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GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By
George L. Bain
Geologist, U. S. Geological Survey

GROUND WATER BULLETIN NO. 17

North Carolina
Department of Water and Air Resources
George E. Pickett, *Director*

DIVISION OF GROUND WATER
Harry M. Peek, *Chief*

Prepared by the
United States Geological Survey
in cooperation with the
New Hanover County Board of Commissioners
and the
North Carolina Department of Water and Air Resources

APRIL 1970

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Raleigh, North Carolina

1970

NORTH CAROLINA

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February 12, 1970

The Honorable Robert W. Scott
Governor of North Carolina
Raleigh, North Carolina

Dear Governor Scott:

I am pleased to submit Ground-Water Bulletin Number 17, "Geology and Ground-Water Resources of New Hanover County, North Carolina" by George L. Bain, Geologist, U. S. Geological Survey.

This report contains the results of a detailed study of the ground-water resources made by the U. S. Geological Survey in cooperation with the New Hanover County Board of Commissioners and the North Carolina Department of Water and Air Resources. It should prove to be of much value toward the economic and industrial development of the County.

Respectfully submitted,

George E. Pickett

GEP:hbd

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The sandstone aquifer in the Peedee Formation averages about 35 feet in thickness, sloping from sea level in the northwestern part of the county to about 190 feet below sea level at Wrightsville Beach. Where data are available, the aquifer is known to contain fresh water and is separated from underlying beds containing salty water by 100 to 150 feet of relatively impermeable clay. Except along the Cape Fear River and the Atlantic coast, ground water in the Peedee sandstone is under sufficient pressure to rise above sea level, and it rises to more than 30 feet above sea level in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity in part of the county is more than 30 gallons per minute per foot of drawdown.

The Castle Hayne Limestone is irregular in thickness and areal distribution, being thicker and more extensive under the northeastern and southern parts of the county. It lies within about 30 feet of the land surface except along the coastal margin where it is somewhat deeper. The Castle Hayne has easy access for replenishment, and much water enters the limestone in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity ranges from 3 to 80 gallons per minute per foot of drawdown.

Sand, clay, and marl of Pleistocene and Miocene age cover the land surface in all of the county. The sands comprise the uppermost aquifer in the county--that is, the water-table aquifer, except in a few places where the Castle Hayne Limestone and Peedee Formation are near the land surface. The water table commonly lies within 10 feet of the land surface and is easily reached by the common type of drive-point well.

Water of acceptable chemical quality for most purposes is available throughout the county, but a wide range in quality of water within the aquifers is common. Water in the Peedee sandstone is hard in most places, and the iron content exceeds 1 milligram per liter in the central and north-central parts. Water in the Castle Hayne Limestone is a calcium bicarbonate type ranging from moderately hard to very hard. The iron content ranges from 0.01 to more than 12 milligrams per liter. Water in the surficial sands is soft but almost everywhere is corrosive.

The current withdrawal of ground water is only a small part of the available supply, but the availability of water varies considerably from one part of the county to another. The aquifers are susceptible to salt-water encroachment because of aquifers containing salty water underlying the Peedee sandstone aquifer and because of the bordering Atlantic Ocean and brackish Cape Fear River. The present position of the interface between salty and fresh water in the ground is maintained by the volume and hydrostatic head of the fresh water. Thus, a substantial reduction in rainfall or changes in ground-water conditions created by man's activities, such as withdrawal of water through pumping, swamp drainage, or dredging which reduces the fresh-water hydrostatic head, may cause a corresponding encroachment of salt water. Salt-water encroachment may be controlled at least partially by well-field design and management. Proper practices include pumping more wells at lower rates and the use of multiple well points and infiltration galleries in shallow aquifers.

GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By

George L. Bain

Geologist, U. S. Geological Survey

ABSTRACT

This report describes the ground-water resources of New Hanover County in southeastern North Carolina. The county is a part of the Atlantic Coastal Plain Province and occupies a peninsula between the Atlantic Ocean and the Cape Fear and Northeast Cape Fear Rivers. New Hanover County is a relatively flat sandy plain, few points in the county being more than 50 feet above sea level. The climate is humid; the average annual precipitation is about 50 inches.

Ground water occurs in a system of slightly inclined formations underlying the Coastal Plain. Although individual formations dip and thicken in various directions, they in aggregate, thicken in wedge-like fashion toward the coast, reaching a maximum thickness in New Hanover County of slightly more than 1,500 feet. Most of the formations are composed of unconsolidated sands and clays containing a few beds of limestone and calcareous sandstone. A veneer of sand and sandy clay of probable Pleistocene age tends to conceal the underlying sequence of rock materials of Tertiary and Cretaceous age.

The volume of water stored in the Coastal Plain formations in New Hanover County is large; however, water in all but the shallow formations is too salty for most uses.

Three major aquifers, or water-bearing beds, furnish water to wells, at least two of them being available for use in most parts of the county. They include a sandstone bed in the Peedee Formation of Late Cretaceous age, the Castle Hayne Limestone of Eocene age, and the shallow surface sands.

The sandstone aquifer in the Peedee Formation averages about 35 feet in thickness, sloping from sea level in the northwestern part of the county to about 190 feet below sea level at Wrightsville Beach. Where data are available, the aquifer is known to contain fresh water and is separated from unde lying beds containing salty water by 100 to 150 feet of relatively impermeab clay. Except along the Cape Fear River and the Atlantic coast, ground water in the Peedee sandstone is under sufficient pressure to rise above sea level and it rises to more than 30 feet above sea level in the center of the count Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity in part of the county is more than 30 gallons per minu per foot of drawdown.

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INTRODUCTION

This report describes the ground-water resources of New Hanover County. The purpose of this study was to determine the thickness, lithology, and areal extent of the water-bearing formations (aquifers), the source of replinishment or recharge to the aquifers, the direction of water movement within the aquifers, and the quantity and chemical quality of the ground water.

Fieldwork, done for this report during the period from January 1963 to June 1966, included the following:

1. Fifty auger holes were drilled to determine the lithology, thickness, age, and areal extent of the geologic formations. Where feasible, the auger holes were cased to permit water sampling, gamma-ray logging, observation of water-level fluctuations, and pumping tests.

2. Two deep test holes were drilled to determine the depth to the deeper lying Black Creek Formation, the chemical quality of water in the deeper aquifers, and the position of the fresh water-salt water interface.

3. Data on 412 wells including drillers' records, well cuttings, and water samples were collected from well drillers and owners, as well as from published sources.

4. Gamma-ray well logs were made in cased auger holes, deep test holes, and some existing wells. Electric logs of the deep test holes also were made.

5. Water-level data were collected at 5 wells equipped with continuous recorders, at 20 wells which were measured monthly, and at more than 100 wells which were measured semiannually.

6. More than 250 water samples were collected and analyzed to determine the quality of the ground water.

7. Thirty-seven pumping tests were made, and data from a few drillers pumping tests were collected to determine hydraulic characteristics of the aquifers.

8. The base-flow discharge of four small streams was measured to evaluate ground-water discharge.

9. A network of more than 150 altitude control points (accurate to $\pm$ 5 feet), necessary for geologic and hydrologic control, was established by barometric leveling.

PREVIOUS INVESTIGATIONS

No previous detailed geologic or ground-water investigations have been made in New Hanover County. David G. Thompson, U. S. Geological Survey, made a preliminary study of the ground-water resources of Wilmington (1941). A drought during the fall of 1940 had so reduced the fresh-water flow in the Cape Fear River that salt water contaminated the public water supply through the Toomers Creek intake. Thompson recommended that the surficial sand deposits of several areas on the outskirts of Wilmington be used as sources of emergency public supplies while the water intake was being extended to Lock 1 on the Cape Fear River. The sand hills area along U. S. 421 northwest of Wilmington was among those areas recommended.

The formations penetrated and the chloride concentrations of several wells in New Hanover County and vicinity were described by Clark and others (1912). Data collected by Thompson in 1941, M. J. Mundorff between 1941 and 1948, and H. E. LeGrand between 1952 and 1958 were combined in a reconnaissance report entitled, "Geology and Ground-Water Resources of Wilmington-New Bern Area, North Carolina" (LeGrand, 1960). LeGrand briefly describes the physiography and geology of the county, points out the potential of the Castle Hayne Limestone as an aquifer, and gives additional hydrologic data on the sand hills area northwest of Wilmington.

ACKNOWLEDGMENTS

The assistance of well owners, municipal and industrial officials, and well drillers is gratefully acknowledged. Particular acknowledgment is due Bill Dobo, Robert Meadows, Maurice Johnson, and H. H. Harward for furnishing well records, water-level data, and well cuttings. Auger and test-hole cuttings were processed and paleontological determinations were made by P. M. Brown, U. S. Geological Survey, Raleigh, North Carolina. Except where otherwise noted, water samples were analyzed by the Laboratory Unit, Water Resources Division, U. S. Geological Survey, Raleigh, North Carolina.

The study was initiated in January of 1963 by the U. S. Geological Survey in cooperation with the New Hanover Board of County Commissioners and the North Carolina Department of Water and Air Resources (formerly the North Carolina Department of Water Resources). The investigation was conducted under the general supervision of O. Milton Hackett, Chief, Ground Water Branch, U. S. Geological Survey. Immediate supervision was by P. M. Brown and G. G. Wyrick, former District Geologists, Raleigh, North Carolina.

GEOGRAPHY

LOCATION, AREA, AND POPULATION

New Hanover County is in the southeastern part of the Coastal Plain of North Carolina and occupies a peninsula between the Atlantic Ocean and the Northeast Cape Fear and Cape Fear Rivers. Figure 1 shows the location of the county.

The county has an area of 194 square miles. The Bureau of the Census reported the population in 1960 to be 71,742--about 370 people per square mile. Wilmington, the county seat, had a population of 44,013. Smaller towns in the county are Carolina Beach, Castle Hayne, Kure Beach, and Wrightsville Beach. Forests and farmland comprise 58 and 14 percent of the total land area, respectively. Sixty-nine percent of the residences are classed as urban.

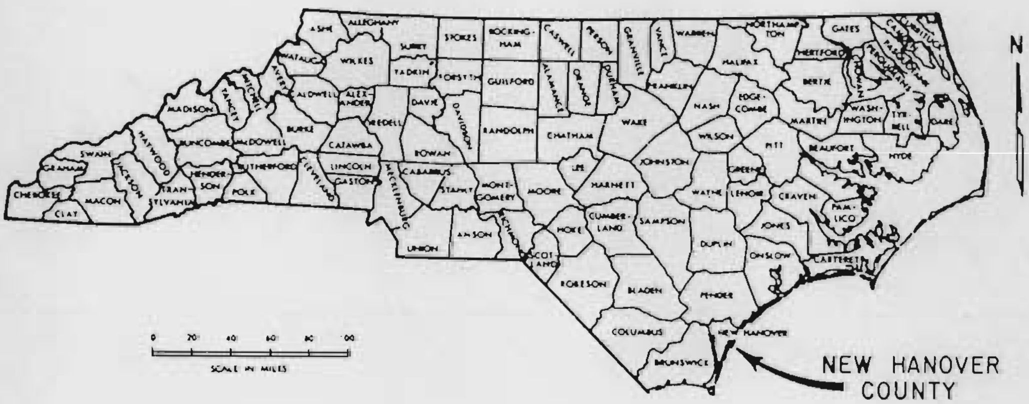


Figure 1.--Index map of North Carolina showing the location of New Hanover County.

CLIMATE

New Hanover County has a mild, humid climate. The U. S. Weather Bureau statistics for the Wilmington station show an average annual temperature of 63.8°F and an average annual precipitation of 51.29 inches for the 30-year period 1931-60. The average monthly variations in temperature and precipitation at this station are shown in figure 2. It may be observed that precipitation during July, August, and September tends to be considerably higher than in the other months. At Southport, near the southern tip of the county, the average annual temperature and precipitation for the same period of record are 64.3°F and 49.49 inches, respectively.

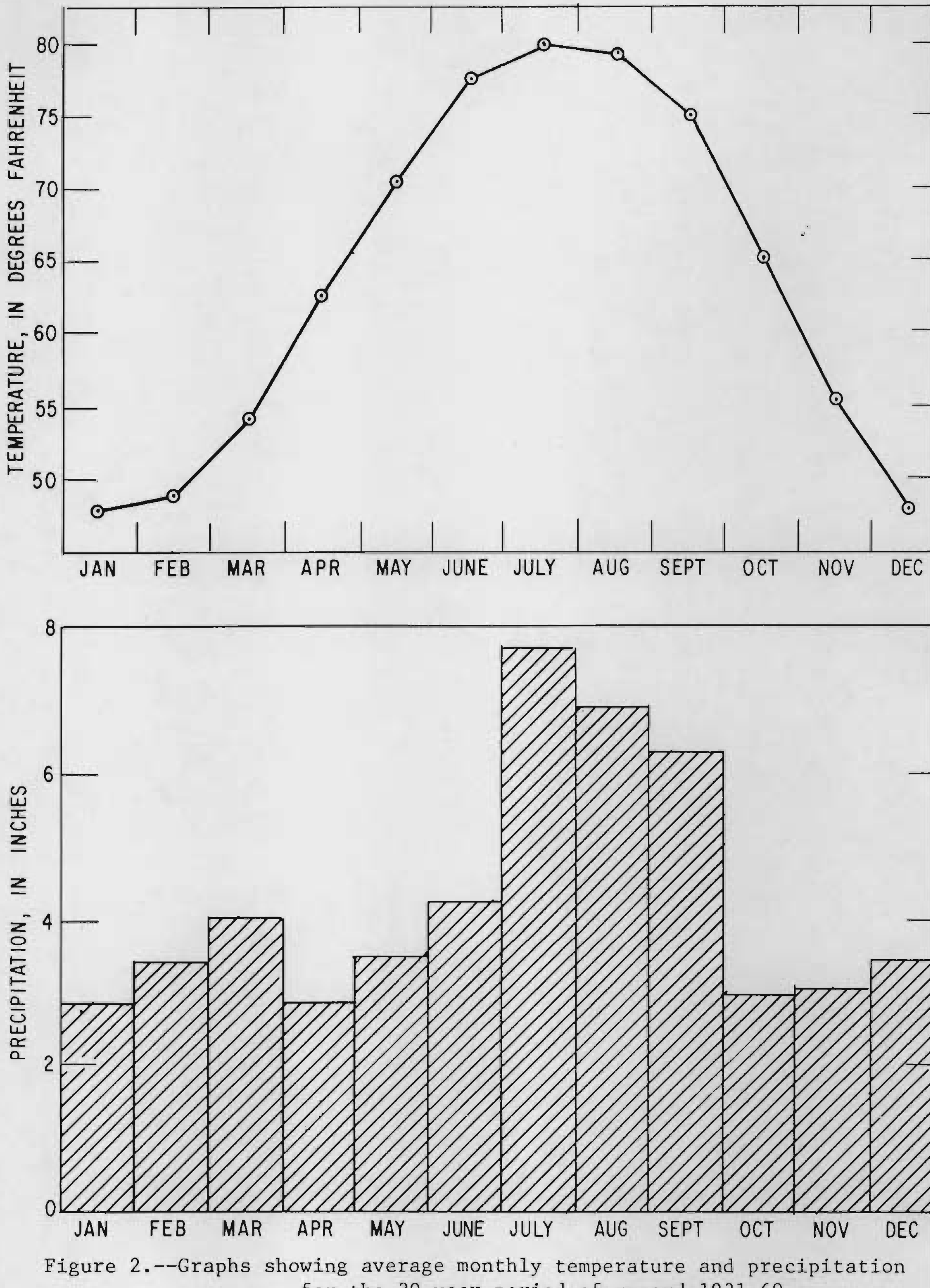


Figure 2.--Graphs showing average monthly temperature and precipitation for the 30-year period of record 1931-60 at Wilmington, North Carolina.

