HYDROGEOLOGIC FRAMEWORK OF THE NORTH CAROLINA COASTAL PLAIN

REGIONAL AQUIFER-SYSTEM ANALYSIS

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Hydrogeologic Framework of the North Carolina Coastal Plain

By M.D. WINNER, JR., *and* R.W. COBLE

REGIONAL AQUIFER-SYSTEM ANALYSIS—
NORTHERN ATLANTIC COASTAL PLAIN

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FOREWORD

THE REGIONAL AQUIFER-SYSTEM ANALYSIS PROGRAM

The Regional Aquifer-System Analysis (RASA) Program represents a systematic effort to study a number of the Nation's most important aquifer systems, which, in aggregate, underlie much of the country and which represent an important component of the Nation's total water supply. In general, the boundaries of these studies are identified by the hydrologic extent of each system and, accordingly, transcend the political subdivisions to which investigations have often arbitrarily been limited in the past. The broad objective for each study is to assemble geologic, hydrologic, and geochemical information; to analyze and develop an understanding of the system; and to develop predictive capabilities that will contribute to the effective management of the system. The use of computer simulation is an important element of the RASA studies to develop an understanding of the natural, undisturbed hydrologic system and the changes brought about in it by human activities and to provide a means of predicting the regional effects of future pumping or other stresses.

The final interpretive results of the RASA Program are presented in a series of U.S. Geological Survey Professional Papers that describe the geology, hydrology, and geochemistry of each regional aquifer system. Each study within the RASA Program is assigned a single Professional Paper number beginning with Professional Paper 1400.

Gordon P. Eaton
Director

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CONVERSION FACTORS AND VERTICAL DATUM

This paper uses the inch-pound system of units as the primary system of measurements and the metric system of units for water chemistry measurements. For readers who wish to convert measurements from the inch-pound system to the metric system, the conversion factors are listed below:

Multiply inch-pound units	By	To obtain metric units
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer
inch per hour (in/h)	25.4	millimeter per hour
inch per year (in/yr)	25.4	millimeter per year
foot per day (ft/d)	0.3048	meter per day
foot per mile (ft/mi)	0.1894	meter per kilometer
foot squared per day (ft^2/d)	0.0929	meter squared per day
gallon per day (gal/d)	3.785	liter per day
million gallons per day (Mgal/d)	3.785	million liters per day
gallon per day per square mile [$(gal/d)/mi^2$]	1.461	liter per day per square kilometer
milligram per liter per foot [(mg/L)/ft]	3.2808	milligram per liter per meter

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

HYDROGEOLOGIC FRAMEWORK OF THE NORTH CAROLINA COASTAL PLAIN

By M.D. WINNER, JR., and R.W. COBLE

ABSTRACT

The hydrogeologic framework of the North Carolina Coastal Plain aquifer system consists of 10 aquifers separated by 9 confining units. From top to bottom, the aquifers are the surficial aquifer, Yorktown aquifer, Pungo River aquifer, Castle Hayne aquifer, Beaufort aquifer, Peedee aquifer, Black Creek aquifer, upper Cape Fear aquifer, lower Cape Fear aquifer, and Lower Cretaceous aquifer. The uppermost aquifer (the surficial aquifer in most places) is a water-table aquifer, and the bottom of the system is underlain by crystalline bedrock.

The sedimentary deposits forming the aquifers are of Holocene to Cretaceous age and are composed mostly of sand, with lesser amounts of gravel and limestone. The confining units between the aquifers are composed primarily of clay and silt. The thickness of the aquifers ranges from zero along the Fall Line to more than 10,000 feet at Cape Hatteras. Prominent structural features are the increasing easterly homoclinal dip of the sediments and the Cape Fear arch, the axis of which trends in a southeast direction.

Stratigraphic continuity was determined from correlations of 161 geophysical logs along with data from drillers' and geologists' logs. Aquifers were defined by means of these logs as well as water-level and water-quality data and evidence of the continuity of pumping effects. Eighteen hydrogeologic sections depict the correlation of these aquifers throughout the North Carolina Coastal Plain.

INTRODUCTION

The Northern Atlantic Coastal Plain regional aquifer system, which is one of the areas studied in the U.S. Geological Survey Regional Aquifer-System Analysis program, borders the east coast of the United States between Long Island, N.Y., and the North Carolina-South Carolina State line. This regional aquifer system is an eastward-dipping and eastward-thickening wedge of sedimentary rocks ranging in age from Early Cretaceous to Holocene that were deposited mostly on metamorphic and igneous crystalline basement rocks; locally, the sedimentary wedge lies on low-permeability red beds of early Mesozoic age. The wedge is a featheredge at the western limit of the Coastal Plain and is more than 10,000 feet (ft) thick at Cape Hatteras, N.C.

To facilitate study of this regional aquifer system, which spans parts of six States, five subregional investigations were conducted—one each for areas in New York, New Jersey, Maryland-Delaware, Virginia, and North Carolina. These detailed studies furnished data to the team that coordinated the efforts of the five subregional investigations and prepared reports on the regional aquifer system as a whole. The basic plan of study had two elements: (1) development of a hydrogeologic framework that describes the geology, hydrology, and geochemistry of a multilayered aquifer system and (2) development of digital flow models that simulate ground-water flow within the hydrogeologic framework.

This report is a product of the first element of the investigation for the North Carolina area. It delineates a hydrogeologic framework for the North Carolina Coastal Plain, which covers a 25,000-square-mile (mi^2) area of eastern North Carolina, or about 47 percent of the State, and which includes all of 35 counties and parts of 11 others (fig. 1).

PURPOSE AND SCOPE

To understand ground-water flow in a regional aquifer system and to evaluate the effects of hydrologic stresses on the aquifer system, the aquifers and confining units that constitute the framework of the aquifer system must be delineated and described. This report presents a hydrogeologic framework for the North Carolina Coastal Plain aquifer system. It is based mainly on analysis and interpretation of lithologic data, geophysical logs, ground-water levels, and water-quality data. The framework is presented by means of hydrogeologic sections, contour maps, and tables that can be used (1) to understand the hydrogeology of the Coastal Plain aquifer system in North Carolina and (2) to prepare computer-

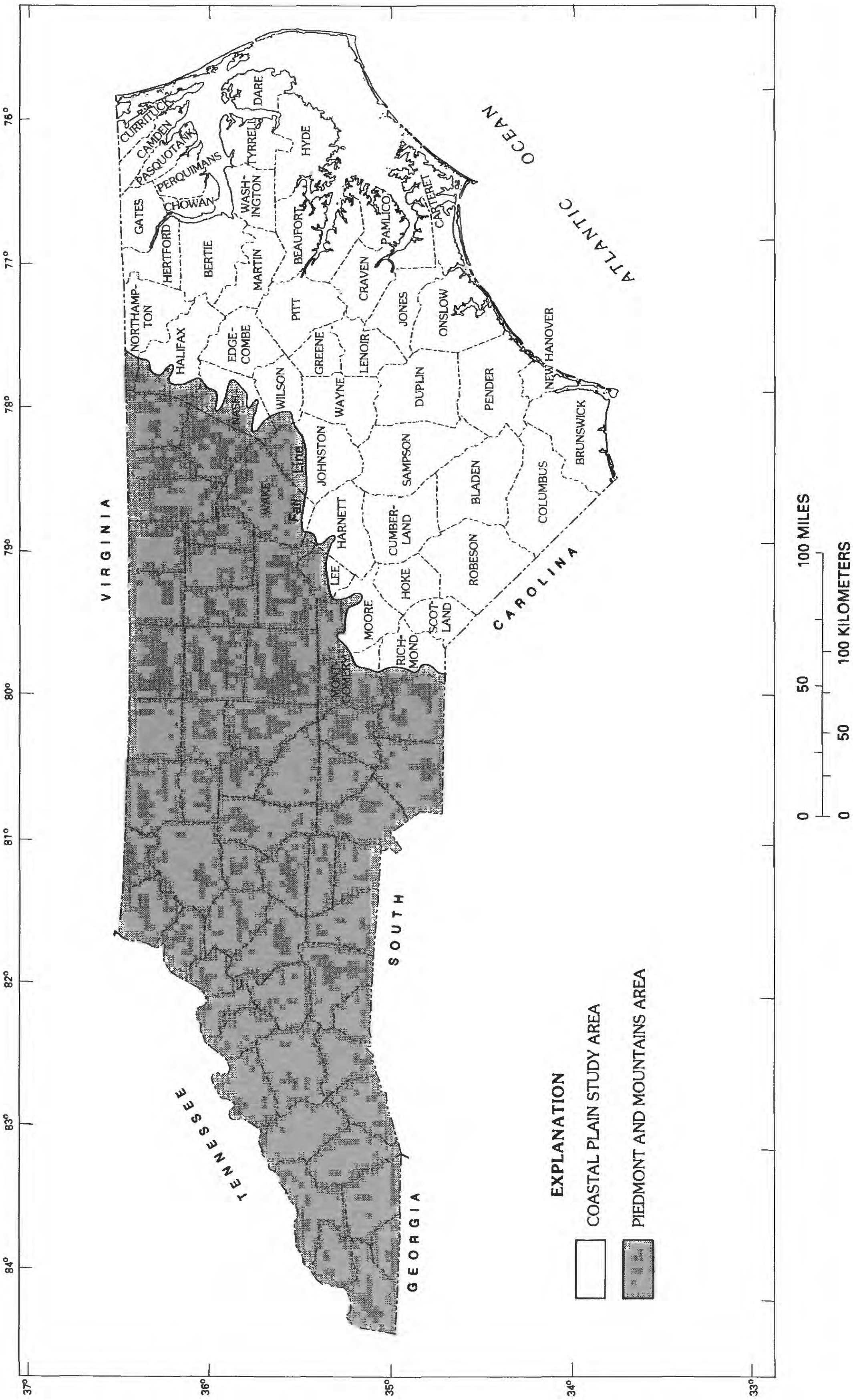

FIGURE 1.—North Carolina Coastal Plain study area.

based flow models for understanding and evaluating the aquifer system.

ACKNOWLEDGMENTS

This study, almost in its entirety, represents the compilation and analysis of existing data. The data were collected by many investigators over the past tens of years, and the authors are grateful for their careful data collection and record keeping.

Much of the data used in this study was furnished by the Groundwater Section, Division of Environmental Management, of the North Carolina Department of Natural Resources and Community Development (NRCD). The section has been engaged in a program of test drilling and monitor-well construction at ground-water research station sites since about 1966. At each research station site in the Coastal Plain, the NRCD drilled an exploratory hole to the basement rock or to a depth of about 1,500 ft, whichever is less, and collected cuttings, made borehole geophysical logs, and performed drill-stem tests and aquifer tests of various zones. One or more permanent observation wells were constructed at each research station to monitor water-level changes and water quality in the most important aquifers at the site. Data from more than 90 of these NRCD ground-water research stations were used during this study. Perry F. Nelson, chief of the Groundwater Section, NRCD, and hydrologists William Jeter, Richard Shiver, Edward Berry, William Bright, and L.A. Register deserve special thanks for their advice and help in furnishing data.

Many borehole geophysical logs of deep oil-test wells were furnished by the Geological Survey Section, Division of Land Resources, NRCD. These logs not only were invaluable in correlating geologic formations in the deep zones near the coast, but also contributed to the delineation of salty ground water in the entire North Atlantic Coastal Plain region (Meisler, 1980).

Considerable water-level data and other valuable well records came from the files of the U.S. Geological Survey (USGS). These data were furnished by numerous investigators who contributed to the 15 areal and county ground-water studies mentioned in the next section of this report and listed in figure 2.

Gerald L. Giese, Douglas A. Harned, Nancy Bonar Sharpless, and Patricia Showalter, our USGS colleagues, made significant contributions to data collection, compilation, and analysis.

PREVIOUS STUDIES

An understanding of the stratigraphic and age relations of the geologic units of the North Carolina Coastal Plain has evolved from results of several studies conducted by geologists beginning in the mid-19th century. The first comprehensive description of the geology was published by Clark and others in 1912. Their basic interpretations generally have withstood the test of time.

The geologic character of the various formations that make up the Coastal Plain is extensively described in the literature, particularly in reports by Stephenson and Rathbun (1923), Kimrey (1965), Swift and Heron (1969), Maher and Applin (1971), Brown and others (1972), Dennison and Wheeler (1975), Mixon and Pilkey (1976), and Ward and Blackwelder (1980).

The first comprehensive survey of the ground-water resources of the North Carolina Coastal Plain was by Stephenson and Johnson (1912). Their description of topographic features, geology, water resources, and prospects for wells in 42 counties is the principal source of data on water levels before the effects of pumping became widespread in the Coastal Plain. Subsequent ground-water investigations have been multicounty reconnaissance studies, county appraisals, and other studies dealing with local situations. The areas covered by these types of studies are shown in figure 2, and the reports cited in the figure are included in the references at the end of this report.

LeGrand (1964) presented a broad review of the hydrogeology of the Gulf and Atlantic Coastal Plain and related hydrologic concepts to the functioning of the ground-water flow throughout this large region. He outlined a hydrogeologic classification of the Coastal Plain, based on concepts of ground-water recharge and discharge conditions that contains elements basic to this study.

Brown and others (1972) divided the Coastal Plain sediments from New York to North Carolina into 17 chronostratigraphic units. For each unit, they mapped lithofacies and distribution of intrinsic permeability based on interpretations of geophysical logs, drillers' logs, and well cuttings.

HYDROGEOLOGY

PHYSIOGRAPHIC SETTING

The Coastal Plain of North Carolina is part of the Atlantic and Gulf Coastal Plain physiographic province of the United States, which extends from Cape Cod in Massachusetts southward and westward into Texas (Fenneman, 1938, p. 8). The North Carolina Coastal Plain is roughly 90 to 150 miles (mi) wide from the Atlantic Ocean westward to its boundary with the Piedmont province (fig. 1). This boundary, generally known

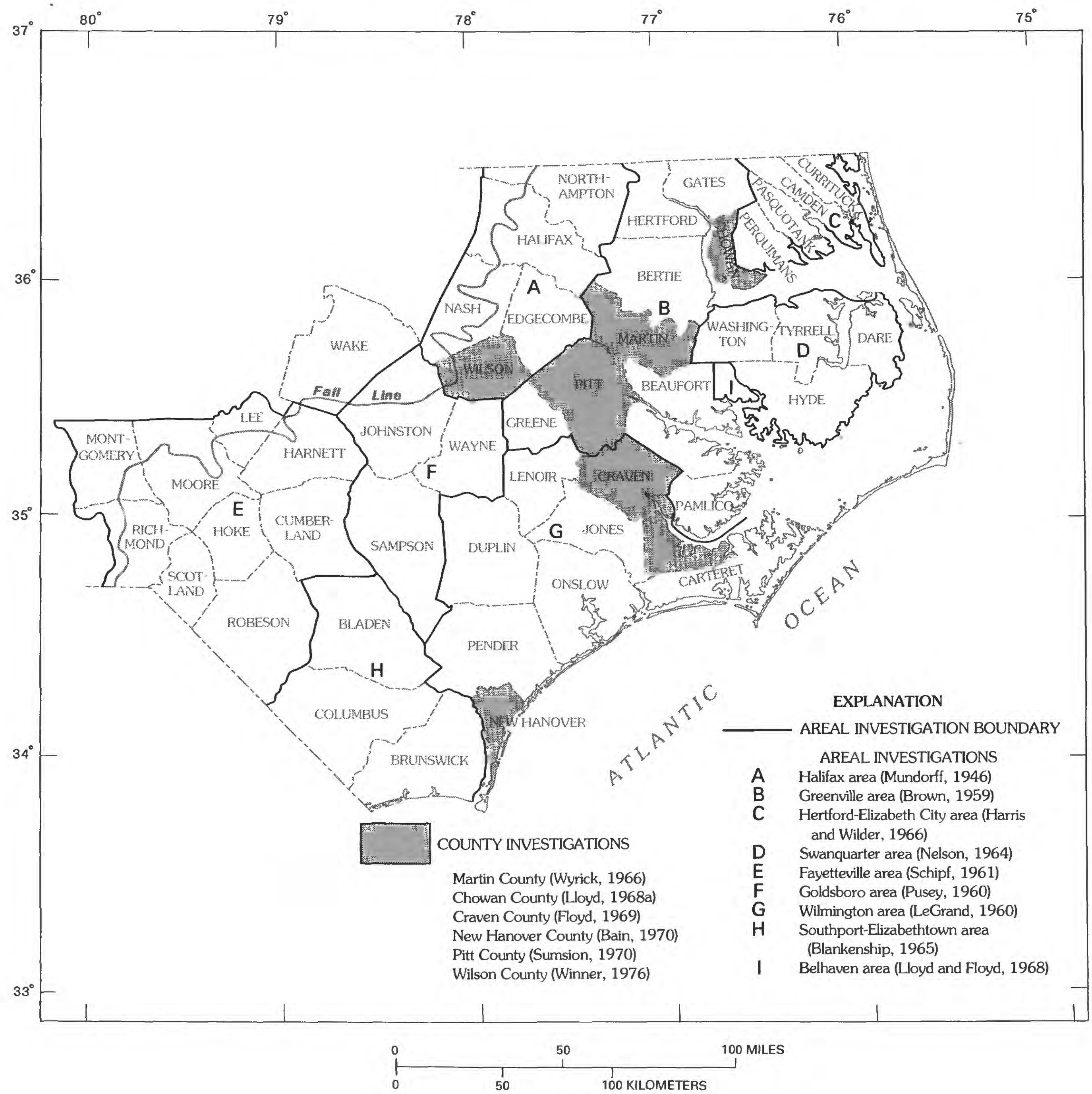

FIGURE 2.—County and areal ground-water investigations, North Carolina Coastal Plain.

as the Fall Line, is recognized as zones of rapids in streams that indicate a change of stream gradient as the streams pass from crystalline basement rocks onto Coastal Plain sediments. Fenneman (1938, pl. III) showed the Fall Line as a relatively smooth line separating the Piedmont and Coastal Plain provinces. In North Carolina, however, this definition does not hold up as well as it does in other States, because in North Carolina many of the larger streams flow on crystalline rocks for many miles after entering the Coastal Plain province. For this reason the Fall Line is represented in this report as a sinuous boundary separating the continuous body of Coastal Plain deposits and the residual Piedmont soils derived from the weathering of the crystalline rock. This Fall Line is the western boundary of the Coastal Plain as shown on all maps in this report.

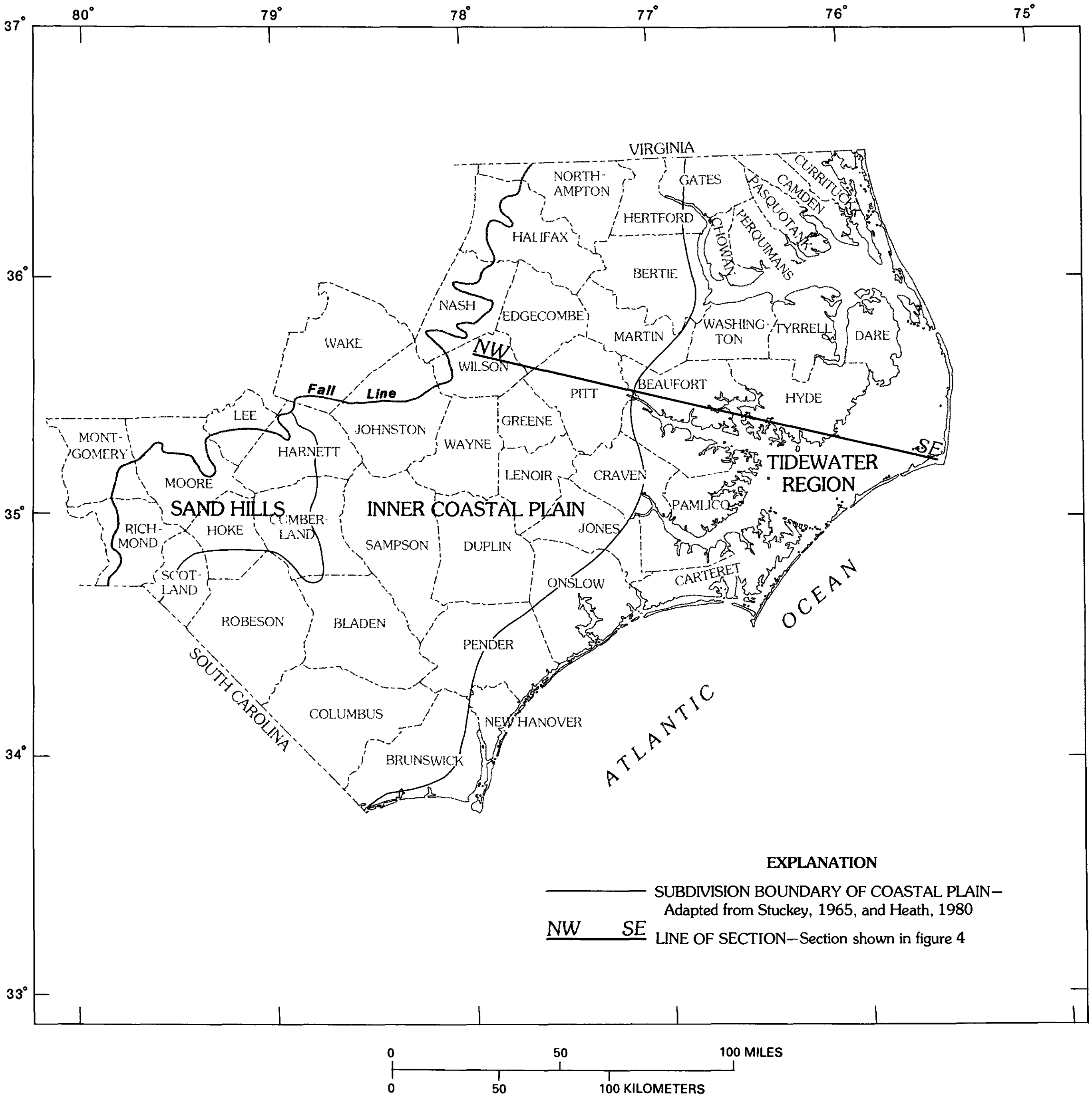

FIGURE 3.—Physiographic subdivisions of the North Carolina Coastal Plain.

The North Carolina Coastal Plain consists of two natural subdivisions, as described by Stuckey (1965, p. 9): the Tidewater region, sometimes called the Outer Coastal Plain, and the Inner Coastal Plain (fig. 3). The Tidewater region consists of the coastal area, where large streams and many of their tributaries are affected by oceanic tides. Land-surface altitudes range from sea level to 50 ft throughout most of the area and average about 20 ft. Altitudes exceed 50 ft only on dunes at Kill Devil Hills on the Outer Banks in Dare County and along a 25-mi-long ridge extending from southern Onslow County into northern New Hanover County. The Tidewater region is generally of low relief and is swampy.

The Inner Coastal Plain lies between the Tidewater region and the Fall Line. It has a gently rolling land surface in contrast to the low relief of the Tidewater region. Land-surface altitudes range from about 50 ft at the Tidewater boundary to more than 700 ft at the Fall Line in southeastern Montgomery County. Altitudes along the Fall Line are lowest in the north—about 100 to 150 ft in Northampton County near the Virginia border, about 150 to 200 ft in Wilson and Edgecombe Counties, about 200 to 300 ft in Harnett and Cumberland Counties, more than 700 ft in Montgomery County, and about 400 to 500 ft near the South Carolina border.

Three subdivisions of the Inner Coastal Plain were recognized by Stuckey (1965). One is the area north of Craven, Lenoir, and Wayne Counties. Here the land surface is generally flat to gently rolling, except near major streams and the western border, where it is dissected in many places.

The second subdivision is the eastern part of the Inner Coastal Plain south of the northern area. Here the broad, flat uplands between major streams commonly are swampy and are very similar to those in the Tidewater area. Several large lakes are found in Columbus and Bladen Counties and throughout much of Cape Fear River valley; especially in Bladen County, circular to elliptical depressions called Carolina bays are a prominent part of the landscape. Some of these bays are filled with lakes, and all except those drained for agricultural purposes are swampy. The land near the major rivers, such as the Cape Fear, is quite dissected. These streams may be incised 50 ft or more into the flat, swampy uplands. The uplands near the dissected valleys are swampy, and this attests to the lack of extensive drainage of the swamps through the shallow aquifers.

The third subdivision is the western part of the southern Inner Coastal Plain, known as the Sand Hills (Fenneman, 1938, p. 39). Figure 3 shows the Sand Hills area relative to the rest of the Coastal Plain. It covers about 2,500 mi^2 in all or parts of Lee, Harnett, Cumberland, Hoke, Moore, Montgomery, and Richmond Counties in North Carolina and extends into South Carolina.

The eastern limit of the Sand Hills is imprecisely defined. The area is generally coincident with the upper Coastal Plain physiographic region of Daniels and others (1972), which includes the area between the Piedmont and the toe of the Coats Scarp in North Carolina and the Orangeburg Scarp in South Carolina at an altitude of about 275 ft.

As the name implies, the dominant feature of the Sand Hills is a deep layer of unconsolidated to poorly consolidated surficial sand that underlies the upland areas. The area is characterized by rolling hills having rather flat crests and altitudes generally ranging from 450 to 550 ft. The larger streams of the area originate in the Piedmont and flow eastward or southeastward across the Coastal Plain, where their valleys have steep sides and well-developed flood plains. Local relief up to 200 ft is common. Rainfall readily infiltrates the surficial sands and percolates downward to the deep water table. Ground water is the major source of streamflow in the local streams. Accordingly, flow in these streams is the most consistent of any area of the State. The streams seldom flood or go dry, because of the large infiltration capacity of the sandy soil and the great ground-water storage capability of the thick sand aquifer.

GEOLOGIC SETTING

The Coastal Plain sediments are characterized by (1) mostly clastic rocks ranging from clay to gravel, with lesser amounts of marine limestone, all resting on a foundation of crystalline basement rocks, (2) a generally eastward dip, (3) a general thickening of beds toward the east, and (4) an increase in the number of individual beds in the seaward (eastward) direction. Figure 4 shows the ages of Coastal Plain sediments and the general eastward thickening of these units. The rock stratigraphic units equivalent to the chronostratigraphic units in figure 4 are listed in table 1.

Table 1 also shows the general age relationship of the Coastal Plain sediments. Geologic names are applied to the hydrogeologic units in this report, and table 1 serves as a stratigraphic reference. Because many authors have begun using stage names from Europe and the Gulf Coast of the United States to define stratigraphic units and to relate them to time-equivalent rocks in those places, these stages are included in table 1 for convenient reference.

The major regional structure of the Coastal Plain that influences the geology and the hydrology is a homocline that dips seaward. During initial stages of continental separation, Coastal Plain sediments were laid down mostly under nonmarine and marginal-marine conditions. Subsequently, the sediments became more marine in character. According to Rona (1973), as the Atlantic Ocean widened, major alternating marine transgressive and regressive phases of sedimentation on each side of the ocean were controlled largely by oceanwide eustatic sea-level changes caused by variable rates of sea-floor spreading and variable volume of the mid-oceanic ridge. Warping or faulting along continental margins also contributed to local sea-level fluctuations which, in turn, controlled the transgressive or regressive depositional character of the sedimentation. Cyclic glaciation and deglaciation, particularly in Pleistocene time, was also an important process with regard to the rise and fall of sea level and to consequent regressive or transgressive Coastal Plain sedimentation (Vail and others, 1977).

The depression of the Earth's crust under the Coastal Plain, beginning about 150 million years ago, apparently

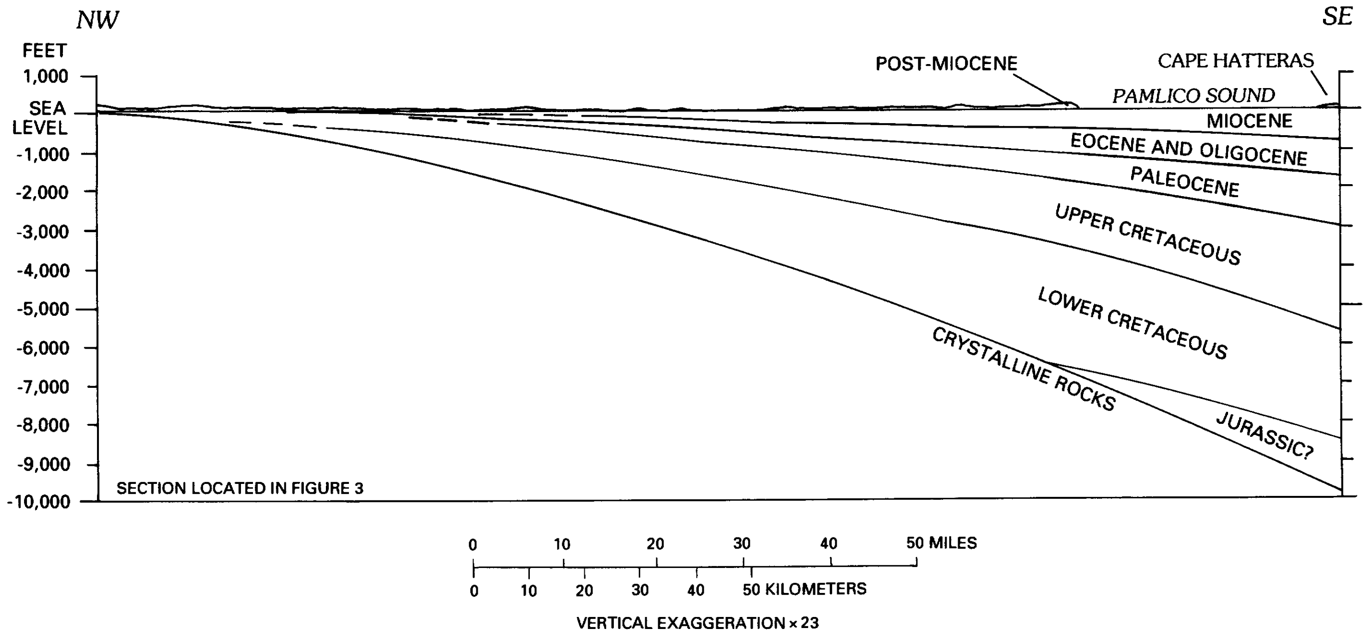

FIGURE 4.—Generalized cross section from Wilson, N.C., to Cape Hatteras, N.C.

has not been a simple process (Watts, 1981). Transverse structural features such as arches and troughs are superimposed on the general homoclinal dip of the sediments. The axes of these structures, the most widely known of which is the Cape Fear arch, trend in an easterly or southeasterly direction. Other less well known structures are the Norfolk arch in the southern Virginia Coastal Plain, the Albemarle embayment on the northern side of Albemarle Sound, and an unnamed positive structure roughly parallel to the lower Neuse River. These structures are shown in figure 5. Similar structures are present elsewhere in the Atlantic Coastal Plain and Continental Shelf areas (Maher and Applin, 1971). The arches and troughs are blocklike structures bounded by zones of weakness (probably faults) in the crystalline basement rocks; the blocks moved up or down relative to each other in response to basement-rock tectonics or to a combination of nonuniform loading resulting from sedimentation and erosion.

Along with the movement of these structures, movement along possibly associated smaller faults is reflected in the sediments accumulated since Late Jurassic time. LeGrand (1955) postulated faulting in the area of the Cape Fear arch. Wrench-fault zones were proposed by Brown and others (1972) to explain intricate patterns of thinning and thickening in chronostratigraphic units of the Coastal Plain. More recent investigations have shown evidence of faulting in Coastal Plain sediments—Mixon and Newell (1977) in Virginia, Prowell and O'Connor (1978) in Georgia, Zoback and others (1978) in South Carolina, Harris and others (1979) in North Carolina, and Behrendt and others (1981) in South Carolina. The maximum known vertical displacement of the contact between the basement and Cretaceous sediments is nearly 200 ft (Mixon and Newell, 1977) along a fault in northern Virginia. In North Carolina, vertical displacement within Coastal Plain sediments is as much as 30 ft, shown in a cross section by Harris and others (1979, fig. 3). The effects of geologic structure on the movement of ground water within Coastal Plain aquifers are discussed in the next section.

HYDROLOGIC SETTING

The Coastal Plain ground-water flow system consists of aquifers made up of permeable sand, gravel, and limestone layers separated by confining units composed of less permeable sediments. These permeable layers and confining units constitute the sediments described in the previous section.

As described by Heath (1980, p. 14), "Water enters ground-water systems in recharge areas and moves through them, as dictated by hydraulic gradients and hydraulic conductivities, to discharge areas.... In a humid area, such as North Carolina, recharge occurs in all interstream areas—that is, in all areas except along streams and their adjoining flood plains. The streams and flood plains are, under most conditions, discharge areas."

Because clay beds, which restrict vertical movement of ground water, are scattered throughout the aquifer system, recharge to shallow-lying unconfined aquifers is considerably greater than recharge that moves down-

TABLE 1.—*Generalized stratigraphic units of the North Carolina Coastal Plain*

SERIES	GLOBAL STAGES USED IN NORTH CAROLINA[1]	GULF COAST STAGES USED IN NORTH CAROLINA[1]	STRATIGRAPHIC UNITS	
Holocene			Post-Miocene undifferentiated; Quaternary deposits	Informal names, alluvium, dunes, etc.
Pleistocene			Post-Miocene undifferentiated; Quaternary deposits	Informal names used as: terrace deposits, Pleistocene deposits, or Pleistocene and Pliocene deposits. Some formal names: Flanner Beach Formation[2], James City Formation[3], and Waccamaw Formation[4].
Pliocene			Post-Miocene undifferentiated	Yorktown Formation[5]
Upper Miocene			Eastover Formation[5]	
Middle Miocene			Pungo River Formation[6]	
Lower Miocene			Belgrade Formation[7]	
Oligocene			Oligocene limestone (informal)	
			River Bend Formation[7]	
Upper Eocene		Jacksonian	Not recognized in North Carolina	
Middle Eocene		Claibornian	Castle Hayne Limestone[8]	
Lower Eocene		Sabinian	Unnamed unit recognized in subsurface[9]	
Paleocene		Midwayan	Beaufort Formation[8]	
Upper Cretaceous	Maestrichtian	Navarroan	Peedee Formation[8]	
	Campanian	Tayloran	Black Creek Formation[8]	
	Santonian	Austinian	Middendorf Formation[10, 11]	
	Coniacian		Cape Fear Formation[12, 13]	
	Turonian	Eaglefordian	Unnamed units[9]	
	Cenomanian	Woodbinian		
Lower Cretaceous	Albian	Washitan and Fredericksburgian	Unnamed units[9]	
Jurassic(?)			Unnamed unit tentatively identified in subsurface[9]	

[1]Jordan and Smith, 1983.
[2]Mixon and Pilkey, 1976.
[3]Blackwelder, 1981.
[4]Swain, 1968.
[5]Ward and Blackwelder, 1980.
[6]Kimrey, 1964.
[7]Ward and others, 1978.
[8]Brown, 1959.
[9]Brown and others, 1972.
[10]Owens, 1983.
[11]Christopher and others, 1979.
[12]Sohl, 1976.
[13]Renken, 1984.

ward to confined aquifers. For example, Heath (1980) estimated that under natural steady-state conditions, rainfall recharge to North Carolina Coastal Plain soils (and hence to the unconfined parts of the aquifers) varies between 5 and 21 inches per year, depending on soil type. Most of this water provides base flow for streams, is transpired by plants, and is evaporated through the soil. Less than 2 inches reaches confined aquifers; the amount that reaches the deepest aquifers of the system has been estimated to be less than 0.5 inch (Heath, 1980).

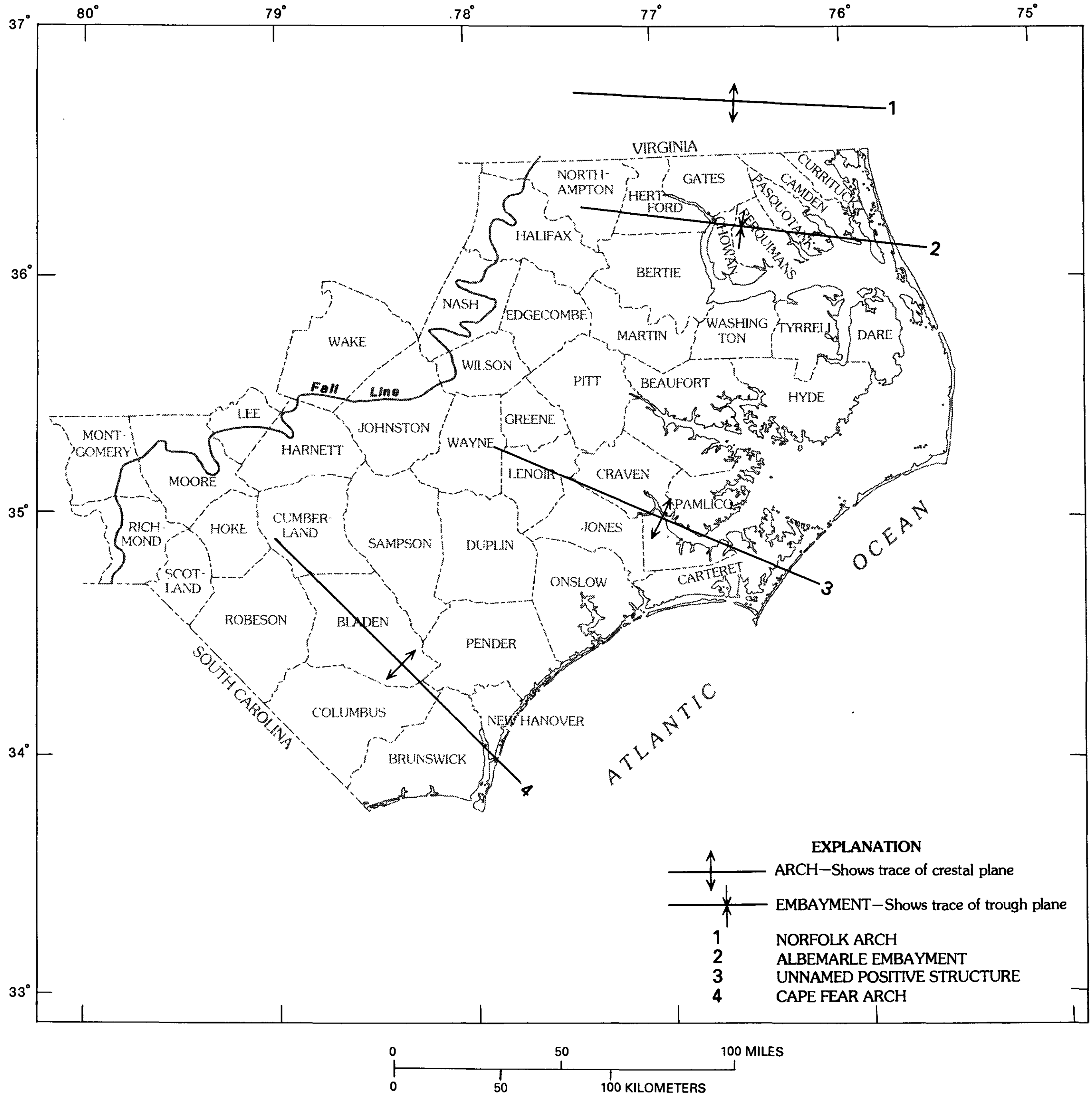

FIGURE 5.—Structural features of the Coastal Plain of North Carolina and southern Virginia. (Adapted from Gibson, 1967.)

