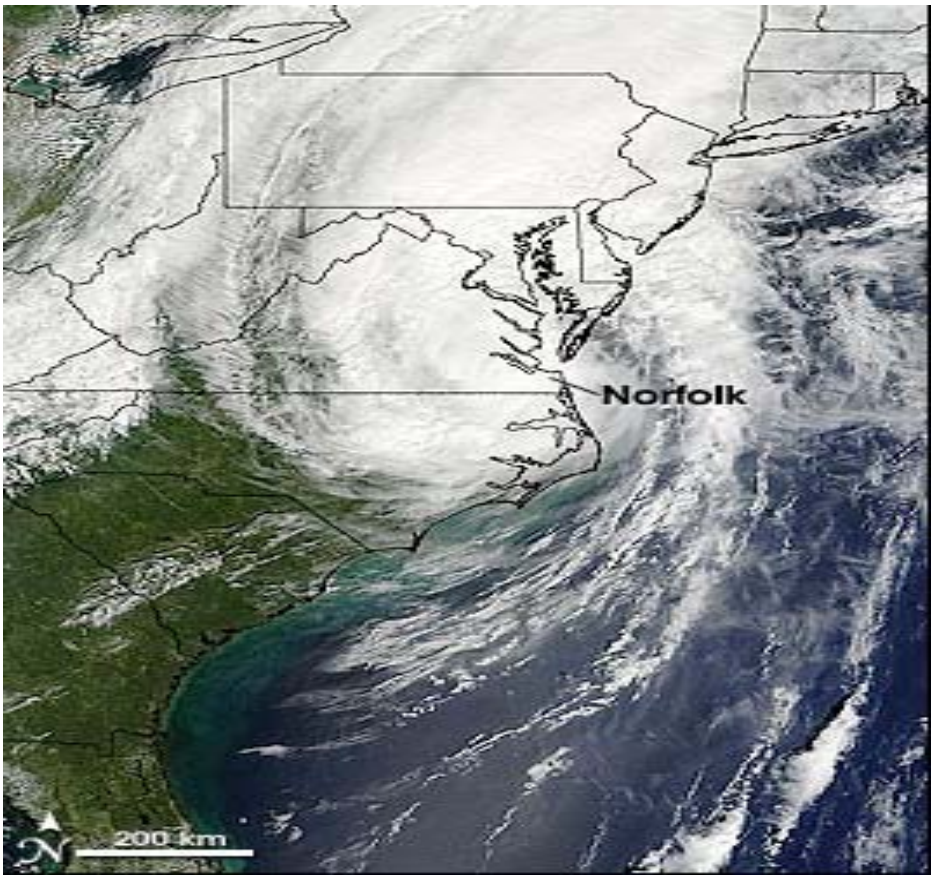
Hydrologic Conditions in the Delaware River Basin



September 6-7, 2008: Tropical Storm Hanna Impacts the Delaware River Basin.
Photo courtesy of NASA, Jeff Schmaltz, MODIS Rapid.

Annual Report 2008

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
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Hydrologic Highlights of 2008

Drought Declarations

Seventeen Delaware River Basin (DRB) counties were under state-declared drought watches as of January 1, 2008, a result of the dry summer and early autumn experienced the previous year. Included in the drought watch were 14 counties in Pennsylvania and all three counties in Delaware.

Surface and groundwater conditions had improved during the last quarter of 2007 and the trend continued during the first few weeks of 2008. In response to the improvement, Pennsylvania Department of Environmental Protection Secretary Kathleen McGinty lifted drought watch declarations in 11 DRB counties on January 11, 2008 and the watch ended for the three remaining basin counties on February 15. On April 25, Delaware Governor Ruth Ann Minner lifted her statewide drought watch declaration, signaling the first time all counties in the DRB were under normal conditions since early August 2007. Although the basin experienced brief dry periods during April and late summer, no new drought declarations were issued by any of the basin states or by the Delaware River Basin Commission during the remainder of the year.

Tropical Storm Hanna: September 6-7, 2008

Tropical Storm (TS) Hanna arrived in the DRB on Saturday, September 6 after making landfall earlier in the day along the border between South Carolina and North Carolina. The majority of the basin received one inch to three inches of rain from the storm, less than was forecasted. A band of heavier rainfall in the three-inch to four-inch range impacted portions of the basin from Southeastern Pennsylvania through Northeastern New Jersey. Although no significant flooding resulted from Hanna, the storm produced some unusual weather, including a confirmed tornado in East Allentown, Pa. The tornado was on the ground for approximately two minutes and covered a path one mile in length and 50 yards wide[1]. No injuries were reported, but 50 properties, including a school, were damaged by the tornado.