PHYSICAL FEATURES

The land surface of New Hanover County is a plain with a slight overall slope toward the Atlantic coast and the Cape Fear River. This plain is relatively flat in the broad interstream areas but is broken by low escarpments along the Northeast Cape Fear and Cape Fear Rivers and breached by short tributary creeks. The plain represents the part of a Pleistocene sea floor that has been exposed by withdrawal of the sea in the relatively recent geologic past. Parts of the land surface are covered with rolling sand hills. These sand hills constitute accumulations of beach sand which were shifted by the wind to form dunes. Salt marshes, tidal flats, and shallow sounds between the present-day barrier beaches and the mainland are connected to the ocean by narrow inlets.

Several topographic features are important to the ground-water hydrology in the county. The fossil dunes or sand hills extend northeastward from Fort Fisher along U. S. Highway 421 through Wilmington to and beyond the Pender-New Hanover County line. They are best developed in an area between the Cape Fear River and the Northeast Cape Fear River, northwest of Wilmington, southeast of Greenfield Lake, and south of Barnard Creek. The highest altitude in the county of 80 feet above sea level occurs on one such fossil dune system east-southeast of Greenfield Lake. Most of these thick sand deposits have no surficial drainage. Another sandy area extends northeast along U. S. Highway [illegible] parallel to the coast in the northeastern part of the county. This sandy area was a long bar at a time when the sea stood some 35 or 40 feet higher than it does today. To the west of this bar was a broad shallow lagoon, which is now drained by the northeast Cape Fear River. Today the area is flat and marshy. Small shallow sinks are common in the vicinity of the town of Castle Hayne and from Wilmington southward. The sinks, usually filled with water, result from the solution of near-surface limestone and coquina beds.

The altitude of much of the county is from 30 to 40 feet above mean sea level. The Talbot Terrace described by Cooke (1931) occurs at this level. Cooke also described a terrace at 25 feet above mean sea level which may be distinctive from the village of Porters Neck southward and slightly west of the sounds.

GEOLOGY

OUTLINE OF GEOLOGY

The present-day quality, occurrence, and availability of ground water i New Hanover County depend upon the physical and chemical character of the sediments beneath the county. Such characteristics as: kind of sediment, lithology, thickness, and attitude have been predetermined by the county's geologic history. When any area is inundated through a general rise in sea level or localized subsidence of the earth's crust, accumulation of marine sediment begins and erosion ceases. The kind and character of the sediment being deposited at any one place, whether limestone, sandstone, clay, shale, or sand, whether coarse or fine, or whether cemented or unconsolidated depen on many complex variables. Some variables include the kind of source materi and degree of weathering, distance of sediment transport, and rate of accumulation of the shells of marine organisms.

Crustal movements along the axis of the geologic structure known as the Cape Fear Arch had a profound effect upon the type, thickness, and inclinati (dip) of the sedimentary formations beneath New Hanover County and thus, ulti mately have influenced the ground water. The Cape Fear Arch is now a broad gentle uplift roughly paralleling the Cape Fear River and trending southeastward through New Hanover County. Crustal movements along this axis are responsible for the lack of deposition of Lower Cretaceous sediments in part o the county, the deposition of a thick sequence of Upper Cretaceous sediments and thin to nondeposition of the more recent Tertiary formations.

Sediment accumulation on the crystalline basement floor ranges in thickness from about 1,100 feet at Wilmington to 1,500 feet at Fort Fisher. Near 90 percent of the sediments accumulated during Cretaceous time when the coun was on the flank of a depositional basin. These deposits, ranging in age fr Cretaceous through Tertiary, are divided from oldest to youngest into the Bl Creek, Peedee, Castle Hayne, and undifferentiated deposits of Oligocene(?) a Miocene age. They are overlain at the surface by sands, clays, and marls deposited during the comparatively recent geologic past.

BASEMENT ROCK

The submerged erosional surface upon which the Upper Cretaceous sedimen were deposited consists of schist, gneiss, granite, and metamorphosed volcan rocks typical of rocks which are exposed in the Piedmont Province of North C olina. Granite occurs at a depth of 1,109 feet in well 202, which was drill as a municipal water well for Wilmington in 1899. A well drilled during 190 07 at Fort Caswell, across the Cape Fear River from the southern tip of the county, penetrated basement rock at 1,540 feet (Clark and others, 1912, p. 1 196). The ages of the basement rocks are unknown but may range from Precambrian(?) to Mississippian(?).

CRETACEOUS SYSTEM

BLACK CREEK FORMATION

The Black Creek Formation of Late Cretaceous age rests unconformably upon the basement rocks at Wilmington. Lower Cretaceous sediments and the Tuscaloosa Formation, prominent in other parts of the Coastal Plain, are not known to be present beneath New Hanover County (Brown, 1959a).

The Black Creek Formation is approximately 380 feet thick in New Hanover County. The upper and lower contacts were placed at 711 and 1,100 feet below sea level, respectively, in the Hilton Park well (well 202, see fig. 3), by T. W. Stanton (Clark and others, 1912). The top of the Black Creek was penetrated at 673 feet below mean sea level in the Murraysville test well (well 87) but was not reached in the Edwards test hole (well 347), which was drilled to a depth of 610 feet below sea level.

The Black Creek Formation is assumed to contain saline water everywhere beneath New Hanover County. Highly saline water was found in the Hilton Park well in all zones below 370 feet and in a well at Fort Caswell, Brunswick County, below 354 feet (Clark and others, 1912).

PEEDEE FORMATION

The Peedee Formation conformably overlies the Black Creek Formation in New Hanover County. It typically consists of unconsolidated greenish-gray to dark-gray silt, olive-green to gray sand, and massive black clay interbedded with consolidated calcareous sandstone and impure limestone. Glauconite gives the Peedee Formation its characteristic salt and pepper appearance. There appears to be an increase in sand and lime and a decrease in clay toward the top of the formation in New Hanover County.

The Peedee Formation in New Hanover County is 710 feet thick at well 202 and 645 feet thick at well 87, and contains four water-bearing beds of sand. The uppermost sand contains fresh water and the lower three contain brackish to saline water throughout the county. The general relationship of the Peedee Formation to the other formations in the county is illustrated in figures 4, 5, and 6. Figure 6 is a structure contour map of the top of the uppermost salt-water bearing sand. The top of the sand strikes N. 25° E. and dips toward the southeast at the rate of 10 feet per mile.

Figure 7 is a structure contour map of the top of a calcareous sandstone, the topmost sandstone in the Peedee Formation and the principal fresh-water aquifer in New Hanover County. It is discussed in a later section as the sandstone aquifer.

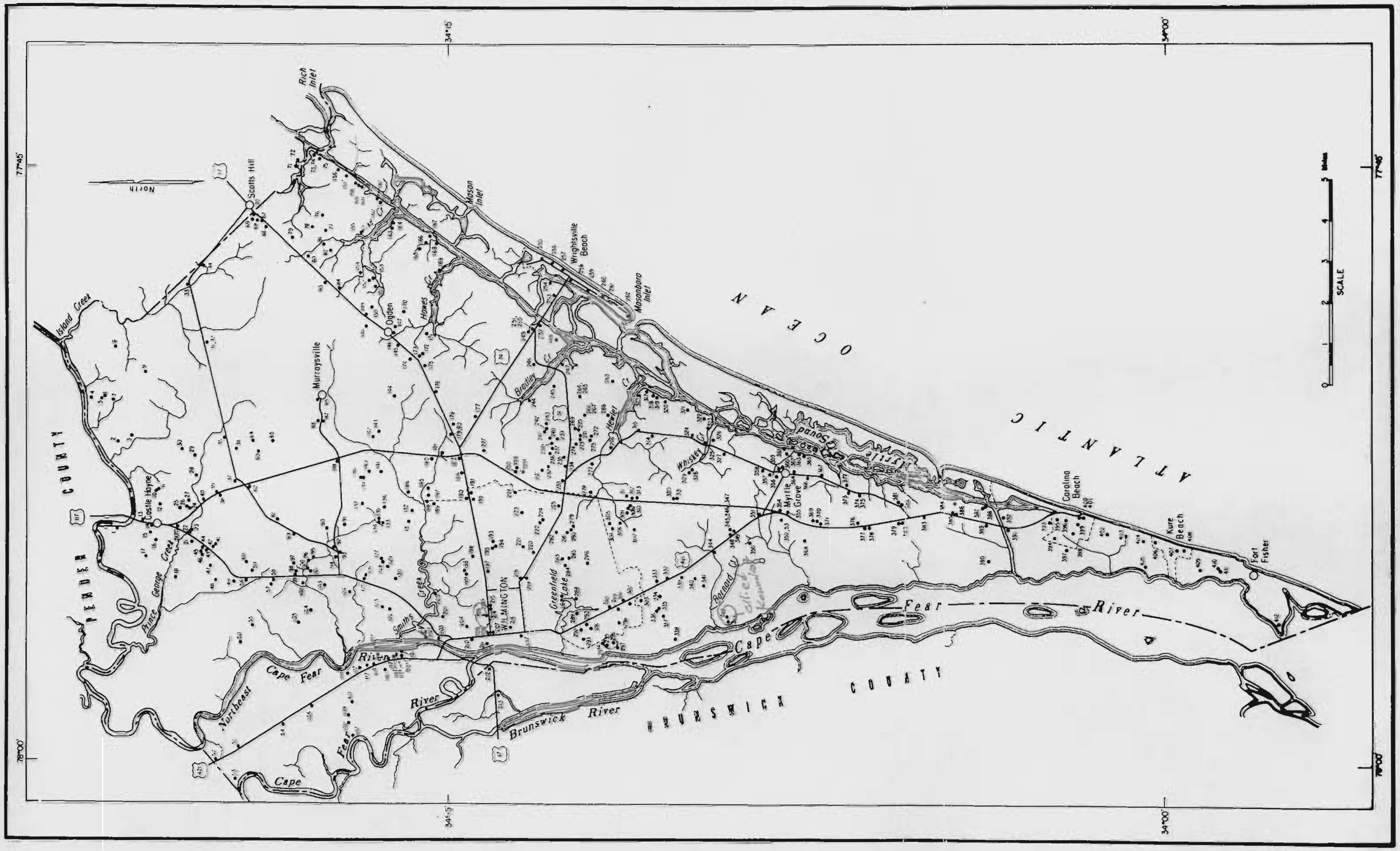


Figure 3.--Map showing the locations of selected wells.

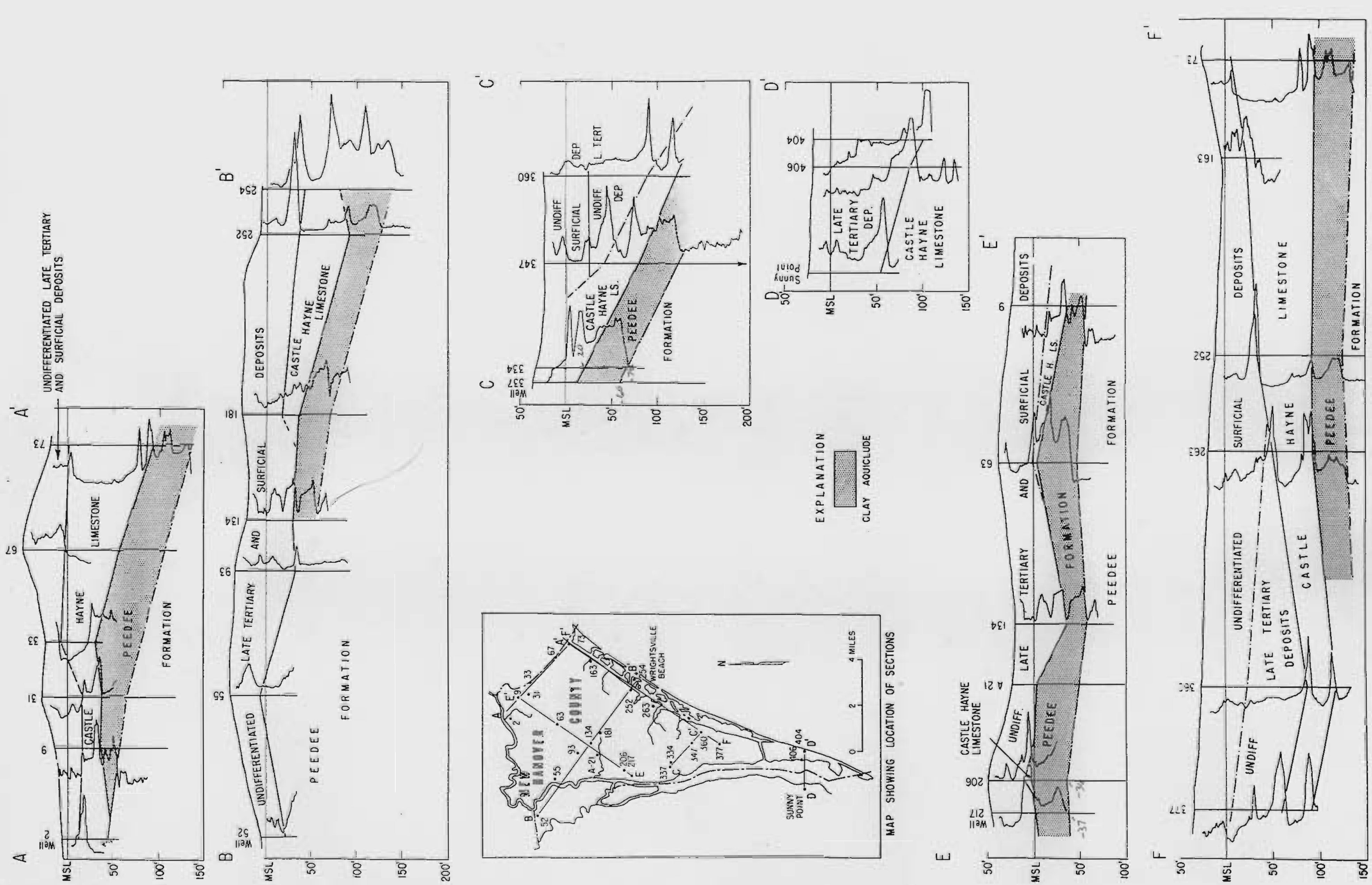


Figure 4.--Sections showing correlation of formations by gamma-ray logs.

