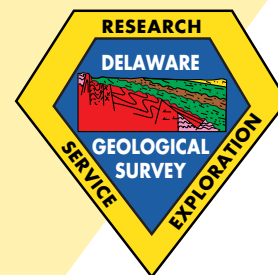


First State Geology

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

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Drought Warning for Delaware

By John H. Talley and Stefanie J. Baxter

On March 5, Governor Minner declared a state-wide drought warning. With the exception of March, below normal precipitation continued to plague much of Delaware since June 2001. February was exceptionally dry across the state with precipitation totals ranging from 1.02 inches at Lewes (31% of normal) to 0.33 inches at New Castle (11% of normal). Record low precipitation occurred in February at New Castle, Wilmington, Dover, and Greenwood whereas the second lowest monthly totals were recorded at Georgetown and Lewes. Above normal rainfall occurred throughout Delaware in March. This is the first time precipitation has been above normal since June 2001 at New Castle and Wilmington, since July 2001 at Dover, and since August 2001 in Sussex County. Precipitation declined to below normal in April 2002 in New Castle County and was slightly above normal at Dover and Georgetown. Precipitation in May 2002 was above normal at Wilmington, normal at Dover, and below normal at New Castle and Georgetown.

Precipitation for the first seven months of the 2001-2002 Water Year (October 1, 2001-April 30, 2002) ranged from 17.39 inches at Lewes (70% of normal) to 12.73 inches at New Castle (57% of normal). The driest 7-month period since at least 1949 occurred at New Castle and Georgetown.

Monthly mean streamflows on Brandywine, White Clay, and Red Clay creeks, and the Christina River, which are used for public drinking water supplies in New Castle County, have been at or near record lows since October 2001. Record low monthly mean flows were established on all four water courses in February 2002. Eighty-seven record low daily streamflows were established on Brandywine Creek, 32 on White Clay Creek, and 77 on Red Clay

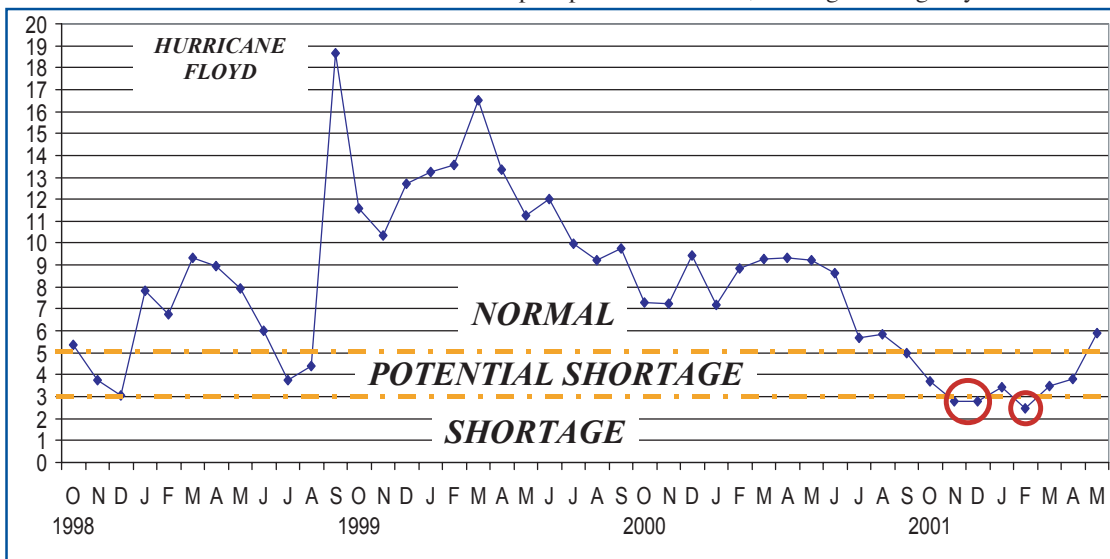
Creek since November 2001. If precipitation remains below normal or near normal during the next several months, it is highly likely that streamflows will remain substantially below normal and that base flows will continue to decline in response to increases in temperature and evapotranspiration. However, even though streamflows have been significantly below normal in northern Delaware, they have been adequate to meet public water supply demands, which are currently about 65-70 million gallons per day. Detailed measurements of streamflow and ground-water levels combined with demand information provided by highly cooperative water purveyors are used to make the distinction between "warning" and "emergency" in Delaware.

