HYDROGEOLOGIC FRAMEWORK OF THE NORTH CAROLINA COASTAL PLAIN AQUIFER SYSTEM

U.S. Geological Survey Open-File Report 87-690

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By M.D. Winner, Jr., and R.W. Coble

U.S. Geological Survey Open-File Report 87-690

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DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information,
contact:

District Chief
U.S. Geological Survey
Post Office Box 2857
Raleigh, North Carolina 27602

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FOREWORD

The Regional Aquifer-System Analysis Program

The Regional Aquifer-System Analysis (RASA) program was started in 1978 after a congressional mandate to develop quantitative appraisals of the major ground-water systems of the United States. The 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 important components 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, both to develop an understanding of the natural, undisturbed hydrologic system, and of any changes brought about by human activities, as well as 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, and where the volume of interpretive material warrants, separate topical chapters that consider the principal elements of the investigation may be published. The series of RASA interpretive reports begins with Professional Paper 1400 and thereafter will continue in numerical sequence as the interpretive products of subsequent studies become available.

Dallas Peck
Director

CONVERSION FACTORS

The following report uses inch-pound units as the primary system of measurements and metric units for water chemistry measurements. The units commonly are abbreviated using the notations shown below in parentheses. Inch-pound units can be converted to metric units by multiplying by the factors given in the following list.

Inch-pound unit	Multiply by	To obtain metric unit
inch	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer
inch per hour	25.4	millimeter per hour
foot per day (ft/d)	0.3048	meter per day
foot per mile	0.1894	meter per kilometer
foot squared per day (ft^2/d)	0.0929	meter squared per day
gallon per day	3.785	liter per day
gallon per day per square mile	1.461	liter per day per square kilometer
milligram per liter per foot	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.

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ABSTRACT

The hydrogeologic framework of the North Carolina Coastal Plain aquifer system consists of ten aquifers separated by nine 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 the 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. Confining units between 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.

The stratigraphic continuity is determined from correlations of 161 geophysical logs along with data from drillers' and geologists' logs. Aquifers were defined by means of these logs plus 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 Coastal Plain.

INTRODUCTION

The study area of the Northern Atlantic Coastal Plain Regional Aquifer System, which is one of the studies of the U.S. Geological Survey Regional Aquifer-System Analysis (RASA) program borders the east coast of the United States between Long Island, New York, 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 thick at Cape Hatteras.

To facilitate the 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--to perform a detailed study of the Coastal Plain aquifer system in those respective areas and to furnish data to the regional 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 has two elements: (1) the development of a hydrogeologic framework that describes the geology, hydrology, and geochemistry of a multilayered aquifer system; and (2) the development of digital-flow models that will 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 area of eastern North Carolina, or about 47 percent of the State, and which includes all of 35 counties and parts of 12 others (fig. 1).

Purpose and Scope

In order to understand the ground-water flow in the regional aquifer system and to evaluate effects of hydrologic stresses on the aquifer system, the definition of the aquifers and confining units that constitute the framework of the aquifer system must be delineated and described.

The purpose of this report is to present a hydrogeologic framework for the North Carolina Coastal Plain aquifer system based mainly on the 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

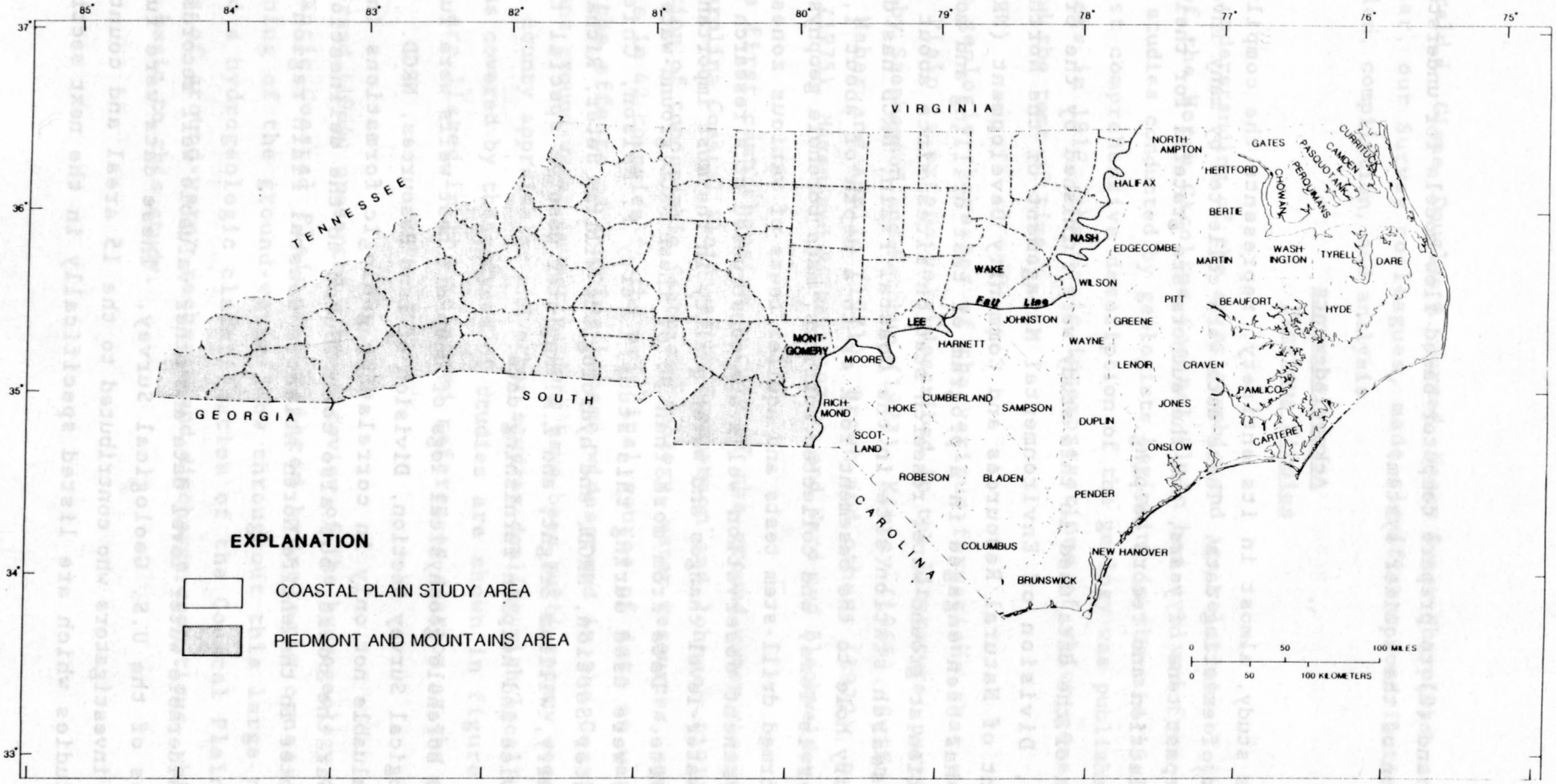

Figure 1.--The North Carolina Coastal Plain study area.

Carolina and (2) to prepare computer-based flow models for understanding and evaluation of the aquifer system.

Acknowledgments

This study, almost in its entirety, represents the compilation and analysis of existing data. These 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 were 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, NRCD has drilled an exploratory hole to the basement rock or to a depth of about 1,500 feet, 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 are constructed at a 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 were invaluable not only 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 come from the files of the U.S. Geological Survey. These data were furnished by numerous investigators who contributed to the 15 areal and county ground-water studies which are listed specifically in the next section of this report.

Gerald L. Giese, Douglas A. Harned, Nancy Bonar Sharpless, and Patricia Showalter, our Survey 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, the basic interpretations of which 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 multi-county 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 are listed in the selected references section 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, which contain elements basic to this study.

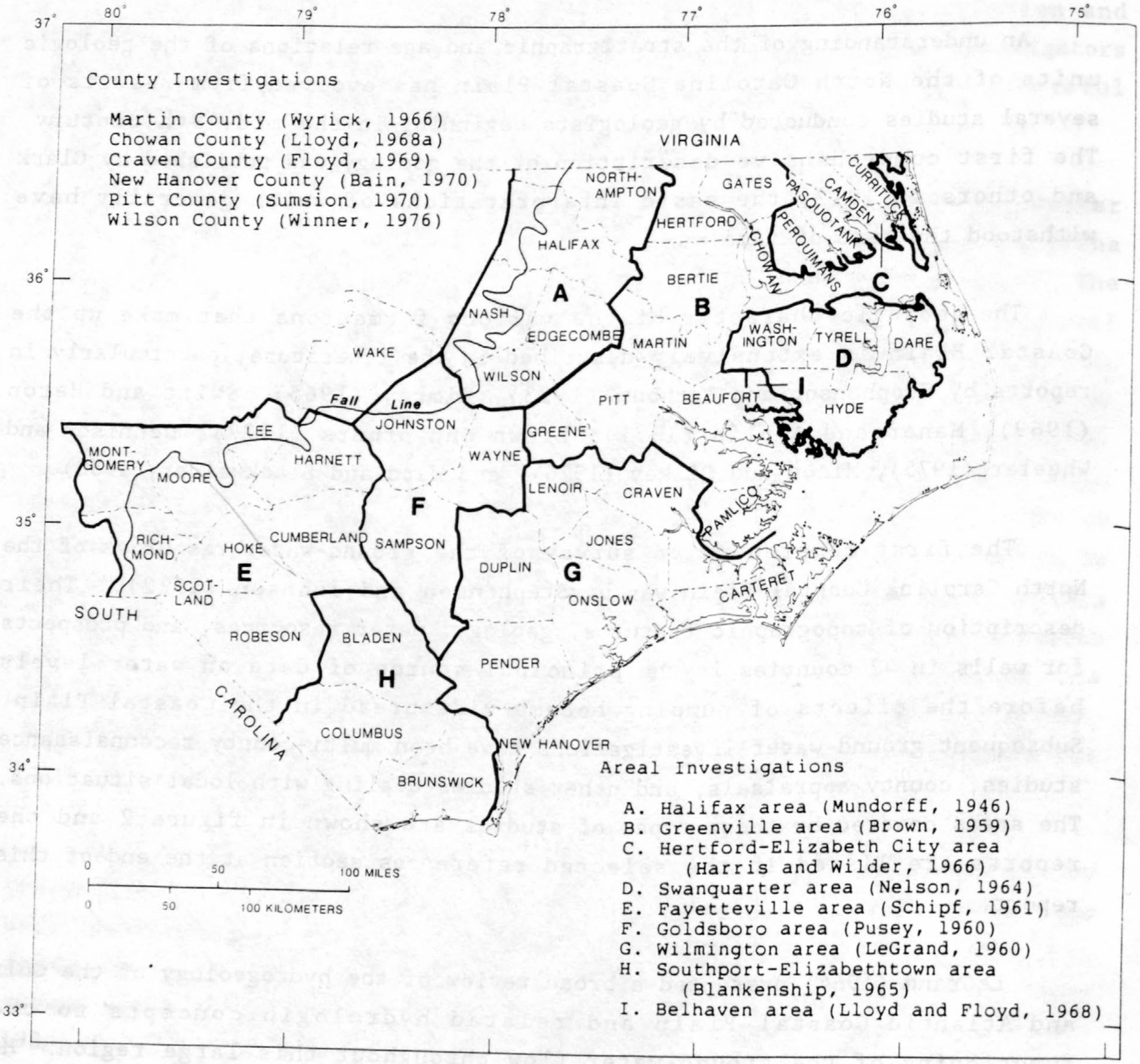

Figure 2.--Areal and county ground-water investigations, North Carolina Coastal Plain.

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 indices 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 that 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 wide from the Atlantic Ocean westward to its boundary with the Piedmont province (fig. 1). This boundary is generally known as the Fall Line and 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) shows the Fall Line as a relatively smooth line separating the Piedmont and Coastal Plain provinces. In North Carolina, however, this definition of separation 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, as used in this report, is a sinuous boundary separating the continuous body of Coastal Plain deposits and 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.

The 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 feet throughout nearly the entire area and average about 20 feet. They exceed 50 feet only on dunes at Kill Devil Hills on the Outer Banks in Dare County and along a 25-mile-long ridge extending from southern Onslow County into northern New Hanover County. The Tidewater region is generally of low relief and is swampy.

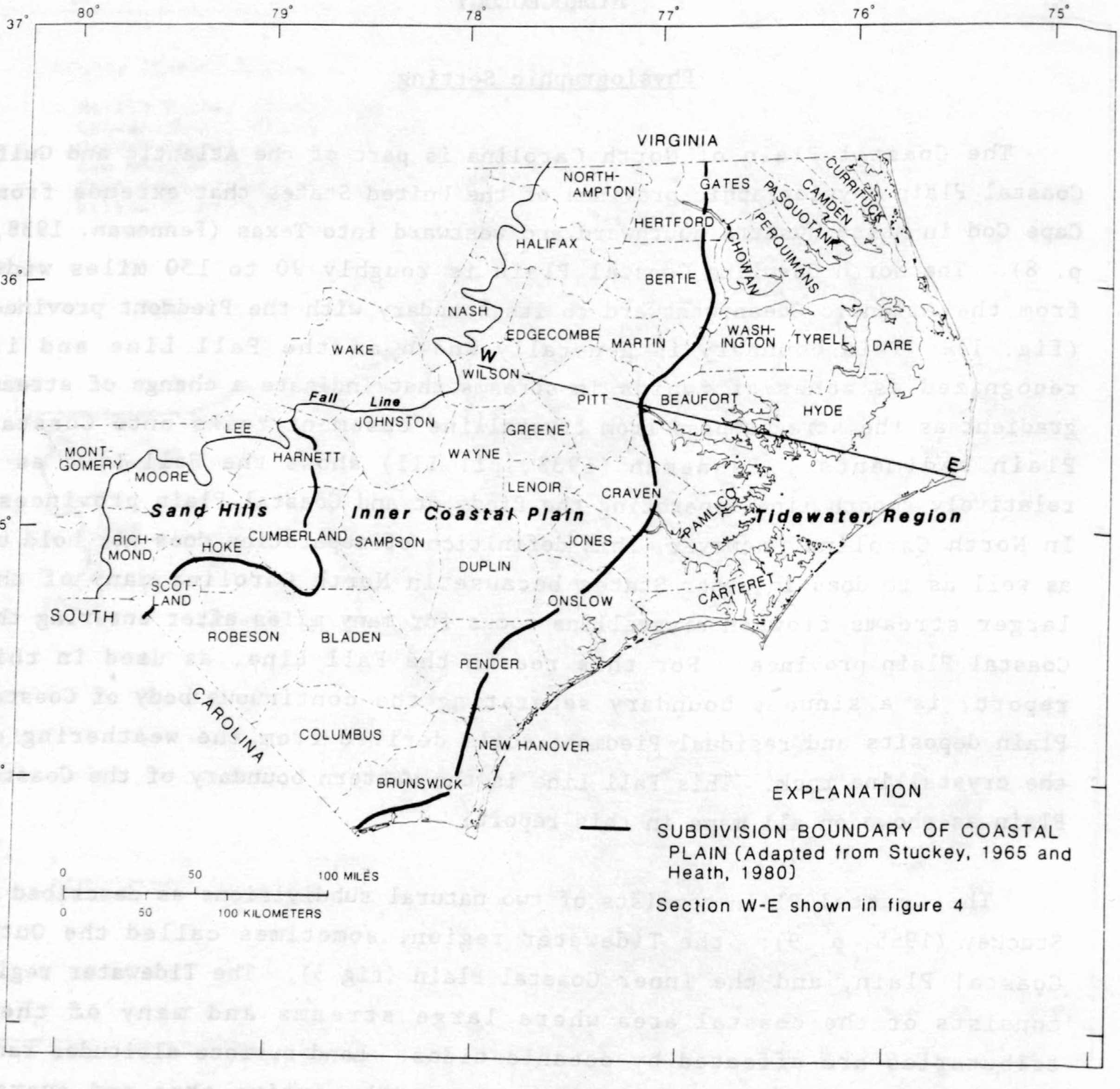

Figure 3.--Physiographic divisions of the North Carolina Coastal Plain.

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 feet at the Tidewater boundary to more than 700 feet at the Fall Line in southeastern Montgomery County. Altitudes along the Fall Line are lowest in the north; being about 100 to 150 feet in Northampton County near the Virginia border, about 150 to 200 feet in Wilson and Edgecombe Counties, about 200 to 300 feet in Harnett and Cumberland Counties, more than 700 feet in Montgomery County, and about 400 to 500 feet 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 often is dissected.

The second subdivision consists of the eastern part of the Inner Coastal Plain south of the northern area where 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 feet or more into the flat swampy uplands. The uplands are swampy near the dissected valleys, which attests to the lack of extensive drainage of the swamps through the shallow aquifers.

