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USGS Water Programs in North Carolina—2001

The scientific nature of the USGS, its long history in North Carolina, its national resources and perspective, and its non-regulatory role enable the USGS to provide unbiased and relevant data, information, and scientific understanding.

The U.S. Geological Survey (USGS) was created by an act of Congress in 1879 and is a bureau within the Department of the Interior (DOI). The USGS serves the Nation as an independent scientific agency and provides scientific information about water resources, biological resources, geology, and mapping. The value of the USGS to North Carolina and the Nation rests in part in its ability to conduct studies and collect data on a regional and national scale, to sustain long-term monitoring and assessment of natural resources, and to provide data and science in a timely manner.

The work of the USGS is funded by a combination of Congressional appropriations and funds from partners—primarily State, local, and Federal agencies. The Cooperative Water-Resources Program allows the USGS to use funds from State and local agencies to conduct water-resource studies that have a strong Federal interest and transfer value to other parts of the Nation. The USGS can match these State and local funds, subject to the availability of Federal appropriations. This type of partnership helps to ensure that USGS programs remain relevant and useful both locally and nationally. In addition to partnering with State and local agencies, the USGS conducts studies for DOI and other Federal agencies. These studies usually are funded by the agency for which the work is performed. Finally, the USGS entirely funds several broad initiatives, such as the National Water-Quality Assessment (NAWQA) Program and the National Streamflow Information Program, both of which have activities in North Carolina.

The USGS Water Programs in North Carolina include activities "from Manteo to Murphy." The types of projects range from long-term hydrologic data collection to fundamental water-resources research. Selected program activities are summarized in this fact sheet.

Streamflow Measurement

The first USGS streamflow gage in North Carolina was established on the French Broad River at Asheville in September 1895. This streamflow gage, which was the first gage in the South and only the third east of the Mississippi River, has been in continuous operation since that time. The USGS cooperates with local, State, and Federal agencies to provide streamflow data and information that also are used by a variety of private utilities, engineering companies, recreationalists, and the general public.

Figure 1. The USGS making discharge measurements in the Tar River during flooding after Hurricane Floyd. Discharge measurements are made by using a meter that measures velocity and depth of flow acoustically. Accurate discharge measurements during floods are critical to the National Weather Service for flood forecasting.

In 2001, the USGS, in cooperation with 25 State, local, and Federal agencies, operated in North Carolina

- 207 continuous-measurement streamflow gages;
- 40 continuous-measurement water-level gages, mostly in lakes, reservoirs, and coastal waters;
- 112 continuous-measurement raingages, 60 of which are in Mecklenburg County; and
- 86 sites where streamflow and water level are measured intermittently.

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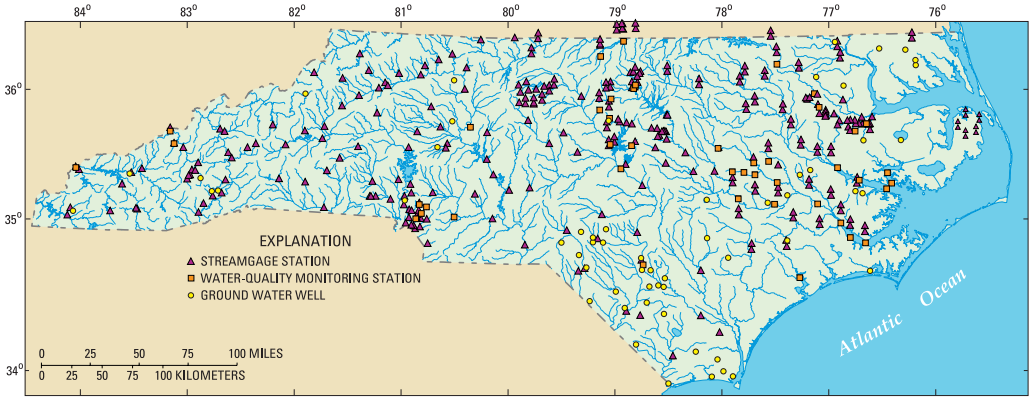

Figure 2. USGS streamflow gaging stations, water-quality monitoring stations, and ground-water level monitoring wells in North Carolina, 2000.

USGS streamflow data for North Carolina are available in real time on the USGS web site, **http://nc.water.usgs.gov**.

Floods and Droughts

During the last 5 years, North Carolina has experienced 100-year or greater floods from Charlotte (1997) to the Research Triangle area (1996) to eastern North Carolina (1999). Following Hurricane Floyd in 1999, all of the river basins in eastern North Carolina, except the Lumber River Basin, experienced 500-year or greater floods.

