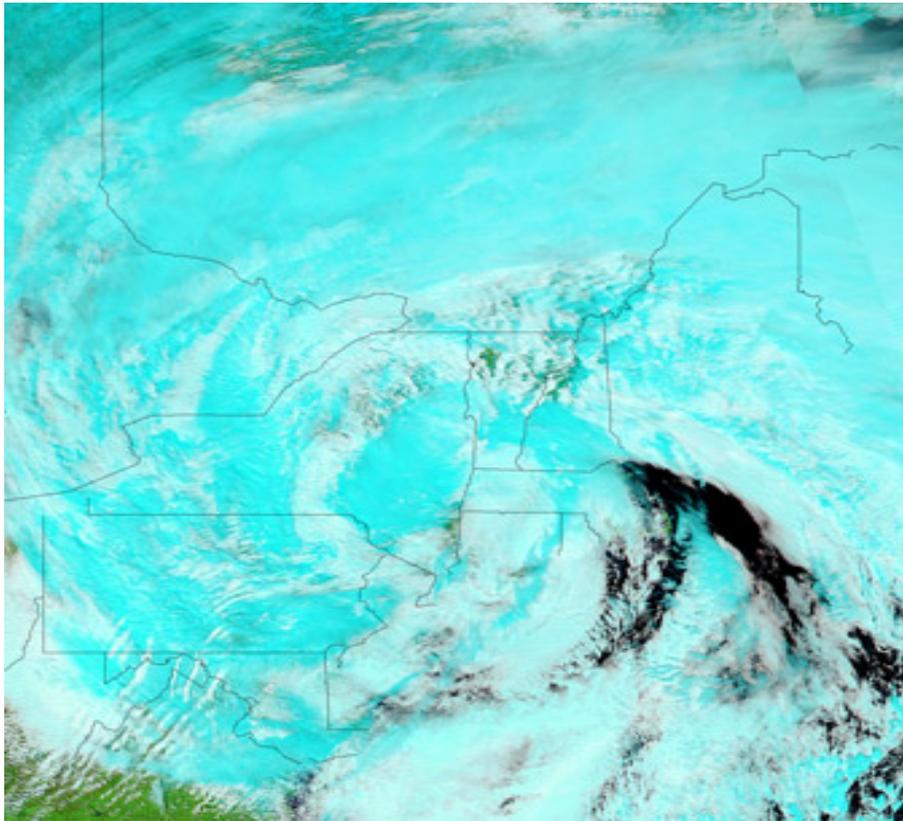

Hydrologic Conditions in the Delaware River Basin



April 15-16, 2007: A Nor'easter strikes the Delaware River Basin.

Photo courtesy of NASA.

Annual Report 2007

Hydrologic Conditions in the Delaware River Basin Annual Report 2007

Hydrologic Highlights of 2007

April 2007: A Nor'easter Brings Flooding to the Basin

Heavy rain began falling in the Delaware River Basin (DRB) late in the evening on Saturday, April 14, 2007 and continued to fall throughout much of the region for the remainder of the weekend. Higher elevations and northern portions of the basin received snow from this event as cold air intercepted the storm. Rainfall totaled between three and seven inches throughout most of the basin, with slightly lower amounts of two to four inches along the New Jersey coast. Northern regions received as much as six inches of heavy, wet snow. Although runoff from the storm produced significant rises along the non-tidal main stem Delaware, the river crested below flood stage. On April 16, the Delaware River at Montague, N.J. crested at 18.50 feet (flood stage is 25 feet) and one day later, the Delaware River at Trenton crested at 18.82 feet (flood stage is 20 feet). Strong winds with peak gusts of 40 to 60 miles per hour produced minor tidal flooding on the Delaware River downstream of Trenton, N.J. and along the Delaware Bay.

Although flooding was avoided along the main stem, minor to moderate flooding occurred on many Delaware tributaries, such as the Neversink River, Beaver Kill River, Schuylkill River, Chester Creek, and Brandywine Creek. A few locations experienced more severe flooding. Major flooding occurred along Assunpink Creek at Trenton, which crested at 13.28 feet; this was nearly 4.8 feet above flood stage and the fourth highest crest on record at this location. Major flooding also occurred on the Neshaminy Creek near Langhorne, Pa., which crested at 14.68 feet, or nearly 5.7 feet above flood stage.

June 2007: Flash Floods in New York State and a “Chocolate Milk” River

Tragic events unfolded on the night of June 19, 2007 after six to eight inches of rain fell during a two-hour period over a small area along the borders of Sullivan and Delaware counties in New York State. This intense storm was triggered by a cold front that arrived from the Midwest and plunged temperatures more than twenty degrees. The Beaver Kill River at Cooks Falls, N.Y. responded to the deluge by rising more than seven feet in only 15 minutes. The resulting flash floods along the Beaver Kill River and the East Branch Delaware River claimed four lives, washed out roads, and destroyed several homes.

