01350120	Platter Kill at Gilboa, N.Y.	10.9	422422	742651	42.40611	-74.44750	<2	50	7	50
48	01350140	Mine Kill near North Blenheim, N.Y.	16.2	422544	742824	42.42889	-74.47333	<2	15	10	15
49	01350180	Schoharie Creek at North Blenheim, N.Y.[2]	358	422757	742745	42.46583	-74.46250	<2	200 to <500	2	200 to <500
50	01350355	Schoharie Creek at Breakabeen, N.Y.[2]	444	423213	742439	42.53694	-74.41083	<2	200 to <500	2	200 to <500
51	01351500	Schoharie Creek at Burtonsville, N.Y.[2]	886	424800	741548	42.80000	-74.26333	<2	500	10	500
		Lower Mohawk River Basin									
52	01356190	Lisha Kill northwest of Niskayuna, N.Y.	15.6	424701	735126	42.78361	-73.85722	<2	15	2	15
53	01357500	Mohawk River at Cohoes, N.Y.[2]	3,450	424707	734229	42.78528	-73.70806	2	30	9	30
		Lower Hudson River Basin									
54	01358000	Hudson River at Green Island, N.Y.[2]	8,090	424508	734122	42.75222	-73.68944	3	60	7	60
55	01359528	Normans Kill at Albany, N.Y.	168	423800	734822	42.63333	-73.80611	2	45	<2	45
56	01360640	Valatie Kill near Nassau, N.Y.	9.48	423307	733531	42.55194	-73.59194	<2	15	4	15
57	01361000	Kinderhook Creek at Rossman, N.Y.	329	421950	734440	42.33056	-73.74444	<2	15	10	15
58	01361500	Catskill Creek at Oak Hill, N.Y.	95.8	422419	740905	42.40528	-74.15139	<2	200 to <500	--	200 to <500
59	01362100	Roeliff Jansen Kill near Hillsdale, N.Y.	27.5	420914	733114	42.15389	-73.52056	<2	15	--	15
60	013621955	Birch Creek at Big Indian, N.Y.	12.5	420632	742708	42.10889	-74.45222	<2	7	2	7
61	01362197	Bushnellsville Creek at Shandaken, N.Y.	11.4	420729	742404	42.12472	-74.40111	<2	50	2	50
62	01362200	Esopus Creek at Allaben, N.Y.	63.7	420701	742250	42.11694	-74.38056	<2	100 to <200	3	100 to <200

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

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Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Lower Hudson River Basin—Continued									
63	0136230002	Woodland Creek above mouth at Phoenicia, N.Y.	20.6	420447	742004	42.07972	-74.33444	<2	15	2	15
64	01362342	Hollow Tree Brook at Lanesville, N.Y.	1.95	420832	741555	42.14222	-74.26528	<2	15	3	15
65	01362370	Stony Clove Creek below Ox Clove at Chichester, N.Y.	30.9	420607	741839	42.10194	-74.31083	<2	80	<2	80
66	01362497	Little Beaver Kill at Beechford near Mount Tremper, N.Y.	16.5	420110	741600	42.01944	-74.26667	<2	15	2	15
67	01362500	Esopus Creek at Coldbrook, N.Y.	192	420051	741615	42.01417	-74.27083	<2	70	3	70
68	01363382	Bush Kill below Maltby Hollow Brook at West Shokan, N.Y.	16.2	415756	741736	41.96556	-74.29333	<2	45	<2	45
69	01363400	Ashokan Reservoir at Ashokan, N.Y.[3]	256	415701	741230	41.95028	-74.20833	--	--	--	--
70	01364500	Esopus Creek at Mount Marion, N.Y.[2]	419	420216	735821	42.03778	-73.97250	<2	40	9	40
71	01365000	Rondout Creek near Lowes Corners, N.Y.	38.3	415159	742915	41.86639	-74.48750	<2	30	<2	30
72	01365500	Chestnut Creek at Grahamsville, N.Y.	20.9	415042	743223	41.84500	-74.53972	2	8	3	8
73	01366400	Rondout Reservoir at Lackawack, N.Y.[3]	95.4	414757	742548	41.79917	-74.43000	--	--	--	--
74	01367500	Rondout Creek at Rosendale, N.Y.[2]	383	415035	740511	41.84306	-74.08639	<2	100	4	100
75	01368500	Rutgers Creek at Gardnerville, N.Y.	59.7	412040	742916	41.34444	-74.48778	<2	40	--	40
76	01371500	Wallkill River at Gardiner, N.Y.	695	414110	740956	41.68611	-74.16556	<2	90	60	90
77	01372058	Hudson River below Poughkeepsie, N.Y.[3]	11,740	413903	735642	41.65083	-73.94500	--	--	--	--
78	01372500	Wappinger Creek near Wappingers Falls, N.Y.	181	413911	735223	41.65306	-73.87306	<2	35	9	35
79	01372800	Fishkill Creek at Hopewell Junction, N.Y.	57.3	413422	734825	41.57278	-73.80694	<2	25	2	25
80	01374019	Hudson River at South Dock at West Point, N.Y.[3]	12,596	412310	735720	41.38611	-73.95556	--	--	--	--
81	01374250	Peekskill Hollow Creek at Tompkins Corners, N.Y.	14.9	412318	734847	41.38833	-73.81306	<2	100	10	100
82	0137449480	East Branch Croton River near Putnam Lake, N.Y.[1]	62.1	412650	733321	41.44722	-73.55583	<2	6	3	6
83	01374505	East Branch Croton River at Brewster, N.Y.[2]	81.2	412340	733627	41.39444	-73.60750	<2	20	7	20
84	01374531	East Branch Croton River near Croton Falls, N.Y.[2]	86.4	412225	733819	41.37361	-73.63861	<2	60	15	60
85	01374559	West Branch Croton River at Richardsville, N.Y.[1]	11.0	412814	734538	41.47056	-73.76056	<2	9	3	9
86	01374581	West Branch Croton River below dam near Kent Cliffs, N.Y.[1]	22.4	412659	734413	41.44972	-73.73694	<2	10	<2	10
87	01374598	Horse Pound Brook near Lake Carmel, N.Y.[1]	3.94	412833	734122	41.47583	-73.68944	<2	5	2	5
88	0137462010	West Branch Croton River near Carmel, N.Y.[2]	42.9	412442	734137	41.41167	-73.69361	<2	15	<2	15
89	01374654	Middle Branch Croton River near Carmel, N.Y.[2]	13.7	412555	733906	41.43194	-73.65167	<2	6	2	6
90	01374701	West Branch Croton River near Croton Falls, N.Y.[2]	80.4	412128	734004	41.35778	-73.66778	2	25	4	25
91	01374781	Titicus River below June Road at Salem Center, N.Y.[1]	12.9	411937	733529	41.32694	-73.59139	--	--	--	--
92	01374821	Titicus River at Purdys Station, N.Y.[2]	23.8	411937	733921	41.32694	-73.65583	<2	35	15	35
93	01374890	Cross River near Cross River, N.Y.[1]	17.1	411536	733606	41.26000	-73.60167	<2	8	5	8
94	01374901	Cross River at Katonah, N.Y.[2]	29.9	411558	733958	41.26611	-73.66611	<2	20	10	20
95	01374930	Muscoot River at Baldwin Place, N.Y.[1]	13.5	412017	734607	41.33806	-73.76861	<2	10	2	10
96	01374941	Muscoot River below dam at Amawalk, N.Y.[2]	19.7	411715	734513	41.28750	-73.75361	<2	10	4	10
97	01375000	Croton River at New Croton Dam near Croton-On-Hudson, N.Y.[2]	378	411330	735132	41.22500	-73.85889	<2	60	10	60
98	01376500	Saw Mill River at Yonkers, N.Y.[1]	25.6	405611	735312	40.93639	-73.88667	<2	45	4	45