A few studies support these estimates of natural recharge. Through analysis of water-level maps, Wyrick (1966) calculated that confined aquifers underlying Martin County at depths of 100 to 300 ft receive recharge at a rate of 22,000,000 gallons per day (gal/d). This is equivalent to 0.96 inch of rainfall over the 482-mi^2 county. Heath (1975) determined that for the uppermost hydrologic units in the Albemarle-Pamlico region—the Quaternary, Yorktown, and Castle Hayne aquifers—combined annual ground-water discharge is about 0.5 inch. Thus, assuming that ground-water recharge is equal to discharge, the combined recharge to these aquifers is also about 0.5 inch per year. In 1976, Winner calculated that the confined Cretaceous aquifers of Wilson County received about 67,000 gallons per day per square mile ((gal/d)/mi^2), or about 1.4 inches of annual recharge. A water-budget analysis of a small watershed in Pitt, Beaufort, and Craven Counties showed the average annual ground-water outflow through the confined Castle Hayne Limestone to be about 0.80 inch (Winner and Simmons, 1977).

Ground water discharges from the Coastal Plain aquifer system as seepage into streams, lakes, and drainage ditches; by evapotranspiration from soil zones; by upward leakage through confining beds to stream valleys; and by upward leakage to the bottoms of estuaries. The amount of discharge from the system equals the recharge to it, and the amount discharged from shallow and deep aquifers is in proportion to their recharge, as described above. The bulk of ground-water discharge, other than that lost to evapotranspiration, provides the base flow of perennial streams. Discharge from deeper confined aquifers is primarily by leakage across confining beds; it is controlled by the difference in heads across these confining beds (or groups of confining beds called confining units) and by the hydraulic properties of the confining beds.

Although the bulk of ground-water discharge to streams is from unconfined aquifers, the areas along streams also are discharge areas for confined aquifers. According to LeGrand and Pettyjohn (1981), for homoclinal aquifer systems such as the North Carolina Coastal Plain aquifers, places where streams cross confining-bed outcrops are the last downdip chance for ground water to discharge easily from confined aquifers. Such places are depicted on potentiometric-surface maps as natural cones of depression, or as V-shaped contours with the apex pointed downstream (see Siple, 1960, fig. 1). The term "artesian water-gap" was used by LeGrand and Pettyjohn (1981) to describe this type of feature, which occurs in most aquifers along the major streams flowing over the Coastal Plain of North Carolina.

All sediments deposited under marine conditions initially contained seawater having a chloride concentration of about 19,000 milligrams per liter (mg/L) (Hem, 1985, p. 7). As sea level declined and land surface was exposed, rainfall on that land surface recharged the ground-water system with freshwater. This initiated a flushing and dilution action that began to remove seawater from the aquifer system. The rate of flushing is directly related to the amount of freshwater flowing in the aquifers. For an unconfined aquifer in a barrier-beach setting, rainfall over a year or two may be sufficient to recreate a freshwater lens following an ocean overwash (Winner, 1978); in contrast, for a deep confined aquifer, significant flushing of seawater requires thousands of years or more. The freshwater-saltwater boundary between ground water containing chloride concentrations of less than 250 mg/L up to about 19,000 mg/L is gradational. In the vertical dimension, this transitional distance can be as much as 3,000 ft (Meisler, 1980, p. 6), depending on the hydraulic conductivity of the aquifer materials and the availability of freshwater.

The occurrence and origin of saltwater in clastic Coastal Plain aquifers from Long Island, N.Y., through North Carolina have been described by Meisler (1980). He attributed ground water fresher than seawater in deep aquifers offshore to sea-level declines of a few hundred feet that have occurred several times during past glacial advances and retreats. Although the flushing of seawater from deep aquifers is a slow process, Upson (1966) concluded that, for the northern Atlantic Coastal Plain, current positions of the freshwater-saltwater boundaries suggest that the hydrodynamic adjustments of these boundaries have been rapid enough to keep pace with sea-level changes since the Late Cretaceous. However, Meisler and others (1984, p. 14, 15) used a mathematical model to simulate the position of the freshwater-saltwater boundary during Tertiary and Quaternary time, and they concluded that, because of frequent sea-level fluctuations, it is unlikely the boundary has been in equilibrium during the past 900,000 years. They also stated that simulation results suggest that the position of the boundary off the New Jersey coast is not in equilibrium with present sea-level conditions but reflects lower sea levels.

Inasmuch as the sea has alternately inundated the present onshore areas of North Carolina and receded offshore, a complex pattern has developed in the position of the freshwater-saltwater transition zone in the several aquifers. Each aquifer has its own seaward limit of freshwater as dictated by (1) its rates and location of recharge, (2) its hydraulic properties, (3) its hydraulic gradients, and (4) the thickness and properties of the overlying confining units, which affect the amount of freshwater circulation in the aquifer.

The most prominent geologic structure that influences regional ground-water movement is the seaward-dipping Coastal Plain homocline. The hydrologic effects of the other structural elements in the Coastal Plain are neither well known nor extensively documented. For the North Carolina Coastal Plain, one can only speculate on how faults may affect the ground-water system. Movement along a fault could partially (and locally) disrupt confining units and allow greater interaquifer leakage.

Superimposed on the natural recharge- and discharge-flow regime of the Coastal Plain aquifers are the effects of pumping from some of the aquifers. Because virtually all withdrawals are from the confined parts of the system, the effects of pumping extend over thousands of square miles. Three large cones of depression have developed in the North Carolina Coastal Plain that affect more than 20 percent of its area (fig. 6) and are important to the future management of ground-water supplies in

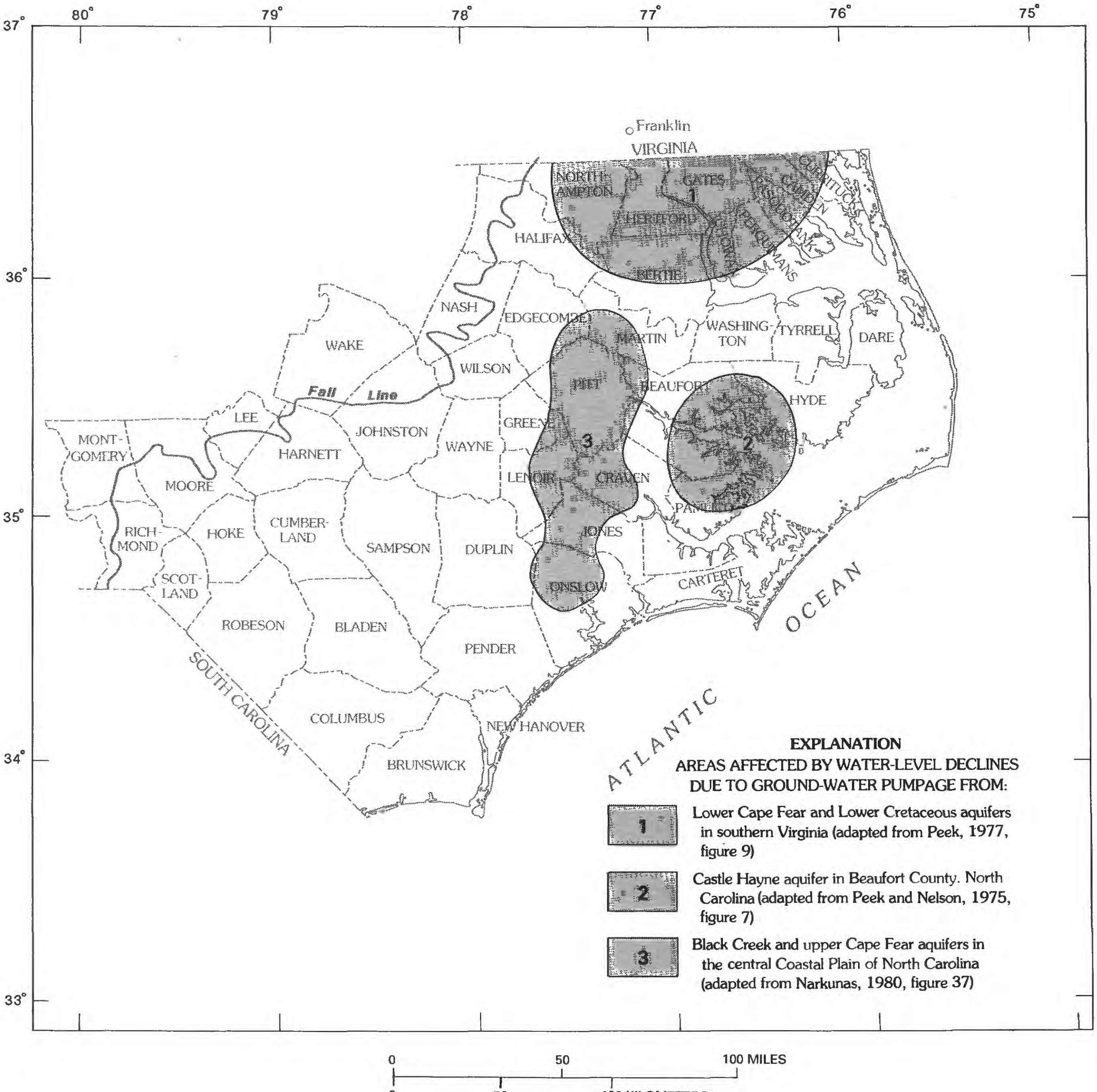

FIGURE 6.—Major cones of depression in the North Carolina Coastal Plain.

the areas affected. One cone of depression is centered around Franklin, Va., about 10 mi north of the State line, where about 38 million gallons per day (Mgal/d) was pumped from Cretaceous aquifers in 1986 (Hamilton and Larson, 1988). The effects of this continued pumping have spread over about 2,500 mi^2 of the northern North Carolina Coastal Plain and over an even larger area in southeastern Virginia.

Since 1965, pumpage from the Castle Hayne Limestone, ranging from about 50 to 65 Mgal/d in Beaufort County, has caused an extensive cone of depression (fig. 6, no. 2). It covers more than 1,000 mi^2, with a water-level decline at the center of more than 125 ft (Peek and Nelson, 1975).

The third area of water-level decline (fig. 6) is in the central Coastal Plain. Seven major water-supply systems and about 15 smaller ones pump from Cretaceous aquifers. Combined withdrawal during the period 1980–82 was about 22 Mgal/d, affecting an area of more than 1,800 mi^2. It is clear, then, not only that geologic units extend over large areas of the Coastal Plain, but that hydraulic continuity is equally extensive, as seen in the development of these cones of depression.

DELINEATION OF HYDROGEOLOGIC UNITS

Criteria generally used to map geologic formations are the lithologic properties and paleontologic characteristics of the rocks. Aquifer definition depends on the mapping of hydraulically connected permeable units. Although aquifer boundaries locally may coincide with, or may parallel, boundaries of stratigraphic units, they rarely correspond everywhere to stratigraphic unit boundaries. This is especially true in deltaic to shallow marine deposits such as the Coastal Plain sediments, where facies changes are rapid.

For the purpose of developing a hydrogeologic framework to define the movement of ground water throughout the Coastal Plain in North Carolina, we have adopted a concept of hydrogeologic units similar to the term "hydrostratigraphic unit" proposed by Maxey (1964, p. 126) to describe "bodies of rock with considerable lateral extent that compose a geologic framework for a reasonably distinct hydrologic system." In this report, the North Carolina Coastal Plain sediments are organized into a system that meets both geologic and hydrologic criteria.

With the exception of the extensive Castle Hayne Limestone, the Coastal Plain aquifer system is made up primarily of a number of imperfectly connected sand bodies, any one of which may have only local extent and, for short periods of time, may act under stress as a distinct hydraulic unit. On a regional scale, however, these sand bodies can be grouped into major aquifers on the basis of three hydrologic factors: (1) significant differences in hydraulic head across the confining units that separate the aquifers, (2) evidence of widespread lateral transmission of drawdown effects, thus indicating the lateral hydraulic connection of permeable beds, and (3) water-quality similarities within an aquifer and differences across confining units.

The confining units separating the major aquifers consist of beds, or groups of beds, of clay and silt that contain varying amounts of sand, either as separate thin beds or mixed throughout the unit. Some confining units can be correlated over long distances; although any given confining unit may not be stratigraphically equivalent everywhere, the important consideration is the demonstrated confinement of the major aquifers.

The northern Atlantic Coastal Plain regional study identifies 21 hydrogeologic units in the Coastal Plain from New York to North Carolina: 12 aquifers and 9 interlying confining units (Henry Trapp, Jr., U.S. Geological Survey, written commun., 1986). Ten of these aquifers and the nine confining units are found at one place or another in the North Carolina Coastal Plain. The North Carolina hydrogeologic units are listed in table 2 along with equivalent units in Virginia and South Carolina. Neither the Virginia nor the South Carolina units are all present at the respective borders with North Carolina; nor are they necessarily contiguous with equivalent North Carolina hydrogeologic units.

The names of the North Carolina aquifers generally are taken from the predominant geologic unit with which the aquifer is associated. Two exceptions are as follows: (1) the surficial aquifer, which is the uppermost hydrogeologic unit, and (2) the Lower Cretaceous hydrogeologic units. The names of the confining units are taken from the aquifers they overlie. Table 3 shows the North Carolina Coastal Plain geologic units and their associated hydrogeologic units.

The approach taken in this investigation to define the framework in terms of both geologic and hydrologic continuity has been outlined above. The remainder of this section describes the methodology used to define the system of aquifers and confining units. This involves interpretation of three sets of data: (1) borehole geophysical logs, (2) water-level measurements in wells, and (3) chemical analyses of water samples from wells.

The primary method used to compile and compare these data and to correlate the aquifers and confining units throughout the Coastal Plain in North Carolina was to construct hydrogeologic sections using wells for which the best combinations of the three types of data were available. Because Coastal Plain geology was the dominant factor in defining the hydrologic framework, the selection of section lines was based on the availability of geophysical logs that reached basement rock or that penetrated a substantial portion of the sediment section. These hydrogeologic sections and a location map are shown on plates 1–14. More than 450 geophysical logs were examined for their potential use in constructing the sections. The geophysical logs generated from the NRCD ground-water research-station program were selected as the principal logs for each section because most of these test holes were drilled to basement and, equally important, because they also provided critical water-level and water-quality data throughout the geologic column. A diagram of a typical NRCD research station is shown in figure 7.

Geophysical logs from other wells located along or near each line of section were used to supplement the coverage between research stations. The average distance

TABLE 2.—*Virginia, North Carolina, and South Carolina Coastal Plain hydrogeologic units*

VIRGINIA HYDROGEOLOGIC UNITS[1]	NORTH CAROLINA HYDROGEOLOGIC UNITS	SOUTH CAROLINA HYDROGEOLOGIC UNITS[2]
Columbia aquifer	Surficial aquifer	Surficial aquifer
Yorktown confining bed	Yorktown confining unit	North Carolina units not present in South Carolina
Yorktown-Eastover aquifer	Yorktown aquifer	
St. Marys confining bed	Pungo River confining unit	
St. Marys-Choptank aquifer	Pungo River aquifer	
Calvert confining bed	Castle Hayne confining unit	
Chickahominy-Piney Point aquifer	Castle Hayne aquifer	
Nanjemoy-Marlboro Clay confining bed	Beaufort confining unit	
Aquia aquifer	Beaufort aquifer	
Brightseat confining bed[3]		
Brightseat aquifer[3]		
North Carolina units not present in Virginia	Peedee confining unit	
	Peedee aquifer	
	Black Creek confining unit	
	Black Creek aquifer	Black Creek aquifer
		Unnamed confining unit
		Middendorf aquifer
Upper Potomac confining bed	Upper Cape Fear confining unit	Unnamed confining unit
Upper Potomac aquifer	Upper Cape Fear aquifer	Cape Fear aquifer
Middle Potomac confining bed	Lower Cape Fear confining unit	
Middle Potomac aquifer	Lower Cape Fear aquifer	
Lower Potomac confining bed	Lower Cretaceous confining unit[4]	
Lower Potomac aquifer	Lower Cretaceous aquifer[4]	

[1]Meng and Harsh (1984).
[2]Southeastern Coastal Plain aquifer system (W.R. Aucott, U.S. Geological Survey, written commun., 1987).
[3]Restricted to northern Virginia; not present along North Carolina-Virginia boundary.
[4]Restricted to northern North Carolina; not present along North Carolina-South Carolina boundary.

between geophysical logs along sections is about 9 mi; the maximum is 24 mi. Dip sections were connected with strike sections (pl. 1) so as to correlate beds from south to north.

GEOPHYSICAL LOGS

The delineation of the hydrogeologic units, as shown in the hydrogeologic sections, was accomplished by means

TABLE 3.—*North Carolina Coastal Plain geologic and hydrogeologic units*

GEOLOGIC UNITS	AQUIFERS AND CONFINING UNITS
Quaternary deposits	Surficial aquifer
Yorktown Formation	Yorktown confining unit
	Yorktown aquifer
Eastover Formation	
Pungo River Formation	Pungo River confining unit
	Pungo River aquifer
Belgrade Formation	Castle Hayne confining unit
River Bend Formation	
Castle Hayne Limestone	Castle Hayne aquifer
Beaufort Formation	Beaufort confining unit
	Beaufort aquifer
Peedee Formation	Peedee confining unit
	Peedee aquifer
Black Creek Formation	Black Creek confining unit
Middendorf Formation	Black Creek aquifer
Cape Fear Formation	Upper Cape Fear confining unit
	Upper Cape Fear aquifer
	Lower Cape Fear confining unit
	Lower Cape Fear aquifer
Unnamed units	Lower Cretaceous confining unit
	Lower Cretaceous aquifer

of well-to-well correlation of lithologic units through use of geophysical logs, mainly standard single-point electric logs (spontaneous-potential and resistance curves) and natural gamma-ray logs. In a number of instances, interpretation of these logs was aided by use of multielectrode resistivity logs, where available, and by drillers' logs and descriptions of well cuttings.

The method of correlation was to compare geophysical logs from adjacent wells on section lines to determine the continuity of sediments between them. Inasmuch as abrupt changes in lithofacies of units can occur over distances of less than a mile, emphasis in correlation was placed on continuity of groups of similar beds rather than on continuity of an individual bed. For example, figure 8 shows the continuity of groups of sand and clay beds over a distance of more than 20 mi. Most individual beds within a group cannot be traced from log to log with reliability, although some with distinctive log character-

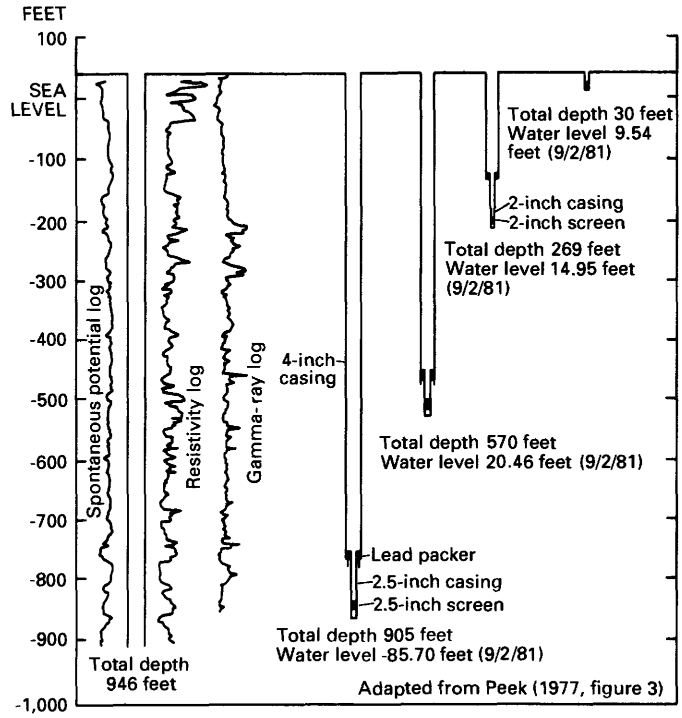

FIGURE 7.—Logs of exploratory hole and construction features of observation wells at a typical NRCD research station.

istics can be traced long distances. These are marker beds used as guides in correlation.

Not all log-to-log correlations are as apparent as those shown in figure 8. Difficulties of interpretation may arise when determining the continuity of a unit between two wells where only an electric log is available from one well and only a gamma-ray log is available from the other, or between wells having electric logs with widely varying curve scales.

GROUND-WATER LEVELS

As geophysical log correlations were developed, water-level data were added to the well traces on the hydrogeologic sections to determine the head distribution throughout the geologic column at a given well site. These data were taken primarily from NRCD observation wells at research stations, such as those illustrated in figure 7, although a significant number of measurements were obtained from drill-stem tests in the initial test holes. Water-level data from wells other than NRCD research-station wells were also used.

The distribution of head in the test hole and observation wells at a research station was compared with the geophysical log of the test hole, and confining units were selected on the basis of this head distribution (fig. 9). Log-to-log correlations of beds, together with analysis of

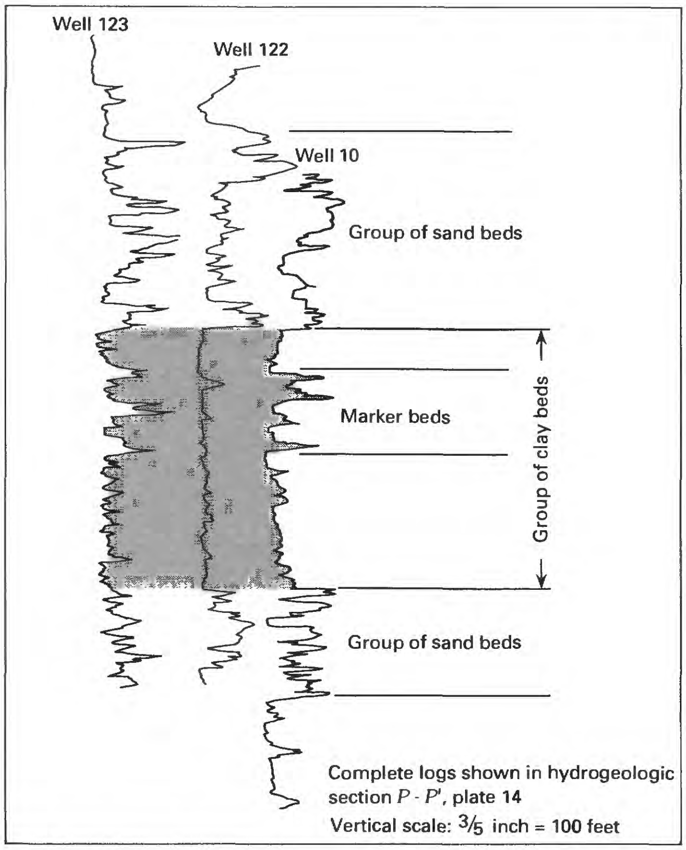

FIGURE 8.—Resistance logs showing correlations of beds and groups of beds.

heads in adjacent test holes and other wells along the sections, led to the definition of aquifers and confining units shown on plates 2–14.

In the case of the NRCD Calabash Research Station shown in figure 9, head differences between aquifers are quite obvious; from top to bottom these differences are 15, 9, 33, and 41 ft. The data also show a relative uniformity of water levels within two thick aquifers, even though there are numerous clay beds within each aquifer.

From these water-level data, some clay layers are known to be more effective than others as confining units over large areas. A particular regional confining unit may not be the same stratigraphic unit everywhere because of lithofacies changes and erosional unconformities. Also, the degree of confinement afforded by a given clay bed is not necessarily the same everywhere. Some test data show relatively small head differences between aquifer zones that might indicate poor confinement. Thus, in interpreting confining-unit and aquifer continuity, the primary factors considered were the persistence of similar head values throughout aquifer zones and head differences across confining units. With these factors established, the log-to-log correlations were used to make the hydrogeologic correlations.

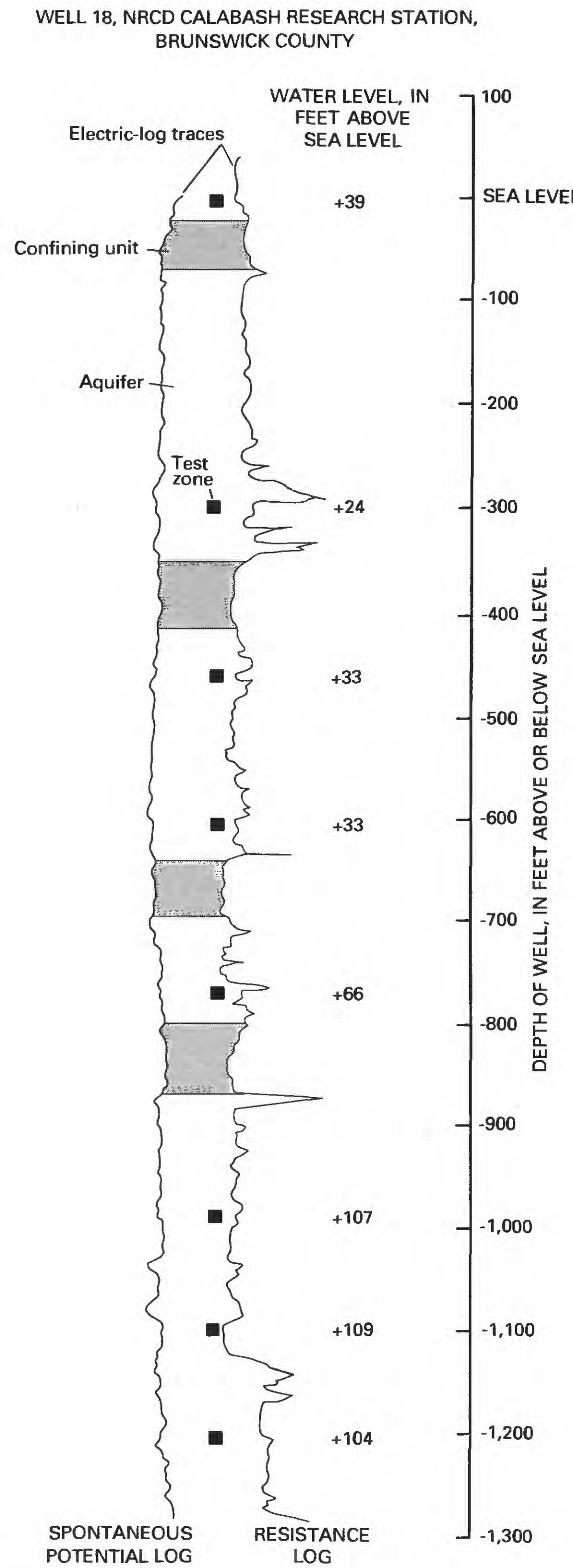

FIGURE 9.—Test zones and distribution of head throughout the section in an NRCD test hole.

Ground-water heads shown on the hydrogeologic sections (pls. 2–14) present a picture of the regional flow pattern in the North Carolina Coastal Plain aquifers. Water moves from areas of high head, usually where recharge occurs, toward areas of lower head, which may represent points of natural discharge, such as along streams or to wells in response to pumping. Clay beds in the aquifer system impede but do not stop the circulation of ground water into and from deeper aquifers.

CHLORIDE DISTRIBUTION

In conjunction with the analysis of water-level data, water-quality data were also used to help delineate the hydrogeologic units. The chloride ion was selected as the constituent for this purpose because it is conservative and is common in Coastal Plain aquifers, and because water samples frequently are analyzed for chloride. Chloride distribution in seaward-dipping Coastal Plain aquifers is gradational in nature; chloride concentrations generally increase with depth and in the downdip (seaward) direction. Available chloride concentration data are given on the hydrogeologic sections (pls. 2–14).

Chloride data from the NRCD research station at Clarendon are used in figure 10 to illustrate the vertical distribution of chloride concentration in Coastal Plain aquifers and to show the use of these data in delineating aquifers and confining units and in understanding the ground-water flow system. The chloride concentration in the water in the Clarendon well (fig. 10) increases from top to bottom of the aquifer system. At this site, the average chloride gradient is just over 4 milligrams per liter per foot of depth ((mg/L)/ft). However, this gradient is not evenly distributed throughout the section. Instead, below a depth of about 400 ft, chloride gradients are as much as 23 (mg/L)/ft. Conversely, low gradients, 2 to 4 (mg/L)/ft, occur within adjacent aquifers.

Chloride in ground water at Clarendon is unevenly distributed and is directly related to relatively rapid lateral ground-water flow through aquifers and relatively slow vertical flow across confining units. Lateral movement of freshwater in the upper 400 ft of sediments at Clarendon has been effective in flushing saltwater from this part of the system as evidenced by low chloride concentrations. The rate of flushing is lower in the deeper aquifers because the fresher water from the recharge area above has not been able to move readily across the confining units. These data show that the confining units are continuous over wide areas and play a significant role in the regional flow system.

The uneven distribution of chloride within the Coastal Plain aquifer system is interpreted as evidence not only of restricted flow across confining units, but also of continuity of flow within aquifers. Data show that salt-

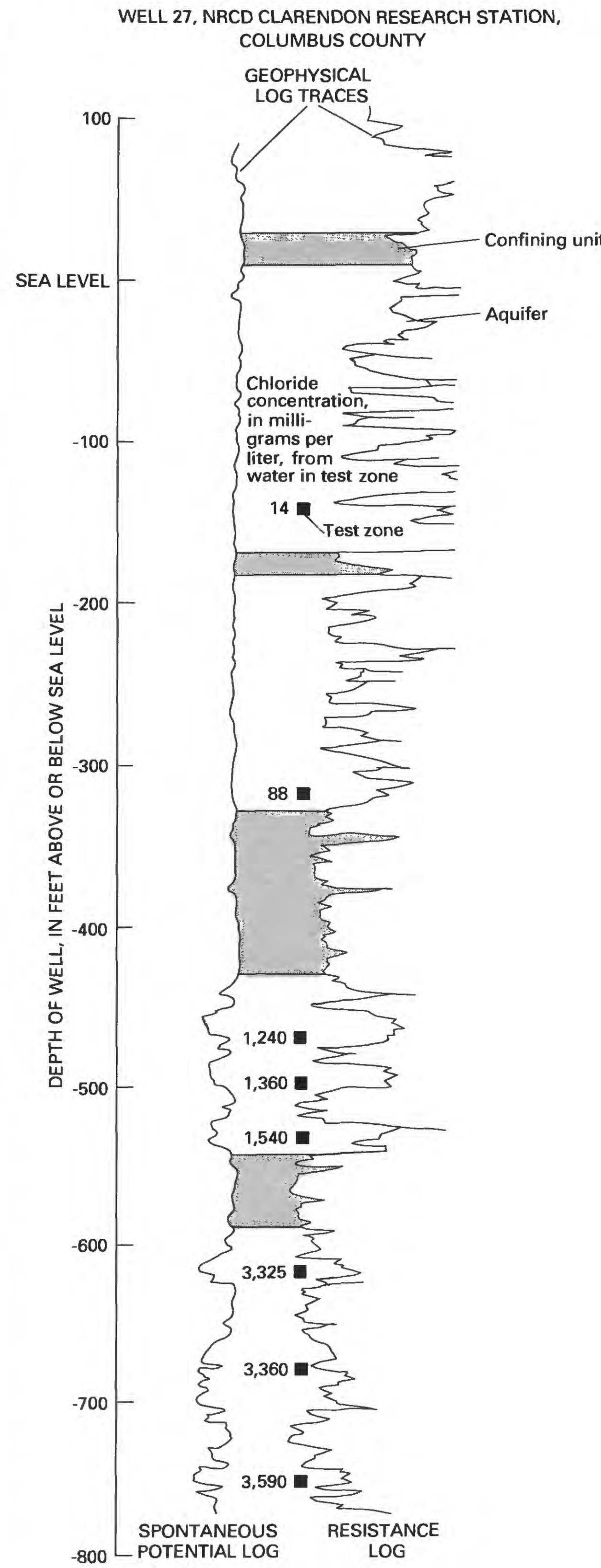

FIGURE 10.—Chloride distribution at the NRCD Clarendon Research Station.

TABLE 4.— *Summary of aquifer and confining-unit hydrogeologic data*

[min., minimum; max., maximum; avg., average]

North Carolina Coastal Plain aquifers and confining units	Altitude of top (in feet)		Thickness[1] (in feet)			Average percent of permeable material	Average estimated hydraulic conductivity (feet per day)	Approximate areal extent of aquifer (square miles)
	min.	max.	max.	min.	avg.			
Surficial aquifer	+2	+605	180	3	35	79	29	25,000
Yorktown confining unit	-173	+107	73	2	22	15	--	--
Yorktown aquifer	-580	+100	343	4	76	71	22	11,800
Pungo River confining unit	-615	-5	160	4	55	14	--	--
Pungo River aquifer	-759	-8	225	4	53	80	32	8,000
Castle Hayne confining unit	-810	+85	43	4	14	14	--	--
Castle Hayne aquifer	-820	+74	952	7	178	81	65	11,500
Beaufort confining unit	-1,127	+19	80	5	24	19	--	--
Beaufort aquifer	-1,207	0	171	4	70	73	35	10,700
Peedee confining unit	-1,324	+100	60	3	24	17	--	--
Peedee aquifer	-1,355	+86	351	6	146	68	34	13,900
Black Creek confining unit	-1,511	+597	168	4	45	16	--	--
Black Creek aquifer	-1,612	+593	409	22	165	59	28	21,200
Upper Cape Fear confining unit	-1,709	+455	180	6	48	18	--	--
Upper Cape Fear aquifer	-1,852	+295	481	12	113	62	30	22,200
Lower Cape Fear confining unit	-1,763	-18	147	12	52	17	--	--
Lower Cape Fear aquifer	-1,910	-64	475	20	173	58	34	17,000
Lower Cretaceous confining unit	-2,203	-347	69	7	44	10	--	--
Lower Cretaceous aquifer	-2,267	-354	2,249	15	773	53	25	7,300

[1]Maximum and minimum observed thickness where unit is present.

water occupies different positions in different aquifers and that chloride gradients vary throughout the sedimentary section.

HYDROGEOLOGIC FRAMEWORK

This section contains a description of each aquifer unit, its areal extent, the distribution of permeable material within the unit, the occurrence of saltwater, the properties of the overlying confining unit, and the relation among aquifers. Discussions center on the movement of ground water between aquifers, the locations where aquifers and confining units overlie or underlie each other, and aspects of ground-water movement related to natural conditions or to pumping conditions. Although not specifically stated in each instance, the discussion of an aquifer is also meant to include its overlying confining unit. A number of figures are presented to show the areal extent of contact between aquifers. Any exchange of water between adjacent aquifers is inferred to pass through intervening confining units, unless otherwise noted.

Summary data for each aquifer and confining unit are listed in table 4. Included are minimum and maximum observed altitude of unit top, maximum and minimum observed thickness of unit, estimated average percent of permeable material making up the unit, average estimated hydraulic conductivity (for aquifers), and areal extent of the aquifer. Hydrologic data for each of the 161 control wells used for the study are given in the "Supplemental Data" at the end of the report. These data were used to construct the maps showing the altitudes of the tops of the aquifers, the percentages of sand in the aquifers, and the thicknesses of the confining units cited in this section (pls. 15–24).

The occurrence of saltwater in each aquifer is included in the discussion because it affects the development of these aquifers. Two chloride concentrations in water were mapped—250 and 10,000 mg/L. The 250 mg/L chloride concentration value was chosen because it is the recommended upper limit in drinking-water standards (U.S. Environmental Protection Agency, 1978). Water containing 250 mg/L chloride, or more, is considered saltwater in this report. The 10,000 mg/L chloride concentration value was used by Meisler and others (1984, p. 14) in their simulation models to represent the no flow boundary, because they assumed that ground water having such high chloride concentration moves very little. Discussions of the hydrogeologic units follow.

SURFICIAL AQUIFER

The surficial aquifer defined in this report consists primarily of post-Yorktown deposits of Quaternary age near land surface. This unit is very important to the hydrology of the area because it extends over a large part of the Coastal Plain and because infiltration from rainfall is the bulk of the recharge to the Coastal Plain aquifer system. The aquifer transmits water laterally to streams and serves as a source bed holding the water that moves downgradient to deeper aquifers.

The surficial aquifer is not restricted to a single geologic unit in terms of either age or lithology. Because the origin and age of the surficial aquifer are not the same everywhere, it is necessary to describe in broad terms the various rock units of the aquifer as they occur in several parts of the Coastal Plain and to discuss some of the names applied to them. Surficial aquifer sediments in the Tidewater region (where land surface altitude is less than 40 to 50 ft) were deposited under shallow marine or estuarine conditions. These consist of fine sand, silt, clay, shell, and peat beds, plus scattered deposits of coarser grained material in the form of relict beach ridges and flood-plain alluvium.

Geologic or morphostratigraphic names have been applied to some of these surficial deposits by several investigators. For most of Carteret County and part of Pamlico County, Mixon and Pilkey (1976) used the name "Flanner Beach Formation" to describe surficial deposits consisting of well-sorted sands and silty sands interbedded with silt and clay. The Flanner Beach Formation is topped in places by the Minnesott sand, a relict beach ridge. Blackwelder (1981) used the names "James City Formation" and "Windsor Formation" (Coch, 1968) for various post-Pliocene beds along and east of a line between central Gates County and central Craven County. Elsewhere in the Tidewater region (fig. 3), the sediments of the surficial aquifer are generally referred to as undifferentiated Pleistocene or Pliocene and Pleistocene rocks generally occupying the upper 30 to 40 ft of section but thickening eastward to about 200 ft near the Outer Banks.

West of the Tidewater region, the sediments composing the surficial aquifer change character; they become coarser and more poorly sorted. With the exception of one area described below, no attempt has been made to assign formal names to these sediments. They are generally described as Pleistocene terraces or simply terrace deposits; where present, they lie unconformably on rocks of Cretaceous to Miocene age and range in thickness from a few feet to as much as 30 ft.

