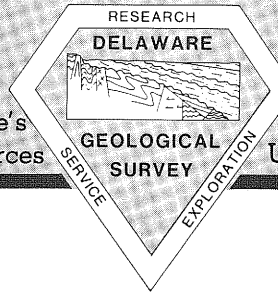


First State Geology

Current information about Delaware's geology, hydrology and mineral resources



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Vol. 14, No. 1

Winter 1996

The Drought of 1995

By John H. Talley

The below normal water conditions described in the previous issue of *First State Geology* (Summer 1995) continued through the summer and early fall. As predicted, the result was low ground-water levels that led to below normal base flow discharge (fair weather flow) of streams. This condition coincided with the summer period of high water demand. Acting on the advice of the Drought Advisory Committee, Governor Carper declared a drought emergency for northern New Castle County (area north of the Chesapeake and Delaware Canal) on September 4. This area is primarily dependent on surface water supplies in contrast to the rest of the state where ground water is the principal source.

Figures 1 and 2 illustrate the problem. Figure 1 shows that the precipitation deficit at New Castle increased steadily for eleven months to nearly 12 inches by the end of August 1995. The long term average annual precipitation is about 44 inches. Figure 2 shows the daily mean stream flow at the confluence of the Red and White Clay creeks and the daily water pumpage by United Water Delaware. Also shown are the times of governmental actions: DA, drought advisory; DW, drought warning; and DE, drought emergency.

Prior to May 1995, stream flows were adequate to meet both United Water's demands and a permit requirement to allow 17.2 mgd (million gallons per day) to pass by their water intake. In June, stream flows declined to a point where United Water could not meet the passby requirement. More than 235 million gallons of water were released from Hoopes Reservoir from June 17 through August 30 to augment stream flows in Red Clay Creek. As shown in Figure 2, the stream flow in late August and early September was less than the amount of water required by United Water to meet demands. The shortfall was made up by pumping water from White Clay Creek during periods of high tide.

The City of Newark, which normally relies on surface water from White Clay Creek to meet a large portion of its water

demands, was required to discontinue use of its surface water plant for 11 days in July, 27 days in August, and 18 days in September because of low stream flows. Water demands were met by utilizing wells and through purchase of water from other utilities.

In response to nine months of significantly below normal precipitation, declining ground-water levels, below normal stream flows, and hot, dry conditions, Governor Carper issued a drought advisory on July 19 and urged voluntary water conservation measures. Water conditions continued to deteriorate and on August 25 a drought warning was declared for northern New Castle County, calling for more stringent water restrictions. The continuing precipitation deficit culminated in the declaration of a drought emergency on September 4 by Governor Carper whereby mandatory water use restrictions were imposed in northern New Castle County.

The citizens and industry in New Castle County responded in earnest to voluntary and mandatory restrictions which

enabled us to get through the critical period. Average daily demands decreased from about 87 mgd on July 15 to a low of 55 mgd on September 14. Precise measurements of stream flows and ground-water levels contributed significantly to the management of water supplies.

Unexpected above normal precipitation across Delaware during September, October, and November resulted in improved water conditions throughout Delaware. Precipitation for September

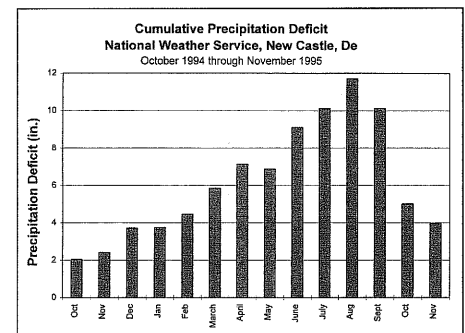


Figure 1.

