SURFACE WATER

This section describes the surface-water system in the Maurice River study area. Discharge, base-flow, and flow-duration data for 4 streamflow-gaging stations and the results of low-flow correlations for 17 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 many tributaries, lakes, and wetland areas of the Maurice River and Cohansey River drainage systems, and the tidal areas and minor tributaries to the Delaware Bay. From their headwaters the Maurice and Cohansey Rivers flow about 37 and 25 mi, respectively, to the south and empty into the Delaware Bay. Overall, these streams are gaining and derive most of their flow from the unconfined ground-water system.

At various times, the USGS has maintained four continuous-record streamflow-gaging stations in the study area (fig. 3-1): Maurice River at Norma, N.J. (01411500), during 1932 to present (1994); Menantico Creek near Millville, N.J. (01412000), during 1931-57 and 1977-85; West Branch Cohansey River at Seeley, N.J. (01412500), during 1951-67; and Cohansey River at Seeley, N.J. (01412800), during 1977-88. The minimum and maximum monthly mean discharge and the mean monthly discharge for these streamflow-gaging stations are shown in figures 3-2 through 3-5. The minimum and maximum daily discharge, the mean annual discharge, and the 30-day, 5-year and 7-day, 10-year low-flow discharges for the period of record at the stations are listed in table 3-1.

day sliding-interval method to divide 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 usually consists mostly of the constant flow of ground water from the aquifer to the stream, and other relatively constant discharges into the stream, such as those from wastewater-treatment plants. Annual mean direct runoff and base flow, by water year, at the four streamflow-gaging stations are shown in figures 3-6 through 3-9.

A base-flow-separation technique described by Pettyjohn and Henning (1979) and adapted by Sloto (1988) makes use of a 3-

The annual mean base flow of the Maurice River at Norma ranged from 59 ft³/s in 1966 to 222 ft³/s in 1973, with a mean of 143 ft³/s, and from 74 percent of total flow in 1940 to 92 percent in 1947, with a mean of 87 percent. The annual mean base flow of Menantico Creek near Millville ranged from 18 ft³/s in 1942 to 44 ft³/s in 1939, with a mean of 32 ft³/s, and from 76 percent of total flow in 1942 to 90 percent in 1932, with a mean of 86 percent. The annual mean base flow of the West Branch Cohansey River at Seeley ranged from 0.7 ft³/s in 1966 to 2.5 ft³/s in 1961, with a mean of 1.49 ft³/s, and from 66 percent of total flow in 1967 to 92 percent in 1962, with a mean of 83 percent. For the Cohansev River at Seeley, annual mean base flow ranged from 20 ft³/s in 1988 to 38 ft³/s in 1980, with a mean of 28 ft³/s, and from 70 percent of total flow in 1983 to 88 percent in 1986, with a mean of 80 percent.

A flow-duration curve is a cumulative-frequency curve that shows the percentage of time that any specified discharge is equaled or exceeded (Langbein and Iseri, 1960, p. 11). 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. Water from storage can come from the ground-water system through the steady release of water from permeable deposits in hydraulic connection with the stream (ground-water discharge), from surface water by the steady release of water from lakes and wetlands, or from a combination of the two sources. A steep curve indicates that a relatively small proportion of streamflow is from storage (little steady release of water from ground and surface water), and that flow is derived largely from direct runoff and tends to be variable. A streamflow-variability index for flow-duration curves, calculated as the discharge that 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 mi² ranged from approximately 2 (low variability) to 20 (high variability). The streamflow-variability index reported by Miller (1966) for Coastal Plain streams ranged from 2.2 to 3.6.

Flow-duration curves for the streamflow-gaging stations at Maurice River at Norma, N.J., during water years 1933-94 and at Cohansey River at Seeley, N.J., during water years 1978-88 are shown in figure 3-10. The streamflow-variability indexes at these gaging stations were 2.7 and 2.0, respectively, which indicates that these streams have uniform flow characteristics. even with respect to other Coastal Plain streams, and derive most of their flow from ground-water and surface-water storage. Curves for the Menantico Creek near Millville, N.J., and West Branch Cohansey River at Seeley, N.J., are not presented because the drainage basins of these streams upstream from the streamflow-gaging station are smaller than 25 mi². The discharges that were equaled or exceeded 5 percent and 95 percent of the time at Maurice River at Norma are 347 ft³/s and 62 ft³/s, respectively; those for Cohansey River at Seeley are 87 ft3/s and 20 ft3/s, respectively. The discharges that were equaled or exceeded 50 percent of the time are 146 ft3/s for Maurice River at Norma and 34 ft³/s for Cohansey River at Seeley.

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 low-flow discharge at the low-flow, partial-record station with the concurrent mean daily discharge at a streamflow-gaging station, or index station, in a similar hydrogeologic setting. In this study, in addition to the 14 low-flow, partial-record stations, 3 streamflow-gaging stations with a short record were used as low-flow, partial-record stations, in the low-flow-correlation analyses. Measured discharge values at each of these 17 low-flow, partial-record stations were correlated with mean discharge at four index gaging stations within the study area and 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.