In Columbus and Brunswick Counties, Swain (1968) assigned surficial gray and white calcareous sands, silty sands, and shelly sands to the Waccamaw Formation of Pliocene age on the basis of ostracods. He suggested that these beds, up to 20 ft thick, may extend northward to Hyde County. Hazel (1977) thought the Waccamaw Formation of southeastern North Carolina and northeastern South Carolina to be of Pliocene and Pleistocene age. The Waccamaw is included in the surficial aquifer.

Grayish-brown coarse sand and gravel containing silt and kaolinitic clay balls constitute the surficial deposits in Moore County. This material, called the Pinehurst Formation by Conley (1962), was mapped by Daniels and others (1972) eastward into Harnett County, where it overlies fine sand, sandy clay, and clay of marine origin called the Macks Formation. The Macks was extended eastward into Johnston County by Daniels and others (1972), but the full extent of this unit is not known. These surficial materials of the Inner Coastal Plain and Sand Hills overlie Cretaceous sediments. They are undifferentiated and in this report are included in the surficial aquifer.

RECHARGE RATES

Recharge to the surficial aquifer depends on how rapidly rainfall can infiltrate into the aquifer. As noted in the preceding discussion, the rocks of the aquifer are not uniform in either composition or thickness. Recharge rates depend on the capacity of the soils formed from the various rock materials to allow water to move downward through the unsaturated zone.

One way of evaluating relative recharge rates is to look at the infiltration capacities of the various soil associations delineated by the U.S. Soil Conservation Service. Soil associations having similar characteristics of drainage, sand-clay content, and permeability were identified on the General Soil Map of North Carolina (Tant and others, 1974) and arranged as groups having good, moderate, or poor infiltration capacity (fig. 11).

Soils deemed to have good infiltration capacity were well-drained to very well-drained sandy soil and sandy loam having vertical saturated permeabilities of 2 to 20 inches per hour. A few sandy soils containing significant amounts of clay were included if their permeabilities were within this range. Heath (1980) estimated that annual recharge to thick, sandy soils in the surficial aquifer may be as much as 20 inches of equivalent rainfall.

Fine sand, silty loam, and sandy clay loam having vertical saturated permeabilities of 0.2 to 6 inches per hour were considered to have moderate infiltration capacity. Poorly drained clay, clay loam, and sandy-clay loam having vertical saturated permeabilities of 0.06 to 2 inches per hour were considered to have poor infiltration capacity. Recharge to the surficial aquifer through these soils having poor infiltration capacity may be as little as 5 inches per year, according to Heath (1980).

The general groupings of soil infiltration capacities in figure 11 show a relation to the rocks making up the surficial aquifer. For the most part, soils derived from fine sand, silt, and clay of marine origin in the Tidewater region have poor to moderate infiltration capacities, whereas soils derived from the coarser fluvial sediments in the Inner Coastal Plain tend to have higher infiltration

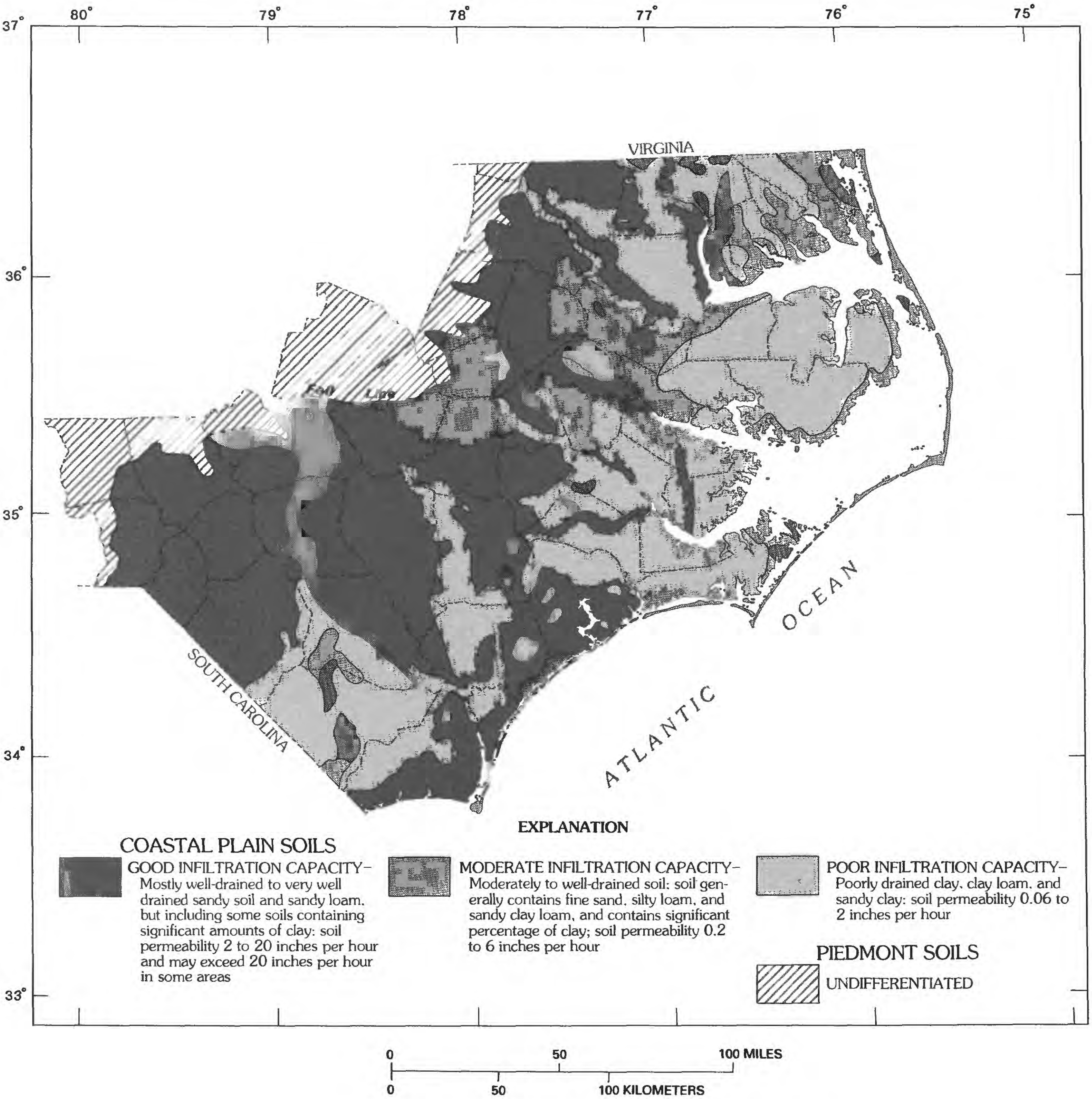

FIGURE 11.—Infiltration capacities of soils in the North Carolina Coastal Plain.

capacities. Soils in the Sand Hills area in the southwestern Coastal Plain have especially high infiltration capacities.

DISTRIBUTION OF PERMEABLE MATERIAL

A sand-percentage map is an effective way to depict the areal distribution of permeable material within an aquifer; however, it neither reflects the hydraulic conductivity of the aquifer nor indicates the size of the sand particles. A sand-percentage map for the surficial aquifer is given on plate 15. This map was constructed with data mostly from gamma-ray geophysical logs and from drillers' logs. Electric logs rarely include the upper several tens of feet of a well because most wells are lined with steel casing.

The percentage of sand in the surficial aquifer generally exceeds 70 percent. However, there are significant areas where it is less than 70 percent sand, and in a few places it is less than 50 percent sand.

The surficial aquifer generally contains less than 70 percent sand northeast of a line extending from the Hertford-Gates County line through central Washington County and into Hyde County. This relatively low sand content can be attributed to the marine character of the Quaternary sediments of the surficial aquifer and the resulting presence of more clay beds. Southwestward, the aquifer also contains less than 70 percent sand in parts of Edgecombe, Wilson, Wayne, Duplin, and Sampson Counties and in scattered areas of the Sand Hills (fig. 3). The aquifer here consists of poorly sorted fluvial material, which explains the lower sand content.

OCCURRENCE OF SALTWATER

The limit of 10,000 mg/L chloride concentration in water in the surficial aquifer is the shoreline of the Atlantic Ocean and, for Carteret County northward, the shorelines of the several sounds behind the Outer Banks, including the wider parts of major estuaries. The limit of 250 mg/L chloride concentration extends farther inland along tidal streams and can be generally defined as being near the upstream limit of saltwater in each stream. Giese and others (1979) have described the occurrence of salinity in the sounds and estuaries of North Carolina and the upstream limit of saltwater in the major streams.

In Hyde, Dare, and Tyrrell Counties, which make up the bulk of the region known as the Albemarle-Pamlico Peninsula, a special case of saltwater intrusion into the surficial aquifer was reported by Heath (1975). Where the bottoms of drainage ditches and canals are lower than sea level, saltwater from the sounds can move inland through these canals and laterally into the surficial aquifer. Insufficient data are available to show the extent of this problem.

On the barrier islands constituting North Carolina's Outer Banks, freshwater occurs in small, isolated, lens-shaped masses above denser saltwater in the surficial aquifer. Winner (1975, 1978) has described and mapped freshwater in the parts of the Outer Banks belonging to the National Park Service. For purposes of modeling the larger ground-water system, however, the freshwater in the Outer Banks is considered unrelated to the larger flow system and, in any case, is too small an area to have an effect at the scale of the Coastal Plain ground-water flow system.

YORKTOWN AQUIFER

The Yorktown aquifer is generally equated with the redefined Pliocene Yorktown Formation and the upper Miocene Eastover Formation of Ward and Blackwelder (1980). It extends throughout the northern half of the North Carolina Coastal Plain (pl. 16) from the Fall Line, where it overlaps crystalline rocks of the Piedmont, eastward to and beyond the coast. West of the Tidewater region (fig. 3), the aquifer is thin (less than 20 ft thick in many places) and has been cut into or eroded away by the larger streams flowing across the area. The aquifer thickens eastward, the slope of the top is up to 7 feet per mile (ft/mi), and, in Dare County, the Yorktown attains a thickness of more than 300 ft (well 48, pl. 7).

The Yorktown aquifer is not present in most of the southern half of the Coastal Plain. Brown and others (1972, pl. 21) showed a number of isolated outliers of rocks largely equivalent to the Yorktown aquifer. These outliers suggest that extensive erosion and removal of these rocks has occurred in the southern Coastal Plain and is responsible for the discontinuity of the aquifer there. The largest of the outliers, in Robeson County at the South Carolina line, is the only one considered of sufficient significance to be mapped as a separate body of the aquifer (pl. 16).

The Yorktown aquifer is composed largely of fine sand, silty and clayey sand, and clay and is characterized by shells and shell beds throughout. This attests to its marine and near-marine origin of deposition. Coarser sand fractions and shell beds have been identified on geophysical logs in some downdip areas, but over most of the Inner Coastal Plain, fine sand is the dominant aquifer material. Brown and others (1972, p. 52) reported the occurrence of limestone in upper Miocene rocks along the easternmost Coastal Plain, and, for parts of northeastern North Carolina, Ward and Blackwelder (1980, p. D29) described the Yorktown Formation as containing, in part, lag deposits of coarse sand and pebbles.

DISTRIBUTION OF PERMEABLE MATERIAL

The average estimated hydraulic conductivity of the Yorktown aquifer is about 22 feet per day (ft/d), based on lithologic- and geophysical-log data from 52 wells and test holes (table 4). Hydraulic conductivity values from aquifer tests in the Yorktown range from 19 ft/d in Chowan County (Lloyd, 1968a, p. 46) to 33 ft/d in Beaufort County (DeWiest and others, 1967, p. 89).

Along the Inner Coastal Plain, sand beds of the Yorktown aquifer are commonly less than 10 ft thick and are somewhat irregularly distributed, as depicted on hydrogeologic section *J′–J″* through this area (pl. 10). These characteristics are also reflected on the sand percentage map (pl. 16), which shows that the aquifer is composed of less than 60 percent sand from Wilson County to Northampton County. Eastward and downdip, sand beds are thicker and consist of coarser material (well 140, pl. 7).

Trending in an easterly direction from Gates County is an area of decreasing sand percentage (pl. 16). Although beds thicken in this direction, the aquifer contains smaller percentages of permeable material. This suggests a major lithofacies change, and the aquifer contains extensive clay beds.

OCCURRENCE OF SALTWATER

Water containing chloride concentrations of more than 250 mg/L has been collected from several wells open to sands of the Yorktown aquifer. The 250 mg/L chloride concentration lines (isochlors) as mapped on plate 16 depict the intersection of the equal-concentration surface with both the bottom and the top of the aquifer (transition zone). The isochlors bear no direct relation to the altitude contours of the aquifer materials but do conform generally to the strike of the Yorktown Formation.

That the 250 mg/L transition zone is nearly horizontal, as shown in cross section on plates 7 and 8, suggests that water movement within the aquifer is virtually horizontal, with only a slight upward component. The distance between the 250 mg/L isochlors that intersect the top and bottom of the Yorktown aquifer ranges from 10 to 25 mi.

Chloride concentrations approaching 10,000 mg/L have not been observed in water from the Yorktown aquifer. Ground water containing this concentration in the aquifer occurs an unknown distance offshore, and the position of the 10,000 mg/L isochlors must be estimated.

YORKTOWN CONFINING UNIT

The Yorktown confining unit overlies the Yorktown aquifer and serves as the hydrologic boundary between the Yorktown aquifer and the overlying surficial aquifer. In this report, the Yorktown confining unit is considered to extend only as far as the aquifer. Any stratigraphically equivalent low-permeability beds beyond the limit of Yorktown aquifer are included in other confining units.

The confining unit is composed largely of clay and sandy clay that locally includes beds of fine sand or shell. It comprises the youngest beds of the Yorktown Formation and may include, in some places, clay beds of Pleistocene or Holocene age.

The average thickness of the Yorktown confining unit is about 22 ft (table 4). As shown on plate 16, the 25-ft thickness line and several places where the confining unit is between 25 and 50 ft thick extend through or occupy the middle of the northern Coastal Plain. Westward toward the Fall Line, the confining unit averages about 13 ft in thickness, and eastward near the coast about 40 ft. It is thinnest (less than 10 ft thick in many places) above the southern part of the main body of the Yorktown aquifer from Wilson to Pamlico Counties. In the northeast from about Gates County eastward, the confining unit averages about 50 ft in thickness and is more than 70 ft thick in northern Pasquotank County. Above the Yorktown aquifer outlier in Robeson County, the Yorktown confining unit is less than 25 ft thick.

RELATION WITH OTHER AQUIFERS

The Yorktown aquifer and its confining unit are almost entirely overlain by the surficial aquifer and receive recharge from it. The Yorktown is in direct contact with streams that have channeled into it (pl. 16) or with their alluvial deposits; outcrops along stream valleys of the Yorktown Formation, of which the aquifer and its confining unit are composed, have been extensively described by many investigators. On the whole, the stream valleys are discharge areas for the Yorktown aquifer.

At least some part of all of the underlying aquifers and their overlying confining units, except the Lower Cretaceous aquifer, subcrop beneath the Yorktown aquifer (fig. 12). In the areas of these subcrops, the opportunity exists for exchange of water between the Yorktown aquifer and the underlying aquifers. Excluding stream valleys, the potential for downward leakage from the Yorktown aquifer to subcropping aquifers exists over about the western two-thirds of the area and in the southern outlier. In these areas, heads in the Yorktown aquifer are higher than heads in underlying aquifers. For the remainder of the Tidewater region, the Yorktown aquifer accepts upward leakage from the underlying Pungo River aquifer.

PUNGO RIVER AQUIFER

The sediments constituting the Pungo River aquifer are defined as the permeable parts of the Pungo River Formation of upper and middle Miocene age, named by Kimrey (1964) for a type locality in Beaufort County. Ward and Blackwelder (1980, p. D4) equated this formation with the Calvert Formation of Virginia and Maryland and indicated it to be partly of early Miocene age. The aquifer is composed of fine- to medium-grained marine sand with considerable phosphate content. The lithology and fossil content of the aquifer show that it was largely deposited in an offshore environment. A few beds of coarse sand may have been deposited in an estuarine or nearshore environment.

The Pungo River aquifer is limited to the eastern part of the northern North Carolina Coastal Plain (pl. 17). Its western limit is a line extending north from western Carteret County to central Gates County. Its northern

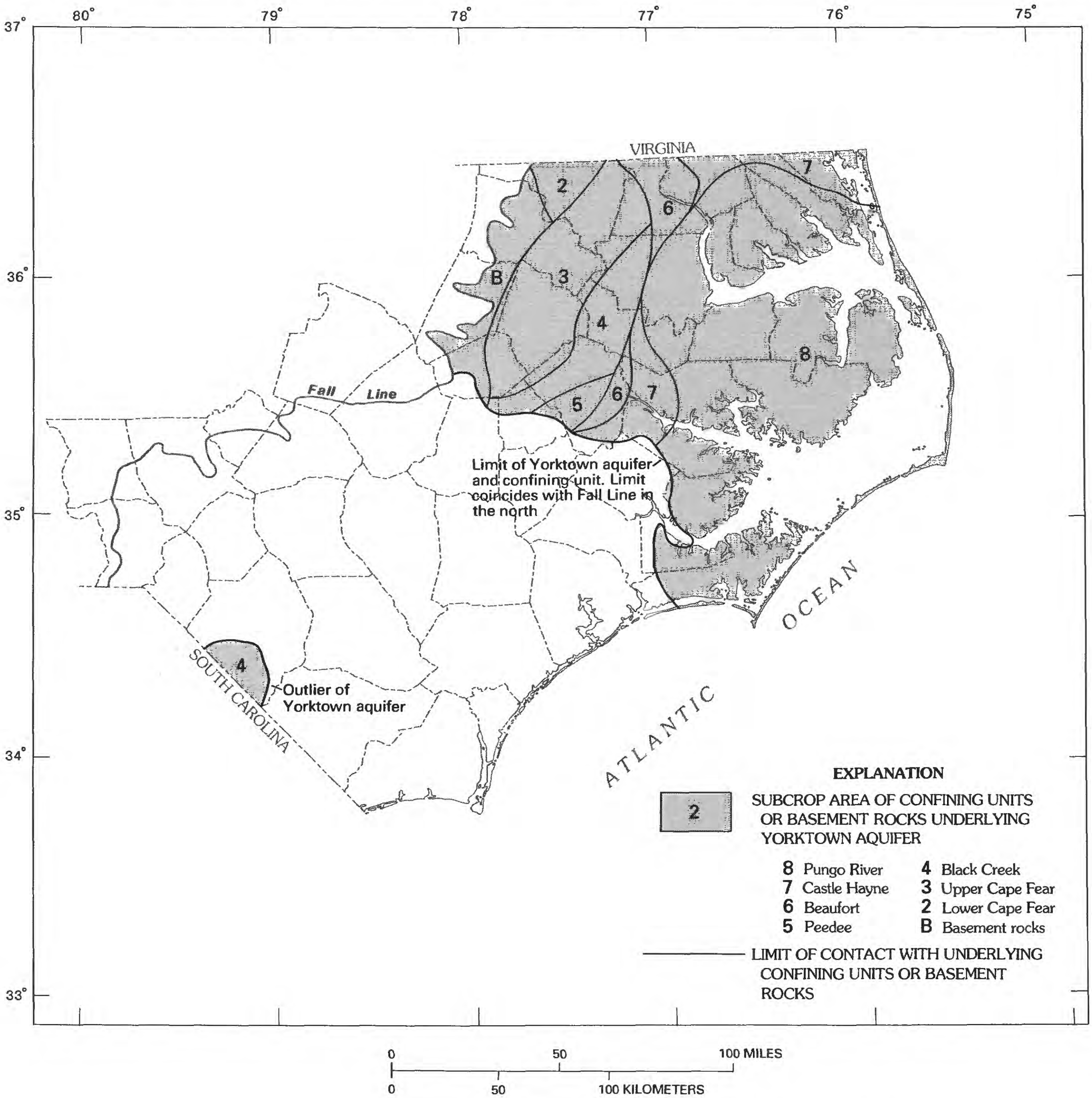

FIGURE 12.—Confining units or basement rocks that directly underlie the Yorktown aquifer.

limit is a line from there to the coast in Currituck County. The Pungo River Formation does not contain sufficient permeable material in southeastern Virginia to be considered an aquifer.

The Pungo River aquifer averages only about 15 ft in thickness near its western and northern limits. As the aquifer dips eastward (10 to 12 ft/mi), it thickens to more than 200 ft in the vicinity of the Outer Banks, where the top is more than 580 ft below sea level (well 71, Hyde Co.).

Except for manmade exposures, the Pungo River aquifer is entirely covered by younger sediments, although the Neuse River may come close to penetrating it at the aquifer's western margin near New Bern. The Pungo River Formation is artificially exposed in pits in Beaufort County, where it is mined for phosphatic-sand ore. The phosphatic sand is believed to constitute much of the Pungo River aquifer there. In order to conduct dry-pit mining operations, heads in the underlying Castle Hayne aquifer are lowered by pumping so that water from this aquifer does not seep upward through clay beds underlying the ore bed. The influence of this pumping is shown as area 2 in figure 6.

DISTRIBUTION OF PERMEABLE MATERIAL

The Pungo River aquifer consists of more than 90 percent sand throughout much of its western area (pl. 17). Where the aquifer thickens eastward and is buried at depths greater than 200 to 300 ft, additional sand beds appear in the section (well 144, pl. 7), but the amount of permeable material decreases to about 50 or 60 percent. Near its northern limit in Gates County, the aquifer is more than 50 ft thick and is composed of several sand bodies (pl. 8). Northward, the aquifer thins and becomes a single sand bed to its pinch out, where the Pungo River Formation no longer contains permeable material and becomes part of the Castle Hayne confining unit (well 58, pl. 14).

Most of the permeable material composing the Pungo River aquifer is fine to medium sand, as reflected by an average estimated hydraulic conductivity of 32 ft/d (table 4). No trends or patterns in the distribution of hydraulic conductivity in the aquifer were detected.

OCCURRENCE OF SALTWATER

The 250 mg/L isochlors for the top and bottom of the Pungo River aquifer are shown on plate 17. This transition zone narrows to about 1 mi north of Washington County because the aquifer is thin and its permeability is low there. To the south the transition zone is at least 10 mi wide; no data are available to determine its width in the extreme southern onshore area. The relatively wide transition zone in the south is due to the aquifer being thicker and in closer proximity to recharge sources.

As is the case for the Yorktown aquifer, the position of the 10,000 mg/L isochlors for the Pungo River aquifer is unknown; very few analyses of water from it are available, and none with which to determine the position of the 10,000 mg/L isochlors. The highest concentration of chloride known is a little more than 1,700 mg/L from one water sample from a test hole (well 71, pl. 17) open to the Pungo River aquifer at Ocracoke on the Outer Banks.

PUNGO RIVER CONFINING UNIT

The upper clay beds of the Pungo River Formation, as described by Kimrey (1964), plus contiguous clays of the lowermost Yorktown or Eastover Formation constitute the Pungo River confining unit, which overlies the Pungo River aquifer. For most of the area, this confining unit is composed of clay containing less than 10 percent sand. Geophysical logs consistently show a nearly uniform clay between the Yorktown and Pungo River aquifers. A few logs show a gradation from sand to clay below the Yorktown, and some indicate an increasing silt content near the top of the Pungo River aquifer; however, the main body of clay is a distinct feature.

Along the western margin of the Pungo River aquifer, its confining unit is less than 10 ft thick. Eastward and downdip it thickens to about 150 ft beneath Currituck County (pl. 17). An average value of thickness for the Pungo River confining unit is nearly 55 ft (table 4).

RELATION WITH OTHER AQUIFERS

The Pungo River aquifer and its confining unit are overlain in most places by the Yorktown aquifer (fig. 13). The lack of water-level data for the Pungo River aquifer makes it difficult to determine the recharge-discharge relationship between the two aquifers. Generally, we can expect that the Pungo River aquifer is recharged from the Yorktown aquifer in the areas beneath the surface-water divides common to both aquifers and that upward discharge from the Pungo River aquifer occurs along the stream valleys.

Locally, in Craven and Carteret Counties, the Yorktown aquifer is not present and the Pungo River is directly overlain by the surficial aquifer (fig. 13). The opportunity for recharge to the Pungo River aquifer is greater in these areas than in areas where the intervening Yorktown aquifer is present.

Underlying the Pungo River aquifer everywhere is the Castle Hayne aquifer and its confining unit, which extend west and north beyond the limits of the Pungo River aquifer. The Castle Hayne confining unit, which separates the Pungo River and Castle Hayne aquifers, is relatively thin (14-ft average, table 4) and in some places is missing (pls. 13, 14), so that the Pungo River and Castle Hayne aquifers are in contact. This suggests a direct hydraulic connection between the two aquifers.

CASTLE HAYNE AQUIFER

The Castle Hayne aquifer includes the Eocene Castle Hayne Limestone, rocks of Oligocene age overlying the Castle Hayne (Brown and others, 1972), which are lithologically similar to the Castle Hayne and in direct hydraulic contact with it, and rocks correlated with middle Eocene to upper Oligocene and lower Miocene deposits in southeastern Virginia (Meng and Harsh, 1984). In Jones and Onslow Counties, the Oligocene River Bend Formation (Ward and others, 1978) forms part of the Castle Hayne aquifer. The basal part of the

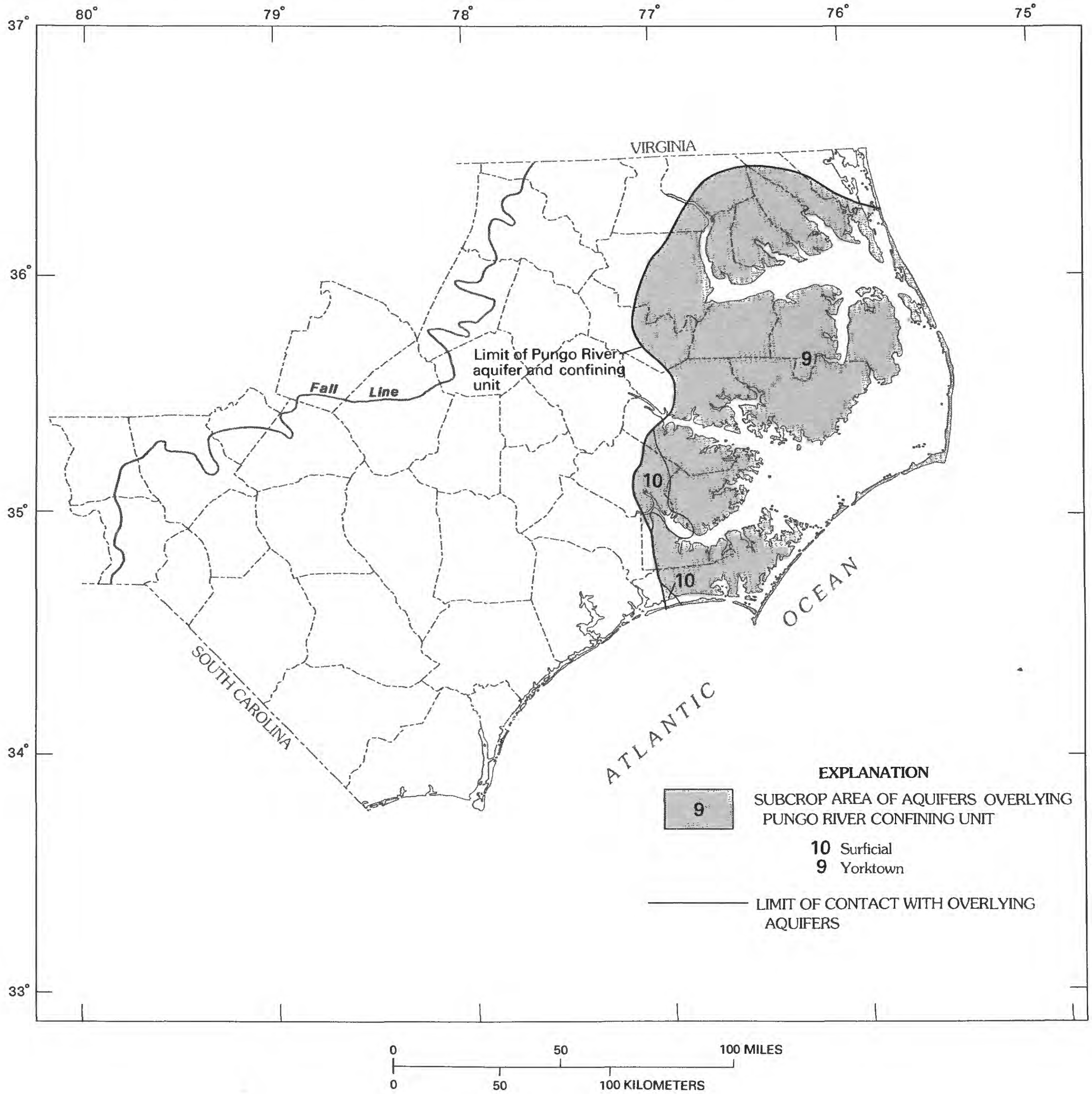

FIGURE 13.—Aquifers that directly overlie the Pungo River confining unit and aquifer.

aquifer locally may include older contiguous permeable units. All of these rocks are mapped as the Castle Hayne aquifer. The aquifer's extent and the altitude of its top are shown on plate 18.

Clark and others (1912) recognized isolated outcrops of calcareous sediments of Eocene age extending as far west as Wake and Harnett Counties and called them erosional remnants. Later workers have also recognized these outliers (Richards, 1950; Schipf, 1961; Brown and others, 1972; Baum and others, 1978). In this report, these outliers are not considered part of the Castle Hayne aquifer.

The Castle Hayne aquifer is composed predominantly of limestone and sand, with minor amounts of clay, and was deposited under marine conditions. The limestone includes shell limestone, dolomitic limestone, and sandy limestone ranging from loosely consolidated to hard and recrystallized. The sand beds have varying carbonate content and range from fine to coarse but typically are composed of fine to medium sand. Clay occurs as marl beds less than 10 ft thick or as matrix in both sand and limestone beds. The most distinguishing features of the Castle Hayne aquifer are its carbonate content and its great thickness of freshwater-bearing permeable material (more than 300 ft in well 101, pl. 13) combined with the absence of extensive or continuous clay layers.

A typical section of the Castle Hayne aquifer consists of alternating beds of limestone, sandy limestone, and sand, with limestone the dominant sediment throughout the upper one-third to one-half of its thickness. In the lower part of the aquifer, sand is the major permeable material; a number of geophysical logs show increasing silt and clay content near the bottom of the aquifer.

Along its western margin, from New Hanover County to Craven County, the Castle Hayne aquifer occurs near land surface and is exposed in many streams. North of this area, it is covered by the Pungo River and Yorktown aquifers. As it dips eastward, the aquifer thickens considerably. It is more than 950 ft thick at Camp Glenn, Carteret County (well 22, Supplemental Data), and approaches 1,200 ft thick beneath Cape Hatteras (Brown, 1958b, fig. 4). The dip of its buried top ranges between 13 and 15 ft/mi.

In the area roughly north of Albemarle Sound, the Castle Hayne aquifer generally is thinner, has a reduced carbonate content, and contains more clay than elsewhere. Limestone beds are thin or nonexistent, and on geophysical logs, sand beds appear to contain more clay. The average thickness of the aquifer north of the sound is about 50 ft between Bertie and Currituck Counties, with a maximum observed thickness of 164 ft in Currituck County (well 46, pl. 8).

DISTRIBUTION OF PERMEABLE MATERIAL

The Castle Hayne aquifer is the most productive aquifer in North Carolina, as exemplified by the 60 Mgal/d pumpage from the aquifer in Beaufort County since the mid-1960's (Peek and Nelson, 1975; Coble and others, 1984). Not only do the carbonate rocks composing the aquifer have higher hydraulic conductivity than the clastic aquifers in the North Carolina Coastal Plain, but also this thick aquifer has an average of 80 to 90 percent permeable material (pl. 18). Even where the aquifer thins near its northern and western limits, the permeable material is generally more than 60 percent of the total aquifer thickness.

Because the Castle Hayne aquifer is composed of rocks of widely different hydraulic conductivities—limestone and sand—the estimates of hydraulic conductivity were based on the amount of each rock type as determined from geophysical logs. The hydraulic conductivity value for limestone was averaged from aquifer-test data reported by Floyd (1969) and by DeWiest and others (1967, p. 94); values for sand were taken from Morris and Johnson (1967, table 5). The average of all values of estimated hydraulic conductivity for the aquifer is 65 ft/d (table 4); the range is from 15 ft/d where the aquifer is a thin bed of fine sand to 200 ft/d where the bulk of the thick aquifer is porous limestone.

OCCURRENCE OF SALTWATER

The positions of the 250 mg/L isochlors at the top and bottom of the Castle Hayne aquifer are shown on plate 18. The narrow width of the transition zone north of Beaufort County results from the aquifer thinning in that direction. Also, the factors that control deep circulation of freshwater in the Pungo River aquifer in this area apply as well to the Castle Hayne aquifer. The widening of the transition zone from Beaufort County southward coincides with the absence of the Yorktown aquifer and its associated clay beds, which overlie the Castle Hayne aquifer to the north. Thus, closer access to recharge plus the higher hydraulic conductivity of the limestone parts of the aquifer allow better circulation of ground water, resulting in the flushing of saltwater from the upper part of the Castle Hayne aquifer over a wide area.

A chloride concentration of as high as 10,000 mg/L has not been detected in water from the Castle Hayne aquifer in North Carolina. As is the case for the overlying Yorktown and Pungo River aquifers, water with this chloride concentration is expected to occur offshore.

CASTLE HAYNE CONFINING UNIT

The beds of clay, sandy clay, and clay with sandy streaks that overlie the Castle Hayne aquifer are designated the Castle Hayne confining unit. These beds belong mostly to the Belgrade Formation, the Pungo River Formation, or the Yorktown Formation, or to younger clays where the surficial aquifer alone overlies the Castle Hayne confining unit. The Belgrade Formation occurs in limited areas in Jones and Onslow Counties and is generally less than 10 ft thick (Ward and others, 1978).

This confining unit has an average thickness of about 14 ft (table 4); it exceeds 25 ft thick only in Gates County along the Virginia border, in eastern Pamlico and Carteret Counties, and in two small areas along the western limit of the Castle Hayne aquifer (pl. 18). In major stream valleys south of Craven County, the confining unit is missing and the Castle Hayne aquifer crops out. A few geophysical logs indicate no confining unit between

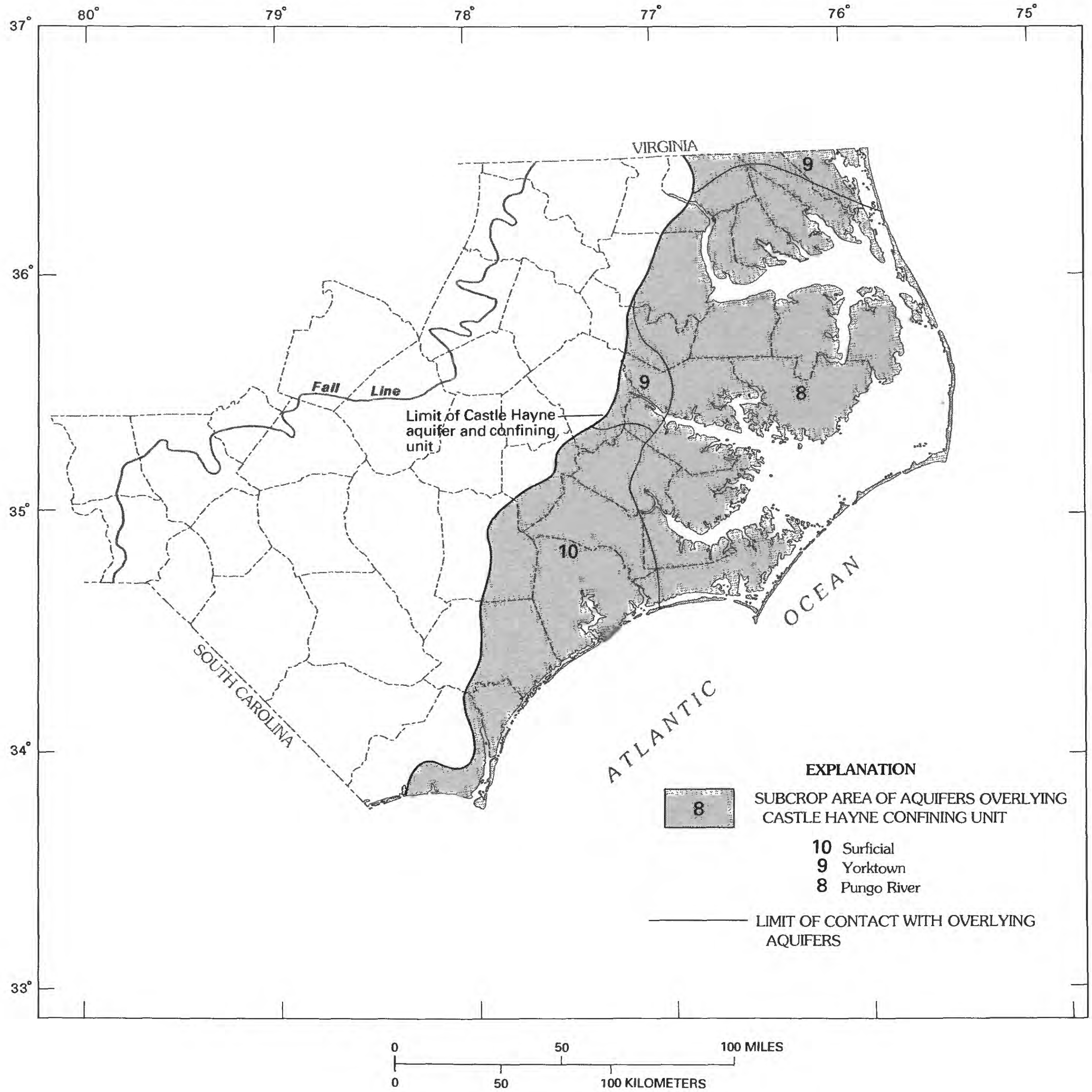

FIGURE 14.—Aquifers that directly overlie the Castle Hayne confining unit and aquifer.

the Pungo River and Castle Hayne aquifers in parts of Bertie and Chowan Counties.

Throughout much of its area, the Castle Hayne confining unit is thin and contains enough sand to allow significant leakage between the Castle Hayne and the overlying aquifers. However, the effectiveness of the confining unit is sufficient to support a 10-ft head difference across it in places (well 104, pl. 6).

