REPORT OF

THE RIVER MASTER

OF THE DELAWARE RIVER

For the period
December 1, 1989 - November 30, 1990

by Stanley P. Sauer, William E. Harkness, and Bruce E. Krejmas
with a section on water quality by Kirk E. White

U.S. Geological Survey

Open-File Report 92-71

Reston, Virginia

1992

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To Obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Volume	
million gallons (Mgal)	3,785	cubic meter
million gallons (Mgal)	1.547	cubic foot per second-day
billion gallons (Bgal)	3.785	cubic hectometer
cubic foot per second-day ($(ft^3/s) \cdot d$)	0.002447	cubic hectometer
	Flow	
million gallons per day (Mgal/d)	1.547	cubic foot per second
million gallons per day (Mgal/d)	0.04381	cubic meter per second
billion gallons per day (Bgal/d)	1547	cubic foot per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 -- a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Section I

RIVER MASTER LETTER OF TRANSMITTAL

and

SPECIAL REPORT

OFFICE OF THE DELAWARE RIVER MASTER
United States Geological Survey
433 National Center, Reston, Virginia 22092

March 2, 1992

The Honorable
William H. Rehnquist
Chief Justice of the Supreme Court
of the United States

The Honorable
Michael N. Castle
Governor of Delaware

The Honorable
James J. Florio
Governor of New Jersey

The Honorable
Mario M. Cuomo
Governor of New York

The Honorable
Robert P. Casey
Governor of Pennsylvania

The Honorable
David N. Dinkins
Mayor of the City of New York

New Jersey v. New York et al
No. 5, Original, October Term 1950

Dear Sirs:

For the record and in compliance with the provisions of the Amended Decree of the Supreme Court of the United States entered June 7, 1954, I am transmitting herewith the thirty-seventh Annual Report of the River Master of the Delaware River for the year December 1, 1989 to November 30, 1990.

Precipitation in the upper Delaware River basin during the 1990 River Master report year ranged from 29 percent of the long-term average during December to 187 percent during August (See table 1). Total precipitation during the year was 1.48 inches above average. Precipitation during the December to May period, when reservoirs typically refill, was slightly below average. However, the wet conditions during January and May filled the reservoirs and helped to keep flows above median for most of the year.

On December 1, 1989, when this report year began, combined storage in the New York City reservoirs in the upper Delaware River basin was 238 billion gallons (Bgal), 88 percent of the combined storage capacity. Median storage on December 1, based on 22 years of data, is 158 Bgal.

During the December through May period, storage in the New York City reservoirs usually increases in response to lower demand for water and to higher base flows in the streams in the basin. During the 1990 report year, storage began to decline in early December, in response to the very low precipitation and declined steadily until mid-January. However, in response to increased precipitation and warmer temperatures during the last ten days of January, the storage increased rapidly. Cannonsville Reservoir filled to capacity and began spilling by the end of January and the combined storage continued to increase throughout February reaching 99 percent of capacity by month end.

The reservoirs reached a maximum of 276.271 Bgal, combined storage for the report year on May 18, 1990 when all three reservoirs were spilling. On June 1, 1990, the start of the water-operations year, storage was 271.027 Bgal and Cannonsville Reservoir was spilling.

Throughout the year, diversions to supply water for New York City and releases designed to maintain the flow of the Delaware River at Montague were made as directed by this office. Diversions by New York City from the Delaware River basin reservoirs did not exceed the limit specified by the Decree.

The Delaware River Master Advisory Committee met at Port Jervis, New York on May 15, 1990 to discuss hydrologic conditions in the basin and operational procedures for the 1990 release season. As River Master, I informed the committee that, on the basis of information provided by New York City, the excess quantity to be released beginning June 15 was 7.381 Bgal. This water would be released at rates designed to maintain the Montague target flow at 100 ft^3/s above the normal 1,750 ft^3/s specified by the Decree.

On August 8, 1990, New York State requested that the Delaware River Basin Commission (DRBC) and the Parties to the Decree consider setting aside 2,000 cfs-days of the excess-release quantity, to be used if needed, for thermal protection prior to September 30, 1990. The request was based on the extraordinary hydrologic conditions in the basin that had resulted in unusually high demands on the 6,000 cfs-day thermal-release bank.

On August 15, 1990, with the unanimous approval of the Parties to the Decree, the Executive Director of the DRBC took emergency action to approve the request. This office received notification of that action on August 17, 1990. Following consultation with the parties to the Decree, I approved the request and made it effective on August 15, 1990 to coincide with the action by DRBC. We subsequently received the signed unanimous consent to the action.

On August 27, 1990, the original 6,000 $(ft^3/s)\cdot d$ thermal-release bank ran out and by September 13, 1,656 $(ft^3/s)\cdot d$ of the additional 2,000 $(ft^3/s)\cdot d$ was used. As prescribed in the agreement, the unused portion, 344 $(ft^3/s)\cdot d$, was returned to the excess-release quantity on October 1,1990.

During the report year, the River Master and staff participated in meetings of the Delaware River Basin Commission to assess water-supply conditions. Upon invitation of the representatives of the Parties to the Decree, the Deputy River Master met periodically with those representatives as a member of the Flow Management Technical Advisory Committee. Discussions primarily centered on proposals for the management of releases from reservoirs in the basin and other measures designed to cope with streamflow deficiences whenever they occur.

The U.S. Geological Survey continued the operation of its field office of the Delaware River Master at Milford, Pennsylvania. William E. Harkness, Deputy Delaware River Master, continued in charge of the office, assisted by Bruce E. Krejmas and Beverly A. Roberts.

During the report year, the Milford office continued the weekly distribution of summary river data. These weekly reports contained preliminary data on releases from the New York City reservoirs to the Delaware River, diversions to the New York City water-supply system, reservoir contents, daily segregation of flow of the Delaware River at Montague gaging station, and diversions by New Jersey. The reports were made available to the State and City representatives on the Delaware River Master Advisory Committee and to other parties interested in the Delaware River operations. A special monthly summary of past hydrologic conditions, supplemented by an "outlook" of the river flow for the forthcoming month, was made available to the representatives on the Advisory Committee.

Section II of this report describes in detail Delaware River operations during the report year. As shown on page 16, the City of New York diverted a total of 256.145 Bgal from the basin during the report year ending November 30, 1990 and released 69.187 Bgal from Pepacton, Cannonsville, and Neversink Reservoirs to the Delaware River during the same period. The River Master directed releases to the Delaware River from these reservoirs totaling 28.427 Bgal.

Section III of this report describes water quality at various sites in the Delaware River Estuary. It was prepared by Kirk E. White, U.S. Geological Survey, Malvern, Pennsylvania and contains data showing the extent of salinity encroachment and other water-quality characteristics in the estuary.

During the report year, the following individuals functioned as members of the River Master Advisory Committee:

Delaware	Dr. Robert R. Jordan
New Jersey	Dirk C. Hofman, P.E. Steven Nieswand
New York	Russell C. Mt. Pleasant
New York City	Harvey W. Schultz Albert F. Appleton
Pennsylvania	John E. McSparran

The appreciation of the River Master and staff is expressed for the continued excellent cooperation of all the representatives of the Parties to the Decree. Also, appreciation is extended to the Pennsylvania Power & Light Company and the Orange and Rockland Utilities, Inc. for their cooperation in keeping us informed of their plans for power generation and resulting releases as requested by this office. As usual, it is gratifying to report that New York City complied willingly with the terms of the Decree and with the directives of the River Master. New Jersey also cooperated fully with the directives of the River Master concerning their diversions from the basin.

A draft of this report was furnished to the Advisory Committee members for comment.

Sincerely yours,

Stanley P. Sauer

Stanley P. Sauer, P.E.
Delaware River Master

Section II

REPORT OF DELAWARE RIVER OPERATIONS

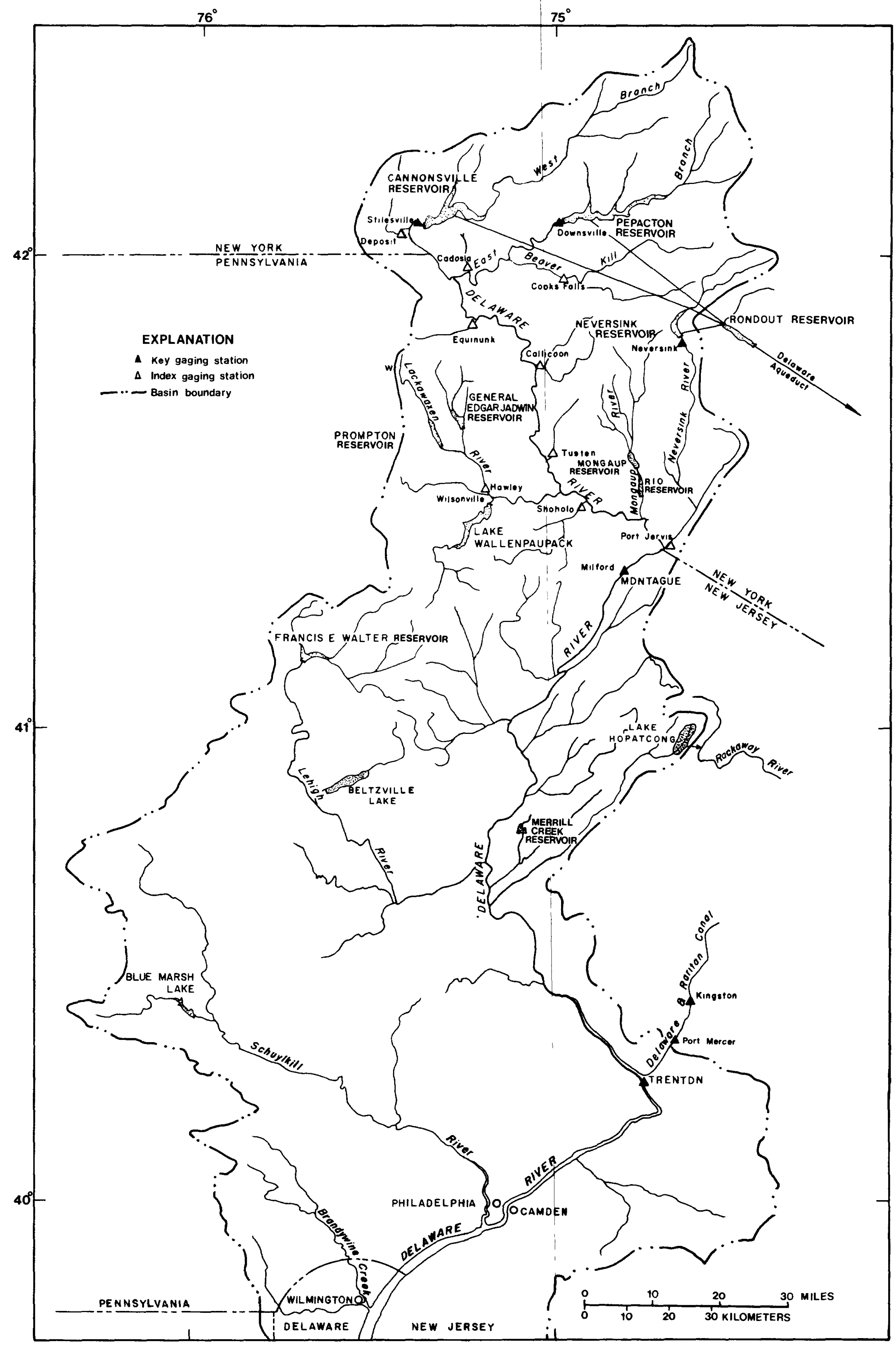

Figure 1. - Delaware River Basin upstream from Wilmington, Delaware.

Section II

REPORT OF DELAWARE RIVER OPERATIONS

by William E. Harkness and Bruce E. Krejmas

ABSTRACT

A Decree of the Supreme Court of the United States in 1954 established the position of Delaware River Master. The Decree authorizes diversions of water from the Delaware River basin (fig. 1) and requires compensating releases from certain New York City owned reservoirs to be made under the supervision and direction of the River Master. Reports to the Court, not less frequently than annually, were stipulated.

During the 1990 report year, December 1, 1989, to November 30, 1990, the monthly precipitation and runoff ranged from below average to above average in the Delaware River basin. For the year as a whole, precipitation was 1.48 inches above average. Reservoir storage in the basin declined briefly in December and January, but remained above median throughout the winter months. Operations were conducted as prescribed in the Decree throughout the year except that at the request of the Parties to the Decree, additional releases to provide thermal protection were made from the excess-release quantity between August 27 and September 13, 1990.

Diversions from the Delaware River basin by New York City and New Jersey did not exceed those authorized by the terms of the Amended Decree. Releases were made as directed by the River Master at rates designed to meet the Montague flow objective on 76 days during the year. Releases were made at the augmented conservation rates or, at other times, at rates designed to relieve thermal stress in the streams downstream from the reservoirs at other times. The excess release quantity as defined by the Decree was not expended by the end of the report year and the Montague design rate remained at 1,850 ft3/s on November 30, 1990.

New York City and New Jersey complied fully with the terms of the Decree and with the directives of the River Master during the year.

INTRODUCTION

The Amended Decree of the United States Supreme Court entered June 7, 1954 authorized diversions of water from the Delaware River basin and provided for releases of water from certain New York City reservoirs to the Delaware River to be made under the supervision and direction of the River Master. The Decree also stipulated that reports be made to the Court not less frequently than annually. This report describes the River Master operations from December 1, 1989 to November 30, 1990.

Part of the hydrologic data presented are records of flow and water quality at U.S. Geological Survey gaging stations. These records were collected, computed, and furnished by the Offices of the U.S. Geological Survey at Albany, New York, Malvern, Pennsylvania, and West Trenton, New Jersey, in cooperation with the States of New York and New Jersey, the Commonwealth of Pennsylvania, and the City of New York.

Definitions of Terms and Procedures

The following definitions apply to various terms and procedures used in the operations described in this report. A table for converting inch-pound units to International System of Units (SI) is given on page v. The map of the Delaware River basin (fig. 1), indicates the location of pertinent streams and reservoirs.

Time of day. - Time of day is expressed in 24-hour eastern standard time, which included a 23-hour day April 1 and a 25-hour day October 28.

Rate of flow. - Mean discharge for any stated 24-hour period, in cubic feet per second (ft^3/s) or million gallons per day (Mgal/d).

Rate of flow at Montague. - Daily mean discharge of the Delaware River at Montague, N.J., on a calendar-day basis.

Reservoir-controlled releases. - Controlled releases from reservoirs passed through outlet valves in the dams or through turbines in powerplants. This does not include spillway overflow at the reservoirs.

Uncontrolled runoff at Montague. - Runoff from the drainage area upstream from Montague exclusive of the drainage area upstream from the Downsville, Cannonsville, Neversink, Wallenpaupack, and Rio dams but including spillway overflow at these dams.

Point of maximum reservoir depletion. - Elevation at the top of the highest outlet, sometimes referred to as minimum full-operation level.

Storage or contents. - Usable volume of water in a reservoir. Unless otherwise indicated, volume is computed on the basis of level pool and above the point of maximum depletion.

Capacity. - Total usable volume between the point of maximum depletion and the elevation of the lowest crest of the spillway.

Diversions. - The transfer of water by New York City from Pepacton, Cannonsville, and Neversink Reservoirs in the upper Delaware River basin through the East Delaware, West Delaware, and Neversink Tunnels, respectively, to its water-supply system. Also, the transfer of water by New Jersey from the Delaware River through the Delaware and Raritan Canal.

Excess quantity and seasonal period for its release. - As defined in the Decree, the excess quantity of water equals 83 percent of the amount by which the estimated consumption in New York City during the year is less than the City's estimate of continuous safe yield (1,665 Mgal/d stipulated by 1954 Decree) from all its sources of supply obtainable without pumping, except that the excess quantity should not exceed 70 billion gallons. Each year the "seasonal period" for release of the excess quantity begins on June 15. The design rate for that period becomes effective at Montague on that date and continues in effect until the following March 15, or until the cumulative total of excess-release credits becomes equal to the seasonal quantity, whichever occurs first.

Daily excess-release credits. - Daily credits and deficits during the seasonal period are equal to the algebraic difference between the daily mean discharge at Montague and 1,750 ft^3/s; however, the daily credit cannot exceed the 24-hour period releases from Pepacton, Cannonsville, and Neversink Reservoirs routed to Montague and made in accordance with direction, with the following exception. During the seasonal period, credits are also made for part or all of other releases from these reservoirs contributing to daily mean discharge at Montague between the excess-release rate and 1,750 ft^3/s.

Precipitation

Precipitation measured in the basin above Montague totaled 44.68 inches for the 1990 report year and was 1.48 inches above the long-term average. Monthly precipitation ranged from 29 percent of the long-term average in December, 1989 to 187 percent of the average in August 1990. Table 1 compares the monthly precipitation during the report year with the long-term average.

Table 1.- Precipitation in inches,
Delaware River basin upstream from Montague, N.J.

Month	December 1940 to November 1989 Monthly Average	December 1989 to November 1990			
		Amount	Percentage of average	Excess (+) or deficit (-) Month	Excess (+) or deficit (-) Cumulative
December	3.38	0.97	29	-2.41	-2.41
January	2.86	4.42	155	+1.56	-.85
February	2.75	2.99	109	+.24	-.61
March	3.24	2.53	78	-.71	-1.32
April	3.75	2.79	74	-.96	-2.28
May	4.27	6.35	149	+2.08	-.20
June	3.96	2.75	69	-1.21	-1.41
July	4.14	3.67	89	-.47	-1.88
August	3.91	7.32	187	+3.41	+1.53
September	3.76	1.74	46	-2.02	-.49
October	3.36	5.29	157	+1.93	+1.44
November	3.82	3.86	101	+.04	+1.48
12 months	43.20	44.68	103	+1.48	

These data were computed from records collected by the National Weather Service, New York City Department of Environmental Protection, Bureau of Water Supply and the River Master, at ten stations distributed over the basin area above Montague.

December to May is generally considered the normal time of year when surface- and ground-water reservoirs fill. During this period in 1989-90, precipitation totaling 20.05 inches was observed, which was 99 percent of the 49-year average. During June to November, 24.63 inches of precipitation was observed, which was 107 percent of the long-term average. The maximum monthly precipitation received during the year for any of the ten stations was 8.92 inches in August at Callicoon, New York; the minimum monthly precipitation observed was 0.47 inches in December at Downsville Dam.

Acknowledgments

The River Master daily operation records were prepared by the Milford Office of the Delaware River Master from hydrologic data collected principally on a day-to-day basis. Data for these records were collected and computed by the Milford Office or were furnished by agencies as follows: Data from Pepacton, Cannonsville, and Neversink Reservoirs by the New York City Department of Environmental Protection, Bureau of Water Supply; from Delaware and Raritan Canal by the New Jersey Water Supply Authority; from Lake Wallenpaupack by the Pennsylvania Power & Light Company; and from Rio Reservoir by Orange and Rockland Utilities, Inc. Precipitation data and quantitative precipitation forecasts were provided by the National Oceanic and Atmospheric Administration, National Weather Service.

OPERATIONS

December through May

During the first half of the report year, precipitation was 0.20 inches below average and ranged from 29 percent of the long-term average in December to 155 percent in January (table 1.) Runoff in the upper basin was below normal during December, March and April and was above normal during February and May.

On December 1, 1989, Pepacton Reservoir contained 119.563 Bgal of water in storage above the point of maximum depletion, or 85.3 percent of the reservoir's storage capacity of 140.190 Bgal. Cannonsville Reservoir contained 91.386 Bgal, or 95.5 percent of the reservoir's storage capacity of 95.706 Bgal and Neversink Reservoir contained 27.473 Bgal, or 78.6 percent of the reservoir's storage capacity of 34.941 Bgal. The combined storage in the three reservoirs as of December 1 was 238.422 Bgal, or 88.0 percent of their combined capacity. Daily storages in Pepacton, Cannonsville, and Neversink Reservoirs are shown in tables 10, 11, and 12, respectively, and the combined storage is shown graphically in figure 2.

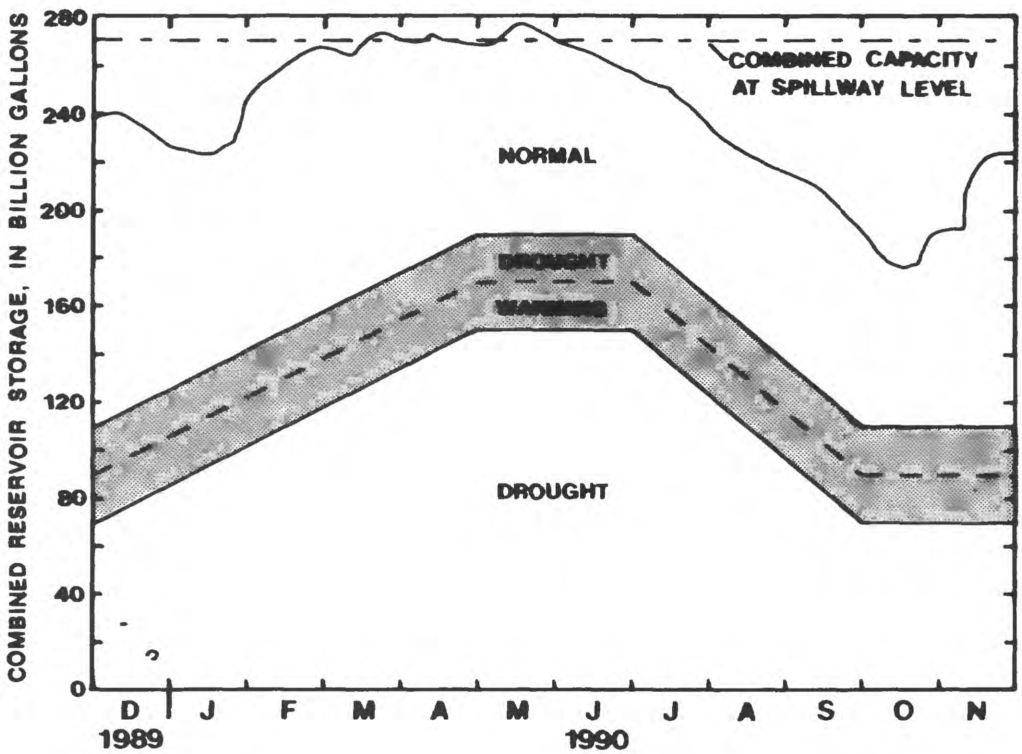

Figure 2. - Operating curves for New York City reservoirs in the Delaware River basin compared with the actual contents of the reservoirs, December 1, 1989 to November 30, 1990 (Sources: Operating curves from Interstate Water Management Recommendations of the Parties to the U.S. Supreme Court Decree of 1954, reservoir contents from New York City Bureau of Water Supply data.)

Operations on December 1, 1989 were being conducted as prescribed by the Decree. The Montague flow objective was 1,750 ft^3/s and the allowable diversions to New York City and New Jersey were 800 Mgal/d and 100 Mgal/d respectively. The average diversion to New York City since June 1, 1989 was 663 Mgal/d. Conservation releases from New York City reservoirs were being made at the augmented levels shown in table 2.

Table 2.- Conservation release rates for New York City Delaware River basin reservoirs

Reservoir	Operative dates	Conservation releases rates Basic (ft^3/s)	Augmented (ft^3/s)
Neversink	April 1-7	5	45
	April 8 to October 31	15	45
	November 1 to March 31	5	25
Pepacton	April 1-7	6	70
	April 8 to October 31	19	70
	November 1 to March 31	6	50
Cannonsville	April 1-15	8	45
	April 16 to June 14	23	45
	June 15 to August 15	23	325
	August 16 to October 31	23	45
	November 1-30	23	33
	December 1 to March 31	8	33

Inflow to the City's reservoirs during the December through May period generally exceeds draft rates and therefore increases storage. The average inflow to Pepacton, Cannonsville, and Neversink Reservoirs for these six months during the 49-year period, December 1940 to May 1989, was 299.9 Bgal. During the corresponding six months of the current report year, inflow to the three reservoirs totaled 324.2 Bgal. Evaporation loss was not included in the computation. Storage in the three reservoirs increased from 237.772 Bgal on November 30, 1989 to 271.632 Bgal on May 31, 1990.

The maximum volume of water in storage in the reservoirs, as shown in figure 2, was 276.271 Bgal on May 18 when all three reservoirs were spilling. Pepacton Reservoir filled to capacity on March 18, 1990 and spilled a total of 23.7 Bgal during March 18 to April 24 and May 10-30, 1990. Cannonsville Reservoir filled to capacity and began spilling on January 29, 1990 and spilled continuously until June 12, 1990. Approximately 109.5 Bgal spilled during the year. Neversink Reservoir filled to capacity on May 7 and spilled a total of 4.4 Bgal during May 7-22, 1990.

Diversions to Rondout Reservoir by the City of New York totaled 116.019 Bgal during the December 1 to May 31 period (637 Mgal/d). During this same period, the anticipated discharge at Montague, exclusive of water released from the City reservoirs, fell below the 1,750 ft^3/s design rate on 21 days and releases were directed to meet the Montague flow objective. New York City made releases for conservation purposes at the augmented conservation rates shown in table 2 on all other days during the period.

There were 3 days during the December through May period when the observed discharge at Montague was less than the design rate (Table 15). All of these deficiencies were the result of difficulty in predicting the effect of the accumulation of ice during cold weather on runoff and on transit time from the reservoirs.

