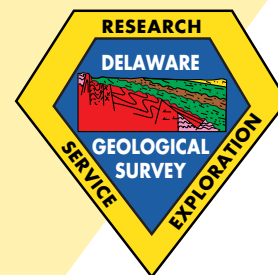


First State Geology

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

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October and November Bring Improved Water Conditions Following Severe Drought

By John H. Talley and Stefanie J. Baxter

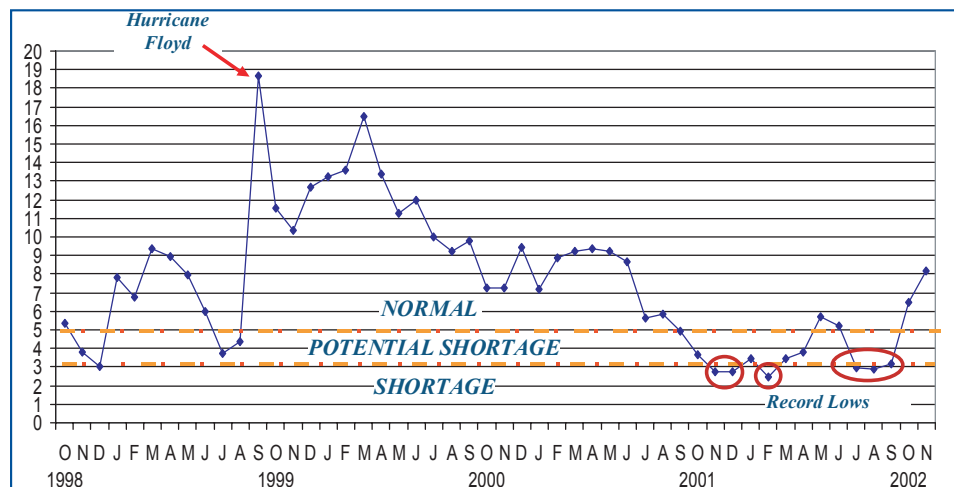
In response to improving hydrologic conditions, Governor Minner on October 11 terminated the Drought Emergency that was declared on August 2 in northern New Castle County, scaling it back to Drought Warning. The Governor's decision was based on improved hydrologic conditions that began in September: normal to above normal precipitation, rising ground-water levels, and normal to above normal streamflows.

The drought that Delaware experienced during 2001-2002 was one of the most severe on record. Precipitation for the period October 2001 through September 2002 ranged from 7.23 inches below normal to 13.99 inches below normal. Below normal precipitation was recorded during 7 of 12 months in northern Delaware and 9 of 12 months in southern Delaware.

Oct. 1, 2002 – Dec. 31, 2002	New Castle (NWS)	Wilmington (Porter Res.)	Dover	Greenwood	Georgetown	Lewes
Total Precipitation	14.86"	17.52"	19.94"	17.23"	14.14"	18.05"
Normal Precipitation	9.67"	10.41"	9.92"	9.88"	9.94"	10.42"
Departure	+5.19"	+7.11"	+10.02"	+7.35"	+4.20"	+7.63"
Percent of Normal	154%	168%	201%	174%	142%	173%

Ground-water levels were significantly below normal across Delaware during this period with record and near record low levels established during ten consecutive months in a well in northern New Castle County and during eight months in central Delaware.

Monthly mean streamflows were below normal during the entire 12-month period in northern Delaware with record low monthly mean streamflows established during five months on Brandywine Creek, which is a major source of public water supply. The annual streamflow of



Water Conditions Index for New Castle County from October 1998 through November 2002.

109 million gallons per day (mgd) on Brandywine Creek during the 12-month period was the lowest since records began in 1947. The average daily streamflow on Brandywine Creek during July, August, and September was about 50 mgd or 20 mgd less than the previous record low for the corresponding period. In addition, record daily mean streamflows were recorded on 57 days during July,

December. Precipitation during the period ranged from 19.94 inches at Dover (201% of normal) to 14.14 inches at Georgetown (142% of normal). Record high rainfall for October was recorded at Dover (8.82 inches) and Greenwood (7.07 inches). This above normal precipitation occurred during a critical time of the year when conditions for ground-water recharge are very favorable (cool temperatures and dormant vegetation).