The third subdivision consists of 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 square miles in all or parts of Lee, Harnett, Cumberland, Hoke, Moore, Montgomery, Anson, and Richmond Counties in North Carolina and extends into South Carolina.

The eastern limit of the Sand Hills is imprecisely defined. The Sand Hills area is generally coincident with the upper Coastal Plain physiographic region of Daniels and others (1972) that 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 feet.

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 with altitudes generally ranging from 450 to 550 feet. 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 feet is common. Rainfall readily infiltrates into 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 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) the number of individual beds increasing 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 will be applied to the hydrogeologic units in this report, and table 1 will serve 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 have been added to table 1 for convenient reference for the reader.

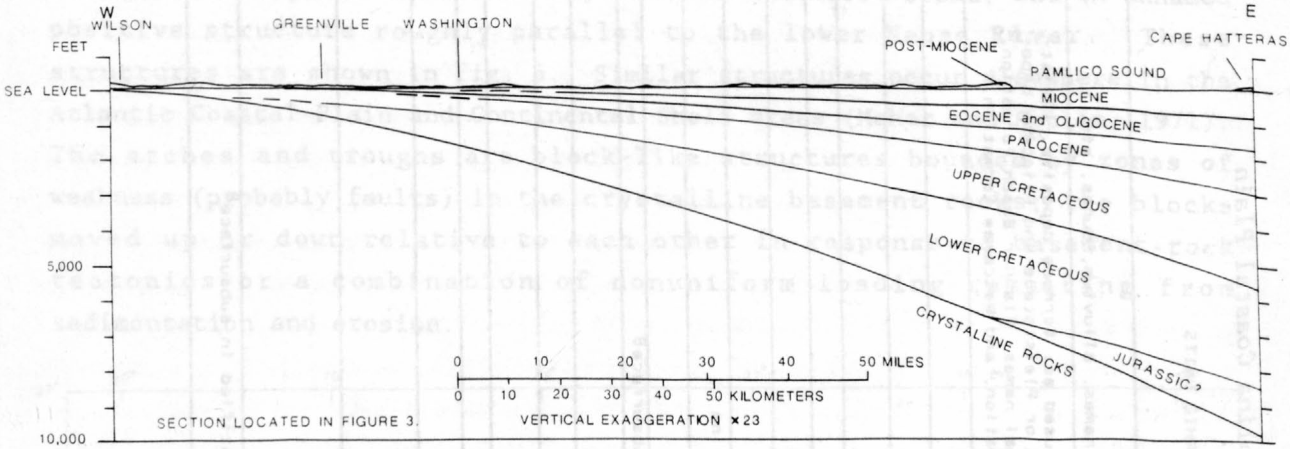

Figure 4.--Generalized geologic section from Wilson, North Carolina, to Cape Hatteras, North Carolina.

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. As the Atlantic Ocean widened, major alternating marine transgressive and regressive phases of sedimentation on each side of the ocean, according to Rona (1973), were controlled largely by ocean-wide 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 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

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					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.[3]
Pliocene				Yorktown Formation[4]	
Upper Miocene			Eastover Formation[4]		
Middle Miocene			Pungo River Formation[5]		
Lower Miocene			Belgrade Formation[6]		
Oligocene			Oligocene limestone(informal)		
			River Bend Formation[6]		
Upper Eocene		Jacksonian	Not recognized in North Carolina		
Middle Eocene		Claibornian	Castle Hayne Limestone[7]		
Lower Eocene		Sabinian	Unnamed unit recognized in subsurface[8]		
Paleocene		Midwayan	Beaufort Formation[7]		
Upper Cretaceous	Maestrichtian	Navarroan	Peedee Formation[7]		
	Campanian	Tayloran	Black Creek Formation[7]		
	Santonian	Austinian	Middendorf Formation[9,10]		
	Coniacian		Cape Fear Formation[11,12]		
	Turonian	Eaglefordian	Unnamed units[8]		
	Cenomanian	Woodbinian			
Lower Cretaceous	Albian	Washitan and Fredericksburgian	Unnamed units[8]		
Jurassic(?)			Unnamed unit tentatively identified in subsurface[8]		

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

Albemarle embayment on the north side of Albemarle Sound, and an unnamed positive structure roughly parallel to the lower Neuse River. These structures are shown in fig. 5. Similar structures occur elsewhere in the Atlantic Coastal Plain and Continental Shelf areas (Maher and Applin, 1971). The arches and troughs are block-like 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 a combination of nonuniform loading resulting from sedimentation and erosion.

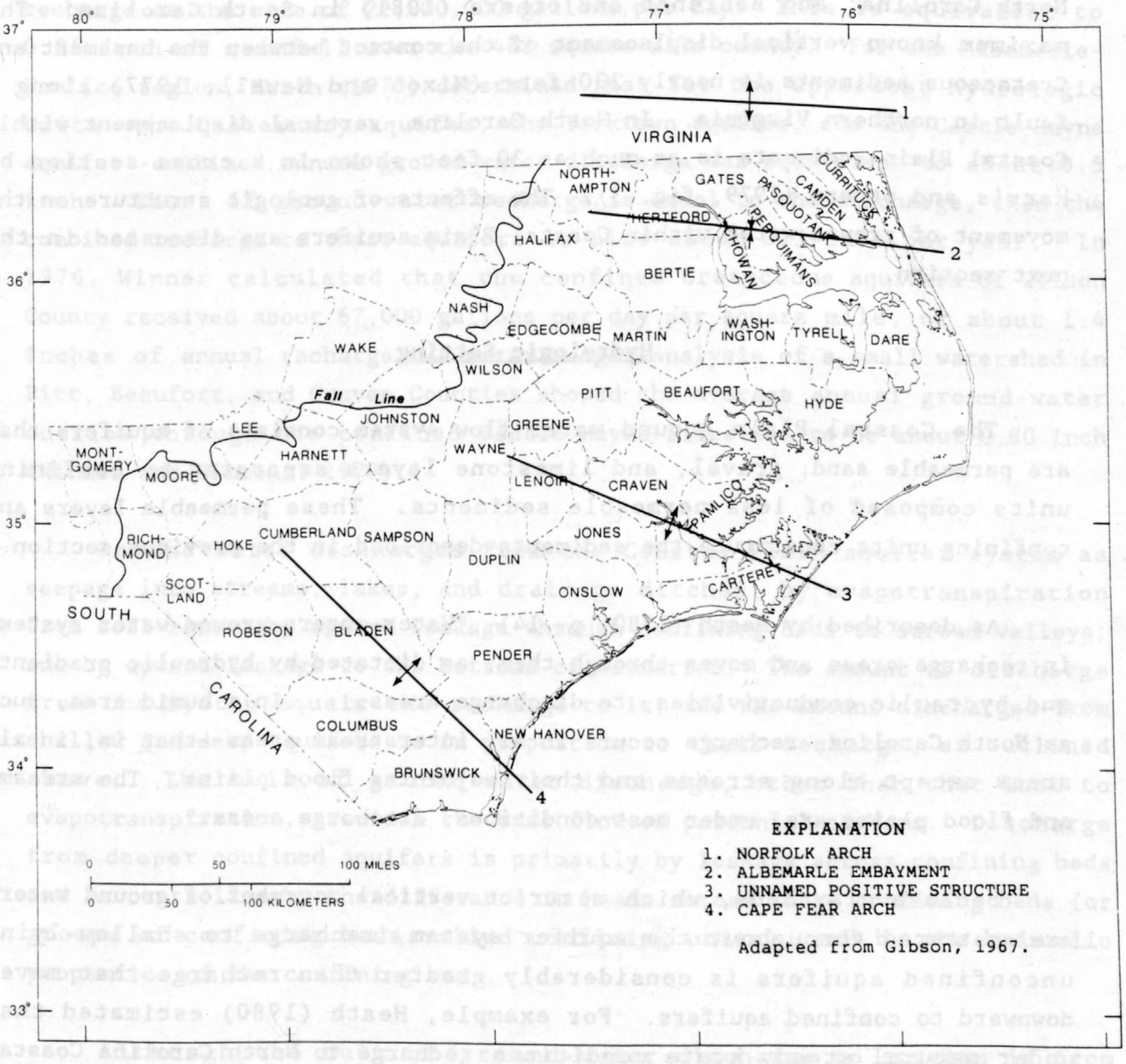

Figure 5.--Structural features of the Coastal Plain of North Carolina and southern Virginia.

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 such as reported by 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 feet (Mixon and Newell, 1977) along a fault in northern Virginia. In North Carolina, vertical displacement within Coastal Plain sediments is as much as 30 feet 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 that are 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 downward to confined aquifers. For example, Heath (1980) estimated that under natural steady-state conditions recharge to North Carolina Coastal Plain soils (and hence to the unconfined parts of the aquifers) varies between 5 and 21 inches of rainfall 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 is estimated to be less than 0.5 inch (Heath, 1980).

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 feet receive recharge at the rate of 22,000,000 gallons per day. This is equivalent to 0.96 inch of rainfall over the 482 square-mile county. For the Albemarle-Pamlico region, Heath (1975) determined that for the uppermost hydrologic units--the Quaternary aquifer, the Yorktown aquifer, and the Castle Hayne aquifer--combined annual ground-water discharge was equivalent to about 0.5 inch. Thus, if ground-water recharge is equal to the discharge, then 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, 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 outlined 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 and 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 are also 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 down-dip chance for ground water to discharge easily from confined aquifers. Such places are depicted as natural cones of depression on potentiometric-surface maps, 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 with a chloride concentration of about 19,000 mg/L (milligrams per liter) (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 re-create a freshwater lens following an ocean overwash (Winner, 1978); whereas, in deep confined aquifers, significant flushing of seawater requires thousands of years or more. The freshwater-saltwater boundary between ground water containing chloride concentrations 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 feet (Meisler, 1980, p. 6), depending on the hydraulic conductivity of the aquifer materials and availability of freshwater.

The occurrence and origin of saltwater in clastic Coastal Plain aquifers from Long Island, New York, through North Carolina was 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 has been rapid enough to keep pace with sea-level changes since the Late Cretaceous. However, Meisler and others (1984,

p. 14 and 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 its (1) rates and location of recharge, (2) its hydraulic properties, (3) hydraulic gradients, and (4) thickness and properties of overlying confining units, which are the factors affecting the amount of freshwater circulation in the aquifer.

The most prominent geologic structure to influence 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 are they 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 inter-aquifer leakage.

Two related factors affect the ground-water flow system: one is the nature and distribution of the surficial materials that control recharge to the system; the other is the geologic setting of the aquifers and confining units.

Superimposed upon 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 of the withdrawals are from the confined parts of the system, effects of pumping have extended over thousands of square miles. Three large cones of depression have developed in the North Carolina Coastal Plain that affect over 20 percent of its area (fig. 6) and are important to the future management of ground-water supplies in the areas affected. One cone of depression is centered around Franklin, Virginia, about 10 miles north of the State line, where about 38 million gallons per day was pumped from Cretaceous aquifers in 1986 (Hamilton and Larson, 1988). The effects of this continued pumping have spread over about 2,500 square miles of the northern North Carolina Coastal Plain and over an even larger area in southeastern Virginia.

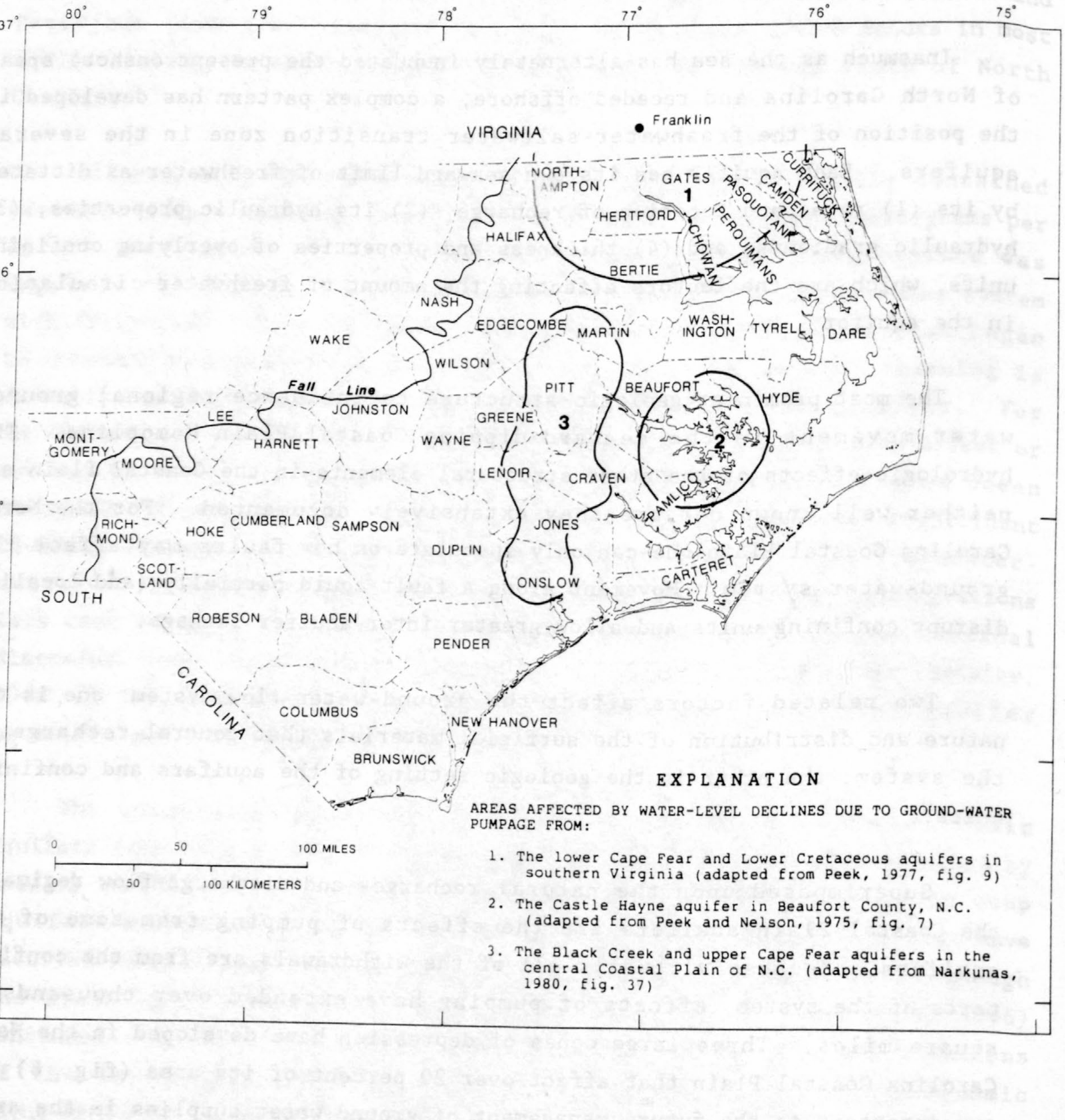

Figure 6.--Major cones of depression in the North Carolina Coastal Plain.

Since 1965, pumpage from the Castle Hayne Limestone, ranging from about 50 to 65 million gallons per day in Beaufort County, has caused an extensive cone of depression (fig. 6, no. 2). It covers over 1,000 square miles, with a water-level decline at the center of over 125 feet (Peek and Nelson, 1975).

A third area of water-level decline shown in figure 6 is in the central Coastal Plain. Seven major water-supply systems and about 15 smaller ones pump from Cretaceous aquifers. Combined withdrawals in the period 1980-82 were about 22 million gallons per day, affecting an area of over 1,800 square miles. It is clear, then, that not only do 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 upon the mapping of hydraulically connected permeable units, and, although aquifer boundaries may coincide locally with or parallel those of stratigraphic units, these boundaries do not correspond everywhere to those of the stratigraphic units. This is especially true in deltaic to shallow marine deposits such as the Coastal Plain sediments where rapid facies changes occur.

For the purpose of developing a hydrogeologic framework to define the movement of ground water throughout the Coastal Plain in North Carolina, we are adopting 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 the following sections of 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 based on hydrologic factors: (1) significant differences in hydraulic head across confining units that separate the major 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.