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

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Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Hackensack River Basin									
99	01376800	Hackensack River at West, Nyack, N.Y.[2]	30.7	410544	735752	41.09556	-73.96444	<2	25	3	25
		Passaic River Basin									
100	01387400	Ramapo River at Ramapo, N.Y.	86.9	410825	741008	41.14028	-74.16889	<2	80	3	80
101	01387420	Ramapo River at Suffern, N.Y.	93.0	410706	740938	41.11833	-74.16056	<2	70	3	70
102	01387450	Mahwah River near Suffern, N.Y.	12.3	410827	740701	41.14083	-74.11694	--	200	--	200
		Delaware River Basin									
103	01413088	East Branch Delaware River at Roxbury, N.Y.	13.5	421730	743335	42.29167	-74.55972	<2	4	2	4
104	01413398	Bush Kill near Arkville, N.Y.	46.7	420903	743606	42.15083	-74.60167	<2	100 to <200	2	100 to <200
105	01413408	Dry Brook at Arkville, N.Y.	82.2	420848	743725	42.14667	-74.62361	<2	100 to <200	2	100 to <200
106	01413500	East Branch Delaware River at Margaretville, N.Y.	163	420841	743914	42.14472	-74.65389	<2	100 to <200	5	100 to <200
107	01414000	Platte Kill at Dunraven, N.Y.	34.9	420759	744145	42.13306	-74.69583	<2	6	5	6
108	01414500	Mill Brook near Dunraven, N.Y.	25.2	420622	744351	42.10611	-74.73083	<2	20	3	20
109	01415000	Tremper Kill near Andes, N.Y.	33.2	420712	744908	42.12000	-74.81889	<2	3	2	3
110	01416900	Pepacton Reservoir near Downsville, N.Y.[3]	372	420438	745804	42.07722	-74.96778	--	--	--	--
111	01417000	East Branch Delaware River at Downsville, N.Y.[2]	372	420430	745836	42.07500	-74.97667	3	10	15	15
112	01417500	East Branch Delaware River at Harvard, N.Y.[2]	458	420128	750709	42.02444	-75.11917	3	10	20	20
113	01420500	Beaver Kill at Cooks Falls, N.Y.	241	415647	745848	41.94639	-74.98000	<2	15	6	15
114	01421000	East Branch Delaware River at Fishs Eddy, N.Y.[2]	784	415823	751028	41.97306	-75.17444	<2	15	6	15
115	01421610	West Branch Delaware River at Hobart, N.Y.	15.5	422217	744010	42.37139	-74.66944	<2	9	7	9
116	01421618	Town Brook southeast of Hobart, N.Y.	14.3	422140	743945	42.36111	-74.66250	<2	9	4	9
117	01421900	West Branch Delaware River upstream from Delhi, N.Y.	134	421649	745427	42.28028	-74.90750	<2	30	10	30
118	01422500	Little Delaware River near Delhi, N.Y.	49.8	421508	745407	42.25222	-74.90194	<2	3	7	7
119	01422747	East Brook East of Walton, N.Y.	24.7	421022	750718	42.17278	-75.12167	2	3	7	7
120	01423000	West Branch Delaware River at Walton, N.Y.	332	420958	750825	42.16611	-75.14028	<2	7	10	10
121	0142400103	Trout Creek near Trout Creek, N.Y.	20.2	421025	751647	42.17361	-75.27972	3	5	20	20
122	01424997	Cannonsville Reservoir near Stilesville, N.Y.[3]	454	420346	752249	42.06278	-75.38028	--	--	--	--
123	01425000	West Branch Delaware River at Stilesville, N.Y.[2]	456	420429	752347	42.07472	-75.39639	2	<2	10	10
124	01426500	West Branch Delaware River at Hale Eddy, N.Y.[2]	595	420011	752302	42.00306	-75.38389	3	3	20	20
125	01427207	Delaware River at Lordville, N.Y.[2]	1,590	415202	751251	41.86722	-75.21417	--	--	--	--
126	01427510	Delaware River at Callicoon, N.Y.[4]	1,820	414524	750328	41.75667	-75.05778	<2	5	8	8
127	01428500	Delaware River above Lackawaxen River near Barryville, N.Y.[4]	2,020	413032	745910	41.50889	-74.98611	2	5	8	8
128	01432900	Mongaup River at Mongaup Valley, N.Y.	76.6	414005	744651	41.66806	-74.78083	<2	4	2	4
129	01434000	Delaware River at Port Jervis, N.Y.[4]	3,070	412214	744152	41.37056	-74.69778	2	5	8	8
130	0143400680	East Branch Neversink River northeast Of Denning, N.Y.	8.93	415801	742654	41.96694	-74.44833	<2	200 to <500	<2	200 to <500
131	01434017	East Branch Neversink River near Claryville, N.Y.	22.9	415531	743226	41.92528	-74.54056	<2	60	<2	60