June through November

Precipitation during the June through November period was above average in August, October and November and was below average in June, July and September. Precipitation during the period was 24.63 inches or 1.68 inches above the 49-year average (table 1).

Diversions to Rondout Reservoir from June 1 to November 30 totaled 140.126 Bgal. The average diversion rate did not exceed the limit specified by the Decree and was 766 Mgal/d on November 30.

Releases were directed to satisfy the Montague Formula on 55 days when the anticipated discharge at Montague exclusive of water released from the City reservoirs fell below the design rate. Releases at augmented conservation rates or at rates designed to relieve thermal stress were made at other times from each reservoir by New York City. During June 1-14, the flow required to be maintained in the Delaware River at Montague was the minimum basic rate of 1,750 ft^3/s. The forecasted discharge, exclusive of releases from Pepacton, Cannonsville, and Neversink Reservoirs, and the observed discharge at Montague were greater than the design rate throughout the period. On June 15, the seasonal period began for release of the excess quantity of water from the reservoirs, and the design rate at Montague was increased to 1,850 ft^3/s. This rate was composed of the basic rate of 1,750 ft^3/s plus 100 ft^3/s of the required excess release. A total of 7,656 $(ft^3/s)\cdot d$ (4.949 Bgal) was released for the relief of thermal stress between June 19 and September 13.

The New York City Department of Environmental Protection, Bureau of Water Supply, furnished the River Master with the following advance data for the 1990 calendar year:

1. The estimated continuous safe yield from all the City's sources, obtainable without pumping, is 1,665 Mgal/d, or a total during the calendar year 1990 of 1.665 Bgal/d x 365 days = 607.725 Bgal. gallons.

2. The estimated consumption that the City must provide from all its sources of supply during the calendar year 1990 is 591.582 + 7.250 = 598.832 Bgal.

On the basis of the provisions of the Decree and the above data, the aggregate quantity of excess-release water was 83 percent of (607.725 598.832) or 7.381 Bgal. The Montague design rate during the excess release period beginning June 15, 1990, was computed as:

$$1{,}750\ ft^3/s + \frac{7.381\ Bgal \times 1{,}547\ (ft^3/s)/(Bgal/d)}{120\ days} = 1{,}850\ ft^3/s$$

Data on consumption of water by the City of New York for each calendar year, beginning in 1950, are shown in table 17.

The design rate of 1,850 ft^3/s at Montague was required June 15 through November 30. Releases from the City reservoirs were designed and directed to maintain the rate of 1,850 ft^3/s at Montague on 55 days between June 17 and October 14, 1990 when the advance estimate of flow at Montague exclusive of releases from New York City reservoirs was less than the design rate. Also during this period there were 20 days when the observed flow at Montague was less than the design rate. Of those 20 days that were below the design rate, two were low because of the balancing adjustment and three additional days were within two percent of the designed flow.

The hydrographs of plate 1, show the total discharge at Montague; the portion derived from uncontrolled runoff downstream from the reservoirs; the portion contributed by the power reservoirs; and the portion contributed by Pepacton, Cannonsville, and Neversink Reservoirs. In analyzing the water budget at Montague, the uncontrolled runoff downstream from the reservoirs was computed as the residual of observed flow less releases from all reservoirs and therefore was subject to all the errors in observations, transit times, and routing of the several components of flow. All of these uncertainties are contained in the computed hydrograph of uncontrolled runoff.

Summary

From December 1, 1989, to November 30, 1990, diversions to Rondout Reservoir totaled 256.145 Bgal, and all releases from the New York City reservoirs to the Delaware River totaled 69.187 Bgal. In addition, a total of 137.6 Bgal spilled from the reservoirs during the year.

During the year, maximum storage in Pepacton Reservoir was 141.876 Bgal, on May 15, 1990. Maximum storage in Cannonsville Reservoir was 99.842 Bgal, on February 17. Maximum storage in Neversink Reservoir was 35.388 Bgal, on May 11 and 14. The maximum combined storage in the three reservoirs during the year was 276.271 Bgal, on May 18 when all three reservoirs were spilling.

Minimum combined storage in the reservoirs during the year was 175.868 Bgal on October 18, 1990. Minimum storage in Pepacton Reservoir was 93.946 Bgal (67.0 percent of capacity) on October 23, 1990. Minimum storage in Cannonsville Reservoir was 59.547 Bgal (62.2 percent of capacity) on October 18, 1990 and minimum storage in Neversink Reservoir was 21.764 Bgal (62.3 percent of capacity) on October 12, 1990.

On November 30, 1990, combined storage in the three reservoirs was 223.502 Bgal, or 82.5 percent of their combined capacity. During the year, combined storage decreased 14.270 Bgal, or 5.3 percent of capacity.

A resume of the combined storage of the three reservoirs on the first day of the month June 1967 to November 1990 is shown in figure 4. Storage was below the median May, July and August, and was above the median the rest of the time. On March 1, the combined storage was the highest for that date during the period of record. This contrasts with one year earlier when the storage was the lowest for March 1 during the period of record.

SUPPLEMENTARY RELEASE FROM WALLENPAUPACK POWERPLANT

An agreement between Pennsylvania Power & Light Company and New York City provides for supplementary releases from Wallenpaupack hydroelectric powerplant if the Delaware River Basin Commission requests compensation for water consumed at the company's Martins Creek steam-electric generating station. Releases may be requested if the flow of the Delaware River at Trenton, N.J. is expected to be less than 3,000 ft^3/s for more than three consecutive days. No supplementary releases were requested during the year.

COMPONENTS OF FLOW, DELAWARE RIVER AT MONTAGUE, N.J.

The data and computations of the various components of flow formed the basic operational records required to carry out the River Master's specific responsibilities with respect to the Montague Formula during the report year. The operational record has two parts: the advance estimates of the daily average flow at Montague, exclusive of controlled releases from New York City's reservoirs (table 15) and the segregation of the daily average flow at Montague among its various source components (table 16).

Discharge of the Delaware River at Montague was composed of the following source components:

1. Controlled releases from Lake Wallenpaupack on Wallenpaupack Creek in the production of hydroelectric power.

2. Controlled releases from Rio Reservoir on Mongaup River in the production of hydroelectric power.

3. Runoff from the uncontrolled area upstream from Montague.

4. Controlled releases from Pepacton, Cannonsville, and Neversink Reservoirs of New York City.

The releases from the City's reservoirs necessary to maintain the applicable rate of flow at Montague was computed from the advance estimates of flow at Montague, exclusive of controlled releases from the City's reservoirs.

TIME OF TRANSIT

The average times for the effective transit of water from the various sources of controlled supply to Montague used for discharge routing during the 1990 report year are as follows:

Source	Hours
Pepacton Reservoir	60
Cannonsville Reservoir	48
Neversink Reservoir	33
Lake Wallenpaupack	16
Rio Reservoir	8

This schedule was developed from reservoir and powerplant operations and gaging-station records of prior years and was found generally suitable. At times, noticeable exceptions occur, for example, when a large release from Cannonsville Reservoir follows a small one, a large part of the release is expended in filling the channel en route, and the remainder may appear at Montague as much as 18 hours late. During the winter, the cold weather causes ice to form in the stream, which, together with the low streamflow, gradually increases the resistance to streamflow and lengthens the time of transit.

On several occasions, when large releases were directed following small ones, these releases were directed to begin from 9 to 12 hours earlier than normal to compensate for the expected increase in travel time. These adjustments were helpful in getting the directed releases to Montague within the appropriate time frame, but were not fully successful. Therefore, the observed Montague flow tended to be low on the first day that these releases were expected to arrive and to be high on the second or third day. The average of the observed flow for approximately three days when this procedure was used was usually close to the design rate.

SEGREGATION OF FLOW AT MONTAGUE

The River Master daily operation record of reservoir releases and daily segregation of flow among the various source components contributing to the flow of the Delaware River at Montague is shown in table 16. The arrangement of data conforms with the downstream movement of water from the various sources to Montague. A horizontal summation of data in the table is equivalent to routing the various contributions to Montague, using the schedule for travel time of water discussed previously. The uncontrolled runoff was computed by subtracting the contributions of the several other sources from the observed discharge at Montague.

COMPUTATION OF DIRECTED RELEASES

In the daily operations, it was necessary that the River Master utilize: (1) discharges computed from recorded or reported stream gage heights for various 24-hour periods without current information about changes in stage-discharge relations that might have occurred; (2) daily discharge from New York City's three reservoirs obtained from venturi meters; (3) rainfall reports for the previous 24 hours; (4) actual powerplant releases converted to daily discharge; (5) advance estimates of power demand converted to daily discharge; (6) advance estimates of uncontrolled runoff at Montague; and (7) average times for routing of water from the several sources. Variable errors of estimate occur in projecting data, but these data must be used in the daily design and direction of releases from the reservoirs.

The time of transit of water from Pepacton Reservoir to Montague was greater than that from any other reservoir above Montague, therefore, the time of daily directed releases to maintain prescribed rates of flow at Montague was based on time of transit from Pepacton Reservoir. Releases from Cannonsville and Neversink Reservoirs were timed to arrive at Montague concurrently with releases from Pepacton Reservoir. To allow for the actual differences in transit times, daily directed releases began at Pepacton at 1200 hours, at Cannonsville at 2400 hours, and at 1500 hours the following day at Neversink.

The determination of the amount of release required from the City's reservoirs to maintain specified rates of flow at Montague was based on estimates of releases from Lake Wallenpaupack and Rio Reservoir and an estimate of the uncontrolled runoff at Montague. Taking into account the time of transit from these sources to Montague, this determination required that advance estimates of the following components be made on the morning of each day: (1) the expected release of water from Lake Wallenpaupack for power production for a 24-hour period, beginning at 0800, two days later; (2) expected release of water from Rio Reservoir for power production for a 24-hour period, beginning at 1600 hours, two days later; and (3) expected uncontrolled runoff at Montague three days later. The River Master daily operation record for computing daily directed release from the City's reservoirs during the periods of low flow is shown in table 15.

The electric power companies cooperated fully in furnishing advance estimates of powerplant releases. As the hydroelectric plants were used chiefly for meeting peak-power demands of the system, advance estimates were subject to many modifying factors such as the influence of the vagaries of weather upon peak-power demand and unpredictable transmission and mechanical difficulties in electric-system operation. In addition, the power companies are members of wide area power pools which may present unforeseen demands for power generation. As a result, the actual use of water for power generation was at times at considerable variance with the advance estimates that were used by the River Master's office in design computation.

For computation purposes during periods of low flow, the estimate of uncontrolled runoff at Montague three days in advance was treated as two items: (1) present runoff and (2) estimated increase in runoff from precipitation. The present runoff was computed for 2,143 square miles (mi^2) of uncontrolled drainage area above Montague based on conditions over the drainage area as of 0800 on the morning the estimate was made. The estimated increase in runoff was computed from precipitation which was forecast to occur on the day the estimate was made and the following two days. Estimated quantities for these items are shown in table 15.

During the winter period, the advance estimate of the uncontrolled runoff (present conditions) was based on flows at nearby gaging stations and on the recession curve of the computed uncontrolled flow at Montague projected to the design date, three days hence.

During open-river conditions, the present runoff portion of the advance estimate of uncontrolled runoff was based on discharges as of 0800 at gaging stations listed below:

Station	Drainage area (mi^2)
Beaver Kill at Cooks Falls, N.Y.	241
Cadosia Creek at Cadosia, N.Y.	17.9
Oquaga Creek at Deposit, N.Y.	67.6
Equinunk Creek at Equinunk, Pa.	56.3
Callicoon Creek at Callicoon, N.Y.	110
Tenmile River at Tusten, N.Y.	45.6
Lackawaxen River at Hawley, Pa.	290
Shohola Creek near Shohola, Pa.	83.6
Neversink River at Port Jervis, N.Y.	336

The procedure for computing the advance estimate combined a routing and recession (as applicable) of the 0800 discharges of the Beaver Kill, Oquaga, Equinunk, Callicoon, and Shohola Creeks and Tenmile, Lackawaxen, and Neversink Rivers to Montague, with a computed yield from the remaining ungaged, uncontrolled drainage area. Releases from Neversink Reservoir were deducted from discharge of the Neversink River site. The yield from the ungaged, uncontrolled drainage area was estimated on the basis of the yield of Cadosia, Oquaga, Equinunk, and Callicoon Creeks, and Tenmile and Lackawaxen Rivers with applicable routing and recession of the individual gaging stations. The yield from the ungaged-uncontrolled area was adjusted periodically to account for differences between the forecasted uncontrolled runoff and the observed runoff at the Montague gaging station.

The advance estimate of increase in runoff from precipitation is shown in table 15 under the heading of "Weather Adjustment." The National Weather Service Office, Philadelphia, Pa., cooperated throughout the low-flow periods by furnishing quantitative forecasts of average precipitation over the drainage area above Montague and air temperatures for each day of the threeday design period. During the winter, the probable increase in runoff was estimated from the current state of snow and ice and from forecasted temperature and precipitation for the several days under consideration. During open-river conditions, runoff from the forecasted precipitation was estimated from previously established relationships.

The total anticipated flow at Montague, exclusive of releases from the City's reservoirs (table 15), was the sum of the forecasted releases from the power reservoirs, the estimated uncontrolled runoff under then current conditions, and the weather adjustment. The amount by which this computed flow was less than the prescribed Montague rate indicated the expected deficiency at Montague, which would have to be made up by corresponding releases from New York City reservoirs.

There were times when revised forecasts of weather or powerplant releases became available before the completion of the required releases from the reservoirs. At such times, the releases required from the reservoirs were recomputed on the basis of the revised information, and the release required was changed. Usually this procedure resulted in a reduced release requirement from New York City reservoirs and the conservation of water. The final figures are shown in table 15.

ANALYSIS OF FORECASTS

Forecasts of the flow at Montague based on the anticipated flow of the several components (exclusive of the release from the City's reservoirs) vary somewhat from observed flow on most days even under the most favorable conditions. Daily variations in the several components are often partially compensating with the resulting flows being fairly close to the estimate.

The advance estimate of flow of the Delaware River at Montague exclusive of the releases from the New York City reservoirs was less than the design rate on 47 days scattered throughout the period from December 1, 1989 to September 15, 1990. The advance estimate was less than the design rate continuously from September 16 to October 14, and releases were directed. The table below compares the advance estimates of the various contributions to the flow at Montague to the observed operations during the September 16 to October 14 period.

	Advance estimates [$(ft^3/s) \cdot d$]	Observed operations [$(ft^3/s) \cdot d$]
New York City releases		
Directed	[a] 21,396	[b] 21,388
Power releases		
Lake Wallenpaupack	2,562	3,503
Rio Reservoir	3,597	4,894
Runoff from uncontrolled area	25,496	25,825

[a] Directed release as designed.
[b] Actual release in response to direction.

During the period of comparison, New York City released slightly less water, 0.04 percent, than was directed. The power companies released 37 percent more water from Lake Wallenpaupack and 36 percent more water from Rio Reservoir than was forecast. The total power releases were 36 percent more than the forecast. The forecasted runoff from the uncontrolled area during the period was 1.3 percent less than the observed runoff from the uncontrolled area.

The principle reason for the relatively large difference between the forecasted releases for power generation and the observed operations during the comparison period is because the temperature during the October 7-13 period was much above normal and therefore the demand for electricity was much higher than anticipated. The maximum daily temperatures during this period ranged from 75° F to 83° F which was more than 10 degrees above normal. If this 7-day period is removed from the comparison, the observed operations would be 97 percent of the forecasted releases for power generation.

On the basis of the observed discharges at Montague, exact forecasting of releases required from the City's reservoirs during the comparison period, September 16 to October 14, would have totaled 19,975 $(ft^3/s) \cdot d$. The directed releases totaled 21,396 $(ft^3/s) \cdot d$, or 7.1 percent more than for exact forecasting. For the entire 1990 report year, a total of 43,976 $(ft^3/s) \cdot d$ were directed to meet the Montague flow objective. Exact forecasting would have required 37,426 $(ft^3/s) \cdot d$ or 14.9 percent less than the directed amount.

A comparison of the hydrographs of forecasted uncontrolled runoff and the actual uncontrolled runoff (fig. 3), indicate that the forecasting procedures were generally adequate. The forecast included anticipated uncontrolled runoff under then-existing conditions plus the weather adjustment based on forecast precipitation. Analysis of the hydrographs indicate that the forecast procedures tended to underestimate the runoff during high precipitation events and to overestimate the runoff during extended dry periods. Adjustments to the forecast procedures were made to compensate for these tendencies, but because of the delay between the release of water and the observation of the effect that release had on the Montague flow, it takes several days for adjustments to become effective.

Analysis of the precipitation forecasts indicate that frequently when a precipitation event moves through the basin, the total precipitation forecasted for the three-day design period is fairly accurate but the storm may occur either earlier or later in the period. The accuracy of the runoff forecasts are significantly affected by the timing of the precipitation events.

DIVERSIONS TO NEW YORK CITY WATER SUPPLY

The 1954 Amended Decree allows New York City to divert water from the Delaware River basin at a rate not to exceed 800 Mgal/d. The Decree also specifies that the rate of diversion will be computed as the aggregate total diversion beginning on June 1 of each year divided by the number of days elapsed since the previous May 31.

Table 14 shows diversions from Pepacton, Cannonsville, and Neversink Reservoirs to the New York City water-supply system during the report year. The tabulation includes a running accou t of the average rates of the combined diversions from the reservoirs, computed as prescribed by the Decree. The tabulation below shows the allowable maximum diversion rates and the actual diversions during those periods.

Effective dates	Allowable diversions Mgal/d	Actual diversions Mgal/d
June 1, 1989 to May 31, 1990	800	651
June 1 to Nov. 30, 1990	800	766

During the year a total of 256.145 Bgal of water was diverted to the New York City water supply system. The allowable diversion during the year was 316.885 Bgal.

STORAGE IN NEW YORK CITY RESERVOIRS

The New York City Board of Water Supply determined the "point of maximum depletion" and other pertinent reservoir levels and contents of Pepacton, Cannonsville, and Neversink Reservoirs as follows:

[Elev. is distance above sea level]

Reservoir level	Pepacton Res.		Cannonsville Res.		Neversink Res.	
	Elev. (ft)	Contents (Bgal)	Elev. (ft)	Contents (Bgal)	Elev. (ft)	Contents (Bgal)
Full pool or spillway crest	1,280.00	*140.190	1,150.00	*95.706	1,440.00	*34.941
Point of maximum depletion	1,152.00	*3.511	1,040.00	*1.020	1,319.00	*0.525
Sill of diversion tunnel	1,143.00	*4.200	+1,035.00	*1.564	1,314.00	
Sill of river outlet tunnel	1,126.50		1,020.5		1,314.00	
Dead storage		1.800		0.328		1.680

*Contents shown are quantities stored between listed elevations.
+Elevation of mouth of inlet channel of diversion works.

Tables 10, 11, and 12 show storage in Pepacton, Cannonsville, and Neversink Reservoirs, respectively, above the "point of maximum depletion" or minimum full-operating level.

On December 1, 1989 combined storage in the three reservoirs was 238.422 Bgal. Storage declined gradually until late January, but remained above the median for the period of record. Storage increased rapidly during late January and February and was above or near combined capacity from April 1 until June 1, 1990.

Storage decreased seasonally from late May through mid-October in response to normal diversions to the New York City water-supply system and the releases required to maintain the Montague flow objective. Precipitation averaging slightly more than three inches over the upper basin occurred during the October 19-25 period. The resulting runoff helped to increase storage from a seasonal low of 175.868 Bgal on October 18 to 223.502 Bgal on November 30, 1990 (fig. 2).

COMPARISONS OF RIVER MASTER OPERATION DATA AND OTHER STREAMFLOW RECORDS

It has been explained that the River Master operations are, in effect, day-to-day operations, for which it is necessary to use preliminary records of streamflow. The following summaries show comparison of records used in the River Master operations and U.S. Geological Survey records. In the comparison of releases, the data used were reported in units of Mgal/d and converted to ft^3/s in the summaries.

Releases from New York City Reservoirs

The River Master operations data on the controlled releases from Pepacton, Cannonsville, and Neversink Reservoirs, to the Delaware River were obtained from calibrated instruments connected to venturi meters installed in the outlet conduits.

The Geological Survey gaging station on the East Branch Delaware River at Downsville, N.Y., is 0.5 mile downstream from Pepacton Reservoir dam. The discharge shown in table 4 includes releases and spillage from Pepacton Reservoir. It also includes a small amount of seepage, which enters the channel between the dam and the gage site, and a small amount of runoff, which originates between the dam and the gage site. The drainage area at the dam is 371 mi^2 and at the gaging station is 372 mi^2.

For releases from Pepacton Reservoir of approximately 50, 69, 83 and 108 ft^3/s reported by New York City, the venturi meter instruments indicated -14.0, +1.5, +6.7, and +11.8 percent difference, respectively, in rates of release from the reservoir compared to those shown by the gaging-station record. These differences are similar to the differences observed in previous years except for the difference at 50 ft^3/s. That difference, -14.0 percent, is much larger than at other flow rates. It is uncertain what is causing this difference at this flow rate. Tests were run during the year which confirmed the differences and more tests are planned during the 1991 report year. This difference was first observed at the end of the 1989 report year.

The Geological Survey gaging station on the West Branch Delaware River at Stilesville, N.Y. is 1.4 miles downstream from Cannonsville Dam. The discharge shown in table 5 includes releases and spillage from Cannonsville Reservoir and the runoff from 2 mi^2 of drainage area between the dam and the gage site. The drainage area at the dam is 454 mi^2, and that at the gaging station is 456 mi^2.

For releases from Cannonsville Reservoir of approximately 35, and 41 ft^3/s reported by New York City, the venturi meter instruments indicated 19.6 and 19.7 percent less water, respectively, being released from the reservoir than shown by the gaging-station records. At flows of approximately 390, 550, and 770 ft^3/s, the agreement was better with the venturi indicating +14.0, -8.6 and -0.5 percent difference respectively, than the discharge shown by the gaging-station records. The gaging-station records are considered good for flows above 700 ft^3/s and fair below. In addition, the gaging-station records include any runoff from precipitation on the area between the dam and the gaging station which affects the agreement at the low flows. However, the difference appears to increase as the flow decreases and cannot totally be explained by the inaccuracy of the gaging station record. More tests are planned to attempt to determine the cause during the 1991 report year.

The Geological Survey gaging station on the Neversink River at Neversink, N.Y., is 1,650 feet downstream from Neversink Dam. The discharge shown in table 7 includes releases from Neversink Reservoir and, during storms, a small amount of runoff which originates between the dam and gage site. The drainage area at the dam is 92.5 mi^2 and that at the gaging station is 92.6 mi^2.

For releases from Neversink Reservoir of approximately 24, 44, and 72 ft^3/s at the Geological Survey gaging station, the venturi meter instrument indicated +4.5, +2.7, and +4.3 percent difference,respectively, in rates of release from the reservoir compared to the gaging-station records.

The above comparisons indicate good agreement between the data from the venturi meters and U.S. Geological Survey gaging stations at Neversink Reservoir, for high flows at Cannonsville Reservoir and mid-range flows at Pepacton Reservoir. The gaging-station records are considered only fair at the Stilesville gage for flows below 700 ft^3/s. Therefore, the venturi instruments are considered to provide more accurate records at the very low-flow rates. Additional studies will be done during 1991 to determine why the records do not agree at other levels for Cannonsville and Pepacton Reservoirs.

Releases from Lake Wallenpaupack

In the River Master operations, December 1 to November 30, records of daily discharge through the Wallenpaupack powerplant were furnished by the Pennsylvania Power & Light Company (table 16). Daily discharges were computed on an 0800 to 0800 time basis to allow for the 16-hour average transit time to Montague. The records of daily mean discharges for Wallenpaupack Creek at Wilsonville, Pa., published by the U.S. Geological Survey, were also furnished by the Company. These discharges, shown in table 6, represent the flow through the turbines of the powerplant and are computed on a midnight-to-midnight basis. During December 1989 through November 1990, the River Master's record based on computations by Pennsylvania Power & Light Company, agrees with the U.S. Geological Survey record except for slight variations due to the difference in the time frame and rounding of the computations.

Delaware River at Montague, N.J.

The River Master's operation record indicated 0.2 percent more discharge for the year than the U.S. Geological Survey record. Daily records were in good agreement.

Diversion Tunnels

Records of diversions through the East Delaware, West Delaware, and Neversink Tunnels were furnished to the River Master's Office by the City of New York. These records were obtained from New York City's calibrated instruments connected to venturi meters installed in the tunnel conduits. These instruments include a differential pressure transmitter which is connected to a numerical totalizer that records the volume of water discharged and a rate-of-flow indicator that records on a Bristol-type chart. The totalizer readings are transmitted electronically to the New York City Bureau of Water Supply and are reported to the River Master office daily. Current-meter measurements were made by the River Master's office to verify the accuracy of the reported diversions. The measurements were made in the outlet channels downstream from the tunnels.

Conditions in the outlet channel of the East Delaware Tunnel were unfavorable for the measurement of flows for much of the year due to high water levels in Rondout Reservoir. The results of one current-meter measurement made during the year showed that the venturi-meter instruments gave higher figures by 2.2 percent for the totalizer and 2.6 percent for the digital indicator needle.

