U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

WATER-RESOURCES INVESTIGATIONS REPORT 03-4337
Surface water--SHEET 3 OF 5

SURFACE WATER

This sheet describes the surface-water system in the Atlantic Coastal study area. Discharge, base-flow, and flow-duration data for three streamflow-gaging stations and the results of low-flow correlations for nine low-flow, partial-record sites in the study area are presented.

Discharge at Gaging Stations

The surface-water system in the study area includes the streams and minor tributaries, lakes, and wetlands that make up the Atlantic Coastal drainage system. The size of the drainage basins ranges from less than 1 (Fresh Creek) to nearly 57 (Cedar Creek) mi^2 (fig. 1-2). These streams generally flow east and drain into Barnegat Bay or other bays in the area, and then into the Atlantic Ocean (fig. 3-1). Overall, these streams are gaining and derive most of their flow from the unconfined aquifer system.

At various times, the USGS has maintained three continuous-record streamflow-gaging stations in the study area (fig. 3-1): Cedar Creek at Lanoka Harbor, N.J. (01409000), during July 1932-September 1958 and December 1970-September 1971; Oyster Creek near Brookville, N.J. (01409095), during July 1965-December 1984; and Westecunk Creek at Stafford Forge, N.J. (01409280), during October 1973-September 1988. Operation of streamflow-gaging stations 01409000 and 01409280 was restored in 2003. The drainage area, mean annual discharge, minimum and maximum daily discharges, 30-day, 5-year (30Q5) and 7-day, 10-year (7Q10) low-flow statistics, and mean annual base flow for the streamflow-gaging stations near and within the study area are listed in table 3-1. The minimum and maximum monthly mean discharges and the mean monthly discharge by water year for the three streamflow-gaging stations in the study area are shown in figures 3-2 through 3-4. (A water year is the 12-month period from October 1 through September 30 and is designated by the calendar year in which it ends.) Mean monthly discharge for the three gaging stations generally is higher in winter and spring than in summer and fall.

Base-Flow Separation

A base-flow-separation technique described by Rutledge (1993) makes use of a computer program that partitions stream discharge into direct-runoff and base-flow components. Direct runoff consists of overland runoff and precipitation that falls directly on the stream. Base flow is the fair-weather flow of the stream and consists of the constant flow of ground water from the aquifer to the stream. Annual mean discharge at the three streamflow-gaging stations, divided into direct runoff and base flow, is shown by water year in figures 3-5 through 3-7.

Annual mean base flow of Cedar Creek at Lanoka Harbor, N.J. (01409000), ranged from 58.2 ft^3/s (14.3 in/yr) in 1957 to 134.0 ft^3/s (32.9 in/yr) in 1939, with a mean of 89.7 ft^3/s (22.0 in/yr), and from 71.6 percent of total flow in 1956 to 90.4 percent in 1943, with a mean of 83.4 percent. Annual mean base flow of Oyster Creek near Brookville, N.J. (01409095), ranged from 18.3 ft^3/s (33.4 in/yr) in 1966 to 35.8 ft^3/s (65.4 in/yr) in 1978, with a mean of 26.3 ft^3/s (48.0 in/yr), and from 88.3 percent of total flow in 1983 to 94.5 percent in 1981, with a mean of 91.3 percent. Annual mean base flow of Westecunk Creek at Stafford Forge, N.J. (01409280), ranged from 18.8 ft^3/s (16.2 in/yr) in 1986 to 42.9 ft^3/s (36.8 in/yr) in 1978, with a mean of 29.7 ft^3/s (25.5 in/yr), and from 91.2 percent of total flow in 1978 to 95.4 percent in 1986, with a mean of 93.3 percent.

Flow-Duration Curves

A flow-duration curve is a cumulative-frequency curve that shows the percentage of time in a given time period during which specified discharges were equaled or exceeded (Searcy, 1959, p. 1). The shape of the curve is determined by the hydrologic and geologic characteristics of the drainage basin. A curve with a gentle slope indicates that streamflow is derived largely from a steady supply of water from storage and, therefore, varies little (Searcy, 1959, p. 22). Water from storage can come from (1) the aquifer system, through the steady release of water from permeable deposits in hydraulic connection with the stream (ground-water discharge); (2) surface water, by the steady release of water from lakes and wetlands; or (3) a combination of the two sources. A steep curve indicates a highly variable stream whose flow largely is from direct runoff and a relatively small proportion is from ground- or surface-water storage; a flat curve indicates that streamflow is relatively steady (compared to a stream with a steep curve) because it is derived primarily from the release of water from ground- or surface-water storage (Searcy, 1959, p. 22).