A few days after the flash floods in New York, a slug of reddish-brown water began making its way down the Delaware River. The odd, chocolate milk-like color was the result of loosened sediments and eroded banks that caused the river's turbidity (cloudiness) to spike. The Delaware's color-change attracted much attention, but proved to be mainly an aesthetic issue; no fish kills or other damaging effects on water quality were reported. The slug of muddy water eventually made its way downstream and within a few days the Delaware's turbidity levels were back in the normal range.

August-December 2007: State Drought Declarations

Growing precipitation deficits during the summer of 2007 caused streamflow and groundwater levels to decline. In response, the Pennsylvania Department of Environmental Protection (PA DEP) declared a drought watch for 58 counties in Pennsylvania on August 6. Eight of these counties were in the DRB. A drought watch is the first and least severe of the state's three drought declarations and calls for a voluntary, five-percent reduction in non-essential water use.

Most counties in the Pennsylvania portion of the basin received normal to above-normal rainfall in August, prompting PA DEP to remove five of the eight DRB counties from Drought Watch status on September 5. Only

Luzerne, Monroe, and Schuylkill counties remained under the drought watch. Deficits of up to 3.5 inches accumulated for many basin counties during an unusually dry September. These deficits, combined with declining streamflow and groundwater levels, prompted PA DEP to add 11 DRB counties to drought watch status on October 5, 2007. A total of 14 of the 17 basin counties in Pennsylvania were now under drought watch.

By early October, the Long-Term Palmer Drought Severity Index (Palmer Index) was indicating moderate drought in southeastern and northeastern Pennsylvania, severe drought in central and southern New Jersey, and extreme drought statewide in Delaware. In response to declining streamflows and groundwater, and very dry soil conditions, Delaware Governor Ruth Ann Minner declared a statewide drought watch on October 20. Of all the basin states, only New York remained unaffected by drought; the Palmer Index showed the state to be in normal to wet conditions.

Hydrologic conditions improved during the last quarter of 2007, but drought declarations remained in effect. By late December, 17 basin counties in Pennsylvania and Delaware remained under drought watch. No drought declarations had been issued in New Jersey and the DRB portion of New York continued in normal hydrologic conditions based on the Palmer Index.

No drought declarations were issued by the DRBC during 2007; storage in the three New York City (NYC) DRB reservoirs and the two lower basin reservoirs (Blue Marsh and Beltzville) remained above levels that would have triggered a drought declaration under DRBC's drought operating plan.

Precipitation

Annual precipitation for 2007 was normal to above normal for the majority of the counties¹ within the DRB. Fourteen counties reported annual deficits. Annual departures from normal ranged from 9.80 inches (22%) below normal in Sussex Co., Del. to 10.90 inches (27%) above normal in Lackawanna Co., Pa.

Year-end precipitation totals ranged from 34.40 inches (Sussex Co., Del.) to 54.60 inches (Morris Co., N.J.). *Figure 1: 2007 Annual Precipitation in the Delaware River Basin* depicts precipitation totals and departures by county.

Regarding precipitation at selected stations around the basin, the observed precipitation above Montague for 2007 was 47.63 inches, or 4.37 inches above normal. Annual observed precipitation above Trenton was 49.27 inches, or 4.38 inches above normal. Finally, annual observed precipitation at Wilmington, Del. was 41.81 inches, or 1.0 inch below normal. *Table 1: 2007 Precipitation at Selected Stations in the Delaware River Basin* provides additional precipitation data.

¹ This information was based on precipitation data from the National Weather Service Middle Atlantic River Forecast Center for 38 of the 42 counties located either partially or completely in the Delaware River Basin. Data for the remaining four counties is not available. Departures from normal were calculated by DRBC staff.

Streamflow

Average monthly streamflow was normal to above normal during January 2007. Flows declined during February, but March's rainfall and melting snowpack combined to replenish streams to above-normal levels. A Nor'easter in mid-April brought heavy wet snow and rain which produced above-normal flows during the remainder of the month and into early May.

May's rainfall deficits averaged nearly 2.5 inches below normal and caused the basin's streamflows to decline throughout the month. By the end of May, the daily streamflow at the Delaware River at Montague and Trenton was 51.1% and 54.6% of normal, respectively.

Streamflow remained below normal throughout most of the summer. Flows briefly improved during August, but a more sustained improvement did not occur until October in many locations. Above-normal streamflow predominated during the last quarter of the year. Please refer to [Table 2: 2007 Streamflow in the Delaware River Basin](#) for average monthly streamflow data at selected stations. Refer to [Figure 2: Delaware River at Montague, N.J.](#) and [Figure 3: Delaware River at Trenton, N.J.](#) for the annual hydrographs of these two Delaware River stations.

Reservoir Storage

Lower Basin

Both Beltzville Reservoir (located on the Pohopoco Creek, a tributary of the Lehigh River) and Blue Marsh Reservoir (located on the Tulpehocken Creek, a tributary of the Schuylkill River) maintained storage in the normal range during 2007. After a dry summer, DRBC-directed releases from lower basin storage were required in early autumn to meet the Delaware River flow objective of 3,000 cubic feet per second (cfs) at Trenton. DRBC directed a total of 453 million gallons (mg) from Blue Marsh Reservoir during the period October 3-10. No releases were made from Beltzville Reservoir. Please refer to [Figure 4: Blue Marsh Reservoir Elevation](#) and [Figure 5: Beltzville Reservoir Elevation](#) for 2007 elevations at these two lower basin reservoirs.

