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### **NORTH CAROLINA GROUNDWATER PROGRAM BEING STRENGTHENED**

Groundwater protection in North

Carolina, which is primarily the responsibility of the Groundwater Section of the Division of Environmental Management (DEM), has been strengthened considerably over the past several years by a number of research and assessment efforts and by regulatory developments, and the Groundwater Section is continuing to develop wider knowledge and better tools for protecting the state's groundwater resources.

North Carolina's groundwater protection program is based on three fundamental efforts: (1) preventing pollution by facilities that generate or treat waste, (2) restoring polluted groundwater, and (3) planning for the wise development and use of the state's groundwater resources.

#### **Waste Treatment and Disposal Guidelines Form Backbone of Groundwater Protection Strategy**

In 1983, as part of its strategy to prevent pollution of groundwater, the State adopted groundwater classifications and standards and implemented a permitting system through which it establishes and enforces guidelines for facilities that generate or treat waste which can pollute groundwater. These guidelines address construction, monitoring, and reporting and establish standards that must be met before permits can be issued for facilities such as solid waste landfills. With establishment of the guidelines, the Groundwater Section began reviewing all relevant State environmental permit applications to assure compliance with groundwater standards. In 1987, the Section began working on revisions to the classifications and standards to incorporate the permitting experience it has gained since the

program began. The proposed revisions are now undergoing public comment. (See related article.)

Under a cooperative arrangement among the Department of Natural Resources and Community Development (NRCD), the UNC Water Resources Research Institute, and Duke University, researchers at Duke have developed a computer-based Groundwater Advisory System which is now being used by permitting staff to evaluate the potential impact of waste disposal activities on groundwater quality.

#### **Standardized Interagency Response to Pollution Protects Public Health and Welfare**

The Groundwater Section's groundwater incident management program provides for standardized procedures in responding to pollution incidents and for a consolidated inventory of contaminated sites. The response program is an outgrowth of North Carolina's interagency emergency response program, which established procedures for interagency management of emergencies which threaten public health or welfare. In addition to emergency response procedures, the Groundwater Section has also implemented procedures for remedial action.

#### **Underground Storage Tank Registration Will Aid in Preventing and Responding to Pollution**

Part of the effort to protect groundwater involves being able to anticipate and avoid or respond quickly to pollution from Underground Storage Tanks (UST). Under the federal Underground Storage Tank program and North Carolina's UST registration effort, 74,000 USTs at 24,000 facilities have been inventoried and the information has been computerized and made available to state and local agencies. UST registration will allow the State to

provide tank owners with current information on tank maintenance to better protect groundwater and will provide a source of information on potential contamination sources when staff investigate incidents of groundwater contamination. Based on North Carolina's tank registration inventory, EPA estimates that as of 1987, there are about 220,000 USTs in the state and that about 80,000 or 36 percent are in danger of failing.

#### **Effort Is Underway to Evaluate Impact of Large Septic Systems**

In a cooperative effort with EPA, the Groundwater Section is evaluating the threat to groundwater from industrial and large domestic septic tank systems. All domestic septic tank systems with a design flow greater than 2,000 gallons and industrial septic tank systems of any size are being inventoried, and an in-depth study of five septic tank systems in North Carolina is being conducted. In 1987, industrial and domestic septic tank systems regulated by DEM were inventoried, and a total of 795 ranging from large systems which accept only domestic sewage, such as subdivision utilities, to industrial process water systems, such as seafood processing facilities, were found. Domestic systems regulated by the N.C. Division of Health Services will be inventoried during 1988.

The inventory of DEM-regulated domestic septic systems revealed that the characteristics of influent to the septic systems may differ widely from true domestic systems because of the use of various commercial and organic compounds, including acids/bases and cleaning solvents. The inventory also showed that a high concentration of these septic systems is a function of proximity to heavy industrial development and the availability of municipal sewer systems.

#### **Federal Trust Fund Is Providing for Cleanup of Major Leaks from Underground Storage Tanks**

The Groundwater Section has established a program to clean up petroleum leaking from underground storage tanks using funds provided by the Leaking Underground Storage Tank (LUST) Trust established by the federal Superfund program. A grant of \$1,057,000 from EPA allows administration and operation of the program, which will provide about \$700,000 over a two-year period to contract for cleanup of major petroleum leaks in North Carolina and for accelerated restoration of contaminated groundwater.

The Groundwater Section staff investigated over 200 incidents of potential groundwater contamination in 1987. The ability to quickly respond to such incidents and the quality of investigation has been greatly improved over the past year through additional staff and training, development of effective procedures, and increased technical capabilities gained through investigative experience.

#### **Development of Groundwater Quality Database Will Allow Tracking of Changes and Trends**

As part of the State's overall water quality monitoring effort, plans have been developed to establish a computerized groundwater quality database. Historical data from sampling at groundwater research station monitoring wells since the 1960s will be reviewed and entered into the database so that it can be analyzed for changes and trends in water quality in the state's aquifers. A revised ambient monitoring network is also being implemented that will provide a continuous record of groundwater quality changes.

#### **Pesticide Monitoring Plan Will Help Improve Application Practices**

In cooperation with an interdepartmental coordinating committee, the Groundwater Section is developing a plan to

monitor the impact of pesticide use on groundwater quality. The plan is expected to be completed 1989 and will help provide information on the impact of pesticide application on groundwater and will lead to improved pesticide application practices where problems are identified.

#### **GROUNDWATER IMPORTANT IN MEETING NORTH CAROLINA'S WATER-SUPPLY NEEDS**

by John N. Morris, Director  
N.C. Division of Water  
Resources

As with other natural resources, the interaction of supply and demand factors determines the value of groundwater in meeting our state's water supply requirements. Water demand in North

Carolina is shaped by our population's size and distribution. Frequently, persons from other states are surprised to learn that North Carolina ranks tenth among the fifty states in population. When asked, most out-of-staters guess that North Carolina ranks somewhere around twenty-fifth or lower because they have an image of a rural state with no large cities. It is true that North Carolina has no really large cities, but we do have a large population dispersed among many medium-sized and small cities and towns and also an unusually large population living in the countryside. This dispersed population pattern makes groundwater particularly important as a water supply for those who live far from city water systems.