A streamflow-variability index for flow-duration curves, calculated as the discharge that historically is equaled or exceeded 20 percent of the time divided by the discharge that is equaled or exceeded 80 percent of the time, was proposed by Miller (1966, p. 24). Miller reported that the streamflow-variability index for New Jersey streams with drainage areas greater than 25 mi^2 ranged from approximately 2 (low variability) to 20 (high variability). The streamflow-variability index reported by Miller (1966) for streams in the Atlantic Coastal study area ranged from 2.03 to 5.83.

The streamflow-variability index for Cedar Creek at Lanoka Harbor, N.J. (01409000), is about 2, which indicates that this stream has uniform flow characteristics and derives most of its flow from ground-water and surface-water storage. The variability index was not calculated for Oyster Creek near Brookville, N.J. (01409095), or Westecunk Creek at Stafford Forge, N.J. (01409280), because the size of the drainage basins of these streams upstream from the gaging station is less than 25 mi^2.

Flow-duration curves of mean daily flow for the three streamflow-gaging stations during their periods of record are shown in figure 3-8. The discharges that were equaled or exceeded 5 percent and 95 percent of the time at Cedar Creek at Lanoka Harbor, N.J. (01409000), are 207.4 ft^3/s and 48.4 ft^3/s, respectively; those for Oyster Creek near Brookville, N.J. (01409095), are 50.1 ft^3/s and 17.7 ft^3/s, respectively; and those for Westecunk Creek at Stafford Forge, N.J. (01409280), are 55.8 ft^3/s and 16.7 ft^3/s, respectively. These values are indicative of the extremes in discharge over the period of record at these three streamflow-gaging stations. The ratio between the 5-percent and 95-percent exceedance discharges for each of these three stations is less than 5. The three basins have a low ratio because base flow constitutes a large percentage of total streamflow. The presence of wetlands in the study area, as well as the high permeability of the Coastal Plain sediments, tends to attenuate peak flows and sustain base flow. The discharges that were equaled or exceeded 50 percent of the time are 94.8 ft^3/s for Cedar Creek at Lanoka Harbor, N.J., 26.4 ft^3/s for Oyster Creek near Brookville, N.J., and 29.7 ft^3/s for Westecunk Creek at Stafford Forge, N.J.

Discharge at Low-Flow, Partial-Record Stations

The magnitude and frequency of streamflow at stations for which a continuous record is unavailable commonly are estimated by correlating instantaneous discharge measurements at a low-flow, partial-record station with the concurrent mean daily discharge at a continuous-record streamflow-gaging station, or index station, in a similar hydrogeologic setting (Gillespie and Schopp, 1982). In this study area, nine low-flow, partial-record stations were selected for use in the low-flow-correlation analyses. Measured discharge values at each of these low-flow, partial-record stations were correlated with mean daily discharge at six index gaging stations adjacent to the study area. The locations of the index gaging stations and low-flow, partial-record stations are shown in figure 3-1 and are described in table 3-2. Because the periods of record for Oyster Creek near Brookville, N.J. (01409095), and Westecunk Creek at Stafford Forge, N.J. (01409280), are less than 20 years, these former continuous-gaging stations were treated as low-flow, partial-record stations rather than as index stations. Cedar Creek was not treated as an index station because its period of record is not concurrent with the period when measurements were made at the other low-flow stations.

The low-flow correlations reported here were developed by using the MOVE.1 (Maintenance of Variance Extension, Type 1) method. In this method, geometric means are used to eliminate the bias of ordinary-least-squares regression (Hirsch, 1982). An example of a low-flow correlation is shown in figure 3-9. The "best-fit" line, $QP_R = (0.37646)\ QI^{(0.8752)}$, is drawn through the data points that represent the measured discharge at the low-flow, partial-record station, or QP_M, plotted against the mean daily discharge at the index gaging station, QI. The equation of the best-fit line then is used to estimate, or predict, specific discharge statistics at the low-flow, partial-record station, QP_R, on the basis of the values of the same discharge statistics measured at the index gaging station, QI. The low-flow, partial-record stations and their associated correlation equations are listed in table 3-2.