The low-flow correlations reported here were developed by use of the MOVE.1 (Maintenance of Variance Extension, Type 1) method, which makes use of geometric means to eliminate the bias of ordinary-least-squares regression (Hirsch, 1982). An example of a low-flow correlation is shown in figure 3-11. The "best-fit" line, or correlation equation, is drawn through the data points that represent the measured discharge at the low-flow, partial-record station, QP_M , plotted against the mean daily discharge at the index gaging station, QI. The equation of the best-fit line, $QP_R = (0.3743) \, QI^{(0.7268)}$, is then used to estimate specific discharge statistics at the lowlow, partial-record station. QPp, on the basis of the values of the same discharge sta 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 estimated 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 7-day, 10-year low flow by using an equation developed specifically for MOVE.1 low-flow correlations by W. O. Thomas, Jr. (U.S. Geological Survey) (Telis, 1991). This equation allows the standard error of estimation to be calculated from the standard error of prediction and the time-sampling error for the index gaging station. The nearer the value (which is a percent) is to zero, the more reliable the predicted discharge, QP_B. This indicator of reliability is calculated only for the 7-day, 10-year low flow, but also is a useful measure of reliability for other MOVE.1-predicted discharges (R.G. Reiser, U.S. Geological Survey, oral commun., 1994). For each lowflow, partial-record site, the three index gaging stations for which the standard errors of estimation were lowest were selected for use in

From these correlations, the 30-day, 5-year low-flow discharge; the 7-day, 10-year low-flow discharge; and the mean annual discharge were calculated for the 17 low-flow, partial-record stations. For example, to estimate the 30-day, 5-year low-flow discharge at the low-flow, partial-record station Barrett Run near Bridgeton, N.J. (01413010), shown in figure 3-11, the 30-day, 5-year low-flow discharge at the index gaging station Menantico Creek near Millville, N.J. (01412000), 13.3 ft³/s, is substituted in the correlation equation, which then is solved for the 30-day, 5-year low-flow discharge at the low-flow, partial-record station (QP_R),

 $QP_B = (0.3743) 13.3 \text{ ft}^3/\text{s}^{(0.7268)}$, and $QP_{R} = 2.5 \text{ ft}^{3}/\text{s}$

By substituting the index-gaging-station discharge values for 7-day, 10-year low flow (7.2 ft³/s) and mean annual flow (37.5 ft³/s) in the correlation equation, the appropriate respective flows, 1.6 ft³/s and 5.2 ft³/s, also are estimated for the low-flow, partialrecord station. This same approach could be used to estimate the mean annual base flow at a low-flow, partial-record station for a drought year. For example, figure 3-7 shows that the mean base flow for Menantico Creek near Bridgeton, N.J. (01412000), in water year 1942 was the lowest on record. The 1942 mean base flow can be estimated for the low-flow, partial-record station Barrett Run near Bridgeton, N.J. (01413010), by using the appropriate prediction equation from table 3-2, QP_R= 0.3743 QI^(0.7268). The 1942 mean base flow for the index gaging station is about 20 ft3/s (fig. 3-7). This value is substituted for QI in the prediction equation to yield a drought-year base-flow estimate of 3.3 ft³/s for Barrett Run near Bridgeton.

Low-flow-correlation prediction equations were developed and used to estimate discharge statistics for all stations listed in table 3-2. Mean base flow was estimated in this way only for those low-flow, partial-record stations that were paired with an index gaging station within the Maurice River study area. Discharge statistics developed from correlation equations provide valuable information about sites for which these statistics would otherwise 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 influence of climatic factors on the hydrology of the unconfined aquifer system in the Maurice River 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 from three National Oceanic and Atmospheric Administration weather stations (fig. 3-1) for the period 1932-94 were used: Wilmington, Del. (1932-62) (National Oceanic and Atmospheric Administration, 1928-95a), and the average from the Glassboro, N.J., and Millville, N.J., weather stations (1963-94) (National Oceanic and Atmospheric Administration, 1928-95b). Until 1963, data from the Wilmington, Del., station were considered to most closely represent precipitation in the study area on the basis of its proximity and the complete precipitation record. In 1963, uninterrupted precipitation records began at the Glassboro, N.J., and Millville, N.J., weather stations (figs. 3-6 through 3-9) in the study area. The Wilmington precipitation record (1932-62) was adjusted slightly downward by using linear regression developed for the period of overlap (1963-94) between the record from the Wilmington station and the average of the records from the Glassboro and Millville stations. These adjusted values are used throughout this report