Comparison of the data provided by New York City with discharges obtained from recorded gage-heights and the rating curve for the weir on the outlet channel indicate that the data provided by New York City were within acceptable limits.

The powerplant that used water diverted through the East Delaware tunnel operated most days of the year. When the powerplant was not in operation, there was a small amount of leakage through the wicket gates which was not recorded on the totalizer. Results of a current-meter measurement March 28, 1989 indicated a rate of 12.3 ft^3/s from cooling water and leakage. This measurement agrees with measurements made in previous years and indicates that the leakage has not changed substantially with time.

Since the powerplant was not operated on 12 days and operated a portion of the time on 43 additional days during the year, the unmeasured flow was approximately 243 Mgal.

Based upon the measurement obtained this year and in previous years, the record of quantity of water diverted through the East Delaware Tunnel was substantially correct.

The West Delaware Tunnel is used to divert water from Cannonsville Reservoir into Rondout Reservoir. Three current-meter measurements of flows in the West Delaware Tunnel made during the year indicated that the venturi instruments gave higher results by 4.0 percent for the totalizer, and 4.8 percent for the rate-of-flow indicator. Inspections of the channel downstream from the outlet, when valves were closed showed negligible leakage.

A powerplant, which uses water diverted through the West Delaware Tunnel, operates only when diversions are less than 300 Mgal/d. When the powerplant is not operating, the valves on the pipelines to the powerplant are closed, and there is no leakage through the system.

The results of the measurements and inspections made this year and durIng past years indicate that the reported record of the quantity of water diverted through the West Delaware Tunnel was substantially correct.

No measurements of flows from the Neversink Tunnel were made during the year, however results of comparative data from venturi measurements and two current-meter measurements made last year showed that on average, the venturi instruments were higher by 2.0 percent for the totalizer and 3.8 percent for the rate-of-flow indicator.

When the powerplant that used water diverted through the Neversink Tunnel was not in operation, a small amount of leakage occurred that was not recorded on the venturi instruments. Based on measurements made during the previous years, the average rate of leakage is 14.0 ft^3/s (9.0 Mgal/d). When the powerplant was operating, the leakage was included in the recorded flow. Based on the above rate and on records of power plant operations, approximately 1.86 Bgal of water was diverted but unrecorded.

DIVERSIONS BY NEW JERSEY

The Amended Decree allows New Jersey to divert water from the Delaware River or its tributaries in New Jersey, outside the Delaware River Basin without compensating releases. These diversions may not exceed 100 Mgal/d (154.7 ft^3/s) as a monthly average, with the diversion on any day not to exceed 120 Mgal/d (185.6 ft^3/s).

Prior to 1986, the diversions through the Delaware & Raritan Canal were measured at Kingston Lock. Since 1986, water has been diverted on a regular basis from the canal into Carnegie Lake and into the Millstone River upstream from the gaging station at the Kingston Lock. The New Jersey Water Supply Authority (NJWSA) made computations of the amount being diverted from the Delaware River on a daily basis and provided the data to the River Master office weekly. Table 13 is a listing of the data provided by the NJWSA.

At the River Master Advisory Committee meeting in May 1986 the apparent inadequacy of the current monitoring system was discussed. Following that meeting, the River Master requested New Jersey to improve the monitoring system to provide accurate records of their diversions. In response to the River Master's request, the State of New Jersey in cooperation with the U.S. Geological Survey began the installation of an acoustic velocity meter and remote sensing equipment at Port Mercer near the Delaware-Raritan divide. The installation was completed during 1987. Since installation, numerous attempts have been made to adjust the equipment to obtain reliable data. For a variety of reasons, much of the equipment had to be replaced. The data are believed to be reliable beginning August 1990 (table 3). However, the new gage will not be used as the official location for measuring the diversions by New Jersey until the 1991 report year.

The 30-day average diversion was computed weekly based on data provided by NJWSA throughout the year to monitor compliance with the terms of the Decree and with the reduced diversions allowed during the period of drought warning. The maximum 30-day average diversion was 97.5 Mgal/d during the 30-day period ending November 18, 1990. The maximum daily diversion reported was 132 million gallons on January 1, 1990. These computations indicate that on a monthly basis the diversions by New Jersey did not exceed the limits allowed by the Decree. The reported diversion on January 1, 1990 exceeded the 120 Mgal/d limitation but that value was affected by inflow into the canal from precipitation in the Raritan basin. It is uncertain what the actual diversion from the basin was on that day, but it is thought to be less than the limitation. The 120 Mgal/d limitation was also exceeded on August 21-22, 1990, during testing of the new gage at Port Mercer. This office approved those tests in order to properly calibrate the new gage.

The data provided by the New Jersey Water Supply Authority for the flow at the Kingston Lock were compared to the U.S. Geological Survey record for the flow in the canal at the Kingston Lock and were found to be within acceptable limits.

CONFORMANCE OF OPERATIONS AS PROVIDED UNDER AMENDED DECREE OF THE U.S. SUPREME COURT, DATED JUNE 7, 1954

Operations were conducted as prescribed by the Decree throughout the year. Diversions from the Delaware River basin to the New York City water-supply system were less than the 800 Mgal/d authorized by the Decree at all times.

Under Compensating Releases of the Montague Formula, New York City released water from its reservoirs at rates designed by the River Master to maintain the applicable Montague flow objectives and complied fully with the directives of the River Master during the year.

Diversions from the Delaware River basin by New Jersey were within the limits prescribed by the Decree. New Jersey also complied fully with the requests of the River Master.

Table 3. - Daily mean discharge, in cubic feet per second, of the Delaware and Raritan Canal at Port Mercer, N.J. (01460440) for the period August 1 to November 30, 1990. U.S. Geological Survey record.

Day	Aug.	Sept.	Oct.	Nov.
1	144	155	154	159
2	149	154	154	159
3	154	155	154	159
4	151	155	153	155
5	149	156	154	159
6	89	158	152	157
7	81	161	153	156
8	141	163	151	159
9	150	155	156	158
10	118	160	154	149
11	108	151	151	142
12	143	152	155	145
13	143	155	153	143
14	137	154	151	150
15	147	154	153	162
16	151	151	155	160
17	152	153	155	149
18	152	153	156	153
19	150	152	144	166
20	151	158	156	162
21	171	157	160	150
22	222	149	165	146
23	161	151	165	148
24	162	153	152	145
25	156	153	157	144
26	153	154	154	150
27	150	157	158	147
28	150	153	158	130
29	152	152	158	130
30	154	151	159	138
31	152		163	
Total	4,543	4,635	4,813	4,530
Mean	147	154	155	151
Max	222	163	165	166
Min	81	149	144	130

Table 4.- Daily mean discharge, in cubic feet per second, of East Branch Delaware River at Downsville, N.Y. (01417000) for the year ending November 30, 1990. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	58	59	59	58	272	66	99	66	77	79	69	64
2	57	57	57	57	213	66	69	76	77	80	68	59
3	57	56	55	58	315	67	67	88	99	66	67	59
4	58	56	56	57	570	67	67	99	113	67	67	59
5	58	56	55	58	673	67	67	100	118	68	67	59
6	58	56	56	58	668	66	70	90	92	67	67	60
7	57	56	57	58	572	67	67	79	67	67	67	59
8	58	56	56	58	449	67	67	78	67	67	67	60
9	58	56	57	58	370	68	68	75	67	67	67	59
10	57	56	58	58	393	111	68	66	67	67	68	63
11	58	56	56	56	1,290	1,510	69	66	67	67	68	62
12	58	56	56	57	1,490	2,020	68	65	67	68	70	62
13	58	57	56	57	1,310	2,130	67	63	67	67	70	62
14	58	58	57	58	1,080	2,820	67	65	67	67	70	63
15	60	58	56	58	895	2,390	66	75	67	67	70	63
16	58	58	57	67	736	1,970	66	85	78	67	71	63
17	56	58	57	58	537	2,150	65	85	90	67	71	62
18	56	59	57	87	418	2,150	73	101	90	67	71	63
19	56	58	56	483	300	1,990	82	121	79	67	70	63
20	56	59	56	1,070	201	1,760	65	123	67	67	71	63
21	56	57	57	1,260	181	1,890	66	99	67	67	71	62
22	56	56	58	1,180	162	1,940	79	85	67	67	71	61
23	56	57	58	1,390	116	1,590	80	86	67	67	71	61
24	56	57	56	1,350	80	1,260	67	86	68	67	71	61
25	56	60	59	1,180	69	1,000	67	88	67	67	71	60
26	56	59	57	969	66	824	67	90	67	68	71	60
27	56	60	56	733	65	529	68	103	79	67	71	59
28	56	59	56	531	65	348	79	104	91	67	72	59
29	56	57		393	66	243	78	91	77	67	71	59
30	57	59		373	66	249	65	102	65	69	71	59
31	59	59		325		175		100	66		71	
Total	1,770	1,781	1,587	12,313	13,688	31,650	2,113	2,700	2,364	2,039	2,158	1,828
Mean	57.1	57.5	56.7	397	456	1,021	70.4	87.1	76.3	68.0	69.6	60.9

Year total 75,991 $(ft^3/s) \cdot d$ Mean 208 ft^3/s

Table 5.- Daily mean discharge, in cubic feet per second, of West Branch Delaware River at Stilesville, N.Y. (01425000) for the year ending November 30, 1990. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	44	167	1,320	1,050	1,190	59	577	330	437	187	985	45
2	44	316	1,550	996	1,110	61	498	329	352	191	1,000	40
3	44	301	2,080	972	1,240	57	464	329	963	151	932	40
4	45	86	2,070	907	1,650	55	406	436	911	62	686	40
5	45	45	2,030	815	1,830	69	355	441	542	54	735	40
6	45	41	1,900	749	1,870	101	292	336	396	145	854	40
7	45	41	1,740	649	1,760	133	235	526	339	213	827	38
8	45	40	1,610	575	1,590	155	160	449	334	254	561	38
9	45	41	1,530	539	1,430	184	119	471	336	80	392	40
10	46	42	2,080	521	1,350	241	99	330	339	144	517	55
11	45	42	2,700	546	2,350	809	100	331	336	66	278	60
12	45	42	2,550	694	3,050	1,450	85	336	336	57	169	43
13	46	42	2,230	1,020	2,820	1,840	60	332	337	241	50	40
14	46	42	1,970	1,220	2,460	2,520	53	333	335	651	50	40
15	75	42	1,810	1,360	2,140	2,610	415	445	336	558	49	40
16	331	41	2,260	1,390	1,870	2,440	341	448	336	375	49	39
17	245	42	3,480	1,480	1,620	2,570	331	448	336	386	63	40
18	319	44	3,270	2,080	1,450	2,910	332	583	336	201	50	40
19	293	44	2,800	2,220	1,270	2,930	438	665	336	280	50	42
20	438	44	2,380	2,690	1,010	2,650	335	570	105	542	50	42
21	482	45	1,930	2,970	882	2,630	331	404	57	682	50	42
22	354	45	1,670	2,800	820	2,870	331	341	54	367	50	42
23	429	44	1,690	3,040	695	2,590	331	343	55	359	50	44
24	446	45	1,760	3,060	539	2,270	331	340	55	560	50	43
25	635	45	1,640	2,730	428	1,950	331	340	79	624	52	42
26	551	54	1,400	2,390	315	1,660	330	340	330	873	50	42
27	487	50	1,210	2,060	218	1,440	330	756	380	895	50	42
28	359	48	1,120	1,740	141	1,270	328	630	416	1,000	51	42
29	711	48		1,500	98	1,100	417	448	222	916	50	42
30	420	350		1,350	66	903	332	541	150	871	50	42
31	194	1,120		1,250		736		560	146		51	
Total	7,399	3,439	55,780	47,363	39,262	43,263	9,087	13,511	10,022	11,985	8,901	1,265
Mean	239	111	1,992	1,528	1,309	1,396	303	436	323	399	287	42.2

Year total 251,277 $(ft^3/s)\cdot d$ Mean 688 ft^3/s

Table 6.- Daily mean discharge, in cubic feet per second, of Wallenpaupack Creek at Wilsonville, Pa. (01432000) for the year ending November 30, 1990. Record furnished by Pennsylvania Power & Light Company.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	0	0	454	1,080	0	226	925	0	457	77	109	0
2	0	227	464	1,110	0	227	0	508	447	78	107	0
3	286	0	0	1,130	117	224	0	517	394	77	116	0
4	606	0	0	1,080	115	229	811	0	0	751	107	0
5	281	116	832	1,080	115	0	448	591	0	880	107	0
6	231	0	935	1,120	113	0	833	551	220	832	109	0
7	285	0	925	1,130	0	116	864	0	220	77	106	0
8	789	629	907	1,150	0	128	576	0	229	737	374	0
9	203	167	926	981	105	0	0	557	222	75	717	304
10	131	171	698	0	111	0	0	523	225	764	0	465
11	263	169	696	0	110	0	769	508	0	772	116	466
12	407	184	1,050	454	110	0	460	507	0	810	117	698
13	223	0	1,100	451	108	0	457	522	480	798	109	808
14	264	0	1,100	457	0	109	461	0	215	162	83	563
15	280	174	1,110	474	0	0	462	0	227	0	45	537
16	180	171	1,120	462	110	0	0	782	223	0	108	746
17	0	171	1,090	0	222	899	0	790	249	0	106	456
18	196	169	1,080	0	207	877	767	816	341	0	109	452
19	99	174	1,100	34	226	0	449	896	0	91	119	696
20	268	0	1,110	0	233	0	522	910	342	112	106	826
21	402	0	1,110	185	0	453	457	787	346	111	108	807
22	935	0	1,110	0	0	797	689	683	341	114	54	0
23	262	0	1,110	0	237	818	0	953	346	114	0	232
24	272	0	1,120	0	224	822	0	882	339	117	0	0
25	283	0	1,110	0	229	536	447	763	0	107	0	0
26	286	0	1,180	226	753	0	732	795	0	109	0	457
27	227	0	1,080	231	607	0	759	739	680	109	0	459
28	285	0	518	224	0	0	778	0	616	109	0	456
29	234	228		228	0	933	751	0	346	110	0	715
30	0	210		231	223	1,610	0	512	337	106	0	785
31	0	228		0		1,450		546	335		0	
Total	8,178	3,188	25,025	13,518	4,275	10,454	13,417	15,638	8,177	8,199	3,032	10,928
Mean	264	103	894	436	142	337	447	504	264	273	97.8	364

Year total 124,029 (ft3/s).d Mean 340 ft3/s

Table 7.- Daily mean discharge, in cubic feet per second, of Neversink River at Neversink, N.Y. (01436000) for the year ending November 30, 1990. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	25	25	25	24	43	50	42	44	56	45	45	33
2	25	24	25	24	52	50	42	52	53	45	45	24
3	24	24	25	24	50	51	42	66	76	45	45	24
4	24	24	25	24	51	51	42	73	87	45	45	24
5	25	24	25	24	52	51	42	78	87	45	45	24
6	25	24	25	24	51	52	42	66	65	45	45	24
7	24	24	25	24	52	68	42	66	44	45	45	24
8	25	24	25	24	52	76	42	66	44	46	45	24
9	25	24	25	24	49	78	42	52	45	45	45	24
10	25	24	26	24	51	106	42	43	45	45	45	26
11	25	24	25	24	49	1,070	42	43	45	45	45	24
12	25	24	25	24	50	486	42	44	45	45	45	23
13	25	24	25	23	51	468	42	43	45	45	45	23
14	25	24	25	24	51	1,140	42	43	45	45	45	25
15	25	24	24	24	51	550	42	51	45	45	45	25
16	25	24	25	24	51	326	42	68	53	45	45	25
17	24	24	23	24	50	296	43	68	67	45	45	25
18	24	24	24	24	50	608	44	79	67	45	45	25
19	24	24	24	24	51	524	42	85	59	45	45	25
20	24	24	25	25	51	423	42	76	46	45	44	25
21	24	24	24	23	51	368	43	68	44	45	44	25
22	24	26	24	25	51	101	44	68	44	45	44	25
23	24	24	24	25	51	44	44	67	44	45	45	25
24	25	24	24	24	52	42	44	67	45	45	44	25
25	25	24	23	24	52	42	44	67	45	45	45	25
26	25	25	23	23	51	42	44	67	45	45	45	25
27	25	24	24	23	52	42	44	67	53	45	45	25
28	25	24	24	23	52	42	51	75	68	45	45	25
29	25	25		23	52	43	58	81	55	45	45	25
30	25	25		23	52	42	44	76	45	45	46	25
31	25	25		23		42		78	45		46	
Total	765	751	686	739	1,524	7,374	1,303	1,987	1,652	1,351	1,393	746
Mean	24.7	24.2	24.5	23.8	50.8	238	43.4	64.1	53.3	45.0	44.9	24.9

Year total 20,271 $(ft^3/s) \cdot d$ Mean 55.5 ft^3/s

Table 8.- Daily mean discharge, in cubic feet per second, of the Delaware River at Montague, N.J. (01438500) for the year ending November 30, 1990. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	3,470	1,900	13,400	7,500	6,690	3,000	7,470	3,100	2,320	3,130	1,920	3,490
2	2,580	1,900	12,200	7,290	6,500	2,860	5,740	3,090	2,230	2,290	1,960	3,140
3	2,180	2,300	15,800	7,190	8,340	2,640	4,300	2,980	2,060	2,160	1,980	2,760
4	3,270	2,500	15,200	6,940	14,400	2,740	4,230	2,460	1,910	2,160	1,990	2,560
5	3,100	2,400	16,400	6,220	12,800	4,010	4,790	2,060	1,860	2,780	2,070	2,560
6	2,550	2,300	13,100	5,840	11,000	4,570	3,670	2,480	3,210	2,780	1,940	2,740
7	3,350	2,100	12,000	5,490	9,920	4,150	4,010	2,190	6,820	2,720	2,020	3,970
8	2,900	2,100	11,000	5,150	8,990	3,570	3,950	1,500	5,730	2,570	1,910	3,890
9	3,300	2,800	10,500	5,190	8,050	3,460	3,320	1,720	3,770	1,440	2,260	3,510
10	2,150	2,400	12,600	4,430	7,250	3,650	2,720	2,340	3,070	1,570	2,640	6,380
11	2,500	2,400	17,000	4,180	8,890	10,900	2,730	2,150	4,960	2,600	1,570	42,700
12	2,900	2,300	14,500	5,000	13,300	14,300	3,510	2,240	5,350	2,500	1,750	23,900
13	2,600	2,400	12,500	6,630	11,900	12,400	2,760	6,660	4,150	2,390	2,060	14,700
14	2,000	2,000	11,200	7,820	10,400	19,600	2,640	5,920	4,910	2,490	2,470	10,700
15	2,000	2,200	10,600	7,750	9,550	20,600	2,450	4,000	4,190	1,720	4,200	8,810
16	2,000	2,300	11,000	7,520	9,220	15,900	2,260	4,200	3,380	1,940	3,060	7,930
17	1,650	2,200	15,300	6,740	8,320	18,000	2,050	5,210	2,910	2,060	2,350	7,250
18	1,600	2,700	15,100	9,200	7,560	19,500	2,100	4,200	2,680	1,830	2,130	6,530
19	2,000	5,000	12,700	9,720	6,880	17,100	2,960	3,830	2,570	1,760	4,770	6,260
20	1,900	6,200	11,300	10,200	6,380	14,500	2,630	3,970	1,940	1,770	7,950	5,960
21	1,800	5,100	9,800	14,100	5,540	13,600	2,600	3,450	2,360	1,850	4,990	5,410
22	2,300	5,100	8,980	13,200	5,530	14,100	2,450	2,970	2,650	1,810	3,780	4,890
23	2,500	4,900	9,670	12,200	5,390	12,900	2,730	2,910	2,490	1,800	3,490	4,230
24	1,600	4,600	13,100	11,900	5,040	11,300	1,860	3,180	2,640	1,620	11,500	4,580
25	1,750	4,700	12,000	11,100	4,390	9,630	2,090	2,840	4,270	1,490	16,400	4,140
26	1,850	11,000	9,590	10,300	4,300	8,310	2,370	2,740	4,440	1,650	10,200	4,090
27	2,300	19,100	8,670	9,210	4,490	7,230	2,430	2,620	3,960	1,760	7,500	4,140
28	2,300	12,300	7,320	8,130	3,770	6,030	2,370	2,280	4,030	2,070	5,880	3,860
29	2,100	10,200		7,250	2,850	5,750	2,400	1,710	4,410	1,980	5,080	3,780
30	2,000	16,300		6,610	2,740	10,800	2,770	1,680	4,850	2,000	4,270	3,910
31	2,000	17,700		6,390		9,830		2,150	3,940		4,070	
Total	72,500	163,400	342,530	246,390	230,380	306,930	94,360	94,830	110,060	62,690	130,160	212,770
Mean	2,339	5,271	12,230	7,948	7,679	9,901	3,145	3,059	3,550	2,090	4,199	7,092

Year total 2,067,000 (ft^3/s)·d Mean 5,663 ft^3/s

Table 9.- Daily mean discharge, in cubic feet per second, of Delaware River at Trenton, N.J. (01463500) for the year ending November 30, 1990. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	9,210	6,050	38,300	14,600	12,800	7,160	23,400	5,830	4,580	8,770	4,330	9,390
2	8,490	6,500	30,400	14,000	12,700	7,140	18,100	6,720	4,950	7,470	4,330	8,790
3	7,540	5,800	27,200	13,500	15,000	6,780	14,900	7,470	4,520	6,250	4,110	8,330
4	6,490	6,000	30,200	13,400	21,200	6,450	12,600	7,190	4,400	5,970	4,040	7,760
5	5,410	6,460	30,600	12,800	26,900	9,790	11,600	6,460	4,140	5,610	4,250	7,110
6	6,820	6,200	29,200	11,900	24,000	12,000	11,600	5,790	5,520	6,110	4,340	6,810
7	6,460	5,840	24,800	11,300	20,900	11,100	10,400	5,150	11,900	5,930	4,480	7,910
8	6,800	5,310	22,500	10,700	18,900	10,200	10,400	4,850	15,100	5,650	4,300	8,350
9	6,460	5,320	20,500	10,100	17,100	9,240	12,700	4,560	12,100	5,440	7,520	8,530
10	5,670	5,720	21,100	10,200	15,500	9,620	11,700	4,600	10,200	4,810	5,430	10,100
11	5,390	8,070	25,200	9,970	14,800	23,200	9,740	4,610	10,500	4,230	5,110	34,300
12	5,350	7,650	27,300	9,120	16,700	29,600	8,640	4,810	11,300	4,420	4,670	58,400
13	5,990	6,510	24,500	9,550	21,000	29,400	8,730	10,200	11,800	5,060	4,500	36,900
14	5,970	5,760	21,700	11,200	19,100	27,400	8,060	15,900	11,700	4,830	6,790	27,100
15	5,220	5,190	19,600	12,100	18,900	33,400	9,280	14,000	14,500	4,890	7,660	21,000
16	4,670	5,100	19,100	12,200	18,100	31,100	8,780	11,200	11,900	7,760	8,250	17,500
17	4,200	5,440	19,500	12,100	16,500	44,900	7,400	10,800	10,100	6,570	7,630	15,800
18	4,270	6,230	23,200	15,000	15,200	47,200	6,740	11,600	8,190	6,280	6,230	14,500
19	4,050	7,260	22,300	17,600	13,800	41,900	11,300	9,640	7,230	5,810	8,840	13,300
20	4,550	8,700	19,800	19,100	12,700	34,800	10,700	8,430	7,150	4,900	12,900	12,800
21	4,450	11,100	17,900	20,400	12,100	29,300	9,940	7,600	6,360	5,140	15,400	12,000
22	4,050	13,100	16,300	23,100	12,100	27,500	8,390	7,510	6,680	5,220	11,900	11,100
23	4,150	12,300	16,300	21,300	11,400	25,500	7,410	7,220	7,500	5,980	10,800	10,700
24	4,850	11,800	20,500	19,700	10,800	22,400	7,360	8,130	9,180	5,360	19,700	10,200
25	4,400	13,000	24,000	18,900	10,400	19,800	6,480	8,000	11,300	4,920	27,200	10,400
26	4,350	24,000	21,200	17,500	9,550	17,500	5,920	6,580	10,800	4,640	28,400	9,630
27	4,350	35,000	17,500	16,200	9,260	15,800	6,020	5,890	10,400	4,380	20,300	8,950
28	4,600	33,300	15,900	14,700	9,260	14,200	5,670	5,590	9,590	4,570	15,800	9,090
29	5,000	25,500		13,500	8,580	15,000	5,550	5,170	9,430	4,550	13,400	8,630
30	4,800	42,700		12,700	7,360	34,000	5,640	4,650	9,760	4,600	11,400	8,120
31	4,800	46,900		12,900		29,500		4,250	9,660		10,300	
Total	168,810	393,810	646,600	441,340	452,610	682,880	295,150	230,400	282,440	166,120	304,310	433,500
Mean	5,445	12,700	23,090	14,240	15,090	22,030	9,838	7,432	9,111	5,537	9,816	14,450