Two statistical indicators, the correlation coefficient and the standard error of estimation, are included in table 3-2 as an indication of the accuracy of the predicted discharge. The correlation coefficient is a number from -1.0 to 1.0 that measures the strength of the linear relation between the logarithm (base 10) of the discharge at the low-flow, partial-record station and that at the index gaging station. For low-flow correlations in this report, the nearer the correlation coefficient is to 1.0, the more reliable the predicted discharge, QP_R. Although the correlation coefficient typically is used to describe the linear strength of ordinary-least-squares regressions, it is computed here for comparison purposes. The standard error of estimation listed in table 3-2 was calculated for the 7Q10 by using an equation developed specifically for MOVE.1 low-flow correlations (Telis, 1991, p. 17). The equation allows the standard error of estimation to be calculated from the standard error of prediction and the time-sampling error for the correlated index gaging station (Telis, 1992). The nearer the value (which is in percent) is to zero, the more reliable the predicted discharge, QP_R. This indicator of reliability is calculated only for the 7Q10. For each low-flow, partial-record site, the three index gaging stations for which the standard errors of estimation were lowest were selected for use in the low-flow-correlation analyses.

From these correlations, the 30Q5; the 7Q10; and the mean annual discharge were calculated for the low-flow, partial-record stations. For example, to estimate the mean annual discharge at the low-flow, partial-record station North Branch Forked River near Forked River, N.J. (01409050) (fig. 3-9), the mean annual discharge at the index gaging station Great Egg Harbor River at Folsom, N.J. (01411000), 86.1 ft^3/s (QI) (table 3-1), is substituted in the correlation equation, which then is solved for the mean annual discharge at the low-flow, partial-record station (QP_R), as:

$$QP_R = (0.37646)\ (86.1\ ft^3/s)^{(0.8752)}, \text{ and}$$

$$QP_R = 18.6\ ft^3/s\ .$$

By substituting the index-gaging-station discharge values for the 30Q5 (28 ft^3/s) and 7Q10 (22 ft^3/s) (table 3-1) in the correlation equation, the appropriate respective flows, 6.9 ft^3/s and 5.6 ft^3/s (table 3-2), are predicted for the low-flow, partial-record station. By substituting the index-gaging-station discharge value for mean annual base flow (76.5 ft^3/s) (table 3-1) in the correlation equation, a base flow of 16.8 ft^3/s (table 3-2) is predicted for the low-flow, partial-record station. Low-flow-correlation prediction equations were developed and used to estimate discharge statistics for all stations listed in table 3-2. Discharge statistics developed from correlation equations provide valuable information about sites for which these statistics otherwise would be unavailable; however, these values are considered to be less reliable than statistics based on direct measurements from a continuous-record streamflow-gaging station.

PRECIPITATION, DISCHARGE, AND EVAPOTRANSPIRATION

This section describes the effect of climatic factors on the hydrology of the unconfined aquifer system in the Atlantic Coastal study area. Precipitation is compared to discharge, and potential evapotranspiration is estimated. These precipitation, discharge, and potential-evapotranspiration values are used in the water-budget analysis on sheet 5 of this report.

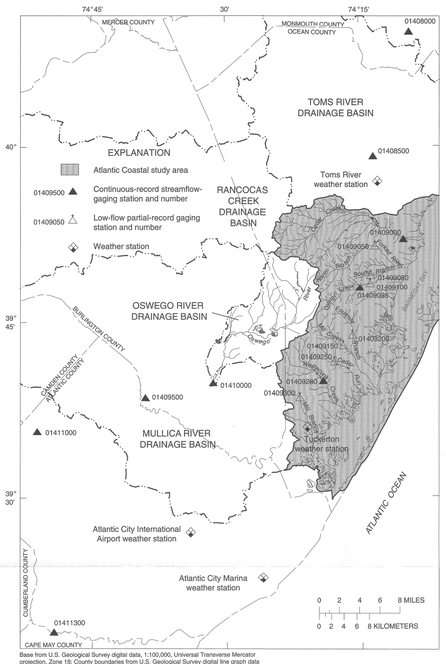
Precipitation data in this report are from the National Oceanic and Atmospheric Administration weather station at Tuckerton, N.J. (fig. 3-1), for the period of record, 1932-95 (National Climatic Data Center, 1997). Data from weather stations adjacent to the study area (Toms River, Atlantic City International Airport, and Atlantic City Marina) were averaged as a substitute for data missing from the Tuckerton weather-station record.

Total annual precipitation during 1932-95 ranged from a minimum of 30.1 in. in water year 1985 to a maximum of 70.5 in. in water year 1958, with a mean of 44.3 in/yr. Monthly minimum, mean, and maximum precipitation values for the Tuckerton weather station during water years 1986-95 are shown in figure 3-10. Monthly precipitation ranged from a minimum of 0.52 in. in December to a maximum of 10.2 in. in March, with a mean of 3.7 in.