1" = 142.8' VERT

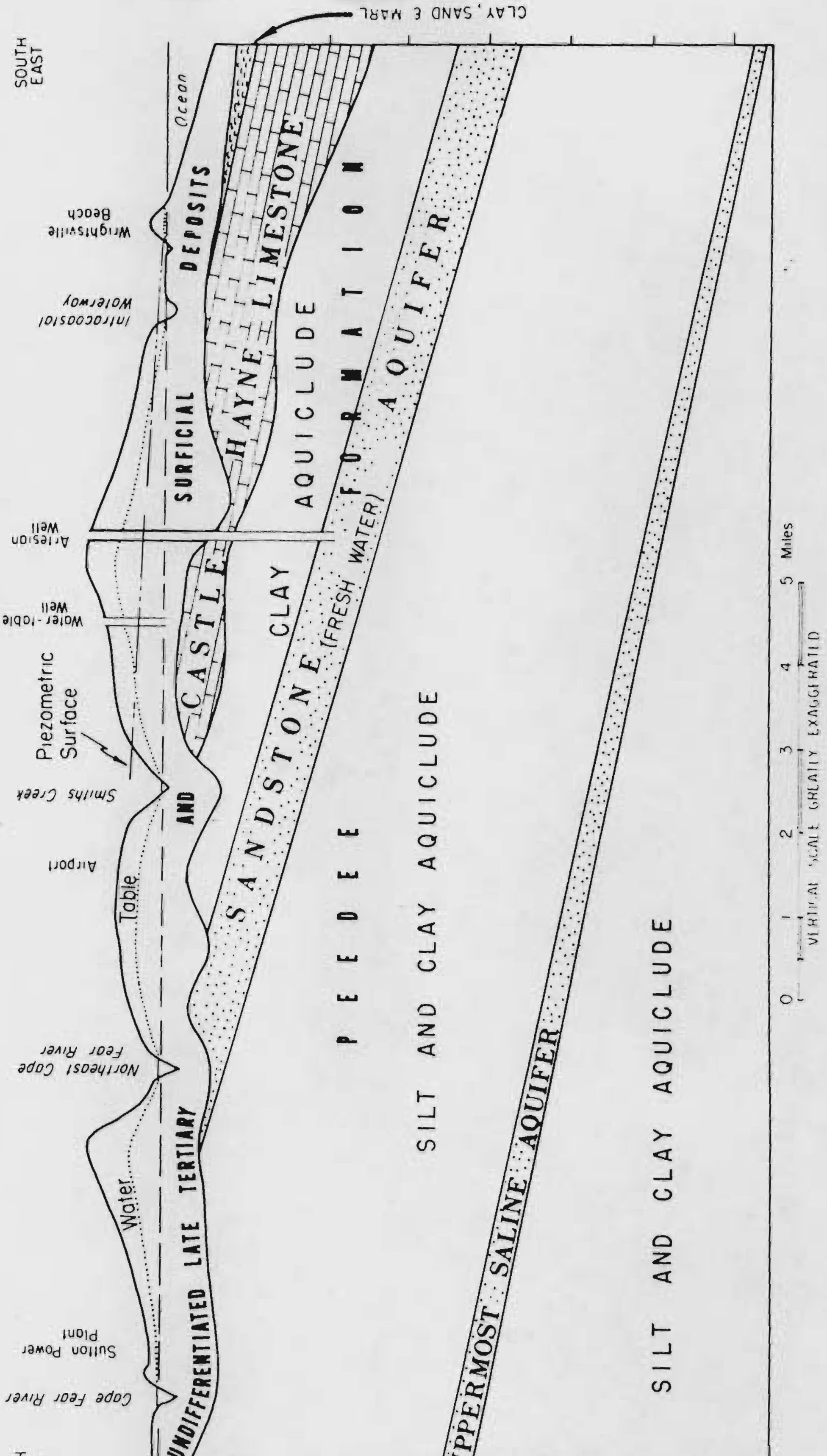
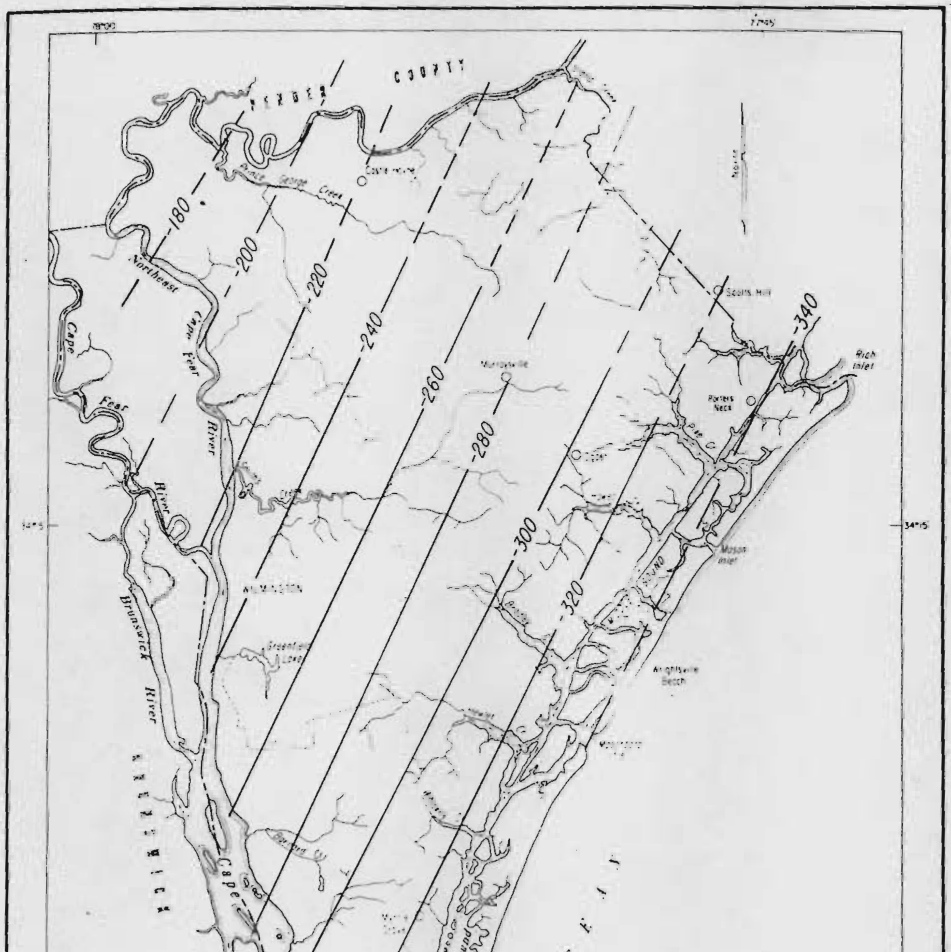


Figure 5.--Generalized diagram showing the relation of geologic conditions to the occurrence of fresh ground water.



gure 6.--Map showing the altitude of the top of the uppermost saline aquifer.

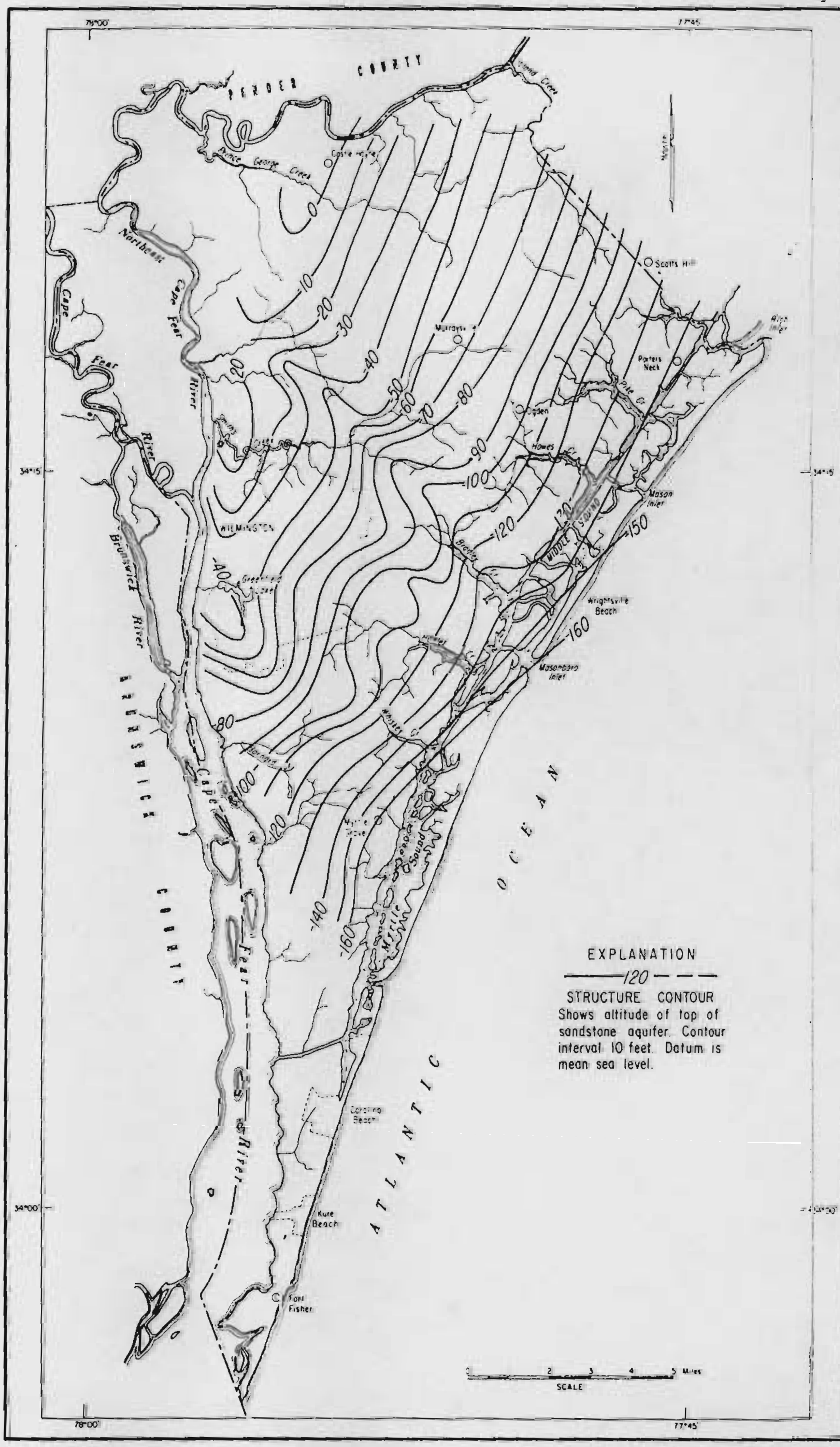


Figure 7.--Map showing the altitude of the top of the sandstone aquifer in the Peedee Formation.

All water below the altitudes shown on figure 6 is saline. All water in and above the sandstone shown in figure 7 is known to be fresh except that south of Myrtle Grove, where there are no data. Fresh water of unknown but probably limited extent and quantity was detected in well 87 in fine unconsolidated sand below the sandstone aquifer.

Figure 8 is an isopach map showing the distribution and thickness of the massive clay aquiclude lying between the calcareous sandstone and the top of the Peedee Formation. In effect, this figure shows the thickness of the impermeable beds lying between the sandstone aquifer and the Castle Hayne Limestone, the next higher aquifer.

TERTIARY SYSTEM

CASTLE HAYNE LIMESTONE

The Castle Hayne Limestone of middle and late Eocene age (LeGrand and Brown, 1955) was first described by Miller (Clark and others, 1912) at a quarry near the intersection of Prince George Creek and U. S. Highway 421 at the town of Castle Hayne. Rocks of Paleocene age were not deposited in the county because of erosion or nondeposition upon the elevated Cape Fear Arch. Thus, the Castle Hayne Limestone unconformably overlies the channeled and eroded upper surface of the Peedee Formation.

The Castle Hayne Limestone is quite variable lithologically, consisting of shell, marl, sand, and limestone. A complete geologic section in New Hanover County includes:

A. A basal sandy shell conglomerate containing much reworked material from the Peedee Formation. It is discontinuous in occurrence because it was deposited in channels on the top of the Peedee Formation. It is approximately 30 feet thick in the Superior Stone quarry near the town of Castle Hayne.

B. Above the basal shell-conglomerate is a glauconitic shell limestone. It is light-gray toward the top and yellow and dolomitic toward the bottom. In places it contains interbedded sand. Where the lower unit is missing the shell limestone facies rests unconformably upon the Peedee Formation. The glauconitic shell limestone thickens from a featheredge along its up-dip extremities to about 40 feet at the town of Wrightsville Beach and to more than 80 feet at the town of Carolina Beach.

C. The shell facies is overlain by a dense, chalk-white siliceous limestone that contains phosphate at its base. This limestone, called "cap rock," by local well drillers averages about 3 feet in thickness throughout the county.

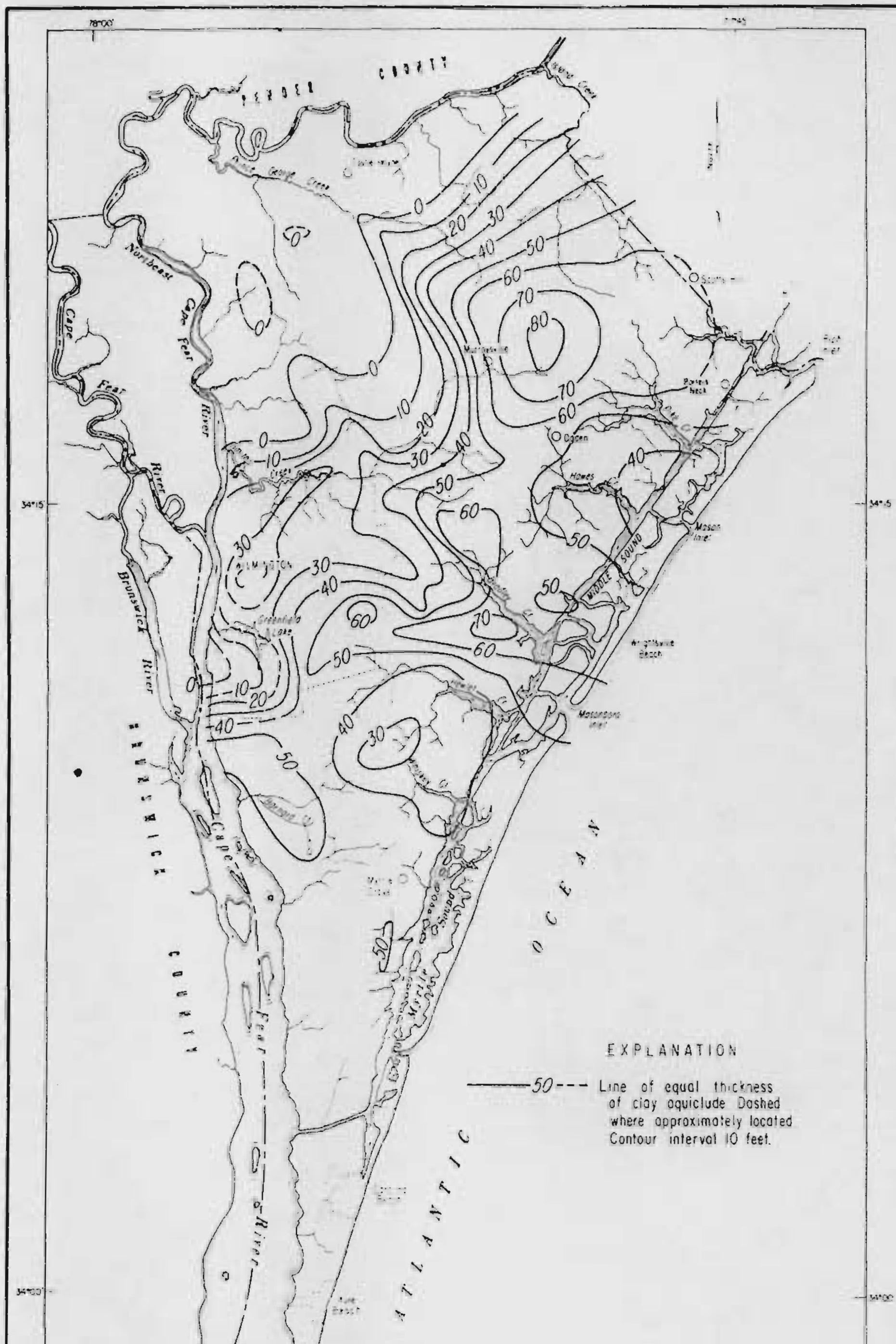


Figure 8.--Map showing thickness of the clay aquiclude in the Peedee Formatic

D. Overlying the "cap rock" is a cream to light-green, glauconitic, bryozoan-bearing "shell hash" (a coarse, braided mixture of shell fragments). This unit is generally confined to the northeastern section of the county north of a line connecting the city of Wilmington and Wrightsville Beach. South of this line the unit, if deposited, has apparently been removed by erosion. At the Ideal Cement Company quarry in the northern part of the county, where this unit is approximately 10 feet thick, it is mined for the manufacturing of cement. At Porters Neck crossroad it ranges from 55 to 80 feet thick.

