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Hurricane Irene and Associated Floods of August 27–30, 2011, in New Jersey

Scientific Investigations Report 2013–5234

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

Cover: Photograph showing flooding of the Passaic River in Totowa, New Jersey, from Hurricane Irene, August 27–30, 2011. View looking east along Totowa Road. (Photograph by Andrew F. Watson, U.S. Geological Survey)

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U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2014

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Hydraulic gradient	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

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

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

Hurricane Irene and Associated Floods of August 27–30, 2011, in New Jersey

By Kara M. Watson, Jerilyn V. Collenburg, and Robert G. Reiser

Abstract

Intense rainfall from Hurricane Irene during August 27–30, 2011, inundated streams throughout New Jersey resulting in peak streamflows exceeding the 100-year recurrence interval at many streamgages and causing heavy property and road damage. The rain event affected the entire State. Some notably affected areas were the Passaic and Hackensack River Basins in northeastern New Jersey with new peaks of record at 10 continuous-record streamflow-gaging stations on streams such as the Hackensack River, Ramapo River, Rockaway River, and Green Pond Brook. In the Atlantic Coastal Basin, new peaks of record were recorded at 6 continuous-record streamflow-gaging stations, 2 of which were on the Manasquan River, 1 on Toms River, 1 on the Mullica River, 1 on the North Branch Metedeconk River, and 1 on the West Branch Wading River. Several tributaries to the Delaware River, such as the Pequest River, Flat Brook, and Assunpink Creek, also experienced major flooding with new peaks of record at nine continuous-record streamflow-gaging stations.

The U.S. Geological Survey (USGS) documented peak streamflows and water-surface elevations at 125 continuous-record streamflow-gaging stations, 27 crest-stage partial-record stations, and peak water-surface elevations at 24 continuous-record tide gages within the State of New Jersey. With rainfall totals averaging more than 10 inches throughout the State, peak-of-record flood elevations and streamflows occurred at 32 continuous-record streamflow-gaging stations. Flood-frequency recurrence-intervals were recomputed for 80 gages with 20 or more years of record; 25 crest-stage gages ranged from 25 years to greater than 500 years for the peak-of-record floods. The maximum peak streamflow per square mile ranged from 20 to 759 cubic feet per second per square mile.

The August 27–30, 2011, flood peaks rank as the peaks of record for 32 continuous-record streamflow-gaging stations with a period of record of 23 to 100 years, as the second highest peaks for 21 continuous-record streamflow-gaging stations with a period of record of 21 to 114 years, and the third highest peaks of record for 11 continuous-record streamflow-gaging stations with a period of record of 43 to 96 years. Several gages have documented peaks dating back to 1903.

About 1 million people across the State were evacuated, and every county was eventually declared a Federal disaster area. Property damage in New Jersey was estimated to be $1 billion. Governor Chris Christie declared a State of Emergency for New Jersey on August 31, 2011. After assessment of the damage by the Federal Emergency Management Agency, President Obama declared all 21 counties major disaster areas in the State of New Jersey on August 31, 2011.

Introduction

Hurricane Irene was a large and destructive tropical storm that affected the Caribbean and the east coast of the United States in August 2011. With a wind speed of 69 miles per hour, the storm made landfall as a strong tropical storm at Little Egg Inlet in southeastern New Jersey on August 28, 2011. For this report we will refer to this storm as Hurricane Irene. The last hurricane to make landfall in New Jersey was in 1903. An aerial view of Hurricane Irene making landfall near New York City on August 28, 2011, after it traveled north from Little Egg Inlet, New Jersey, is shown in figure 1.

Streamflow, precipitation, tide water-surface elevation, ground-water level, and water-quality data were available on a near real-time basis through the U.S. Geological Survey (USGS), New Jersey Water Science Center (NJWSC) website, *http://nj.usgs.gov*, to monitor hydrologic conditions during the event. The website was accessible to other agencies, emergency management officials, and the public for various flood-related decisions. The near real-time data are collected for various projects in cooperation with Federal, State, and local agencies and water purveyors. The near real-time streamflow data were used by the USGS in deciding where field-data collection would be most beneficial.

The rainfall totaling as much as 10 inches that fell during August 27–28, 2011, combined with wet antecedent conditions caused by 8 to more than 16 inches of rain statewide during the 3 weeks preceding Hurricane Irene, set the stage for record-breaking floods on many streams in New Jersey. Thirty-two of the 96 USGS continuous-record streamflow-gaging stations (streamgages) with 20 or more years of record

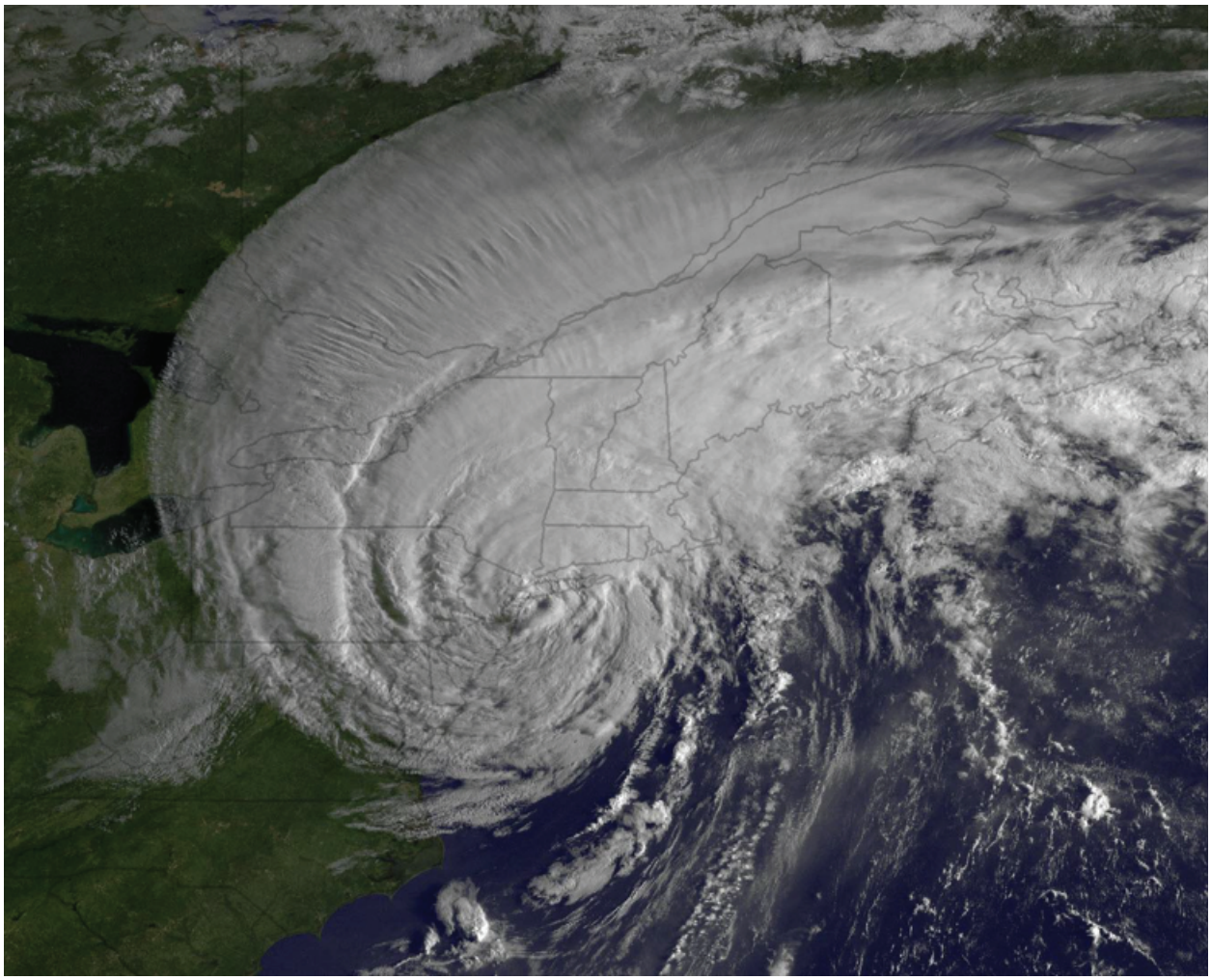


Figure 1. Geostationary Operational Environmental Satellite (GOES) East image of Hurricane Irene making landfall near New York City on August 28, 2011. Image is courtesy of the National Oceanic and Atmospheric Administration, 2011.

recorded new peaks-of-record. Twenty-eight streamgages experienced peak streamflows equal to or greater than the 100-year recurrence interval (< 1.0% annual-exceedance probability). Five of the 27 USGS crest-stage partial-record stations (crest-stage gage) recorded new peaks-of-record. Three crest-stage gages had peaks equal to or greater than the 100-year recurrence interval. Six of 24 continuous-record tide gages (tide gage) recorded peaks of record. President Obama signed a Major Disaster Declaration, FEMA-DR-4021, on August 31, 2011, for all 21 counties in New Jersey.

The USGS, in cooperation with the Federal Emergency Management Agency (FEMA), conducted a study to collect, compile, and compute flood-related data in selected basins throughout the State. Peak stream elevations were determined from HWMs at 157 sites. Flood frequencies were computed at 80 streamgages and 25 crest-stage gages. Peak tide water-surface elevations were determined for 24 continuous-record tide-telemetry gages.

Purpose and Scope

The purpose of this report is to document flood conditions on stream reaches throughout the State of New Jersey as a result of Hurricane Irene. This report lists locations of streamgages, crest-stage gages, and tide-telemetry gages with peaks of record, precipitation amounts, peak streamflows, and elevations. Flood frequencies associated with the August 27–30, 2011, flood were recomputed by using the period of record through 2011. Peak stages and streamflows at 98 USGS streamgages with 20 or more years of record, 31 streamgages with less than 20 years of record, and 27 crest-stage gages throughout New Jersey, as well as the peak elevations at 24 USGS tide-telemetry gages are presented in tables and figures. The elevations, detailed descriptions, photographs, and maps of sites for 943 HWMs are included in the appendix. An overview of historic floods of streams in New Jersey is also included.

Description of Study Area

New Jersey is located on the North Atlantic slope adjacent to the Atlantic Ocean. New Jersey shares a land border with New York along the north. On the west side, the Delaware River forms the border between New Jersey and Pennsylvania. New Jersey covers a total area of 8,730 square miles, spans 70 miles at its widest point, and stretches 130 miles in length. The State is divided into 21 counties, which contain 566 municipalities. The U.S. Bureau of the Census reported in the 2010 Census that the population density of New Jersey was 1,195 persons per square mile (U.S. Census Bureau, 2013), maintaining New Jersey's status as the most densely populated State in the United States for more than 40 years.

Major rivers in the State include the Raritan, Passaic, Hackensack, Pompton, Delaware, Manasquan, Rahway, Mullica, Great Egg Harbor, and Musconetcong. The drainage areas of New Jersey river basins span four physiographic provinces. The Piedmont, New England (Highlands), and Valley and Ridge Provinces lie in northern New Jersey above the Fall Line (fig. 2), and the Coastal Plain Province encompasses southern New Jersey below the Fall Line. The Fall Line is a low, east-facing largely buried cliff extending more or less parallel to the Atlantic coastline from New Jersey to the Carolinas (Newell and others, 1998).

Methods of Investigation

The methods by which high-water marks (HWMs) caused by Hurricane Irene in New Jersey were identified, documented, and referenced are discussed in this section. The methods by which the estimation of flood magnitude and frequency were developed through analysis of the annual peak streamflows at 80 streamflow-gaging stations and 25 crest-stage gages in the State are also discussed.

High-Water Marks

HWMs are the evidence of the highest water levels during a flood (Benson and Dalrymple, 1967). The best HWMs are formed from small seeds or floating debris carried by flood waters that adhere to smooth surfaces or lodge in tree bark that form a distinct line. Stain lines on buildings, fences, and other structures also provide excellent marks. HWMs are best identified immediately following the peak stage as time and weather (wind, rain, the sun) may blow, wash, or fade away the evidence of the peak water line. In addition, care was taken to identify HWMs as far from the main channel as feasible where velocities are generally small and where pileup or drawdown's effect in fast-moving waters are best avoided. The general methods used to identify and document HWMs are described by Benson and Dalrymple (1967).

Documenting High-Water Marks

USGS field crews identified 1,101 HWMs and supporting evidence surrounding the HWMs at 157 sites along 27 stream reaches following Hurricane Irene. After an acceptable HWM was found, a more permanent identification mark was established, such as a Parker-Kalon (PK) nail with a disk, a stake, a chiseled mark, or a paint line (typically all of these were accompanied by orange flagging if possible). Written descriptions, sketches, photos, and handheld global positioning system (GPS) horizontal measurements were made so the marks could easily be found later and surveyed to the standard vertical datum, North American Vertical Datum of 1988 (NAVD 88). A catalogue of the 943 HWMs that were identified, surveyed, and considered satisfactory after analysis can be found in the appendix.

Identification of HWMs began on September 5 and continued through October 4, 2011. Three USGS field crews were mobilized to identify HWMs along the Passaic River, the Whippany River, and Pascack Brook as soon as possible because of the significance of the flood in these areas, and to minimize loss of essential time-sensitive data. More crews were subsequently mobilized to the remaining 24 river reaches. With time, HWMs become more challenging and time-consuming to identify, and the quality of the HWMs deteriorate; therefore, it is important to collect data as quickly as possible.

Elevation of High-Water Marks

Elevations of 1,075 HWMs were determined by utilizing a Virtual Reference Station System (VRS) along with standard optical leveling. Logging into a VRS requires a network of Global Navigation Satellite System (GNSS) receivers that are connected to a control center via the Internet. This system does not require establishment of a base station because the base stations are provided by the VRS (VRS Explained, 2013). The GNSS surveys were conducted by using four Trimble R8 VRS rovers that support the L1 and L2 frequencies. The survey crew set the GNSS receiver supported by a bipod in an open area while logging into the VRS using cell phones with Bluetooth capability to identify the starting location of the survey. Once the location was sent to the VRS, the network and associated software corrected for ionospheric and other atmospheric conditions in the satellite signals resulting in reduced loss in the accuracy of the GNSS at the survey location. The fixed-base stations provided by the VRS continuously stream data to a control center that calculates corrections at the location of the field GNSS receiver in real time. Continuous real-time differential corrections to the GPS horizontal and vertical positions were made using a proprietary fixed-base station GPS network operated by KeyNetGPS, Inc. (KeyNetGPS, Inc., 2013).

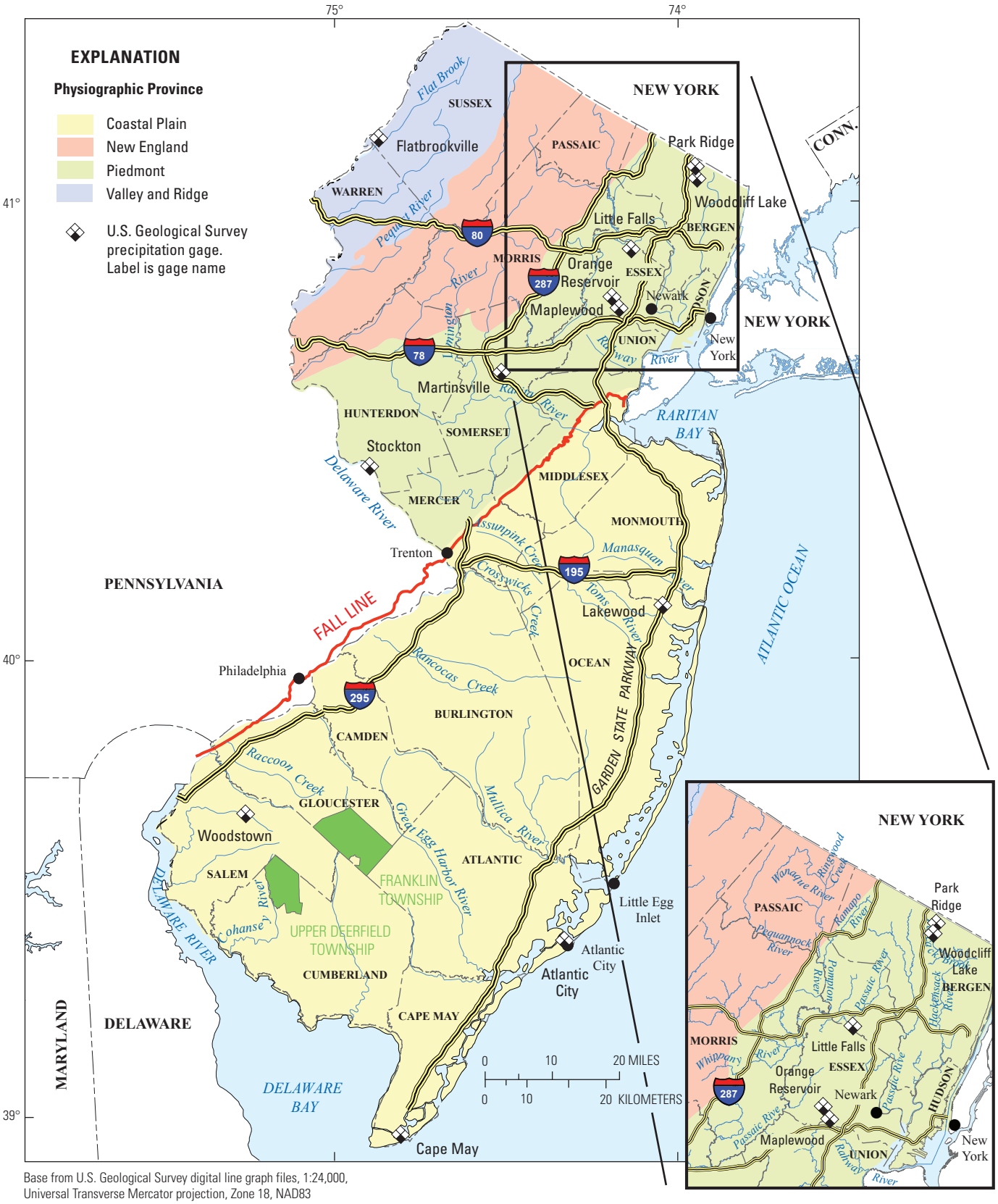


Figure 2. Location of study area for the Hurricane Irene flood of August 27–30, 2011, and U.S. Geological Survey precipitation gages in New Jersey.

The USGS survey crews set temporary survey points using PK nails with metal washers stamped "USGS" for ease of identification near HWM sites in an open area to provide the best possible satellite reception. The PK nails were set in sidewalks, roadways, or parking lots. For each temporary survey point (PK nail), the GNSS receiver was initialized away from the survey point and then positioned and leveled over the PK nail. This procedure was repeated by reinitializing the Trimble R8 unit by flipping the unit upside down for several seconds to lose the GPS signals to obtain an independent reading. If the vertical elevation of the PK nail differed by more than about 0.10 feet (ft), the procedure was repeated until an acceptable agreement was reached. Elevations of repeated survey point measurements generally agreed within 0.05 ft. Standard optical surveying equipment was then used to tie the HWMs to the temporary survey point elevation using a closed-loop survey. Quality-assurance GNSS measurements were made at 26 National Geodetic Survey bench marks (BMs) with vertical datum throughout the study area. The elevation of the GNSS-measured BMs yielded a vertical root mean square error of 0.09 ft for 24 of the 26 BMs when two outliers were removed and 0.12 ft when the outliers were included (table 1).

Summary of High-Water Marks Identified

HWMs were identified following the August 27–30, 2011, flood by several USGS field crews. The USGS identified a total of 1,101 HWMs at 157 sites. Sites generally had at least 4 HWMs and an average of 7, typically at a bridge or dam with marks identified on the upstream and downstream side of the delineating structure. Of the 1,101 HWMs that were identified, 2.4 percent of the marks were found destroyed, were not found at all, or were inaccessible by the survey crews. Of the remaining 97.6 percent of the marks that were surveyed, 12.3 percent were eliminated from the final data due to uncertainty or inaccuracy. In the appendix are listed the 943 HWMs that were identified, surveyed, and considered satisfactory after thorough analysis.

The HWMs identified by the USGS from September 5 through October 4, 2011, covered a total of 27 river reaches in 4 major river basins throughout the State. The elevations were surveyed from October 25 through November 2, 2011, to the NAVD 88 by using the GNSS and survey-grade GPS receivers, along with traditional optical leveling equipment. The elevations of HWMs upstream from bridges were on average 0.14 ft higher than those of the downstream HWMs near the same bridge. At 6 of the 157 sites, the average upstream elevation was lower than the average downstream elevation by an average of 0.14 ft. HWMs that were found to have a higher average downstream elevation may be the result of poor quality marks, which are most often suggested in the description and the rating of the HWMs. There were 15 sites where marks were only found on either the upstream or downstream side of a bridge or dam, or the site location did not have a structure that could be used to identify the mark in relation to the streamflow orientation.

Flood-Frequency Methods

Estimation of flood magnitude and frequency for a specific location can be developed by analyzing the annual peak streamflows at a streamflow-gaging station. Typically, these estimates are reported in terms of exceedance probability, or they may be presented in terms of recurrence intervals, for example the 100-year flood. Exceedance probability is defined as the probability of exceeding a specified streamflow within a 1-year period and is usually expressed as a value less than 1.0. It can also be expressed as a percentage less than 100, the reciprocal of recurrence interval. Recurrence interval is the average interval of time, in years, within which annual-maximum flood peaks were greater than a particular value. For example, a peak streamflow at the 100-year recurrence interval would be expected to be equaled or exceeded, on average, once every 100 years. However, a peak streamflow equal to or greater than the 100-year discharge may occur more frequently and, indeed, may occur more than once in a single year. The designation 100-year flood does not mean that peak streamflow will occur only once every 100 years; it is a probability of occurrence, not a certainty. The 100-year flood means a recurrence interval of 100 years has an annual exceedance probability of 0.01 (1 percent), hence the definition that there is a 1 percent chance the peak streamflow will be equaled or exceeded in any given year.

Estimates for peak-streamflow frequency for streamgages and crest-stage gages were made using log-Pearson type III statistics, following recommendations found in the publication "Guidelines for Determining Flood Flow Frequency, Bulletin 17B" (U.S. Interagency Advisory Committee on Water Data, 1982). The log-Pearson type III estimates of flow at specific frequencies for the streamgages and crest-stage gages are computed by entering the annual-maximum flood peak streamflows measured at the selected gage into the USGS computer program PeakFQ. The PeakFQ program and associated documentation can be downloaded from the web at *http://water.usgs.gov/software/PeakFQ/*. Regional regression equations developed by Watson and Schopp (2009) are used with the Log Pearson Type III values to compute the weighted peak streamflow for each recurrence interval at streamgages without regulated streamflows. The regression equations were developed with data collected through water year 2007. Flood magnitudes at the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence intervals were estimated for streamgages and crest-stage gages on streams in New Jersey during the August 27–30, 2011, floods.

Table 1. Characteristics of survey monuments on record with the National Geodetic Survey that were incorporated into the Virtual Reference Station System used for determining peak flood elevations of the August 27–30, 2011, flood in New Jersey.

[PID, permanent identifier; NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988; VRS, Virtual Reference Station System]

Benchmark designation	Benchmark PID	Published latitude (NAD 83)	Published longitude (NAD 83)	Published elevation, in feet (NAVD 88)	Elevation determined by VRS, in feet (NAVD 88)	Difference[1] in elevation, in feet
8 D 1	AI4356	39° 43’ 24.1” N	75° 13’ 29” W	83.40	83.31	-0.09
11 M 4	DE9832	40° 12’ 35” N	74° 45’ 20” W	51.87	52.03	0.16
14 P 11	DF7148	40° 49’ 17” N	74° 24’ 44” W	196.98	197.03	0.05
6 V 2	DI3285	39° 32’ 52” N	75° 03’ 31” W	101.92	101.97	0.05
13 H 6	DK6560	40° 14’ 04” N	74° 13’ 57” W	146.67	146.84	0.17
27284	DM7244	39° 57’ 39” N	74° 48’ 25” W	13.36	13.71	0.35
3 X 3	DM7279	39° 58’ 13” N	74° 41’ 03” W	38.79	38.84	0.05
H 9	JU0946	39° 25’ 39” N	75° 14’ 22” W	46.05	46.07	0.02
V 9	JU1937	39° 37’ 12.8” N	75° 30’ 19.8” W	14.12	14.09	-0.03
SUMMIT	KV0669	40° 42’ 51” N	74° 21’ 34” W	383.63	383.72	0.09
B 53	KV0939	40° 29’ 52” N	74° 26’ 06” W	57.45	57.40	-0.05
A 74	KV1122	40° 18’ 38” N	74° 30’ 36” W	94.02	94.15	0.13
C 74	KV1123	40° 17’ 43” N	74° 31’ 03” W	87.30	87.25	-0.05
F 26	KV1180	40° 34’ 14” N	74° 38’ 04” W	75.09	74.95	-0.14
U 18	KV1225	40° 54’ 19” N	74° 35’ 57.2” W	681.78	681.78	0.00
Y 18	KV1231	40° 52’ 46.1” N	74° 31’ 30.9” W	550.30	550.26	-0.04
S 25	KV1350	40° 39’ 55” N	74° 43’ 18” W	164.97	164.86	-0.11
M 29	KV1380	40° 32’ 38.1” N	74° 49’ 38.1” W	187.48	187.47	-0.01
F 101	KV3412	40° 47’ 11.8” N	74° 08’ 54.7” W	16.20	15.92	-0.28
T 101	KV3430	40° 54’ 17” N	74° 12’ 26” W	149.08	149.11	0.03
G 102	KV3442	40° 59’ 15” N	74° 18’ 05” W	210.20	210.14	-0.06
E 102	KV3443	40° 59’ 14” N	74° 17’ 57” W	200.85	200.67	-0.18
K 103	KV3445	40° 59’ 23” N	74° 06’ 51” W	126.69	126.78	0.09
EWING	KV6645	40° 14’ 40.5” N	74° 46’ 00.3” W	72.62	72.67	0.05
8105	KV6802	40° 10’ 16.6” N	74° 38’ 07.2” W	83.48	83.55	0.07
C 103	LY2266	41° 06’ 09” N	74° 08’ 53” W	282.72	282.67	-0.05

[1]Vertical root mean square error (RMSE) of all 26 benchmarks, 0.12 feet.

Continuous-Record Streamflow-Gaging Station Network

Continuous-record streamflow-gaging stations provide stage and streamflow data at regular intervals throughout the day. The streamflow data, usually computed at 15-minute intervals, are used to compute daily mean flow and annual maximum peak streamflow values. Annual peak discharges for the period of record at each gage are stored in the USGS National Water Information System (NWIS) data base available on the World Wide Web at *http://nwis.waterdata.usgs.gov/nj/nwis*. Flood-frequency statistics in this report were computed from the annual peak discharge from continuous records of streamflow collected at 80 active streamgages across New Jersey with 20 or more years of record. The New Jersey Water Science Center operated 130 streamflow-gaging stations during Hurricane Irene. Peaks from three gages were not approved for publication. New Jersey currently (2013) has a network of 137 active continuous-record streamflow-gaging stations. A discharge measurement being made during the Hurricane Irene flood along the Saddle River at Lodi in New Jersey is shown in figure 3. Figure 4 is a photograph of the streamflow-gaging station on the Saddle River at Lodi in New Jersey just after the peak on August 28, 2011.

Figure 3. Peak-streamflow measurement along the Saddle River at Lodi, New Jersey (U.S. Geological Survey station 01391500) on August 28, 2011. (Photograph by John J. Trainor, U.S. Geological Survey)

Figure 4. Flooding at the streamgage on the Saddle River at Lodi, New Jersey (U.S.Geological Survey station 01391500), after the peak on August 28, 2011. (Photograph by John J. Trainor, U.S. Geological Survey)

Datums

Elevations presented in this report are referenced to the gage datum and North American Vertical Datum of 1988 (NAVD 88). All latitudes and longitudes presented in this report are referenced to the North American Datum of 1983 (NAD 83).

- **Gage datum** is a horizontal surface used as a zero point for measurement of stage or gage height. This surface usually is located slightly below the lowest point of the stream bottom such that the gage height is usually slightly greater than the maximum depth of water. Gage datum is set to give users a perspective on high and low streamflows and is usually defined by specifying the elevations of permanent reference marks such as bridge abutments and survey monuments. The gage is set to agree with the reference marks. Gage datum is a local datum that is maintained independently of any national geodetic datum. However, if the elevation of the gage datum relative to the national datum NAVD 88 has been determined, then the gage readings can be converted to elevations above the national datum by adding the elevation of the gage datum to the gage reading.
- **North American Vertical Datum of 1988** (NAVD 88) is a fixed reference adopted as the official civilian vertical datum for elevations determined by Federal surveying and mapping activities in the United States. This datum was established in 1991 by minimum-constraint adjustment of the Canadian**,** Mexican, and United States first-order terrestrial leveling networks.
- **North American Datum of 1983** (NAD 83) is the horizontal control datum for the United States, Canada, Mexico, and Central America that is based on the adjustment of 250,000 points including 600 satellite Doppler stations that constrain the system to a geocentric origin. NAD 83 has been officially adopted as the legal horizontal datum for the United States by the Federal Government.

Conditions Preceding and During Floods

Antecedent precipitation, precipitation during the storm, stream elevations, and flows during August 27–30, 2011, as well as the extent of the flood and hydrologic components supplemental to the flood are discussed in the following sections.

Antecedent Conditions

Rainfall in New Jersey during the period August 1 through August 26, 2011, ranged from 8 inches to more than 16 inches. These totals ranged from 150 to 600 percent of the normal total for the month of August. The total precipitation observed during the 2-week period preceding Hurricane Irene ranged from 300 to 600 percent of normal from southwestern through central New Jersey (fig. 5). Heavy rain associated with a low-pressure system that moved northeast along the Atlantic Coast, in general, dropped 4 to 8 inches of rain over most of the State from late Saturday night, August 13, through late Sunday night, August 14, 2011. The storms that accompanied this system would have normally caused the largest flooding event in most months; flash flooding and flooding of some moderate-size rivers in eastern Salem, western Cumberland, eastern Gloucester, eastern Camden, and western Atlantic Counties caused some roads and dams to become damaged or submerged. In Upper Deerfield Township (Cumberland County), 10.82 inches of rain fell from the 13th into the 14th, and in Franklin Township (Gloucester County), 8.53 inches was recorded. Even after this major event, localized rainstorms that caused notable flooding occurred on the 15th in Sussex, Morris, Cape May, and Somerset Counties. Thunderstorms occurred on the 18th and 19th in most of the State. Another storm occurred on the 21st in Monmouth and northern Ocean Counties, and heavy rain fell on the 25th in southwestern New Jersey, causing river levels to remain high and soils to stay saturated prior to Hurricane Irene (Northeast Regional Climate Center Mid-Atlantic Climate, 2011).

Despite below-average precipitation in June and July (U.S. Geological Survey, 2011), the precipitation in August made the summer of 2011 the wettest season on record for New Jersey. Precipitation totaled 24.25 inches from June through August, which is 4.58 inches more than the previous summer season record of 19.67 inches in 1928. The annual total for New Jersey was 64.78 inches in 2011, which was 17.58 inches more than normal (table 2), and 4.80 inches more than the previous record set in 1996 (New Jersey State Climatologist, 2013).

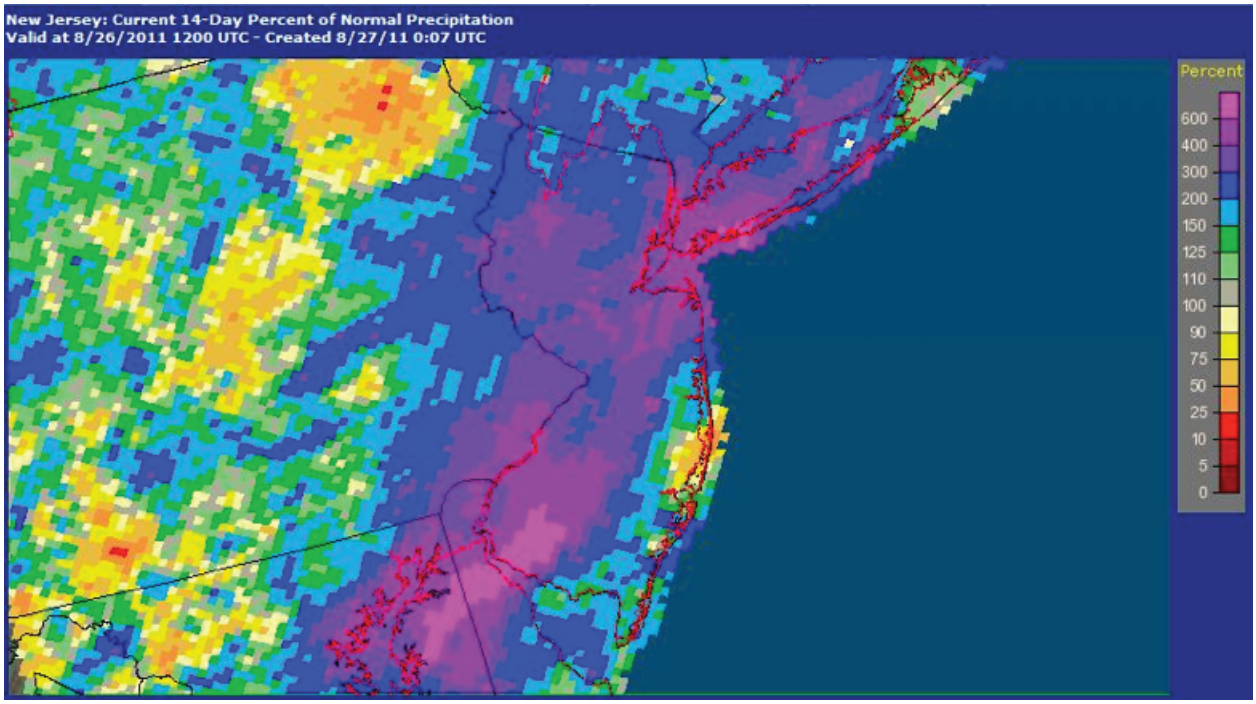


Figure 5. National Weather Service map showing the percent of normal precipitation in New Jersey and vicinity observed for the 2-week period preceding Hurricane Irene, August 26, 2011. (From National Weather Service, 2011)

Table 2. Top 10 annual precipitation totals for New Jersey, 1895–2011.

[Data courtesy of the New Jersey State Climatologist, 2013]

Rank	Year	Total rainfall (inches)	Departure from normal (in inches)
1	2011	64.78	17.58
2	1996	59.98	12.78
3	1975	58.85	11.65
4	1983	58.33	11.13
5	2003	57.76	10.56
6	1972	57.56	10.36
7	1979	56.60	9.4
8	1989	55.56	8.36
9	1903	55.08	7.88
10	1902	54.73	7.53

Precipitation

Hurricane Irene moved north along the Atlantic Coast, making landfall near Cape Lookout, North Carolina, in the early morning hours on Saturday, August 27, 2011. The hurricane then moved back over open water before making landfall as a strong tropical storm at Little Egg Inlet, New Jersey, at 0535 hours Eastern Daylight Time Sunday morning, August 28, 2011 (Associated Press, 2011) (fig. 6). Light rain began to fall during late morning on Saturday, August 27 in southern New Jersey. Steady, heavier rain developed on Saturday afternoon moving into northern New Jersey by mid-afternoon. Rain continued for about an 18-hour period through Sunday morning. From 6 to 8 inches fell across most of the State. Higher amounts, from 9 inches to as much as 11.27 inches, were observed at USGS, National Weather Service (NWS), and Office of the New Jersey State Climatologist precipitation gages in southwestern, central, and northeastern New Jersey (table 3). A NWS map of total observed precipitation for the 24-hour period ending August 28, 2011, at 0800 hours Eastern Daylight Time (fig. 7) shows the distribution of precipitation from Hurricane Irene across the State. The total precipitation amounts associated with Hurricane Irene from August 25–29, 2011, spanning the entire east coast are shown in figure 8.

During August 27–30, precipitation data were collected from 41 precipitation gages operated by the USGS. In

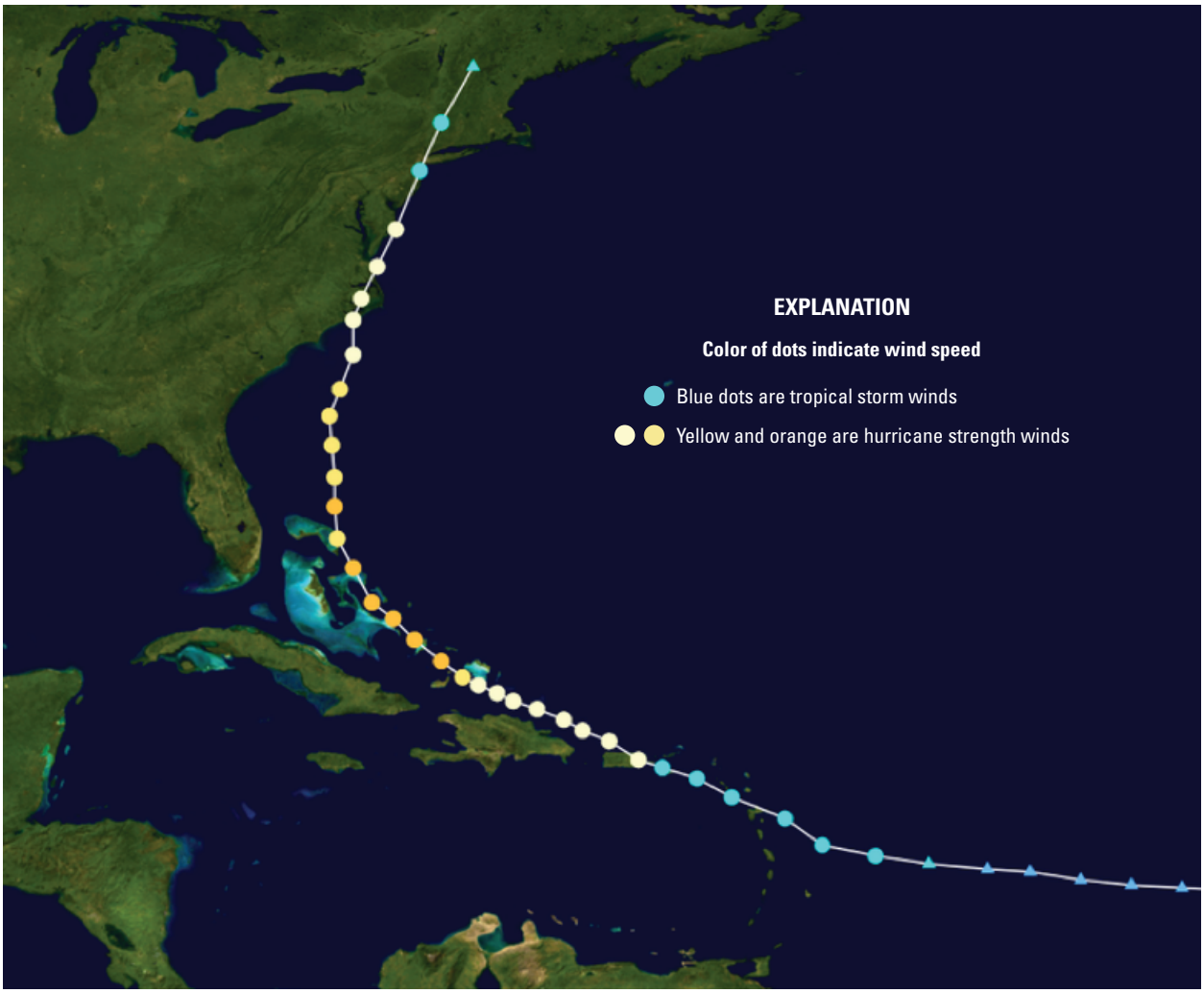


Figure 6. Hurricane Irene's track up the east coast of the United States, August 21–28, 2011. The points show the location of the storm at 6-hour intervals. Image is courtesy of NASA and the National Hurricane Center. (National Oceanic and Atmospheric Administration, 2011)

addition, precipitation data were collected at 106 locations by the NWS. Precipitation gages operated by the USGS recorded total precipitation amounts ranging from 4.2 inches at the USGS precipitation gage at Lakewood in Monmouth County (400530074090901) to 10.3 inches at the USGS precipitation gage at Stockton in Hunterdon County (402414074584401) (table 4). Precipitation gages at NWS climate sites at Newark, Trenton, and Atlantic City recorded 8.92 inches, 5.74 inches, and 5.88 inches, respectively (National Climatic Data Center, 2011). USGS precipitation gages recorded from about 5.5 to almost 10 inches of rain in the Raritan and Rahway River Basins, 7.9 to 8.7 inches in the Passaic and Hackensack River Basins, 4.9 to almost 8.0 inches in the Lower Delaware River Basin, 6.2 to 10.3 inches in the Upper Delaware Basin, and 4.2 to 8.6 inches in the southern Atlantic Coastal Plain Basins (table 4). Precipitation gages at NWS sites in Morris County recorded between 8.9 and 10.5 inches, in Ocean County between 7.1 and 9.1 inches, and in Cape May County between 4.9 and 8.6 inches of rain (National Climatic Data Center, 2011).

Precipitation totals were remarkably higher than normal in August across the State. August was the wettest month on record in New Jersey since record keeping began in 1895. An average of 17.16 inches of rain fell statewide. This is 12.95 inches greater than the 1981 to 2010 monthly average of 4.21 inches and 5.18 inches more than the second wettest month on record, October 2005. Rainfall in August 2011 exceeded many records for any month at various rain gages throughout New Jersey. For instance, at Seabrook Farms in Upper Deerfield Township, 24.28 inches was observed for the month, 11.29 inches more than the record set in August 1967. At Hightstown (Monmouth County) 19.29 inches was observed, 5.43 inches

Table 3. The maximum recorded precipitation in each New Jersey county during August 27–28, 2011.

[Data are drawn from more than 200 observations deemed reasonable. Sources include Spotter, National Weather Service (NWS) spotters; Coop, NWS Cooperative Observers; Mesonet, Office of the New Jersey State Climatologist (ONJSC); CoCoRaHS, Community Collaborative Rain, Hail, Snow network; ONJSC, a direct report to the ONJSC; USGS, U.S. Geological Survey]

County	Precipitation (inches)	Town	Source
Atlantic	8.6	Estell Manor	Spotter
Bergen	9.1	Garfield	Spotter
Burlington	7.3	Crosswicks	Spotter
Camden	8.6	Somerdale	Coop
Cape May	8.6	Upper Township	CoCoRaHS
Cumberland	7.9	Upper Deerfield Township	Mesonet
Essex	10.0	Orange	Spotter, USGS
Gloucester	7.8	Franklin Township	CoCoRaHS
Hudson	9.2	Harrison	Coop
Hunterdon	10.3	Stockton	USGS
Mercer	8.4	Windsor	Spotter
Middlesex	8.9	Edison	Spotter
Monmouth	11.3	Freehold Township	CoCoRaHS
Morris	10.5	Jefferson Township	CoCoRaHS
Ocean	7.3	Brick Township	CoCoRaHS
Passaic	10.2	Wayne	ONJSC
Salem	8.0	Woodstown	USGS
Somerset	8.4	Bedminster	CoCoRaHS
Sussex	8.0	Wantage	CoCoRaHS
Union	10.8	Elizabeth	Spotter
Warren	7.3	Mansfield Township	CoCoRaHS

more than the record set in August 1955. Newark International Airport had 18.79 inches of precipitation, surpassing the record of 13.22 inches recorded in October 2005 (Northeast Regional Climate Center Mid-Atlantic Climate, 2011). Precipitation recorded at the NWS Philadelphia, Pennsylvania, gage from August 1 through August 28 was 19.31 inches, making this the all-time wettest month on record in Philadelphia (Northeast Regional Climate Center Archived News, 2011). This breaks the previous monthly record of 13.07 inches set in September 1999 (National Weather Service, 2011).

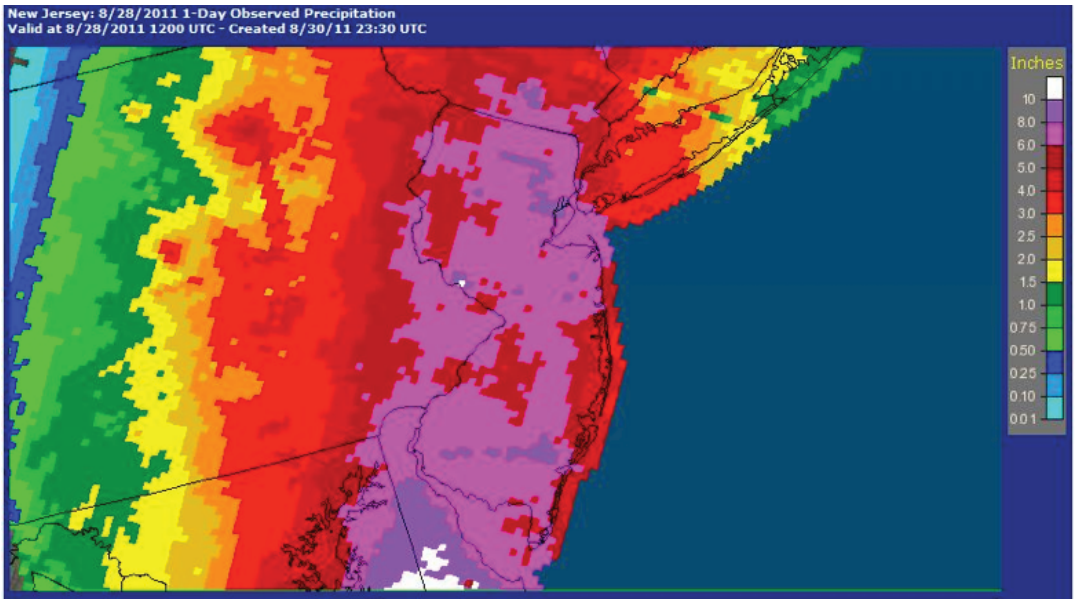


Figure 7. National Weather Service map of total observed precipitation in New Jersey and vicinity for 24-hour period ending August 28, 2011, at 0800 hours eastern daylight time. (From National Weather Service, 2011)

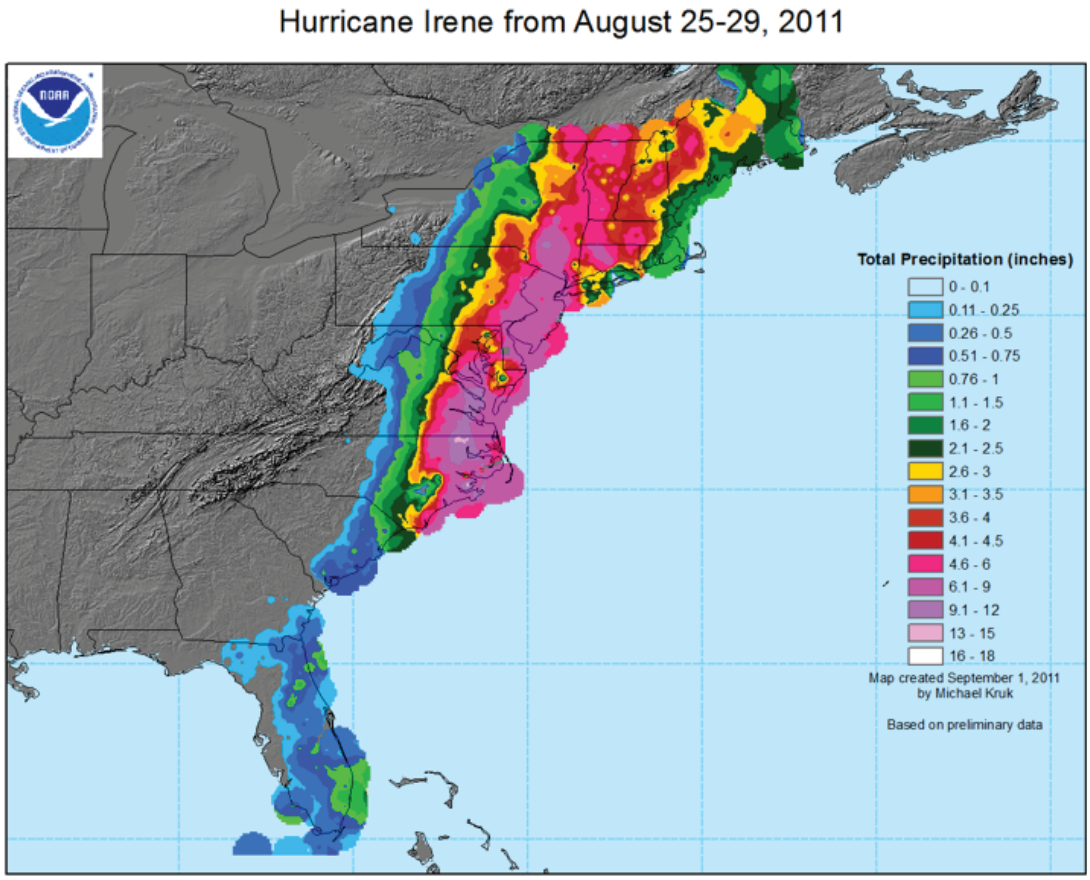


Figure 8. Total precipitation amounts from Hurricane Irene, August 25–29, 2011. Courtesy of the National Oceanic and Atmospheric Administration.

Table 4. Total rainfall at U.S. Geological Survey precipitation gages, in New Jersey, excluding 10 gages with missing or inaccurate data, August 27–30, 2011, and August 1–31, 2011.