Most of the precipitation that falls on the study area leaves as stream discharge (direct runoff plus base flow). Annual mean discharge at the three streamflow-gaging stations in the study area was compared with total annual precipitation, which is assumed to be uniform over the study area. (All values in figures 3-5 to 3-7 are presented in units of inches of water over the area of the basin to facilitate comparison; discharge values also are presented in units of cubic feet per second.) Annual mean discharge of Cedar Creek at Lanoka Harbor, N.J. (01409000), ranged from 18.9 in. (77.2 ft^3/s) in water year 1957 to 41.4 in. (168.7 ft^3/s) in water year 1958 (fig. 3-5). The mean annual discharge was 26.4 in. (107.5 ft^3/s), or 60 percent of the mean annual precipitation for water years 1932-95 at the Tuckerton weather station. The annual mean discharge of Oyster Creek near Brookville, N.J. (01409095), ranged from 36 in. (19.7 ft^3/s) in water year 1966 to 72.5 in. (39.7 ft^3/s) in water year 1978 (fig. 3-6). The mean annual discharge was 52.7 in. (28.8 ft^3/s), or 119 percent of the mean annual precipitation for water years 1932-95 at the Tuckerton weather station. The annual mean discharge of Westecunk Creek at Stafford Forge, N.J. (01409280), ranged from 16.9 in. (19.7 ft^3/s) in water year 1986 to 40.3 in. (47 ft^3/s) in water year 1978 (fig. 3-7). The mean annual discharge was 27.4 in. (31.9 ft^3/s), or 62 percent of the mean annual precipitation for water years 1932-95 at the Tuckerton weather station.

The percentage of mean annual streamflow that was base flow is similar for the three streamflow-gaging stations (about 83 to 93 percent of mean annual streamflow). In contrast, mean annual streamflow was 60 and 62 percent of mean annual precipitation at two of the streamflow-gaging stations but was 119 percent at Oyster Creek near Brookville, N.J. (01409095). This difference is attributed to nonconindent surface-water and ground-water divides, which results in the natural transfer of ground water among basins. The ground-water contributing area of Oyster Creek is assumed to be larger than its surface-water drainage area; therefore, this stream may receive ground-water inflow from adjacent surface-water basins. Because of the lack of wells in the vicinity of the surface-water divide, the location of the ground-water divide is unknown. Ground water may flow from the Oswego River drainage basin (fig. 3-1), east of Oyster Creek, or the North Branch Forked River drainage basin, northwest of Oyster Creek and located in the northern part of the Forked River drainage basin (fig. 1-2), into the Oyster Creek drainage basin, which topographically is lower than the adjacent basins (Fusillo and others, 1980). The precipitation that falls on the upland areas of the Oswego River and North Branch Forked River drainage basins may bypass local streams and discharge to more distant streams at lower elevations in adjacent surface-water basins.

The precipitation that does not discharge as streamflow leaves the Atlantic Coastal study area as evapotranspiration. Potential evapotranspiration was estimated by using the Thornthwaite equation (Thornthwaite and Mather, 1957). Mean monthly air temperature and latitude are used in the equation as an index of the energy available for evapotranspiration. Potential evapotranspiration is the amount of water that would be lost through transpiration from plants and evaporation from the soil if the supply of water always were unlimited. The mean monthly air temperature at the Tuckerton weather station during 1961-90 (Owenby and Ezell, 1992) is shown in figure 3-11. Estimated mean monthly potential evapotranspiration during water years 1986-95 is shown in figure 3-12. The calculated mean annual potential evapotranspiration for the study area during 1986-95 is 25.4 in/yr.



Base from U.S. Geological Survey digital data, 1:100,000, Universal Transverse Mercator projection, Zone 18; County boundaries from U.S. Geological Survey digital line graph data files, 1:24,000.

Figure 3-1. Location of selected continuous-record streamflow-gaging stations, low-flow partial-record gaging stations, and weather stations in and near the Atlantic Coastal study area, New Jersey.

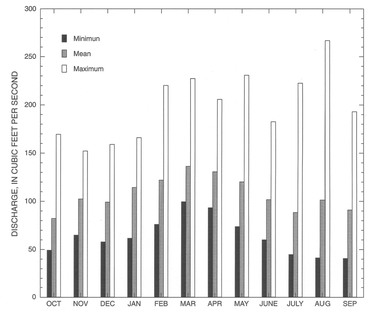


Figure 3-2. Minimum and maximum monthly mean, and mean monthly discharge at Cedar Creek at Lanoka Harbor, N.J. (01409000), water years 1933-58 and 1971.