Ground-water levels in shallow water-table observation wells generally declined from April and May 2001 through February 2002 at which time they started to rise slightly. April 2002 water levels are two to three feet lower than those recorded during the corresponding period in 1999, the last drought year. Record and near record low ground-water levels have been occurring throughout Delaware since January 2002. Ground-water levels recovered significantly in Kent and Sussex counties during April and early May of this year with levels in two observation wells rising into the normal range in May in response to recharge associated with normal to above normal precipita-

tion in March and April in central and southern Delaware. Ground-water levels are not expected to rise very much in shallow observation wells located in New Castle County. Accordingly, if dry conditions persist, the amount of ground water available to support streamflow (fair weather flow) during the upcoming hot summer months will remain at or near record lows. Voluntary conservation of water is urged throughout the state.

The Water Conditions Index (WCI) for New Castle County has exhibited an unusual declining trend since March 2000 in response to the substantially below normal conditions described above (see figure). Record low indexes were established in November and December 2001, and in February 2002 (red circles). The second lowest indexes of record were recorded in January, March, and April, 2002. The WCI is calculated using the population of northern New Castle County, water levels recorded in well Db24-10 (located near Ogletown), monthly mean flows on the Brandywine Creek, and 6-month antecedent precipitation at New Castle and Wilmington.

On May 29th the Governor's Drought Advisory Committee met and recommended continuance of the drought warning status. Cool, wet weather in May, and conservation measures helped keep outdoor water use to a minimum. As long as demands remain low and supplies are adequate to meet the demands, a drought emergency and corre-



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

sponding mandatory restrictions may be avoided. Current hydrologic conditions are available on the DGS website at www.udel.edu/dgs under Hydrology.

Delaware DataMIL Receives National Award

The Delaware DataMIL website has been selected by Environmental Systems Research Institute (ESRI) to receive a Special Achievement in GIS award. The DataMIL site (see Winter 2002 issue of *First State Geology*) was one of only 150 sites chosen from more than 100,000 worldwide ESRI user sites to receive this award. This award is being given to the DataMIL team in recognition of their outstanding work in the GIS field. Congratulations to John Callahan, Christina Callahan, Dick Sacher (UD

Rebecca N. Reed (Bedford Middle School) for their outstanding work using GIS in their classrooms.

Governor Minner also officially released the Delaware DataMIL (see Winter 2002 issue of *First State Geology*) web site to the Delaware GIS community and the world. The DataMIL web site www.datamil.udel.edu/nationalmappilot/ serves Delaware's Spatial Data Framework layers and allows for public interaction for the creation of maps of Delaware with input for correcting map features. At the conference, the USGS presented the National Map; the Delaware DataMIL is a National Map pilot project.

Hurricane of 1878

By Kelvin W. Ramsey

Although no hurricane has been documented as having made landfall in Delaware, the storms can cause damage in the region. Perhaps one of the most destructive of these storms to affect Delaware passed through the region on October 23rd, 1878. This storm was a Category 1 hurricane (based on documented wind speed) that made landfall on the Outer Banks of North Carolina and moved rapidly north leaving a path of death and destruction from Norfolk, Virginia, Baltimore, Maryland, Wilmington, Delaware, Philadelphia, Pennsylvania, to as far north as Albany, New York. More than 100 fatalities are attributed to the hurricane, many of them drowning victims from numerous ships and boats on the Chesapeake and Delaware bays. Damage estimates for property, both lost ships and buildings damaged or destroyed by high winds, are perhaps as high as 150 million dollars in today's currency. A storm surge in Delaware Bay raised water levels at Pea Patch Island as much as 6 feet in one hour. The highest water levels in the

Delaware River at Wilmington were as much as 12 feet above present sea level.

The effects of this hurricane on Delaware and the mid-Atlantic region are documented in Delaware Geological Survey Special Publication No. 22. This publication, authored by Kelvin W. Ramsey and Marijke J. Reilly, reconstructs the path of the storm and uses newspaper and other sources of the day to show how even a small to moderate hurricane can cause a great deal of destruction. The Hurricane of 1878 may well be the hurricane of record for the Delaware Bay and River region and provides a worst-case scenario for a modern hurricane. If such a storm were to occur today, there would be extensive flooding of the Wilmington waterfront, massive disruption of traffic from downed trees and power lines, and much wind damage to houses.