Precipitation

Annual precipitation for 2008 was below normal for the majority of the counties[2] within the DRB. Only 14 counties reported above-normal precipitation for the year. Annual precipitation departures-from-normal ranged from 8.70 inches (22%) below normal in Kent Co., Del. to 4.40 inches (12%) above normal in Delaware Co., N.Y.

Year-end precipitation totals ranged from 31.5 inches (Kent Co., Del.) to 45.1 inches (Lehigh Co., Pa.). *Figure 1: 2008 Annual Precipitation in the Delaware River Basin* depicts precipitation totals and departures by county.

According to precipitation data at selected stations around the basin, the observed precipitation above Montague, N.J. in 2008 was 48.3 inches, or 5.1 inches above normal. Annual observed precipitation above Trenton, N.J. was 50.7 inches, or 5.8 inches above normal. Finally, annual observed precipitation at Wilmington, Del. was 40.4 inches, or 2.4 inches below normal. *Table 1: 2008 Precipitation at Selected Stations in the Delaware River Basin* provides additional precipitation data.

[1] Based on National Weather Service's Local Storm Report, 9/7/08.

[2] 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.

Report prepared by the Operations Section, Water Resources Management Branch, Delaware River Basin Commission, 2009.

Streamflow

Average monthly streamflow was normal to above normal during January 2008. Spring-like temperatures in early January melted nearly the entire snowpack above the New York City reservoirs and the melting snow contributed to high flows. The average monthly streamflow above Montague for January was 10,800 cubic feet per second (cfs) or 217% of normal flow for the month. Similarly, the average monthly streamflow above Trenton was 19,300 cfs or 150% of the normal flow for the month. Above-normal streamflow and precipitation continued during February and March.

On average, streamflows were below-normal to normal throughout the rest of the spring, summer and autumn. Much above-normal precipitation in December boosted streamflows at many locations to more than double their normal flow. December's average streamflow above Montague was 12,500 cfs or 255% of normal monthly flow. Similarly, the flow at Trenton was 26,700 cfs or 236% of normal flow.

Please refer to *Table 2: 2008 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 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 2008. Consequently, DRBC's lower basin drought operating plan was not triggered. After a dry August, DRBC-directed releases from lower basin storage were made to ensure that the Delaware River flow objective of 3,000 cfs at Trenton was met. DRBC directed a total of 485 million gallons (mg) from Blue Marsh Reservoir during the period August 28 through September 25. Releases totaling 1.067 billion gallons (bg) were made from Beltzville Reservoir over the same period. Please refer to *Figure 4: Blue Marsh Reservoir Elevation* and *Figure 5: Beltzville Reservoir Elevation* for 2008 reservoir elevations at these two lower basin reservoirs.

No releases were required from Merrill Creek Reservoir during 2008 to replace consumptive use losses from the power industry. This reservoir, located near Phillipsburg, N.J., provides storage when the basin is under DRBC drought operations and is used for replacing evaporative losses caused by power generation and augmenting flows at Trenton.

Upper Basin

Storage within the three New York City (NYC)-Delaware Basin reservoirs, located in the upper DRB and operated under the Flexible Flow Management Program (FFMP)[3], remained within the normal range throughout 2008. Consequently, DRBC's drought operating plan was not triggered. The year began with above-normal storage in the NYC-Delaware Basin reservoir system. On January 1, 2008, storage was 250 bg, which is more than 60 bg above the long-term median usable storage for the date. Heavy precipitation in February caused the reservoirs to fill and spill by mid-February, earlier than the normal May 1 refill target date.

After the wettest February and second wettest March on record, and predicted continued wet weather and high flood risk[4], the Temporary Wet Spring Releases Schedule Adjustment was created by the decree parties to

[3] Since October 2007, the NYC-Delaware Basin reservoirs have been operated in accordance with the FFMP agreement unanimously approved by the five parties to 1954 U.S. Supreme Court Decree (Del., N.J., Pa., N.Y., and NYC). This temporary operations plan is to be codified pursuant to DRBC Resolution 2007-14 adopted on September 26, 2007.