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, and 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 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 are generally taken from the predominant geologic unit with which the aquifer is associated. Two exceptions are: (1) the surficial aquifer, which is the uppermost hydrogeologic unit, and (2) the Lower Cretaceous hydrogeologic units. The names of 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 of the report deals with the methodology used to define the system of aquifers and confining units. This involves the

Table 2.-- *North Carolina, South Carolina and Virginia 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[3] Brightseat confining bed[3] Brightseat aquifer[3]	Beaufort aquifer	
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

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 confining unit
Pungo River Formation	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

interpretation of three sets of data: (1) bore-hole 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 with the best combinations of the three types of data. 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 in plates 1 to 16. Over 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 of each section because these test holes usually were drilled to basement, and, equally important, 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 between geophysical logs along sections is about 9 miles; the maximum is 24 miles. 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 of well-to-well correlation of lithologic units through use of geophysical logs, mainly the standard single-point electric log (spontaneous-potential and resistance curves) and the natural gamma-ray log. In a number of instances, interpretation of these logs was aided by use of multi-electrode resistivity logs, where available, and by drillers' logs and descriptions of well cuttings.

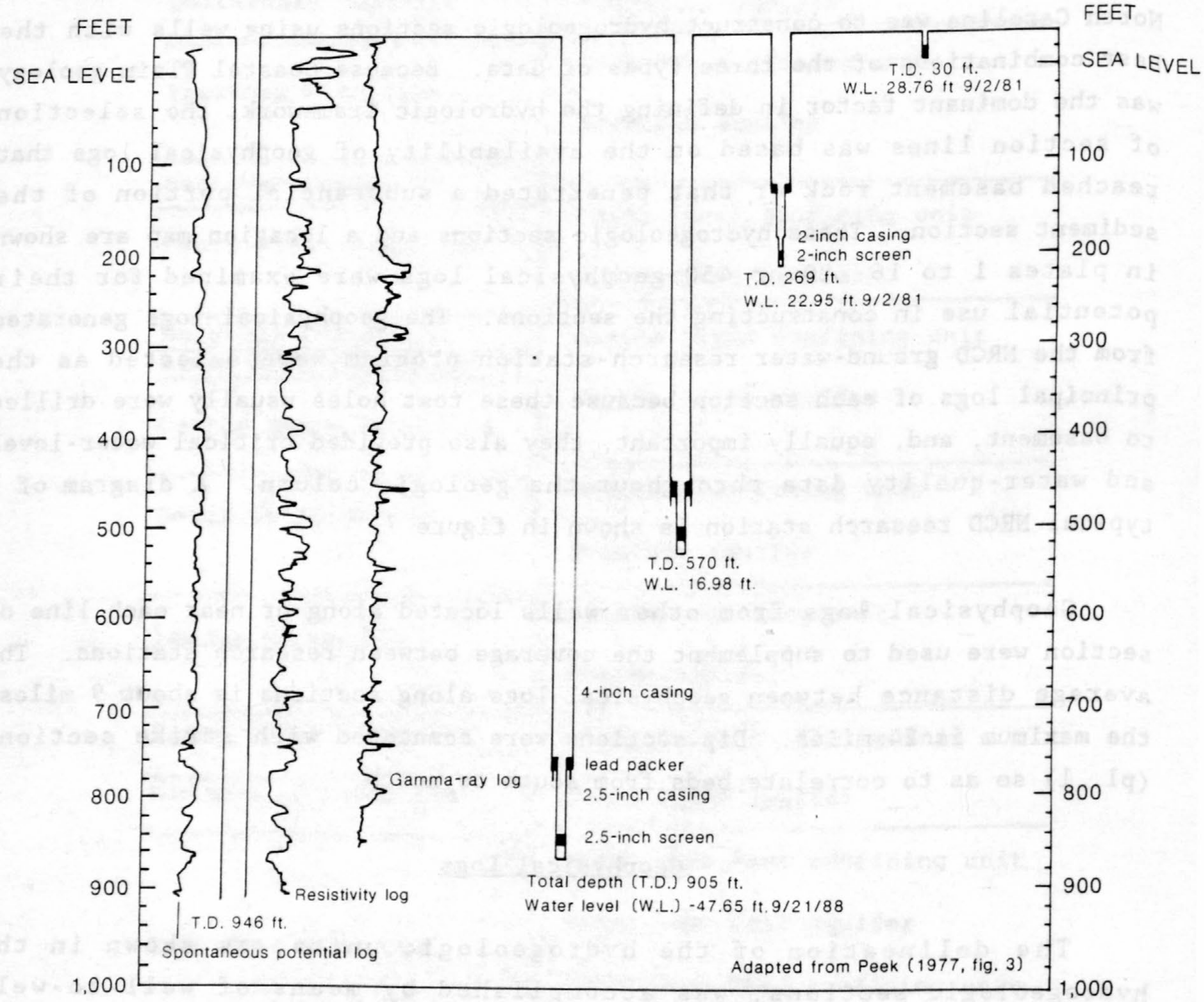

Figure 7.--Log of exploratory hole and construction features of observation wells at a typical NRCD research station.

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, correlation emphasis was placed on the recognition of the continuity of groups of similar beds rather than on the 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 miles. Most individual beds within a group cannot be traced from log to log with reliability, although some with distinctive log characteristics 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 shown 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 appropriate confining units were selected on the basis of this head distribution (fig. 9). Log-to-log correlations of beds, together with analysis of heads in adjacent test holes and other wells along the sections led to the definition of aquifers and confining units shown in plates 2 to 16.

In the case of the Calabash research station shown in figure 9, head differences between aquifers are quite obvious; from top to bottom these

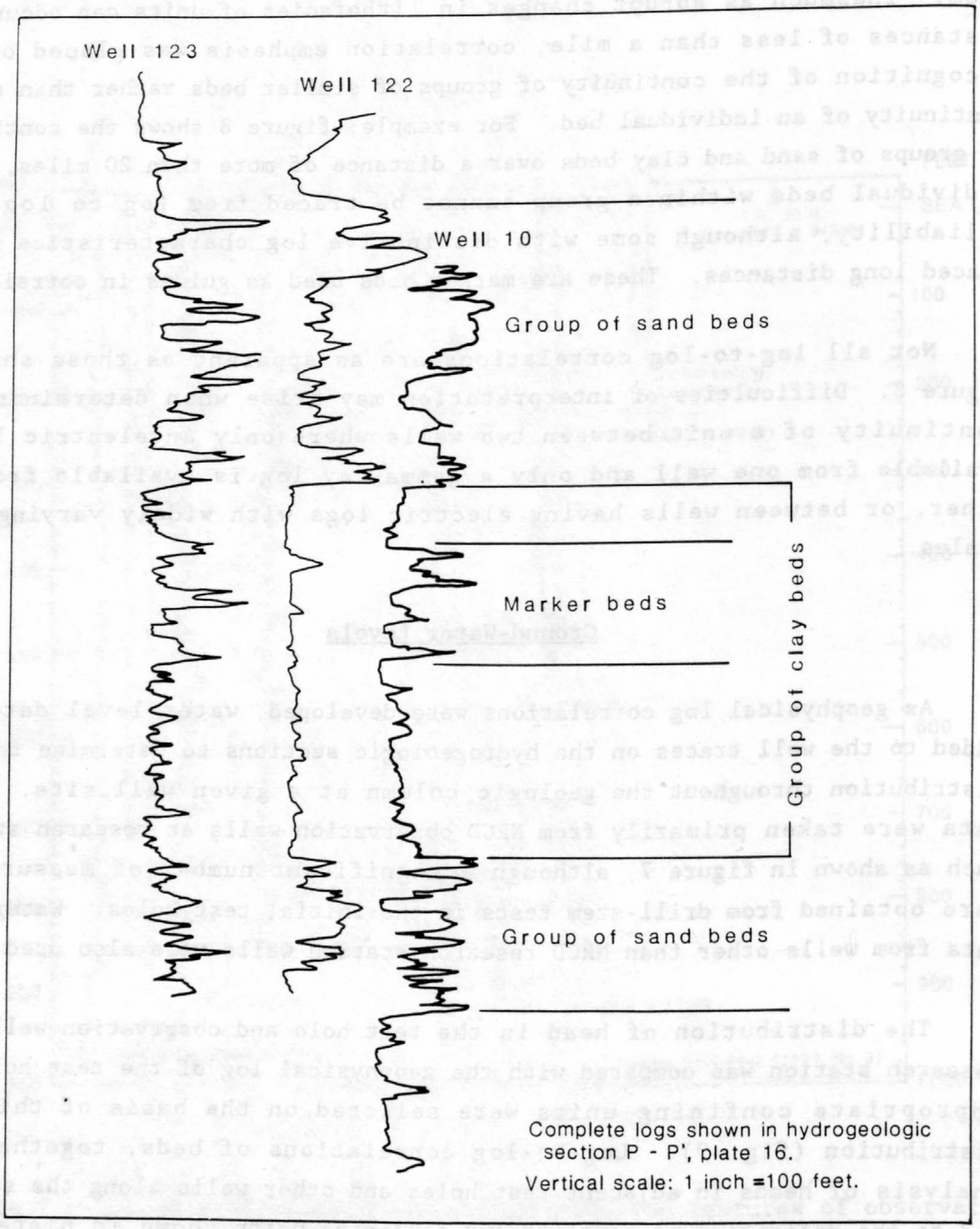

Figure 8.--Comparison of resistance logs shows correlations of beds and groups of beds.

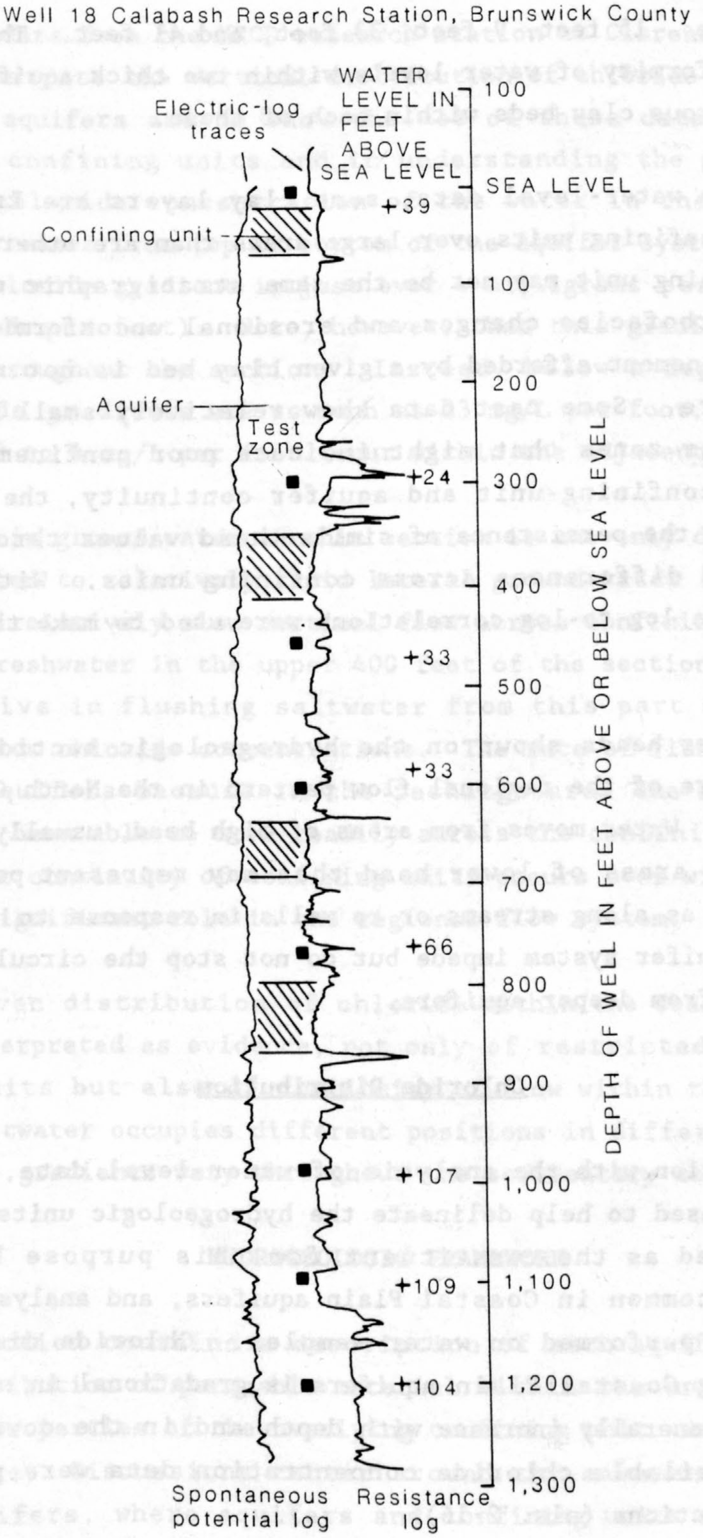

Figure 9.--Test zones and distribution of head throughout the section in an NRCD test hole.

differences are: 15 feet, 9 feet, 33 feet, and 41 feet. The data also show a relative uniformity of water levels within two thick aquifers, even though there are numerous clay beds within each of these.

From these water-level data, some clay layers are known to be more effective as confining units over large areas than are others. 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.

Ground-water heads shown on the hydrogeologic sections (pls. 2-16) 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 that 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, common in Coastal Plain aquifers, and analyses for chloride are frequently performed on water samples. 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 were plotted on the hydrogeologic sections (pls. 2-16).

Chloride data from the NRCD research station at Clarendon (fig. 10) is shown 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 of 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 per foot). Note, however, that this gradient is not evenly distributed throughout the section. Instead, below a depth of about 400 feet, chloride gradients are as much as 23 mg/L per foot. Conversely, low gradients of 2 to 4 mg/L per foot occur within the adjacent aquifers.

Chloride in ground water in this section is unevenly distributed and is directly related to relatively rapid lateral ground-water flow through the aquifers and relatively slow vertical flow across confining units. Lateral movement of freshwater in the upper 400 feet of the section 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 in the recharge area the fresher water from above has not been able to move readily across the confining units. These data show that continuity of confining units occurs over wide areas and that they 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 the confining units but also of continuity of flow within the aquifers. Data show that saltwater 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, distribution of permeable material within the unit, occurrence of saltwater, properties of the overlying confining unit, and the relationship among aquifers. Discussions center around the movement of ground water between aquifers, 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

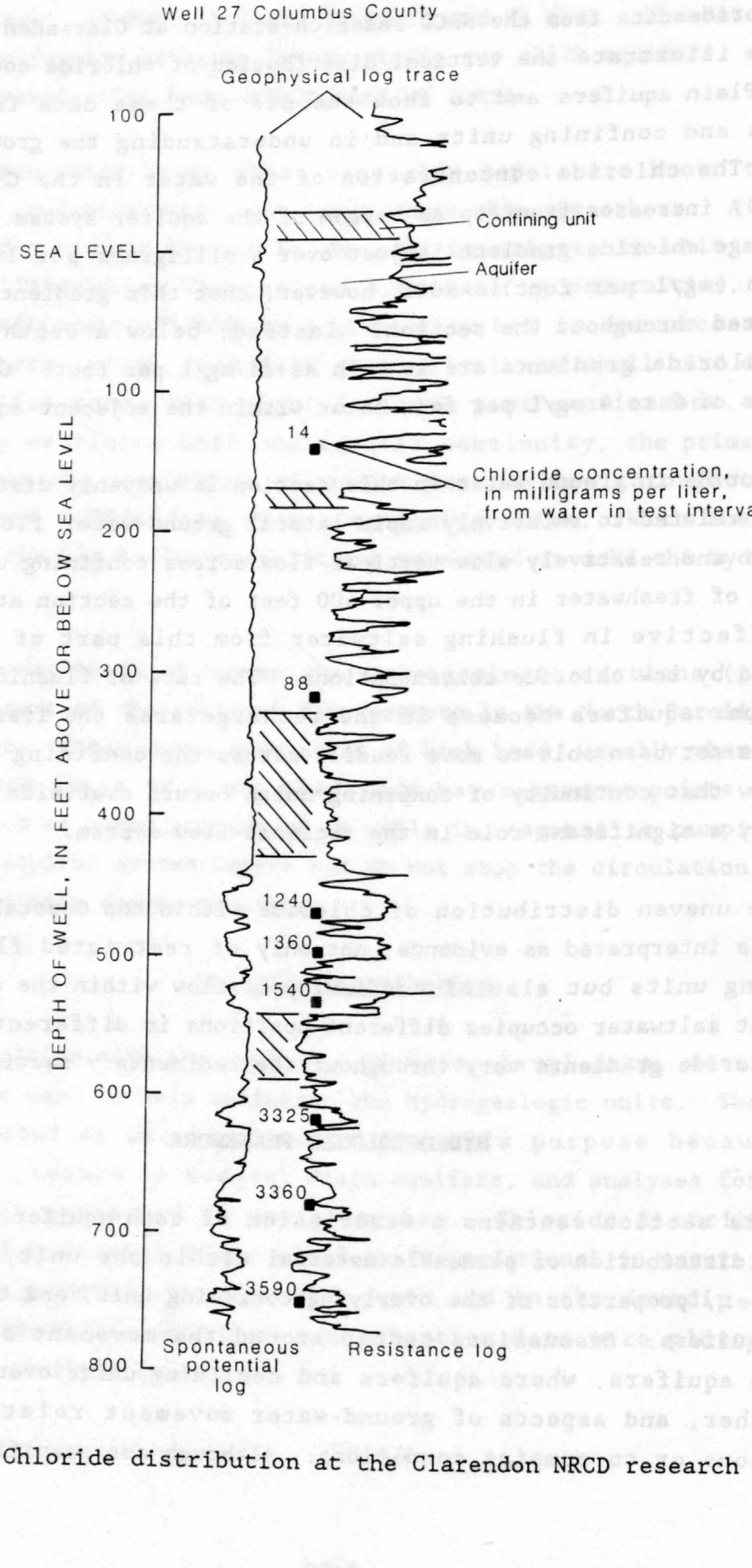

Figure 10.--Chloride distribution at the Clarendon NRCD research station.

each instance, the discussion of an aquifer is also meant to include its overlying confining unit. A number of figures are also 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. These are: maximum and minimum observed altitude of unit top; maximum and minimum observed thickness of unit; an estimate of the average percent of permeable material comprising the unit; an average estimated hydraulic conductivity (aquifers); and the areal extent of the aquifer. Hydrologic data for each of the 161 control wells used for this report are given in the Supplemental Data section. These data were used to construct maps of the altitude of the tops of aquifers, the sand percentage of aquifers, and the thickness of confining units that are presented in this section.