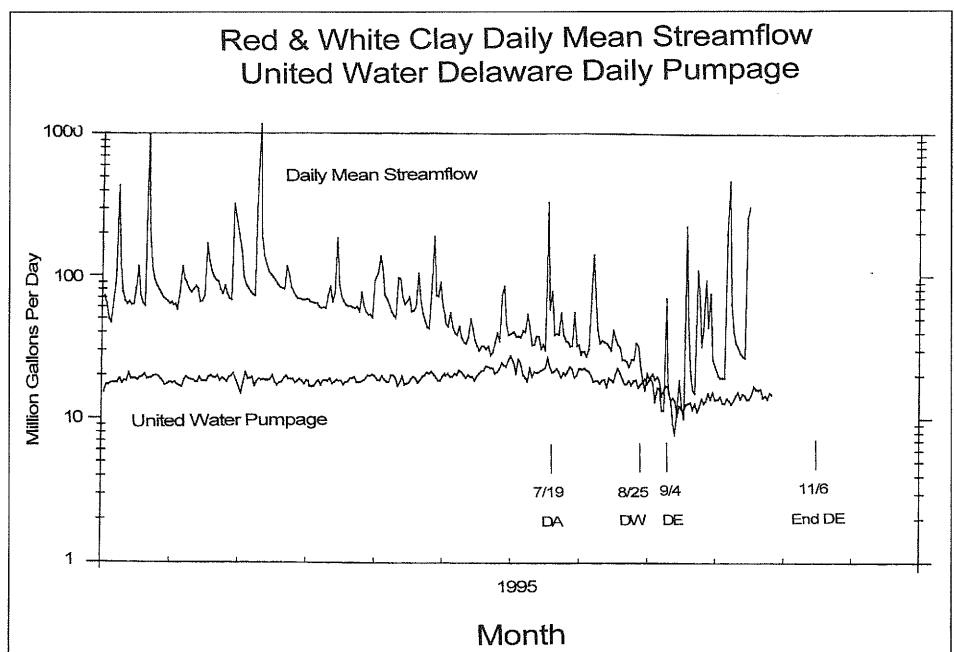


Figure 2. Data after late October were unavailable at time of publication.

through November ranged from 18.77 inches (172 percent of normal) at Wilmington to 13.52 inches (139 percent of normal) at Lewes. A record 8.01 inches of rainfall was recorded in October at New Castle whereas 9.14 inches were recorded in Wilmington.

Significantly greater than normal precipitation restored stream flows to levels that can reliably meet public water supply demands in northern New Castle County. In addition, ground-water levels have started to rise and are expected to continue to improve with normal winter precipitation and decreased evapotranspiration. The Water Conditions Index for New Castle County has improved significantly since August when the Index was in the water shortage range.

In response to improved water conditions, Governor Carper signed an Executive Order on November 6 ending the drought emergency and lifting the mandatory water use restrictions for northern New Castle County. Even though the mandatory water use restrictions have ended, all water users are reminded of the need for conservation.

The DGS will continue to monitor and analyze all water conditions indicators, especially ground-water conditions, into the spring of 1996 to determine the adequacy of supplies as we again enter the high-use summer season.

The DGS Observation and Monitoring Well Network

By Roland E. Bounds

During the drought of 1995, an important function of the DGS was to provide accurate information about hydrologic conditions within Delaware. A key source of much of this information is the network of wells observed and monitored regularly by the DGS and the accumulated database of historical information from these wells. Water level measurements are taken and then compared with those in the historical records in order to determine any unusual trends in either usage or availability. By combining the well information with rainfall and stream flow data, general water availability throughout the state is estimated.

The DGS observation and monitoring well network comprises a combination of sites involving several on-going projects and includes data from both public and private sources. Currently, there are 67 wells in the network to cover all aquifer systems in the state, although this number varies with projects and specific needs. Water levels are measured in 55 of these wells, four on a continuous basis by means

of 30-day chart recorders and 51 others monthly or as needed during special conditions such as the drought.

Samples for determining water quality are taken from 14 of the 55 wells plus another 12 for the total of 67 in the network. These samples are used to monitor salinity in the ground-water system along the Atlantic coast. Samples are taken in late spring when recharge is theoretically at its maximum and usage is relatively low; the follow-up samples are taken in late summer or early fall following the period of high water demand in the coastal area. Data are then compared with the historical records, and trends in quality can be estimated.