The USGS collects streamflow data and documents flood levels during all major floods. These data are invaluable to the National Weather Service for developing flood forecasts and to emergency managers for disaster response, recovery, and mitigation. The USGS also participates in the North Carolina Floodplain Mapping Program, providing data and technical assistance to the State as floodplain maps for the entire State are updated. Techniques developed by the USGS for estimating flood flows are used in the Floodplain Mapping Program, and by engineers and managers in designing structures to pass flood flows and mitigate the effects of floods. USGS flood data provide a solid foundation for estimating flood levels at ungaged locations.

Although less dramatic than floods, droughts are more persistent and can cause far greater economic losses than floods. The USGS documents the severity of droughts through streamflow measurements and statistical analysis of data, provides estimates of expected low flows on gaged and ungaged streams, publishes interpretive reports on low flows, and participates in the North Carolina Drought Monitoring Council.

Research Triangle Area Water Quality

The Research Triangle area (Raleigh, Chapel Hill, and Durham) has one of the fastest growing populations in North Carolina. The USGS, in cooperation with 13 Research Triangle municipalities and agencies and the North Carolina Division of Water Quality (NCDWQ), monitors the effects of development and a growing population on surface-water quality, with a focus on run-of-river and reservoir drinking-water supplies and their major tributaries. The number of monitored sites has ranged from more than 60, in 1988, to 25, in 2001. Sites are sampled from 4 to 12 times per year, with some stream sampling during high-flow events. Samples are analyzed for major ions, nutrients, trace elements, suspended sediment, and (in lakes) chlorophyll *a*, an indicator of algal biomass. Some samples also are collected and analyzed for herbicides and insecticides, volatile organic compounds, and the microorganisms *Cryptosporidium parvum* and *Giardia lamblia*.

Figure 3. Stream-water sample being collected by the USGS. Water is collected throughout the channel cross section to ensure that a representative sample is obtained. Ultra-clean methods are used to avoid environmental contamination of the water sample.

Monitoring data from 1983 to 1995 indicate that nitrogen and phosphorus concentrations have decreased slightly or remained stable at most lake sites, but chlorophyll *a* concentrations appear to be increasing in many area lakes. Chlorophyll *a* concentrations are used by the NCDWQ to assess whether lakes are meeting State water-quality criteria.

Trace elements, synthetic organic compounds, and volatile organic compounds seldom are detected near water-supply intakes at concentrations above the laboratory reporting level. Few exceedances of maximum contaminant levels have occurred. The pesticides most often detected are lindane, dieldrin, diazinon, atrazine, simazine, prometon, 2,4-D, and 2,4-DP. During 8 years of monitoring runoff from a completely developed residential area, however, 10 different herbicide compounds were detected. The stream draining this area consistently had more detections of herbicides than nearby streams draining a mixed land-use basin.

Catawba River Basin Studies

The Catawba River Basin in North Carolina has the highest population density and one of the highest population growth rates of the 17 major river basins in the State. The only free-flowing reach of this highly regulated river in North Carolina is between Bridgewater Dam at Lake James, the upstream-most reservoir, and the headwaters of Rhodhiss Lake. Of the eight reservoirs on the river, seven were constructed before 1930. The Catawba River provides water supplies to the Charlotte-Gastonia-Mount Holly area, as well as to smaller communities.

USGS computer models are used to simulate flow and water-quality conditions in three important water-supply reservoirs in North Carolina—Mountain Island Lake, Lake Hickory, and Rhodhiss Lake. The computer models are being used by the NCDWQ for wasteload allocation and by local agencies for predicting the effects of population growth on water quality.

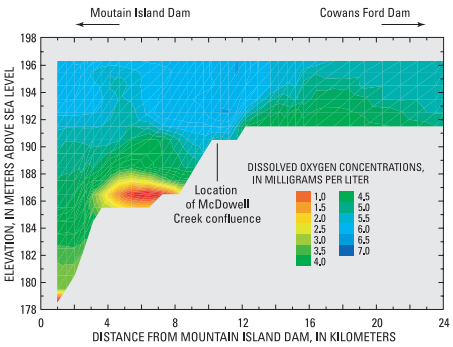

Figure 4. Computer simulation of dissolved-oxygen concentration in Mountain Island Lake, which is located near Charlotte. The simulation shows conditions in the reservoir 3 days after a large storm, which caused flooding in the McDowell Creek watershed and resulted in high inputs of organic matter to the lake. As the organic matter moves into and along the bottom of the lake, dissolved oxygen is depleted as the organic matter decays.