Ground-water levels rose from below normal to normal and above normal during the period September through mid-December in Kent and Sussex counties, and started to increase toward the normal range in northern New Castle County. Streamflows increased significantly across Delaware and were above the median in northern Delaware and well above normal in Kent and Sussex counties. The third highest streamflow of record for October and a record high monthly mean streamflow for November were recorded for the Nanticoke River near Bridgeville. We anticipate that ground-water levels will continue to rise and streamflows to increase if precipitation continues to be normal to above normal and the ground remains unfrozen.

The Water Conditions Index for New Castle County shows the effects of very poor hydrologic conditions during the period July 2001 through September 2002

August, and September, and a record low daily mean streamflow of 21 mgd was observed in August, eclipsing the previous record low flow established in 1995 by 13 mgd. Record low monthly mean streamflows were also established during several months on Red Clay and White Clay creeks, and the Christina River, all of which are used for public water supply in northern New Castle County, and on streams and rivers in Kent and Sussex counties.

Hydrologic conditions improved significantly during October, November, and

and the improved hydrologic conditions experienced during the past two and a half months in northern New Castle County. The Index was in the Potential Shortage or Shortage range for 11 of the past 15 months with record low indices established for November and December 2001, and February, July, August, and September 2002. The Index is currently in the Normal range and increasing.

Current hydrologic conditions are available on the DGS website at www.udel.edu/dgs under Hydrology.

In Memory of Roland Bounds



Roland at an outdoor mineral show at Goucher College, Baltimore, Maryland.

Mr. Roland E. Bounds, Senior Research Technician at the Delaware Geological Survey, passed away on October 18, 2002, after a short illness. The Survey and all who knew Roland will sorely miss his professionalism, skills, knowledge, and great sense of humor.

Roland began his career at the Survey on January 28, 1980. During his more than 22 years with the Survey he contributed significantly to the research, exploration, and service mission through the operation of the DGS truck-mounted drilling rig, and operation and management of the DGS water-level and water-quality monitoring networks. During the past eight years he drilled 575 test holes that totaled more than 17,500 feet. Mr. Bounds was a licensed water well driller in Delaware.

Roland received a Bachelor's Degree in Geology from the University of Delaware and was very involved in mineralogy as an avid mineral collector. He held numerous officer and committee positions in the Delaware Mineralogical Society and the Friends of Mineralogy, a national organization, and was a 25-year member of the Mineralogical Society of America. Roland collected science fiction books, loved sports, (especially hockey), and enjoyed traveling.

Digital Products — A New DGS Publication Series

By A. Scott Andres and Kelvin W. Ramsey

The DGS added Digital Products as a new category of publications available to the public. The definition of a Digital Product is a reviewed publication of the DGS that is solely dependent upon a computer for its use. The first two products in the series are "Digital Ground-Water Recharge Potential Map Data for Kent and Sussex Counties, Delaware," and "Delaware Inland Bays Tributary Total Maximum Daily Load Water-Quality Database" which are discussed elsewhere in this issue of *First State Geology*.

All Digital Products are peer reviewed. The editor and author, on the bases of complexity of the digital application and scientific content, and any previous review that the geology may have undergone as a DGS publication, determine the extent of review. Review includes assessment of functionality, structure, and quality assurance standards of the product.

Digital Products are numbered sequentially on the basis of the year of their release. Digital Products that include a significant contribution of a geologist and GIS or computer specialist will credit both with the geologist being the primary author. Metadata include reference to any associated DGS publications. Julian date refers to the specific date and time at which the digital file was generated. For example, *Andres, A. S., Savidge, K. B., Scudlark, J. R., and Ullman, W. J., 2002, Delaware Inland Bays Tributary Total Maximum Daily Load Water-Quality Database: Delaware Geological Survey Digital Product 02-02, Version 6.68, 2452625 (Julian date), MS Access format*. For Digital Products that have no primary author such as georectified maps, the person who completed the digital work is cited.

With use, digital publications may be in need of refinement, modifications, or updates (addition of data) that do not affect the scientific content of the work. Initial release of a publication is designated Version 1. Subsequent modifications are numbered consecutively Version 2, 3, 4, etc. Any revision of a digital publication that changes the scientific content of the publication requires peer review and a new publication citation.

