

In cooperation with  
Brookhaven National Laboratory and  
U.S. Department of Energy

## **Analysis of Mid- and High-Stage Conditions for the Peconic River at the Eastern Boundary of Brookhaven National Laboratory, Suffolk County, New York**



Scientific Investigations Report 2005-5292

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

**Cover.** Photograph of the Peconic River at the eastern boundary of Brookhaven National Laboratory (BNL), Suffolk County, New York, taken during June 2003 and provided by BNL Environmental Management Directorate.

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By Christopher E. Schubert, Terrance M. Sullivan, and William H. Medeiros

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## Conversion Factors and Datums

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Flow rate	
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second (m <sup>3</sup> /s)
gallon per day (gal/d)	0.003785	cubic meter per day (m <sup>3</sup> /d)

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

# Analysis of Mid- and High-Stage Conditions for the Peconic River at the Eastern Boundary of Brookhaven National Laboratory, Suffolk County, New York

By Christopher E. Schubert<sup>1</sup>, Terrence M. Sullivan<sup>2</sup>, and William H. Medeiros<sup>3</sup>

## Abstract

Brookhaven National Laboratory (BNL) has historically discharged sewage treatment plant (STP) effluent to the Peconic River, which runs through the BNL site in Suffolk County, N.Y. This effluent discharge has averaged about 700,000 gallons per day (about 1.1 cubic feet per second [ft<sup>3</sup>/s]) since 1962 and led to contamination of streambed sediments by radioactive and hazardous constituents. Large sections of the stream channel near BNL are dry during periods of relatively low water-table altitude referred to as low-stage conditions. During mid-stage conditions, the water table intersects the streambed and base flow commences and increases as the water table rises to the tops of the streambanks. Areas adjacent to the stream become flooded during high-stage conditions as the water table rises above the streambanks. Information on the long-term (1943-2003) percentages of time that discharges at two nearby streamflow-gaging stations exceeded thresholds associated with mid- and high-stage conditions is needed to provide a range of estimates of the prevalence and seasonal variability of these conditions during the same years for streamflow-gaging station HQ on the Peconic River at the eastern boundary of BNL. Analysis and correlation of discharge data from the three streamflow-gaging stations—BNL's station HQ and the U.S. Geological Survey stations on the Peconic River at Riverhead, N.Y., and Carmans River at Yaphank, N.Y.—were performed to extend the 1995-2003 period of record for station HQ.

Low-stage conditions occur when there is no flow at station HQ and, therefore, the start-of-flow for the Peconic River is downstream of BNL property. Mid-stage conditions occur when there is flow at station HQ but its daily mean value does not exceed 4.2 ft<sup>3</sup>/s; high-stage conditions occur when this discharge exceeds 4.2 ft<sup>3</sup>/s. Daily mean streamflows at station HQ were associated with low-stage

conditions most of the time during 1995-2003 for all flow durations. Low-stage conditions predominated during January, March, and July through December of these years, whereas mid-stage conditions prevailed during parts of February and April through June. Mid-stage conditions generally appeared throughout the year during 1995-2003, except for mid-October, during which only low-stage conditions were observed. High-stage conditions were attained the least amount of time for all flow durations, and appeared only during parts of March through July and December of these years.

The percentages of time during 1943-2003 that daily mean streamflows at the Riverhead and Yaphank stations were associated with low-, mid-, and high-stage conditions provide a range of estimates of the amounts of time that these conditions occurred during these years at station HQ. Daily mean streamflows were associated with low-stage conditions most of the time during 1943-2003 for durations of 30 and 60 days; with mid-stage conditions most of the time for durations of 1, 3, and 7 days; and with either of these conditions for a duration of 14 days. High-stage conditions were attained the least amount of time during these years for all durations, except perhaps that of 1 day, for which low-stage conditions could have occurred the least amount of time. Mid-stage conditions predominated during January through early March, June through early July, and late November through December of these years. These conditions typically appeared throughout the year during 1943-2003, and occurred most often during late February. High-stage conditions also generally appeared throughout the year, except perhaps for a few days during early September of these years, and occurred most often during April. These results indicate that streamflows observed during 1943-2003 at the Riverhead and Yaphank stations—used to estimate a longer record for station HQ—were considerably higher than those observed during 1995-2003 at the three stations, and provide information that can be used in future studies to better understand the long-term capacity of streams such as the Peconic River near BNL to supply continuous flow, flood adjacent low-lying areas, and sustain aquatic habitats.

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## 2 Analysis of Mid- and High-Stage Conditions for the Peconic River at the Eastern Boundary of Brookhaven National Laboratory, Suffolk County, New York

### Introduction

Brookhaven National Laboratory (BNL), a U.S. Department of Energy (USDOE) interdisciplinary scientific research facility in operation since 1948, has historically discharged sewage-treatment-plant (STP) effluent to the Peconic River, which runs through the BNL site in Suffolk County, N.Y. (fig. 1). A report on flow conditions in the western branch of the Peconic River (Sullivan, 2003) indicates that this wastewater discharge has averaged about 700,000 gal/d (about 1.1 ft<sup>3</sup>/s) since 1962 and has led to contamination of streambed sediments by radioactive and hazardous constituents. Wastewater discharge records for the BNL STP prior to the early 1960s are not available.

During characterization of Peconic River sediments, BNL identified contaminants of concern that include mercury, polychlorinated biphenyls (PCBs), cesium-137, copper, silver, and other metals (International Technology Corporation, 1998). A series of assessments of potential ecological risks (International Technology Corporation, 1998) and potential human health risk (International Technology Corporation, 1998 and 2000, and Brookhaven National Laboratory, 2003) from exposure to Peconic River contaminants indicated that mercury and PCBs in sediment on BNL property, and mercury in sediment outside the BNL property, presented a potential human health risk through consumption of fish containing mercury and PCBs.

A Record of Decision for the cleanup of contaminated Peconic River sediment (Brookhaven National Laboratory, 2004) was approved by the U.S. Environmental Protection

Agency (USEPA) in January 2005. Sediment cleanup was initiated in March 2004 and cleanup and environmental restoration were completed in April 2005. The result of the cleanup was a reduction of contaminant concentrations to equal or less than background levels for sections of the Peconic River cleaned up between the BNL STP and the Manor Road area (fig. 2, Envirocon 2005a and 2005b).

More than 90 percent of the annual flow of the Peconic River and nearby Carmans River (fig. 2) is **base flow**<sup>1</sup> derived from ground-water discharge; only about 10 percent is from **direct runoff** (Scorca and others, 1999). The start-of-flow for a stream on Long Island generally represents the intersection of the **water table** with the stream channel, and its position can move upstream or downstream in response to the rise or fall of the water table, respectively. Start-of-flow positions observed periodically by the USGS during October 1966 to March 1997 indicate that the flowing **reach** of the Peconic River begins on or near BNL property (Scorca and others, 1999).

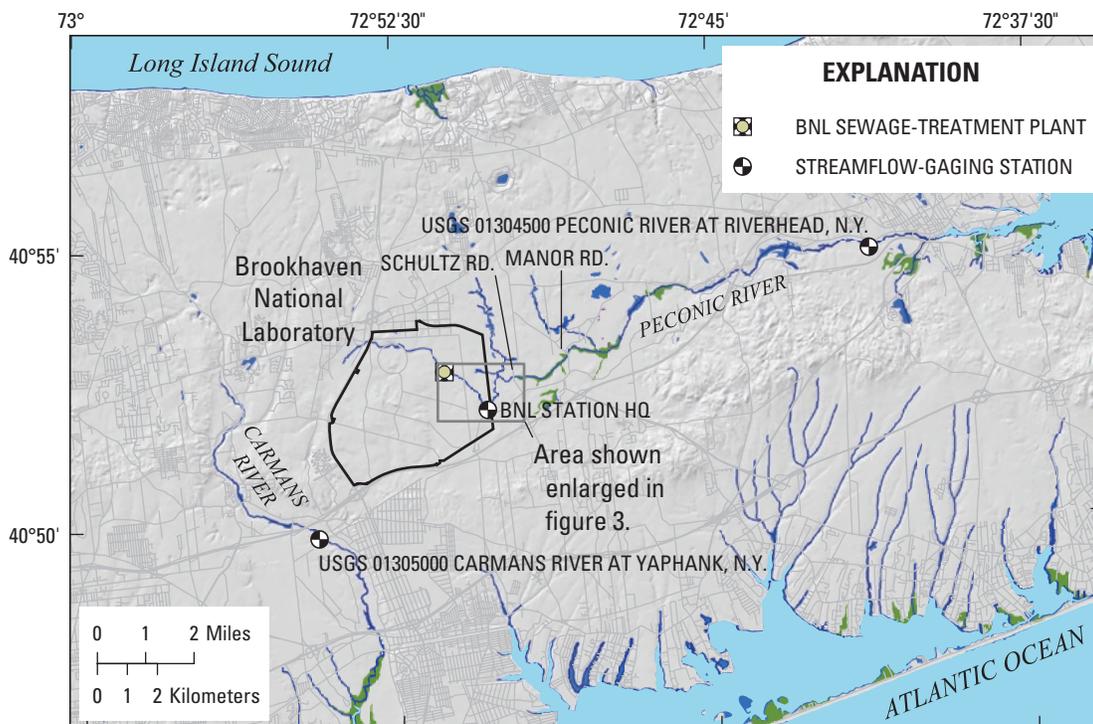
In the 3.1-mi reach of the Peconic River between the BNL STP and Schultz (Center Moriches) Road (fig. 2), the topography gently slopes and the stream channel depth is shallow, generally between 1 and 2 feet (fig. 3). During periods of relatively low water-table altitude, large sections of the stream channel are dry; these flow characteristics are referred to as low-**stage** conditions. As the water table rises above the streambed, base flow commences and increases as the water table rises to the tops of the streambanks; these flow characteristics are referred to as mid-stage conditions.