The supply side of groundwater in North Carolina is the other key factor determining its importance to the state. In the Coastal Plain, we are fortunate to have several major aquifers which provide large and predictable supplies of good quality groundwater. In the Piedmont and Mountain regions of North Carolina, the availability of groundwater is generally more limited and is highly variable, depending on the presence of bedrock fractures and the total aquifer thickness in each specific area. In most of the Piedmont and Mountain regions, however, it is possible to get adequate supplies for single-family residences and farms and also for community or small-town water supplies.

As determined by these supply and demand factors, groundwater is a major resource in North Carolina. According to statistics gathered by the National Water Well Association, North Carolina ranks second among the states in the number of household wells, estimated at 822,000. There are an estimated 16,000 public water supply wells, ranking us fifth among the states in this category.

Several examples will illustrate the value of groundwater to North Carolina and the management problems that are emerging in some areas.

#### **Groundwater Important Resource Even in Piedmont**

The Eno River is a water supply source in northern Orange and Durham counties. Growth in this area, coupled with the extremely low flows of the Eno during drought periods, has created a serious surface water supply shortage. The Division of Water Resources is conducting a study of the Eno River for the Environmental Management Commission to determine if regulation of water use under the Water Use Act of 1967 is needed to deal with the water-use conflicts and shortages that are emerging. Until the capacity use study, groundwater use in the Eno Basin had not been accurately documented. The study has shown that groundwater provides 26 percent of the total water use in the Eno Basin. This demonstrates that groundwater is a major and necessary source of water supply even in the Piedmont of North Carolina, where it is not generally thought of as such a critical resource. With careful

development and management, groundwater can play an important part in meeting the water supply needs of the Eno Basin, although it cannot meet all of the projected needs.

In the Coastal Plain of North Carolina, groundwater is recognized as an abundant resource. In the central Coastal Plain, the area including Kinston, New Bern, Jacksonville, and Greenville, large centers of population are primarily dependent on groundwater. Increasing use of groundwater in this area over a period of decades has created a significant and widespread reduction in aquifer water pressure levels. As a result, water has to be pumped from greater depths at a greater cost, and interference among wells is an increasing problem. The local governments in the central Coastal Plain have joined with the Department of Natural Resources and Community Development (NRCD) and the U.S. Geological Survey (USGS) to prepare for the more careful management of this resource that will be needed in the future. Through this jointly-funded effort, the USGS is constructing a computer model of the groundwater system that can answer "what if" questions about the regional effects of new wells and changed pumping rates. The model will be used as a basis for technical assistance to local governments on well location and pumping decisions and will provide a better foundation for the long-range management of this resource.

The Dare and Currituck County Outer Banks provide another example of groundwater management concerns. Extremely rapid tourist and recreational development is underway on the North Carolina Outer Banks. The primary water source for this development is the surficial aquifer, an underground lens of fresh water, replenished by rainfall and floating on the underlying salt water. This aquifer is vulnerable to pollution by septic tanks and spills as well as to salt-water intrusion resulting from heavy pumping. As growth continues, careful management and protection of this aquifer will be needed to maintain its usefulness into the future.

#### **Groundwater Use for Irrigation Growing**

Irrigation is a fast-growing water use in North Carolina for such uses as tobacco, corn, soybeans, and truck farms. Nationwide, about 40 percent of irrigation water comes from groundwater. In North Carolina, we are at about the halfway point of a detailed county-by-county survey of water use, including use of water for irrigation. In North Carolina, of the 41 counties surveyed thus far, groundwater is only about seven percent of total irrigation water use. But water use for irrigation is growing rapidly and many irrigators will turn to groundwater where fresh surface water is not available, particularly in such counties as Craven, Pamlico, and Carteret. So far, our survey has found that the largest use of groundwater for irrigation is in Beaufort, Franklin, Pamlico, Pitt, and Pasquotank counties. This increased groundwater use will have to be accommodated in regional water-use plans. The Division of Water Resources is creating an information base for this purpose through county water-use surveys. Because of the large potential demand for water for irrigation, we attempt to interview every significant irrigator when a county water-use survey is undertaken.

#### **Setting Priorities for Groundwater Management Will Allow Continued Development of Resource**

As North Carolina's economy and population continue to grow, we need to manage and protect groundwater so that it can provide a share of our increasing water supply requirements. Four high priorities for groundwater management are:

1. Water users and managers need more data and scientific knowledge about groundwater conditions and use. Groundwater cannot be measured and monitored as easily as surface water, but we must make the necessary investment to understand and be

able to predict the behavior of our aquifers as we attempt to withdraw more water from them. This predictive ability is necessary to make full productive use of our groundwater resource without damaging its long-term yield and quality. Developing the necessary groundwater knowledge will require a cooperative effort among local governments, NRCD, and USGS.

2. Water resources managers must spend more time informing the public and public officials about groundwater. Groundwater is much less well understood by nonspecialists than is surface water. Misinformation and erroneous ideas about the nature and behavior of groundwater are at an epidemic level. To achieve the best use and protection of groundwater, we have to have knowledgeable elected and appointed officials to provide leadership and well-informed citizens to support good water management.
3. Local governments must do more careful and farsighted planning for the use of groundwater. Each city and county should have a water supply plan, identifying sources of water supply needed to meet projected growth. These water-supply plans should include consideration of both surface and groundwater sources. There are many opportunities for conjunctive use of groundwater and surface water. The term "conjunctive use" means using groundwater and surface water together in a coordinated and efficient way to meet water supply needs. Most wells are highly resistant to drought and continue to provide a normal yield, even during dry periods when stream flow and lake levels are low. New wells can be quickly and flexibly constructed to meet increases in water supply demand, particularly when compared to the extremely long time required to plan and construct a new reservoir. For these reasons, groundwater has a great potential as a supplement to surface water sources. Even in the Piedmont and Mountain regions of North Carolina, where groundwater availability is more variable, there are many opportunities for an increased use of groundwater by towns as a supplement to surface water sources.
4. North Carolina should manage groundwater actively to assure the long-range useability of this resource. For example, on the Dare and Currituck Outer Banks, the closely spaced individual wells and conventional septic tanks on each lot may endanger the long-run water quality of the aquifer. Community wells and waste disposal facilities could be planned in some areas to provide a higher water-supply yield and better protection of the water quality in the aquifer. In areas like the central Coastal Plain of North Carolina, coordination of well locations and pumping rates will be needed to avoid costly conflicts among neighboring local governments for groundwater. The necessary planning and management of groundwater can be achieved through communication, cooperation, and planning by the local governments, developers, and businesses who use groundwater, with technical assistance by NRCD. In cases where this approach will not resolve problems, the Environmental Management Commission can provide a framework of state regulation through the Water Use Act of 1967. At the