The occurrence of saltwater in each aquifer is included in the discussion because it has an effect on the development of these aquifers. Two specific chloride concentrations in water were selected to be 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 with such high chloride concentration apparently has very little movement. The following are discussions of the hydrogeologic units.

Surficial Aquifer

The surficial aquifer defined in this report consists primarily of post-Yorktown deposits of Quaternary age near land surface. This unit is of major importance to the hydrology of the area because it extends over a large part of the Coastal Plain and infiltration from rainfall into it 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 the deeper aquifers.

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.

The surficial aquifer is not restricted to a single geologic unit either in terms of 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 rocks in the Tidewater Region (where land surface altitude is less than 40 to 50 feet) 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 floodplain 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 feet of section but thickening eastward to about 200 feet 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 Cretaceous to rocks of Miocene age and range in thickness from a few feet to as much as 30 feet.

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 feet 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 eastward by Daniels and others (1972) 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 presently known. These surficial materials of the Inner Coastal Plain and Sand Hills overlie Cretaceous sediments. They are undifferentiated in this report and are included in the surficial aquifer.

Recharge Rates

Recharge to the surficial aquifer depends on how rapidly rainfall can infiltrate into the aquifer. As seen in the previous discussion, the rocks of the aquifer are neither of uniform composition nor 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 capacities (fig. 11).

Soils deemed to have a good infiltration capacity were those classified as being well-drained to very well-drained sandy soil and sandy loam and have vertical saturated permeabilities of 2 to 20 inches per hour. A few sandy soils containing significant amounts of clay were included where their permeabilities were within the above range. Heath (1980) estimated that the recharge rate to the shallow aquifer may be as much as 20 inches of equivalent rainfall per year for thick, sandy soils.

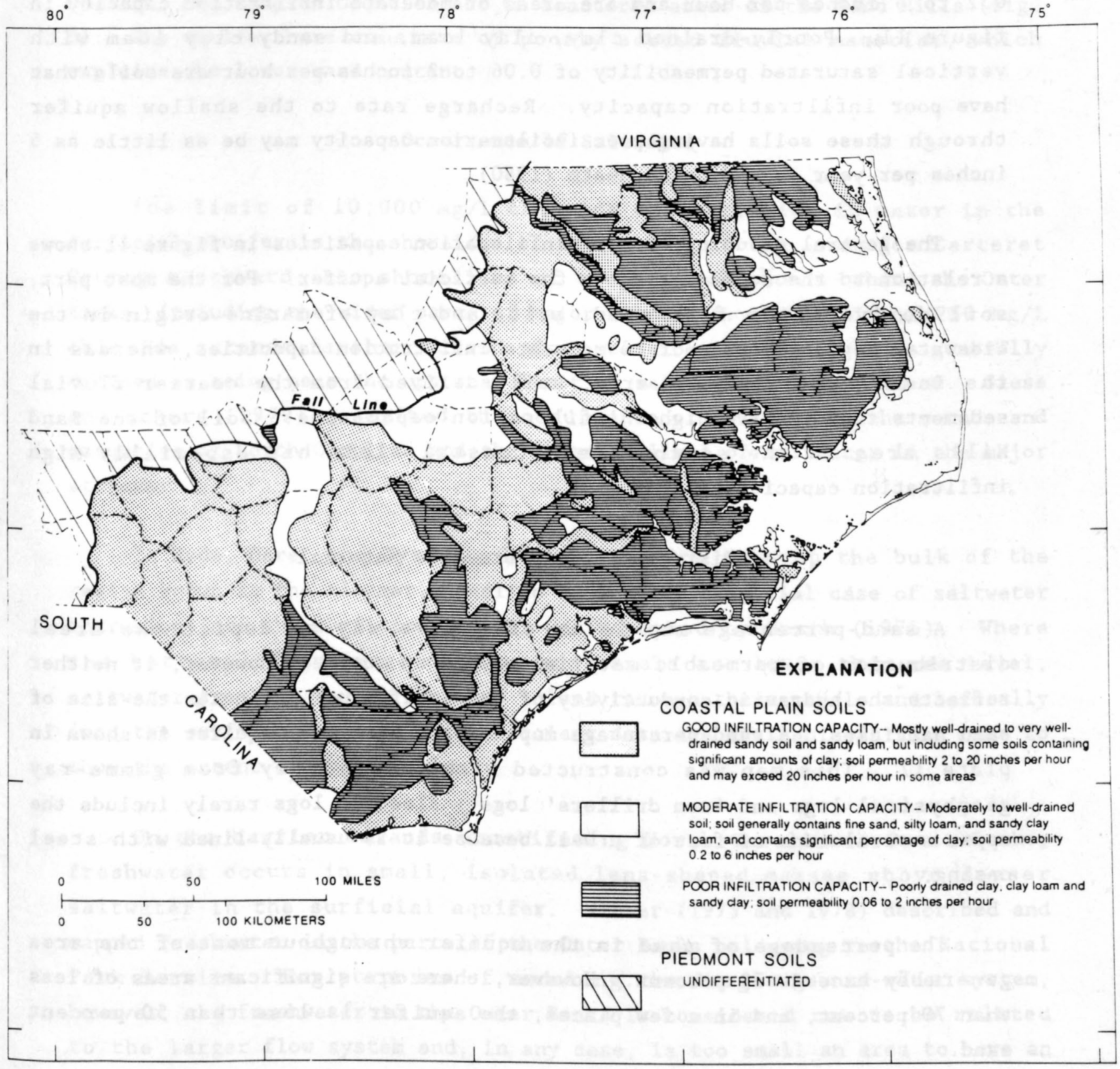

Figure 11.--Infiltration capacities of soils in the North Carolina Coastal Plain.

Moderately- to well-drained soil is composed of fine sand, silty loam, and sandy clay loam that has vertical saturated permeability ranging from 0.2 to 6 inches per hour and are areas of moderate infiltration capacity in figure 11. Poorly-drained clay, clay loam, and sandy-clay loam with vertical saturated permeability of 0.06 to 2 inches per hour are soils that have poor infiltration capacity. Recharge rate to the shallow aquifer through these soils having poor infiltration capacity may be as little as 5 inches per year according to Heath (1980).

The general grouping of soil infiltration capacities in figure 11 shows a relation to the rocks making up the surficial aquifer. For the most part, soil derived from fine sand, silt, and clay of marine origin in the Tidewater Region shows poor to moderate infiltration capacities, whereas in the Inner Coastal Plain area, soils derived from the coarser fluvial sediments tend to have higher infiltration capacities. Soil of the Sand Hills area in the southwestern Coastal Plain has 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 sand particles. A sand-percentage map for the surficial aquifer is shown in plate 17. 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 it is usually lined with steel casing.

The percentage of sand in the aquifer throughout most of the area generally exceeds 70 percent. However, there are significant areas of less than 70 percent, and in a few places, the aquifer 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 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 has 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 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) 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 at this time 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 and 1978) 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 not to be related 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.

<u>Yorktown Aquifer</u>

The Yorktown aquifer is generally equated with the redefined Pliocene Yorktown Formation and the upper Miocene Eastover Formation of Ward and

Blackwelder (1980) and extends throughout the northern half of the North Carolina Coastal Plain (pl. 18) 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 feet 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, and, in Dare County, the Yorktown attains a thickness of over 300 feet in well 48 (pl. 8).

The 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. 18).

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 are identified on geophysical logs in some downdip areas, although 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 northeast 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 for the Yorktown aquifer is about 22 ft/d (feet per day) 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 feet thick and are somewhat irregularly distributed, as depicted on hydrogeologic section J'-J" through this area (pl. 11). This is also reflected on the sand percentage map (pl. 19) where 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 (pl. 8, well 140).

Trending in an easterly direction from Gates County is an area of decreasing sand percentage (pl. 19). Although beds are thickening 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 in plate 18 depict the intersection of the equal-concentration surface with both the bottom and the top of the aquifer. 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 surface of equal chloride concentration is nearly horizontal, as shown in cross-section in plates 8 and 9, suggests that water movement within the aquifer is virtually horizontal with only a slight upward component. The distance between 250 mg/L isochlors that intersect top and bottom of the Yorktown aquifer ranges from 10 to 25 miles.

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 at an unknown distance offshore, and the position of the 10,000 mg/L line of equal chloride concentration 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. For this study, the Yorktown confining unit extends 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 feet (table 4). As shown in plate 20, the 25-ft thickness line and several places where the confining unit is between 25 and 50 feet thick extend through or occupy the middle of the northern Coastal Plain. Westward toward the Fall Line, the confining unit averages about 13 feet in thickness, and eastward near the coast about 40 feet. It is thinnest (less than 10 feet 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 feet in thickness and is over 70 feet thick in northern Pasquotank County. Above the Yorktown aquifer outlier in Robeson County, the Yorktown confining unit is less than 25 feet 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. 20) 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 underlying aquifers and their upper confining units subcrop beneath the Yorktown aquifer, except for the Lower Cretaceous aquifer (fig. 12). In the areas of these subcrops the opportunity exists for the exchange of water between the Yorktown aquifer and the underlying aquifers. Excluding stream valleys, the potential downward leakage from the Yorktown aquifer to subcropping aquifers occurs 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 the 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 early 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 near-shore environment.

The Pungo River aquifer is limited to the eastern part of the northern North Carolina Coastal Plain (pl. 21). Its western limit is a line extending north from western Carteret County to central Gates County. Its northern 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 feet in thickness near its western and northern limits. As the aquifer dips eastward (10 to 12 feet per mile), it thickens to over 200 feet in the vicinity of the Outer Banks where the top is more than 800 feet below sea level (well 71, Hyde Co.).

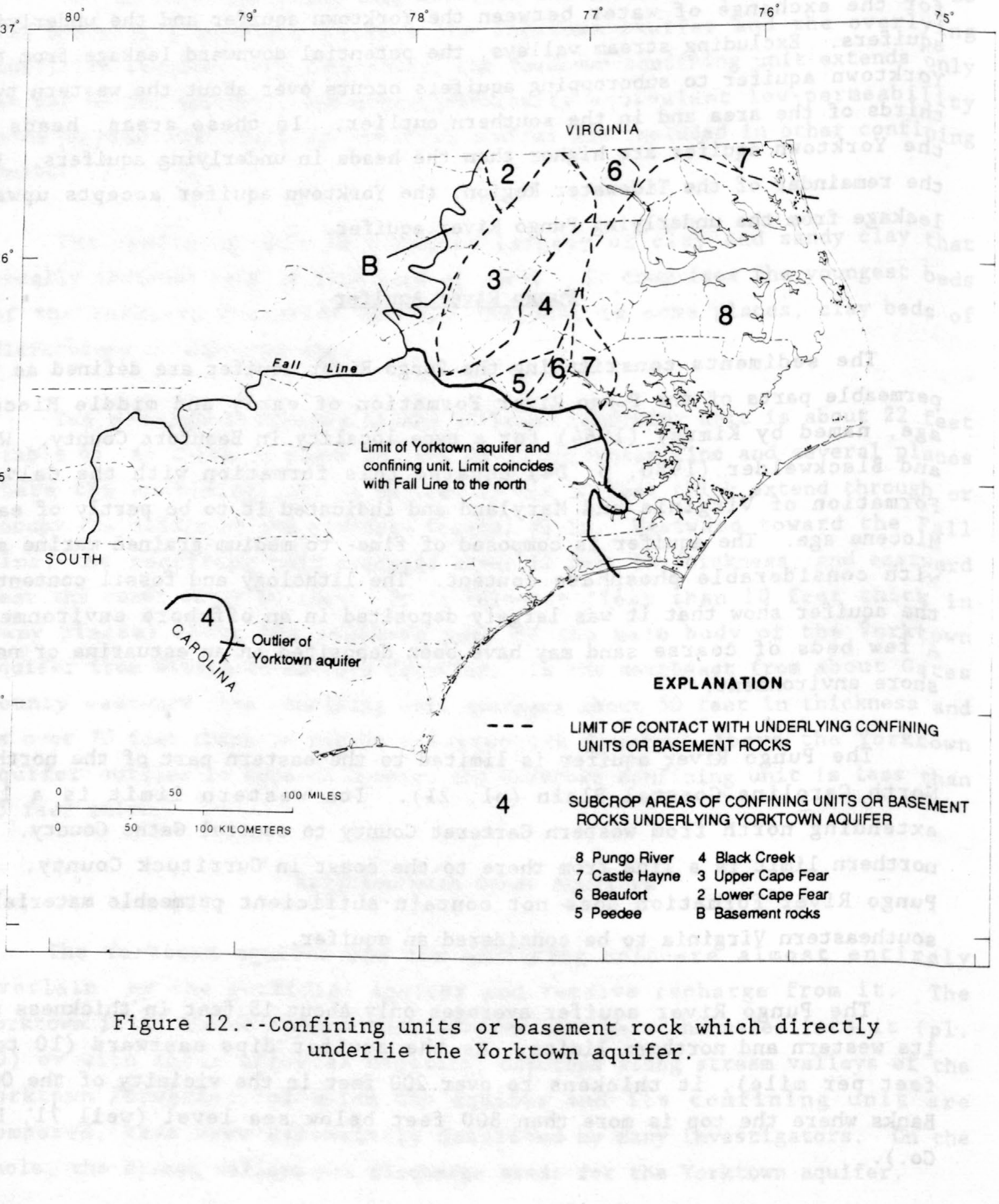

Figure 12.--Confining units or basement rock which directly underlie the Yorktown aquifer.

Except for man-made 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. Where the aquifer thickens eastward and is buried at depths greater than 200 to 300 feet, additional sand beds appear in the section (well 144, pl. 8; well 47, pl. 9), but the amount of permeable material decreases to about 50 or 60 percent (fig. 22). Near its northern limit in Gates County, the aquifer is more than 50 feet thick and is composed of several sand bodies (pl. 9). 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. 15).

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 were detected in the aquifer.

Occurrence of Saltwater

The 250 mg/L chloride-concentration lines for the top and bottom of the Pungo River aquifer are shown on plate 21. The distance between the 250 mg/L isochlors that intersect the top and bottom of the Pungo River aquifer narrows to about one mile to the north of Washington County because the aquifer is thin, and its permeability is low there. To the south the distance between the two isochlors is at least 10 miles. No data are available to determine the distance between isochlors at the extreme southern on-shore area. The relatively wide distance between the isochlors in the south is due to the aquifer being thicker and in closer proximity to recharge sources.

As in the case of the Yorktown aquifer, the position of the 10,000 mg/L chloride concentration is unknown for the Pungo River aquifer; there are very few available analyses of water from it, 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. 21) 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 Formation constitute the Pungo River confining unit that 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; but 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 feet thick. Eastward and downdip it thickens to about 150 feet beneath Currituck County (pl. 23). An average value of thickness for the Pungo River confining unit is nearly 55 feet (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 in 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.