<sup>1</sup>Boldface terms are explained in the glossary.



Base from *The National Map*,  
Universal Transverse Mercator projection, NAD 27, Zone 18

**Figure 1.** Location of Brookhaven National Laboratory and study area in Suffolk County, Long Island, N.Y. (NAD 27, North American Datum of 1927)



Base from *The National Map*,  
Universal Transverse Mercator projection, NAD 27, Zone 18

**Figure 2.** Location of sewage-treatment plant at Brookhaven National Laboratory (BNL) and selected BNL and U.S. Geological Survey (USGS) streamflow-gaging stations in the study area, Suffolk County, N.Y. (NAD 27, North American Datum of 1927)

Several species of fish migrate into this reach during sustained periods of flow (Brookhaven National Laboratory, 2005). As the water table rises above the streambanks, adjacent areas become flooded; these flow characteristics are referred to as high-stage conditions. Due to gradual land-surface elevation changes, relatively large areas can become flooded. Because flooding increases fish habitat area and supplies additional food sources, the number of fish is likely to increase under flooded conditions. To evaluate the capacity of the river to supply continuous flow, flood adjacent low-lying areas, and sustain aquatic habitats, it is first necessary to characterize the prevalence and seasonal variability of mid- and high-stage conditions.

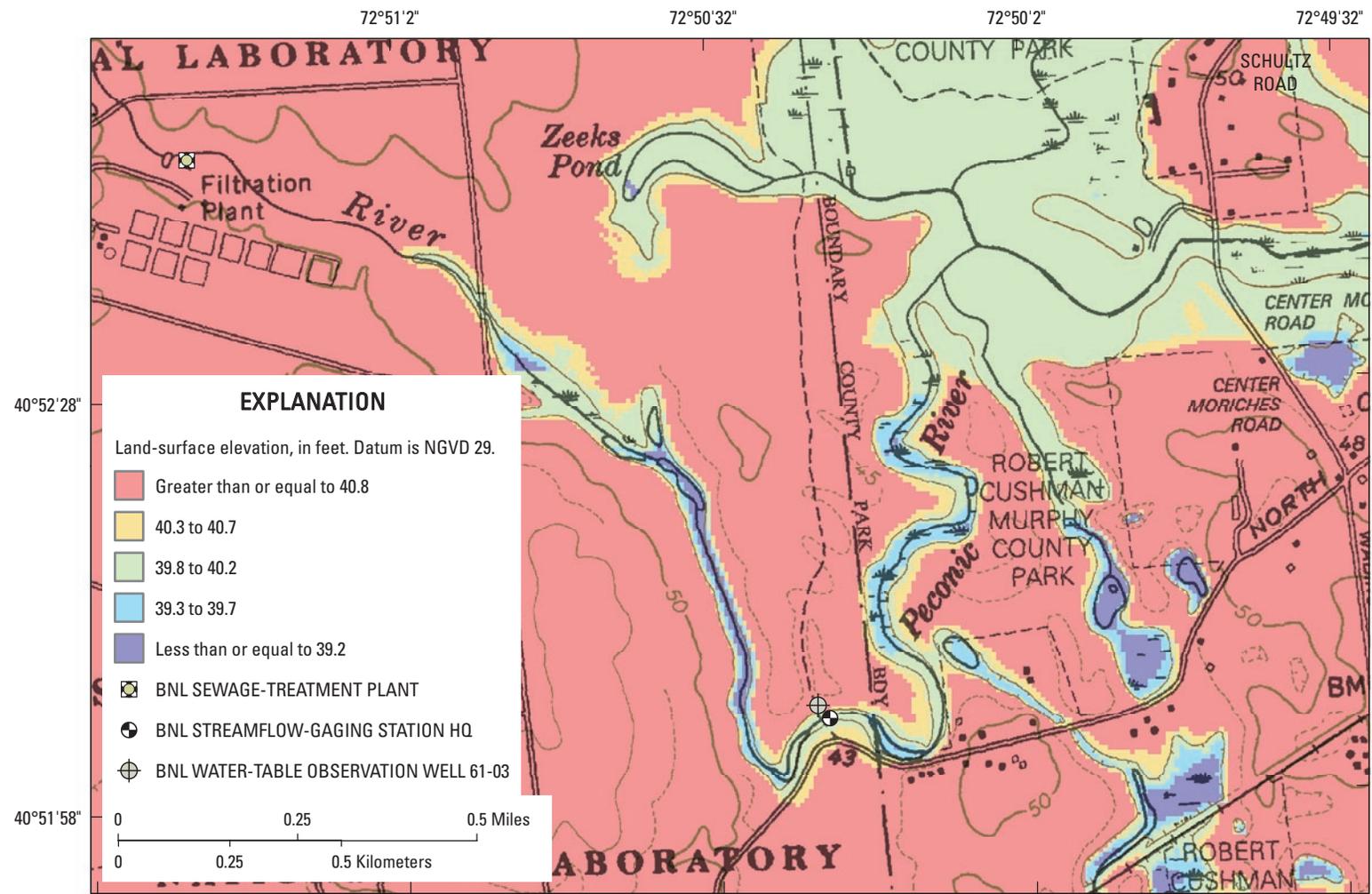
In response to the need for an improved understanding of the flow characteristics of the Peconic River near BNL, the U.S. Geological Survey (USGS) designed a 1-year study in 2005 in cooperation with BNL and USDOE to characterize the prevalence and seasonal variability of mid- and high-stage conditions for the stream at the eastern boundary of BNL. Discharge data from three **streamflow-gaging stations** (fig. 2)—BNL's Peconic River station HQ (period of record from March 1995 to present [2005]) and the USGS stations on the Peconic River at Riverhead, N.Y., and Carmans River at Yaphank, N.Y. (both with period of record from June 1942 to present)—were analyzed and correlated to estimate a longer discharge record for station HQ.

## Purpose and Scope

This report characterizes the prevalence and seasonal variability of mid- and high-stage conditions for the Peconic River at BNL streamflow-gaging station HQ at the eastern boundary of BNL. It (1) describes the study area, and (2) provides estimates of the magnitude, duration, and timing of mid- and high-stage conditions at station HQ, and of corresponding conditions at USGS streamflow-gaging stations on this stream at Riverhead and on Carmans River at Yaphank, through analysis and correlation of discharge data at the three stations.

## Methods and Approach

The flow characteristics of the Peconic River near BNL were analyzed from daily mean streamflows during calendar years 1995-2003 for the Peconic River at BNL station HQ, and during calendar years 1943-2003 at USGS stations on the Peconic River at Riverhead and Carmans River at Yaphank (station numbers 01304500 and 01305000, respectively). Daily mean streamflow values for station HQ were compiled from paper records and digitized by BNL. Daily mean streamflow values for stations on the Peconic River at Riverhead and Carmans River at Yaphank were obtained



Base from New York State Department of Transportation Wading River and Moriches planimetric (1991) and topographic (1967) quadrangles, 1:24,000, Universal Transverse Mercator projection, NAD 27, Zone 18

**Figure 3.** Location of Brookhaven National Laboratory (BNL) water-table observation well 61-03 and streamflow-gaging station HQ, and land-surface elevation near the Peconic River between the sewage-treatment plant at BNL and Schultz (Center Moriches) Road, Suffolk County, N.Y. (Land-surface-elevation data from a mosaic of U.S. Geological Survey National Elevation Dataset 7.5-minute digital elevation models. NAD 27, North American Datum of 1927. NGVD 29, National Geodetic Vertical Datum of 1929)

from the USGS National Water Information System (NWIS) database (<http://waterdata.usgs.gov/nwis>).

The thresholds of mid- and high-stage conditions at station HQ were evaluated from the observed series of daily mean streamflow at this station, from concurrent water-level measurements at nearby BNL water-table observation well 61-03 (hereafter referred to as well 61-03, fig. 3), and from land-surface elevations near the Peconic River between the BNL STP and Schultz (Center Moriches) Road (fig. 3). Daily mean streamflows that continuously exceeded discharges associated with these thresholds were evaluated for flow durations of 1, 3, 7, 14, 30, and 60 consecutive days.

The observed series of daily mean streamflow that continuously exceeded discharges associated with mid- and high-stage thresholds at station HQ for each selected flow duration during 1995-2003 were used to determine the corresponding set of thresholds for the same years at stations on the Peconic River at Riverhead and Carmans River at Yaphank. Initially, records of daily mean values at the two USGS stations were examined during the intervals of streamflow that continuously exceeded discharges associated with mid-stage conditions at station HQ. In this analysis, time lags of 1 to 10 days were applied incrementally to the series of daily mean streamflow evaluated at each USGS station until the minimum daily mean value was maximized, to account for discharge time-of-travel between station locations. The resulting highest minimum streamflows were the equivalent thresholds at each USGS station associated with mid-stage conditions at station HQ.