present time, only one capacity use area under the 1967 Act has been designated.

Groundwater will be an increasingly important element in meeting North Carolina's growing water supply needs. Groundwater will continue to be an essential source for dispersed homes, farms, and businesses that are not served by public water-supply systems. Groundwater will be the primary supply for many population centers in the Coastal Plain, a region of our state where increasing growth is expected. On the Outer Banks, groundwater will continue to be the only source of water available, with the exception of water imported from the mainland or desalted at a high cost. Throughout North Carolina, the flexibility of development and drought resistance of groundwater will make it an increasingly important supplement to surface water sources.

**STATE'S GROUNDWATER CLASSIFICATIONS AND STANDARDS UNDERGOING REVISION, PUBLIC HEARINGS ARE SCHEDULED**

The Department of Natural Resources and Community Development, on behalf of the Environmental Management Commission, will hold public hearings in

July and August to receive comments on proposed revisions to the North Carolina Groundwater Classifications and Standards.

Hearings will be held as follows:

Asheville  
July 26, 1988--7:00 pm  
Humanities Lecture Hall, UNC-Asheville

Raleigh  
July 28, 1988--7:00 pm  
Ground Floor Hearing Room, Archdale Building  
512 N. Salisbury Street

New Bern  
August 2, 1988--7:00 pm  
Room C-15, Building C  
Craven County Community College

**Number of Classifications to Be Reduced**

Groundwater classifications established under the state's water quality statutes in 1983 are as follows:

1. **Class GA Waters:** Fresh water in the saturated zone at depths greater than 20 feet below land surface which is being used or can be used as a source of drinking water supply for humans
2. **Class GSA Waters:** Water in the saturated zone at depths greater than 20 feet below land surface that has a chloride concentration greater than 250 mg/l (saltwater) and which is a present or potential source of potable mineral water or which could be converted to fresh water
3. **Class GB Waters:** Fresh waters occurring at depths less than 20 feet below land surface that are of suitable quality for recharge to the deep aquifers and surface waters of the state
4. **Class GSB Waters:** Saline groundwaters occurring at depths less than 20 feet below land surface that are of suitable quality for recharge to the deeper aquifers and surface waters of the state
5. **Class GC Waters:** Waters in the saturated zone which do not meet the criteria for drinking water and which cannot be treated either in situ or at the point of use to bring it to drinking water standards (or for which in situ treatment may not

be in the public interest) but which can be used for purposes other than drinking

Under the proposed changes, Class GB and Class GSB would be eliminated and Classes GA and GSA descriptions would be rewritten to include waters occurring in the saturated zone at depths less than 20 feet below land surface.

**Degradation Policy to Be Changed**

Current policy, as written, is that the state will not approve of any project or development under its jurisdiction which would cause degradation of groundwaters from existing background quality unless such degradation is found to be economically and socially justifiable and in the best public interest.

The proposed policy is that the state may permit degradation of groundwater quality below the level of the applicable standards within the compliance boundary and other limits within the property established by a variance but not beyond the property boundaries on which the source of pollution is located or which would result in the impairment of existing groundwater uses or impacts that would adversely affect the public health, safety, or welfare.

Groundwater standards adopted in 1983 established a compliance boundary (500 feet from source of waste or at the property boundary, whichever is closer to the source, if the facility was permitted prior to December 30, 1983; 250 feet from the source of waste or 50 feet within the property boundary, whichever is close to the source, if the facility was permitted after December 30, 1983) within which contamination of groundwater in excess of applicable standards is not subject to penalty provisions. The proposed amendments establish a review boundary at the mid-point between the compliance boundary and the waste boundary. Monitoring wells at the review boundary may be required. If standards are reached or exceeded at the review boundary, action must be taken to demonstrate violation will not occur at the compliance boundary or to prevent violation at the compliance boundary.

Proposed policy also states that concentrations of agricultural chemicals in excess of water quality standards will not be considered a violation if chemical applications have been made in accordance with label instructions or accepted agronomic practices and if concentrations exceeding the water quality standards do not occur beyond the boundary of the property on which the chemicals were applied or below a depth of 10 feet below land surface.

**Number of Substances Covered by Numerical Standards Is Increased**

Rules authorize the state to modify an existing permit, require additional monitoring, or issue a Special Order where a violation outside the compliance boundary may be predicted if anywhere within the compliance boundary there is an increase in concentration to 50 percent of the standard for any substance. The proposed amendments replace the 50-percent-of-standard rule with a review boundary and maximum concentration levels. The current list of 31 numerical standards is proposed to be increased to 74. Maximum concentrations are proposed to be established as the least of several health and safety criteria including the national primary drinking water standards and the national secondary drinking water standards. Among the substances for which new numerical standards are established are a number of pesticides and hydrocarbons.

### **Authority to Issue Special Orders Would Be Delegated to DEM Director**

Under the proposed changes, any person conducting, permitting or controlling an activity not officially permitted by the state which causes a violation of water quality standards would be required to eliminate the source of contamination and restore groundwater quality in accordance with a Special Order to be issued by the director of the Division of Environmental Management. Any persons responsible for a permitted activity that results in violation of standards outside the compliance boundary would be required to restore groundwater quality in accordance with a Special Order. The proposed amendments delegate authority to the director of DEM to determine when restoration to standards is not feasible and to authorize by Consent Special Order alternate contaminant concentrations. The proposed statutes spell out the procedures for requesting alternate contaminant concentrations and require that before authorizing alternate contaminant concentrations the director receive public comment on the request.