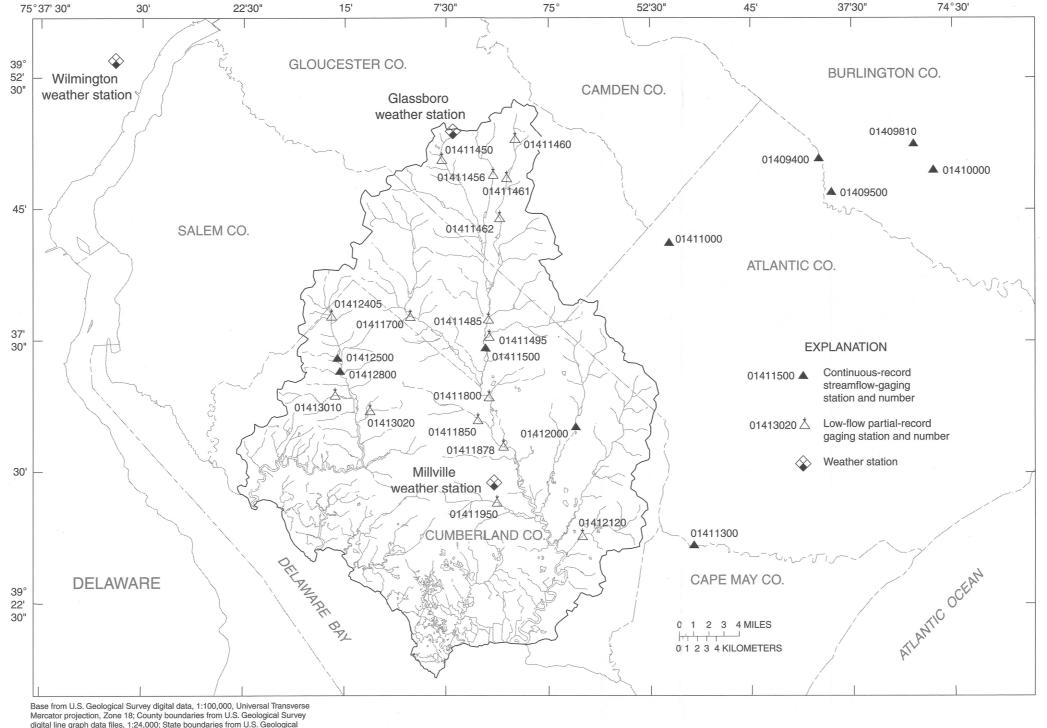
Total annual precipitation during 1932-94 ranged from a minimum of 31.2 in. in water year 1965 to a maximum of 58.2 in. in 1975, with a mean of 42.6 in/yr. Monthly mean, minimum, and maximum precipitation values for the average of the records from the Glassboro and Millville weather stations for 10 water years (1985-94) are shown in figure 3-12. Monthly precipitation ranged from a minimum of 0.43 in. in October 1993 to a maximum of 8.85 in. in March 1987, with a mean of 3.58 in.

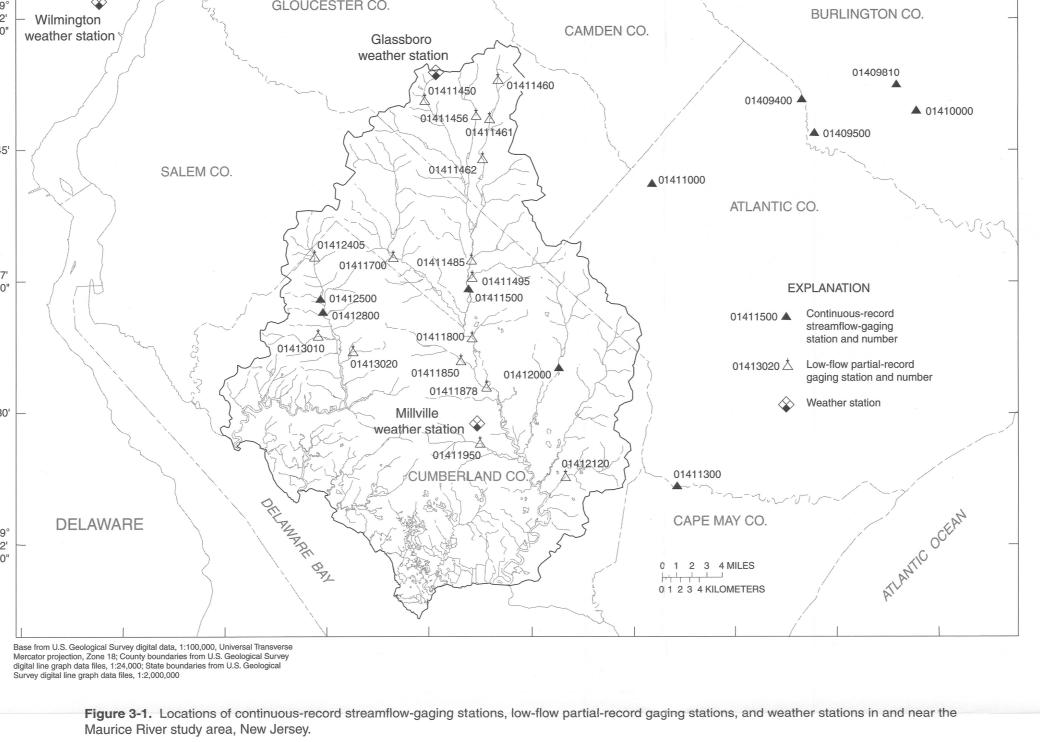
Most of the precipitation that falls on the Maurice River study area leaves as stream discharge (direct runoff plus base flow). Total annual discharge at the four streamflow-gaging stations in the study area was compared to total annual precipitation, which is assumed to be uniform over the study area. (All values in figs. 3-6 through 3-9 are presented in units of inches of water over the area of the basin and units of cubic feet per second; values are discussed below only in units of inches of water over the area of the basin.) The total annual discharge of the Maurice River at Norma, N.J. (01411500), ranged from 8.2 in. in water year 1966 to 30.7 in. in water year 1973 (fig. 3-6). The mean annual discharge was 20.0 in/yr, or 47 percent of the mean annual precipitation for water years 1933-94. The total annual discharge of Menantico Creek near Millville, N.J. (01412000), ranged from 12.6 in. in water year 1981 to 31.7 in. in water year 1979 (fig. 3-7). The mean annual discharge was 21.8 in/yr, or 51 percent of the mean annual precipitation for water years 1932-57 and 1979-84. The total annual discharge of West Branch Cohansey River at Seeley, N.J. (01412500), ranged from 4.1 in. in water year 1966 to 14.9 in. in water year 1961 (fig. 3-8). The mean annual discharge was 9.5 in/yr, or 24 percent of the mean annual precipitation for water years 1952-67. The total annual discharge of Cohansey River at Seeley, N.J. (01412800), ranged from 11.8 in. in water year 1988 to 22.5 in. in water year 1979 (fig. 3-9). The mean annual discharge was 17.14 in/yr, or 40 percent of the mean annual