RELATION WITH OTHER AQUIFERS

Throughout most of the northern and eastern areas of the Castle Hayne aquifer, the aquifer and its confining unit are overlain by the Pungo River aquifer (fig. 14). In most of the southern third of the aquifer area, the Castle Hayne aquifer and its overlying confining unit are covered by the surficial aquifer. The Yorktown aquifer overlies the Castle Hayne aquifer in a small area of Pitt and Beaufort Counties. Where the Pungo River aquifer pinches out near the Virginia State line, the Yorktown aquifer also overlies the Castle Hayne.

The most significant recharge area for the Castle Hayne aquifer is where it is overlain by only the surficial aquifer and rainwater need not percolate far to enter the Castle Hayne. Evidence of this recharge is found at well 99 (pl. 5) and at well 34 (pl. 6), where water levels in the surficial aquifer are only a few feet higher than those in the Castle Hayne aquifer immediately underlying it.

In the northern half of the Coastal Plain, the Castle Hayne aquifer is more deeply buried than in the southern half and is overlain by the upper two aquifers—the Pungo River and Yorktown aquifers. Typically, the head decreases downward into the Castle Hayne aquifer from overlying beds (well 144, pl. 7; well 56, pl. 8), indicating recharge.

Natural discharge from the Castle Hayne aquifer occurs in stream channels where the streams have cut into the aquifer or as upward leakage through overlying sediments beneath streams and estuaries where the aquifer is covered (Winner and Simmons, 1977). The potential for upward leakage is present in downdip areas, even where other overlying confining units are more than 80 to 100 ft thick, as at wells 108 and 109 (pl. 8).

The Castle Hayne aquifer is underlain by the Beaufort aquifer and its confining unit northeast of Jones and Onslow Counties and by the Peedee aquifer south of there (fig. 15). Differences in head between the Beaufort and Castle Hayne aquifers indicate that water moves upward into the Castle Hayne nearly everywhere that the Beaufort aquifer underlies it, except in a narrow zone about 10 mi wide paralleling the western limit of the Castle Hayne aquifer, where water moves downward to the Beaufort. In contrast, where the Peedee aquifer and confining unit directly underlie the Castle Hayne, differences in head between these aquifers indicate a general downward movement of water into the Peedee aquifer.

BEAUFORT AQUIFER

The Beaufort aquifer is composed primarily of rocks of the Beaufort Formation that were described by Brown (1959) as dark green and gray sand and clay of Paleocene age, and later by Brown and others (1972) as green or greenish-gray shale and fine to medium shaly, glauconitic sand of Midwayan age. The Beaufort Formation lies unconformably on rocks of Cretaceous age and is unconformably overlain by younger rocks (Lloyd, 1968a; Sumsion, 1970). The Beaufort Formation is covered by younger rocks except for some exposures in streambeds near its western limit. Brown and others (1977) describe such an exposure of the Beaufort Formation along a small stream northeast of Kinston in Lenoir County. As with the other hydrogeologic units, the definition of the Beaufort aquifer is not restricted to a single geologic formation; the aquifer may include permeable rock units of older Cretaceous formations that directly underlie the Beaufort Formation.

The Beaufort aquifer is composed of fine to medium glauconitic sand, clayey sand, and clay beds of marine origin, with occasional shell and limestone beds up to 5 or 6 ft thick. Except along the western margin of the unit (shown on pl. 19) and along the Virginia border, limestone and shell beds are distinctive in geophysical logs of wells and test holes in the central two-thirds of the area from Onslow County to Pasquotank County. They provide some of the marker beds for the correlation of this aquifer unit.

The altitude of the highest occurrence of the Beaufort aquifer is at sea level along its western margin just east of Kinston, Lenoir County (well 82, pl. 6). The top of the aquifer dips eastward at 14 to 33 ft/mi and is more than 1,300 ft deep from eastern Currituck County to eastern Carteret County (pl. 19).

The thickness of the Beaufort aquifer ranges from zero along its western limit to more than 150 ft east of a line between Swanquarter, Hyde County, and Hertford, Perquimans County. The maximum observed thickness is 171 ft in well 21 in Camden County (table 4). Where the aquifer is less than 100 ft thick, its average thickness is about 60 ft; where it is more than 100 ft thick, its average thickness is about 120 ft.

In the northern part of the area in Camden and Currituck Counties, the aquifer thins toward the east, as shown between wells 21 and 46 in hydrogeologic section *H–H′* (pl. 8). A general increase in clay content in the upper part of the aquifer and a corresponding thickening of the overlying confining unit suggest a nearby offshore limit to the aquifer.

DISTRIBUTION OF PERMEABLE MATERIAL

For most of the area along and within 10 to 15 mi of its western margin, the Beaufort aquifer consists of a single sand bed ranging in thickness from a few feet to about 40 ft; along a strip extending from Pitt County to Pamlico County, this single layer thickens to 80 ft (well 103, pl. 6). Elsewhere, the aquifer is composed of two or more sand layers. The areal extent of the single-sand-layer part of the Beaufort aquifer roughly corresponds to those areas where the unit consists of 80 to 90 percent permeable material, as shown on plate 19.

Over a large area of the northeastern Coastal Plain in and north of Beaufort and Hyde Counties, the aquifer contains less than 70 percent permeable material. To the east, in Dare County, it contains less than 50 percent

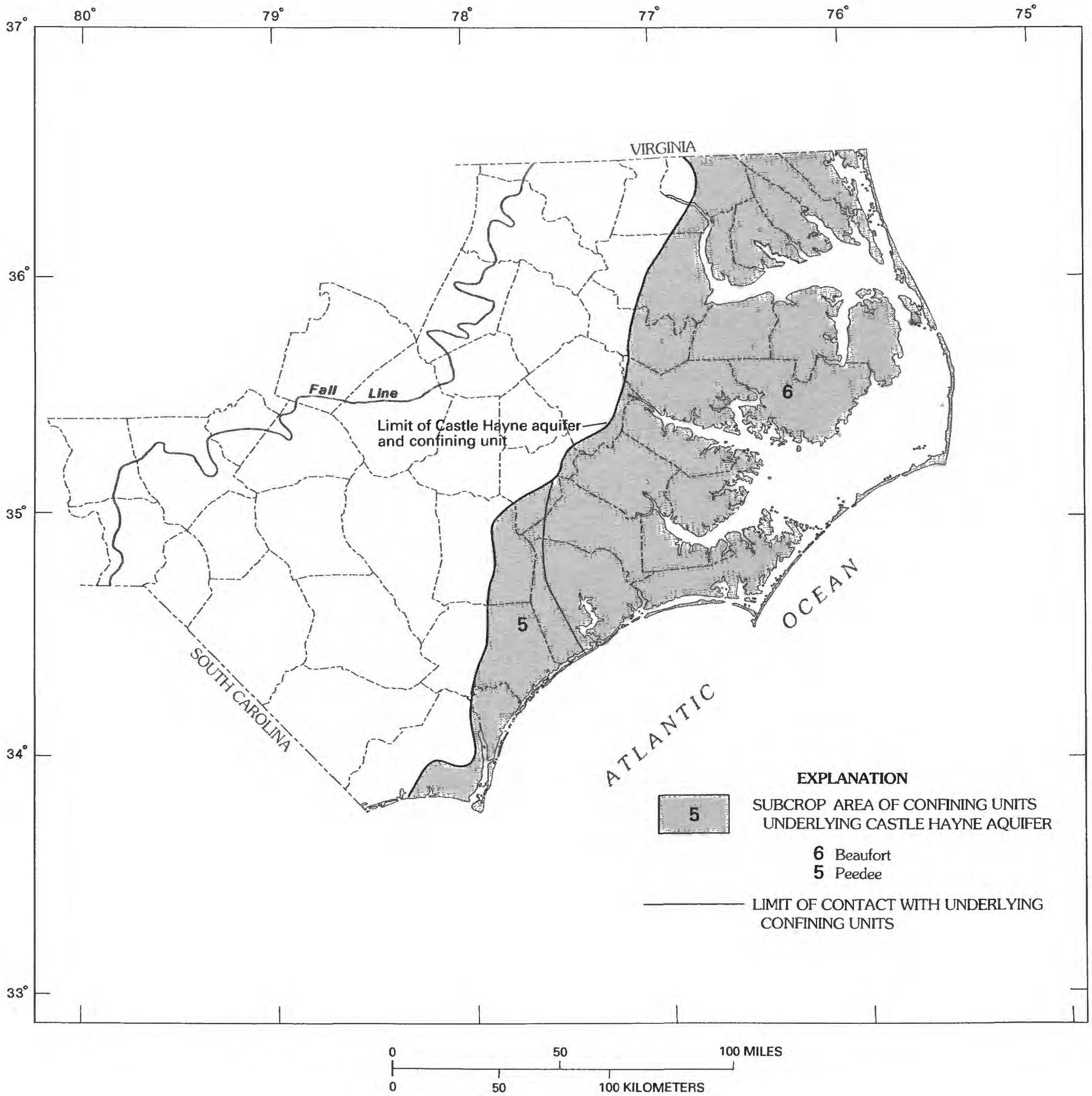

FIGURE 15.—Confining units that directly underlie the Castle Hayne aquifer.

sand. This eastward or northeastward trend of decreasing percentage of permeable material in the Beaufort aquifer parallels similar trends in the other aquifers composed of Tertiary sediments in this area of the Coastal Plain—the Castle Hayne, Pungo River, and Yorktown aquifers.

The average estimated hydraulic conductivity for the Beaufort aquifer is about 35 ft/d (table 4). Along its western margin, especially from Bertie County northward, where the aquifer consists of thin beds of fine sand, the estimated hydraulic conductivity is 15 to 25 ft/d. Lower than average hydraulic conductivity values also are estimated for the easternmost parts of the aquifer in Hyde, Dare, and Currituck Counties where, along with an increasing clay content, the aquifer contains greater proportions of finer sand. Lloyd (1968a, p.

46) reported a hydraulic conductivity of 29 ft/d for the Beaufort in Chowan County.

OCCURRENCE OF SALTWATER

Saltwater occurs in the Beaufort aquifer between 12 and 25 mi east of its western limit, as depicted by the 250 mg/L isochlors on plate 19. The transition zone is about 1 mi wide in Craven and Beaufort Counties and lies to the west of the transition zone in the highly transmissive Castle Hayne aquifer except in Gates County, where it lies to the east. In Gates County, the Beaufort extends up to 15 mi beyond the western limit of the Castle Hayne, affording a better opportunity for freshwater to recharge and circulate in the Beaufort aquifer than in any other part of the aquifer in the North Carolina Coastal Plain.

The interpretation of the location of the 10,000 mg/L isochlors in the Beaufort aquifer (pl. 19) is based on a water sample containing a chloride concentration of 13,000 mg/L taken from the top of this aquifer at the New Lake Research Station (well 72) in Hyde County and on data from Meisler (1980, fig. 4). The 10,000 mg/L isochlor is also shown in cross section as projected to hydrogeologic section *G–G′* (pl. 7).

Water in the Beaufort aquifer having a chloride concentration of 10,000 mg/L or greater is in an offshore area east of Currituck County and south of Carteret County and encompassing nearly all of Dare and Hyde Counties and parts of adjacent counties. Areas where the Beaufort aquifer contains saltwater onshore are interpreted to be parts of the aquifer from which residual seawater is not yet flushed.

The seaward turn of the 10,000 mg/L isochlors in the north may be due to better recharge conditions in Gates and Hertford Counties, as discussed above. In the south, better hydraulic connection with the Castle Hayne aquifer and its recharge source may be responsible for the Beaufort containing more extensive freshwater.

BEAUFORT CONFINING UNIT

The Beaufort confining unit consists of the uppermost sediments of the Beaufort Formation and possibly some younger clay, silt, and sandy clay. Over most of the area, geophysical logs typically show a gradation from sandy clay to clay in this confining unit. In a few places the confining unit is composed of a distinct clay with interlayered beds of fine sand or silt.

The thickness of the confining unit, shown on plate 19, ranges from zero to 80 ft and averages about 24 ft (table 4). From northern Onslow County to southern Beaufort County the confining unit averages only about 15 ft in thickness. In and northeast of Washington County, it thickens and is more than 50 ft thick in the vicinity of the coastline.

RELATION WITH OTHER AQUIFERS

More than 90 percent of the Beaufort aquifer and its confining unit are overlain by the Castle Hayne aquifer. They are overlain by the Yorktown aquifer along the northwestern margin in and north of Pitt County (fig. 16). The Beaufort aquifer is recharged from both the Yorktown and Castle Hayne aquifers in upland areas along a 15- to 20-mi-wide band paralleling the western margin of the aquifer.

The Beaufort aquifer discharges beneath stream valleys and throughout the area east of the recharge area described above. The Chowan River channel incises the Beaufort confining unit along the Gates-Hertford County border (pl. 8), as does the Neuse River just east of Kinston, Lenoir County (pl. 6). These two places are likely the last downdip points of relatively easy groundwater discharge from the Beaufort aquifer, although the aquifer may not be in direct contact with the stream channels.

Underlying the Beaufort aquifer are the upper Cape Fear, Black Creek, and Peedee aquifers and their confining units (fig. 17). The Peedee aquifer underlies most of the areal extent of the Beaufort aquifer (about 80 percent) and, thus, has the greatest potential for exchanging ground water with the Beaufort. The confining units overlying these lower aquifers appear to be both thicker and less permeable, on the whole, than the confining units above the Beaufort.

PEEDEE AQUIFER

The Peedee aquifer is composed largely of the Peedee Sand of Late Cretaceous age, as traced by Clark and others (1912, p. 145) from the type locality in South Carolina. The Peedee Sand later was redefined as the Peedee Formation by Stephenson and Rathbun (1923, p. 11). The Peedee aquifer may also contain sand units of older or younger age in some places. In North Carolina, the aquifer is present east and southeast of a line that extends from near the Robeson-Columbus County line at the South Carolina border northeastward through central Greene, Pitt, and Martin Counties and then east to the coast in southern Currituck County (pl. 20). The Peedee Formation is exposed at many points along the Cape Fear and Northeast Cape Fear Rivers and also along the Neuse River and streams as far north as Pitt County (Sumsion, 1970). The Peedee Formation disconformably overlies the Black Creek Formation (Sohl and Christopher, 1983, p. 30) and is mantled by a relatively thin veneer of Quaternary surficial deposits of fluvial and

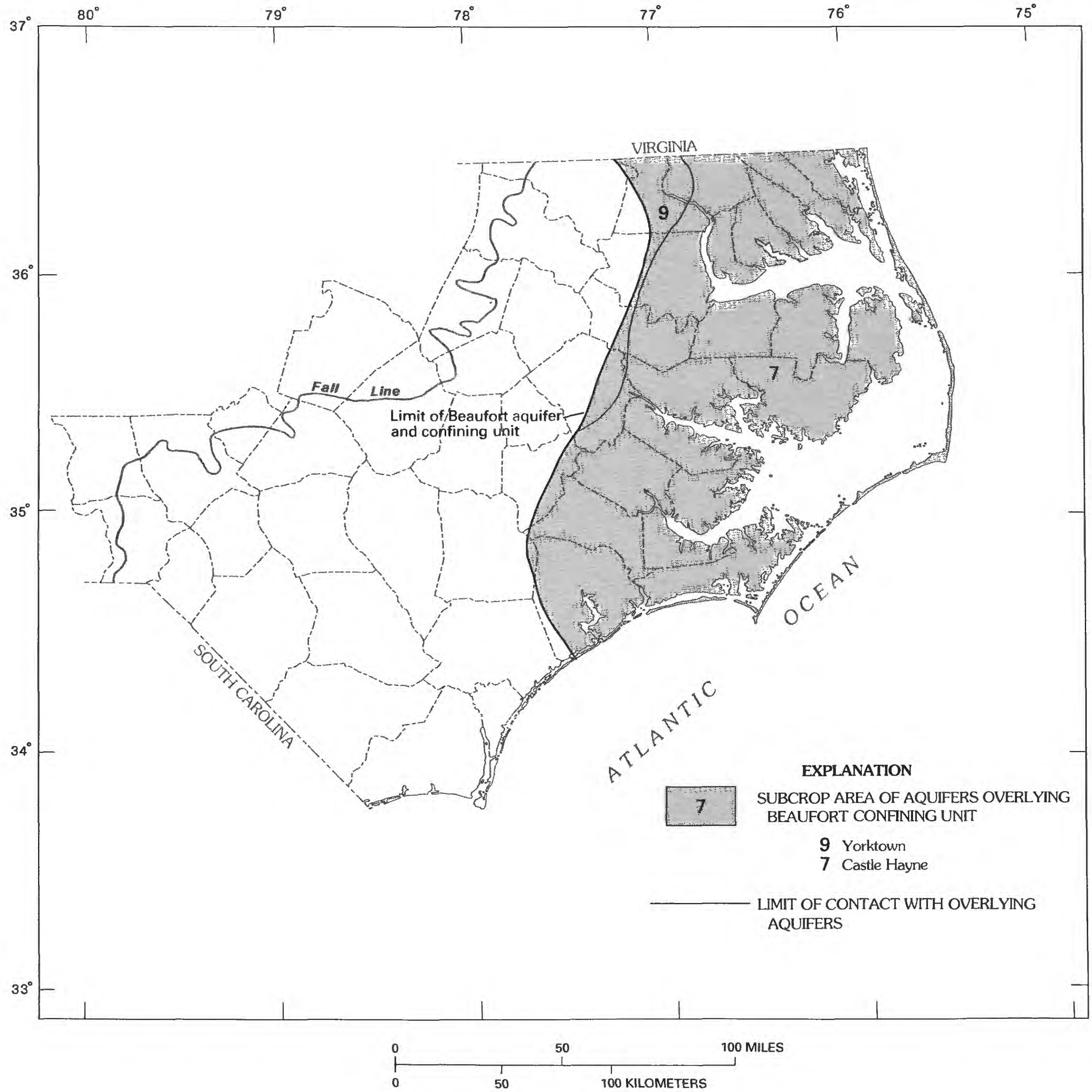

FIGURE 16.—Aquifers that directly overlie the Beaufort confining unit and aquifer.

littoral origin in the southern part of the area and by a thicker section of Tertiary sediments to the north.

The Peedee Formation is composed of fine- to medium-grained sand interbedded with gray to black marine clay and silt. Sand beds are commonly gray or greenish-gray and contain varying amounts of glauconite. Thin beds of consolidated calcareous sandstone and impure limestone are interlayered with the sands in some places, particularly in the southeastern North Carolina Coastal Plain. Shells are common throughout the formation.

The Peedee Formation is not recognized in northeastern North Carolina north of Albemarle Sound (pl. 20) or in Virginia. It is correlated with sediments of Navarro age in Maryland (Maher and Applin, 1971, p. 29) now included in the Severn Formation (Minard and others, 1977).

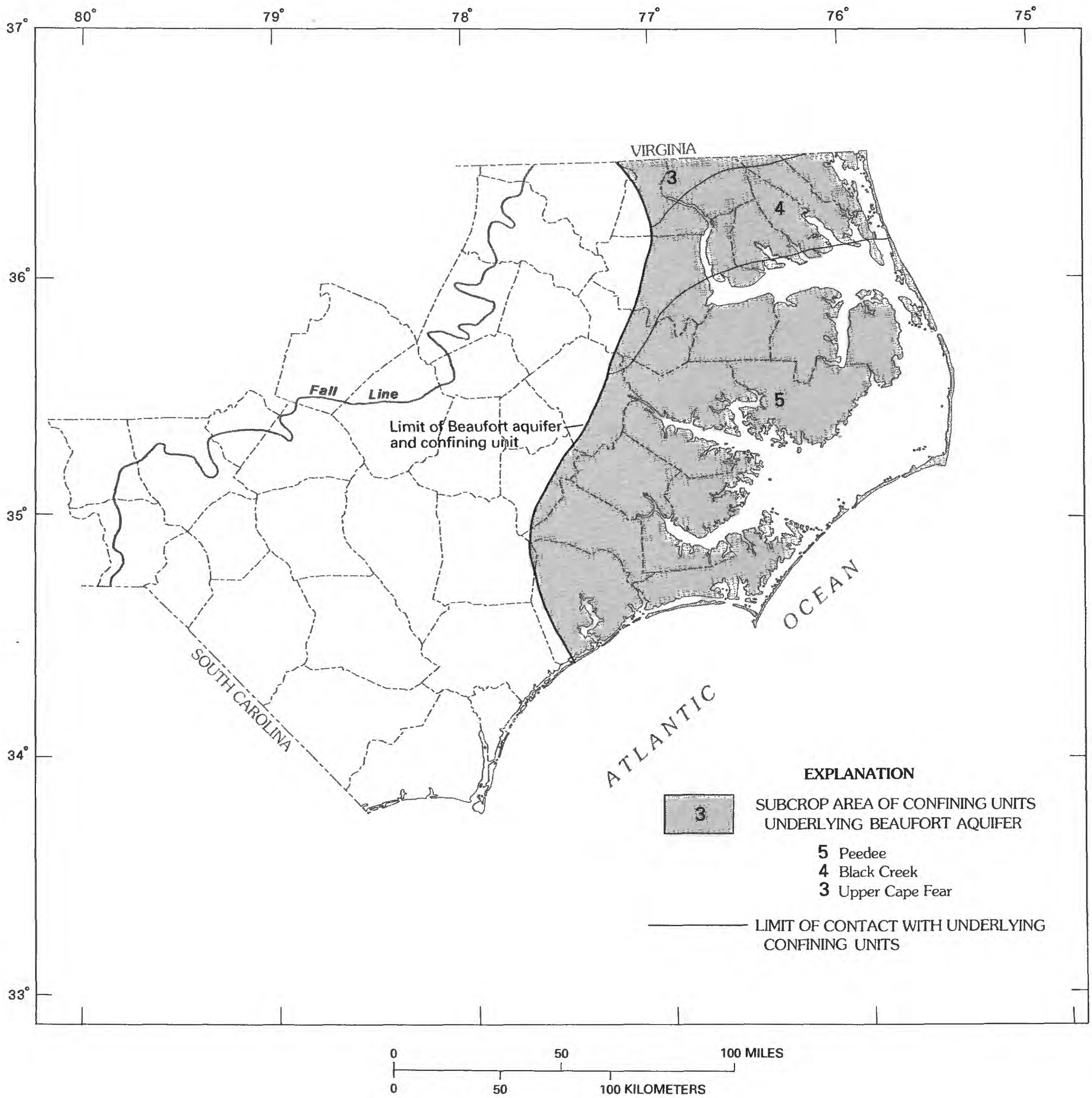

FIGURE 17.—Confining units that directly underlie the Beaufort aquifer.

The Late Cretaceous age of the Peedee Formation has been determined on the basis of fauna collected in outcrop areas. Downdip from the band of outcrop, the Cretaceous section thickens and beds that have no updip equivalents appear. The subsurface Peedee Formation has been defined differently by various authors. Spangler (1950, p. 116) restricted the Peedee Formation to Navarro-equivalent sediments. Brown and others (1972, p. 45) used microfauna and geophysical-log patterns to define their Unit A (Navarroan Stage) time-stratigraphic unit, and they mentioned the Peedee Formation in connection with that unit. Swift and Heron (1969, p. 238) defined the subsurface Peedee Formation on the basis of lithostratigraphic evidence of a depositional regime that was largely open marine and could be interpreted from geophysical logs.

Correlations of lithologic units composing the Peedee aquifer are shown in cross section on plates 2–7, 9, and 11–14; contours of the top of the aquifer are shown on plate 20. The top of the Peedee aquifer dips eastward at an average rate of about 24 ft/mi, with a range of from about 10 ft/mi along its inner margin, especially in the vicinity of the Cape Fear River, to more than 33 ft/mi along the coast, where the aquifer is deeply buried. The aquifer thickens from zero along its western limit to more than 300 ft along the coast from southern Onslow County to the South Carolina border. Northeast of Onslow County aquifer thickness is less than 200 ft.

DISTRIBUTION OF PERMEABLE MATERIAL

The Peedee aquifer consists of nearly 70 percent sand, on the average, throughout the Coastal Plain. The areas where sand exceeds this percentage are generally along the aquifer's western margin from Bertie County to Duplin County and from Bladen County to the South Carolina line. The aquifer also contains a high percentage of sand from Duplin County southeast to Onslow County, as well as in several smaller scattered areas (pl. 20).

The Peedee aquifer contains a substantial fraction of clay in three areas, as indicated by the sand percentage being less than 60 percent. These areas are east of Chowan County along the northern margin of the aquifer in Columbus, Brunswick, and New Hanover Counties, and in Onslow, Jones, and Carteret Counties.

The aquifer's typical fine to medium sand size suggests a hydraulic conductivity of about 25 ft/d; average estimated hydraulic conductivity is 34 ft/d (table 4). Generally, higher values of conductivity occur from southern Craven County southwestward to the South Carolina border, and lower values are found north and northeast of this area. Hydraulic conductivity values derived from aquifer-test data in New Hanover County (Bain, 1970, p. 35) and Pitt County (Sumsion, 1970, p. 34) are consistent with estimated values.

OCCURRENCE OF SALTWATER

The area delineating the freshwater-saltwater transition zone in the Peedee aquifer extends in a southerly direction from the aquifer limit in Bertie County to Onslow County, where it takes a more southwesterly course through Pender and Brunswick Counties (pl. 20). The transition zone widens along this trend from about 1 mi at the aquifer limit in Bertie County to almost 20 mi at the Cape Fear River. The transition zone is shown in cross section on plates 2, 4, 6, 7, and 11–13. Of particular note is a lens of freshwater in the Peedee aquifer beneath a wedge of saltwater in the overlying Beaufort aquifer in eastern Jones and Onslow Counties (pl. 13).

The 10,000 mg/L isochlors also are shown on plate 20. Chloride concentrations in excess of this amount have been measured in water from NRCD research station test wells in Pamlico and Tyrrell Counties (wells 103 and 104, pl. 6; well 140, pl. 7). The estimated positions of the 10,000 mg/L isochlors are also shown on these hydrogeologic sections.

PEEDEE CONFINING UNIT

The Peedee confining unit, which overlies the Peedee aquifer, is composed of clay, silty clay, and sandy clay. With the available data, this confining unit cannot be correlated with a particular geologic unit. However, it is known to represent the sediment at the Cenozoic-Mesozoic boundary, especially where the Beaufort aquifer overlies the Peedee aquifer; elsewhere, it may represent material spanning a longer period of geologic time.

The delineation of this confining unit is based largely on geophysical-log correlations and on scattered head and chloride data. In the deeper subsurface, a measured head difference across the Peedee confining unit was 13 ft in Jones County (well 77, pl. 5), and chloride values differed by several thousand milligrams per liter in well 90 in New Hanover County (pl. 4). Some confining layers locally within the aquifer may also cause significant vertical changes in head or chloride concentration in a few isolated areas.

The average thickness of the Peedee confining unit is nearly 25 ft; this is represented on plate 20 by the 25-ft thickness contour which extends from Bertie County southwestward to Brunswick County. East of this line, the confining unit is as much as 60 ft thick but does not exceed 35 ft thick in most places. West of the 25-ft contour, the confining unit averages about 15 ft in thickness, and in several areas it is very thin or missing.

The Peedee confining unit is missing in a few areas where streams have cut directly into the Peedee aquifer, such as along the Cape Fear and South Rivers in Bladen County, along the Neuse River in Wayne and Lenoir Counties, and along Contentnea Creek in Greene County (pl. 20). The confining unit probably is very thin or missing in a broad, low area between the Cape Fear and South Rivers (pl. 9). Accordingly, the updip limit of the Peedee confining unit as shown on plate 20 does not everywhere conform to the updip limit of the underlying Peedee aquifer, which extends farther west than the confining unit in several places.

The clays of the Peedee confining unit have very low permeability throughout most of its areal extent, but in two areas the confining unit appears to have a higher than usual vertical hydraulic conductivity because of a significant sand content. In these areas, water can move into or out of the Peedee aquifer more easily than in other areas. One area is in Bladen, Columbus, and Pender Counties where, in addition to its higher hydraulic conductivity, the confining unit is also less than 25 ft thick (pl. 20). The surficial aquifer overlies the Peedee aquifer here, and the confining unit between them is typically a clayey sand layer. The other area is where the Castle Hayne aquifer overlies the Peedee in southern Duplin and eastern Pender Counties. Geophysical logs indicate that the Peedee confining unit there is clayey sand or sandy clay.

RELATION WITH OTHER AQUIFERS

East and northeast of Onslow, Jones, Lenoir, and Pitt Counties, the Peedee aquifer and its confining unit are overlain by the Beaufort aquifer. They are also in contact with the Yorktown aquifer in a small area of Pitt and Greene Counties, with the Castle Hayne aquifer in a strip from southern Lenoir to eastern Brunswick County, and with the surficial aquifer over the remainder of the area where the Peedee aquifer is present (fig. 18).

In general, the Peedee aquifer is recharged by all overlying aquifers west of a line from central Onslow County to central Pitt County; east of this line, higher heads in the Peedee create the potential for upward leakage into the overlying aquifers. Discharge from the Peedee aquifer occurs along streams in the general recharge area in a similar way that streams are lines of discharge for other aquifers. The Cape Fear River and its larger tributaries in the Bladen County-Pender County area probably are major lines of discharge for the Peedee aquifer and deeper aquifers. Discharge in the Cape Fear valley is demonstrated by the increasing heads with depth observed in well 134 (pl. 4) and wells 12 and 116 (pl. 11).

The Black Creek aquifer underlies the Peedee throughout its extent. Head differences between the two aquifers allow for vertical exchange of ground water in both directions.

BLACK CREEK AQUIFER

The Black Creek aquifer consists mainly of sediments of both the Black Creek and Middendorf Formations. Clark and others (1912, p. 111) extensively described the Black Creek Formation outcrops from the Cape Fear River region to the Greenville area along the Tar River (Pitt County). It is well established that the Black Creek Formation is of Late Cretaceous age, and a number of investigators have further assigned Gulf Coast stage designations to the Black Creek. For example, Swift and Heron (1969, p. 211) correlated it with most of the Tayloran Stage and the upper part of the Austinian Stage, Maher and Applin (1971, p. 29) equated the formation with all of both Tayloran and Austinian Stages, and Dennison and Wheeler (1975, p. 186) extended older Black Creek sediments into the upper part of the Eaglefordian Stage. The Black Creek is composed of all or parts of chronostratigraphic units B, C, and D of Brown and others (1972, pl. 2), which correspond to the Tayloran, Austinian, and Eaglefordian Stages, respectively.

The Black Creek Formation is lagoonal to marine, consisting of thinly laminated gray to black clay interlayered with gray to tan sands. In some outcrops, the formation is characterized by sand-dominated or clay-dominated lenses. Other outcrops show well-defined beds of clean sand and gray to black clay. A primary characteristic of Black Creek sediments in the subsurface is their high content of organic material, particularly lignitized wood. Shell material and glauconite are also common.

The Middendorf Formation was originally named by Sloan (1904), who thought the unit was of Early Cretaceous age. Subsequently, Berry (1914) recognized that these rocks were of Late Cretaceous age and treated the Middendorf as a member of the Black Creek Formation. Swift and Heron (1969, p. 213) raised the Middendorf to formational status as part of their differentiation of the "Tuscaloosa Formation" into the Middendorf and Cape Fear Formations. The name "Middendorf Formation" is herein applied to a fluvial sequence of sediments cropping out to the west of the Black Creek Formation in the Sand Hills area of the Coastal Plain. Although the Middendorf is recognized as underlying the Black Creek in South Carolina (Hazel and others, 1977), Swift and Heron (1969, p. 217) suggested an intertonguing relation between these formations in their outcrop areas in North Carolina.

The Middendorf Formation ranges in age from early Austinian to Woodbinian, according to Swift and Heron (1969, p. 211) and Dennison and Wheeler (1975, p. 186). Harris (1978, p. 210), however, thought the Middendorf ranged from early Tayloran through Austinian. Hazel and others (1977, p. 73) assigned an age range from middle Eaglefordian to early Austinian. Christopher and others (1979) and Owens (1983) described the Middendorf as Austinian age only.

The Middendorf is composed of a heterogeneous mix of fine to medium sand and silty clay beds, coarse channel sand, and thin laminated beds of sand and clay, all of nonmarine origin. Crossbedding, lenses, pinch outs, and facies changes are common in the Middendorf and are typical of sediments deposited in a deltaic environment. Other characteristic features of the Middendorf are its

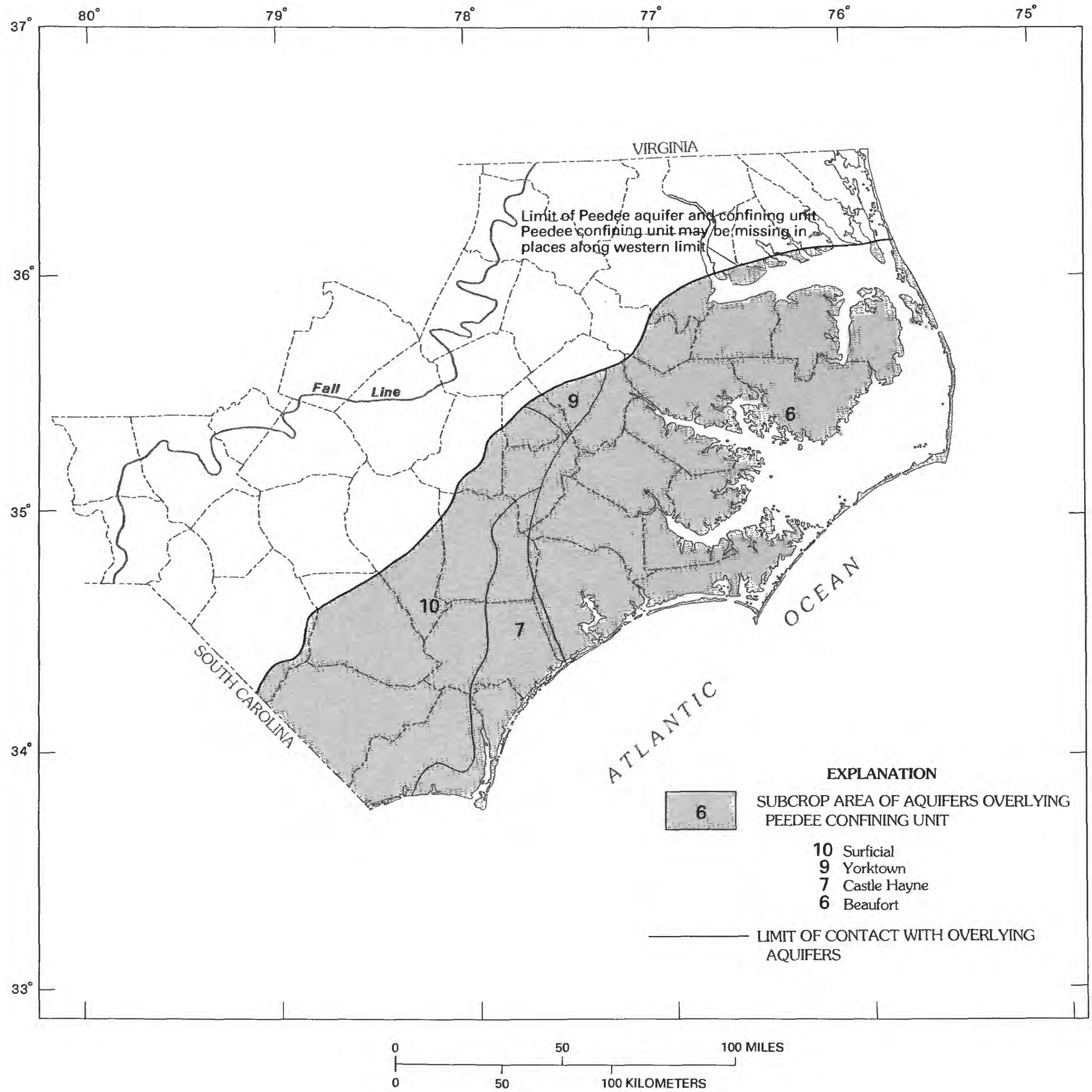

FIGURE 18.—Aquifers that directly overlie the Peedee confining unit and aquifer.

light color tones of white, tan, and red and kaolinitic clay balls or clay fragments scattered throughout the sand beds in outcrops.

Both the Middendorf and Black Creek Formations are reported to unconformably overlie older Cretaceous beds (Heron and Wheeler, 1964, p. 49). The surficial aquifer overlies these formations from outcrop eastward to the point where the Peedee Formation overlies the Black Creek Formation; the Middendorf Formation is not known to be in contact with the Peedee.

The type localities of the Black Creek and Middendorf Formations are in South Carolina, and the formations have been correlated into North Carolina. In Virginia, neither the Black Creek nor the Middendorf are recognized depositional units; however, Brown and others (1972, pls. 11–13) showed equivalent chronostratigraphic units B, C, and D in the extreme southeastern part of Virginia.

The Black Creek aquifer in this report is defined to include the sediments of both the Black Creek and Middendorf Formations and their downdip equivalents as interpreted from geophysical logs and lithologic descriptions. The correlation of the Black Creek aquifer throughout the Coastal Plain is shown on the hydrogeologic sections on plates 2–14.

The updip limit of the Black Creek aquifer extends eastward from the Fall Line at the South Carolina State line to Johnston County, and thence northeastward to Gates County, where it swings eastward, nearly paralleling the Virginia border (pl. 21). The top of the Black Creek aquifer is about 1,600 ft below sea level in western Dare County (well 48, pl. 7). Although data are not available to define the aquifer farther east with confidence, sediments equivalent to those of the Black Creek aquifer are as deep as 3,000 ft at Cape Hatteras (Brown and others, 1972, pl. 50). In general, the aquifer is more steeply dipping in the northern Coastal Plain than to the south. It dips east-southeast at a rate of about 17 ft/mi, increasing coastward to about 38 ft/mi in the north; in the south, the maximum southeastward dip of the aquifer is about 12 ft/mi. The aquifer is thickest along the Pender County coast northward to central Craven County, where it is as much as 400 ft thick.

DISTRIBUTION OF PERMEABLE MATERIAL

On the average, the Black Creek aquifer contains nearly 60 percent sand (pl. 21). The distribution of sand is fairly uniform throughout the aquifer. There are no large areas where the aquifer is composed of less than 50 percent or more than 70 percent sand, nor are there any regional trends. The largest variations of sand percentage are in the Sand Hills area. These are attributed to the heterogeneous, fluvial nature of the Middendorf sediments.

Sand in the Black Creek aquifer is predominantly very fine to fine. Lithologic descriptions commonly refer to some Black Creek beds as fine "salt and pepper" sands, a reference to their content of dark glauconite grains. The hydraulic conductivity of the Black Creek aquifer is estimated to range from about 15 to 50 ft/d, the average value being about 28 ft/d (table 4).