No releases were required from Merrill Creek Reservoir during 2007 to replace consumptive use losses from the power industry. This reservoir, located near Phillipsburg, N.J., provides storage when the basin is under drought operations and is used for replacing evaporative losses caused by power generation and augmenting flows at Trenton. Special releases totaling approximately 252 mg were made in early January and in late April to maintain the reservoir level below the maximum operating level of 922.80 feet.

Upper Basin

The three NYC reservoirs in the upper DRB began the year with storage above the long-term median. As of January 1, 2007, the Cannonsville, Pepacton, and Neversink reservoirs had a combined storage of 254 billion gallons (bg), which is 94.0 percent of usable storage and 64.9 bg above the long-term median storage for the date. By January 16, storage had increased to 100 percent from rainfall and snowmelt. From mid-January through mid-March, storage steadily declined, mostly due to releases which were a part of a temporary spill mitigation program in effect since September 2006. March's rain and snowmelt combined to raise storage to 100 percent usable capacity by March 27. A mid-April Nor'easter further added to storage and the reservoirs remained full on May 1, the median refill date. Beginning in October 2007, the NYC reservoirs were operated in accordance with the Flexible Flow Management Program (FFMP), a temporary agreement that was unanimously approved by the five parties to the 1954 U.S. Supreme Court Decree (Delaware, New Jersey, Pennsylvania, New York State, and New York City) on September 26, 2007. Please refer to the [Delaware River Master's web site](#) for more information about the FFMP.

May 2007 was the second driest on record² for the DRB above Montague. Rainfall totaled 1.40 inches, or 33% of normal for the month. The reduced inflow to the reservoirs resulted in lower storage. Reservoir levels dropped below the long-term median storage in early May and remained below normal through early autumn. Streamflows also declined during this period and the Delaware River Master directed releases from the reservoir system by late May to maintain the 1,750 cfs flow target at Montague. River Master-directed releases continued as-needed through mid-October. Approximately 54 bg³ was released during this time, compared to 14 bg released during 2006 and 103 bg released during the drought year 2001.

The declining storage trend that began in May was reversed in October when more than double the normal rainfall was received in the area above Montague. By late October, the total NYC Delaware storage increased to above the long-term median storage. Storage remained above the median storage and trended upward for the remainder of 2007. On December 31, 2007, total combined storage in the three NYC reservoirs was 249 bg, 92.1% of usable storage and 60.6 bg above the long-term median for that date. For a graphical presentation of NYC Delaware reservoir storage levels for 2007, please refer to [Figure 6: New York City Delaware River Basin Storage 2007](#).

Groundwater

The average observed groundwater level in eight reported U.S. Geological Survey (USGS) observation wells in the Pennsylvania portion of the basin remained above the long-term average through May. May's below-normal rainfall impacted groundwater; the eight-well average had declined to below the long-term average by June. The average water level in the wells continued to decline and remained below the long-term average during the summer and into early autumn. In October, much-above normal rainfall caused groundwater levels to rebound. Although water levels in the observation wells remained below the long-term average for the remainder of 2007, levels continued their upward trend into 2008.

Monthly measurements of groundwater within two coastal plain wells (New Castle Co., Del. and Cumberland Co., N.J.) recorded levels within the normal (25- to 75-percentile) to above-normal range (greater than 75-percentile) during 2007. Please refer to [Figure 7: USGS Network Wells-Pennsylvania](#), [Figure 8: DGS Well-New Castle Co., Delaware](#), and [Figure 9: USGS Well-Cumberland Co., New Jersey](#) for graphical presentations of groundwater levels throughout the year.

Salt Front

The *salt front* is defined as the 250 parts-per-million (or milligram-per-liter) chloride concentration and is based on drinking water quality standards originally established by the U.S. Public Health Service. The seven-day average location of the salt front is used by DRBC as an indicator of salinity intrusion in the estuary. The salt front's location fluctuates along the main stem Delaware River as streamflow increases or decreases in response to changing inflows, diluting or concentrating chlorides in the river. Long-term average mid-month locations range from river mile 61 (0.5 miles below Pea Patch Island, Del.) in mid-April to river mile 81 (Marcus Hook, Pa.) in mid-October. The farthest recorded upstream location of the salt front -- river mile 102 -- was measured during the 1960's drought of record.

During 2007, the seven-day average salt front location ranged from below river mile 54 (April-May 2007) to as far upstream as river mile 86 (October 2007), a location that is eight miles upstream of the Delaware-Pennsylvania state line. See [Figure 10: 7-Day Average Location of the 250-PPM Isochlor](#) for an overview of salt front locations along the Delaware River during 2007.

² Based on data obtained from the Office of the Delaware River Master; five-station average and 66 years of record.

³ Based on data obtained from the Office of the Delaware River Master.