[USGS, U.S. Geological Survey; NJ, New Jersey]

River basins	Map identification number	Station name	County	Station number	Total rainfall, August 27–30, 2011 (inches)	Total rainfall, August 1–31, 2011 (inches)
Passaic	1	Little Falls USGS heated rain gage NJ	Passaic	405219074132001	8.6	15.6
	2	Nanuet USGS unheated rain gage NY	Rockland	410518074020300	8.0	16.2
Hackensack	3	Woodcliff Lake USGS unheated rain gage NJ	Bergen	410043074025301	8.7	16.1
	4	Park Ridge USGS heated rain gage NJ	Bergen	410212074022101	7.9	16.0
Raritan	5	Old Bridge USGS heated rain gage NJ	Middlesex	402454074205601	6.0	14.5
	6	Skillman USGS unheated rain gage NJ	Somerset	402504074414201	7.4	17.4
	7	Belle Mead USGS unheated rain gage NJ	Somerset	402805074385601	5.5	17.3
	8	Middlebush USGS unheated rain gage NJ	Somerset	402955074312501	6.8	16.3
	9	Readington USGS unheated rain gage NJ	Somerset	403328074434901	6.5	14.6
	10	Bound Brook USGS unheated rain gage NJ	Somerset	403338074325301	7.1	20.3
	11	Middlesex USGS unheated rain gage NJ	Somerset	403506074302801	7.9	21.7
	12	Martinsville USGS unheated rain gage NJ	Somerset	403644074352701	6.2	14.5
	13	Clinton USGS heated rain gage NJ	Hunterdon	403824074545601	6.3	14.6
	14	Far Hills USGS unheated rain gage NJ	Somerset	404223074381101	6.2	14.3
	15	Four Bridges USGS unheated rain gage NJ	Morris	404822074442601	6.6	15.8
Rahway	16	Mountainside USGS unheated rain gage NJ	Union	404059074223301	8.5	16.1
	17	Maplewood USGS unheated rain gage NJ	Essex	404405074161401	9.0	16.7
	18	Orange Reservoir USGS unheated rain gage NJ	Essex	404550074171600	10.0	20.0
Atlantic Coastal	19	Cape May USGS weather station NJ	Cape May	385655074532601	7.5	10.0
	20	Atlantic City USGS weather station NJ	Atlantic	392239074252401	5.2	9.4
	21	Folsom USGS heated rain gage NJ	Atlantic	393541074510601	5.8	16.2
	22	Shamong USGS heated rain gage NJ	Burlington	394728074452501	8.6	21.3
	23	Lakewood USGS unheated rain gage NJ	Ocean	400530074090901	4.2	9.2
	24	Point Pleasant USGS weather station NJ	Ocean	400606074021501	5.0	11.7
Lower Delaware	25	Woodstown USGS unheated rain gage NJ	Salem	393838075194901	8.0	17.1
	26	Medford USGS unheated rain gage NJ	Burlington	395343074492501	4.9	13.9
	27	New Lisbon USGS unheated rain gage NJ	Burlington	395722074374001	6.7	16.9
Upper Delaware	28	Stockton USGS heated rain gage NJ	Hunterdon	402414074584401	10.3	22.0
	29	Riegelsville USGS heated rain gage NJ	Warren	403541075112301	6.2	13.5
	30	Lake Hopatcong USGS unheated rain gage NJ	Morris	405502074395601	6.4	16.2
	31	Flatbrookville USGS heated rain gage NJ	Sussex	410622074570901	7.2	14.7

Response to the Event

The USGS New Jersey Water Science Center's Hydrologic Data Assessment Program prepared for field work in response to the forecast of flood conditions the week before the high water occurred. Seven storm-surge sensors were deployed on Friday, August 26, 2011, at tidal crest-stage gage sites along the coast in support of the USGS national storm-surge monitoring network. These sensors collected continuous water-level data throughout the storm to supplement the 24 long-term tide gages along the back bays and tidal rivers along the coast. The storm-surge data collected were used to verify the data collected at the 24 long-term tide gages as well as to assess storm, wind, and flood damage. They may also be used to improve models that will forecast coastal change in the future.

Real-time data from USGS streamgages across New Jersey were invaluable in planning the first line of response to the storm. The real-time data helped USGS personnel focus efforts on the watersheds experiencing the most flooding. Early Sunday morning, August 28, 2011, six crews were dispatched to selected streamgages to make discharge measurements (fig. 9). Two other crews collected water-quality samples on the rising limb of the hydrograph of the Delaware River at Trenton, NJ, (01463500) and Raritan River at Queens Bridge at Bound Brook, NJ (01403300), gages for the USGS National Water Quality Assessment NAWQA program (fig. 10). Sampling continued at these sites during the peak and recession on Monday and Tuesday, August 29–30. Samples were collected for bacteria analysis at six sites along the Passaic River on Wednesday, August 31, and Thursday, September 1.

Six crews continued to make high-water discharge measurements throughout the week. Over 75 discharge measurements were made from August 28 through September 2, and HWMs were flagged for indirect measurements of peak flow at 8 streamgages. Discharge measurements were the highest ever made at many long-term streamgages. Discharge measurements also were the highest ever made at many relatively new streamgages, defining the upper limb of the stage-discharge rating curves. Discharge measurements were made at streamgages on small streams on August 28. Discharge measurements were made August 30–31 at or near the flood peak at streamgages with drainage from larger basins where streams were slower to crest. Discharge measurements at some of these streamgages were made on the receding limb of the hydrograph during September 1–2. Photographs of the flooded areas were taken at many streamgages (fig. 11).

Peak stage exceeded the upper end of the stage-discharge rating curves at many streamgages during this event. Discharge measurements were used to extend stage-discharge ratings at more than 25 streamgages.

The USGS NJWSC stayed in communication with the U.S. Army Corps of Engineers, New York District; the NWS Mount Holly forecast office; and the NWS Mid-Atlantic River

Figure 9. Peak-flow measurement along the South Branch Rancocas Creek at Vincentown, New Jersey (U.S. Geological Survey station 01465850) made on August 28, 2011. (Photograph by Richard W. Edwards, U.S. Geological Survey)

Figure 10. Water-quality sampling along the Raritan River at Queens Bridge at Bound Brook, New Jersey (U.S. Geological Survey station 01403300), following Hurricane Irene. (Photograph by Pamela Reilly, U.S. Geological Survey)

Forecast Center office during the hurricane. Requests were answered for maximum recordable stages at flood-forecast gages, rating extensions at numerous streamgages, peak-stage and flow data from streamgages, comparisons of peaks from this storm with historic peaks, and the flood frequency of the event at various locations by USGS NJWSC personnel. NJWSC personnel participated in daily conference calls with the USGS National Flood Specialist and personnel at other Water Science Centers about flooding in east coast states. FEMA was contacted by the NJWSC with an offer of assistance with flood-related work. A mission assignment was accepted to document HWMs at more than 150 locations along streams that experienced record-breaking flooding.

Peak Streamflows at Continuous-Record Streamflow-Gaging Stations

New Jersey experienced record flooding at USGS streamgages during the month of August. The streamgage on the Cohansey River at Seeley (01412800) registered a record peak on August 14, 2011 (fig. 12). The second and third highest peaks of record occurred at other streamgages in

Figure 11. Flooding along the Rahway River near Springfield, New Jersey (U.S. Geological Survey station 01394500) on August 28, 2011. (Photograph by Andrew F. Watson)

southwestern New Jersey from August 14 to 16, 2011. Record high peaks were recorded statewide from August 28 to 30 as a result of Hurricane Irene. Thirty-seven of the 96 streamgages with greater than or equal to 20 years of record, considered long-term streamgages, registered record high peaks. Another 26 streamgages recorded the second highest peaks of record, and 14 streamgages recorded the third highest peaks of record (fig. 13). Statewide 28 streamgages recorded peaks equal to or greater than the 100-year recurrence interval (< 1.0% annual-exceedance probability) (fig.14). Maximum streamflow per square mile ranged from 20 to 759 cubic feet per second per square mile. Flood peaks for this event, and historical peaks of record for streamgages and crest-stage gages throughout the State are listed in tables 5, 6, and 7 (tables 5, 6, and 7 are in back of report). Flood frequency statistics computed for streamgaging stations with at least 20 years of record and crest-stage gages with more than 10 years of record are listed in tables 5 and 7.

Peaks at a few active continuous-record discharge gages are not listed in tables 5 or 6. The gage on the Delaware and Raritan Canal at Port Mercer, New Jersey (01460440), is not listed in either table because a breach in the canal berm during the flood damaged the gage. No data were collected at the peak. The new index velocity gage on the Point Pleasant Canal at Point Pleasant, New Jersey (01408043), was being calibrated during the event. Peak discharge was not approved for publication. Instantaneous peak flows at the gage on Canoe Brook near Summit, New Jersey (01379530), were not approved for publication.

Flood peaks were the highest ever recorded at 23 of the 31 streamflow-gaging stations with less than 20 years of record (table 6). Four of these gages recorded the second highest peak, and two recorded the third highest peaks of record. Maximum streamflow per square mile ranged from 9.3 to 989 cubic feet per second per square mile

Flood peaks were the highest ever recorded at 10 of the 23 USGS long-term continuous-record streamflow-gaging stations in the Passaic and Hackensack River Basin (table 5). The streamgages at Whippany River at Morristown, NJ (01381800), Wanaque River at Awosting, NJ (01383500; fig. 15), Ramapo River near Mahwah, NJ (01387450), and Ramapo River at Pompton Lakes, NJ (01388000), recorded

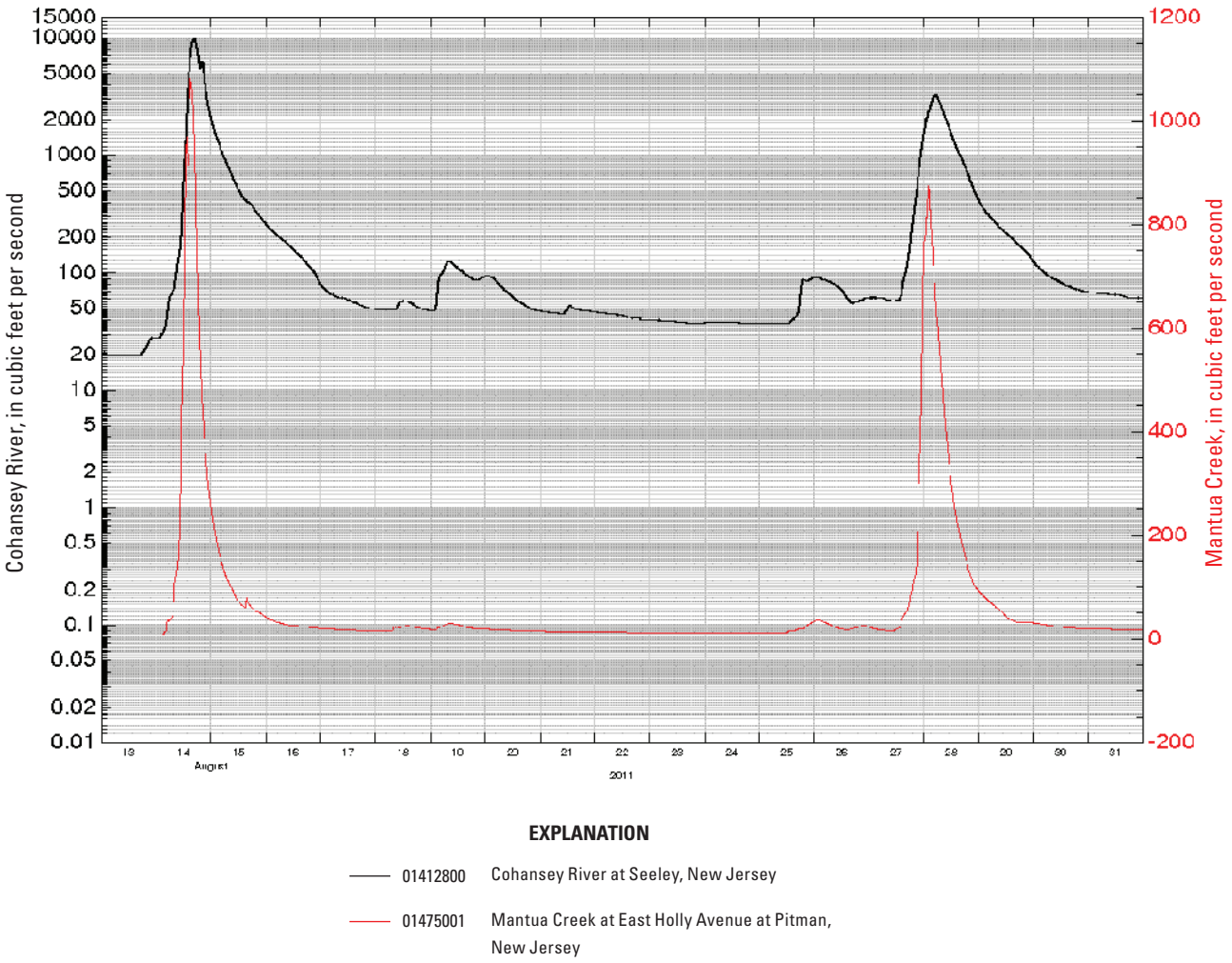


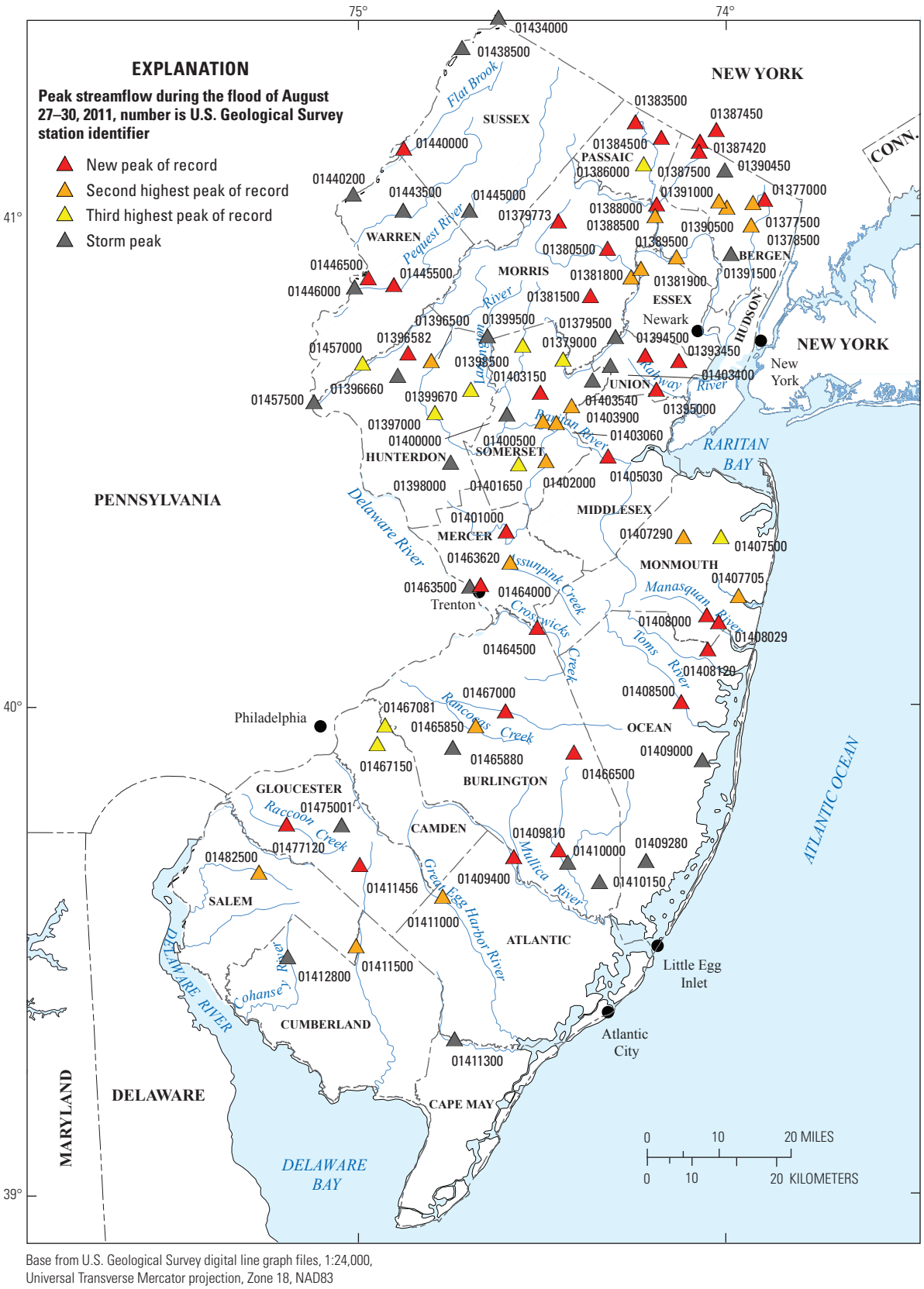
Figure 12. Computed discharge at U.S. Geological Survey continuous-record streamflow-gaging stations Cohansey River at Seeley, New Jersey (01412800) and Mantua Creek at East Holly Avenue at Pitman, New Jersey (01475001), August 13–31, 2011.

the highest flood peaks in more than 90 years of record. The peak stages at the Rockaway River above Reservoir at Boonton, NJ (01380500), Ramapo River near Mahwah, NJ (01387500), and Whippany River near Pine Brook, NJ (01381800), were more than 2 ft higher than the previous peaks of record (fig. 16). The second highest peaks of record were recorded at 9 of the 23 streamgages in the basins. Many residential and commercial properties along the Pompton and Ramapo Rivers in the Passaic River Basin were flooded (fig. 17). Many roads throughout the basin were impassable (fig. 18).

In the Raritan River Basin, flood peaks were the highest ever recorded at 5 of the 20 long-term streamgages (fig. 19). Lamington (Black) River near Pottersville (01399500) streamgage recorded the highest peak in more than 90 years of record. The peak stages at the Stony Brook at Princeton (01401000) and Millstone River at Blackwells Mills, NJ (01402000), streamgages were nearly 2 ft higher than the previous record. Six of the 20 streamgages in the basin recorded the second highest peak of record.

The streamgage on the Elizabeth River (01393450) and the two streamgages on the Rahway River at Springfield (01394500) and at Rahway (1395000) recorded new peaks of record for 90, 74, and 90 years of record, respectively. The peak stage at the Rahway River at Rahway was 2.5 ft higher than the previous peak of record set on September 17, 1999.

Along the Delaware River on tributaries north of Trenton, NJ, 5 of the 8 long-term streamgages recorded peaks of record. Peak-streamflow records were set at the streamgages Flat Brook near Flatbrookville, NJ (01440000), Assunpink Creek at Trenton, NJ (01464000), Pequest River at Huntsville, NJ (01445000), Pequest River at Pequest, NJ (01445500), and Beaver Brook near Belvidere, NJ (01446000), which have 88, 88, 67, 90, and 82 years of record, respectively. Two additional streamgages on these tributaries recorded the second highest peaks of record. Along tributaries to the Delaware River in the Coastal Plain south of Trenton, 5 of the 13



Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 13. Location and rank of flood peaks recorded at U.S. Geological Survey continuous-record streamflow-gaging stations during the Hurricane Irene flood of August 27–30, 2011, in New Jersey. Figure 13. Location and rank of flood peaks recorded at U.S. Geological Survey continuous-record streamflow-gaging stations during the Hurricane Irene flood of August 27–30, 2011, in New Jersey.

Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 14. Location and recurrence interval of peak streamflow recorded at U.S. Geological Survey continuous-record streamflow-gaging stations during the Hurricane Irene flood of August 27–30, 2011, in New Jersey.

Figure 15. Flooding at the continuous-record streamflow-gaging station, Wanaque River at Awosting, New Jersey (U.S.Geological Survey station 01383500), after the peak stage on August 28, 2011. (Photograph by John J. Trainor, U.S. Geological Survey)

long-term streamgages recorded peaks of record. Peak streamflow records were set at Little Ease Run near Clayton, NJ (01411456), Crosswicks Creek at Extonville, NJ (01464500), McDonalds Branch in Byrne State Forest, NJ (01466500), North Branch Rancocas Creek at Pemberton, NJ (01467000), and Raccoon Creek near Swedesboro, NJ (01477120), which have 24, 72, 58, 90, and 45 years of record, respectively. The peak stage at the Crosswicks Creek at Extonville, NJ (01464500), streamgage was 2.9 ft higher than the previous peak of record (figs. 20 and 21). Four other streamgages on tributaries to the Delaware River in the Coastal Plain recorded the second highest peaks of record.

In the Atlantic coastal drainages, 6 of 14 long-term streamgages recorded peaks of record. Peak-flow records were set at the streamgages Manasquan River at Squankum, NJ (01408000), Manasquan River near Allenwood, NJ (01408029), North Branch Metedeconk River near Lakewood, NJ (01408120), Toms River near Toms River, NJ (01408500), Mullica River near Batsto, NJ (01409400), and West Branch Wading River near Jenkins, NJ (01409810). The record peak at the Toms River streamgage was the highest in 83 years of record. Two other streamgages recorded the second highest peaks of record.

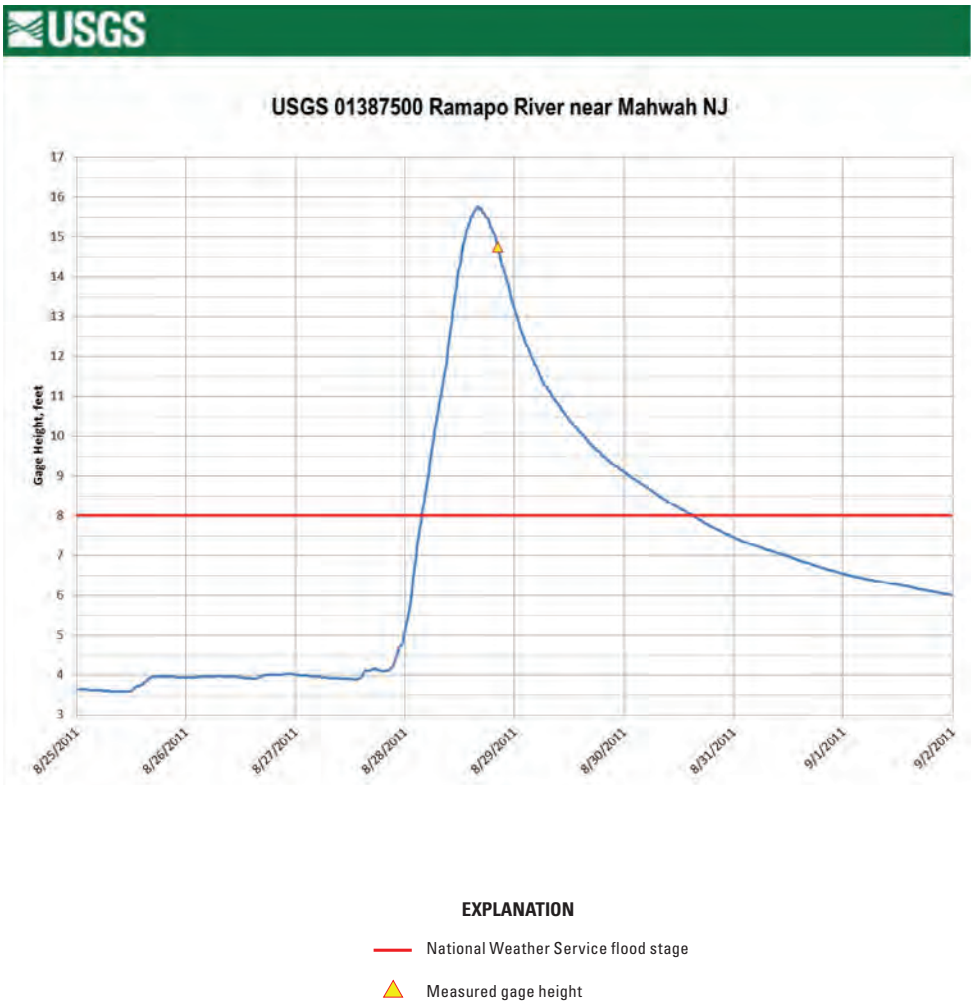


Figure 16. Hydrograph showing the record peak stage on August 28, 2011, at the U.S. Geological Survey continuous-record streamflow-gaging station on the Ramapo River near Mahwah, New Jersey. (U.S. Geological Survey station 01387500)

Figure 17. Flooding at the stage-only gaging station on the Ramapo River at Dawes Highway, at Pompton, New Jersey (U.S. Geological Survey station 01388100), after the peak on August 29, 2011. (Photograph by Robert W. Atkinson, U.S. Geological Survey)

Figure 18. Flooding on Jackson Avenue near the streamgage on the Pompton River at Pompton Plains, New Jersey (U.S.Geological Survey station 01388500), after the peak on August 29, 2011. (Photograph by Robert W. Atkinson, U.S. Geological Survey)

Figure 19. Flooding along the Raritan River below Calco Dam at Bound Brook, New Jersey (U.S. Geological Survey station 01403060), following the peak on August 28, 2011. (Photograph by Andrew F. Watson, U.S. Geological Survey)

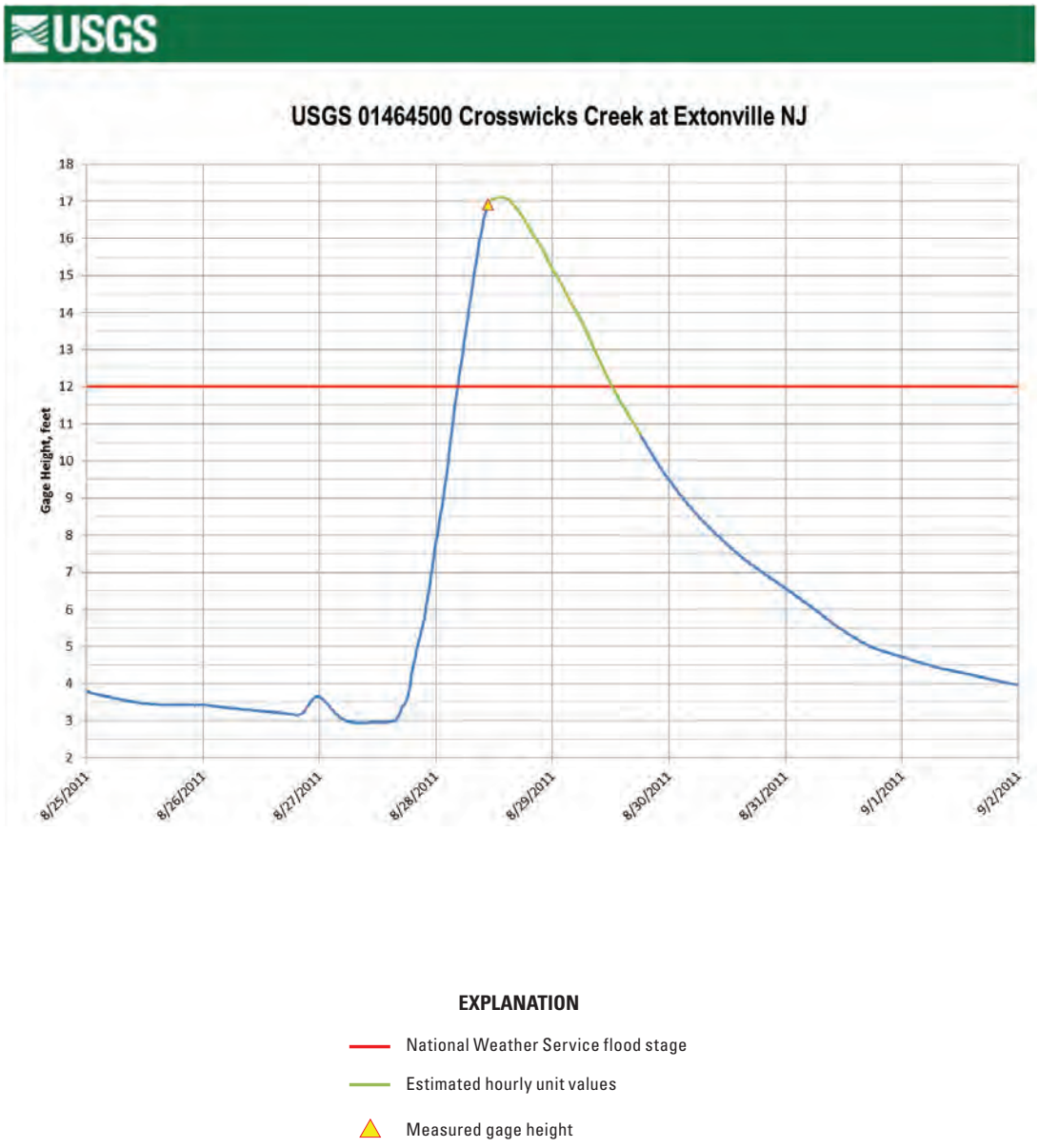


Figure 20. Hydrograph showing record peak stage on August 28, 2011, at the continuous-record streamflow-gaging station on Crosswicks Creek at Extonville, New Jersey (U.S. Geological Survey station 01464500).

Figure 21. Flooding along Crosswicks Creek at Extonville, Mercer County, New Jersey (U.S. Geological Survey station 01464500), following the peak on August 28, 2011. (Photograph by Andrew F. Watson, U.S. Geological Survey)

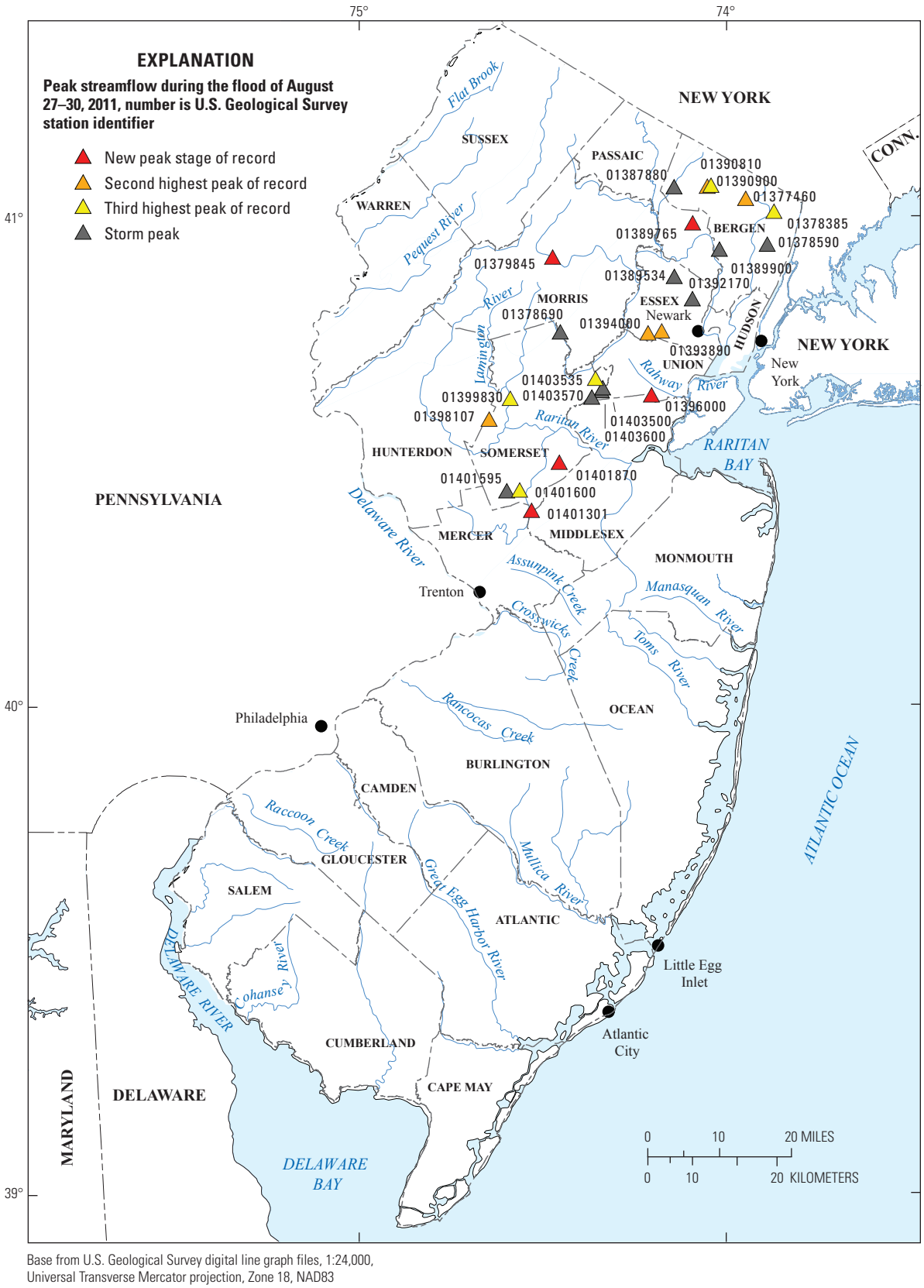
Peak Streamflows at Crest-Stage Partial-Record Stations

The August 27–30, 2011, flood peaks rank as the highest peak of record at 5 of the 27 USGS crest-stage partial-record stations in New Jersey. A new peak of record was recorded at crest-stage gages on Stony Brook at North Plainfield, NJ (01403570), Rockaway River at Warren Street at Dover, NJ (01379845), Robinsons Branch at Rahway, NJ (01396000), Millstone River at Carnegie Lake at Princeton, NJ (01401301), and Six Mile Run near Middlebush, NJ (01401870) (fig. 22). The second highest peak of record was recorded at 5 of the 27 crest-stage gages. Flood-frequency recurrence intervals for the peak-of-record floods ranged from greater than 10 to greater than 100 years at the crest-stage gages (fig. 23). Flood peaks for this event, historical peaks of record, and flood frequency statistics for streamgages throughout the State are listed in tables 8 and 9 (table 8 is in back of report).

Water-Surface Elevation at Continuous-Record Tide-Telemetry Gages

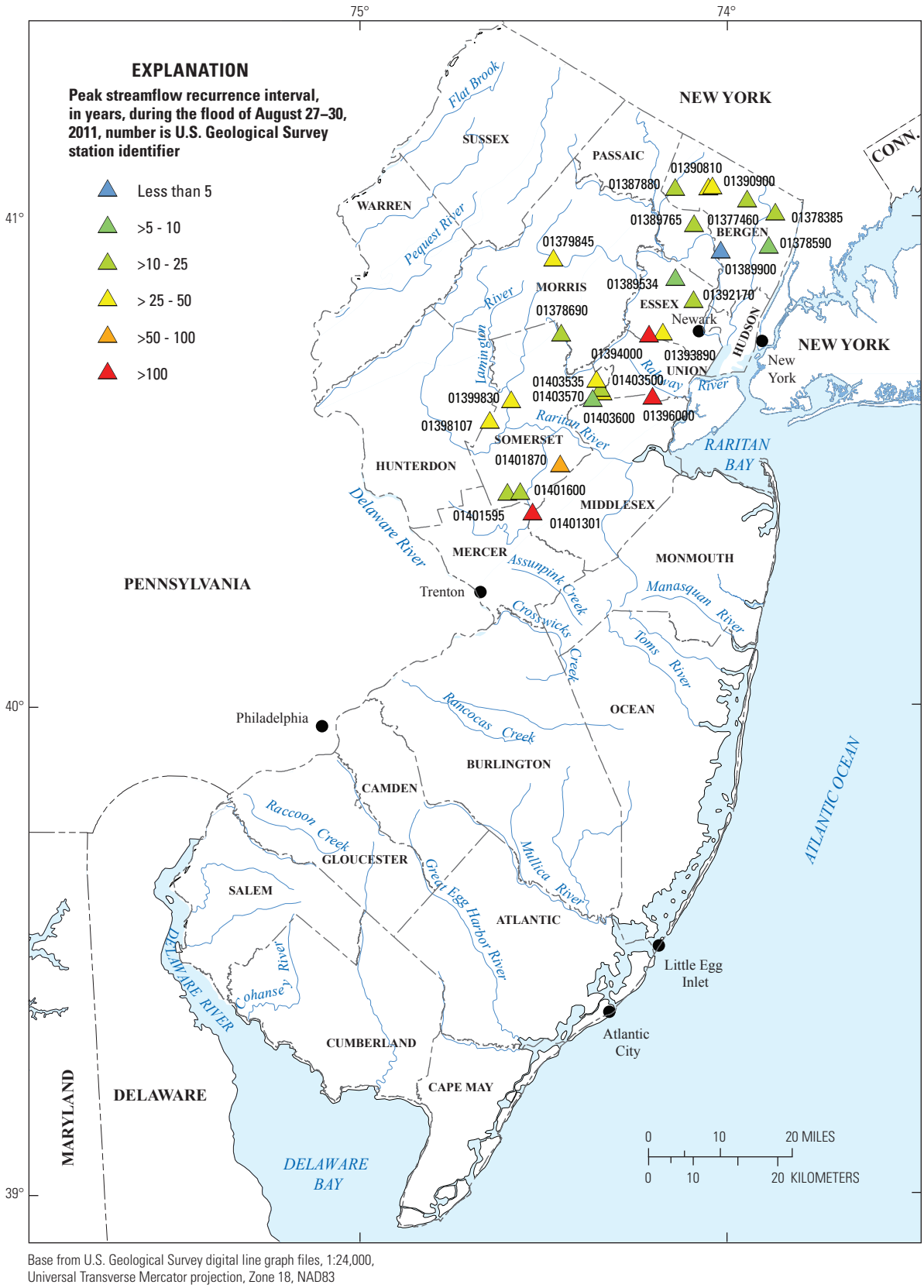
The water-surface elevation during high tide on Sunday morning, August 28, 2011, was the highest at 6 of the 24 USGS continuous-record tide-telemetry gages (tide-telemetry gage) for a period of record ranging between 11 and 14 years (fig. 24). The six tide-telemetry gages with new record high water-surface elevations are Passaic River at Passaic Valley Sewerage Commission at Newark, NJ (01392650), Raritan Bay at Keansburg, NJ (01407081), Shrewsbury River at Sea Bright (01407600), Shark River at Belmar, NJ (01407770), Manasquan River at Point Pleasant, NJ (01408050), and Barnegat Bay at Seaside Heights, NJ (01408750) (fig. 25). The datum of these tide-telemetry gages is NAVD 88. The new water-surface elevations are a result of major rainfall runoff and not from tidal storm surge.

The tide-telemetry gage at Passaic River at Passaic Valley Sewerage Commission at Newark had an estimated



Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 22. Location and rank of peak streamflow recorded at U.S. Geological Survey crest-stage partial-record gaging stations during the flood from Hurricane Irene, August 27–30, 2011, in New Jersey.



Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 23. Location and recurrence interval of peak streamflow recorded at U.S. Geological Survey crest-stage partial-record gaging stations during the flood from Hurricane Irene, August 27–30, 2011, in New Jersey.

Table 9. Flood-frequency estimates computed for U.S. Geological Survey crest-stage partial-record stations in New Jersey from observed continuous-record streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second, (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																			
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
Hackensack River Gages																							
01377460	Pascack Brook at Hillsdale, NJ	20.7	1,388	1,300	1,380	2,761	1,930	2,650	4,099	2,390	3,800	6,420	3,020	5,660	8,713	3,490	7,440	11,590	4,000	9,560	21,290	5,200	16,400
01378385	Tenakill Brook at Closter, NJ	8.56	485	811	493	740	1,240	761	934	1,560	972	1,210	1,990	1,270	1,437	2,330	1,520	1,685	2,690	1,790	2,347	3,570	2,490
01378590	Metzler Brook at Englewood, NJ	1.54	194	196	194	272	297	273	330	370	333	411	468	415	476	544	482	547	622	554	732	807	741
Passaic River Basin Gages																							
01378690	Passaic River near Bernardsville, NJ	8.83	779	369	767	1,403	618	1,370	1,953	820	1,880	2,828	1,110	2,690	3,628	1,350	3,420	4,570	1,620	4,260	7,437	2,310	6,810
01379845	Rockaway River at Warren Street at Dover, NJ	52.1	1,299	1,750	1,320	1,975	2,590	2,020	2,498	3,190	2,560	3,246	3,980	3,330	3,871	4,580	3,960	4,556	5,220	4,650	6,421	6,730	6,470
01387880	Pond Brook at Oakland, NJ	6.76	412	299	408	655	480	645	858	621	841	1,172	818	1,140	1,451	970	1,400	1,774	1,140	1,700	2,731	1,560	2,570
01389534	Peckman River at Ozone Avenue at Verona, NJ	4.45	1,037	473	1,020	1,507	725	1,460	1,878	913	1,800	2,418	1,170	2,280	2,878	1,370	2,700	3,390	1,580	3,150	4,825	2,090	4,400
01389765	Molly Ann Brook at North Haledon, NJ	3.89	574	404	567	755	620	747	870	780	862	1,010	996	1,010	1,110	1,170	1,120	1,209	1,340	1,230	1,434	1,770	1,490
01389900	Fleischer Brook at Market Street at Elmwood Park, NJ	1.37	136	146	136	178	225	180	210	284	215	256	363	265	294	425	306	336	489	352	450	644	474
01390810	Hohokus Brook at Allendale, NJ	9.11	479	556	481	761	835	764	1,010	1,040	1,010	1,409	1,300	1,400	1,779	1,500	1,750	2,222	1,720	2,170	3,613	2,220	3,440
01390900	Ramsey Brook at Allendale, NJ	2.55	297	269	296	480	411	476	627	514	619	846	652	827	1,035	758	1,000	1,246	869	1,200	1,842	1,140	1,740
01392170	Third River at Bloomfield, NJ	7.71	866	650	854	1,303	988	1,280	1,653	1,240	1,610	2,169	1,580	2,080	2,613	1,850	2,490	3,110	2,130	2,930	4,521	2,800	4,160
Rahway River Gages																							
01393890	East Branch Rahway River at Maplewood, NJ	5.11	1,041	627	1,010	1,380	967	1,330	1,646	1,230	1,570	2,034	1,590	1,930	2,363	1,870	2,240	2,729	2,180	2,580	3,751	2,910	3,500
01394000	West Branch Rahway River at Millburn, NJ	7.10	508	511	509	879	778	871	1,182	975	1,160	1,633	1,240	1,580	2,020	1,440	1,930	2,454	1,660	2,320	3,666	2,180	3,370

Table 9. Flood-frequency estimates computed for U.S. Geological Survey crest-stage partial-record stations in New Jersey from observed continuous-record streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.—Continued

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second, (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																			
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
01396000	Robinsons Branch at Rahway, NJ	21.6	1,159	921	1,150	1,890	1,330	1,870	2,508	1,620	2,470	3,461	1,990	3,380	4,312	2,270	4,190	5,296	2,550	5,110	8,219	3,210	7,810
Raritan River Gages																							
01398107	Holland Brook at Readington, NJ	9.00	964	884	960	1,542	1,450	1,540	2,043	1,890	2,030	2,836	2,510	2,800	3,560	3,000	3,490	4,415	3,560	4,290	7,049	4,940	6,690
01399830	North Branch Raritan River at North Branch, NJ	174	8,902	7,550	8,850	13,710	11,700	13,600	17,760	14,700	17,500	24,040	18,900	23,500	29,670	22,100	28,700	36,210	25,900	34,800	55,860	34,600	52,500
01401301	Millstone River at Carnegie Lake at Princeton, NJ	159	4,888	4,980	4,890	7,487	7,340	7,480	9,313	8,970	9,290	11,710	11,100	11,700	13,560	12,700	13,500	15,440	14,400	15,400	20,030	18,300	19,900
01401595	Rock Brook near Blawenburg, NJ	9.03	1,124	972	1,120	1,821	1,550	1,810	2,405	1,990	2,380	3,303	2,590	3,240	4,100	3,050	4,000	5,020	3,570	4,870	7,737	4,820	7,380
01401600	Beden Brook near Rocky Hill, NJ	27.0	3,599	1,850	3,550	5,850	2,910	5,720	7,705	3,680	7,450	10,510	4,750	10,000	12,970	5,550	12,300	15,760	6,480	14,800	23,840	8,650	22,000
01401870	Six Mile Run near Middlebush, NJ	10.7	1,378	1,180	1,370	3,089	1,790	3,030	4,895	2,220	4,720	8,238	2,800	7,790	11,720	3,230	10,900	16,290	3,710	15,000	32,750	4,790	29,300
01403500	Green Brook at Plainfield, NJ	9.75	854	1,100	858	1,266	1,720	1,280	1,600	2,190	1,620	2,098	2,850	2,140	2,530	3,350	2,580	3,019	3,920	3,080	4,428	5,240	4,490
01403535	East Branch Stony Brook at Best Lake at Watchung, NJ	1.57	334	369	335	711	624	705	1,114	828	1,090	1,877	1,130	1,790	2,692	1,370	2,530	3,787	1,640	3,490	7,931	2,330	7,030
01403570	Stony Brook at North Plainfield, NJ	6.88	1,063	1,140	1,070	1,754	1,790	1,760	2,367	2,270	2,350	3,354	2,930	3,280	4,271	3,440	4,120	5,369	4,020	5,090	8,818	5,350	8,010
01403600	Green Brook at Rock Avenue at Plainfield, NJ	18.2	2,430	1,900	2,410	4,023	2,910	3,950	5,415	3,660	5,250	7,633	4,680	7,270	9,671	5,440	9,100	12,090	6,310	11,200	19,560	8,280	17,600

[1] Using regression equations developed in SIR 2009–5167, by Watson and Schopp.

Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 24. Location of record high water-surface elevation recorded at U.S. Geological Survey continuous-record tide-telemetry gages during the flood from Hurricane Irene, August 27–30, 2011, in New Jersey.

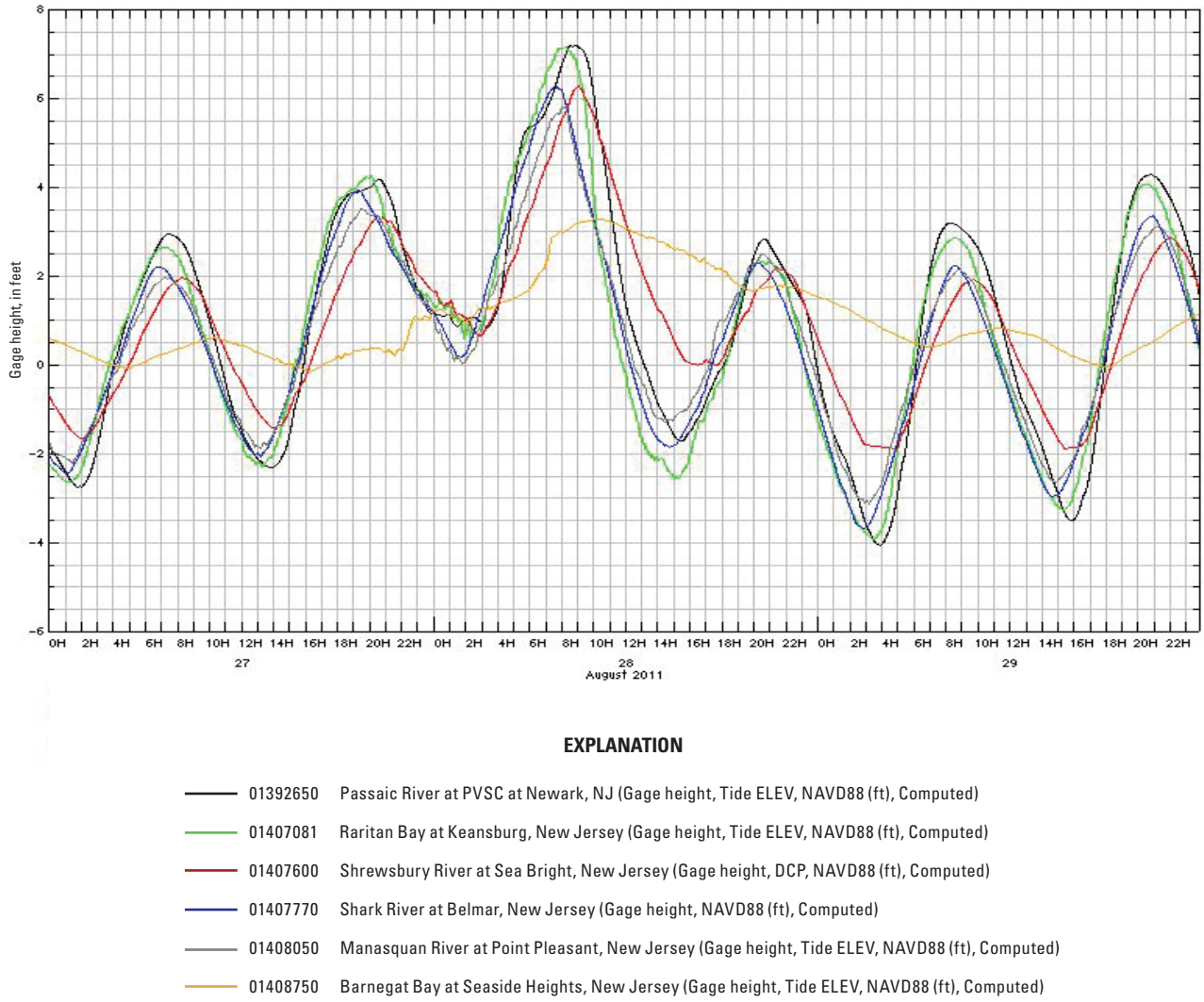


Figure 25. Hydrograph showing the record high water-surface elevation as a result from Hurricane Irene at 6 of the 24 U.S. Geological Survey continuous-record tide-telemetry gages in New Jersey on August 27–29, 2011. [H, hours; NAVD 88, North American Vertical Datum of 1988; ELEV, elevation in feet; ft, feet; DCP, data collection platform; NJ, New Jersey]

water-surface elevation of 7.2 ft, 0.73 ft higher than the previous highest water-surface elevation of record on March 13, 2010. The tide-telemetry gage at Raritan Bay at Keansburg recorded a water-surface elevation of 7.16 ft, 0.15 ft higher than the previous highest water-surface elevation of record on March 13, 2010. The tide-telemetry gage at Shrewsbury River at Sea Bright recorded a water-surface elevation of 6.29 ft, 0.97 ft higher than the previous highest water-surface elevation of record on March 13, 2010. The tide-telemetry gage at Shark River at Belmar recorded a water-surface elevation of 6.3 ft (estimated), 0.71 ft higher than the previous highest water-surface elevation of record on March 13, 2010. The tide-telemetry gage at Manasquan River at Point Pleasant recorded a water-surface elevation of 5.85 ft, 0.98 ft higher than the previous highest water-surface elevation of record on March 13, 2010. Lastly, the tide-telemetry gage at Barnegat Bay at Seaside Heights recorded a water-surface elevation of 3.28 ft, 0.45 ft higher than the previous highest water-surface elevation of record set on October 25, 2005 (table 10).

Dams

Numerous dams failed due to the storms in August 2011. The New Jersey Department of Environmental Protection (NJDEP) Bureau of Dam Safety and Flood Control reported the failure of six dams as a result of the storm on August 14, 2011 (fig. 12 shows the August 14 storm hydrograph). The Seeley's Mill Pond Dam, located upstream from the Cohansey River at Seeley, NJ (01412800), gaging station, failed completely.

As a result of Hurricane Irene, the NJDEP Bureau of Dam Safety and Flood Control reported the failure of six

Table 10. Water-surface elevations recorded at U.S. Geological Survey continuous-record tide-telemetry gages in New Jersey during the flood of August 27–31, 2011, and previous peak of record.