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

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Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Delaware River Basin—Continued									
132	01434021	West Branch Neversink River at Winnisook Lake near Frost Valley, N.Y.	0.77	420040	742453	42.01111	-74.41472	<2	50	<2	50
133	01434025	Biscuit Brook above Pigeon Brook at Frost Valley, N.Y.	3.72	415945	743000	41.99583	-74.50000	<2	80	2	80
134	01434498	West Branch Neversink River at Claryville, N.Y.	33.8	415513	743430	41.92028	-74.57500	<2	45	3	45
135	01435000	Neversink River near Claryville, N.Y.	66.6	415324	743525	41.89000	-74.59028	<2	60	2	60
136	01435900	Neversink Reservoir near Neversink, N.Y.[3]	92.5	414927	743820	41.82417	-74.63889	--	--	--	--
137	01436000	Neversink River at Neversink, N.Y.[2]	92.6	414912	743809	41.82000	-74.63583	4	35	10	35
138	01436690	Neversink River at Bridgeville, N.Y.[2]	171	413816	743702	41.63778	-74.61722	2	25	6	25
139	01437500	Neversink River at Godeffroy, N.Y.[2]	307	412628	743608	41.44111	-74.60222	2	60	7	60
		Susquehanna River Basin									
140	01497805	Little Elk Creek near Westford, N.Y.	3.73	423801	744745	42.63361	-74.79583	--	7	≥500	≥500
141	01498620	Susquehanna River southwest of Oneonta, N.Y.	678	422624	750600	42.44000	-75.10000	--	--	--	--
142	01499500	East Sidney Lake at East Sidney, N.Y.[3]	103	421940	751342	42.32778	-75.22833	--	--	--	--
143	01500000	Ouleout Creek at East Sidney, N.Y.[2]	103	422000	751407	42.33333	-75.23528	3	<2	<2	3
144	01500500	Susquehanna River at Unadilla, N.Y.	982	421917	751901	42.32139	-75.31694	2	<2	60	60
145	01502500	Unadilla River at Rockdale, N.Y.	520	422240	752423	42.37778	-75.40639	3	<2	100	100
146	01502632	Susquehanna River at Bainbridge, N.Y.	1,610	421729	752836	42.29139	-75.47667	2	<2	90	90
147	01502731	Susquehanna River at Windsor, N.Y.	1,820	420429	753817	42.07472	-75.63806	2	<2	100 to <200	100 to <200
148	01503000	Susquehanna River at Conklin, N.Y.	2,232	420207	754812	42.03528	-75.80333	2	4	100 to <200	100 to <200
149	01503500	Susquehanna River at Binghamton, N.Y.	2,283	420533	755454	42.09250	-75.91500	--	--	--	--
150	01503980	Chenango River at Eaton, N.Y.	24.3	425102	753621	42.85056	-75.60583		<2	30	30
151	01505000	Chenango River at Sherburne, N.Y.	263	424043	753039	42.67861	-75.51083	4	<2	60	60
152	01505031	Chenango River at Norwich, N.Y.	329	423216.5	753048.4	42.53792	-75.51344	--	--	--	--
153	01505810	Chenango River at Oxford, N.Y.	458	422630	753547	42.44167	-75.59639	--	--	--	--
154	01507000	Chenango River at Greene, N.Y.	593	421928	754618	42.32444	-75.77167	5	<2	200	200
155	01509000	Tioughnioga River at Cortland, N.Y.	292	423610	760935	42.60278	-76.15972	<2	<2	2	2
156	01509520	Tioughnioga River at Lisle, N.Y.	453	422058	755958	42.34944	-75.99944	3	<2	8	8
157	01510000	Otselic River at Cincinnatus, N.Y.	147	423228	755400	42.54111	-75.90000	3	<2	8	8
158	01510610	Merrill Creek Tributary near Texas Valley, N.Y.	5.32	422803	755919	42.46750	-75.98861	2	--	2	2
159	01511000	Whitney Point Lake at Whitney Point, N.Y.[3]	257	422034	755757	42.34278	-75.96583	--	--	--	--
160	01511500	Tioughnioga River at Itaska, N.Y.[2]	730	421753	755433	42.29806	-75.90917	2	<2	9	9
161	01512500	Chenango River near Chenango Forks, N.Y.	1,483	421305	755055	42.21806	-75.84861	3	<2	40	40
162	01513500	Susquehanna River at Vestal, N.Y.	3,941	420527	760323	42.09083	-76.05639	3	<2	100 to <200	100 to <200
163	01513831	Susquehanna River at Owego, N.Y.	4,216	420550	761600	42.09722	-76.26667	4	<2	200 to <500	200 to <500
164	01514000	Owego Creek near Owego, N.Y.	185	420745	761615	42.12917	-76.27083	4	<2	60	60
165	01514801	Catatonk Creek northwest of Owego, N.Y.	151	420818	761723	42.13833	-76.28972	2	--	200 to <500	200 to <500

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

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Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Susquehanna River Basin—Continued									
166	01515000	Susquehanna River near Waverly, N.Y.	4,773	415905	763005	41.98472	-76.50139	4	<2	>100 & <200	>100 & <200
167	01520500	Tioga River at Lindley, N.Y.[2]	771	420143	770757	42.02861	-77.13250	2	<2	<2	2
168	01521500	Canisteo River at Arkport, N.Y.[2]	30.6	422345	774242	42.39583	-77.71167	<2	<2	<2	<2
169	01521596	Big Creek near Howard, N.Y.	6.32	422201	773433	42.36694	-77.57583	<2	<2	<2	<2
170	01522075	Canacadea Creek at Alfred, N.Y.	1.28	421513	774724	42.25361	-77.79000	<2	<2	<2	<2
171	01523500	Canacadea Creek near Hornell, N.Y.[2]	57.9	422005	774100	42.33472	-77.68333	<2	<2	<2	<2
172	01524500	Canisteo River below Canacadea Creek at Hornell, N.Y.[2]	158	421850	773905	42.31389	-77.65139	2	<2	<2	2
173	01525500	Canisteo River at West Cameron, N.Y.	340	421320	772505	42.22222	-77.41806	<2	<2	<2	<2
174	01526000	Tuscarora Creek near South Addison, N.Y.	114	420420	771757	42.07222	-77.29917	2	<2	<2	2
175	01526500	Tioga River near Erwins, N.Y.[2]	1,377	420716	770746	42.12111	-77.12944	4	<2	<2	4
176	01527500	Cohocton River at Avoca, N.Y.	152	422352	772504	42.39778	-77.41778	<2	<2	<2	<2
177	01528320	Cohocton River at Bath, N.Y.	316	422036	772039	42.34333	-77.34417	<2	<2	<2	<2
178	01529500	Cohocton River near Campbell, N.Y.	470	421509	771301	42.25250	-77.21694	<2	<2	<2	<2
179	01529950	Chemung River at Corning, N.Y.[2]	2,006	420847	770328	42.14639	-77.05778	3	<2	<2	3
180	01530301	Cuthrie Run near Big Flats, N.Y.	5.39	421043	765532	42.17861	-76.92556	<2	<2	7	7
181	01530332	Chemung River at Elmira, N.Y.[2]	2,162	420511	764805	42.08639	-76.80139	3	<2	<2	3
182	01531000	Chemung River at Chemung, N.Y.[2]	2,506	420008	763806	42.00222	-76.63500	4	<2	2	4
		Allegheny River Basin									
183	03010734	Ischua Creek Tributary near Machias, N.Y.	5.12	422428	783133	42.40778	-78.52583	<2	<2	<2	<2
184	03011020	Allegheny River at Salamanca, N.Y.	1,608	420923	784256	42.15639	-78.71556	<2	<2	<2	<2
185	03013800	Ball Creek at Stow, N.Y.	9.58	420913	792427	42.15361	-79.40750	<2	<2	<2	<2
186	03014500	Chadakoin River at Falconer, N.Y.[2]	194	420645	791215	42.11250	-79.20417	9	<2	<2	9
		Lake Erie Basin									
187	04213376	Canadaway Creek at Fredonia, N.Y.	32.9	422702	792103	42.45056	-79.35083	<2	<2	<2	<2
188	04213500	Cattaraugus Creek at Gowanda, N.Y.	436	422750	785607	42.46389	-78.93528	<2	<2	<2	<2
189	04214500	Buffalo Creek at Gardenville, N.Y.	142	425117	784519	42.85472	-78.75528	<2	<2	<2	<2
190	04215000	Cayuga Creek near Lancaster, N.Y.	96.4	425324	783843	42.89000	-78.64528	2	<2	<2	2
191	04215500	Cazenovia Creek at Ebenezer, N.Y.	135	424947	784631	42.82972	-78.77528	2	<2	<2	2
		Niagara River Basin									
192	04216418	Tonawanda Creek at Attica, N.Y.	76.9	425150	781702	42.86389	-78.28389	<2	<2	<2	<2
193	04217000	Tonawanda Creek at Batavia, N.Y.	171	425951	781120	42.99750	-78.18889	<2	<2	<2	<2
194	04218000	Tonawanda Creek at Rapids, N.Y.	349	430535	783811	43.09306	-78.63639	<2	<2	<2	<2
195	04218518	Ellicott Creek below Williamsville, N.Y.	81.6	425840	784550	42.97778	-78.76389	<2	<2	<2	<2
		Lake Ontario Basin									
196	04219767	Eighteenmile Creek at Newfane, N.Y.	75.4	431643	784232	43.27861	-78.70889	<2	--	--	<2
197	0422026250	Northrup Creek at North Greece, N.Y.	10.1	431513	774433	43.25361	-77.74250	<2	<2	<2	<2