Digital Products may be found on the DGS website at www.udel.edu/dgs/Publications/pubform.html.

Recharge Maps Available for Kent and Sussex Counties

By A. Scott Andres

DGS Digital Product 02-01, "Digital Ground-Water Recharge Potential Map Data For Kent And Sussex Counties, Delaware" by A. Scott Andres, C. Scott Howard, Todd A. Keyser, and Lillian T. Wang, documents the results of a 10-year mapping program and provides detailed technical information on the water-transmitting properties of the shallow subsurface for land-use planning, water-resources evaluations, and environmental protection efforts.

The study was funded and supported by the Department of Natural Resources and Environmental Control and the DGS. Numerous state, federal, and local government agencies provided logistical support, and many landowners provided access to their properties for data acquisition. More than 6,000 water well records were evaluated and hundreds of geologic test borings and aquifer tests were completed during the program.

According to provisions of Senate Bill 119, signed into law on June 27, 2002, excellent ground-water recharge potential areas are to be included as sensitive water resource areas in future revisions to comprehensive land use plans prepared by counties and municipalities. Recharge Resource Protection Areas have been protected in New Castle County since the 1980s.

The publication is the first product of the program and presents digital files for use in geographic information system software.

The results in Digital Product 02-01 represent important contributions to the understanding and protection of Delaware's water resources. The publication is available as downloadable files from the DGS website at www.udel.edu/dgs/Publications/pubform.html. Inquiries about the publication should be directed to DGS at (302) 831-2833 or via email at delgeosurvey@udel.edu.

Inland Bays TMDL Database

By A. Scott Andres

DGS Digital Product 02-02, "Delaware Inland Bays Tributary Total Maximum Daily Load Water-Quality Database" by A. Scott Andres, and Karen B. Savidge, Joseph R. Scudlark, and William J. Ullman

of the College of Marine Studies, University of Delaware, documents the results of accurate and precise measurements of the concentrations of nitrogen, phosphorus, carbon, suspended solids, chlorophyll-a, dissolved oxygen, and silica from more than 2000 samples collected from 14 fresh-water streams and more than 40 salt-water tidal stream and bay sites.

These data are needed to compute loadings or masses of the chemical, physical, and biological components that affect the environmental health of the streams and bays. It is the loadings of nitrogen, phosphorus, and other constituents from streams that cause many of the algal blooms, fish kills, and other environmental problems experienced in the bays. The data are also being used in ongoing research into the processes controlling the transport and recycling of nitrogen and phosphorus.

The data are presented in digital format in a relational database rather than in printed form because of the large number of sampling stations and samples, and because users of the information have widely differing requirements for data analysis, display, and reporting. Comments from users of early versions prompted development of utilities for selecting and reporting data to be included in the database.

The results in Digital Product 02-02 are an important part of understanding the nature of surface-water quality problems in the Inland Bays watershed and complement the recently released Open File Report No. 44. Both publications are available as downloadable files from the DGS website at www.udel.edu/dgs/Publications/pubform.html. Inquiries about the publication should be directed to DGS at 302-831-2833 or via email at delgeosurvey@udel.edu.

Fossil Dig for Kids at Coast Day



*Peter McLaughlin (standing) helps children and adults identify fossils at Coast Day.
by Lillian T. Wang*

The DGS sponsored a "Fossil Dig for

Kids," which is becoming a DGS annual tradition at Coast Day in Lewes, Delaware. The University of Delaware, Delaware Sea Grant College Program and the College of Marine Studies held its 26th annual open house on October 6, 2002. The DGS sandbox was filled with several Delaware and Maryland marine fossils. Children had a great time identifying fossils such as *Gryphaea* (oyster) from the Cretaceous Period, and scallops and marine mammal bones from the Miocene Epoch.