[NAVD 88, North American Vertical Datum of 1988; ft, feet; e, estimated; *, new high water-surface elevation; shaded rows are new record high water-surface elevations]

U.S. Goelogical Survey station number	Station name	Tidal peak in feet above NAVD 88, August 27–31, 2011	Previous peak of record in feet above NAVD 88	Date of previous peak or peak of record	Difference between Hurricane Irene peak and previous peak or peak of record (ft)	Number of years of record
01392650*	Passaic River at PVSC at Newark, NJ	7.2 e	6.47	Mar 13, 2010	0.73	14
01406710	Raritan River at South Amboy, NJ	7.68	8.16	Mar 13, 2010	- .48	14
01407081*	Raritan Bay at Keansburg, NJ	7.16	7.01	Mar 13, 2010	.15	14
01407600*	Shrewsbury River at Sea Bright, NJ	6.29	5.32	Mar 13, 2010	.97	13
01407770*	Shark River at Belmar, NJ	6.3 e	5.59	Mar 13, 2010	.71	11
01408050*	Manasquan River at Point Pleasant, NJ	5.85	4.87	Mar 13, 2010	.98	14
01408168	Barnegat Bay at Mantoloking, NJ	3.56	3.81	Dec 11, 1992	- .25	25
01408750*	Barnegat Bay at Seaside Heights, NJ	3.28	2.83	Oct 25, 2005	.45	14
01409110	Barnegat Bay at Waretown, NJ	2.48	2.93	Mar 13, 2010	- .45	18
01409125	Barnegat Bay at Barnegat Light, NJ	3.84	4.90	Aug 9, 1976	-1.06	29
01409146	East Thorofare at Ship Bottom, NJ	3.17	3.52	Oct 25, 2005	- .35	14
01409335	Little Egg Inlet near Tuckerton, NJ	4.11	4.61	Feb 19, 1972	- .5	18
01410510	Absecon Creek at US Route 30 at Absecon, NJ	5.04	5.11	Nov 13, 2009	- .07	14
01410560	Inside Thorofare at US Rt 40 at Atlantic City, NJ	4.48	5.05	Nov 13, 2009	- .57	14
01410600	Absecon Channel at Atlantic City, NJ	5.14	5.20	Nov 13, 2009	- .06	14
01411320	Great Egg Harbor Bay at Ocean City, NJ	4.67	6.61	Dec 11, 1992	-1.94	46
01411330	Beach Thorofare at Margate City, NJ	4.69	5.04	Nov 13, 2009	- .35	14
01411350	Ludlum Thorofare at Sea Isle City, NJ	5.10	6.34	Mar 29, 1984	-1.24	23
01411355	Ingram Thorofare at Avalon, NJ	5.0 e	6.29	Mar 29, 1984	-1.29	19
01411360	Great Channel at Stone Harbor, NJ	5.30	6.28	Feb 5, 1998	- .98	48
01411390	Cape May Harbor at Cape May, NJ	5.15	5.53	Oct 25, 1980	- .38	35
01411435	Sluice Creek near South Dennis, NJ	3.66	3.97	Nov 14, 2009	- .31	14
01412150	Maurice River at Bivalve, NJ	5.6 e	6.91	Oct 25, 1980	-1.31	35
01413038	Cohansey River at Greenwich, NJ	3.51	5.99	Oct 25, 1980	-2.48	37

Table 11. Damaged and failed dams throughout New Jersey during the flood caused by Hurricane Irene, August 27–30, 2011.

[Data provided by New Jersey Department of Environmental Protection, Bureau of Dam Safety and Flood Control. Class defines hazard potential: S, significant; L, low; O, other; NAD 83, North American Datum of 1983]

Stream	Dam name	Condition	Class	Municipality	Latitude and longitude (NAD 83)	
South Branch Metedeconk Tributary	Cedar Bridge Dam	Failed	L	Brick Township	40 03 38.88	-74 09 07.38
Toms River Tributary	Cassville Dam	Failed	S	Jackson Township	40 06 38.52	-74 23 19.98
Weldon Brook	Saffin Pond Dam	Failed	S	Jefferson Township	41 00 15.42	-74 35 13.08
Hakihokake Creek	Stone's Dam	Failed	0	Milford Borough	40 34 30.00	-75 05 42.00
Crosswicks Creek Tributary	New Jersey No Name # 89 Dam	Failed	L	North Hanover Township	40 03 23.87	-74 32 51.05
Unnamed	Lenartowicz Dam	Failed	L	Vernon Township	41 12 00.66	-74 28 19.07

dams (table 11, fig. 26). Three of these dams are located upstream from USGS streamgages. Saffin Pond Dam failed completely. It is located on Weldon Brook, a tributary to Lake Hopatcong, upstream from the USGS stage-only gage on Lake Hopatcong and the continuous-record streamflow-gaging station on Musconetcong River at the outlet of Lake Hopatcong, NJ (01455500). The New Jersey No Name # 89 Dam, located on a tributary to Crosswicks Creek in North Hanover Township in Burlington County upstream from the gage on Crosswicks Creek at Extonville, NJ (01464500), also failed completely. The Bureau of Dam Safety and Flood Control reported damage to the spillway at Cassville Dam, located on a small tributary to the Toms River, upstream from the gage on Toms River near Toms River, NJ (01408500). Water stored in these impoundments contributed to the flow past these gages during the flood. The portion of the hydrograph contributed by the dam breaches is not distinguishable from the runoff contributed by the rainfall. Hydrographs from August 27–30, 2011, of the computed discharge of the three streamgages that are located downstream from the failed dams are shown in figure 27.

Peak Streamflow Statistical Analysis

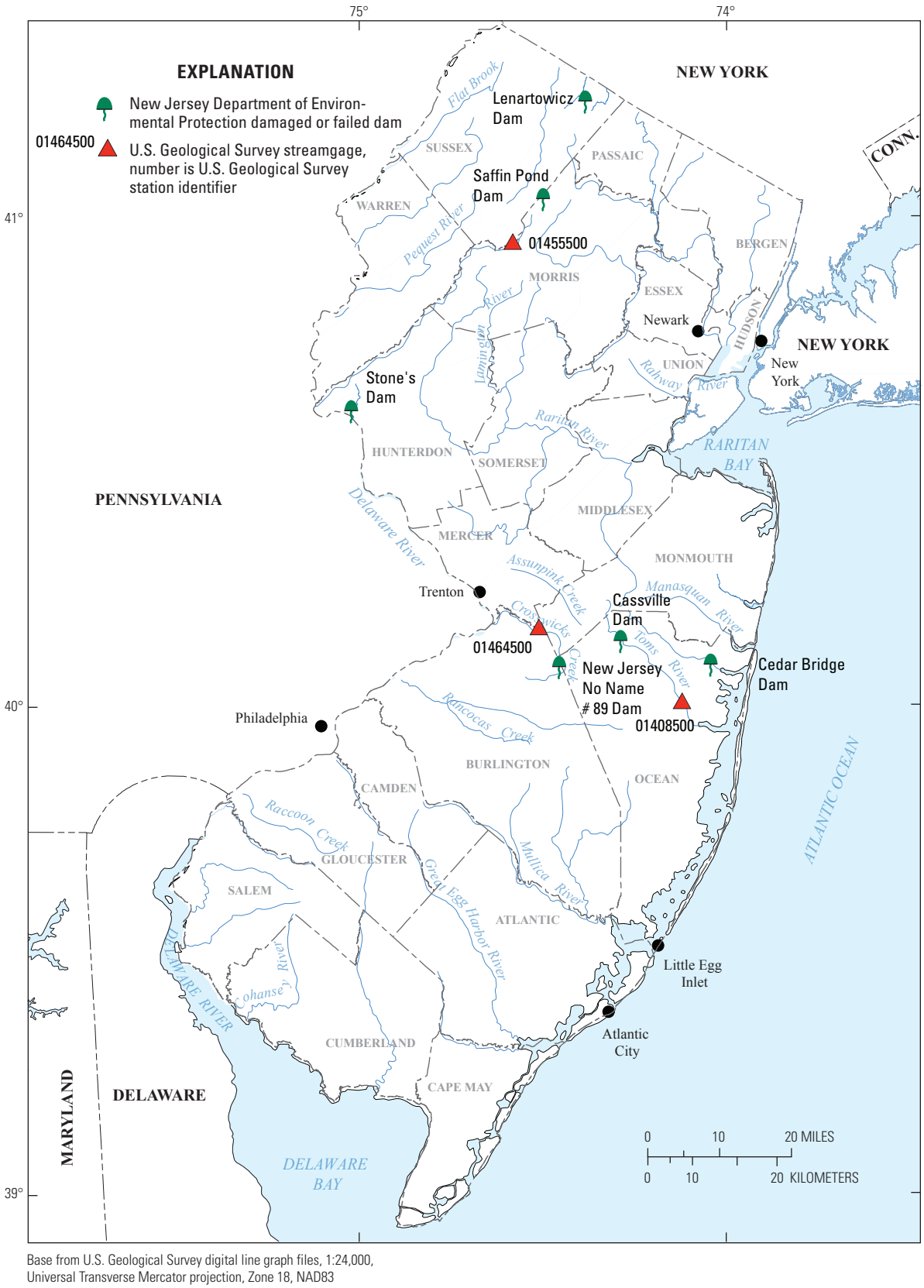
Flood magnitudes at the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence intervals were estimated for streamgages and crest-stage gages on streams in New Jersey for peaks during the 2011 water year[1]. The streamflow data forming the basis of the current flood-frequency study are the records of annual maximum flood-peak streamflows measured for 80 USGS streamgages located throughout New Jersey through the 2011 water year. Recurrence intervals of the peak streamflows on streams in New Jersey during the August 27–30, 2011, storm range from 2 years to greater than 500 years, meaning that streamflows of this magnitude have a 50 percent to less than 0.2 percent (1/500) probability of occurring in any given year (tables 5 and 7). Sixty of the 80 streamgages and 12 of the 25 crest-stage gages experienced a flood with greater than a 25-year recurrence interval as a result of the storm.

The optimal estimate of peak streamflow for a given recurrence interval at a streamgage is determined by weighting the observed flood discharge estimate determined from the log-Pearson Type III distribution using the procedures outlined in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) and the estimated flood discharge determined from the regional regression equation (Watson and Schopp, 2009). The weighted average flood discharge for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence intervals for the 80 streamgages and 25 crest-stage gages in this study are presented in tables 6 and 8, respectively.

Statewide 28 streamgages recorded peaks greater than the 100-year recurrence interval (< 1.0% annual-exceedance probability). Flood frequencies observed during this flood exceeded the 100-year recurrence interval at streamgages in the Hackensack River, Elizabeth River, Raritan River, Pequest River, Ramapo River, Stony Brook, Assunpink River, Toms River, Maurice River, Rancocas Creek, Raccoon Creek, and Salem River Basins. The Rahway, Raritan, and Manasquan River Basins had recorded peaks greater than the 500-year recurrence interval (< 0.2% annual-exceedance probability).

Streamgages along the main stem of the Delaware River recorded only 2- to 5-year flood events (17–25% annual-exceedance probabilities) during the Hurricane. The streamgages on Cedar Creek at Lanoka Harbor, NJ (01409000), and Westecunk Creek at Stafford Forge, NJ

[1] A water year is the 12-month period beginning October 1 and ending September 30. It is designated by the year in which it ends.



Base from U.S. Geological Survey digital line graph files, 1:24,000, Universal Transverse Mercator projection, Zone 18, NAD83

Figure 26. Location of damaged and failed dams during the Hurricane Irene flood of August 27–30, 2011, in New Jersey.

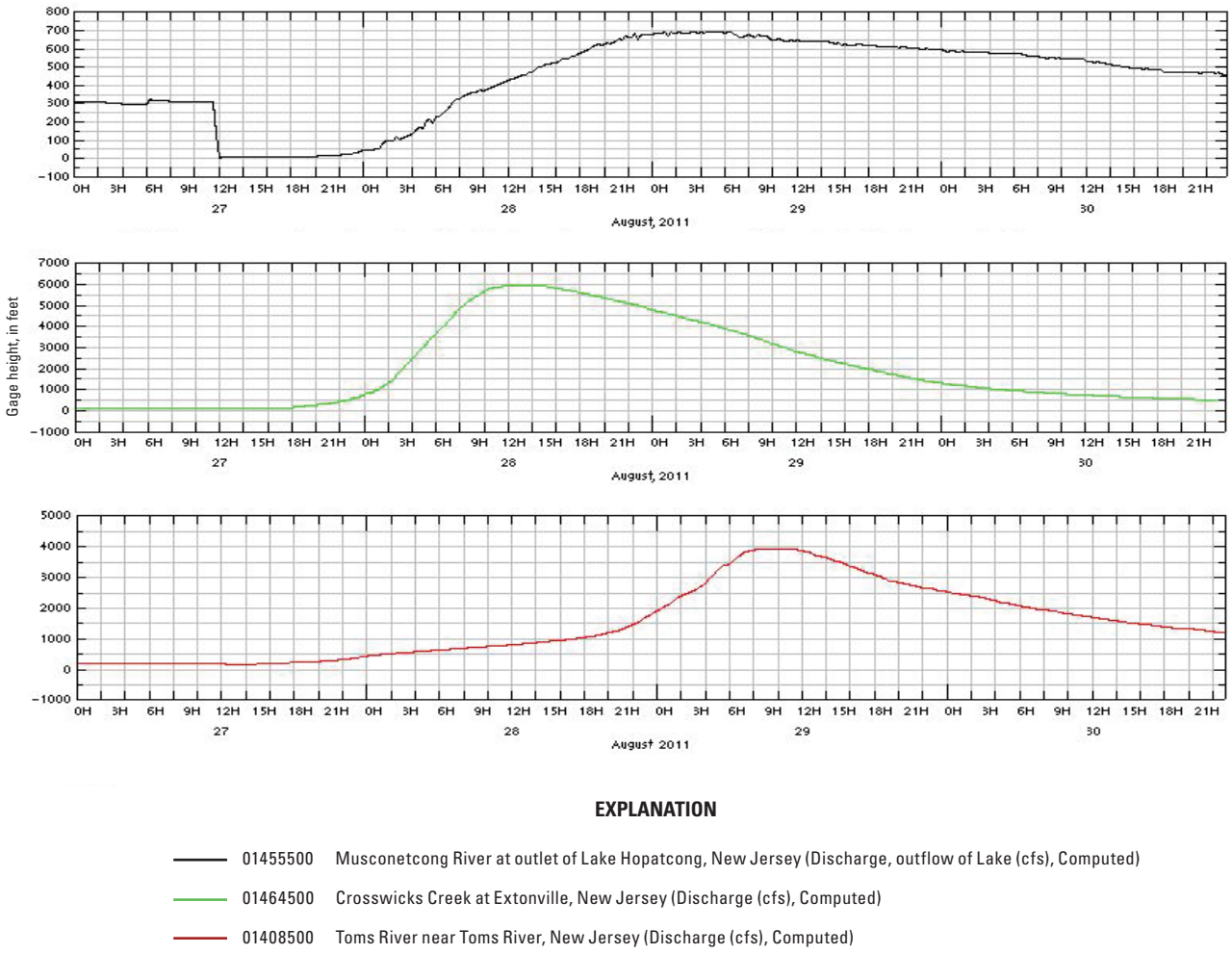


Figure 27. Hydrographs showing the computed discharge at three U.S. Geological Survey countinuous-record streamflow-gaging stations located downstream from dam failures resulting from flooding caused by Hurricane Irene in New Jersey, August 27–30, 2011. [cfs, cubic feet per second; H, hour; NJ, New Jersey]

(01409280), recorded 2-year events. The streamgage on East Branch Bass River near New Gretna, NJ (01410150), recorded a less than 2-year event (>50-percent annual-exceedance probability).

Flood Damage

Hurricane Irene was one of the most costly disasters in New Jersey history. Soon after President Obama's visit to Paterson on September 4, 2011, he declared the State a disaster area and announced that all 21 counties would be eligible for FEMA aid. The effects of the flooding and storm damage from Hurricane Irene have been estimated at $1 billion, including damage to 200,000 homes and buildings throughout the State (Wikipedia, 2013). The most significant damage was seen in northern and central New Jersey, where in addition to record flooding, heavy wind caused trees to topple and power lines to fall in these densely populated areas (fig. 28). Some local roads, as well as some vital highways, were impassable in places (fig. 29). For instance, the extreme flooding of the Rockaway River caused the northbound shoulder of Interstate 287 in Boonton to collapse. Flood waters also caused the brief closure of a portion of the Holland Tunnel, as well as several bridges in the New York City area. And in Union County, the rising stage of the Rahway River caused the flooding of the Garden State Parkway in Cranford. In central New Jersey, The Trenton Transit Center was inundated by Assunpink Creek flood waters (fig. 30).

Before the storm made landfall in New Jersey, hundreds of thousands of people were ordered to evacuate low-lying areas in northeastern New Jersey and the Atlantic Coast communities, which included all barrier islands, Atlantic City, Cape May, and numerous other towns and cities. Even with the precautionary widespread mandatory evacuations,

Figure 28. In addition to extreme flooding, the heavy winds associated with Hurricane Irene caused other widespread damage, costing millions of dollars to remedy. This photograph was taken along US Route 202, approaching U.S. Geological Survey station 01388000, Ramapo River at Pompton Lakes, New Jersey. (Photograph taken by Daniel S. Skulski, U.S. Geological Survey)

Figure 29. Numerous roads throughout the State of New Jersey, such as this highway bridge on Blackwells Mills Causeway at Blackwells Mills in Somerset County (U.S. Geological Survey station 01402000) became hazardous to cross after the flooding caused by Hurricane Irene. (Photograph by Andrew F. Watson, U.S. Geological Survey)

Figure 30. Flooding associated with Hurricane Irene, August 27–30, 2011, along the Assunpink Creek in Trenton, New Jersey, caused some of Trenton's major public transportation to be shut down for a brief period of time. (Photograph by Patrick W. Bowen, U.S. Geological Survey)

Figure 31. Many commercial properties, such as this grocery store in Pompton Plains, New Jersey, were devastated by the flood waters associated with Hurricane Irene. (Photograph by John J. Trainor, U.S. Geological Survey)

Figure 32. Interior of a commercial fast food restaurant flooded by the Pompton River in Pompton Plains, New Jersey (U.S. Geological Survey station 01388500), on August 29, 2011, following Hurricane Irene. (Photograph by John J. Trainor, U.S. Geological Survey)

Figure 33. Damage to the parking area and part of the towpath along the upstream left bank of the Delaware and Raritan Canal at Port Mercer, New Jersey (U.S. Geological Survey station 01460440), after the August 27–30, 2011 floods. (Photograph by Jason C. Shvanda, U.S. Geological Survey)

11 people in New Jersey lost their lives because of the storm. Power outages affected about 2 million residents for upwards of 1 week, especially in places where the combination of flooded electrical substations and downed wires increased the amount of time towns were left in the dark. The damage to commercial properties in Pompton Plains in northeastern New Jersey is shown in figures 31 and 32, and figure 33 shows flood damage to a recreational path and parking area near Port Mercer in central New Jersey, all as a result of the flooding associated with Hurricane Irene.

In addition to the power outages and the costly, yet somewhat recoverable, property damage many faced, some New Jersey residents were permanently displaced by the storm. Along the Passaic River, approximately 56 homes in Wayne are slotted to be purchased and destroyed through the FEMA Hazard Mitigation Grant Program, and the land is to be returned to the floodplain and preserved as green space. Seven other towns were also approved to receive funding through FEMA for the purchase of homes in flood-prone areas, including Middlesex Borough, Little Falls, Pompton Lakes, and Pequannock Township (Wikipedia, 2013).

Historic Floods

New Jersey has experienced numerous significant floods as recorded by USGS streamflow-gaging stations dating back to 1903 as a result of rainfall from tropical and post-tropical systems. The last hurricane to make landfall in New Jersey was in 1903 near Atlantic City (Nese and Schwartz, 2002). The 1944 Great Atlantic Hurricane caused severe flooding along the entire New Jersey coastline, destroying hundreds of homes (Schwartz, 2007). In 1955, Hurricanes Connie and Diane, occurring within the same week, caused severe flooding in New Jersey with record levels recorded by USGS streamflow-gaging stations all over the northeast. Hurricane Floyd in 1999 hit New Jersey as a tropical storm. This storm crossed the entire State and was a significant rainfall event.

Flooding has been a problem in the Passaic and Hackensack River Basins since colonial times. The storm of October 7–12, 1903, caused one of the worst floods in the history of the Passaic River Basin. This storm followed 3 months of excessive rainfall, which left the ground saturated. The maximum rainfall recorded was 15.5 inches in Paterson, New Jersey. The average rainfall over the Passaic River Basin was 11.4 inches (U.S. Army Corps of Engineers, 1972). For most major streams in these basins, the flood of record occurred in October 1903. The flood peaks from this storm are still the peaks of record at the Passaic River at Little Falls, NJ (01389500), and the Pompton River at Pompton Plains, NJ (01388500), streamgages. The streamgage, Passaic River at Chatham, NJ (01379500), the only other active streamgaging station in operation at that time, has experienced higher peaks since the 1903 flood, including the peak from Hurricane Irene and the peaks in 1973, 1905, 1907, and 2010.

Another major storm to affect the Passaic River Basin was the storm of April 1984. Recorded rainfall varied from 2 inches to slightly more than 8 inches within northeastern New Jersey. The flooding caused three deaths, $250 million in property damages, and forced 6,000 people from their homes (Philips and Schopp, 1986). Many streamgages in the Passaic River Basin recorded new record peaks during this event. Hurricane Irene caused flood peaks that exceeded the peaks from the 1984 flood at 18 of 19 active streamgages. The Passaic River at Pine Brook is the only gage that experienced a larger flood peak from the 1984 storm than from Hurricane Irene.

The storm of September 1, 1940, classified as a severe thunderstorm, produced torrential rains over southern New Jersey, causing high rates of runoff in a relatively short period of time (U.S. Army Corps of Engineers, 1972). The storm produced the greatest flooding of record at gages on the Great Egg Harbor River, Mantua Creek, Maurice River, and Salem River. Hurricane Irene produced the second highest peaks of record at gages on these streams.

The August 1955 flood was caused by two rainfall events that occurred within a few days of each other from the remnants of Hurricane Connie and Hurricane Diane. Both hurricanes made landfall in North Carolina, and the storms made their way north through the eastern states (Bogart, 1960). Flood peaks from these storms are still the highest recorded on the Delaware River, the Paulins Kill tributary to the Delaware River, and the South Branch Raritan River at Stanton, NJ (01397000), in northwestern New Jersey. The flood peak at the Neshanic River at Reaville, NJ (01398000), streamgage was higher during the 1955 flood than during the flood produced by Hurricane Irene. Hurricane Irene produced higher peaks at the other streamgages in operation during both events.

The remnants of Tropical Storm Floyd produced heavy rain in New Jersey on September 16, 1999. The heaviest amounts were in the Raritan River Basin in central New Jersey where 13.3 inches was recorded in Somerville (Pasch and others, 1999). The storm produced record flooding at streamgages in the Raritan River, Rahway River, Elizabeth River, and portions of the Passaic and Hackensack River Basins. The peak of record at 18 active streamgages in these basins was the result of Tropical Storm Floyd, prior to the arrival of Hurricane Irene. Flooding from Hurricane Irene set new record peaks at 6 of the 18 gages on Ringwood Creek, Elizabeth River, Rahway River, Spruce Run, and West Branch Middle Brook.

The storm of July 12–13, 2004, generated as much as 13.2 inches of rain at rates of more than 3 inches per hour over south-central New Jersey (Protz and Reed, 2006). The storm caused record flooding at all six USGS streamgaging stations in the Rancocas Creek, Cooper River, and Pennsauken Creek Basins; these streams are tributaries to the Delaware River. Hurricane Irene caused flooding that exceeded the July 2004 flood at the McDonalds Branch in Byrne State Forest, NJ (01466500), and the North Branch Rancocas Creek at Pemberton, NJ (01467000), streamgages.

Summary

Hurricane Irene made landfall in New Jersey on August 28, 2011, as a tropical storm with a wind speed of 69 miles per hour. It caused historic levels of flooding and devastation throughout the State. From 6 to 8 inches of rain fell across most of New Jersey. Higher amounts, from 9 inches to as much as 10 inches, were observed at U.S. Geological Survey (USGS) and National Weather Service (NWS) precipitation gages in southwestern, central, and northeastern New Jersey. During the Hurricane Irene flood of August 27–30, 2011, peak-streamflow recurrence intervals ranged from 2 to greater than 500 years. As a result of this storm, six dams failed. The U.S. Geological Survey , in cooperation with the Federal Emergency Management Agency (FEMA), conducted a study to collect, compute, and compile flood-related data throughout the State subsequent to the event.

Above-average precipitation occurred in New Jersey during August 1 through August 26, 2011, with rainfall totals ranging from 8 inches to more than 16 inches, 150 to 600 percent of normal. A band of precipitation ranging from 300 to 600 percent of normal was observed from southwestern through central New Jersey during the 2-week period preceding the hurricane, which left soils extremely wet or saturated, adding to the significance of the event.

Record peaks were recorded statewide from August 28–30, 2011, as a result of Hurricane Irene. Thirty-two of the 96 streamgages with greater than or equal to 20 years of record, considered long-term streamgages, recorded new period-of-record peaks. Another 21 streamgages recorded the second highest peaks of record, and 11 streamgages recorded the third highest peaks of record. Statewide, 28 streamgages recorded peaks equal to or greater than the 100-year recurrence interval (< 1.0% annual-exceedance probability). Flood peaks ranked as the highest peak of record at 5 of the 27 active USGS crest-stage partial-record stations in New Jersey.

Hurricane Irene was extremely consequential in New Jersey, costing the State approximately $1 billion in recovery efforts. Thousands of homes and businesses were affected, in addition to the millions of people who were displaced. Thousands of residents filed for assistance through the Federal Emergency Management Agency (FEMA), and millions of dollars were disbursed speedily in the most devastated counties. All 21 counties in the State of New Jersey received aid from FEMA, making the flood of August 27–30, 2011 one of the most widespread, expensive, and extraordinary floods in the State's history.

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Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ft³/s/mi², cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
Hackensack River Gages													
01377000	Hackensack River at Rivervale, NJ	58.0	5.0	New peak of record	8/28/2011	4,660	80.3	12.26	1315	< 1	> 100	70	Regulation
				Previous peak of record	4/16/2007	4,620	79.7	12.19	--	--	--	--	NR
01377500	Pascack Brook at Westwood, NJ	29.6	5.0	Second highest peak	8/28/2011	4,630	156.4	8.69	--	< 1	> 100	77	NR
				Historic peak of record	9/16/1999	9,630	325.3	12.22	--	--	--	--	NR
01378500	Hackensack River at New Milford, NJ	113	6.0	Second highest peak	8/28/2011	10,500	92.9	11.84	--	< 1	> 100	90	Regulation
				Historic peak of record	4/16/2007	11,600	102.7	12.36	--	--	--	--	NR
Passaic River Basin Gages													
01379000	Passaic River near Millington, NJ	55.4	8.0	Third highest peak	8/29/2011	2,120	38.3	10.26	1300	< 4	> 25	93	NR
				Historic peak of record	10/20/1996	2,290	41.3	9.89	--	--	--	--	NR
01379500	Passaic River near Chatham, NJ	100	6.0	Storm peak[2]	8/29/2011	2,620	26.2	7.76	1245	< 10	> 10	82	NR
				Historic peak of record	8/2/1973	3,380	33.8	9.36	--	--	--	--	NR
01379773	Green Pond Brook at Picatinny Arsenal, NJ	7.65	3.0	New peak of record	8/28/2011	455	59.5	3.84	--	4	25	29	NR
				Previous peak of record	4/5/1984	333	43.5	3.51	--	--	--	--	NR
01379780	Green Pond Brook below Picatinny Lake at Picatinny Arsenal, NJ	9.16	--	Second highest peak	8/28/2011	855	93.3	5.91	--	NA	NA	27	Regulation
				Historic peak of record	4/16/2007	1,300	141.9	6.9	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

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U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01380500	Rockaway River above Reservoir at Boonton, NJ	116	5.0	New peak of record	8/28/2011	8,210	70.8	9.31	--	< 1	> 100	74	NR
				Previous peak of record	4/5/1984	5,590	48.2	7.23	--	--	--	--	NR
01381000	Rockaway River below Boonton Reservoir at Boonton, NJ	119	5.0	Second highest peak	8/28/2011	7,390	62.1	9.73	--	NA	NA	100	Regulation
				Historic peak of record	10/10/1903	7,560[3]	63.5	7.8[4]	--	--	--	--	NR
01381500	Whippany River at Morristown, NJ	29.4	6.0	New peak of record	8/28/2011	3,780	128.6	9.58	--	< 1	> 100	90	NR
				Previous peak of record	9/28/1971	2,800	95.2	8.6	--	--	--	--	NR
01381800	Whippany River near Pine Brook, NJ	68.5	9.0	Second highest peak	8/30/2011	1,700	24.8	12.54	--	< 10	> 10	21	NR
				Historic peak of record	10/20/1996	2,080	30.4	9.22	--	--	--	--	NR
01381900	Passaic River at Pine Brook, NJ	349	19.0	Second highest peak	8/30/2011	7,110	20.4	24.12	--	4	25	47	NR
				Historic peak of record	4/7/1984	8,000	22.9	22.9	--	--	--	--	NR
01382500	Pequannock River at Macopin Intake Dam, NJ	63.7	5.5	Third highest peak	8/28/2011	4,360	68.4	7.42 ##	--	NA	NA	114	Regulation
				Historic peak of record	10/10/1903	6,100	95.8	17.40	--	--	--	--	NR
01383500	Wanaque River at Awosting, NJ	27.1	5.0	New peak of record	8/28/2011	3,290	121.4	7.00	2015	< 2	> 50	93	NR
				Previous peak of record	4/5/1984	2,800	103.3	6.65	--	--	--	--	NR

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U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01384500	Ringwood Creek near Wanaque, NJ	19.1	12.5	New peak of record	8/28/2011	2,430	127.2	14.02	0945	< 2	> 50	69	NR
				Previous peak of record	9/16/1999	2,300	120.4	13.92	--	--	--	--	NR
01386000	West Brook near Wanaque, NJ	11.8	4.0	Third highest peak	8/28/2011	1,840	155.9	6.40	0815	< 20	> 5	54	NR
				Historic peak of record	9/16/1999	2,500	211.9	7.10	--	--	--	--	NR
01387000	Wanaque River at Wanaque, NJ	90	5.0	Storm peak[2]	3/11/2011	3,740	41.4	8.04	--	NA	NA	96	Regulation
				Historic peak of record	4/5/1984	10,500	116.2	10.82	--	--	--	--	NR
01387420	Ramapo River at Suffern, NY[5]	93.0	NA	New peak of record	8/28/2011	14,700	158.1	18.88	1345	< 1	80	32	NR
				Previous peak of record	4/5/1984	12,300	132.3	15.38	--	--	--	--	NR
01387450	Mahwah River near Suffern, NY	12.3	4.0	New peak of record	8/28/2011	3,700	300.8	10.66	1145	< 1	> 100	53	NR
				Previous peak of record	11/8/1977	1,840	149.6	9.91	--	--	--	--	NR
01387500	Ramapo River near Mahwah, NJ	120	8.0	New peak of record	8/28/2011	15,000	125.0	15.77	1600	< 2	> 50	100	NR
				Previous peak of record	4/5/1984	12,100	100.8	13.35	--	--	--	--	NR
01388000	Ramapo River at Pompton Lakes, NJ	160	11.5	New peak of record	8/28/2011	17,800	111.3	22.61 ##	2150	< 1	> 100	93	NR
				Previous peak of record	4/5/1984	15,400	96.3	15.21	--	--	--	--	NR

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U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01388500	Pompton River at Pompton Plains, NJ	355	16.0	Second highest peak	8/29/2011	25,000	70.4	25.24	0115	< 1	100	72	Regulation
				Historic peak of record	10/10/1903	28,340	79.8	NA	--	--	--	--	NR
01389500	Passaic River at Little Falls, NJ	762	7.0	Second highest peak	8/30/2011	20,800	27.3	14.19 ##	0845	< 2	> 50	114	Regulation
				Historic peak of record	10/10/1903	31,700	41.6	12.91	--	--	--	--	NR
01390450	Saddle River at Upper Saddle River, NJ	10.9	4.5	Third highest peak	6/23/2011	3,790	347.7	5.41	1030	4	25	46	NR
				Historic peak of record	9/16/1999	6,290	577.1	5.64	--	--	--	--	NR
01390500	Saddle River at Ridgewood, NJ	21.6	6.0	Second highest peak	8/28/2011	6,770	313.4	11.41	0900	< 2	> 50	59	NR
				Historic peak of record	7/23/1945	6,800	314.8	NA	--	--	--	--	NR
01391000	Hohokus Brook at Ho-Ho-Kus, NJ	16.4	3.0	Second highest peak	8/28/2011	4,230	257.9	6.71	1100	< 2	> 50	58	NR
				Historic peak of record	9/16/1999	4,670	284.8	7.32	--	--	--	--	NR
01391500	Saddle River at Lodi, NJ	24.0	6.0	Second highest peak	8/28/2011	5,320	221.7	13.50	1845	2	50	87	NR
				Historic peak of record	9/17/1999	5,330	222.1	13.94	--	--	--	--	NR
01392500	Second River at Belleville, NJ	11.6	--	Storm peak[2]	8/28/2011	4,890	421.6	8.56	0200	NA	NA	61[6]	NR
				Historic peak of record	8/28/1971	6,500	560.3	9.8	--	--	--	--	NR

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U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
					Elizabeth River Gages								
01393450	Elizabeth River at Ursino Lake at Elizabeth, NJ	16.9	20.0	New peak of record	8/28/2011	6,260	370.4	22.62	--	< 1	> 100	90	NR
				Previous peak of record	9/16/1999	4,510	266.9	21.61	--	--	--	--	NR
					Rahway River Gages								
01394500	Rahway River near Springfield, NJ	25.5	5.5	New peak of record	8/28/2011	8,620	338.0	10.88	0915	< 1	> 100	74	NR
				Previous peak of record	9/16/1999	7,990	313.3	10.67	--	--	--	--	NR
01395000	Rahway River at Rahway, NJ	40.9	6.0	New peak of record	8/28/2011	7,250	177.3	12.1	--	< 0.2	> 500	90	NR
				Historic peak of record	9/17/1999	5,590	136.7	9.60	--	1.3	75	--	NR
					Raritan River Gages								
01396500	South Branch Raritan River near High Bridge, NJ	65.3	10.0	Second highest peak	8/28/2011	6,640	101.7	12.93	--	< 2	> 50	96	NR
				Historic peak of record	1/25/1979	6,910	105.8	12.07	--	--	--	--	NR
01396582	Spruce Run at Main Street at Glen Gardner, NJ	11.3	4.5	New peak of record	8/28/2011	2,960	261.9	8.39 ##	0530	2	50	30	NR
				Previous peak of record	9/16/1999	2,830	250.4	9.27	--	--	--	--	NR
01396660	Mulhockaway Creek at Van Syckel, NJ	11.8	5.5	Storm peak[2]	8/28/2011	2,370	200.8	6.3	--	< 20	> 5	34	NR
				Historic peak of record	9/20/1989	3,590	304.2	7.41	--	--	--	--	NR

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U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01396800	Spruce Run at Clinton, NJ	41.3	4.0	Second highest peak	8/28/2011	4,000	96.9	5.13	--	NA	NA	52	Regulation
				Historic peak of record	4/2/1970	4,080	98.8	5.17	--	--	--	--	NR
01397000	South Branch Raritan River at Stanton, NJ	147	8.0	Third highest peak	8/28/2011	14,100	95.9	13.61	--	< 4	> 25	96	NR
				Historic peak of record	8/19/1955	18,000	122.4	15.22	--	--	--	--	NR
01398000	Neshanic River at Reaville, NJ	25.7	5.0	Storm peak[2]	8/28/2011	8,150	317.1	14.66	0400	< 4	> 25	81	NR
				Historic peak of record	9/16/1999	23,100	898.8	15.33	--	--	--	--	NR
01398500	North Branch Raritan River near Far Hills, NJ	26.2	5.0	Third highest peak	8/28/2011	5,460	208.4	6.84	0715	< 2	> 50	91	NR
				Historic peak of record	7/23/1919	7,000	267.2	7.6	--	--	--	--	NR
01399500	Lamington (Black) River near Pottersville, NJ	32.8	4.5	New peak of record	9/8/2011	3,590	109.5	5.24	0630	< 2	> 50	91	NR
				Historic peak of record	7/7/1984	3,460	105.5	5.94	--	--	--	--	NR
01399670	South Branch Rockaway Creek at Whitehouse Station, NJ	12.3	6.0	Third highest peak	8/28/2011	2,060	167.5	9.56	--	< 10	> 10	34	Regulation
				Historic peak of record	9/16/1999	2,620	213.0	10.68	--	--	--	--	NR
01400000	North Branch Raritan River near Raritan, NJ	190	10.0	Storm peak[2]	8/28/2011	27,800	146.3	17.96	1145	< 2	> 50	89	NR
				Historic peak of record	9/16/1999	29,000	152.6	18.98	--	--	--	--	NR

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U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01400500	Raritan River at Manville, NJ	490	14.0	Second highest peak	8/28/2011	53,000	108.2	26.24	1600	< 1	> 100	100	NR
				Historic peakof record	9/16/1999	77,600	158.4	27.1	--	--	--	--	NR
01401000	Stony Brook at Princeton, NJ	44.5	9.0	New peak of record	8/28/2011	10,600	238.2	16.23	--	< 1	> 100	58	NR
				Previous peak of record	8/28/1971	8,960	201.3	14.26	--	--	--	--	NR
01401650	Pike Run at Belle Mead, NJ	5.36	7.0	Third highest peak	8/28/2011	3,280	611.9	13.1	0600	< 4	> 25	32	NR
				Historic peak of record	9/16/1999	8,200	1529.9	13.61	--	--	--	--	NR
01402000	Millstone River at Blackwells Mills, NJ	258	9.0	Second highest peak	8/28/2011	20,700	80.2	21.24	1730	< 2	> 50	91	NR
				Historic peak of record	8/28/1971	22,200	86.0	18.68	--	--	--	--	NR
01403060	Raritan River below Calco Dam at Bound Brook, NJ	785	28.0	Second highest peak	8/28/2011	80,400	102.4	41.9	2000	< 0.2	> 500	80	NR
				Historic peak of record	9/17/1999	82,900	105.6	42.13	--	--	--	--	NR
01403150	West Branch Middle Brook near Martinsville, NJ	1.99	6.0	New peak of record	8/28/2011	1,510	758.8	9.35	--	< 2	> 50	32	NR
				Previous peak of record	9/16/1999	1,490	748.7	9.3	--	--	--	--	NR
01403400	Green Brook at Seeley Mills, NJ	9.75	5.5	Storm peak[2]	8/28/2011	2,440	250.3	6.46 ##	--	4	> 25	47	NR
				Historic peak of record	8/2/1973	6,240	640.0	16.1	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01403540	Stony Brook at Watchung, NJ	5.51	14.5	Storm peak[2]	8/28/2011	3,900	707.8	16.39	--	< 10	> 10	38	NR
				Historic peak of record	9/16/1999	5,380	976.4	17.16	--	--	--	--	NR
01403900	Bound Brook at Middlesex, NJ	48.4	9.0	Second highest peak	8/28/2011	5,860	121.1	14.01 ##	--	< 10	> 10	26	NR
				Historic peak of record	8/2/1973	7,000	144.6	41.18	--	--	--	--	NR
01405030	Lawrence Brook at Westons Mills, NJ	44.9	18.0	New peak of record	8/28/2011	7,700	171.5	20.26	--	< 4	> 25	23	NR
				Previous peak of record	9/21/1989	4,850	108.0	19.2	--	--	--	--	NR
01405400	Manalapan Brook at Spotswood, NJ	40.7	19.0	New peak of record	8/28/2011	6,650	163.4	22.22	--	NA	NA	55	Regulation
				Previous peak of record	7/18/2005	2,550	62.7	20.42	--	--	--	--	NR
01407290	Big Brook near Marlboro, NJ	6.42	18.0	Second highest peak	8/28/2011	1,350	210.3	19.7	--	< 10	> 10	32	NR
				Historic peak of record	9/20/1989	1,370	213.4	20.16	--	--	--	--	NR
				Southern New Jersey, Atlantic Coastal Plain Gages									
01407500	Swimming River near Red Bank, NJ	49.2	6.0	Third highest peak	8/28/2011	7,590	154.3	7.92	--	< 2	> 50	90	Regulation
				Historic peak of record	10/27/1943	8,910	181.1	8.96	--	--	--	--	NR
01407705	Shark River near Neptune City, NJ	9.96	6.0	Second highest peak	8/28/2011	2,020	202.8	7.61	--	< 4	> 25	45	NR
				Historic peak of record	12/26/1969	2,340	234.9	7.94	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01407760	Jumping Brook near Neptune City, NJ	6.46	--	Third highest peak	8/28/2011	709	109.8	8.58	--	NA	NA	45	Regulation
				Historic peak of record	9/12/1971	1,830	283.3	6.34	--	--	--	--	NR
01408000	Manasquan River at Squankum, NJ	44.0	7.0	New peak of record	8/28/2011	9,100	206.8	13.06	--	< 1	> 500	80	NR
				Previous peak of record	9/21/1938	2,940	66.8	12.45	--	--	--	--	NR
01408029	Manasquan River near Allenwood, NJ	63.3	14.5	New peak of record	8/28/2011	12,600	199.1	20.38	1200	< 1	> 500	43	NR
				Previous peak of record	10/14/2005	3,880	61.3	16.97	--	--	--	--	NR
01408120	North Branch Metedeconk River near Lakewood, NJ	34.9	8.0	New peak of record	8/28/2011	2,500	71.6	11.4	1715	< 1	> 100	39	NR
				Previous peak of record	11/8/1977	1,370	39.3	9.28	--	--	--	--	NR
01408500	Toms River near Toms River, NJ	123	8.0	New peak of record	8/28/2011	3,940	32.0	13.62	0930	< 1	> 100	83	NR
				Previous peak of record	3/15/2010	2,360	19.2	12.25	--	--	--	--	NR
01409000	Cedar Creek at Lanoka Harbor, NJ	53.3	4.0	Storm peak[2]	8/28/2011	349	6.5	4.35	1745	50	2	44	NR
				Historic peak of record	10/28/1943	1,050	19.7	6.5	--	--	--	--	NR
01409280	Westecunk Creek at Stafford Forge, NJ	15.8	13.0	Storm peak[2]	8/27/2011	101	6.4	11.52	2300	50	2	26	NR
				Historic peak of record	11/24/2009	277	17.5	13.08	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01409400	Mullica River near Batsto, NJ	46.7	5.0	New peak of record	8/28/2011	1,860	39.8	7.3	1830	< 2	> 50	54	NR
				Previous peak of record	2/26/1979	1,840	39.4	6.14	--	--	--	--	NR
01409810	West Branch Wading River near Jenkins, NJ	84.1	15.0	New peak of record	8/28/2011	1,820	21.6	16.16	1915	2	50	29	NR
				Previous peak of record	2/26/1979	1,320	15.7	16.14	--	--	--	--	NR
01410000	Oswego River at Harrisville, NJ	72.5	5.0	Storm peak[2]	8/29/2011	755	10.4	6.67	0230	< 10	> 10	81	NR
				Historic peak of record	8/20/1939	1,390	19.2	9.54	--	--	--	--	NR
01410150	East Branch Bass River near New Gretna, NJ	8.11	6.0	Storm peak[2]	8/28/2011	61	7.5	5.05	--	> 50	< 2	34	NR
				Historic peak of record	8/21/1997	1,130	139.3	7.28	--	--	--	--	NR
01410500	Absecon Creek at Absecon, NJ	17.9	--	New peak of record	8/28/2011	636	35.5	4.3	--	NA	NA	61	Regulation
				Previous peak of record	9/6/1935	295	16.5	--	--	--	--	--	NR
01411000	Great Egg Harbor River at Folsom, NJ	57.1	6.0	Second highest peak	8/29/2011	1,370	24.0	8.27	2315	< 1	> 100	86	NR
				Historic peak of record	9/3/1940	1,440	25.2	9.09	--	--	--	--	NR
01411300	Tuckahoe River at Head of River, NJ	30.8	6.0	Storm peak[2]	8/28/2011	364	11.8	5.91	--	16.7	> 5	41	NR
				Historic peak of record	9/21/1997	1340	43.5	9.09	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ft³/s/mi², cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
Delaware River Basin													
01411456	Little Ease Run near Clayton, NJ	9.77	4.2	New peak of record	8/28/2011	627	64.2	6.71	1230	< 2	> 50	24	NR
				Previous peak of record	4/16/2007	410	42.0	5.45	--	--	--	--	NR
01411500	Maurice River at Norma, NJ	112	4.0	Second highest peak	8/29/2011	3,960	35.4	7.72	--	< 1	> 100	79	NR
				Historic peak of record	9/2/1940	7,360	65.7	8.72	--	--	--	--	NR
01412800	Cohansey River at Seeley, NJ	28.0	6.0	New peak of record	8/14/2011	10,000	357.1	10.61	--	< 2	> 50	27	NR
				Previous peak of record	6/21/1983	3,800	135.7	8.5	--	--	--	--	NR
01434000	Delaware River at Port Jervis, NY	3,070	NA	Storm peak[2]	9/8/2011	96,000	31.3	15.11	0445	20	> 5	107	Regulation
				Historic peak of record	8/19/1955	233,000	75.9	23.91	--	--	--	--	NR
01438500	Delaware River at Montague, NJ	3,480	25.0	Storm peak[2]	9/8/2011	111,000	31.9	23.01	0730	20	> 5	71	Regulation
				Historic peak of record	8/19/1955	250,000	71.8	35.15	--	--	--	--	NR
01440000	Flat Brook near Flatbrookville, NJ	64.0	6.0	New peak of record	8/28/2011	10,200	159.4	12.94	1800	< 1	> 100	88	NR
				Previous peak of record	8/19/1955	9,560	149.4	12.58	--	--	--	--	NR
01443500	Paulins Kill at Blairstown, NJ	126	5.0	Second highest peak	9/8/2011	6,520	51.7	9.88	2200	< 1	> 100	89	NR
				Historic peak of record	8/19/1955	8,750	69.4	11.12	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak dischage per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01443900	Yards Creek near Blairstown, NJ	5.34	--	Storm peak[2]	9/8/2013	199	37.3	3.22	--	NA	NA	45	Regulation
				Historic peak of record	2/24/1977	583	109.2	5.89	--	--	--	--	NR
01445000	Pequest River at Huntsville, NJ	31.0	4.0	New peak of record	9/9/2011	1,060	34.2	6.3	0100	< 2	> 50	67	NR
				Previous peak of record	1/25/1979	906	29.2	5.44	--	--	--	--	NR
01445500	Pequest River at Pequest, NJ	106	4.0	New peak of record	8/28/2011	2,370	22.4	6.42	--	1	100	90	NR
				Previous peak of record	1/25/1979	2,130	20.1	5.97	--	--	--	--	NR
01446000	Beaver Brook near Belvidere, NJ	37.0	4.5	New peak of record	8/28/2011	2,400	64.9	6.33	2345	< 1	> 100	82	NR
				Previous peak of record	3/12/1936	1,510	40.8	5.76	--	--	--	--	NR
01446500	Delaware River at Belvidere, NJ	4,540	22.0	Storm peak[2]	9/9/2011	147,000	32.4	21.55	1430	16.7	6	89	Regulation
				Historic peak of record	8/19/1955	273,000	60.1	30.21	--	--	--	--	NR
01455500	Musconetcong River at outlet of Lake Hopatcong, NJ	25.3	4.0	Third highest peak	9/9/2011	790	31.2	5.4	--	NA	NA	77	Regulation
				Historic peak of record	8/13/2000	1,900	75.1	10.47	--	--	--	--	NR
01457000	Musconetcong River near Bloomsbury, NJ	141	6.0	Third highest peak	8/28/2011	6,400	45.4	8.75	0845	2	50	93	NR
				Historic peak of record	1/25/1979	7,200	51.1	8.5	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

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U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01463500	Delaware River at Trenton, NJ	6,780	20.0	Storm peak[2]	9/8/2011	195,000	28.8	23.11	1530	16.7	6	98	NR
				Historic peak of record	8/20/1955	329,000	48.5	28.60	--	--	--	--	NR
01463620	Assunpink Creek near Clarksville, NJ	34.3	8.0	Second highest peak	8/29/2011	1,250	36.4	9.74	0315	< 10	> 10	30	Regulation
				Historic peak of record	8/28/1971	1,500	43.7	10.90	--	--	--	--	NR
01464000	Assunpink Creek at Trenton, NJ	90.6	8.5	New peak of record	8/28/2011	5,820	64.2	15.12	1900	< 1	> 100	88	NR
				Previous peak of record	7/21/1975	5,450	60.2	14.61	--	--	--	--	NR
01464500	Crosswicks Creek at Extonville, NJ	81.5	12.0	New peak of record	8/28/2011	5,940	72.9	17.1	1445	< 2	> 50	72	NR
				Previous peak of record	9/1/1978	4,860	59.6	14.18	--	--	--	--	NR
01465850	South Branch Rancocas Creek at Vincentown, NJ	64.5	7.0	Second highest peak	8/28/2011	2,550	39.5	9.5	--	< 1	> 100	46	NR
				Historic peak of record	7/13/2004	4,160	64.5	12.34	--	--	--	--	NR
01465880	Southwest Branch Rancocas Creek at Medford, NJ	47.2	12.0	Storm peak[2]	8/28/2011	2,310	48.9	14.31	--	< 20	> 5	21	NR
				Historic peak of record	7/13/2004	12,400	262.7	19.7	--	--	--	--	NR
01466500	McDonalds Branch in Byrne State Forest, NJ	2.35	3.0	New peak of record	8/28/2011	61.0	26.0	2.54	--	< 1	> 100	58	NR
				Previous peak of record	7/13/2004	38	16.2	2.33	--	--	--	--	NR

Table 5. Summary of historical flood peak streamflow and flood peak streamflow recorded at 96 active U.S. Geological Survey continuous-record streamflow-gaging stations with 20 or more years of record during the 2011 water year[1].—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ft³/s/mi², cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak dischage per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Annual exceedance probability (%)	Recurrence interval (years)	Years of record through 2011	Flow regulation
01467000	North Branch Rancocas Creek at Pemberton, NJ	118	2.5	New peak of record	8/29/2011	2,400	20.3	4.91	0815	< 1	> 100	90	NR
				Previous peak of record	7/14/2004	2,050	17.4	4.20	--	--	--	--	NR
01467081	South Branch Pennsauken Creek at Cherry Hill, NJ	8.98	9.0	Third highest peak	8/28/2011	1,280	142.5	11.23	--	4	25	43	NR
				Historic peak of record	7/13/2004	1,560	173.7	11.76	--	--	--	--	NR
01467150	Cooper River at Haddonfield, NJ	17.0	2.8	Third highest peak	8/28/2011	2,910	171.2	5.86	--	< 10	> 10	48	NR
				Historic peak of record	7/13/2004	3,300	194.1	6.27	--	--	--	--	NR
01475001	Mantua Creek at East Holly Avenue at Pitman, NJ	6.05	4.0	Second highest peak	8/14/2011	1,080	178.5	7.31 ##	--	< 4	> 25	63	NR
				Historic peak of record	9/1/1940	4,200	694.2	6.64	--	--	--	--	NR
01477120	Raccoon Creek near Swedesboro, NJ	26.9	13.0	New peak of record	8/28/2011	5,510	204.8	18.68	--	< 1	> 100	45	NR
				Previous peak of record	8/10/1967	3,530	131.2	17.44	--	--	--	--	NR
01482500	Salem River at Woodstown, NJ	14.6	13.0	Second highest peak	8/28/2011	8,760	600.0	15.26	0300	< 1	> 100	65	NR
				Historic peak of record	9/1/1940	22,000	1506.8	17.98	--	--	--	--	NR

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

[2] Storm peak refers to the flood peak from a storm event that is not ranked in the top three highest peaks recorded for the period of record for a streamgage.

[3] Peak is a maximum daily average affected by an unknown degree of regulation. This is an historic peak before gage began operation.