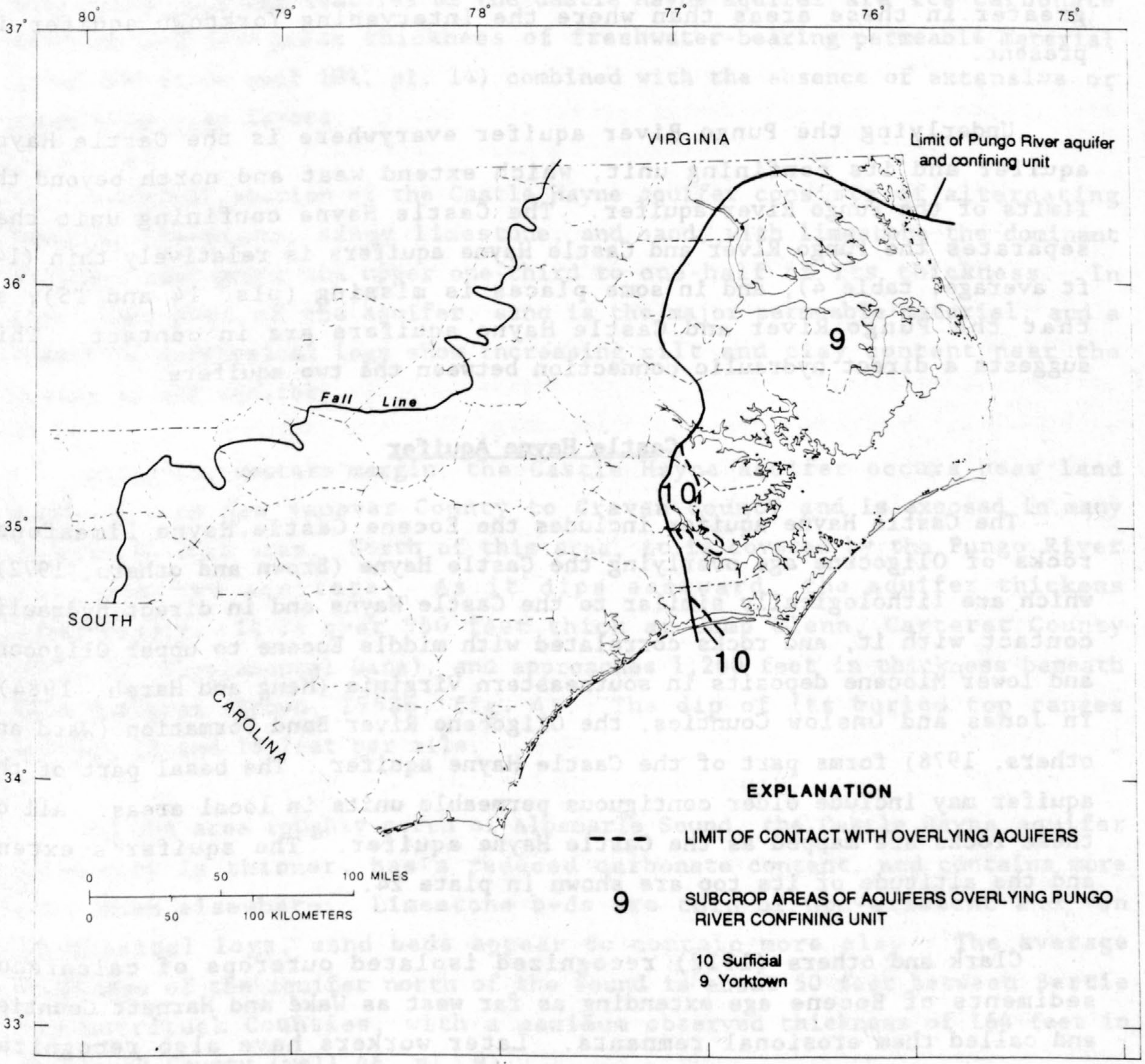

Figure 13.--Aquifers which directly overlie the Pungo River confining unit and aquifer.

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). Thus, the opportunity for recharge to the Pungo River aquifer is greater in these areas than 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 that separates the Pungo River and Castle Hayne aquifers is relatively thin (14-ft average, table 4), and in some places is missing (pls. 14 and 15), 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 aquifer may include older contiguous permeable units in local areas. All of these rocks are mapped as the Castle Hayne aquifer. The aquifer's extent and the altitude of its top are shown in plate 24.

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). For the purposes of this report, these outliers are not considered to be part of the Castle Hayne aquifer.

The Castle Hayne aquifer is composed predominately 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 feet 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 (over 300 ft in well 101, pl. 14) 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, and a number of geophysical logs show increasing silt and clay content near the bottom of the aquifer.

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

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 non-existent and, on geophysical logs, sand beds appear to contain more clay. The average thickness of the aquifer north of the Sound is about 50 feet between Bertie and Currituck Counties, with a maximum observed thickness of 164 feet in Currituck County (well 46, pl. 9).

Distribution of Permeable Material

The Castle Hayne aquifer is the most productive aquifer in North Carolina as exemplified by the 60 million gallon per day pumpage from the aquifer in Beaufort County since the mid-1960's (Peek and Nelson, 1975; Coble and others, 1984). The carbonate rocks composing the aquifer not only have a 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. 25). 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 that may have 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) and ranges 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 in plate 24. The narrow distance between these isochlors 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 for this area apply as well to the Castle Hayne aquifer. The wide distance between the two isochlors from Beaufort County southward coincides with the absence of the Yorktown aquifer and its associated clay beds that 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 in the cases of 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 as the Castle Hayne confining unit. These beds belong mostly to the Belgrade Formation, the Pungo River Formation, 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 of Jones and Onslow Counties and is generally less than 10 feet thick (Ward and others, 1978).

This confining unit has an average thickness of about 14 feet (table 4); it exceeds 25 feet 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. 26). 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 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-foot head difference across it in places (well 104, pl. 7).

Relation with Other Aquifers

Throughout most of the northern and eastern area 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 only by the surficial aquifer, and rainwater need not

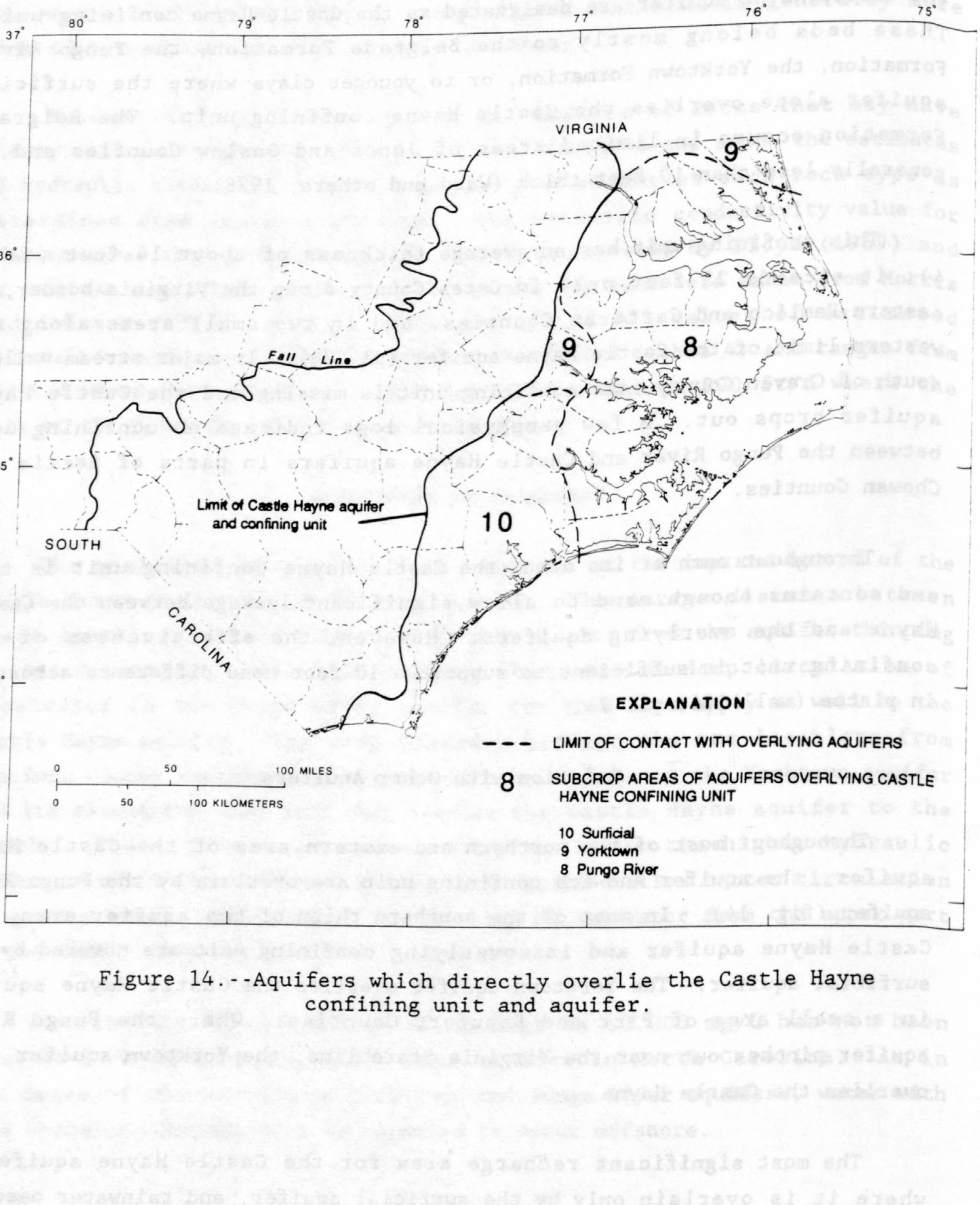

Figure 14.--Aquifers which directly overlie the Castle Hayne confining unit and aquifer.

percolate far to enter the Castle Hayne. Evidence of this recharge is shown at well 99 (pl. 6) and at well 34 (pl. 7) 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--Pungo River and Yorktown aquifers. Typically, the head decreases downward into the Castle Hayne aquifer from overlying beds (well 144 in pl. 8, and well 56 in pl. 9) 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 confining units are more than 80 to 100 feet thick as seen at wells 108 and 109 (pl. 9).

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 for a narrow zone about 10 miles wide paralleling the western limit of the Castle Hayne aquifer, where water moves downward to the Beaufort. By 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 as dark green and gray sand and clay of Paleocene age by Brown (1959), and later by Brown and others (1972), as green or greenish-gray shale and fine to medium shaly, glauconitic sand of Midway age. The Beaufort Formation lies unconformably on rocks of Cretaceous age and is unconformably overlain by younger rocks (Lloyd, 1968a, and Sumsion, 1970). Throughout its areal extent the Beaufort Formation is

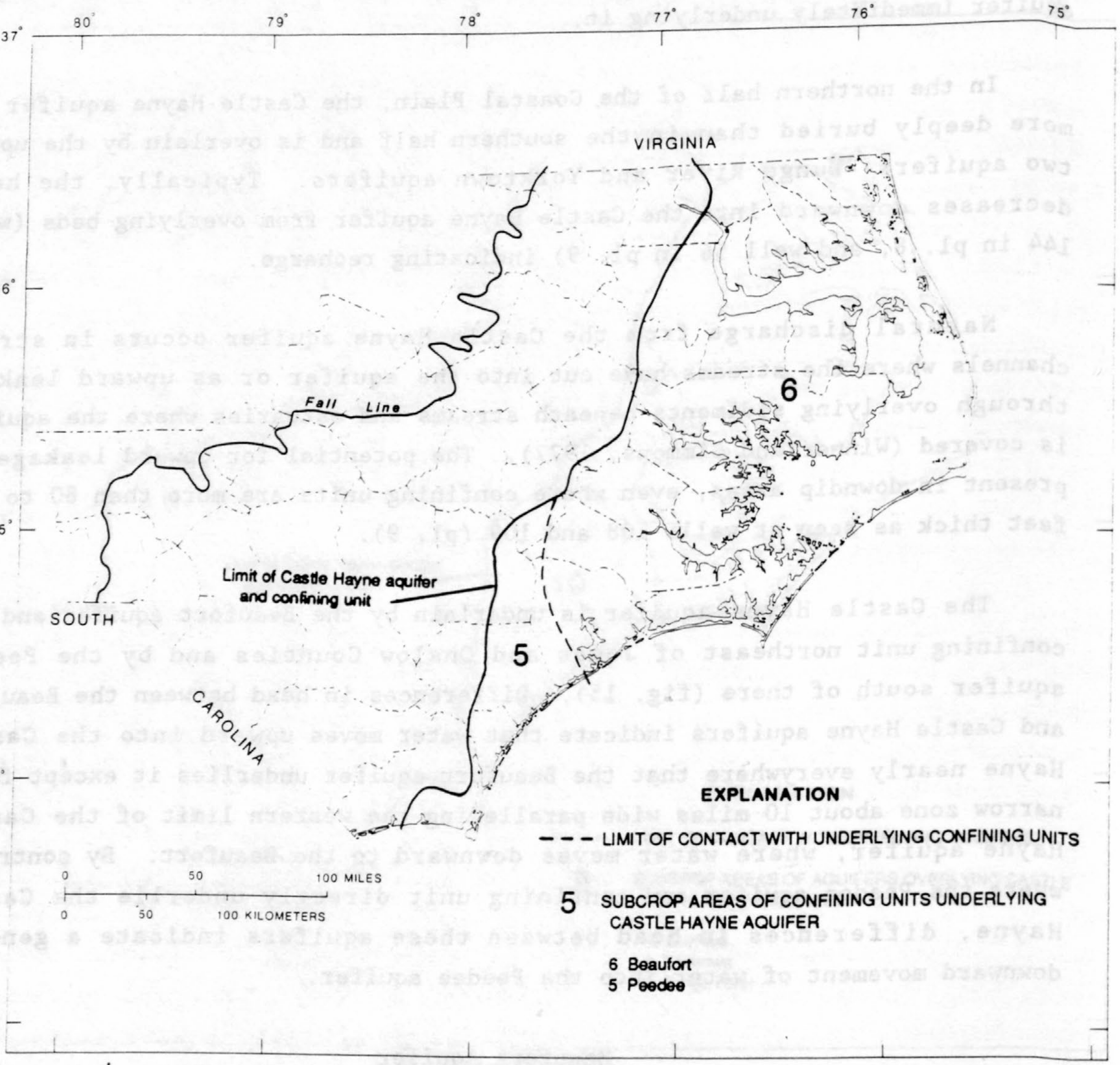

Figure 15.--Confining units which directly underlie the Castle Hayne aquifer.

covered by younger rocks except for some exposures in stream beds 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 of up to 5 or 6 feet in thickness. Except for along the western margin of the unit (shown in pl. 27) 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 slightly above sea level along its western margin just east of Kinston, Lenoir County. The top of the aquifer dips eastward between 14 and 33 feet per mile and is more than 1,300 feet deep from eastern Currituck County to eastern Carteret County (pl. 27).

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

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. 9). A general increase in clay content in the upper part of the aquifer and a corresponding thickening of overlying confining unit suggest a nearby offshore limit to the aquifer.

Distribution of Permeable Material

For most of the area along and within a distance of 10 to 15 miles of its western margin, the Beaufort aquifer consists of a single sand bed ranging in thickness from a few feet to about 40 feet; along a strip extending from Pitt County to Pamlico County, this single layer thickens to 80 feet (well 103, pl. 7). 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 of permeable material as shown in plate 28.

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, the aquifer contains less than 50 percent sand. This eastward or northeastward trend of decreasing percentage of permeable material in the Beaufort aquifer parallels the 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 the western margin of the aquifer, especially from Bertie County northward, it consists of thin beds of fine sand and has an estimated hydraulic conductivity of 15 to 25 ft/d. Also, lower than average hydraulic conductivity values 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 miles east of its western limit as depicted by the 250 mg/L isochlors in plate 27. The distance between the 250 mg/L isochlors intersecting the top and bottom of the aquifer is about a mile within a strip in Craven and Beaufort Counties and lies to the west of the 250 mg/L isochlors in the highly transmissive Castle Hayne aquifer, except in Gates County where it lies to the east.

There, the Beaufort extends up to 15 miles 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. 27) 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 chloride line is also shown in cross section as projected to hydrogeologic section G-G′ (pl. 8).

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

The seaward turn of the 10,000 mg/L chloride-concentration line in the northern section 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 in plate 29, ranges from zero to 80 feet, and it averages about 24 feet (table 4). From northern Onslow County to southern Beaufort County it averages only about 15 feet in thickness. In and northeast of Washington County, the confining unit thickens and is over 50 feet 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 northwestern margins 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-mile wide band paralleling the western margin of the Beaufort aquifer.