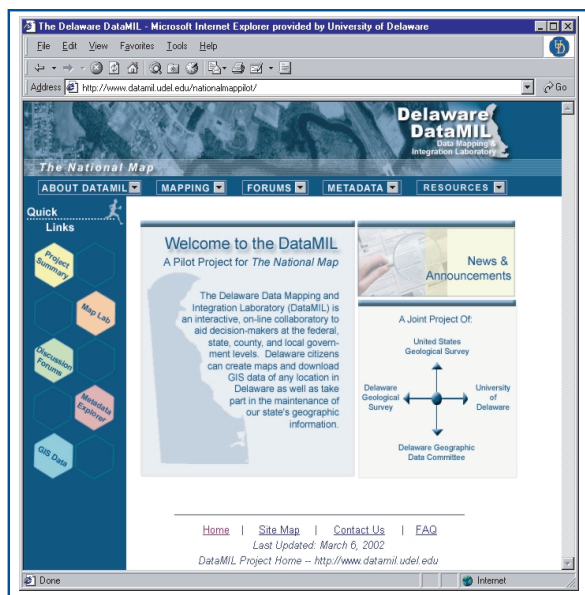
Contact the DGS at 302-831-2833 for a copy of this report which will be available later this summer. The report will also be available on the DGS website at www.udel.edu/dgs under Publications.

Potential Sand Resources Offshore Delaware

By Kimberly K. McKenna

DGS Report of Investigations No. 63, "An Evaluation of Sand Resources, Atlantic Offshore, Delaware," by Kimberly K. McKenna and Kelvin W. Ramsey, provides information on the distribution of sand resources in state and federal waters. Since 1992, the Minerals Management Service (MMS) of the U. S. Department of the Interior and the DGS have worked together to determine the geologic framework offshore Delaware. Sand is a natural resource sought after by those who manage the Delaware shoreline. It is used to build beaches for tourism and for protecting structures; therefore, maintenance of the beaches is important for the economy of the state. In order to maintain wide, sandy beaches in the areas where beach width has been decreasing, beach replenishment has been implemented. According to the Delaware Department of Natural Resources and Environmental Control (DNREC), from 1988 to 1998, over 4.1 million cubic yards of sand were dredged from several offshore borrow areas to nourish beaches in ten Delaware Atlantic coastal communities. Locating known sand resources, preferably as close as possible to the site needing the sand, is the goal of coastal community managers as costs for obtaining offshore sand can be very high.

The report describes the use of a model known as "stack-unit mapping" for sand resource evaluation and compatibility with historical beach sediment textures. The results from the model were added to a geographic information system to produce detailed maps of beach-quality sand resources in state and federal offshore waters. Results



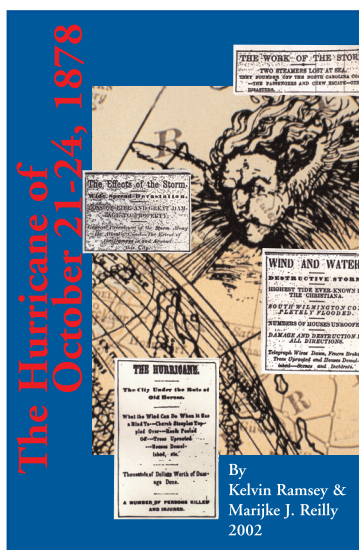
Snapshot of DataMIL homepage.

Research Data Management Services), Sandy Schenck (DGS), Mike Mahaffie (Office of State Planning and Coordination), and Shannon Bain, Roger Barlow, William Harris, and Robert Rinehart (USGS) for this distinguished award. Visit the DataMIL site at www.datamil.udel.edu.

Delaware's GIS Conference

By William S. Schenck

Delaware's GIS conference (DE GIS2002) was held on April 18th in Rehoboth Beach and was attended this year by over 125 persons. Governor Minner was the keynote speaker at this year's conference. During the opening session, she presented the first annual GIS in Education Award to three Delaware teachers. Congratulations to Jacqueline B. Wilson (John Basset Moore Middle School), Dawn L. Willis (Milford Middle School), and



show significant quantities (approximately 54 million cubic yards) of excellent beach-quality sand sources within the three-mile state limit offshore Indian River Inlet, and within the Inner Platform and Detached Shoal Field geomorphic regions. In federal waters, beach-quality sand was found on Fenwick Shoal Field and farther offshore Indian River Inlet on the Outer Platform (approximately 43.6 million cubic yards combined). Most of the beach-quality sand resources are believed to be tidal delta deposits reworked during periods of lower sea level. Farther south, the resources are accumulations of recent surficial sands of the inner shelf (Detached Shoal Field and Fenwick Shoal Field).