The percentage of mean annual streamflow that is base flow was similar for the four streamflow-gaging stations (80 to 87 percent of mean annual streamflow). In contrast, mean annual streamflow ranged from 40 to 51 percent of mean annual precipitation at three of the streamflow-gaging stations, but was 24 percent at West Branch Cohansey River at Seeley, N.J. (01412500). This difference is attributed to the fact that the stream reach above the West Branch Cohansey River gaging station is higher and is cut less deeply into the aquifer than the stream reaches above the other three gaging stations. Therefore, it is likely that proportionately more ground water flows underneath the West Branch Cohansey River than underneath the other three streams. Consequently, proportionately less ground water discharges as base flow. The ground water that flows underneath the stream ultimately discharges to stream reaches at lower elevations.

Most of the precipitation that does not discharge as streamflow leaves the Maurice River study area as evapotranspiration. Potential evapotranspiration was estimated by using the Thornthwaite equation (Thornthwaite and Mather, 1957), which uses mean monthly air temperature and latitude as an index of the energy available for evapotranspiration. Potential evapotranspiration is the amount of water that is lost through transpiration from plants and evaporation from the soil if water is always unlimited. The average mean monthly air temperature at the Glassboro and Millville weather stations during 1985-94 (National Oceanic and Atmospheric Administration, 1928-95c) is shown in figure 3-13. Estimated mean monthly potential evapotranspiration is shown in figure 3-14. The

calculated mean annual potential evapotranspiration for the study area for the period of the water budget (1985-94) is 28.9 in/yr.





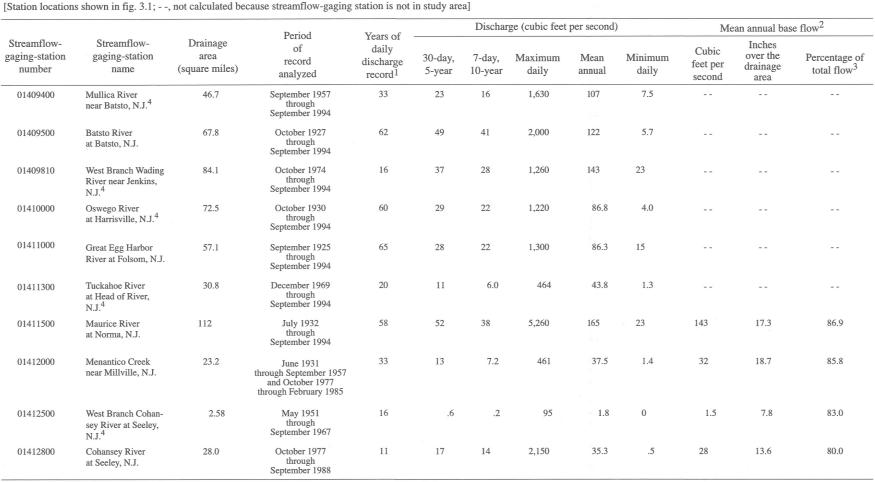


Table 3-1. Summary of discharge statistics for continuous-record streamflow-gaging stations in and near the Maurice River study area, New Jersey

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, 1990. ²Base flow was estimated by using the 3-day sliding-interval technique described by Pettyjohn and Henning (1979) and adapted by Sloto (1988). Base flow was calculated by using data for the water year. The water year is the 12-month period from October 1 through September 30. It is designated by the calendar year in which it ends. For base flow in this study, the periods of record begin with the earliest October 1 and end with the latest September 30. reentages were calculated from unrounded discharge values and therefore may not be precisely reproducible from the discharge values shown here.

Table 3-2. Correlation equations relating instantaneous low-flow measurements at low-flow partial-record gaging stations to concurrent mean daily flow at continuous-record streamflow-gaging stations (index stations) in and near the Maurice River study area, New Jersey [Station locations shown in fig. 3-1; QP_R, predicted discharge at partial-record station; QI, measured discharge at index station; --, not calculated because mean base flow was predicted only from correlation equations developed from index stations located in the study area]

Standard error of

estimation for 7-day,

10-year low-flow

⁴Natural flow is altered by upstream regulation of impounded water and (or) diversion of water to or from the stream.

Low-flow

partial-record

gaging-station

low-flow correlation equation (R.D. Schopp, U.S. Geological Survey, oral commun., 1996).