The irregular distribution and thickness of the Castle Hayne Limestone (figs. 9 and 10) results from its deposition on an eroded surface of the Peedee Formation and from subsequent erosion and solution of the upper surface of the Castle Hayne. Areas in which the Castle Hayne Limestone is missing or spotty are also shown in figure 9.

The sandy, shell part of the Castle Hayne Limestone is generally a productive aquifer. Yields of individual wells in the county depend largely upon the degree to which the porosity and permeability have been increased by solution.

UNDIFFERENTIATED DEPOSITS OF LATE TERTIARY AGE

Overlying the Castle Hayne Limestone in the southern part of the county are sediments that probably range in age from late Oligocene through late Miocene. Most of the sediments in this late Tertiary sequence are phosphatic sands, silts and clays, and phosphatic limestones similar to materials in the Pungo River Formation described by Kimrey (1964) in Beaufort County, North Carolina. The upper part of the Pungo River Formation is equivalent in age to the Calvert Formation of Maryland (Brown, 1958b, p. 89) (Gibson, 1967, p. 636), which the U. S. Geological Survey currently recognizes as middle Miocene. The possibility that the lower part of the Pungo River is of early Miocene or late Oligocene has not been discounted (Brown, 1958b, p. 90) (Gibson, 1967, p. 637). According to Gibson (written communication, July 1, 1968), the sediments in southern New Hanover County "are in part facies equivalents of the phosphatic sands, limes, and diatomites of the Pungo River, but whether they belong lithologically and genetically is another question." Thus, the name Pungo River should not be applied to the deposits in New Hanover County although they are probably facies equivalents.

In the Carolina Beach area the above deposits consist chiefly of marl interbedded with light-green to dark-gray silty clay containing thin shell beds. The silty phase is replaced to the northwest by light-gray sand and sandy coquina overlain by olive-green sand. The sandy coquina, present in wells 368 and 381, is possibly of late Miocene age. Phosphate is present but is not known to be in sufficient quantities to warrant economic

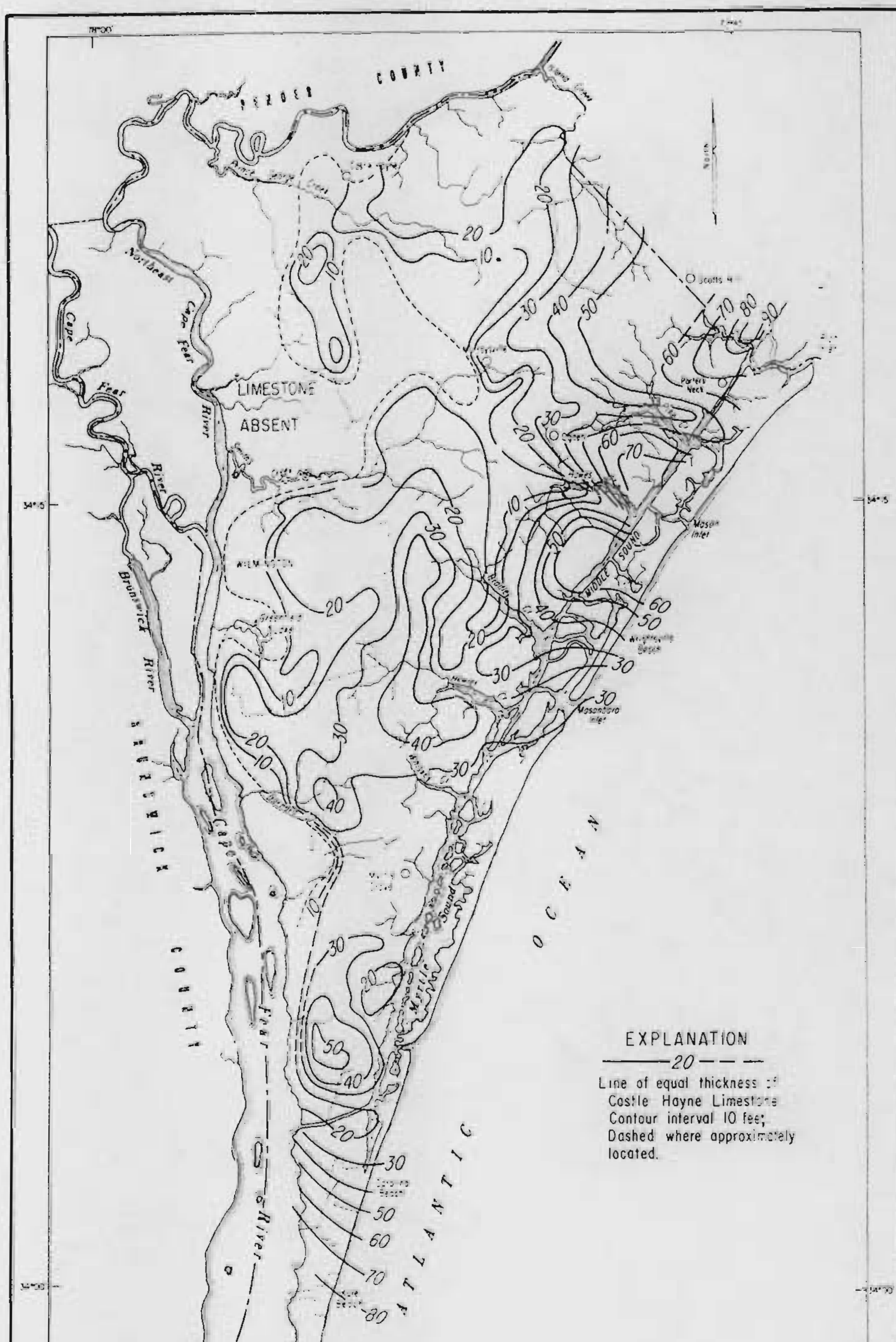


Figure 9.--Map showing thickness of the Castle Hayne Limestone.

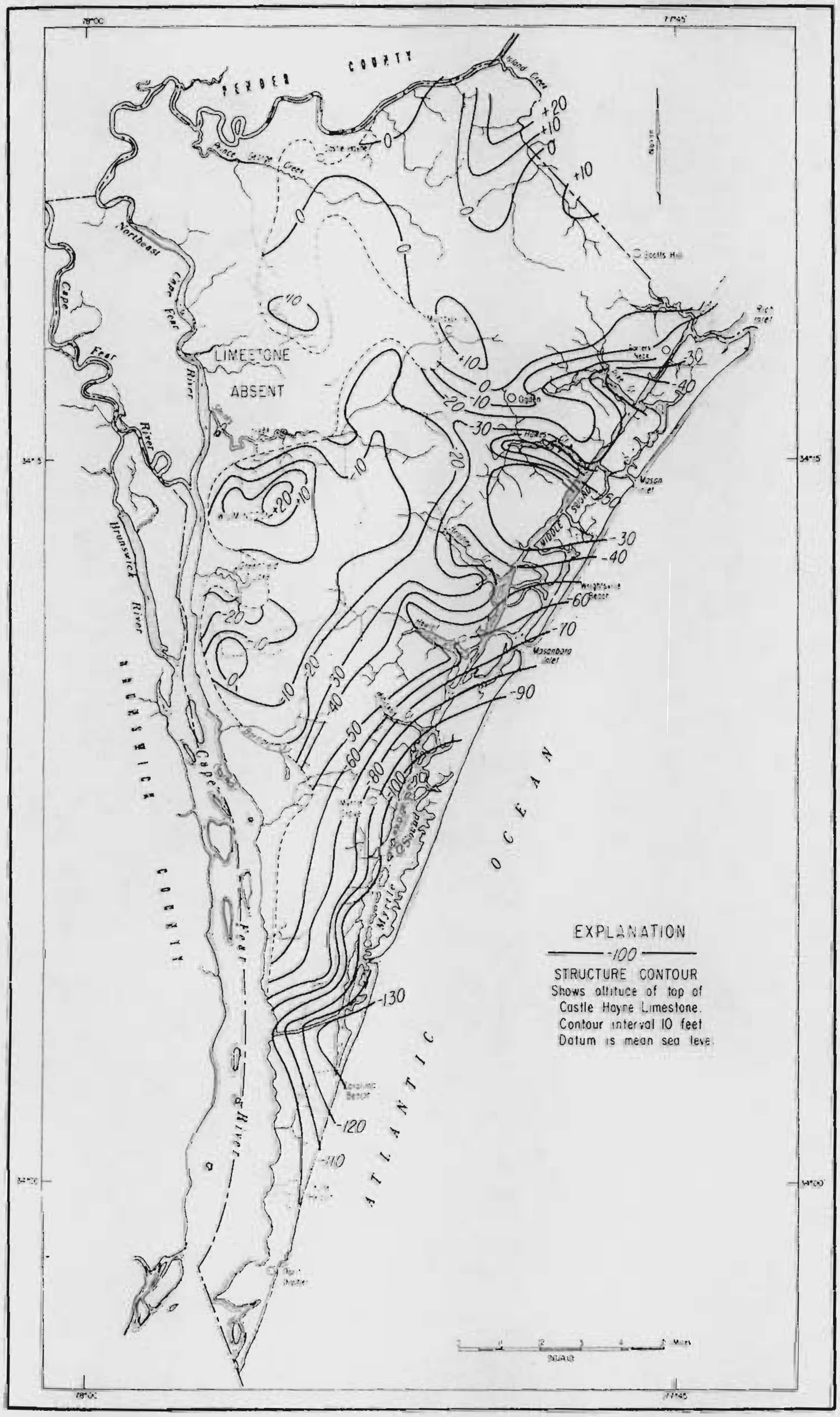


Figure 10.--Map showing altitude of the top of the Castle Hayne Limestone.

development. The lower silty part of the unit thickens southward from about 10 feet at Wrightsville Beach to 75 feet at well 394 at Carolina Beach and dips to the south-southeast and southeast at 10 to 25 feet per mile. It is overlain in the southeastern part of the county by 20 to 30 feet of fine- to medium-grained sand containing dark-gray to chocolate-brown clay beds that change southward to light-gray to olive-green clay and shell beds. This late Miocene unit is as much as 10 feet above sea level. In the north-central and northeastern sections of the county--10 to 20 feet of fine- to medium-grained sand containing a dark-gray to blue-gray clay is overlain by 5 to 20 feet of blue or gray dense clay of late Miocene age. The late Miocene clay occurs in a zone as much as 25 feet above sea level.

The silty part of the unit functions as a hydraulic barrier (aquiclude) between the overlying water-table aquifer and the underlying Castle Hayne aquifer near the seacoast.

Small to moderate water supplies are available from the sandy coquina, but only small supplies are available from the shallow sands and from the thin shell beds of this formation.

QUATERNARY SYSTEM

UNDIFFERENTIATED SURFACE DEPOSITS

Overlying the channeled surfaces of the formations previously described are deposits of clay, sand, and marl. Their age, thickness, and origin vary from one place to another. As used in this report the deposits include all of the sediments between land surface and the undifferentiated deposits of late Tertiary age. Thus, they include terraced and barrier-beach deposits, sandy coquinas (DuBar and Johnson, 1964), fossil sand dunes, stream channel deposits, and possibly thin and scattered remnants of the underlying formation. These sediments are absent in the towns of Castle Hayne and Wilmington where the underlying limestone is exposed, but are as much as 70 feet deep near the Cape Fear River west of Myrtle Grove.

Eastward from a line connecting Fort Fisher, Myrtle Grove, and Wrightsvi Beach, the base of these surficial sediments rests upon silt, clay, and shell beds of the underlying deposits of late Tertiary age. In the northwest one-third of the county they rest upon the Peedee Formation where the Castle Hayr Limestone is missing as shown in figure 10. Between the above areas they res upon the Castle Hayne Limestone.

The surficial sediments may be divided into the following oversimplifiec or generalized categories:

1. In the central and western parts of the county, 0 to 35 feet of coarse, clean, nonfossiliferous quartz sand generally from 0 to 30 feet below sea level. Reference to figures 10 and 11 shows that the coarse sand occurs where the Castle Hayne is missing, or more specifically, in

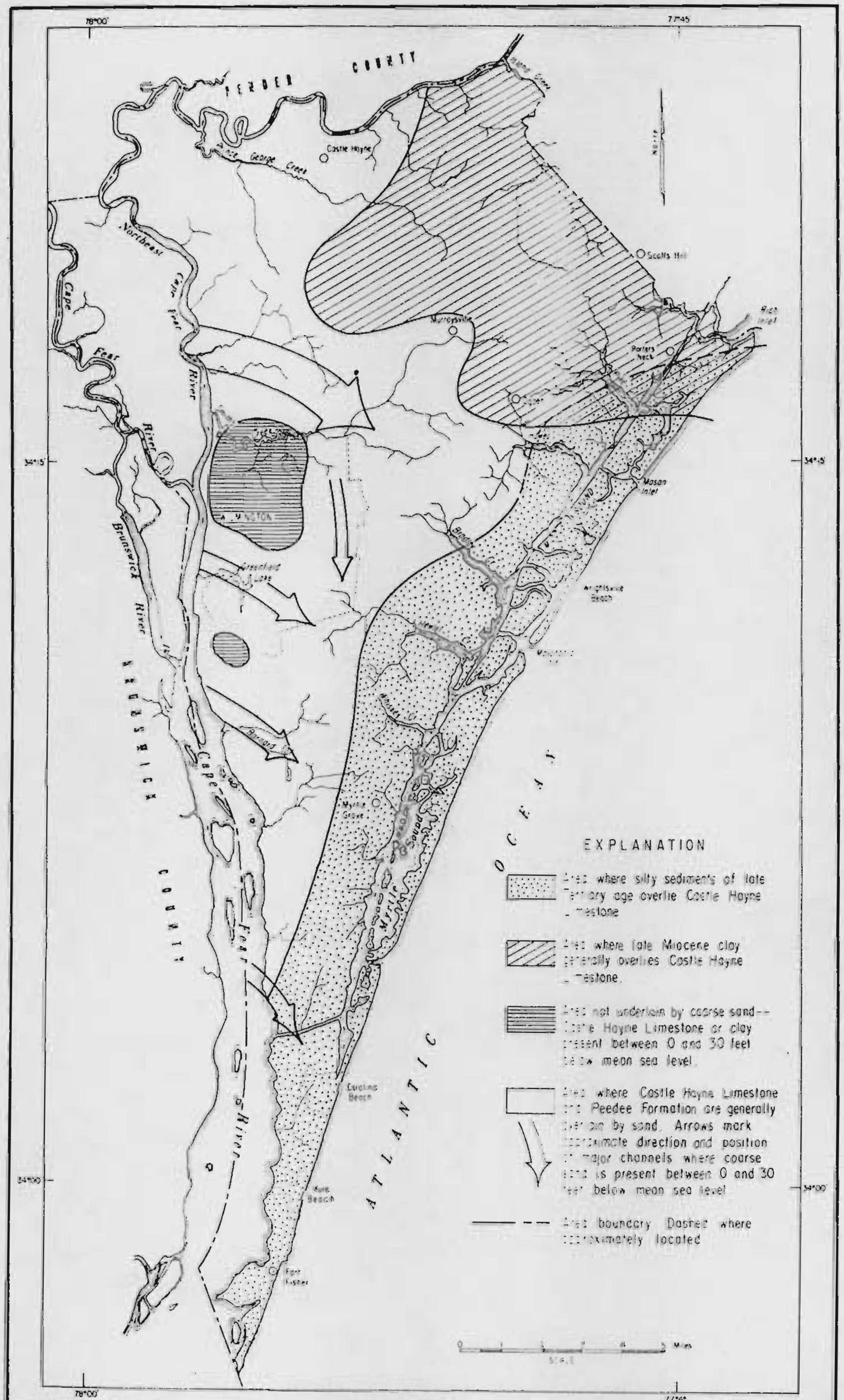


Figure 11.--Map showing the geographic distribution of Miocene clay and sand and Pleistocene(?) coarse sand.

channels cut into the surfaces of the Peedee and Castle Hayne Formations. Although there is no direct evidence, the sand is probably of Pleistocene age.