[4] Gage height affected by backwater is at a different datum.

[5] Flood frequency computed for this continuous-record streamflow-gaging station by the U.S. Geological Survey, New York Water Science Center.

[6] Gage reactivated a few months before Hurricane Irene. Continuous flow data 1937–64, 2011, and annual peak data from 1965–95, 1999.

Table 6. Summary of historical flood peak streamflow and flood peak streamflow recorded at 31 active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or fewer years of record during the 2011 water year[1].

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak discharge per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Years of record through 2011	Flow regulation
				Hudson River Basin Gages							
01367690	Franklin Pond Creek at Beaver Lake, NJ	5.7	--	Peak of record	8/28/2011	913	159.1	4.65	1,315	< 1	NR
				Previous peak of record	NA	--	--	--	--	--	NR
01367800	Papakating Creek at Pellettown, NJ	15.8	4.0	New peak of record	8/28/2011	2,750	174.1	10.0	--	8	NR
				Previous peak of record	4/16/2007	1,210	76.6	8.5	--	--	NR
				Hackensack River Basin Gages							
01377370	Pascack Brook at Parkridge, NJ	13.4	4.5	Second highest peak	8/29/2011	3,500	261.2	6.72	--	9	NR
				Historic peak of record	9/16/1999	5,730	427.6	--	--	--	NR
				Passaic River Basin Gages							
01379699	Rockaway River at Route 15 at Berkshire Valley, NJ	24	--	Storm peak[2]	8/28/2011	1,840	76.0	13.53	--	1	NR
				Historic peak of record	8/13/2000	2,500	103.3	--	--	--	NR
01379868	Mill Brook at Route 10 at Victory Gardens, NJ	4	--	New peak of record	8/28/2013	1,100	258.2	10.27	--	3	NR
				Previous peak of record	3/14/2010	380	89.2	8.44	--	--	NR
01381400	Whippany River at Morristown, NJ	14.0	--	New peak of record	8/28/2011	2,300	164.3	10.42	--	17	NR
				Previous peak of record	9/16/1999	1,920	137.1	9.31	--	--	NR

Table 6. Summary of historical flood peak streamflow and flood peak streamflow recorded at 31 active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or fewer years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak discharge per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Years of record through 2011	Flow regulation
01382170	Pequannock River at Route 23 near Oak Ridge, NJ	19.3	7.0	New peak of record	8/28/2011	2,410	124.9	9.47	--	3	Regulation
				Previous peak of record	3/14/2010	1,740	90.2	8.50	--	--	NR
01382210	Pequannock River at Oak Ridge NJ	27.4	--	Peak of record	8/28/2011	4,150	151.5	9.21	--	1	Regulation
				Previous peak of record	NA	--	--	--	--	--	NR
01382270	Pequannock River at Route 23 at Newfoundland NJ	32.0	--	Peak of record	8/28/2011	3,400	106.3	7.59	--	1	NR
				Previous peak of record	NA	--	--	--	--	--	NR
01382385	Pequannock River at Green Pond Junction, NJ	57.1	--	Peak of record	8/28/2011	3,650	63.9	11.09	--	1	NR
				Previous peak of record	--	--	--	--	--	--	NR
01382800	Pequannock River at Riverdale, NJ	83.9	--	Second highest peak	8/30/2011	6,900	82.2	12.57	--	6	NR
				Historic peak of record	4/5/1984	8,000[3]	95.4	13.6	--	--	NR
01387908	Ramapo River at railroad bridge at Oakland, NJ	145.0	--	New peak of record	8/28/2011	18,300	126.2	13.40	--	3	NR
				Previous peak of record	3/14/2010	11,200	77.2	9.42	--	--	NR
01389550	Peckman River at Little Falls, NJ	7.8	7.0	New peak of record	8/28/2011	2,010	257.0	9.16	--	4	NR
				Previous peak of record	9/6/2008	1,280	163.7	6.40	--	--	NR

Table 6. Summary of historical flood peak streamflow and flood peak streamflow recorded at 31 active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or fewer years of record during the 2011 water year[1].—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ft³/s/mi², cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak discharge per square mile (ft³/s/mi²)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Years of record through 2011	Flow regulation
01389890	Passaic River at Dundee Dam at Clifton, NJ	805.0	--	Third highest peak	8/30/2011	24,700	30.7	5.9	--	4, 24[4]	NR
				Historic peak of record	10/10/1903	35,800[5]	44.5	8.4	--	--	NR
				Raritan River Gages							
01396091	SB Raritan River at Route 46 at Budd Lake, NJ	5.08	--	New peak of record	8/28/2011	134	26.4	7.71	--	3	NR
				Previous peak of record	3/14/2010	92	18.1	6.78	--	--	NR
01396152	Flanders Brook at Route 206 near Flanders, NJ	1.97	--	New peak of record	8/28/2011	1,360	690.4	8.57	--	3	NR
				Previous peak of record	3/13/2010	427	216.8	6.54	--	--	NR
01396190	SB Raritan River at Four Bridges, NJ	31.0	--	New peak of record	8/28/2011	3,590	115.8	12.03	--	13	NR
				Previous peak of record	9/16/1999	3,000	96.8	10.6	--	--	NR
01398900	NB Raritan River at Bedminster, NJ	40.8	--	New peak of record	8/28/2011	6,550	160.5	13.07	--	1	NR
				Previous peak of record	8/22/2010	157	3.8	3.84	--	--	NR
01399100	Middle Brook near Burnt Mills, NJ	6.67	8.0	New peak of record	8/28/2011	2,570	385.3	10.79	--	6	NR
				Previous peak of record	8/2/2009	1,710	256.4	10.02	--	--	NR
01406050	Deep Run at Old Bridge, NJ	16.0	8.0	New peak of record	8/28/2011	4,000	250.0	9.6	--	11	NR
				Previous peak of record	4/16/2007	1,270	79.4	8.15	--	--	NR

Table 6. Summary of historical flood peak streamflow and flood peak streamflow recorded at 31 active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or fewer years of record during the 2011 water year[1].—Continued

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U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak discharge per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Years of record through 2011	Flow regulation
Southern New Jersey, Atlantic Coastal Plain Gages											
01408151	SB Metedeconk Creek at New Hampshire Ave nr Lakewood, NJ	29.5	--	Peak of record	8/28/2011	1,880	63.7	14.28	1,900	< 1	NR
				Previous peak of record	NA	--	--	--	--	--	NR
01409095	Oyster Creek at Brookville, NJ	7.43	--	Storm peak[2]	8/28/2011	159	21.4	5.33	--	21[6]	NR
				Historic peak of record	7/13/1991	550	74.0	8.41	--	--	NR
01409210	Mill Creek at Manahawkin, NJ	20.4	--	Peak of record	8/28/2011	189	9.3	6.5	--	< 1	NR
				Previous peak of record	NA	--	--	--	--	--	NR
01410784	Great Egg Harbor River near Sicklerville, NJ	15.1	--	New peak of record	8/28/2011	538	35.6	7.6	--	3	NR
				Previous peak of record	12/15/1996	105	7.0	5.34[7]	--	--	NR
01410820	Great Egg Harbor River near Blue Anchor, NJ	37.3	--	New peak of record	8/28/2011	1,240	33.2	7.53	--	8	NR
				Previous peak of record	7/15/1975	754	20.2	6.79	--	--	NR
Delaware River Basin											
01439800	Big Flatbrook near Hainesville, NJ	22.8	--	Second highest peak	8/28/2011	3,840	168.4	9.53	--	4	NR
				Historic peak of record	8/19/1955	4,490	196.9	--	--	--	NR
01443280	EB Paulins Kill near Lafayette, NJ	13.0	--	New peak of record	8/28/2011	589	45.3	6.63	--	19	NR
				Previous peak of record	4/16/2007	376	28.9	5.89	--	--	NR

Table 6. Summary of historical flood peak streamflow and flood peak streamflow recorded at 31 active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or fewer years of record during the 2011 water year[1].—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; >, greater than; < less than; %, percent; ##, different gage datum than historical peak; NA, not available; --, no data; NR, no regulation]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Flood stage (ft)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak discharge per square mile ($ft^3/s/mi^2$)	Peak stream elevation (in feet above gage datum)	Time (Eastern Standard Time)	Years of record through 2011	Flow regulation
01460880	Lockatong Creek at Raven Rock, NJ	22.9	--	New peak of record	8/28/2011	7,190	314.0	10.5	--	6	NR
				Previous peak of record	6/28/2006	6,690	292.1	10.25	--	--	NR
01461300	Wickecheoke Creek at Stockton, NJ	26.6	--	New peak of record	9/8/2011	26,300	988.7	14.36	--	6	NR
				Previous peak of record	6/28/2006	17,500	657.9	12.06	--	--	NR
01463740	Shabakunk Creek at Sylvia Lake Dam at Ewingville, NJ	4	--	Third highest peak	9/9/2011	1,920	481.2	6.17	--	4	NR
				Historic peak of record	7/21/1975	5,550	1391.0	9.30	--	--	NR
01466900	Greenwood Branch at New Lisbon, NJ	78	4.5	Second highest peak	8/29/2011	1,800	23.1	9.87	--	14	NR
				Historic peak of record	7/13/2004	1,080	13.9	8.91	--	--	NR

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

[2] Storm peak refers to the flood peak from a storm event that is not ranked in the top three highest peaks recorded for the period of record for a continuous-record streamflow-gaging station.

[3] An estimated historic peak affected by regulation.

[4] 20 of the 24 years of annual peak flows are estimated historic peaks. Continuous-record flows from April 2007 through 2011.

[5] An estimated historical peak.

[6] Gage reactivated 2 months before Hurricane Irene. Continuous flow data 1966–85, 2011.

[7] Gage height is at a different datum.

Table 7. Flood-frequency estimates computed for active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or more years of peak streamflow record from observed streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at U.S. Geological Survey streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																				
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
Hackensack River Basin Gages																							
01377000	Hackensack River at Rivervale, NJ	58.0	944	1,784	959	1,630	2,596	1,660	2,170	3,167	2,210	2,960	3,919	3,010	3,610	4,475	3,660	4,320	5,068	4,370	6,210	6,448	6,230
01377500	Pascack Brook at Westwood, NJ	29.6	897	1,557	908	1,437	2,311	1,460	1,847	2,862	1,890	2,424	3,602	2,480	2,896	4,169	2,970	3,402	4,771	3,490	4,734	6,198	4,840
01378500	Hackensack River at New Milford, NJ	113	2,040	2,861	2,050	3,320	4,112	3,340	4,300	4,986	4,320	5,660	6,133	5,680	6,760	6,975	6,770	7,940	7,877	7,940	11,000	9,956	10,900
Passaic River Basin Gages																							
01379000	Passaic River near Millington, NJ	55.4	827	857	827	1,201	1,321	1,200	1,479	1,662	1,480	1,863	2,127	1,870	2,174	2,467	2,190	2,508	2,857	2,530	3,384	3,781	3,410
01379500	Passaic River near Chatham, NJ	100	1,308	1,100	1,300	1,831	1,672	1,830	2,204	2,086	2,200	2,708	2,646	2,710	3,105	3,050	3,100	3,523	3,513	3,520	4,586	4,599	4,590
01379773	Green Pond Brook at Picatinny Arsenal, NJ	7.65	125	256	130	206	423	220	273	553	300	376	736	420	467	879	522	571	1,043	641	873	1,454	974
01380500	Rockaway River above Reservoir at Boonton, NJ	116	2,072	1,919	2,070	3,188	2,975	3,180	4,036	3,776	4,030	5,235	4,888	5,220	6,222	5,720	6,190	7,290	6,681	7,250	10,140	8,997	10,100
01381500	Whippany River at Morristown, NJ	29.4	949	1,037	950	1,442	1,653	1,450	1,802	2,137	1,810	2,293	2,823	2,320	2,684	3,356	2,720	3,096	3,964	3,140	4,150	5,464	4,230
01381800	Whippany River near Pine Brook, NJ	68.5	905	1,454	937	1,310	2,237	1,390	1,630	2,827	1,780	2,090	3,639	2,340	2,490	4,244	2,800	2,920	4,938	3,310	4,140	6,587	4,690
01381900	Passaic River at Pine Brook, NJ	349	3,511	4,868	3,550	4,886	7,347	4,990	5,805	9,206	6,010	6,976	11,766	7,350	7,854	13,647	8,360	8,738	15,848	9,430	10,840	21,030	12,000
01382500	Pequannock River at Macopin Intake Dam, NJ	63.7	Flood Frequency not run[2]																				
01383500	Wanaque River at Awosting, NJ	27.1	494	836	499	936	1,332	945	1,347	1,715	1,360	2,030	2,251	2,040	2,681	2,662	2,680	3,472	3,134	3,450	6,015	4,290	5,900
01384500	Ringwood Creek near Wanaque, NJ	19.1	450	510	451	778	866	780	1,074	1,157	1,080	1,558	1,582	1,560	2,015	1,926	2,010	2,566	2,323	2,550	4,328	3,363	4,250
01386000	West Brook near Wanaque, NJ	11.8	622	589	621	1,007	970	1,010	1,312	1,277	1,310	1,755	1,716	1,750	2,130	2,066	2,130	2,544	2,467	2,540	3,683	3,482	3,660
01387420	Ramapo River at Suffern, NY	93.0	3,100	2,110	2,980	5,570	3,440	5,170	7,830	4,560	7,050	11,600	6,250	9,980	15,100	7,700	12,700	19,400	9,360	15,800	33,200	14,100	25,800

Table 7. Flood-frequency estimates computed for active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or more years of peak streamflow record from observed streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at U.S. Geological Survey streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.—Continued

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

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			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
01387450	Mahwah River near Suffern, NY	12.3	574	954	583	974	1,505	994	1,319	1,932	1,350	1,862	2,528	1,910	2,354	3,009	2,410	2,930	3,526	2,980	4,671	4,830	4,690
01387500	Ramapo River near Mahwah, NJ	120	2,992	2,084	2,980	5,161	3,355	5,120	7,049	4,364	6,970	10,040	5,808	9,880	12,760	6,938	12,500	15,960	8,245	15,600	25,690	11,537	24,900
01388000	Ramapo River at Pompton Lakes, NJ	160	3,360	2,407	3,350	5,770	3,815	5,730	7,840	4,913	7,750	111,000	6,470	107,000	13,900	7,667	13,600	17,300	9,053	16,900	27,300	12,491	26,400
01388500	Pompton River at Pompton Plains, NJ	355	5,730	4,176	5,700	9,860	6,486	9,760	13,100	8,258	12,900	17,700	10,743	17,300	21,400	12,615	20,900	25,500	14,804	24,800	36,200	20,137	34,900
01389500	Passaic River at Little Falls, NJ	762	7,151	7,768	7,160	10,590	11,719	10,600	13,050	14,692	13,100	16,360	18,809	16,400	18,950	21,835	19,100	21,660	25,401	21,800	28,480	33,851	28,800
01390450	Saddle River at Upper Saddle River, NJ	10.9	1,424	911	1,410	2,279	1,430	2,240	2,936	1,832	2,870	3,870	2,392	3,750	4,641	2,845	4,480	5,478	3,329	5,260	7,710	4,540	7,340
01390500	Saddle River at Ridgewood, NJ	21.6	1,019	1,233	1,020	1,780	1,873	1,780	2,504	2,349	2,500	3,750	2,997	3,700	4,978	3,503	4,870	6,522	4,041	6,320	11,790	5,349	11,200
01391000	Hohokus Brook at Ho-Ho-Kus, NJ	16.4	1,119	904	1,110	1,901	1,342	1,880	2,552	1,657	2,510	3,544	2,074	3,450	4,416	2,391	4,270	5,410	2,725	5,190	8,284	3,514	7,830
01391500	Saddle River at Lodi, NJ	24.0	2,293	2,246	2,290	3,205	3,307	3,210	3,831	4,076	3,840	4,645	5,103	4,670	5,269	5,882	5,300	5,908	6,714	5,950	7,467	8,680	7,550
	Elizabeth River Gages																						
01393450	Elizabeth River at Ursino Lake at Elizabeth, NJ	16.9	2,054	1,134	2,030	2,773	1,661	2,740	3,284	2,043	3,220	3,970	2,551	3,880	4,511	2,938	4,400	5,078	3,341	4,940	6,522	4,280	6,320
	Rahway River Gages																						
01394500	Rahway River near Springfield, NJ	25.5	1,255	1,501	1,260	2,136	2,252	2,140	2,969	2,809	2,960	4,392	3,564	4,350	5,786	4,151	5,690	7,532	4,773	7,350	13,450	6,266	12,900
01395000	Rahway River at Rahway, NJ	40.9	977	1,889	990	1,417	2,787	1,450	1,749	3,441	1,800	2,218	4,317	2,310	2,604	4,984	2,720	3,024	5,692	3,170	4,130	7,367	4,340
	Raritan River Gages																						
01396500	South Branch Raritan River near High Bridge, NJ	65.3	1,831	1,217	1,820	2,838	1,916	2,820	3,643	2,450	3,610	4,830	3,195	4,760	5,848	3,759	5,750	6,987	4,408	6,860	10,200	5,990	9,950
01396582	Spruce Run at Main Street at Glen Gardner, NJ	11.3	1,343	462	1,310	1,908	764	1,830	2,297	1,005	2,180	2,805	1,349	2,630	3,194	1,622	2,990	3,593	1,934	3,350	4,566	2,727	4,260

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[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																				
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
01396660	Mulhockaway Creek at Van Syckel, NJ	11.8	1,445	1,111	1,430	2,124	1,794	2,100	2,604	2,313	2,580	3,243	3,042	3,220	3,741	3,607	3,730	4,257	4,256	4,260	5,542	5,820	5,580
01397000	South Branch Raritan River at Stanton, NJ	147	4,594	6,402	4,620	7,215	9,737	7,270	9,297	12,156	9,380	12,350	15,483	12,500	14,950	17,927	15,100	17,840	20,794	18,000	25,910	27,367	26,000
01398000	Neshanic River at Reaville, NJ	25.7	3,170	1,826	3,150	4,782	2,874	4,730	5,982	3,650	5,900	7,651	4,726	7,510	9,004	5,540	8,820	10,450	6,477	10,200	14,240	8,686	13,900
01398500	North Branch Raritan River near Far Hills, NJ	26.2	1,433	888	1,430	2,455	1,458	2,430	3,297	1,916	3,250	4,564	2,574	4,480	5,663	3,096	5,540	6,903	3,697	6,730	10,430	5,223	10,100
01399500	Lamington (Black) River near Pottersville, NJ	32.8	743	750	743	1,273	1,188	1,270	1,727	1,522	1,720	2,435	1,987	2,420	3,073	2,341	3,040	3,814	2,745	3,760	6,029	3,730	5,880
01399670	South Branch Rockaway Creek at Whitehouse Station, NJ	12.3	1,080	1,262	1,090	1,512	2,026	1,540	1,831	2,604	1,890	2,274	3,417	2,390	2,633	4,045	2,800	3,019	4,765	3,250	4,037	6,493	4,410
01400000	North Branch Raritan River near Raritan, NJ	190	8,978	7,966	8,960	13,470	12,264	13,400	17,030	15,444	17,000	22,250	19,877	22,100	26,710	23,190	26,500	31,690	27,083	31,400	45,680	36,174	45,100
01400500	Raritan River at Manville, NJ	490	15,800	14,092	15,800	22,700	21,176	22,700	28,000	26,296	28,000	35,800	33,353	35,700	42,500	38,489	42,300	49,900	44,585	49,600	70,500	58,502	69,800
01401000	Stony Brook at Princeton, NJ	44.5	3,548	2,588	3,530	4,995	3,998	4,960	6,092	5,024	6,040	7,646	6,434	7,570	8,932	7,478	8,830	10,330	8,689	10,200	11,870	11,488	11,800
01401650	Pike Run at Belle Mead, NJ	5.36	785	757	784	1,340	1,197	1,330	1,850	1,522	1,820	2,730	1,971	2,650	3,590	2,311	3,430	4,660	2,698	4,390	8,260	3,602	7,510
01402000	Millstone River at Blackwells Mills, NJ	258	6,027	7,054	6,040	9,542	10,385	9,560	12,330	12,688	12,300	16,400	15,777	16,400	19,850	17,941	19,800	23,680	20,496	23,500	34,320	26,123	33,800
01403060	Raritan River below Calco Dam at Bound Brook, NJ	785	20,400	19,798	20,400	28,400	29,242	28,400	34,300	35,962	34,400	42,200	45,150	42,300	48,700	51,715	48,900	55,500	59,571	55,700	73,300	77,161	73,600
01403150	West Branch Middle Brook near Martinsville, NJ	1.99	374	347	373	596	543	593	789	685	780	1,096	877	1,070	1,377	1,020	1,330	1,711	1,180	1,640	2,743	1,546	2,550
01403400	Green Brook at Seeley Mills, NJ	9.75	624	738	627	1,138	1,179	1,140	1,620	1,513	1,610	2,435	1,979	2,400	3,224	2,339	3,150	4,198	2,746	4,060	7,420	3,713	6,990
01403540	Stony Brook at Watchung, NJ	5.51	1,097	852	1,090	1,986	1,354	1,950	2,840	1,732	2,760	4,320	2,258	4,120	5,786	2,662	5,460	7,634	3,120	7,100	14,000	4,201	12,600
01403900	Bound Brook at Middlesex, NJ	48.4	2,220	3,685	2,290	3,611	5,437	3,750	4,771	6,676	4,970	6,539	8,341	6,780	8,097	9,533	8,310	9,883	10,911	10,100	15,100	13,911	14,900

Table 7. Flood-frequency estimates computed for active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or more years of peak streamflow record from observed streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at U.S. Geological Survey streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.—Continued

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																			
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
01405030	Lawrence Brook at Westons Mills, NJ	44.9	1,931	2,132	1,940	3,443	3,155	3,420	4,757	3,859	4,650	6,827	4,794	6,530	8,700	5,451	8,170	10,890	6,209	10,000	17,450	7,859	15,400
01407290	Big Brook near Marlboro, NJ	6.42	789	315	770	1,084	522	1,050	1,262	679	1,210	1,469	897	1,410	1,612	1,068	1,540	1,746	1,256	1,680	2,033	1,688	1,980
Southern New Jersey, Atlantic Coastal Plain Gages																							
01407500	Swimming River near Red Bank, NJ	49.2	1,383	1,178	1,380	2,575	1,924	2,560	3,663	2,486	3,630	5,449	3,267	5,360	7,127	3,872	6,970	9,148	4,548	8,900	15,530	6,102	14,900
01407705	Shark River near Neptune City, NJ	9.96	436	176	429	810	274	786	1,152	347	1,100	1,716	444	1,610	2,247	515	2,090	2,888	594	2,650	4,924	773	4,430
01408000	Manasquan River at Squankum, NJ	44.0	1,000	493	991	1,577	747	1,560	2,063	934	2,020	2,813	1,180	2,740	3,483	1,356	3,370	4,260	1,556	4,100	6,578	1,995	6,250
01408029	Manasquan River near Allenwood, NJ	63.3	1,837	608	1,800	2,981	917	2,880	3,890	1,142	3,710	5,218	1,440	4,900	6,345	1,651	5,900	7,593	1,892	6,990	11,040	2,420	9,970
01408120	North Branch Metedeconk River near Lakewood, NJ	34.9	515	425	512	848	637	837	1,124	790	1,100	1,544	992	1,490	1,913	1,134	1,830	2,334	1,295	2,210	3,558	1,643	3,300
01408500	Toms River near Toms River, NJ	123	791	882	792	1,220	1,348	1,220	1,556	1,693	1,560	2,041	2,156	2,050	2,449	2,490	2,450	2,899	2,873	2,900	4,134	3,735	4,110
01409000	Cedar Creek at Lanoka Harbor, NJ	53.3	399	454	401	570	726	577	702	934	717	890	1,222	918	1,047	1,438	1,080	1,219	1,685	1,270	1,690	2,269	1,760
01409280	Westecunk Creek at Stafford Forge, NJ	15.8	100	176	103	152	295	163	194	389	214	255	520	290	307	623	353	364	740	426	525	1,030	620
01409400	Mullica River near Batsto, NJ	46.7	483	313	479	801	481	789	1,057	603	1,030	1,436	764	1,390	1,760	878	1,690	2,121	1,008	2,020	3,133	1,299	2,950
01409810	West Branch Wading River near Jenkins, NJ	84.1	722	457	711	1,084	737	1,060	1,322	950	1,290	1,617	1,242	1,570	1,830	1,460	1,780	2,038	1,712	1,990	2,508	2,313	2,470
01410000	Oswego River at Harrisville, NJ	72.5	382	425	382	582	701	585	729	917	736	931	1,220	944	1,093	1,452	1,110	1,263	1,720	1,290	1,690	2,377	1,740
01410150	East Branch Bass River near New Gretna, NJ	8.11	69	100	70	144	172	146	225	230	226	381	312	374	551	378	530	781	452	738	1,676	639	1,520
01411000	Great Egg Harbor River at Folsom, NJ	57.1	306	525	309	489	794	496	639	990	651	866	1,250	883	1,064	1,435	1,080	1,289	1,644	1,310	1,939	2,105	1,950

Table 7. Flood-frequency estimates computed for active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or more years of peak streamflow record from observed streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at U.S. Geological Survey streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.—Continued

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																			
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
Delaware River Basin[4]																						
01411300	Tuckahoe River at Head of River, NJ	30.8	224	270	225	355	441	359	464	573	471	632	755	643	780	893	791	951	1,051	962	1,455	1,432	1,450
01411456	Little Ease Run near Clayton, NJ	9.77	81	154	85	165	241	171	248	305	254	389	392	389	527	455	516	698	526	668	1,265	687	1,150
01411500	Maurice River at Norma, NJ	112	503	843	509	851	1,293	863	1,173	1,627	1,190	1,711	2,077	1,730	2,227	2,404	2,240	2,864	2,779	2,860	4,963	3,622	4,870
01412800	Cohansey River at Seeley, NJ	28.0	457	336	450	1,160	552	1,110	2,000	723	1,850	3,740	964	3,310	5,770	1,150	4,990	8,660	1,363	7,290	20,810	1,879	16,700
01434000	Delaware River at Port Jervis, NY[4]	3,070	59,500			91,000			114,000			147,000			173,000			201,000			273,000		
01438500	Delaware River at Montague, NJ[4]	3,480	65,200			101,000			127,000			164,000			194,000			226,000			308,000		
01440000	Flat Brook near Flatbrookville, NJ	64.0	1,644	1,069	1,640	2,744	1,813	2,720	3,667	2,418	3,630	5,083	3,302	5,010	6,337	4,015	6,220	7,778	4,847	7,620	12,010	7,041	11,700
01440200	Delaware River at Delaware Water Gap, NJ[4]	3,850	71,800			110,000			139,000			178,000			210,000			244,000			332,000		
01443500	Paulins Kill at Blairstown, NJ	126	1,870	1,467	1,860	2,821	2,324	2,810	3,552	2,976	3,530	4,595	3,888	4,560	5,464	4,576	5,420	6,413	5,373	6,360	8,988	7,339	8,880
01445000	Pequest River at Huntsville, NJ	31.0	282	579	288	441	929	456	568	1,197	595	752	1,572	798	908	1,858	968	1,082	2,184	1,160	1,564	2,993	1,680
01445500	Pequest River at Pequest, NJ	106	938	1,073	940	1,309	1,697	1,320	1,558	2,168	1,580	1,876	2,820	1,920	2,116	3,309	2,170	2,358	3,873	2,440	2,936	5,261	3,080
01446000	Beaver Brook near Belvidere, NJ	37.0	504	707	507	793	1,171	803	1,025	1,540	1,040	1,369	2,069	1,400	1,665	2,486	1,710	1,996	2,967	2,050	2,934	4,202	3,020
01446500	Delaware River at Belvidere, NJ[4]	4,540	76,900			116,000			145,000			184,000			215,000			248,000			334,000		
01457000	Musconetcong River near Bloomsbury, NJ	141	1,981	2,257	1,980	3,197	3,533	3,200	4,122	4,514	4,130	5,424	5,886	5,440	6,487	6,926	6,510	7,630	8,132	7,660	10,630	11,072	10,700
01457500	Delaware River at Riegelsville, NJ[4]	6,330	92,300			136,000			167,000			208,000			241,000			274,000			358,000		
01463500	Delaware River at Trenton, NJ[4]	6,780	94,900			138,000			169,000			211,000			245,000			280,000			372,000		

Table 7. Flood-frequency estimates computed for active U.S. Geological Survey continuous-record streamflow-gaging stations in New Jersey with 20 or more years of peak streamflow record from observed streamflow-gaging station data, from estimates predicted using regression equations[1], and from a weighted average for streamflow data recorded at U.S. Geological Survey streamflow-gaging stations including peak flows from the flood of August 27–30, 2011.—Continued

[mi², square miles; %, percent; O , flood frequency computed from observed data; R, flood frequency estimated from the regression equation; W, is the weighted estimate of flood frequency]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Estimated discharge for recurrence intervals, in cubic feet per second (the reciprocal of the recurrence interval is the annual exceedance probability, in percent)																				
			2-year (50%)			5-year (20%)			10-year (10%)			25-year (4%)			50-year (2%)			100-year (1%)			500-year (0.2%)		
			O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W	O	R	W
01463620	Assunpink Creek near Clarksville, NJ	34.3	338	702	353	639	1,151	673	898	1,485	952	1,297	1,946	1,370	1,648	2,300	1,730	2,048	2,694	2,140	3,198	3,599	3,270
01464000	Assunpink Creek at Trenton, NJ	90.6	1,709	3,429	1,730	2,522	4,986	2,580	3,112	6,039	3,210	3,914	7,424	4,070	4,551	8,375	4,740	5,223	9,486	5,460	6,940	11,862	7,260
01464500	Crosswicks Creek at Extonville, NJ	81.5	1,625	1,168	1,620	2,657	1,896	2,640	3,429	2,435	3,390	4,495	3,176	4,430	5,349	3,741	5,250	6,251	4,372	6,130	8,556	5,816	8,340
01465850	South Branch Rancocas Creek at Vincentown, NJ	64.5	751	932	755	1,136	1,524	1,150	1,395	1,962	1,430	1,722	2,565	1,790	1,964	3,025	2,060	2,204	3,540	2,340	2,760	4,726	2,990
01465880	Southwest Branch Rancocas Creek at Medford, NJ	47.2	1,090	1,156	1,090	1,900	1,841	1,890	2,640	2,344	2,600	3,840	3,029	3,710	4,960	3,546	4,710	6,310	4,121	5,880	10,600	5,398	9,430
01466500	McDonalds Branch in Byrne State Forest, NJ	2.35	10	38	10	18	68	20	25	93	29	36	130	42	46	159	54	57	193	68	90	281	108
01467000	North Branch Rancocas Creek at Pemberton, NJ	118	771	1,642	783	1,148	2,649	1,180	1,408	3,392	1,470	1,748	4,416	1,860	2,007	5,194	2,160	2,272	6,067	2,480	2,911	8,056	3,240
01467081	South Branch Pennsauken Creek at Cherry Hill, NJ	8.98	575	384	570	824	621	814	1,015	798	1,000	1,289	1,040	1,270	1,518	1,226	1,490	1,769	1,428	1,730	2,457	1,881	2,390
01467150	Cooper River at Haddonfield, NJ	17.0	814	638	810	1,298	1,035	1,290	1,698	1,334	1,680	2,306	1,748	2,260	2,842	2,068	2,780	3,455	2,420	3,360	5,246	3,216	5,020
01475001	Mantua Creek at East Holly Avenue at Pitman, NJ	6.05	129	358	134	274	592	284	437	772	452	760	1,022	776	1,123	1,220	1,130	1,629	1,436	1,610	3,695	1,933	3,540
01477120	Raccoon Creek near Swedesboro, NJ	26.9	750	671	747	1,353	1,140	1,340	1,869	1,507	1,850	2,666	2,028	2,610	3,374	2,445	3,290	4,187	2,912	4,060	6,558	4,033	6,260
01482500	Salem River at Woodstown, NJ	14.6	707	413	702	1,518	719	1,490	2,350	963	2,290	3,853	1,314	3,710	5,392	1,599	5,150	7,374	1,918	6,980	14,360	2,704	13,400

[1] Using regression equations developed in SIR 2009-5167, by Watson and Schopp.

[2] Flood-frequency estimates were not calculated due to regulation at the streamgage.

[3] Peak is a maximum daily average affected by an unknown degree of regulation. This is an historic peak before gage began operation.

[4] Flood-frequency estimates for streamgages on the Delaware River come from U.S. Geological Survey Open-File Report 2008-1203.

Table 8. Summary of historical flood peak streamflow and flood peak streamflow recorded at U.S. Geological Survey crest-stage partial-record streamgages and continous-record stage gages with annual peak discharge during the flood of August 27–30, 2011, across the State of New Jersey.

[mi^2, square miles; ft^3/s, cubic feet per second; >, greater than; < less than; %, percent; --, not determined]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak stream elevation (in feet above gage datum)	Annual exceedence probability (%)	Recurrence Interval (Years)	Years of record through water year 2011
			Hackensack River Basin Gages						
01377460	Pascack Brook at Hillsdale, NJ	20.7	Second highest peak	8/28/2011	4,850	14.28	< 10	>10	14
			Historic peak of record	9/16/1999	7,610	15.48			
01378385	Tenakill Brook at Closter, NJ	8.56	Third highest peak	8/28/2011	1,150	5.7	< 10	>10	47
			Historic peak of record	4/15/2007	1,500	7.2			
01378590	Metzler Brook at Englewood, NJ	1.54	Storm peak [2]	8/28/2011	296	2.49	< 20	>5	47
			Historic peak of record	9/16/1999	534	2.91			
			Passaic River Basin Gages						
01378690	Passaic River near Bernardsville, NJ	8.83	Storm peak [2]	8/28/2011	2,180	16.59	< 10	>10	44
			Historic peak of record	8/28/1971	3,850	18.56			
01379845	Rockaway River at Warren Street at Dover, NJ	52.1	New peak of record	8/28/2011	3,820	9.35	< 4	>25	30
			Previous peak of record	9/17/1999	3,440	8.91			
01387880	Pond Brook at Oakland, NJ	6.76	Storm peak [2]	8/28/2011	961	4.22	< 10	>10	39
			Historic peak of record	9/16/1999	1,680	7.83			
01389534[1]	Peckman River at Ozone Avenue at Verona, NJ	4.45	Storm peak [2]	8/28/2011	1,750	5.32	< 20	>5	34
			Historic peak of record	9/16/1999	2,770	6.57			

Table 8. Summary of historical flood peak streamflow and flood peak streamflow recorded at U.S. Geological Survey crest-stage partial-record streamgages and continous-record stage gages with annual peak discharge during the flood of August 27–30, 2011, across the State of New Jersey.—Continued

[mi², square miles; ft³/s, cubic feet per second; >, greater than; < less than; %, percent; --, not determined]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak stream elevation (in feet above gage datum)	Annual exceedence probability (%)	Recurrence Interval (Years)	Years of record through water year 2011
01389765[1]	Molly Ann Brook at North Haledon, NJ	3.89	Storm peak [2]	8/28/2011	990	8.3	< 10	>10	34
			Historic peak of record	5/16/1990	1,300	10.93			
01389900	Fleischer Brook at Market Street at Elmwood Park, NJ	1.37	Storm peak [2]	8/28/2011	154	3.93	< 50	>2	44
			Historic peak of record	9/16/1999	--	5.66			
01390810	Hohokus Brook at Allendale, NJ	9.11	Second highest peak	8/28/2011	1,520	8.72	< 4	>25	43
			Historic peak of record	9/16/1999	3,010	12.15			
01390900	Ramsey Brook at Allendale, NJ	2.55	Third highest peak	8/28/2011	972	5.38	< 4	>25	37
			Historic peak of record	9/16/1999	987	5.41			
01392170[1]	Third River at Bloomfield, NJ	7.71	Storm peak [2]	8/28/2011	2,020	8.71	< 10	>10	23
			Historic peak of record	9/16/1999	2,670	9.97			
			Rahway River Basin Gages						
01393890[1]	East Branch Rahway River at Maplewood, NJ	5.11	Second highest peak	8/28/2011	2,340	8.62	< 2	50	15
			Historic peak of record	9/16/1999	3,470	10.08			
01394000[1]	West Branch Rahway River at Millburn, NJ	7.10	Second highest peak	8/28/2011	2,610	4.86	< 1	>100	27
			Historic peak of record	9/16/1999	2,840	5.2			

Table 8. Summary of historical flood peak streamflow and flood peak streamflow recorded at U.S. Geological Survey crest-stage partial-record streamgages and continous-record stage gages with annual peak discharge during the flood of August 27–30, 2011, across the State of New Jersey.—Continued

[mi^2, square miles; ft^3/s, cubic feet per second; >, greater than; < less than; %, percent; --, not determined]

U.S. Geological Survey station number	Station name	Drainage area (mi^2)	Remarks	Date of peak discharge	Peak discharge (ft^3/s)	Peak stream elevation (in feet above gage datum)	Annual exceedence probability (%)	Recurrence Interval (Years)	Years of record through water year 2011
01396000[1]	Robinsons Branch at Rahway, NJ	21.6	New peak of record	8/28/2011	5,600	6.56	< 1	>100	70
			Previous peak of record	9/16/1999	4,800	6.48			
			Raritan River Basin Gages						
01398107	Holland Brook at Readington, NJ	9.00	Second highest peak	8/28/2011	3,360	10.10	< 4	>25	30
			Historic peak of record	9/16/1999	4,150	10.67			
01399830[1]	North Branch Raritan River at North Branch, NJ	174	Third highest peak	8/28/2011	24,700	20.54	< 4	>25	35
			Historic peak of record	9/16/1999	27,800	21.53			
01401301	Millstone River at Carnegie Lake at Princeton, NJ	159	New peak of record	8/28/2011	17,700	9.52	< 1	>100	71
			Previous peak of record	4/16/2007	13,800	7.51			
01401595	Rock Brook near Blawenburg, NJ	9.03	Storm peak [2]	8/28/2011	2,990	7.90	< 10	>10	44
			Historic peak of record	8/28/1971	4,530	10.0			
01401600	Beden Brook near Rocky Hill, NJ	27.0	Third highest peak	8/28/2011	11,100	16.19	< 10	>10	45
			Historic peak of record	9/16/1999	15,300	18.61			
01401870	Six Mile Run near Middlebush, NJ	10.7	New peak of record	8/28/2011	12,000	12.2	< 2	>50	44
			Previous peak of record	7/14/1975	10,200	11.77			

Table 8. Summary of historical flood peak streamflow and flood peak streamflow recorded at U.S. Geological Survey crest-stage partial-record streamgages and continous-record stage gages with annual peak discharge during the flood of August 27–30, 2011, across the State of New Jersey.—Continued

[mi², square miles; ft³/s, cubic feet per second; >, greater than; < less than; %, percent; --, not determined]

U.S. Geological Survey station number	Station name	Drainage area (mi²)	Remarks	Date of peak discharge	Peak discharge (ft³/s)	Peak stream elevation (in feet above gage datum)	Annual exceedence probability (%)	Recurrence Interval (Years)	Years of record through water year 2011
01403500	Green Brook at Plainfield, NJ	9.75	Storm peak [2]	8/28/2011	2,410	6.22	< 4	>25	77
			Historic peak of record	7/23/1938	2,890	5.82			
01403535	East Branch Stony Brook at Best Lake at Watchung, NJ	1.57	Third highest peak	8/28/2011	2,300	5.31	< 4	>25	33
			Historic peak of record	8/2/1973	2,840	5.90			
01403570[1]	Stony Brook at North Plainfield, NJ	6.88	New peak of record	8/28/2011	3,140	8.36	< 10	>10	30
			Previous peak of record	10/19/1996	3,130	8.35			
01403600[1]	Green Brook at Rock Avenue at Plainfield, NJ	18.2	Storm peak [2]	8/28/2011	5,170	10.76	< 20	>5	29
			Historic peak of record	8/2/1973	10,400	13.6			
			Delaware River Basin Gages						
01440200[1]	Delaware River at Delaware Water Gap, NJ	3,850	Storm peak [2]	9/9/2011	128,000	24.94	<20	6	42
			Historic peak of record	8/19/1955	260,000	37.40			
01457500[1]	Delaware River at Riegelsville, NJ	6,330	Storm peak [2]	9/8/2011	175,000	28.06	<20	6	105
			Historic peak of record	8/19/1955	340,000	38.85			

[1] Continuous record of stage is collected. Annual peak discharge is published.

[2] Storm peak refers to the flood peak from a storm event that is not ranked in the top three highest peaks recorded for the period of record of the station.

Appendix 1

Descriptions of high-water mark sites

Site maps, showing locations of stream reaches, U.S. Geological Survey (USGS) streamflow-gaging stations, and high-water mark sites are included for each stream reach. The main stream reach for each map is shown as a thicker blue line.

Selected photographs taken by USGS field crews of HWMs are included for some stream reaches.

Because of the elimination of some sites and HWMs, the sequence of site identification numbers and high-water mark numbers has been interrupted.

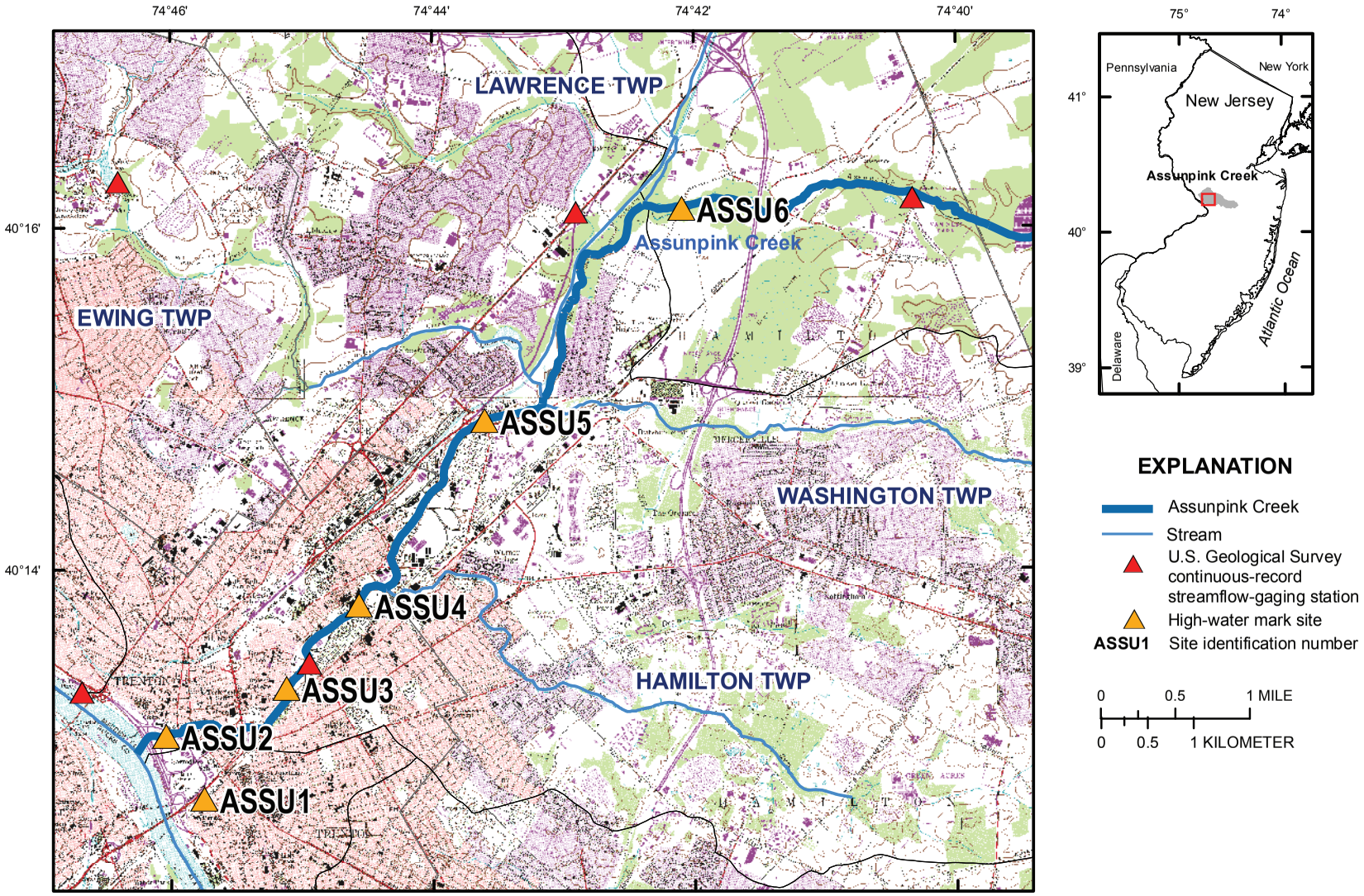
Site identification includes the site identification number (for example ASSU1), name, and location (Lat, Latitude; Long, Longitude). All location coordinates are referenced to North American Datum of 1983 (NAD 83).

High-water mark location descriptions in relation to a delineating structure follow a simplified format, where 50’ is 50 feet, USR is upstream right bank, USL is upstream left bank, DSR is downstream right bank, DSL is downstream left bank, US is upstream, DS is downstream, R is right bank, and L is left bank.

Elevations of individual HWMs are provided in feet above North American Vertical Datum of 1988 (NAVD 88), along with the average of the upstream marks and the average of the downstream marks at each site.

Figures use the abbreviations TWP, township; Boro, Borough. Latitudes and longitudes are in °, degrees; ', minutes; ", seconds.

Additional field notes are on file at the U.S. Geological Survey New Jersey Water Science Center, Lawrenceville, NJ.