gaging-station

Low-flow

partial-record

gaging-station

number	name	(square miles)	number	analysis	record ¹	coefficient	discharge (percent) ²	- 1	5-year QP _R	10-year QP _R	annual QP _R	Cubic feet per second	year over the drainage area	of total flow
01411450	Still Run at Aura, N.J.	3.21	01409400 01409810 01411500	22 21 22	33 16 58	0.82 .76 .77	22.6 26.8 27.3	$QP_R = .02023 QI (1.1739)$ $QP_R = .00720 QI (1.3234)$ $QP_R = .00665 QI (1.2252)$	0.8 .8 .8	0.5 .6 .6	4.9 5.1 3.5	2.9	12.3	83
01411456	Little Ease Run near Clayton, N.J. ³	9.77	01409400 01411000 01411500	51 59 64	33 65 58	.92 .96 .94	17.9 9.9 14.2	$QP_R = .00488 \text{ QI } (1.638)$ $QP_R = .0008329 \text{ QI } (2.1088)$ $QP_R = .0002461 \text{ QI } (2.0637)$.8 1.0 .9	.5 .6 .4	10.3 10.1 9.5	 47.8	4 _{10.8}	4 ₈₂
01411460	Scotland Run near Williamstown, N.J.	3.96	01411000 01411300 01411500	22 22 20	65 20 58	.83 .84 .89	16.5 18.8 11.5	$QP_R = .03734 QI (1.0975)$ $QP_R = .19343 QI (0.8712)$ $QP_R = .03288 QI (0.9502)$	1.5 1.5 1.4	1.1 .9 1.0	5.0 5.2 4.3	3.7	12.6	 86
01411461	Scotland Run at Fries Mill, N.J.	9.25	01409400 01411000 01411500	18 22 21	33 65 58	.68 .70 .82	34.8 44.8 27.7	$QP_R = .37665 QI (0.7239)$ $QP_R = .01282 QI (1.5922)$ $QP_R = .01182 QI (1.3614)$	3.7 2.6 2.6	2.8 1.8 1.7	11.1 15.5 12.6	10.2	 14.9	 81
01411462	Scotland Run at Franklin- ville, N.J.	14.8	01409400 01410000 01411500	20 20 20	33 60 58	.87 .88 .87	13.6 10.5 13.5	$QP_R = .22468 \text{ QI } (1.0212)$ $QP_R = .10745 \text{ QI } (1.2095)$ $QP_R = .06999 \text{ QI } (1.0950)$	5.6 6.3 5.3	3.8 4.4 3.7	26.5 23.8 19.0	16.0	 14.7	 84
01411485	Maurice River at Brotmanville, N.J. ⁴	88.1	01409400 01411000 01411500	9 10 9	33 65 58	.95 .95 .99	10.4 7.4 4.8	$\begin{array}{l} {\rm QP_R} = & 2.17551 \; {\rm QI} \; \stackrel{(0.8760)}{\rm CP_R} = & 1.24705 \; {\rm QI} \; \stackrel{(1.0412)}{\rm CP_R} = & 20777 \; {\rm QI} \; \stackrel{(1.2804)}{\rm CP_R} \end{array}$	34.4 40.5 32.6	24.6 31.5 21.8	130 129 145	 119	18.4	82
01411495	Blackwater Branch at Norma, N.J. ³	12.5	01410000 01411300 01411500	16 13 13	60 20 58	.90 .92 .97	11.2 18.7 3.2	$\begin{array}{l} {\rm QP_R} = \; .31269 \; {\rm QI} \; ^{(0.8887)} \\ {\rm QP_R} = \; .96797 \; {\rm QI} \; (0.7769) \\ {\rm QP_R} = \; .20878 \; {\rm QI} \; ^{(0.8606)} \end{array}$	6.2 6.1 6.2	4.8 3.9 4.8	16.5 18.2 17.1	15.0	16.2	 87
01411700	Muddy Run at Centerton, N.J.	37.3	01409400 01410000 01412000	16 16 12	33 60 33	.76 .71 .85	21.2 20.9 12.2	$QP_R = .79052 QI (0.8679)$ $QP_R = .38331 QI (1.0657)$ $QP_R = 1.6933 QI (0.8783)$	12.2 13.9 16.4	8.8 10.1 9.5	45.6 44.6 40.8	35.4	12.9	 87
01411800	Maurice River near Millville, N.J. ³	191	01409400 01411000 01411500	17 17 17	33 65 58	.92 .97 .97	12.8 6.8 7.0	$QP_R = 3.6899 QI (0.9264)$ $QP_R = 2.41296 QI (1.074)$ $QP_R = 1.0789 QI (1.0794)$	68.5 87.4 76.6	48.1 67.5 54.5	280 290 270	229	16.3	 85
01411850	Mill Creek near Millville, N.J.	15.1	01409400 01411000 01411500	13 13 15	33 65 58	.88 .89 .88	16.2 14.0 15.0	$QP_R = .18865 QI (0.9572)$ $QP_R = .05961 QI (1.2565)$ $QP_R = .04317 QI (1.1333)$	3.9 4.0 3.8	2.7 2.9 2.6	16.5 16.1 14.3	 12.0	10.8	 84
01411878	Maurice River at Union Lake Dam at Millville, N.J.	216	01409500 01411000 01411500	21 20 20	62 65 58	.75 .79 .95	31.6 23.5 8.9	$\begin{array}{l} {\rm QP}_{\rm R} = .15118 \; {\rm QI} \; ^{(1.612)} \\ {\rm QP}_{\rm R} = 1.81746 \; {\rm QI} \; ^{(1.1753)} \\ {\rm QP}_{\rm R} = 1.29526 \; {\rm QI} \; ^{(1.0731)} \end{array}$	78.9 92.4 89.7	60.7 69.6 64.0	349 343 314	266	 16.7	 85
01411950	Buckshutem Creek near Laurel Lake, N.J.	16.1	01411300 01411500 01412000	15 16 12	20 58 33	.91 .84 .91	62.8 65.5 34.2	$\begin{array}{l} {\rm QP_R} = .000001565 \; {\rm QI} \stackrel{(4.4939)}{=} \\ {\rm QP_R} = .000000375 \; {\rm QI} \stackrel{(3.2739)}{=} \\ {\rm QP_R} = .0003606 \; {\rm QI} \stackrel{(2.8353)}{=} \end{array}$.1 .2 .6	0 .1 .1	37.3 7.1 10.5	4.3 6.6	3.6 5.6	60 63
01412100	Manumuskin River near Manumuskin, N.J.	32.1	01411000 01409500 01411500	14 14 14	65 62 58	.96 .96 .93	4.5 4.3 6.7	$QP_R = .329 \text{ QI } (1.065)$ $QP_R = .036 \text{ QI } (1.483)$ $QP_R = .340 \text{ QI } (0.917)$	11.6 11.5 12.7	8.9 9.0 9.5	37.9 45.1 37.2	32.2	13.6	 86
01412120	Muskee Creek near Port Eliz- abeth, N.J.	13.1	01411300 01411500 01409500	14 15 15	20 58 62	.65 .73 .68	34.2 37.2 30.7	$QP_R = 1.374 QI \frac{(0.728)}{2000}$ $QP_R = .0174 QI \frac{(1.4033)}{2000}$ $QP_R = .0076 QI \frac{(1.7079)}{2000}$	7.7 4.4 5.8	5.1 2.8 4.4	21.6 22.9 27.8	18.4	19.1	80
01412405	Cohansey- River near- Beals Mills, N.J.	9.44	01410000 01411500 01412000	16 16 12	60 58 33	.85 .84 .82	8.7 10.6 11.8	$\begin{array}{l} {\rm QP_R} = \ .17598 \ {\rm QI} \ ^{(0.872)} \\ {\rm QP_R} = \ .14673 \ {\rm QI} \ ^{(0.7666)} \\ {\rm QP_R} = \ .59502 \ {\rm QI} \ ^{(0.7357)} \end{array}$	3.3 3.0 4.0	2.6 2.4 2.5	8.6 7.4 8.6	6.6 7.6	9.5 10.9	89 89
01413010	Barrett Run- near Bridge- ton, N.J.	7.02	01411000 01411500 01412000	14 14 9	65 58 33	.74 .75 .89	27.7 27.2 7.1	$QP_R = .00818 QI (1.5215)$ $QP_R = .00783 QI (1.3095)$ $QP_R = .3743 QI (0.7268)$	1.3 1.4 2.5	.9 .9 1.6	7.2 6.4 5.2	5.2 4.6	10.1 9.0	82 89
01413020	Indian Fields- Branch at Bridgeton, N.J.	4.64	01410000 01412000	16 12	60 33	.67 .80	14.6 10.1	$QP_R = .36706 QI (0.7163)$ $QP_R = .956 QI (0.6156)$	4.1 4.7	3.0 3.2	9.0 8.9	8.1	23.6	91