USGS investigations of stormwater quality in Charlotte indicate that residential areas contribute more nitrogen to surface waters than other land uses. Moreover, more pesticides are detected in stormwater draining from residential areas than from other land uses in Charlotte. USGS studies also indicate that atmospheric deposition appears to be a substantial source of nitrogen and some metals, such as chromium and zinc, to surface waters.

Because of the high potential for flooding in Charlotte and surrounding areas, the USGS works closely with local agencies to provide real-time information on rainfall and streamflow. Real-time data from

60 USGS raingages and about 25 streamgages in Mecklenburg County are transmitted by radio directly to City and County emergency managers. The data, which are quality assured and maintained in the USGS database, are used in the analysis of streamflow and rainfall characteristics.

NAWQA Studies and Investigations of Agricultural Effects on Water Quality

Since 1991, the USGS NAWQA Program has focused on the effects of agriculture on water quality in the Albemarle-Pamlico Drainage Basin, one of 60 major basins in the United States under investigation by NAWQA. Concentrations of atrazine, alachlor, and metolachlor, the most frequently detected pesticides in surface water in North Carolina, are highest in the Tar and Neuse Rivers in March and return to very low levels by July. Ground water beneath cropland typically has low pesticide concentrations. Pesticides were not detected in deep aquifers that are used for drinking-water supply.

Figure 5. Water sample being collected from a tile drain beneath cropland. Water from the tile drain typically flows into the drainage ditch and subsequently to a stream. High nutrient loadings from cropland can have undesirable effects on surface-water quality.

The USGS is investigating processes affecting nitrate and other forms of nitrogen in ground- and surface-water drainage from agricultural areas in eastern North Carolina. Nitrate concentrations in ground water frequently are elevated in agricultural areas. At high concentrations, nitrate can cause human health problems, and nitrate-contaminated ground water discharging to streams can contribute to algal blooms and fish kills. A method for identifying sources of nitrate-contaminated ground water is being developed in cooperation with the North Carolina Department of Environment and Natural Resources (NCDENR). Results of a cooperative study indicate that riparian buffers and, particularly, organic debris on streambeds are effective in reducing nitrate in ground water discharging from agricultural fields. The focus of another study is on the effects of agricultural drain tiles and ditches, which allow flow to bypass riparian buffers, on nutrient export to streams. In the Multimedia Integrated Modeling System (MIMS) project, conducted with the U.S. Environmental Protection Agency (USEPA) and NCDENR, the USGS is examining nitrogen changes in the environment, including effects of ground-water and surface-water interaction on nitrogen loads.

Ground-Water Resources

The USGS operates a network of more than 100 wells statewide for measuring ground-water levels. Included in this network are specific study areas in Brunswick County and the southern Coastal Plain, where a large number of wells are monitored to document change over time in ground-water levels.

In addition to the heavily used aquifers of the Coastal Plain, ground-water resources in the Piedmont and mountains of North Carolina are a valuable water-supply source, particularly in areas with stressed surface-water supplies. However, ground-water flow in the fractured crystalline-bedrock aquifers of these regions of the State is complex and not nearly as well understood as ground-water flow in the confined aquifers of the Coastal Plain. The USGS Water-Resources and Geologic Programs are collaborating with the NCDWQ on a long-term scientific study to better define the ground-water flow system and determine factors affecting ground-water quantity and quality in the central and western parts of the State. Study sites are located in Wake, Iredell, Rockingham, and Buncombe Counties. At these study sites, investigations include collection of geologic cores and cuttings, well installation, borehole geophysical logging, and ground-water level monitoring. Ground-water sampling includes major ion analyses for all wells, and ground-water age-dating techniques and isotope sampling to determine potential flow paths and recharge mechanisms.

Figure 6. Research well being drilled near Raleigh. Data collected from this and other wells are used to describe the fractured rock aquifer system beneath much of the North Carolina Piedmont, and to understand ground-water movement in this system.

Continuous Measurement of Water-Quality Conditions

Water-quality conditions can change very rapidly in North Carolina's coastal waters. Dissolved oxygen, which is essential for aquatic life, can change from plentiful to inadequate in minutes because of changes in wind, the movement of salt, or other mechanisms. USGS continuously monitored dissolved-oxygen, salinity, and temperature data are uploaded in real time to the World Wide Web and provide resource managers, fishermen, and the public with timely information at 14 locations throughout eastern North Carolina, including sites on the Roanoke, Pamlico, Neuse, New, and Cape Fear Rivers. New technology also is being used by the USGS to monitor nitrate and chlorophyll *a* (an indicator of algal biomass) concentrations continuously at two locations in coastal waters in order to better understand the effects of various processes on nitrate levels and the response of algal populations to these changes in nitrate.