Year total 4,497,970 $(ft^3/s) \cdot d$ Mean 12,320 ft^3/s

Table 10. - Storage in Pepacton Reservoir, N.Y., for year ending November 30, 1990
(Storage in millions of gallons above elevation 1,152.00 ft. Add 7,711 million gallons for total contents above sill of outlet tunnel, elevation 1,126.50 ft.) Storage at spillway level is 140,190 million gallons.
(River Master daily operations record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	119,563	116,780	122,173	137,110	140,486	139,583	139,987	133,114	122,036	112,481	100,544	96,461
2	119,512	117,065	122,826	137,183	140,430	139,473	139,896	132,845	121,642	112,120	100,141	96,536
3	119,699	116,814	123,773	137,165	140,486	139,271	139,767	132,523	121,232	111,842	99,660	96,400
4	119,919	116,696	124,500	137,220	140,709	139,215	139,565	132,202	120,718	111,514	99,106	96,219
5	119,919	116,395	125,072	137,110	140,783	139,197	139,381	131,934	120,225	111,073	98,829	95,902
6	120,038	116,228	125,506	137,110	140,727	139,271	139,050	131,559	120,021	110,729	98,430	95,720
7	119,919	116,010	125,888	136,928	140,709	139,179	139,050	131,149	119,953	110,274	98,000	95,932
8	120,463	116,094	126,115	136,818	140,542	139,307	138,976	130,777	119,818	109,965	97,649	95,630
9	120,429	115,893	126,447	136,654	140,542	139,583	138,756	130,440	119,444	109,446	97,222	95,252
10	120,480	115,608	126,866	136,563	140,560	139,583	138,752	130,227	119,223	109,072	96,811	95,237
11	120,599	115,592	127,987	136,490	141,191	141,191	138,425	129,767	119,070	108,621	96,476	100,792
12	120,429	115,293	128,620	136,709	141,228	141,543	138,077	129,377	118,833	108,492	96,128	103,405
13	120,106	115,027	129,148	137,183	141,191	141,617	137,822	129,341	118,496	108,073	95,766	104,478
14	119,818	114,725	129,572	137,658	141,061	141,857	137,676	129,095	118,142	107,686	95,675	105,320
15	119,665	114,479	129,926	138,223	140,876	141,876	137,493	128,866	118,007	107,316	95,418	105,876
16	119,495	114,280	130,617	138,844	140,820	141,709	137,220	128,497	117,619	106,980	95,131	106,468
17	119,240	114,064	132,006	138,903	140,653	141,709	136,891	128,216	117,316	106,564	94,770	106,916
18	119,495	114,014	133,114	139,877	140,579	141,691	136,636	127,899	116,914	106,084	94,321	107,156
19	119,121	114,097	133,833	140,598	140,394	141,469	136,435	127,460	116,546	105,574	94,471	107,284
20	118,934	114,113	134,372	140,987	140,338	141,246	136,109	126,884	116,613	105,256	94,456	107,444
21	118,513	114,246	134,660	141,265	140,375	141,154	135,692	126,674	115,792	104,828	94,336	107,670
22	118,243	114,280	135,022	141,172	140,320	141,301	135,475	126,272	115,426	104,335	94,141	107,605
23	117,990	114,213	135,584	141,394	140,264	141,116	135,149	125,888	114,994	103,894	93,946	107,686
24	117,636	114,213	136,055	141,301	140,246	140,913	134,968	125,489	114,628	103,436	94,546	107,670
25	117,316	114,230	136,363	141,154	140,080	140,783	134,696	125,107	114,545	102,901	95,735	107,686
26	117,014	115,575	136,526	141,024	140,061	140,672	134,282	124,673	114,363	102,586	96,174	107,653
27	116,814	116,027	136,818	140,857	139,933	140,542	134,013	124,205	114,113	102,117	96,521	107,492
28	116,629	118,395	137,037	140,709	139,859	140,338	133,689	123,704	113,799	101,727	96,567	107,509
29	116,228	119,053		140,579	139,767	140,190	133,276	123,291	113,601	101,305	96,719	107,364
30	116,395	120,395		140,542	139,620	140,209	133,258	122,826	113,305	100,962	96,567	107,188
31	116,412	121,454		140,468		140,080		122,447	112,926		96,491	
Change	-2,879	+5,042	+15,583	+3,431	-848	+460	-6,822	-10,811	-9,521	-11,964	-4,471	+10,697
Equiv. Mgal/d	-92.9	+162.6	+556.5	+110.7	-28.3	+14.8	-227.4	-348.7	-307.1	-398.8	-144.2	+356.6
Equiv. ft^3/s	-144	+252	+861	+171	-43.7	+23.0	-352	-540	-475	-617	-223	+552

Change for year -12,103 Mgal　　Equiv. for year -33.2 Mgal/d　　Equiv. for year -51.3 ft^3/s

Table 11. - Storage in Cannonsville Reservoir, N.Y., for year ending November 30, 1990
(Storage in millions of gallons above elevation 1,040.00 ft. Add 2,584 million gallons for total contents above sill of outlet tunnel, elevation 1,020.50 ft.) Storage at spillway level is 95,706 million gallons.
(River Master daily operations record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	91,386	84,183	97,814	97,540	97,766	95,851	96,704	91,386	82,651	75,859	66,095	69,252
2	91,507	84,068	97,927	97,508	97,669	95,851	96,800	91,355	82,305	75,846	65,281	69,702
3	91,629	83,952	98,716	97,412	97,669	95,851	96,687	91,264	81,828	75,804	64,593	70,006
4	91,766	83,822	98,716	97,315	98,023	95,835	96,607	91,066	81,004	75,846	63,943	70,311
5	91,766	83,750	98,619	97,283	98,458	95,851	96,543	90,777	80,335	75,846	63,383	70,589
6	91,888	83,880	98,587	97,154	98,458	95,980	96,494	90,534	80,101	75,928	62,721	70,669
7	92,040	83,938	98,362	97,025	98,410	95,980	96,237	90,290	79,990	75,846	62,186	70,762
8	92,131	83,938	98,329	96,881	98,233	96,108	96,108	89,910	79,838	75,832	61,524	70,841
9	92,131	83,938	98,200	96,864	98,104	96,237	95,899	89,621	79,562	75,721	61,065	70,868
10	92,086	84,169	98,442	96,768	97,927	96,221	95,851	89,408	79,410	75,721	60,659	70,987
11	92,131	84,299	99,247	96,768	98,635	97,074	95,851	89,149	79,217	75,611	60,341	74,450
12	92,010	84,530	99,182	97,025	99,504	97,911	95,803	88,921	79,092	75,500	60,146	77,890
13	92,010	84,530	98,909	97,412	99,456	98,313	95,691	88,937	78,871	75,320	59,987	79,521
14	91,766	84,530	98,603	97,621	99,118	98,989	95,463	88,921	78,747	74,837	59,963	80,612
15	91,614	84,559	98,458	97,814	98,780	99,134	95,234	88,678	78,429	74,312	59,950	81,553
16	91,294	84,646	98,587	97,814	98,506	99,005	94,854	88,541	78,194	73,901	59,877	82,420
17	90,990	84,762	99,842	97,878	98,249	99,102	94,611	88,298	77,862	73,503	59,767	83,157
18	90,665	85,239	99,778	98,571	98,088	99,376	94,352	88,057	77,545	73,079	59,547	83,851
19	90,275	86,048	99,376	98,716	97,911	99,456	94,139	87,580	77,227	72,854	60,243	84,299
20	89,804	86,742	98,989	99,054	97,637	99,199	93,744	87,117	76,965	72,536	61,040	84,733
21	89,286	87,334	98,587	99,376	97,412	98,989	93,424	86,872	76,854	71,954	61,320	85,123
22	88,830	87,825	98,249	99,376	97,412	99,376	93,120	86,641	76,785	71,437	61,537	85,412
23	88,404	88,176	98,200	99,376	97,235	99,118	92,862	86,323	76,675	71,132	61,677	85,774
24	87,912	88,435	98,329	99,504	97,009	98,861	92,634	86,063	76,509	70,695	62,937	86,178
25	87,349	88,739	98,200	99,279	96,784	98,458	92,375	85,831	76,481	70,112	65,013	86,496
26	86,771	89,773	98,040	98,989	96,655	98,233	92,207	85,470	76,315	69,463	66,108	86,626
27	86,236	92,420	97,782	98,716	96,366	97,991	91,888	85,138	76,039	68,881	66,834	86,886
28	85,788	93,790	97,589	98,297	96,076	97,685	91,644	84,530	75,846	68,139	67,357	87,002
29	85,239	94,824		98,072	95,980	97,573	91,279	84,024	75,804	67,370	67,781	87,117
30	84,689	96,157		97,943	95,851	97,283	91,142	83,591	75,832	66,758	68,338	87,204
31	84,270	97,540		97,814		97,138		83,128	75,846		68,854	
Change	-6,872	+13,270	+49.0	+225	-1,963	+1,287	-5,996	-8,014	-7,282	-9,088	-2,096	+18,350
Equiv. Mgal/d	-221.7	+428.1	+1.75	+7.26	-65.4	+41.5	-199.9	-258.5	-234.9	-302.9	-67.6	+611.7
Equiv. ft^3/s	-343	+662	+2.71	+11.2	-101	+64.2	-309	-400	-363	-469	-105	+946

Change for year -3,938 Mgal   Equiv. for year -10.8 Mgal/d   Equiv. for year -16.7 ft^3/s

Table 12. - Storage in Neversink Reservoir, N.Y. for year ending November 30, 1990
(Storage in millions of gallons above elevation 1,319.00. Add 525 million gallons for total contents above sill of outlet tunnel, elevation 1,314.00 ft.) Storage at spillway level is 34,941 million gallons.
(River Master daily operation record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	27,473	27,296	27,378	33,283	32,066	34,067	34,336	32,686	28,293	26,736	23,048	25,076
2	27,533	25,230	27,589	33,192	31,925	34,199	34,292	32,600	28,158	26,655	22,913	25,192
3	27,624	25,147	27,914	33,077	31,813	34,296	34,204	32,514	27,944	26,545	22,740	25,288
4	27,693	25,031	28,210	32,938	31,873	34,384	34,101	32,344	27,779	26,435	22,599	25,383
5	27,650	24,932	28,522	32,819	31,869	34,561	34,008	32,212	27,606	26,320	22,501	25,462
6	27,645	24,830	28,729	32,643	31,784	34,695	33,925	32,085	27,580	26,198	22,392	25,528
7	27,680	24,711	28,866	32,434	31,653	34,892	33,857	31,897	27,875	26,123	22,256	25,629
8	27,619	24,608	29,057	32,245	31,536	35,011	33,799	31,747	28,022	25,984	22,101	25,674
9	27,550	24,555	29,240	32,061	31,322	35,025	33,819	31,592	27,983	25,866	22,039	25,679
10	27,511	24,478	29,468	31,878	31,248	34,951	33,780	31,448	27,905	25,762	21,938	25,724
11	27,468	24,429	29,987	31,700	31,490	35,388	33,765	31,355	27,866	25,658	21,830	27,498
12	27,412	24,368	30,273	31,644	31,930	35,180	33,702	31,206	27,823	25,545	21,764	28,040
13	27,326	24,303	30,497	31,822	32,047	35,110	33,635	31,290	27,754	25,374	21,787	28,315
14	27,227	24,213	30,703	32,061	32,094	35,388	33,581	31,239	27,684	25,254	21,984	28,451
15	27,116	24,124	30,910	32,245	32,160	35,219	33,538	31,150	27,593	25,176	22,085	28,544
16	27,047	24,064	31,122	32,330	32,165	35,170	33,470	31,062	27,658	25,085	22,085	28,729
17	26,932	24,044	31,592	32,368	32,349	35,075	33,441	30,887	27,559	24,965	22,054	28,839
18	26,821	23,995	31,939	32,595	32,524	35,204	33,374	30,767	27,417	24,813	22,000	28,915
19	26,710	24,092	32,184	32,752	32,662	35,185	33,307	30,593	27,283	24,686	22,193	28,968
20	26,595	24,092	32,255	32,828	32,800	35,145	33,278	30,305	27,163	24,539	22,353	29,012
21	26,477	24,100	32,292	33,038	32,933	35,145	33,206	30,082	27,034	24,421	22,388	29,048
22	26,367	24,108	32,292	33,009	33,072	35,016	33,149	29,928	26,911	24,270	22,420	29,070
23	26,236	24,193	32,491	33,005	33,192	34,857	33,110	29,783	26,800	24,145	22,443	29,097
24	26,127	24,283	33,033	32,981	33,312	34,699	33,110	29,643	26,701	24,031	23,425	29,128
25	25,992	24,360	33,331	32,938	33,403	34,685	33,067	29,477	27,069	23,894	24,124	29,133
26	25,904	24,826	33,417	32,838	33,456	34,625	32,981	29,333	27,206	23,741	24,388	29,146
27	25,787	25,608	33,384	32,724	33,601	34,492	32,914	29,168	27,219	23,613	24,539	29,155
28	25,666	25,950	33,389	32,590	33,688	34,419	32,847	28,982	27,189	23,485	24,649	29,146
29	25,558	26,173		32,462	33,775	34,394	32,781	28,822	26,996	23,318	24,711	29,128
30	25,437	26,608		32,363	33,867	34,438	32,714	28,650	26,919	23,194	24,846	29,110
31	25,333	27,107		32,174		34,414		28,451	26,851		24,981	
Change	-2,006	+1,774	+6,282	-1,215	+1,693	+547	-1,700	-4,263	-1,600	-3,657	+1,787	+4,129
Equiv. mgal/d	-64.7	+57.2	+224.4	-39.2	+56.4	+17.6	-56.7	-137.5	-51.6	-121.9	+57.6	+137.6
Equiv. ft^3/s	-100	+88.5	+347	-60.6	+87.3	+27.3	-87.7	-213	-79.8	-189	+89.2	+213

Change for year -1,771 Mgal Equiv. for year -4.85 Mgal/d Equiv. for year -7.51 ft^3/s

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in millions of gallons for the year ending November 30, 1990.
Record furnished by New Jersey Water Supply Authority

Day	December 1989			January 1990			February			March		
	Lake Carnegie	Kingston Lock	Daily total	Lake Carnegie	Kingston Lock	Daily total	Lake Carnegie	Kingston Lock	Daily total	Lake Carnegie	Kingston Lock	Daily total
1		39	39	82	50	132	10	85	95		85	85
2		39	39	61	51	112	10	85	95		85	85
3		39	39	55	51	106	10	84	94		86	86
4		39	39	49	51	100	10	84	94		86	86
5		37	37	51	51	102	10	88	98		85	85
6		45	45	51	51	102	10	85	95		86	86
7		47	47	51	51	102	10	85	95		86	86
8		47	47	51	51	102	11	85	96		86	86
9		44	44	57	52	109	11	86	97		87	87
10		45	45	46	55	101	11	88	99		87	87
11		45	45	46	69	115	10	88	98		87	87
12		45	45	41	56	97	10	86	96		87	87
13	10	45	55	36	55	91	10	85	95		87	87
14	18	64	82	35	54	89	11	87	98		87	87
15	21	47	68	33	65	98	9	85	94		90	90
16	28	48	76	32	67	99	5	86	91		90	90
17	22	48	70	31	41	72	0	81	81		91	91
18	23	48	71	42	0	42	0	84	84		90	90
19	23	48	71	32	18	50	0	85	85		90	90
20	23	47	70	24	69	93	0	85	85		90	90
21	25	39	64	25	69	94	0	85	85		91	91
22	30	57	87	25	69	94	0	85	85		91	91
23	32	58	90	25	69	94	0	81	81		90	90
24	43	59	102	18	77	95	0	84	84		89	89
25	56	50	106	10	86	96	0	86	86		93	93
26	51	48	99	9	87	96	0	87	87		92	92
27	43	48	91	9	84	93	0	86	86		92	92
28	36	50	86	9	84	93	0	86	86		92	92
29	62	50	112	9	83	92					92	92
30	54	48	102	9	86	95					92	92
31	52	48	100	9	86	95					93	93
Total			2,113			2,951			2,545			2,755
Mean			68.2			95.2			90.9			88.9
Maximum			112			132			99			93

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in millions of gallons - continued
for the year ending November 30, 1990
Record furnished by New Jersey Water Supply Authority

Day	April			May			June			July		
	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total
1		94	94		94	94		96	96		90	90
2		91	91		94	94		96	96		90	90
3		94	94		93	93		96	96		88	88
4		92	92		94	94		96	96		88	88
5		94	94		99	99		96	96		88	88
6		94	94		98	98		94	94		88	88
7		94	94		96	96		94	94		82	82
8		94	94		96	96		94	94		81	81
9		96	96		96	96		96	96		81	81
10		96	96		96	96		96	96		82	82
11		98	98		98	98		94	94		81	81
12		96	96		98	98		94	94		81	81
13		96	96		94	94		94	94		89	89
14		96	96		96	96		94	94		89	89
15		100	100		94	94		96	96		89	89
16		98	98		94	94		96	96		90	90
17		98	98		101	101		96	96		90	90
18		98	98		98	98		96	96		90	90
19		98	98		92	92		99	99		103	103
20		98	98		98	98		98	98		80	80
21		98	98		96	96		98	98		74	74
22		96	96		96	96		98	98		80	80
23		96	96		96	96		96	96		83	83
24		96	96		96	96		94	94		81	81
25		96	96		96	96		94	94		80	80
26		96	96		98	98		94	94		80	80
27		96	96		98	98		93	93		80	80
28		96	96		96	96		90	90		80	80
29		96	96		94	94		89	89		80	80
30		96	96		98	98		90	90		80	80
31					98	98					80	80
Total			2,877			2,981			2,847			2,618
Mean			95.9			96.2			94.9			84.5
Max			100			101			99			103

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in millions of gallons - continued
for the year ending November 30, 1990
Record furnished by New Jersey Water Supply Authority

Day	August			September			October			November		
	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total
1		92	92		93	93		94	94		98	98
2		93	93		94	94		94	94		98	98
3		92	92		93	93		94	94		98	98
4		92	92		93	93		94	94		98	98
5		93	93		93	93		94	94		96	96
6		96	96		93	93		94	94		96	96
7		103	103		93	93		94	94		96	96
8		101	101		96	96		94	94		96	96
9		100	100		98	98		94	94		96	96
10		100	100		96	96		94	94		98	98
11		102	102		96	96		94	94		98	98
12		99	99		94	94		94	94		96	96
13		99	99		94	94		92	92		98	98
14		96	96		93	93		93	93		96	96
15		96	96		98	98		93	93		96	96
16		93	93		98	98		93	93		98	98
17		93	93		94	94		94	94		98	98
18		93	93		94	94		94	94		98	98
19		93	93		94	94		98	98		96	96
20		92	92		94	94		98	98		106	106
21	38	93	131		94	94		98	98		103	103
22	63	64	127		94	94		98	98		90	90
23		65	65		94	94		98	98		90	90
24		93	93		94	94		98	98		89	89
25		93	93		94	94		99	99		88	88
26		93	93		94	94		103	103		88	88
27		94	94		94	94		96	96		89	89
28		94	94		94	94		98	98		83	83
29		94	94		93	93		96	96		83	83
30		94	94		94	94		98	98		83	83
31		94	94					98	98			
Total			2,990			2,830			2,963			2,836
Mean			96.5			94.3			95.6			94.5
Maximum			131			98			103			106

Table 14. - Diversions to New York City water supply
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
Dec. 1	246	200	0	663	Jan. 1	0	297	159	660
2	189	200	0	661	2	450	297	157	661
3	0	200	0	659	3	450	298	155	662
4	246	200	99	658	4	448	298	155	664
5	244	200	96	658	5	450	298	156	665
6	243	202	101	657	6	299	298	152	665
7	244	202	97	656	7	152	298	147	665
8	244	202	97	656	8	450	182	95	665
9	189	202	93	655	9	450	90	98	665
10	1	202	109	653	10	336	122	98	664
11	399	297	140	654	11	451	129	98	664
12	400	297	144	655	12	451	181	98	665
13	399	298	152	656	13	451	182	93	665
14	399	297	126	657	14	450	181	100	665
15	266	297	145	657	15	449	182	100	666
16	229	296	143	657	16	450	129	98	666
17	0	296	148	656	17	449	118	99	666
18	400	296	149	657	18	450	180	97	666
19	399	296	146	658	19	449	93	98	666
20	398	296	137	659	20	447	176	100	666
21	401	296	156	660	21	448	182	98	666
22	279	296	154	660	22	448	297	0	667
23	395	296	155	661	23	463	298	0	667
24	395	296	158	662	24	451	297	0	667
25	394	296	150	663	25	450	298	0	668
26	238	295	152	663	26	452	297	0	668
27	233	299	154	663	27	453	296	0	668
28	231	298	154	663	28	453	297	0	669
29	233	297	152	663	29	451	297	0	669
30	0	297	145	662	30	451	269	0	669
31	0	297	153	661	31	451	296	5	670

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
Feb. 1	450	296	0	670	Mar. 1	423	0	273	654
2	450	295	0	670	2	401	0	277	654
3	450	296	0	671	3	400	0	288	654
4	433	291	0	671	4	401	0	291	654
5	398	0	0	670	5	400	0	285	654
6	403	0	0	669	6	401	0	314	654
7	400	0	0	668	7	401	0	268	654
8	400	0	0	666	8	400	0	277	654
9	400	0	0	665	9	401	0	311	655
10	400	0	0	664	10	401	0	297	655
11	401	0	0	663	11	399	0	282	655
12	401	0	0	662	12	448	0	186	655
13	400	0	0	661	13	448	0	184	655
14	401	0	0	660	14	451	0	187	655
15	400	8	0	659	15	451	0	187	655
16	402	0	0	658	16	461	0	183	655
17	402	0	0	657	17	450	0	198	655
18	402	0	0	656	18	450	0	191	655
19	402	0	140	656	19	451	0	193	654
20	402	0	137	656	20	451	12	307	655
21	400	0	145	655	21	450	0	344	655
22	400	0	138	655	22	450	0	281	656
23	400	0	151	654	23	450	0	298	656
24	400	0	147	654	24	450	0	280	656
25	400	0	146	653	25	450	0	300	656
26	400	0	247	653	26	448	0	289	657
27	400	0	225	653	27	453	0	280	657
28	400	0	283	653	28	452	0	273	657
					29	416	0	251	657
					30	337	0	329	657
					31	432	0	262	657
Total	11,397	1,186	1,759			13,277	12	8,166	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
Apr. 1	450	0	273	658	May 1	406	295	0	661
2	450	0	288	658	2	406	295	0	662
3	450	0	300	658	3	405	295	0	662
4	467	126	249	659	4	405	295	0	662
5	453	0	281	659	5	405	295	0	662
6	415	0	288	659	6	404	295	0	662
7	449	0	274	659	7	233	295	0	662
8	430	0	347	660	8	223	295	92	661
9	398	11	187	660	9	227	294	189	662
10	402	0	190	659	10	225	294	192	662
11	406	0	195	659	11	223	12	190	661
12	403	0	191	659	12	225	0	207	660
13	403	0	169	659	13	250	0	185	660
14	403	0	124	658	14	196	0	197	659
15	403	0	282	658	15	224	0	185	658
16	452	0	0	658	16	226	0	475	658
17	453	0	0	657	17	0	0	18	657
18	452	0	0	656	18	0	0	0	655
19	453	143	0	656	19	0	0	0	653
20	453	207	0	656	20	0	0	0	651
21	454	207	0	656	21	0	10	346	650
22	454	207	0	656	22	0	0	390	649
23	454	294	0	657	23	247	0	404	649
24	455	295	0	657	24	248	0	187	649
25	453	454	0	658	25	248	0	281	649
26	454	501	0	658	26	375	0	325	649
27	456	501	0	659	27	436	0	191	649
28	457	501	0	660	28	437	0	168	648
29	458	501	0	661	29	453	257	195	649
30	403	301	0	661	30	451	294	203	650
					31	452	294	187	651
Total	13,143	4,249	3,638			8,030	3,815	4,807	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date
June 1	450	94	193	737	July 1	451	266	99	778
2	450	101	195	742	2	451	199	141	778
3	450	98	191	741	3	449	199	141	779
4	449	101	194	742	4	451	202	143	779
5	450	181	139	747	5	454	202	111	779
6	449	181	144	752	6	452	202	182	780
7	400	292	95	757	7	452	202	142	781
8	401	295	93	761	8	451	201	141	781
9	400	295	92	764	9	452	202	142	782
10	400	295	96	766	10	452	201	148	782
11	401	295	92	768	11	451	202	145	782
12	400	295	93	770	12	450	204	139	783
13	400	295	114	773	13	450	203	140	783
14	400	295	95	774	14	450	203	141	783
15	399	296	93	775	15	450	203	142	783
16	399	295	94	776	16	450	202	163	784
17	399	295	92	777	17	451	203	141	784
18	400	210	93	772	18	451	203	141	785
19	401	295	93	773	19	452	202	243	787
20	398	293	93	774	20	452	203	233	789
21	369	288	94	773	21	452	202	143	789
22	398	295	97	774	22	452	203	140	789
23	416	295	98	775	23	452	203	161	790
24	450	294	97	778	24	453	203	142	790
25	451	252	101	779	25	452	203	145	790
26	451	247	93	779	26	452	203	147	790
27	325	182	93	773	27	452	203	147	790
28	451	266	94	774	28	452	203	143	791
29	451	266	95	775	29	452	202	151	791
30	451	266	98	777	30	405	165	153	790
					31	450	208	154	790
Total	12,509	7,448	3,344			13,946	6,302	4,644	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date
Aug. 1	452	208	148	790	Sept. 1	451	0	147	781
2	452	208	154	791	2	451	0	144	779
3	452	207	152	791	3	450	0	142	777
4	452	207	127	791	4	453	0	145	775
5	451	207	144	791	5	451	0	146	773
6	451	207	150	791	6	451	0	158	771
7	453	207	148	792	7	451	0	139	770
8	355	207	160	791	8	451	0	146	768
9	452	205	144	791	9	449	0	145	766
10	452	204	143	791	10	452	202	146	766
11	451	203	145	791	11	271	170	153	765
12	451	203	144	791	12	450	206	179	765
13	451	205	158	791	13	376	207	115	765
14	451	204	153	792	14	452	207	145	765
15	453	204	142	792	15	453	206	150	766
16	450	204	149	792	16	452	207	142	766
17	452	200	141	792	17	451	208	153	766
18	451	204	156	792	18	451	202	148	767
19	451	204	147	792	19	451	201	150	767
20	453	192	168	792	20	381	201	144	767
21	451	203	148	793	21	452	201	149	767
22	451	208	145	793	22	452	201	150	767
23	451	203	140	793	23	450	201	148	768
24	452	203	147	793	24	453	202	149	768
25	451	203	141	793	25	455	201	149	768
26	452	202	146	793	26	455	203	146	768
27	452	0	148	791	27	443	201	147	769
28	452	10	143	789	28	455	202	146	769
29	453	28	143	787	29	455	201	150	769
30	453	0	141	785	30	455	201	148	770
31	452	0	144	783					
Total	13,906	5,350	4,559			13,223	4,231	4,419	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date	Date 1990	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1990 to date
Oct. 1	455	200	149	770	Nov. 1	302	9	0	766
2	455	200	150	770	2	301	0	0	763
3	454	201	151	770	3	458	0	0	761
4	453	203	149	771	4	458	0	0	759
5	452	202	153	771	5	458	263	97	760
6	452	203	147	771	6	458	260	108	760
7	452	202	149	771	7	458	265	101	760
8	452	247	89	772	8	458	266	99	761
9	452	259	108	772	9	457	266	96	761
10	452	200	98	772	10	459	267	102	762
11	452	260	98	772	11	461	268	97	762
12	451	260	99	772	12	462	286	102	763
13	451	260	102	773	13	462	279	97	763
14	452	253	99	773	14	459	273	96	763
15	452	262	102	773	15	304	178	98	762
16	457	262	117	774	16	314	195	94	761
17	454	263	88	774	17	458	294	96	762
18	401	216	90	773	18	458	294	97	762
19	455	264	99	774	19	456	258	95	763
20	454	265	100	774	20	457	258	100	763
21	454	265	98	774	21	457	258	97	763
22	455	265	88	775	22	458	259	96	764
23	456	265	99	775	23	458	259	100	764
24	445	266	98	775	24	458	259	97	764
25	455	267	99	775	25	458	259	99	764
26	456	268	96	776	26	457	253	100	765
27	475	279	98	776	27	453	263	95	765
28	456	268	97	777	28	452	263	95	765
29	454	0	0	774	29	456	263	99	765
30	453	0	0	772	30	455	263	95	766
31	297	0	0	769					
Total	13,864	6,825	3,110			13,120	6,778	2,548	