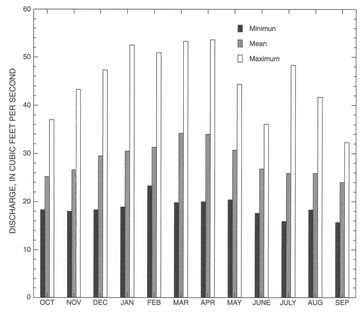


Figure 3-3. Minimum and maximum monthly mean, and mean monthly discharge at Oyster Creek near Brookville, N.J. (01409095), water years 1966-84.

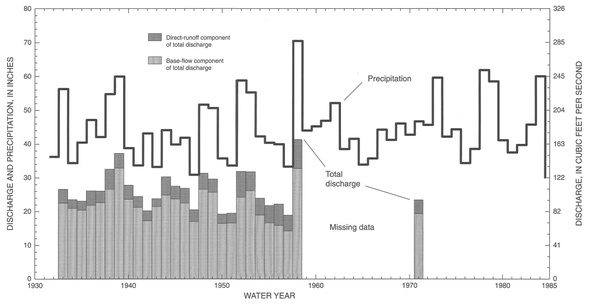


Figure 3-5. Total annual precipitation at the Tuckerton, N.J., weather station, water years 1932-73 (National Cliimatic Data Center, 1997), and annual mean discharge, base flow, and direct runoff at Cedar Creek at Lanoka Harbor, N.J. (01409000), water years 1933-58 and 1971.

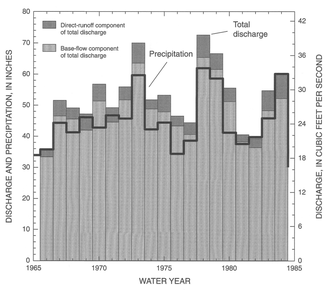


Figure 3-6. Total annual precipitation at the Tuckerton, N.J., weather station, water years 1965-85 (National Climatic Data Center, 1997), and annual mean discharge, base flow, and direct runoff at Oyster Creek near Brookville, N.J. (01409095), water years 1966-84.

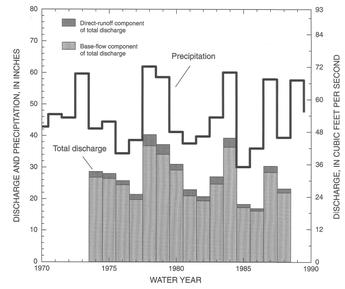


Figure 3-7. Total annual precipitation at the Tuckerton, N.J., weather station, water years 1970-90 (National Climatic Data Center, 1997), and annual mean discharge, base flow, and direct runoff at Westecunk Creek at Stafford Forge, N.J. (01409280), water years 1974-88.

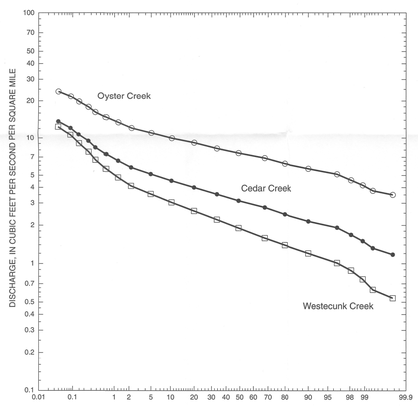


Figure 3-8. Duration curve of daily mean flow, Cedar Creek at Lanoka Harbor, N.J. (01409000), water years 1933-58; Oyster Creek near Brookville, N.J. (01409095), water years 1966-84; and Westecunk Creek at Stafford Forge, N.J. (01409280), water years 1974-88.

QI - Concurrent mean daily discharge, in cubic feet per second, at index gaging station Great Egg Harbor River at Folsom, N.J. (01411000)

QP_M - Discharge, in cubic feet per second, at partial-record station North Branch Forked River near Forked River, N.J. (01409050)

DATE	QI	QP_M
06/02/61	96	21.30
07/06/61	49	15.10
09/08/61	37	9.38
10/24/62	50	9.79
04/05/63	88	17.40
08/29/63	38	6.64
05/07/64	124	25.90
08/24/64	28	12.20
04/14/65	85	13.60
08/31/65	23	5.35

A low-flow correlation was made by correlating low-flow discharge at the partial-record station with discharge at the index station.