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, 1990. Calculated for the 7-day, 10-year low-flow discharge, but also is a useful measure of reliability for other 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 (R.G. Reiser, U.S. Geological Survey, oral commun., 1994). ontinuous-record streamflow-gaging station with a short record. For purposes of this study this station is used as a low-flow partial-record station.

⁴The correlation equation was not used to predict base-flow discharge for this station. Instead, the continuous record allowed a more reliable long-term base-flow value to be estimated by applying the percentage of base flow to mean annual flow (81.64) from the continuous record to the mean annual discharge predicted from the

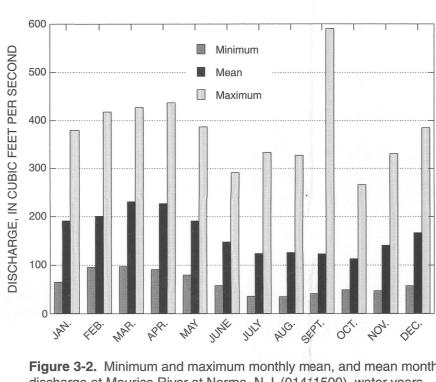
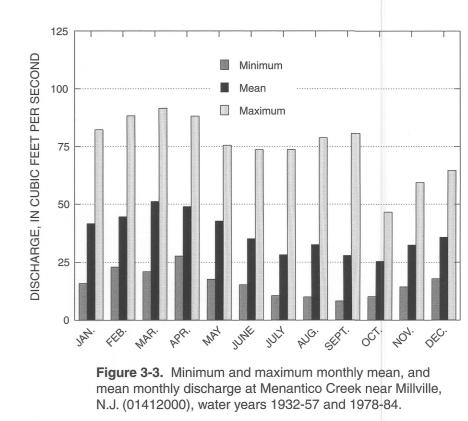


Figure 3-2. Minimum and maximum monthly mean, and mean monthly discharge at Maurice River at Norma, N.J. (01411500), water years 1933-94.



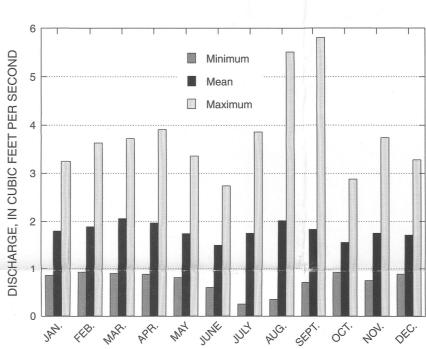


Figure 3-4. Minimum and maximum monthly mean, and mean monthly discharge at West Branch Cohansey River at Seeley, N.J. (01412500), water years 1952-67.