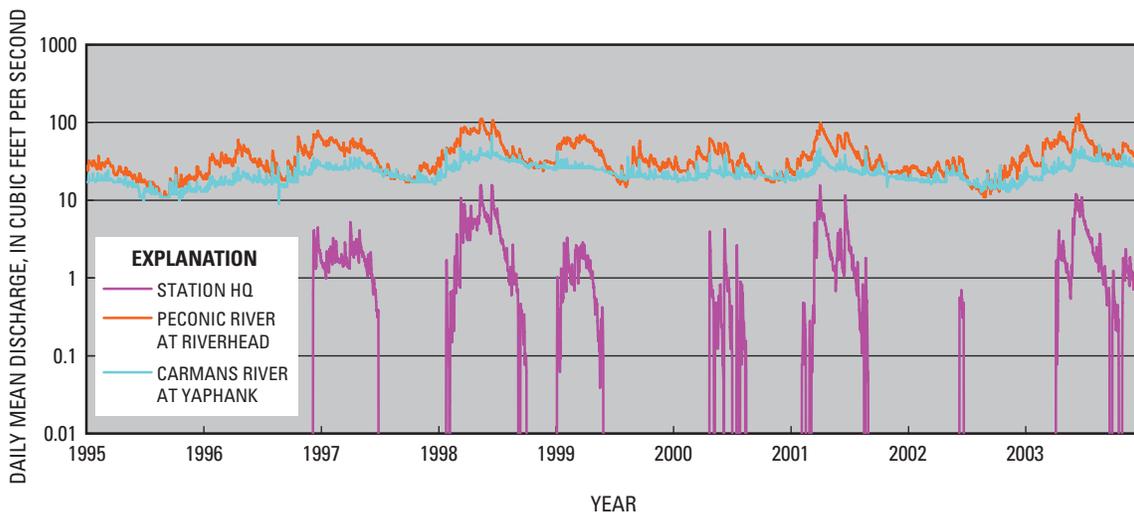
The above process was repeated for the intervals of daily mean streamflow that continuously exceeded discharges associated with high-stage conditions at station HQ to yield the equivalent threshold associated with these conditions at each USGS station. The percentage of time at the two USGS stations that daily mean values continuously

exceeded discharges associated with mid- and high-stage thresholds was then evaluated for each selected flow duration during 1943-2003. The percentages of time that daily mean discharges associated with mid- and high-stage conditions at station HQ were observed during the period of record at each USGS station provide estimates of the percentages of time that these conditions would have occurred during 1943-2003 at station HQ.

## Analysis of Mid- and High-Stage Conditions for the Peconic River at the Eastern Boundary of Brookhaven National Laboratory

The investigation of flow characteristics for the Peconic River near BNL focused on BNL’s Peconic River station HQ and included the areas adjacent to the Peconic River and Carmans River upstream of the USGS streamflow-gaging stations at Riverhead and Yaphank, respectively (fig. 2). Discharge data from the three stations were analyzed and correlated to characterize the prevalence and seasonal variability of mid- and high-stage conditions for the Peconic River at station HQ. These conditions, and those associated with low stage at station HQ, were broadly defined in this report according to how physical features (such as the supply of continuous flow, and flooding of adjacent low-lying areas) and ecological resources (such as the availability of aquatic habitat) are affected.

*Low-stage conditions.* Low-stage conditions are similar to those observed on the Peconic River at station HQ during most of 2002 (fig. 4). During these conditions, large sections



**Figure 4.** Daily mean discharges for selected streamflow-gaging stations in the study area, calendar years 1995-2003, Suffolk County, N.Y. (Streamflow-gaging station locations are shown in fig. 2.)

## 6 Analysis of Mid- and High-Stage Conditions for the Peconic River at the Eastern Boundary of Brookhaven National Laboratory, Suffolk County, New York

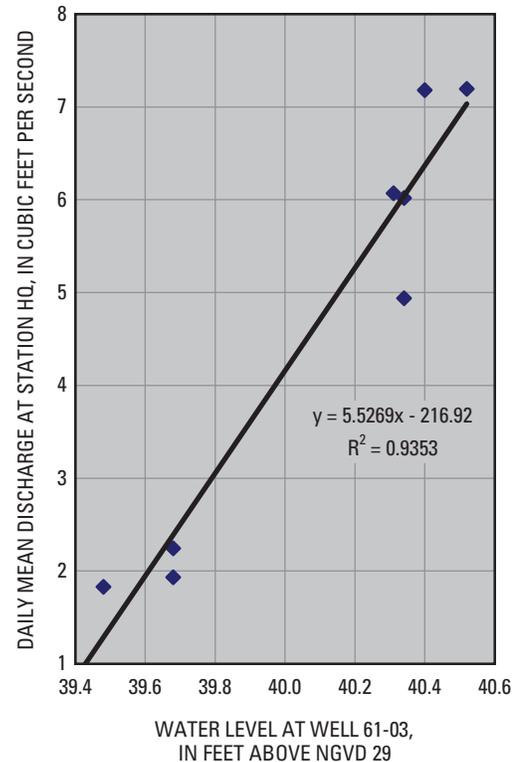
of the stream channel upstream of station HQ are dry. In this report, low-stage conditions are defined as occurring when there is no flow at station HQ and, therefore, the start-of-flow for the Peconic River is downstream of BNL property. Under these conditions, fish are unable to pass the **Parshall flume** at station HQ to reach potential upstream habitat and spawning areas on BNL property or to retreat from drying conditions in upstream reaches of the river.

**High-stage conditions.** During high-stage conditions, the stream channel of the Peconic River near BNL is full and water has started to flood adjacent marshes and other low-lying areas and expand the habitat for fish. Streambank elevations along most of the reach of the Peconic River between the BNL STP and Schultz (Center Moriches) Road are about 40 feet above NGVD 29 (fig. 3). To determine the discharge associated with **bankfull stage**, water-table altitudes at well 61-03 and concurrent daily mean streamflows at station HQ were plotted and the resulting relation was assessed for values near the transition to high-stage conditions (fig. 5). On the basis of this relation, the discharge at station HQ associated with a water-table altitude of 40 ft (bankfull stage) is 4.2 ft<sup>3</sup>/s; the standard error of the regression is 0.64 ft<sup>3</sup>/s (plus or minus 15 percent). Accordingly, high-stage conditions are hereafter defined as occurring when the daily mean streamflow at station HQ exceeds 4.2 ft<sup>3</sup>/s. Under these conditions, fish should have unrestricted passage through the Parshall flume at station HQ and access to most Peconic River wetlands near BNL.

**Mid-stage conditions.** During mid-stage conditions, there is flow at station HQ but it is contained within the banks of the Peconic River. Thus, mid-stage conditions are defined as occurring when there is flow at station HQ but it does not exceed 4.2 ft<sup>3</sup>/s. Under these conditions, fish should be able to migrate past the Parshall flume at station HQ unimpeded, but would be generally restricted in their access to Peconic River wetlands near BNL.