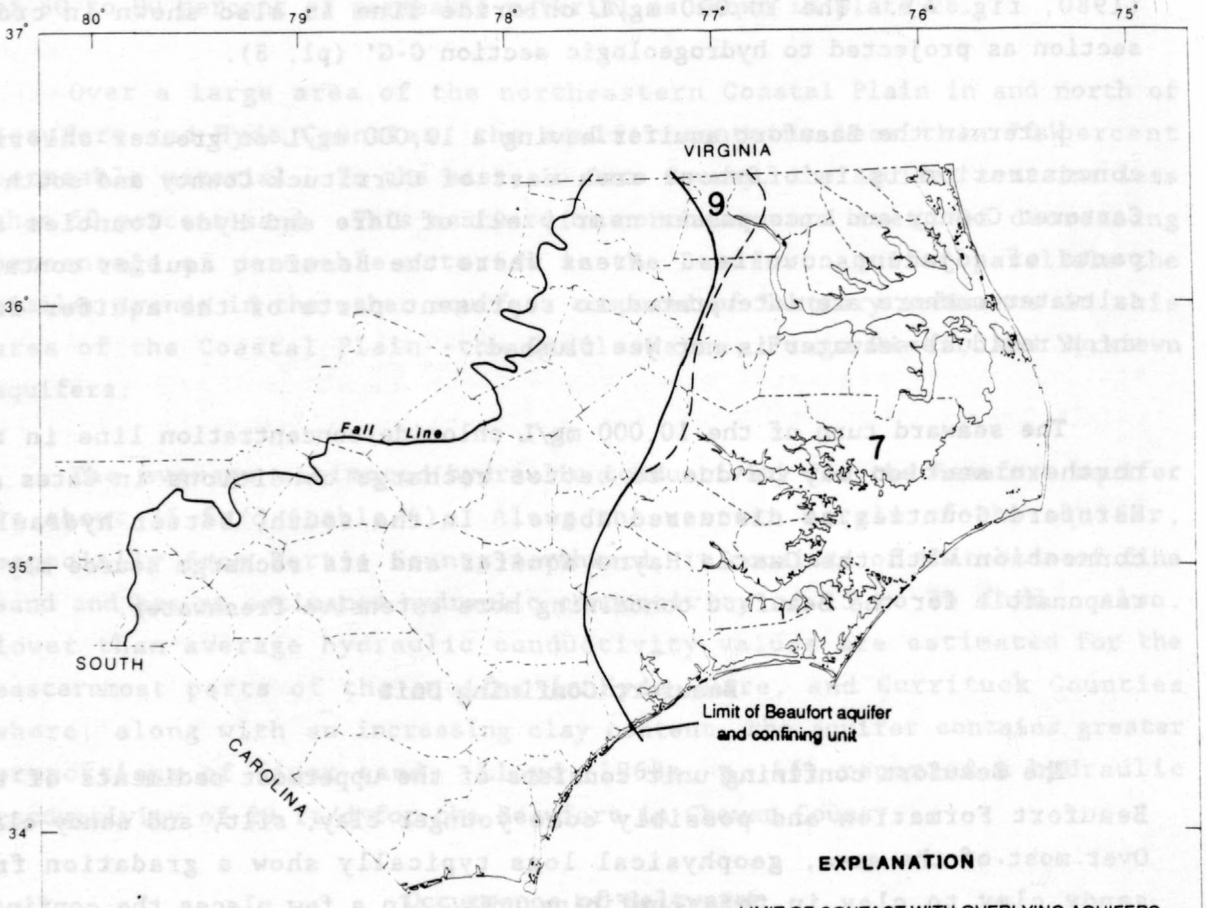

Figure 16.--Aquifers which directly overlie the Beaufort confining unit and aquifer.

The Beaufort aquifer discharges beneath stream valleys and throughout the area east of the recharge area described above. The Chowan River channel is deep enough to incise the Beaufort confining unit along the Gates-Hertford County border (pl. 9), as does the Neuse River just east of Kinston, Lenoir County (pl. 7). Both these places are likely to be the last downdip points of relatively easy ground-water 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 to exchange 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 largely composed of the Peedee Sand of Late Cretaceous age, as traced by Clark and others (1912, p. 145) from the type locality in South Carolina. It 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 occurs 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. 30). 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 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

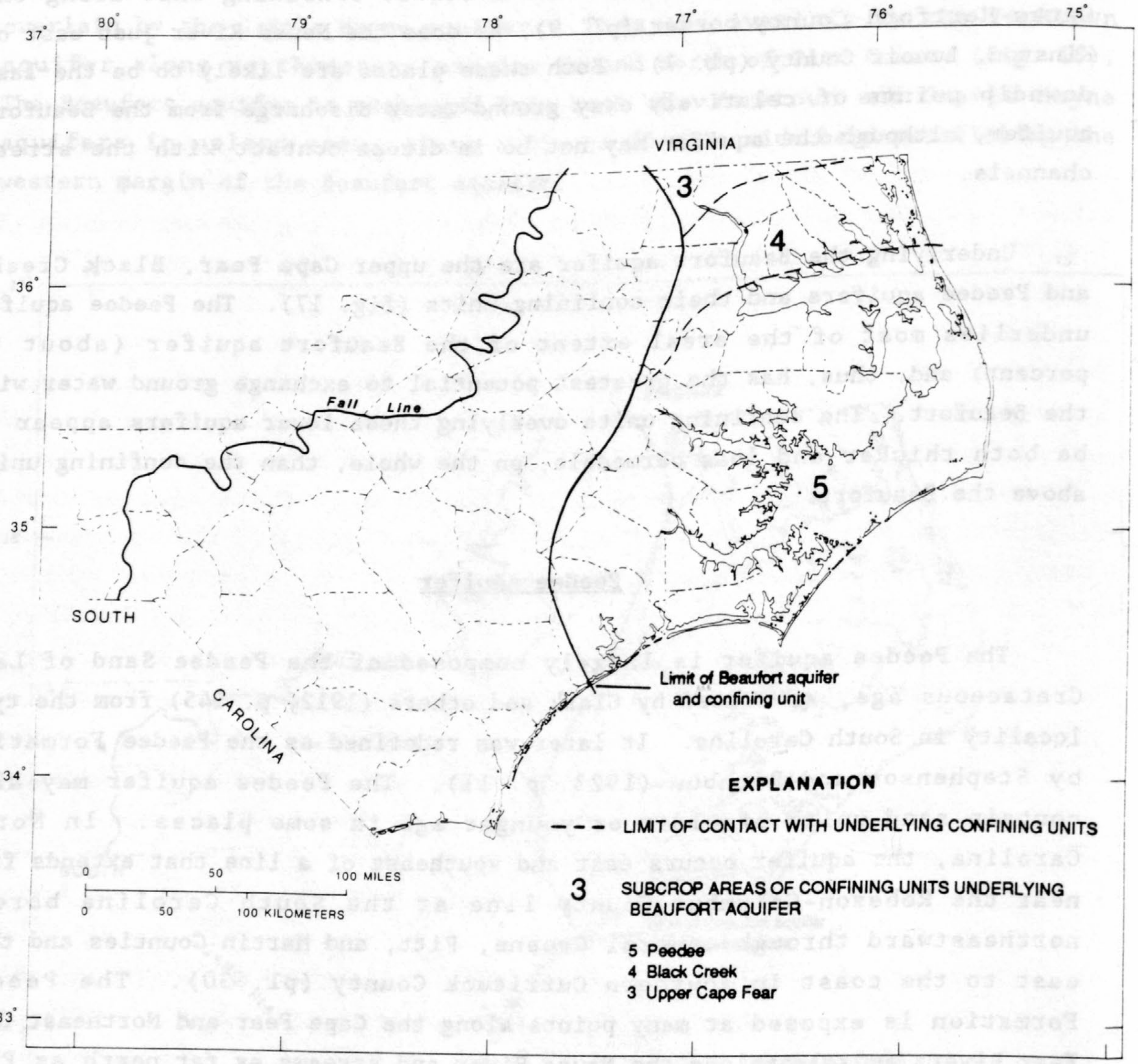

Figure 17.--Confining units which directly underlie the Beaufort aquifer.

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. 30) or in Virginia. The Peedee Formation, however, 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).

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 appear that have no updip equivalents. 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 (Navarroian Stage) time-stratigraphic unit, and they mentioned the Peedee Formation in connection with this 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 which could be interpreted from geophysical logs.

Correlations of lithologic units composing the Peedee aquifer are shown in cross section in plates 2-8, 10, 12-14, and 16; contours of the top of the aquifer are shown in plate 30. The top of the Peedee aquifer dips eastward at an average rate of about 24 feet per mile, with a range of from about 10 feet per mile along its inner margin, especially in the vicinity of the Cape Fear River, to more than 33 feet per mile along the coast where the aquifer is deeply buried. The aquifer thickens from zero along its western limit to more than 300 feet along the coast from southern Onslow County to the South Carolina border. Northeast of Onslow County the aquifer thickness is less than 200 feet.

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. 31).

The Peedee aquifer contains a substantial fraction of clay in three areas as indicated by the sand percentage being less than 60 percent. These 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 value of about 25 ft/d; the average estimated hydraulic conductivity is 33 ft/d (table 4). Generally, higher values of conductivity occur from southern Craven County southeastward 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 the estimated values.

Occurrence of Saltwater

The area delineating saltwater 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. 30). The distance between the 250 mg/L isochlors intersecting top and bottom of the aquifer widens along this trend from about a mile at the aquifer limit in Bertie County to almost 20 miles at the Cape Fear River. The 250 mg/L isochlors are also shown in cross section (pls. 2, 5, 7-9, and 12-14). Of particular note is a lens of freshwater in the aquifer beneath a wedge of saltwater in the overlying Beaufort aquifer in eastern Jones and Onslow Counties (pl. 14).

The 10,000 mg/L isochlors also are shown in plate 30. 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. 7; well 140, pl. 8). The estimated positions of the 10,000 mg/L isochlors are also shown on these hydrogeologic sections.

Peedee Confining Unit

The Peedee confining unit overlies the Peedee aquifer and is composed of clay, silty clay, and sandy clay. With the available data, this confining unit cannot be correlated with a particular geologic unit, but it represents the sediment at the Cenozoic-Mesozoic boundary, especially where the Beaufort aquifer overlies the Peedee aquifer; elsewhere, they 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 feet in well 77 in Jones County (pl. 6), and chloride values differed by several thousand milligrams per liter in well 90 in New Hanover County (pl. 5). 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 feet, and this is represented in plate 32 by the 25-foot thickness contour which extends from Bertie County southwestward to Brunswick County. East of this line, the confining unit is as thick as 60 feet but usually does not exceed 35 feet in thickness. West of the 25-foot contour, the confining unit averages about 15 feet in thickness and, in several areas, 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. 32). The confining unit probably is very thin or missing in a broad, low area between the Cape Fear and South Rivers (pl. 10). Accordingly, the updip limit of the Peedee confining unit as shown in plate 32 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 feet thick (pl. 32). 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-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 in plate 5 and wells 12 and 116 in plate 12.

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

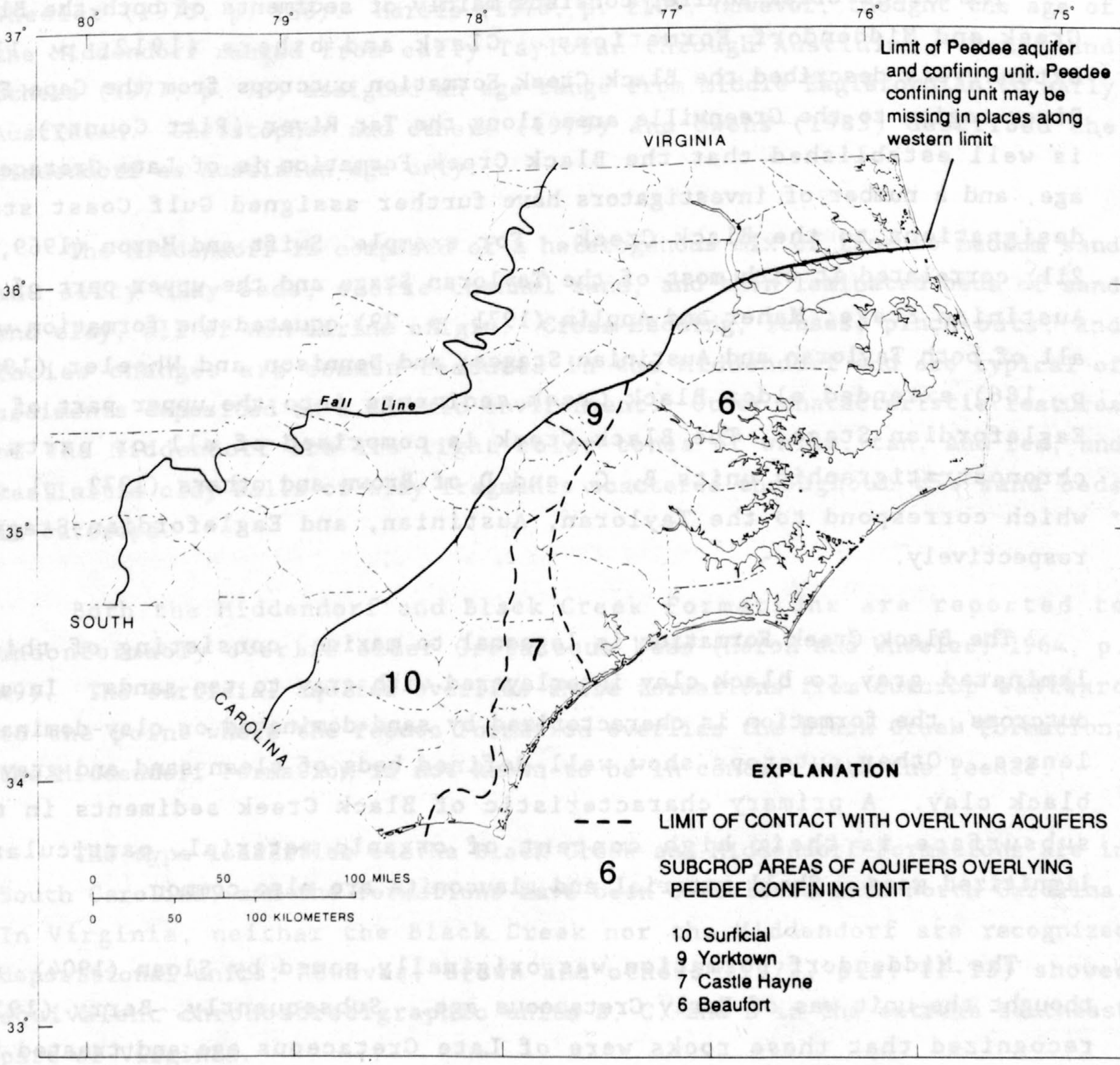

Figure 18.--Aquifers which directly overlie the Peedee confining unit and aquifer.

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 comprised 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 relationship 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 age of 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 heterogenous mix of fine to medium sand and silty clay beds, coarse channel sand, and thin laminated beds of sand and clay, all of non-marine origin. Cross-bedding, lenses, pinch-outs, and facies changes are common features in the Middendorf and are typical of sediments deposited in a deltaic environment. Other characteristic features of the Middendorf are its 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 southeast 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 in plates 2-16.

The updip limit of the Black Creek aquifer extends eastward from the Fall Line at the South Carolina State line to Johnston County, thence northeastward to Gates County, where it swings eastward nearly paralleling the Virginia border (pl. 33). The top of the Black Creek aquifer is about 1,600 feet below sea level in western Dare County (well 48, pl. 8). 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 feet 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 the rate of about 17 feet per mile, increasing coastward to about 38 feet per mile in the north; in the south, the maximum southeastward dip of the aquifer is about 12 feet per mile. The aquifer is thickest along the Pender County coast northward to central Craven County, where it is as much as 400 feet thick.

Distribution of Permeable Material

On the average, the Black Creek aquifer contains nearly 60 percent sand (pl. 34). 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 shown on the map. The largest variations of sand percentage in the aquifer occur 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 being fine "salt and pepper" sands, which refers 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.

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); and 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 250 mg/L isochlors for the top and bottom of the Black Creek aquifer are shown in plate 33. The distance between these two isochlors closely parallels that for the Peedee aquifer in the northern half of the Coastal Plain, but in the south it lies slightly west of that located in the Peedee aquifer. The greatest distance between these two isochlors in the Black Creek aquifer ranges between 6 and 10 miles, similar to that in the Peedee aquifer in the southern Coastal Plain.

The positions of the 250 mg/L isochlors are shown on several hydrogeologic sections (pls. 2, 4-9, 12, and 14) along with chloride concentration values for points within the aquifer. In a small area of central Craven County, freshwater in the Black Creek aquifer occurs beneath saltwater in the Peedee aquifer (pls. 7 and 14). The areal extent of this anomaly can be seen by comparing the 250 mg/L isochlors shown in plates 30 and 33.