Table 15.- New York City Reservoir release design data

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft^3/s	Powerplant release forecasts: Rio Reservoir ft^3/s	Uncontrolled runoff: Present conditions ft^3/s	Uncontrolled runoff: Weather adjustment ft^3/s	Date	Discharge ft^3/s	Indicated deficiency ft^3/s	Balancing adjustment ft^3/s	Directed Release ft^3/s	Computation of the Balancing Adjustment: Adjusted Directed release: Daily ft^3/s	Adjusted Directed release: Cumulative (ft^3/s)·d	Actual deficiency: Daily ft^3/s	Actual deficiency: Cumulative (ft^3/s)·d	Cumulative difference (ft^3/s)·d	Balancing adjustment ft^3/s
1989/90	1	2	3	4		5	6	7	8	9	10	11	12	13	14
MONTAGUE DESIGN RATE = 1,750 ft^3/s DECEMBER 1, 1989 TO JUNE 14, 1990															
The estimated Montague discharge was greater than the Montague design rate December 1-16, 1989															
Dec. 14	0	140	1,410	0	Dec. 17	1,550	200		200						
15	0	0	1,350	0	18	1,350	400		400						
16	0	140	1,260	0	19	1,400	350		350						
17	0	140	1,210	0	20	1,350	400		400						
18	0	140	1,160	0	21	1,300	450		450						
19	0	210	940	0	22	1,150	600		600						
20	222	0	938	0	23	1,160	590		590						
21	222	0	1,028	0	24	1,250	500		500						
22	222	0	958	0	25	1,180	570		570						
23	222	0	928	0	26	1,150	600		600						
24	0	100	890	0	27	990	760		760						
25	0	100	950	0	28	1,050	700		700						
26	0	190	950	0	29	1,140	610		610						
27	238	100	912	0	30	1,250	500		500						
28	0	0	900	0	31	900	850		850						
29	0	0	920	284	Jan. 1	1,204	546		546						
30	0	0	850	660	2	1,510	240		240						
31	240	0	950	240	3	1,430	320		320						
Jan. 1	240	0	1,065	0	4	1,305	445		445						
2	0	0	1,350	0	5	1,350	400		400						
3	0	0	1,625	0	6	1,625	125		125						
The estimated Montague discharge was greater than the Montague design rate January 7 to June 14, 1990															

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 14 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 16.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 16), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Nov. 30.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Powerplant release forecasts: Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Uncontrolled runoff: Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computation of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Adjusted Directed release: Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Actual deficiency: Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1990	1	2	3	4		5	6	7	8	9	10	11	12	13	14
MONTAGUE DESIGN RATE = 1,850 ft³/s JUNE 15 TO NOVEMBER 30, 1990															
June 12	470	340	1,458	0	June 15	2,268	0		0	0	0	0	0	0	0
13	470	110	1,331	0	16	1,911	0		0	0	0	0	0	0	0
14	0	0	1,218	0	17	1,218	632		632	638	638	428	428	210	-21
15	0	177	1,224	77	18	1,478	372		372	372	1,010	234	662	348	-35
16	470	355	1,181	58	19	2,064	0		0	0	1,010	0	662	348	-35
17	470	355	1,110	93	20	2,028	0		0	0	1,010	0	662	348	-35
18	470	355	1,017	289	21	2,131	0	-21	0	0	1,010	0	662	348	-35
19	470	355	1,199	464	22	2,488	0	-35	0	0	1,010	0	662	348	-35
20	470	0	1,233	135	23	1,838	12	-35	0	0	1,010	0	662	348	-35
21	0	0	1,225	234	24	1,459	391	-35	356	356	1,366	480	1,142	224	-22
22	0	0	1,108	267	25	1,375	475	-35	440	440	1,806	273	1,415	391	-39
23	470	140	1,085	164	26	1,859	0	-35	0	0	1,806	0	1,415	391	-39
24	470	250	1,243	34	27	1,997	0	-35	0	0	1,806	0	1,415	391	-39
25	470	0	1,156	28	28	1,654	196	-22	174	174	1,980	0	1,415	565	-56
26	470	0	1,069	139	29	1,678	172	-39	133	133	2,113	0	1,415	698	-70
27	470	0	1,018	209	30	1,697	153	-39	114	114	2,227	0	1,415	812	-81
28	0	0	952	240	July 1	1,192	658	-39	619	623	2,850	0	1,415	1,435	-100
29	0	0	890	498	2	1,388	462	-56	406	406	3,256	0	1,415	1,841	-100
30	530	0	1,511	258	3	2,229	0	-70	0	0	3,256	0	1,415	1,841	-100
July 1	530	0	1,982	120	4	2,632	0	-81	0	0	3,256	0	1,415	1,841	-100
2	0	177	1,379	197	5	1,753	97	-100	0	0	3,256	318	1,733	1,523	-100
3	530	355	1,161	15	6	2,061	0	-100	0	0	3,256	61	1,794	1,462	-100
4	530	177	1,058	116	7	1,881	0	-100	0	0	3,256	348	2,142	1,114	-100
5	0	0	943	267	8	1,210	640	-100	540	540	3,796	886	3,028	768	-77
6	0	177	814	0	9	991	859	-100	759	761	4,557	881	3,909	648	-65
7	531	355	799	96	10	1,781	69	-100	0	0	4,557	142	4,051	506	-51
8	531	355	797	153	11	1,836	14	-100	0	0	4,557	341	4,392	165	-16
9	531	355	796	132	12	1,814	36	-77	0	0	4,557	88	4,480	77	-8
10	531	89	806	37	13	1,463	387	-65	322	322	4,879	0	4,480	399	-40

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 14 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 16.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 16), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Powerplant release forecasts: Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Uncontrolled runoff: Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computation of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Adjusted Directed release: Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Actual deficiency: Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1990	1	2	3	4		5	6	7	8	9	10	11	12	13	14
The estimated Montague discharge was greater than the Montague design rate July 14-27															
July 25	825	177	992	0	July 28	1,994	0	-40	0	0	4,879	49	4,529	350	-35
26	0	0	834	0	29	834	1,016	-40	976	978	5,857	1,108	5,637	220	-22
27	0	177	757	0	30	934	916	-40	876	886	6,743	1,046	6,683	60	-6
28	533	496	707	0	31	1,736	114	-40	74	74	6,817	337	7,020	-203	+20
29	533	496	683	34	Aug. 1	1,746	104	-35	69	69	6,886	284	7,304	-418	+42
30	533	177	678	51	2	1,439	411	-22	389	389	7,275	391	7,695	-420	+42
31	533	177	511	3	3	1,224	626	-6	620	618	7,893	398	8,093	-200	+20
Aug. 1	533	106	706	0	4	1,345	505	+20	525	532	8,425	492	8,595	-160	+16
2	0	71	626	0	5	697	1,153	+42	1,195	1,198	9,623	1,218	9,803	-180	+18
3	0	177	569	8	6	754	1,096	+42	1,138	1,147	10,770	0	9,803	9677	-97
4	237	177	531	142	7	1,087	763	+20	783	783	11,553	0	9,803	1,750	-100
The estimated Montague discharge was greater than the Montague design rate August 8-19															
17	0	0	1,574	93	20	1,667	183	-100	83	83	11,636	423	10,226	1,410	-100
18	356	0	1,401	142	21	1,899	0	-100	0	0	11,636	16	10,242	1,394	-100
19	356	0	1,257	161	22	1,774	76	-100	0	0	11,636	0	10,242	1,394	-100
20	356	0	1,275	23	23	1,654	196	-100	96	96	11,732	0	10,242	1,490	-100
The estimated Montague discharge was greater than the Montague design rate August 24 - September 8															
Sept. 6	84	0	1,029	293	Sept. 9	1,406	444	-100	344	342	12,074	752	11,078	996	-100
7	84	142	989	146	10	1,361	489	-100	389	391	12,465	681	11,759	706	-71
The estimated Montague discharge was greater than the Montague design rate September 11-14															

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 14 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 16.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 16), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Powerplant release forecasts: Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Uncontrolled runoff: Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computation of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Adjusted Directed release: Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Actual deficiency: Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1990	1	2	3	4		5	6	7	8	9	10	11	12	13	14
Sept.12	770	130	868	33	Sept. 15	1,801	49	-71	0	0	12,465	346	12,105	360	-36
13	84	0	622	63	16	769	1,081	-71	1,010	1,010	13,475	960	13,065	410	-41
14	0	100	777	198	17	1,075	775	-71	704	701	14,176	521	13,586	590	-59
15	0	250	978	42	18	1,270	580	-71	509	511	14,687	581	14,167	520	-52
16	0	250	980	80	19	1,310	540	-36	504	502	15,189	622	14,789	400	-40
17	0	500	1,043	0	20	1,543	307	-41	266	263	15,452	373	15,162	290	-29
18	0	500	839	44	21	1,383	467	-59	408	406	15,858	446	15,608	250	-25
19	0	200	712	189	22	1,101	749	-52	697	704	16,562	774	16,382	180	-18
20	119	0	829	43	23	991	859	-40	819	809	17,371	909	17,291	80	-8
21	119	210	877	130	24	1,336	514	-29	485	484	17,855	724	18,015	-160	+16
22	119	355	799	55	25	1,328	522	-25	497	496	18,351	826	18,841	-490	+49
23	119	175	847	0	26	1,141	709	-18	691	696	19,047	846	19,687	-640	+64
24	119	175	818	0	27	1,112	738	-8	730	734	19,781	764	20,451	-670	+67
25	119	70	695	0	28	884	966	+16	982	980	20,761	750	21,201	-440	+44
26	119	0	677	100	29	896	964	+49	1,013	1,015	21,776	955	22,156	-380	+38
27	109	0	695	0	30	804	1,046	+64	1,110	1,104	22,880	984	23,140	-260	+26
28	119	124	644	21	Oct. 1	908	942	+67	1,009	1,007	23,887	957	24,097	-210	+21
29	109	124	621	59	2	913	937	+44	981	982	24,869	882	24,979	-110	+11
30	109	0	621	63	3	793	1,057	+38	1,095	1,098	25,967	978	25,957	10	-1
Oct. 1	109	0	680	0	4	789	1,061	+26	1,087	1,085	27,052	945	26,902	150	-15
2	109	0	628	100	5	837	1,013	+21	1,034	1,037	28,089	827	27,729	360	-36
3	109	0	618	359	6	1,086	764	+11	775	771	28,860	691	28,420	440	-44
4	109	0	574	321	7	1,004	846	-1	845	841	29,701	671	29,091	610	-61
5	109	0	789	0	8	898	952	-15	937	932	30,633	872	29,963	670	-67
6	109	70	710	0	9	889	961	-36	925	924	31,557	514	30,477	1,080	-100
7	109	70	669	329	10	1,177	673	-44	629	629	32,186	0	30,477	1,709	-100
8	109	70	674	441	11	1,294	556	-61	495	494	32,680	784	31,261	1,419	-100
9	109	284	641	166	12	1,200	650	-67	583	585	33,265	695	31,956	1,309	-100
10	109	70	722	530	13	1,431	419	-100	319	324	33,589	124	32,080	1,509	-100
11	109	0	709	675	14	1,493	357	-100	257	264	33,853	0	32,080	1,773	-100

The estimated Montague discharge was greater than the Montague design rate October 15 - November 30, 1990

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 14 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 16.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 16), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin
and segregation of flow of Delaware River at Montague, N.J.
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow						Excess Release Credits	
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallenpaupack	Rio Reservoir	Date	Controlled releases			Computed uncontrolled	Total		
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Nov. 28	0	50	36	26	Nov. 30	48	372	Dec. 1	0	112	420	2,938	3,470		
29	0	50	36	26	Dec. 1	0	174	2	0	112	174	2,294	2,580		
30	0	50	36	26	2	0	81	3	0	112	81	1,997	2,190		
Dec. 1	0	50	36	26	3	414	408	4	0	112	822	2,346	3,280		
2	0	50	36	26	4	478	365	5	0	112	843	2,145	3,100		
3	0	51	36	26	5	281	177	6	0	113	458	1,979	2,550		
4	0	50	36	26	6	286	414	7	0	112	700	2,538	3,350		
5	0	50	36	26	7	231	108	8	0	112	339	2,449	2,900		
6	0	50	36	26	8	789	0	9	0	112	789	2,399	3,300		
7	0	50	36	26	9	203	39	10	0	112	242	1,796	2,150		
8	0	50	36	26	10	159	88	11	0	112	247	2,141	2,500		
9	0	50	36	26	11	235	744	12	0	112	979	1,809	2,900		
10	0	50	36	26	12	407	252	13	0	112	659	1,829	2,600		
11	0	51	36	26	13	223	167	14	0	113	390	1,497	2,000		
12	0	51	36	26	14	304	170	15	0	113	474	1,413	2,000		
13	0	51	36	26	15	241	199	16	0	113	440	1,447	2,000		
14	200	53	125	26	16	180	39	17	204	0	219	1,227	1,650		
15	400	53	322	26	17	28	17	18	401	0	45	1,154	1,600		
16	350	53	286	26	18	168	149	19	365	0	317	1,318	2,000		
17	400	51	331	26	19	99	160	20	408	0	259	1,233	1,900		
18	450	51	371	26	20	268	14	21	448	0	282	1,070	1,800		
19	600	51	526	26	21	458	297	22	603	0	755	942	2,300		
20	590	51	515	26	22	878	42	23	592	0	920	988	2,500		
21	500	51	410	25	23	262	0	24	486	0	262	852	1,600		
22	570	51	495	25	24	272	21	25	571	0	293	886	1,750		
23	600	51	523	25	25	283	17	26	599	0	300	951	1,850		
24	760	51	685	25	26	286	386	27	761	0	672	867	2,300		
25	700	51	623	25	27	227	106	28	699	0	333	1,268	2,300		
26	610	51	532	25	28	285	67	29	608	0	352	1,140	2,100		
27	500	51	430	25	29	234	149	30	506	0	383	1,111	2,000		
28	850	50	775	25	30	0	0	31	850	0	0	1,150	2,000		
Total	8,080	1,574	7,525	798		8,227	5,222		8,101	1,796	13,449	49,174	72,520		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases N.Y.C. reservoirs Directed	Controlled releases N.Y.C. reservoirs Other	Controlled releases Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date	Amount														
1989/90	1	2	3	4		5	6		7	8	9	10	11	12	13
Dec. 29	546	48	473	25	Dec. 31	0	0	Jan. 1	546	0	0	1,354	1,900		
30	240	54	162	25	Jan. 1	0	0	2	241	0	0	1,659	1,900		
31	320	54	243	25	2	227	0	3	322	0	227	1,751	2,300		
Jan. 1	445	54	370	25	3	0	113	4	449	0	113	1,938	2,500		
2	400	50	319	25	4	0	181	5	394	0	181	1,825	2,400		
3	125	48	53	25	5	116	0	6	126	0	116	2,058	2,300		
4	0	48	36	25	6	0	0	7	0	109	0	1,991	2,100		
5	0	48	36	25	7	0	106	8	0	109	106	1,885	2,100		
6	0	48	36	25	8	629	280	9	0	109	909	1,782	2,800		
7	0	48	36	25	9	167	401	10	0	109	568	1,723	2,400		
8	0	48	36	25	10	171	195	11	0	109	366	1,925	2,400		
9	0	48	36	25	11	169	14	12	0	109	183	2,008	2,300		
10	0	48	36	25	12	184	131	13	0	109	315	1,976	2,400		
11	0	48	36	25	13	0	0	14	0	109	0	1,891	2,000		
12	0	50	36	25	14	0	234	15	0	111	234	1,855	2,200		
13	0	51	36	25	15	174	397	16	0	112	571	1,617	2,300		
14	0	51	36	25	16	171	284	17	0	112	455	1,633	2,200		
15	0	51	36	25	17	171	209	18	0	112	380	2,208	2,700		
16	0	50	36	25	18	169	282	19	0	111	451	4,438	5,000		
17	0	51	36	25	19	174	145	20	0	112	319	5,769	6,200		
18	0	51	36	25	20	0	0	21	0	112	0	4,988	5,100		
19	0	51	36	25	21	0	163	22	0	112	163	4,825	5,100		
20	0	50	36	26	22	0	383	23	0	112	383	4,405	4,900		
21	0	48	36	25	23	0	390	24	0	109	390	4,101	4,600		
22	0	48	36	25	24	0	415	25	0	109	415	4,176	4,700		
23	0	48	36	25	25	0	613	26	0	109	613	10,278	11,000		
24	0	51	36	25	26	0	585	27	0	112	585	18,403	19,100		
25	0	53	36	25	27	0	400	28	0	114	400	11,786	12,300		
26	0	50	36	25	28	0	674	29	0	111	674	9,415	10,200		
27	0	51	36	25	29	228	642	30	0	112	870	15,418	16,400		
28	0	51	36	25	30	210	706	31	0	112	916	16,672	17,700		
Total	2,076	1,548	2,520	776		2,960	7,943		2,078	2,766	10,903	147,753	163,500		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Jan. 29		50	36	25	Jan. 31	228	695	Feb. 1		111	923	12,366	13,400		
30		51	36	26	Feb. 1	454	684	2		113	1,138	10,949	12,200		
31		53	36	26	2	464	770	3		115	1,234	14,451	15,800		
Feb. 1		50	36	26	3	0	695	4		112	695	14,393	15,200		
2		46	36	25	4	0	744	5		107	744	15,549	16,400		
3		45	36	26	5	948	851	6		107	1,799	11,194	13,100		
4		45	36	26	6	932	879	7		107	1,811	10,082	12,000		
5		45	36	26	7	927	699	8		107	1,626	9,267	11,000		
6		50	36	26	8	907	564	9		112	1,471	8,917	10,500		
7		46	62	26	9	812	790	10		134	1,602	10,864	12,600		
8		51	36	26	10	698	741	11		113	1,439	15,548	17,100		
9		50	36	26	11	809	819	12		112	1,628	12,760	14,500		
10		48	36	26	12	1,113	805	13		110	1,918	10,472	12,500		
11		48	36	26	13	1,094	815	14		110	1,909	9,181	11,200		
12		48	36	26	14	1,103	791	15		110	1,894	8,596	10,600		
13		48	36	25	15	1,120	801	16		109	1,921	8,970	11,000		
14		48	36	25	16	1,109	660	17		109	1,769	13,422	15,300		
15		48	36	25	17	1,094	670	18		109	1,764	13,227	15,100		
16		48	36	25	18	1,082	667	19		109	1,749	10,842	12,700		
17		50	36	25	19	1,098	687	20		111	1,785	9,504	11,400		
18		48	36	29	20	1,112	713	21		113	1,825	7,862	9,800		
19		46	36	25	21	1,100	688	22		107	1,788	7,095	8,990		
20		46	36	25	22	1,120	695	23		107	1,815	7,778	9,700		
21		50	36	25	23	1,111	674	24		111	1,785	11,204	13,100		
22		50	36	25	24	1,120	677	25		111	1,797	10,092	12,000		
23		48	36	25	25	1,126	599	26		109	1,725	7,756	9,590		
24		51	36	25	26	1,167	823	27		112	1,990	6,578	8,680		
25		51	36	25	27	913	848	28		112	1,761	5,457	7,330		
Total		1,358	1,034	717		24,761	20,544			3,109	45,305	294,376	342,790		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs Directed	Controlled releases: N.Y.C. reservoirs Other	Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date	Amount														
1990	1	2	3	4		5	6		7	8	9	10	11	12	13
Feb. 26		48	36	25	Feb. 28	687	617	Mar. 1		109	1,304	6,097	7,510		
27		48	36	25	Mar. 1	1,084	631	2		109	1,715	5,476	7,300		
28		51	36	25	2	1,118	716	3		112	1,834	5,254	7,200		
Mar. 1		50	36	25	3	1,065	681	4		111	1,746	5,103	6,960		
2		50	36	25	4	1,120	539	5		111	1,659	4,460	6,230		
3		50	36	25	5	1,094	574	6		111	1,668	4,081	5,860		
4		50	36	25	6	1,125	627	7		111	1,752	3,637	5,500		
5		50	36	25	7	1,131	578	8		111	1,709	3,340	5,160		
6		50	36	25	8	1,148	673	9		111	1,821	3,278	5,210		
7		50	36	25	9	804	372	10		111	1,176	3,153	4,440		
8		50	36	25	10	0	511	11		111	511	3,568	4,190		
9		50	36	25	11	0	429	12		111	429	4,470	5,010		
10		48	36	25	12	454	546	13		109	1,000	5,531	6,640		
11		46	36	25	13	451	634	14		107	1,085	6,638	7,830		
12		50	36	26	14	457	464	15		112	921	6,727	7,760		
13		50	36	25	15	474	656	16		111	1,130	6,299	7,540		
14		50	36	25	16	462	191	17		111	653	5,986	6,750		
15		59	36	25	17	0	241	18		120	241	8,849	9,210		
16		54	36	25	18	0	475	19		115	475	9,140	9,730		
17		50	36	25	19	34	414	20		111	448	9,641	10,200		
18		51	36	25	20	37	617	21		112	654	13,334	14,100		
19		48	36	25	21	148	713	22		109	861	12,330	13,300		
20		48	36	26	22	0	570	23		110	570	11,520	12,200		
21		50	36	25	23	0	670	24		111	670	11,119	11,900		
22		48	36	25	24	0	673	25		109	673	10,318	11,100		
23		50	36	25	25	51	688	26		111	739	9,450	10,300		
24		50	36	25	26	175	649	27		111	824	8,255	9,190		
25		50	36	25	27	231	695	28		111	926	7,073	8,110		
26		50	36	25	28	277	691	29		111	968	6,161	7,240		
27		48	36	25	29	231	550	30		109	781	5,710	6,600		
28		48	36	25	30	175	660	31		109	835	5,446	6,390		
Total	0	1,545	1,116	777		14,033	17,745		0	3,438	31,778	211,444	246,660		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregstion of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1990	1	2	3	4		5	6		7	8	9	10	11	12	13
Mar. 29		48	36	25	Mar. 31	0	638	Apr. 1		109	638	5,883	6,630		
30		48	34	29	Apr. 1	0	479	2		111	479	5,890	6,480		
31		50	45	45	2	56	546	3		140	602	7,328	8,070		
Apr. 1		70	45	43	3	118	688	4		158	806	13,236	14,200		
2		70	45	43	4	113	160	5		158	273	12,469	12,900		
3		70	45	48	5	115	0	6		163	115	10,922	11,200		
4		70	45	45	6	58	138	7		160	196	9,644	10,000		
5		70	45	46	7	0	273	8		161	273	8,676	9,110		
6		70	45	48	8	56	408	9		163	464	7,513	8,140		
7		70	45	43	9	104	397	10		158	501	6,671	7,330		
8		70	45	43	10	112	460	11		158	572	8,230	8,960		
9		71	45	43	11	80	415	12		159	495	12,746	13,400		
10		70	45	45	12	129	407	13		160	536	11,304	12,000		
11		68	45	45	13	62	439	14		158	501	9,841	10,500		
12		68	45	45	14	0	457	15		158	457	9,005	9,620		
13		68	45	45	15	54	439	16		158	493	8,649	9,300		
14		73	45	45	16	105	482	17		163	587	7,640	8,390		
15		71	45	45	17	213	446	18		161	659	6,810	7,630		
16		74	45	45	18	166	433	19		164	599	6,177	6,940		
17		74	45	45	19	285	652	20		164	937	5,339	6,440		
18		71	45	45	20	174	478	21		161	652	4,787	5,600		
19		68	45	46	21	0	482	22		159	482	4,949	5,590		
20		68	45	45	22	0	500	23		158	500	4,792	5,450		
21		68	45	46	23	237	602	24		159	839	4,102	5,100		
22		68	45	46	24	224	390	25		159	614	3,677	4,450		
23		68	45	46	25	229	394	26		159	623	3,578	4,360		
24		68	45	46	26	753	283	27		159	1,036	3.355	4,550		
25		68	45	46	27	607	220	28		159	827	2,834	3,820		
26		68	45	46	28	0	0	29		159	0	2,741	2,900		
27		68	45	46	29	0	0	30		159	0	2,611	2,770		
Total	0	2,026	1,330	1,319		4,050	11,706		0	4,675	15,756	211,399	231,830		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued

(River Master daily operation record)

Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs Directed	Controlled releases: N.Y.C. reservoirs Other	Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date 1990	Amount 1	2	3	4		5	6		7	8	9	10	11	12	13
Apr. 28		68	45	46	Apr. 30	223	0	May 1		159	223	2,628	3,010		
29		65	45	46	May 1	226	0	2		156	226	2,488	2,870		
30		68	45	45	2	227	0	3		158	227	2,265	2,650		
May 1		68	45	45	3	224	226	4		158	450	2,152	2,760		
2		68	45	45	4	229	794	5		158	1,023	2,839	4,020		
3		68	45	45	5	0	0	6		158	0	4,422	4,580		
4		68	45	45	6	0	25	7		158	25	3,977	4,160		
5		67	45	45	7	116	0	8		157	116	3,307	3,580		
6		68	45	45	8	128	0	9		158	128	3,184	3,470		
7		68	45	46	9	0	163	10		159	163	3,348	3,670		
8		70	45	46	10	0	142	11		161	142	10,597	10,900		
9		67	45	46	11	0	35	12		158	35	14,107	14,300		
10		67	45	46	12	0	167	13		158	167	12,175	12,500		
11		67	45	46	13	0	447	14		158	447	18,995	19,600		
12		67	45	43	14	109	680	15		155	789	19,656	20,600		
13		67	45	43	15	0	620	16		155	620	15,125	15,900		
14		67	45	43	16	10	603	17		155	613	17,332	18,100		
15		67	45	43	17	943	734	18		155	1,677	17,668	19,500		
16		68	45	43	18	823	748	19		156	1,571	15,373	17,100		
17		65	45	43	19	0	833	20		153	833	13,514	14,500		
18		67	45	43	20	0	833	21		155	833	12,612	13,600		
19		67	45	43	21	453	695	22		155	1,148	12,797	14,100		
20		67	45	43	22	797	695	23		155	1,492	11,253	12,900		
21		67	45	45	23	818	691	24		157	1,509	9,634	11,300		
22		67	45	43	24	822	606	25		155	1,428	8,057	9,640		
23		67	45	43	25	536	368	26		155	904	7,251	8,310		
24		68	45	43	26	0	652	27		156	652	6,432	7,240		
25		67	45	43	27	0	0	28		155	0	5,875	6,030		
26		67	45	43	28	0	125	29		155	125	5,450	5,730		
27		67	45	43	29	1,405	596	30		155	2,001	8,544	10,700		
28		67	45	43	30	1,611	727	31		155	2,338	7,377	9,870		
Total	0	2,086	1,395	1,370		9,700	12,205		0	4,851	21,905	280,434	307,190		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1990	1	2	3	4		5	6		7	8	9	10	11	12	13
May 29	0	67	45	43	May 31	1,093	681	June 1	0	155	1,774	5,571	7,500		
30	0	67	45	43	June 1	809	816	2	0	155	1,625	4,020	5,800		
31	0	67	45	43	2	0	241	3	0	155	241	3,934	4,330		
June 1	0	67	45	45	3	0	493	4	0	155	493	3,582	4,230		
2	0	67	45	43	4	811	706	5	0	155	1,517	3,128	4,800		
3	0	67	45	45	5	448	234	6	0	157	682	2,851	3,690		
4	0	67	45	45	6	833	99	7	0	157	932	2,921	4,010		
5	0	71	45	45	7	864	394	8	0	161	1,258	2,551	3,970		
6	0	67	45	43	8	576	0	9	0	155	576	2,609	3,340		
7	0	68	45	45	9	0	0	10	0	158	0	2,582	2,740		
8	0	68	45	45	10	0	206	11	0	158	206	2,366	2,730		
9	0	68	45	45	11	769	592	12	0	158	1,361	2,001	3,520		
10	0	68	45	45	12	460	319	13	0	158	779	1,833	2,700		
11	0	68	45	45	13	457	355	14	0	158	812	1,690	2,660		
12	0	68	45	45	14	461	209	15	0	158	670	1,642	2,470	0	0
13	0	68	46	45	15	462	0	16	0	159	462	1,639	2,260	0	0
14	632	67	526	45	16	0	96	17	638	0	96	1,326	2,060	310	310
15	372	68	381	45	17	0	191	18	372	122	191	1,425	2,110	238	548
16	0	67	381	45	18	767	206	19	0	493	973	1,504	2,970	0	548
17	0	67	381	45	19	449	89	20	0	493	538	1,609	2,640	0	548
18	0	93	507	43	20	522	0	21	0	643	522	1,445	2,610	0	548
19	0	73	376	45	21	457	174	22	0	494	631	1,335	2,460	0	548
20	0	68	377	45	22	689	362	23	0	490	1,051	1,199	2,740	0	548
21	356	68	377	45	23	0	0	24	356	134	0	1,370	1,860	100	648
22	440	101	377	45	24	0	56	25	440	83	56	1,521	2,100	267	915
23	0	71	376	45	25	447	131	26	0	492	578	1,310	2,380	0	915
24	0	71	377	45	26	732	11	27	0	493	743	1,204	2,440	0	915
25	174	70	376	45	27	759	89	28	174	317	848	1,041	2,380	174	1,089
26	133	70	376	45	28	778	149	29	133	358	927	992	2,410	133	1,222
27	114	70	376	67	29	751	251	30	114	399	1,002	1,275	2,790	114	1,336
Total	2,221	2,107	6,285	1,358		14,394	7,150		2,227	7,523	21,544	63,476	94,770		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.

Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1990 = 11,418 $(ft^3/d) \cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued

(River Master daily operation record)

Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs: Directed, Date 1990	Directed Amount (1)	Pepacton (2)	Cannonsville (3)	Neversink (4)	Controlled releases from power reservoirs: Date	Lake Wallenpaupack (5)	Rio Reservoir (6)	Delaware River at Montague, Segregation of flow: Date	Controlled releases, N.Y.C. reservoirs, Directed (7)	N.Y.C. reservoirs, Other (8)	Powerplants (9)	Computed uncontrolled (10)	Total (11)	Excess Release Credits, Daily (12)	Excess Release Credits, Cumul. (13)
June 28	619	99	478	46	June 30	0	0	July 1	623	0	0	2,477	3,100	623	1,959
29	406	68	377	45	July 1	0	89	2	406	84	89	2,521	3,100	406	2,365
30	0	70	377	45	2	508	270	3	0	492	778	1,720	2,990	0	2,365
July 1	0	67	377	68	3	517	11	4	0	512	528	1,430	2,470	0	2,365
2	0	97	373	68	4	0	326	5	0	538	326	1,206	2,070	100	2,465
3	0	97	504	90	5	591	262	6	0	691	853	936	2,480	61	2,526
4	0	124	504	70	6	551	21	7	0	698	572	930	2,200	100	2,626
5	540	99	377	70	7	0	0	8	540	6	0	964	1,510	-240	2,386
6	759	99	594	68	8	0	166	9	761	0	166	803	1,730	-20	2,366
7	0	73	506	63	9	557	273	10	0	642	830	878	2,350	100	2,466
8	0	94	512	45	10	523	113	11	0	651	636	873	2,160	100	2,566
9	0	67	376	45	11	508	67	12	0	488	575	1,187	2,250	88	2,654
10	322	68	376	45	12	507	337	13	322	167	844	5,347	6,680	322	2,976
11	0	68	376	45	13	522	283	14	0	489	805	4,626	5,920	0	2,976
12	0	65	374	45	14	0	220	15	0	484	220	3,306	4,010	0	2,976
13	0	68	376	45	15	0	358	16	0	489	358	3,363	4,210	0	2,976
14	0	70	501	71	16	782	535	17	0	642	1,317	3,291	5,250	0	2,976
15	0	97	501	71	17	790	365	18	0	669	1,155	2,416	4,240	0	2,976
16	0	97	500	77	18	816	358	19	0	674	1,174	2,042	3,890	0	2,976
17	0	101	634	90	19	896	635	20	0	825	1,531	1,694	4,050	0	2,976
18	0	122	699	87	20	910	262	21	0	908	1,172	1,460	3,540	0	2,976
19	0	147	599	70	21	787	0	22	0	816	787	1,457	3,060	0	2,976
20	0	124	436	70	22	683	191	23	0	630	874	1,506	3,010	0	2,976
21	0	97	373	70	23	953	397	24	0	540	1,350	1,390	3,280	0	2,976
22	0	97	373	70	24	882	262	25	0	540	1,144	1,246	2,930	0	2,976
23	0	97	373	70	25	763	429	26	0	540	1,192	1,088	2,820	0	2,976
24	0	97	371	70	26	795	379	27	0	538	1,174	988	2,700	0	2,976
25	0	101	368	70	27	739	56	28	0	539	795	1,006	2,340	49	3,025
26	976	102	806	70	28	0	0	29	978	0	0	742	1,720	-30	2,995
27	876	128	664	94	29	0	106	30	886	0	106	698	1,690	-60	2,935
28	74	101	495	71	30	512	223	31	74	593	735	778	2,180	100	3,035
Total	4,572	2,901	14,550	2,024		15,092	6,994		4,590	14,885	22,086	54,369	95,930		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.

Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1990 = 11,418 $(ft^3/d) \cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs Directed	Controlled releases: N.Y.C. reservoirs Other	Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date 1990	Amount 1	2	3	4		5	6		7	8	9	10	11	12	13
July 29	69	102	591	91	July 31	546	149	Aug. 1	69	715	695	871	2,350	100	3,135
30	389	119	594	68	Aug. 1	457	160	2	389	392	617	842	2,240	100	3,235
31	620	97	478	43	2	447	174	3	618	0	621	831	2,070	320	3,555
Aug. 1	525	68	391	73	3	394	276	4	532	0	670	688	1,890	140	3,695
2	1,195	99	1,009	90	4	0	103	5	1,198	0	103	529	1,830	80	3,775
3	1,138	121	936	90	5	0	270	6	1,147	0	270	1,823	3,240	1,147	4,922
4	783	127	572	84	6	220	546	7	783	0	766	5,321	6,870	783	5,705
5	0	125	427	45	7	220	525	8	0	597	745	4,428	5,770	0	5,705
6	0	71	370	45	8	229	220	9	0	486	449	2,895	3,830	0	5,705
7	0	71	365	45	9	222	323	10	0	481	545	2,074	3,100	0	5,705
8	0	71	365	45	10	225	113	11	0	481	338	4,181	5,000	0	5,705
9	0	71	365	45	11	0	0	12	0	481	0	4,889	5,370	0	5,705
10	0	71	367	46	12	0	223	13	0	484	223	3,453	4,160	0	5,705
11	0	71	365	46	13	480	404	14	0	482	884	3,544	4,910	0	5,705
12	0	71	365	46	14	215	213	15	0	482	428	3,270	4,180	0	5,705
13	0	71	365	45	15	227	117	16	0	481	344	2,545	3,370	0	5,705
14	0	71	365	46	16	223	96	17	0	482	319	2,109	2,910	0	5,705
15	0	71	365	70	17	249	180	18	0	506	429	1,755	2,690	0	5,705
16	0	99	364	70	18	341	199	19	0	533	540	1,437	2,510	0	5,705
17	83	99	364	70	19	0	0	20	83	450	0	1,427	1,960	100	5,805
18	0	99	362	45	20	342	0	21	0	506	342	1,492	2,340	16	5,821
19	0	70	42	45	21	346	145	22	0	157	491	1,992	2,640	0	5,821
20	96	70	42	45	22	341	50	23	96	61	391	1,902	2,450	96	5,917
21	0	70	42	45	23	346	99	24	0	157	445	2,018	2,620	0	5,917
22	0	70	42	45	24	339	184	25	0	157	523	3,460	4,140	0	5,917
23	0	70	42	45	25	0	270	26	0	157	270	4,003	4,430	0	5,917
24	0	70	124	45	26	0	539	27	0	239	539	3,082	3,860	0	5,917
25	0	68	364	46	27	680	404	28	0	478	1,084	2,388	3,950	0	5,917
26	0	70	419	70	28	616	397	29	0	559	1,013	2,738	4,310	0	5,917
27	0	97	447	66	29	346	230	30	0	610	576	3,524	4,710	0	5,917
28	0	96	192	46	30	337	270	31	0	334	607	2,829	3,770	0	5,917
Total	4,898	2,616	11,501	1,746		8,388	6,879		4,915	10,948	15,267	78,340	109,470		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.

Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15 to Aug. 14 = 11,418 $(ft^3/s)\cdot s$: Aug. 15 to Sept. 30 = 9,418 $(ft^3/s)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs		Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits	
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Aug. 29	0	67	149	45	Aug. 31	335	106	Sept. 1	0	261	441	2,288	2,990	0	5,917
30	0	67	149	46	Sept. 1	77	0	2	0	262	77	1,911	2,250	0	5,917
31	0	67	201	46	2	78	0	3	0	314	78	1,748	2,140	24	5,941
Sept. 1	0	101	203	46	3	77	131	4	0	350	208	1,582	2,140	60	6,001
2	0	67	147	46	4	751	245	5	0	260	996	1,434	2,690	0	6,001
3	0	67	42	46	5	737	457	6	0	155	1,194	1,341	2,690	0	6,001
4	0	68	43	46	6	880	333	7	0	157	1,213	1,280	2,650	0	6,001
5	0	67	149	46	7	832	252	8	0	262	1,084	1,174	2,520	0	6,001
6	344	67	229	46	8	77	0	9	342	0	77	1,021	1,440	-310	5,691
7	389	67	278	46	9	75	131	10	391	0	206	963	1,560	-190	5,501
8	0	67	43	46	10	764	362	11	0	156	1,126	1,268	2,550	0	5,501
9	0	67	149	46	11	772	298	12	0	262	1,070	1,108	2,440	0	5,501
10	0	67	42	46	12	810	192	13	0	155	1,002	1,173	2,330	0	5,501
11	0	65	42	46	13	798	489	14	0	153	1,287	1,000	2,440	0	5,501
12	0	68	82	46	14	162	0	15	0	196	162	1,342	1,700	-50	5,451
13	1.010	67	897	46	15	0	0	16	1,010	0	0	890	1,900	150	5,601
14	704	67	588	46	16	0	138	17	701	0	138	1,191	2,030	280	5,881
15	509	67	398	46	17	0	259	18	511	0	259	1,010	1,780	30	5,911
16	504	65	391	46	18	0	362	19	502	0	362	866	1,730	-20	5,891
17	266	65	152	46	19	91	354	20	263	0	445	1,032	1,740	-10	5,881
18	408	65	295	46	20	112	461	21	406	0	573	831	1,810	60	5,941
19	697	65	593	46	21	111	0	22	704	0	111	965	1,780	30	5,971
20	819	65	698	46	22	114	0	23	809	0	114	827	1,750	0	5,971
21	485	67	371	46	23	114	81	24	484	0	195	931	1,610	-140	5,831
22	497	65	385	46	24	117	81	25	496	0	198	826	1,520	-230	5,601
23	691	65	585	46	25	107	152	26	696	0	259	745	1,700	-50	5,551
24	730	65	623	46	26	109	170	27	734	0	279	807	1,820	70	5,621
25	982	65	869	46	27	109	223	28	980	0	332	768	2,080	330	5,951
26	1,013	67	902	46	28	109	0	29	1,015	0	109	786	1,910	160	6,111
27	1,110	65	993	46	29	110	0	30	1,104	0	110	756	1,970	220	6,331
Total	11,158	2,024	10,688	1,379		8,428	5,277		11,148	2,943	13,705	33,864	61,660		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.

Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit Aug. 15 to Sept. 30, 1990 = 9,418 $(ft^3/d)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date 1990	Amount 1	2	3	4		5	6		Directed 7	Other 8	9	10	11	Daily 12	Cumul. 13
Sept.28	1,009	65	896	46	Sept.30	106	0	Oct. 1	1,007	0	106	787	1,900	150	6,481
29	981	65	871	46	Oct. 1	109	43	2	982	0	152	816	1,950	200	6,681
30	1,095	71	981	46	2	107	7	3	1,098	0	114	758	1,970	220	6,901
Oct. 1	1,087	67	972	46	3	116	99	4	1,085	0	215	690	1,990	240	7,141
2	1,034	67	924	46	4	107	181	5	1,037	0	288	735	2,060	310	7,451
3	775	67	659	45	5	107	92	6	771	0	199	960	1,930	180	7,631
4	845	67	729	45	6	109	177	7	841	0	286	893	2,020	270	7,901
5	937	67	820	45	7	106	117	8	932	0	223	755	1,910	160	8,061
6	925	67	812	45	8	374	262	9	924	0	636	700	2,260	510	8,571
7	629	67	517	45	9	717	574	10	629	0	1,291	740	2,660	629	9,200
8	495	65	384	45	10	0	362	11	494	0	362	704	1,560	-190	9,010
9	583	67	473	45	11	116	227	12	585	0	343	812	1,740	-10	9,000
10	319	70	209	45	12	117	472	13	324	0	589	1,137	2,050	300	9,300
11	257	74	145	45	13	109	0	14	264	0	109	2,107	2,480	264	9,564
12	0	74	40	45	14	83	0	15	0	159	83	4,018	4,260	0	9,564
13	0	74	40	45	15	45	0	16	0	159	45	2,886	3,090	0	9,564
14	0	74	39	46	16	108	0	17	0	159	108	2,083	2,350	0	9,564
15	0	74	39	46	17	106	53	18	0	159	159	1,812	2,130	0	9,564
16	0	74	53	45	18	109	294	19	0	172	403	4,215	4,790	0	9,564
17	0	73	40	46	19	119	0	20	0	159	119	7,682	7,960	0	9,564
18	0	73	40	45	20	106	0	21	0	158	106	4,776	5,040	0	9,564
19	0	73	40	45	21	108	0	22	0	158	108	3,564	3,830	0	9,564
20	0	73	40	45	22	54	124	23	0	158	178	3,184	3,520	0	9,564
21	0	73	40	45	23	0	270	24	0	158	270	11,072	11,500	0	9,564
22	0	73	40	45	24	0	489	25	0	158	489	15,653	16,300	0	9,564
23	0	73	40	45	25	0	532	26	0	158	532	9,510	10,200	0	9,564
24	0	74	40	45	26	0	433	27	0	159	433	6,888	7,480	0	9,564
25	0	74	40	46	27	0	362	28	0	160	362	5,338	5,860	0	9,564
26	0	74	40	48	28	0	390	29	0	162	390	4,498	5,050	0	9,564
27	0	77	42	46	29	0	131	30	0	165	131	3,934	4,230	0	9,564
28	0	74	40	46	30	0	567	31	0	160	567	3,303	4,030	0	9,564
Total	10,971	2,200	10,085	1,409		3,138	6,258		10,973	2,721	9,396	107,010	130,100		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
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Col. 11 - 24 hours of calendar day shown.

Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning October 1, 1990 = 9,762 $(ft^3/d) \cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1990	1	2	3	4		5	6		7	8	9	10	11	12	13
Oct. 29		71	40	46	Oct. 31	0	270	Nov. 1		157	270	3,053	3,480	0	9,564
30		71	40	40	Nov. 1	0	255	2		151	255	2,744	3,150	0	9,564
31		68	32	25	2	0	60	3		125	60	2,585	2,770	0	9,564
Nov. 1		51	32	26	3	0	57	4		109	57	2,404	2,570	0	9,564
2		51	32	26	4	0	238	5		109	238	2,223	2,570	0	9,564
3		51	32	26	5	0	137	6		109	137	2,494	2,740	0	9,564
4		51	32	26	6	0	57	7		109	57	3,794	3,960	0	9,564
5		50	32	26	7	0	174	8		108	174	3,588	3,870	0	9,564
6		51	32	26	8	0	265	9		109	265	3,126	3,500	0	9,564
7		50	32	26	9	304	255	10		108	559	5,753	6,420	0	9,564
8		50	32	26	10	465	826	11		108	1,291	40,901	42,300	0	9,564
9		50	32	26	11	466	844	12		108	1,310	25,182	26,600	0	9,564
10		51	32	26	12	753	865	13		109	1,618	12,973	14,700	0	9,564
11		53	34	26	13	780	624	14		113	1,404	9,183	10,700	0	9,564
12		53	34	26	14	537	688	15		113	1,225	7,482	8,820	0	9,564
13		53	45	26	15	537	553	16		124	1,090	6,726	7,940	0	9,564
14		53	34	26	16	746	631	17		113	1,377	5,770	7,260	0	9,564
15		53	34	26	17	456	564	18		113	1,020	5,417	6,550	0	9,564
16		53	34	26	18	452	613	19		113	1,065	5,092	6,270	0	9,564
17		53	34	26	19	751	592	20		113	1,343	4,514	5,970	0	9,564
18		53	34	26	20	821	734	21		113	1,555	3,752	5,420	0	9,564
19		53	34	26	21	756	500	22		113	1,256	3,531	4,900	0	9,564
20		53	34	26	22	0	248	23		113	248	3,879	4,240	0	9,564
21		50	34	26	23	232	411	24		110	643	3,837	4,590	0	9,564
22		50	34	26	24	0	183	25		110	183	3,857	4,150	0	9,564
23		50	34	26	25	0	404	26		110	404	3,586	4,100	0	9,564
24		50	34	26	26	457	461	27		110	918	3,112	4,140	0	9,564
25		50	34	26	27	459	379	28		110	838	2,922	3,870	0	9,564
26		50	34	26	28	456	443	29		110	899	2,781	3,790	0	9,564
27		50	34	26	29	715	507	30		110	1,222	2,588	3,920	0	9,564
Total	0	1,596	1,021	813		10,143	12,838		0	3,430	22,981	188,849	215,260		

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Col. 4 - 24 hours beginning 1500 one day later.
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Col. 9 = Col. 5 + Col. 6.
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Col. 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning October 1, 1990 = 9,762 $(ft^3/d)\cdot d$.