### Mid- and High-Stage Conditions for the Peconic River at Station HQ during 1995-2003

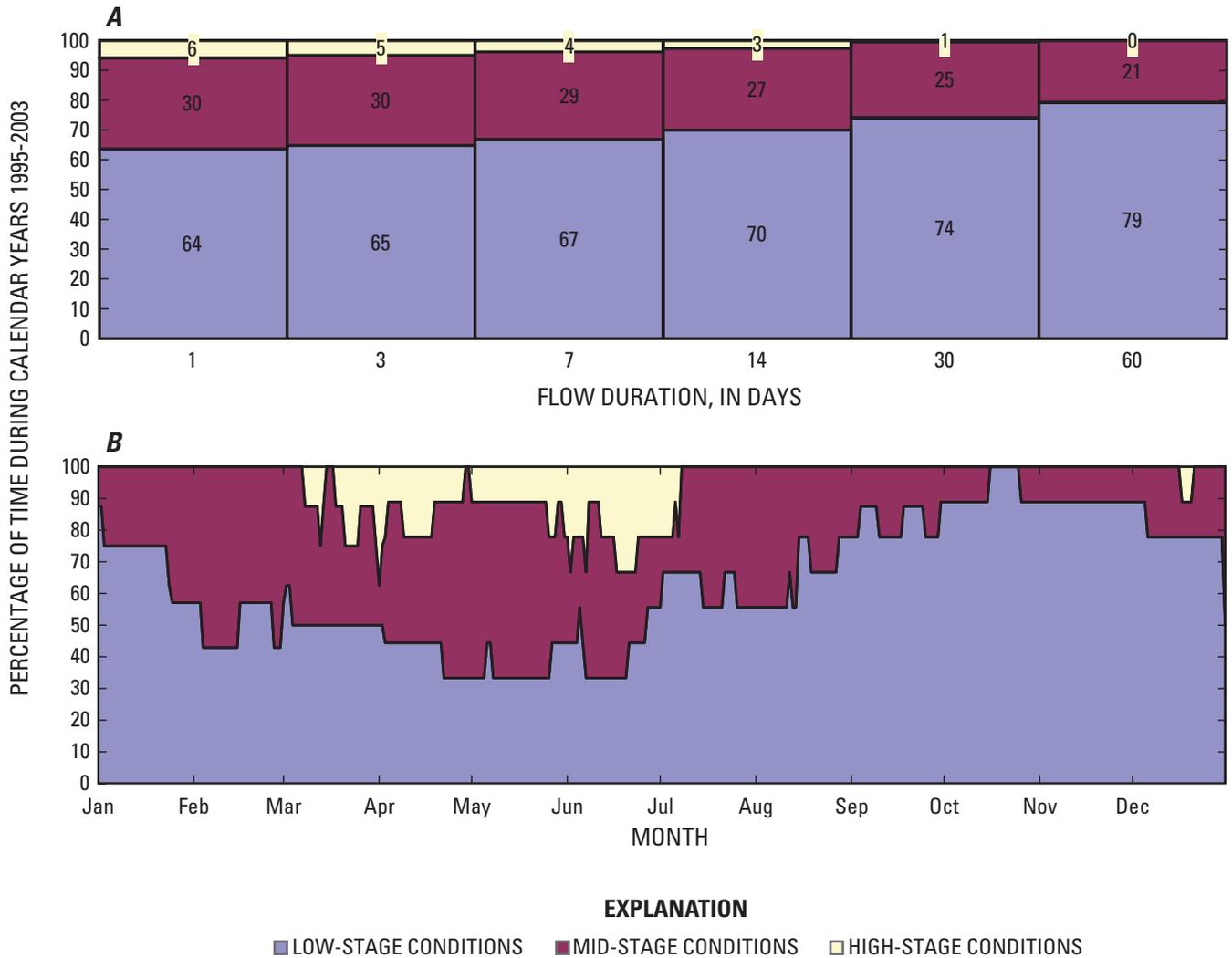
The percentage of time that daily mean streamflows of the Peconic River at station HQ were associated with low-, mid-, and high-stage conditions for flow durations of 1, 3, 7, 14, 30, and 60 consecutive days during calendar years 1995-2003 is shown in figure 6A. Daily mean streamflows at station HQ were primarily associated with low-stage conditions during these years for all flow durations. The amount of time that low-stage conditions occurred lengthened with increasing flow duration, and ranged from 64 to 79 percent for durations of 1 and 60 days, respectively. The amount of time that daily mean streamflows at station HQ were associated with mid-stage conditions generally shortened with increasing flow duration, and ranged from 21 to 30 percent for durations of 60 and 1 days, respectively. High-stage conditions were attained the least amount of time during 1995-2003 for all



**Figure 5.** Relation between selected water-table altitudes in well 61-03 and daily mean streamflows at station HQ with best-fit line, regression equation, and correlation coefficient ( $R^2$ ) value, calendar years 1995-2003, Suffolk County, N.Y. (Water-table observation-well and streamflow-gaging station locations are shown in fig. 3. NGVD 29, National Geodetic Vertical Datum of 1929)

flow durations. The amount of time that high-stage conditions occurred shortened with increasing flow duration, and ranged from 0 to 6 percent for durations of 60 and 1 days, respectively.

The percentage of time that daily mean streamflows of the Peconic River at station HQ were associated with low-, mid-, and high-stage conditions by Julian day (for a duration of 1 day) during calendar years 1995-2003 is shown in figure 6B. The graph indicates that low-stage conditions predominated during January, March, and July through December, whereas mid-stage conditions prevailed during parts of February and April through June. Mid-stage conditions generally appeared throughout the year during 1995-2003, except for mid-October, during which only low-stage conditions were observed. The maximum amount of time that mid-stage conditions occurred was 67 percent, which was reached during late April. High-stage conditions appeared only during parts of March through July and December of these years, and the maximum amount of time that high stage occurred was 38 percent in early April.



**Figure 6.** Percentage of time that daily mean streamflows of the Peconic River at station HQ were associated with low-, mid-, and high-stage conditions, calendar years 1995-2003, Suffolk County, N.Y. *A*, Percentage of time for selected flow durations. *B*, Percentage of time by Julian day. (Numbers inside shaded bars are percentages. Streamflow-gaging station location is shown in fig. 2.)

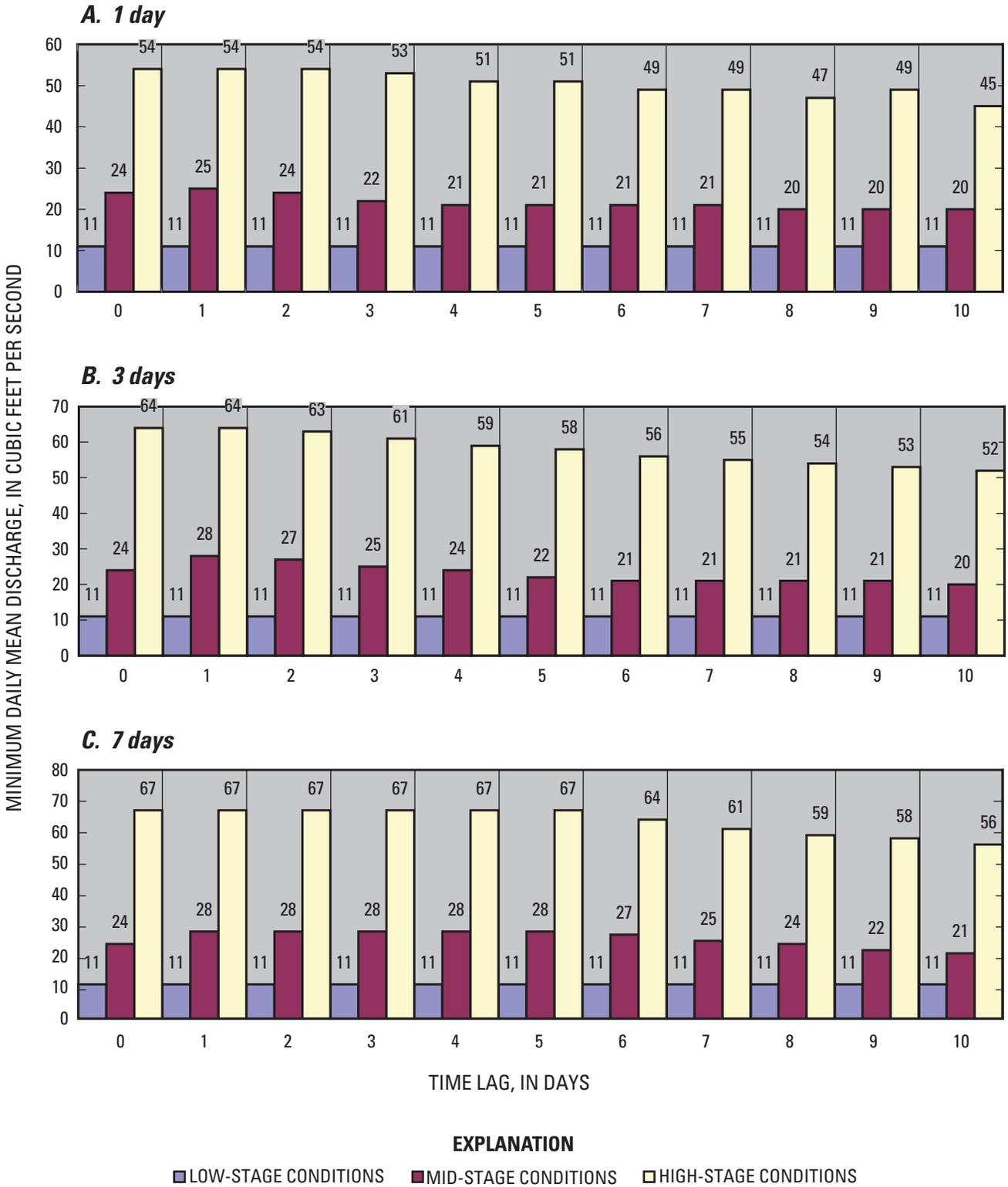
### Equivalent Thresholds for Mid- and High-Stage Conditions during 1995-2003