As interpreted from lithology, the aquifer has lower hydraulic conductivity values in the northeast from Currituck to Tyrrell and Dare Counties, along its northwest limit, and in the Sand Hills area. It has higher hydraulic conductivity values along the southeast coast from eastern Brunswick County to Onslow County.

More definitive values of hydraulic conductivity for the Black Creek aquifer are derived from aquifer tests. In Martin County, an average test value is 23 ft/d (Wyrick, 1966, p. 39). Sumsion (1970, p. 33) listed tests in Pitt County showing a range of values from 16 to 33 ft/d. A value of 30 ft/d was derived from two aquifer tests at Kinston, Lenoir County (Nelson and Barksdale, 1965, p. 22); for the Middendorf sediments (locally called the Sandhills aquifer) at Pinehurst, Moore County, test data indicated a hydraulic conductivity of 19 ft/d (NRCD, Office of Water Resources, 1980). In addition to these data, preliminary tests at several NRCD research stations showed the hydraulic conductivity of the Black Creek aquifer to be approximately 15 to 50 ft/d.

OCCURRENCE OF SALTWATER

The transition zone in the Black Creek aquifer closely parallels the transition zone in the Peedee aquifer in the northern half of the Coastal Plain, but in the south it is slightly west of the one in the Peedee aquifer. The greatest width of the transition zone in the Black Creek aquifer ranges between 6 and 10 mi, and is similar to that in the Peedee aquifer in the southern Coastal Plain.

The position of the 250 mg/L isochlor, along with chloride concentration values for points within the aquifer, are shown on several hydrogeologic sections (pls. 2, 4–8, 11, 13). In a small area of central Craven County, freshwater in the Black Creek aquifer occurs beneath saltwater in the Peedee aquifer (pls. 6, 13). The areal extent of this anomaly can be seen by comparing the 250 mg/L isochlors on plates 20 and 21.

The 10,000 mg/L isochlors in the Black Creek aquifer also are shown on plate 21 and in three hydrogeologic sections (pls. 6–8). No analyses of water from the Black Creek aquifer are available that show chloride concentrations of 10,000 mg/L or more; the positions of these isochlors have been inferred from the chloride values of water samples from overlying and underlying aquifers and from Meisler (1980, fig. 4).

BLACK CREEK CONFINING UNIT

The Black Creek confining unit, which overlies the Black Creek aquifer, is composed of clay, silty clay, and sandy clay, primarily of the uppermost beds of the Black Creek Formation. Along the western limit of the Black Creek aquifer in the northern Coastal Plain, where Tertiary rocks overlie it, the confining unit may include clay beds of the lower parts of the Beaufort or Yorktown Formations. In the deeper subsurface, where the continuity of confining units is interpreted from head relationships and water-quality data, the confining unit may be composed of clay beds of either the Black Creek or Peedee Formation. Where the Black Creek aquifer is composed of the Middendorf Formation in the Sand Hills, the Black Creek confining unit is the uppermost Middendorf clay.

The correlation and interpretation of the extent of the Black Creek confining unit are shown on plates 2–14. In the highly dissected Sand Hills, the Middendorf clays that constitute this confining unit are cut through in many places by streams, as illustrated on plate 2. Thus, the aquifer here is confined only beneath hilltops. Farther east, the channels of larger streams, such as the Cape Fear and Neuse Rivers, also have cut through the confining unit to allow direct hydraulic connection between the streams and the Black Creek aquifer.

The Black Creek aquifer pinches out before reaching the Fall Line along the northern half of the Coastal Plain. Beyond the pinch out, clay beds equivalent to the Black Creek confining unit are included in the upper Cape Fear confining unit overlying the upper Cape Fear aquifer, which extends farther west than the Black Creek aquifer.

The extent and thickness of the Black Creek confining unit are shown on plate 21. The average thickness of the confining unit is about 45 ft, but it ranges up to at least 168 ft (table 4). The confining unit thickens over the eastern part of the Coastal Plain. This thickening reflects the regional coastward thickening of Coastal Plain sediments. The pinching out of aquifer units and the merging of clay beds add considerable thickness to the confining unit in a number of places along the Inner Coastal Plain.

The Black Creek confining unit is thinnest in the Sand Hills area, averaging about 10 ft, owing to the discontinuous nature of Middendorf fluvial sand and clay beds. Here, the confining unit is defined as the first clay bed occurring near the top of the Middendorf Formation.

RELATION WITH OTHER AQUIFERS

The Black Creek aquifer and its confining unit are overlain by the Peedee, Beaufort, Yorktown, and surficial aquifers (fig. 19). The Peedee aquifer covers the eastern two-thirds of the Black Creek aquifer, and the surficial aquifer (where present) is in contact with the Black Creek aquifer from the Fall Line to the western limit of the Peedee aquifer in much of the southern Coastal Plain, except for a small area of intervening Yorktown aquifer in Robeson County. The Yorktown and Beaufort aquifers overlie the Black Creek along its western limit in the northern Coastal Plain.

Recharge to the Black Creek aquifer occurs mainly by downward percolation from the overlying aquifers. This recharge process generally is limited to interstream areas along the western half of the area.

The Black Creek aquifer in the western part of the aquifer area discharges into streams where their channels cut into it or into its overlying confining unit. Discharge by upward leakage generally occurs southeast of a line from central Gates County to central Columbus County. However, in some areas of heavy pumping from the Black Creek aquifer, such as in the central Coastal Plain around Lenoir and Craven Counties (fig. 6), natural discharge has been completely captured by pumping.

The upper Cape Fear aquifer and confining unit underlie the Black Creek aquifer everywhere except in a narrow area along the Fall Line from Richmond to Johnston Counties. Where the upper Cape Fear aquifer is absent near the Fall Line, the Black Creek aquifer directly overlies basement rocks, as shown on plates 2, 4, and 5.

UPPER CAPE FEAR AQUIFER

The upper Cape Fear aquifer comprises permeable zones in the upper part of the Cape Fear Formation. These sediments compose a distinct hydrologic unit apart from the lower part of the Cape Fear Formation. The Cape Fear Formation has been described by various workers from its outcrops exposed along the Cape Fear, Neuse, and Tar Rivers and is the oldest exposed Cretaceous unit of the North Carolina Coastal Plain. First named by Stephenson (1907), these rocks were called the Patuxent Formation by Clark and others (1912) and the Tuscaloosa Formation by Cooke (1936). The name "Cape Fear Formation" was reinstated by Sohl (1976). The Cretaceous age of the Cape Fear has been long established, but the specific placement of the formation within the system has not been firmly fixed. For example, the age of the Cape Fear as given by recent workers ranges from late Santonian (Christopher and others, 1979) for an upper limit, to Early Cretaceous (Jordan and Smith, 1983) for a lower limit. However, the U.S. Geological Survey considers the Cape Fear Formation Austinian in age (Renken, 1984).

The Cape Fear Formation is not recognized from Virginia northward, and its extension north of the Cape Fear River is by virtue of similar exposures along the Neuse, Tar, and Roanoke Rivers. Swift and Heron (1969, p. 209) also correlated the Cape Fear Formation in the northeast Coastal Plain with the Washitan and Fredericksburgian sediments in Halifax County described by Brown (1963, p. 4).

The lithologic characteristics of the Cape Fear Formation in outcrop were thought by Heron and Wheeler (1964, p. 16) to indicate deposition in a nearshore marine environment. The outcropping Cape Fear consists of alternating beds of sand and clay that are commonly 3 to 5 ft thick but range from a fraction of a foot to 15 ft thick. Some beds show vertical gradation from sand to clay, while others carry thin conglomerates of quartz pebbles or mudstone fragments. Where the Cape Fear is deeply

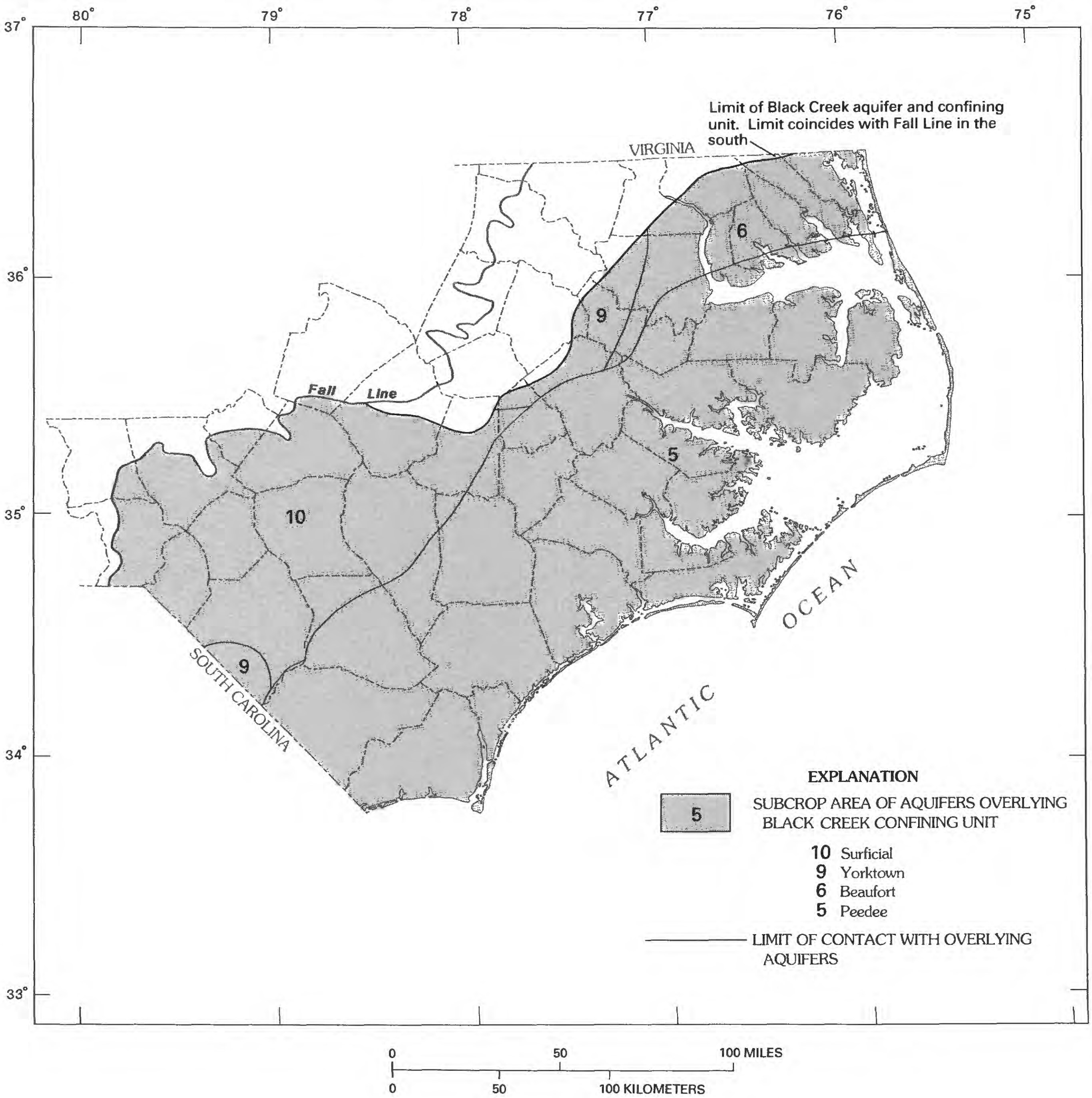

FIGURE 19.—Aquifers that directly overlie the Black Creek confining unit and aquifer.

buried in South Carolina, it is reported to have sand and clay beds of marginal-marine origin interbedded with coarse feldspathic sands and silty clays of continental origin (Gohn and others, 1977, p. 66).

Within the eastward-thickening wedge of Cape Fear sediments, at least two hydrologic units can be differentiated on the basis of hydraulic head. The uppermost unit is termed the "upper Cape Fear aquifer," which is further defined as consisting of the rocks of the Cape Fear Formation as recognized in outcrop areas and as traced laterally by geophysical- and lithologic-log correlations. Where hydrologic continuity dictates, the upper Cape Fear aquifer may also include some lowermost Middendorf beds in downdip areas. The correlation of the upper Cape Fear aquifer throughout the Coastal Plain is presented in the hydrogeologic sections on plates 2–14.

In a small area in Columbus County, at least two interpretations for subdividing the formation are possible. Data are not available that indicate how these continental-type deposits can be correlated in the dip direction and to the south along strike into South Carolina. Hydrogeologic sections through this area are labeled "aquifer correlation uncertain" (pls. 2, 9, 14).

The top of the upper Cape Fear aquifer, shown on plate 22, has a general northeast strike and a dip of up to 50 ft/mi toward the southeast; however, the dip is only about 10 ft/mi along the axis of the Cape Fear arch in Bladen, Columbus, and Brunswick Counties. The aquifer does not extend to the Fall Line except in a few places. Generally, sand units of the upper Cape Fear aquifer along its western edge are thin and pinch out, as shown on plates 2–5. Also, along the western edge of the aquifer from near Goldsboro, Wayne County, to Halifax County, a thick section of clay containing very little permeable material is present between basement rocks and the upper Cape Fear aquifer (pl. 10).

The aquifer thickens eastward from about 10 ft along its western edge to nearly 500 ft in central Tyrrell County. Its average thickness is just over 100 ft (table 4), and its greatest thickness occurs beneath the Albemarle-Pamlico Peninsula east of Beaufort and Washington Counties. It is generally less than 100 ft thick over and along the northern flank of the Cape Fear arch.

DISTRIBUTION OF PERMEABLE MATERIAL

The upper Cape Fear aquifer, on the average, is composed of about 60 percent sand, with the amount of sand ranging between about 30 and 90 percent. The areal distribution of sand in the aquifer is shown on plate 22. The region east of Wilson and Edgecombe Counties to Beaufort and Washington Counties, and possibly beyond, is the largest area where the percentage of sand in the aquifer is lower than average. The aquifer contains a slightly greater proportion of sand in the southeast Coastal Plain in the vicinity of the Cape Fear River. Relatively small areas of the aquifer along the Inner Coastal Plain contain more than 80 percent sand; in these areas the aquifer is thin and consists of a single sand bed (pls. 3, 10).

The sands that compose the upper Cape Fear aquifer are poorly sorted, with grain size ranging from very fine to gravel; the most common sand size, as determined from lithologic logs, is medium or fine to medium. Aquifer-test data for the upper Cape Fear aquifer are scarce. Hydraulic conductivity values from two tests in Wilson County (Winner, 1976, p. 54), from tests in Pitt County (Sumsion, 1970, p. 32), and from an unpublished test by NRCD in Greene County range from about 25 to 50 ft/d. Hydraulic conductivity as estimated in this study ranges from 10 to 70 ft/d and averages 30 ft/d (table 4).

Generally, the upper Cape Fear aquifer has lower hydraulic conductivity in the Sand Hills region and higher hydraulic conductivity along the coast from Brunswick to Onslow Counties. The sands of the Cape Fear Formation are poorly sorted and have a clay matrix in most areas of the Inner Coastal Plain, including the Sand Hills (Heron and Wheeler, 1964, p. 13); the sand beds are more uniform (as determined from geophysical logs) in downdip areas.

OCCURRENCE OF SALTWATER

Except for an area near the Virginia border from Gates to Pasquotank Counties, the freshwater-saltwater transition zone in the upper Cape Fear aquifer (pl. 22) lies just west of the transition zone in the Black Creek aquifer (pl. 21). Where the upper Cape Fear aquifer is thin (well 119, pl. 7), the transition zone is 1 to 2 mi wide. In parts of the Cape Fear valley, the aquifer is thicker (pl. 4) and the transition zone is as much as 8 mi wide, as shown in the hydrogeologic sections on plates 2, 4–9, and 14. There are no known places where freshwater occurs or is likely to occur beneath the upper Cape Fear aquifer where this aquifer contains saltwater.

The position of the 10,000 mg/L isochlors shown on plate 22 is based on analyses of water samples collected at several NRCD research stations. These isochlors parallel and lie slightly west of those in the Black Creek aquifer in the northern half of the Coastal Plain. The distance between the 10,000 mg/L isochlors intersecting the top and bottom of the upper Cape Fear aquifer ranges from 5 to 10 mi. Southeast of Craven County the 10,000 mg/L isochlors are near the coast, and east of Brunswick County they lie offshore.

The landward reentrant of the 10,000 mg/L isochlors in New Hanover and Pender Counties along the Cape Fear River is based on data from a test hole (well 115, pl. 4) at Moores Creek National Park near Currie in Pender County. This reentrant of saltwater appears to be related to the ground-water circulation pattern in the aquifer. Primarily, the Cape Fear River valley is a discharge area of the upper Cape Fear aquifer.

UPPER CAPE FEAR CONFINING UNIT

The upper Cape Fear confining unit, which overlies the upper Cape Fear aquifer, consists of nearly continuous clay, silty clay, and sandy clay beds. Most of these beds belong either to the lower Middendorf Formation in the Sand Hills area (and possibly extend downdip) or to the Black Creek Formation. The confining unit may also

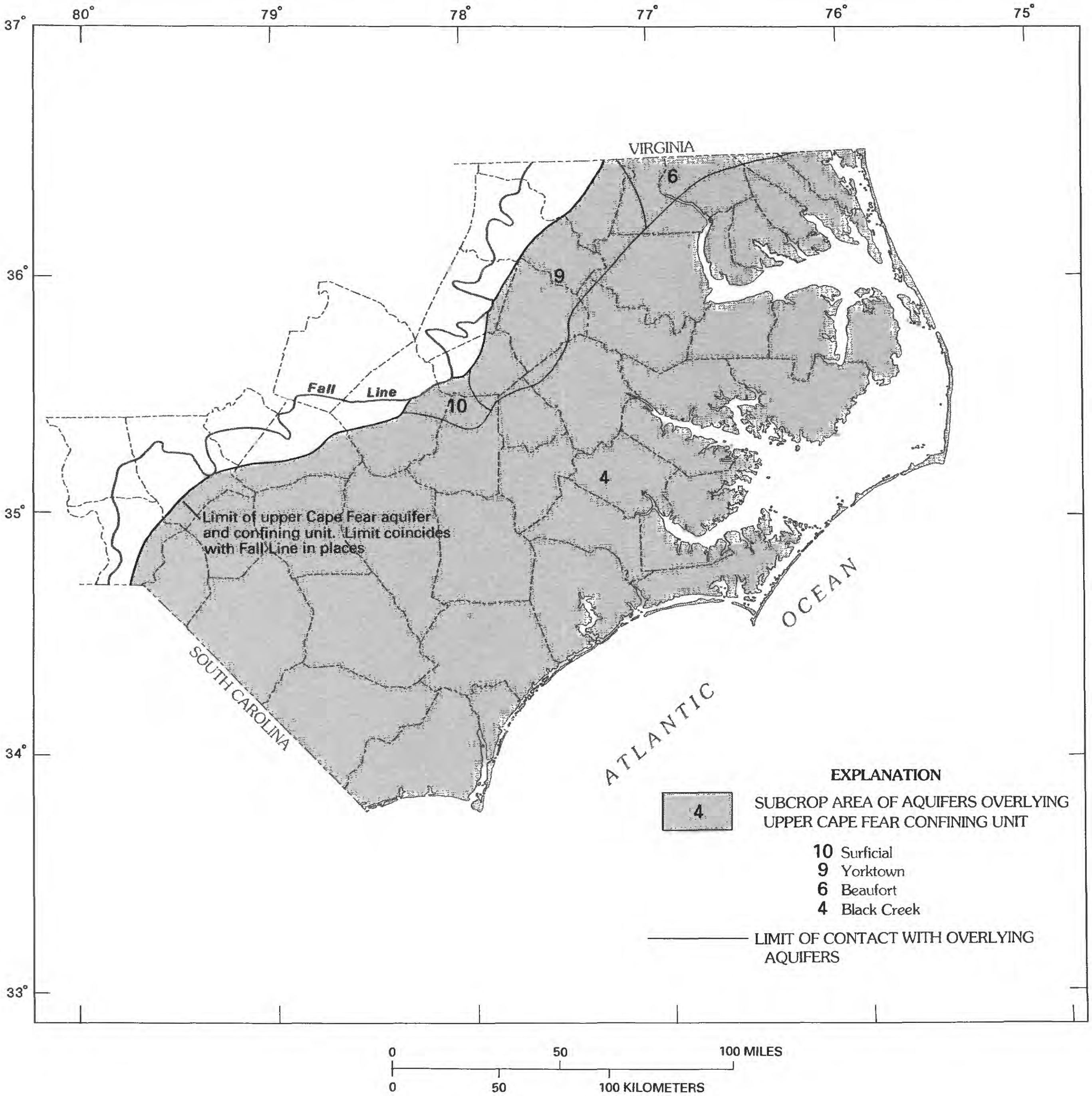

FIGURE 20.—Aquifers that directly overlie the upper Cape Fear confining unit and aquifer.

include clay beds in the uppermost Cape Fear Formation in the eastern third of the Coastal Plain, where the sedimentary wedge thickens greatly. Along the northwestern part of the Coastal Plain in and north of Wayne County, where the Cape Fear Formation is overlain by the Yorktown Formation (fig. 20), clays in the lower part of the Yorktown are also included in this confining unit.

The hydrogeologic sections (pls. 2–14) show the correlation of the upper Cape Fear confining unit throughout the Coastal Plain and its relation to the aquifers it separates. Along the Inner Coastal Plain, the Cape Fear and Neuse Rivers are in close hydraulic connection with the upper Cape Fear aquifer where their channels cut through or into the confining unit (pls. 3, 6). On the basis of geologic descriptions of outcropping materials, the Tar and Roanoke Rivers are also inferred to cut into the upper Cape Fear aquifer along short reaches near the western limit of the aquifer.

A general coastward thickening of the confining unit is indicated on plate 22. The average thickness of the unit calculated from measurements in wells penetrating it is 48 ft (table 4); however, there are areas where the confining unit is thicker than 100 ft. One of these is from Scotland and Hoke Counties southeastward into Bladen County, and possibly into Columbus County; another area is centered around the common point of Onslow, Duplin, and Pender Counties, and a third is in Dare County.

RELATION WITH OTHER AQUIFERS

Over about 90 percent of the aquifer area—from the Sand Hills, where the Black Creek overlaps the upper Cape Fear northeast to Currituck County at the Virginia border—the upper Cape Fear aquifer and its confining unit are overlain by the Black Creek aquifer (fig. 20). The Yorktown aquifer overlies the upper Cape Fear along its northwestern limit, and the Beaufort aquifer overlies the upper Cape Fear in Gates, Hertford, and Camden Counties near the Virginia border. A small patch of undifferentiated post-Miocene deposits (surficial aquifer) overlies the upper Cape Fear in Wayne, Wilson, and Johnston Counties.

Recharge to the upper Cape Fear aquifer is from downward percolation of water through the overlying aquifers and confining units, primarily in interstream areas along the western limit of the aquifer. Before the advent of large-scale pumping from the upper Cape Fear, its natural recharge area was a zone estimated to be about 25 mi wide paralleling the western limit of the aquifer. Pumping has altered this natural recharge pattern in some areas, and widespread cones of depression cause water to move into the aquifer from both overlying and underlying aquifers.

Natural discharge from the upper Cape Fear aquifer occurs along and directly into streams whose channels incise the unit. Plate 22 shows where the upper Cape Fear confining unit is missing in valleys of some of the larger streams. Discharge to many smaller streams undoubtedly occurs as upward leakage through overlying sediments. Discharge from the upper Cape Fear aquifer in predevelopment times probably occurred everywhere east of the zone of recharge; the natural discharge pattern has also been altered by ground-water withdrawals.

The lower Cape Fear aquifer underlies the upper Cape Fear aquifer throughout the eastern three-fourths of its area in the Coastal Plain (fig. 21). Everywhere to the west of the lower Cape Fear aquifer, the upper Cape Fear aquifer is in direct contact with basement rocks or with undifferentiated clay units on top of the basement rocks.

LOWER CAPE FEAR AQUIFER

The lower Cape Fear aquifer is composed of older sand beds of the Cape Fear Formation, as discussed in the section on the upper Cape Fear aquifer. These older sediments are distinguished as a hydrogeologic unit separate from the overlying younger sand units of the Cape Fear Formation. The lower Cape Fear sediments do not extend as far west as do the sands that compose the upper Cape Fear aquifer; rather, they pinch out against the eastward-sloping bedrock surface (pls. 2, 3). The lower Cape Fear aquifer is traced northward to a point where it extends farther west and is close to the Fall Line near the Virginia border (fig. 21).

The extent of the lower Cape Fear aquifer is also shown on plate 23. The top of this aquifer has a northeastward strike similar to that of the upper Cape Fear aquifer and shows a slightly greater southeast dip (15 to 55 ft/mi). The thickness of the lower Cape Fear aquifer ranges from a few feet along its western margin to at least 400 ft downdip, with an average of nearly 175 ft (table 4). Its greatest thickness in the northeastern Coastal Plain is attributed to the influence of the Albemarle embayment on deposition of the Cape Fear Formation (fig. 5).

DISTRIBUTION OF PERMEABLE MATERIAL

The sand composition of the lower Cape Fear aquifer averages about 58 percent and ranges from about 40 to 90 percent, according to data from 48 wells that penetrate the aquifer (table 4). Sand percentage distribution in the aquifer is shown on plate 23. Sand beds compose more than 60 percent of the aquifer in several scattered areas; the largest of these is an arc-shaped area extending from southern Duplin County, through Sampson and Bladen Counties, to Columbus County, where the aquifer has an average sand content of more than 70 percent.

Clay predominates in the aquifer in two areas. One is along its western margin in southern Pitt, western Craven, Jones, and eastern Lenoir Counties; the other is in Pender and Brunswick Counties. The aquifer averages only about 48 percent sand in these places.

The sand beds of the lower Cape Fear aquifer have a range in grain size from fine to coarse, but the most common descriptions in lithologic logs are of medium to fine and medium sands. Gravel has been noted in a few wells along the inner margin of the aquifer, and along the

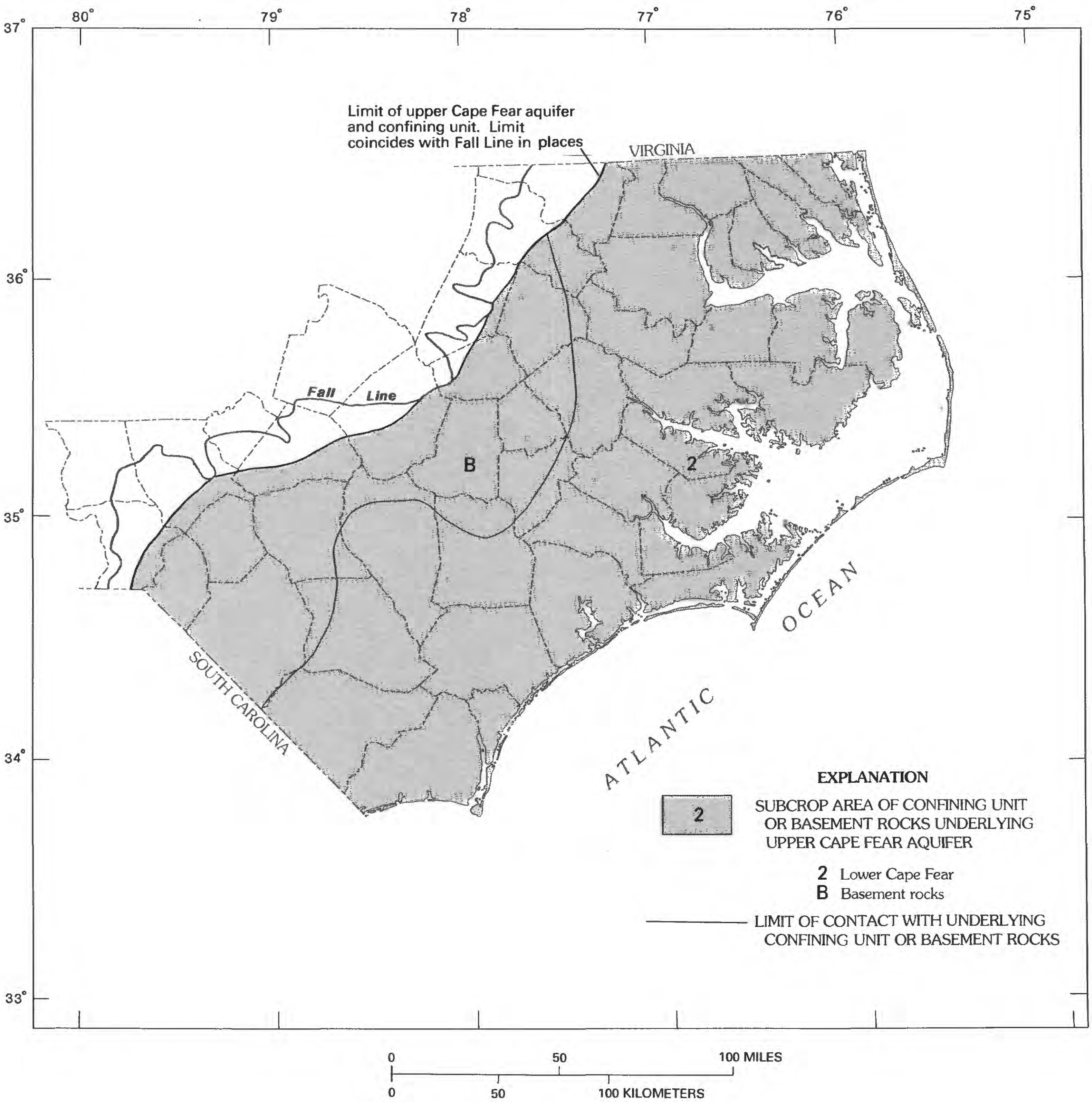

FIGURE 21.—Areas where the lower Cape Fear confining unit or basement rocks directly underlie the upper Cape Fear aquifer.

coastline the aquifer contains some thin beds of limestone.

Estimated hydraulic conductivity for the aquifer ranges between 20 and 75 ft/d and averages 34 ft/d (table 4). No aquifer tests have been conducted on the lower Cape Fear aquifer in North Carolina. However, some tests at Norfolk, Va., in a sand bed approximately equivalent to part of this aquifer, indicate a hydraulic conductivity of about 60 ft/d (Brown and Silvey, 1977, p. 11).

OCCURRENCE OF SALTWATER

In North Carolina, the lower Cape Fear aquifer contains freshwater only along its western margin in Northampton, eastern Halifax, southern Pitt, eastern

Lenoir, and central Duplin and Sampson Counties. The freshwater-saltwater transition zone lies east and southeast of these counties; within them only the uppermost sands of the aquifer contain freshwater. The width of the transition zone, as shown on plate 23, is about 32 mi along the Virginia border, where the aquifer is thickest. The width narrows to about 5 mi in the central part of the Coastal Plain in Craven County. The position of the 250 mg/L isochlors is also shown in hydrogeologic sections (pls. 2–6, 8, 9, 14).

Analyses of water samples from NRCD research station wells tapping the lower Cape Fear aquifer provide data for locating the 10,000 mg/L isochlors shown on plate 23. Data from overlying and underlying aquifers were also used in the analysis. These isochlors parallel and lie west of those in the overlying upper Cape Fear aquifer. The distance between the 10,000 mg/L isochlors intersecting the top and bottom of the aquifer is between 2 and 15 mi. Profiles of the 10,000 mg/L isochlors are shown in the hydrogeologic sections (pls. 4–8, 11–13).

A landward reentrant of the 10,000 mg/L isochlors in the vicinity of the Cape Fear River is similar to that in the overlying upper Cape Fear aquifer; in the lower Cape Fear, however, the isochlors extend slightly farther up the river. This reentrant of saltwater probably is due to the Cape Fear River Valley acting as a discharge area for the aquifer.

LOWER CAPE FEAR CONFINING UNIT

The lower Cape Fear confining unit, which overlies the lower Cape Fear aquifer, is composed of clay and sandy clay beds that belong largely to the Cape Fear Formation. In the northwestern Coastal Plain where the aquifer is overlain by Tertiary sediments, part of the confining unit may be of Tertiary age.

The continuity of the confining unit is shown in the hydrogeologic sections on plates 2–14. In places along the western edge of the aquifer, the confining unit pinches out so that the lower Cape Fear and upper Cape Fear aquifers merge; elsewhere, the confining unit either terminates against bedrock or is combined with younger clay beds to form a thick clay section overlying bedrock.

Downdip, the lower Cape Fear confining unit becomes thicker, as would be expected in the eastward-thickening Coastal Plain sedimentary wedge (pl. 23). The confining unit is more than 75 ft thick throughout the eastern quarter of the Coastal Plain and in Bertie and Halifax Counties. It is more than 100 ft thick in parts or all of Pasquotank, Camden, and Currituck Counties, and in Columbus and Brunswick Counties in the southeast. The average thickness of this confining unit is about 52 ft (table 4).

RELATION WITH OTHER AQUIFERS

The lower Cape Fear aquifer and its confining unit are overlain everywhere by the upper Cape Fear aquifer, except in a small area near the Fall Line in Northampton County, where it is covered by the Yorktown aquifer (fig. 22). Before the effects of pumping from the Cretaceous aquifers became widespread, natural recharge to the lower Cape Fear aquifer probably occurred from the upper Cape Fear and Yorktown aquifers in the interstream areas along its western margin from about Sampson County northward. Because all the known water-level measurements in this aquifer have been made during the postdevelopment period, it is difficult to reconstruct predevelopment areas of natural recharge; however, the recharge areas during both predevelopment and postdevelopment times probably are less than 10 mi wide along the western limit of the aquifer.

Predevelopment discharge from the aquifer probably consisted almost exclusively of upward leakage into the upper Cape Fear aquifer. An exception may have been along a short reach of the Roanoke River between Northampton and Halifax Counties where the lower Cape Fear confining unit is incised by the river (pl. 23), and where the lower Cape Fear aquifer may be discharging directly into the stream.

Along the South Carolina border in Columbus and Brunswick Counties, the lower Cape Fear aquifer is not being used for water supply because it contains water that is too salty for most purposes. Hence, recent water-level measurements probably reflect heads not very different from those in predevelopment times. It is likely, also, that the north and northwest direction of ground-water flow, as indicated by the heads, reflects a predevelopment flow pattern. Further analysis of this pattern indicates that ground water is moving through the lower Cape Fear aquifer from South Carolina into North Carolina, and that some of it discharges upward into the upper Cape Fear aquifer in the vicinity of the Cape Fear River. Evidence of this includes (1) progressive upward loss of head at several test sites in the Cape Fear River-Northeast Cape Fear River valleys and (2) the presence of saltwater seeps in the Cape Fear River valley observed by LeGrand (1955, p. 2023). The northwest flow direction may have developed because of the presence of the reentrant of dense saltwater (chloride concentration more than 10,000 mg/L) in the aquifer (pl. 23), so that less dense saltwater, moving generally northeast, is forced to move updip and around the saltwater reentrant.

The Lower Cretaceous confining unit and aquifer underlie the lower Cape Fear aquifer in the eastern half of the Coastal Plain east of a line from Carteret County north and northwest to Hertford County (fig. 23). Every-

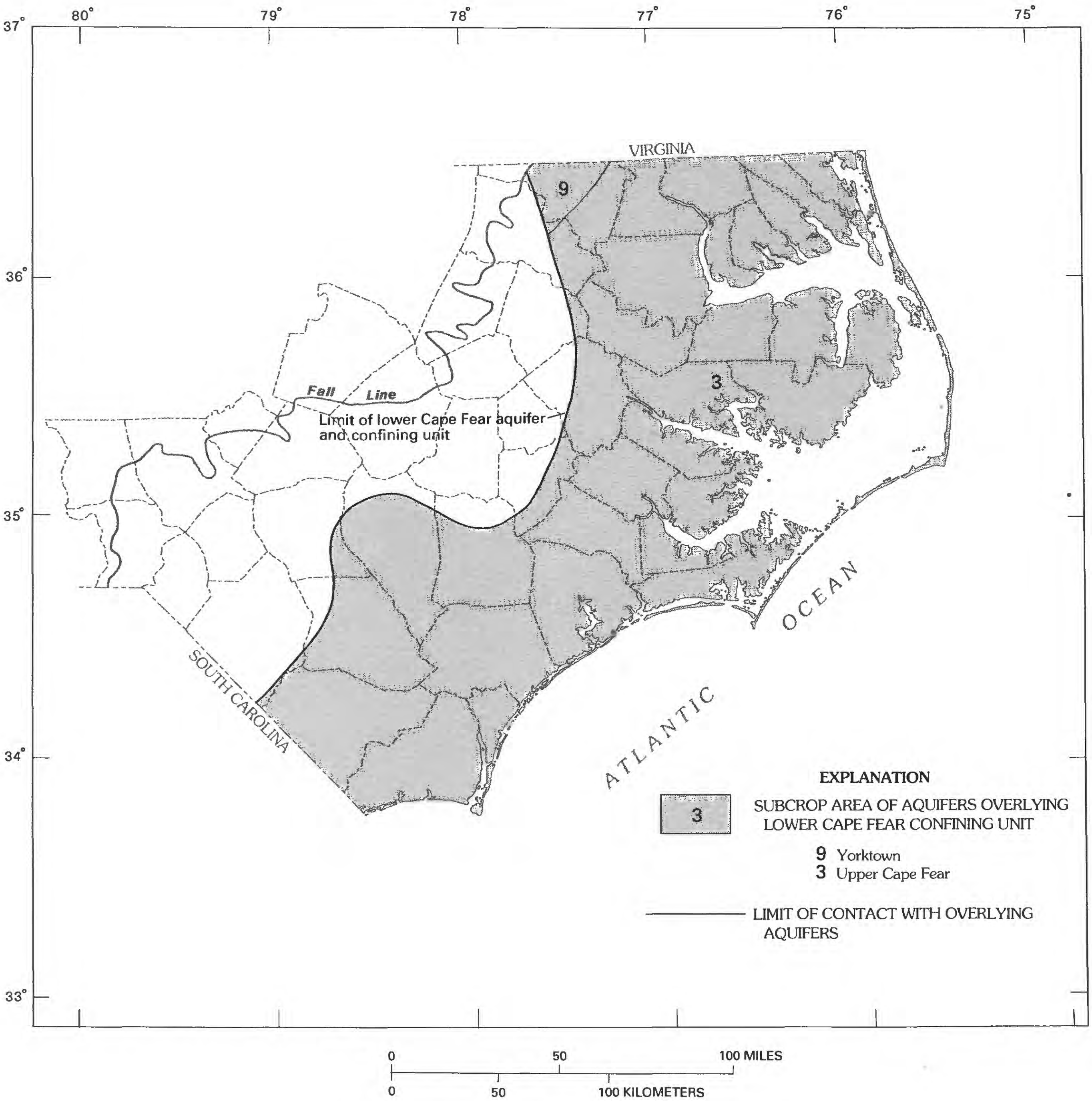

FIGURE 22.—Aquifers that directly overlie the lower Cape Fear confining unit and aquifer.

where west of the Lower Cretaceous aquifer subcrop, the lower Cape Fear aquifer lies directly on basement rock or on thick clay beds.