### **Procedures for Granting Variances Are Proposed**

Under the proposed changes, the EMC could grant variances to water quality standards and compliance boundaries in cases where groundwater contamination has occurred or will occur and the EMC determines that (1) the variance will not endanger the public health and safety, (2) standards cannot be achieved by providing the best available technology economically reasonable, (3) compliance would produce serious hardship on the person or institution requesting the variance, (4) compliance would produce serious hardship without equal or greater public benefit, and (4) any special order that has been issued related to the area for which the variance is requested, including alternate contaminant concentrations, has been complied with.

### **UNDERGROUND STORAGE TANK REGULATIONS AND CLEAN-UP FUND BEING CONSIDERED**

North Carolina, 36 percent of which are at risk of failing and leaking their contents into the surrounding earth, threatening to contaminate groundwater. Data collected through North Carolina's UST registration program shows that about 20,000 of the almost 74,000 registered tanks are 20 years old or older. Time-to-failure studies have shown that at 20 years, the risk of failure, most often due to corrosion of tanks and piping lacking corrosion protection, rises sharply. The N.C. Division of Environmental Management has confirmed more than 300 incidents of leaking USTs.

New federal UST regulations, which contain provisions requiring replacement or upgrading of millions of regulated tanks as well as leak detection/prevention requirements, are expected to emerge from Congress soon, and North Carolina UST regulations, under development since 1986, will then be reconciled with federal regulations and finalized. Many large companies have already begun to replace aging tanks.

### **Federal LUST Trust Provides Some Funding for Cleanup of Major Pollution Incidents**

Even with new regulations and replacement of many older tanks, UST leaks will continue to be a major environmental problem for many years, and solutions to the problem in North Carolina have been slow to emerge. Cleanup of some major pollution incidents may be paid for by the federal Leaking Underground Storage Tank (LUST) Trust established through Superfund legislation and administered in North Carolina by the Groundwater Section of the Division of

Environmental Management. The fund is currently providing \$700,000 for a two-year period for clean-up and groundwater restoration efforts.

However, according to the EPA, the average cost of cleaning up a site where petroleum has leaked from a tank is about \$70,000, and if the tank must be removed and the surrounding soils must be treated, the cost can total more than \$1 million. If groundwater, surface water, reservoirs, sewers, or utility trenches are affected by the leakage, the cost of correcting the problems can quickly exceed the \$1 million range.

In the North Carolina General Assembly, legislators are grappling with the issue of how to pay for cleaning up pollution caused by leaking tanks. A much-amended House bill aimed at establishing a fund to help pay for environmental damage caused by leaking USTs was substantially rewritten by a Senate committee and had passed third reading in the Senate in mid June.

### **N.C. Senate Version of LUST Cleanup Bill Establishes Two Funds**

The Senate version of the bill calls for establishment of two funds, one to help pay for cleanup of leaks from "commercial" tanks and another to help pay for cleanup of leaks from "noncommercial" tanks.

Noncommercial tanks are essentially residential and farm petroleum tanks. The money to pay for cleanup of leaks from noncommercial tanks (and commercial tanks taken out of operation before 1974 and located on land not owned by the original tank owner or operator) would come from general appropriations, grants, and monies recovered on the fund's behalf. The bill appropriates \$4 million from the General Fund to the noncommercial fund for 1988-89. The noncommercial fund would pay all the costs of cleaning up noncommercial leaks up to \$1 million.

Commercial tanks are essentially all underground petroleum storage tanks not defined as noncommercial. The commercial cleanup fund would come from annual operating fees to be paid by owners or operators of commercial tanks. Each commercial tank of 3,500 gallons or less capacity would be assessed an annual fee of \$30; each tank over 3,500 gallons, \$60. Companies or individuals who fill commercial petroleum tanks would be required to inform the owners/operators of the requirement to pay the annual fees but would not be liable to the owner/operator for failure to do so. Owners or operators of commercial tanks would be responsible for the first \$100,000 of the cost of cleaning up a leak. The fund would pay costs in excess of \$100,000 up to \$1 million, but no payment could be made from the fund until it reaches \$1 million and no payment can be made from the fund to an owner/operator who has not paid the required annual fees. If at anytime the commercial fund balance reaches \$15 million, the annual fee will be suspended until the balance falls below \$5 million.

The bill provides amnesty for civil penalties for any owner/operator who reports a leak within 15 months of the bill's effective date, unless the leak was willfully or negligently caused. It also requires that owners/operators of USTs who are required by federal law to be insured for cleanup liability must demonstrate the ability to pay for at least \$100,000 of cleanup costs per occurrence. The bill authorizes the establishment of insurance pools for this purpose.

The provisions of the bill apply only to leaks discovered or reported on or after its effective date. An amendment was added in late June to have the bill's provisions expire next year.

## House Version Sets Minimum Liability for All Tank Owners

The House version of the bill differed substantially from the Senate's committee substitute. The House version called for creation of a Leaking Underground Tank Cleanup Fund to be funded by a 1/4 of 1 cent per gallon tax on kerosene and motor fuel and to be maintained at a level between \$5 million and \$15 million. It provided for suspension of the tax when the fund reached \$15 million. The bill established minimum liability for all owners of underground storage tanks, depending upon the number of tanks owned. Any person, business, trust, or other legal entity that owns one to three tanks would have to pay the first \$5,000 of cleanup costs; any person or legal entity owning four to ten tanks would have to pay the first \$15,000; and any person or legal entity owning 11 or more would have to pay the first \$50,000. After minimum liability was satisfied, the state fund would pay for cleanup costs up to \$1 million. An early version of the House bill specifically excluded refiners and their affiliates from using the fund.