#### Peconic River at Riverhead, N.Y

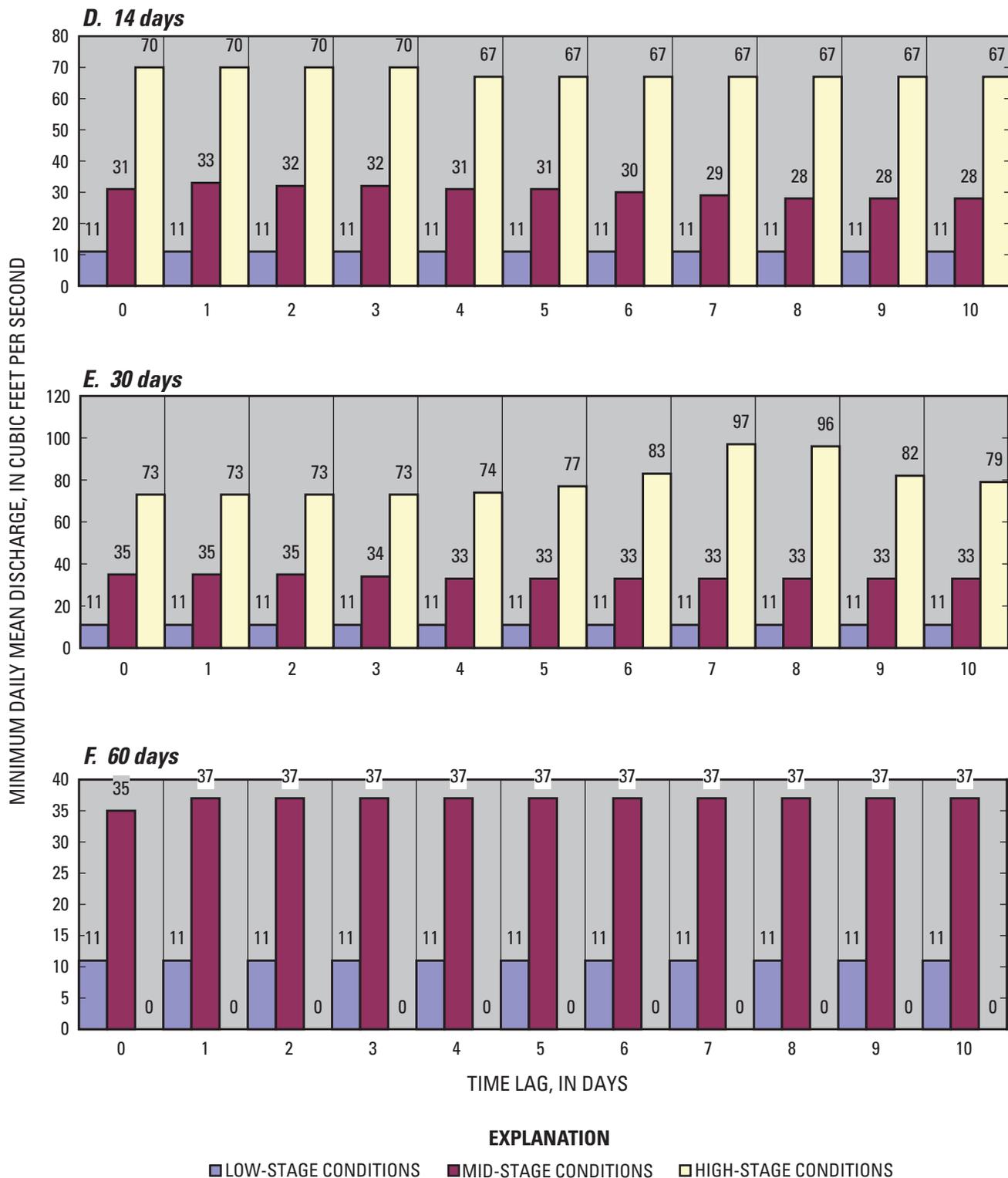
The highest minimum daily mean streamflows of the Peconic River at Riverhead that were associated with low-, mid-, and high-stage conditions at station HQ for flow durations of 1, 3, 7, 14, 30, and 60 consecutive days during calendar years 1995-2003 (fig. 7A-F) were the equivalent thresholds for these conditions at the Riverhead station. Highest minimum streamflows at the Riverhead station

associated with mid-stage conditions at station HQ ranged from 25 to 37 ft<sup>3</sup>/s for durations of 1 and 60 days, respectively. These values generally appeared at the Riverhead station 1 day after mid-stage conditions arrived at station HQ for all flow durations, except that of 30 days, for which there was no change in daily mean discharge at the Riverhead station through the first 2 days (fig. 7E). Highest minimum streamflows at the Riverhead station associated with high-stage conditions at station HQ ranged from 54 to 97 ft<sup>3</sup>/s for durations of 1 and 30 days, respectively; because high-stage conditions at station HQ were not sustained for 60 days, there was no equivalent threshold for this duration at the Riverhead station. As shown in figure 7A-E, these values were observed at the Riverhead station 1 to 5 days after high-stage

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**Figure 7.** Minimum daily mean streamflows of the Peconic River at Riverhead (unlagged and lagged) associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations, calendar years 1995-2003, Suffolk County, N.Y. A, 1 day. B, 3 days. C, 7 days. D, 14 days. E, 30 days. F, 60 days. (Numbers above shaded bars are discharges. Streamflow-gaging station locations are shown in fig. 2.)



**Figure 7.** (Continued) Minimum daily mean streamflows of the Peconic River at Riverhead (unlagged and lagged) associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations, calendar years 1995-2003, Suffolk County, N.Y. A, 1 day. B, 3 days. C, 7 days. D, 14 days. E, 30 days. F, 60 days. (Numbers above shaded bars are discharges. Streamflow-gaging station locations are shown in fig. 2.)

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conditions arrived at station HQ for most flow durations during which high stage was sustained. The exception is a duration of 30 days, for which the highest minimum discharge was reached at the Riverhead station 7 days after high-stage conditions arrived at station HQ (fig. 7E). These results generally are consistent with observed delays in the downstream arrival of **peak flows** at the Riverhead station following heavy precipitation (A.G. Spinello, U.S. Geological Survey, oral commun., 2005). The delays are attributed partly to the reported **regulation** of flow by ponds upstream of this station (Spinello and others, 2005), and partly to the delayed response of base flow derived from ground-water discharge, which can be moderated and damped through time by concomitant changes in ground-water **storage** (Schubert, 1998). The minimum daily mean streamflow at the Riverhead station associated with low-stage conditions at station HQ was 11 ft<sup>3</sup>/s for all flow durations. There was no change in this value up to 10 days after these conditions arrived at station HQ (fig. 7A-F).

### Carmans River at Yaphank, N.Y.

The highest minimum daily mean streamflows of Carmans River at Yaphank that were associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations during calendar years 1995-2003 (fig. 8A-F) were the equivalent thresholds for these conditions at the Yaphank station. Highest minimum streamflows at the Yaphank station associated with mid-stage conditions at station HQ ranged from 18 to 24 ft<sup>3</sup>/s for durations of 1 and 60 days, respectively. These values appeared at the Yaphank station up to 4 days after mid-stage conditions arrived at station HQ for most flow durations. The exceptions included durations of 30 and 60 days, for which the highest minimum discharge at the Yaphank station was observed 8 days after mid-stage conditions arrived at station HQ (fig. 8E and F). Highest minimum streamflows at the Yaphank station associated with high-stage conditions at station HQ ranged from 26 to 36 ft<sup>3</sup>/s for durations of 1 and 30 days, respectively; because high-stage conditions at station HQ were not sustained for 60 days, there was no equivalent threshold for this duration at the Yaphank station. These values were reached at the Yaphank station up to 2 days after high-stage conditions arrived at station HQ for most flow durations during which high stage was sustained (fig. 8A-E). Exceptions included durations of 14 and 30 days, for which the highest minimum discharge at the Yaphank station appeared between 4 and 9 days after high-stage conditions arrived at station HQ (fig. 8D and E). These findings generally are consistent with observed delays in the arrival of peak flows at the Yaphank station following heavy precipitation (A.G. Spinello, U.S. Geological Survey, oral commun., 2005). The delays may be attributed partly to the reported regulation of some flow by two lakes upstream of this station (Spinello and others, 2005), but probably result from the delayed response of base flow derived from ground-water discharge. The minimum daily mean streamflow at the Yaphank station associated

with low-stage conditions at station HQ was 9 ft<sup>3</sup>/s for all flow durations, and remained unchanged up to 10 days after low-stage conditions arrived at station HQ (fig. 8A-F).

## Mid- and High-Stage Conditions during 1943-2003

### Peconic River at Riverhead, N.Y.

The percentage of time during calendar years 1943-2003 that daily mean streamflows of the Peconic River at Riverhead were associated with low-, mid-, and high-stage conditions at station HQ for flow durations of 1, 3, 7, 14, 30, and 60 consecutive days is shown in figure 9A. During these years, daily mean streamflows at the Riverhead station were primarily associated with low-stage conditions at station HQ for durations of 14, 30, and 60 days, and with mid-stage conditions at station HQ for 1, 3, and 7 days. The amount of time that low-stage conditions occurred generally lengthened with increasing flow duration, and ranged from 31 to 61 percent for durations of 1 and 60 days, respectively. The amount of time that daily mean streamflows at the Riverhead station were associated with mid-stage conditions at station HQ generally shortened with increasing flow duration, and ranged from 39 percent for 60 days to 53 percent for durations of 1 and 7 days. Daily mean streamflows at the Riverhead station that were associated with high-stage conditions at station HQ were attained the least amount of time during 1943-2003 for all flow durations. The amount of time that high-stage conditions occurred shortened with increasing flow duration, and ranged from 0 to 16 percent for durations of 60 and 1 days, respectively.

The percentage of time by Julian day (for a duration of 1 day) during calendar years 1943-2003 that daily mean streamflows of the Peconic River at Riverhead were associated with low-, mid-, and high-stage conditions at station HQ is shown in figure 9B. The graph indicates that low-stage conditions predominated during mid-July through early November, whereas mid-stage conditions prevailed during January through early July and late November through December. Mid-stage conditions typically appeared throughout the year during 1943-2003, and the amount of time that these conditions occurred ranged from 30 percent in mid-September to 74 percent in late February. High-stage conditions generally appeared throughout the year, except for a few days during early September of these years, and the maximum amount of time that high stage occurred was 48 percent in early April.