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Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Genesee River Basin									
198	04221000	Genesee River at Wellsville, N.Y.	288	420720	775727	42.12222	-77.95750	2	<2	<2	2
199	04223000	Genesee River at Portageville, N.Y.	984	423413	780233	42.57028	-78.04250	<2	<2	<2	<2
200	04224775	Canaseraga Creek above Dansville, N.Y.	88.9	423208	774216	42.53556	-77.70444	<2	<2	<2	<2
201	04224807	Stony Brook Tributary at South Dansville, N.Y.	3.15	422816	774021	42.47111	-77.67250	<2	--	--	<2
202	04227500	Genesee River near Mount Morris, N.Y.[2]	1,424	424600	775021	42.76667	-77.83917	2	<2	<2	2
203	04227995	Conesus Creek near Lakeville, N.Y.[2]	72.00	425114	774255	42.85389	-77.71528	3	<2	<2	3
204	04228500	Genesee River at Avon, N.Y.[2]	1,673	425504	774527	42.91778	-77.75750	2	<2	<2	2
205	04230380	Oatka Creek at Warsaw, N.Y.	39.1	424439	780816	42.74417	-78.13778	<2	<2	<2	<2
206	04230500	Oatka Creek at Garbutt, N.Y.	200	430036	774730	43.01000	-77.79167	<2	<2	<2	<2
207	04231000	Black Creek at Churchville, N.Y.	130	430602	775257	43.10056	-77.88250	2	<2	<2	2
208	04231600	Genesee River at Ford Street Bridge, Rochester, N.Y.[2]	2,474	430830	773659	43.14167	-77.61639	<2	<2	<2	<2
		Lake Ontario Basin									
209	04232050	Allen Creek near Rochester, N.Y.[1]	30.1	430749	773108	43.13028	-77.51889	<2	<2	<2	<2
210	0423205010	Irondequoit Creek above Blossom Road near Rochester, N.Y.	142	430842	773044	43.14500	-77.51222	7	<2	<2	7
211	042320578	Bear Creek at Ontario, N.Y.	6.74	431330	771700	43.22500	-77.28333	6	--	<2	6
		Oswego River Basin									
212	04232200	Catharine Creek at Montour Falls, N.Y.	41.1	421942	765039	42.32833	-76.84417	--	--	<2	<2
213	04232400	Seneca Lake at Watkins Glen, N.Y.[3]	704	422300	765205	42.38333	-76.86806	--	--	--	--
214	04232482	Keuka Lake Outlet at Dresden, N.Y.[2]	207	424049	765715	42.68028	-76.95417	4	<2	<2	4
215	04232630	Kendig Creek near Macdougall, N.Y.	13.8	425057	765333	42.84917	-76.89250	3	--	<2	3
216	04233000	Cayuga Inlet near Ithaca, N.Y.	35.2	422335	763243	42.39306	-76.54528	5	<2	100	100
217	04233286	Sixmile Creek at Brooktondale, N.Y.	27.0	422253	762341	42.38139	-76.39472	<2	<2	15	15
218	04233300	Sixmile Creek at Bethel Grove, N.Y.	39.0	422411	762607	42.40306	-76.43528	<2	<2	10	10
219	04233500	Cayuga Inlet (Cayuga Lake) at Ithaca, N.Y.[3]	1,564	422645	763045	42.44583	-76.51250	--	--	--	--
220	04234000	Fall Creek near Ithaca, N.Y.	126	422712	762823	42.45333	-76.47306	2	<2	4	4
221	0423403092	Trumansburg Creek near Trumansburg, N.Y.	2.52	423216	764106	42.53778	-76.68500		--	<2	<2
222	04234138	Schaeffer Creek near Canandaigua, N.Y.	7.84	425425	772214	42.90694	-77.37056	<2	--	--	<2
223	04234200	Mud Creek at East Victor, N.Y.	64.2	425828	772258	42.97444	-77.38278	<2	--	--	<2
224	04234500	Canandaigua Lake at Canandaigua, N.Y.[3]	184	425330	771722	42.89167	-77.28944	--	--	--	--
225	04235000	Canandaigua Outlet at Chapin, N.Y.[2]	195	425505	771359	42.91806	-77.23306	30	<2	<2	30
226	04235250	Flint Creek at Phelps, N.Y.	102	425728	770406	42.95778	-77.06833	25	<2	<2	25
227	04235255	Canandaigua Outlet Tributary near Alloway, N.Y.	2.94	430021	770054	43.00583	-77.01500	40	--	--	40
228	04235299	Owasco Inlet below Aurora Street at Moravia, N.Y.	106	424241.7	762602.4	42.71158	-76.43400	--	--	<2	<2
229	04235396	Owasco Lake near Auburn, N.Y.[3]	205	425414	763222	42.90389	-76.53944	--	--	--	--
230	04235440	Owasco Outlet at Genesee Street, Auburn, N.Y.[2]	207	425556	763355	42.93222	-76.56528	2	<2	<2	2