LOWER CRETACEOUS AQUIFER

Sediments beneath the Cape Fear Formation are generally regarded as Early Cretaceous in age and possibly include older rocks. These rocks do not crop out in North Carolina and are known only from geophysical logs and well cuttings. Their depth has precluded gathering much geologic and hydrologic data. The Lower Cretaceous aquifer includes the principal water-bearing zones in the Lower Cretaceous section of the North Carolina Coastal Plain.

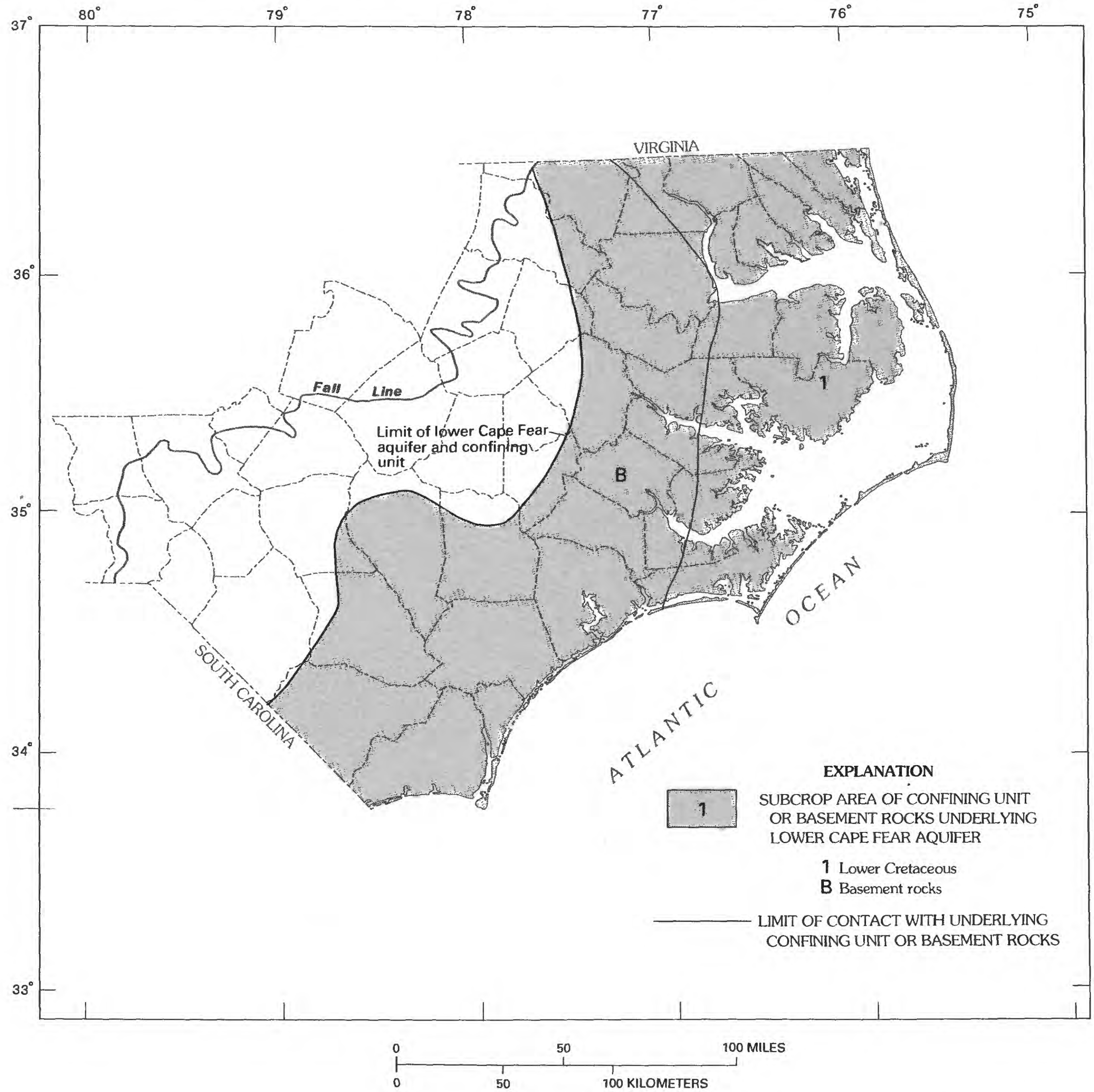

FIGURE 23.—Areas where the Lower Cretaceous confining unit or basement rocks directly underlie the lower Cape Fear aquifer.

Although the western limit of the Lower Cretaceous sediments extends only about halfway into the northern Coastal Plain (fig. 23), the beds thicken greatly eastward so that they form about one-third to one-half the total thickness of the Coastal Plain sediments along the northern coastline. Spangler (1950, p. 123) described these sediments as largely marine deposits, but interbedded nonmarine sediments are seen throughout the sections. Maher and Applin (1971, p. 38) reported that Lower Cretaceous sediments nearest the surface are lithologically similar to overlying Upper Cretaceous nonmarine beds, and that downdip the occurrence of marine beds increases. The nonmarine beds are varicolored shale, arkosic, micaceous, or lignitic sand, and gravelly sand. Marine beds are chiefly limestones that may be sandy or dolomitic; anhydrite is a minor constituent.

Lower Cretaceous sediments were correlated into Virginia by Brown and others (1972) as sediments belonging to Trinitian, Fredericksburgian, and Washitan Stages. Brown and Cosner (1974) also described Lower Cretaceous strata in southern Virginia along the North Carolina border, and equated these with sediments of the Potomac Formation. Lower Cretaceous sediments are not known in the subsurface along the North Carolina-South Carolina border.

The Lower Cretaceous aquifer is the lowermost aquifer defined in this report. The mapped extent in North Carolina is limited to the northern tier of counties, as shown on plate 24; south of this area, hydrogeologic data are lacking to separate the lower Cape Fear and Lower Cretaceous aquifers. The southward projection of the limit of the Lower Cretaceous aquifer was estimated from the limit of Lower Cretaceous sediments shown by Maher and Applin (1971, pl. 17). The section on plate 8 shows the aquifer from its western limit in Virginia downdip to Currituck County, N.C. The aquifer also has been identified in a test hole (well 160, pl. 14) in Virginia that penetrates all the Coastal Plain sediments.

The upper surface of the Lower Cretaceous aquifer dips east, steepening from 15 ft/mi near its western limit to about 25 ft/mi near the coast. The altitude of the aquifer top in northeastern North Carolina ranges from less than 600 ft to as much as 2,267 ft below sea level (pl. 24). The thickness of the aquifer also increases to the east, as shown on plate 8, from about 25 ft near its western limit (well 161) to 812 ft in well 57. The average thickness of the aquifer west of the 10,000 mg/L isochlor boundary is about 500 ft.

DISTRIBUTION OF PERMEABLE MATERIAL

The Lower Cretaceous aquifer averages 53 percent sand in five wells that penetrate it (table 4). The distribution of these wells is shown on plate 24. The proportion of sand to clay varies little from west to east in the aquifer, although the aquifer thickens greatly in this direction.

Grain sizes interpreted from geophysical logs appear to be mostly fine to medium, with a few scattered beds of coarse sand. Some sand layers apparently either contain a significant proportion of clay or are somewhat glauconitic. The deeper parts of the aquifer include limestone beds. Estimates of hydraulic conductivity range between 20 and 30 ft/d. Brown and Cosner (1974) report transmissivity values for the Lower Cretaceous aquifer at Franklin, Va., about 10 mi due north of the Gates County-Hertford County line at the Virginia border, to be between 6,000 and 24,000 feet squared per day (ft^2/d). Given an average thickness of about 600 ft, the hydraulic conductivity for the aquifer in that area ranges between 10 and 40 ft/d.

OCCURRENCE OF SALTWATER

The Lower Cretaceous aquifer in North Carolina contains little freshwater. Freshwater is restricted to a small area along the Virginia border in Hertford and Northampton Counties (pl. 24) where the freshwater-saltwater transition zone trends almost east-west. The transition zone is 1 to 2 mi wide. Just at the southern edge of the transition zone, a water sample from near the bottom of the aquifer contained 1,100 mg/L chloride (well 67, pl. 8).

The 10,000 mg/L isochlors extend southward from the Virginia border in the vicinity of the Camden County-Currituck County line to northern Pasquotank County, and thence westward to the aquifer limit in southern Hertford County (pl. 24). The distance between the 10,000 mg/L isochlors intersecting the top and bottom of the aquifer is large, primarily because of the great thickness of the Lower Cretaceous aquifer. Two water samples, one from the upper part of the aquifer in Pasquotank County (well 108, pl. 8) and another from the lower part of the aquifer in well 160 (pl. 14) in Virginia, were the control data for the interpretation of the 10,000 mg/L isochlors.

LOWER CRETACEOUS CONFINING UNIT

The Lower Cretaceous confining unit, which overlies the Lower Cretaceous aquifer, consists of clay and sandy clay beds that belong to sediments of either Early Cretaceous or Late Cretaceous age. The degree of continuity of this confining unit along the western margin of the aquifer is not well understood. For example, there are no data to indicate whether the aquifer or the confining unit first pinches out updip.

Downdip, the confining unit is correlated between a few wells (pl. 8) and shows a general trend of thickening toward the coast (pl. 24). The thickness of the unit ranges to nearly 70 ft in Camden and Currituck Counties. The average thickness is about 44 ft, based on data from eight wells that penetrate the confining unit (table 4).

RELATION WITH OTHER AQUIFERS

The Lower Cretaceous aquifer and its confining unit are overlain everywhere by the lower Cape Fear aquifer, as shown in figure 23, and are underlain everywhere by crystalline basement rocks. Aside from the negligible ground-water flow in fractured or weathered bedrock, all water flowing into or out of the Lower Cretaceous aquifer must pass through the lower Cape Fear aquifer. Patterns of natural recharge and discharge in the Lower

Cretaceous aquifer have been masked, at least in the northern Coastal Plain, by the effects of large ground-water withdrawals from the Lower Cretaceous and lower Cape Fear aquifers in Virginia.

Comparative water-level measurements in these aquifers in North Carolina do not extend far enough back in time to provide information about the predevelopment condition of the aquifer. However, the direction of ground-water movement in the Lower Cretaceous aquifer may be inferred from the orientation of saltwater in the aquifer. The transition zone in the Lower Cretaceous aquifer (pl. 24), which is oriented nearly east-west, is presumed to represent a front of saltwater that has been created by action of freshwater flowing in a direction more or less perpendicular to the front. Therefore, it appears that predevelopment ground-water movement in the aquifer was in a southerly direction, flowing from recharge areas in Virginia to discharge areas in Virginia and North Carolina. All of this discharge in North Carolina was by upward leakage through the Lower Cretaceous confining unit to the lower Cape Fear aquifer.

SUMMARY

The North Carolina Coastal Plain is underlain by a generally eastward dipping and eastward thickening wedge of sedimentary rocks ranging in age from Holocene to Cretaceous and composed of unconsolidated gravel, sand, silt, and clay with scattered beds of shells, indurated to loosely consolidated beds of limestone, sandy limestone, and shell limestone. These sediments lie on crystalline basement rocks and attain a thickness of more than 10,000 ft east of Cape Hatteras. Most of these rocks are nonmarine and deltaic in origin. They consist largely of sand and clay sequences that are discontinuous and heterogeneous and locally show evidence of exposure to the atmosphere. This is especially true of the lowermost one-third to one-half of the sedimentary section making up the oldest rock layers. The upper sequences are largely marine in origin and include nearshore and estuarine deposits, lagoonal sediments, and beds deposited in deep waters. The entire Coastal Plain sedimentary sequence has a complex erosional and depositional history as a result of continental rifting, the presence of structural highs and lows in the underlying basement rocks, and fluctuations in the level of the sea.

The stratigraphic continuity of these sediments was delineated primarily by using geophysical logs in conjunction with lithologic data to construct 18 interconnected hydrogeologic sections throughout the Coastal Plain. Aquifers and confining units also were delineated on the basis of lithologic similarities, information on water levels in different sedimentary layers, and differences in water quality.

Ten aquifers and nine confining units constitute the hydrogeologic framework of the North Carolina Coastal Plain. The names of the aquifers (except the lowermost aquifer) were derived from the geologic formation most closely associated with each aquifer. Uppermost to lowermost, these are the surficial aquifer, Yorktown aquifer, Pungo River aquifer, Castle Hayne aquifer, Beaufort aquifer, Peedee aquifer, Black Creek aquifer, upper Cape Fear aquifer, lower Cape Fear aquifer, and Lower Cretaceous aquifer.

Along with the hydrogeologic sections, maps showing the altitude of the top of each aquifer, the thickness of each confining unit, and the percentage of permeable material in each aquifer provide areal descriptions of these aquifers. Hydrogeologic data for each of 161 well sites include the altitude of the top of each unit, the thickness of each unit, the percentage of permeable material in each unit, and an estimate of hydraulic conductivity for each aquifer; these data are given in the "Supplemental Data" section at the end of the report.

SELECTED REFERENCES

Bain, G.L., 1970, Geology and ground-water resources of New Hanover County, North Carolina: North Carolina Department of Water and Air Resources Ground-Water Bulletin 17, 79 p.

Baum, G.R., Harris, W.B., and Zullo, V.A., 1978, Stratigraphic revision of the exposed middle Eocene to lower Miocene formations of North Carolina: Southeastern Geology, v. 20, no. 1, p. 1–19.

Behrendt, J.C., Hamilton, R.M., Ackermann, H.D., and Henry, V.J., 1981, Cenozoic faulting in the vicinity of the Charleston, South Carolina, 1886 earthquake: Geology, v. 9, no. 3, p. 117–122.

Berry, E.W., 1914, The Upper Cretaceous and Eocene floras of South Carolina and Georgia: U.S. Geological Survey Professional Paper 84, 200 p.

Billingsley, G.A., Fish, R.E., and Schipf, R.G., 1957, Water resources of the Neuse River basin, North Carolina: U.S. Geological Survey Water-Supply Paper 1414, 89 p.

Blackwelder, B.W., 1981, Stratigraphy of upper Pliocene and lower Pleistocene marine and estuarine deposits of northeastern North Carolina and southeastern Virginia: U.S. Geological Survey Bulletin 1502–B, 19 p.

Blankenship, R.R., 1965, Reconnaissance of ground-water resources of the Southport-Elizabethtown area, North Carolina: North Carolina Department of Water Resources Ground-Water Bulletin 6, 47 p.

Brown, D.L., and Silvey, W.D., 1977, Artificial recharge to a freshwater-sensitive brackish-water sand aquifer, Norfolk, Virginia: U.S. Geological Survey Professional Paper 939, 53 p.

Brown, G.A., and Cosner, O.J., 1974, Ground-water conditions in the Franklin area, southeastern Virginia: U.S. Geological Survey Hydrologic Investigations Atlas HA–538, 3 sheets.

Brown, P.M., 1958a, The relation of phosphorites to ground water in Beaufort County, North Carolina: Economic Geology, v. 53, no. 1, p. 85–101.

———1958b, Well logs from the Coastal Plain of North Carolina: North Carolina Department of Conservation and Development Bulletin 72, 68 p.

———1959, Geology and ground-water resources in the Greenville area, North Carolina: North Carolina Department of Conservation and Development Bulletin 73, 87 p.

———1960, Ground-water supply of Cape Hatteras National Seashore recreational area: North Carolina Department of Water Resources Report of Investigations 1, 14 p.

———1963, The geology of northeastern North Carolina (Guidebook for the fourth annual field conference of the Atlantic Coastal Plain Geological Association in northeastern North Carolina): Raleigh, North Carolina Department of Conservation and Development, Division of Mineral Resources Special Publication, 44 p.

Brown, P.M., Brown, D.L., Shufflebarger, T.E., and Sampair, J.L., 1977, Wrench-style deformation in rocks of Cretaceous and Paleocene age, North Carolina Coastal Plain: North Carolina Department of Natural and Economic Resources, Division of Earth Resources Special Publication 5, 44 p.

Brown, P.M., Miller, J.A., and Swain, F.M., 1972, Structural and stratigraphic framework, and spatial distribution of permeability of the Atlantic Coastal Plain, North Carolina to New York: U.S. Geological Survey Professional Paper 796, 79 p.

Carter, J.G., comp., 1983, Summary of lithostratigraphy and biostratigraphy for the Coastal Plain of the Southeastern United States: Chapel Hill, N.C., Biostratigraphy Newsletter, no. 2, Oct. 15, 1983.

Cederstrom, D.J., Boswell, E.H., and Tarver, G.R., 1979, Summary appraisals of the Nation's ground-water resources—South Atlantic- Gulf Region: U.S. Geological Survey Professional Paper 813–O, 35 p.

Christopher, R.A., Owens, J.P., and Sohl, N.F., 1979, Late Cretaceous palynomorphs from the Cape Fear Formation of North Carolina: Southeastern Geology, v. 20, no. 3, p. 145–159.

Clark, W.B., Miller, B.L., Stephenson, L.W., Johnson, B.L., and Parker, H.N., 1912, The Coastal Plain of North Carolina: North Carolina Geological and Economic Survey, v. 3, pt. 1, p. 1–330.

Coble, R.W., Giese, G.L., and Eimers, J.L., 1984, North Carolina ground-water resources, *in* National water summary 1984, Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 329–334.

Coch, N.K., 1968, Geology of the Binns Church, Smithfield, Windsor, and Chuckatuck quadrangles, Virginia: Virginia Division of Mineral Resources Report of Investigations 17, 39 p.

Conley, J.F., 1962, Geology and mineral resources of Moore County, North Carolina: North Carolina Department of Conservation and Development, Division of Mineral Resources Bulletin 76, 40 p.

Cooke, C.W., 1936, Geology of the Coastal Plain of South Carolina: U.S. Geological Survey Bulletin 867, 196 p.

Cosner, O.J., 1976, Measured and simulated ground-water levels in the Franklin area, southeastern Virginia, 1973–74: U.S. Geological Survey Water-Resources Investigations Report 76–83, 5 sheets.

Daniel, C.C., III, 1978, Land use, land cover, and drainage on the Albemarle-Pamlico Peninsula, eastern North Carolina, 1974: U.S. Geological Survey Water-Resources Investigation 78–134, 2 sheets.

———1981, Hydrology, geology and soils of pocosins: A comparison of natural and altered systems, *in* Richardson, C.J., ed., Pocosin wetlands, An integrated analysis of Coastal Plain freshwater bogs in North Carolina: Stroudsburg, Pa., Hutchison and Ross, Inc., p. 69–108.

Daniels, R.B., Gamble, E.E., Wheeler, W.H., and Holzhey, C.S., 1972, Some details of the surficial stratigraphy and geomorphology of the Coastal Plain between New Bern and Coats, North Carolina: Carolina Geological Society and Atlantic Coastal Plain Geological Association Field Trip Guidebook, Oct. 7–8, 1972, 44 p.

———1977, The Arapahoe Ridge, a Pleistocene storm beach: Southeastern Geology, v. 18, no. 4, p. 231–247.

Dennison, J.M., and Wheeler, W.H., 1975, Stratigraphy of Precambrian through Cretaceous strata of probable fluvial origin in Southeastern United States and their potential as uranium host rocks: Southeastern Geology Special Publication 5, 210 p.

DeWiest, R.J.M., Sayre, A.N., and Jacob, C.E., 1967, Evaluation of potential impact of phosphate mining on ground-water resources of eastern North Carolina: North Carolina Department of Water Resources, 167 p.

Fallaw, Wallace, and Wheeler, W.H., 1969, Marine fossiliferous Pleistocene deposits in southeastern North Carolina: Southeastern Geology, v. 10, no. 1, p. 35–54.

Faye, R.E., and Prowell, D.C., 1982, Effects of Late Cretaceous and Cenozoic faulting on the geology and hydrology of the Coastal Plain near the Savannah River, Georgia and South Carolina: U.S. Geological Survey Open-File Report 82–156, 73 p.

Fenneman, N.M., 1938, Physiography of Eastern United States: New York, McGraw-Hill, 714 p.

Fish, R.E., LeGrand, H.E., and Billingsley, G.A., 1957, Water resources of the Yadkin-Pee Dee River basin, North Carolina: U.S. Geological Survey Water-Supply Paper 1415, 115 p.

Floyd, E.O., 1969, Ground-water resources of Craven County, North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas HA–343.

Floyd, E.O., and Long, A.T., 1970, Well records and other basic ground-water data, Craven County, North Carolina: North Carolina Department of Water and Air Resources Ground-Water Circular 14, 111 p.

Floyd, E.O., and Peace, R.R., 1974, An appraisal of the ground-water resources of the upper Cape Fear River basin, North Carolina: North Carolina Department of Water and Air Resources Ground-Water Bulletin 20, 17 p.

Gibson, T.G., 1967, Stratigraphy and paleoenvironment of the phosphatic Miocene strata of North Carolina: Geological Society of America Bulletin, v. 78, no. 5, p. 631–650.

Giese, G.L., Wilder, H.B., and Parker, G.G., Jr., 1979, Hydrology of major estuaries and sounds of North Carolina: U.S. Geological Survey Water-Resources Investigations 79–46, 175 p.

Gohn, G.S., Higgins, B.B., Smith, C.C., and Owens, J.P. 1977, Lithostratigraphy of the deep corehole (Clubhouse Crossroads corehole 1) near Charleston, South Carolina: U.S. Geological Survey Professional Paper 1028–E, p. 59–70.

Hamilton, P.A., and Larson, J.D., 1988, Hydrogeology and analysis of the ground-water flow system in the Coastal Plain of southeastern Virginia: U.S. Geological Survey Water-Resources Investigations Report 87–4240, 175 p.

Harris, W.B., 1978, Stratigraphic and structural framework of the Rocky Point member of the Cretaceous Peedee Formation, North Carolina: Southeastern Geology, v. 19, no. 4, p. 207–229.

Harris, W.B., Zullo, V.A., and Baum, G.R., 1979, Tectonic effects on Cretaceous, Paleogene, and early Neogene sedimentation, North Carolina, *in* Baum, G.R., and others, eds., Structural and stratigraphic framework for the Coastal Plain of North Carolina: Wrightsville Beach, N.C., Carolina Geological Society and Atlantic Coastal Plain Geological Association Field Trip Guidebook, Oct. 19–21, 1979, p. 17–30.

Harris, W.H., and Wilder, H.B., 1964, Ground-water supply of Cape Hatteras National Seashore recreational area, North Carolina—Part 3: North Carolina Department of Water Resources Report of Investigations 4, 22 p.

———1966, Geology and ground-water resources of the Hertford-Elizabeth City area, North Carolina: North Carolina Department of Water Resources Ground-Water Bulletin 10, 89 p.

Hazel, J.E., 1977, Distribution of some biostratigraphically diagnostic ostracodes in the Pliocene and lower Pleistocene of Virginia and northern North Carolina: U.S. Geological Survey Journal of Research, v. 5, no. 3, p. 373–388.

Hazel, J.E., Bybell, L.M., Christopher, R.A., Frederickson, N.O., May, F.E., McLean, D.M., Poore, R.Z., Smith, C.C., Sohl, N.F., Valentine, P.C., and Witmer, R.J., 1977, Biostratigraphy of the deep corehole (Clubhouse Crossroads corehole 1) near Charleston, South Carolina: U.S. Geological Survey Professional Paper 1028–F, p. 71–89.

Heath, R.C., 1975, Hydrology of the Albemarle-Pamlico region, North Carolina: U.S. Geological Survey Water-Resources Investigation 9–75, 98 p.

———1980, Basic elements of ground-water hydrology with reference to conditions in North Carolina: U.S. Geological Survey Water-Resources Investigations Open-File Report 80–44, 86 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Heron, S.D., and Wheeler, W.H., 1964, The Cretaceous formations along the Cape Fear River, North Carolina: Atlantic Coastal Plain Geological Association annual field excursion, 5th, Guidebook, 55 p.

Hopkins, H.T., Bower, R.F., Abe, J.M., and Harsh, J.F., 1981, Potentiometric surface map for the Cretaceous aquifer, Virginia Coastal Plain, 1978: U.S. Geological Survey Water-Resources Investigations Open-File Report 80–965, 1 sheet.

Jordan, R.R., and Smith, R.V., coords., 1983, Correlation of stratigraphic units of North America (COSUNA) project, Atlantic Coastal Plain region: American Association of Petroleum Geologists Correlation Chart Series, 1 sheet.

Kimrey, J.O., 1964, The Pungo River Formation, a new name for middle Miocene phosphorites in Beaufort County, North Carolina: Southeastern Geology, v. 5, no. 4, p. 195–205.

———1965, Description of the Pungo River Formation in Beaufort County, North Carolina: North Carolina Department of Conservation and Development, Division of Mineral Resources Bulletin 79, 131 p.

Larson, J.D., 1981, Distribution of saltwater in the Coastal Plain aquifers of Virginia: U.S. Geological Survey Open-File Report 81–1013, 25 p.

Laymon, L.L., and Barksdale, R.G., 1964, Ground-water conditions in the Clinton area, North Carolina: North Carolina Department of Water Resources Ground-Water Circular 3, 24 p.

LeGrand, H.E., 1955, Brackish water and its structural implications in the Great Carolina Ridge, North Carolina: American Association of Petroleum Geologists Bulletin, v. 39, no. 10, p. 2020–2037.

———1960, Geology and ground-water resources of the Wilmington-New Bern area: North Carolina Department of Water Resources Ground-Water Bulletin 1, 80 p.

———1964, Hydrogeologic framework of the Gulf and Atlantic Coastal Plain: Southeastern Geology, v. 5, no. 4, p. 177–194.

LeGrand, H.E., and Pettyjohn, W.A., 1981, Regional hydrogeologic concepts of homoclinal flanks: Ground Water, v. 19, no. 3, p. 303–310.

Lindskov, K.L., 1973, Water resources of northeast North Carolina above Cape Lookout—Interim report: U.S. Geological Survey Open-File Report, 71 p.

Lloyd, O.B., Jr., 1968a, Ground-water resources of Chowan County, North Carolina: North Carolina Department of Water and Air Resources Ground-Water Bulletin 14, 133 p.

———1968b, Ground-water resources of Chowan County, North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas HA–292, 1 sheet.

Lloyd, O.B., Jr., and Floyd, E.O., 1968, Ground-water resources of the Belhaven area, North Carolina: North Carolina Department of Water and Air Resources Report of Investigations 8, 38 p.

Lohman, S.W., 1936, Geology and ground-water resources of the Elizabeth City area, North Carolina: U.S. Geological Survey Water-Supply Paper 773–A, 57 p.

Maher, J.C., and Applin, E.R., 1971, Geologic framework and petroleum potential of the Atlantic Coastal Plain and Continental Shelf: U.S. Geological Survey Professional Paper 659, 98 p.

Manheim, E.T., and Horn, M.K., 1968, Composition of deeper subsurface water along the Atlantic continental margin: Southeastern Geology, v. 9, no. 4, p. 215–236.

Maxey, G.B., 1964, Hydrostratigraphic units: Journal of Hydrology, v. 2, no. 2, p. 124–129.

Meisler, Harold, 1980, Preliminary delineation of salty ground water in the Northern Atlantic Coastal Plain: U.S. Geological Survey Open-File Report 81–71, 12 p.

Meisler, Harold, Leahy, P.P., and Knobel, LeRoy, 1984, Effect of eustatic sea-level changes on saltwater-freshwater relations in the Northern Atlantic Coastal Plain: U.S. Geological Survey Water-Supply Paper 2255, 28 p.

Meng, A.A., III, and Harsh, J.F., 1984, Hydrogeologic framework of the Virginia Coastal Plain: U.S. Geological Survey Open-File Report 84–728, 78 p.

Minard, J.P., Sohl, N.F., and Owens, J.P., 1977, Reintroduction of the Severn Formation (Upper Cretaceous) to replace the Monmouth Formation in Maryland, *in* Sohl, N.F., and Wright, W.B., Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1976: U.S. Geological Survey Bulletin 1435–A, p. A132–A133.

Mixon, R.B., and Newell, W.L., 1977, Stafford fault system: Structures documenting Cretaceous and Tertiary deformation along the Fall Line in northeastern Virginia: Geology, v. 5, no. 7, p. 437–440.

Mixon, R.B., and Pilkey, O.H., 1976, Reconnaissance geology of the submerged and emerged Coastal Plain province, Cape Lookout area, North Carolina: U.S. Geological Survey Professional Paper 859, 45 p.

Morris, D.A., and Johnson, A.I., 1967, Summary of hydrologic and physical properties of rock and soil materials, as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey, 1948–60: U.S. Geological Survey Water-Supply Paper 1839–D, 42 p.

Mundorff, M.J., 1946, Ground water in the Halifax area, North Carolina: North Carolina Department of Conservation and Development Bulletin 51, 76 p.

Narkunas, James, 1980, Groundwater evaluation in the central Coastal Plain of North Carolina: Raleigh, North Carolina Department of Natural Resources and Community Development, 119 p.

Nelson, P.F., 1964, Geology and ground-water resources of the Swanquarter area: North Carolina Department of Water Resources Ground-Water Bulletin 4, 79 p.

———1976, Interim report on ground-water conditions in capacity use area no. 1, central Coastal Plain, North Carolina, 1974–75: North Carolina Department of Natural and Economic Resources Report of Investigations 13, 55 p.

Nelson, P.F., and Barksdale, R.G., 1965, Interim report on the ground-water resources of the Kinston area, North Carolina: North Carolina Department of Water Resources Ground-Water Circular 10, 31 p.

Nelson, P.F., and Peek, H.M., 1964, Preliminary report on ground water in Beaufort County with special reference to potential effects of phosphate mining: North Carolina Department of Water Resources Ground-Water Circular 2, 25 p.

North Carolina Department of Natural and Economic Resources, 1977, Exploratory oil wells of North Carolina, 1925–1976: Division of Earth Resources, Geology and Mineral Resources Section Information Circular 22, 52 p.

North Carolina Department of Natural Resources and Community Development, Office of Water Resources, 1980, Ground-water resources of the Southern Pines area—A supplement to the Sandhills capacity use study: Raleigh, 41 p.

Owens, J.P., 1983, The northwestern Atlantic Ocean margin, *in* Moullade, M., and Nairn, A.E.M., eds., The Phanerozoic geology of the world, II., The Mesozoic B: Amsterdam and New York, Elsevier Science Publishers, chap. 2, p. 33–60.

Peek, H.M., 1977, Interim report on ground-water conditions in northeastern North Carolina: North Carolina Department of Natural Resources and Community Development Report of Investigations 15, 29 p.

Peek, H.M., and Laymon, L.L., 1975, Ground-water quality management and monitoring program for North Carolina: North Carolina Department of Natural and Economic Resources Ground-Water Circular 16, 34 p.

Peek, H.M., and Nelson, P.F., 1967, Ground-water problems in the Coastal Plain related to heavy withdrawals, *in* Symposium on hydrology of the coastal waters of North Carolina, May 12, 1967: Water Resources Research Institute Report 5, p. 62–80.

———1975, Potential effects of withdrawals from the Castle Hayne aquifer for expanded phosphate mining in Beaufort County, North Carolina: North Carolina Department of Natural and Economic Resources Report of Investigations 11, 33 p.

Peek, H.M., Nelson, P.F., Laymon, L.L., Register, L.A., and Jeter, W.J., 1974, Status report on ground-water conditions in capacity use area no. 1, central Coastal Plain, North Carolina: North Carolina Department of Natural and Economic Resources Ground-Water Bulletin 21, 146 p.

Peek, H.M., and Register, L.A., 1975, A preliminary report on anomalous pressure in deep artesian aquifer in southeastern North Carolina: North Carolina Department of Natural and Economic Resources Report of Investigations 10, 20 p.

Peek, H.M., Register, L.A., and Nelson, P.F., 1972, Potential ground-water supplies for Roanoke Island and the Dare County beaches, North Carolina: North Carolina Department of Natural and Economic Resources Report of Investigations 9, 26 p.

Prowell, D.C., and O'Connor, B.J., 1978, Belair fault zone: Evidence of Tertiary fault displacement in eastern Georgia: Geology, v. 6, no. 11, p. 681–684.

Pusey, R.D., 1960, Geology and ground water in the Goldsboro area, North Carolina: North Carolina Department of Water Resources Ground-Water Bulletin 2, 77 p.

Renken, R.A., 1984, The hydrogeologic framework for the sand aquifer of the southeastern United States Coastal Plain: U.S. Geological Survey Water-Resources Investigations Report 84–4243, 26 p.

Richards, H.G., 1950, Geology of the Coastal Plain of North Carolina: American Philosophical Society Transactions, new ser., v. 40, pt. 1, 83 p.

Robison, T.M., 1977, Public water supplies of North Carolina—Part 4, Northern Coastal Plain: North Carolina Department of Natural and Economic Resources, 224 p.

Robison, T.M., and Mann, L.T., Jr., 1977, Public water supplies of North Carolina—Part 5, Southern Coastal Plain: North Carolina Department of Natural and Economic Resources, 341 p.

Rona, P.A., 1973, Relations between rates of sediment accumulation on continental shelves, sea-floor spreading, and eustacy inferred from the central North Atlantic: Geological Society of America Bulletin, v. 84, no. 9, p. 2851–2872.

Schipf, R.G., 1961, Geology and ground-water resources of the Fayetteville area: North Carolina Department of Water Resources Ground-Water Bulletin 3, 99 p.

Siple, G.A., 1960, Piezometric levels in the Cretaceous sand aquifer of the Savannah River basin: Georgia Mineral Newsletter, v. 8, no. 4, p. 163–166.

Sloan, Earle, 1904, A preliminary report on the clays of South Carolina: South Carolina Geological Survey Bulletin, ser. 4, no. 1, 175 p.

Sohl, N.F., 1976, Reinstatement of the name Cape Fear Formation in North and South Carolina, *in* Cohee, G.V., and Wright, W.B., 1976, Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1975: U.S. Geological Survey Bulletin 1422–A, p. A68.

Sohl, N.F., and Christopher, R.A., 1983, The Black Creek-Peedee formational contact (Upper Cretaceous) in the Cape Fear region of North Carolina: U.S. Geological Survey Professional Paper 1285, 37 p.

Spangler, W.B., 1950, Subsurface geology of Atlantic Coastal Plain of North Carolina: American Association of Petroleum Geologists Bulletin, v. 34, no. 1, p. 100–132.

Stephenson, L.W., 1907, Some facts relating to the Mesozoic deposits of the Coastal Plain of North Carolina: Johns Hopkins University Circular n.s. no. 7 (whole number 199), p. 93–99.

Stephenson, L.W., and Johnson, B.L., 1912, The water resources of the Coastal Plain of North Carolina, *in* Clark, W.B., Miller, B.L., Stephenson, L.W., Johnson, B.L., and Parker, H.N., The Coastal Plain of North Carolina: North Carolina Geological and Economic Survey, v. 3, pt. 2, p. 333–509.

Stephenson, L.W., and Rathbun, M.J., 1923, The Cretaceous formations of North Carolina: North Carolina Geological and Economic Survey, v. 5, pt. 1, 604 p.

Stuckey, J.L., 1965, North Carolina: Its geology and mineral resources: Raleigh, North Carolina Department of Conservation and Development, 550 p.

Stuckey, J.L, and Conrad, S.G., 1958, Explanatory text for geologic map of North Carolina: North Carolina Department of Conservation and Development, Division of Mineral Resources Bulletin 71, 51 p.

Sumsion, C.T., 1968, Summary of the geology and ground-water resources of Pitt County, North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas HA–291, 1 sheet.

———1970, Geology and ground-water resources of Pitt County, North Carolina: North Carolina Department of Water and Air Resources Ground-Water Bulletin 18, 75 p.

Swain, F.M., 1968, Ostracoda from the upper Tertiary Waccamaw Formation of North Carolina and South Carolina: U.S. Geological Survey Professional Paper 573–D, p. D1–D37.

Swift, D.J.P., and Heron, S.D., Jr., 1969, Stratigraphy of the Carolina Cretaceous: Southeastern Geology, v. 10, no. 4, p. 201–245.

Tant, P.L., Byrd, H.J., and Horton, R.E., 1974, General soil map of North Carolina: U.S. Soil Conservation Service 1:1,000,000 scale map.

U.S. Environmental Protection Agency, 1978, Quality criteria for water, 1976: Washington, D.C., U.S. Government Printing Office, 256 p.

Upson, J.E., 1966, Relationships of fresh and salty ground water in the Northern Atlantic Coastal Plain of the United States: U.S. Geological Survey Professional Paper 550–C, p. C235–C243.

Vail, P.R., Mitchum, R.M., Jr., and Thompson, S., III, 1977, Seismic stratigraphy and global changes of sea level, Part 4: Global cycles of relative changes of sea level, *in* Payton, C.E., ed., Seismic stratigraphy—Applications to hydrocarbon exploration: American Association of Petroleum Geologists Memoir 26, p. 83–97.

Ward, L.W., and Blackwelder, B.W., 1980, Stratigraphic revision of upper Miocene and lower Pliocene beds of the Chesapeake Group, Middle Atlantic Coastal Plain of North Carolina: U.S. Geological Survey Bulletin 1482–D, 71 p.

Ward, L.W., Lawrence, D.R., and Blackwelder, B.W., 1978, Stratigraphic revision of the middle Eocene, Oligocene, and lower Miocene—Atlantic Coastal Plain of North Carolina: U.S. Geological Survey Bulletin 1457–F, 23 p.

Watts, A.B., 1981, The U.S. Atlantic continental margin: Subsidence history, crustal structure and thermal evolution, *in* Geology of passive continental margins: History, structure, and sedimentologic record (with special emphasis on the Atlantic margin): American Association of Petroleum Geologists and Atlantic Margin Energy Conference, Education Course Note Series 19, 75 p.

Welby, C.W., and Leith, C.J., 1968, Bedrock surface beneath Pamlico River channel, Beaufort County, North Carolina: North Carolina State University Department of Engineering research study, 28 p.

Wilder, H.B., Robison, T.M., and Lindskov, K.L., 1978, Water resources of northeast North Carolina: U.S. Geological Survey Water-Resources Investigation 77–81, 113 p.

Winner, M.D., Jr., 1975, Ground-water resources of the Cape Hatteras National Seashore, North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas HA–540, 2 sheets.