### Carmans River at Yaphank, N.Y.

The percentage of time during calendar years 1943-2003 that daily mean streamflows of Carmans River at Yaphank

were associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations is shown in figure 10A. During these years, daily mean streamflows at the Yaphank station were associated with low-stage conditions at station HQ most of the time for durations of 30 and 60 days, and with mid-stage conditions at station HQ most of the time for 1, 3, 7, and 14 days. The amount of time that low-stage conditions occurred generally lengthened with increasing flow duration, and ranged from 24 to 59 percent for durations of 1 and 60 days, respectively. The amount of time that daily mean streamflows at the Yaphank station were associated with mid-stage conditions at station HQ varied little with increasing flow duration, and ranged from 40 percent for 30 days to 45 percent for durations of 7 and 14 days. Daily mean streamflows at the Yaphank station associated with high-stage conditions at station HQ generally were reached the least amount of time during 1943-2003 for all flow durations, except that of 1 day, for which low-stage conditions at station HQ occurred the least amount of time (24 percent). The amount of time that high-stage conditions occurred shortened with increasing flow duration, and ranged from 0 to 32 percent for durations of 60 and 1 days, respectively.

The percentage of time by Julian day (for a duration of 1 day) during calendar years 1943-2003 that daily mean streamflows of Carmans River at Yaphank were associated with low-, mid-, and high-stage conditions at station HQ is shown in figure 10B. The graph indicates that mid-stage conditions predominated during January through early March and June through December, whereas high-stage conditions prevailed during mid-March through early May. Mid-stage conditions typically appeared throughout the year during 1943-2003, and the amount of time that these conditions occurred ranged from 31 percent in late March and late April to 61 percent in late February. High-stage conditions also appeared throughout the year, and the amount of time that high stage occurred ranged from 15 percent in early October to 56 percent during late April of these years.

## Summary and Conclusions

Brookhaven National Laboratory (BNL) has historically discharged sewage-treatment-plant (STP) effluent to the Peconic River, which runs through the BNL site in Suffolk County, N.Y. This wastewater discharge has averaged about 700,000 gal/d (about 1.1 ft<sup>3</sup>/s) since 1962 and led to contamination of streambed sediments by radioactive and hazardous constituents. A series of assessments of potential ecological risks and potential human health risk from exposure to Peconic River contaminants indicated that mercury and polychlorinated biphenyls (PCBs) in sediment on BNL property and mercury in sediment outside the BNL property presented a potential human health risk through consumption of fish containing mercury and PCBs. A Record of Decision for the cleanup of contaminated Peconic River sediment

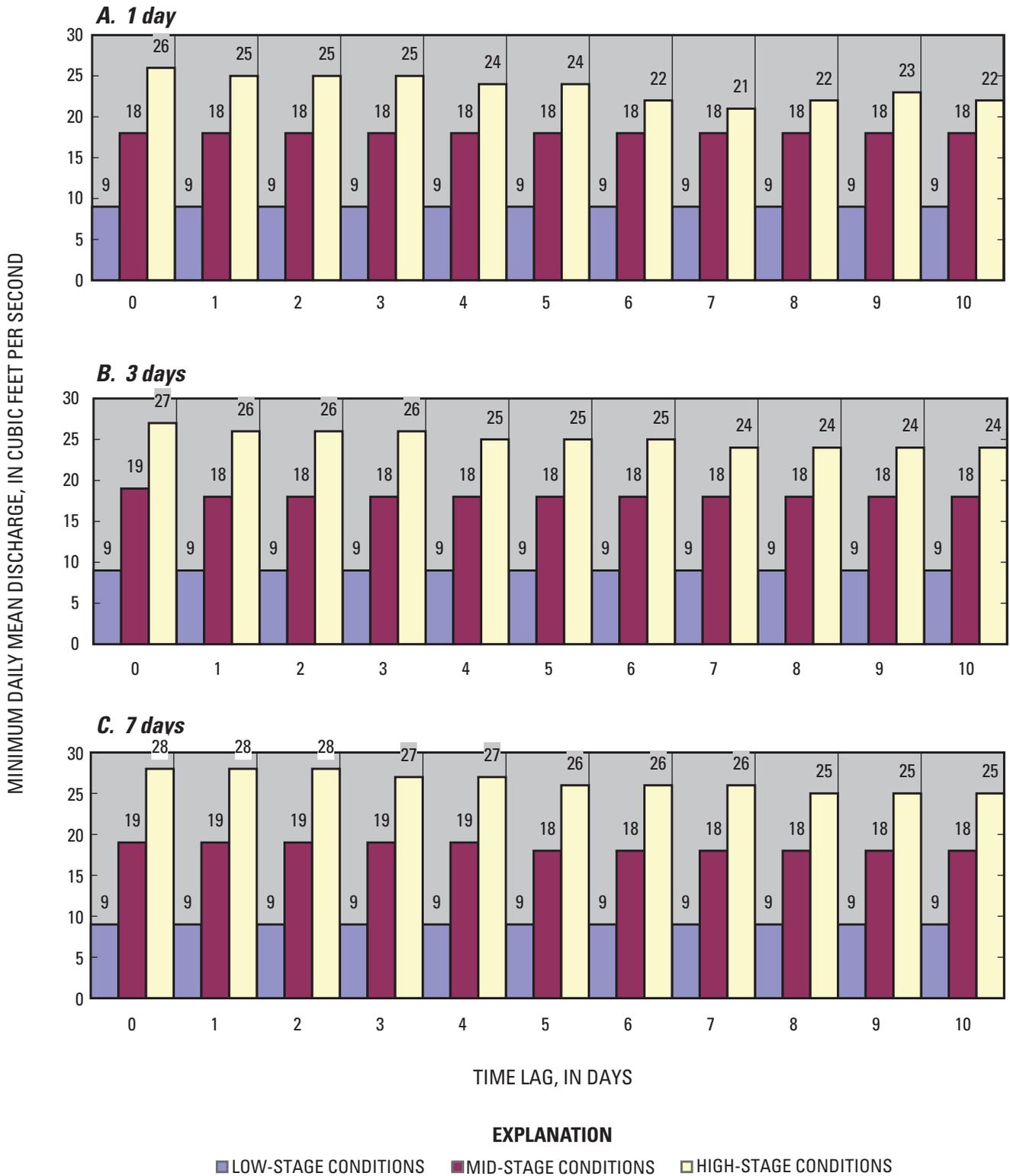
was approved by the U.S. Environmental Protection Agency (USEPA) in January 2005.

Large sections of the stream channel near BNL are dry during periods of relatively low water-table altitude, referred to as low-stage conditions. During mid-stage conditions, the water table intersects the streambed and base flow commences and increases as the water table rises to the tops of the streambanks. Several species of fish migrate into this reach during sustained periods of flow. Areas adjacent to stream channels become flooded during high-stage conditions as the water table rises above the streambanks. Due to gradual elevation changes, large areas flood, which then expands fish habitat area and supplies additional food sources that likely increase the number of fish. To better understand the flow characteristics of the Peconic River near BNL, the U.S. Geological Survey (USGS) designed a study in 2005 in cooperation with BNL and the U.S. Department of Energy to characterize the prevalence and seasonal variability of mid- and high-stage conditions for the Peconic River at the eastern boundary of BNL.