### WRRI-SUPPORTED PROJECT STUDIES EFFECTS OF LANDFILLS ON GROUNDWATER QUALITY IN NORTH CAROLINA

Researchers at North Carolina State University say that solid waste landfills in North Carolina are having

a significant adverse impact on the state's surface and groundwater resources. In a study supported by the Water Resources Research Institute, Dr. Robert C. Borden and graduate assistant Thomas M. Yanoschak of the NCSU Department of Civil Engineering analyzed data from sanitary landfills throughout North Carolina to quantify the extent of water quality impacts and to identify landfills where water quality standards are being violated.

To perform their statistical assessment, the researchers used organic and inorganic water quality analyses of 322 surface water and 411 groundwater samples taken at 71 different landfills by the Solid and Hazardous Waste Management Branch of the N.C. Department of Human Resources between 1980 and 1987. When they compared statistical averages of monitoring data from water samples taken upstream from landfills to that from groundwater and surface water samples taken downstream from landfills, they found significant increases in concentrations of zinc, turbidity, total organic carbon, conductivity, total dissolved solids, and lead.

In their analysis of groundwater monitoring data, the researchers found violations of N.C. groundwater quality standards for heavy metals and hazardous organic compounds at 53 percent of the landfills with adequate data. Iron, manganese, and pH were the inorganic parameters which most frequently exceeded standards. The organic compounds which appear to pose the greatest threat of groundwater contamination are the chlorinated solvents, petroleum derived hydrocarbons, and pesticides.

The researchers are currently attempting to correlate site hydrogeology with observed instances of groundwater contamination to help in developing guidelines for safer siting of new landfills. They presented the results of their statistical work in a paper prepared for the American Water Resources Association's Symposium on Coastal Water Resources in May.

### COOPERATIVE STUDY WILL PROVIDE INFORMATION FOR FUTURE MANAGEMENT OF CASTLE HAYNE AQUIFER

The U.S. Geological Survey (USGS), the N.C. Department of Natural Resources and Community Development (NRCD), and a

number of local governments in North Carolina's Coastal Plain area have agreed to cooperate on a study of the hydrology and groundwater resource potential of the Castle Hayne Aquifer in Eastern North Carolina. Several Coastal

Plain municipalities are joining USGS and NRCD as cooperators on the study in order to assure that they have accurate information for developing future water supply plans.

The Castle Hayne Aquifer, covering a 12,500-square-mile area in the eastern part of North Carolina, is the major and, in many places the only, source of fresh groundwater in Coastal North Carolina. A 2,500-square-mile area encompassing all or part of eight counties which get their water supplies from the aquifer was declared a Capacity Use Area in 1968 in response to concerns about the effects on the aquifer of major withdrawals related to mining operations. According to a paper prepared by William L. Lyke and M.W. Treece, Jr. of USGS for the American Water Resources Association's Symposium on Coastal Water Resources in May 1988, the population of coastal counties where the Castle Hayne Aquifer is a major source of potable groundwater has increased by 44 percent in the last 25 years. Overall, more than 300,000 people in the Coastal Plain are supplied by the aquifer.

Withdrawals from the aquifer in 1986 totaled an estimated 146 million gallons per day (MGD). Public water supply withdrawals totaled 26 MGD. Industrial withdrawals accounted for about 69 percent of the water use from the aquifer, totaling about 105 MGD; agricultural usage accounted for 5 MGD; and domestic, 10 MGD.

According to the Lyke/Treece report, as a result of increasing withdrawals from the Castle Hayne Aquifer since 1965, there have been a number of incidences of water level decline and saltwater intrusion into public water supplies in Eastern North Carolina.

Shallow wells and artesian wells in an area of several hundred square miles around the town of Aurora in Beaufort County have been affected by water-level declines caused by nearby mining. The greatest decline--125 feet between 1969 and 1974--has been observed at the mine. Declining water levels have also been observed at the U.S. Marine Corps Air Station at Cherry Point in Craven County and in the Morehead City area in Carteret County.

At Aurora, Cherry Point, and perhaps other places, water level decline has reversed the natural flow of groundwater. Instead of groundwater discharging into rivers and streams, the potential now exists for rivers, like the Pamlico, to discharge water into the aquifer. Wherever there has been a change in vertical flow, the potential for contamination of the aquifer by surface pollutants has increased.

Camp Lejeune and the Town of Wrightsville Beach have experienced saltwater intrusion, or increased concentrations of chloride in their water supplies. Saltwater can be drawn toward wells from underlying saltwater aquifers in a process called upconing, from nearby estuaries, and, through lateral movement of saltwater within the Castle Hayne aquifer itself.

In spite of these localized problems, the report says that the Castle Hayne Aquifer can be used more extensively in the future as development in the eastern part of the state continues and communities experience problems, such as contamination and water-level declines, with supplies from deeper aquifers.

However, wise and efficient development of the Castle Hayne Aquifer resource will require a more thorough understanding of the aquifer's physical characteristics and more reliable water-use data. The Castle Hayne Aquifer study, expected to get underway next summer, is designed to provide this information. The study will produce a series of hydrogeologic maps showing the altitude of the top of the aquifer, location of saltwater in the aquifer, aquifer thickness, aquifer transmissivity, and confining-unit thickness. These maps will be useful

to water-systems managers, well drillers, irrigators, and property owners in planning and constructing water wells and test holes. Hydrogeologic, pumpage, and water-level data to be collected as part of the study can be used to develop estimates of aquifer and confining-unit hydraulic coefficients and to develop a groundwater flow model, which can be used to assess groundwater development scenarios of the entire aquifer.

A similar cooperative study of the Cretaceous aquifers underlying the Castle Hayne was begun in 1980 and has produced a map of the deeper aquifer system's lower boundary and a report on the history of pumpage in the Black Creek and Upper Cape Fear Aquifers which documented water-level declines in an area centered around Kinston and Greenville. According to Allen Brockman of the N.C. Division of Water Resources, who is involved with both cooperative studies, a number of other reports resulting from the earlier study, including one on the history of pumpage and water-level declines in the Jacksonville/Onslow County area, as well as maps and a computer model of the Cretaceous aquifer system are nearing completion. Brockman said that USGS has also completed a broad-scale study of the Northern Atlantic Coastal Plain Aquifer System which defined and described the hydrogeology of ten regional aquifers and produced maps of the aquifers as well as a flow model of the entire system. The USGS study is useful as a conceptual tool, Brockman said, while the two local studies will provide area-specific information for over-all management of Eastern North Carolina's groundwater resources.

