90-192

WATER FACT SHEET

U.S GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

GROUND-WATER STUDY OF THE CENTRAL COASTAL PLAIN, NORTH CAROLINA

BACKGROUND

Ground-water levels in aquifers in the central Coastal Plain of North Carolina (fig. 1) have declined as a result of increasing ground-water withdrawals by county, municipal, and industrial water systems. Withdrawals by these systems generally were less than 10,000 gallons per day before about 1900, but by 1986 withdrawals totaled about 30 million gallons per day. During this period, water levels declined more than 120 feet in some areas (fig. 2), and in 1986 water levels were declining at rates of 5 to 10 feet per year at major pumping centers. Concern about the large ground-water level declines and the future availability of ground-water resources led to the initiation of a study of the aquifers in the central Coastal Plain in 1983.

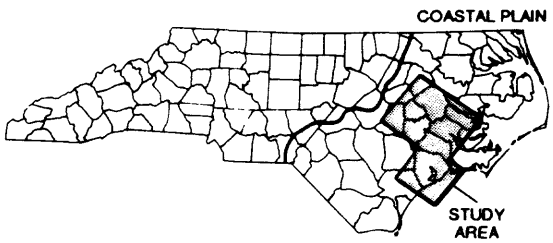

Figure 1.--Central Coastal Plain study area in North Carolina.

This study, completed in 1988, was conducted by personnel of the U.S. Geological Survey (USGS) in cooperation with the North Carolina Department of Environment, Health, and Natural Resources (EHNR) formerly called the North Carolina Department of Natural Resources and Community Development; Greene, Jones, and Onslow Counties; the cities of Jacksonville (Onslow County), Kinston (Lenoir County), and New Bern (Craven County); the towns of Ayden and Farmville (Pitt County), La Grange (Lenoir County), Pinetops (Edgecombe County), Snow Hill (Greene County), and Stantonsburg (Wilson County); Greenville Utilities (Pitt County); and North Lenoir Water Corporation (Lenoir County). This study covered an area of about 3,600 square miles.

OBJECTIVES AND APPROACH

The objectives of this study were to evaluate the hydrogeology and utilization of the water-supply aquifers in the central Coastal Plain of North Carolina by:

- Describing the limits and geometry of each aquifer and confining unit;
- Assessing water-bearing properties of aquifers and confining units;
- Delineating the limits of saltwater in the aquifers; and
- Determining the distribution of withdrawals from individual aquifers.

To meet these objectives, geophysical logs, water-level measurements, and water-quality data were obtained from 9 test holes and 14 observation wells constructed by EHNR and more than 200 water-supply wells. These data were used to describe the physical aquifer system and the hydraulic characteristics of the aquifers and confining units needed to construct, calibrate, and operate a digital (computer) model of the flow system. The model was developed by the following steps:

- Using rectangular grids of varying cell size to represent the aquifers in the study area;
- Assigning hydrologic properties to each aquifer and confining unit in each grid;
- Reconstructing the natural, unstressed flow regime; and
- Calibrating the model by comparison of simulations with observational data.

The calibrated model was then used to analyze the effects of pumping on the ground-water system.

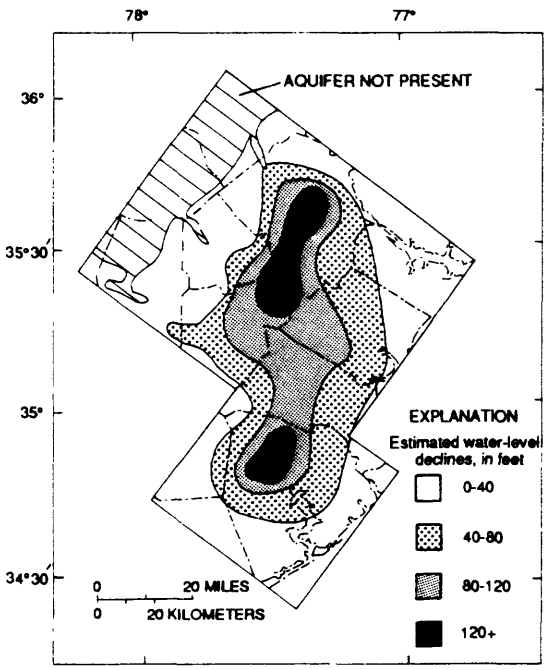

Figure 2.--Total water-level declines from 1900 to 1986 in the Black Creek aquifer.

HYDROGEOLOGY AND WATER USE

Four aquifers are of primary interest in the study area. They are, from top to bottom, the Peedee, Black Creek, upper Cape Fear, and lower Cape Fear aquifers. These aquifers are composed of interbedded sands and clays that generally thicken and dip toward the east. Selected hydrogeologic characteristics of these aquifers are summarized in table 1.

Table 1.--*Selected hydrogeologic characteristics of aquifers in the study area*
[--, no data]

Aquifer name	Average thickness (feet)	Percent of permeable material	Average 1986 withdrawal (million gallons per day)	Median value of transmissivity measured from aquifer tests (feet squared per day)	Median value of model derived transmissivity (feet squared per day)
Peedee	94	66	230	2,200	1,400
Black Creek	193	49	515	2,300	2,100
Upper Cape Fear	146	60	270	1,800	1,200
Lower Cape Fear	125	59	--	--	3,400

Well yields in the study area range from 35 to 1,400 gallons per minute. The average yield for supply wells tapping both the Black Creek and upper Cape Fear aquifers generally is higher than that for wells in other aquifers in the area.