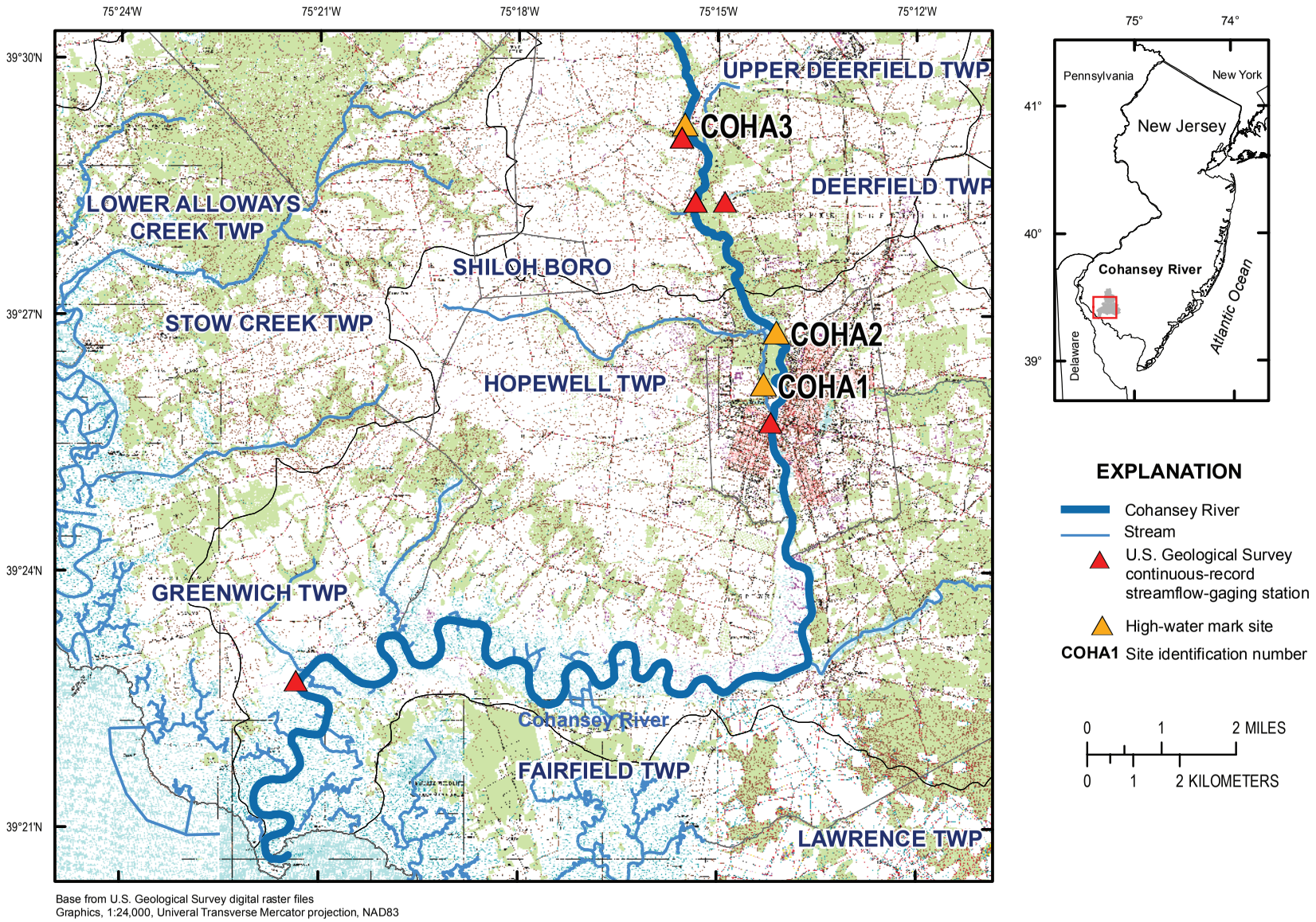


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Assunpink Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-1 Assunpink Creek.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
1	ASSU1: Assunpink Creek bypass at Trenton, Mercer County, NJ. Lat 040°12'39.55"N Long 074°45'44.90"W, located at Ferry Street.	1.1	Bypass	Good mark on a utility pole.	25.96	25.21	
		1.2	Bypass	Good debris line on a chain-link fence.	26.34		
		1.3	Bypass	Fair seed line on a 1-foot diameter tree.	24.33		
		1.4	Bypass	Fair seed line on an 8-inch diameter tree.	24.23		
2	ASSU2: Assunpink Creek at Trenton, Mercer County, NJ. Lat 040°13'01.70"N Long 074°46'02.38"W, located at the bridge on Memorial Drive.	2.1	100' DSR	Good seed line on a 1-foot diameter tree.	19.94	24.63	19.97
		2.2	65' DSR	Good seed line on a 3-foot diameter tree.	19.83		
		2.3	70' DSL	Fair seed line on a 1.5-foot diameter tree.	20.05		
		2.4	75' DSL	Fair seed line on a 1.5-foot diameter tree.	20.06		
		2.6	70' USL	Fair seed line on a 1.5-foot diameter tree.	24.66		
		2.7	50' USR	Fair seed line on a 3-foot diameter tree.	24.60		
		2.8	45' USR	Seed line on a 3.5-foot diameter tree.	24.64		
3	ASSU3: Assunpink Creek at Trenton, Mercer County, NJ. Lat 040°13'18.33"N Long 074°45'07.20"W, located at the bridge on Wall Street.	3.2	60' USL	Fair seed line on a 6-inch diameter tree.	36.31	36.28	34.65
		3.3	50' USR	Fair wash line on the ground.	36.24		
		3.5	55' DSL	Fair seed line on a 3-foot diameter tree.	34.88		
		3.6	40' DSL	Good seed line on a 1-foot diameter tree.	35.32		
		3.7	75' DSR	Fair seed line on a 3-foot diameter tree.	34.35		
		3.8	95' DSR	Fair seed line on a 2-foot diameter tree.	34.05		
4	ASSU4: Assunpink Creek at Trenton, Mercer County, NJ. Lat 040°13'47.47"N Long 074°44'33.94"W, located at the bridge on Olden Avenue.	4.1	120' USR	Good seed line on a 3-inch diameter tree.	44.17	44.32	43.68
		4.2	125' USR	Good seed line on a 3-inch diameter tree.	44.46		
		4.5	40' DSL	Fair seed line on a 2.5-foot diameter tree.	43.62		
		4.6	80' DSL	Poor seed line on a 2-foot diameter tree.	43.65		
		4.8	50' DSR	Fair mark on a 1.5-foot diameter tree.	43.78		
5	ASSU5: Assunpink Creek at Trenton, Mercer County, NJ. Lat 040°14'52.23"N Long 074°43'36.12"W, located at the bridge on Whitehead Road.	5.1	150' USR	Good seed line on a 3-foot diameter tree.	50.29	50.11	49.76
		5.2	145' USR	Good seed line on a 3-foot diameter tree.	49.79		
		5.3	45' USL	Good seed line on a 2-foot diameter tree.	50.09		
		5.4	50' USL	Good mud line on an electrical box.	50.26		
		5.5	100' DSR	Good seed line on a 6-inch diameter tree.	50.03		
		5.6	120' DSR	Good seed line on an 8-inch diameter tree.	50.12		
		5.7	300' DSL	Good seed line on a 1-foot diameter tree.	49.49		
		5.8	320' DSL	Good seed line on a 4.5-foot diameter tree.	49.41		
6	ASSU6: Assunpink Creek at Bakersville, Mercer County, NJ. Lat 040°16'06.56"N Long 074°42'05.61"W, located at the bridge on Basin Road.	6.1	60' USL	Fair seed line on a 2-foot diameter tree.	54.03	53.87	53.46
		6.3	100' USR	Fair seed line on a 1-foot diameter tree.	53.70		
		6.4	130' USR	Fair seed line on a 2-foot diameter tree.	53.88		
		6.5	40' DSR	Good seed line on a 2.5-foot diameter tree.	53.47		
		6.6	100' DSR	Fair mark on a 2-foot diameter tree.	53.67		
		6.7	90' DSL	Poor seed line on a 2-foot diameter tree.	53.40		
		6.8	45' DSL	Fair seed line on a 3-foot diameter tree.	53.33		

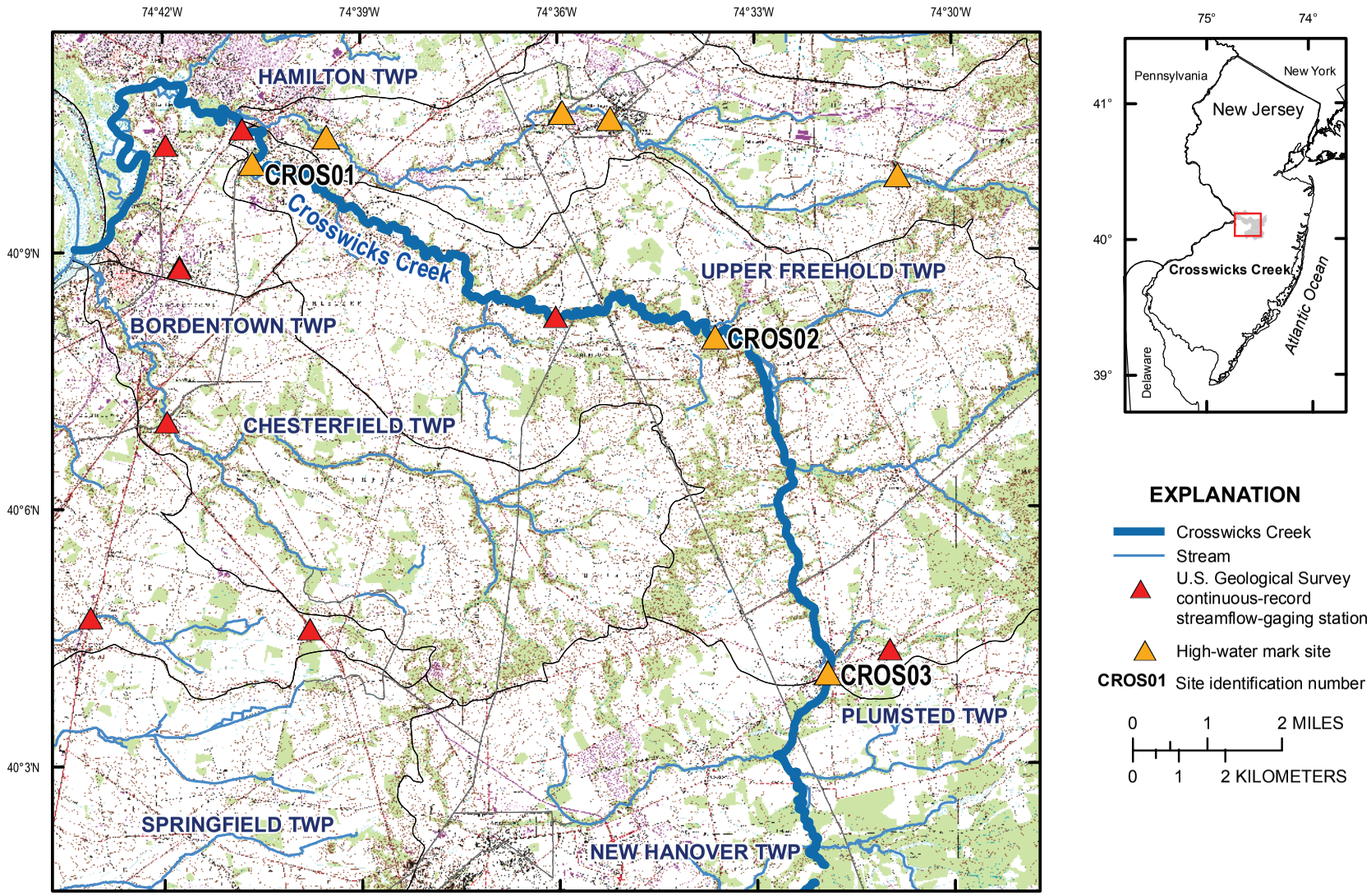


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Cohansey River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, southern New Jersey.

Appendix 1-2 Cohansey River.

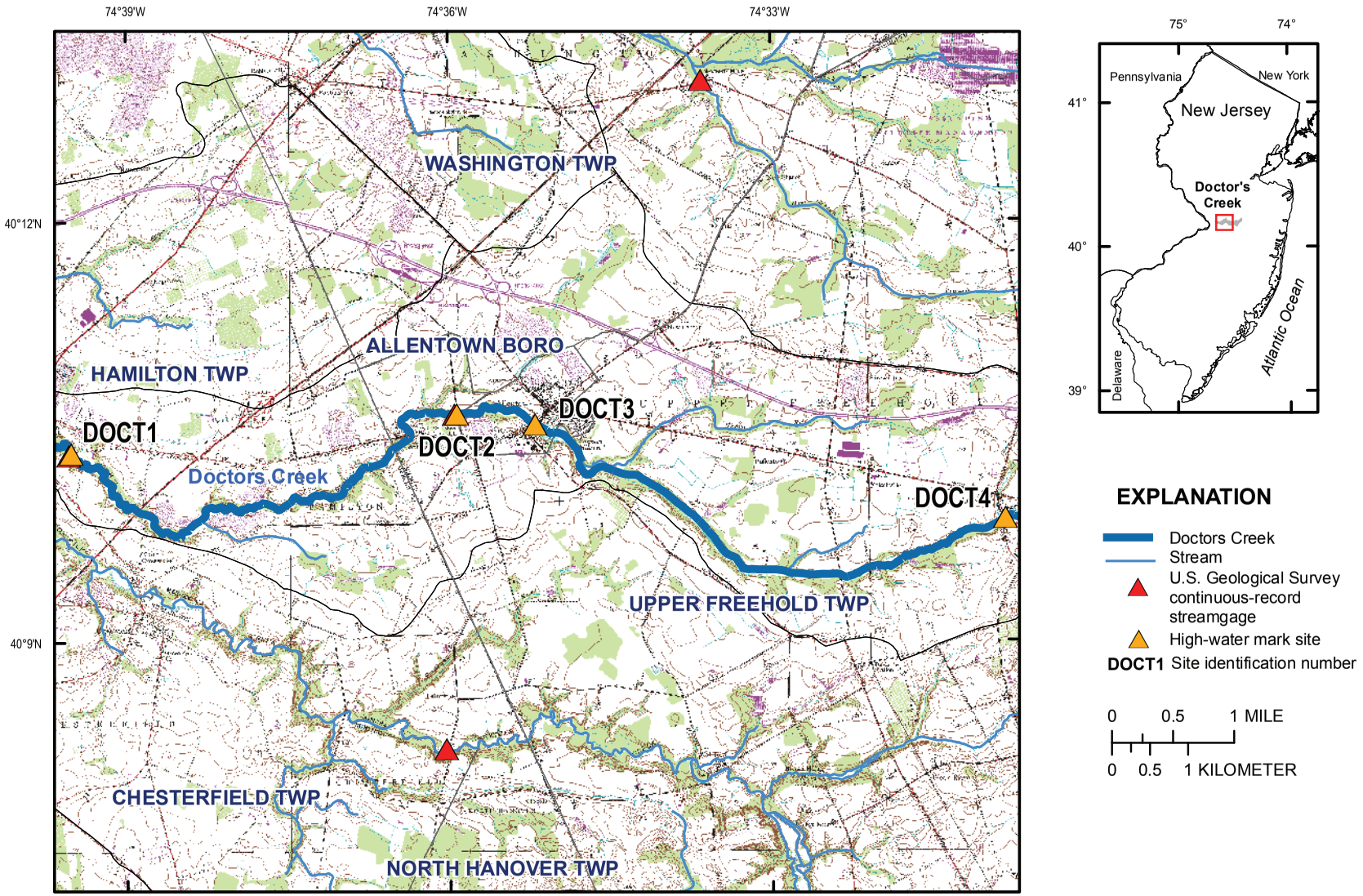
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
7	COHA1: Cohansey River at Bridgeton, Cumberland County, NJ. Lat 039°26'12.00"N Long 075°14'18.61"W, located at the bridge on Mayor Aitken Drive.	7.1	500' USR	Fair mud/debris line on a chain link fence.	17.01	16.88	16.99
		7.2	520' USR	Fair seed line on a 1.5-foot diameter tree.	16.86		
		7.3	500' USL	Fair seed line on a 1-foot diameter tree.	16.93		
		7.4	480' USL	Fair seed line on a 10-inch diameter tree.	16.70		
		7.5	300' DSL	Poor seed line on a 1.5-foot diameter tree.	17.02		
		7.6	270' DSL	Fair seed line on a 2-foot diameter tree.	16.94		
		7.7	270' DSR	Fair seed line on a 1-foot diameter tree.	16.97		
		7.8	300' DSR	Poor seed line on a 2-foot diameter tree.	17.06		
8	COHA2: Cohansey River at Bridgeton, Cumberland County, NJ. Lat 039°26'48.53"N Long 075°14'07.04"W, located at the outlet of Sunset Lake at the bridge on W. Park Drive.	8.1	100' USR	Good seed line on a 2.5-foot diameter tree.	21.05	21.09	19.29
		8.2	100' USR	Good seed line on an 8-inch diameter tree.	21.09		
		8.3	100' DSR	Fair seed line on a 4-inch diameter tree.	19.52		
		8.4	60' DSR	Fair seed line on a 10-inch diameter tree.	19.05		
		8.5	40' USL	Fair seed line on a 2-foot diameter tree.	21.09		
		8.6	40' USL	Unrated mark on a 1-foot diameter tree.	21.12		
10	COHA4: Cohansey River at Upper Deerfield, Cumberland County, NJ. Lat 040°13'18.33"N Long 074°45'07.20"W, located at the bridge on Friesburg Deerfield Road in Beals Mill, NJ.	10.1	15' USR	Fair seed line on a 1-foot diameter tree.	77.18	77.11	72.85
		10.2	20' USR	Good seed line on a 1-foot diameter tree.	77.15		
		10.3	40' USL	Good seed line on an 8-inch diameter tree.	77.17		
		10.4	20' USL	Poor seed line on an 8-inch diameter tree.	76.96		
		10.5	15' DSR	Fair seed line on a 6-inch diameter tree.	72.88		
		10.6	10' DSR	Fair seed line on a 6-foot diameter tree.	73.04		
		10.7	8' DSL	Good seed line on a 10-inch diameter tree.	72.72		
		10.8	10' DSL	Fair seed line on an 8-inch diameter tree.	72.76		



Location of Crosswicks Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-3 Crosswicks Creek.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
11	CROS1: Crosswicks Creek at Groveville, Mercer County, NJ. Lat 040°10'02.41"N Long 074°40'38.52"W, located at the bridge on Groveville Road in Groveville, NJ.	11.1	30' USR	Fair seed line on a 6-inch diameter tree.	18.32	18.07	16.61
		11.3	40' USL	Fair seed line on a 1.5-foot diameter tree.	17.83		
		11.7	80' DSR	Fair seed line on an 8-inch diameter tree.	16.58		
		11.8	95' DSR	Fair seed line on a 3-inch diameter tree.	16.65		
12	CROS2: Crosswicks Creek near Upper Freehold, Monmouth County, NJ. Lat 040°07'59.68"N Long 074°33'36.53"W, located at the bridge on Walnford Road.	12.1	90' USR	Fair mark on a 1.5-foot diameter tree.	47.98	48.24	47.10
		12.2	85' USR	Fair mark on a 1.5-foot diameter tree.	48.50		
		12.5	40' DSR	Unrated seed line on a tree.	47.08		
		12.6	45' DSR	Fair mark on a 3-foot diameter tree.	47.13		
13	CROS3: Crosswicks Creek at New Egypt, Ocean County, NJ. Lat 040°04'03.66"N Long 074°31'55.02"W, located at the bridge on Main Street.	13.1	170' USL	Unrated seed line on a 4-inch diameter tree.	70.67	70.66	69.74
		13.2	160' USL	Fair seed/debris line on a utility pole.	70.78		
		13.3	60' USR	Fair seed line on an 8-inch diameter tree.	70.57		
		13.4	80' USR	Unrated seed line on a 5-inch diameter tree.	70.64		
		13.5	100' DSR	Fair mark on a 6-inch diameter tree.	69.75		
		13.6	80' DSR	Poor mark on a 4-inch diameter tree.	69.52		
		13.7	140' DSL	Good seed line on a 1-foot diameter tree.	69.90		
		13.8	160' DSL	Fair seed line on a 1-foot diameter tree.	69.79		

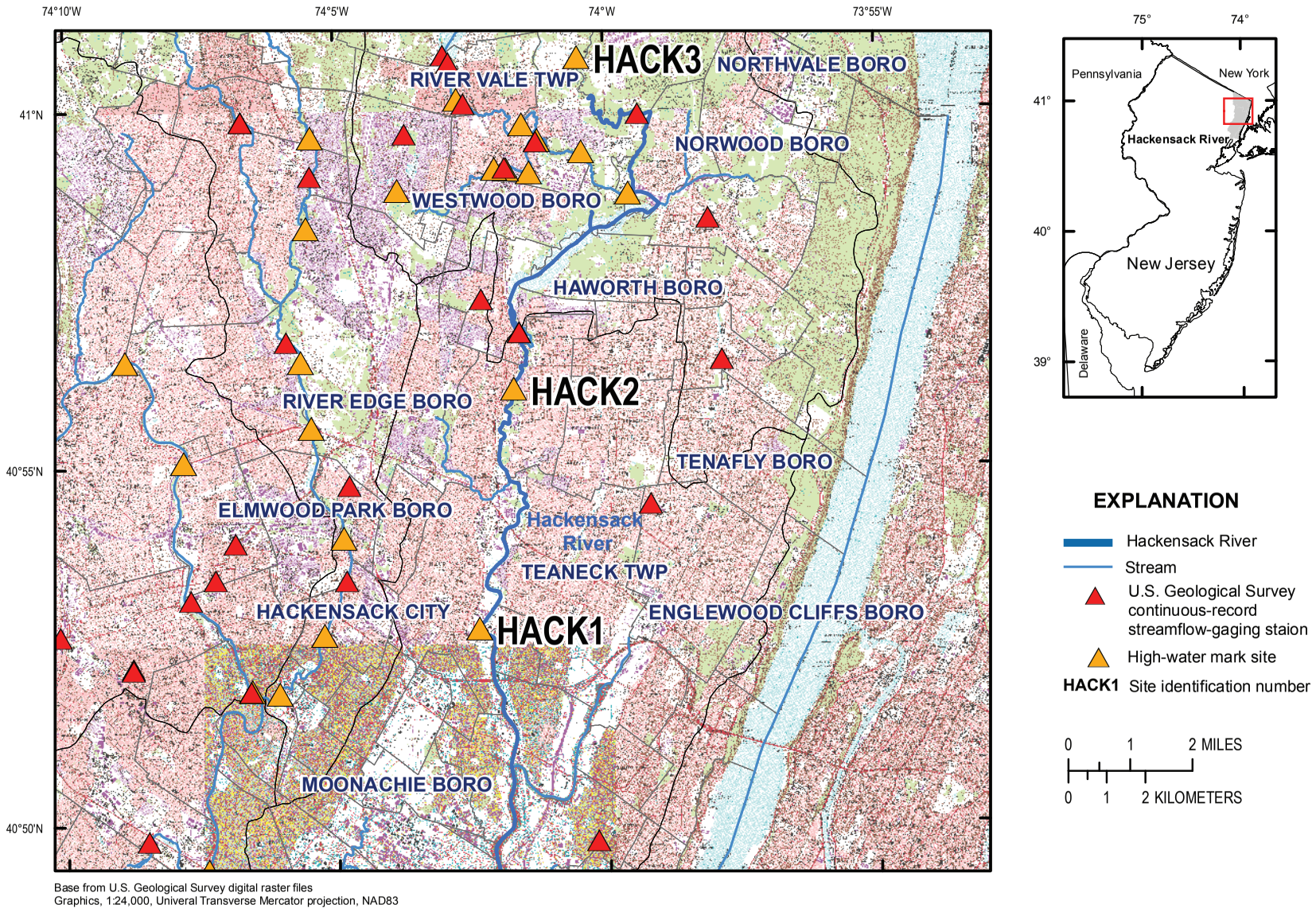


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Doctors Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-4 Doctors Creek.

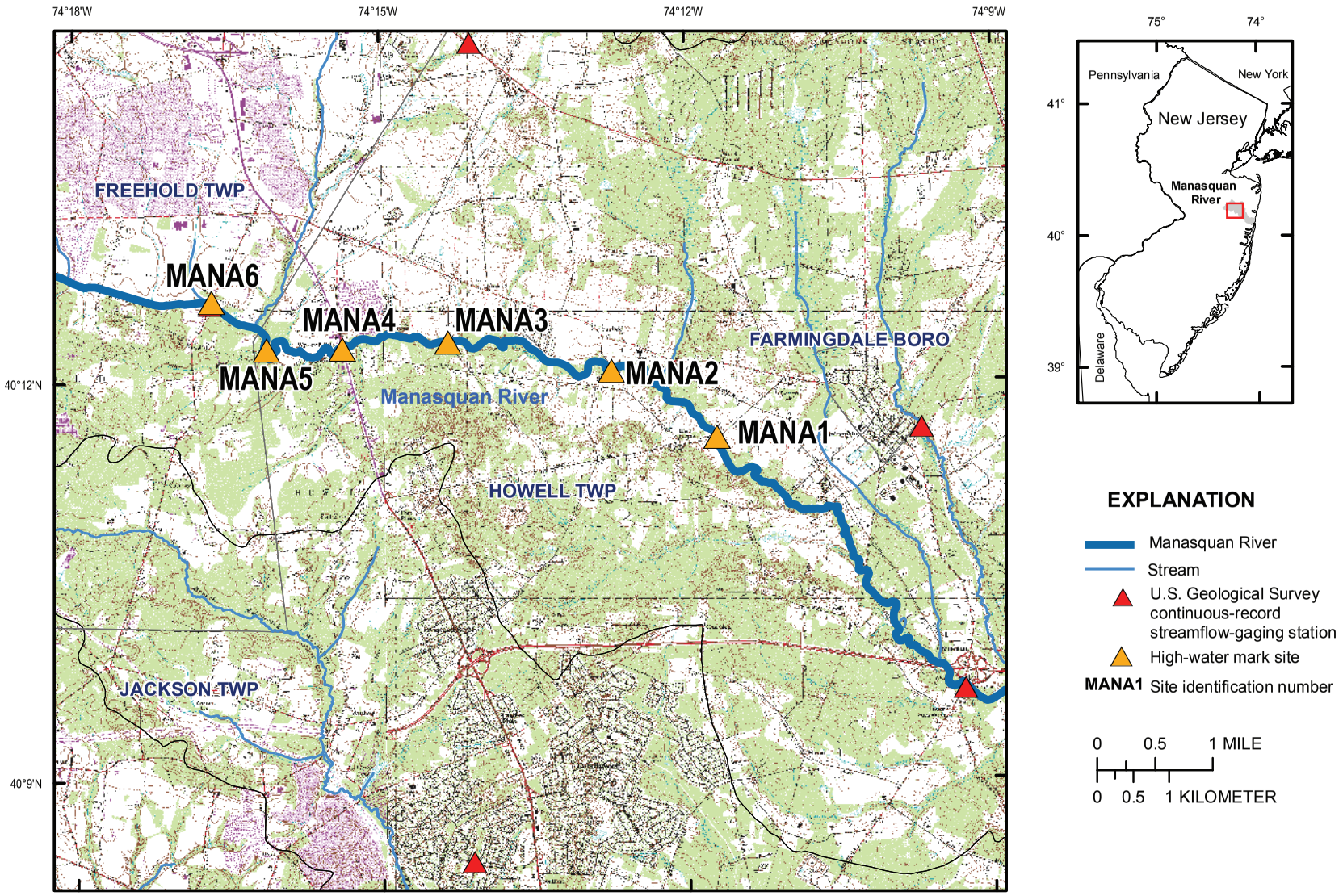
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
14	DOCT1: Doctors Creek at Groveville, Mercer County, NJ. Lat 040°10’20.76”N Long 074°39’31.10”W, Located at the bridge on Groveville Allentown Road.	14.1	70’ USR	Fair seed line on a 6-inch diameter tree.	23.50	24.18	23.76
		14.2	70’ USR	Fair seed line on a 3-foot diameter tree.	23.77		
		14.3	100’ USL	Poor seed line on a 3-inch diameter tree.	24.48		
		14.4	100’ USL	Poor seed line on a 2-foot diameter tree.	24.98		
		14.5	60’ DSL	Poor seed line on a 2-foot diameter tree.	23.99		
		14.6	75’ DSL	Poor seed line on a 10-inch diameter tree.	23.83		
		14.7	60’ DSR	Fair seed line on a 3-foot diameter tree.	23.63		
		14.8	60’ DSR	Fair seed line on a 10-inch diameter tree.	23.61		
15	DOCT2: Doctors Creek at Allentown, Monmouth County, NJ. Lat 040°10’37.31”N Long 074°35’55.64”W, located at the bridge on Breza Road.	15.1	85’ USR	Fair seed line on a 2-foot diameter tree.	64.32	64.16	62.14
		15.2	40’ USR	Fair mark on a 4-inch diameter tree.	64.00		
		15.6	100’ DSR	Fair seed line on a 2-foot diameter tree.	62.49		
		15.7	60’ DSL	Poor seed line on a 2.5-foot diameter tree.	61.85		
		15.8	70’ DSL	Unrated seed line on an 8-inch diameter tree.	62.07		
16	DOCT3: Doctors Creek at Allentown, Monmouth County, NJ. Lat 040°10’32.85”N Long 074°35’11.78”W, located at the bridge on S. Main Street.	16.1	80’ USL	Fair mark on a 1-foot diameter tree.	73.43	72.96	66.82
		16.2	80’ USL	Fair mark on a 2-foot diameter tree.	73.57		
		16.3	120’ DSR	Fair debris line on a 6-inch diameter tree.	66.67		
		16.4	130’ DSR	Fair seed line on a 6-foot diameter tree.	66.81		
		16.5	120’ DSL	Poor seed line on a 6-inch diameter tree.	66.76		
		16.6	100’ DSL	Poor seed line on an 8-inch diameter tree.	67.03		
		16.7	300’ USR	Fair seed line on a 1-foot diameter tree.	72.43		
		16.8	300’ USR	Fair mark on a 10-inch diameter tree.	72.40		
17	DOCT4: Doctors Creek at Imlaystown, Monmouth County, NJ. Lat 040°09’52.42”N Long 074°30’49.67”W, located at the bridge on Davis Station Road.	17.3	100’ USR	Fair seed line on a 3-inch diameter tree.	104.10	104.1	98.25
		17.5	120’ DSR	Fair seed line on a 3-foot diameter tree.	98.26		
		17.6	80’ DSR	Fair seed line on an 8-inch diameter tree.	98.14		
		17.7	130’ DSL	Fair seed line on a 4-foot diameter tree.	98.34		



Location of Hackensack River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-5 Hackensack River.

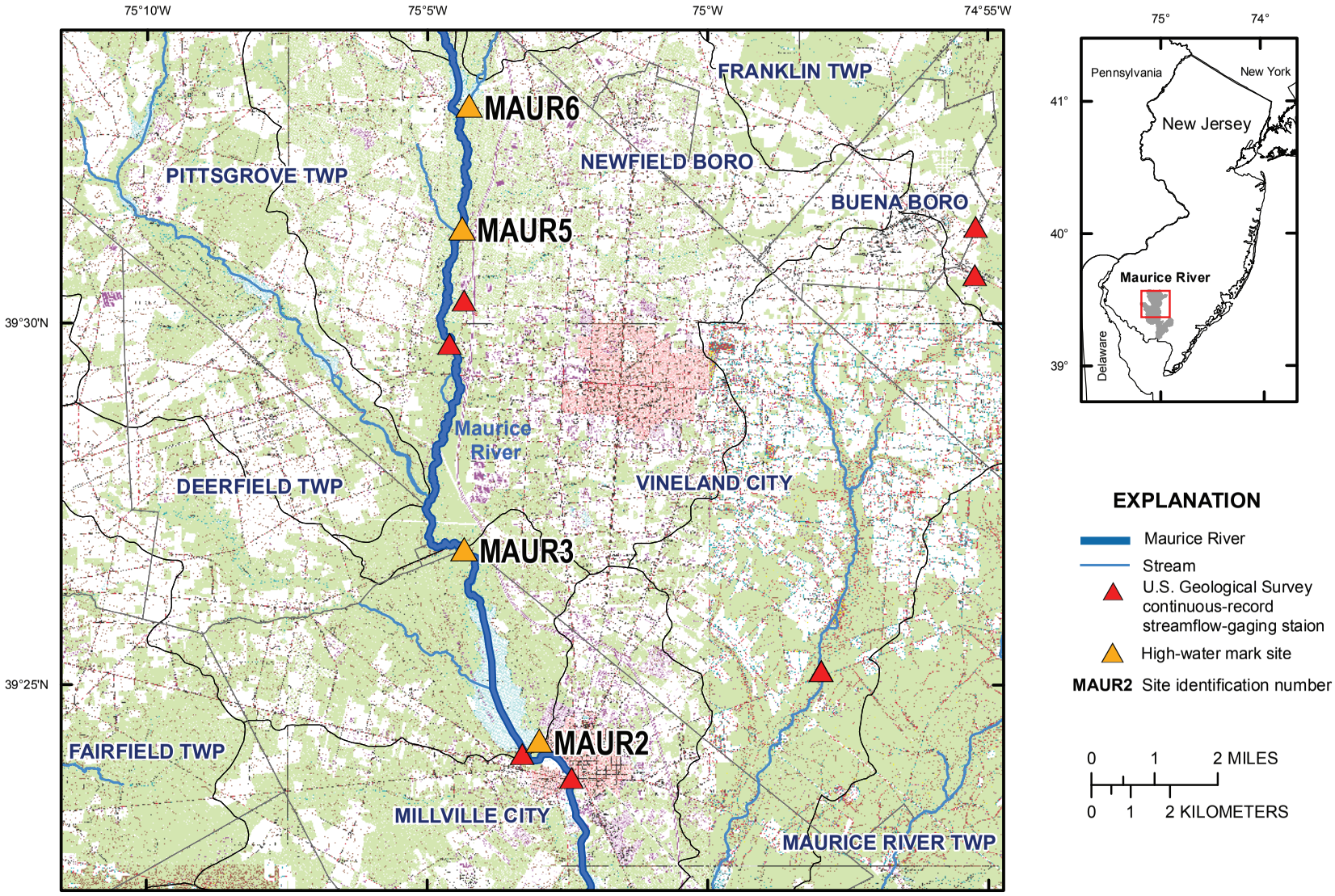
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
18	HACK1: Hackensack River at Hackensack, Bergen County, NJ. Lat 040°52’44.70”N Long 074°02’23.00”W, located at the bridge on Court Street.	18.4	25’ DSR	Good mud line on a sheet pile wall.	4.49	4.64	4.49
		18.5	200’ USR	Fair mud line on a sign post.	4.64		
19	HACK2: Hackensack River at New Milford, Bergen County, NJ. Lat 040°56’05.74”N Long 074°01’42.54”W, located at the bridge on River Edge Avenue.	19.2	50’ DSR	Fair mud line on a building door.	13.15	12.93	13.26
		19.4	10’ DSL	Poor seed line on a 3-foot diameter tree.	13.37		
		19.5	50’ USL	Excellent seed line on a door.	12.93		
20	HACK3: Hackensack River at Old Tappan, Bergen County, NJ. Lat 041°00’44.26”N Long 074°00’29.69”W, located at the bridge on Old Tappan Road.	20.3	200’ USR	Poor seed line on a 2-foot diameter tree.	42.78	42.72	39.93
		20.4	175’ USR	Poor seed line on an 8-inch diameter tree.	42.66		
		20.5	25’ DSR	Good mud line on a small metal shelter.	40.28		
		20.6	20’ DSR	Poor seed line on a 5.5-foot diameter tree.	39.99		
		20.7	15’ DSL	Good mud line on an electrical box.	39.41		
		20.8	20’ DSL	Poor seed line on a 5.5-foot diameter tree.	40.04		



Location of Manasquan River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-6 Manasquan River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
21	MANA1: Manasquan River at West Farms, Monmouth County, NJ. Lat 040°11'34.35"N Long 074°11'42.41"W, located at the bridge on West Farms Road.	21.1	100' DSR	Good seed line on a 5-foot diameter tree.	56.55	57.11	56.05
		21.2	150' DSR	Good seed line on a triple-trunked tree.	55.92		
		21.3	300' DSL	Fair seed line on a 10-inch diameter tree.	55.68		
		21.4	60' USR	Fair seed line on a 6-inch diameter tree.	57.19		
		21.5	55' USR	Good seed line on a 6-inch diameter tree.	57.03		
22	MANA2: Manasquan River at Fairfield, Monmouth County, NJ. Lat 040°12'04.41"N Long 074°12'44.19"W, located at the bridge on Ketcham Road.	22.1	60' DSL	Good seed line on a 2-foot diameter tree.	66.02	67.29	65.90
		22.2	70' DSR	Excellent mud line on the corner of a garage.	66.01		
		22.3	150' DSR	Excellent mud line on the corner of a building.	65.68		
		22.5	200' USL	Fair seed line on a 6-inch diameter tree.	67.29		
23	MANA3: Manasquan River at Farmingdale, Monmouth County, NJ. Lat 040°12'17.95"N Long 074°14'20.46"W, located at the bridge on Havens Bridge Road.	23.1	30' USL	Fair seed line on a 2-foot diameter tree.	76.40	76.34	75.97
		23.2	60' USL	Fair seed line on a 3-foot diameter tree.	76.76		
		23.3	80' DSL	Good seed/debris line on a 2-foot diameter tree.	76.04		
		23.4	50' DSL	Poor seed line on a 1-foot diameter tree.	76.44		
		23.5	100' USR	Fair seed line on a 2.5-foot diameter tree.	76.08		
		23.6	115' USR	Good seed line on a 6-inch diameter tree.	76.14		
		23.7	80' DSR	Good seed line on a 1.5-foot diameter tree.	75.68		
		23.8	120' DSR	Fair seed line on a 2-foot diameter tree.	75.71		
24	MANA4: Manasquan River at Wychoff Mills, Monmouth County, NJ. Lat 040°12'15.23"N Long 074°15'22.68"W, located at the bridge on Route 9.	24.1	4' DSR	Poor seed line on a 1-foot diameter tree.	79.40	81.19	79.70
		24.2	130' DSL	Fair seed line on an 8-inch diameter tree.	80.00		
		24.3	200' DSL	Poor seed line on an 8-inch diameter tree.	79.69		
		24.4A	60' USL	Excellent seed/debris line on a house.	81.33		
		24.5	5' USR	Good seed line on a 1-foot diameter tree.	81.04		
25	MANA5: Manasquan River at Wychoff Mills, Monmouth County, NJ. Lat 040°12'13.00"N Long 074°15'44.34"W, located at Mariners Cove near Bergerville Road.	25.1	L	Excellent seed line on a window frame.	84.04	83.86	
		25.2B	L	Good seed line on a gutter.	83.72		
		25.5	R	Poor seed line on a 3-foot diameter tree.	83.99		
		25.6	R	Poor seed line on a 2-foot diameter tree.	83.70		
26	MANA6: Manasquan River at Freehold, Monmouth County, NJ. Lat 040°12'36.64"N Long 074°16'39.41"W, located at the bridge on Jackson Mills Road.	26.1	220' USL	Good seed line on an 8-inch diameter tree.	87.54	87.73	85.67
		26.2	130' USL	Good seed line on a 1.5-foot diameter tree.	88.07		
		26.3	150' USR	Fair seed line on a 1.5-foot diameter tree.	87.57		
		26.5	80' DSR	Good seed line on a 5-inch diameter tree.	85.41		
		26.6	80' DSR	Fair seed line on a 1.3-foot diameter tree.	85.96		
		26.7	300' DSL	Excellent seed line on a garage door frame.	85.66		
		26.9	290' DSL	Good seed line on a 2-foot diameter tree.	85.63		

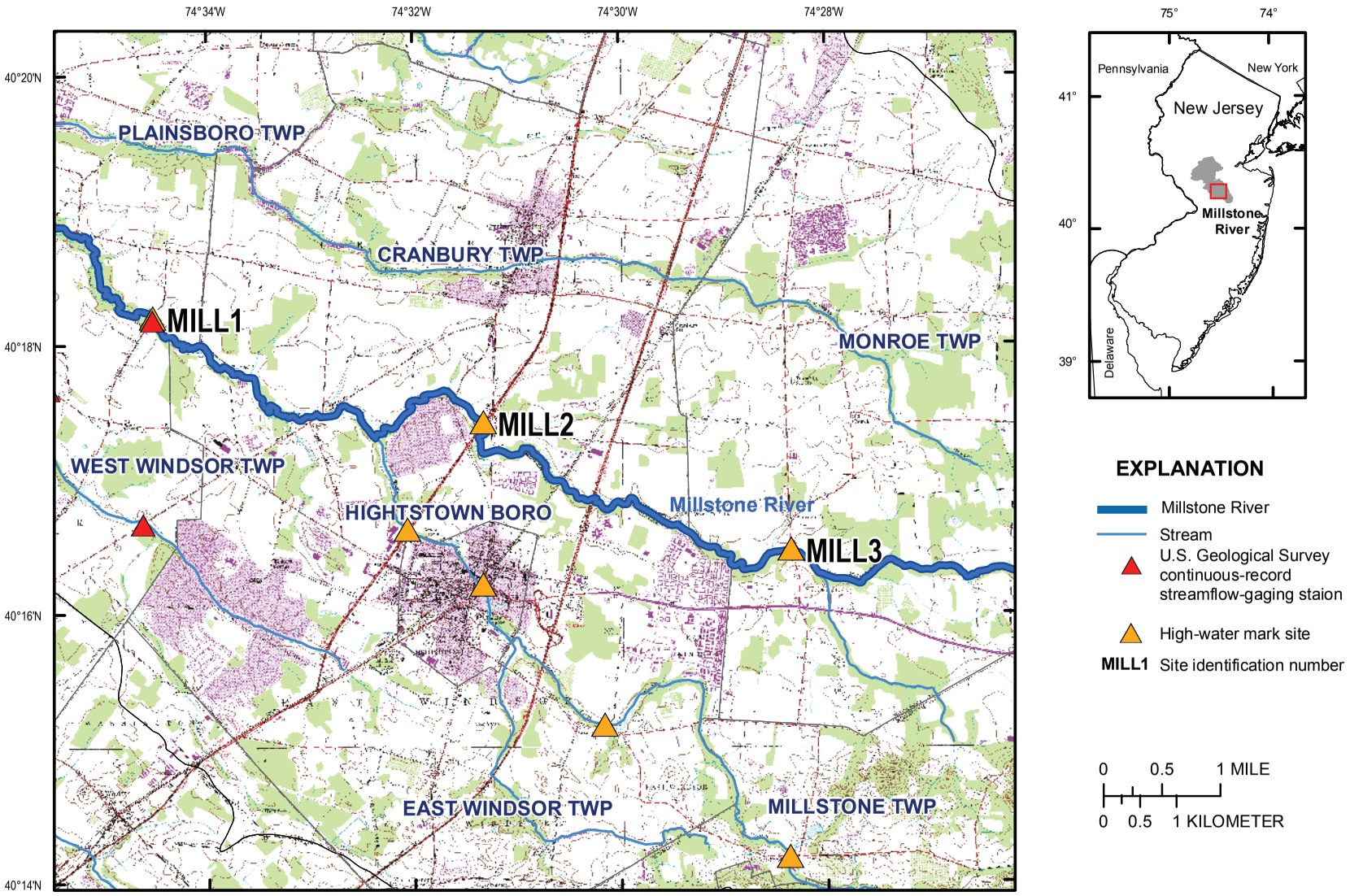


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Maurice River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, southern New Jersey.

Appendix 1-7 Maurice River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
27	MAUR2: Maurice River at Millville, Cumberland County, NJ. Lat 039°24'14.31"N Long 075°03'00.70"W, located at the dam on Sharp Street near Union Lake.	27.1	50' USL	Poor seed line on a 4-inch diameter tree.	28.91	28.56	20.79
		27.2	75' USL	Poor seed line on a a 4-foot diameter tree.	28.88		
		27.3	5' USR	Poor debris/wash line on a rock at dam opening.	27.87		
		27.4	75' DSL	Fair seed line on a 3-inch diameter tree.	20.73		
		27.5	90' DSL	Fair seed line on a 2-inch diameter tree.	20.32		
		27.6	70' DSR	Poor seed line on a 3-inch diameter tree.	21.03		
		27.7	65' DSR	Poor seed line on a 2-foot diameter tree.	21.06		
28	MAUR3: Maurice River at Millville, Cumberland County, NJ. Lat 039°26'53.41"N Long 075°04'20.77"W, located at the bridge on W. Sherman Avenue.	28.1	20' DSL	Fair seed line on a 4-inch diameter tree.	32.98	32.29	32.54
		28.2	20' DSL	Poor seed line on a 2-inch diameter tree.	32.90		
		28.3	15' DSR	Poor seed line on a 6-inch diameter tree.	32.24		
		28.4	25' DSR	Poor seed line on a 6-inch diameter tree.	32.07		
		28.5	8' USR	Fair seed line on a 3-inch diameter tree.	32.72		
		28.6	8' USR	Poor seed line on a 4-inch diameter tree.	32.63		
		28.7	15' USL	Fair seed line on an 8-inch diameter tree.	31.80		
		28.8	15' USL	Fair seed line on a 6-inch diameter tree.	32.02		
29	MAUR5: Maurice River at Brotmanville, Salem County, NJ. Lat 039°31'19.36"N Long 075°04'23.19"W, located at the bridge on Garden Road.	29.3	20' USL	Good seed line on a 4-inch diameter tree.	62.10	62.13	61.12
		29.4	20' USL	Fair seed line on a 5-inch diameter tree.	62.16		
		29.5	10' DSL	Fair seed line on a 4-inch diameter tree.	61.31		
		29.6	15' DSL	Poor seed line on a 5-inch diameter tree.	61.20		
		29.7	10' DSR	Fair seed line on a double-trunked tree.	60.49		
		29.8	15' DSR	Fair seed line on a 1.5-foot diameter tree.	61.46		
30	MAUR6: Maurice River at Willow Grove, Salem County, NJ. Lat 039°33'01.00"N Long 075°04'15.85"W, located at the bridge on Willow Grove Lake and Willow Grove/West Weymouth Road.	30.1	5' USL	Fair seed line on a 3-inch diameter tree.	74.54	74.53	69.99
		30.2	5' USL	Unrated seed line on a 4-inch diameter tree.	74.49		
		30.3	0' USR	Fair mud line on a guard rail support.	74.57		
		30.4	5' DSR	Poor seed line on a 3-inch diameter tree.	69.90		
		30.5	10' DSR	Poor seed line on an 8-inch diameter tree.	69.40		
		30.7	15' DSL	Poor seed line on a 2-inch diameter tree.	70.67		

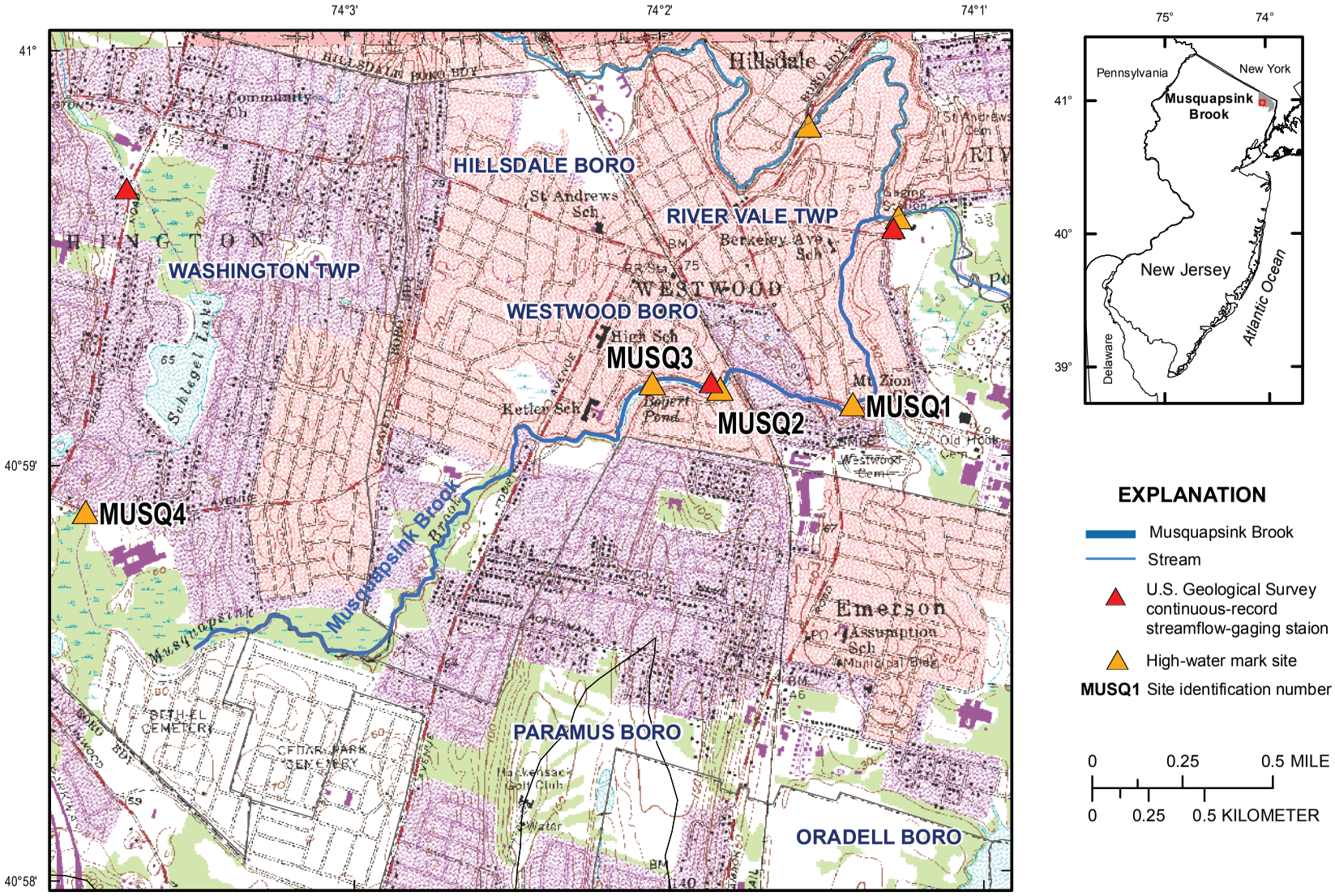


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Millstone River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-8 Millstone River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
31	MILL1: Millstone River near Plainsboro Township, Middlesex County, NJ. Lat 040°18'12.50"N Long 074°34'31.65"W, located at the bridge on Southfield/Nostrand Road.	31.3	10' DSL	Good seed line on an 8-inch diameter tree.	71.09	71.74	71.27
		31.4	15' DSL	Fair seed line on an 8-inch diameter tree.	71.46		
		31.5	5' USL	Fair seed line on a 2-inch diameter tree.	71.79		
		31.6	8' USL	Fair seed line on a 4-inch diameter tree.	71.70		
		31.7	15' USR	Fair seed line on a 4-inch diameter tree.	71.72		
		31.8	20' USR	Good seed line on a 4-inch diameter tree.	71.75		
32	MILL2: Millstone River at Hightstown, Mercer County, NJ. Lat 040°17'25.47"N Long 074°31'19.59"W, located at the bridge on US Highway 130.	32.1	10' USL	Fair mark on a 10-inch diameter tree.	85.13	85.01	83.92
		32.3	20' USR	Good seed line on a 1-foot diameter tree.	84.96		
		32.4	10' USR	Fair seed line on a 1-foot diameter tree.	84.93		
		32.5	20' DSL	Fair seed line on a 10-inch diameter tree.	83.91		
		32.6	20' DSL	Good seed line on a 6-inch diameter tree.	83.93		
		32.7	15' DSR	Good seed line on a 1.5-foot diameter tree.	83.92		
		32.8	15' DSR	Fair seed line on a 2-foot diameter tree.	83.93		
33	MILL3: Millstone River near East Windsor, Mercer County, NJ. Lat 040°16'28.29"N Long 074°28'20.55"W, located at the bridge on Applegarth Road.	33.1	30' DSR	Fair seed line on a multi-trunked tree.	99.18	100.10	99.26
		33.2	50' DSR	Fair seed line on a 1-foot diameter tree.	98.95		
		33.4	50' DSL	Good seed line on a 1.5-foot diameter tree.	99.66		
		33.5	25' USL	Poor seed line on a 10-inch diameter tree.	99.89		
		33.6	25' USL	Fair seed line on a 6-inch diameter tree.	99.81		
		33.7	15' USR	Fair seed line on a multi-trunked tree.	100.21		
		33.8	0' USR	Good mud line on the bridge wall.	100.49		

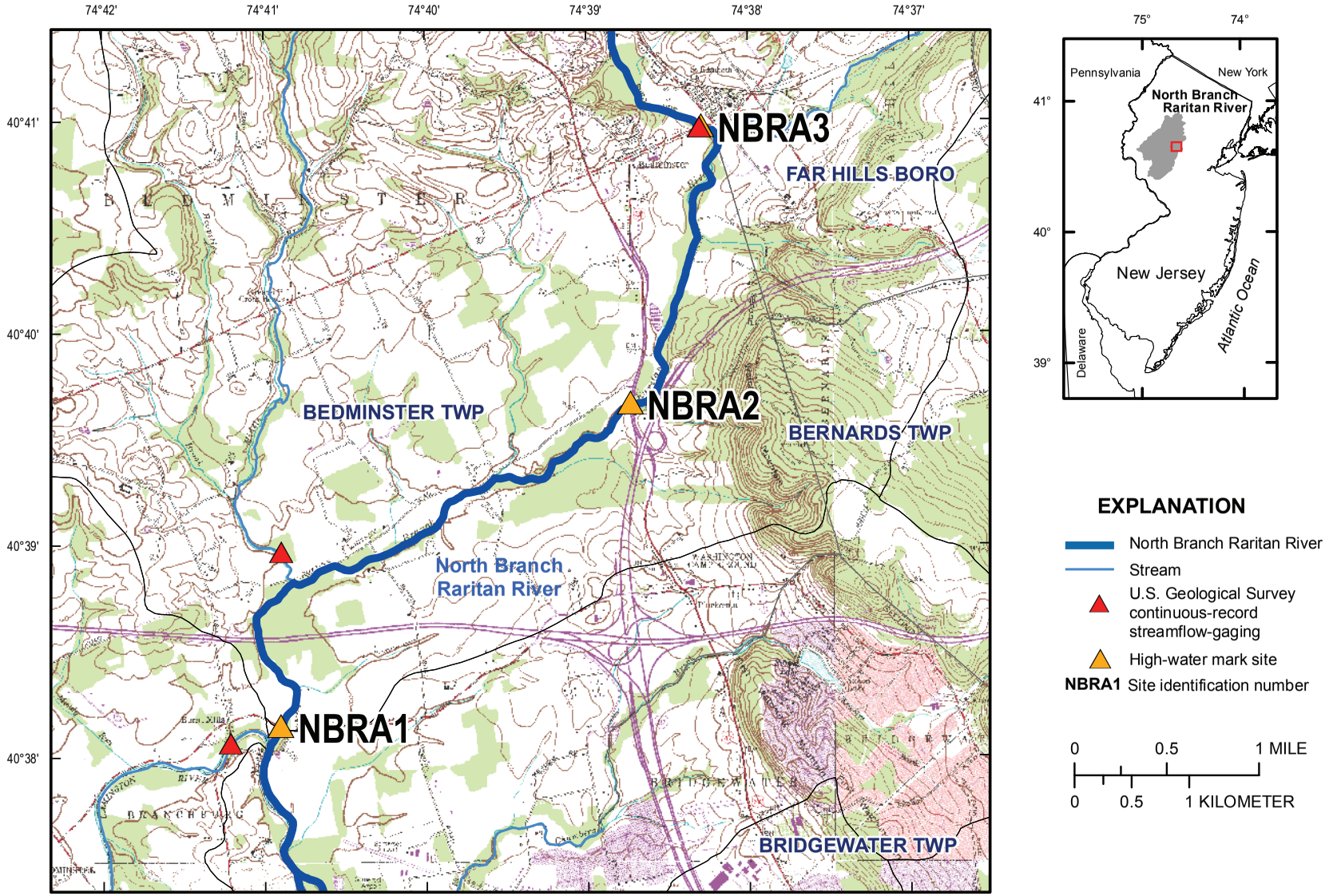


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Musquapsink Brook stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-9 Musquapsink Brook.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
34	MUSQ1: Musquapsink Brook at Westwood, Bergen County, NJ. Lat 040°59'07.70"N Long 074°01'24.00"W, located at the bridge on Old Hook Road.	34.1	200' DSR	Poor seed line on a 1.5-foot diameter tree.	38.54	41.85	38.70
		34.2	250' DSR	Poor seed line on a 4-foot diameter tree.	38.87		
		34.3	50' USL	Poor seed line on a 1-foot diameter tree.	41.76		
		34.4	60' USL	Poor seed line on a 10-inch diameter tree.	42.10		
		34.6	110' USR	Poor seed line on a tree.	41.70		
35	MUSQ2: Musquapsink Brook at Westwood, Bergen County, NJ. Lat 040°59'10.17"N Long 074°01'49.26"W, located at the bridge on Prospect Avenue.	35.1	3' DSR	Poor mud line on a wooden fence.	45.18	46.95	45.18
		35.2	10' USL	Poor seed line on a 3.5-inch diameter tree.	46.78		
		35.3	5' USL	Poor seed line on a 5-inch diameter tree.	47.12		
36	MUSQ3: Musquapsink Brook at Westwood, Bergen County, NJ. Lat 040°59'11.04"N Long 074°02'02.22"W, located at the bridge on 1st Avenue.	36.1	5' DSL	Fair debris line on a fence.	49.36		49.36
37	MUSQ4: Musquapsink Brook at Washington, Bergen County, NJ. Lat 040°58'53.31"N Long 074°03'50.54"W, located at the bridge on Ridgewood Road.	37.2	75' USR	Poor mud line on a swingset post.	57.35	57.56	
		37.3	50' USL	Poor wash line on the ground, top of bank.	57.86		
		37.4	50' USL	Poor seed line on a 1-foot diameter tree.	57.46		