During the course of a given 12-month period under average conditions, 660 measurements of water levels are made and 38 water samples are taken and processed. In a year with overly dry or wet conditions, many additional readings may be added. During the drought some wells were measured weekly instead of monthly. More information about these wells can be obtained from the DGS files and the "Summary of Water Conditions in Delaware" compiled by John H. Talley and published by the DGS about every two months.

Draft OCS 5-Year Oil and Gas Leasing Program

By Richard N. Benson

In July, the Minerals Management Service (MMS) of the U. S. Department of the Interior issued its draft proposed Outer Continental Shelf (OCS) oil and gas leasing program for the years 1997 to 2002. There are no sales planned for the Atlantic OCS. A relatively large area of blocks, no closer than approximately 75 miles off the coast, that includes the Texaco-Tenneco structure (Hudson Canyon unit) discussed in the Summer 1995 issue of *First State Geology* will be considered in the Draft Environmental Impact Statement (EIS) for the proposed program, which is scheduled for release in January 1996. According to the MMS, this natural gas-prone area needs to be included for environmental analysis, which will be helpful in planning the following 5-year program (2002-2007).

One other Atlantic OCS area identified as having natural gas-prone prospects encompasses the 21-block Manteo Unit and other existing leases off North Carolina. The Unit has been estimated to contain as much as 5 trillion cubic feet of natural gas, but this could only be verified by exploratory drilling resulting in commercial discoveries. Drilling, however, is prohibited unless several issues under litigation are settled in favor of exploration rights.

The central and western Gulf of Mexico areas are the cornerstones of the program with a lease sale scheduled

annually in each. One eastern Gulf of Mexico sale is scheduled for 2001 that will offer tracts in deep water and over gas prospects offshore Alabama, in an area previously under a moratorium. There are no Pacific OCS lease sales on the proposed schedule. The only other region where sales are planned is offshore Alaska: two in the Beaufort Sea and one each in the Cook Inlet/Shelikof Strait, Gulf of Alaska, and Chukchi Sea/Hope Basin planning areas.

DGS Home Page on World Wide Web

By W. S. Schenck

The DGS has a World Wide Web home page on the University of Delaware's WWW server. If you have access to a Web browser, the Universal Resource Locator (URL) is <http://www.udel.edu/dgs/dgs.html>, and you will see:

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 - State Boundary Monument Data Base with Clickable Map
 - Aerial Photography and Map Inventory
- DGS Seismic Network

Other Geological Web Sites

- American Geological Institute
- The Geological Society of America
- US Geological Survey
- Virginia Tech
- Minerals Management Service

If you do not have access to a Web browser but have a University of Delaware UNIX account, you can use a browser program called Lynx by logging into the UNIX computer system and typing the command *lynx*. You can read all the text of a Web document as well as perform text searches. Web hypertext links will show up as bold face print rather than colored text.

Information requests have increased since the DGS first provided internet access. Requests for our publications are easily made by online viewing of the DGS List of Publications and accessing our e-mail address DGS@MVS.UDEL.EDU. Access

to online Cartographic Center databases such as Vertical Control in Delaware was invaluable to the Delaware Department of Natural Resources and Environmental Control (DNREC) in preparing a forthcoming catalog of elevation reference marks in Sussex County, Delaware, which will aid surveyors performing flood surveys in accordance with National Flood Insurance Program guidelines. Online access of water data by state, county, and local agencies was very beneficial during the drought crisis earlier this year.

Work on the DGS home page is ongoing. Any comments you have on how to make it better will be most welcome. Please contact W. S. Schenck by e-mail at rockman@udel.edu or by phone at (302) 831-8262.

Mysterious "Intruder" in Wilmington

By Suzanne Sayer

Late in the evening of October 16, reports of strange noises or attempted break-ins were reported to the police by people in a neighborhood in southwest Wilmington. The police responded to several calls at about 10:15 P.M. Again at 5:00 A.M. on October 17, the police received a call about noisy prowlers from the same neighborhood. After a thorough investigation they found no evidence of any prowlers, but the reports from people several blocks apart all similarly described a bang or boom, with a sharp jolt to the house. So the police thought that perhaps it was a gas explosion in the sewers, but the sewers in that neighborhood were investigated on October 17 and no signs of damage were found. But the residents of the neighborhood continued to worry.