#### **DROUGHT CAUSES PROBLEMS FOR AGRICULTURE AND WATER UTILITIES**

many areas of the nation for both the agricultural community and water utilities.

In the Southeast, a major dry area includes Georgia, Tennessee, and the Appalachian regions of North and South Carolina. These are the same areas that experienced droughts in 1985 and 1986, drought that was the worst in over 100 years. In much of Western North Carolina rainfall since January 1, 1988, has been about 60 percent of normal. In the southern mountains where conditions are worst, climatologists say 26 inches of rain are needed to break the drought. Here surface water supplies have not recovered from the record 1986 drought. Water officials from local governments met with state and federal agencies in a drought conference on June 30 in Asheville to assess the current situation and to improve the capacity of local governments to cope with the continuing drought.

The drought has cut the Tennessee Valley Authority's hydroelectric power production nearly in half and has caused a loss of more than \$110 million.

Another large dry area experiencing severe-to-extreme droughts includes the grain-belt on both sides of the Canadian border from Montana and Wyoming through the Dakotas to Minnesota. In all of these areas farm production is being impacted. The U.S. Department of Agriculture has created a drought relief task force to track the effects of the dry weather and develop strategies to deal with it in California, Nevada, Oregon, Montana, Idaho, Wyoming, Washington, Utah, and North Dakota. In both the Mississippi and Ohio rivers, barge traffic has either slowed or stopped. The Mississippi reached its lowest level since authorities began keeping records in 1872.

The West Coast and Pacific Northwest continue to have precipitation as much as 75 percent below normal with some states in the area having the driest months on record. Water shortages are harming agricultural crops and may reduce production of hydroelectricity.

#### **Water Utilities Urge Water Conservation**

In many areas across the nation water utilities are beginning to implement voluntary and in some instances, mandatory water restrictions. In North Carolina, the drought coupled with high temperatures resulted in record amounts of water being used in cities like Charlotte and Asheville. These communities along with about a dozen others have requested that residents voluntarily conserve water.

In Georgia a "drought alert" has been issued for the northern section of the state. The alert means that reservoirs are being operated to conserve water. Water use is restricted for drinking water and water quality, and limited quantities are being released for hydropower or navigation. Lake Lanier, which supplies water to metropolitan Atlanta, was seven feet below its normal level in May. Because Lanier and all of Georgia's lakes and reservoirs are at record low levels, water suppliers in the Atlanta area have been directed to reduce water use by 10 percent.

For additional details on the impact of the drought on North Carolina's surface and groundwaters, see the Water Resources Conditions section of this newsletter.

#### **STUDY LOOKS AT HOW NORTH CAROLINA COMMUNITIES RESPOND TO WATER SHORTAGES**

A recently completed study funded by the Water Resources

Research Institute

shows the experiences of 28 North Carolina communities with the 1986 water shortages and how prepared they are for future shortages. The communities were selected because they had to implement water conservation programs during the drought of 1986. Results of in-person interviews with water plant supervisors, public works directors, and water resources directors show that almost three-fourths of these communities had a water conservation ordinance in place at the time of the study. Only 14 percent of all systems had one before the 1986 drought. Despite their serious water shortages, about 30 percent still did not have any form of water conservation ordinance.

Communities used a variety of activities to educate the public on ways to conserve water. Mass media--including television, radio, and newspapers--were cited as effective means of reaching the public with water conservation information. Interpersonal communication was considered an effective way of encouraging water conservation with business and industry.

According to the survey, local water systems faced few serious obstacles to their water conservation program. Many communities did, however, feel the need for more technical information to improve conservation efforts.

Some 43 percent of the communities felt their inexperience with droughts hampered their ability to implement a water conservation program. Still others were concerned with outdated technology (41 percent), inadequate long-range planning (30 percent), and inadequate technical information (30 percent) for their water conservation program.

The Water Resources Research Institute study was conducted by Dr. Thomas J. Hoban of the Department of Sociology and Anthropology at North Carolina State University. A report for this project is in its final stages of preparation.

**INTERAGENCY COMMITTEE  
PRESENTS DRAFT STRATEGY FOR  
MONITORING PESTICIDES IN N.C.  
GROUNDWATER**

At the June 2 meeting of the North Carolina Pesticide Board, an interagency working

committee presented a draft plan for monitoring groundwater across the state for the presence of 123 primary pesticide leachers including pesticides used for agricultural, silvicultural, right-of-way, industrial, and structural purposes. The committee, made up of representatives from the Departments of Agriculture (NCDA), Human Resources, and Natural Resources and Community Development (NRCDC) and chaired by Dr. T. J. Sheets of the North Carolina State University Pesticide Laboratory, spent a year exploring the need for a pesticide monitoring program and developing the draft two-year monitoring plan.

The plan calls for the construction of 100 monitoring wells to be located in the major hydrogeologic areas of North Carolina and in areas where large quantities of pesticides which are primary leachers are used. Thirty-nine counties have been selected for the construction of the monitoring wells, which are to be drilled in the surficial aquifer (the aquifer closest to the land surface). Well locations were selected by using the DRASTIC hydrologic evaluation procedure combined with pesticide use information.

One hundred existing wells used in NRCDC's ambient groundwater monitoring network will also be used for the pesticide study. Data from the NRCDC wells will be used as background information to establish the possible presence of pesticides in confined aquifers. Most communities that use groundwater obtain it from wells in confined aquifers. The newly established wells will be sampled semi-annually, and the existing wells, annually. Since the new wells are in the upper aquifer, it is expected that water in these wells would have been subjected to pesticide leaching if it has occurred.