The 10,000 mg/L isochlors in the Black Creek aquifer also are shown in plate 33 and in three hydrogeologic sections (pls. 7-9). No water analyses from the Black Creek aquifer are available that show chloride concentrations of 10,000 mg/L or more, but the positions of these isochlors are 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 overlies the Black Creek aquifer and 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 by means of head relationships and water-quality data, the confining unit may be composed of clay beds of either the Black Creek or Peedee Formations. 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 is shown in plates 2-16. In the highly dissected Sand Hills, the Middendorf clays that serve as this confining unit are cut through in many places by streams, as illustrated in 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 pinchout, 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 in plate 35. The average thickness of the confining unit is about 45 feet, but it ranges up to at least 168 feet. 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 adds 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 feet, due 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.

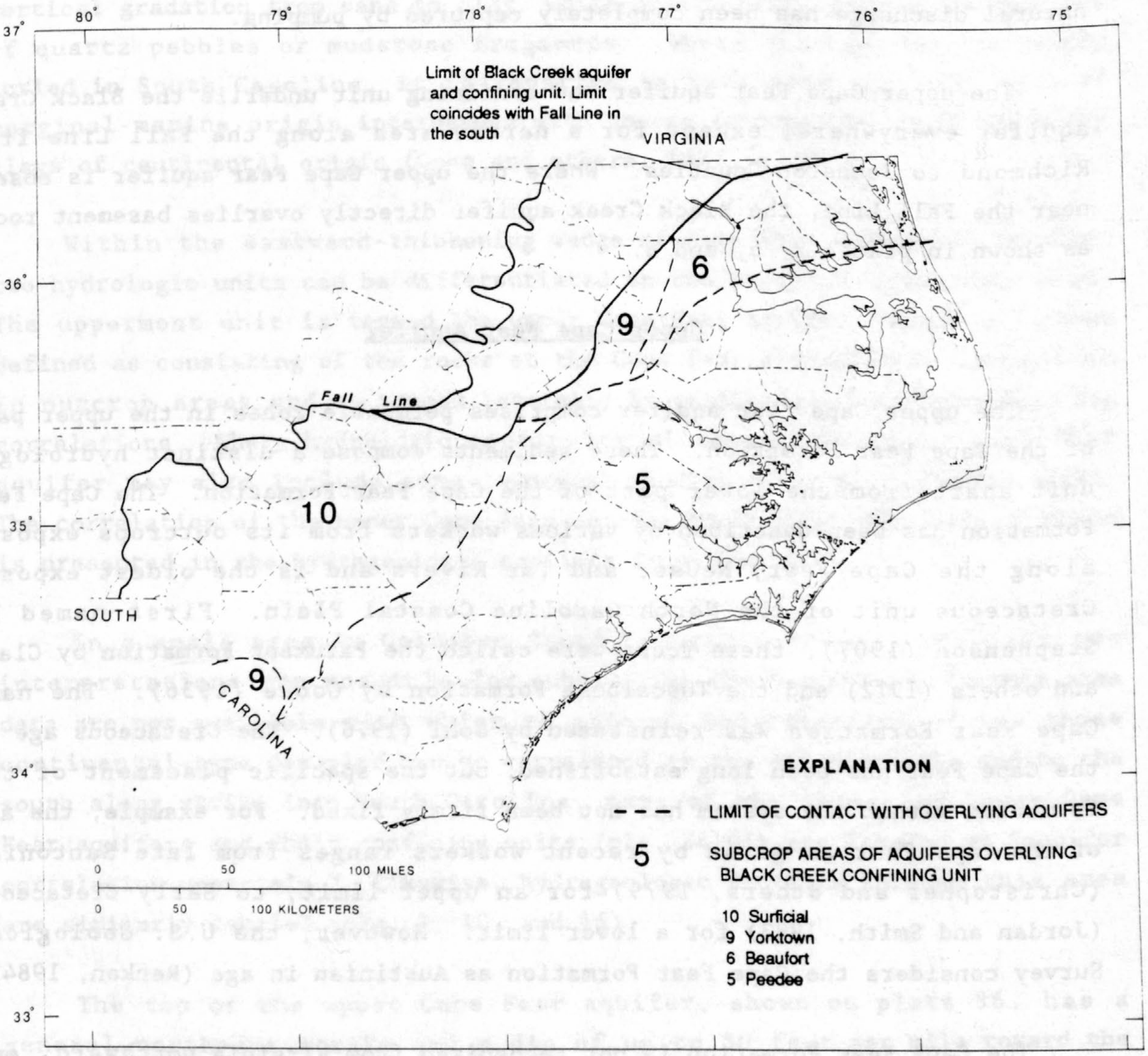

Figure 19.--Aquifers which directly overlie the Black Creek confining unit and aquifer.

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 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 for 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 in plates 2, 5, and 6.

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 as 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 Fredericksburgan sediments described by Brown (1963, p. 4) in Halifax County.

The lithologic characteristics of the Cape Fear Formation in outcrop were thought by Heron and Wheeler (1964, p. 16) to indicate deposition in a near-shore marine environment. The outcropping Cape Fear consists of alternating beds of sand and clay that are commonly 3 to 5 feet thick but range from a fraction of a foot to 15 feet in thickness. 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 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 in plates 2-16.

In a small area in Columbus County, North Carolina, at least two interpretations are possible for subdividing the formation. In this area data are not available with which to gain an understanding of how these continental-type deposits can be correlated in the dip direction and to the south along strike into South Carolina, maps of the upper and lower Cape Fear aquifers and their confining units (pls. 36-41) are labeled as "aquifer correlation uncertain." Likewise, hydrogeologic sections through this area are similarly labeled (pls. 2, 10, and 16).

The top of the upper Cape Fear aquifer, shown on plate 36, has a general northeast strike and a dip of up to 50 feet per mile toward the southeast; however, the dip is only about 10 feet per mile 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 in plates 2, 3, 5, and 6. 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 occurs between basement rocks and the upper Cape Fear aquifer (pl. 11).

The aquifer thickens eastward from about 10 feet along its western edge to nearly 500 feet in central Tyrrell County. Its average thickness is just over 100 feet (table 4), and its greatest thickness occurs beneath the Albemarle-Pamlico Peninsula east of Beaufort and Washington Counties. It is generally less than 100 feet thick over and along the north 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 in the aquifer ranging between about 30 and 90 percent. The areal distribution of sand percent in the aquifer is shown in plate 37. The region east of Wilson and Edgecombe Counties to Beaufort and Washington Counties, and possibly beyond, is the largest area where sand percentage of 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 have more than 80 percent sand; these occur where the aquifer is thin and consists of a single sand bed (pls. 3 and 11).

The sands that compose the upper Cape Fear aquifer are poorly sorted, with grain sizes ranging from very fine to gravel, but the most common sand size as described 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. The estimates of hydraulic conductivity range from 10 to 70 ft/d; the average value is 34 ft/d (table 4).

Two very general observations about the distribution of permeable material within the upper Cape Fear aquifer are that the aquifer materials in the Sand Hills region have lower hydraulic conductivity values and that higher values are found along the coast from Brunswick to Onslow Counties. Usually, the sands of the Cape Fear Formation are poorly sorted and have a clay matrix in the Inner Coastal Plain areas, including the Sand Hills (Heron and Wheeler, 1964, p. 13); whereas downdip, the sand beds are more uniform as determined from geophysical logs.

Occurrence of Saltwater

Except for an area near the Virginia border from Gates to Pasquotank Counties, the 250 mg/L isochlors intersecting the top and bottom of the upper Cape Fear aquifer (pl. 36) lie just west of these 250 mg/L isochlors in the Black Creek aquifer (pl. 33). Where the upper Cape Fear aquifer is thin in Pitt and Martin Counties (pl. 8), the distance between the 250 mg/L isochlors intersecting the top and bottom of the upper Cape Fear aquifer is 1- to 2-miles wide. In parts of the Cape Fear Valley, the aquifer is thicker (pl. 5), and this distance is as much as 8 miles, as shown in hydrogeologic sections in plates 2, 5-10, 15, and 16. 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 in plate 36 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 miles. Southeast of Craven County the 10,000 mg/L isochlors are near the coast and lie offshore east of Brunswick County.

A landward reentrant of the 10,000 mg/L isochlors is shown in New Hanover and Pender Counties along the Cape Fear River, the interpretation of which is based on data from a test hole (well 115, pl. 5) at Moores Creek National Military Park in Pender County. This reentrant of saltwater appears to be related to the ground-water circulation pattern in the aquifer. Primarily, 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 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, clays in the lower part of the Yorktown are also included in this confining unit.

The hydrogeologic sections (pls. 2-16) 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 probably in close hydraulic connection with the upper Cape Fear aquifer, and their channels may cut almost through the confining unit as depicted in plate 7. 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 in plate 38. The average thickness of the unit from wells penetrating it is 48 feet (table 4); however, there are areas where the thickness of the confining unit exceeds 100 feet. One of these is from Scotland and Hoke Counties southeastward into Bladen and, possibly, Columbus Counties; another centers 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, the upper Cape Fear aquifer and its confining unit are overlain by the Black Creek aquifer (fig. 20) from the Sand Hills, where the Black Creek overlaps the upper Cape Fear, northeast to Currituck County at the Virginia border. The Yorktown aquifer overlies the upper Cape Fear along its northwestern limit, and the Beaufort aquifer overlies the upper Cape Fear aquifer 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 County.

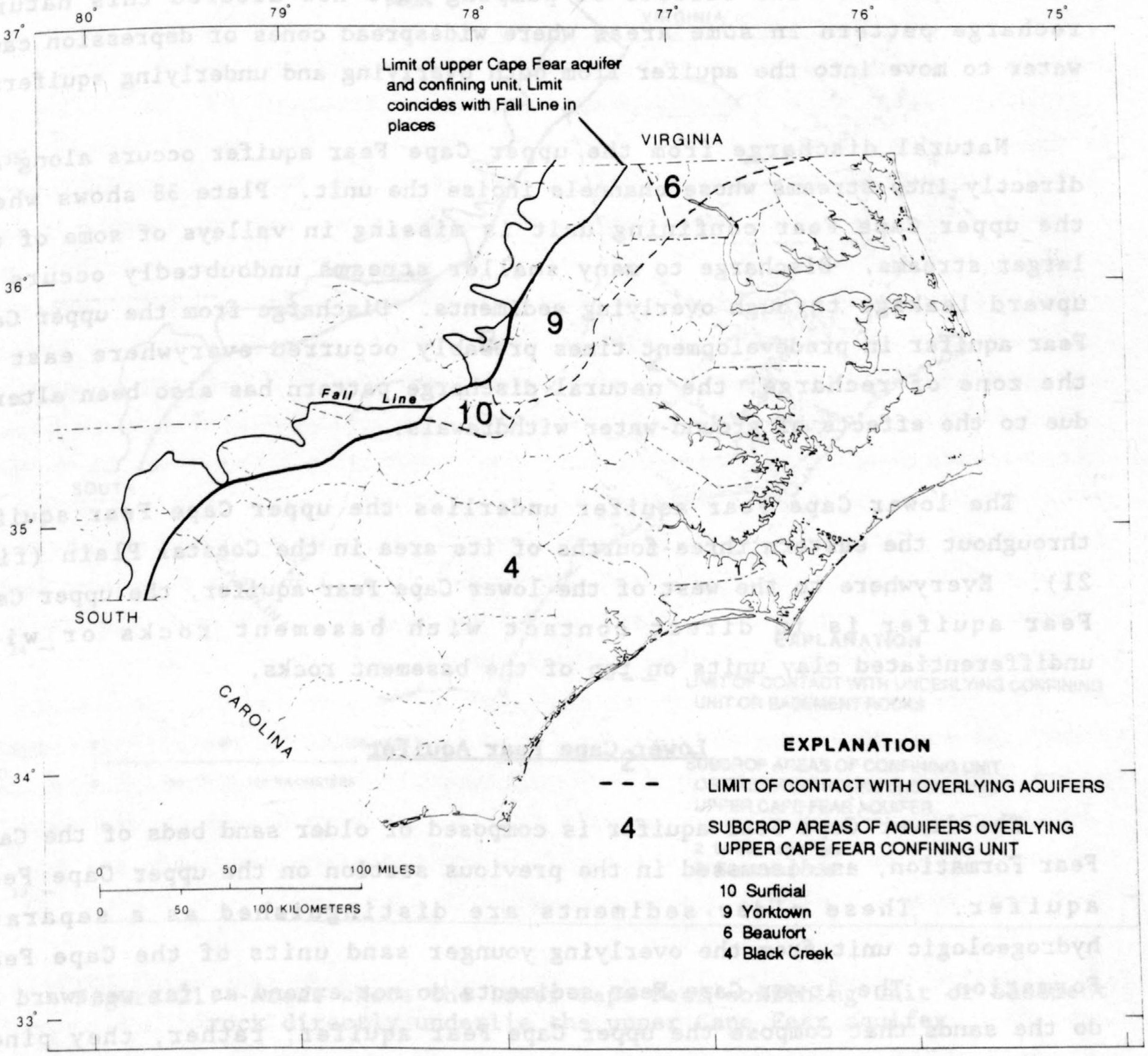

Figure 20.--Aquifers which directly overlie the upper Cape Fear confining unit and aquifer.

Recharge to the upper Cape Fear aquifer is 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 miles wide paralleling the western limit of the aquifer. The effects of pumping have now altered this natural recharge pattern in some areas where 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 38 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 due to the effects of 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 previous section on the upper Cape Fear aquifer. These older sediments are distinguished as a separate hydrogeologic unit from the overlying younger sand units of the Cape Fear Formation. The lower Cape Fear sediments do not extend as far westward as do the sands that compose the upper Cape Fear aquifer; rather, they pinch out against the eastward-sloping bedrock surface (pls. 2-4). 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 in plate 39, which depicts the altitude of the top of this aquifer. Its surface has a

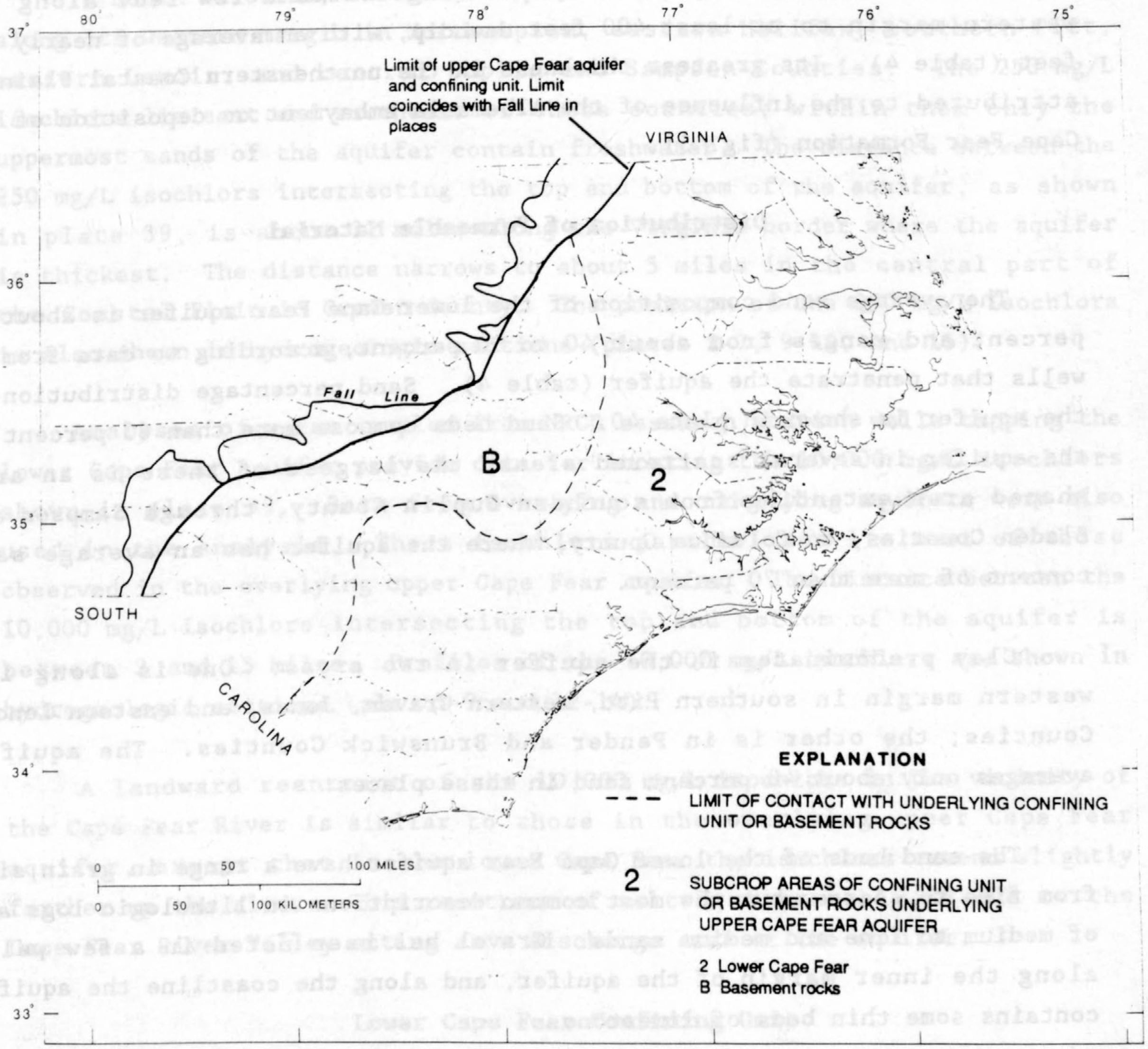

Figure 21.--Areas where the lower Cape Fear confining unit or basement rock directly underlie the upper Cape Fear aquifer.

northeastward strike similar to that of the upper Cape Fear aquifer and shows a slightly greater southeast dip (15 to 55 feet per mile). The thickness of the lower Cape Fear aquifer ranges from a few feet along its western margin to at least 400 feet downdip, with an average of nearly 175 feet (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 average sand composition of the lower Cape Fear aquifer is 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 in plate 40. 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 coastline the aquifer contains some thin beds of limestone.

