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# Hydrologic Conditions in the Delaware River Basin

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Photo By: R. Fromuth, DRBC

September 19, 2004 - The Aftermath of Tropical Storm Ivan  
Looking upstream at the Washington Crossing Bridge from Washington Crossing, N.J.

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## Annual Report 2004

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### Hydrologic Highlights of 2004

The second half of 2004 proved an active time for intense weather systems in the Delaware River Basin. The following storm events are worthy of mention:

- **July 12-13:** A slow moving system dropped rainfall averaging four- to six-inches on the lower basin. Portions of south-central New Jersey were the hardest hit as more than a foot of rain fell in some localities (Tabernacle in Burlington County, N.J. was hardest hit, receiving 13.2 inches of rain during what was determined to be a one-in-one-thousand year storm event). As many as 25 roads were closed due to rising waters and hundreds of residents had to be evacuated from their homes. A total of 17 dams in south-central New Jersey were either totally or partially breached, and many creeks and streams flooded their banks. A state of emergency was declared in Burlington County on July 13. On July 16, President Bush declared the county a federal disaster zone, opening the way for the use of federal funds to help the flood victims. Adjacent Camden County also was made eligible for federal aid.
- **August 1:** Heavy rainfall returned to portions of the lower basin. Two communities that bore the brunt of the storm were Upper Darby and Darby Borough in Delaware County, Pa., where more than five inches of rain fell. Darby Borough declared a state of emergency after 80 families were displaced by flooding. Elsewhere in the region, intense rains temporarily shut down Philadelphia's Broad Street Subway and SEPTA's regional railways. Portions of the Schuylkill Expressway were closed due to mudslides. On August 5, Pennsylvania Governor Rendell declared a state of emergency allowing flood victims in Philadelphia, Delaware, and Montgomery counties to apply for grants and low interest loans.
- **August 12-14:** A strong storm system and two tropical storms were predicted to drench the Delaware River Basin over a three-day period. During the evening of August 12, storms rolled through the basin producing more than seven inches of rain over the headwaters of the Schuylkill River. On August 13, forecasters were anticipating the arrival of **Tropical Storm Bonnie**. With the basin's streams and rivers already brimming from the storms the night before, there was a potential for serious flooding. Fortunately, Bonnie only affected the very southern portion of the basin with moderate rainfall.

On August 14, the basin was gearing up for another potential soggy blow, this time from **Tropical Storm Charley**. Charley had already devastated portions of southwestern Florida as a Category Four hurricane and was forecasted to track along the basin, almost on top of the Trenton, N.J. area. The majority of the basin was spared from the wind and rain when Charley tracked further east than expected.

- **September 17-18:** The remnants of **Tropical Storm Ivan**, interacting with a cold front that dropped into the northeastern United States late Friday, September 17, 2004, produced tremendous rainfall amounts across northeast Pennsylvania and southern New York. Most of the Delaware River Basin upstream of Trenton received three- to five-inches of rain in a 12-hour period, with some isolated areas receiving as much as seven or eight inches. Much of the heavier rain occurred in the mountainous regions of the basin in the Poconos and Catskills, while many areas in the southern half of the watershed received an inch or less. This rain fell on soils already saturated by a wet summer, including **Tropical Storm Frances** just a week before, creating a "parking lot" runoff effect over a very large portion of the basin's drainage area. Even before the rains from Ivan arrived, the Delaware River at Montague, N.J. and Trenton was flowing at 298 percent and 265 percent of normal, respectively, for the first half of September.

The flooding on the main stem Delaware River was the worst since August 1955 when the basin was hit by the remnants of two hurricanes, Connie and Diane, in one week. Below is a list<sup>1</sup> of the 2004 crests measured along the main stem Delaware River from north to south:

<u>Location</u>	<u>2004 Crest (Ft.)/ Date</u>	<u>Flood Stage (Ft.)</u>
Port Jervis, N.Y./Matamoras, Pa.	19.52 9/18	18.0
Montague, N.J.	28.39 9/18	25.0
Belvidere, N.J.	24.83 9/19	22.0
Easton, Pa.-Phillipsburg, N.J. Bridge	33.45 9/19	22.0
Riegelsville, N.J.	30.78 9/19	22.0
Washington Crossing, N.J.	20.12 9/19	20.0
Trenton, N.J.	23.39 9/19	20.0

- September 28:** The remnants of **Tropical Storm Jeanne** brought four- to eight- inches of rain to the Philadelphia metropolitan area, primarily in Delaware, Pennsylvania, and New Jersey north of the “Fall Line” (a geologic divide that separates the Coastal Plain from the more highly elevated Piedmont region to the north). The heavy precipitation caused widespread urban and small stream flooding. Streams from northern Delaware to central New Jersey rose rapidly above flood stage during the evening hours, making roadways hazardous and evacuations difficult.

### Precipitation

The majority of counties<sup>2</sup> within the Delaware River Basin reported normal to above-normal precipitation at the end of 2004, with annual departures ranging from 3.60 inches below normal to 15.50 inches above normal. Year-end precipitation totals ranged from 38.30 inches (Cape May County, N.J.) to as much as 59.50 inches (Schuylkill County, Pa.). See the attached map, *Figure 1: 2004 Annual Precipitation in the Delaware River Basin*, for a depiction of precipitation totals and departures by county.