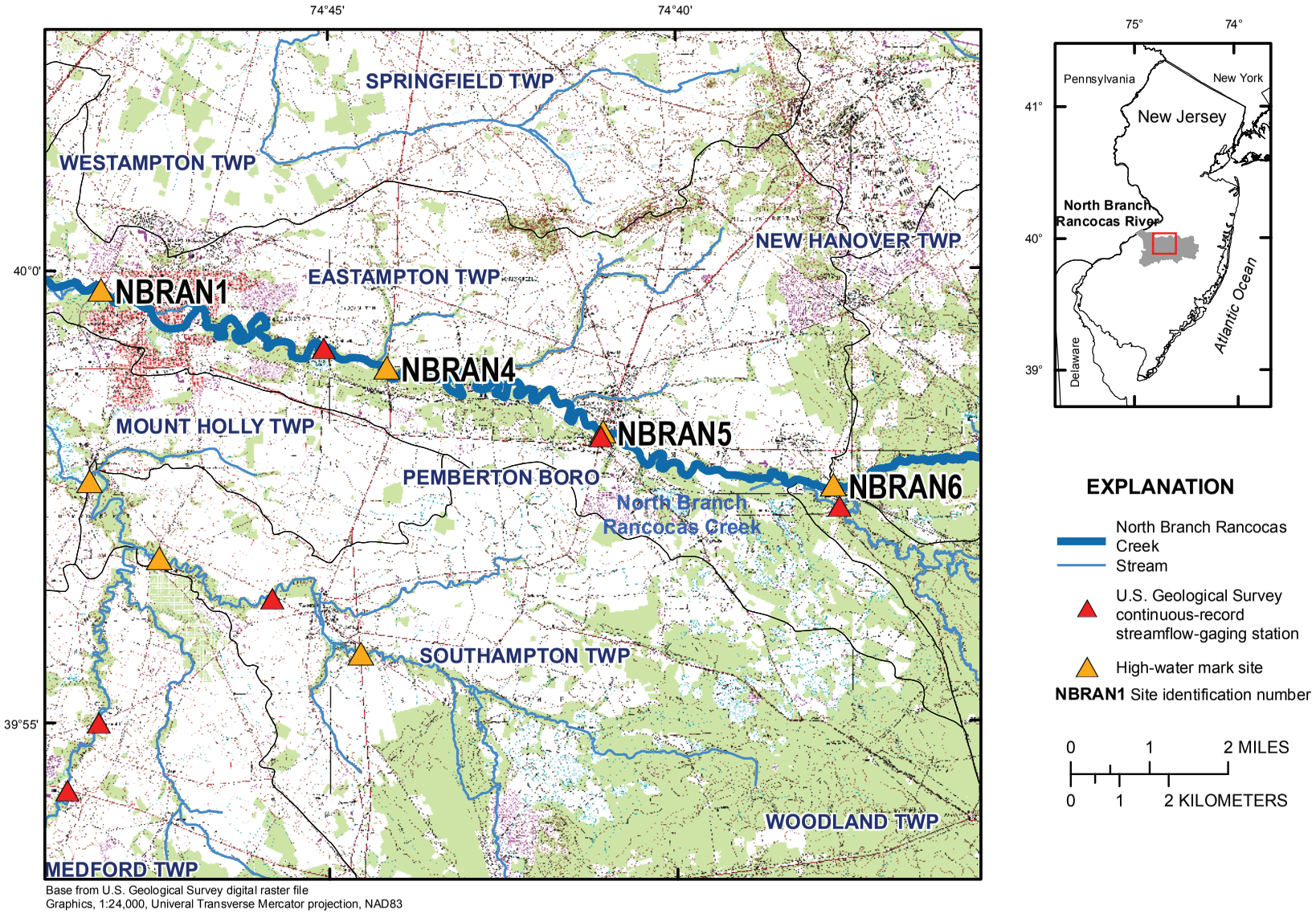


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of North Branch Raritan River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-10 North Branch Raritan River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
38	NBRA1: North Branch Raritan River at Burnt Mills, Somerset County, NJ. Lat 040°38'08.99"N Long 074°40'54.20"W, located at the bridge on Burnt Mills Road.	38.1	40' USL	Fair seed line on a 3-foot diameter tree.	88.84	88.95	87.98
		38.2	90' USL	Fair seed line on a 1.5-foot diameter tree.	88.75		
		38.3	85' USR	Fair seed line on a 1-foot diameter tree.	89.19		
		38.4	85' USR	Fair seed line on a 1-foot diameter tree.	89.02		
		38.5	70' DSR	Good seed line on a 1-foot diameter tree.	88.02		
		38.6	80' DSR	Good mark on a 1.5' diameter tree.	88.01		
		38.7	90' DSL	Poor seed line on a 1-foot diameter tree.	87.78		
		38.8	100' DSL	Fair seed line on a 3.5-foot diameter tree.	88.11		
39	NBRA2: North Branch Raritan River at Far Hills, Somerset County, NJ. Lat 040°39'40.15"N Long 074°38'43.98"W, located at the bridge on Route 206.	39.1	150' DSL	Fair seed line on a 2.5-foot diameter tree.	112.33	114.80	112.24
		39.2	150' DSL	Fair seed line on a 1.5' diameter tree.	112.20		
		39.3	150' DSR	Fair seed line on a 1-foot diameter tree.	112.15		
		39.4	135' DSR	Poor seed line on a 1-foot diameter tree.	112.29		
		39.5	150' USL	Fair seed line on a 2-foot diameter tree.	114.94		
		39.6	150' USL	Fair seed line on a 10-inch diameter tree.	114.94		
		39.7	80' USR	Fair seed line on a 1-foot diameter tree.	114.75		
		39.8	95' USR	Fair mark on a 2-foot diameter tree.	114.58		
40	NBRA3: North Branch Raritan River at Bedminster, Somerset County, NJ. Lat 040°40'58.53"N Long 074°38'17.37"W, located at the bridge on Route 202.	40.1	200' USR	Poor seed line on a 5-inch diameter tree.	137.88	137.90	135.86
		40.2	210' USR	Unrated seed line on a 4-inch diameter tree.	137.90		
		40.3	150' USL	Fair seed line on a on a 2-foot diameter tree.	138.06		
		40.4	190' USL	Fair seed line on a 4-foot diameter tree.	137.79		
		40.5	60' DSL	Poor seed line on a 5-foot diameter tree.	135.69		
		40.6	100' DSL	Poor seed line on a 10-inch diameter tree.	135.66		
		40.7	60' DSR	Poor seed line on a 1-foot diameter tree.	136.30		
		40.8	70' DSR	Fair seed line on a 3-foot diameter tree.	135.82		

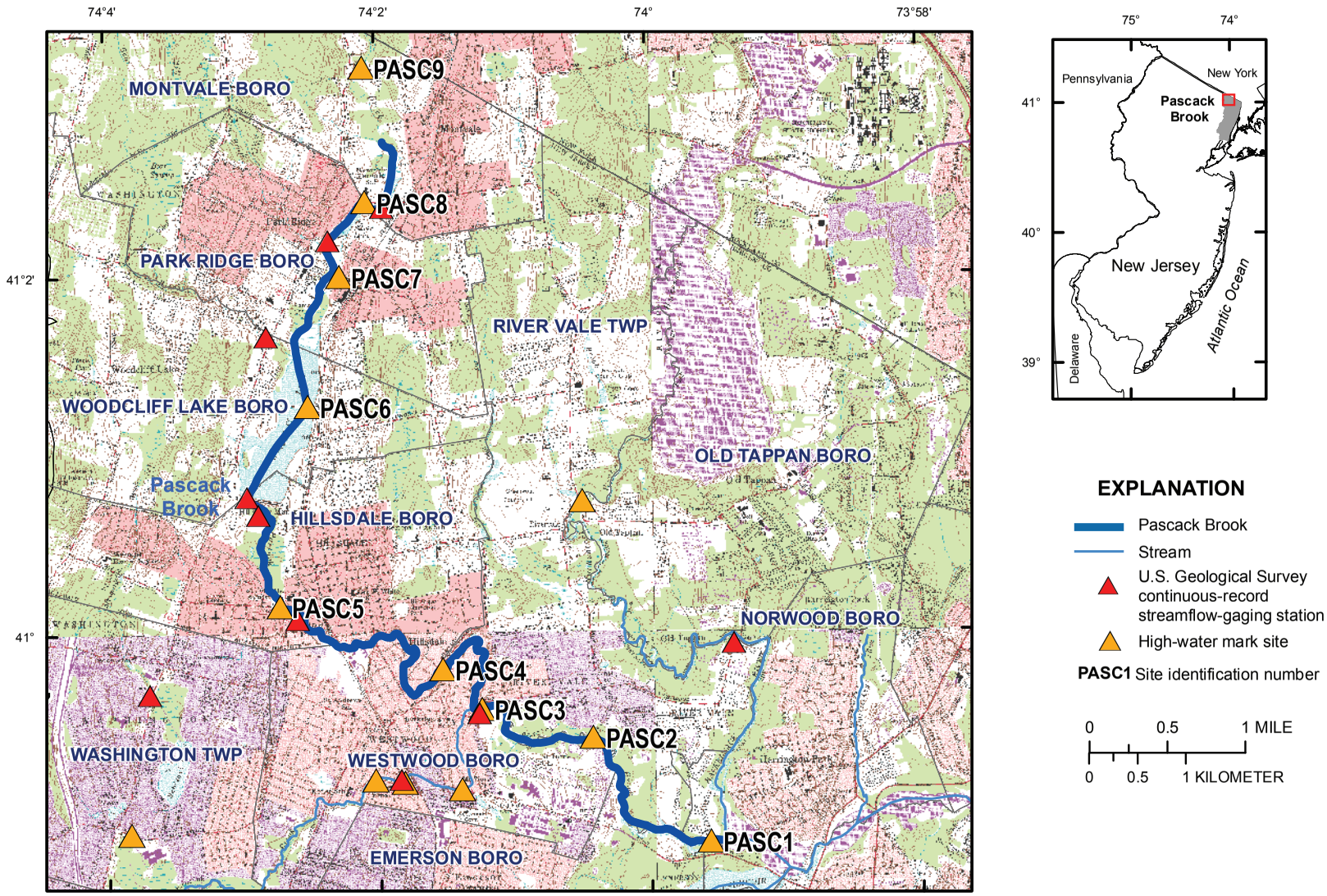


Base from U.S. Geological Survey digital raster file
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of North Branch Rancocas Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-11 North Branch Rancocas Creek.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
41	NBRAN1: North Branch Rancocas Creek at Mt. Holly, Burlington County, NJ. Lat 039°59'47.63"N Long 074°48'16.23"W, located at the bridge on Highway 541.	41.1	80' DSL	Fair seed line on a 5-foot diameter tree.	9.21	9.49	9.30
		41.2	100' DSL	Fair seed line on a 3-foot diameter tree.	9.30		
		41.4	50' DSR	Fair seed line on a 1.5-foot diameter tree.	9.39		
		41.5	50' USR	Fair seed line on a 1-foot diameter tree.	9.55		
		41.6	60' USR	Good seed line on a 1-foot diameter tree.	9.43		
		41.7	70' USL	Fair seed line on a 2-foot diameter tree.	9.50		
42	NBRAN4: North Branch Rancocas Creek at Ewansville, Burlington County, NJ. Lat 039°58'55.39"N Long 074°41'03.47"W, located at the bridge on Route 206.	42.1	125' USL	Fair seed line on a 4-foot diameter tree.	24.60	24.67	24.06
		42.2	80' USL	Fair seed line on a 9-inch diameter tree.	24.80		
		42.3	35' USR	Fair mark on a tree.	24.85		
		42.4	40' USR	Fair seed line on an 8-inch diameter tree.	24.44		
		42.5	50' DSR	Fair seed line on a 2.5-foot diameter tree.	24.90		
		42.6	45' DSR	Fair seed line on a 5-inch diameter tree.	24.72		
		42.7	90' DSL	Fair seed line on a 2.5-foot diameter tree.	23.30		
		42.8	110' DSL	Fair seed line on a 3.5-foot diameter tree.	23.34		
43	NBRAN5: North Branch Rancocas Creek at Pemberton, Burlington County, NJ. Lat 039°58'12.51"N Long 075°04'23.19"W, located at the bridge on Hanover Street.	43.1	90' DSR	Fair seed line on a 3-foot diameter tree.	34.69		34.30
		43.2	110' DSR	Fair seed line on a 3-foot diameter tree.	34.64		
		43.3	50' DSL	Fair seed line on a 6-inch diameter tree.	33.91		
		43.4	50' DSL	Fair seed line on a 3-foot diameter tree.	33.98		
44	NBRAN6: North Branch Rancocas Creek at New Lisbon, Burlington County, NJ. Lat 039°57'36.67"N Long 074°37'44.65"W, located at the bridge on Four Mile Road.	44.1	120' DSR	Fair mark on a 10-inch diameter tree.	43.84	45.02	43.38
		44.2	120' DSR	Fair seed line on an 8-inch diameter tree.	43.71		
		44.3	100' DSL	Fair seed line on an 8-inch diameter tree.	42.88		
		44.4	105' DSL	Fair seed line on a 10-inch diameter tree.	43.09		
		44.5	55' USL	Fair mark on a 6-inch diameter tree.	44.85		
		44.6	60' USL	Fair seed line on a 1-foot diameter tree.	44.88		
		44.7	70' USR	Good seed line on a 2-foot diameter tree.	45.20		
		44.8	60' USR	Fair seed line on a 1.5-foot diameter tree.	45.14		



Base from U.S. Geological Survey digital raster files
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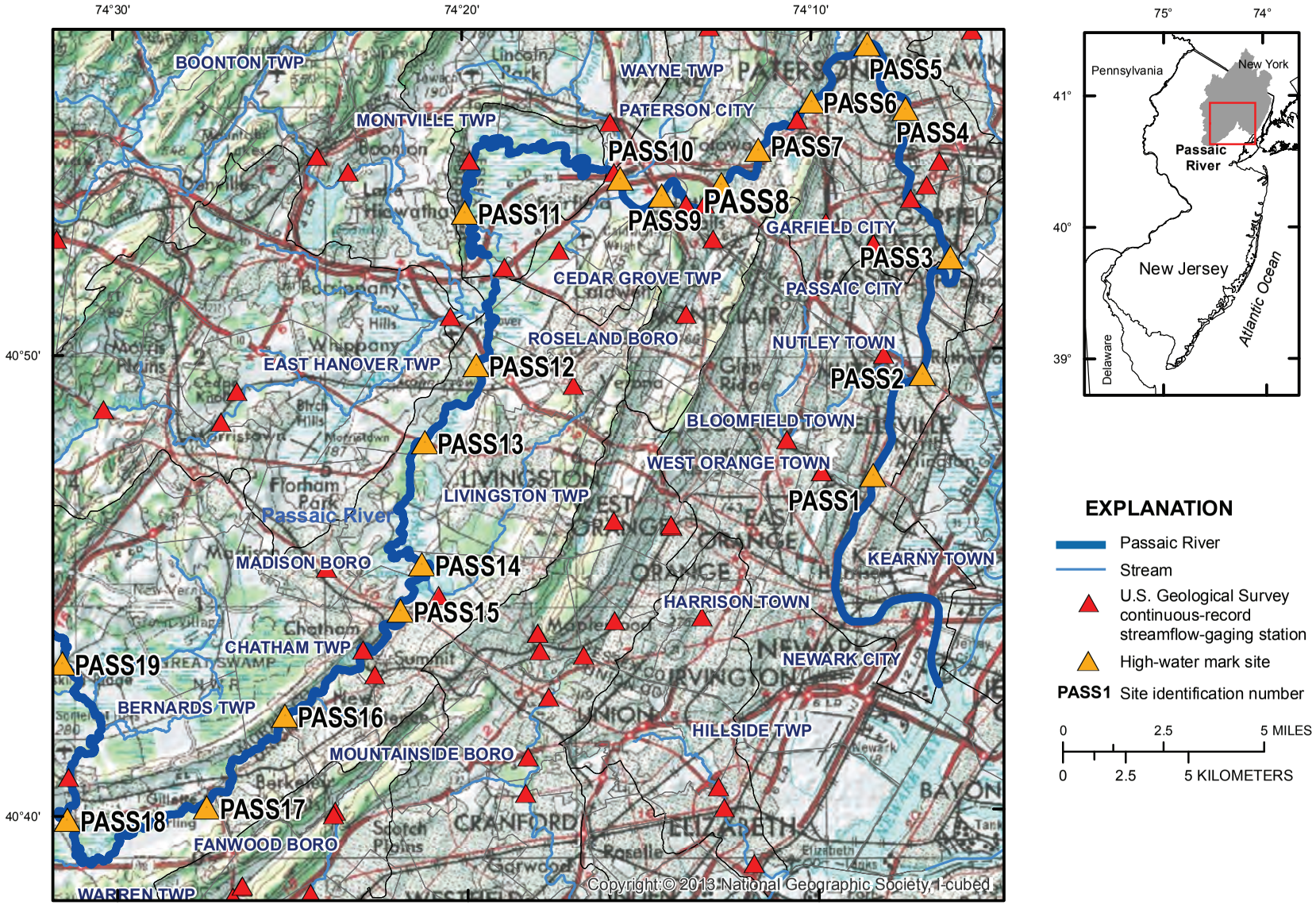
Location of Pascack Brook stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-12 Pascack Brook.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
45	PASC1: Pascack Brook at Harrington Park, Bergen County, NJ. Lat 040°58'49.62"N Long 073°59'33.94"W, located at the bridge on Bogerts Mill Road.	45.1	250' DSL	Good seed line on a 2-inch diameter tree.	27.23	28.46	27.11
		45.2	245' DSL	Fair seed line on a 2.5-foot diameter tree.	26.85		
		45.3	200' USL	Good seed line on a 2-foot diameter tree.	28.45		
		45.4	100' USL	Poor seed line on a 2.5-foot diameter tree.	28.44		
		45.6	80' DSR	Good seed line on a fence post.	27.25		
		45.7	200' USR	Good seed line on a 1.5-foot diameter tree.	28.50		
		45.8	250' USR	Good seed line on an 8-inch diameter tree.	28.47		
46	PASC2: Pascack Brook at River Vale, Bergen County, NJ. Lat 040°59'24.85"N Long 074°00'25.63"W, located at the bridge on Emerson Road near Brookside Avenue.	46.3	200' USL	Good seed line on a 1.5-foot diameter tree.	31.94	31.72	30.39
		46.4	180' USL	Fair seed line on a 2-foot diameter tree.	31.91		
		46.5	100' DSR	Good seed line on a fence post.	30.34		
		46.6	100' DSR	Good seed line on a fence post.	30.33		
		46.7	150' DSL	Good seed line on a 1.5-foot diameter tree.	30.46		
		46.8	200' DSL	Good seed line on a 1-foot diameter tree.	30.43		
		46.9	0' USR	Good seed line on bridge abutment.	31.33		
47	PASC3: Pascack Brook at Westwood, Bergen County, NJ. Lat 040°59'34.68"N Long 074°01'14.88"W, located at the bridge on Harrington Avenue.	47.1	75' USR	Good seed line on a gage house wall.	36.21	35.97	34.70
		47.2	100' USR	Poor wash line on the ground, right bank.	35.78		
		47.3	150' USL	Good seed line on a 10-inch diameter tree.	36.08		
		47.4	150' USL	Poor seed line on a 1.5-foot diameter tree.	35.83		
		47.5	80' DSR	Good seed line on a wall of the Westwood Recycling Center.	34.77		
		47.7	150' DSL	Good seed line on an 8-inch diameter tree.	34.64		
		47.8	150' DSL	Good seed line on a 9-inch diameter tree.	34.70		
48	PASC4: Pascack Brook at Hillsdale, Bergen County, NJ. Lat 040°59'48.02"N Long 074°01'31.92"W, located at the bridge on Westwood/Demarest Avenue.	48.1	200' USR	Good seed line on a 10-inch diameter tree.	45.90	45.78	42.59
		48.2	180' USR	Good seed line on a 1.2-foot diameter tree.	45.88		
		48.3	300' USL	Good seed line on a 1.5-foot diameter tree.	45.61		
		48.4	310' USL	Good seed line on a 1.5-foot diameter tree.	45.75		
		48.5	150' DSR	Good seed line on a shed wall.	42.63		
		48.7	100' DSL	Fair seed line on a 1-foot diameter tree.	42.55		

Appendix 1-12 Pascack Brook.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
49	PASC5: Pascack Brook at Hillsdale, Bergen County, NJ. Lat 041°00'09.56"N Long 074°02'43.73"W, located at the bridge on Hillsdale Avenue.	49.1	300' USL	Good seed line on the wall of a church.	60.47	59.80	56.34
		49.2	250' USL	Good seed line on the wall of a church.	60.27		
		49.3	150' DSR	Good seed line on a retaining wall.	54.99		
		49.4	150' DSR	Good seed line on an 8-inch diameter tree.	54.99		
		49.5	0' USR	Good seed line on bridge abutment.	59.19		
		49.6	4' USR	Good seed line on a 2-foot diameter tree.	59.25		
		49.7	150' DSL	Poor seed line on a 1-foot diameter tree.	57.41		
		49.8	30' DSL	Poor seed line on an 8-inch diameter tree.	57.96		
50	PASC6: Pascack Brook at Park Ridge, Bergen County, NJ. 041°01'16.61"N Long 074°02'30.60"W, located at the culvert on Woodcliff Avenue near Woodcliff Lake.	50.1	100' USL	Fair seed line on a 6-inch diameter tree.	97.90	97.38	94.80
		50.2	100' USL	Fair seed line on an 8-inch diameter tree.	98.07		
		50.3	50' USR	Fair seed line on a 1.2-foot diameter tree.	96.81		
		50.4	100' USR	Fair seed line on a 1.2-foot diameter tree.	96.76		
		50.5	150' DSL	Fair seed line on a 1-foot diameter tree.	95.04		
		50.6	DSR	Poor seed line on a rock.	94.56		
51	PASC7: Pascack Brook at Park Ridge, Bergen County, NJ. Lat 041°02'00.14"N Long 074°02'16.25"W, located at the bridge on Park Avenue.	51.2	400' USL	Fair debris line on a fence.	116.44	116.32	111.26
		51.3	50' DSL	Poor wash line on the ground.	110.99		
		51.4	50' DSR	Poor wash line on the ground.	111.43		
		51.5	100' DSL	Poor seed line on a tree root.	111.35		
		51.6	100' USR	Excellent seed line on the wall of a lumber building.	116.23		
		51.7	100' USR	Excellent seed line on the wall of a lumber shed.	116.27		
52	PASC8: Pascack Brook at Park Ridge, Bergen County, NJ. Lat 041°02'25.15"N Long 074°02'04.67"W, located at the bridge on Grand Avenue.	52.1	65' USL	Fair seed line on a 2-foot diameter tree.	144.06	144.12	142.40
		52.2	95' USL	Fair seed line on a 2-foot diameter tree.	143.94		
		52.3	60' USR	Fair seed line on a 5-foot diameter tree.	144.42		
		52.4	95' USR	Fair seed line on a 5-foot diameter tree.	144.06		
		52.5	5' DSR	Fair seed line on a 1-foot diameter tree.	142.28		
		52.8	75' DSL	Fair seed line on a 2.5-foot diameter tree.	142.51		
53	PASC9: Pascack Brook at Montvale, Bergen County, NJ. Lat 041°03'10.29"N Long 074°02'05.32"W, located at the bridge on Magnolia Avenue.	53.1	150' DSL	Fair seed line on a 1.5-foot diameter tree.	189.04	191.10	189.16
		53.3	60' DSR	Poor seed line on a 1-foot diameter tree.	189.51		
		53.4	120' DSR	Fair seed line on a 1.5-foot diameter tree.	188.93		
		53.5	50' USL	Fair seed line on a 2-foot diameter tree.	191.15		
		53.7	30' USR	Fair wash line on the ground.	191.05		



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Location of Passaic River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-13 Passaic River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
54	PASS1: Passaic River at Belleville, Essex County, NJ. Lat 040°47'11.54"N Long 073°59'33.94"W, located at the bridge on Belleville Turnpike.	54.1	5' DSR	Good seed line on an 8-inch diameter tree.	9.51	9.74	9.50
		54.2	7' DSR	Good seed line on a 10-inch diameter tree.	9.49		
		54.3	10' USR	Good seed line on a 6-inch diameter tree.	9.63		
		54.4	10' USR	Good seed line on a 6-inch diameter tree.	9.66		
		54.5	0' USR	Good seed line on bridge abutment.	9.69		
		54.6	120' USL	Fair seed line on a 10-inch diameter tree.	9.89		
		54.7	140' USL	Fair seed line on a 1-foot diameter tree.	9.81		
55	PASS2: Passaic River in Rutherford, Bergen County, NJ. Lat 040°49'22.29"N Long 074°07'25.41"W, located at the bridge on Route 3.	55.1	92' DSL	Good mud line on a telephone pole.	11.27	11.58	11.32
		55.2	138' DSL	Good seed/mud line on guard rail I-beam.	11.24		
		55.3	160' USL	Fair seed line on a telephone pole.	11.62		
		55.4	130' USL	Good seed/mud line on a river access sign.	11.64		
		55.5	32' DSR	Good seed line on abutment under Route 21.	11.46		
		55.6	16' USR	Good seed line on a pier under Route 21.	11.43		
		55.7	86' USR	Fair seed line on a pier under Route 21.	11.64		
56	PASS3: Passaic River at Garfield, Bergen County, NJ. Lat 040°51'52.93"N Long 074°06'35.63"W, located at the bridge on Passaic/Wall Street.	56.2	128' DSL	Fair seed line on a telephone pole.	14.93	15.02	14.87
		56.3	75' USL	Good seed line on a 2-foot diameter tree.	15.17		
		56.4	144' USL	Fair seed line on a multi-trunked tree.	15.29		
		56.5	0' USR	Good seed line on a 1-foot diameter tree.	14.89		
		56.6	5' USR	Fair seed line on a 1-foot diameter tree.	14.73		
		56.7	33' DSR	Poor seed line on a 1.5-foot diameter tree.	14.85		
		56.8	30' DSR	Good seed line on a telephone pole.	14.82		
57	PASS4: Passaic River at Elmwood Park, Bergen County, NJ. Lat 040°55'05.38"N Long 074°07'49.84"W, located at the bridge on Route 4/Broadway.	57.1	5' DSL	Good seed line on a 2-foot diameter tree.	34.13	34.17	34.06
		57.2	20' DSL	Fair seed line on a 2-foot diameter tree.	34.05		
		57.3	56' USL	Good seed line on a 2.5-foot diameter tree.	34.32		
		57.4	71' USL	Good seed line on a multi-trunked tree.	34.26		
		57.5	9.5' USR	Fair seed line on an 8-inch diameter tree.	34.03		
		57.6	11' USR	Fair seed line on a 2-foot diameter tree.	34.07		
		57.7	62' DSR	Fair seed line on an 8-inch diameter tree.	34.08		
		57.8	73' DSR	Good seed line on a 1-foot diameter tree.	33.97		

Appendix 1-13 Passaic River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
58	PASS5: Passaic River Paterson, Passaic County, NJ. Lat 040°56'30.04"N Long 074°08'53.83"W, located at the bridge on Lincoln Avenue.	58.1	208' USL	Good seed line on a multi-trunked tree.	41.03	40.91	40.92
		58.2	150' USL	Fair seed line on a 2-foot diameter tree.	40.79		
		58.3	10' DSL	Fair seed line on the trunk of a large shrub.	41.09		
		58.4	9' DSL	Poor seed line on the trunk of a shrub.	41.02		
		58.5	63' DSR	Good seed line on a double-trunked tree.	40.84		
		58.6	78' DSR	Fair seed line on a 1-foot diameter tree.	40.76		
59	PASS6: Passaic River at Paterson, Passaic County, NJ. 040°55'16.48"N Long 074°10'30.60"W, located at the bridge on West Broadway.	59.1	100' USR	Fair seed line on a telephone pole.	52.41	51.97	51.13
		59.2	126' USR	Poor seed line on a 2-foot diameter tree.	52.76		
		59.3	30' DSR	Poor seed line on a 10-inch diameter tree.	50.91		
		59.4	87' DSR	Poor seed/debris line on a double-trunked tree.	50.97		
		59.5	215' USL	Fair seed line on a telephone pole.	51.40		
		59.6	100' USL	Fair seed line on an 8-inch diameter tree.	51.32		
		59.7	177' DSL	Fair mud line on a pole to a covered pavilion.	51.51		
60	PASS7: Passaic River at Totowa, Passaic County, NJ. Lat 040°54'14.41"N Long 074°12'01.79"W, located at the bridge on Totowa Road.	60.1	10' USL	Fair seed line on a telephone pole.	125.53	125.37	125.07
		60.2	105' USL	Fair seed line on a telephone pole.	125.56		
		60.3	10' DSL	Good seed line on a 2-foot diameter tree.	125.53		
		60.4	41' DSL	Fair seed line on a guard rail I-beam.	125.44		
		60.5	115' DSR	Fair seed line on a 1-foot diameter tree.	124.95		
		60.6	154' DSR	Poor seed line on a 1.5-foot diameter tree.	124.36		
		60.7	0' USR	Fair seed line on a telephone pole.	125.08		
		60.8	100' USR	Good seed line on a 2-foot diameter tree.	125.32		
61	PASS8: Passaic River at Woodland Park, Passaic County, NJ. Lat 040°53'30.38"N Long 074°13'05.61"W, located at the bridge on Lackawanna Avenue.	61.1	78' DSR	Good seed line on a 3.5-foot diameter tree.	131.20	131.24	131.16
		61.2	43' DSR	Fair seed line on a split-trunked tree.	131.14		
		61.5	105' DSL	Fair seed line on a 1.5-foot diameter tree.	131.14		
		61.6	120' DSL	Fair seed line on a large tree.	131.15		
		61.7	110' USL	Fair seed line on a 6-inch diameter tree.	131.21		
		61.8	110' USL	Good seed line on the corner of a building.	131.28		

Appendix 1-13 Passaic River.—Continued

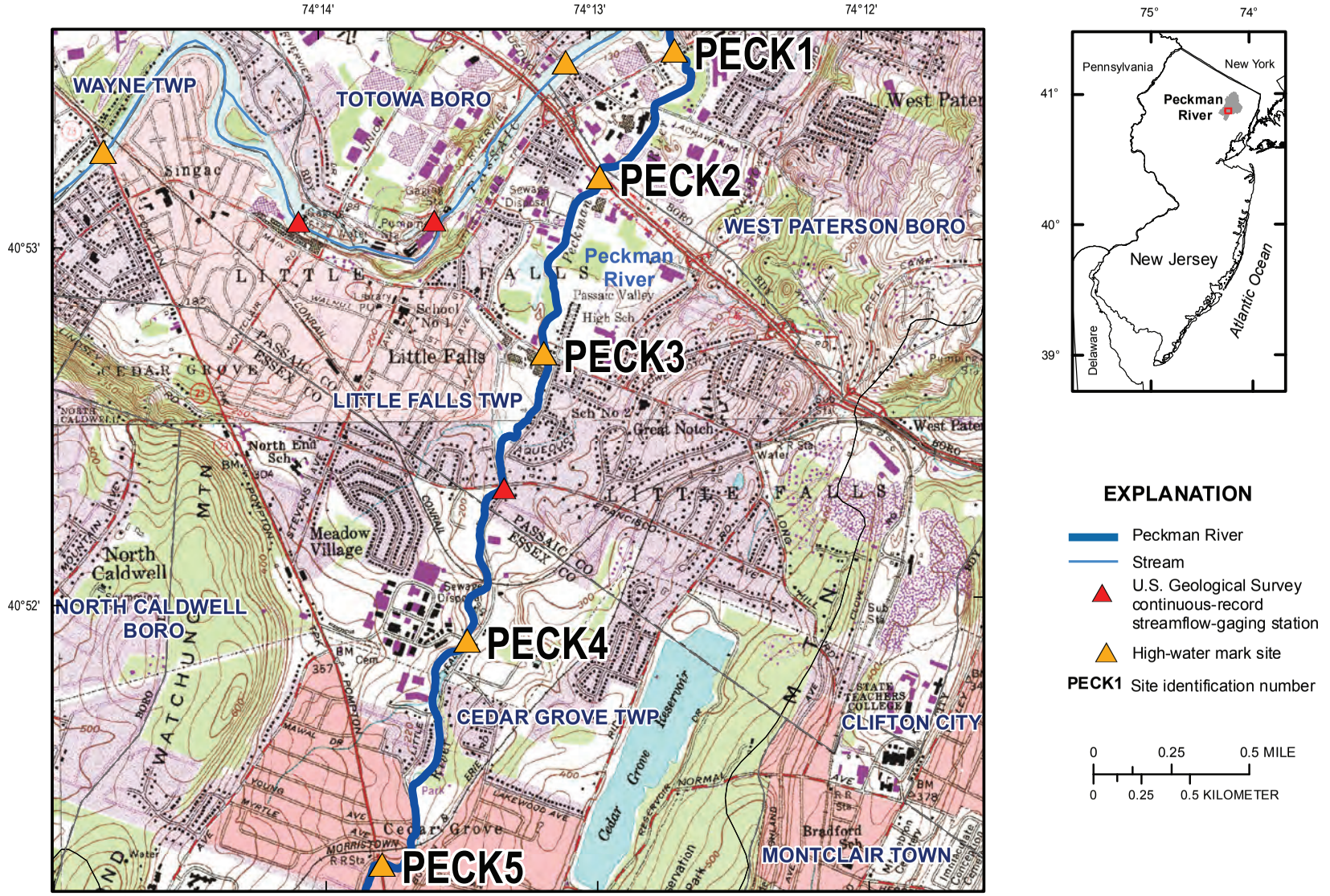
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
62	PASS9: Passaic River at Singac, Passaic County, NJ. Lat 040°53’16.10”N Long 074°14’48.01”W, located at the bridge on Route 23.	62.1	35’ USR	Good seed line on a telephone pole.	168.72	168.59	168.39
		62.2	44’ USR	Fair seed line on an 8-inch diameter tree.	168.55		
		62.3	30’ DSR	Fair seed line on a2.5-foot diameter tree.	168.92		
		62.5	173’ DSL	Fair seed line on a retaining wall for the railroad bridge.	168.02		
		62.6	214’ DSL	Fair seed line on a telephone pole.	168.24		
		62.7	85’ USL	Good seed line on a 1-foot diameter tree.	168.51		
63	PASS10: Passaic River at Singac, Passaic County, NJ. Lat 040°53’38.92”N Long 074°15’57.71”W, located at the bridge on Route 46 near Interstate 80.	63.1	300’ USR	Fair seed line on a 1-foot diameter tree.	170.91	170.90	170.56
		63.2	315’ USR	Fair seed line on a 2.5-foot diameter tree.	171.04		
		63.3	320’ USR	Excellent seed line on a fence.	171.00		
		63.4	100’ DSR	Excellent seed line on the corner of a parking garage.	170.79		
		63.5	200’ DSR	Poor seed line on a 2-foot diameter tree.	170.09		
		63.6	100’ USL	Good seed/debris line on a house.	170.74		
		63.7	140’ USL	Fair seed line on a 1.5-foot diameter tree.	170.85		
		63.8	250’ DSL	Excellent seed line on a garage.	170.72		
		63.9	200’ DSL	Fair seed line on a 2-foot diameter tree.	170.64		
64	PASS11: Passaic River near Pine Brook, Morris County, NJ. Lat 040°52’56.12”N Long 074°20’23.50”W, located at the Horse Neck Bridge.	64.1	70’ DSR	Good seed line on a multi-trunked tree.	172.03	172.13	172.05
		64.2	110’ DSR	Good seed line on a multi-trunked tree.	172.14		
		64.3	40’ USR	Unrated seed line on a 6-inch diameter tree.	171.93		
		64.4	180’ USL	Good seed line on a 1.5-foot diameter tree.	172.20		
		64.5	190’ USL	Fair debris line on the ground.	172.26		
		64.6	150’ DSL	Good seed line on a multi-trunked tree.	172.03		
		64.7	200’ DSL	Excellent seed line on a deck post.	172.03		

Appendix 1-13 Passaic River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
65	PASS12: Passaic River at Hanover Neck, Morris County, NJ. Lat 040°49’38.91”N Long 074°20’05.87”W, located at Swinefield Bridge/Eagle Rock Avenue.	65.2	80’ USL	Good seed line on a 4-inch diameter tree.	173.28	173.29	173.25
		65.3	120’ USL	Fair seed line on a 1-foot diameter tree.	173.30		
		65.4	250’ DSL	Fair seed line on a double-trunked tree.	173.21		
		65.5	350’ DSL	Good mud line on a fence post.	173.25		
		65.6	100’ DSL	Excellent mud line on the corner of banquet hall.	173.31		
		65.7	30’ DSR	Fair seed line on a 2.5-foot diameter tree.	173.26		
		65.8	30’ DSR	Fair seed line on a 6-inch diameter tree.	173.23		
		65.9	110’ USR	Poor seed line on an 8-inch diameter tree.	173.30		
		65.10	110’ USR	Good seed line on a multi-trunked tree.	173.28		
66	PASS13: Passaic River at Hanover, Morris County, NJ. Lat 040°47’59.45”N Long 074°21’34.40”W, located at the bridge on Route 10/Mt. Pleasant Avenue.	66.1	100’ DSL	Good seed/mud line on a 10-inch diameter tree.	173.63	173.91	173.64
		66.2	150’ DSL	Good seed/mud line on a 1-foot diameter tree.	173.64		
		66.3	250’ USL	Excellent mud line on a door frame.	174.15		
		66.4	200’ USL	Excellent mud line on the corner of a barn.	173.67		
		66.5	80’ USR	Good seed/debris line on a 2.5-foot diameter tree.	174.04		
		66.6	200’ USR	Poor seed/mud line on a 6-inch diameter tree.	173.75		
67	PASS14: Passaic River at Chatham, Morris County, NJ. Lat 040°45’21.00”N Long 074°21’40.92”W, located at Lower Chatham Bridge/Passaic Avenue.	67.1	215’ DSR	Fair seed line on a 1.5-foot diameter tree.	175.62	176.66	175.67
		67.2	200’ DSR	Fair seed line on a 1.7-foot diameter tree.	175.70		
		67.3	200’ USR	Fair seed line on an 8-inch diameter tree.	176.56		
		67.4	220’ USR	Fair seed line on a 10-inch diameter tree.	176.74		
		67.5	250’ USL	Good seed line on a building.	176.70		
		67.6	175’ DSL	Good seed line on a 1.5-foot diameter tree.	175.67		
		67.7	100’ DSL	Good seed line on a 10-inch diameter tree.	175.69		
68	PASS15: Passaic River at Summit, Union County, NJ. Lat 040°44’21.41”N Long 074°22’18.34”W, located at the bridge on Morris Turnpike.	68.2	75’ USR	Fair seed line on a 1-foot diameter tree.	179.44	179.42	178.90
		68.3	75’ USR	Good seed line on a 1-foot diameter tree.	179.39		
		68.4	100’ DSL	Good seed line on a 2.5-foot diameter tree.	178.93		
		68.5	120’ DSL	Fair seed line on 1.5-foot diameter tree.	179.23		
		68.6	DSR	Excellent seed line on a building.	178.54		

Appendix 1-13 Passaic River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
69	PASS16: Passaic River at Chatham, Morris County, NJ. Lat 040°42'06.08"N Long 074°25'36.21"W, located at the bridge on Fairmount/Central Avenue.	69.1	100' USR	Fair seed line on a 1.5-foot diameter tree.	210.54	210.42	210.44
		69.2	150' USR	Fair seed line on a 1-foot diameter tree.	210.29		
		69.3	75' USL	Excellent debris line on the corner of a shed.	210.38		
		69.4	75' USL	Good seed line on a double-trunked tree.	210.50		
		69.5	50' DSL	Good seed line on a 6-inch diameter tree.	210.49		
		69.6	75' DSL	Fair seed line on a 1-foot diameter tree.	210.49		
		69.7	90' DSR	Poor seed line on a 4-inch diameter tree.	210.38		
		69.8	40' DSR	Good seed line on a 1.5-foot diameter tree.	210.40		
70	PASS17: Passaic River at Stirling, Morris County, NJ. Lat 040°39'57.55"N Long 074°28'56.09"W, located at the bridge on Plainfield/Stirling Road.	70.1	30' DSL	Fair seed line on a 2-foot diameter tree.	212.61	212.99	212.88
		70.2	40' DSL	Good seed line on a 1-foot diameter tree.	213.00		
		70.3	100' DSR	Fair seed line on a 1-foot diameter tree.	212.93		
		70.4	125' DSR	Good seed line on a 6-inch diameter tree.	213.01		
		70.5	30' USR	Poor seed/mud line on a 4-inch diameter tree.	213.06		
		70.6	100' USR	Fair seed line on a 3-inch diameter tree.	212.89		
		70.7	30' USL	Good seed line on a 2-foot diameter tree.	213.04		
71	PASS18: Passaic River at Millington, Morris County, NJ. Lat 040°39'53.17"N Long 074°31'47.71"W, located at the bridge on Valley Road.	71.1	150' DSL	Fair seed line on a 6-inch diameter tree.	215.56	215.85	215.50
		71.2	140' DSL	Fair seed line on a 1.5-foot diameter tree.	215.69		
		71.3	20' DSR	Poor seed line on a 1-foot diameter tree.	215.46		
		71.4	40' DSR	Poor seed line on a 10-inch diameter tree.	215.29		
		71.5	34' USR	Fair seed line on an 8-inch diameter tree.	215.68		
		71.6	8' USR	Fair seed line on an 8-inch diameter tree.	215.75		
		71.7	145' USL	Fair seed line on a 1.5-foot diameter tree.	215.96		
		71.8	140' USL	Poor seed line on a telephone pole.	216.01		
72	PASS19: Passaic River at Bernards, Somerset County, NJ. Lat 040°43'15.66"N Long 074°31'54.94"W, located at the bridge on Madisonville/Lees Hill Road.	72.1	50' DSR	Poor debris line on a split-trunked tree.	240.59	248.24	239.52
		72.2	50' DSR	Poor seed line on a split-trunked tree.	240.29		
		72.3	150' DSL	Fair seed line on an 8-inch diameter tree.	238.48		
		72.4	155' DSL	Poor seed line on a 10-inch diameter tree.	238.71		
		72.5	245' USR	Fair seed line on a 1-foot diameter tree.	248.31		
		72.6	215' USR	Poor seed line on a large split-trunked tree.	248.17		

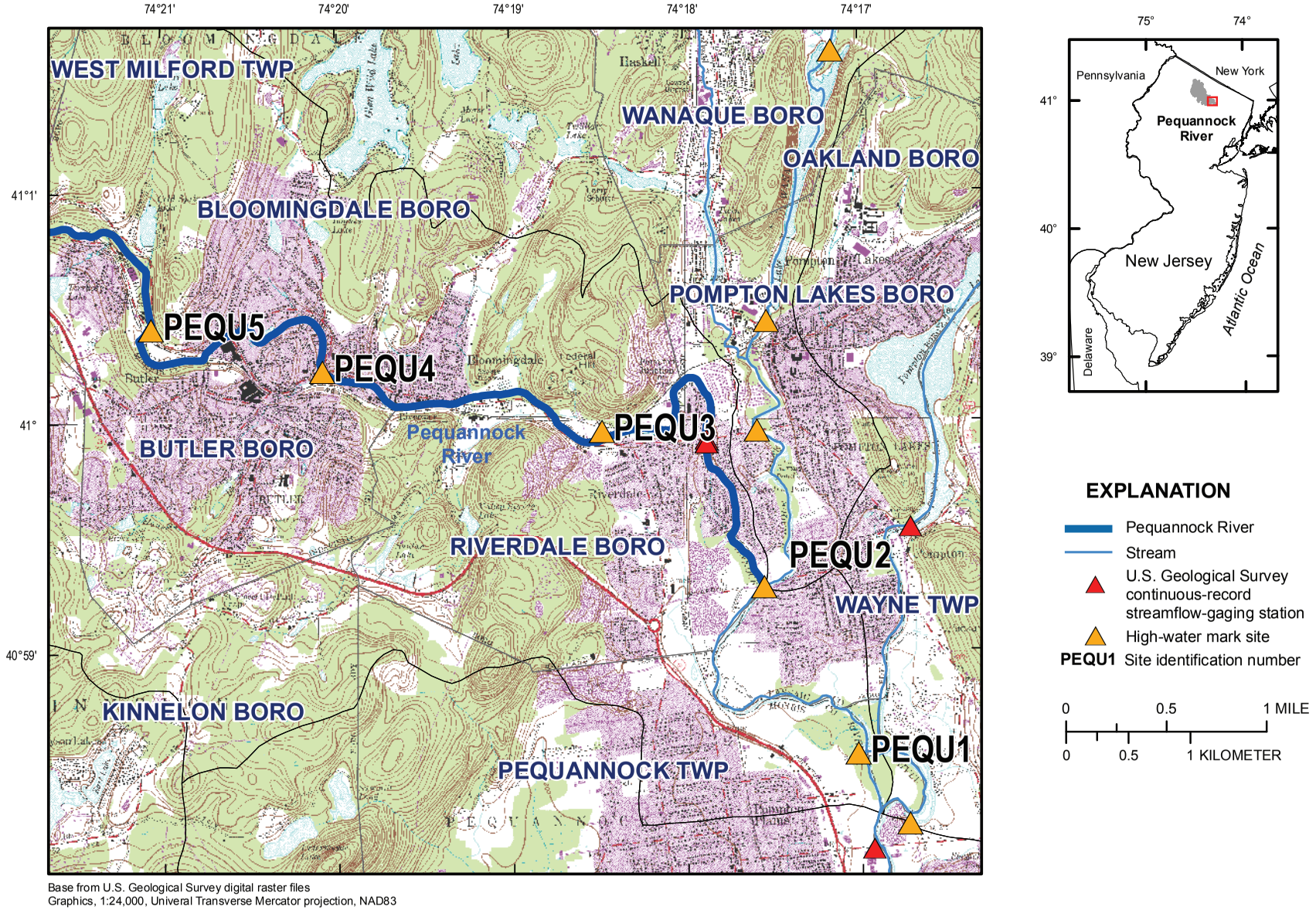


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Peckman River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-14 Peckman River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
73	PECK1: Peckman River at West Paterson, Passaic County, NJ. Lat 040°53'32.24"N Long 074°12'41.51"W, located at the bridge on McBride Avenue.	73.2	50' DSL	Fair seed line on a 2-foot diameter tree.	130.32	131.29	130.33
		73.3	60' DSR	Fair seed line on a 1-foot diameter tree.	130.34		
		73.4	100' DSR	Fair seed line on a 1.5-foot diameter tree.	130.32		
		73.5	150' USR	Poor seed line on a 2-foot diameter tree.	132.16		
		73.6	150' USR	Poor seed line on a 2-foot diameter tree.	131.61		
		73.7	70' USL	Fair seed line on a 2.5-foot diameter tree.	130.50		
		73.8	80' USL	Fair seed line on a 2.5-foot diameter tree.	130.88		
74	PECK2: Peckman River at West Paterson, Passaic County, NJ. Lat 040°53'11.12"N Long 074°12'58.28"W, located at the bridge on Route 46.	74.1	60' DSL	Fair seed line on a 10-inch diameter tree.	136.18	138.03	135.05
		74.2	70' DSL	Fair debris line on a chain link fence.	135.86		
		74.3	30' DSR	Good seed line on a concrete wall.	133.79		
		74.4	40' DSR	Poor seed line on a 3-inch diameter tree.	134.36		
		74.5	120' USL	Fair seed line on a 1-foot diameter tree.	137.86		
		74.6	140' USL	Fair seed line on a 1.5-foot diameter tree.	137.89		
		74.7	220' USR	Fair seed line on a 2-foot diameter tree.	138.33		
		74.8	230' USR	Fair seed line on a 2.5-foot diameter tree.	138.05		
75	PECK3: Peckman River at Little Falls, Passaic County, NJ. Lat 040°52'41.66"N Long 074°13'10.97"W, located at the bridge on East Main Street.	75.1	235' USR	Fair seed line on a 1.5-foot diameter tree.	155.26	155.14	150.32
		75.2	230' USR	Fair seed line on a 2-foot diameter tree.	155.19		
		75.3	220' USL	Fair seed line on a 3-inch diameter tree.	155.16		
		75.4	215' USL	Fair seed line on an 8-inch diameter tree.	154.93		
		75.5	180' DSL	Fair seed line on a 1-foot diameter tree.	149.80		
		75.7	110' DSR	Poor seed line on a 3-foot diameter tree.	150.86		
		75.8	300' DSR	Poor mark on a 5-foot diameter tree.	150.28		
76	PECK4: Peckman River at Cedar Grove, Essex County, NJ. Lat 040°51'53.61"N Long 074°13'28.53"W, located at the bridge on Commerce Road.	76.1	75' DSR	Poor seed line on a 2-foot diameter tree.	201.31	207.45	201.33
		76.2	80' DSR	Fair seed line on a 4-inch diameter branch of a 1.5-foot diameter tree.	201.29		
		76.3	75' DSL	Fair seed line on a 1.5-foot diameter tree.	201.29		
		76.4	90' DSL	Fair seed line on a 1.5-foot diameter tree.	201.41		
		76.6	140' USR	Fair seed line on a 1-foot diameter tree.	208.24		
		76.7	200' USL	Fair seed line on a 3-foot diameter tree.	206.65		
77	PECK5: Peckman River at Cedar Grove, Essex County, NJ. Lat 040°51'16.19"N Long 074°13'47.73"W, located at the bridge on Pompton Avenue/Route 23.	77.1	90' DSL	Fair seed line on a 2.5-foot diameter tree.	280.45	281.18	280.29
		77.2	80' DSL	Poor seed line on a tree root at ground level.	280.71		
		77.3	80' DSR	Poor seed line on a 4-inch diameter tree.	279.72		
		77.5	100' USL	Poor seed line on a 2-foot diameter tree.	281.37		
		77.6	70' USL	Poor seed line on a 2.5-foot diameter tree.	281.27		
		77.7	50' USR	Poor seed line on a 2-foot diameter tree.	281.04		
		77.8	75' USR	Poor mark on a 4-inch diameter tree.	281.04		