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

[mi², square miles; ddmmss, degrees, minutes, seconds; decimal degrees North American Datum of 1983 (NAD 83); RI, recurrence interval; <, less than; >, greater than; ≥, greater than or equal to; ≤, less than or equal to; --, no data available; site and basin locations are shown on figures 2 and 10]

Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		Oswego River Basin—Continued									
231	04237962	Onondaga Creek near Cardiff, N.Y.	33.9	425400	761010	42.90000	-76.16944	2	<2	<2	2
232	04239000	Onondaga Creek at Dorwin Avenue, Syracuse, N.Y.[2]	88.5	425900	760904	42.98333	-76.15111	<2	<2	<2	<2
233	04240010	Onondaga Creek at Spencer Street, Syracuse, N.Y.[2]	110	430327	760946	43.05750	-76.16278	<2	<2	2	2
234	04240100	Harbor Brook at Syracuse, N.Y.	10.0	430209	761055	43.03583	-76.18194	6	<2	2	6
235	04240105	Harbor Brook at Hiawatha Boulevard, Syracuse, N.Y.[1]	12.1	430322	761107	43.05611	-76.18528	15	<2	2	15
236	04240120	Ley Creek at Park Street, Syracuse, N.Y.[1]	29.9	430438	761014	43.07722	-76.17056	80	<2	7	80
237	04240180	Ninemile Creek near Marietta, N.Y.[2]	45.1	425515	761947	42.92083	-76.32972	15	<2	<2	15
238	04240300	Ninemile Creek at Lakeland, N.Y.[2]	115	430451	761336	43.08083	-76.22667	6	<2	<2	6
239	04240495	Onondaga Lake at Liverpool, N.Y.[3]	285	430601	761234	43.10028	-76.20944	--	--	--	--
240	04242500	East Branch Fish Creek at Taberg, N.Y.	188	431804	753718	43.30111	-75.62167	70	<2	<2	70
241	04243500	Oneida Creek at Oneida, N.Y.	113	430551	753822	43.09750	-75.63944	<2	<2	10	10
242	04245200	Butternut Creek near Jamesville, N.Y.	32.2	425602	760344	42.93389	-76.06222	2	<2	2	2
243	04245840	Scriba Creek near Constantia, N.Y.	38.4	431535	760011	43.25972	-76.00306	<2	<2	<2	<2
244	04249000	Oswego River at Lock 7, Oswego, N.Y.[2]	5,100	432706	763020	43.45167	-76.50556	15	<2	<2	15
		Lake Ontario Basin									
245	04249050	Catfish Creek at New Haven, N.Y.	31.7	432900	761934	43.48333	-76.32611	<2	<2	<2	<2
246	042490673	North Branch Grindstone Creek near Altmar, N.Y.	10.1	432931	760541	43.49194	-76.09472	<2	--	3	3
247	04249200	North Branch Salmon River at Redfield, N.Y.	82.5	433232	754851	43.54222	-75.81417	≥500	<2	<2	≥500
248	04250200	Salmon River at Pineville, N.Y.	238	433200	760220	43.53333	-76.03889	<2	<2	<2	<2
249	04250750	Sandy Creek near Adams, N.Y.	137	434848	760430	43.81333	-76.07500	<2	<2	<2	<2
		Black River Basin									
250	04252500	Black River near Boonville, N.Y.	304	433042	751825	43.51167	-75.30694	15	<2	<2	15
251	04253300	Sixth Lake near Old Forge, N.Y.[3]	18.6	434443	744658	43.74528	-74.78278	--	--	--	--
252	04253400	First Lake at Old Forge, N.Y.[3]	53.6	434244	745812	43.71222	-74.97000	--	--	--	--
253	04254500	Moose River at McKeever, N.Y.	363	433637	750639	43.61028	-75.11083	50	<2	<2	50
254	04256000	Independence River at Donnattsburg, N.Y.	88.7	434450	752005	43.74722	-75.33472	6	<2	<2	6
255	04256040	Tributary to Mill Creek Tributary near Lowville, N.Y.	1.66	434543	753113	43.76194	-75.52028	<2	<2	<2	<2
256	04256500	Stillwater Reservoir near Beaver River, N.Y.[3]	171	435350	750305	43.89722	-75.05139	--	--	--	--
257	04258000	Beaver River at Croghan, N.Y.[2]	291	435350	752416	43.89722	-75.40444	50	<2	<2	50
258	04258700	Deer River at Deer River, N.Y.	94.8	435549	753527	43.93028	-75.59083	2	<2	<2	2
259	04260500	Black River at Watertown, N.Y.	1,864	435908	755530	43.98556	-75.92500	25	<2	<2	25
		St. Lawrence River Basin									
260	04260990	Cranberry Lake at Cranberry Lake, N.Y.[3]	140	441314	745055	44.22056	-74.84861	--	--	--	--
261	04262000	Oswegatchie River near Oswegatchie, N.Y.[2]	259	441321	750429	44.22250	-75.07472	10	<2	<2	10
262	04262500	West Branch Oswegatchie River near Harrisville, N.Y.	258	441108	751952	44.18556	-75.33111	2	<2	<2	2
263	04263000	Oswegatchie River near Heuvelton, N.Y.	986	443558	752245	44.59944	-75.37917	2	<2	<2	2
264	04265000	Grass River at Pyrites, N.Y.	333	443128	751148	44.52444	-75.19667	2	<2	<2	2

Table 1–1. Map numbers, U.S. Geological Survey streamgage numbers and names, and selected flood information used in the study.—Continued

[mi², square miles; ddmmss, degrees, minutes, seconds; decimal degrees North American Datum of 1983 (NAD 83); RI, recurrence interval; <, less than; >, greater than; ≥, greater than or equal to; ≤, less than or equal to; --, no data available; site and basin locations are shown on figures 2 and 10]

Annual exceedance probability, in percent:	>50	>10 to 50	>4.0 to 10	>2.0 to 4.0	>1.0 to 2.0	>0.5 to 1.0	>0.2 to 0.5	≤0.20
Recurrence interval, in years:	<2	2 to <10	10 to <25	25 to <50	50 to <100	100 to <200	200 to <500	≥500