———1976, Ground-water resources of Wilson County, North Carolina: U.S. Geological Survey Water-Resources Investigation 76–60, 85 p.

———1978, Ground-water resources of the Cape Lookout National Seashore, North Carolina: U.S. Geological Survey Water-Resources Investigation 78–52, 49 p.

———1981a, An observation-well network concept as applied to North Carolina: U.S. Geological Survey Water-Resources Investigation 81–13, 59 p.

———1981b, Proposed observation-well networks and ground-water level program for North Carolina: U.S. Geological Survey Open-File Report 81–544, 68 p.

Winner, M.D., Jr., and Simmons, C.E., 1977, Hydrology of the Creeping Swamp watershed, North Carolina, with reference to potential effects of stream channelization: U.S. Geological Survey Water-Resources Investigation 77–26, 54 p.

Wyrick, G.G., 1966, Ground-water resources of Martin County, North Carolina: North Carolina Department of Water Resources Ground-Water Bulletin 9, 85 p.

———1967, Water-bearing characteristics and occurrence of aquifers in Martin County, North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas HA–264, 1 sheet.

Zack, A.L., 1977, The occurrence, availability, and chemical quality of ground water, Grand Strand area and surrounding parts of Horry and Georgetown Counties, South Carolina: South Carolina Water Resources Commission Report 8, 100 p.

———1980, Geochemistry of fluoride in the Black Creek aquifer system of Horry and Georgetown Counties, South Carolina—And its physiological implications: U.S. Geological Survey Water-Supply Paper 2067, 40 p.

Zoback, M.D., Healy, J.H., Roller, J.C., Gohn, G.S., and Higgins, B.B., 1978, Normal faulting and in situ stress in the South Carolina Coastal Plain near Charleston: Geology, v. 6, no. 3, p. 147–152.

SUPPLEMENTAL DATA
[Properties of Aquifers and Confining Units]

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*

[Well No: NRCD well-numbering system number; American Petroleum Institute (API) number given for oil-test well; USGS well-numbering system number given for wells in Virginia. Map No: Reference number used in text, on maps, and in sections (listed sequentially in this table). Log Depth: Depth of well log, in feet below land surface. Latitude: Degrees, minutes, seconds North. Longitude: Degrees, minutes, seconds West. Altitude of Land Surface: In feet above sea level. Basement: Where known, altitude of top, in feet above or below sea level. SUR, surficial; AQ, aquifer; CONF UNIT, confining unit separating aquifers; YKN, Yorktown; PGR, Pungo River; CLH, Castle Hayne; BFR, Beaufort; PD, Peedee; BC, Black Creek; UCF, upper Cape Fear; LCF, lower Cape Fear; LC, Lower Cretaceous. ALT TOP: Altitude of top of aquifer or confining unit, in feet above or below sea level. THICK: Thickness of aquifer or confining unit, in feet. PCT PERM MATERIAL: Percent of permeable material making up aquifer or confining unit. EST HYD CONDUCT: Estimated hydraulic conductivity, in feet per day. Dashes indicate data were incomplete or values were not estimated; blank spaces indicate aquifer or confining unit not present or not reached by test hole]

BEAUFORT COUNTY

NRCD Wilmar Research Station. Well No: P21k5
Map No: 1 Log Depth 918 Latitude: 352252 Longitude: 770507 Altitude of Land Surface: 43 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	43					18	-10	-183	-194	-217	-239	-335	-387	-666	-695	-862			
THICK	25					28	173	11	23	22	96	52	279	29	167	--			
PCT PERM MATERIAL	60					<10	86	<10	87	14	62	19	47	21	58	--			
EST HYD CONDUCT	25					--	60	--	80	--	40	--	30	--	25	--			

City of Washington. Well No: N20k4
Map No: 2 Log Depth 770 Latitude: 353320 Longitude: 770125 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25	-9	-14			-27	-45	-179	-211	-266	-302	-383	-510	-597	-658				
THICK	34	5	13			18	134	32	55	36	81	127	87	61	--				
PCT PERM MATERIAL	82	<10	90			<10	86	<10	73	<10	56	<5	67	16	--				
EST HYD CONDUCT	25	--	25			--	60	--	50	--	25	--	40	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Coastal Plains Oil Company. Well No: M181- API No. 32-013-5 (H.M. Jackson No. 1)
Map No: 3 Log Depth 1,526 Latitude: 353815 Longitude: 765115 Altitude of Land Surface: 40 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	40	--	--	--	-63	-73	-90	-222	-245	-348	-367	-453	-570	-647	-692	-1,173	-1,243		
THICK	--	--	--	>18	10	17	132	23	103	19	86	117	77	45	481	70	--		
PCT PERM MATERIAL	--	--	--	<5	90	<10	85	<15	77	<10	62	<10	75	<10	49	<20	--		
EST HYD CONDUCT	--	--	--	--	15	--	75	--	45	--	35	--	40	--	40	--	--		

NRCD Cox's Crossroad Research Sta. Well No: P19m4
Map No: 4 Log Depth 800 Latitude: 352223 Longitude: 765704 Altitude of Land Surface: 27 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	--	27	1	-9	-17	-35	-45	-333	-351	-371	-405	-467	-521	-757					
THICK	--	26	10	8	18	10	288	18	20	34	62	54	236	--					
PCT PERM MATERIAL	--	10	90	<10	90	<10	73	<20	80	24	74	37	53	--					
EST HYD CONDUCT	--	--	25	--	25	--	80	--	80	--	30	--	35	--					

NRCD Chocowinity Test. Well No: N21v5
Map No: 5 Log Depth 458 Latitude: 353038 Longitude: 770601 Altitude of Land Surface: 33 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	33	21	13			3	-2	-185	-214	-235	-250	-359	-389						
THICK	12	8	10			5	183	29	21	15	109	30	--						
PCT PERM MATERIAL	90	<10	90			<5	66	17	90	20	64	<10	--						
EST HYD CONDUCT	50	--	25			--	80	--	50	--	30	--	--						

NRCD Belhaven Research Station. Well No: N15h2
Map No: 6 Log Depth 510 Latitude: 353351 Longitude: 763740 Altitude of Land Surface: 5 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	5	-25	-31	-145	-193	-228	-237	-481	-497										
THICK	30	6	114	48	25	19	244	16	--										
PCT PERM MATERIAL	90	<10	63	<20	80	<25	90	<15	--										
EST HYD CONDUCT	30	--	40	--	35	--	70	--	--										

NRCD Lee Creek Research Station. Well No: P17h4
Map No: 7 Log Depth 954 Latitude: 352311 Longitude: 764701 Altitude of Land Surface: 7 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	7	-22	-29	-66	-88	-137	-145	-489	-510	-561	-595	-683	-749						
THICK	29	7	37	22	49	8	344	21	51	34	88	66	--						
PCT PERM MATERIAL	>90	<10	75	<10	53	<10	80	<10	55	15	46	15	--						
EST HYD CONDUCT	30	--	15	--	30	--	70	--	25	--	15	--	--						

B E R T I E C O U N T Y

NRCD Cremo Research Station. Well No: G19b3
Map No: 8 Log Depth 1,192 Latitude: 361002 Longitude: 765621 Altitude of Land Surface: 67 Basement:-1,033

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	67	45	2	-35	-39			-45	-50			-54	-72	-114	-145	-363	-451	-991	
THICK	22	43	37	4	6			5	4			18	42	31	218	88	540	42	
PCT PERM MATERIAL	68	<10	86	<25	90			<10	90			17	67	19	62	18	50	<5	
EST HYD CONDUCT	15	--	25	--	40			--	25			--	20	--	30	--	30	--	

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

R.J. Reynolds Company. Well No: I16g-
Map No: 9 Log Depth 452 Latitude: 355820 Longitude: 764310 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25	-12	-25	-81	-131		-149	-199	-235	-289	-323	-345	-368						
THICK	37	13	56	50	18		50	36	54	34	22	23	--						
PCT PERM MATERIAL	84	<10	71	<5	90		80	<5	74	<10	90	<5	--						
EST HYD CONDUCT	50	--	30	--	100		80	--	45	--	25	--	--						

B L A D E N   C O U N T Y

NRCD Bladenboro Research Station. Well No: Z41u2
Map No: **10** Log Depth 575 Latitude: 343027 Longitude: 784519 Altitude of Land Surface: 116 Basement: -459

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	116									68	50	-14	-33	-151	-196	-367	-408		
THICK	48									18	64	19	118	45	171	41	51		
PCT PERM MATERIAL	75									<10	81	10	55	18	60	12	45		
EST HYD CONDUCT	30									--	35	--	30	--	40	--	20		

NRCD White Lake Prison Res. Sta. Well No: Y38b6
Map No: **11** Log Depth 497 Latitude: 343920 Longitude: 783111 Altitude of Land Surface: 65 Basement: -425

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	65										--	-38	-49	-168	-203	-318	-365		
THICK	--										>67	11	119	35	115	47	60		
PCT PERM MATERIAL	--										70	<20	60	28	65	<5	83		
EST HYD CONDUCT	--										25	--	20	--	25	--	30		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Kelley Research Station. Well No: AA35n1
Map No: **12** Log Depth 670 Latitude: 342718 Longitude: 781831 Altitude of Land Surface: 28 Basement: -642

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	28									-6	-14	-150	-233	-366	-407	-517	-577		
THICK	34									8	136	83	137	41	110	60	65		
PCT PERM MATERIAL	85									<10	66	16	55	22	53	<10	46		
EST HYD CONDUCT	50									--	45	--	20	--	40	--	25		

Town of White Oak. Well No: X40c4
Map No: **13** Log Depth 386 Latitude: 344430 Longitude: 784230 Altitude of Land Surface: 75 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	75											37	32	-131	-205	-281			
THICK	38											5	163	74	76	--			
PCT PERM MATERIAL	90											<10	50	20	68	--			
EST HYD CONDUCT	30											--	25	--	30	--			

DuPont Corporation. Well No: V41y-
Map No: **14** Log Depth 384 Latitude: 345037 Longitude: 785018 Altitude of Land Surface: 147 Basement: -237

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	147											125	113	-86	-119				
THICK	22											12	199	33	118				
PCT PERM MATERIAL	90											<25	56	<10	59				
EST HYD CONDUCT	50											--	30	--	25				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

West Point Pepperell Company. Well No: Y39g6
Map No: **15** Log Depth 518 Latitude: 343757 Longitude: 783715 Altitude of Land Surface: 130 Basement: -384

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	130									100	86	14	1	-135	-177	-131	-330		
THICK	30									14	72	13	136	42	134	19	54		
PCT PERM MATERIAL	65									<10	71	15	44	19	62	16	56		
EST HYD CONDUCT	25									--	30	--	25	--	35	--	35		

B R U N S W I C K   C O U N T Y

NRCD Bear Pen Research Station. Well No: EE36k2
Map No: **16** Log Depth 1,118 Latitude: 340743 Longitude: 782017 Altitude of Land Surface: 64 Basement:-1,054

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	64										--	-300	-373	-592	-618	-754	-834		
THICK	--										>306	73	219	26	136	80	220		
PCT PERM MATERIAL	--										66	14	75	<20	71	<10	54		
EST HYD CONDUCT	--										35	--	35	--	50	--	55		

Colonial Oil and Gas Company. Well No: DD31h- API No. 32-019-2 (Trask No. 1)
Map No: **17** Log Depth 1,235 Latitude: 340820 Longitude: 775745 Altitude of Land Surface: 15 Basement:-1,220

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	15					-25	-35			-140	-190	-435	-507	-765	-820	-975	-1,041		
THICK	40					10	105			50	245	72	258	55	155	66	179		
PCT PERM MATERIAL	90					<10	67			<25	41	<10	59	<10	74	<10	46		
EST HYD CONDUCT	25					--	85			--	65	--	50	--	35	--	50		

NRCD Calabash Research Station. Well No: HH39j2
Map No: **18** Log Depth 1,335 Latitude: 335336 Longitude: 783522 Altitude of Land Surface: 50 Basement:-1,282

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	50									-12	-50	-349	-416	-638	-694	-802	-868		
THICK	62									38	299	67	219	56	108	66	414		
PCT PERM MATERIAL	80									<5	50	<10	73	<10	51	<10	45		
EST HYD CONDUCT	25									--	45	--	30	--	45	--	45		

NRCD Grissettown Research Station. Well No: GG38k3
Map No: **19** Log Depth 500 Latitude: 335733 Longitude: 782958 Altitude of Land Surface: 42 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	42									-18	-32	-360	-405						
THICK	60									14	328	45	--						
PCT PERM MATERIAL	87									<10	47	<10	--						
EST HYD CONDUCT	20									--	50	--	--						

Albert Glenn. Well No: DD33y1
Map No: **20** Log Depth 400 Latitude: 341018 Longitude: 780954 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25									8	0	-329							
THICK	17									8	329	--							
PCT PERM MATERIAL	90									<10	61	--							
EST HYD CONDUCT	50									--	30	--							

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

C A M D E N   C O U N T Y

Edwin Blair Company. Well No: D10a- API No. 32-029-2 (Weyerhaeuser No. 1)
Map No: 21 Log Depth 3,471 Latitude: 362440 Longitude: 761030 Altitude of Land Surface: 8 Basement: -2,814

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8	--	--	--	-510	-534	-541	-624	-647			-818	-862	-995	-1,045	-1,212	-1,332	-1,612	-1,670
THICK	--	--	--	>138	24	7	83	23	171			44	133	50	167	120	280	58	1,144
PCT PERM MATERIAL	--	--	--	<5	90	<10	82	<10	56			34	60	18	53	17	61	<5	--
EST HYD CONDUCT	--	--	--	--	15	--	85	--	40			--	30	--	25	--	45	--	--

C A R T E R E T   C O U N T Y

NRCD Camp Glenn Research Station. Well No: X1716
Map No: 22 Log Depth 1,120 Latitude: 344323 Longitude: 764513 Altitude of Land Surface: 8 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8	-18	-36	-48	-58	-102	-130	-1,082	-1,096										
THICK	26	18	12	10	44	28	952	14	--										
PCT PERM MATERIAL	90	<25	90	<25	80	<15	93	<15	--										
EST HYD CONDUCT	50	--	40	--	35	--	60	--	--										

C H O W A N   C O U N T Y

USGS Glidden Test. Well No: E15b1
Map No: 23 Log Depth 940 Latitude: 361902 Longitude: 763634 Altitude of Land Surface: 36 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	36	-28	-81	-161	-194	-206	-213	-231	-258			-321	-343	-490	-518	-666	-697		
THICK	64	53	80	33	12	7	18	27	63			22	147	28	148	31	--		
PCT PERM MATERIAL	66	<25	52	<25	90	<10	67	<25	71			23	58	<10	59	<10	--		
EST HYD CONDUCT	20	--	15	--	25	--	65	--	50			--	40	--	30	--	--		

USGS Edenton Airport Test. Well No: H14p1
Map No: **24** Log Depth 847 Latitude: 360100 Longitude: 763438 Altitude of Land Surface: 8 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8	-27	-48	-148	-182		-220	-263	-289	-398	-427	-488	-543	-595	-654				
THICK	35	21	100	34	38		43	26	109	29	61	55	69	59	--				
PCT PERM MATERIAL	46	28	58	<10	66		90	<20	60	20	52	<10	63	<25	--				
EST HYD CONDUCT	35	--	30	--	20		45	--	50	--	15	--	30	--	--				

USGS Valhalla Test. Well No: G15f-
Map No: **25** Log Depth 528 Latitude: 360836 Longitude: 763924 Altitude of Land Surface: 39 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	39	-3	-27	-134	-150	-191	-199	-218	-257			-315	-387						
THICK	42	24	107	16	41	8	19	39	58			72	--						
PCT PERM MATERIAL	83	20	58	<10	68	<25	90	15	66			19	--						
EST HYD CONDUCT	15	--	25	--	30	--	40	--	50			--	--						

C O L U M B U S   C O U N T Y

NRCD Nakina Research Station. Well No: EE39o2
Map No: **26** Log Depth 1,028 Latitude: 340733 Longitude: 783952 Altitude of Land Surface: 60 Basement: -901

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	60										-5	-20	-272	-290	-433	-506	-647	-742	
THICK	65										15	252	18	143	73	141	95	159	
PCT PERM MATERIAL	68										<10	59	22	42	22	45	<10	46	
EST HYD CONDUCT	20										--	40	--	25	--	40	--	30	

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Clarendon Research Station. Well No: DD42n2
Map No: 27 Log Depth 879 Latitude: 341237 Longitude: 785342 Altitude of Land Surface: 108 Basement: -771

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	108									19	6	-187	-204	-333	-432	-542	-586		
THICK	89									25	181	17	129	99	110	44	185		
PCT PERM MATERIAL	67									28	68	<10	66	<10	64	14	57		
EST HYD CONDUCT	25									--	55	--	30	--	35	--	25		

NRCD Green Swamp Research Station. Well No: DD36y1
Map No: 28 Log Depth 932 Latitude: 341230 Longitude: 782630 Altitude of Land Surface: 48 Basement: -884

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	48									-8	-30	-222	-266	-448	-476	-597	-714		
THICK	--									22	192	44	182	28	121	117	170		
PCT PERM MATERIAL	--									<10	57	11	60	<5	85	10	73		
EST HYD CONDUCT	--									--	35	--	20	--	30	--	25		

Town of Fairbluff. Well No: CC44h-
Map No: 29 Log Depth 314 Latitude: 341846 Longitude: 790207 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	65									37	12	-17	-66						
THICK	28									25	29	49	--						
PCT PERM MATERIAL	86									<10	90	30	--						
EST HYD CONDUCT	25									--	30	--	--						

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Chadbourne. Well No: CC41e-
Map No: **30** Log Depth 436 Latitude: 341945 Longitude: 784953 Altitude of Land Surface: 110 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	110									63	60	-74	-98	-222					
THICK	47									3	134	24	124	--					
PCT PERM MATERIAL	66									<50	66	<10	60	--					
EST HYD CONDUCT	25									--	25	--	25	--					

C R A V E N   C O U N T Y

USGS Simmons Farm Test. Well No: T22a1
Map No: **31** Log Depth 1,000 Latitude: 350458 Longitude: 771049 Altitude of Land Surface: 34 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	34						--	-222	-252	-317	-341	-475	-587	-871	-907				
THICK	--						>215	30	65	24	134	112	284	36	--				
PCT PERM MATERIAL	--						74	26	55	29	67	<15	50	<10	--				
EST HYD CONDUCT	--						60	--	35	--	30	--	30	--	--				

USGS New Bern Properties Test. Well No: S21i-
Map No: **32** Log Depth 960 Latitude: 350815 Longitude: 770620 Altitude of Land Surface: 27 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	27					17	1	-266	-289	-333	-347	-501	-553	-893	-911				
THICK	10					16	267	23	44	14	154	52	340	18	--				
PCT PERM MATERIAL	90					19	81	<20	80	<10	51	<20	50	<10	--				
EST HYD CONDUCT	25					--	50	--	30	--	25	--	30	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

USGS N.W. Fields Property Test. Well No: S21y-
Map No: **33** Log Depth 605 Latitude: 350544 Longitude: 770908 Altitude of Land Surface: 21 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	21					--	-2	-217	-229	-325	-341	-464	-553						
THICK	--					>5	215	12	96	16	123	89	--						
PCT PERM MATERIAL	--					<10	72	<10	57	12	63	<20	--						
EST HYD CONDUCT	--					--	70	--	20	--	30	--	--						

NRCD Clarks Research Station. Well No: S22j6
Map No: **34** Log Depth 1,286 Latitude: 350816 Longitude: 771018 Altitude of Land Surface: 28 Basement: -1,254

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	28					10	2	-221	-228	-292	-300	-432	-520	-830	-860	-1,079	-1,144		
THICK	18					8	223	7	64	8	132	88	310	30	219	65	110		
PCT PERM MATERIAL	90					<20	86	<10	76	<10	49	<25	54	23	65	34	42		
EST HYD CONDUCT	25					--	55	--	30	--	25	--	35	--	45	--	75		

Peter Havfich. Well No: R24n5
Map No: **35** Log Depth 1,195 Latitude: 351018 Longitude: 772332 Altitude of Land Surface: 60 Basement: -998

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	60					52	46	-43	-50	-117	-147	-221	-264	-611	-629	-788	-810		
THICK	8					6	89	7	67	30	74	43	347	18	159	22	188		
PCT PERM MATERIAL	90					<10	90	<10	57	<5	81	<10	56	<5	69	<5	59		
EST HYD CONDUCT	50					--	50	--	40	--	45	--	30	--	25	--	20		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

City of New Bern Cove City Test. Well No: R23w1
Map No: **36** Log Depth 884 Latitude: 351038 Longitude: 771752 Altitude of Land Surface: 34 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	34						24	-108	-116	-194	-236	-300	-363	-714	-732				
THICK	10						132	8	78	42	64	63	351	18	--				
PCT PERM MATERIAL	90						90	<10	72	<20	75	22	66	<5	--				
EST HYD CONDUCT	50						70	--	40	--	40	--	30	--	--				

USGS Rice Property Test. Well No: R21o1
Map No: **37** Log Depth 554 Latitude: 351239 Longitude: 770924 Altitude of Land Surface: 23 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	23					16	-3	-197	-206	-241	-275	-391	-415						
THICK	7					19	194	9	35	34	116	24	--						
PCT PERM MATERIAL	90					<10	89	<50	90	26	69	17	--						
EST HYD CONDUCT	25					--	55	--	25	--	30	--	35						

City of New Bern Dover Test. Well No: R2513
Map No: **38** Log Depth 400 Latitude: 351255 Longitude: 772615 Altitude of Land Surface: 55 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	55					39	21	-9	-27	-71	-131	-191	-289						
THICK	16					18	30	18	44	60	60	98	--						
PCT PERM MATERIAL	90					17	90	<10	68	42	<90	20	--						
EST HYD CONDUCT	25					--	70	--	35	--	30	--	--						

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

City of New Bern Test No. 13. Well No: S20o1
Map No: **39** Log Depth 496 Latitude: 350730 Longitude: 770430 Altitude of Land Surface: 20 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	20				--	-22	-35	-320	-338										
THICK	--				>14	13	285	18	--										
PCT PERM MATERIAL	--				90	<25	82	22	--										
EST HYD CONDUCT	--				25	--	60	--	--										

C U M B E R L A N D   C O U N T Y

Town of Falcon. Well No: R39p1
Map No: **40** Log Depth 230 Latitude: 351130 Longitude: 783915 Altitude of Land Surface: 143 Basement: -60

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	143											95	86	29	9				
THICK	18											9	57	20	69				
PCT PERM MATERIAL	90											<10	64	17	42				
EST HYD CONDUCT	25											--	30	--	20				

NRCD Seabrook Research Station. Well No: U41a1
Map No: **41** Log Depth 280 Latitude: 345915 Longitude: 784518 Altitude of Land Surface: 130 Basement: -103

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	130											88	70	15	-20				
THICK	42											18	55	35	83				
PCT PERM MATERIAL	78											<10	55	17	48				
EST HYD CONDUCT	25											--	25	--	25				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Eastover Rest Home. Well No: S41w4
Map No: **42** Log Depth 433 Latitude: 350526 Longitude: 784717 Altitude of Land Surface: 125 Basement: -75

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	125											96	90	49	13				
THICK	29											6	41	36	88				
PCT PERM MATERIAL	90											<10	49	22	52				
EST HYD CONDUCT	30											--	15	--	20				

Walter Moorman. Well No: S42o3
Map No: **43** Log Depth 268 Latitude: 350709 Longitude: 785442 Altitude of Land Surface: 240 Basement: -28

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	240											--	--	113	74				
THICK	--											--	>100	39	102				
PCT PERM MATERIAL	90											--	68	<10	57				
EST HYD CONDUCT	50											--	15	--	10				

Town of Spring Lake. Well No: S43d10
Map No: **44** Log Depth 152 Latitude: 350957 Longitude: 785813 Altitude of Land Surface: 300 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	300											--	--	195					
THICK	--											--	>50	--					
PCT PERM MATERIAL	70											--	78	--					
EST HYD CONDUCT	25											--	20	--					

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

U.S. Army Forest Fire Fighting Hq. Well No: S44g-
Map No: **45** Log Depth 257 Latitude: 350825 Longitude: 790347 Altitude of Land Surface: 405 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	405												--	175					
THICK	--												>200	--					
PCT PERM MATERIAL	--												69	--					
EST HYD CONDUCT	--												15	--					

C U R R I T U C K C O U N T Y

E.F. Blair and Associates. Well No: E7j- API No. 32-053-1 (Twiford No. 1)
Map No: **46** Log Depth 4,553 Latitude: 361810 Longitude: 755530 Altitude of Land Surface: 5 Basement:-4,516

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	5	--	--	-615	-759	-770	-784	-948	-1,000			-1,060	-1,220	-1,423	-1,469	-1,763	-1,910	-2,203	-2,267
THICK	--	--	>35	144	11	14	164	52	60			160	203	46	294	147	293	64	2,249
PCT PERM MATERIAL	--	--	--	<5	90	<10	74	23	75			<10	54	<10	68	23	64	12	--
EST HYD CONDUCT	--	--	--	--	50	--	70	--	25			--	20	--	25	--	35	--	--

D A R E C O U N T Y

NRCD Mann's Harbor Research Sta. Well No: J5j1
Map No: **47** Log Depth 500 Latitude: 355315 Longitude: 754558 Altitude of Land Surface: 7 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	7	-173	-233	-439															
THICK	180	60	206	--															
PCT PERM MATERIAL	66	<5	78	--															
EST HYD	35	--	25	--															

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

E.F. Blair and Associates. Well No: J7t- API No. 32-055-6 (W.Va. Pulp and Paper No. 1)
Map No: **48** Log Depth 5,147 Latitude: 355150 Longitude: 755530 Altitude of Land Surface: 3 Basement:-5,119

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	3	-143	-189	-532	-617	-797	-813	-1,127	-1,207	-1,324	-1,355	-1,511	-1,612	-1,709	-1,852	--	--	--	--
THICK	146	46	343	85	180	16	314	80	117	31	156	101	97	143	--	--	--	--	--
PCT PERM MATERIAL	--	<10	45	<10	44	<15	65	<10	47	<50	45	<10	50	<25	--	--	--	--	--
EST HYD CONDUCT	25	--	30	--	25	--	90	--	25	--	20	--	20	--	--	--	--	--	--

D U P L I N   C O U N T Y

NRCD Chinquapin Research Station. Well No: W29d6
Map No: **49** Log Depth 822 Latitude: 344922 Longitude: 774847 Altitude of Land Surface: 45 Basement: -743

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	45									37	33	-193	-247	-540	-582	-670	-700		
THICK	8									4	226	54	293	42	88	30	43		
PCT PERM MATERIAL	90									<10	66	11	55	<10	43	47	70		
EST HYD CONDUCT	15									--	40	--	20	--	30	--	35		

Town of Faison. Well No: S33v-
Map No: **50** Log Depth 260 Latitude: 350645 Longitude: 780705 Altitude of Land Surface: 150 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	150											130	94	-40	-85				
THICK	20											36	134	45	--				
PCT PERM MATERIAL	40											<5	60	13	--				
EST HYD CONDUCT	50											--	25	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Pink Hill Research Station. Well No: T29g3
Map No: **51** Log Depth 689 Latitude: 350323 Longitude: 774826 Altitude of Land Surface: 127 Basement: -553

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	127					85	74			67	35	-43	-115	-292	-325				
THICK	42					11	7			32	78	72	177	33	228				
PCT PERM MATERIAL	69					<10	100			38	88	<25	60	18	43				
EST HYD CONDUCT	35					--	15			--	60	--	30	--	20				

E D G E C O M B E   C O U N T Y

Town of Pinetops. Well No: K27n1
Map No: **52** Log Depth 317 Latitude: 354724 Longitude: 773822 Altitude of Land Surface: 108 Basement: -196

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	108	75	68											41	6	**			
THICK	33	7	27											35	67				
PCT PERM MATERIAL	54	<5	67											<10	75				
EST HYD CONDUCT	25	--	20											--	25				

City of Tarboro. Well No: J26h-
Map No: **53** Log Depth 349 Latitude: 355334 Longitude: 773218 Altitude of Land Surface: 50 Basement: -299

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	50	--	--											25	10	**			
THICK	--	--	--											15	159				
PCT PERM MATERIAL	--	--	--											--	--				
EST HYD CONDUCT	--	--	--											--	--				

** Thick clay beds occur between lowermost aquifer and bedrock

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Frank Eason. Well No: K28u-
Map No: **54** Log Depth 242 Latitude: 354503 Longitude: 774022 Altitude of Land Surface: 102 Basement: -140

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	102	80	68											64	30				
THICK	22	12	4											34	--				
PCT PERM MATERIAL	41	<10	<90											18	--				
EST HYD CONDUCT	25	--	15											--	--				

Town of Speed. Well No: I25i3
Map No: **55** Log Depth 300 Latitude: 355817 Longitude: 772648 Altitude of Land Surface: 52 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	52	44	25											-6	-26				
THICK	8	19	31											20	191				
PCT PERM MATERIAL	90	<50	58											<30	50				
EST HYD CONDUCT	20	--	20											--	30				

G A T E S   C O U N T Y

NRCD Sunbury Research Station. Well No: C15s4
Map No: **56** Log Depth 942 Latitude: 362646 Longitude: 763614 Altitude of Land Surface: 40 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	40	-52	-82	-145	-159	-210	-214	-226	-249			-336	-352	-412	-441	-548	-560		
THICK	92	30	63	14	51	4	12	23	87			16	60	29	107	12	--		
PCT PERM MATERIAL	60	23	81	<10	86	<10	90	26	67			18	75	34	67	<20	--		
EST HYD CONDUCT	25	--	25	--	30	--	80	--	30			--	40	--	40	--	--		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

S.E. Cullinan Drilling Company. Well No: C14t- API No. 32-073-1 (Weyerhaeuser No. 1)
Map No: **57** Log Depth 2,138 Latitude: 362610 Longitude: 763005 Altitude of Land Surface: 15 Basement:-2,088

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	15	-55	-87	-211	-240	-280	-303	-317	-364			-426	-455	-554	-621	-711	-746	-1,221	-1,276
THICK	70	32	124	29	40	23	14	47	62			29	99	67	90	35	475	55	812
PCT PERM MATERIAL	85	<10	55	21	70	<10	90	<20	66			<10	77	27	77	20	59	<10	55
EST HYD CONDUCT	25	--	10	--	25	--	50	--	30			--	35	--	30	--	25	--	25

Kittrell Farm. Well No: B15u-
Map No: **58** Log Depth 416 Latitude: 363057 Longitude: 763546 Altitude of Land Surface: 42 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	42	-38	-86			-176	-219	-233	-260										
THICK	80	48	90			43	14	27	--										
PCT PERM MATERIAL	69	<20	64			<15	90	<10	--										
EST HYD CONDUCT	25	--	20			--	25	--	--										

Buckland School. Well No: C17j-
Map No: **59** Log Depth 394 Latitude: 362830 Longitude: 764550 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25	-15	-83					-136	-156			-185	-229	-258	-280				
THICK	40	68	53					20	29			44	29	22	--				
PCT PERM MATERIAL	60	<20	64					20	90			14	69	<10	--				
EST HYD CONDUCT	25	--	15					--	20			--	25	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

GREENE COUNTY

NRCD Maury Research Station. Well No: 027j4
Map No: **60** Log Depth 568 Latitude: 352840 Longitude: 773555 Altitude of Land Surface: 78 Basement: -490

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	78									63	34	10	-14	-160	-202				
THICK	15									29	24	24	146	42	288				
PCT PERM MATERIAL	90									<5	75	33	51	20	48				
EST HYD CONDUCT	25									--	25	--	30	--	25				

HALIFAX COUNTY

NRCD Caledonia Research Station. Well No: E25i1
Map No: **61** Log Depth 220 Latitude: 361804 Longitude: 772612 Altitude of Land Surface: 37 Basement: -182

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	37													20	-3	-49	-67		
THICK	17													23	46	18	115		
PCT PERM MATERIAL	90													<10	87	<10	52		
EST HYD CONDUCT	50													--	50	--	35		

Town of Scotland Neck. Well No: G25k1
Map No: **62** Log Depth 338 Latitude: 360736 Longitude: 772442 Altitude of Land Surface: 93 Basement: -245

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	93	65	53											21	11	-89	-150		
THICK	28	12	32											10	100	61	95		
PCT PERM MATERIAL	90	<10	56											<10	50	<20	55		
EST HYD CONDUCT	25	--	20											--	20	--	30		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Hobgood. Well No: H25q-
Map No: **63** Log Depth 396 Latitude: 360148 Longitude: 772350 Altitude of Land Surface: 90 Basement: -306

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	90	79	50											-5	-19	-158	-255		
THICK	11	29	55											14	139	97	51		
PCT PERM MATERIAL	90	14	54											28	59	<5	67		
EST HYD CONDUCT	25	--	15											--	30	--	25		

H A R N E T T   C O U N T Y

Harnett Co. Board of Education. Well No: 04111
Map No: **64** Log Depth 457 Latitude: 352752 Longitude: 784643 Altitude of Land Surface: 290 Basement: 209

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	290											278	264						
THICK	12											14	55						
PCT PERM MATERIAL	50											<20	44						
EST HYD CONDUCT	20											--	20						

Hugh W. Dean. Well No: R45f1
Map No: **65** Log Depth 316 Latitude: 351257 Longitude: 790846 Altitude of Land Surface: 325 Basement: 143

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	325											--	--	251	226				
THICK	--											--	>30	25	83				
PCT PERM MATERIAL	90											--	90	20	41				
EST HYD CONDUCT	15											--	10	--	20				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

P.T. Perkins. Well No: P41f1
Map No: **66** Log Depth 125 Latitude: 352256 Longitude: 784942 Altitude of Land Surface: 239 Basement: 183

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	239											229	220	**					
THICK	10											9	25						
PCT PERM MATERIAL	90											<10	54						
EST HYD CONDUCT	25											--	25						

H E R T F O R D   C O U N T Y

NRCD Como Research Station. Well No: B20u6
Map No: **67** Log Depth 818 Latitude: 363026 Longitude: 770019 Altitude of Land Surface: 62 Basement: -752

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	62	38	32					14	-15					-58	-90	-163	-178	-606	-625
THICK	24	6	18					29	43					32	73	15	428	19	127
PCT PERM MATERIAL	90	<20	90					<20	86					31	56	<10	55	<10	51
EST HYD CONDUCT	20	--	20					--	30					--	25	--	30	--	25

H O K E   C O U N T Y

Town of Raeford. Well No: U46f-
Map No: **68** Log Depth 308 Latitude: 345831 Longitude: 791412 Altitude of Land Surface: 253 Basement: -4

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	253											231	218	126	51				
THICK	22											13	92	75	55				
PCT PERM MATERIAL	90											<10	65	33	51				
EST HYD CONDUCT	25											--	25	--	20				

** Thick clay beds occur between lowermost aquifer and bedrock

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

W.W. Camaran, Jr. Well No: T48k1
Map No: **69** Log Depth 248 Latitude: 350200 Longitude: 792056 Altitude of Land Surface: 350 Basement: 102

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	350											--	--	198	144				
THICK	--											--	>100	54	42				
PCT PERM MATERIAL	90											--	54	28	52				
EST HYD CONDUCT	25											--	25	--	20				

H Y D E C O U N T Y

NRCD Hydeland Research Station. Well No: O10w2
Map No: **70** Log Depth 1,505 Latitude: 352527 Longitude: 761231 Altitude of Land Surface: 3 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	3	-92	-104	-365	-501	-619	-629	-1,061	-1,095	-1,218	-1,230	-1,375							
THICK	95	12	261	136	118	10	432	34	123	12	145	--							
PCT PERM MATERIAL	80	<20	77	29	76	<10	92	24	57	<10	72	--							
EST HYD CONDUCT	30	--	25	--	60	--	55	--	25	--	30	--							

USGS Ocracoke Test. Well No: S7q-
Map No: **71** Log Depth 895 Latitude: 350647 Longitude: 755839 Altitude of Land Surface: 3 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	3	-95	-132	-466	-585	-810	-820												
THICK	98	37	334	119	225	10	--												
PCT PERM MATERIAL	80	<20	85	<25	60	<10	--												
EST HYD CONDUCT	25	--	30	--	30	--	--												

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD New Lake Research Station. Well No: M1213
Map No: **72** Log Depth 1,011 Latitude: 353720 Longitude: 762118 Altitude of Land Surface: 11 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	11	-58	-68	-311	-365	-429	-437	-735	-771	-897	-927								
THICK	63	10	243	54	64	8	298	36	126	30	--								
PCT PERM MATERIAL	68	<10	68	<10	75	<10	75	<20	59	<25	--								
EST HYD CONDUCT	20	--	30	--	30	--	50	--	25	--	--								

J O H N S T O N   C O U N T Y

D.H. Johnston. Well No: P37w2
Map No: **73** Log Depth 203 Latitude: 352003 Longitude: 787753 Altitude of Land Surface: 203 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	203											166	145	76	53				
THICK	37											21	69	23	--				
PCT PERM MATERIAL	70											<10	65	<10	--				
EST HYD CONDUCT	50											--	30	--	--				

Tuscarora Scout Council. Well No: P35u1
Map No: **74** Log Depth 139 Latitude: 352035 Longitude: 781525 Altitude of Land Surface: 125 Basement: 14

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	125											117	108	86	70				
THICK	8											9	22	16	84				
PCT PERM MATERIAL	90											<10	73	<10	57				
EST HYD CONDUCT	25											--	25	--	70				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Norwood Sorrell. Well No: P38n2
Map No: **75** Log Depth 160 Latitude: 352228 Longitude: 783403 Altitude of Land Surface: 210 Basement: 62

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	210											190	160	124	109				
THICK	20											30	36	15	47				
PCT PERM MATERIAL	85											<20	43	33	57				
EST HYD CONDUCT	25											--	25	--	70				

J O N E S   C O U N T Y

Town of Maysville. Well No: V22d1
Map No: **76** Log Depth 504 Latitude: 345435 Longitude: 771330 Altitude of Land Surface: 35 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	35					27	-2	-303	-321	-434									
THICK	8					29	301	18	113	--									
PCT PERM MATERIAL	90					14	76	<20	73	--									
EST HYD CONDUCT	25					--	65	--	45	--									

NRCD Comfort Research Station. Well No: U26j2
Map No: **77** Log Depth 877 Latitude: 345809 Longitude: 773014 Altitude of Land Surface: 70 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	70					60	46	-78	-92	-120	-156	-249	-392	-663	-702				
THICK	10					14	124	14	28	36	93	143	271	39	--				
PCT PERM MATERIAL	90					<10	68	<10	90	<5	59	24	46	<10	--				
EST HYD CONDUCT	25					--	85	--	75	--	55	--	20	--	--				