Meanwhile, at the DGS two signals were observed on the seismic records that looked different from the normal background noise. The times of the various phases were recorded, and their source locations were plotted near Wawaset Park and near Brandywine Creek and Baynard Boulevard for the October 16 and 17 events, respectively. Richter magnitudes were estimated at 2.1 and 2.0, respectively. Shortly after the small earthquakes were reported in the press, residents of Delaware from as far away as Camden and north to Bear reported having felt or heard a sound at about 10:15 P.M. on October 16. Later, a south Wilmington resident reported the whole neighborhood felt the earthquake, and police confirmed the numerous calls from residents upset by an "intruder" on October 16 and 17, but the DGS seismic records proved the "intruder" to be a naturally occurring event.

The last earthquake to be detected in northern Delaware occurred on April 23, 1994, in the vicinity of the October 17 event.

Most Delaware earthquakes are too small to be felt but are recorded by the sensitive instruments of the DGS, three-station seismograph network in northern New Castle County. The largest event recorded was a 3.8-magnitude earthquake on February 28, 1973. Since the installation of the first DGS seismograph in 1971, about 44 small earthquakes in Delaware and environs have been recorded.

National Seismic Network Station Installed near Greenwood

By Suzanne Sayer and Charles T. Smith

The United States Geological Survey (USGS) in cooperation with the Delaware Geological Survey has completed the installation and testing of a U. S. National Seismic Network (USNSN) station near Greenwood in Kent County. The station location was chosen to provide geometric coverage of the middle Atlantic region between other USNSN stations in Virginia, West Virginia, Pennsylvania, and Connecticut. The U. S. Nuclear Regulatory Commission provided funds to the USGS for completion of stations east of the Rocky Mountains. The frequency of occurrence, geographical distribution, and magnitude of earthquakes are important for assessing the seismic hazard of a region and for establishing design and construction criteria for critical facilities.

The new station is equipped with modern broad-band seismometers that are designed to record the horizontal and vertical earth movements created by earthquakes of greater than 2.5 Richter magnitude that occur within an approximate 200-mile radius. Also, measurements of ground acceleration are recorded on three accelerometers at the site. Signals are transmitted via satellite to the National Earthquake Information Center in Golden, Colorado, for analysis and cataloging. Reports from the Center indicate that the station is providing excellent results for use in locating distant earthquakes, but at this time it has not recorded any >2.5 magnitude events within our region.

DGS personnel in cooperation with the University of Delaware determined the location of the station and provided background details for its installation. Our personnel have been instructed in normal maintenance and servicing procedures for the delicate instruments. The DGS is acquiring the equipment necessary to access and evaluate the data from these instruments that is currently being stored in Golden, Colorado. The data will be useful to engineers in the design of buildings, bridges, and other infrastructure to minimize the potential adverse impacts of

earthquakes. The DGS will use the data in advising emergency response officials of the Delaware Emergency Management Agency (DEMA).

The Greenwood station will complement the DGS, three-station, local seismograph network in northern New Castle County, which has been in operation since the 1970s. The local network remains essential to record and analyze the events of relatively low magnitude that are typical of Delaware and nearby areas.

Cartographic Corner

By W. S. Schenck

- The CDROM with digital hypsography (topography contours) for 52 Delaware quadrangles is available for loan from DGSCIC. The layers are available in USGS Standard and Optional formats in order to suit your GIS software needs. They are the final product of a five-year program that produced new 1:24,000-scale paper topographic maps from which, for the first time, the contour layers were collected in digital form.
- The DGSCIC Benchmark, Boundary Monument, and Map and Aerial Photography databases for Delaware are now available through the internet on the University of Delaware World Wide Web server by accessing the DGS home page <http://www.udel.edu/dgs/dgs.html>. The databases have straight text searchable formats as well as a new clickable map on which you can search for this information by USGS quadrangle.

To borrow the CDROM or if you have comments or need more information on the above items, please contact W. S. Schenck at the DGS.

Publications

Recent DGS Publications

Open File Reports

No. 38, Data Report on Rock Cores from Red Mill Road, Harmony Road, Prices Corner, and Newport, Delaware: W. S. Schenck and M. O. Plank, 42 p.