Map number	Streamgage number	Streamgage name	Drainage area (mi²)	Latitude (ddmmss)	Longitude (ddmmss)	Latitude (decimal degrees)	Longitude (decimal degrees)	April 2011 flood RI (years)	August 2011 flood RI (years)	September 2011 flood RI (years)	Maximum 2011 flood RI (years)
		St. Lawrence River Basin—Continued									
265	04265100	Elm Creek near Hermon, N.Y.	32.6	442615	751249	44.43750	-75.21361	3	<2	<2	3
266	04265432	Grass River at Chase Mills, N.Y.	598	445048	750441	44.84667	-75.07806	2	<2	<2	2
267	04266500	Raquette River at Piercefield, N.Y.[2]	721	441405	743420	44.23472	-74.57222	200 to <500	<2	<2	200 to <500
268	04267500	Raquette River at South Colton, N.Y.[2]	937	443042	745300	44.51167	-74.88333	≥500	<2	<2	≥500
269	04268000	Raquette River at Raymondville, N.Y.[2]	1,125	445020	745845	44.83889	-74.97917	100	<2	<2	100
270	04268200	Plum Brook near Grantville, N.Y.	43.9	445246	745454	44.87944	-74.91500	<2	<2	<2	<2
271	04268800	West Branch St. Regis River near Parishville, N.Y.	171	443555	744415	44.59861	-74.73750	4	<2	<2	4
272	04269000	St. Regis River at Brasher Center, N.Y.	612	445149	744645	44.86361	-74.77917	2	<2	<2	2
273	04269856	Duane Stream southeast of Duane Center, N.Y.	1.80	443912	741342	44.65333	-74.22833	<2	<2	<2	<2
274	04270000	Salmon River at Chasm Falls, N.Y.	132	444522	741309	44.75611	-74.21917	4	<2	<2	4
275	04270200	Little Salmon River at Bombay, N.Y.	92.2	445624	743324	44.94000	-74.55667	<2	<2	<2	<2
276	04270700	Trout River at Trout River, N.Y.	107	445923	741756	44.98972	-74.29889	<2	<2	--	<2
		Lake Champlain Basin									
277	04271500	Great Chazy River at Perry Mills, N.Y.	243	450000	733005	45.00000	-73.50139	--	--	--	--
278	04271815	Little Chazy River near Chazy, N.Y.	50.3	445408	732456	44.90222	-73.41556	3	20	<2	20
279	04273500	Saranac River at Plattsburgh, N.Y.	608	444054	732818	44.68167	-73.47167	9	4	<2	9
280	04273700	Salmon River at South Plattsburgh, N.Y.	63.3	443824	732943	44.64000	-73.49528	5	15	<2	15
281	04273800	Little Ausable River near Valcour, N.Y.	67.8	443539	732948	44.59417	-73.49667	3	9	<2	9
282	04274000	West Branch Ausable River near Lake Placid, N.Y.	116	441840	735500	44.31111	-73.91667	80	200 to <500	--	200 to <500
283	04275000	East Branch Ausable River at Au Sable Forks, N.Y.	198	442620	734055	44.43889	-73.68194	20	≥500	<2	≥500
284	04275500	Ausable River near Au Sable Forks, N.Y.	446	442705	733835	44.45139	-73.64306	35	≥500	<2	≥500
285	04276500	Bouquet River at Willsboro, N.Y.	270	442130	732350	44.35833	-73.39722	10	200 to <500	<2	200 to <500
286	04276842	Putnam Creek east of Crown Point Center, N.Y.	51.6	435633	732751	43.94250	-73.46417	<2	60	<2	60
287	04278000	Lake George at Rogers Rock, N.Y.[3]	233	434828	732730	43.80778	-73.45833	--	--	--	--
288	04279085	Lake Champlain north of Whitehall, N.Y.[3]	725	433718	732508	43.62167	-73.41889	--	--	--	--
289	04280450	Mettawee River near Middle Granville, N.Y.	167	432750	731705	43.46389	-73.28472	<2	70	<2	70
290	04295000	Richelieu River (Lake Champlain) at Rouses Point, N.Y.[3]	8,277	445946	732137	44.99611	-73.36028	--	--	--	--

[1]Sites in blue indicate significant urbanization. Flood frequencies at these sites, which have many years of record, may not represent current conditions because the degree of development may have increased significantly over time.

[2]Sites in pink indicate significant regulation. Flood frequencies at these sites were calculated from statistical analyses of annual peak discharges during the regulated period. No adjustments were made for the amount of available storage in the reservoirs before or during floods nor for changes in regulation procedures during the period of regulation. Other studies, such as flood-insurance studies, and other procedures can be investigated for alternate methods of determining discharge recurrence intervals at these sites.

[3]Sites in green are stream/reservoir/lake elevation sites (discharge not computed).

[4]Annual exceedance probabilities and recurrence intervals at regulated sites in orange were calculated from statistical analyses of annual peak discharges by using the entire period of record and were agreed upon by a multiagency committee (Schopp and Firda, 2008).

Appendix 2. Selected Photographs of Flood Damage Caused by the Floods of 2011 in New York

Photographs were taken by U.S. Geological Survey personnel unless noted otherwise.

Figure 2–1. Flood of April 2011, West Branch Ausable River near Lake Placid, New York. Photo courtesy of Adirondack Daily Enterprise by Eric Voorhis.

Figure 2–2. Flood of April 2011, Broad Street bridge washout caused by Mill Brook near Port Henry, New York. Photo courtesy of Lohr McKinstry/Press-Republican.

Figure 2–3. Flood of April 2011, West Canada Creek at Wilmurt, New York.

Figure 2–4. Flood of April 2011, Hudson River at Lake Luzerne, New York.

Figure 2–5. Flood of April 2011, Raquette River at Piercefield Dam, Piercefield, New York. Photo courtesy of John Derby, Saranac Lake Fire Department.

Figure 2–6. Flood of April 2011, West Canada Creek at Newport Dam, Newport, New York (April 28, 2011). Photo courtesy of New York State Department of Environmental Conservation.

Figure 2–7. Flood of August 2011, flood debris on Mill Hollow Road bridge over East Kill near Jewett Center, New York.

Figure 2–8. Flood of August 2011, County Route 17 road washout caused by East Kill near Jewett Center, New York.

Figure 2–9. Flood of August 2011, State Route 23 near Batavia Kill at Windham, New York.

Figure 2–10. Flood of August 2011, State Route 23 near Batavia Kill at Windham, New York.

Figure 2–11. Flood of August 2011, Bush Road bridge washout caused by Schoharie Creek near Lexington, New York.

Figure 2–12. Flood of August 2011, State Route 42 bridge over Schoharie Creek at Lexington, New York.

Figure 2–13. Flood of August 2011, flood damaged house caused by Schoharie Creek at Prattsville, New York (September 28, 2011).

Figure 2–14. Flood of August 2011, State Route 23 bridge over Schoharie Creek at Prattsville, New York.

Figure 2–15. Flood of August 2011, State Route 30 road washout caused by Schoharie Creek at Breakabeen, New York. Photo by Joseph Griffin, courtesy of New York State Department of Transportation.

Figure 2–16. Flood of August 2011, Schoharie Creek at Fort Hunter, New York. Photo courtesy of the Times Union, Albany, New York.

Figure 2–17. Flood of August 2011, Mohawk River at Scotia and Schenectady, New York. Photo courtesy of the Times Union, Albany, New York.

Figure 2–18. Flood of August 2011, Mohawk River at Scotia and Schenectady, New York. Photo courtesy of the Times Union, Albany, New York.