Contact the DGS at 302-831-2833 for a copy of this report which will be available later this summer. The report will also be available on the DGS website at www.udel.edu/dgs under Publications.

DGS Releases Georeferenced Hundred Maps

By William S. Schenck

The Delaware Geological Survey, through a cooperative effort with the State Historic Preservation Office, has made available to the GIS community georeferenced images of the Delaware Hundreds Maps from the 1868 Pomeroy and Beers Atlas of Delaware. Delaware is the only state to have land boundaries known as hundreds. Several theories exist regarding the origin of these types of boundaries. The boundaries are taken from similar boundaries once used in England and were presumably brought over to Delaware by the early English colonists. The atlas shows the hundreds land areas, land ownership, locations of past industry, road networks, historic place names, and stream and mill pond locations in Delaware. By georeferencing the images of these maps, researchers, historians, ecologists, scientists, and planners can bring these maps into the GIS environment to study and compare present-day spatial data with what existed in the past.

The Delaware Office of Historic Preservation made scanned images of the Atlas available to the DGS. The Survey, through student help, was able to georeference each of the hundred maps as well as many of the smaller city maps. These downloadable images may be accessed at www.udel.edu/dgs under Data Transfer.

Georeferenced Historic USGS 15-minute Quadrangles

By William S. Schenck

The Delaware Geological Survey has made georeferenced images of historic USGS 15-minute, 1:62,500-scale topographic quad-

rangle maps available for download. These maps are an excellent resource for researchers to track environmental changes that have occurred over the last century in Delaware. The georeferenced maps vary in age from 1904 to the mid 1940s and can be brought into the GIS environment for use with other digital data for comparative purposes. These downloadable images may be accessed at www.udel.edu/dgs under Data Transfer.

Corehole Project Improves Understanding of Interstate Aquifer Framework

By Peter P. McLaughlin, Jr.

The Potomac and Magothy formations contain important aquifers used for water supply in both Delaware and New Jersey. Because of the importance of these aquifers in both states, the DGS collaborated with the New Jersey Geological Survey (NJGS) in a geological study of a continuously cored research borehole at Ft. Mott, New Jersey, located just across the Delaware River from Delaware City and less than a mile from the Delaware-New Jersey state line.

The NJGS proposed that a corehole be drilled at Ft. Mott as part of their efforts to better understand the water-resource potential of the Magothy and Potomac aquifers that occur in a belt through New Jersey from Monmouth County south to Salem County. The DGS joined the effort because of the unique opportunity it presented to obtain core samples and accompanying geophysical log data from important aquifer (water-bearing) and aquitard (water-impeding) intervals that can be tied to aquifer characteristics in New Castle County. The NJGS provided funds to drill the borehole and science personnel; the DGS provided science personnel and down-hole logging support; and Rutgers University provided science personnel and logistical support. Peter J. Sugarman (NJGS), Kenneth G. Miller (Rutgers University), and Peter P. McLaughlin, Jr. (DGS) are the project coordinators.

The well was drilled by the U.S. Geological Survey Eastern Region drilling team in October 2001, using a Mobile truck-mounted rotary drilling rig. A wireline coring device was used to capture 2- to 3-inch-diameter cylindrical core samples of sediment

during drilling. The device uses a ring-shaped drill-bit at the end of a rotating set of drill rods; the core passes through the hole in the center of the bit and is captured in an inner core barrel. At the end of each drilled interval, typically 10 ft, the inner core barrel containing the core is retrieved by a latching device at the end of a wireline that is run down the inside of the drill rods.

An excellent stratigraphic record was obtained in this 820-ft-deep hole, with 78% of the drilled section recovered as core. Each core was carefully cleaned, described, labeled, photographed, and packed for storage. Onsite core descriptions recorded sedimentary textures, structures, colors, fossil content, lithostratigraphic units, lithologic contacts, and sequences (unconformity-bounded units). The DGS logging unit collected a full suite of open-hole geophysical logs at the completion of drilling. Detailed core studies have continued since the completion of the hole, including detailed descriptions of the cores, grain-size analyses, and calibration of core lithologies to the geophysical logs. Analyses of fossil pollen are also underway to establish the age and environmental framework for the deposition of these units.