Samples taken from a total of 200 wells will be analyzed for the 123 primary pesticide leachers and their metabolites (byproducts). Analytical work will be shared by the NRCDC and NCDA laboratories. Some six different analytical methods will be needed to check for the pesticides and metabolites.

Costs of the 100 monitoring wells, personnel, analytical equipment, travel, and other associated costs are estimated to be between \$1.2 and \$1.4 million for the two-year study.

The Pesticide Board will solicit public comment on the proposed monitoring plan at its July 7 meeting.

**REPORT SAYS NEED FOR WATER  
IN SOUTHEAST VIRGINIA  
IS OVERSTATED**

In a report prepared for North Carolina Attorney General Lacy Thornburg, Dr. David H.

Moreau, Director of WRRRI, concludes that the City of Virginia Beach and Corps of Engineers' estimate that Virginia Beach and the Southside Hampton Roads metropolitan area of Virginia will need an additional 60 million gallons of water per day (MGD) by 2030 is "very much of an overstatement." Moreau prepared the report in November 1987 as part of the attorney general's response to a request by U.S. District Court Judge W. Earl Britt for additional information regarding North Carolina's suit to prevent Virginia Beach from withdrawing water from Lake Gaston on the North Carolina/Virginia border.

According to the report, review of water supply studies by the Corps of Engineers, a consultant for the City of Virginia Beach, and Research Triangle Institute as well as a number of other pertinent documents and accepted water supply criteria supports the conclusion that the Virginia Beach-Hampton Roads area's actual additional water need in 2030 will be more on the order of 20 MGD.

The report contends that in its need projections, the Corps of Engineers not only went far beyond accepted water supply criteria but also ignored its own principles and guidelines to arbitrarily increase the projected 2030 deficit.

According to the report, the Corps first established a 19 MGD deficit by 2030 by (1) using the worst drought in 55 years of recorded streamflow; (2) explicitly rejecting use of a drought management plan, which its guidelines advocate and which it has recommended in other projects; and (3) ignoring the potential for use of groundwater. Use of the 55-year record as a basis for projecting need, the report says, was sufficient to arrive at a projection consistent with the Virginia Department of Public Health's criterion for reliable estimates of safe water supply yield and established a probability of shortage of not more than 1.8 percent.

However, the Corps then added to the projected deficit an "unprecedented reserve requirement" equal to 75 percent of the existing capacity of the Norfolk reservoirs (Norfolk supplies water to Virginia Beach), increasing the projected deficit by 36 MGD. The report cites a standard reference in the field of water supply engineering that calls for only a 25 percent reserve when the risk of a shortage is 5 percent. Using that standard, says the report, an additional supply of 20 MGD would be more than sufficient.

In addition, the report notes that the Corps has based its project design on projected need represented by a single number arrived at by extrapolation from current population and economic trends, which is not likely to produce an accurate long-term prediction. Further, the report says, the Corps, again, ignored its own guidelines in proposing a single, large project to supply the projected long-term need. The report points out that accepted principles of utilities operation support planning for new facilities over a 50-year period but advocate financing and constructing facilities in stages to match growth as it materializes since there is a high degree of uncertainty in long-term projections.

The report concludes that the Corps has not demonstrated the need for additional water supply for Virginia Beach-Hampton Roads before 2010 and that the area's need for additional water after that time can be provided by drought management, groundwater development, and incremental development of surface water supplies to meet actual demand.

**Corps of Engineers Responds**

When Judge Britt issued his request for more information, he rejected North Carolina's contention that Southeastern Virginia has a surplus of water supplies which would last through 2030 but agreed that the Virginia Beach need should be assessed based on its existing and projected supply as opposed to its entire demand. In addition to requesting information from North Carolina, he ordered the Norfolk District, Corps of Engineers to make a determination of the extent of Virginia Beach's water needs. In response, the Corps recently submitted a "Supplement Environmental Assessment" in which they responded to the Moreau report and to other documents related to water supply need submitted to the court earlier.

In the assessment, the Corps reviewed the various documents related to supply need submitted by both sides in the dispute and noted that the documents present a wide range of opinions about the extent of need for additional water supplies for the Virginia Beach area by the year 2030. The difference, the Corps contended, is attributable to three factors:

\* **The acceptable risk of system failure:** The Research Triangle Institute study prepared under contract with the UNC Water Resources Research Institute projects that under a scenario in which Norfolk's surface system is interconnected with Portsmouth's and Norfolk draws more water from the Blackwater and Nottoway Rivers, the system will fail only once in 56 years. Without saying what it considers to be acceptable risk for the Virginia Beach area, the Corps states, "System failure in a major metropolitan center, with military installations vital to national defense, could be catastrophic."

\* **The extent to which groundwater and water from the Nottoway and Blackwater River can be used:** According to the Corps' assessment, Southside Hampton Roads has been declared a groundwater management area because of effects of withdrawals on groundwater levels. In addition, the Blackwater and Nottoway Rivers contribute to the freshwater inflow into the western Albemarle Sound through the Chowan, and the State of North Carolina has strongly objected to increased use of water from these rivers. Therefore, the Corps contends, that groundwater and water from the Blackwater and Nottoway Rivers should be considered only for alternative sources, not for increased use of current sources.

\* **The acceptable frequency of mandatory water-use restrictions:** According to the assessment, the Corps developed its deficit figure based on the premise that reservoir levels should not drop below 50 percent of total storage because this was the level at which Norfolk imposed a mandatory 25 percent reduction in average usage on all of its system's customers in the 1980-81 drought, and the premise was that the social and economic hardships resulting from invoking mandatory conservation during 1980 and 1981 should be avoided in the future, if possible.

**LEGISLATION CALLS FOR STUDY AND CONSTRUCTION OF A WELL INJECTION SYSTEM FOR WASTE-WATER ON THE COAST**

Legislation has been introduced in the N.C. General Assembly directing the Environmental Manage-

ment Commission to study the feasibility of using a well injection system for wastewater disposal in the coastal areas. The legislation calls for appropriations of \$50,000 for the study and \$1 million for the construction of a test injection well on or near the barrier islands if this alternative is considered feasible.