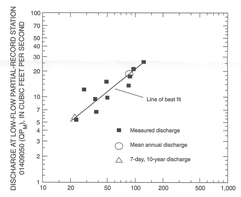
CORRELATION COEFFICIENT: 0.86

EQUATION OF "BEST-FIT" LINE DRAWN THROUGH DATA:

$QP_R = (0.37646)\ QI^{(.8752)}$,

where QI = Concurrent mean daily discharge at index gaging station,

and QP_R = Predicted discharge at low-flow partial-record station



ESTIMATED STREAMFLOW STATISTICS FOR THE 7-DAY, 10-YEAR LOW FLOW:

Standard error of prediction for index gaging station = 3.5 percent

Standard error of prediction for low-flow, partial-record station = 11.7 percent

Standard error of estimation for low-flow, partial-record station = 11.8 percent

Figure 3-9. Low-flow correlation of flow at North Branch Forked River near Forked River, N.J., partial-record station (01409050) with flow at Great Egg Harbor River at Folsom, N.J., index gaging station (01411000).

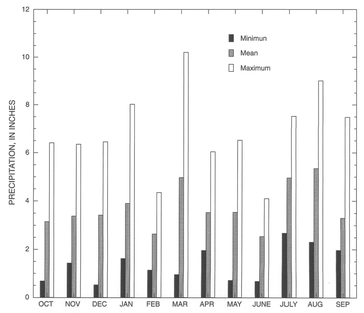


Figure 3-10. Minimum, mean, and maximum monthly precipitation at the Tuckerton, N.J., weather station, water years 1986-95 (National Climatic Data Center, 1997).

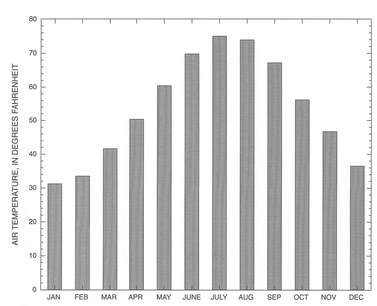


Figure 3-11. Mean monthly air temperature at the Tuckerton, N.J., weather station, 1961-90 (Owenby and Ezell, 1992).

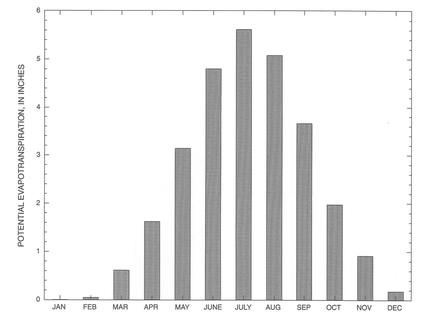


Figure 3-12. Mean monthly potential evapotranspiration at the Tuckerton, N.J., weather station, water years 1986-95.

Table 3-1. Summary of discharge statistics for continuous-record streamflow-gaging stations in and near the Atlantic Coastal study area, New Jersey

[Station locations shown in figure 3-1; --, data not available]

Streamflow-gaging-station number	Streamflow-gaging-station name	Drainage area (square miles)	Period of record	Years of daily discharge record	Discharge (cubic feet per second)					Mean annual base flow[3]		
					Mean annual[1]	Minimum daily[1]	Maximum daily[2]	30-day 5-year[2]	7-day, 10-year[2]	Cubic feet per second	Inches over the drainage area	Percentage of total flow[4]
01408000	Manasquan River at Squankum, N.J.	44.0	July 1931 to 1998	67	74.7	12	1,720	22	17	54.7	16.9	73.2
01408500	Toms River near Toms River, N.J.	123.0	October 1928 to 1998	70	213	43	1,910	79	62	184.7	20.4	87.0
01409000	Cedar Creek at Lanoka Harbor, N.J.	55.3	July 1932 to September 1958, December 1970 to September 1971	27	[5]107	[5]12	[5]1,050	--	--	90.0	22.1	83.3
[6]01409095	Oyster Creek near Brookville, N.J.	7.43	July 1965 to December 1984	19	[7]28.7	[7]2.4	[7]352	--	--	26.2	48.0	91.1
[6]01409280	Westecunk Creek at Stafford Forge, N.J.[8]	15.8	October 1973 to September 1988	15	[9]31.9	[9]1.1	[9]218	--	--	29.7	25.5	93.1
01409500	Batsto River at Batsto, N.J.	67.8	October 1927 to 1998	71	122	5.7	2,000	48	41	106.8	21.4	87.2
01410000	Oswego River at Harrisville, N.J.	72.5	October 1930 to 1998	68	87.1	4.0	1,220	29	21	74.2	13.9	85.0
01411000	Great Egg Harbor River at Folsom, N.J.	57.1	September 1925 to 1998	73	86.1	15	1,300	28	22	76.5	18.2	88.8
01411300	Tuckahoe River at Head of River, N.J.	30.8	December 1969 to 1998	28	44.0	1.3	920	11	7.0	37.2	16.4	84.8