L E N O I R   C O U N T Y

NRCD Kinston Supply Yard Res. Sta. Well No: Q27r5
Map No: **78** Log Depth 673 Latitude: 351609 Longitude: 773706 Altitude of Land Surface: 44 Basement: -629

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	44									37	23	-57	-138	-345	-363				
THICK	7									14	80	81	207	18	224				
PCT PERM MATERIAL	90									<20	58	7	63	<5	49				
EST HYD CONDUCT	25									--	40	--	30	--	20				

Town of La Grange. Well No: Q29k3
Map No: **79** Log Depth 410 Latitude: 351715 Longitude: 774510 Altitude of Land Surface: 102 Basement: -304

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	102									77	60	30	0	-191	-219				
THICK	25									17	30	30	191	28	85				
PCT PERM MATERIAL	60									<10	85	<10	50	18	53				
EST HYD CONDUCT	25									--	40	--	30	--	35				

Falling Creek Water Company. Well No: Q28k2
Map No: **80** Log Depth 390 Latitude: 351706 Longitude: 774012 Altitude of Land Surface: 98 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	98									45	31	-16	-71	-256	-280				
THICK	53									14	47	55	185	24	--				
PCT PERM MATERIAL	57									<10	64	34	64	38	--				
EST HYD CONDUCT	30									--	20	--	30	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

USGS Pink Hill Test. Well No: T28f2
Map No: **81** Log Depth 392 Latitude: 350305 Longitude: 774450 Altitude of Land Surface: 100 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	100					66	46			16	-16	-140	-203						
THICK	36					20	30			32	124	63	--						
PCT PERM MATERIAL	81					<20	73			31	73	<20	--						
EST HYD CONDUCT	30					--	25			--	25	--	--						

City of Kinston. Well No: R26d1
Map No: **82** Log Depth 600 Latitude: 351412 Longitude: 773355 Altitude of Land Surface: 33 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	33							19	0	-20	-41	-139	-227	-447	-469				
THICK	14							19	20	21	98	88	220	22	--				
PCT PERM MATERIAL	90							<10	80	<10	82	23	66	23	--				
EST HYD CONDUCT	25							--	15	--	35	--	30	--	--				

M A R T I N   C O U N T Y

Town of Williamston. Well No: J20q-
Map No: **83** Log Depth 665 Latitude: 355111 Longitude: 770338 Altitude of Land Surface: 60 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	60	40	19	-5	-55	-67	-74	-88	-103	-157	-165	-171	-205	-403	-435				
THICK	20	21	24	50	12	7	14	15	54	8	6	34	198	32	--				
PCT PERM MATERIAL	90	<20	79	16	90	<25	90	<10	56	25	90	<10	62	25	--				
EST HYD CONDUCT	25	--	15	--	50	--	25	--	30	--	15	--	35	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Robersonville. Well No: K23a1
Map No: **84** Log Depth 420 Latitude: 354932 Longitude: 771559 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	65	46	26									15	-77	-273	-307				
THICK	19	20	11									92	196	34	--				
PCT PERM MATERIAL	90	<10	82									47	62	29	--				
EST HYD CONDUCT	50	--	15									--	35	--	--				

USGS Jamesville Test. Well No: L18n-
Map No: **85** Log Depth 970 Latitude: 354232 Longitude: 765307 Altitude of Land Surface: 35 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	35	14	-3	-25	-42	-52	-67	-178	-194	-289	-318	-346	-391	-582	-615				
THICK	21	17	22	17	10	15	111	16	95	29	28	45	191	33	--				
PCT PERM MATERIAL	90	<10	77	24	90	<10	80	<25	80	17	71	13	60	30	--				
EST HYD CONDUCT	25	--	25	--	25	--	45	--	40	--	20	--	30	--	--				

M O O R E   C O U N T Y

NRCD Pinewild Research Station. Well No: R50k2
Map No: **86** Log Depth 230 Latitude: 351230 Longitude: 793059 Altitude of Land Surface: 520 Basement: 340

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	520											--	--	**					
THICK	--											--	>90						
PCT PERM MATERIAL	90											--	--						
EST HYD CONDUCT	25											--	--						

** Thick clay beds occur between lowermost aquifer and bedrock

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Weymouth Woods Research Sta. Well No: S48h1
Map No: **87** Log Depth 269 Latitude: 350841 Longitude: 792218 Altitude of Land Surface: 475 Basement: 206

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	475											--	--	299	229				
THICK	--											--	>140	70	23				
PCT PERM MATERIAL	57											--	64	25	90				
EST HYD CONDUCT	25											--	25	--	--				

Longleaf, Incorporated. Well No: Q51u3
Map No: **88** Log Depth 191 Latitude: 351557 Longitude: 793523 Altitude of Land Surface: 605 Basement: 414

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	605											--	--	**					
THICK	--											--	>130						
PCT PERM MATERIAL	90											--	58						
EST HYD CONDUCT	25											--	25						

Pinehurst, Incorporated. Well No: R49m3
Map No: **89** Log Depth 224 Latitude: 351219 Longitude: 792751 Altitude of Land Surface: 505 Basement: 281

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	505											--	--	349	295				
THICK	--											--	>130	54	14				
PCT PERM MATERIAL	90											--	53	30	86				
EST HYD CONDUCT	45											--	25	--	15				

** Thick clay beds occur between lowermost aquifer and bedrock

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NEW HANOVER COUNTY

Hercofina Corporation. Well No: CC31g-
Map No: **90** Log Depth 1,060 Latitude: 341856 Longitude: 775851 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25						--			-90	-102	-343	-398	-650	-704	-849	-908		
THICK	--						>95			12	241	55	252	54	145	59	--		
PCT PERM MATERIAL	--						90			<20	60	<10	65	<40	65	<50	--		
EST HYD CONDUCT	--						25			--	35	--	35	--	20	--	--		

USGS Wilmington Test. Well No: CC301-
Map No: **91** Log Depth 684 Latitude: 341800 Longitude: 775140 Altitude of Land Surface: 25 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	25										--	-415	-458						
THICK	--										>314	43	--						
PCT PERM MATERIAL	--										62	<10	--						
EST HYD CONDUCT	--										35	--	--						

NORTHAMPTON COUNTY

Town of Rich Square. Well No: E23r1
Map No: **92** Log Depth 335 Latitude: 361635 Longitude: 771700 Altitude of Land Surface: 75 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	75	65	55											-3	-15	-99	-120		
THICK	10	10	58											12	84	21	--		
PCT PERM MATERIAL	90	<20	66											<10	78	29	--		
EST HYD CONDUCT	25	--	25											--	30	--	--		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

G.B. Barnes. Well No: B22y-
Map No: **93** Log Depth 310 Latitude: 363100 Longitude: 771426 Altitude of Land Surface: 120 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	120	59	33											7	-16	-43	-64		
THICK	61	26	26											23	27	21	--		
PCT PERM MATERIAL	79	23	90											<10	70	<10	--		
EST HYD CONDUCT	20	--	20											--	25	--	--		

Town of Conway. Well No: C22q2
Map No: **94** Log Depth 520 Latitude: 362603 Longitude: 771339 Altitude of Land Surface: 105 Basement: -415

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	105	66	50											-1	-15	-27	-82		
THICK	39	16	51											14	12	55	333		
PCT PERM MATERIAL	75	<10	82											<10	90	<20	57		
EST HYD CONDUCT	25	--	20											--	30	--	25		

O N S L O W   C O U N T Y

NRCD Folkstone Research Station. Well No: Y25q2(x)
Map No: **95** Log Depth 1,220 Latitude: 343642 Longitude: 772901 Altitude of Land Surface: 67 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	67					43	11	-245	-260	-279	-291	-642	-706	-1,080					
THICK	24					32	256	15	19	12	351	64	374	--					
PCT PERM MATERIAL	75					<10	76	<10	74	<10	75	<20	58	--					
EST HYD CONDUCT	25					--	75	--	40	--	35	--	30	--					

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

N.C. Oil and Gas Company. Well No: Z24m- API No. 32-133-11 (Justice No. 1)
Map No: **96** Log Depth 1,681 Latitude: 343300 Longitude: 772230 Altitude of Land Surface: 8 Basement:-1,660

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8						--	-304	-349	-392	-435	-692	-780	-1,162	-1,229	-1,347	-1,417		
THICK	--						>262	43	43	43	257	88	382	67	118	70	243		
PCT PERM MATERIAL	--						86	<20	90	16	69	11	66	30	70	26	63		
EST HYD CONDUCT	--						70	--	30	--	35	--	30	--	50	--	45		

Bryant P. Seay Company. Well No: U25g- API No. 32-133-4 (Hoffman Forest No. 1)
Map No: **97** Log Depth 1,433 Latitude: 345400 Longitude: 772345 Altitude of Land Surface: 50 Basement:-1,368

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	50						--	-211	-224	-293	-330	-451	-586	-888	-954	-1,018	-1,073		
THICK	--						>161	13	69	37	121	135	302	66	64	55	295		
PCT PERM MATERIAL	--						83	<20	86	<5	72	20	56	15	92	18	42		
EST HYD CONDUCT	--						80	--	35	--	45	--	35	--	30	--	45		

E.T. Burton Company. Well No: V23v- API No. 32-133-3 (Hoffman Forest No. 1)
Map No: **98** Log Depth 1,570 Latitude: 345000 Longitude: 771640 Altitude of Land Surface: 40 Basement:-1,520

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	40						--	-305	-322	-465	-524	-669	-745	-1,070	-1,108	-1,223	-1,283		
THICK	--						>255	17	143	59	145	76	325	38	115	60	237		
PCT PERM MATERIAL	--						79	<20	77	22	75	20	52	<10	59	30	57		
EST HYD CONDUCT	--						75	--	25	--	65	--	35	--	55	--	55		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Deppe Research Station. Well No: V23x2
Map No: **99** Log Depth 1,001 Latitude: 345016 Longitude: 771814 Altitude of Land Surface: 45 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	45					2	-20	-283	-306	-420	-458	-621	-714						
THICK	43					22	263	23	114	38	163	93	--						
PCT PERM MATERIAL	90					18	80	35	80	18	77	27	--						
EST HYD CONDUCT	25					--	65	--	30	--	30	--	--						

Onslow Water Association. Well No: V27a1
Map No: **100** Log Depth 484 Latitude: 345430 Longitude: 773530 Altitude of Land Surface: 65 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	65					27	11	-42	-69	-99	-143	-244	-378						
THICK	38					16	53	27	30	44	101	134	--						
PCT PERM MATERIAL	79					<10	64	22	67	16	70	28	--						
EST HYD CONDUCT	35					--	65	--	25	--	75	--	--						

U.S. Marine Corps. Well No: Y23e-
Map No: **101** Log Depth 500 Latitude: 343920 Longitude: 771950 Altitude of Land Surface: 20 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	20					10	0	-312	-332	-412	-454								
THICK	10					10	312	20	80	42	--								
PCT PERM MATERIAL	90					<10	76	<10	62	24	--								
EST HYD CONDUCT	50					--	45	--	55	--	--								

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

P A M L I C O   C O U N T Y

Carolina Petroleum Company. Well No: T15d- API No. 32-137-1 (N.C. Pulpwood No. 1)
Map No: **102** Log Depth 3,666 Latitude: 350435 Longitude: 763900 Altitude of Land Surface: 4 Basement: -3,654

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	4	--	--	--	--	--	-260	-823	-846	-921	-952	-1,141	-1,308						
THICK	--	--	--	--	--	>23	563	23	75	31	189	167	--						
PCT PERM MATERIAL	--	--	--	--	--	<15	89	<15	90	<10	87	<10	--						
EST HYD CONDUCT	--	--	--	--	--	--	55	--	30	--	20	--	--						

NRCD Whortonsville Research Sta. Well No: S15y2
Map No: **103** Log Depth 1,521 Latitude: 350525 Longitude: 763924 Altitude of Land Surface: 9 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	9	-3	-37	-128	-171	-231	-249	-779	-803	-883	-921	-1,099	-1,267						
THICK	12	34	91	43	60	18	530	24	80	38	178	168	--						
PCT PERM MATERIAL	90	<15	49	21	73	<25	85	29	90	<15	75	<10	--						
EST HYD CONDUCT	25	--	20	--	35	--	50	--	25	--	20	--	--						

NRCD Arapahoe Research Station. Well No: S18u2
Map No: **104** Log Depth 1,050 Latitude: 350508 Longitude: 765008 Altitude of Land Surface: 38 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	38	8	0	-45	-60	-92	-100	-583	-609	-661	-671	-847	-991						
THICK	30	8	45	15	32	8	483	26	52	10	176	144	--						
PCT PERM MATERIAL	67	<15	56	<10	90	<20	78	31	85	<25	65	35	--						
EST HYD CONDUCT	15	--	25	--	25	--	60	--	35	--	40	--	--						

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Bayboro Chevrolet Company. Well No: S17i-
Map No: **105** Log Depth 210 Latitude: 350820 Longitude: 764640 Altitude of Land Surface: 15 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	15	-7	-19	-83	-93	-137	-145												
THICK	22	12	64	10	44	8	--												
PCT PERM MATERIAL	90	<25	59	<10	90	<10	--												
EST HYD CONDUCT	15	--	20	--	25	--	--												

E. Edwards. Well No: S16w-
Map No: **106** Log Depth 234 Latitude: 350555 Longitude: 764245 Altitude of Land Surface: 10 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	10	-2	-15	-107	-134	-171	-186												
THICK	12	13	92	27	37	15	--												
PCT PERM MATERIAL	90	<25	48	<10	73	<10	--												
EST HYD CONDUCT	15	--	20	--	25	--	--												

NRCD Hobucken Research Station. Well No: Q15u2
Map No: **107** Log Depth 1,003 Latitude: 351517 Longitude: 763547 Altitude of Land Surface: 6 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	6	-24	-46	-126	-140	-302	-326	-750	-764	-824	-851								
THICK	30	22	80	14	162	24	424	14	60	27	--								
PCT PERM MATERIAL	90	<20	78	<10	82	<25	85	<50	65	<20	--								
EST HYD CONDUCT	40	--	15	--	25	--	75	--	15	--	--								

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

P A S Q U O T A N K   C O U N T Y

NRCD Morgans Corner Research Sta. Well No: C12r3
Map No: **108** Log Depth 1,529 Latitude: 362601 Longitude: 762307 Altitude of Land Surface: 10 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	10	-42	-115	-286	-363	-368	-372	-410	-446			-572	-598	-714	-758	-888	-938	-1,300	-1,351
THICK	52	73	171	77	5	4	38	36	126			26	116	44	130	50	362	51	--
PCT PERM MATERIAL	58	19	53	<10	90	<10	90	22	56			27	63	18	63	12	58	12	--
EST HYD CONDUCT	25	--	25	--	50	--	90	--	50			--	30	--	35	--	30	--	--

NRCD Elizabeth City Research Sta. Well No: D11v5
Map No: **109** Log Depth 500 Latitude: 362050 Longitude: 761637 Altitude of Land Surface: 7 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	7	-85	-111	-379	-437	-441	-447												
THICK	92	26	268	58	4	6	--												
PCT PERM MATERIAL	73	<10	37	<10	90	<10	--												
EST HYD CONDUCT	25	--	20	--	50	--	--												

NRCD Big Flatty Creek Res.Sta. Well No: G9c4
Map No: **110** Log Depth 731 Latitude: 360859 Longitude: 760758 Altitude of Land Surface: 20 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	20	-78	-102	-255	-415	-538	-547	-682											
THICK	98	24	153	160	123	9	135	--											
PCT PERM MATERIAL	65	<10	45	<10	66	<10	73	--											
EST HYD CONDUCT	25	--	20	--	20	--	40	--											

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

PENDER COUNTY

N.C. Oil and Gas Company. Well No: BB28o- API No. 32-141-6 (Lea No. 1)
Map No: **111** Log Depth 1,253 Latitude: 342235 Longitude: 774400 Altitude of Land Surface: 34 Basement:-1,213

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	34						--			-114	-142	-440	-480	-814	-869	-1,076	-1,137		
THICK	--						>88			28	297	41	334	55	207	61	76		
PCT PERM MATERIAL	--						75			<10	69	17	51	<15	63	<10	62		
EST HYD CONDUCT	--						85			--	40	--	45	--	20	--	30		

NRCD Topsail Research Station. Well No: BB28j3
Map No: **112** Log Depth 1,348 Latitude: 342357 Longitude: 774042 Altitude of Land Surface: 60 Basement:-1,288

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	60					2	-17			-110	-142	-447	-505	-862	-1,000	-1,088	-1,154		
THICK	58					19	93			32	305	58	357	138	88	66	134		
PCT PERM MATERIAL	80					<25	65			<25	65	<15	50	<20	64	<20	54		
EST HYD CONDUCT	40					--	50			--	25	--	30	--	40	--	20		

N.C. Oil and Gas Company. Well No: AA27w- API No. 32-141-5 (Macmillan No. 1)
Map No: **113** Log Depth 1,421 Latitude: 342540 Longitude: 773710 Altitude of Land Surface: 37 Basement:-1,363

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	37						--			-172	-195	-488	-546	-955	-1,035	-1,135	-1,206		
THICK	--						>99			23	293	58	409	80	100	71	157		
PCT PERM MATERIAL	--						76			<10	72	14	61	22	67	25	51		
EST HYD CONDUCT	--						80			--	35	--	40	--	45	--	40		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

N.C. Oil and Gas Company. Well No: AA26x- API No. 32-141-4 (Batts No. 2)
Map No: **114** Log Depth 1,462 Latitude: 342600 Longitude: 773350 Altitude of Land Surface: 10 Basement: -1,445

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	10					--	--			-221	-246	-533	-607	-1,006	-1,092	-1,202	-1,267		
THICK	--					--	>112			25	287	74	399	86	110	65	178		
PCT PERM MATERIAL	--					--	65			<10	73	9	58	12	71	<10	60		
EST HYD CONDUCT	--					--	65			--	35	--	40	--	45	--	45		

Moores Creek National Park Test. Well No: AA331-
Map No: **115** Log Depth 650 Latitude: 342731 Longitude: 780630 Altitude of Land Surface: 30 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	30									12	-5	-215	-288	-417	-486	-592			
THICK	18									17	210	73	129	69	106	--			
PCT PERM MATERIAL	67									<25	63	11	68	19	69	--			
EST HYD CONDUCT	25									--	40	--	25	--	40	--			

NRCD Burgaw Research Station. Well No: Y30s5
Map No: **116** Log Depth 931 Latitude: 343616 Longitude: 775120 Altitude of Land Surface: 19 Basement: -912

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	19					8	2			-23	-47	-297	-345	-635	-726	-761	-803		
THICK	11					6	25			24	250	48	290	91	35	42	109		
PCT PERM MATERIAL	73					<10	64			<15	58	12	47	<10	74	<10	50		
EST HYD CONDUCT	15					--	75			--	30	--	25	--	30	--	35		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

N.C. Oil and Gas Company. Well No: X28w- API No. 32-141-2 (Cowan No. 1)
Map No: **117** Log Depth 1,000 Latitude: 344030 Longitude: 774230 Altitude of Land Surface: 33 Basement: -956

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	33					24	18			-27	-47	-355	-405	-679	-791	-872	-892		
THICK	9					6	45			20	308	50	274	112	81	20	64		
PCT PERM MATERIAL	90					<10	90			<10	75	12	48	19	56	<20	59		
EST HYD CONDUCT	25					--	65			--	55	--	40	--	25	--	30		

P E R Q U I M A N S   C O U N T Y

NRCD Parkville Research Station. Well No: E13m2
Map No: **118** Log Depth 1,210 Latitude: 361744 Longitude: 762744 Altitude of Land Surface: 16 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	16	-71	-88	-248	-302		-319	-352	-382			-510	-558	-640	-674	-922	-989		
THICK	87	17	160	54	17		33	30	60			48	82	34	248	67	--		
PCT PERM MATERIAL	90	<20	48	<20	85		80	<20	65			<25	65	<20	60	<10	--		
EST HYD CONDUCT	25	--	15	--	15		30	--	30			--	30	--	25	--	--		

P I T T   C O U N T Y

NRCD Bethel Research Station. Well No: L24b3
Map No: **119** Log Depth 690 Latitude: 354457 Longitude: 772155 Altitude of Land Surface: 65 Basement: -625

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	65	39	27									5	-16	-266	-290	-531	-561		
THICK	26	12	22									21	250	24	241	30	64		
PCT PERM MATERIAL	62	17	68									<10	62	33	54	<10	47		
EST HYD CONDUCT	25	--	25									--	25	--	20	--	20		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

R I C H M O N D   C O U N T Y

Town of Hamlet. Well No: V52i-
Map No: **120** Log Depth 287 Latitude: 345330 Longitude: 794110 Altitude of Land Surface: 325 Basement: 117

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	325											303	283	147					
THICK	22											20	136	30					
PCT PERM MATERIAL	77											<15	44	<10					
EST HYD CONDUCT	25											--	30	--					

N.C. Dept. Transportation. Well No: U35g1
Map No: **121** Log Depth 304 Latitude: 345738 Longitude: 794728 Altitude of Land Surface: 340 Basement: 225

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	340											332	317						
THICK	8											15	92						
PCT PERM MATERIAL	90											<10	45						
EST HYD CONDUCT	25											--	30						

R O B E S O N   C O U N T Y

NRCD Boardman Research Station. Well No: AA43q3
Map No: **122** Log Depth 496 Latitude: 342620 Longitude: 785818 Altitude of Land Surface: 80 Basement: -416

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	80									48	31	-12	-28	-180	-309				
THICK	32									17	43	16	152	129	107				
PCT PERM MATERIAL	78									<15	77	25	54	22	66				
EST HYD CONDUCT	30									--	30	--	30	--	30				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Marietta Research Station. Well No: BB45m2
Map No: **123** Log Depth 549 Latitude: 342224 Longitude: 790738 Altitude of Land Surface: 94 Basement: -455

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	94	76	74									34	-11	-266	-368				
THICK	18	2	40									45	255	102	87				
PCT PERM MATERIAL	90	<10	90									18	52	24	62				
EST HYD CONDUCT	10	--	10									--	30	--	30				

NRCD Rex Rennert Research Station. Well No: V45u2
Map No: **124** Log Depth 353 Latitude: 345035 Longitude: 790518 Altitude of Land Surface: 185 Basement: -167

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	185											173	160	55	-103				
THICK	12											13	105	158	64				
PCT PERM MATERIAL	90											<15	65	20	56				
EST HYD CONDUCT	25											--	30	--	20				

NRCD Prevette Research Station. Well No: X45j2
Map No: **125** Log Depth 469 Latitude: 344337 Longitude: 790534 Altitude of Land Surface: 166 Basement: -296

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	166											154	132	-32	-184				
THICK	12											22	164	152	112				
PCT PERM MATERIAL	90											32	73	26	59				
EST HYD CONDUCT	25											--	30	--	25				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Littlefield Research Station. Well No: Y42f9
Map No: **126** Log Depth 467 Latitude: 343836 Longitude: 785449 Altitude of Land Surface: 140 Basement: -327

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	140											114	67	-185	-242				
THICK	26											47	252	57	85				
PCT PERM MATERIAL	90											17	52	12	70				
EST HYD CONDUCT	50											--	30	--	30				

NRCD Rowland Research Station. Well No: Z47m1
Map No: **127** Log Depth 548 Latitude: 343156 Longitude: 791747 Altitude of Land Surface: 145 Basement: -357

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	145	105	100									61	33	-170	-288				
THICK	40	5	39									28	203	118	69				
PCT PERM MATERIAL	58	<5	62									<10	51	25	58				
EST HYD CONDUCT	25	--	20									--	30	--	25				

Town of Saint Pauls. Well No: W4311
Map No: **128** Log Depth 362 Latitude: 344755 Longitude: 785115 Altitude of Land Surface: 151 Basement: -209

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	151											138	126	-51	-127				
THICK	13											12	177	76	82				
PCT PERM MATERIAL	77											<10	69	29	63				
EST HYD CONDUCT	50											--	25	--	20				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Fairmont. Well No: Z45v-
Map No: **129** Log Depth 612 Latitude: 343004 Longitude: 790634 Altitude of Land Surface: 108 Basement: -504

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	108	88	64									40	-10	-258	-438				
THICK	20	24	24									50	248	180	66				
PCT PERM MATERIAL	77	<10	83									<10	56	25	64				
EST HYD CONDUCT	50	--	35									--	30	--	25				

S A M P S O N . C O U N T Y

Town of Roseboro. Well No: U38t-
Map No: **130** Log Depth 353 Latitude: 345639 Longitude: 783028 Altitude of Land Surface: 134 Basement: -219

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	134											95	59	-30	-86	-166	-176		
THICK	39											36	89	56	80	10	43		
PCT PERM MATERIAL	44											<10	50	<10	66	<5	75		
EST HYD CONDUCT	50											--	15	--	25	--	50		

Town of Salemburg. Well No: T38t-
Map No: **131** Log Depth 320 Latitude: 350122 Longitude: 783013 Altitude of Land Surface: 165 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	165											101	81	0	-44	-113	-133		
THICK	64											20	81	44	69	20	--		
PCT PERM MATERIAL	70											<50	55	<40	67	40	--		
EST HYD CONDUCT	35											--	25	--	25	--	--		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Garland. Well No: W36n2
Map No: **132** Log Depth 404 Latitude: 344710 Longitude: 782349 Altitude of Land Surface: 125 Basement: -279

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	125									72	56	31	17	-119	-150	-231	-259		
THICK	53									16	25	14	136	31	81	28	20		
PCT PERM MATERIAL	77									<10	56	21	65	<10	48	<25	60		
EST HYD CONDUCT	30									--	30	--	25	--	25	--	50		

Clement School. Well No: S39t5
Map No: **133** Log Depth 350 Latitude: 350616 Longitude: 783523 Altitude of Land Surface: 170 Basement: -180

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	170											103	74	41	-5	-110	-145		
THICK	67											29	33	46	105	35	35		
PCT PERM MATERIAL	45											<20	52	<20	76	<20	46		
EST HYD CONDUCT	20											--	25	--	35	--	25		

NRCD Ivanhoe Research Station. Well No: Y34p1
Map No: **134** Log Depth 583 Latitude: 343625 Longitude: 781432 Altitude of Land Surface: 34 Basement: -544

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	34									1	-30	-107	-123	-255	-294	-451	-474		
THICK	33									31	77	16	132	39	157	20	70		
PCT PERM MATERIAL	79									29	71	12	71	<20	54	10	48		
EST HYD CONDUCT	40									--	50	--	35	--	30	--	25		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Turkey Research Station. Well No: U34b5
Map No: **135** Log Depth 455 Latitude: 345921 Longitude: 781123 Altitude of Land Surface: 145 Basement: -310

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	145											99	71	-58	-93	-190	-208		
THICK	46											28	129	35	97	18	102		
PCT PERM MATERIAL	67											<15	54	<10	65	16	72		
EST HYD CONDUCT	25											--	30	--	35	--	40		

City of Clinton. Well No: U35g1
Map No: **136** Log Depth 455 Latitude: 345831 Longitude: 781822 Altitude of Land Surface: 155 Basement: -297

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	155											104	81	-67	-112	-191	-204		
THICK	51											23	148	45	79	13	93		
PCT PERM MATERIAL	69											<5	55	13	70	15	62		
EST HYD CONDUCT	35											--	25	--	30	--	30		

Town of Newton Grove. Well No: R36b2
Map No: **137** Log Depth 325 Latitude: 351503 Longitude: 782053 Altitude of Land Surface: 180 Basement: -119

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	180											130	108	14	-1				
THICK	50											22	94	15	118				
PCT PERM MATERIAL	64											<15	60	27	57				
EST HYD CONDUCT	35											--	25	--	30				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

S C O T L A N D   C O U N T Y

Town of Gibson. Well No: W51v2
Map No: **138** Log Depth 291 Latitude: 344535 Longitude: 793638 Altitude of Land Surface: 250 Basement: 5

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	250											186	177	68	20				
THICK	64											9	109	48	15				
PCT PERM MATERIAL	78											<10	62	25	80				
EST HYD CONDUCT	50											--	30	--	30				

Laurenburg-Maxton Airport. Well No: W49r1
Map No: **139** Log Depth 364 Latitude: 344559 Longitude: 792159 Altitude of Land Surface: 208 Basement: -156

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	208											152	124	-29	-101				
THICK	56											28	153	72	55				
PCT PERM MATERIAL	75											<10	67	35	65				
EST HYD CONDUCT	30											--	30	--	20				

T Y R R E L L   C O U N T Y

NRCD Newlands Research Station. Well No: J11v5
Map No: **140** Log Depth 1,449 Latitude: 355050 Longitude: 761607 Altitude of Land Surface: 8 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8	-66	-94	-218	-354	-472	-477	-652	-677	-824	-844	-936	-1,000	-1,174	-1,214				
THICK	74	28	124	136	118	5	175	25	147	20	92	64	174	40	--				
PCT PERM MATERIAL	59	<15	82	<10	54	<10	86	<20	64	30	65	<10	62	22	--				
EST HYD CONDUCT	15	--	20	--	25	--	60	--	30	--	25	--	20	--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Town of Columbia. Well No: I10y4
Map No: **141** Log Depth 208 Latitude: 355530 Longitude: 761430 Altitude of Land Surface: 5 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	5	-80	-93																
THICK	85	13	--																
PCT PERM MATERIAL	74	<10	--																
EST HYD CONDUCT	25	--	--																

Exchange Oil and Gas Company. Well No: J9f- API No. 32-177-1 (Westvaco No. 2)
Map No: **142** Log Depth 4,198 Latitude: 355333 Longitude: 760935 Altitude of Land Surface: 12 Basement:-3,882

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	12	--	--	--	--	--	--	-761	-785	-912	-928	-1,084	-1,110	-1,286	-1,326	--	--	--	--
THICK	--	--	--	--	--	--	>131	24	127	16	156	26	176	40	--	--	--	--	--
PCT PERM MATERIAL	--	--	--	--	--	--	--	<15	53	<10	46	<10	42	<10	--	--	--	--	--
EST HYD CONDUCT	--	--	--	--	--	--	45	--	30	--	20	--	20	--	--	--	--	--	--

WASHINGTON COUNTY

NRCD Plymouth Research Station. Well No: K17a3
Map No: **143** Log Depth 1,494 Latitude: 354925 Longitude: 764530 Altitude of Land Surface: 33 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	33	15	-7	-68	-105	-125	-131	-216	-238	-322	-335	-341	-395	-599	-632	-1,084	-1,148		
THICK	18	22	61	37	20	6	85	22	84	13	6	54	204	33	452	64	--		
PCT PERM MATERIAL	90	<10	77	<10	90	<10	82	<10	74	<10	90	<10	50	<10	54	26	--		
EST HYD CONDUCT	15	--	20	--	25	--	90	--	20	--	25	--	25	--	30	--	--		

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

NRCD Scuppernong Research Station. Well No: J13d3
Map No: **144** Log Depth 1,312 Latitude: 355459 Longitude: 762814 Altitude of Land Surface: 8 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	8	-28	-75	-140	-200	-315	-326	-448	-498	-566	-582	-645	-714	-888	-910				
THICK	36	47	65	60	115	11	122	50	68	16	63	69	174	22	--				
PCT PERM MATERIAL	67	<20	71	<10	53	<50	74	36	76	<10	63	22	69	23	--				
EST HYD CONDUCT	25	--	20	--	25	--	90	--	40	--	20	--	35	--	--				

Town of Roper. Well No: J1513
Map No: **145** Log Depth 232 Latitude: 355250 Longitude: 763635 Altitude of Land Surface: 15 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	15	-51	-63	-95	-187														
THICK	66	12	32	92	--														
PCT PERM MATERIAL	65	<10	75	<5	--														
EST HYD CONDUCT	30	--	25	--	35														

W A Y N E C O U N T Y

NRCD Saulston Research Station. Well No: O3Oi2
Map No: **146** Log Depth 216 Latitude: 352812 Longitude: 775103 Altitude of Land Surface: 97 Basement: -119

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	97											85	66	1	-26				
THICK	12											19	65	27	93				
PCT PERM MATERIAL	83											21	40	<10	32				
EST HYD CONDUCT	30											--	25	--	30				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Georgia-Pacific Corporation. Well No: Q32w1
Map No: **147** Log Depth 297 Latitude: 351542 Longitude: 780203 Altitude of Land Surface: 190 Basement: -107

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	190											162	156	10	-18	-72			
THICK	28											6	146	28	54	35			
PCT PERM MATERIAL	61											<10	62	<10	65	<10			
EST HYD CONDUCT	30											--	30	--	30	--			

Wells Realty Company. Well No: Q32i1
Map No: **148** Log Depth 214 Latitude: 351843 Longitude: 780157 Altitude of Land Surface: 135 Basement: -66

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	135											100	92	37	12				
THICK	35											8	55	25	78				
PCT PERM MATERIAL	86											<10	62	<10	58				
EST HYD CONDUCT	25											--	25	--	30				

Town of Saulston. Well No: O30q1
Map No: **149** Log Depth 224 Latitude: 352620 Longitude: 773355 Altitude of Land Surface: 128 Basement: -96

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	128												--	23	-13				
THICK	--												>35	36	83				
PCT PERM MATERIAL	--												57	<10	45				
EST HYD CONDUCT	--												25	--	50				

Town of Eureka. Well No: N30m3
Map No: **150** Log Depth 215 Latitude: 353222 Longitude: 775221 Altitude of Land Surface: 130 Basement: -85

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	130	107	96									85	65	25	10				
THICK	23	11	11									20	40	15	95				
PCT PERM MATERIAL	65	<10	90									<10	65	<10	19				
EST HYD CONDUCT	20	--	15									--	20	--	15				

Mt. Olive Pickle Company. Well No: R32o-
Map No: **151** Log Depth 354 Latitude: 351220 Longitude: 780430 Altitude of Land Surface: 180 Basement: -157

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	180											140	123	-32	-44				
THICK	40											17	155	12	113				
PCT PERM MATERIAL	58											<25	64	<10	41				
EST HYD CONDUCT	25											--	25	--	20				

Seymour Johnson AFB Test No. 2. Well No: P31y-
Map No: **152** Log Depth 176 Latitude: 352008 Longitude: 775908 Altitude of Land Surface: 58 Basement: -98

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	58													31	14				
THICK	27													17	112				
PCT PERM MATERIAL	90													<10	54				
EST HYD CONDUCT	30													--	25				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Cliffs of Neuse State Park. Well No: R30d2
Map No: **153** Log Depth 376 Latitude: 351430 Longitude: 775315 Altitude of Land Surface: 105 Basement: -257

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	105									77	67	44	18	-113	-145				
THICK	28									10	23	26	131	32	112				
PCT PERM MATERIAL	90									<10	74	12	59	12	61				
EST HYD CONDUCT	25									--	25	--	35	--	25				

Cooper King. Well No: Q35u1
Map No: **154** Log Depth 237 Latitude: 351523 Longitude: 781532 Altitude of Land Surface: 165 Basement: -72

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	165											147	136	55	14				
THICK	18											11	81	41	86				
PCT PERM MATERIAL	90											18	58	29	44				
EST HYD CONDUCT	25											--	25	--	20				

W I L S O N   C O U N T Y

Dr. A.B. Williams Estate. Well No: L28f1
Map No: **155** Log Depth 333 Latitude: 354352 Longitude: 774425 Altitude of Land Surface: 122 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	122	106	83											79	41				
THICK	17	23	4											38	--				
PCT PERM MATERIAL	82	<10	60											21	--				
EST HYD CONDUCT	15	--	30											--	--				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

Coastal States Oil Company. Well No: M29p- API No. 32-195-1 (No. 1 Thompson)
Map No: **156** Log Depth 218 Latitude: 353611 Longitude: 774921 Altitude of Land Surface: 80 Basement: -122

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	--	80	72											54	-7				
THICK	--	8	18											61	115				
PCT PERM MATERIAL	--	<10	90											20	61				
EST HYD CONDUCT	--	--	15											--	25				

S.J. Wooten. Well No: M29m-
Map No: **157** Log Depth 155 Latitude: 353811 Longitude: 774725 Altitude of Land Surface: 110 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	110	96	78											66	13				
THICK	14	18	12											53	--				
PCT PERM MATERIAL	90	16	90											19	--				
EST HYD CONDUCT	30	--	20											--	--				

Bruce Foods, Incorporated. Well No: L30q1
Map No: **158** Log Depth 453 Latitude: 354144 Longitude: 775354 Altitude of Land Surface: 110 Basement: 34

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	110	93	89											74	68				
THICK	17	4	15											6	34				
PCT PERM MATERIAL	59	<10	67											--	25				
EST HYD CONDUCT	15	--	15											--	25				

SUPPLEMENTAL DATA.—*Properties of aquifers and confining units*—Continued

V I R G I N I A

Mr. Parker. Well No: 54A3 (USGS)
Map No: **159** Log Depth 348 Latitude: 363522 Longitude: 770634 Altitude of Land Surface: 100 Basement: --

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	100	52	22					7	-22					-32	-46	-78	-115		
THICK	48	30	15					29	10					14	32	37	--		
PCT PERM MATERIAL	90	<10	90					<40	90					<5	90	13	--		
EST HYD CONDUCT	25	--	20					--	25					--	35	--	--		

Virginia. Dept. Water Resources. Well No. 58A2 (USGS)
Map No: **160** Log Depth 2,017 Latitude: 363410 Longitude: 763505 Altitude of Land Surface: 60 Basement:-1,820

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	60	-60	-97			-182	-218	-251	-276					-362	-414	-480	-588	-1,087	-1,156
THICK	120	37	85			36	33	25	86					52	66	108	499	69	664
PCT PERM MATERIAL	59	16	53			17	90	24	65					<10	82	7	52	<10	53
EST HYD CONDUCT	25	--	25			--	40	--	35					--	25	--	30	--	25

Town of Boykins. Well No: 53A4 (USGS)
Map No: **161** Log Depth 465 Latitude: 363505 Longitude: 771200 Altitude of Land Surface: 39 Basement: -380

	SUR AQ	CONF UNIT	YKN AQ	CONF UNIT	PGR AQ	CONF UNIT	CLH AQ	CONF UNIT	BFR AQ	CONF UNIT	PD AQ	CONF UNIT	BC AQ	CONF UNIT	UCF AQ	CONF UNIT	LCF AQ	CONF UNIT	LC AQ
ALT TOP	--	39	32													17	-9	-348	-355
THICK	--	7	15													26	339	7	25
PCT PERM MATERIAL	--	<10	67													11	68	<10	53
EST HYD CONDUCT	--	--	20													--	30	--	20

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