In a number of southeastern states, injection wells are used to dispose of treated wastewater. Currently, all North Carolina wastewater treatment systems other than septic tanks discharge directly to surface water. No well injection systems are currently permitted in North Carolina. The legislation was first recommended by the North Carolina Commission on Jobs and Economic Growth, a commission established in 1985.

**WATER RESOURCES CONDITIONS FOR JUNE**

Streamflow decreased throughout the state during June and remained

in the below-normal range in the Piedmont and Blue Ridge for the fifth consecutive month. At the Blue Ridge index site on the French Broad River, the monthly mean flow of 566 cubic feet per second (CFS) and minimum daily discharge of 455 CFS were record lows. Streamflow declined in the Coastal Plain also, but remained within the normal flow range. Compared to the statistics for June for the 30-

year reference period, 1951-80, mean, streamflow for the month at selected index stations was as follows:

Index Station	Mean Flow During Month (CFS)	Percent of Long-Term Median
French Broad at Asheville	566	32
South Yadkin at Mocksville	102	36
Contentnea Creek at Hookerton	220	63

For comparison, during the 1986 drought monthly mean flows for June at the streamflow index stations were 954, 75, and 38 CFS respectively.

Mean streamflow for the month of June ranged from 9 to 67 percent of long-term (period of record) median for the month. Flows along the upper Yadkin River basin, the French Broad River basin, and the Little Tennessee River basin were 30 to 40 percent of median. Flows in the Pigeon River basin and New River basin were slightly higher. The lowest percentages of median flow (9 to 25 percent) were generally located in the southeastern Piedmont. Relatively higher flows were scattered throughout the Piedmont and Blue Ridge, reflecting widely scattered thunderstorms throughout the month.

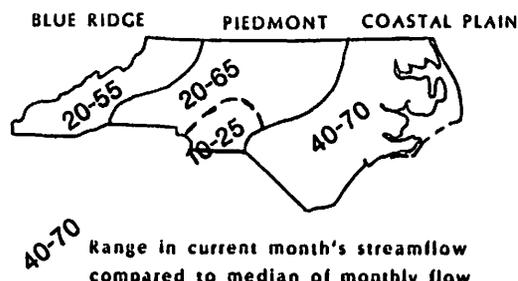
Fourteen stations recorded record low monthly mean flows for June. Seven stations recorded record low daily flows for June. The mean flows at 19 stations were less than June mean flows in 1986.

Groundwater levels in unconfined (water table) aquifers at month's end declined seasonally across the state. In the Blue Ridge, water levels are below average, while at the index well in the Piedmont, the water level is slightly above average. Although declining seasonally, the water levels for the index well in the Coastal Plain is above average, apparently in response to recent rains in that area. For comparison, levels in the index wells near Blantyre, Mocksville, and Elizabeth City are 1.5, 1.5, and 2.6 feet higher, respectively, than the levels for the June 1986 drought conditions.

At month's end, index reservoirs in the western Piedmont had a combined volume of 86 percent of capacity as compared to the long-term average of 88 percent. During June 1986, volume was 79 percent of capacity.

-- U.S. Geological Survey

**SURFACE WATER CONDITIONS AT A GLANCE**



**NEW PUBLICATIONS RECEIVED BY THE INSTITUTE**

(Residents of North Carolina may borrow these from the Institute for a two-week period. Where individual copies are desired, readers are encouraged to request copies from the organization issuing the publication. The addresses are provided by the NEWS for this purpose.)

Water Resources Planning

- "Upper Contentnea Creek Watershed Plan and Environmental Assessment," 1988, avail. from Div. of Soil and Water Conservation, NRCD, 512 North Salisbury St., PO Box 27687, Raleigh, NC 27611, telephone - 919-733-2302. (SCS)
- "The Lake and Reservoir Restoration Guidance Manual - First Edition," (EPA 440/5-88-002), 2/88, by N. American Lake Management Society for Office of R&D, Env. Research Lab., Corvallis, Oregon and Office of Water Criteria & Standards, Div. Nonpoint Sources Br., USEPA, Washington, DC 20460. (02H)
- "Sanitary Landfill Siting and Design, A Comparative Analysis of State-Level Regulations for Six Southeastern States," 1988, by V. Capels, Dept. of City and Regional Planning, CB #3140, Chapel Hill, NC 27514 (05B GW) (Loan copy avail. at WRII)

Water Quality Management

- "Biomonitoring to Achieve Control of Toxic Effluents," (EPA/625/8-87/013), 9/87, by Office of Water, Permits Div., USEPA, Washington, DC 20460 and Office of R&D, Env. Research Lab., Duluth, MN 55804. (05B)
- "Chemical and Biological Assessment of the Deep River," (#88-01), 2/88, by Water Quality Sec., DEM, NRCD, PO Box 27687, Raleigh, NC 27611. (05A)
- "Strategies for Reduction of Effluent Toxicity (Proceedings)," 6/88, sponsored by NCAWWA, WPCA, (Loan copy avail. at WRII). (05B)
- "Potential for Migration of Hazardous Wood Treating Chemicals During Land Treatment Operations," 7/87, by G. D. McGinnis, avail. from MS WRII, PO Drawer AD, Mississippi State, MS 39762, price \$10.00. (05B)
- "Development of a Sediment Transport Model for Field Application," 7/87, by S.-Y. Wang, avail. from MS WRII, PO Drawer AD, Mississippi State, MS 39762, price \$5.00. (02J)
- "Design of Stormwater Control Facilities," 5/4/88, sponsored by Water Quality Sec., NC DEM, and Prof. Engrs. of NC, avail. from Prof. Engrs. of NC, 4000 Wake Forest Rd, Suite 108, Raleigh, NC 27609, telephone - 919-872-0683. (04A Stormwater)
- "Water Quality Study B. Everett Jordan Lake, N.C.," (Year IV 12/84-11/85), 4/88, by C. M. Weiss, et al., avail. from Dept. of ESE, Sch. of Public Hlth., UNC-CH, CB #7400, Chapel Hill, NC 27599-7400. (Lake Jordan)

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