[1]Values from Reed and others (1999), unless noted otherwise.
[2]Low-flow statistics were calculated by using data for each complete climatic year. A climatic year is the 12-month period from April 1 through March 31, and is designated by the calendar year in which it begins. This period allows the entire low-water season to occur in 1 year. For the low-flow statistics in this study, the periods of record begin with the earliest April 1 and end with the latest March 31, but no later than March 31, 1999. Values are given to two significant figures.
[3]Base flow was estimated by using the methodology of Rutledge (1993). Base flow was calculated by using data for the water year. For base flow in this study, the periods of record begin with the earliest October 1 and end with the latest September 30.
[4]Because of intermediate rounding, manually computed percentages of flow may be slightly different from those given in the table.
[5]Values from U.S. Geological Survey (1972).
[6]Station also was used as a low-flow partial-record station because of the short period of record (less than 20 years).
[7]Values from Bauersfeld and others (1985).
[8]Flow regulated by dam 75 feet upstream from gage.
[9]Values from Bauersfeld and others (1989).

Table 3-2. Correlation equations relating instantaneous low-flow measurements at low-flow, partial-record gaging stations to concurrent mean daily discharge at continuous-record streamflow-gaging stations (index stations) in and near the Atlantic Coastal study area, New Jersey

[Station locations shown in fig. 3-1; QP_R, predicted discharge at partial-record station; QI, discharge at index station]