The observed precipitation at selected stations above Montague, N.J. for 2004 was 50.35 inches, or 7.09 inches above normal. Annual observed precipitation above Trenton, N.J. was 53.38 inches, or 8.49 inches above normal. See the attached *Table 1: 2004 Precipitation at Selected Stations in the Delaware River Basin* for additional precipitation data at selected basin locations.

### Streamflow

A drier than normal weather pattern persisted during the early months of 2004 and some streams in the Delaware River Basin reflected this trend. Streamflows throughout the basin were in the below-normal to normal range during the months of February through June.

Heavy rainfall during the second half of 2004 raised streams to above-normal levels. The highest average monthly streamflows for 2004 were recorded during September as a result of three tropical storms impacting the basin during a thirty-day period (see the “*Hydrologic Highlights of 2004*” section of this report for more details about these storms). The average monthly streamflow at Montague for September was 17,141 cubic feet per second (cfs), or 791.4 percent of normal for the month. Similarly, the streamflow at Trenton averaged 32,529 cfs (650.7 percent of normal). The average monthly streamflow of the Lehigh River at Bethlehem, Pa. during

September was 6,305 cfs (546.3 percent of normal) while the Schuylkill River at Philadelphia flowed at an average rate of 6,962 cfs (631.8 percent of normal) during the month.

Please refer to the attached [Table 2: 2004 Streamflow in the Delaware River Basin](#) for average monthly streamflow 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 2004. No directed releases were required from either of these reservoirs to meet the Delaware River flow objective of 3,000 cfs at Trenton. Please refer to [Figure 4: Blue Marsh Reservoir Elevation](#) and [Figure 5: Beltzville Reservoir Elevation](#) for additional 2004 information.

No releases were made from Merrill Creek Reservoir (located in Phillipsburg, N.J.) during 2004 to augment flows at Trenton and replace evaporative losses caused by power generation.

### **Upper Basin**

The New York City (NYC) reservoirs in the upper Delaware River Basin began 2004 brimming with storage due to the abundance of precipitation that fell during the previous year. As of January 1, the Cannonsville, Pepacton, and Neversink reservoirs had a combined storage of 274.144 billion gallons (bg), or 101.2 percent of capacity and 84.581 bg above the median storage for the date.

Storage gradually declined through early March, but remained above the long-term median storage. A gradual melt of the snowpack above the reservoirs began a seasonal increase in storage and by early April, the NYC Delaware reservoirs had refilled and were spilling excess water into the tributaries below.

Reservoir storage remained above the long-term median for most of the remainder of 2004, with the exception of a brief period during July. Combined storage in the three reservoirs ended the year the same as it began -- above both the usable capacity and the median storage. As of December 31, total usable storage in the three NYC Delaware reservoirs was 271.146 bg (100.1 percent of usable storage), or 82.318 bg above the median storage for the date. For a graphical presentation of NYC reservoir storage levels for 2004, please refer to [Figure 6: New York City Delaware River Basin Storage 2004](#).

## **Ground Water**

The average ground water levels in eight reported U.S. Geological Survey (USGS) observation wells in the Pennsylvania portion of the basin remained above average for most of 2004, except for a brief period during June. Storms during July recharged the Pennsylvania wells and the average "depth to water" rose to above-average levels, where it remained until the end of 2004.

Ground water levels within two coastal plain wells (New Castle County, Del. and Cumberland County, N.J.) remained within the normal (25- to 75-percentile) to above-normal range and above the average level for all of 2004. The Kent County well, while within the normal range, declined to below the average level from March through June, and then once again from September through the end of 2004.

Please refer to the attached [Figure 7: USGS Network Wells - Pennsylvania](#), [Figure 8: DGS Well - New Castle Co., Delaware](#), [Figure 9: USGS Well - Kent Co., Delaware](#), and [Figure 10: USGS Well - Cumberland Co., New Jersey](#) for graphical presentations of ground water levels throughout 2004.

## **Chlorides**

The seven-day average of the 250 parts-per-million (ppm) isochlor (salt line) was situated downstream of its normal location at the start of 2004. This was due to above-normal streamflows experienced during December 2003. During January 2004, streamflows along the main stem gradually declined to normal levels and the salt line began to advance upstream. On February 4, the salt line was located at river mile 73, its furthest upstream advancement for the year. This point in the river, which is approximately five miles below the Delaware-Pennsylvania state line, was five miles upstream of the normal mid-February location.

Throughout spring and early summer, the salt line seasonally retreated and advanced along the main stem as precipitation and streamflows fluctuated. A trend of stormy weather July through September brought heavy precipitation and high freshwater inflows to the Delaware River, causing the salt line to retreat to below its normal location. Sustained high streamflows on the main stem kept the salt line many miles downstream of its normal location through the end of the year. As of December 31, the salt line was found at river mile 65, four miles downstream of the Delaware Memorial Bridge and nine miles downstream of its normal location for that time of the year. See the attached [\*Figure 11: Location of the Seven-Day Average of the 250-PPM Isochlor\*](#) for an overview of salt line locations along the Delaware River during 2004.

### **Notes:**

<sup>1</sup>The 2004 crest and flood stage data used for this report was referenced from the National Weather Service's *Public Information Statement* issued on 9/22/04 from its Mt. Holly, N.J. office.

<sup>2</sup>This information was based on precipitation data from the National Weather Service's Middle Atlantic River Forecast Center for 38 of the 42 counties located either partially or completely in the Delaware River Basin. Departures from normal were calculated by DRBC staff.