Table 17. - Consumption of Water by New York City - 1950 to 1990. Data furnished by New York City, Department of Environmental Protection, Bureau of Water Supply

Year	Average daily consumption			Annual consumption (bg)
	City proper (Mgal/d)	Outside communities (Mgal/d)	Total (Mgal/d)	
1950	953.3	29.1	982.4	358.576
51	1,041.9	28.1	1,070.0	390.550
52	1,087.0	32.7	1,119.7	409.810
53	1,093.9	44.6	1,138.5	415.552
54	1,063.4	46.3	1,109.7	405.040
1955	1,109.9	45.3	1,155.2	421.648
56	1,111.3	48.9	1,160.2	424.633
57	1,169.0	57.2	1,226.2	447.563
58	1,152.9	49.6	1,202.5	438.912
59	1,204.3	60.3	1,264.6	461.579
1960	1,199.4	58.9	1,258.3	460.529
61	1,221.0	64.0	1,285.0	469.022
62	1,207.6	68.8	1,276.4	465.896
63	1,218.0	76.7	1,294.7	472.582
64	1,189.2	79.4	1,268.6	464.295
1965	1,052.1	71.2	1,123.3	409.995
66	1,044.9	73.2	1,118.1	408.128
67	1,135.3	71.0	1,206.3	440.302
68	1,242.0	78.2	1,320.2	483.175
69	1,328.7	80.1	1,408.8	514.229
1970	1,400.3	90.4	1,490.7	544.116
71	1,423.6	87.9	1,511.5	551.695
72	1,412.4	83.0	1,495.4	547.340
73	1,448.9	95.4	1,544.3	563.681
74	1,441.8	96.3	1,538.1	561.409
1975	1,415.0	92.1	1,507.1	550.093
76	1,435.0	95.8	1,530.8	560.264
77	1,483.0	104.7	1,587.7	579.510
78	1,479.4	103.0	1.582.4	577.566
79	1,513.0	104.6	1,617.6	590.426
1980	1,506.3	110.1	1,616.3	591.582
81	1,309.5	100.0	1,409.5	514.475
82	1,383.0	104.8	1,487.8	543.060
83	1,424.2	112.6	1,536.8	561.010
84	1,465.2	113.9	1,579.1	577.963
1985	1,325.4	106.5	1,431.9	522.656
86	1,351.1	115.2	1,466.3	535.200
87	1,447.1	119.8	1,566.9	571.885
88	1,484.3	125.6	1,609.9	589.090
89	1,402.0	113.4	1,515.4	553.158
1990	1,424.4	122.4	1,546.8	564.577

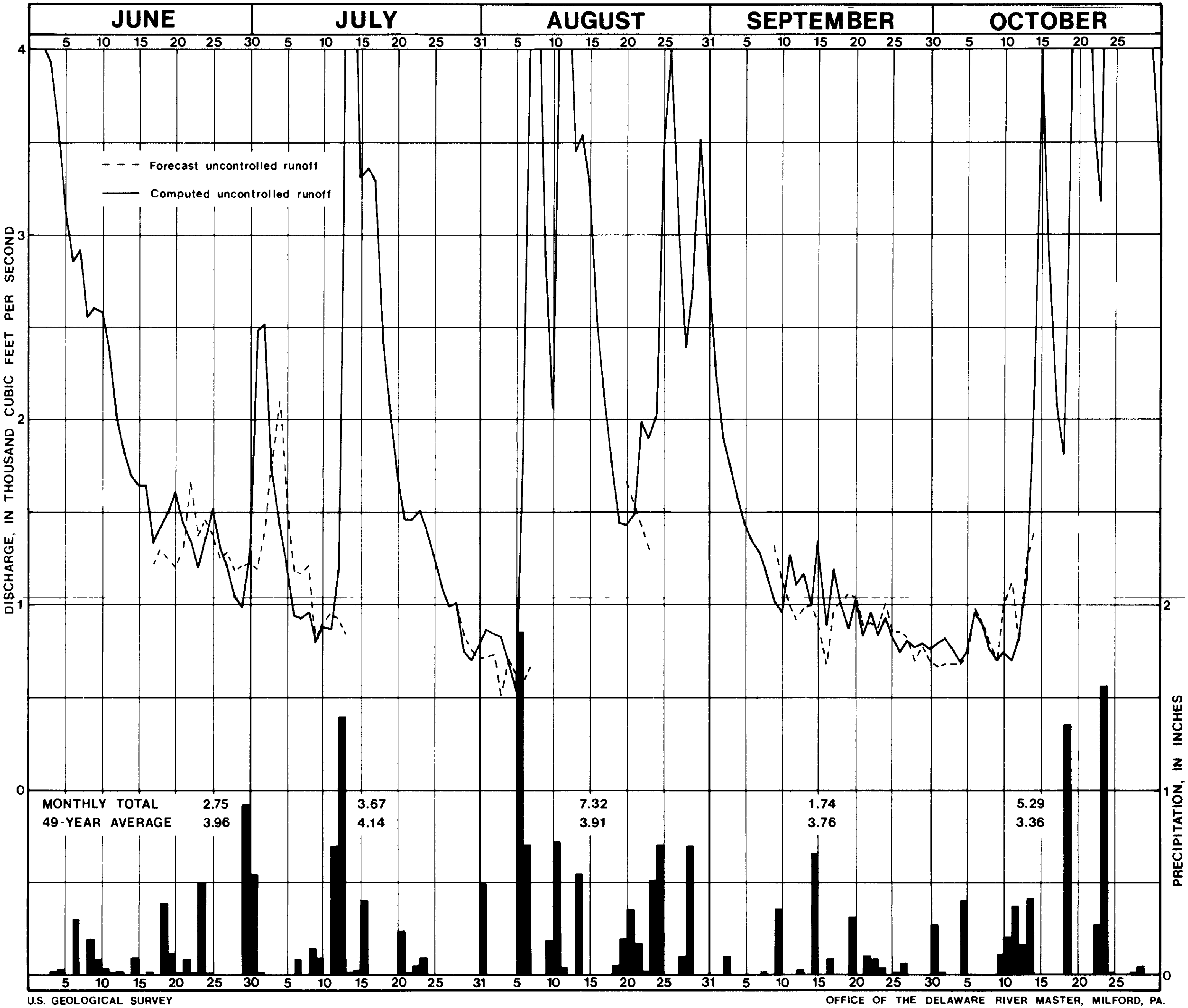

Figure 3. - Uncontrolled runoff component, Delaware River at Montague, N.J., June 1 to October 31, 1990.

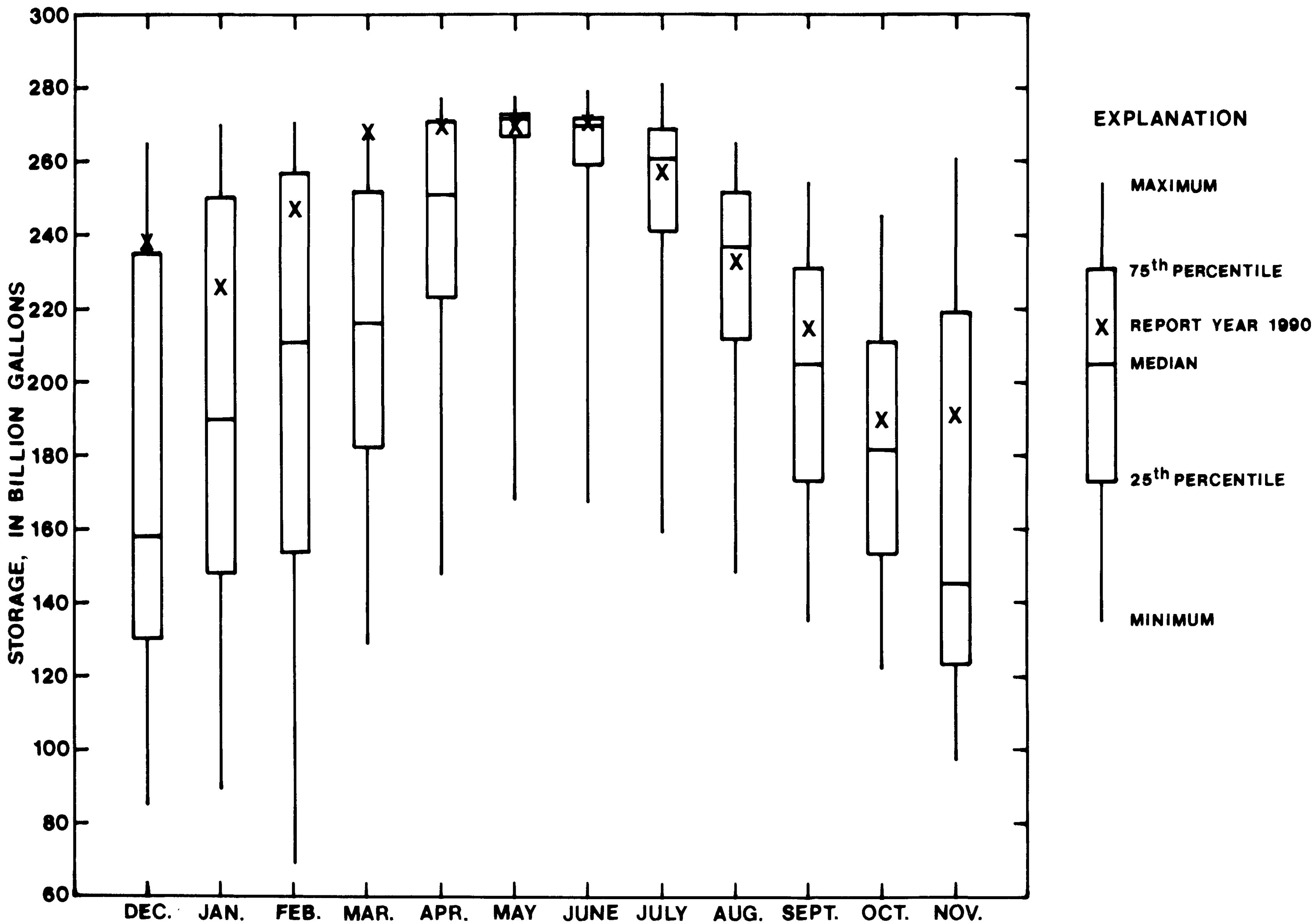

Figure 4. - Combined storage in Pepacton, Cannonsville, and Neversink Reservoirs on the first day of the month, December 1989 to November 1990 and compared to the period June 1967 to November 1989.

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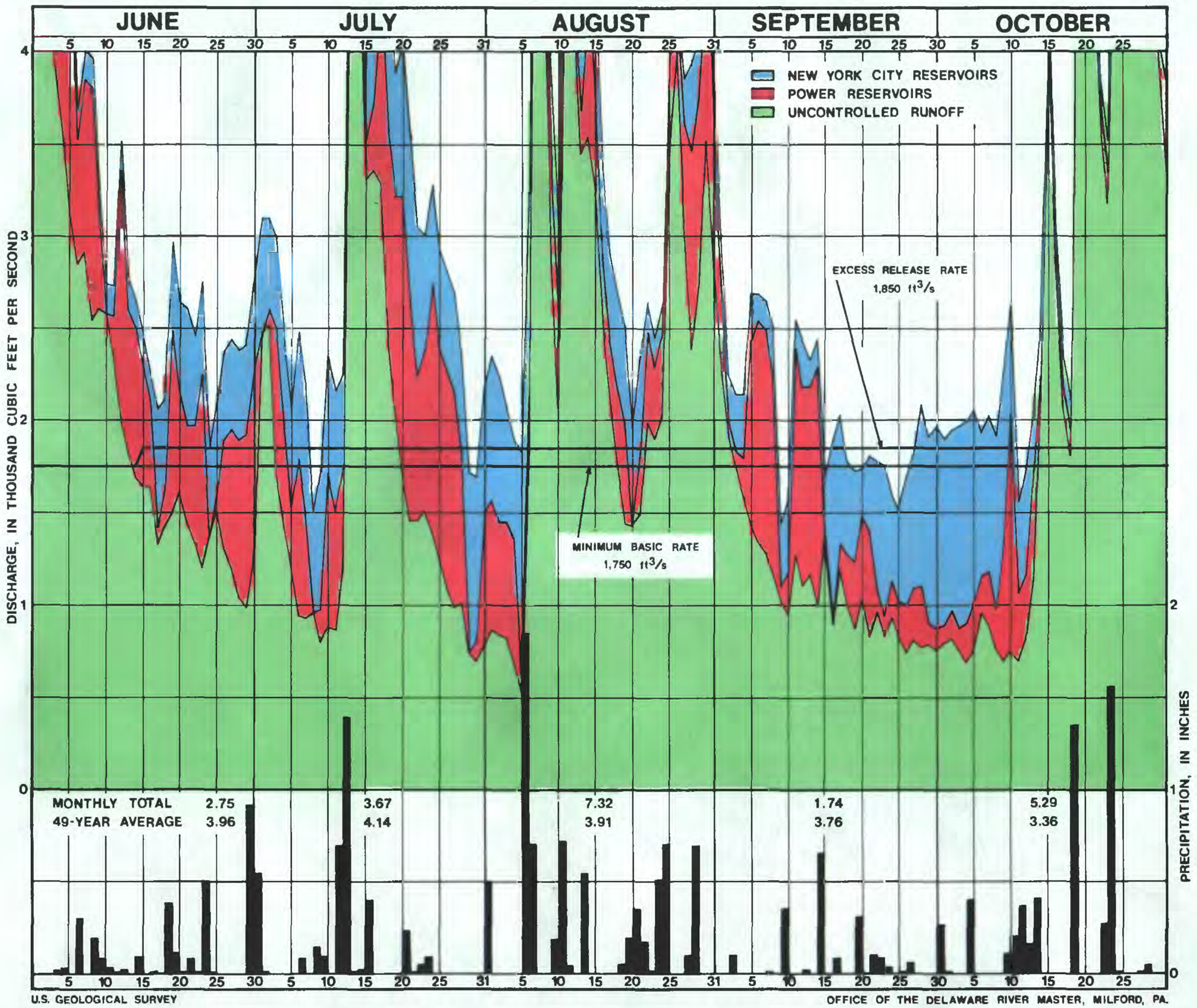

Plate 1. - Components of flow, Delaware River at Montague, N.J., June 1 to October 31, 1990.

Section III

WATER QUALITY OF THE DELAWARE RIVER ESTUARY

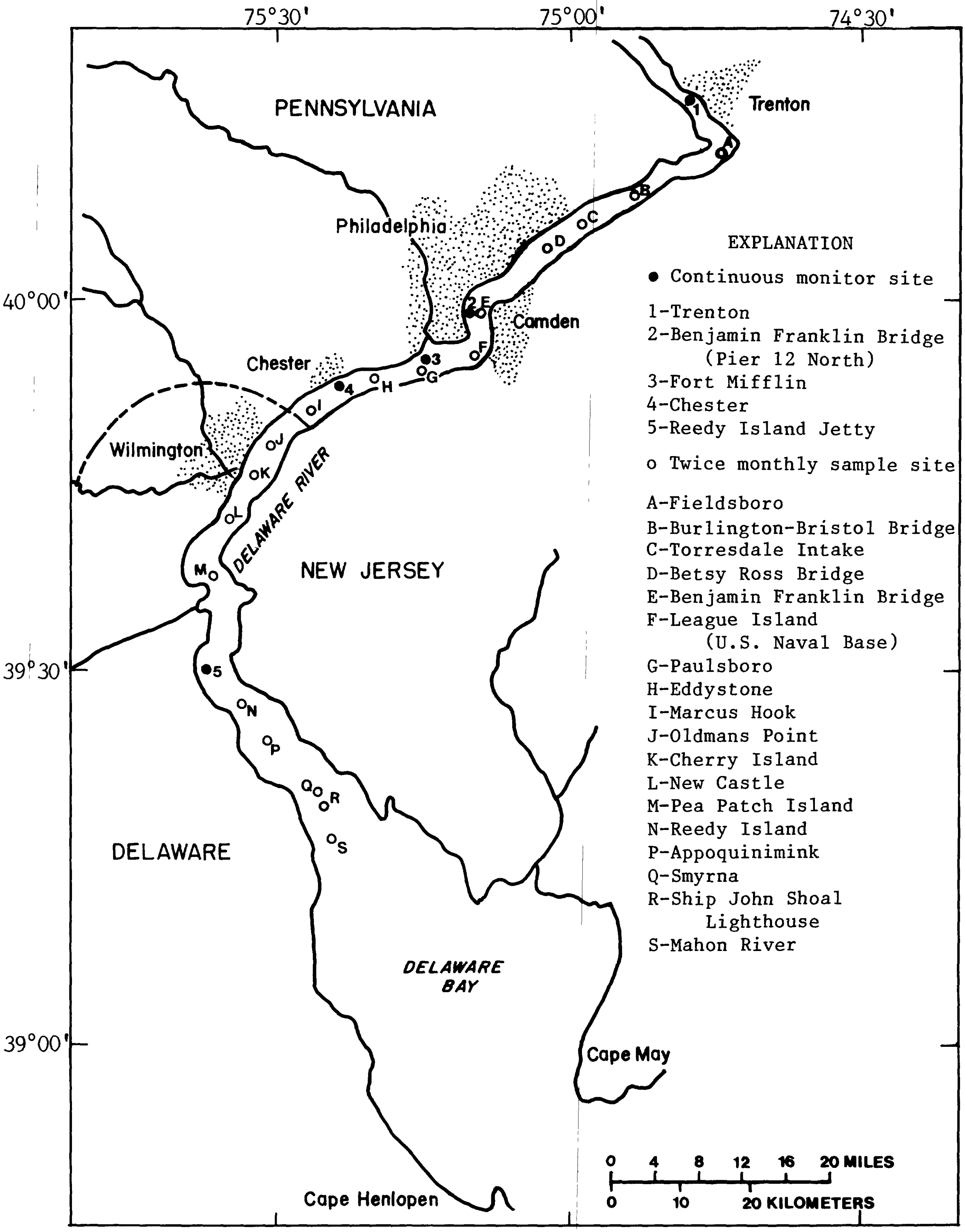

Figure 5.- Delaware River Estuary

Section III

WATER QUALITY OF THE DELAWARE RIVER ESTUARY

By Kirk E. White

INTRODUCTION

This section describes the water-quality monitoring program conducted by the U.S. Geological Survey in the Delaware Estuary during the 1990 report year. Also presented here are some of the data that were obtained by this program and a brief discussion of the significance of the data.

WATER-QUALITY MONITORING PROGRAM

Water quality of the Delaware River and Estuary was monitored between Trenton, N.J., and Reedy Island Jetty, Del. Data were acquired continuously by electronic instruments at five monitor sites, one at Trenton just upstream of the head of tidewater and four in the estuary (fig. 5). The monitors at Chester, Pa., Fort Mifflin, Pa., and Benjamin Franklin Bridge were not operated from December 1, 1989 through the February 28, 1990. At Fort Mifflin the water was monitored for two parameters: temperature and specific conductance. At the remaining sites, the water was monitored for four parameters: temperature, specific conductance, dissolved oxygen, and pH.

Additional data were obtained twice a month from March to November at 18 sites between Fieldsboro, N.J., and the mouth of the Mahon River (fig. 5). At each of these sites, samples of water were collected at the center of the river channel. These samples were analyzed for 28 parameters including temperature, chloride, alkalinity, specific conductance, dissolved oxygen, and pH.

Data obtained from the continuous monitoring sites were processed by computer and stored for future reference by the U.S. Geological Survey. They were also distributed regularly to cooperators and published annually by the U.S. Geological Survey in "Water Resources Data for Pennsylvania, Volume 1, Delaware River Basin." Data from the twice a month sites were collected by the state of Delaware for the Delaware River Basin Commission (DRBC) at 18 sites. These data are available from the DRBC and from STORET, the United States Environmental Protection Agency's data storage system.

The above-described programs were carried out in cooperation with the Delaware River Basin Commission, Delaware River Master, and other agencies of federal, state, and county governments.

ESTUARINE WATER-QUALITY DATA DURING 1990

The following is a summary and discussion of the data that were collected during the 1990 report year.

Streamflow

Streamflow is a vital factor which influences the water quality of the estuary. Increased streamflow usually results in better water quality by limiting salt-water intrusion and by diluting the concentration of dissolved minerals, both of which contribute to a lower specific conductance and chloride level. Increased flow also aids in maintaining lower water temperature during warm weather and supporting higher dissolved-oxygen levels.

On the basis of streamflow records for the Delaware River at Trenton, mean monthly streamflow was lowest for the year during December (5,445 ft^3/s) and highest for the year during February (23,090 ft^3/s). (table 9). The monthly mean streamflow was above the respective median for the period of record in December, June, July, August, September, and October, and below the median for the remainder of the year.

Temperature

The significance of water temperature in regard to water quality in the estuary lies in its profound influence on various physical, chemical, and biological properties of the water. In general, increases in water temperature have deleterious effects on water quality by lowering the saturation level of dissolved oxygen and increasing biological activities. The primary factors involved in controlling water temperature in the estuary are climatic; however, various uses of the water by man can also have significant effects.

Based on records from Benjamin Franklin Bridge (Pier 12 North), Philadelphia, Pa., monthly mean water temperatures for the period March to November 1990 were below normal during May through August, and November, and equaled or exceeded the norm during March, April, September, and October. The norm is based on historical temperature records from 1962 to 1989 (fig. 6).

Specific Conductance and Chloride

Specific conductance is the ability of a solution to conduct electricity. It can be used as an indicator of the amount of ionized material in solution and relates approximately to dissolved-solids content.

Specific conductance values in bodies of water usually reflect the geochemistry of the drainage basin; however, pollution and the intrusion of oceanic salts can also have a considerable effect on specific conductance. Increasing streamflows reduce the concentration of dissolved solids, thus lowering specific conductance and chloride levels. Conversely, decreasing flows have the opposite effects.

In the Delaware Estuary, the intrusion of oceanic salts is important to those who must use the estuary as a water supply. For this reason, chloride concentration is of great interest. Water with chloride concentrations in excess of 250 mg/L (milligrams per liter) is usually considered undesirable for domestic use, and water with concentrations in excess of 50 mg/L is unsatisfactory for some industrial uses.

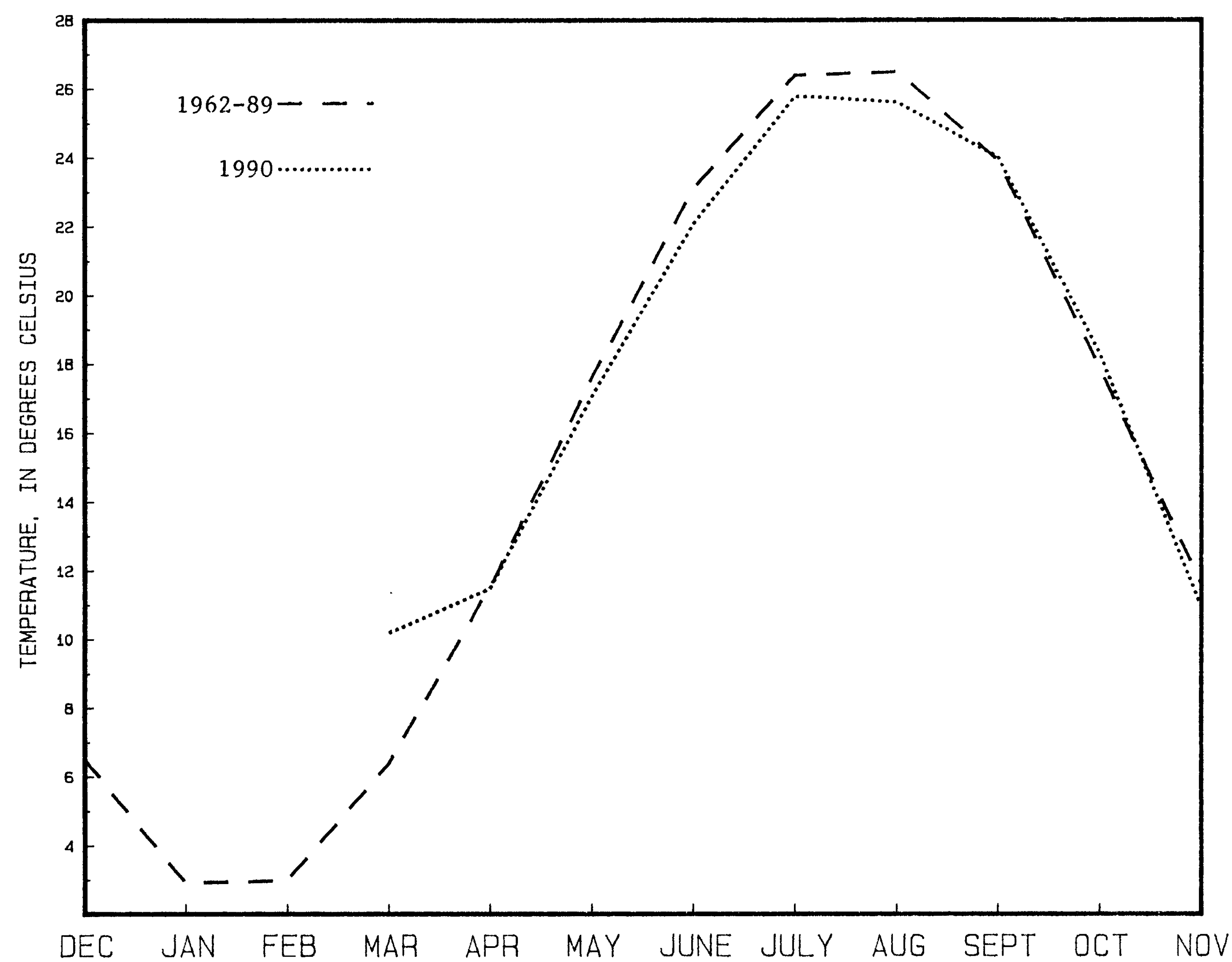

Figure 6. - Mean monthly temperatures of the Delaware River at Benjamin Franklin Bridge, Philadelphia, Pennsylvania.

As sea water has a chloride concentration of approximately 19,000 mg/L, the location of a body of water in relation to the sea can influence chloride concetrations in that body of water. For this reason, chloride concentrations in the Delaware Estuary generally increase with distance downstream toward the Delaware Bay and Atlantic Ocean.

Chloride concentration was not measured directly at Fort Mifflin, Pa., and Reedy Island Jetty, Del., but a correlation between specific conductance and chloride concentration has been developed based on analyses of water samples taken in the estuary. Chloride concentrations estimated from that correlation are presented in tables 18 and 20. The correlation is less reliable when chloride concentrations are lower than 30 mg/L because other ionized materials may be present in amounts large enough to affect the conductance-chloride correlation. Therefore, chloride concentrations derived from specific conductance are not given when chloride concentrations of less than 30 mg/L are indicated. Chloride concentrations at Chester, Pa., (table 19) were furnished by Scott Paper Company.