Figure 2–19. Flood of August 2011, coastal flooding from Long Island Sound near Branford, Connecticut. Photo courtesy of Connecticut Fund for the Environment and its program Save the Sound.

Figure 2–20. Flood of September 2011, Susquehanna River at Bainbridge, New York.

Figure 2–21. Flood of September 2011, Susquehanna River at Bainbridge, New York.

Figure 2–22. Flood of September 2011, Susquehanna River at Binghamton, New York (September 8, 2011). Photo by Sargeant 1st Class Steven Petibone, 42nd Combat Aviation Brigade, courtesy of New York Division of Military and Naval Affairs.

Figure 2–23. Flood of September 2011, Susquehanna River at Binghamton, New York (September 8, 2011). Photo courtesy of Bill Walsh.

Figure 2–24. Flood of September 2011, Goudy Station, Susquehanna River at Johnson City, New York (September 8, 2011). Photo courtesy of Bill Walsh.

Figure 2–25. Flood of September 2011, Susquehanna River at Johnson City, New York (September 8, 2011). Photo courtesy of Bill Walsh.

Figure 2–26. Flood of September 2011, State Route 17/Vestal Parkway, Susquehanna River at Apalachin, New York (September 8, 2011). Photo courtesy of Bill Walsh.

Figure 2–27. Flood of September 2011, Susquehanna River at Owego, New York (September 8, 2011).

Figure 2–28. Flood of September 2011, runaway boat stranded in field after floodwaters receded, Susquehanna River at Waverly, New York.

Appendix 3. Selection and Accuracy of High-Water Marks

Appendix 3. Selection and Accuracy of High-Water Marks

High-water marks (HWMs) are evidence of the highest elevations reached by a flood (Benson and Dalrymple, 1967). HWM-elevation data have many uses such as assessing the accuracy of flood-insurance-study profiles, developing flood-inundation maps, calibrating future flood-profile models, and examining the effects of highway embankments, bridges, culverts, dams, levees, and floodwalls on the flood profile. In hydraulic analyses, the stream channel is assumed to be free of debris and downstream obstructions.

After a flood, HWMs usually deteriorate quickly from rain, wind, and residential cleanup efforts. A subsequent lower magnitude flood could also interfere with the accurate identification of HWMs from an earlier flood. Although HWMs inside abandoned or condemned buildings or outbuildings might be preserved for many years, a timely response to identify (mark with a flag) HWMs as soon as possible after a flood is imperative.

The four most common types of HWMs are seed lines, mud lines, debris piles or lines, and wash lines; a HWM can be a combination of these types. HWMs are rated as “excellent,” “good,” “fair,” or “poor” (Benson and Dalrymple, 1967). “Excellent” means that the rated HWM is considered to be within 0.02 foot (ft) of the true high-water elevation, “good” within 0.05 ft, “fair” within 0.10 ft, and the rating “poor” implies less than “fair” accuracy (Suro and others, 2009). The following paragraphs reproduced and rearranged from Benson and Dalrymple (1967) discuss the various types of HWMs.

“Many kinds of material which float, chiefly vegetative, are left stranded at the high-water line (and at lower elevations) when the water subsides. The finer material produces more definite and better marks and is apt to represent the highest elevation that the water attained than would some scattered clumps of large drift. Leaves or cornstalks are apt to become waterlogged, and at the very edge in slow velocities they will not rise with a slight rise of the water surface. In this manner, a mound of material, sometimes a foot or more in height, will form at the edge of the channel. Where this occurs, the elevation found by holding the rod on the top of the mound would be the proper high-water elevation if the material is consolidated; if the material is loose, the shoreward toe would be the correct elevation.”

(*******)

“Often the small seeds of various plants will provide excellent high-water marks, remaining in the crevices of bark or in the cracks in fence posts or utility poles. The highest of such particles should be used. At times, seeds will adhere to smooth surfaces and encircle trees, poles, metal posts, or guy wires. When present, seeds are an excellent source of high-water data.”

(*******)

“Water carrying mud or silt will at times leave easily recognizable lines along banks, on trees, brush, rocks, and buildings. If there is only a slight difference in color, the mud line may be more readily visible from a distance.”

(*******)

“Much drift usually will be found on bushes or trees within the channel. Such marks are not generally as dependable as those on the banks. In swift water, varying amounts of pileup due to velocity will affect the marks at the upstream side of such objects. Marks at the downstream sides of large objects may be lower than normal. Brush in fast velocities often will be bent downstream by the flow, and drift will be caught on the upper limbs. When the velocities slow down, the brush becomes erect once more, and the drift will appear to be at an elevation much higher than that of the actual water surface. In quiet water on overflow plains, the highest drift in brush or trees may be reliable.”

(*******)

“In arid regions, or where sandy soil or steepness of banks prevent vegetative growth, the water surface may lap against bare banks. Soil will be washed away by the moving water and under some conditions will show “wash lines” which may be reliable high-water indicators. Good marks are indicators by the straightness of the top of the wash line. Where the bank is steep or the soil unstable, the material may slough to elevations above the water surface. This condition may be recognized by the uneven ragged line at the top edge of the washing—such marks should be avoided. Usually wash lines are poor.”

(*******)

“Buildings within the flood plain should be investigated; they sometimes are an excellent source of high-water marks. Even relatively clean water will leave stain marks within buildings. Excellent marks may be found on windowpanes or screens. Use care to select marks that are not affected by velocity head, as are marks on the upstream side of buildings in an area where velocities were high. The exposure of flood-water entrances into buildings should be noted in order to judge drawdown or pileup."

A few examples of the different types and ratings of HWMs are shown on figures 3–1 to 3–8. Figure 3–1 shows a "good" seed line on a tree; figure 3–2 shows an "excellent" mud/seed line on a wall; figure 3–3 shows an "excellent" mud line on a door; figure 3–4 shows a "fair" debris line on the ground; figure 3–5 shows a "fair" debris line on the upstream face of a highway embankment; and figure 3–6 shows a flagged "poor" wash line on a stream bank. Figure 3–7 shows debris caught in vegetation along a stream bank. This HWM would be rated "poor" because its proximity to the stream channel and associated high velocities would make accurate identification of the actual high-water elevation difficult. Figure 3–8 shows a debris line on the ground that would be rated "poor" because of the thickness of the unconsolidated, loosely packed material.

The best location to search for a HWM along a given stream reach depends largely on the gradient of the stream and the degree to which the land has been developed. Generally, there are four types of stream reaches: (1) high-gradient rural (slope greater than 1 percent (Jarrett, 1985), (2) high-gradient developed, (3) low-gradient rural, and (4) low-gradient developed. In all reach types, HWMs chosen for surveying should be in areas as far away from the stream channel as possible to avoid pileup or drawdown associated with high water velocities.