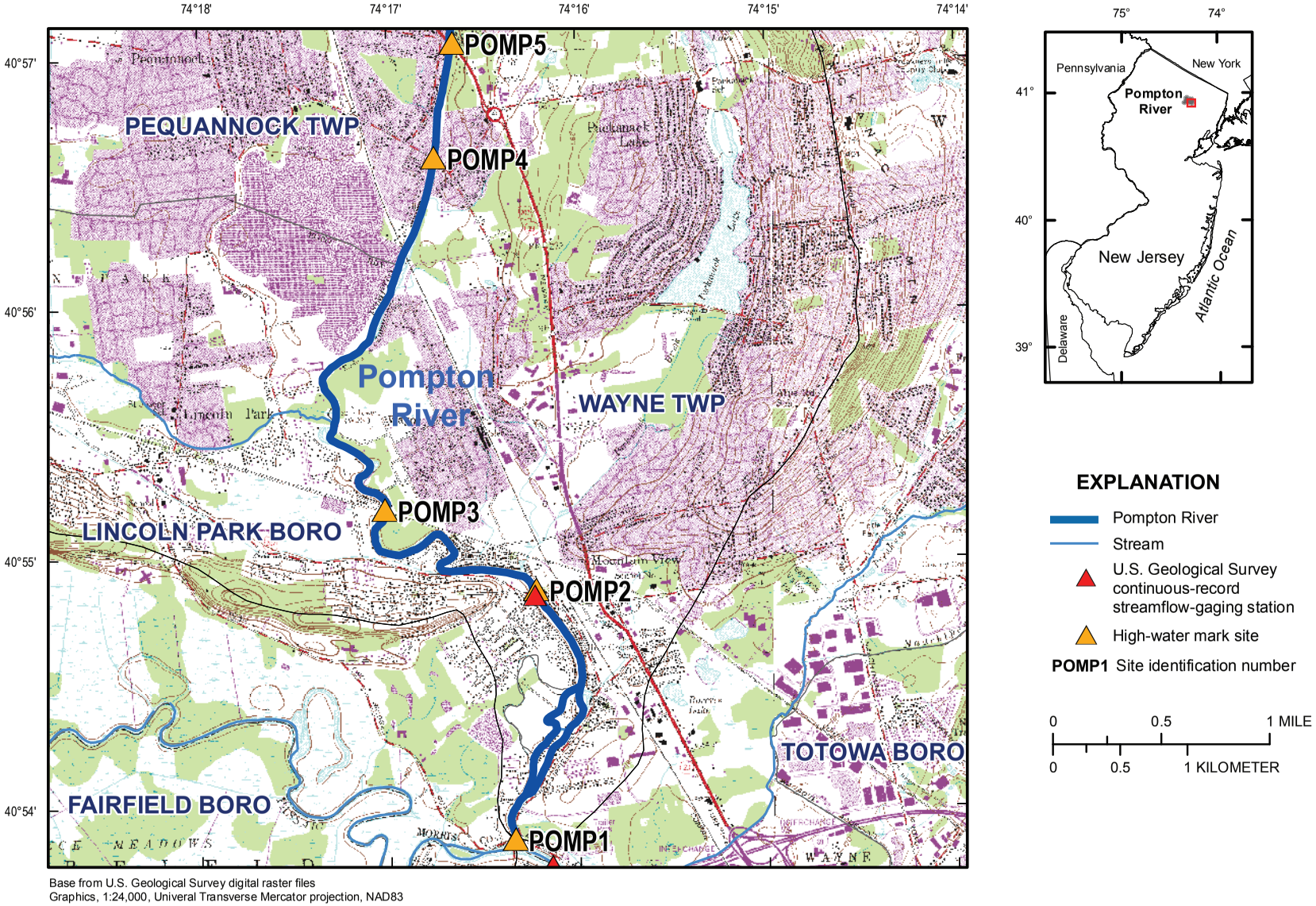


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Pequannock River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-15 Pequannock River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
78	PEQU1: Pequannock River at Pompton Plains, Morris County, NJ. Lat 040°58'32.96"N Long 074°17'01.34"W, located at the dam near Carlson Place.	78.1	235' DSR	Fair debris line on a 2-foot diameter tree.	184.93	185.99	184.47
		78.2	245' DSR	Poor debris line on a 2-foot diameter tree.	184.91		
		78.4	75' USR	Poor debris line on a 2-foot diameter tree.	185.26		
		78.5	15' USL	Fair debris line on a 2.5-foot diameter tree.	186.18		
		78.6	10' USL	Good seed line on an 8-inch diameter tree.	186.53		
		78.7	200' DSL	Poor seed line on a 1-foot diameter tree.	184.18		
		78.8	160' DSL	Fair debris line on a split-trunked tree.	183.85		
79	PEQU2: Pequannock River at Pompton Lakes, Passaic County, NJ. Lat 040°59'16.56"N Long 074°17'33.30"W located at the bridge on Riverdale Road.	79.1	200' DSL	Fair debris line on a 6-inch diameter tree.	187.76	189.91	188.17
		79.2	230' DSL	Fair seed/debris line on a double-trunked tree.	187.48		
		79.3	150' DSR	Good seed/debris line on a 10-inch diameter tree.	188.73		
		79.4	140' DSR	Good seed/debris line on a 1.5-foot diameter tree.	188.71		
		79.5	50' USR	Good seed/debris line on a multi-trunked tree.	189.86		
		79.6	100' USR	Fair seed line on a 1.3-foot diameter tree.	189.96		
80	PEQU3: Pequannock River at Riverdale, Morris County, NJ. Lat 040°59'54.87"N Long 074°18'31.61"W, located at the bridge on Hamburg Turnpike/Interstate 287.	80.1	50' R	Excellent debris line on a Gabion wall.	226.75	226.10	
		80.2	50' L	Excellent debris line on a Gabion wall.	225.93		
		80.3	40' L	Excellent seed line on a bridge piling.	225.62		
81	PEQU4: Pequannock River at Butler, Morris County, NJ. Lat 041°00'13.33"N Long 074°20'05.00"W, located at the bridge on Route 511/Main Street.	81.1	120' USL	Poor seed line on a 4-foot diameter tree.	293.41	293.41	290.52
		81.3	250' DSL	Excellent seed/mud line on a garage door.	290.52		
82	PEQU5: Pequannock River at Butler, Morris County, NJ. Lat 041°00'24.45"N Long 074°21'03.87"W, located at the bridge near Hamburg Turnpike and Macopin Road.	82.1	70' USR	Fair seed line on a 9.6-inch diameter multi-trunked tree.	366.65	366.50	364.15
		82.2	60' USR	Poor seed line on a 6-inch diameter tree.	366.59		
		82.3	100' USL	Poor debris line on a 3-foot diameter tree.	366.26		
		82.4	50' DSL	Poor seed line on a 2.4-inch diameter tree.	364.00		
		82.5	49' DSL	Poor seed line on a small boulder.	364.08		
		82.6	55' DSL	Poor seed line on a 3.6-inch diameter tree.	363.96		
		82.7	50' DSR	Fair debris line at the base of a tree.	364.57		

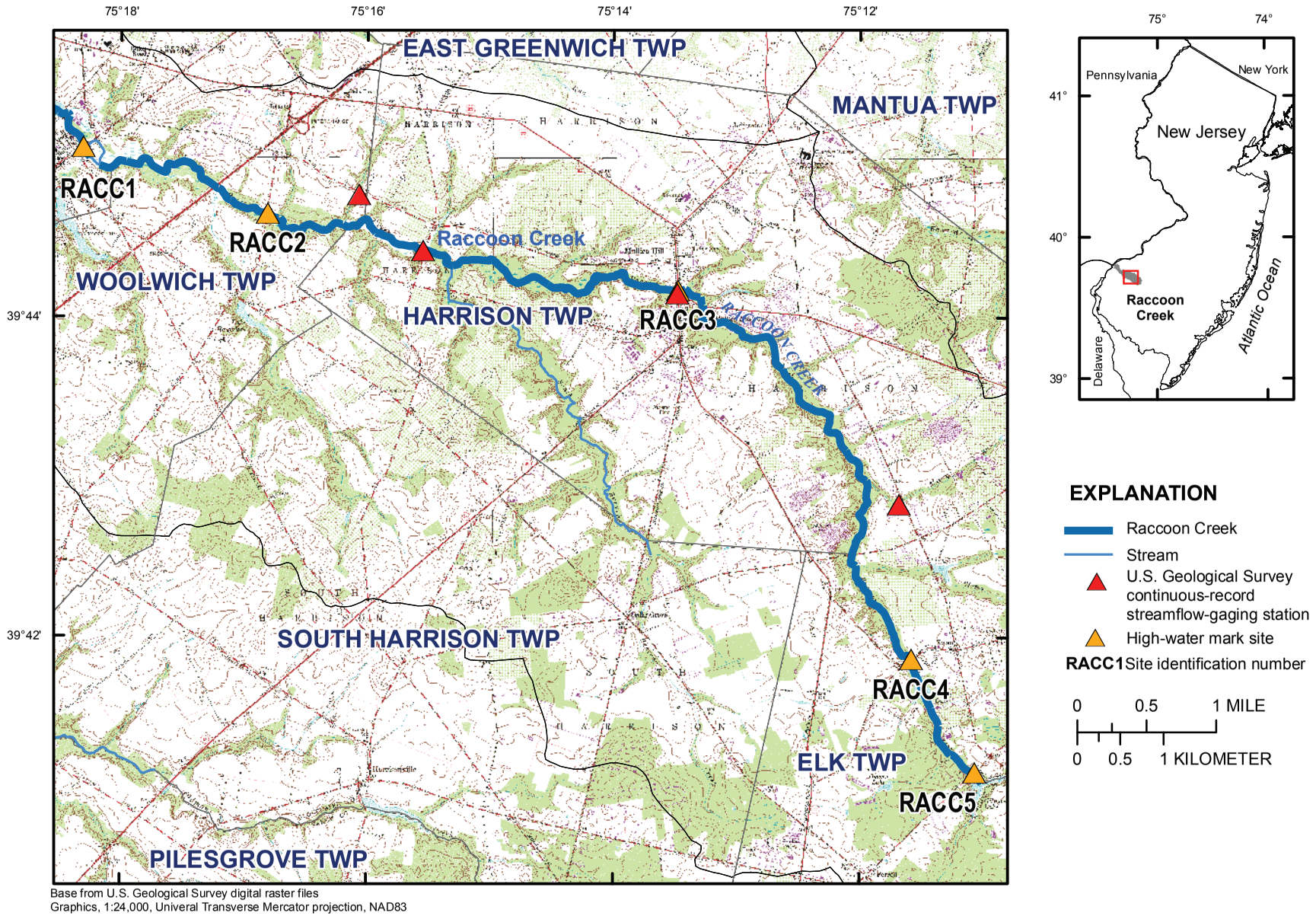


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Pompton River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-16 Pompton River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
83	POMP1: Pompton River near Fairfield, Essex County, NJ. Lat 040°53'52.50"N Long 074°16'20.75"W, located at the bridge on Two Bridges Road near Fairfield Road.	83.1	450' USL	Poor seed line on a telephone pole.	171.08	171.51	
		83.2	450' USL	Good seed line on a 1-foot diameter tree.	171.27		
		83.3	250' USR	Good mud line on a garage door.	171.84		
		83.4	250' USR	Good seed line on an 8-inch diameter tree.	171.86		
84	POMP2: Pompton River at Mountain View, Passaic County, NJ. Lat 040°54'52.47"N Long 074°16'13.59"W located at the bridge on Boonton Turnpike/ Route 202.	84.2	75' DSR	Excellent mud line on a house foundation.	172.85	173.54	173.01
		84.3	100' USR	Excellent mud line on a door to pumping station.	173.46		
		84.4	200' USR	Good mud line on a swing set frame.	173.58		
		84.6	200' USL	Fair seed line on a 5-foot diameter tree.	173.58		
		84.7	10' DSL	Excellent mud line on a door.	173.33		
		84.8	75' DSL	Excellent mud line on a house.	172.86		
85	POMP3: Pompton River at Wayne, Passaic County, NJ. Lat 040°55'11.86"N Long 074°17'01.48"W, located between Forest Avenue and South Boulevard Drive.	85.1	USL	Excellent mud line on a wall.	176.18	176.06	175.08
		85.2	USL	Fair seed line on a 4-foot diameter tree.	176.16		
		85.3	USR	Excellent mud line on a house.	175.94		
		85.4	USR	Excellent seed line on a house.	175.95		
		85.5	DSR	Good mud line on a white fence.	175.20		
		85.6	DSR	Fair seed line on a 1.2-foot diameter tree.	174.96		
86	POMP4: Pompton River at Packanack, Passaic County, NJ. Lat 040°56'36.54"N Long 074°16'45.10"W, located at the bridge on Newark Pompton Turnpike.	86.1	100' DSR	Excellent mud line on a house.	178.32	178.85	178.34
		86.2	50' DSR	Poor seed line on a telephone pole.	178.37		
		86.3	25' USR	Fair seed line on a 1.2-foot diameter tree.	178.97		
		86.5	25' USL	Poor wash line on an embankment.	179.06		
		86.6	10' USL	Poor seed line on a 1-foot diameter tree.	178.53		
87	POMP5: Pompton River at Wayne, Passaic County, NJ. Lat 040°57'04.14"N Long 074°16'39.07"W, located at the bridge on Route 23.	87.1	300' USR	Good mud line on a glass door of a business.	182.01	181.84	181.06
		87.2	290' USR	Poor seed line on a telephone pole.	181.66		
		87.3	200' DSR	Excellent mud line on a sports bar.	181.62		
		87.4	150' DSR	Poor seed line on a telephone pole.	181.38		
		87.5	100' DSL	Fair seed line on a 4-foot diameter tree.	180.29		
		87.6	150' DSL	Poor seed line on a 1.5-foot diameter tree.	180.96		

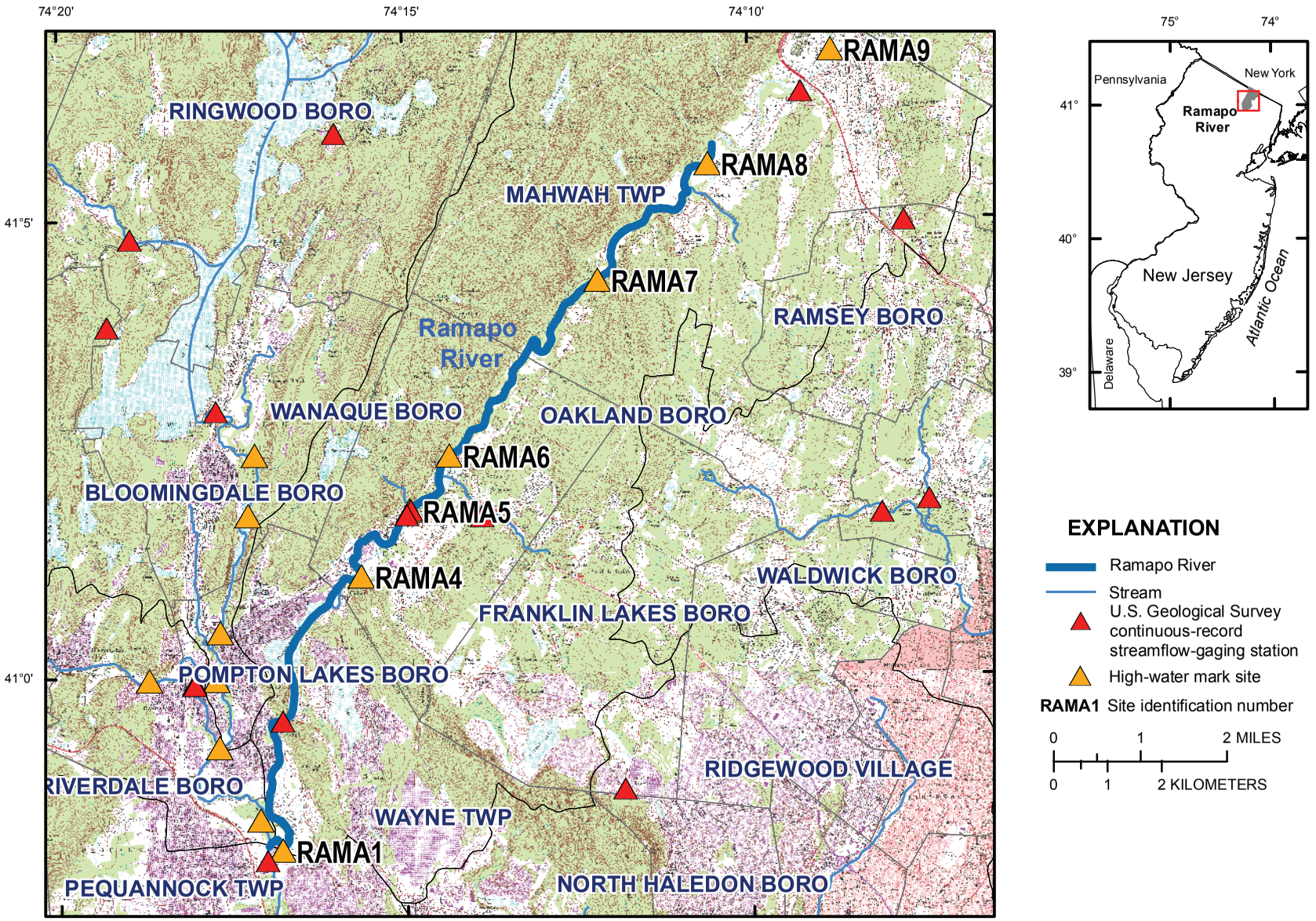


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Raccoon Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, southern New Jersey.

Appendix 1-17 Raccoon Creek.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
88	RACC1: Raccoon Creek at Swedesboro, Salem County, NJ. Lat 039°45'03.87"N Long 075°18'18.40"W, located at the bridge on Kings Highway.	88.1	15' DSR	Good seed line on a multi-trunked tree.	7.36	7.72	7.36
		88.2	30' DSR	Good seed line on an 8-inch diameter tree.	7.35		
		88.3	5' USR	Fair seed line on a 3-foot diameter tree.	7.59		
		88.4	10' USR	Poor seed line on a 2-foot diameter tree.	7.85		
89	RACC2: Raccoon Creek at Swedesboro, Salem County, NJ. Lat 039°44'39.07"N Long 075°16'48.74"W located at the bridge on Russell Mill Road.	89.1	5' USR	Excellent debris line on a 10-inch diameter tree.	12.67	12.84	11.70
		89.2	20' USR	Fair debris line on a 1-foot diameter tree.	12.53		
		89.3	15' DSR	Good debris line on a 10-inch diameter tree.	11.73		
		89.4	50' DSR	Fair seed line on a double-trunked tree.	11.63		
		89.5	50' DSL	Good seed line on a double-trunked tree.	11.74		
		89.7	5' USL	Excellent seed line on a 3-foot diameter tree.	13.09		
		89.8	30' USL	Unrated seed line on an 8-inch diameter tree.	13.06		
90	RACC3: Raccoon Creek at Mullica Hill, Salem County, NJ. Lat 039°44'10.36"N Long 075°13'28.69"W, located at the bridge on Route 45.	90.1	200' DSL	Fair seed line on a 6-inch diameter tree.	28.18	29.66	28.27
		90.2	150' DSL	Fair seed line on a 1-foot diameter tree.	28.33		
		90.3	200' DSR	Fair seed line on a 1.5-foot diameter tree.	28.45		
		90.4	150' DSR	Fair seed line on a 10-inch diameter tree.	28.11		
		90.5	50' USR	Good seed line on a 4-inch diameter tree.	29.59		
		90.6	60' USR	Fair seed line on a 10-inch diameter tree.	29.72		
91	RACC4: Raccoon Creek at Ewan, Salem County, NJ. Lat 039°41'51.78"N Long 075°11'34.87"W, located at the outlet of Ewan Lake near Ewan Road.	91.2	70' USR	Fair seed line on a 1-foot diameter tree.	77.18	77.28	69.12
		91.3	5' USL	Good seed line on a 1-foot diameter tree.	77.27		
		91.4	10' USL	Fair seed line on an 8-inch diameter tree.	77.41		
		91.5	300' DSL	Poor seed line on a 1-foot diameter tree.	68.21		
		91.6	10' DSL	Poor seed line on a 1-foot diameter tree.	69.68		
		91.7	300' DSR	Fair seed line on a 10-inch diameter tree.	68.58		
		91.8	75' DSR	Poor seed line on a 4-inch diameter tree.	70.01		
92	RACC5: Raccoon Creek at Wrights Mill, Salem County, NJ. Lat 039°41'09.28"N Long 075°11'04.24"W, located at the outlet of Gilman Lake on Ellis Mill Road.	92.1	10' USR	Good seed line on an 8-inch diameter tree.	91.06	91.03	82.75
		92.2	8' USR	Fair seed line on on a 10-inch diameter tree.	91.01		
		92.3	150' DSL	Good seed line on an 8-inch diameter tree.	82.90		
		92.4	140' DSL	Fair seed line on an 8-inch diameter tree.	82.92		
		92.5	160' DSR	Good seed line on a 1-foot diameter tree.	82.43		



Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

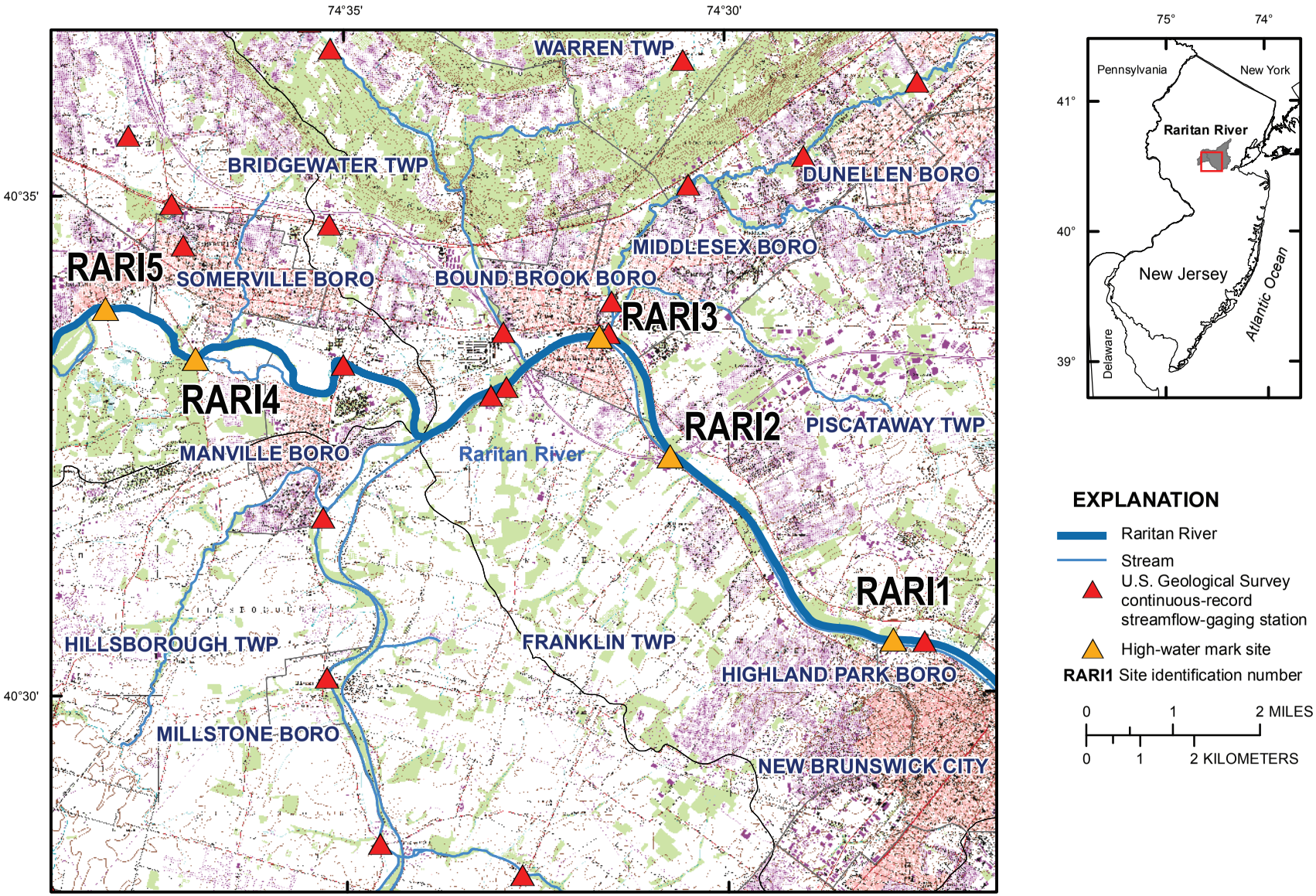
Location of Ramapo River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-18 Ramapo River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
93	RAMA1: Ramapo River at Pompton Plains, Morris County, NJ. Lat 040°58'14.57"N Long 074°16'43.68"W, located at the dam near Pompton Plains Circle.	93.1	200' USL	Fair seed line on a 3-foot diameter tree.	186.11	186.00	
		93.2	100' USL	Poor seed line on a 10-inch diameter tree.	185.88		
94	RAMA4: Ramapo River at Oakland, Bergen County, NJ. Lat 041°00'59.48"N Long 074°15'39.67"W, located at the bridge on Doty Road.	94.1	250' DSL	Fair seed line on a 10-inch diameter tree.	206.54	207.09	206.42
		94.2	250' DSL	Fair seed line on a 10-inch diameter tree.	206.79		
		94.3	50' USL	Poor seed line on a 5-inch diameter tree.	207.06		
		94.4	50' USL	Poor seed line on a 5-inch diameter tree.	207.19		
		94.5	250' USR	Good seed line on a 2-foot diameter tree.	207.03		
		94.7	20' DSR	Fair seed line on a 10-inch diameter tree.	206.22		
		94.8	10' DSR	Poor wash line on an embankment.	206.19		
		94.9	0' DSR	Poor seed line on an electrical box.	206.37		
95	RAMA5: Ramapo River at Oakland, Bergen County, NJ. Lat 041°01'38.95"N Long 074°15'00.69"W, located at the bridge on West Oakland Avenue.	95.1	40' USR	Good algae line on a house.	219.53	219.74	217.55
		95.2	125' USR	Good seed line on a window of a house.	220.07		
		95.3	20' USL	Good algae line a door to a business.	219.34		
		95.4	15' USL	Poor seed line on a 2.5-foot diameter tree.	220.00		
		95.5	25' DSL	Good algae line on a gutter attached to a house.	217.54		
		95.6	25' DSL	Good mud line on a wall to a business.	217.56		
96	RAMA6: Ramapo River at Oakland, Bergen County, NJ. Lat 041°02'12.11"N Long 074°14'28.95"W, located at the bridge on Lenape Lane.	96.2	15' DSR	Poor seed line on a 1-foot diameter tree.	229.97	229.91	229.77
		96.3	40' USR	Good seed line on the screen of a gazebo.	229.91		
		96.6	5' DSL	Poor seed line on a 1-foot diameter tree.	229.57		
97	RAMA7: Ramapo River at Darlington, Bergen County, NJ. Lat 041°03'57.23"N Long 074°12'29.58"W, located at the bridge on Bear Swamp Road.	97.1	10' DSR	Fair seed line on a 2.5-foot diameter tree.	244.83	244.98	244.78
		97.2	10' DSR	Fair seed line on a 1-foot diameter tree.	244.73		
		97.3	25' USL	Poor seed line on a 4-foot diameter tree.	245.08		
		97.4	30' USL	Poor seed line on an 8-inch diameter tree.	244.87		
		97.5	20' DSL	Poor seed line on a telephone pole.	245.15		
		97.6	10' DSL	Poor seed line on a 2-foot diameter tree.	244.40		
98	RAMA8: Ramapo River at Darlington, Bergen County, NJ. 041°05'06.96"N Long 074°11'01.03"W, located at the bridge on Halifax Road.	98.3	25' USL	Fair seed line on a 4.5-foot diameter tree.	254.38	254.28	252.86
		98.4	35' USL	Good seed line on a 2.5-foot diameter tree.	254.19		
		98.5	35' DSR	Fair seed line on a 2-foot diameter tree.	252.86		
		98.6	50' USR	Poor seed line on a 1.5-foot diameter tree.	254.28		

Appendix 1-18 Ramapo River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
99	RAMA9: Ramapo River at West Mahwah, Bergen County, NJ. Lat 041°06'15.39"N Long 074°09'22.66"W, located at the confluence with Mahwah River near Strysco Avenue.	99.1	USL		274.39	274.39	274.14
		99.2	DSL		274.47		
		99.3	DSL		274.36		
		99.4	DSR		273.61		

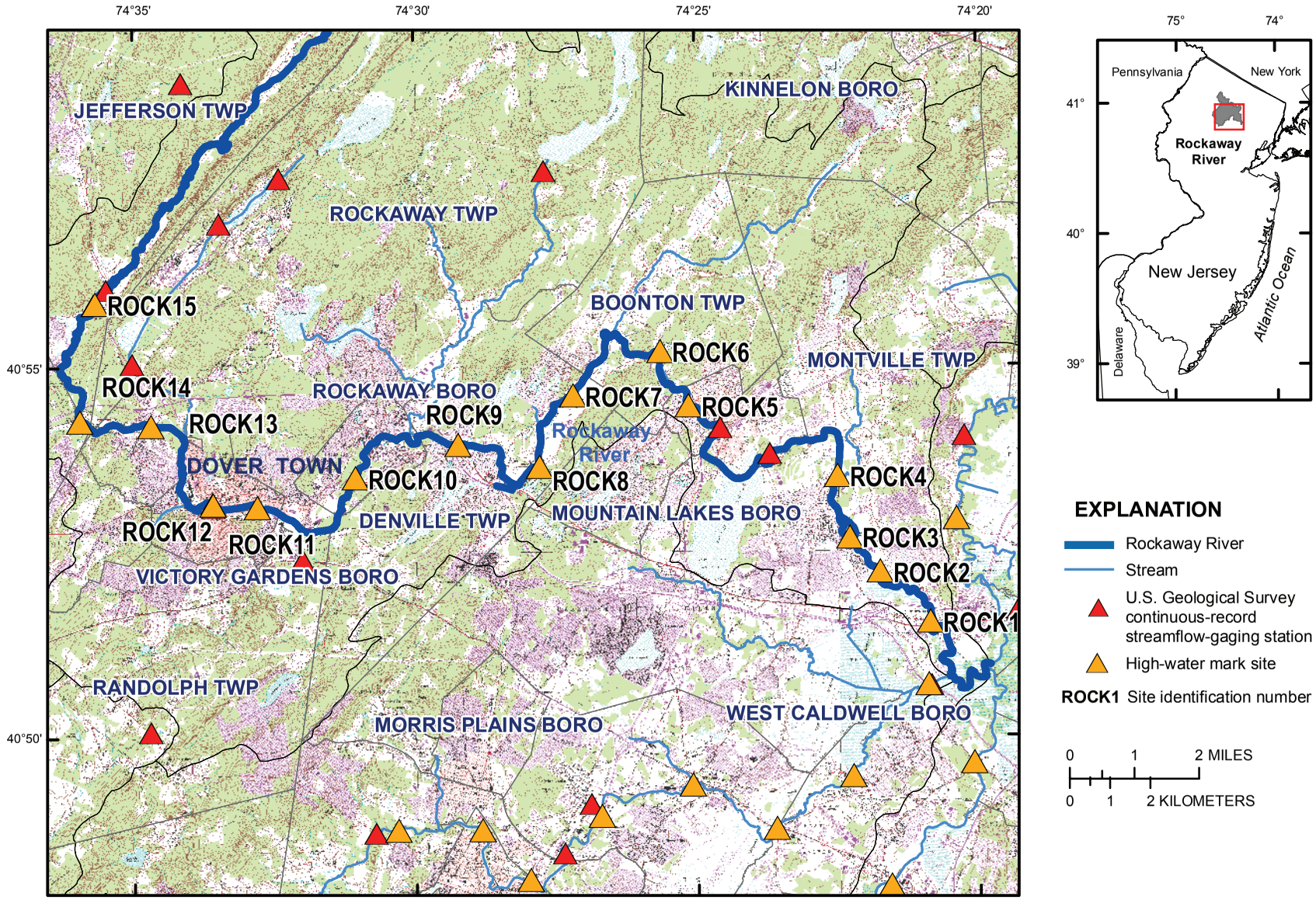


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Raritan River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-19 Raritan River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
100	RARI1: Raritan River at New Brunswick, Middlesex County, NJ. Lat 040°30'31.31"N Long 074°27'49.56"W, located at the bridge on Landing Lane.	100.3	10' DSL	Fair debris line on a 10-inch diameter tree.	19.79	23.01	20.16
		100.4	10' DSL	Fair debris line on a double-trunked tree.	19.76		
		100.5	25' USR	Poor seed line on an 8-inch diameter tree.	22.80		
		100.6	30' USR	Fair debris line on a 1-foot diameter tree.	23.22		
		100.7	120' DSR	Poor debris line on a 1-foot diameter tree.	20.53		
		100.8	130' DSR	Poor debris line on a 1-foot diameter tree.	20.54		
101	RARI2: Raritan River at South Bound Brook, Somerset County, NJ. Lat 040°32'22.19"N Long 074°30'44.27"W located at the bridge on Interstate 287.	101.1	62' DSR	Poor mud line on a 1-foot diameter tree.	33.48	34.78	33.52
		101.2	90' DSR	Poor seed/debris line on a 1-foot diameter tree.	33.57		
		101.3	128' USR	Fair seed/debris line on a 2-foot diameter tree.	34.87		
		101.4	136' USR	Poor seed/debris line on a double-trunked tree.	34.70		
102	RARI3: Raritan River at Bound Brook, Somerset, County, NJ. Lat 040°33'34.41"N Long 074°31'39.67"W, located at Queens Bridge/South Main Street.	102.1	10' DSL	Good mud line on an ornamental tree.	36.42	36.53	36.46
		102.2	18' DSL	Poor seed/debris line on a telephone pole.	36.64		
		102.3	10' USL	Fair seed/debris line on a telephone pole.	36.59		
		102.4	168' USL	Good mud line on a telephone pole.	36.75		
		102.5	129' DSR	Fair seed/debris line on a double-trunked tree.	35.98		
		102.6	154' DSR	Poor seed line on a 1.5-foot diameter tree.	36.82		
		102.7	0' USR	Fair seed/debris line on a telephone pole.	36.48		
		102.8	25' USR	Fair seed line on a 10-inch diameter tree.	36.32		
103	RARI4: Raritan River at Somerville, Somerset County, NJ. Lat 040°33'22.05"N Long 074°36'57.71"W, located at the bridge on Route 206.	103.1	40' DSL	Fair seed line a a 6-inch diameter tree.	48.84	50.19	48.70
		103.2	20' DSL	Poor seed line on a 6-inch diameter tree.	49.28		
		103.3	10' USL	Poor seed line on a 4-inch diameter tree.	49.75		
		103.4	8' USL	Poor seed line on a 6-inch diameter tree.	50.60		
		103.5	150' DSR	Fair seed line on a multi-trunked tree.	48.69		
		103.6	225' DSR	Poor debris line on a leaning tree.	47.99		
		103.7	10' USR	Fair seed/debris line on an 8-inch diameter tree.	50.02		
		103.8	75' USR	Fair seed/debris line on a 10-inch diameter tree.	50.38		
104	RARI5: Raritan River at Raritan, Hunterdon County, NJ. Lat 040°33'52.55"N Long 074°38'08.55"W, located at the River Road/Nevius Street bridge.	104.1	200' DSR	Good debris line on a 2-foot diameter tree.	51.31	52.48	52.03
		104.2	200' DSR	Fair debris line on a multi-trunked tree.	52.06		
		104.5	95' USL	Poor seed line on a 1.5-foot diameter tree.	52.66		
		104.6	75' USL	Poor debris line on a 1-foot diameter tree.	52.30		
		104.7	60' DSL	Poor debris line on a 1-foot diameter tree.	52.31		
		104.8	35' DSL	Poor debris line on a 1.5-foot diameter tree.	52.47		



Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Rockaway River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-20 Rockaway River.

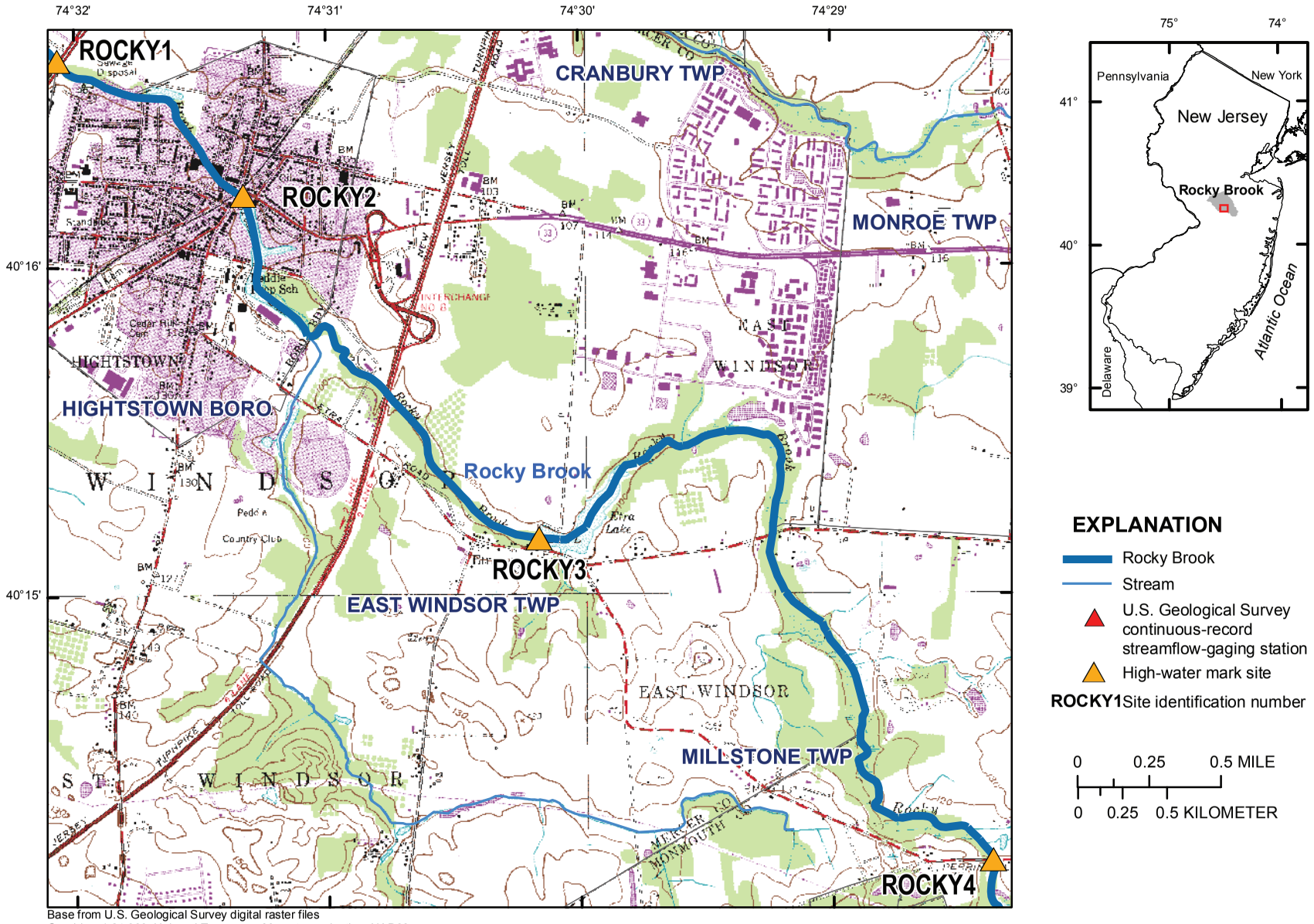
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
105	ROCK1: Rockaway River at Pine Brook, Morris County, NJ. Lat 040°51’32.80”N Long 074°20’51.61”W, located at the bridges on Old Bloomfield Road and US Highway 46.	105.2	200’ USR	Poor seed line on a 2-foot diameter tree.	176.17	176.03	174.86
		105.3	200’ USL	Good mud line on on a fence.	176.04		
		105.4	200’ USL	Fair mud line on a stairway to a business.	175.89		
		105.5	300’ DSR	Fair mud line on a dumpster enclosure.	175.83		
		105.6	300’ DSR	Poor seed line on a 2-foot diameter tree.	175.69		
		105.7	400’ DSL	Poor mud line on a fence post.	173.71		
		105.8	600’ DSL	Fair mud line on an electrical box.	174.23		
106	ROCK2: Rockaway River at Montville, Morris County, NJ. Lat 040°52’13.69”N Long 074°21’44.65”W, located at the bridge on Vale Road.	106.1	100’ DSL	Fair mud line on a fence.	177.19	181.93	176.94
		106.2	200’ DSL	Good mud line on a ladder to a cell tower.	177.23		
		106.3	200’ USL	Fair seed line on on a 1.5-foot diameter tree.	181.93		
		106.5	25’ DSR	Poor seed line on on a 2-foot diameter tree.	176.41		
107	ROCK3: Rockaway River at Lake Hiawatha, Morris County, NJ. Lat 040°52’41.42”N Long 074°22’16.83”W, located on Lake Shore Drive.	107.1		Excellent seed line on a house.	178.50	178.29	
		107.2		Good seed line on a tree.	178.53		
		107.3		Good seed line on a 5-foot diameter tree.	178.62		
		107.4		Good mark on a concrete wall.	177.53		
108	ROCK4: Rockaway River at Lower Montville, Morris County, NJ. Lat 040°53’31.13”N Long 074°22’29.98”W, located at the bridge on Knoll Road.	108.1	100’ USR	Fair seed line on a 1.5-foot diameter tree.	183.54	183.44	
		108.2	75’ USR	Poor seed line on a tree.	183.67		
		108.3	100’ USL	Poor seed line on a 1-foot diameter tree.	183.31		
		108.4	100’ USL	Poor seed line on a 1-foot diameter tree.	183.26		
109	ROCK5: Rockaway River at Boonton, Morris County, NJ. Lat 040°54’28.26”N Long 074°25’08.00”W, located at the bridge on West Main Street.	109.1	200’ USL	Fair seed line on a 1-foot diameter tree.	489.74	489.54	485.48
		109.2	200’ DSR	Poor debris line on a chain-link fence.	485.73		
		109.3	150’ DSR	Fair seed line on a 3.5-foot diameter tree.	486.88		
		109.4	100’ USR	Poor wash line on the ground.	489.34		
		109.5	30’ DSL	Poor debris line on a chain-link fence.	484.91		
		109.6	100’ DSL	Fair wash line on the ground.	484.39		

Appendix 1-20 Rockaway River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
110	ROCK6: Rockaway River at Powerville, Morris County, NJ. 040°55'12.42"N Long 074°25'37.97"W, located at bridge on Powerville Road and Rockaway Drive.	110.1	20' USL	Poor seed line on a 4.5-foot diameter tree.	501.99	501.93	500.73
		110.2	30' USL	Poor seed line on a 4.5-foot diameter tree.	501.87		
		110.3	100' DSL	Poor seed line on a 1.5-foot diameter tree.	500.52		
		110.4	60' DSL	Fair seed line on a 1-foot diameter tree.	500.94		
111	ROCK7: Rockaway River at Denville, Morris County, NJ. Lat 040°54'36.97"N Long 074°27'10.94"W, located at the bridge on Bush Road.	111.1	10' USR	Excellent seed line on a house.	503.85	504.57	
		111.2	150' USR	Poor seed line on a 2-foot diameter tree.	505.93		
		111.4	100' USL	Poor seed line on a 3.5-foot diameter tree.	504.27		
		111.5	75' USL	Fair seed line on a 6-inch diameter tree.	504.21		
112	ROCK8: Rockaway River at Denville, Morris County, NJ. Lat 040°53'39.34"N Long 074°27'47.00"W, located at the bridge on Pocono Road.	112.1	125' DSR	Good seed line on a window frame to a garage.	501.58	506.11	502.14
		112.2	100' DSR	Good seed line on a window shutter.	502.70		
		112.5	100' USL	Poor seed line on a telephone pole.	505.94		
		112.6	200' USL	Fair seed line on a 3.5-foot diameter tree.	506.27		
113	ROCK9: Rockaway River at Denville, Morris County, NJ. Lat 040°53'57.44"N Long 074°29'13.68"W, located at the bridge on Savage Road.	113.1	150' USL	Excellent mud line on a basement window.	511.71	511.53	510.42
		113.2	100' USL	Good seed line on a brick wall to a building.	511.64		
		113.3	75' USR	Fair seed line on on a 1.5-foot diameter tree.	511.41		
		113.4	125' USR	Poor seed line on on a 3.5-foot diameter tree.	511.35		
		113.5	200' DSR	Excellent silt line on a fence.	510.03		
		113.6	200' DSR	Poor seed line on a 5-foot diameter tree.	510.06		
		113.7	10' DSL	Poor seed line on a 4.5-foot diameter tree.	511.19		
114	ROCK10: Rockaway River at Rockaway, Morris County, NJ. Lat 040°53'30.66"N Long 074°31'03.44"W, located at the bridge on Route 46.	114.1	250' USL	Fair seed line on an 8-inch diameter tree.	535.12	535.36	534.87
		114.2	250' USL	Fair seed line on a 6-inch diameter tree.	535.55		
		114.4	20' DSR	Fair seed line on a 6-inch diameter tree.	534.78		
		114.5	75' DSR	Fair seed line on a 1.5-foot diameter tree.	534.97		
		114.6	250' USR	Fair seed line on an 8-inch diameter tree.	535.29		
		114.7	250' USR	Fair seed line on a 1-foot diameter tree.	535.47		

Appendix 1-20 Rockaway River.—Continued

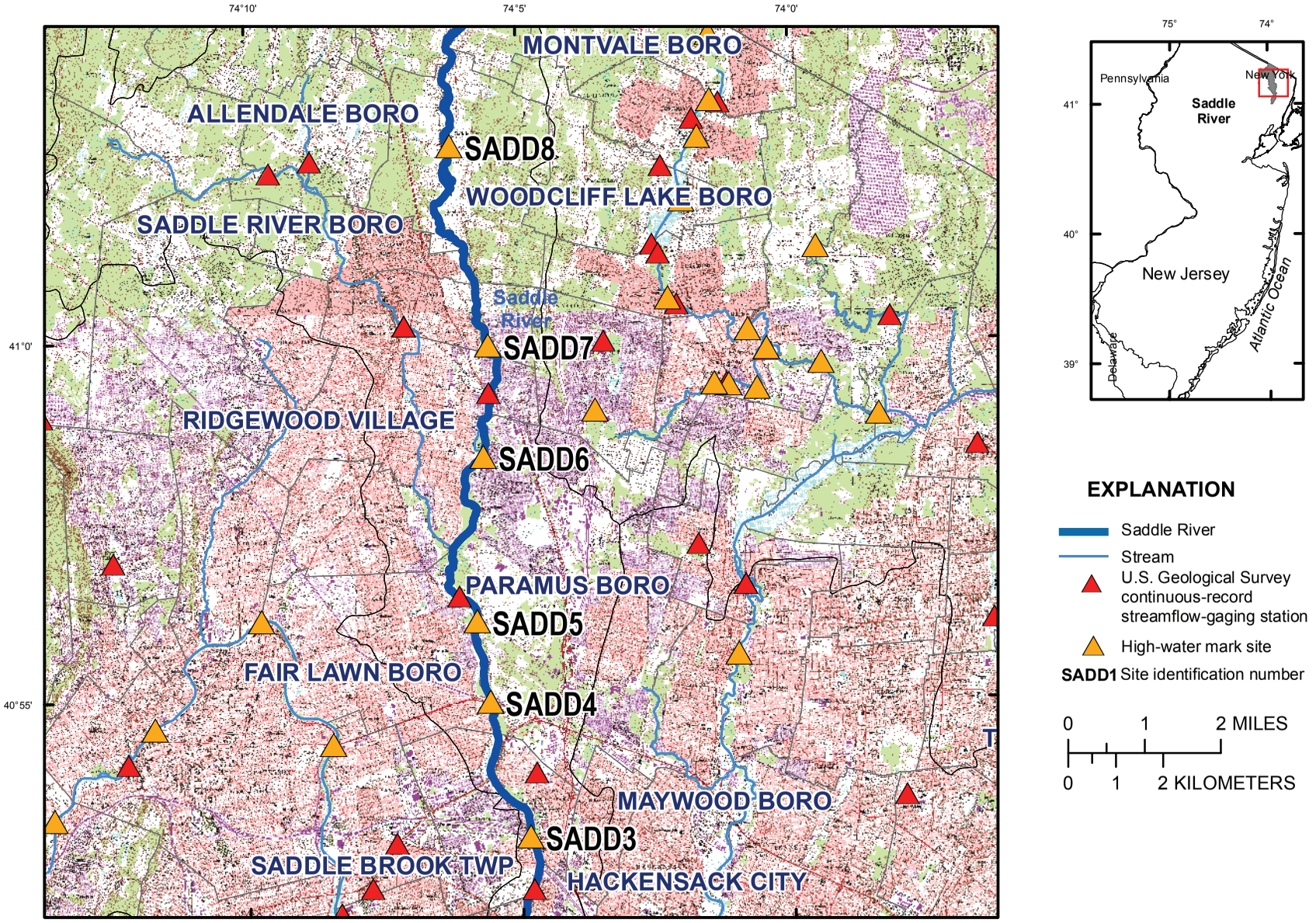
Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
115	ROCK11: Rockaway River at Dover, Morris County, NJ. Lat 040°53’07.07”N Long 074°32’48.10”W, located at the bridge on Blackwell Street.	115.1	100’ USL	Good mud line on an entranceway to a building.	554.91	554.92	554.92
		115.2	0’ USR	Good mud line on a traffic control signal shelter.	554.93		
		115.3	100’ DSR	Good seed line on a concrete retaining wall.	555.10		
		115.4	150’ DSL	Fair seed line on a 1.5-foot diameter tree.	554.93		
		115.5	150’ DSL	Fair seed line on a 1-foot diameter tree.	554.72		
117	ROCK13: Rockaway River at Wharton, Morris County, NJ. Lat 040°54’13.17”N Long 074°34’41.08”W, located at the bridge before the outlet of Washington Pond at North Main Street.	117.1	50’ DSL	Good seed line on a 1-foot diameter tree.	633.34	642.51	633.13
		117.2	100’ DSR	Good seed line on a 1-foot diameter tree.	633.05		
		117.3	75’ DSR	Fair seed line on a 2-foot diameter tree.	633.00		
		117.4	1500’ USR	Good seed line on a multi-trunked tree.	642.46		
		117.5	500’ USL	Poor seed line on a multi-trunked tree.	642.57		
118	ROCK14: Rockaway River at Wharton, Morris County, NJ. Lat 040°54’17.18”N Long 074°35’57.20”W, located at the bridge on West Dewey Avenue.	118.1	20’ USL	Good seed line on a 1-foot diameter tree.	673.09	673.13	672.04
		118.2	20’ USL	Good seed line on a 1-foot diameter tree.	673.14		
		118.3	10’ USR	Poor seed line on a 10-inch diameter tree.	673.14		
		118.4	75’ DSR	Fair seed line on a 1.2-foot diameter tree.	672.16		
		118.5	60’ DSR	Poor seed line on a 2-foot diameter tree.	671.98		
		118.6	15’ DSL	Poor seed line on a multi-trunked tree.	671.97		
119	ROCK15: Rockaway River at Berkshire Valley, Morris County, NJ. Lat 040°55’52.42”N Long 074°35’40.67”W, located at the bridge on Berkshire Valley Road.	119.1	100’ DSL	Good seed line on a 6-inch diameter tree.	691.62	692.27	691.58
		119.2	100’ DSL	Good seed line on a 6-inch diameter tree.	691.61		
		119.3	150’ DSL	Good seed line on a 1-foot diameter tree.	691.60		
		119.4	10’ DSR	Fair seed line on a split-trunked tree.	691.47		
		119.5	10’ DSR	Fair seed line on a 2-foot diameter tree.	691.62		
		119.6	25’ USR	Fair seed line on a 6-inch diameter tree.	692.92		
		119.7	20’ USL	Good seed line on a garage door.	691.62		