At Fort Mifflin, the maximum daily chloride concentration equaled or exceeded 50 mg/L, 4 percent of the time (table 18). The maximum was 95 mg/L on October 14. At Chester, the minimum daily chloride concentration equaled equaled or exceeded 50 mg/L, 8 percent of the time and the maximum daily concentration was greater than 50 mg/L, 23 percent of the time (table 19). The maximum daily chloride concentration was 260 mg/L on December 31. Minimum chloride concentrations at Reedy Island Jetty were below 250 mg/L on January 30 through February 18, February 20, April 5 - 19, May 16 - 21, and May 30 through June 5 (see table 20). During the year, maximum chloride concentra-tions typically ranged from 2,000 to 6,000 mg/L. The maximum at this site was 9,600 mg/L on March 5.

Dissolved Oxygen

Dissolved oxygen is necessary in water for the respiration of aquatic organisms. It also plays a significant role in chemical reactions in aquatic environments. The major sources of dissolved oxygen in water are diffusion from the atmosphere and photosynthesis in aquatic plants. Dissolved-oxygen concentrations are limited by temperature, salinity, and the partial pressure of atmospheric oxygen.

Dissolved-oxygen levels in the estuary tend to be highest near Trenton and to decrease with distance downstream to a point near or somewhat downstream from the Benjamin Franklin Bridge, where minimum values are usually reached. During the past year, daily mean dissolved-oxygen concentration at the Benjamin Franklin Bridge was below 5 mg/L from July 11 - 17, July 26 through August 12, August 19 - 28, September 12 - 17, 23, and October 22 (table 21). The minimum daily mean was 3.7 mg/L on July 14. At Chester, the daily mean dissolved-oxygen concentration was below 5 mg/L during the periods July 10 - 13, 15 - 20, 22 - 27, August 7 - 17, 27, and September 11 - 17 (table 22). The lowest daily mean was 3.9 mg/L on August 9. The minimum hourly value was 3.6 mg/L on August 10. At Reedy Island Jetty, the minimum hourly value during the period December 1 through July 10 was 6.3 mg/L on June 4. Dissolved oxygen data are not available beyond July 10, due to lack of power to the monitoring site.

Table 18.- Daily maximum and minimum chloride concentrations, Delaware River at Fort Mifflin, Pa., in milligrams per liter
December 1, 1989 to November 30, 1990

[Monitor was not in operation December 1, 1989 to February 28, 1990; A dash (-) indicates missing data;
* indicated less than 30 mg/L (milligrams per liter); max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1							*	*	36	*	*	*	*	*	34	*	30	*	31	*	37	*	*	*
2							*	*	*	*	*	*	*	*	35	*	31	*	31	*	35	*	*	*
3							*	*	42	*	*	*	*	*	32	*	35	*	*	*	34	*	*	*
4							33	*	41	*	*	*	*	*	34	*	33	*	30	*	34	*	*	*
5							*	*	34	*	31	*	*	*	31	*	31	*	*	*	33	*	*	*
6							30	*	*	*	41	*	*	*	34	*	51	*	33	*	34	*	*	*
7							*	*	32	*	46	*	*	*	34	*	71	30	33	*	38	30	*	*
8							*	*	58	*	*	*	*	*	37	*	54	*	34	*	38	31	35	*
9							*	*	34	*	*	*	*	*	35	*	31	*	*	*	42	31	*	*
10							31	*	*	*	*	*	*	*	35	*	35	*	32	*	41	33	45	*
11							33	*	32	*	33	*	33	*	35	*	37	*	35	*	40	33	48	*
12							30	*	30	*	*	*	33	*	39	*	*	*	31	*	39	34	38	*
13							37	*	*	*	*	*	33	*	54	*	*	*	35	*	57	33	*	*
14							37	*	*	*	*	*	32	*	54	31	*	*	36	*	95	34	*	*
15							35	*	33	*	*	*	33	*	34	*	*	*	46	*	65	37	*	*
16							31	*	31	*	*	*	*	*	*	*	*	*	44	*	44	34	*	*
17							35	*	*	*	*	*	*	*	*	*	*	*	66	*	46	33	*	*
18							36	*	*	*	*	*	*	*	*	*	*	*	50	*	41	32	*	*
19							40	*	*	*	*	*	*	*	*	*	*	*	34	*	40	31	*	*
20							36	*	*	*	*	*	*	*	*	*	*	*	41	*	42	*	*	*
21							37	*	*	*	*	*	*	*	*	*	41	*	35	*	32	*	*	*
22							38	*	*	*	*	*	*	*	34	*	41	*	45	*	31	*	*	*
23							*	*	*	*	*	*	*	*	32	*	42	*	35	*	30	*	*	*
24							*	*	*	*	*	*	*	*	32	*	31	*	33	*	*	*	*	*
25							*	*	*	*	*	*	*	*	30	*	*	*	31	*	*	*	*	*
26							30	*	*	*	*	*	*	*	*	*	*	*	31	*	*	*	*	*
27							31	*	*	*	*	*	31	*	*	*	*	*	30	*	*	*	*	*
28							*	*	*	*	*	*	33	*	*	*	*	*	30	*	*	*	*	*
29							32	*	*	*	34	*	32	*	*	*	*	*	30	*	*	*	36	*
30							33	*	30	*	30	*	33	*	*	*	33	*	30	*	*	*	*	*
31							37	*			*	*			31	*	35	*			*	*		

Table 19.- Daily maximum and minimum chloride concentrations, Delaware River at Chester, Pa., in milligrams per liter December 1, 1989, to November 30, 1990. Collection and analysis by Scott Paper Company.

[A dash (-) indicates missing data; * indicates less than 30 mg/L (milligrams per liter); max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	34	*	100	55	38	*	32	*	34	30	30	*	*	*	32	30	41	31	35	*	61	32	*	*
2	37	31	67	57	40	*	35	*	38	*	32	*	*	*	32	*	40	35	36	30	61	42	*	*
3	37	33	65	54	34	*	32	*	45	30	30	*	*	*	32	30	36	*	45	30	52	43	*	*
4	39	31	70	45	36	*	34	*	38	31	35	*	*	*	34	30	50	35	34	30	59	48	33	*
5	40	34	70	44	36	*	31	*	39	32	35	*	*	*	34	*	40	*	33	*	72	46	30	*
6	36	33	64	52	36	*	32	*	34	*	30	*	*	*	35	*	41	*	35	*	48	46	30	*
7	44	32	68	50	32	*	32	*	32	*	35	30	*	*	38	30	37	30	32	*	55	42	*	*
8	42	35	69	49	32	*	31	*	40	30	37	30	*	*	36	31	38	*	38	32	70	41	*	*
9	41	32	100	54	36	*	38	*	37	33	32	30	*	*	38	*	44	*	40	30	83	42	38	*
10	-	-	83	55	30	*	31	*	-	-	32	30	*	*	42	36	34	32	42	36	82	34	31	*
11	36	32	70	57	32	*	40	*	45	33	31	*	32	*	45	36	36	*	40	35	86	55	30	*
12	36	32	74	50	31	*	38	30	38	30	35	*	32	*	36	*	40	36	50	39	76	53	*	*
13	70	30	68	34	32	*	55	*	33	30	33	*	32	30	38	*	40	*	50	38	85	52	*	*
14	55	36	62	55	34	*	36	30	34	*	38	32	38	32	38	30	38	30	68	35	82	50	*	*
15	50	40	66	54	34	*	34	30	32	*	32	*	*	*	44	34	35	*	67	45	75	50	*	*
16	54	44	65	47	30	*	35	30	32	*	40	*	30	*	38	34	36	*	46	37	75	50	*	*
17	48	43	58	53	36	32	35	*	30	*	30	*	33	31	46	34	38	32	57	*	80	50	*	*
18	48	43	68	55	60	*	36	30	36	*	*	*	33	*	46	33	38	*	55	32	78	56	*	*
19	63	45	61	55	32	*	35	*	32	30	*	*	41	30	44	33	35	32	65	38	70	49	*	*
20	50	44	60	55	30	*	40	30	33	*	*	*	32	31	42	33	39	*	65	42	62	40	*	*
21	48	43	65	55	34	*	38	*	35	30	*	*	34	*	46	*	40	32	67	38	48	41	*	*
22	46	44	66	54	32	*	31	*	32	*	*	*	35	*	44	35	34	*	78	40	54	41	*	*
23	53	44	58	50	30	*	38	31	35	*	*	*	34	30	41	35	35	30	62	40	51	36	*	*
24	-	-	57	55	32	*	33	*	33	*	*	*	32	*	42	33	33	*	54	30	84	42	*	*
25	44	36	58	50	30	*	36	30	30	*	*	*	33	*	40	35	33	*	52	36	45	36	*	*
26	65	45	52	47	33	*	38	*	30	*	*	*	30	*	72	34	-	-	54	34	40	30	*	*
27	60	46	52	45	32	*	32	*	33	*	*	*	31	*	44	32	31	*	55	39	38	30	31	*
28	62	52	44	39	34	*	34	*	34	30	*	*	30	*	42	34	35	*	47	32	38	*	*	*
29	65	45	41	38			34	*	32	*	32	*	32	*	40	32	32	30	51	30	39	*	*	*
30	206	46	44	35			34	*	*	*	*	*	30	*	42	37	40	*	55	39	35	*	*	*
31	260	55	34	*			34	30			*	*			41	35	34	*			*	*		

Table 20.- Daily maximum and minimum chloride concentrations, Delaware River at Reedy Island Jetty, Del., in milligrams per liter
December 1, 1989 to November 30, 1990
[A dash (-) indicates missing data; * indicates less than 30 mg/L (milligrams per liter; max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	4100	1300	6900	4200	250	77	2600	420	2700	680	2200	850	1100	84	3800	1000	-	-	6500	2400	-	-	-	-
2	5200	1700	5300	3400	150	40	2700	320	3000	730	2200	850	1300	140	4900	1500	-	-	6500	2200	-	-	-	-
3	3600	1500	5100	3300	100	36	1800	280	2800	700	2700	770	1100	160	4100	1500	-	-	6500	2400	-	-	-	-
4	4100	1100	6300	3200	1200	45	8800	410	2900	650	2900	780	1300	140	4500	1200	-	-	-	-	-	-	-	-
5	4900	1300	5700	660	1700	38	9600	330	2200	48	4100	900	2800	160	4200	810	-	-	5500	3000	-	-	-	-
6	5000	1500	940	740	2000	*	3200	440	490	31	5100	1300	2500	290	5100	850	-	-	5800	2800	-	-	-	-
7	5000	1900	1000	440	1800	38	9400	560	530	*	4800	1400	2500	330	4300	1500	-	-	6100	2800	-	-	-	-
8	4600	1800	1100	570	2100	51	8500	290	330	*	4600	1400	2800	280	5300	1800	-	-	6400	2700	-	-	-	-
9	5300	2100	2100	990	1700	79	2900	600	440	*	4800	1400	2700	470	4600	1200	-	-	6100	2900	-	-	-	-
10	5700	2400	-	-	960	87	3300	610	350	*	4700	1600	2600	540	3500	1100	-	-	5500	3000	-	-	-	-
11	6000	2400	-	-	1100	43	3300	650	230	*	3200	720	2600	610	-	-	-	-	6000	2700	-	-	-	-
12	6100	2600	-	-	400	62	2500	690	300	*	2100	620	3400	790	-	-	-	-	6100	2700	-	-	-	-
13	6300	2900	-	-	380	35	2900	720	790	130	2000	500	4500	750	-	-	-	-	6200	2800	-	-	-	-
14	6300	2600	4400	1900	150	*	2800	720	1900	150	1400	330	3300	810	-	-	-	-	6100	2900	-	-	-	-
15	5500	2800	4400	1900	280	33	3300	730	910	120	-	-	3400	890	-	-	-	-	5700	3000	-	-	-	-
16	4200	2400	4400	1900	1100	57	2800	840	980	130	260	130	3000	770	-	-	-	-	6200	2800	-	-	-	-
17	-	-	4100	2000	100	*	2900	680	950	71	740	140	3300	770	-	-	-	-	5700	2700	-	-	-	-
18	-	-	4300	2100	1600	*	1500	440	1500	71	900	87	3000	940	-	-	-	-	5700	2700	-	-	-	-
19	5300	2400	3900	1700	2400	410	1900	430	2200	220	1100	71	2900	640	-	-	-	-	6200	2800	-	-	-	-
20	5400	2600	4300	1700	2400	140	2000	460	2700	540	2100	54	3500	740	-	-	-	-	5900	2800	-	-	-	-
21	5900	2600	5200	2000	3100	600	3100	460	2700	410	3400	170	3400	680	-	-	-	-	5700	2800	-	-	-	-
22	4500	2600	6000	2300	4000	1100	3900	1400	3100	460	3100	300	3300	580	-	-	-	-	5400	2700	-	-	-	-
23	-	-	5700	2200	3200	780	3900	1400	3500	550	2600	290	3400	850	-	-	-	-	5300	2600	-	-	-	-
24	-	-	6200	2100	3100	650	3500	900	3100	820	2900	290	3900	930	-	-	-	-	4800	2300	-	-	-	-
25	-	-	5900	2100	3000	330	3300	990	3500	930	2300	280	3400	900	-	-	-	-	5200	2200	-	-	-	-
26	-	-	3900	1400	3000	350	3400	830	3700	750	2200	340	3300	910	-	-	-	-	4800	2200	-	-	-	-
27	-	-	3000	630	3700	500	2400	640	2900	770	1500	340	3000	920	-	-	-	-	5800	2000	-	-	-	-
28	-	-	1300	390	2200	420	2700	640	2800	770	1900	310	2800	850	-	-	-	-	5700	2600	-	-	-	-
29	-	-	2800	380			2500	570	2500	850	1500	340	3000	800	-	-	-	-	6400	2600	-	-	-	-
30	7700	4800	2700	190			2800	610	2600	860	750	230	3300	960	-	-	5400	1900	6300	2500	-	-	-	-
31	8100	4600	430	130			3000	630			1100	110			-	-	5800	2200			-	-		

Table 21.- Daily mean dissolved oxygen concentration, Delaware River at Benjamin Franklin Bridge at Philadelphia Pa., in milligrams per liter
December 1, 1989 to November 30, 1990
[Monitor was not in operation December 1, 1989 to February 28, 1990; a dash (-) indicates missing data]

Day	December	January	February	March	April	May	June	July	August	September	October	November
1				-	9.1	7.2	7.4	6.6	4.4	6.9	-	8.7
2				-	9.0	7.0	7.2	6.7	4.5	7.0	-	8.8
3				-	9.0	6.8	7.1	6.5	4.5	7.0	-	8.7
4				-	9.1	6.7	6.8	6.5	4.5	7.3	-	8.6
5				-	9.2	6.4	6.9	6.4	4.6	7.1	6.5	8.5
6				-	9.4	6.2	6.9	6.0	4.2	6.6	6.3	8.6
7				-	-	6.3	7.1	5.8	4.0	6.2	6.1	8.9
8				-	9.0	6.4	7.0	-	4.3	6.1	6.0	-
9				-	-	-	6.8	5.4	4.6	5.9	5.7	8.9
10				-	-	-	6.6	-	4.5	5.4	-	8.7
11				-	-	6.5	6.5	4.7	4.2	-	-	8.9
12				-	-	-	-	4.3	4.6	4.5	5.3	-
13				9.6	-	6.8	-	4.1	5.1	4.3	5.3	-
14				9.6	-	6.7	-	3.7	5.5	4.4	5.3	-
15				9.6	-	7.2	-	4.0	5.8	4.2	5.3	-
16				9.5	-	7.7	-	4.4	5.6	4.4	5.4	-
17				9.3	-	7.7	-	4.7	5.3	4.7	5.4	-
18				8.9	-	7.9	-	5.5	5.1	5.2	-	-
19				8.6	-	7.7	7.9	6.3	4.8	5.3	-	-
20				8.0	-	7.8	7.6	6.8	4.9	5.3	-	-
21				7.7	-	8.0	7.1	6.9	4.7	5.5	5.3	-
22				7.4	-	8.1	6.4	6.5	4.5	-	4.9	-
23				7.6	-	8.0	5.8	6.1	4.2	4.9	-	11.3
24				8.2	-	8.0	5.3	5.7	4.1	-	5.1	11.2
25				8.3	9.0	7.9	5.1	5.2	4.0	-	6.0	11.1
26				8.4	8.5	8.0	5.1	4.9	4.3	-	7.7	11.0
27				8.6	8.2	8.0	5.4	4.6	4.6	-	8.6	11.1
28				8.5	7.9	8.0	5.8	4.6	4.7	-	8.5	10.9
29				8.7	7.7	7.9	6.1	4.8	5.1	-	8.8	10.7
30				9.1	7.6	7.7	6.4	4.7	5.7	-	8.9	-
31				9.1	-	7.6	-	4.6	6.4	-	8.8	-

Table 22.- Daily mean dissolved oxygen concentration, Delaware River at Chester, Pa., in milligrams per liter
December 1, 1989, to November 30, 1990
A dash (-) indicates missing data.
[Monitor was not in operation December 1, 1989 to February 28, 1990]

Day	December	January	February	March	April	May	June	July	August	September	October	November
1				9.9	8.2	7.2	7.0	5.5	5.4	6.2	5.4	7.6
2				9.9	8.1	7.2	6.9	5.6	5.5	6.2	5.7	7.5
3				9.7	8.2	7.3	6.6	6.0	-	6.1	5.7	7.5
4				9.9	8.3	7.4	6.6	6.0	-	6.1	5.8	7.3
5				10.7	8.5	7.0	6.9	5.6	5.8	6.0	6.0	7.3
6				10.8	8.6	6.7	7.0	5.3	5.5	5.6	6.0	7.5
7				11.0	8.7	7.2	6.7	5.4	4.9	5.3	5.9	7.7
8				11.0	9.4	7.6	6.8	5.6	4.2	5.3	5.6	7.8
9				10.5	9.5	7.8	6.8	5.3	3.9	5.5	5.6	9.9
10				9.5	9.2	7.7	6.7	4.8	4.0	5.3	5.6	8.0
11				9.5	-	7.6	6.6	4.6	4.1	4.9	5.8	7.9
12				9.5	9.0	7.6	7.3	4.6	4.0	4.7	5.8	8.6
13				9.5	9.9	7.2	7.8	4.9	4.1	4.5	5.5	8.9
14				9.5	10.2	6.8	7.6	5.0	4.4	4.4	5.1	9.7
15				9.7	9.3	7.1	7.4	4.7	4.5	4.5	5.0	11.4
16				9.2	8.3	6.8	7.2	4.3	4.7	4.5	5.1	9.3
17				9.2	8.4	6.3	7.2	4.4	4.9	4.7	5.3	8.9
18				9.1	9.3	6.6	7.1	4.5	5.1	5.1	5.8	9.3
19				9.9	9.5	7.1	6.6	4.6	5.3	5.2	6.3	11.2
20				10.0	9.4	7.3	6.1	4.8	5.6	5.4	6.2	15.8
21				10.1	8.8	7.4	5.7	5.0	5.7	5.4	6.1	15.6
22				9.9	8.3	7.4	5.7	4.9	5.9	5.4	6.1	13.4
23				8.8	7.7	7.1	5.7	4.9	5.8	5.3	6.0	10.1
24				8.7	7.9	7.0	5.5	4.9	5.5	5.4	5.9	9.1
25				8.8	8.1	7.0	5.6	4.7	5.2	5.6	5.8	9.1
26				7.8	7.2	7.1	5.6	4.7	5.0	5.7	6.1	9.2
27				7.9	7.0	7.1	5.5	4.8	4.9	5.7	6.5	9.3
28				7.9	6.8	7.3	5.5	5.0	5.1	5.7	6.8	9.2
29				8.1	7.4	7.3	5.5	5.2	5.4	5.6	7.4	9.0
30				8.3	7.8	7.2	5.5	5.2	5.8	5.5	7.5	13.1
31				8.3		7.1		5.2	6.0		7.7	

Figure 7 shows the frequency of occurrence for hourly dissolved-oxygen concentration at Benjamin Franklin Bridge and Chester during the critical summer period, July through September, 1990. Dissolved-oxygen concentration was equal to or below 4 mg/L, 4 percent of the time at Chester in 1990, as compared with 8 percent of the time in 1989. At Benjamin Franklin Bridge the dissolved-oxygen concentration was equal to or below 4 mg/L, 9 percent of the time, compared with 70 percent of the time in 1989.

Hydrogen-Ion Concentration (pH)

Hydrogen-ion concentration (pH) is fundamentally a measure of acidity or alkalinity. Values of pH below 7 indicate acidity, whereas values above 7 indicate alkalinity. In natural waters, pH generally ranges from 6.0 to 8.5. The main factors controlling the pH of a body of water are usually the geochemistry of the drainage basin and external influences such as pollution. Photosynthetic activity can also have a considerable influence on pH values. Increased photosynthetic activity (algal bloom) produces higher pH values. All pH values at Benjamin Franklin Bridge, Chester, and Reedy Island Jetty were in the range of 6.4 to 7.9. The pH range for each station is: Reedy Island Jetty, 6.7 to 7.9; Chester, 6.5 to 7.0; Benjamin Franklin Bridge, 6.4 to 7.6. The pH in the estuary tends to be lowest near Trenton, N.J., and to increase downstream.

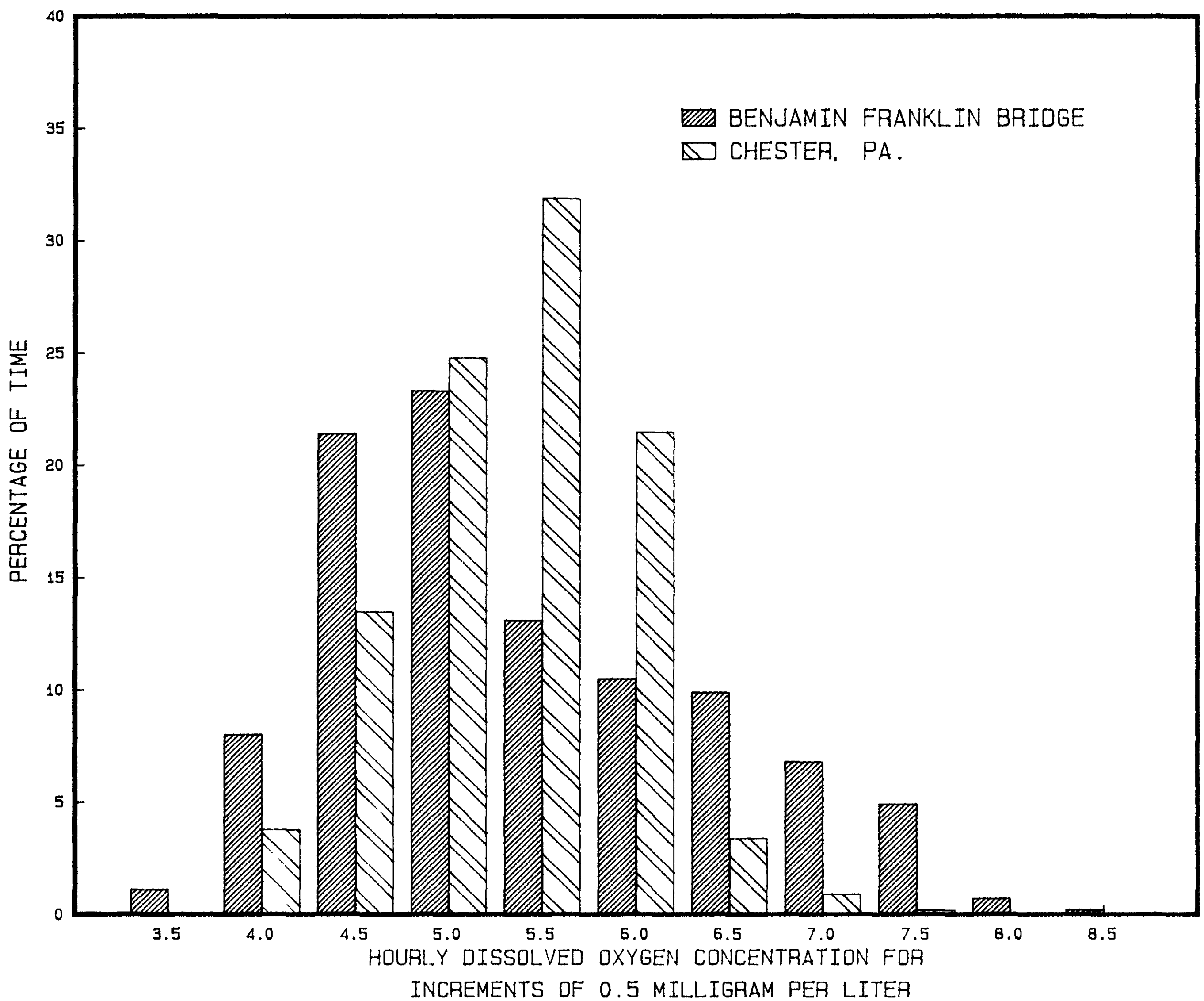

Figure 7. - Frequency of occurrence of dissolved-oxygen concentrations at two stations in the Delaware River, during July, August and September 1990.

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CALENDAR FOR REPORT YEAR 1990

DECEMBER 1989

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

JANUARY 1990

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

MARCH

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE 1990

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SEPTEMBER

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	