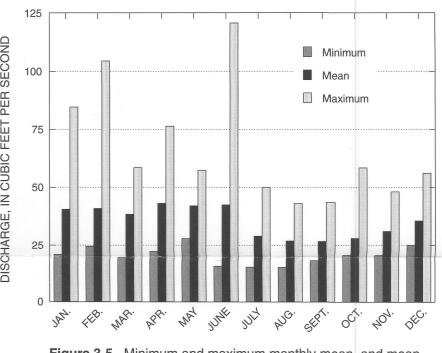


Figure 3-5. Minimum and maximum monthly mean, and mean monthly discharge at Cohansey River at Seeley, N.J. (01412800). water years 1978-88.

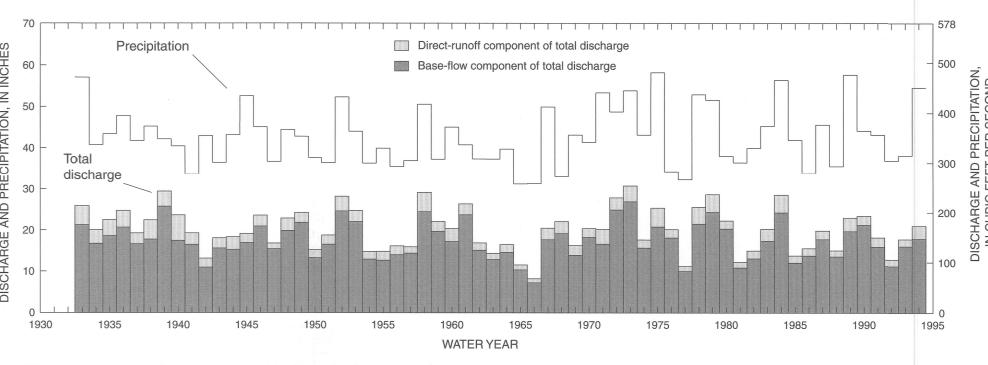


Figure 3-6. Average of total annual precipitation at the Glassboro, N.J., and Millville, N.J., weather stations (National Oceanic and Atmospheric Administration, 1928-95a, 1928-95b), and total annual discharge, base flow, and direct runoff at Maurice River at Norma, N.J. (01411500), water years 1933-94.

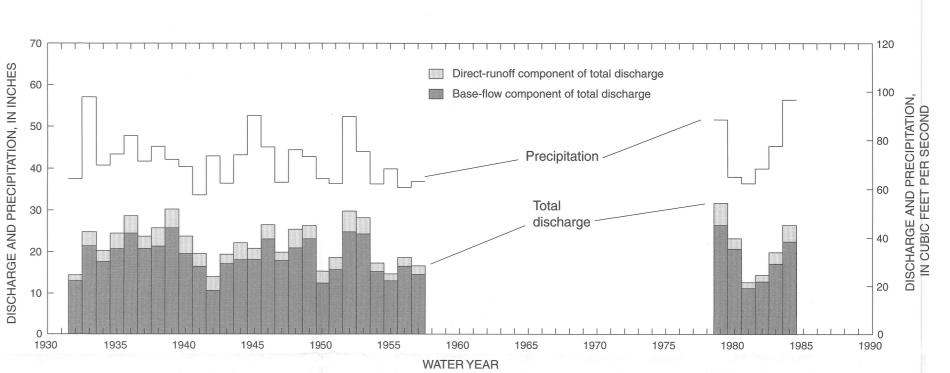


Figure 3-7. Average of total annual precipitation at the Glassboro, N.J., and Millville, N.J., weather stations (National Oceanic and Atmospheric Administration, 1928-95a, 1928-95b), and total annual discharge, base flow, and direct runoff at Menantico Creek near Millville, N.J. (01412000), water years 1932-57 and 1979-84.

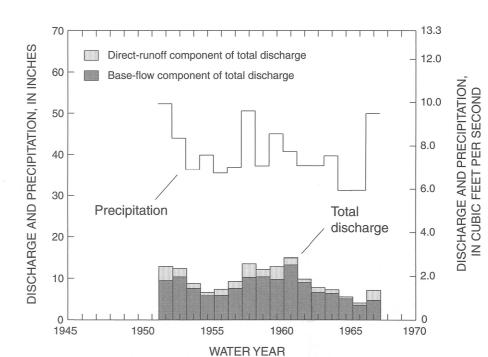


Figure 3-8. Average of total annual precipitation at the Glassboro, N.J., and Millville, N.J., weather stations (National Oceanic and Atmospheric Administration, 1928-95a, 1928-95b), and total annual discharge, base flow, and direct runoff at West Branch Cohansey River at Seeley, N.J. (01412500), water years 1952-67.

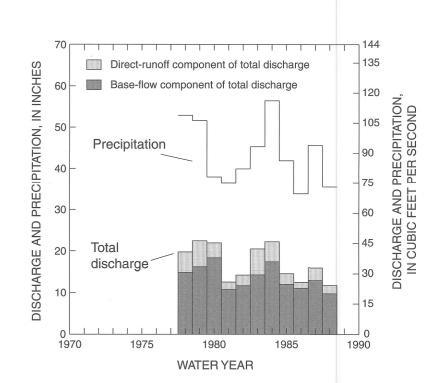


Figure 3-9. Average of total annual precipitation at the Glassboro, N.J., and Millville, N.J., weather stations (National Oceanic and Atmospheric Administration, 1928-95a, 1928-95b), and total annual discharge, base flow, and direct runoff at Cohansey River at Seeley, N.J. (0142800), water years 1978-88.