2. Throughout the county 0 to 60 feet of fine- to medium-grained Pleistocene sand tend to cover underlying clays and sands. The sandy veneer includes the commonplace surface sand and the fossil dunes and beach bars. Where swampy the sand is dark brown or black with humic material, and where well drained it is tan to gray white. Sandy coquina and marl beds occur at shallow depths in the sand along the present-day coast and mark the sites of Pleistocene beaches and inlets. As much as 20 feet of red clay and sandy clay overlie the Castle Hayne Limestone along Middle and Topsail Sounds. At a few isolated spots the surface material is a weathered product of the Castle Hayne Limestone or Peedee Formation.

The occurrence and distribution of the above sands and clays affect the water yield potential of various parts of the county. Moderate to large yields are available from these deposits northwest of Wilmington and south and southeast of Greenfield Lake where coarse sand is overlain by thick and extensive fossil dune deposits. Although the water in such deposits is acidic, iron and hydrogen sulfide are negligible. Small yields are available for domestic and small irrigation supplies from the finer grained and shallower surface sands throughout the county.

HYDROLOGY

GENERAL STATEMENT

The earth's vast but fixed supply of water is kept in endless circulation by energy supplied from the sun. Water evaporates from the oceans, lakes, streams, and land surfaces and is carried in the atmosphere as water vapor until it condenses and falls as precipitation. Part of the precipitation flows overland as surface runoff, a part is returned directly to the atmosphere by evaporation, a part is transpired by plants, and the remaining part enters the ground from which it eventually discharges to streams or to the coast.

Ground water occurs in the spaces between the rock particles in the zone of saturation. Where the spaces are interconnected and large enough to permit flow through them the rocks will yield water to wells. Rock units that yield water to wells are called aquifers. In New Hanover County two types of spaces that transmit and store water are: (1) the openings between the sand grains; and (2) the larger interconnected openings, created by solution of some of the calcareous cement and shell material from the limestone and shell beds. Interbedded clay sediments contain numerous pore spaces, but the pores are extremely small and the yield to wells is so small that they are not considered to be aquifers.

Ground water not evaporated to the atmosphere or transpired by vegetation is eventually discharged to the streams or to the ocean. The discharge of ground water is facilitated where streams have incised their channels into, or below, the water table. The discharge of water as springs or seeps in such topographically low places creates a significant difference in hydrostatic head between the water level in the interstream and stream areas. New Hanover County is essentially a peninsula; thus the Northeast Cape Fear and the Cape Fear Rivers serve as diffuse discharge lines along the west boundary and the coast serves the same purpose along the east boundary. The upward movement through the confining beds occurs over large areas, and through the geologic ages it has been sufficient to cause partial flushing of the original connate sea water from the aquifers.

The uppermost water-bearing unit includes the surface sand that covers most of the county to depths of 50 feet or more in places. The lower part of the surface material is saturated with water; in the upper part the water is moving downward in response to gravity. The upper surface of the saturated zone is called the water table.

All of the sediments below the water table are saturated, not only in the surface sand, but also in the underlying limestone, clay, and sand. Where beds of clay and silt (aquicludes) are impermeable enough to retard the movement of water, the water in the underlying beds of limestone and sand is confined under hydraulic pressure and is called artesian water. The height to which artesian water will rise in wells forms an imaginary surface called the piezometric surface.

Artesian water moves to discharge areas in many places along the major streams and the coast. The rate of water movement from areas of recharge to areas of discharge ranges from a few feet to as much as a few hundred feet per year.

The aquifers in New Hanover County are recharged by local rainfall. Areas of significant recharge are identified on the maps showing the piezometric surfaces as the areas having higher water levels, and on the water quality maps as the areas of lower chloride and of higher iron and hardness values. These are in the interstream areas where the topography is relatively high. Conditions for recharge are excellent in New Hanover County because most of the areas are underlain by sand.

AQUIFER CHARACTERISTICS

The quantity of water that an aquifer can hold in storage is governed by its porosity. Porosity is the ratio of volume of pore space or interstices to the total volume of the rock material and is usually expressed as a percentage. Clean, well-sorted sand may have an initial porosity as high as 40 percent, but during its transformation into a sandstone the porosity may be reduced by compaction and cementation to less than 10 percent. Clay may have a porosity of 50 percent, but because of the minute size of its pores, a large percentage of the water stored in clay is retained by molecular attraction. Consequently, clays and clayey sediments act as aquicludes and tend to retard water movement.

The permeability of an aquifer is a measure of its ability to transmit water in response to gravity or to differences in hydrostatic pressure. It is governed by the size and shape of pore spaces and the degree to which these spaces are interconnected. A rock unit that is nonporous is also impermeable. However, water may be yielded freely from rocks of low porosity if the pores are interconnected and are large enough to freely transmit water. In New Hanover County, the removal of cementing material from the calcareous sandstones and limestones by solution has increased the effective porosity and permeability of these rocks, thus increasing their water-bearing potential.

The water level in an unpumped well is referred to as the "static" water level. Withdrawal of water from a well creates a difference in head between the water in the well and that in the surrounding aquifer with the result that water flows toward the well. The surface of the water around the well assumes the shape of an inverted cone (cone of depression) whose apex is at the well. (See fig. 12.) The vertical distance between the static water level and the pumping level is called the drawdown. The area in which water levels are lowered by the pumping of a well is termed the area of influence.

The coefficient of transmissibility is the quantity of water, in gallons per day, that will move through a vertical section of an aquifer 1-foot wide and extending to its full saturated thickness under a hydraulic gradient of 1 foot per foot at the prevailing water temperature. The coefficient of storage is a measure of the volume of water that an aquifer releases from or takes into storage under a unit surface area by a unit change in head.

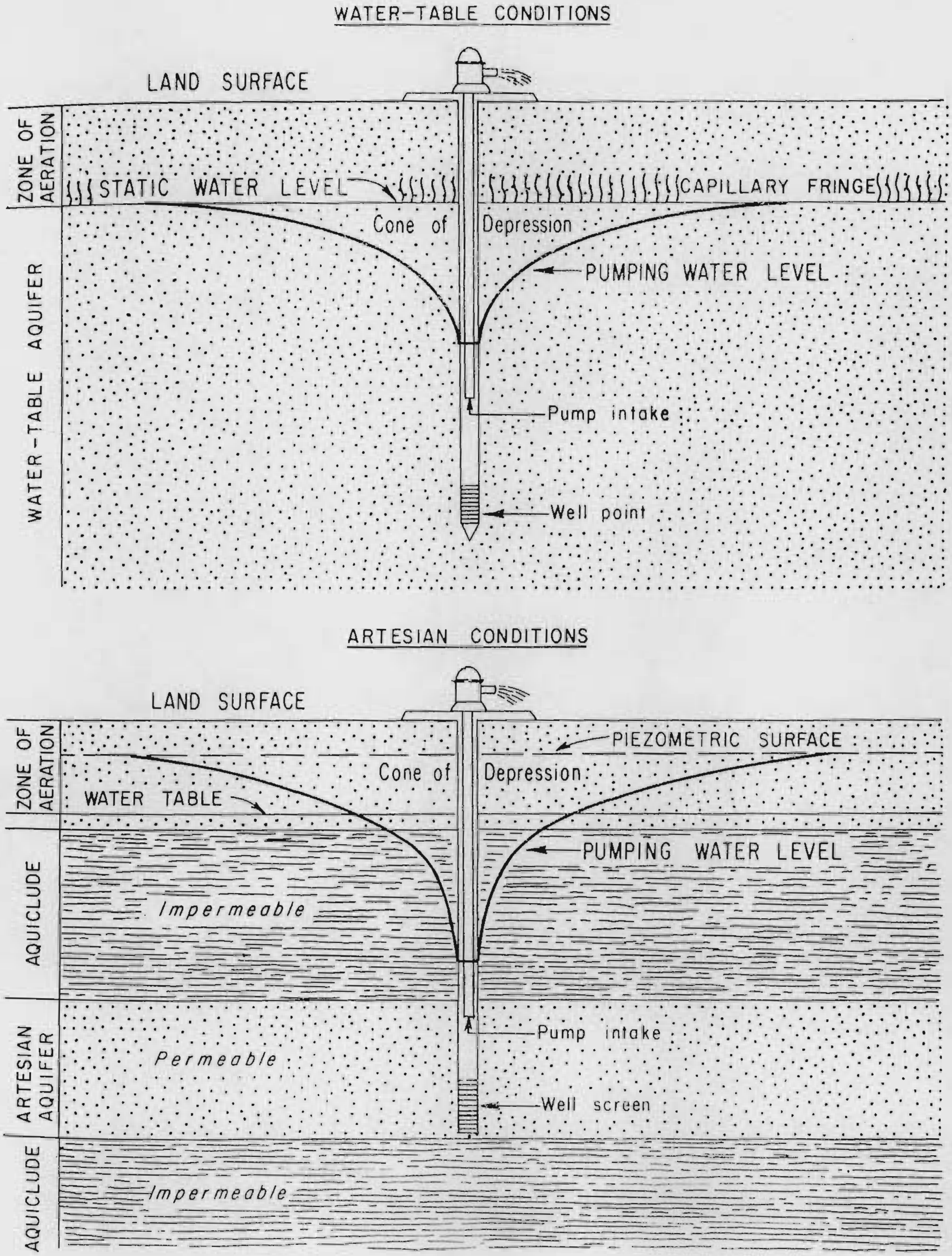


Figure 12.--Diagrammatic sections showing the effect of pumping on the water table and the piezometric surface.

The shape, size, and rate of growth of the cone of depression (and thus the yield of the well) are controlled by the transmissibility and storage coefficients of the aquifer and the rate and duration of pumping.

The specific capacity of a well is the quantity of water in gallons per minute (gpm) that a well yields for each foot of drawdown in water level after a given period of continuous pumping. The theoretical specific capacity can be calculated from the transmissibility and storage coefficients of the aquifer. The actual specific capacity is found by dividing the yield in gallons per minute by the number of feet of drawdown. Comparison of the theoretical and actual specific capacities is useful in determining the efficiency of a well.

AQUIFERS CONTAINING FRESH WATER

The deposits underlying New Hanover County may be grouped according to their ability to transmit water. The productive zones are termed aquifers, and the relatively nonproductive zones are termed aquicludes. One objective of the study was to identify and map the productive zones.

The chief fresh-water-bearing zones or aquifers in New Hanover County are: an indurated calcareous sand in the upper part of the Peedee Formation, a sandy limestone in the Castle Hayne Limestone, and beds of sand and some coquina in deposits younger than the Castle Hayne at the land surface.

Peedee Formation

The lowermost productive zone is a bed of sand in the upper part of the Peedee Formation (see fig. 7). This zone is about 35 feet thick in most of the county except where it has been partly or entirely removed by erosion; it dips to the southeast at about 14 feet per mile. It consists of quartz sand which is usually indurated with calcareous cement and is underlain by an aquiclude about 150 feet thick consisting of very fine sand and clay. Water in this zone is under artesian pressure throughout most of the county. The permeability of this sand has been increased by solution of its calcareous cement in an area that lies generally northwest of U. S. Route 17. The specific capacities of wells in this area range from 20 to 75 gpm per foot of drawdown, whereas they range from 1 to 7 gpm per foot in the eastern part of the county.

Many of the wells that tap this productive zone in the Peedee Formation are of the open-hole type, the casing being set in sandstone or on the overlying limestone. These wells are developed by using compressed air to remove loose sand, silt, and clay.

The zone is generally 10 to 25 feet below land surface in the northwestern part of the county but is more than 150 feet below land surface along the Atlantic coast. It is overlain by a clay bed that ranges in thickness from only a few feet to more than 50 feet in places. The clay bed retards the movement of water both into and out of the sand. The piezometric surface (fig. 13) is highest in the interstream areas in the central part of the county. These are the areas in which the sandstone aquifer is recharged.

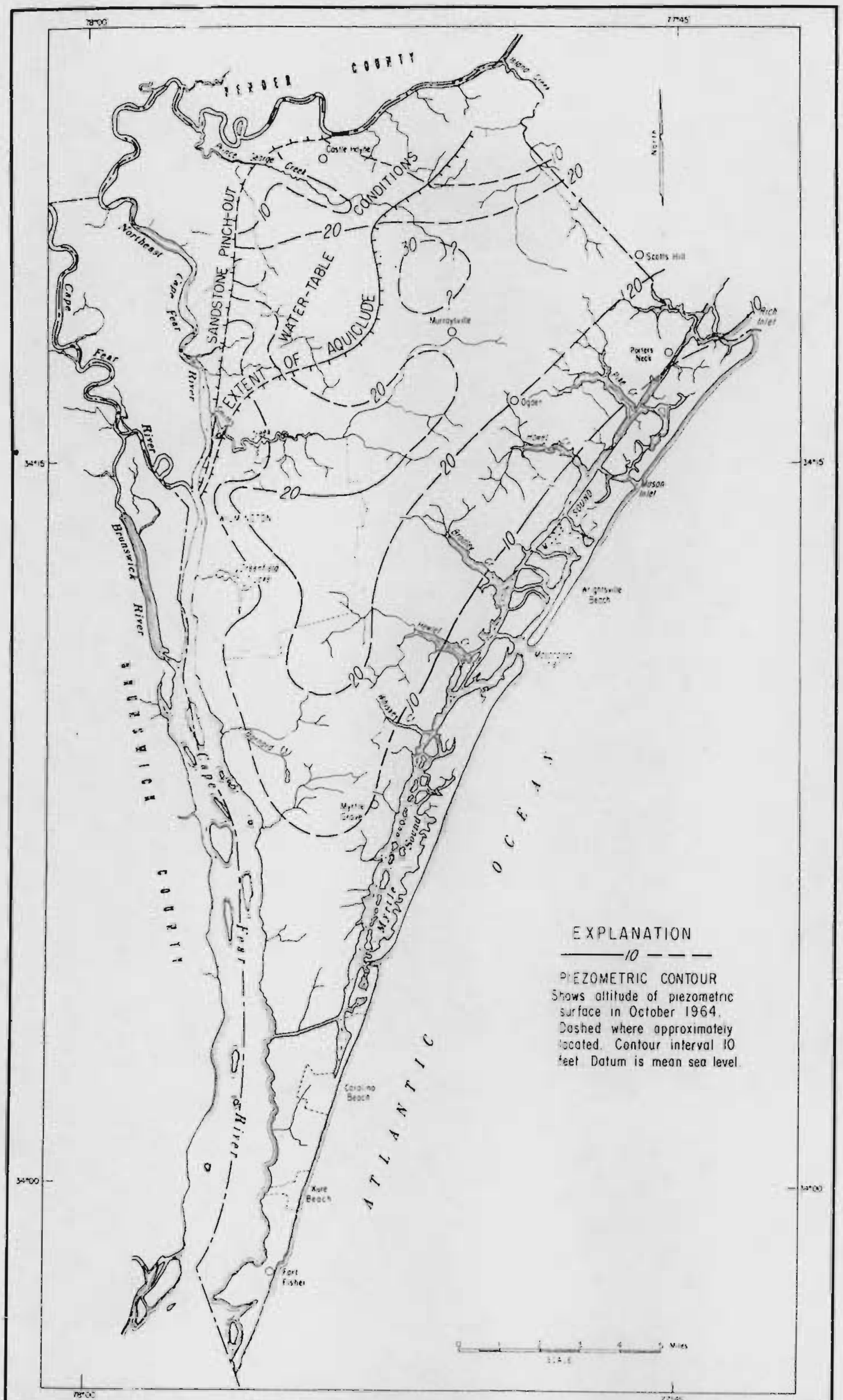


Figure 13.--Map showing the piezometric surface of the sandstone aquifer in the Peedee Formation.