High-gradient rural reaches are the most difficult type of reach in which to identify good HWMs because of high velocities and lack of buildings. High velocities may occur up to the edge of inundation, and only fair or poor debris lines and wash lines may be present at the edges. The selection of debris in trees and bushes as HWMs should be avoided because of pileup. At times debris will slide down a tree during recession and produce a false seed line that appears like a scatter of fine particles; this debris should not be flagged. The field person should check for natural depressions in the overbank, where the water will slow because of increased depths, and search for seed lines on trees in these areas.

In high-gradient developed reaches, building surfaces offer another source for HWMs, but several factors should be considered. The field person should avoid HWMs on upstream or downstream sides of buildings because of pile up or drawdown. Mud lines on the streamward or landward sides of buildings are the best indicators of the true water-surface elevation and are usually most distinct on windows and screens. HWMs inside a building need to be flagged with caution in high-gradient reaches because they may not represent the true water-surface elevation in a well-sealed building; the water in the building may not have reached equilibrium with the water outside because of rapidly rising and falling stages. It is common for mud lines on the inside of a window to be several inches lower than mud lines on the outside of the same window. Good or excellent HWMs can usually be found inside small outbuildings that are not well sealed.

In low-gradient rural reaches, the field person should check for HWMs near the edges of inundation; good debris lines can usually be found on the ground and good or excellent seed lines on trees. Seed lines that encircle a tree are preferable to debris lines on the ground in the same vicinity.

In low-gradient developed reaches, HWMs near the edges of inundation are again preferable. Good or excellent seed lines and mud lines can usually be found on trees, fences, buildings, and outbuildings (for example, sheds or garages), and good debris lines can usually be found on the ground. In areas where emergency vehicles or boats may have caused wakes, HWMs inside buildings are preferable because they are less affected by these conditions.

In all four reach types, HWMs can be used to help define the effects that bridges or culverts may have on the flood profile. HWMs should be flagged (1) near the edges of inundation (2) one bridge- or culvert-opening width upstream from the bridge or culvert (to avoid the drawdown zone), and (3) laterally along both sides of the opening on the upstream face of the embankment (Matthai, 1967). HWMs should also be flagged at the downstream ends of bridge abutments. Eddies can form where the downstream highway embankment meets the abutment, and debris lines usually can be found at these locations; if not, however, debris lines should be flagged laterally along both sides of the opening on the downstream face of the embankment. If the road has been overtopped by floodwaters, HWMs should be flagged along the end segments of the downstream embankment near the edges of inundation. The HWMs surveyed upstream and downstream from the bridge or culvert can be used to help determine if backwater was created by the structure. A field form that is used by the U.S. Geological Survey New York Water Science Center in flagging HWMs is shown on figure 3–9.

Figure 3–1. Good seed line on a tree.

Figure 3–2. Excellent seed/mud line on a wall.

Figure 3–3. Excellent mud line on a door.

Figure 3–4. Fair debris line on a river overbank.

Figure 3–5. Fair debris line on an upstream-left road embankment.

Figure 3–6. Poor wash line on the river bank.

Figure 3–7. Poor debris pile on the bank near the river.

Figure 3–8. Poor debris line on the ground.

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U.S. Department of the Interior
Geological Survey
High-Water Mark Documentation Notes

Date of Flood: ___________________

Site Number: ____________________

River / Stream : _________________________________

Road / Highway Name: ___________________________

Nearest Community: _____________________________

FEMA Study Community: _________________________

County : ________________________

Party : ______________________ **Date :** ___________

Horizontal datum used: (circle one) 1927 NAD/1983 NAD

Vertical datum used: (circle one) 1929 NGVD/1988 NAVD

Thalweg Elevation : __________ **(at bridge crossing sites)**

Sketch

BM / RM Description: ____
____
____

HWM# _______ **Elevation** _____________ **GPS reading: lat** ___ ____' ____'' **long** ___ ____' ____'' **(good /poor)**
Mark condition (Circle one) excellent / good / fair / poor **Photo #** ______________
HWM is: seed /mud /debris line /other (describe) ___________ **found HWM on (describe)** ____________**on Lft / Rt bank**
HWM is:_______**ft. US / DS / Lft / Rt of bridge / house no.** _______ **/ bldg no.** _______**, and is** _______ **ft. above ground**
HWM marked with: paint / hub / rebar / nail / PK nail / chiseled mark / other (describe) __________________
Comments: ____

HWM# _______ **Elevation** _____________ **GPS reading: lat** ___ ____' ____'' **long** ___ ____' ____'' **(good /poor)**
Mark condition (Circle one) excellent / good / fair / poor **Photo #** ______________
HWM is: seed /mud /debris line /other (describe) ___________ **found HWM on (describe)** ____________**on Lft / Rt bank**
HWM is:_______**ft. US / DS / Lft / Rt of bridge / house no.** _______ **/ bldg no.** _______**, and is** _______ **ft. above ground**
HWM marked with: paint / hub / rebar / nail / PK nail / chiseled mark / other (describe) __________________
Comments: ____

HWM# _______ **Elevation** _____________ **GPS reading: lat** ___ ____' ____'' **long** ___ ____' ____'' **(good /poor)**
Mark condition (Circle one) excellent / good / fair / poor **Photo #** ______________
HWM is: seed /mud /debris line /other (describe) ___________ **found HWM on (describe)** ____________**on Lft / Rt bank**
HWM is:_______**ft. US / DS / Lft / Rt of bridge / house no.** _______ **/ bldg no.** _______**, and is** _______ **ft. above ground**
HWM marked with: paint / hub / rebar / nail / PK nail / chiseled mark / other (describe) __________________
Comments: ____

HWM# _______ **Elevation** _____________ **GPS reading: lat** ___ ____' ____'' **long** ___ ____' ____'' **(good /poor)**
Mark condition (Circle one) excellent / good / fair / poor **Photo #** ______________
HWM is: seed /mud /debris line /other (describe) ___________ **found HWM on (describe)** ____________**on Lft / Rt bank**
HWM is:_______**ft. US / DS / Lft / Rt of bridge / house no.** _______ **/ bldg no.** _______**, and is** _______ **ft. above ground**
HWM marked with: paint / hub / rebar / nail / PK nail / chiseled mark / other (describe) __________________
Comments: ____

HWM# _______ **Elevation** _____________ **GPS reading: lat** ___ ____' ____'' **long** ___ ____' ____'' **(good /poor)**
Mark condition (Circle one) excellent / good / fair / poor **Photo #** ______________
HWM is: seed /mud /debris line /other (describe) ___________ **found HWM on (describe)** ____________**on Lft / Rt bank**
HWM is:_______**ft. US / DS / Lft / Rt of bridge / house no.** _______ **/ bldg no.** _______**, and is** _______ **ft. above ground**
HWM marked with: paint / hub / rebar / nail / PK nail / chiseled mark / other (describe) __________________
Comments: ____
Prepared By: ________________ **Date :** ___________ NY-2005

Figure 3–9. Sample form for documenting high-water marks.

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