The preliminary core interpretations help us to better understand correlation of Potomac aquifer sands and aquitards in the area. The thickest aquifer-quality sands at Ft. Mott can be tied to similar sands in nearby Delaware wells between New Castle and Port Penn, suggesting that the aquifers may be in communication beneath the Delaware River. The study also helped improve our understanding of how geophysical log patterns can be used to delineate aquifer characteristics in the Potomac Formation. Better aquifer facies appear to correspond to stacked fluvial channel sands characterized by "blocky" gamma log patterns. Future work planned by the project collaborators includes detailed sedimentological, micropaleontological, and geochemical analyses.



At the Ft. Mott site (from left): Tom McKenna (DGS), Peter Sugarman (NJGS), Kenneth Miller (Rutgers), and John Talley (DGS).

Ground-Water Flow Modeling of Lewes-Rehoboth Beach Area

By A. Scott Andres and Cheryl A. Duffy

More than 80 public water wells and hundreds of domestic wells supply water to the rapidly developing Lewes-Rehoboth Beach area of coastal Sussex County, Delaware. There has been significant concern about the future viability of ground-water resources in light of the threats of contamination and loss of recharge area. Research to delineate well-head protection areas (WHPAs) for 15 wells of the largest (>50,000 gallons per day) three public water systems has been done with a 6-layer, 315,000-node model coupled with GIS-based data coverages of land use/land cover, ground-water recharge and resource potentials, and maps and aerial imagery. The WHPAs are based on analysis of the areas from which the model predicts water will move from land surface to well intakes. Model results indicate that development has only slightly altered the sizes and shapes of recharge areas. Effects of additional growth are the subject of current research.

Additional information about this project can be obtained from the Winter 2002 issue of *First State Geology*.

Publications

Recent DGS Publications

Open File Reports

No. 43, Results of Trenching Investigations along the New Castle Railroad Survey-1 and Seismic Line New Castle, Delaware: Peter P. McLaughlin Jr., Stefanie J. Baxter, Kelvin W. Ramsey, Scott A. Strohmeier, and Thomas E. McKenna, 17 p.

Special Publications

No. 22, The Hurricane of October 21-24, 1878: Kelvin W. Ramsey and Marijke J. Reilly, 90 p.

Report of Investigations

No. 63, An Evaluation of Sand Resources, Atlantic Offshore, Delaware: Kimberly K. McKenna and Kelvin W. Ramsey, 44 p.

Other Publications by DGS Staff

J. M. Sharp Jr., T. Fenstemaker, C. T. Simmons, **Thomas E. McKenna**, and J. K. Dickinson, Potential Thermohaline Convection in a Shale-Rich Sedimentary Basin: Example from the Gulf of Mexico Basin in South Texas: American Association of Petroleum Geologists Bulletin, vol. 85, p. 2089-2110.

Staff Notes

Presentations

A. Scott Andres, "Watershed Monitoring and Best Management Practices for the Little Assawoman Bay Watershed," Center for the Inland Bays Scientific and Technical Advisory Committee, U of D Lewes Campus, February 1; "Assessment of Baseflow and Stormflow Loadings of N and P in the Delaware Inland Bays," U of D Geology Department Seminar, April 25.

Robert R. Jordan, "Delaware's Geology-History Connection," Delaware Nature Society, May 8.

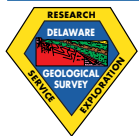
Thomas E. McKenna, Peter P. McLaughlin Jr., and Richard N. Benson, "Characterization of the Potomac Aquifer, an Extremely Heterogeneous Fluvial System in the Atlantic Coastal Plain of Delaware," at the SEPM Research Conference on Ancient and Modern Coastal Plain Depositional Environments: Aquifer Heterogeneity and Environmental Implications, Charleston, South Carolina, March 24-25.

Peter P. McLaughlin Jr., "Delaware During the Cretaceous," at the Delaware Museum of Natural History, January 26.

Lillian T. Wang, "Locating Ground-Water Discharge in Rehoboth and Indian River Bays using Satellite Imagery," at the Delaware GIS2002 Conference, Rehoboth Beach Country Club, April 18.

Service and Awards

The University of Delaware presented service awards for 15 years to **Charles T. Smith**, and for 5 years to **Thomas E. McKenna**.



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