This recharge occurs as water moves downward from the overlying beds. The natural discharge from the sandstone aquifer is in the major stream valleys and upward through the overlying beds along the coast.

The quality of the water from the sand in the Peedee Formation is acceptable for most uses. The hardness ranges from less than 60 mg/l (milligrams per liter) to more than 200 mg/l (fig. 14), the higher values being in the northern half of the county where the sandstone aquifer shows the greatest degree of calcium carbonate concentration. Figure 15 shows that the chloride content generally ranges from 5 to about 200 mg/l. Note that the chloride map roughly outlines the areas of recharge and discharge. The area surrounded by the 20 mg/l chloride contour approximates the area in which the Peedee sandstone aquifer is receiving recharge, and the area outside of this contour is approximately the area of discharge. The iron content in samples analyzed ranges from 0.01 mg/l to 3.0 mg/l in areas of effective recharge (fig. 16).

Castle Hayne Limestone

The Castle Hayne Limestone overlies the Peedee Formation and is a productive aquifer in much of the county. The limestone is absent in an area west and northwest of Wilmington but in other parts of the county it thickens toward the southeast. It is predominantly a sandy shell limestone, but in some places it is a hard limestone. The Castle Hayne is readily identified from well-cuttings, as it is an indurated light-colored fossiliferous limestone. Although it contains some relatively impermeable beds of marl or dense limestone, much of it is highly permeable; the permeability resulting from solution of the rock by circulating ground water (LeGrand, 1960, p. 17-18) (Mundorff, 1945, p. 50).

In the southern part of the county beds of sandy coquina and clay, probably of Miocene age, overlie the Castle Hayne Limestone. The sandy coquina yields some water to wells and probably forms a single hydrologic unit with the Castle Hayne.

Where the Castle Hayne Limestone is present in the northern part of the county, it lies near the land surface, but is more than 100 feet deep in the southern part. The thickness of the Castle Hayne varies greatly from one place to another, being generally less than 50 feet in much of the county and more than 100 feet in the southern part (fig. 9).

The water-bearing characteristics of the Castle Hayne are variable from place to place, depending on the thickness and permeability. The specific capacities of wells tested range from 4 to more than 50 gpm per foot of drawdown. The highest yields obtained from the Castle Hayne Limestone are in the area between U. S. Highway 17 and Wrightsville Beach. The water in the Castle Hayne occurs under water-table conditions in the northern part of the county. Elsewhere, however, the water may be confined beneath clay beds. Wells generally tap only the Castle Hayne in the southern part of the county where the limestone is thickest, but in the northern part, where it is thinner, the wells also generally tap both the Castle Hayne and the sand in the Peedee Formation.

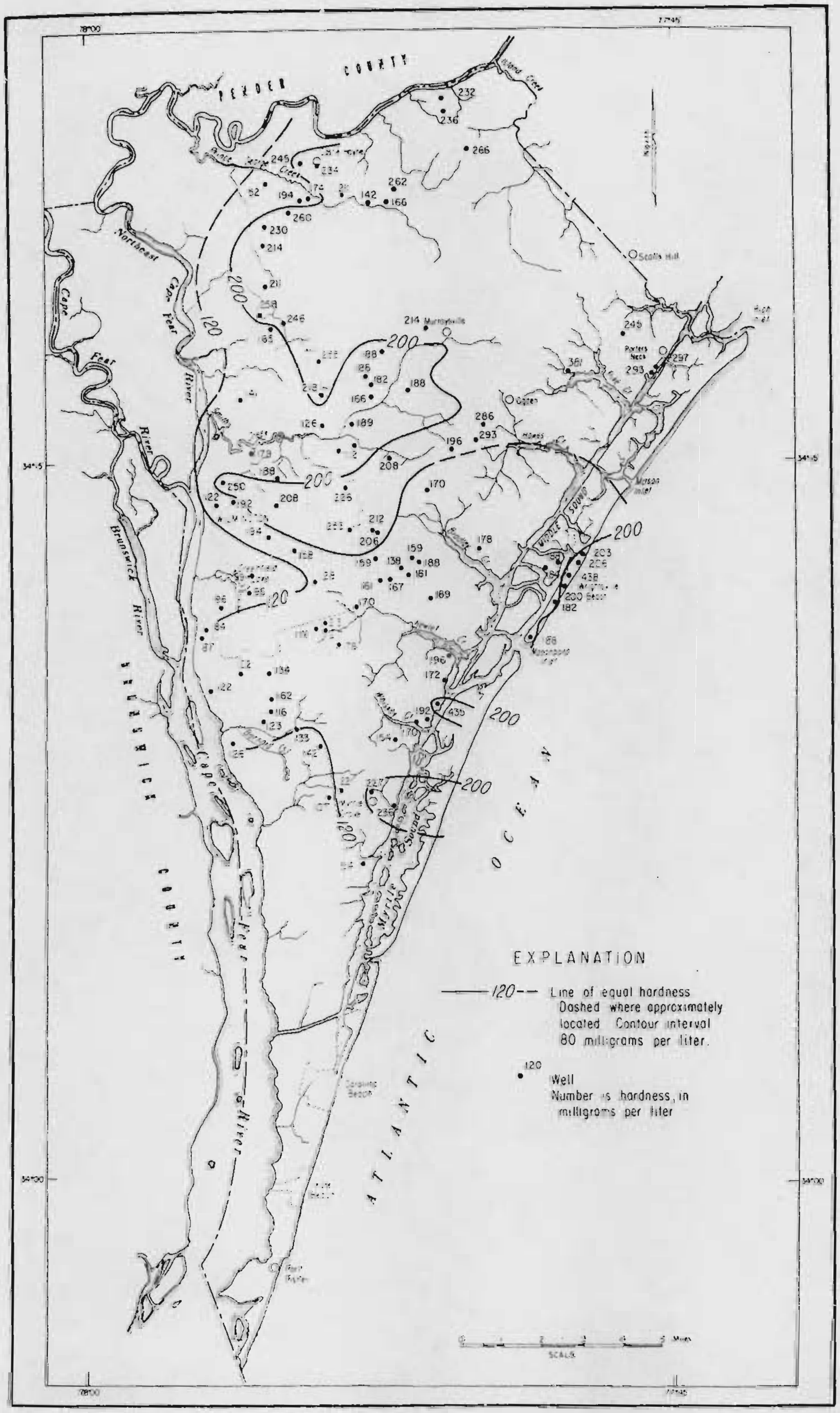


Figure 14.--Map showing the hardness of water in the sandstone aquifer in the Peedee Formation.

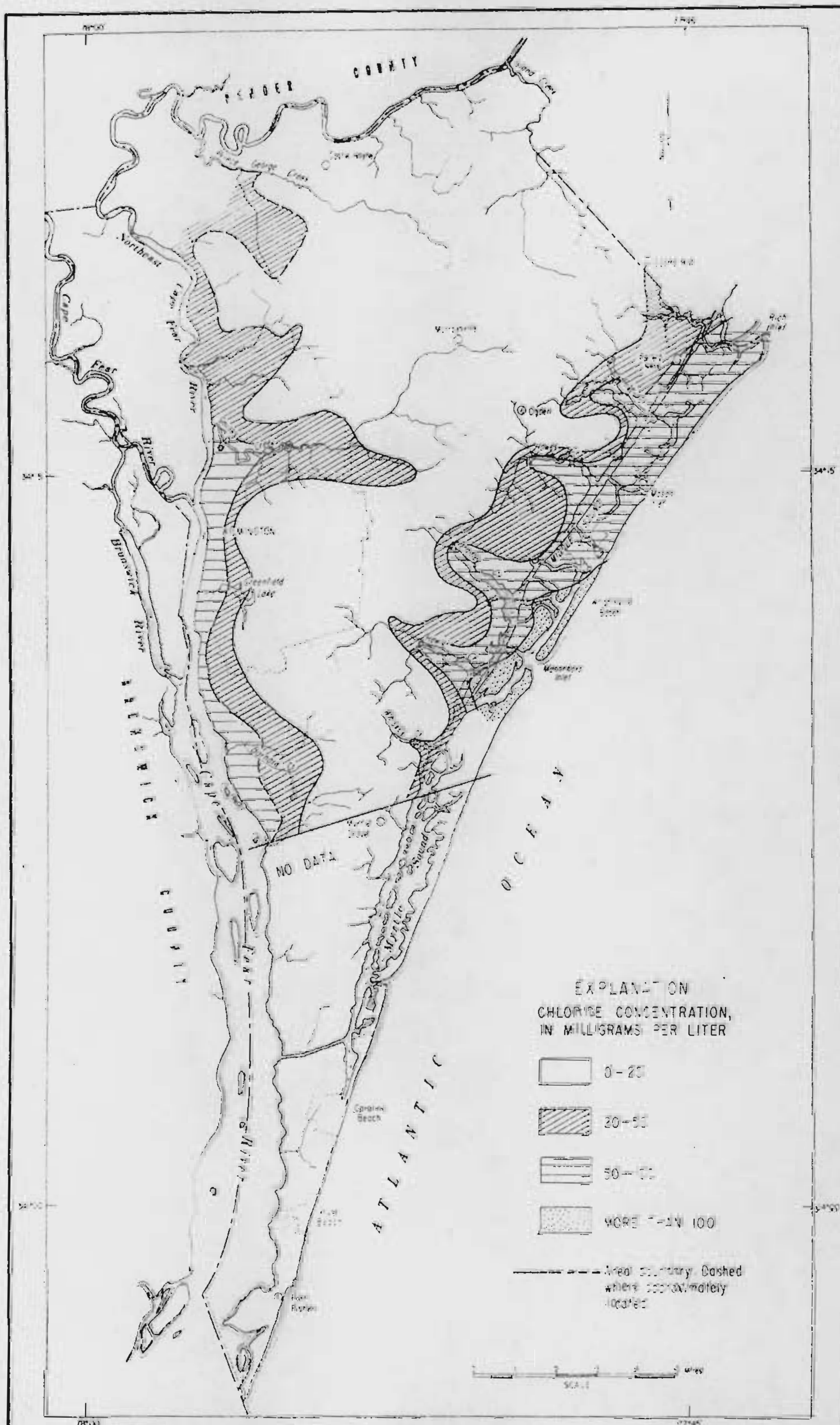
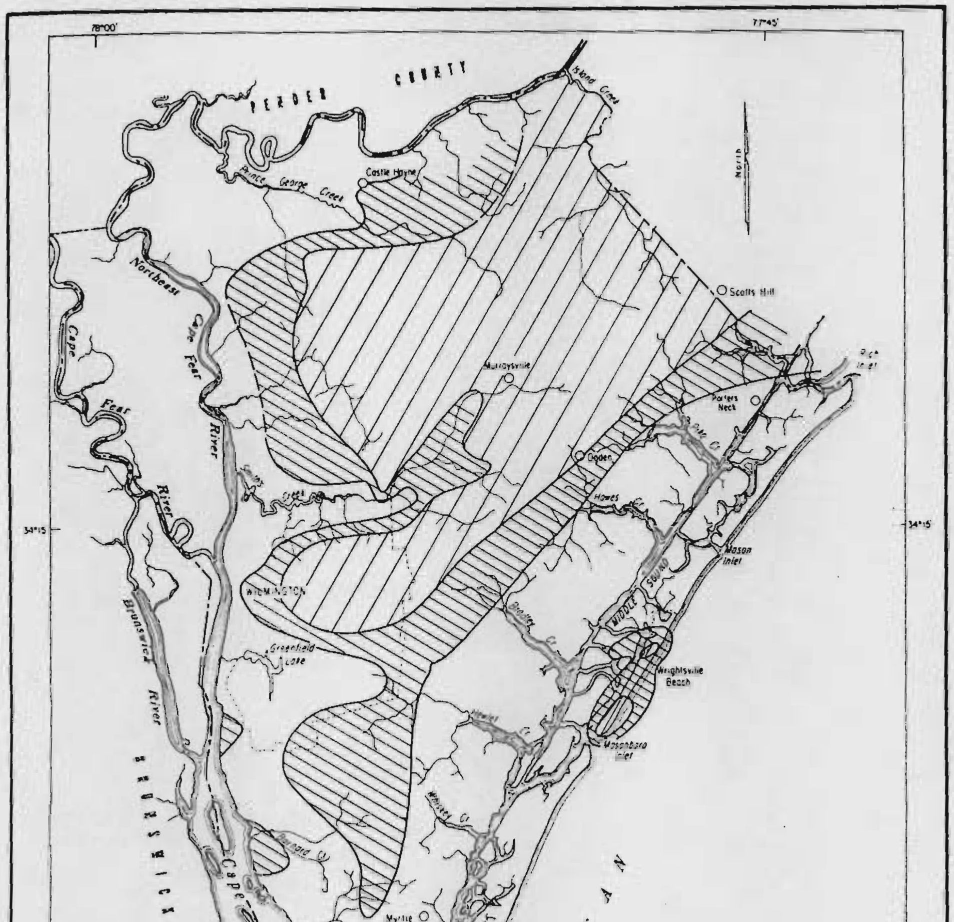


Figure 15.--Map showing the concentration of chloride in water of the sandstone aquifer in the Peedee Formation.



ure 16.--Map showing the concentration of iron in water of the sandstone aquifer in the Peedee Formation.

Many wells penetrating the Castle Hayne are of the open-end type, the casing being set near the top of the formation in hard limestone. A few unscreened wells have been noted to yield water containing coarse quartz sand and fine gravel from the upper part of the formation, probably from sand-filled solution channels or cavities in the weathered surface.

The water levels in the limestone (fig. 17) are highest in the interstream areas, indicating that the formation is recharged locally; water levels are lowest in the major stream valleys and along the Atlantic coast where natural discharge takes place. Recharge of the limestone is facilitated in the northeastern part of the county where the limestone is shallow and where it is overlain by flat-lying sandy material into which precipitation readily infiltrates.