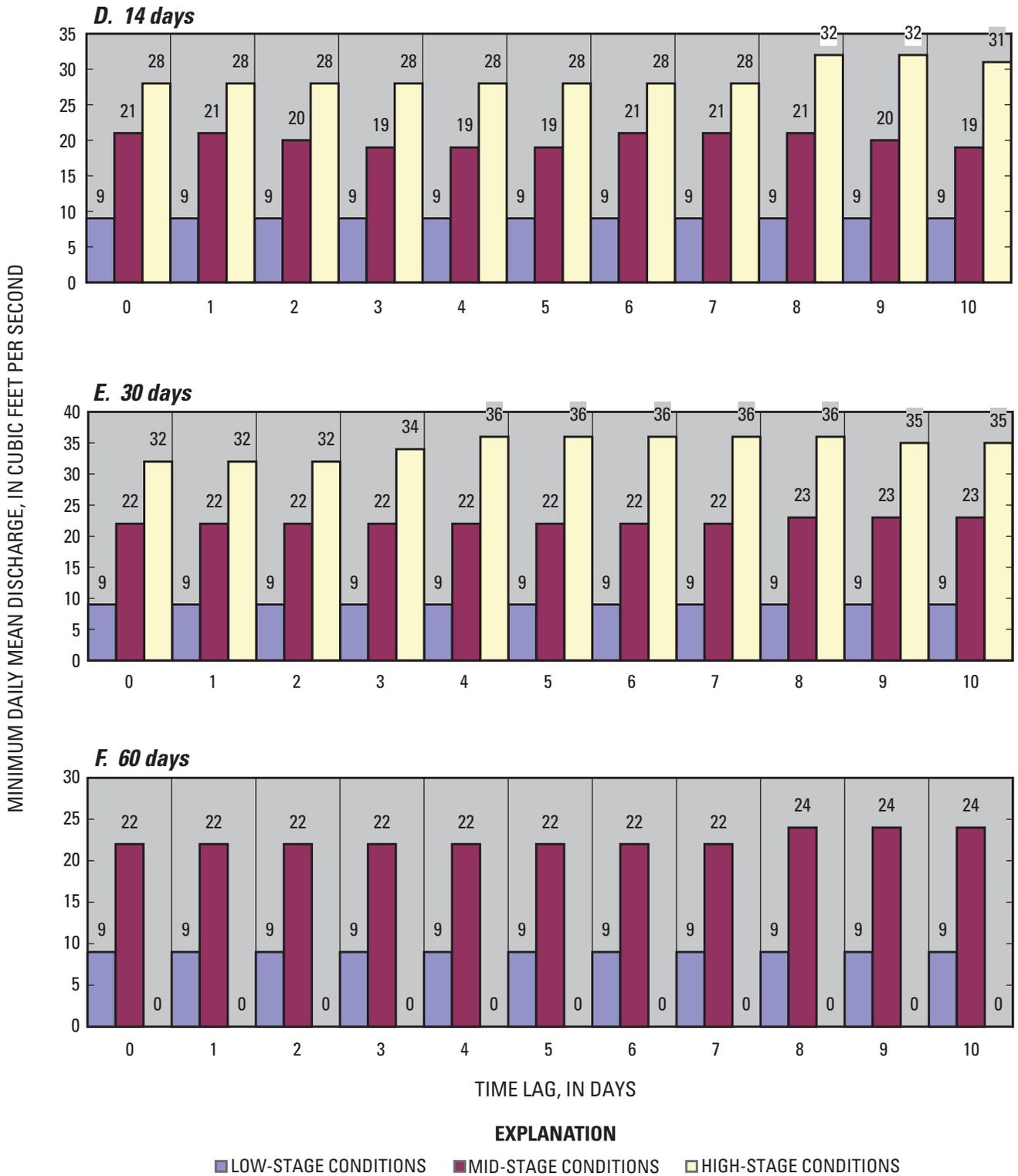
The flow characteristics of the Peconic River near BNL were analyzed from daily mean streamflows during calendar years 1995-2003 for the Peconic River at BNL station HQ, and during calendar years 1943-2003 at USGS stations on the Peconic River at Riverhead and Carmans River at Yaphank. The thresholds of mid- and high-stage conditions at station HQ were evaluated from the observed series of daily mean streamflow at this station, from concurrent water-level measurements at nearby BNL water-table observation well 61-03, and from land-surface elevations near the Peconic River between the BNL STP and Schultz (Center Moriches) Road. Daily mean streamflows that continuously exceeded discharges associated with these thresholds were evaluated for flow durations of 1, 3, 7, 14, 30, and 60 consecutive days. The observed series of daily mean streamflow that continuously exceeded discharges associated with mid- and high-stage thresholds at station HQ for each selected flow duration during 1995-2003 was used to determine the corresponding set of thresholds for the same years at stations on the Peconic River at Riverhead and Carmans River at Yaphank. The resulting highest minimum streamflows were the equivalent thresholds at each USGS station associated with mid- and high-stage conditions at station HQ. The percentages of time that daily mean discharges associated with mid- and high-stage conditions at station HQ were observed during the period of record at each USGS station provide estimates of the percentages of time that these conditions would have occurred during 1943-2003 at station HQ.

In this report, low-stage conditions are defined as occurring when there is no flow at station HQ and, therefore, the start-of-flow for the Peconic River is downstream of BNL property. Under these conditions, fish are unable to pass the Parshall flume at station HQ to reach potential upstream habitat and spawning areas on BNL property or to retreat from drying conditions in upstream reaches of the river. On the basis of the relation between water-table altitudes at

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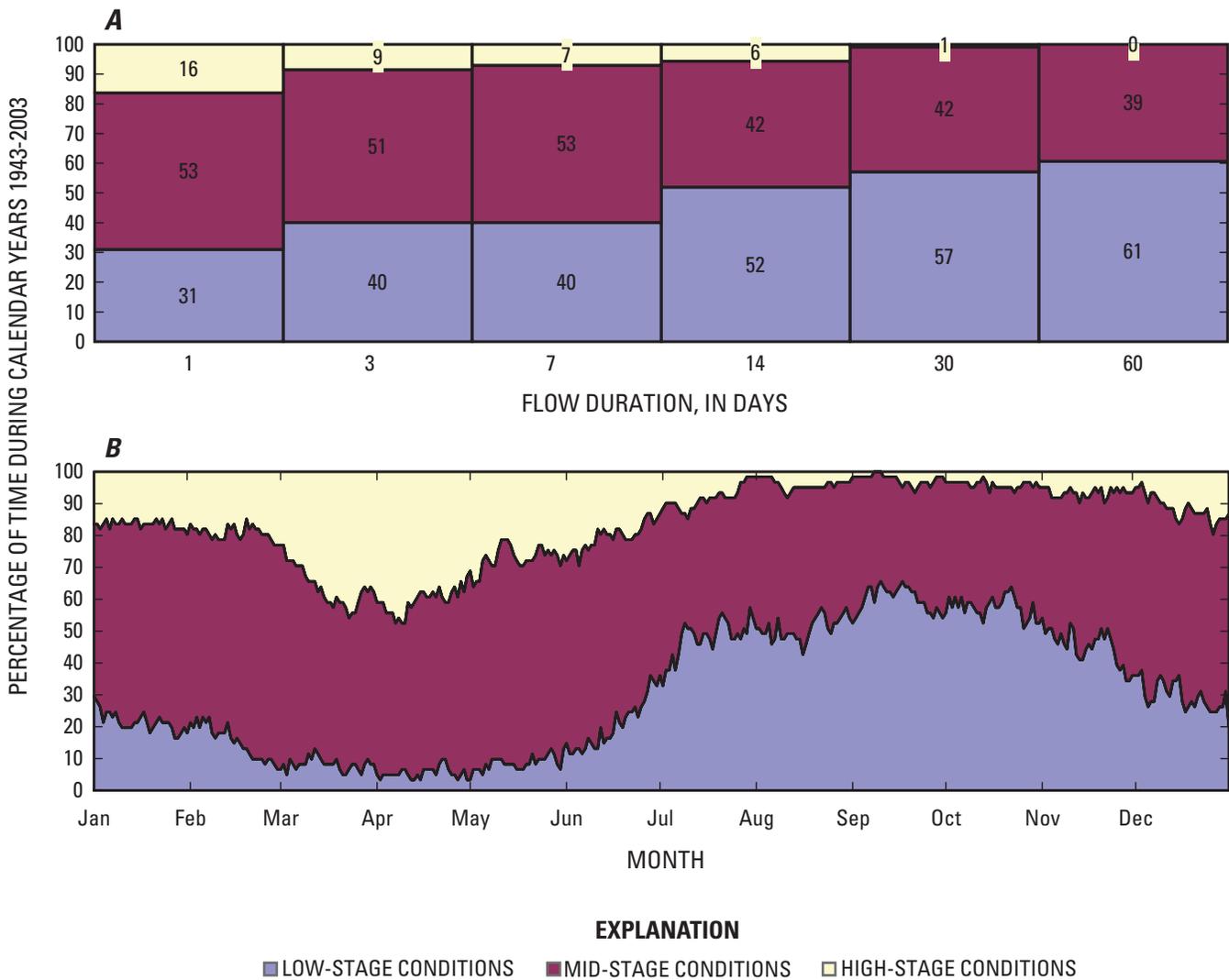


**Figure 8.** Minimum daily mean streamflows of Carmans River at Yaphank (unlagged and lagged) associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations, calendar years 1995-2003, Suffolk County, N.Y. A, 1 day. B, 3 days. C, 7 days. D, 14 days. E, 30 days. F, 60 days. (Numbers above shaded bars are discharges. Streamflow-gaging station locations are shown in fig. 2.)