Location of Rocky Brook stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-21 Rocky Brook.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
120	ROCKY1: Rocky Brook at Hightstown, Mercer County, NJ. Lat 040°16'37.87"N Long 074°32'04.01"W, Located at the bridge on US Highway 130.	120.1	50' DSR	Good seed line on a 2-foot diameter tree.	80.38	81.12	80.34
		120.2	50' DSR	Good seed line on a 1-foot diameter tree.	80.17		
		120.3	70' DSL	Good seed line on a a 10-inch diameter tree.	80.43		
		120.4	60' DSL	Fair seed line on a 10-inch diameter tree.	80.38		
		120.5	10' USR	Good seed line on a 3-foot diameter tree.	80.95		
		120.6	150' USR	Poor seed line on a 2-inch diameter tree.	81.50		
		120.7	50' USL	Good seed line on a 1-foot diameter tree.	81.05		
		120.8	60' USL	Good mark on a 10-inch diameter tree.	80.95		
121	ROCKY2: Rocky Brook at Hightstown, Mercer County, NJ. Lat 040°16'13.20"N Long 074°31'19.89"W, located on the Main Street bridge at Peddie Look Out.	121.1	250' USR	Good seed line on a 2-foot diameter tree.	87.19	87.15	85.08
		121.2	210' USR	Good seed line on a rock wall.	87.22		
		121.4	300' USL	Fair seed/debris line on a 4-inch diameter tree.	87.06		
		121.5	100' DSR	Good mud/debris line on an air-conditioning unit.	85.24		
		121.6	250' DSL	Fair seed line on an 8-inch diameter tree.	84.88		
		121.7	225' DSL	Good mud line on the stairs to the back entrance of a loading dock.	85.12		
122	ROCKY3: Rocky Brook near East Windsor, Mercer County, NJ. Lat 040°15'10.45"N Long 074°30'09.73"W, located at the outlet of Etra Lake on Etra Road.	122.1	250' DSR	Good seed line on a 2.5-foot diameter tree.	94.41	97.46	94.15
		122.2	210' DSR	Fair seed line on a 1-foot diameter tree.	95.01		
		122.3	260' DSL	Poor debris line on a 3.5-foot diameter tree.	93.81		
		122.4	200' DSL	Fair seed line on a 1-foot diameter tree.	93.36		
		122.5	150' USR	Good seed line on a shrub.	97.57		
		122.6	300' USR	Good seed line on a double-trunked tree.	97.30		
		122.7	150' USL	Good seed line on a leaning tree.	97.29		
		122.8	USL	Good seed line on a 1-foot diameter tree.	97.67		
123	ROCKY4: Rocky Brook at East Windsor, Mercer County, NJ. Lat 040°14'11.39"N Long 074°28'22.01"W, located at the bridge on Perrineville Road.	123.1	2' USL	Fair seed/mud line at the edge of a bulkhead.	119.47	119.50	118.36
		123.2	5' USL	Poor seed line on a 4-inch diameter tree.	119.66		
		123.3	2' USR	Good seed line on a bulkhead.	119.37		
		123.5	40' DSR	Fair seed line on a 2-inch diameter tree.	118.00		
		123.6	2' DSL	Good seed line on a bulkhead.	118.72		



Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

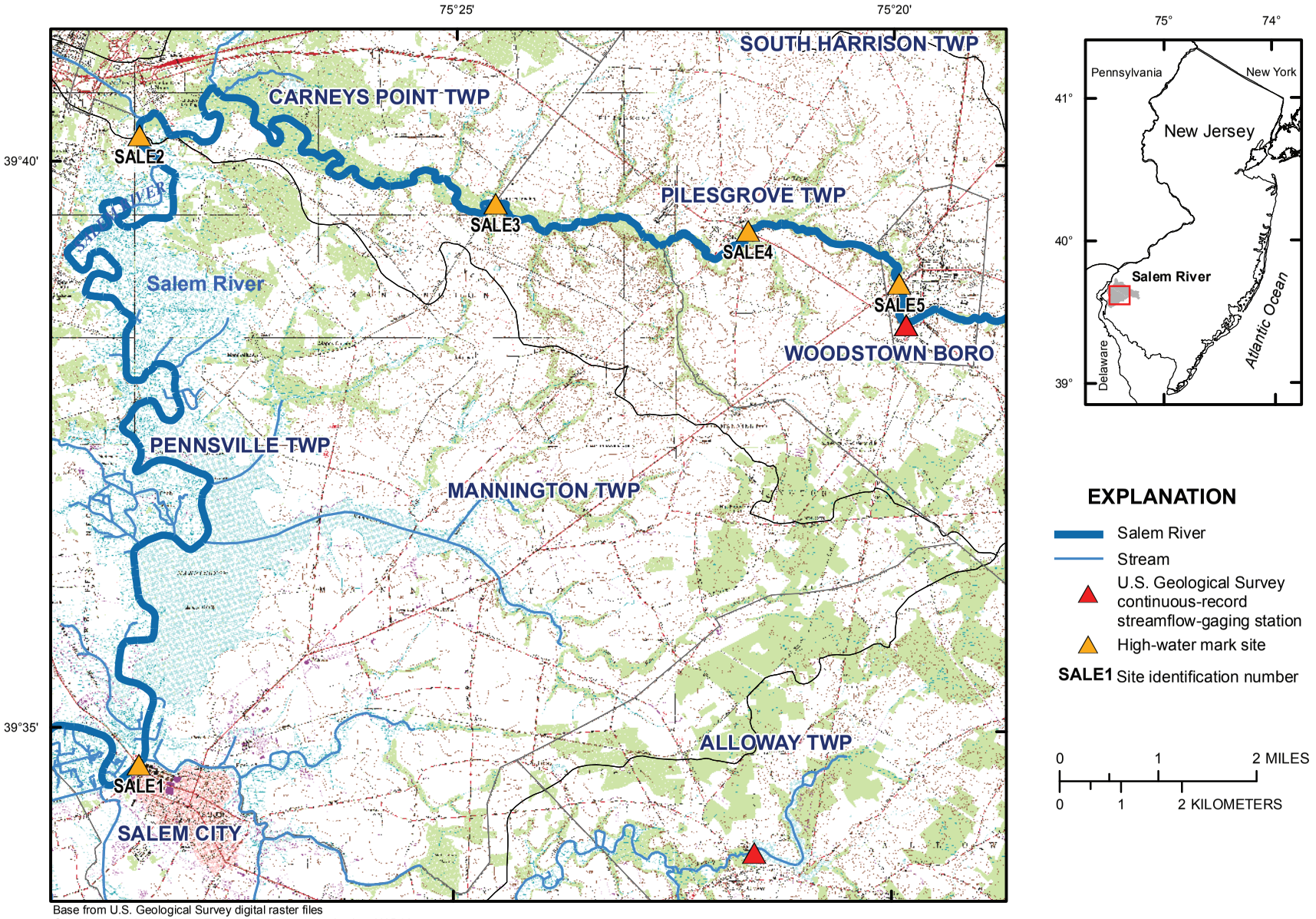
Location of Saddle River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-22 Saddle River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
124	SADD1: Saddle River at Garfield, Bergen County, NJ. Lat 040°51'50.66"N Long 074°06'05.15"W, located at the bridge on Saddle River Road.	124.1	150' USL	Excellent seed line on a garage door.	20.23	19.90	18.85
		124.3	25' USR	Fair seed line on an 8-inch diameter tree.	19.55		
		124.4	25' USR	Excellent seed line on the wall of an auto body shop.	19.94		
		124.5	20' DSR	Fair seed line on a railway piling wall.	18.77		
		124.6	20' DSR	Poor seed line on the truss of a railway piling.	18.93		
125	SADD2: Saddle River at Lodi, Bergen County, NJ. Lat 040°52'39.69"N Long 074°05'15.06"W, located at the bridge on Arnot Street.	125.1	100' USL	Excellent seed line on a steel electrical box.	29.80	30.02	28.98
		125.2	300' USL	Good seed line on the wall of a loading dock.	30.20		
		125.3	300' DSL	Excellent seed line on a trash/recycling bin.	28.63		
		125.4	310' DSL	Poor seed line on a 1.5-foot diameter tree.	28.93		
		125.5	10' DSR	Excellent seed line on an access door to electrical equipment.	29.32		
		125.6	100' DSR	Good seed line on a 6-inch diameter tree.	29.07		
		125.7	200' USR	Excellent seed line on a building.	30.17		
		125.8	100' USR	Fair seed line on an 8-inch diameter tree.	29.93		
126	SADD3: Saddle River at Rochelle Park, Bergen County, NJ. Lat 040°54'01.32"N Long 074°04'52.43"W, located at the bridge on Railroad Avenue.	126.1	20' USL	Excellent seed line on a building.	42.88	42.83	41.76
		126.2	50' USL	Fair seed line on a building.	42.86		
		126.3	50' USR	Good seed line on a 1-foot diameter tree.	42.74		
		126.5	200' DSR	Poor seed line on a 2-foot diameter tree.	41.60		
		126.6	200' DSR	Poor wash line on the ground.	41.48		
		126.7	100' DSL	Fair seed line on a 1.5-foot diameter tree.	42.19		
127	SADD4: Saddle River at Fair Lawn, Bergen County, NJ. Lat 040°55'33.81"N Long 074°05'27.69"W, located at the bridge on Route 4/208.	127.1	50' USL	Excellent seed line on a 1.2-foot diameter tree.	48.99	48.82	47.02
		127.2	40' USL	Good seed line on a 1.5-foot diameter tree.	48.65		
		127.3	450' DSL	Excellent seed line on the inside of a historic tower.	47.41		
		127.4	350' DSL	Fair seed line on a 1.5-foot diameter tree.	47.60		
		127.5	500' DSR	Poor seed line on a 3-foot diameter tree.	46.06		

Appendix 1-22 Saddle River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
128	SADD5: Saddle River at Fair Lawn, Bergen County, NJ. Lat 040°56'29.14"N Long 074°05'39.01"W, located at the bridge on Century Road.	128.1	175' USR	Poor seed line on a 1.5-foot diameter tree.	52.05	52.06	51.18
		128.2	200' USR	Poor seed line on a 1-foot diameter tree.	52.09		
		128.3	40' DSR	Good seed line on a 10-inch diameter tree.	51.15		
		128.4	40' DSR	Fair seed line on a 1-foot diameter tree.	51.19		
		128.6	50' DSL	Good seed line on a 1.5-foot diameter tree.	51.20		
		128.7	50' USL	Fair seed line on a 2.5-foot diameter tree.	52.04		
129	SADD6: Saddle River at Ridgewood, Bergen County, NJ. 040°58'21.63"N Long 074°05'32.09"W, located at the bridge on Ridgewood Avenue.	129.1	25' USL	Good seed line on a 2-foot diameter tree.	68.12	68.04	66.85
		129.2	50' USL	Fair seed line on a 2.5-foot diameter tree.	68.70		
		129.4	65' DSL	Fair seed line on a 1.5-foot diameter tree.	66.91		
		129.5	15' DSR	Fair debris line on a fence.	66.80		
		129.7	20' USR	Poor wash line on the ground.	67.98		
		129.8	20' USR	Good debris line on a fence.	67.37		
130	SADD7: Saddle River at Hohokus, Bergen County, NJ. Lat 040°59'37.89"N Long 074°05'26.87"W, located at the bridge on Bogert Road.	130.1	50' USR	Fair seed line on a 10-inch diameter tree.	93.51	93.07	92.13
		130.2	25' USR	Fair seed line on a 10-inch diameter tree.	92.79		
		130.3	20' USL	Fair seed line on a 1.2-foot diameter tree.	92.76		
		130.4	20' USL	Poor seed line on a 4-foot diameter tree.	93.23		
		130.5	50' DSL	Poor seed line on a 4-foot diameter tree.	92.05		
		130.6	100' DSR	Fair seed line on a 4-foot diameter tree.	92.18		
		130.7	150' DSR	Fair seed line on a 2-foot diameter tree.	92.15		
131	SADD8: Saddle River at Saddle River, Bergen County, NJ. Lat 041°01'54.57"N Long 074°06'00.22"W, located at the bridge on East Allendale Road.	131.1	60' DSR	Excellent seed line on a greenhouse window.	140.49	143.42	140.40
		131.2	50' DSR	Good seed line on a 2-foot diameter tree.	140.81		
		131.3	60' DSL	Fair seed line on a 1-foot diameter tree.	139.91		
		131.7	50' USR	Good seed line on a building.	144.39		
		131.8	80' USR	Good seed line on a 1.5-foot diameter tree.	143.76		
		131.9	50' USL	Fair seed line on a 10-inch diameter tree.	142.66		
		131.10	46' USL	Excellent seed line on a sheet pile wall.	142.90		
132	SADD9: Saddle River at Saddle River, Bergen County, NJ. Lat 041°04'32.15"N Long 074°05'06.70"W, located at the bridge on Brook Road.	132.1	100' USR	Fair seed line on a 2-foot diameter tree.	273.41	271.81	266.26
		132.2	50' USR	Fair seed line on an 8-inch diameter tree.	270.87		
		132.3	60' USL	Poor seed line on a 1.5-foot diameter tree.	270.02		
		132.4	100' USL	Poor wash line on the ground.	272.94		
		132.5	50' DSR	Poor wash line on the ground.	266.37		
		132.6	40' DSR	Poor seed line on a 3-foot diameter tree.	266.34		
		132.7	45' DSL	Poor seed line on a 6-inch diameter tree.	266.07		

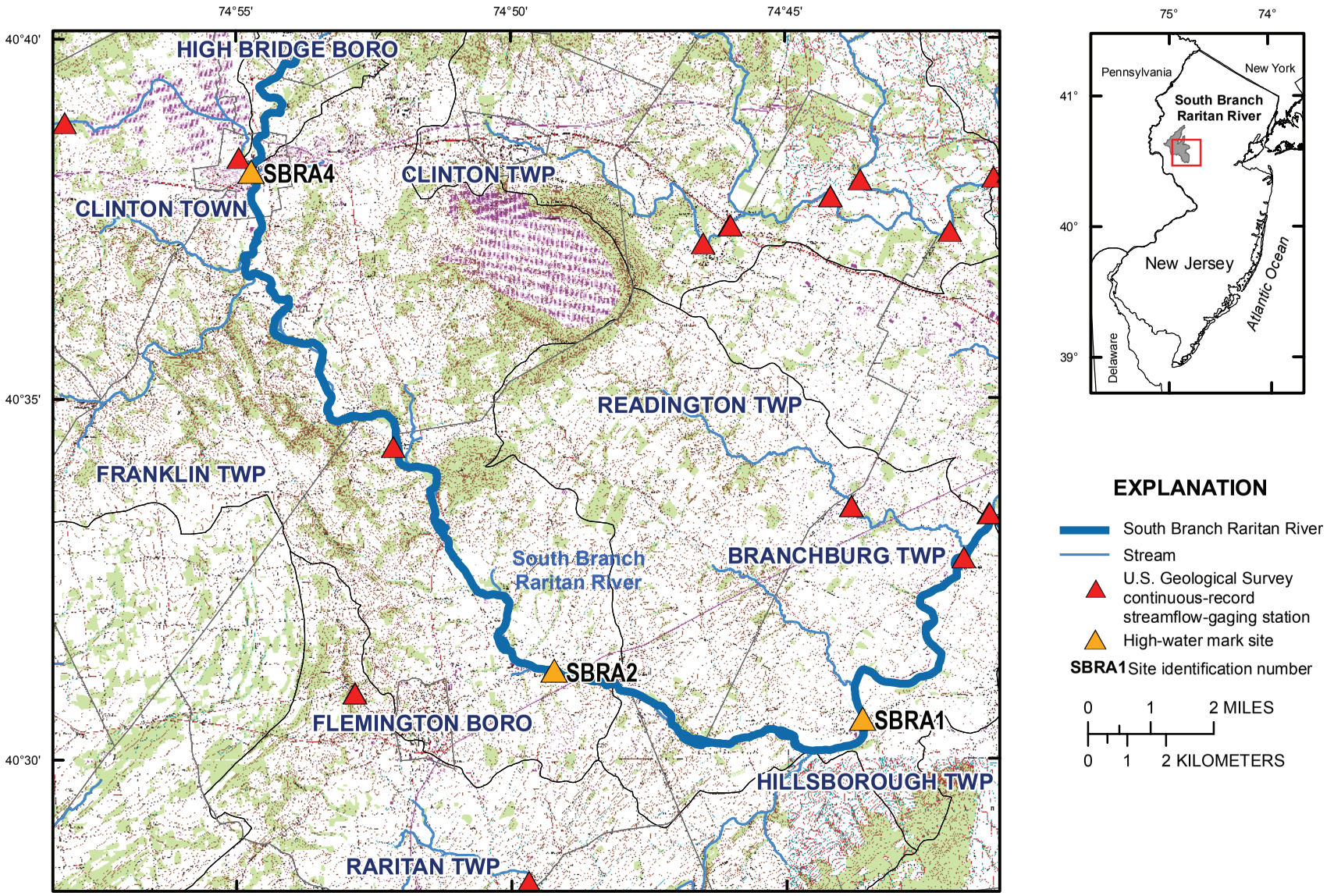


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Salem River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, southern New Jersey.

Appendix 1-23 Salem River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
133	SALE1: Salem River at Salem, Salem County, NJ. Lat 039°34'40.34"N Long 075°28'35.83"W, located at the South Broadway Bridge.	133.1	DSR	Excellent mud line on the wall of a marina building.	5.66		5.66
134	SALE2: Salem River at Glenside, Salem County, NJ. Lat 039°40'13.73"N Long 075°28'37.82"W, located at the dam near Humphreys Avenue.	134.1	20' USR	Poor seed line on a 2.5-foot diameter tree.	5.88	5.93	
		134.2	0' USR	Good mud line on the dam.	5.86		
		134.3	50' USL	Fair mud line on a grouping of trees.	6.04		
135	SALE3: Salem River at Courses River, Salem County, NJ. Lat 039°39'38.65"N Long 075°24'33.04"W, located at the bridge on Pointers Auburn Road.	135.1	20' DSR	Fair seed line on a triple-trunked tree.	9.14	9.18	9.02
		135.2	50' DSR	Unrated seed line on a multi-trunked tree.	9.05		
		135.3	80' USR	Excellent seed line on an old outhouse building.	9.40		
		135.5	420' DSL	Fair seed line on a 5-inch diameter tree.	8.86		
		135.6	120' USL	Fair seed line on a 6-inch diameter tree.	8.98		
		135.7	140' USL	Fair seed line on a 4-inch diameter tree.	9.17		
136	SALE4: Salem River at Sharptown, Salem County, NJ. Lat 039°39'24.71"N Long 075°21'39.96"W, located at the bridge on US Route 40.	136.2	150' USL	Poor seed line on a 6-inch diameter tree.	17.40	17.57	16.04
		136.3	300' DSL	Poor seed line on a 3-foot diameter tree.	15.92		
		136.4	300' DSL	Fair seed line on a 6-inch diameter tree.	16.15		
		136.7	50' USR	Fair seed line on a 1-foot diameter tree.	17.70		
		136.8	100' USR	Poor seed line on a 1-foot diameter tree.	17.60		
137	SALE5: Salem River at Woodstown, Salem County, NJ. Lat 039°38'56.94"N Long 075°19'55.86"W, located at the bridge on US Route 40.	137.1	100' USR	Good debris line on a fence.	28.27	28.56	25.52
		137.2	200' USR	Fair debris line on a fence.	28.85		
		137.3	75' DSR	Fair seed line on a 1.5-foot diameter tree.	25.60		
		137.4	200' DSL	Fair seed line on a 2-foot diameter tree.	25.44		

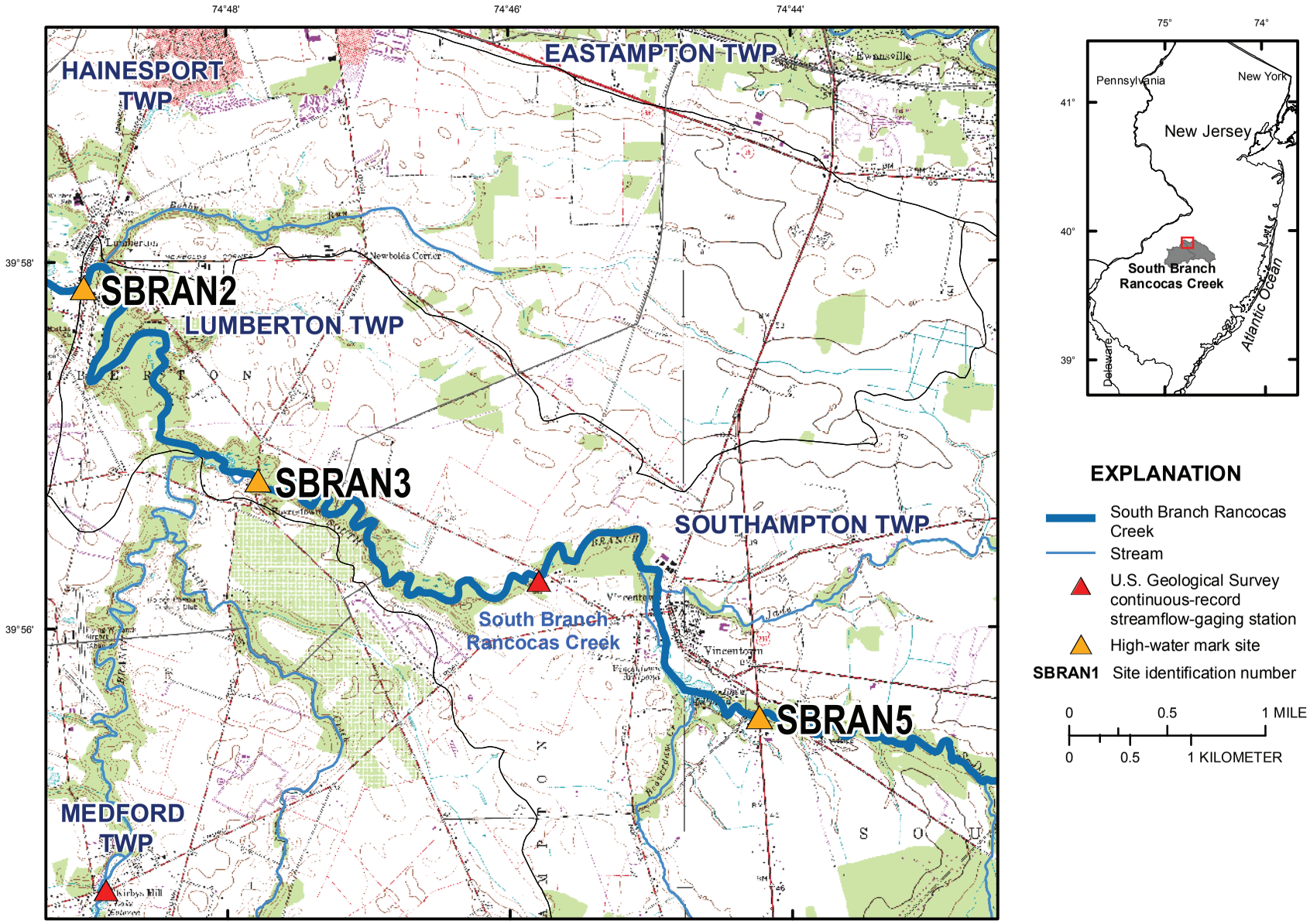


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of South Branch Raritan River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-24 South Branch Raritan River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
138	SBRA1: South Branch Raritan River at Neshanic Station, Somerset County, NJ. Lat 040°30'33.59"N Long 074°43'37.18"W, located at the bridge on Elm Street.	138.1	200' USL	Good seed line on a 3-foot diameter tree.	78.37	78.37	78.50
		138.2	200' USL	Fair seed line on a 2-foot diameter tree.	78.36		
		138.7	80' DSR	Good seed line on a 3-foot diameter tree.	78.52		
		138.8	70' DSR	Good seed line on a 2-foot diameter tree.	78.47		
139	SBRA2: South Branch Raritan River at Flemington, Hunterdon County, NJ. Lat 040°31'14.28" N Long 074°49'13.63"W, located at the bridge on Rockafellows Mill Road.	139.1	80' USL	Fair seed line on a 1-foot diameter tree.	104.29	104.50	103.77
		139.2	150' USL	Good seed line on a 10-inch diameter tree.	104.30		
		139.3	80' DSL	Fair seed line on an 8-inch diameter tree.	104.10		
		139.4	120' DSL	Good seed line on a 4-inch diameter tree.	103.56		
		139.5	70' DSR	Fair seed line on a 1-foot diameter tree.	103.86		
		139.6	40' DSR	Fair seed line on a 2.5-foot diameter tree.	103.57		
		139.7	80' USR	Fair seed line on a 2.5-foot diameter tree.	104.64		
		139.8	115' USR	Fair seed line on a 7-inch diameter tree.	104.75		
140	SBRA4: South Branch Raritan River at Clinton, Hunterdon County, NJ. Lat 040°38'09.74"N Long 074°54'43.63"W, located at the bridge on Main Street.	140.1	300' USR	Fair seed line on a 3-foot diameter tree.	195.97	195.88	189.55
		140.2	200' USR	Unrated seed line on s 3-foot diameter tree.	195.98		
		140.3	170' USL	Poor seed line on a building.	195.70		
		140.5	250' DSL	Good mark on a 1-foot diameter tree.	189.99		
		140.6	250' DSL	Good seed line on a 3-foot diameter tree.	189.72		
		140.7	250' DSR	Good seed line on a 10-inch diameter tree.	189.24		
		140.8	230' DSR	Good seed line on a 4-inch diameter tree.	189.25		

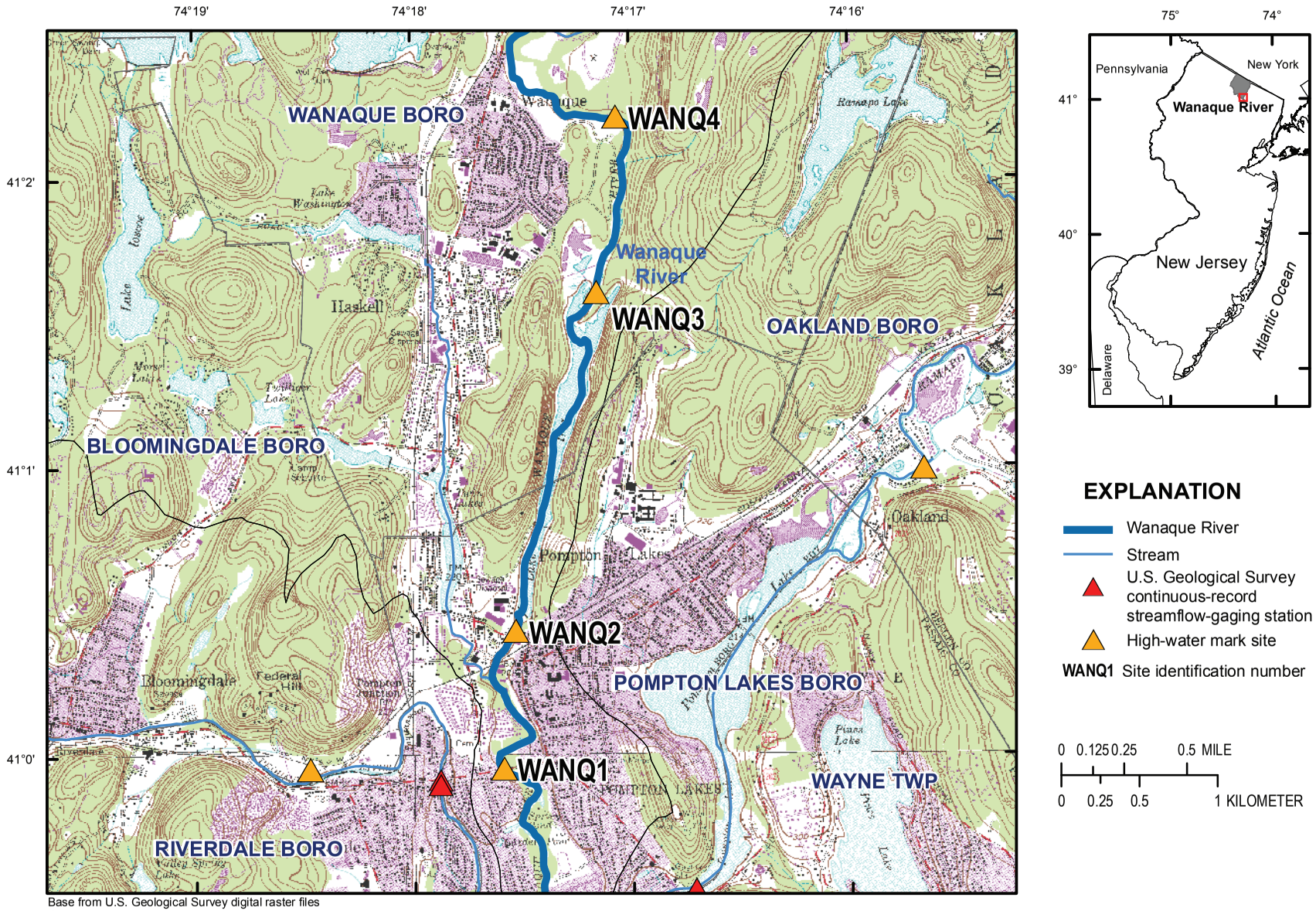


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of South Branch Rancocas Creek stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, central New Jersey.

Appendix 1-25 South Branch Rancocas Creek.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
141	SBRAN2: South Branch Rancocas Creek at Lumberton, Burlington County, NJ. Lat 039°57'40.48"N Long 074°48'26.27"W, located at the bridge on Main Street.	141.1	40' DSL	Fair seed line on a 1-foot diameter tree.	10.80	11.40	10.87
		141.2	60' DSL	Fair seed line on a 3-foot diameter tree.	10.96		
		141.3	50' DSR	Fair seed line on a 3.5-foot diameter tree.	10.85		
		141.5	140' USR	Fair seed line on a 4-foot diameter tree.	11.07		
		141.6	180' USR	Fair seed line on a 3-foot diameter tree.	11.73		
142	SBRAN3: South Branch Rancocas Creek at Eayrestown, Burlington County, NJ. Lat 039°56'49.20"N Long 074°47'26.02"W, located at the bridge on Eayrestown Road.	142.1	40' USR	Fair seed line on a 2.5-foot diameter tree.	14.33	14.99	14.36
		142.2	60' USR	Fair seed line on a 2-foot diameter tree.	14.64		
		142.3	90' USL	Fair seed line on a 2.5-foot diameter tree.	15.43		
		142.4	80' USL	Fair seed line on a 2-foot diameter tree.	15.56		
		142.5	50' DSL	Unrated seed line on a 3-foot diameter tree.	14.57		
		142.6	50' DSL	Unrated seed line on a 5-foot diameter tree.	14.33		
		142.7	90' DSR	Fair seed line on a 2-foot diameter tree.	14.31		
		142.8	110' DSR	Unrated seed line on a 4-foot diameter tree.	14.21		
143	SBRAN5: South Branch Rancocas Creek at Vincentown, Burlington County, NJ. Lat 039°55'45.66"N Long 074°44'32.75"W, located at the bridge on US Route 206.	143.1	60' USL	Fair seed line on a 1-foot diameter tree.	26.91	27.06	26.36
		143.2	65' USL	Fair seed line on a 10-inch diameter tree.	26.93		
		143.3	55' USR	Poor seed line on a 1-foot diameter tree.	27.32		
		143.4	50' DSR	Fair seed line on an 8-inch diameter tree.	26.25		
		143.5	70' DSR	Fair seed line on a 2-foot diameter tree.	26.45		
		143.6	40' DSL	Fair seed line on a 2-foot diameter tree.	26.34		
		143.7	40' DSL	Fair seed line on a 1-foot diameter tree.	26.38		

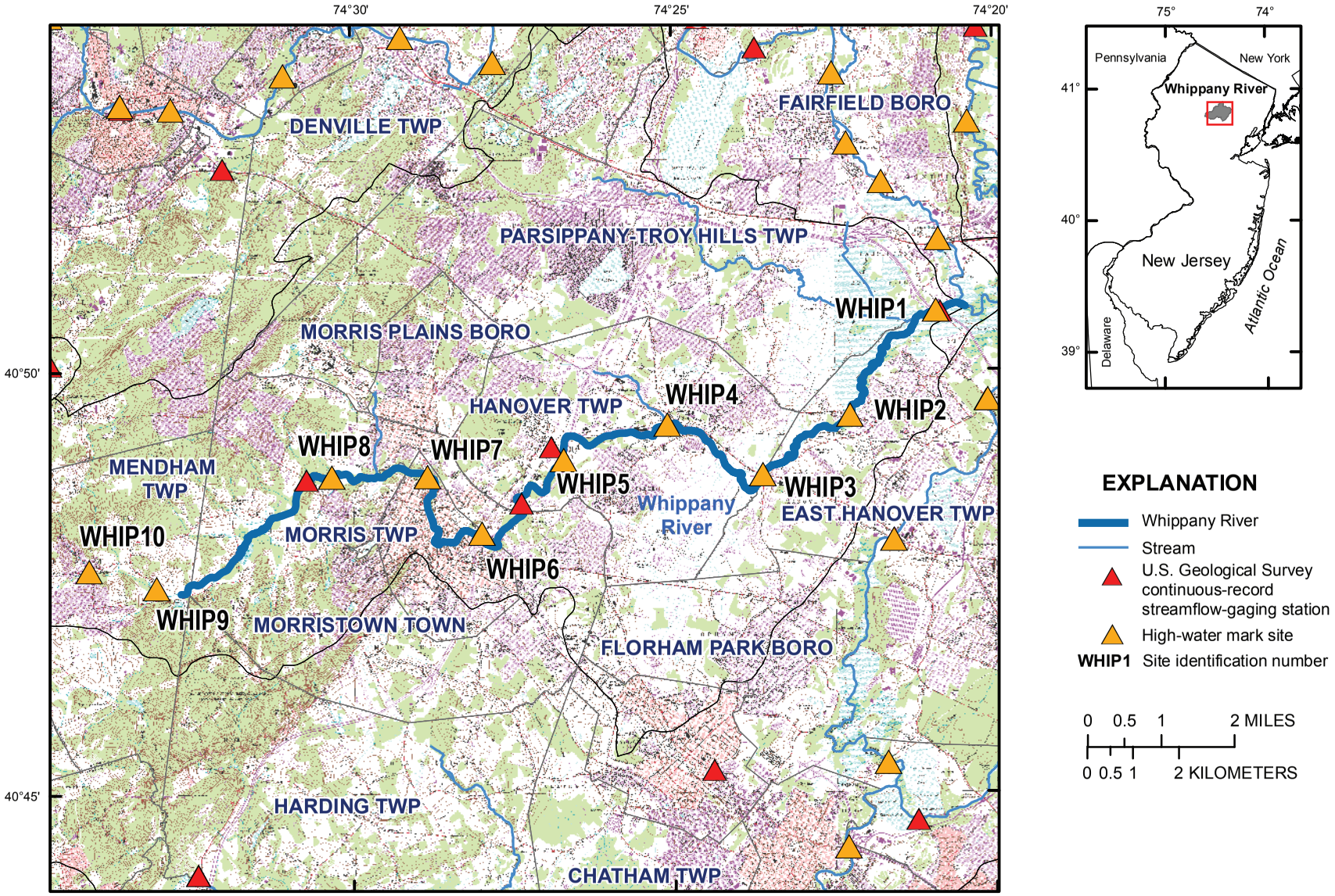


Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Wanaque River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-26 Wanaque River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
144	WANQ1: Wanaque River at Riverdale, Passaic County, NJ. Lat 040°59'57.39"N Long 074°17'35.59"W, located at the bridge on Hamburg Turnpike.	144.1	100' USL	Fair seed line on a 6-inch diameter tree.	193.24	193.60	193.07
		144.2	120' USL	Fair seed line on a 2-foot diameter tree.	193.62		
		144.3	120' DSL	Fair seed line on a 1.5-foot diameter tree.	192.90		
		144.4	100' DS	Good mark on a 1-foot diameter tree.	192.99		
		144.5	200' DSR	Fair seed line on a 1.5-foot diameter tree.	193.33		
		144.6	60' USR	Fair seed line on a 1-foot diameter tree.	193.80		
		144.7	75' US	Poor seed line on a double-trunked tree.	193.77		
145	WANQ2: Wanaque River at Pompton Lakes, Passaic County, NJ. Lat 041°00'25.99"N Long 074°17'32.17"W, located at the bridge on Wanaque Avenue.	145.1	100' DSR	Good seed line on a 3.6-inch diameter tree.	197.73	199.51	197.95
		145.2	150' DSR	Fair seed line on a 6-inch diameter tree.	198.05		
		145.3	180' DSL	Fair seed line on a 1-foot diameter tree.	197.65		
		145.4	185' DSL	Fair seed line on a 4-foot diameter tree.	198.16		
		145.5	100' USL	Excellent seed line on a 1-foot diameter tree.	199.64		
		145.6	50' USL	Excellent seed line on a 9.6-inch diameter tree.	199.47		
		145.7	100' USR	Fair seed line on a 2-foot diameter tree.	199.48		
		145.8	200' USR	Poor seed line on a multi-trunked tree.	199.43		
		145.9	DSL	Unrated mark on a triple-trunked tree.	198.14		
146	WANQ3: Wanaque River at Wanaque, Passaic County, NJ. Lat 041°01'36.40"N Long 074°17'09.42"W, located at the bridge on Interstate 287.	146.1	3' R	Poor seed line on a 6-inch diameter tree.	208.91	208.92	
		146.2	75' R	Poor seed line on the downstream side of a piling.	208.95		
		146.4	200' R	Fair mud line on the downstream corner of a piling.	208.92		
147	WANQ4: Wanaque River at Wanaque, Passaic County, NJ. Lat 041°02'12.84"N Long 074°17'03.79"W, located at the bridge on Highland Avenue.	147.1	40' R	Fair seed line on a 1-foot diameter tree.	210.16	210.06	
		147.2	10' R	Fair seed line on a multi-trunked tree.	210.17		
		147.3	30' L	Good seed line on a 4.8-inch diameter tree.	209.78		
		147.4	40' L	Good seed line on a 6-inch diameter tree.	210.13		



Base from U.S. Geological Survey digital raster files
Graphics, 1:24,000, Univeral Transverse Mercator projection, NAD83

Location of Whippany River stream reach, U.S. Geological Survey continuous-record streamflow-gaging stations, and high-water marks associated with the August 27–30, 2011, flood event, northern New Jersey.

Appendix 1-27 Whippany River.

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
148	WHIP1: Whippany River at Pine Brook, Morris County, NJ. Lat 040°50'42.15"N Long 074°20'53.69"W, located at the bridge on Interstate 280.	148.3	80' DSL	Fair seed line on a 2.5-foot diameter tree.	173.58	175.06	173.61
		148.4	85' DSL	Fair seed line on a tree.	173.49		
		148.5	150' DSR	Fair seed line on a 6-inch diameter tree.	173.81		
		148.6	100' DSR	Good seed line on a 3-foot diameter tree.	173.55		
		148.7	150' USR	Fair seed line on a 1-foot diameter tree.	175.77		
		148.8	180' USR	Poor seed line on a tree.	174.35		
149	WHIP2: Whippany River at East Hanover, Morris County, NJ. Lat 040°49'28.07"N Long 074°22'14.61"W, located at the bridge on Troy Road.	149.1	50' USL	Fair seed/mud line on a tree.	174.09	174.11	174.03
		149.2	55' USL	Fair mud line on a tree.	174.08		
		149.3	60' DSL	Fair mud line on a tree.	174.02		
		149.4	55' DSL	Fair mud line on a 6-inch diameter tree.	174.01		
		149.5	55' DSR	Fair seed line on a tree.	174.08		
		149.6	80' DSR	Poor seed line on a tree.	174.00		
		149.7	70' USR	Fair seed/mud line on a tree.	174.03		
		149.8	80' USR	Fair seed/mud line on a tree.	174.25		
150	WHIP3: Whippany River at Whippany, Morris County, NJ. Lat 040°48'45.97"N Long 074°23'36.28"W, located at the bridge on Route 10.	150.1	50' DSL	Fair mud line on a tree.	179.25	180.14	179.25
		150.2	60' DSL	Fair seed/mud line on a tree.	179.22		
		150.3	60' DSR	Fair seed line on a tree.	179.19		
		150.4	70' DSR	Fair seed/mud line on a tree.	179.34		
		150.5	100' USL	Good seed/debris line on a fence.	180.37		
		150.6	90' USL	Fair mud line on a tree.	180.19		
		150.7	120' USR	Fair seed line on a tree.	179.98		
		150.8	120' USR	Good seed line on a tree.	180.03		
151	WHIP4: Whippany River at Lower Whippany, Morris County, NJ. Lat 040°49'21.67"N Long 074°25'05.32"W, located at the bridge on Parsippany Road near Malapardis Brook.	151.1	50' USL	Fair seed line on a utility pole.	207.95	207.70	204.89
		151.2	40' USL	Good debris line on a fence.	207.57		
		151.3	125' DSL	Fair seed line on a tree.	205.47		
		151.4	150' DSL	Fair seed line on a tree.	204.85		
		151.5	120' DSR	Poor seed line on a tree.	204.79		
		151.6	140' DSR	Poor seed line on a tree.	204.45		
		151.7	60' USR	Fair seed line on a tree.	207.55		
		151.8	50' USR	Fair mark on a tree.	207.72		
152	WHIP5: Whippany River at Hanover, NJ. Lat 040°48'56.82"N Long 074°26'42.60"W, located at the bridge on Cedar Knolls Road.	152.3	50' USR	Good debris line on a chain-link fence.	256.01	256.04	255.58
		152.4	50' USR	Fair mark on a 6-inch diameter tree.	256.07		
		152.5	50' DSR	Fair debris line on a 6-inch diameter tree.	255.40		
		152.6	50' DSR	Fair debris line on a chain-link fence.	255.51		
		152.7	70' DSL	Fair seed line on a tree.	255.87		
		152.8	50' DSL	Fair seed line on a tree.	255.53		

Appendix 1-27 Whippany River.—Continued

Site number	Site identification	High-water mark number	High-water mark location relative to bridge/dam	High-water mark description	Elevation of high-water mark in feet above NAVD 88	Average of upstream high-water marks in feet above NAVD 88	Average of downstream high-water marks in feet above NAVD 88
153	WHIP6: Whippany River at Morristown, Morris County, NJ. 040°48’05.11”N Long 074°27’58.85”W, located at the bridge on Ridgedale Avenue.	153.1	70’ DSL	Fair seed line on a tree.	289.56	291.47	290.02
		153.2	90’ DSL	Poor seed line on a tree.	289.70		
		153.4	50’ DSR	Poor seed line on a tree.	290.78		
		153.5	120’ USR	Fair seed line on a tree.	291.36		
		153.6	115’ USR	Poor seed line on a tree.	291.50		
		153.7	200’ USL	Fair seed line on a tree.	291.69		
		153.8	220’ USL	Fair seed line on a tree.	291.32		
154	WHIP7: Whippany River at Morristown, Morris County, NJ. Lat 040°48’45.60”N Long 074°28’49.71”W, located at the bridge on Speedwell Avenue.	154.1	100’ USR	Fair debris line on the ground.	313.48	313.57	310.22
		154.2	80’ USR	Fair seed line on a tree.	314.09		
		154.3	110’ USL	Poor seed line on a tree.	313.45		
		154.4	100’ USL	Poor debris line on a tree.	313.28		
		154.5	80’ DSL	Poor seed line on a tree.	310.27		
		154.6	90’ DSL	Poor seed line on a tree.	309.68		
		154.7	40’ DSR	Unrated seed line on a tree.	310.92		
		154.8	50’ DSR	Fair seed line on a tree.	310.01		
155	WHIP8: Whippany River at Morristown, Morris County, NJ. Lat 040°48’45.67”N Long 074°30’19.18”W, located at the bridge on Pocono Road.	155.3	80’ USL	Poor seed line on a 1.5-foot diameter tree.	321.73	321.89	321.42
		155.4	50’ USL	Fair seed line on a 6-foot diameter tree.	322.04		
		155.5	40’ DSL	Fair seed line on a 1-foot diameter tree.	321.39		
		155.6	60’ DSL	Fair seed line on a tree.	321.52		
		155.7	120’ DSR	Fair seed line on a tree.	321.24		
		155.8	120’ DSR	Fair seed line on a 1.5-foot diameter tree.	321.51		
156	WHIP9: Whippany River at Brookside, Morris County, NJ. Lat 040°47’27.02”N Long 074°33’03.43”W, located at the bridge on Inamere Road.	156.1	50’ DSR	Fair seed line on a tree.	361.05	360.68	360.39
		156.2	40’ DSR	Fair debris line on the ground.	360.88		
		156.3	50’ DSL	Fair debris line on the ground.	359.65		
		156.4	45’ DSL	Fair debris line on the ground.	359.96		
		156.5	35’ USL	Poor debris line on the ground.	360.95		
		156.6	30’ USL	Poor seed line on a tree.	361.20		
		156.7	40’ USR	Fair seed line on a tree.	360.19		
		156.8	30’ USR	Poor seed line on a tree.	360.35		
157	WHIP10: Whippany River at Brookside, Morris County, NJ. Lat 040°47’39.38”N Long 074°34’06.39”W, located at the bridge on Cherry Lane.	157.1	50’ USL	Fair seed line on a tree.	427.64	428.31	423.03
		157.2	80’ USL	Fair debris line on a fence.	429.06		
		157.3	60’ USR	Good seed line on a tree.	428.37		
		157.4	45’ USR	Fair seed line on a tree.	428.16		
		157.5	60’ DSR	Poor mud line on the wall of a house.	422.43		
		157.7	50’ DSL	Poor seed line on a tree.	423.44		
		157.8	70’ DSL	Poor seed line on a tree.	423.23		

Appendix 2

Descriptions of high-water mark sites

Selected photographs of HWMs and post-flood stream conditions in the study area. (All photographs taken by U.S. Geological Survey field crews)

High-water mark on bank of Assunpink Creek in Trenton, Mercer County, New Jersey (ASSU1).

High-water mark on upstream right bank of the Cohansey River at Bridgeton, Cumberland County, New Jersey (COHA1).

High-water mark on upstream left bank of Crosswicks Creek at New Egypt, Ocean County, New Jersey (CROS3).

High-water marks on upstream right bank of Hackensack River at New Milford, Bergen County, New Jersey (HACK2).

High-water mark on downstream right bank of Manasquan River at West Farms, Monmouth County, New Jersey (MANA1).

High-water mark on downstream right bank of Manasquan River at Farmingdale, Monmouth County, New Jersey (MANA3).

High-water mark on upstream left bank of Maurice River at Millville, Cumberland County, New Jersey (MAUR2).

High-water mark on downstream left bank of Millstone River at Hightstown, Mercer County, New Jersey (MILL2).

High-water mark on downstream right bank of Musquapsink Brook at Westwood, Bergen County, New Jersey (MUSQ1).

High-water mark on downstream right bank of the North Branch Rancocas Creek at Mt. Holly, Burlington County, New Jersey (NBRAN1).

High-water mark on downstream right bank of Pascack Brook at Harrington Park, Bergen County, New Jersey (PASC1).

High-water mark on downstream left bank of Passaic River at Belleville, Essex County, New Jersey (PASS1).

High-water mark on upstream right bank of Peckman River at Cedar Grove, Essex County, New Jersey (PECK5).

High-water mark on upstream right bank of Pequannock River at Pompton Plains, Morris County, New Jersey (PEQU1).

High-water mark on upstream left bank of Pompton River at Fairfield, Essex County, New Jersey (POMP1).

High-water mark on downstream left bank of Raccoon Creek at Mullica Hill, Salem County, New Jersey (RACC3).

High-water mark on downstream right bank of Ramapo River at Oakland, Bergen County, New Jersey (RAMA4).

High-water mark on downstream right bank of Raritan River at New Brunswick, Middlesex County, New Jersey (RARI1).

High-water mark on downstream right bank of Rockaway River at Pine Brook, Morris County, New Jersey (ROCK1).

High-water mark on upstream right bank of Rockaway River at Denville, Morris County, New Jersey (ROCK7).

High-water mark on upstream right bank of Rocky Brook at Hightstown, Mercer County, New Jersey (ROCKY2).

High-water mark on base of the bridge located on the right bank of the Saddle River at Garfield, Bergen County, New Jersey (SADD1).

High-water mark on downstream right bank of Salem River at Salem, Salem County, New Jersey (SALE1).

High-water mark on upstream right bank of Salem River at Courses River, Salem County, New Jersey (SALE3).

High-water mark on downstream left bank of Wanaque River at Riverdale, Passaic County, New Jersey (WANA1).

High-water mark on the upstream right bank of the Whippany River at Pine Brook, Morris County, New Jersey (WHIP1).

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