Saltwater that has a chloride concentration greater than 250 milligrams per liter is present in the eastern part of each aquifer. The chloride concentration in water generally increases with depth and toward the coast in each aquifer.

Records of ground-water withdrawals were used along with historical water-level data to characterize the stresses on the flow system as a result of pumpage. The Black Creek aquifer, the major water-supply aquifer in the area, produced about 20.5 million gallons per day in 1986, and some of the greatest rates of water-level declines have occurred in this aquifer. As a result of these withdrawals, large areally-extensive cones of depression have formed around the major centers of pumping. This information was used to identify important water-supply problems in the study area and, along with hydrogeologic framework data, was used to develop the ground-water flow model of the aquifer system in sediments of Cretaceous age in the central Coastal Plain.

FLOW MODEL DEVELOPMENT

Ground-water flow in this area was simulated using a quasi-three-dimensional finite-difference model. The time from 1900 to 1986 was divided into 12 periods ranging from 3 to 21 years in length. Ground-water flow in the entire North Carolina Coastal Plain was simulated to provide accurate flow boundaries for the study area. Grid spacing in the model simulation of the study area was 0.875 miles by 0.875 miles.

The ground-water flow model was calibrated by matching computed, model-derived water levels with observed water levels. During calibration of the model, values of hydraulic parameters, such as transmissivity and vertical leakance, were adjusted within acceptable limits until computed and observed water levels closely matched. The average difference between more than 1,800 computed and observed water levels from 1900 to 1986 was about 10 feet.

SIMULATION OF THE GROUND-WATER FLOW SYSTEM

Simulation of the ground-water flow system aided in the characterization of this system and the changes that have occurred as the result of increased development of the ground-water resource. Some of the findings from this simulation were:

- The amount of water flowing laterally through aquifers tends to increase toward the coast;
- The rate of vertical flow across confining units tends to decrease toward the coast and with increasing depth of burial;
- Recharge to the aquifer system increased from 1900 to 1986 as a result of increasing ground-water withdrawals;
- Discharge, including both natural and pumping, exceeded recharge to the aquifer system in 1986; and
- Ground water was released from aquifer storage at a rate of about 1 million gallons per day as water levels declined and withdrawals increased.

FUTURE USE OF THE FLOW MODEL

The flow model can be used to estimate the effects of future pumping on the ground-water system. For example, assuming that pumpage from the Black Creek aquifer increases by 19 percent per year from 1986 to 1991, the amount of drawdown that may occur in the aquifer by 1991 is estimated to be as much as 30 feet (fig. 3). The model also can be used to estimate water levels at existing and proposed well fields. Such capabilities will enable water-resource managers, municipalities, and industries to (1) evaluate regional effects of various ground-water withdrawal scenarios on water levels, (2) minimize drawdowns by managing withdrawals, and (3) minimize drawdown interference between wells by evaluating the effects of new wells.

The data base and model need to be updated regularly for the model to continue to be used for water-resource management. Yearly estimates of water withdrawals and measurements of water levels are particularly needed. Periodic model calibration would improve hydraulic parameter estimates and maintain the predictive capabilities of the model. Some of the periodic data collection required to keep the model up to date is gathered through existing State-Federal cooperative programs.

The central Coastal Plain aquifer study is an example of a cooperative effort between Federal, State, and local governments to address water issues and concerns of local and regional interest. State and local governments benefit from this cooperative effort by receiving matching Federal funds to address these problems. The USGS benefits from such studies by fulfilling its mission to develop and disseminate scientific information on the Nation's water resources.

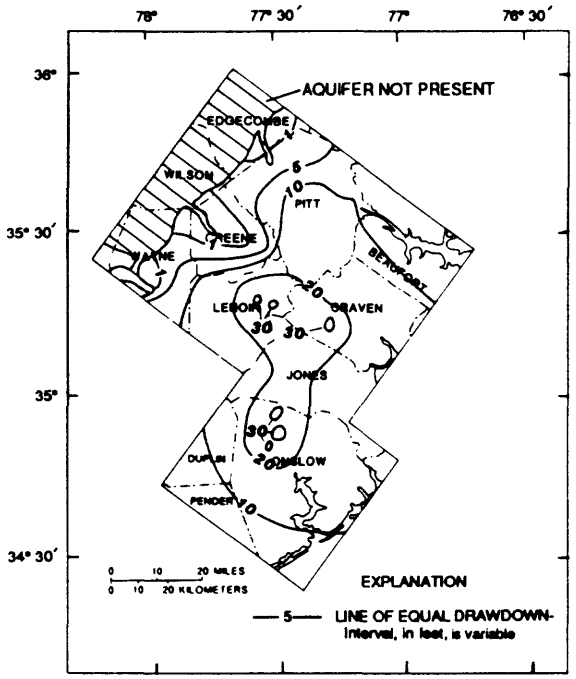

Figure 3.--Estimated amount of water-level decline in the Black Creek aquifer by 1991 if withdrawals from this aquifer increase by 19 percent per year.

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