Low-flow partial-record gaging-station number	Low-flow partial-record gaging-station name	Drainage area (square miles)	Index-gaging-station number	Number of measurements used in analysis	Number of years of daily discharge record	Correlation coefficient[1]	Standard error of estimation for 7-day, 10-year low-flow discharge (percent)[2]	Correlation equation[3]	Predicted discharge (QP_R) (cubic feet per second)			Predicted mean annual base flow (QP_R)		
									30-day, 5-year[4]	7-day, 10-year[4]	Mean, annual[5]	Cubic feet per second	Inches per year over the drainage area	Percentage of total flow[6]
01409050	North Branch Forked River near Forked River, N.J.	13.4	01411000	10	65	0.86	11.8	$QP_R = 0.37646\ QI^{(0.8752)}$	6.9	5.6	18.6	16.8	17.0	90.3
			01410000	10	60	.84	18.1	$QP_R = .16404\ QI^{(1.0578)}$	5.8	4.1	18.5	15.6	15.8	84.3
			01408500	10	62	.83	14.7	$QP_R = .09765\ QI^{(0.971)}$	6.8	5.4	17.8	15.5	15.7	87.1
01409080	South Branch Forked River near Forked River, N.J.	1.28	01411300	8	20	.89	14.2	$QP_R = .28012\ QI^{(0.7361)}$	1.6	1.2	4.5	4.0	42.6	88.8
			01408000	13	59	.8	19.7	$QP_R = .11736\ QI^{(0.856)}$	1.6	1.3	4.7	3.6	38.2	76.6
			01411000	13	65	.77	19.3	$QP_R = .16596\ QI^{(0.7243)}$	1.8	1.6	4.2	3.8	40.7	90.5
[7]01409095	Oyster Creek near Brookville, N.J.	7.43	01410000	73	60	.89	6.5	$QP_R = 3.23\ QI^{(0.44)}$	16	14	27.6	25.5	46.6	92.4
			01408500	67	62	.79	11.1	$QP_R = 1.58\ QI^{(0.54)}$	17	15	28.6	26.5	48.4	92.7
			01408000	61	59	.76	13.5	$QP_R = 2.89\ QI^{(0.54)}$	15	13	29.7	25.1	45.8	84.5
01409100	Oyster Creek near Warretown, N.J.	9.95	01410000	11	60	.9	6.6	$QP_R = 3.21878\ QI^{(0.5521)}$	21	17	37.9	34.6	47.3	91.3
			01408500	11	62	.88	5.3	$QP_R = 2.51665\ QI^{(0.5417)}$	22	20	37.0	34.5	47.1	93.2
			01411000	11	65	.88	5.6	$QP_R = 5.14312\ QI^{(0.5)}$	23	21	37.7	35.7	48.7	94.7
01409150	Mill Creek near Manahawkin, N.J.	10.4	01408500	13	62	.92	3.6	$QP_R = 1.22332\ QI^{(0.5237)}$	12	11	20.5	19.0	24.8	92.7
			01408000	13	59	.88	6.2	$QP_R = 2.29505\ QI^{(0.5375)}$	12	11	23.3	19.7	25.7	84.5
			01410000	14	60	.82	9.4	$QP_R = 2.16\ QI^{(0.52)}$	12	11	22.0	20.2	26.4	91.8
01409200	Fourmile Branch near Manahawkin, N.J.	5.24	01410000	15	60	.92	8.6	$QP_R = .04733\ QI^{(1.1555)}$	2.3	1.6	8.2	6.8	17.7	82.9
			01411000	15	65	.91	9.9	$QP_R = .08149\ QI^{(1.1012)}$	2.4	1.9	7.5	6.7	17.3	89.3
			01408500	15	62	.88	11.7	$QP_R = .01496\ QI^{(1.1605)}$	2.4	1.8	7.5	6.4	16.6	85.3
01409250	Cedar Run near Manahawkin, N.J.	3.34	01411000	15	65	.85	13.8	$QP_R = .04925\ QI^{(0.9641)}$	1.2	.98	3.7	3.3	13.3	89.2
			01410000	15	60	.91	9.9	$QP_R = .02935\ QI^{(1.1008)}$	1.2	.84	4.0	3.3	13.6	82.5
			01408500	15	62	.88	11.8	$QP_R = .00979\ QI^{(1.1054)}$	1.2	.94	3.7	3.1	12.8	83.8
[7]01409280	Westecunk Creek at Stafford Forge, N.J.	15.8	01410000	83	60	.86	10	$QP_R = 1.69\ QI^{(0.68)}$	17	13	35.2	31.5	27.1	89.5
			01408500	79	62	.83	10.9	$QP_R = .61\ QI^{(0.76)}$	17	14	35.9	32.2	27.7	89.7
			01409500	85	62	.83	11.5	$QP_R = .47\ QI^{(0.91)}$	16	14	37.2	32.9	28.3	88.4
01409300	Mill Branch near Tuckerton, N.J.	4.89	01410000	15	60	.89	10.9	$QP_R = .05766\ QI^{(1.0002)}$	1.7	1.2	5.0	4.3	11.9	86.0
			01408500	15	62	.87	11.1	$QP_R = .02127\ QI^{(1.0043)}$	1.7	1.3	4.6	4.0	11.2	90.0
			01411000	15	65	.85	12.5	$QP_R = .09228\ QI^{(0.8796)}$	1.7	1.4	4.6	4.2	11.6	91.3

[1]Index gaging stations are listed in order of decreasing correlation coefficient for each low-flow, partial-record gaging station.
[2]Calculated for the 7-day, 10-year low-flow discharge by using an equation developed specifically for MOVE.1 low-flow correlations by Thomas (Telis, 1991). This indicator of reliability is calculated only for the 7-day, 10-year low-flow discharge, but also is a useful measure of reliability for other MOVE.1-predicted discharges (Johnson and Charles, 1997).
[3]The results are affected by the difference in degree of precision in the decimal places of the correlation equations.
[4]Low-flow statistics were calculated by using data for each complete climatic year. A climatic year is the 12-month period from April 1 through March 31, and is designated by the calendar year in which it begins. This period allows the entire low-water season to occur in one year. For the low-flow statistics in this study, the periods of record begin with the earliest April 1 and end with the latest March 31, but no later than March 31, 1999. Values for predicted 30-day, 5 year and 7-day, 10 year discharges are given to two significant figures.
[5]Values are based on data from Reed and others (1999), except those for station numbers 01409095 and 01409280, which are based on data from Bauersfeld and others (1985) and Bauersfeld and others (1989), respectively.
[6]Percentage of total flow = predicted mean annual base flow divided by predicted mean annual discharge, in cubic feet per second.
[7]Station also was a continous-record streamflow-gaging station.

HYDROLOGY OF THE UNCONFINED KIRKWOOD-COHANSEY AQUIFER SYSTEM, FORKED RIVER AND CEDAR, OYSTER, MILL, WESTECUNK, AND TUCKERTON CREEK BASINS AND ADJACENT BASINS IN THE SOUTHERN OCEAN COUNTY AREA, NEW JERSEY, 1998-99

by
Alison D. Gordon

2004