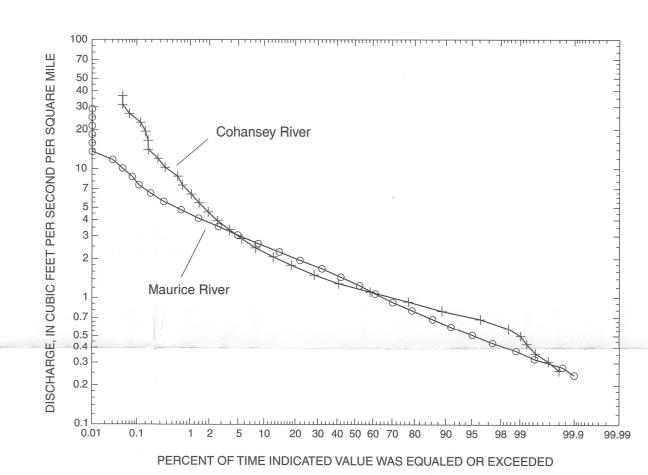


Figure 3-10. Duration curves of mean daily flow, Maurice River at Norma, N.J. (01411500), water years 1933-94, and Cohansey River at Seeley, N.J. (01412800), water years 1978-88.

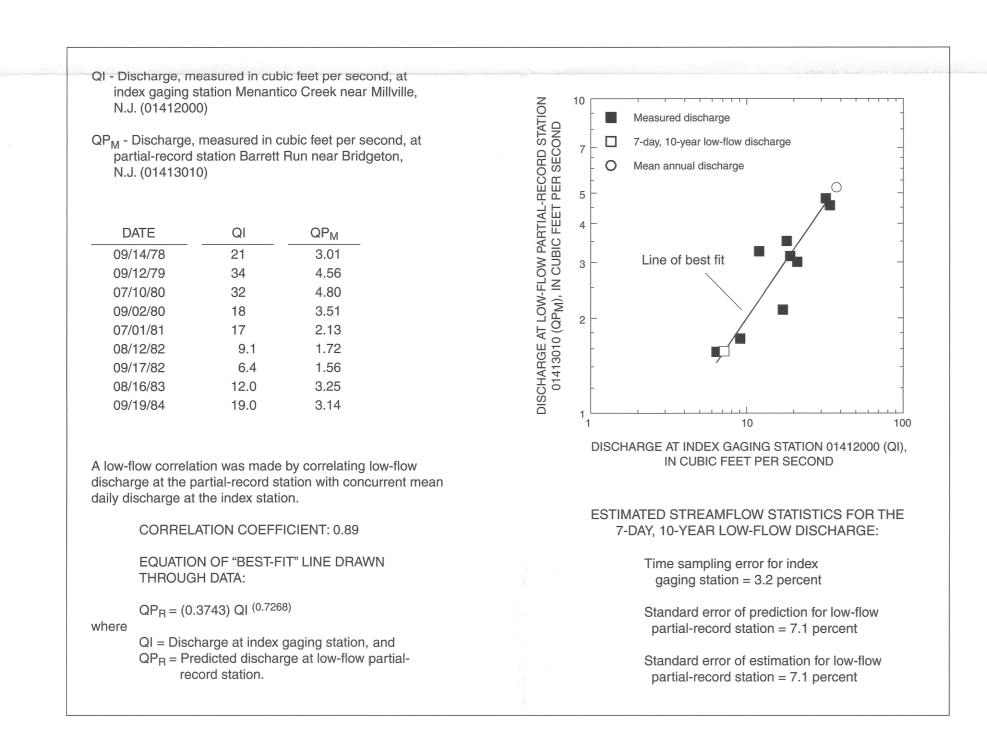
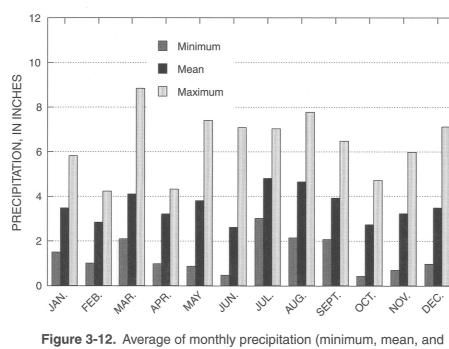


Figure 3-11. Low-flow correlation of discharge at Barrett Run near Bridgeton, N.J., partial-record station (01413010) with discharge at Menantico Creek near Millville, N.J., index gaging station (01412000).

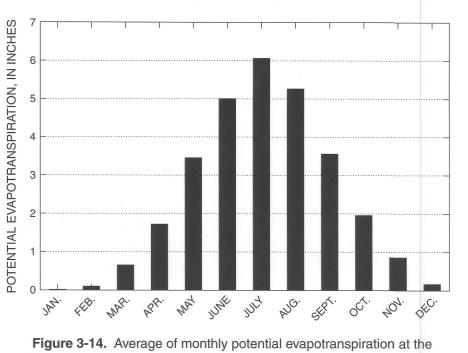


Predicted discharge (QP_R)

(cubic feet per second)

base flow (QP_R)

Figure 3-13. Average of monthly air temperature at the Glassboro, N.J., maximum) at the Glassboro, N.J., and Millville, N.J., weather stations, and Millville, N.J., weather stations, water years 1985-94 (National water years 1985-94 (National Oceanic and Atmospheric Administration, Oceanic and Atmospheric Administration, 1928-95c).



Glassboro, N.J., and Millville, N.J., weather stations, water years 1985-94 (National Oceanic and Atmospheric Administration, 1928-95c).

Emmanuel G. Charles, Donald A. Storck, and Rick M. Clawges