No. 39, Basic Data for the Geologic Map of the Seaford Area, Delaware: A. S. Andres, K. W. Ramsey, and W. S. Schenck, 39 p.

Other Publications by DGS Staff

A. S. Andres, 1995, Nitrate Loss Via Ground Water Flow, Coastal Sussex County, Delaware, in K. Steele, ed., *Animal Waste and the Land-Water Interface*: Boca Raton, FL, CRC Press, Inc., p. 69-75.

R. N. Benson, 1995, with other compilers and authors, *Transect E-3, Southwestern Pennsylvania to Baltimore Canyon Trough*: Boulder, CO, The Geological Society of America, Centennial

Continent/Ocean Transect #19, 2 sheets plus explanatory pamphlet.

Jordan, R. R., 1995, Change and the Profession: The Professional Geologist, v. 32, p. 14.

— 1995, Citation for Donald C. Haney, Recipient of George V. Cohee Public Service Award: Northeastern Geology and Environmental Sciences, v. 17, p. 359.

N. Pendkar (UD Department of Geology) and R. R. Jordan, 1995, Tectonic Evolution of Mid-Atlantic Passive Margin: Interpretations from Sandstone Petrology, Baltimore Canyon Trough, Mid-Atlantic Continental Margin: Geological Society of America, Annual Meeting Abstracts with Programs, p. A62-A63.

Staff Notes

Presentations

A. Scott Andres, "Nitrate Loss Via Ground Water Flow, Coastal Sussex County, Delaware" at the Interdisciplinary Conference on Animal Waste and the Land-Water Interface, University of Arkansas, Fayetteville, July 17.

Robert R. Jordan, "Tribute to Norman F. Williams of Arkansas," at Association of American State Geologists annual meeting, Reno, Nevada, June 14; "Twenty-two Years of Professional Licensing: The Delaware Experience" at Symposium on the Professional Licensing of Geologists in New York State, New York State Council of Professional Geologists, Syracuse, September 28; " 'Immediate' Geology - Droughts and Earthquakes" for The

Society of American Military Engineers, Dover, October 5; "Career Opportunities in the Geosciences" at the joint meeting of the New York State Geological Association and the Eastern Section of the American Association of Petroleum Geologists, Schenectady, October 15; "The Drought of '95," at the annual meeting of the Delaware Academy of Science, Newark, November 29.

Thomas E. Pickett, "Early History of Water Supply Efforts in Northern Delaware" at the Delaware Nature Center, October 17.

William S. Schenck, "Delaware's State Boundaries," at Mason-Dixon Task Force meeting, Water Resources Agency for New Castle County, November 9.

John H. Talley and Stefanie J. Baxter, "Design and Development of a Ground-Water Monitoring Network in Southern New Castle County, Delaware," at Mason-Dixon Task Force meeting, Water Resources Agency for New Castle County, November 9.

Service and Awards

Robert R. Jordan was nominated as a candidate for President-Elect of the American Institute of Professional Geologists; also, he was elected to the House of Delegates of the American Association of Petroleum Geologists as a representative of the Geological Society of Washington.

Thomas E. Pickett led a field trip for the Delaware Nature Society to Gettysburg PA to study the relationship of the geology of the area to the battle, November 15.

Nenad Spoljaric completed 30 years of service to the DGS on September 1.

Externally Supported Projects

Kelvin W. Ramsey from the U. S.

Department of the Interior, Minerals Management Service for "Assessment of Sand Resources Offshore Delaware."

John H. Talley from New Castle County

Department of Public Works for "Implementation of a Ground-Water Quality Monitoring Network in Southern New Castle County, Delaware;" from Delaware Department of Natural Resources and Environmental Control, Division of Water Resources, for "Ground Water Monitoring of Coastal Aquifers in Sussex County, Delaware."

First State Geology is published by the Delaware Geological Survey, a State agency established by an Act of the Delaware General Assembly in 1951 and organized as a unit of the University of Delaware.

Robert R. Jordan
State Geologist and Director
Richard N. Benson,
Editor, First State Geology

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