Estimates of hydraulic conductivity for the aquifer range between 20 and 75 ft/d; the average hydraulic conductivity is 34 ft/d. No aquifer tests have been conducted on the lower Cape Fear aquifer in North Carolina. However, some tests at Norfolk, Virginia, 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 250 mg/L isochlors lie east and southeast of these counties; within them only the uppermost sands of the aquifer contain freshwater. The distance between the 250 mg/L isochlors intersecting the top and bottom of the aquifer, as shown in plate 39, is about 32 miles along the Virginia border where the aquifer is thickest. The distance narrows to about 5 miles 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 (plates 2-7, 9-10, and 15).

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 in plate 39. Data from overlying and underlying aquifers were also used in the analysis. These isochlors parallel and lie west of those observed 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 miles. Profiles of the 10,000 mg/L isochlors are shown in hydrogeologic sections (pls. 5-9 and 12-14).

A landward reentrant of the 10,000 mg/L isochlors in the vicinity of the Cape Fear River is similar to those in the overlying upper Cape Fear aquifer, except that in the lower Cape Fear 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 of the aquifer.

Lower Cape Fear Confining Unit

The lower Cape Fear confining unit overlies the lower Cape Fear aquifer and is composed of clay and sandy clay beds that belong largely to the Cape Fear Formation. However, 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 in plates 2-16. 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 one would expect in the eastward-thickening Coastal Plain sedimentary wedge (pl. 41). The thickness of the confining unit exceeds 75 feet throughout the eastern quarter of the Coastal Plain and in Bertie and Halifax Counties. It is more than 100 feet 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 feet (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 for 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 of the known water-level measurements in this aquifer have been made in the post-development period, it is difficult to reconstruct predevelopment areas of natural recharge; however, the recharge areas for both predevelopment and post-development times probably are less than 10 miles 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. A possible exception occurs 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. 41), 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-

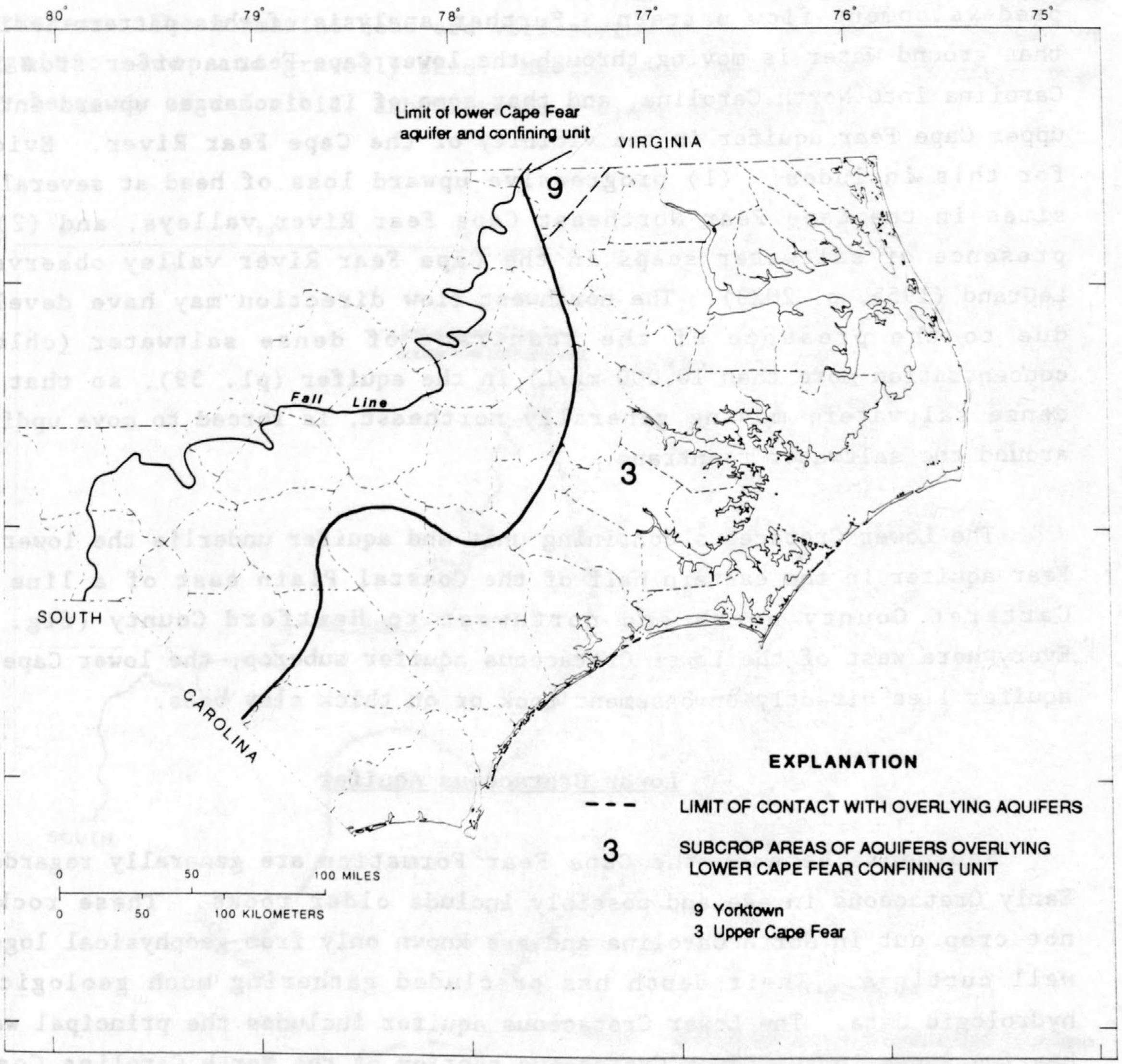

Figure 22.--Aquifers which directly overlie the lower Cape Fear confining unit and aquifer.

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 for this includes: (1) progressive upward loss of head at several test sites in the Cape Fear-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 due to the presence of the reentrant of dense saltwater (chloride concentration more than 10,000 mg/L) in the aquifer (pl. 39), 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). Everywhere 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.

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 being 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.

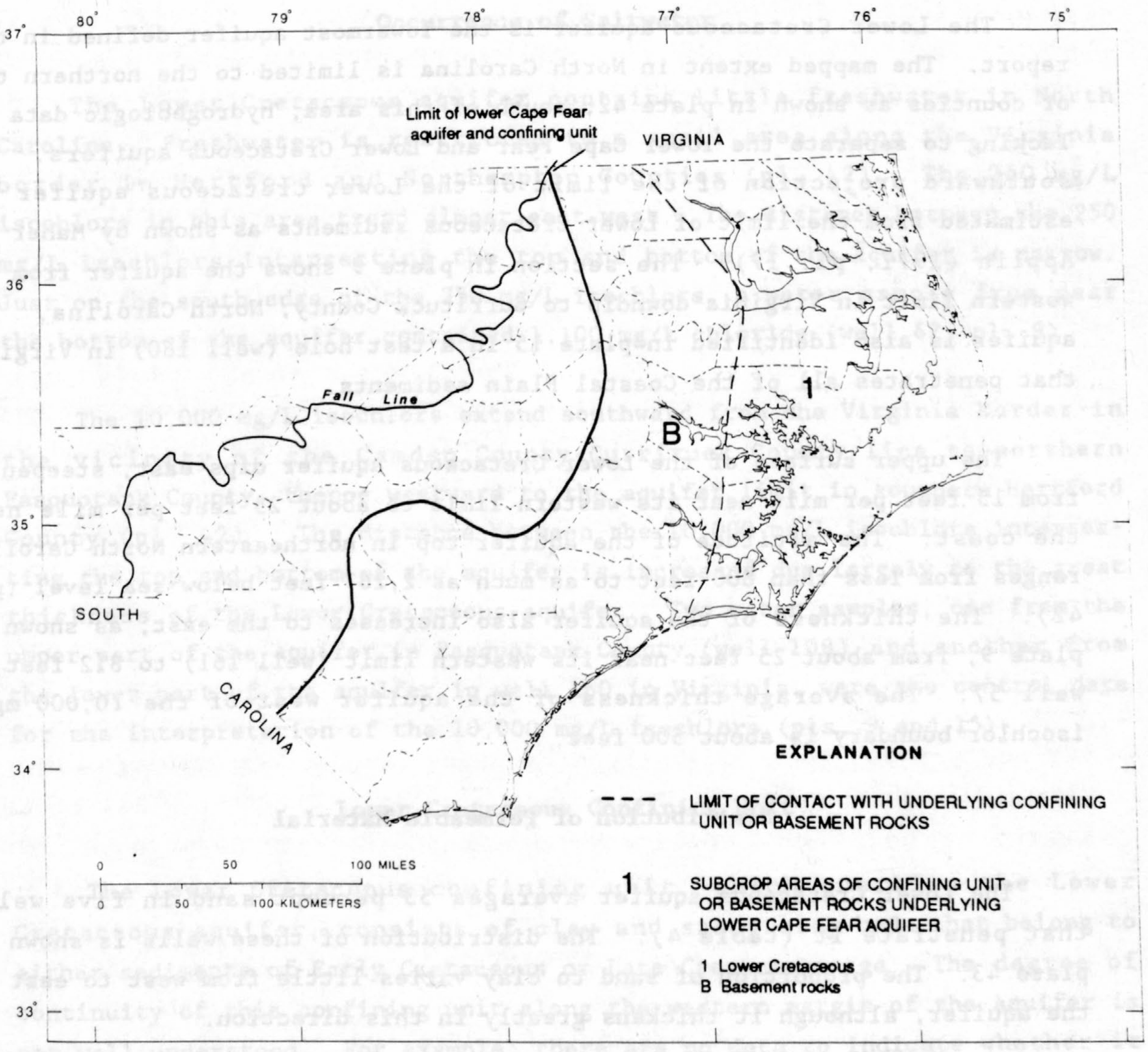

Figure 23.--Areas where the Lower Cretaceous confining unit or basement rock directly underlie the lower Cape Fear aquifer.

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 in plate 42; 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 as shown by Maher and Applin (1971, pl. 17). The section in plate 9 shows the aquifer from its western limit in Virginia downdip to Currituck County, North Carolina. The aquifer is also identified in plate 15 in a test hole (well 160) in Virginia that penetrates all of the Coastal Plain sediments.

The upper surface of the Lower Cretaceous aquifer dips east, steepening from 15 feet per mile near its western limit to about 25 feet per mile near the coast. The altitude of the aquifer top in northeastern North Carolina ranges from less than 600 feet to as much as 2,267 feet below sea level (pl. 42). The thickness of the aquifer also increases to the east, as shown in plate 9, from about 25 feet near its western limit (well 161) to 812 feet in well 57. The average thickness of the aquifer west of the 10,000 mg/L isochlor boundary is about 500 feet.

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 43. The proportion of sand to clay varies little from west to east in the aquifer, although it 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, Virginia, about 10 miles due north of the Gates County-Hertford County line at the Virginia border, to be between 6,000 and 24,000 ft^2/d (feet squared per day). Given an average thickness of about 600 feet, the hydraulic conductivity for the aquifer in that area ranges between 10 and 40 ft/d.

Occurrence of Saltwater

The Lower Cretaceous aquifer contains little freshwater in North Carolina. Freshwater is restricted to a small area along the Virginia border in Hertford and Northampton Counties (pl. 42). The 250 mg/L isochlors in this area trend almost east-west. The distance between the 250 mg/L isochlors intersecting the top and bottom of the aquifer is narrow. Just on the south edge of the 250 mg/L isochlors, a water sample from near the bottom of the aquifer contained 1,100 mg/L chloride (well 67, pl. 9).

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, thence westward to the aquifer limit in southern Hertford County (pl. 42). The distance between the 10,000 mg/L isochlors intersecting the top and bottom of the aquifer is increased due largely to the great thickness of the Lower Cretaceous aquifer. Two water samples, one from the upper part of the aquifer in Pasquotank County (well 108) and another from the lower part of the aquifer in well 160 in Virginia, were the control data for the interpretation of the 10,000 mg/L isochlors (pls. 9 and 15).

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 either sediments of 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 it is the aquifer or the confining unit that first pinches out updip.

Downdip, the confining unit is correlated between a few wells (pl. 9) and shows a general trend of thickening toward the coast (pl. 44). The thickness of the unit ranges to nearly 70 feet in Camden and Currituck Counties. The average thickness is about 44 feet, based on data from 8 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. Without considering 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 250 mg/L isochlors in the Lower Cretaceous aquifer (pl. 42), which is oriented nearly east-west, are 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 feet 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, 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 comprising the oldest rock layers. The upper sequences are largely marine in origin and include near-shore 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 occurrence 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 by use of geophysical logs in conjunction with lithologic data to construct 18 interconnected hydrogeologic sections throughout the Coastal Plain. Other means used to delineate aquifers and confining units include 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 are derived from the geologic formation most closely associated with each aquifer, except the lowermost 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 of 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, thickness, percentage of permeable material, and an estimate of hydraulic conductivity for each aquifer and are given in a table presented in the Supplemental Data section of the report.

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SUPPLEMENTAL DATA

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Supplemental data-- *Properties of aquifers and confining units*

[**Well No:** NRCD well-numbering system number; American Petroleum Institute (API) number given here for oil-test well; USGS well-numbering system used for wells in Virginia. **Map No:** Reference number for data in text, maps, and sections sequentially listed in this table. **Log Depth:** Depth of well log, in feet, below land surface. **Altitude of Land Surface:** Given in feet above sea level. **Basement:** Where known, altitude of top, in feet, above or below sea level. **AQ:** Aquifer-- **SUR**, surficial aquifer; **YKN**, Yorktown aquifer; **PGR**, Pungo River aquifer; **CLH**, Castle Hayne aquifer; **BFR**; Beaufort aquifer; **PD**, Peedee aquifer; **BC**, Black Creek aquifer; **UCF**, upper Cape Fear aquifer; **LCF**, lower Cape Fear aquifer; **LC**, Lower Cretaceous aquifer. **CONF UNIT:** Confining unit separating aquifers. **ALT TOP:** Altitude,in feet, of top of aquifer or confining unit above or below sea level. **THICK:** Thickness, in feet, of aquifer or confining unit. **PCT PERM MATERIAL:** Percent of permeable material comprising 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]

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

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: M18l- 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	--	--						

Supplemental data-- *Properties of aquifers and confining units*--Continued

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	-311	-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		

Supplemental data-- *Properties of aquifers and confining units*--Continued

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	--							

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: X17i6
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	--	--		

Supplemental data-- *Properties of aquifers and confining units*--Continued

USGS Edenton Airport Test. Well No: H14pl

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: S20ol

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: R39pl

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	--					

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 CONDUCT	35	--	25	--															

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	--	--	--	--	--	--

DUPLIN COUNTY

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	--	--				

GREENE COUNTY

NRCD Maury Research Station. Well No: O27j4

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: O4111
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 co..ining 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	--	--				

Supplemental data-- *Properties of aquifers and confining units*--Continued

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

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

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	--	--						

N O R T H A M P T O N   C O U N T Y

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	--	--								

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

P E N D E R   C O U N T Y

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				

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: 245v-

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	90		
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				

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	--	--				

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	--	--	--	--	--	--

W A S H I N G T O N C O U N T Y

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	--	--		

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: O30i2
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				

Supplemental data-- *Properties of aquifers and confining units*--Continued

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				

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