[4] NOAA press release dated March 20, 2008.

reduce flood risk in the DRB. The schedule allowed for extra releases from the NYC-Delaware Basin reservoirs during the period April 15-30, 2008. The predicted wet weather did not materialize and the reservoirs were not full by May 1 or June 1, the target refill dates specified in the agreement to make extra releases. The resulting storage deficit decreased the amount of available water in the Interim Excess Release Quantity (IERQ), which would have been used to raise the Montague target to 1,850 cfs in the summer months under the FFMP.

NYC-Delaware Basin reservoir storage remained below the long-term median until late July when several inches of rain raised storage levels. Starting in October, the NYC-Delaware Basin reservoirs began releasing extra water to compensate for the lack of diversions during a temporary shutdown for repairs to the Delaware Aqueduct (please refer to the description of the Rondout West Branch Tunnel Shutdown below). Reservoir storage stayed above the median for the remainder of the year. On December 31, 2008, combined storage was 271 bg (100% usable storage), or more than 82 bg above normal for the date. For a graphical presentation of NYC-Delaware Basin reservoir storage levels during the year, please refer to *Figure 6: New York City Delaware River Basin Storage 2008.*

The Office of the Delaware River Master directed releases from the NYC-Delaware Basin reservoirs during 2008 to meet the normal minimum flow target of 1,750 cfs at Montague as required by the 1954 U.S. Supreme Court Decree. Releases began in June and continued as-needed through October. Approximately 47 bg[5] were released compared to the 54 bg released during 2007 and the 101 bg released during the drought year 2001.

It should be noted there were five adjustments to the FFMP agreed to by the five decree parties during 2008[6] that resulted in extra releases to meet various reservoir and downstream needs:

- **Temporary Increase in the Controlled Releases from New York City's Pepacton, Cannonsville, and Neversink Reservoirs**. This program was conducted to facilitate the release of excess water from the reservoirs while a corrective maintenance inspection of a portion of the Delaware Aqueduct was conducted. It was effective February to March 2008.

- **Temporary Wet Spring Releases Schedule Adjustment for April 2008**. This program was instituted to better protect DRB communities by authorizing, subject to certain reservoir-storage criteria, releases of water greater than those specified in FFMP. It was effective April 15-30, 2008.

- **Temporary Thermal Releases Program for Fishery Protection.** This program was put into effect for the period June 9-11, 2008 to allow for emergency releases of water from Cannonsville Reservoir, subject to specific air temperature-based triggering criteria, to provide additional thermal protection for the main stem Delaware River downstream to near Hancock, N.Y. from the IERQ.

- **Interim Excess Release Quantity Extraordinary Needs Bank for an Emergency Thermal Releases Program for Fishery Protection.** This program was in effect July 1 to September 15, 2008 and was essentially a continuation of the earlier Temporary Thermal Releases Program that allowed for emergency releases of water from Cannonsville Reservoir, subject to specific air-temperature based triggering criteria, to provide additional thermal protection for the main stem Delaware River downstream to near Hancock, N.Y.

[5] Based on data obtained from the Office of the Delaware River Master.
[6] Based on information contained in *Summary of First Year FFMP Modifications and Adjustments and Changes for Incorporation in the Revised FFMP Agreement* appearing on the Office of the Delaware River Master's web site.

- **Temporary Releases Program for the 2008 Rondout West Branch Tunnel Shutdown.** This program was in effect from October 1, 2008 to May 1, 2009 to facilitate the release of water from Pepacton, Cannonsville, and Neversink reservoirs while necessary underwater repair work was performed at a dewatering shaft of the Delaware Aqueduct.

Groundwater

The average monthly 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 2008. The average water level of the observation wells declined below the long-term average beginning in June and continued to decline until autumn. Although water levels began a seasonal upward trend in October, they remained below the long-term average for the remainder of the year.

Monthly groundwater measurements at the New Castle Co., Del. coastal plain well recorded levels within the normal range (25- to 75-percentile) for all of 2008. The Cumberland Co., N.J. coastal plain well recorded levels above the normal range through June; water levels there began to decline in July, but remained within the normal range (25- to 75-percentile) until the end of the year. 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 2008, the salt front location ranged from below river mile 54 at Reedy Island, Del. (which is about four miles downstream of the Chesapeake and Delaware Canal) in March 2008 to river mile 86 (eight miles upstream of the Delaware-Pennsylvania state line) in October. See *Figure 10: 7-Day Average Location of the 250-PPM Isochlor* for an overview of salt front locations along the Delaware River during 2008.