Flow and water quality also can change quickly in urban streams as a result of rapid rainfall runoff from impervious surfaces. The USGS is continuously monitoring water quality, including suspended-sediment concentrations, at several sites on streams in Mecklenburg and Union Counties. These continuous suspended-sediment data are the first information of this kind in the State and can be used to characterize sediment loads in streams draining urban and developing areas.

Figure 7. USGS servicing of estuary monitoring platform. These monitoring systems provide real-time data on dissolved oxygen, salinity, and temperature; the data are used by researchers, State resource managers, fishermen, and the public.

Support for DOI and Other Federal Agencies

As the sole science agency for the DOI, the USGS provides data and conducts studies to help DOI agencies manage Federal lands. The USGS is monitoring hydrologic conditions in the Great Smoky Mountains National Park. The effects of changes in river flow on wetland water levels and instream water quality are being investigated in the Roanoke River National Wildlife Refuge in order to provide a framework for management decisions. The USGS is characterizing the complex hydrology of the Alligator River National Wildlife Refuge, which includes the Dare County Bombing Range, natural areas, and intensively ditched and drained areas. Improved water management in this refuge is critical to the restoration of native species, such as the Atlantic white cedar, and to the improvement of fisheries and wildlife habitat.

Other Federal agencies use USGS expertise for various mission responsibilities, including contaminant mitigation and water-resources protection. At Cherry Point Marine Corps Air Station, the USGS is delineating paleochannels (geologic features that can strongly affect contaminant movement) beneath the Air Station by using high-resolution seismic-reflection surveys to define subsurface geology. Working closely with the USEPA, the USGS is developing analytical methods that can be used to detect low levels of pharmaceutical products in surface and ground waters. Concerns are increasing that these types of compounds may have adverse effects on the health of aquatic systems, as well as on people.

Outreach and Public Education

The World Wide Web makes it possible to rapidly deliver real-time streamflow, rainfall, water-quality, and ground-water level information from more than 300 sites across the State to water-resource managers and the public. Many requests for information and data are answered automatically by the USGS Web site, **http://nc.water.usgs.gov**. During September and October 1999, in the aftermath of Hurricane Floyd and the resulting floods, more than one million pages of information were served to the public and emergency managers from the USGS North Carolina web site.

Figure 8. Demonstration of streamgaging equipment to an elementary school student. The USGS regularly participates in a variety of public information and outreach programs across the State, including classroom and field demonstrations, career fairs, and science fairs.

In addition to real-time and historical data, the USGS North Carolina District has a number of reports available online, as well as digital map data (as GIS coverages), project information, and software that can be downloaded for use in hydrologic analyses.

The USGS personally responds to more complex requests for information. For example, in January 2001, the USGS answered more than 50 individual requests, which typically range from information for school projects to complex low-flow analyses to be used in wastewater-discharge permitting. In 2000, the USGS North Carolina District produced more than 40 different printed reports and articles that document USGS data, interpretive studies, and research investigations across the State.

— Prepared by Jerad D. Bales

Selected URL's for additional information include:

- The USGS—http://www.usgs.gov/
- USGS Water Programs—http://water.usgs.gov/
- National Streamflow Information Program—http://water.usgs.gov/nsip/
- North Carolina USGS Water Programs—http://nc.water.usgs.gov/
- Real-time Streamflow Data for North Carolina—http://water.usgs.gov/nc/nwis/rt
- Hurricane Floyd Flood Information—http://water.usgs.gov/pubs/wri/wri004093/
- Flood Frequency Information—http://nc.water.usgs.gov/floodstats/
- North Carolina Drought Information—http://nc.water.usgs.gov/drought/
- Research Triangle Area Water-Quality Programs—http://nc.water.usgs.gov/triangle/
- National Water-Quality Assessment Program—http://nc.water.usgs.gov/albe/index.html
- Continuously Monitored Water-Quality Data for North Carolina—http://water.usgs.gov/nc/nwis/current/?type=quality
- Publications—http://www.usgs.gov/pubprod/ *and* http://nc.water.usgs.gov/pubs/index.html
- Educational Resources—http://water.usgs.gov/education.html *and* http://ask.usgs.gov/education.html

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