Back by popular demand, the DGS distributed Special Publication 26 again this year. This poster publication, titled "Historical Coastline Changes of Cape Henlopen, Delaware," illustrates changes in Delaware's coastline at Cape Henlopen from 1926 to 1997. Copies are available by contacting the DGS at (302) 831-2833 or via e-mail at delgeosurvey@udel.edu

Hydrogeologic Report on the Cypress Swamp

By A. Scott Andres

DGS Report of Investigation No. 64, "Results of Hydrogeologic Studies of the Cypress Swamp Formation, Delaware" by A. Scott Andres and C. Scott Howard, provides baseline information on ground- and surface-water levels, hydraulic properties, and descriptions of aquifer and confining beds that occur within near-surface sedimentary deposits found in and around the Cypress and Burnt swamps. Differences in the responses of ditched and unditched areas to short-term climatic fluctuations and water-level management practices document the profound effects of drainage practices on hydrology. This information is useful to environmental managers, researchers, and others interested in this and similar swampy areas in the state.

The report documents parts of several investigations done in cooperation with the Delaware Natural Heritage Program of the Department of Natural Resources and Environmental Control, the Delaware Department of Transportation, University of Delaware College of Agriculture and Natural Resources, U. S. Geological Survey, and a major property owner, Delaware Wildlands, Inc. The results of the work are part of an existing natural resource characterization report and have been used to assist planning and design of a wetlands mitigation site on a small portion of the property. The report complements an existing DGS publication, Report of Investigations No. 62, on the geology of the Cypress Swamp Formation.

The publication is available as a downloadable file from the DGS website at

www.udel.edu/dgs/Publications/pubform.html. Printed copies may be obtained by calling the DGS at (302) 831-2833 or via email at delgeosurvey@udel.edu

Preliminary Report on the Inland Bays

By A. Scott Andres

DGS Open File Report No. 44, "Storm-Water and Base-Flow Sampling and Analysis in The Inland Bays: Preliminary Report of Findings 1998-2000," by A. Scott Andres, and William J. Ullman, Joseph R. Scudlark, and Karen B. Savidge of the College of Marine Studies, University of Delaware, documents part of a larger multidisciplinary study designed to provide detailed technical information to support ongoing environmental restoration and regulatory programs for Rehoboth and Indian River bays.

The six streams studied are considered representative of other streams in the Inland Bays watershed. Key components of the study are accurate and precise measurements of flow rates and the concentrations of nitrogen, phosphorus, carbon, suspended solids, chlorophyll-a, dissolved oxygen, and silica.

Measurement of both flow and concentration were made in order to compute loadings, or masses, of the chemical, physical, and biological components. It is the loadings of nitrogen, phosphorus, and other constituents from streams that cause many of the algal blooms, fish kills, and other environmental problems experienced in the bays. One key finding is that base flow delivers more nitrogen and phosphorus load to the bays than storm flow.

The results of this investigation are an important part of understanding the nature of surface-water quality problems in the Inland Bays watershed. The publication is available as a downloadable file from the DGS website at

www.udel.edu/dgs/Publications/pubform.html. Printed copies may be obtained by calling the DGS at (302) 831-2833 or via email at delgeosurvey@udel.edu.

Publications

Recent DGS Publications Open File Reports

No. 44, Storm-Water and Base-Flow Sampling and Analysis in the Delaware Inland Bays: Preliminary Report of Findings 1998-2000: **A. Scott Andres**, William J. Ullman, Joseph R. Scudlark, and Karen B. Savidge, 40 p.

Report of Investigations

No. 64, Results of Hydrogeologic Studies of the Cypress Swamp Formation, Delaware: **A. Scott Andres** and **C. Scott Howard**, 21 p.

Digital Products

No. 02-01, Digital Ground-Water Recharge Potential Map Data for Kent and Sussex Counties, Delaware: **A. Scott Andres**, **C. Scott Howard**, **Todd A. Keyser**, and **Lillian T. Wang** (see p. 2).

No. 02-02, Delaware Inland Bays Tributary Total Maximum Daily Load Water-Quality Database: **A. Scott Andres**, **Karen B. Savidge**, **Joseph R. Scudlark**, and **William J. Ullman** (see p. 2).

Other Publications by DGS Staff

A. Scott Andres, Surface Water-Ground Water Interactions and Non-point Source Pollution in the Delaware Inland Bays Watershed: Proceedings of American Water Resources Association 2002 Annual Water Resources Conference, p. 274, (Abstract); Geochemical Indicators of Base and Storm Flows in Four Small Coastal Plain Watersheds in Delaware: Linking Surface and Subsurface Hydrology—From Science to Technology, p. 49, (Abstract).