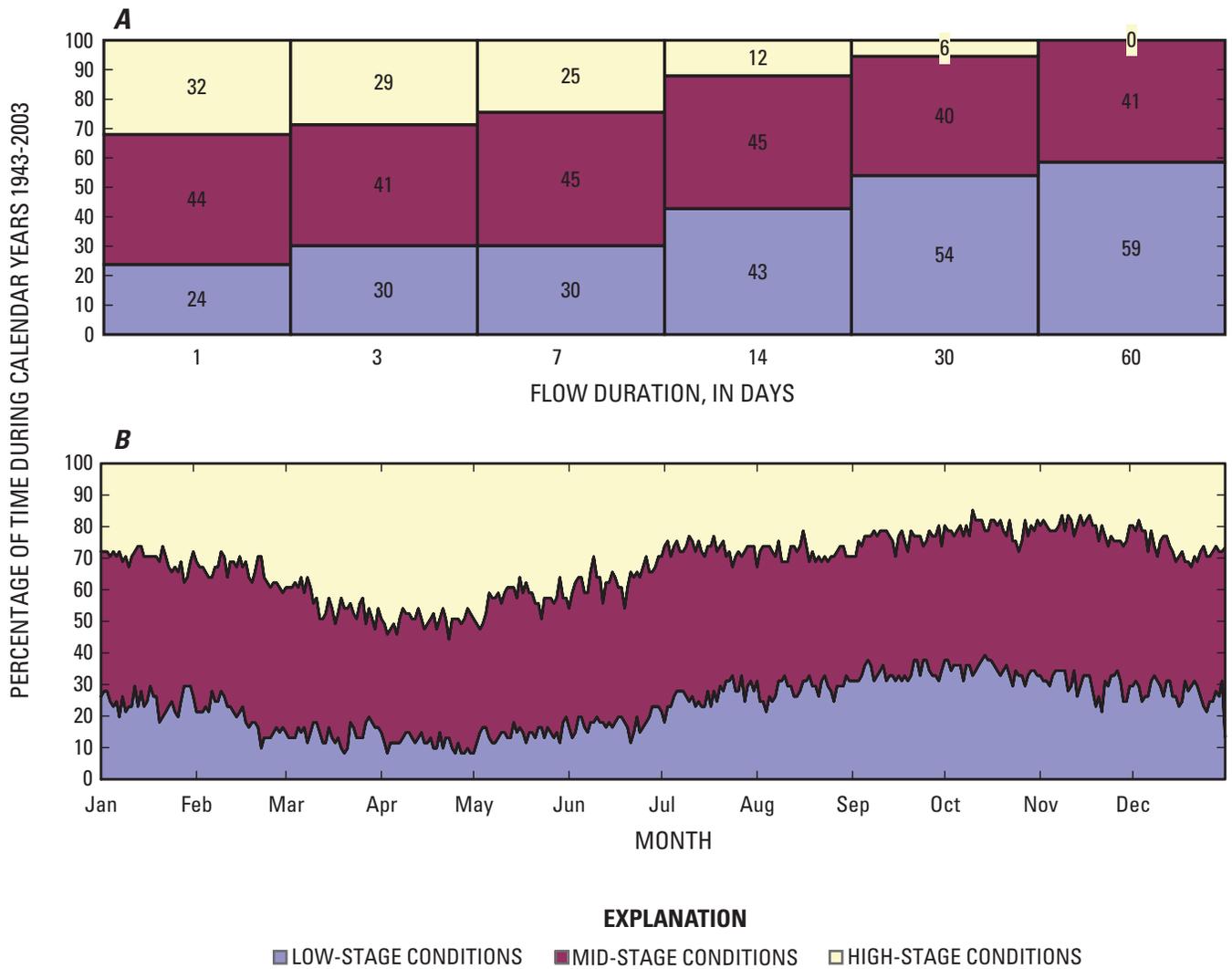


**Figure 8.** (Continued) Minimum daily mean streamflows of Carmans River at Yaphank (unlagged and lagged) associated with low-, mid-, and high-stage conditions at station HQ for selected flow durations, calendar years 1995-2003, Suffolk County, N.Y. A, 1 day. B, 3 days. C, 7 days. D, 14 days. E, 30 days. F, 60 days. (Numbers above shaded bars are discharges. Streamflow-gaging station locations are shown in fig. 2.)

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**Figure 9.** Percentage of time that daily mean streamflows of the Peconic River at Riverhead were associated with low-, mid-, and high-stage conditions at station HQ, calendar years 1943-2003, Suffolk County, N.Y. *A*, Percentage of time for selected flow durations. *B*, Percentage of time by Julian day. (Numbers inside shaded bars are percentages. Streamflow-gaging station locations are shown in fig. 2.)



**Figure 10.** Percentage of time that daily mean streamflows of Carmans River at Yaphank were associated with low-, mid-, and high-stage conditions at station HQ, calendar years 1943-2003, Suffolk County, N.Y. *A*, Percentage of time for selected flow durations. *B*, Percentage of time by Julian day. (Numbers inside shaded bars are percentages. Streamflow-gaging station locations are shown in fig. 2.)

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well 61-03 and concurrent daily mean streamflows at station HQ, high-stage conditions are defined as occurring when the daily mean streamflow at station HQ exceeds 4.2 ft<sup>3</sup>/s. Under these conditions, fish should have unrestricted passage through the Parshall flume at station HQ and access to most Peconic River wetlands near BNL. Mid-stage conditions are defined as occurring when there is flow at station HQ but it does not exceed 4.2 ft<sup>3</sup>/s. Under these conditions, fish should be able to migrate past the Parshall flume at station HQ unimpeded, but would be generally restricted in their access to Peconic River wetlands near BNL.

Daily mean streamflows at station HQ were associated with low-stage conditions most of the time during 1995-2003 for all flow durations. The amount of time that these conditions occurred lengthened with increasing flow duration, and ranged from 64 to 79 percent for durations of 1 and 60 days, respectively. The amount of time that daily mean streamflows at station HQ were associated with mid-stage conditions generally shortened with increasing flow duration, and ranged from 21 to 30 percent for durations of 60 and 1 days, respectively. High-stage conditions were attained the least amount of time during 1995-2003 for all flow durations. The amount of time that these conditions occurred shortened with increasing flow duration, and ranged from 0 to 6 percent for durations of 60 and 1 days, respectively. Low-stage conditions predominated during January, March, and July through December of these years, whereas mid-stage conditions prevailed during parts of February and April through June. Mid-stage conditions generally appeared throughout the year during 1995-2003, except for mid-October, during which only low-stage conditions were observed. The maximum amount of time that mid-stage conditions occurred was 67 percent, which was reached during late April. High-stage conditions appeared only during parts of March through July and December of these years, and the maximum amount of time that high stage occurred was 38 percent in early April.

The percentages of time during 1943-2003 that daily mean streamflows at the Riverhead and Yaphank stations were associated with low-, mid-, and high-stage conditions provide a range of estimates of the prevalence and seasonal variability of these conditions during these years at station HQ. Daily mean streamflows were associated with low-stage conditions most of the time during 1943-2003 for durations of 30 and 60 days, and with mid-stage conditions most of the time for 1, 3, and 7 days; streamflows were equally likely to have been associated with either of these conditions for a duration of 14 days. The amount of time that low-stage conditions occurred generally lengthened with increasing flow duration, and ranged from 24 to 61 percent for durations of 1 and 60 days,

respectively. The amount of time that daily mean streamflows were associated with mid-stage conditions generally shortened with increasing flow duration, and ranged from 39 percent for 60 days to 53 percent for durations of 1 and 7 days. High-stage conditions generally were attained the least amount of time during 1943-2003 for all flow durations, except perhaps that of 1 day, for which low-stage conditions could have occurred the least amount of time. The amount of time that high-stage conditions occurred shortened with increasing flow duration, and ranged from 0 to 32 percent for durations of 60 and 1 days, respectively. Mid-stage conditions predominated during January through early March, June through early July, and late November through December of these years. Low- or mid-stage conditions prevailed during mid-July through early November of 1943-2003, whereas high stage could have prevailed during mid-March through early May. Mid-stage conditions typically appeared throughout the year, and the amount of time that mid-stage occurred ranged from 30 percent in mid-September to 74 percent during late February of these years. High-stage conditions also generally appeared throughout the year, except perhaps for a few days during early September of 1943-2003, and the maximum amount of time that these conditions occurred was 56 percent in late April.

Plots of daily mean streamflow at station HQ and concurrent values at the Riverhead and Yaphank stations that were assessed for mid- and high-stage conditions indicate a slightly better relation between streamflows at station HQ and Riverhead. Overall, results indicate that streamflows observed during 1943-2003 at the Riverhead and Yaphank stations and used to estimate a longer record for station HQ were considerably higher than those observed during 1995-2003 at the three stations. This analysis can be used in future studies to better understand the long-term capacity of streams such as the Peconic River near BNL to supply continuous flow, flood adjacent low-lying areas, and sustain aquatic habitats.

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## Glossary

Specialized technical terms related to streamflow and other hydrologic data, as used in this report, are defined below. Terms such as water level and precipitation are used in their common everyday meanings, definitions of which are given in standard dictionaries. See also table for converting English units to International System (SI) Units. Other glossaries that also define water-related terms are accessible from <http://water.usgs.gov/glossaries.html>.

### B

**bankfull stage** The stage (see definition below) at which a stream first overflows its natural banks formed by floods with 1- to 3-year recurrence intervals.

**base flow** Sustained flow of a stream in the absence of direct runoff (see definition below). It includes natural and human-induced streamflows. Natural base flow is sustained largely by ground-water discharge.

### D

**direct runoff** The runoff (see definition below) entering stream channels promptly after rainfall or snowmelt.

### G

**gaging station** A site on a stream, canal, lake, or reservoir where systematic observations of stage, discharge, or other hydrologic data are obtained. (See also “streamflow-gaging station.”)

### P

**Parshall flume** A calibrated device developed by Parshall for measuring the flow of liquid in an open conduit.

**Peak flow (peak stage)** An instantaneous local maximum value in the continuous time series of streamflows or stages preceded by a period of increasing values and followed by a period of decreasing values.

### R

**reach** A length of stream that is chosen to represent a uniform set of physical, chemical, and biological conditions within a segment. It is the principal sampling unit for collecting physical, chemical, and biological data.

**regulation** The artificial manipulation of the flow of a stream.

**runoff** That part of the precipitation that appears in surface streams.

### S

**stage** The height of a water surface above an established datum plane.

**storage** Water naturally detained in a drainage basin, such as ground water, channel storage, and depression storage.

**streamflow-gaging station** A gaging station where a record of discharge of a stream is obtained. Within the Geological Survey this term is used only for those gaging stations where a continuous record of discharge is obtained.

### W

**water table** That surface in a ground-water body at which the water pressure is equal to the atmospheric pressure. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists.

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