The quality of the water in the Castle Hayne Limestone is acceptable for most uses. The iron concentration of water samples analyzed ranges from 0.1 to 12 mg/l (fig. 18) and in general decreased from areas of recharge toward areas of discharge. The chloride content of the water generally is low except along the Atlantic coast where there may be leakage of sea water into the limestone. Figure 18 also shows that the chloride concentrations increase in the areas of discharge--creeks, sounds, and inlets--and are greatest along the coast from Wrightsville Beach northward. The water is moderately hard (61 - 120 mg/l) to very hard (more than 200 mg/l).

Undifferentiated deposits of late Tertiary age

Southwest of Wrightsville Beach the Castle Hayne is overlain by an aquiclude of calcareous clays, sands, and silts containing thin shell beds. This marly sequence thickens southward from Wrightsville Beach and Barnard Creek toward Carolina Beach where it is about 75 feet thick. Only very small supplies are available from the thin shell beds and cleaner shallow sands of this unit. Locally sandy coquina of irregular distribution forms a minor aquifer at or near the top of the above sequence. Specific capacities of two wells in sandy coquina (table 1) were 2.6 gpm per foot of drawdown for well 368 and 6 gpm per foot of drawdown for well 381. In four wells for which quality of water data are available, the iron concentration ranged from 0.3 to 3.1 mg/l, the chloride concentration ranged from 5 to 22 mg/l, and the total hardness ranged from 84 to 278 mg/l.

Undifferentiated surface deposits

The slightly inclined rock units previously described are overlain at the surface by beds of sand, clay, and marl. Such surficial deposits include terraced materials and related beach sands, the present day beaches, sandy coquina beds marking Pleistocene beaches and inlets, high fossil sand dunes along U. S. Highway 421 from the Pender County line to Carolina Beach, Pleistocene stream channels filled with coarse sand, and silty interstream deposits. The surface material throughout almost all the area contains the uppermost ground-water body.

The water in the surface material is under water-table conditions throughout the county. The configuration of the water table approximates the topography of the land surface.

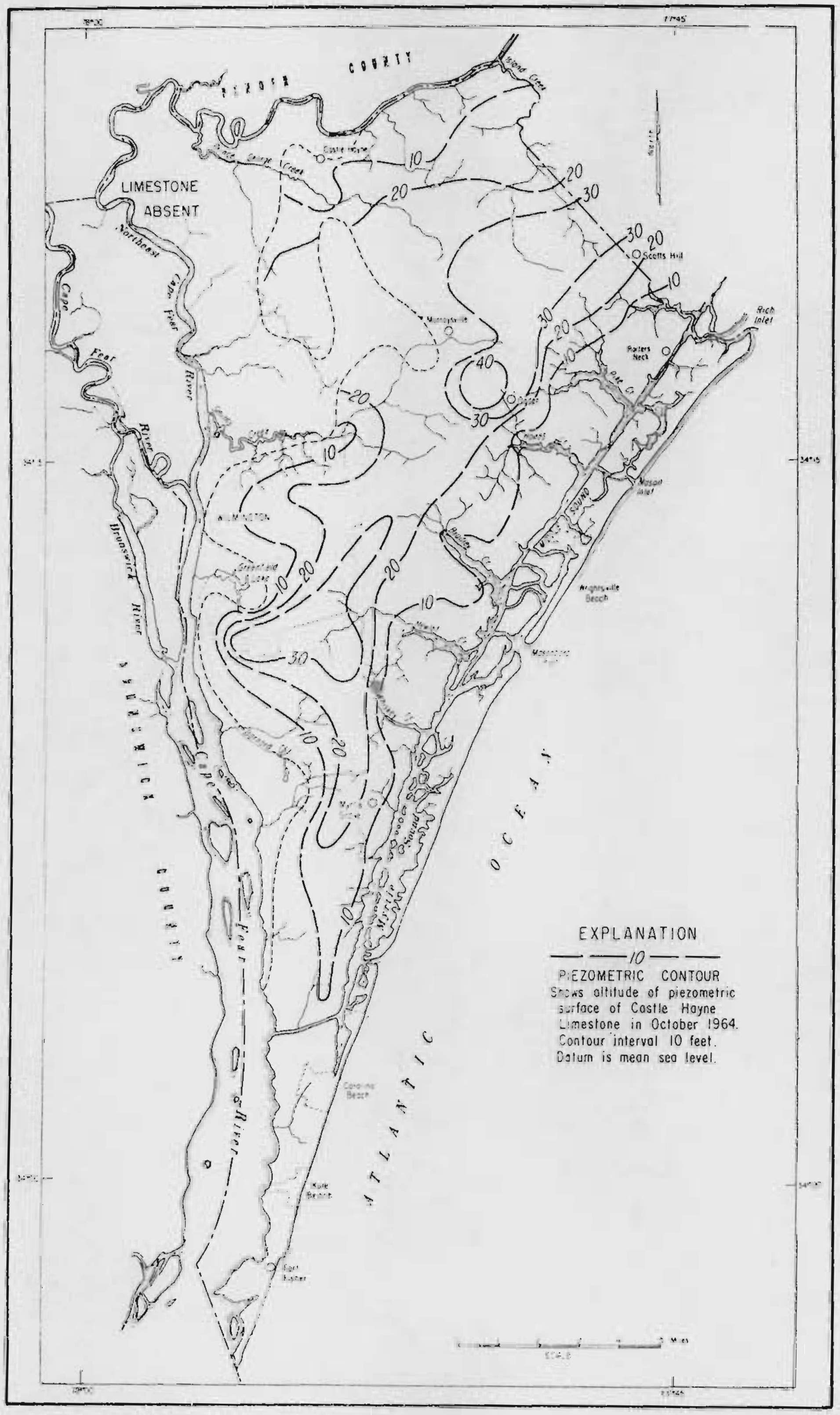


Figure 17.--Map showing the altitude of the water level in wells penetrating the Castle Hayne Limestone.

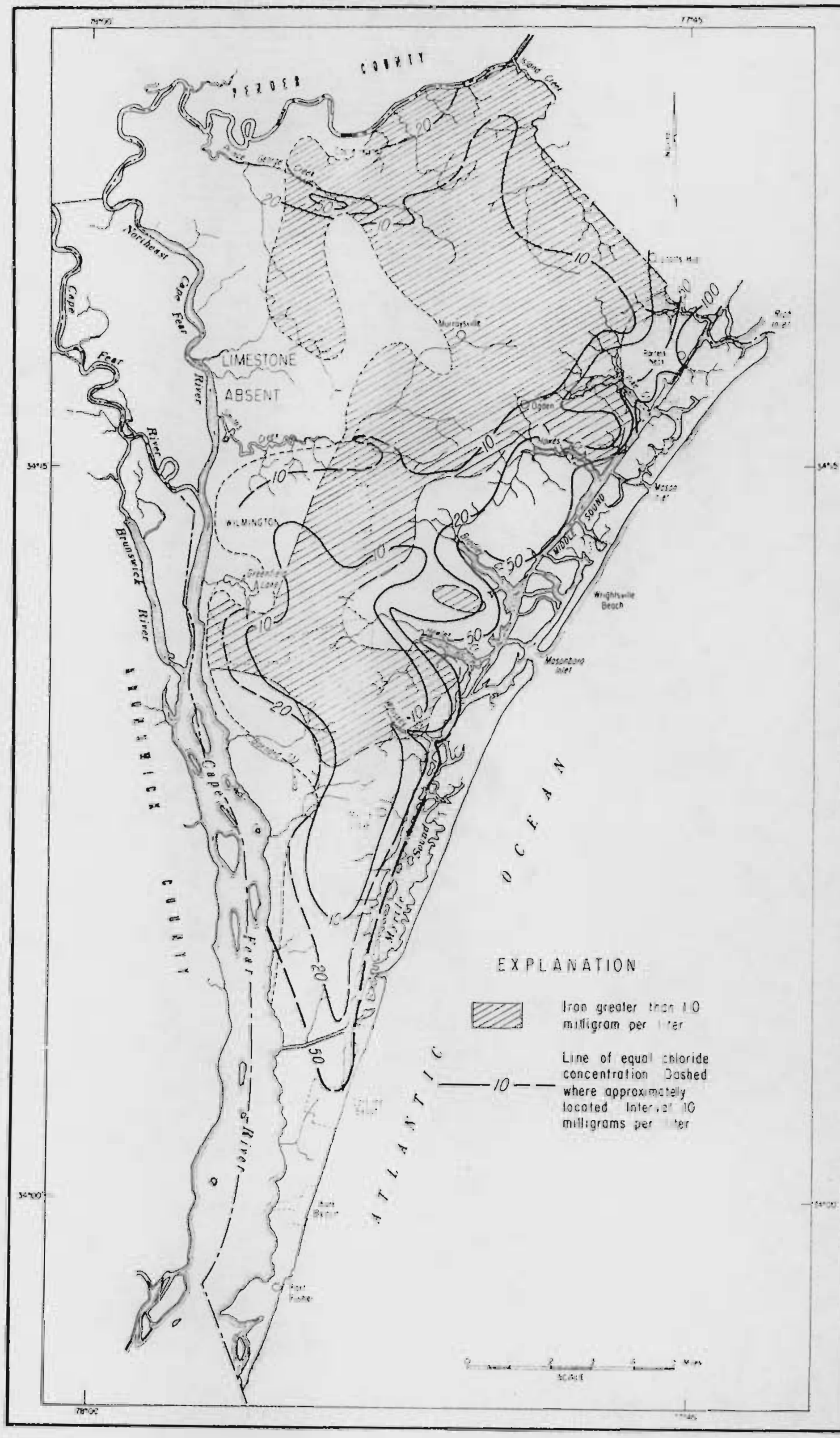


Figure 18.--Map showing the concentration of iron and chloride in water of the Castle Hayne Limestone aquifer.

The high altitude of the water table beneath topographic highs in New Hanover County indicate that the recharge areas are the broad areas between the streams. The uplands are favorable recharge areas, as they generally are flat and very sandy. Runoff is low to nonexistent. The streams have incised their channels into the surface material, and the ground water discharges as springs and seeps along the stream channels.

The thickness and water-bearing capacity of the surface material vary considerably from one site to another. The thickness determined from auger holes, ranges from less than 20 feet to about 60 feet. The water-bearing capacity depends not only on the thickness but also on the character of the material.

During this investigation the geology and hydrology were further explored through installation of 8 test sites and observation wells. The results of these tests are reported and interpreted in the following section of Hydraulic Characteristics of Aquifers.

The sand dune areas south of Wilmington are similarly underlain by coarse sand in many places, and the hydrology is thus similar. However, infiltration from the tidal creeks and the river must be prevented because the Cape Fear River estuary is quite brackish downstream from Wilmington. Brackish water extends farther up the Northeast Cape Fear than up the Cape Fear River. Therefore, all infiltration wells to be screened in the dune sand and stream deposits adjacent to the Northeast Cape Fear River between Wilmington and Castle Hayne should be managed carefully to avoid lateral salt-water encroachment.

Elsewhere, small yields are available for small irrigation and domestic supplies from the finer grained and shallower surface sands throughout the county.

The iron content in water from the surface material generally is high everywhere except adjacent to creeks, sounds, and estuaries, ranging from 0.01 to 12 mg/l. However, in the sand hills area the iron content of the water is less than 0.3 mg/l except near the rivers where some infiltration probably occurs.

The chloride concentration is less than 20 mg/l throughout the county in the surface sands. Where the sands are adjacent to parts of the Cape Fear River that contain brackish water, the risk of drawing brackish water into the sands is increased by pumping of wells.

The hardness of the water in the surface sediments ranges from soft (less than 60 mg/l) to moderately hard (61-120 mg/l) throughout most of the county.

Large yields of water have been obtained from wells in the sand hills area between the Cape Fear River and Northeast Cape Fear River north of Wilmington. A yield of 1,100 gpm was obtained from a multiple well-point installation for several weeks during construction of the Sutton Power Plant in 1952 (LeGrand, 1960). One large pond near well 105 on the east bank of the Cape Fear River is reported to have a similar high yield. Well 108 which taps the dune sand has been tested at 480 gpm at 7.0 feet of drawdown--or a specific capacity of 69 gpm per foot of drawdown. However, specific capacities of wells at the nearby Nitrex Plant range from 2 to 15 gpm per foot. Screens for naturally developed wells in these sands range from 35 to 60 slot size.

Previous investigators (LeGrand, 1960, and Thompson, 1941) have noted the permeable character, the lack of surface runoff from, and the infiltration potential of the above sand hill deposits. LeGrand (1960) suggested that about 90 percent of the prcipitation in the sand hills area soaks into the ground, and estimated that about 730 million gallons a year per square mile becomes ground water. He also indicated that because of the great permeability of the sand, the ground water discharges readily into the swamps bordering the rivers, and the water table is nowhere more than a few feet above river level. He further suggested that water from the rivers could be induced as additional recharge to the sand where water levels are lowered below river level by pumping wells and cautioned that where recharge from the river occurs, the chemical quality of the water pumped from the sand may be objectionable where the river water is brackish.

HYDRAULIC CHARACTERISTICS OF AQUIFERS

A phase of the ground-water study was designed to determine such characteristics as the coefficients of transmissibility and storage of the aquifers, and the specific capacity of wells drawing from the several aquifers. Aquifer characteristics were determined by making pumping tests on test wells, selected irrigation wells, and domestic wells; assisting well drillers in making pumping tests on wells following construction; evaluating drillers' records of previous pumping tests; comparing tidal fluctuations in wells with the corresponding ocean tides, and making pressure recovery tests on flowing wells. The test data are presented in table 1. The well numbers correspond to the numbers shown on the well location map (fig. 3).

For those tests which were of less than 24-hours duration, the specific capacities are shown as measured at the end of the tests. The adjusted 24-hour specific capacities are then tabulated in the following column, and plotted on figure 19. The coefficients of transmissibility are calculated from pumping-test data or estimated from specific-capacity data. The saturated thickness of an aquifer is given where that information is available. The approximate field permeability may be calculated at some well sites by dividing the transmissibility by the saturated thickness.

Specific-capacity data derived from the tests of 1-1/2- and 1-1/4-inch wells are affected by incomplete development, partial penetration of aquifers, pipe friction, and screen losses. Adjusted specific capacities of small diameter wells in the sand hills northwest of Wilmington differed from the observed specific capacity of the 10-inch gravel-packed wells at the Sutton Plant by a factor of about 1 to 20. Calculated coefficients of transmissibilities differed by as much as 1 to 4.

Comparison of the tested coefficients of transmissibility of wells 51 and 107 with those of established production wells in the area indicates that the coefficients of transmissibility of the coarse sand most reasonably range from 50,000 gpd (gallons per day) per foot in the north near the Pender County line to 100,000 gpd per foot in the vicinity of the Sutton Plant. The sand is also known to thicken in this direction. From the above transmissibilities and the observed ground-water levels the sand hills area is calculated to be discharging 0.88 to 2.0 mgd (million gallons per day) per square mile to the surrounding river and underlying formations. Of the 50 inches of annual precipitation 18.5 to 41 inches is contributed to ground-water recharge.