Richard N. Benson, 2002, Age Estimates of the Seaward-Dipping Volcanic Wedge, Earliest Oceanic Crust, and Earliest Drift-Stage Sediments along the North American Atlantic Continental Margin, in Hames, W.E., McHone, J.G., Renne, P.R., and Ruppel, C. (Editors), The Central Atlantic Magmatic Province: Insights from Fragments of Pangea: Washington, D.C., American Geophysical Union, Geophysical Monograph Series Volume 136, p.61–75.

Cheryl A. Duffy and **A. Scott Andres**, A Ground-Water Flow Modeling Assessment of Lewes-Rehoboth Wellhead Protection Areas:

Proceedings of American Water Resources Association 2002 Annual Water Resources Conference, p. 269, (Abstract).

Staff Notes

Presentations

A. Scott Andres, "Surface Water-Ground Water Interactions and Non-Point Source Pollution in the Delaware Inland Bays Watershed," American Water Resources Association annual conference, November 4-6; "Geochemical Indicators of Base and Storm Flows in Four Small Coastal Plain Watersheds in Delaware," 2002 National Ground Water Association annual meeting, December 11.

Cheryl A. Duffy and **A. Scott Andres**, "A Ground-Water Flow Modeling Assessment of Lewes-Rehoboth Wellhead Protection Areas," American Water Resources Association annual conference, November 4-6.

Todd A. Keyser, "Ground-Water Recharge Potential Mapping Project Conducted by the DGS from 1990-2001," Delaware Non-Point Source Program Advisory Board at the Virden Center in Lewes, December 12.

Peter P. McLaughlin Jr., "More Than Jurassic Park: Life on Land and in the Seas in the Age of the Reptiles" to the eighth grade classes at Patton Middle School, November 27; **Peter P. McLaughlin, Jr.**, **Richard N. Benson**, **Kenneth G. Miller**, Rutgers University, and **James V. Browning**, Rutgers University, "Sequence Stratigraphic Context for Aquifer Characterization in the Miocene of the Southern Delaware Coastal Plain," 2002 Bald Head Island Conference on Coastal Plain Geology, November 16-19; **Peter P. McLaughlin Jr.**, **Kenneth G. Miller**, Rutgers University, **Richard N. Benson**, and **James V. Browning**, Rutgers University, "Palynological Record of Miocene Sequences of the U. S. Middle Atlantic Coastal Plain: Initial Results from the Bethany Beach, Delaware, Borehole," Joint International

Meeting of the American Association of Stratigraphic Palynologists, the British Micropalaeontological Society, and the North American Micropaleontology Section of SEPM, September 12; **Peter P. McLaughlin Jr.**, **Richard N. Benson**, and **Thomas E. McKenna**, "Stratigraphy and Aquifer Architecture of the Mid-Cretaceous Potomac Formation, Northern Delaware," Rutgers University, Geology Department colloquium series, October 2.

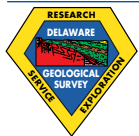
Kelvin W. Ramsey conducted a workshop on beaches and coastal processes as a part of a graduate course in environmental education for teachers sponsored by the Abbotts Mill Nature Center and the University of Delaware, July 17; "A Blast from the Past: Destruction and Death on Chesapeake and Delaware Bays from the Hurricane of October 1878," Geology Department Seminar Series, the College of William and Mary, September 18; "The Piedmont-Coastal Plain Contact: Subsurface and Surficial Geologic Mapping along the Fall Zone," 2002 Bald Head Island Conference on Coastal Plain Geology, November 16-19.

William S. Schenck, "The Delaware DataMIL: Implementation Through Partnership," at Inner City/Council Management Association (ICMA) 2002 Annual Conference, October 1; "Rocks and Minerals and Geologists," Jenny Smith Elementary School, October 30.

John H. Talley and **Stefanie J. Baxter**, "Ground-Water Resources of the Delmarva Peninsula," 7th Annual Mid-Atlantic Crop Management School, November 19.

Service and Awards

Congratulations to **John H. Talley** for 30 years of service at the Delaware Geological Survey. He was also presented the Presidential Certificate of Merit from the American Institute of Professional Geologists for enthusiastic support for and effective management of AIPG government liaison efforts, especially in regards to the Washington, D.C. Fly-In.



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