Table 1.--Aquifer test data on selected wells

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown		Transmissibility (gpd/ft)	Storage coeffi-cient	Aquifer[a]	Saturated thickness (ft)	Remarks
				End of test	End of 24-hours					
1	25.5	7.6	3	3.4	3.2	13,000 - 29,000[b]		Kpd	45	3' of $1\frac{1}{4}$" screen, #30 slot
2	30	5.3	2.5	5.7	5	7,000 - 14,000[b]	0.1-0.25	Tch	50	
4	322	45	24	7.2	7.2	10,000[b]		Tch-Kpd		
5	325	20	24	16	16	20,000[b]		Tch-Kpd		
7	325	47	24	7	7	10,000[b]		Tch-Kpd		
16	63	3.6	.67	17.5	14	25,000[b]		Tch-Kpd	40	
24	400	75	96	5.3	5.3+	8,000[c]		Tch-Kpd		
25	300	28	24	10.7	10.7	15,500[c]		Tch-Kpd		
27	200	12	24	16.7	16.7	24,000[c]		Tch-Kpd		
36	32	2.6	.3	12.7	9.0	20,000[b]	.005-.05	Kpd		
47	35	4.1	.6	9	6.5	10,900[b]		Kpd		
48	55	4.6	.9	12	8.3	11,200[b]		Kpd		
50	2.6	8.7	.3	.3	.3[c]	4,550[b]		Kpd	20	2' of 2" screen, #10 slot
51	10	4.4	.7	2.3	2.3[c]	20,000 - 30,000[b]		TQ	38	2' of $1\frac{1}{2}$" screen, #10 slot
52	12.3	5.2	2	2.4	2.4[c]	26,000 - 50,000[d]	.2	TQ	22	Transmissibility calculated from tidal effects
53	2	24	.5	.1	.1[c]	3,000[b]		TQ	27	3' of $1\frac{1}{2}$" screen, #10 slot
54	12	3.7	2	3.2	3.2[c]	22,600 - 63,500[b]		TQ	41	3' of $1\frac{1}{2}$" screen, #10 slot
63	36.5	2.6	.3	14	7.7	11,000[b]		Kpd	40+	
73	24	?	.5	1.8 ?	1.3	4,000[b]		Kpd		Only 7' penetrate

Table 1.--Aquifer test data on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity, gpm/ft of drawdown: End of test	Specific capacity, gpm/ft of drawdown: End of 24-hours	Transmissibility (gpd/ft)	Storage coeffi-cient	Aquifer[a]	Saturated thickness (ft)	Remarks
82	52.5	0.65	0.3	81	60	140,000[b]		Tch	50+	
88	36	1	4	36	30	40,000[c]		Kpd		
90	53	1.3	.3	40	28	40,000[b]		Kpd	20+	
91	62	1.4	.5	44	23	25,000[b]		Kpd	30+	
106	46	12.7	2	3.6	3.6[e]	28,000 - 30,000[b]	0.15	TQ	33	10' of 2" screen, #10 slot
107	12	3.5	2	3.4	3.4[e]	60,000 - 130,000[d]		TQ	25	3' of 1½" screen, #10 slot
108	480	7	?	69		100,000[c]		Kpd-TQ	46 - 67	Gravel packed frc 33 to 53'
110	16.5	4.2	2.2	3.9	3.9[e]	70,000[b]	.3	TQ	36	
111	3.9	9.3	1	.42	.42[e]	4,000[b]		Kpd-TQ	20+	3' of 1½" screen, #30 slot
113	200	18	19	11	11	15,000[c]		Kpd	28	
114	200	13	72	15	15+	20,000[c]		Kpd	37	
115	80	20.4	24	3.9	3.9	5,000[c]		Kpd	24+	
127	7.8	.16	1	49	34	80,000[b]		Kpd	40+	
128	210	8.7	18	24.4	24	30,000[c]		Kpd	40+	
129	300	7.5	?	40		60,000[c]		Kpd	40	
131	343	9	10	38		50,000[b]		Kpd		
132	465	8	?	58		70,000[c]		Kpd		
134	64	2.6	.3	24	15	30,000[b]		Kpd		
141	73	.73	.25	100	75	100,000[b]		Tch-Kpd	38+	
175	165	<54	?	3.1+		6,000[c]		Tch-Kpd		
181	250	60	24	4.2	4.2	6,000[c]		Kpd		Gravel pack
196	100	14	?	7.1		10,000[c]		Tch-Kpd		

SAQ

Table 1.--Aquifer test d[illegible] on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown End of test	End of 24-hours	Transmissibility (gpd/ft)	Storage coeffi-cient	Aquifer[a]	Saturated thickness (ft)	Remarks
208	97	14.4	24	6.8	6.8	13,000[b]		Kpd	40+	
215	165	44.5	?	3.7		5,000[c]		Kpd		
218	220	20	?	11		20,000[c]		Tch-Kpd		
228	340	80	24	4.25	4.25	6,000[c]		Tch-Kpd		Gravel pack
230	360	55	24	6.6	6.6	10,000[c]		Tch-Kpd		Gravel pack
244	16.4	5.9	3	2.8	2.5	8,000[b]		Tch-Kpd		
254	60	16	.3	3.7	2.6	6,000[c]	0.001	Kpd		
260	150	20	48 ?	7.5	7.5	11,000[c]		Kpd		
262	150	90	48 ?	1.7	1.7	4,000[c]		Kpd		
290	100	15		6.7		10,000[c]		Kpd		
294	275	58	24	4.8	4.8	9,000[c]		Kpd		Gravel pack
299	144	36.7	24	4.0	4.0	7,000[c]		Tch-Kpd		
302	110	17	24	6.5	6.5	14,000[c]		Tch-Kpd		
323	50	7.6	?	6.6		14,000[c]		Tch-Kpd		
329	25	7.8	1	3.2[c]		9,000[b]		Tch-Kpd		
335	192	36	24	5.3	5.3	7,000[b]		Kpd		
341	4.7	2.4	5.4	1.95	1.8	4,000[b]		Kpd		
342	600	19.6	8	30.6	21.3	40,000[b]		TQ-Kpd		Gravel pack
343	60	15	24	4	4	6,000[b]		Kpd		
361	50	7	.17	7	4	6,000[b]		Tch-Kpd		
368	5	1.8	5.1	2.8	2.6	4,000[b]	.5	TQ	54	2' of $1\frac{1}{4}$" screen, #10 slot
397	150	33	24	4.55	4.55	7,000+ [c]		Tch		
398	153	51	24	3.0	3.0	5,000+[c]		Tch		

Table 1.--Aquifer test data on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown		Transmissibility (gpd/ft)	Storage coeffi-cient	Aquifer[a]	Saturated thickness (ft)	Remarks
				End of test	End of 24-hours					
406	28	1.7	0.3	16.5	12	30,000[b]	0.0001	Tch		
407	170	30	5	5.7	5.4	20,000[b]		Tch		
410	235	23	9	10	9	20,000[c]		Tch		
412	30	8	3	3.8	2.8	5,000+		Tch		

a/ Kpd - Peedee.
Tch - Castle Hayne.
TQ - Undifferentiated late Tertiary and Quaternary sands.

b/ Calculated from time-drawdown graph.

c/ Estimated from specific capacity and storage data.

d/ Calculated from tidal effects.

e/ Still undergoing development at end of test.

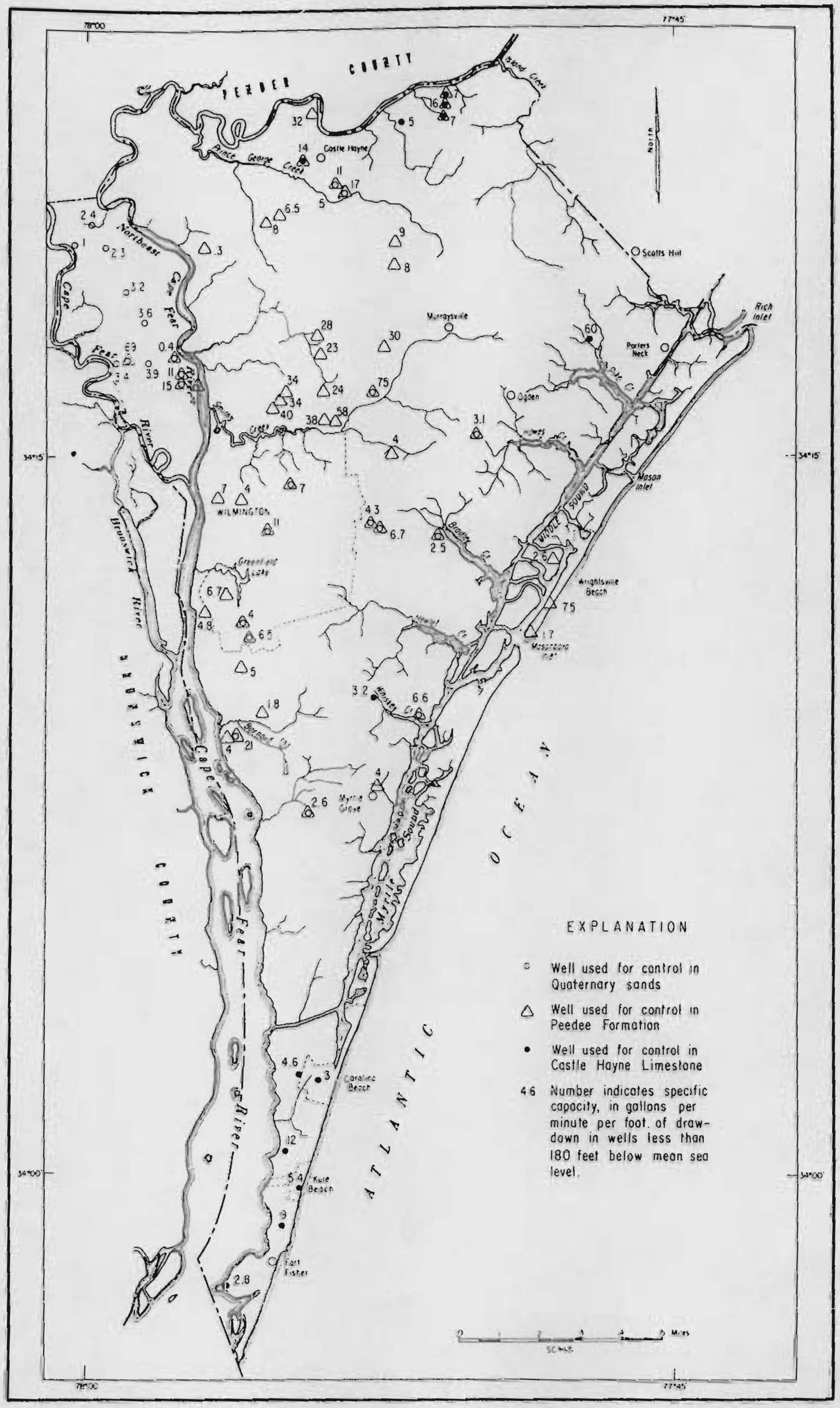


Figure 19.--Map showing measured specific capacities of wells with depths less than 180 feet below mean sea level.

The amount of ground-water discharge that can be salvaged as potable water depends upon future well-field design and development, the degree to which the area is left unpaved, and the manner of disposal of industrial wastes. The moderate coefficient of transmissibility and high coefficient of storage indicate that the coarse sand deposits can be developed using infiltration galleries, open ponds, multiple well points or large-diameter gravel-packed wells.

The data from the sand hills area northwest of Wilmington indicate that yields from wells 8-inches in diameter, gravel packed to a nominal 16-inch diameter with 20 feet of screen, and spaced at least 500 feet apart will be at least 250 gpm. Similar yields should be expected from such well-field designs in the sand-dune area south of Wilmington where underlain by coarse sand. Larger yields may be obtainable as a result of induced infiltration in areas where the sands are hydraulically connected with the rivers, such as at the Carolina Power and Light Company's Sutton Plant and along the Northeast Cape Fear River below Castle Hayne. Care must be exercised, however to prevent infiltration from the rivers where they contain brackish water. Brackish water extends upstream in the Cape Fear River as much as 10 miles above Wilmington during periods of low flow. This fluctuation in quality of water from time to time requires careful planning of ground-water development near the river.

Elsewhere the specific capacity of a properly designed and developed well generally is found to be at least 3 gpm per foot of drawdown throughout the county (fig. 19). Minimum yields of 150 to 250 gpm of potable water may be developed almost anywhere in the county.

The specific capacity of wells in the watershed of Smiths Creek north of Wilmington is greater than 20 gpm per foot of drawdown. Here, the sandstone aquifer, containing some calcareous material, has undergone solution and channels (fig. 19) in its upper surface contain up to 30 feet of coarse sand. Solution in the aquifer may account in part for the abnormally high specific capacity of well 112. Wells having exceptionally high specific capacities also are found in the limestone aquifer at Porters Neck (well 82) and near Wrightsville Beach (well 251). However, high specific capacities of wells in the limestone is much more sporadic than in the other aquifers.

The prohibitive cost of drilling test wells and the limited time available made it necessary to collect most of the data from existing privately owned wells. Thus, the available hydrologic data from remote and unpopulated areas are less than desired. Specifically, the position of the salt-water interface and information on the water-bearing characteristics of the sandstone aquifer are unavailable in the southern tip of the county. In areas where the geology is known but the hydrologic data are deficient, the aquifer characteristics are estimated by projecting known data from similar geologic situations.

The information presented in this section does not preclude the necessity of drilling exploratory wells when the desired quality of water is critical or when the needed quantity of water approaches the limits indicated in this report.

WATER-LEVEL FLUCTUATIONS

Observation wells were established in the different aquifers during the initial phase of the study to measure changes in ground-water storage.

Despite heavy rains ground-water storage is least during June, July, and August when evapotranspiration demands are greatest, and again during December after the fall "drought." The water level is highest in late February and early March during the period when winter rains are heavy and vegetation is dormant. There is frequently a secondary peak in ground-water levels in September resulting from heavy rains.

LOW-FLOW DISCHARGE MEASUREMENTS

The low-flow discharge of streams, sometimes called the "base flow," is that streamflow which occurs during long periods of fair weather. This flow is derived entirely from ground-water discharge. In order to evaluate the amount of ground water discharging in New Hanover County, measurements were made of the low flow of Smiths, Prince George, and Todds Creeks, as well as the flow from Greenfield Lake. These creeks and the lake are important areas of ground-water discharge in New Hanover County and may represent significant sources of water supplies.

In October 1965 a low-flow recession recorder was placed in operation on Smiths Creek about 500 feet southwest of N. C. Highway 132. Data from this recorder were used to determine what part of the streamflow is supplied by ground water. The streamflow in Smiths Creek, water levels in well 141, and the precipitation at the New Hanover County Airport are shown for the period from October 1965 to March 1966 in figure 20.

Smiths Creek has a drainage area of 8.9 square miles upstream from the low-flow recession recorder. It is a rural, sparsely populated area of which two-thirds is forest-covered and one-third is agricultural. Large ground-water withdrawals are not known in the area.

Figure 20 illustrates the relationship between precipitation, ground-water levels, and streamflow variations. During the period from late October through December the total precipitation at the nearby New Hanover County Airport totaled only 2 inches. Although plant transpiration and evaporation were low, they utilized nearly all the precipitation, and very little ground water was added to storage. Thus, the water level in well 141 declined at the nearly uniform rate of 0.03 feet per day. The ground water discharge into Smiths Creek, as indicated by the nearly horizontal segments of streamflow graph during this period, was approximately 2 cfs (cubic feet per second).

During the period from early January through the middle of March, when evapotranspiration losses were still at a minimum, the increased precipitation resulted in a rise in the water level in well 141 at rates of about 0.06 to 0.03 feet per day. As the aquifers became saturated a decreasing amount of the available precipitation went into storage and the contribution to streamflow was correspondingly increased.

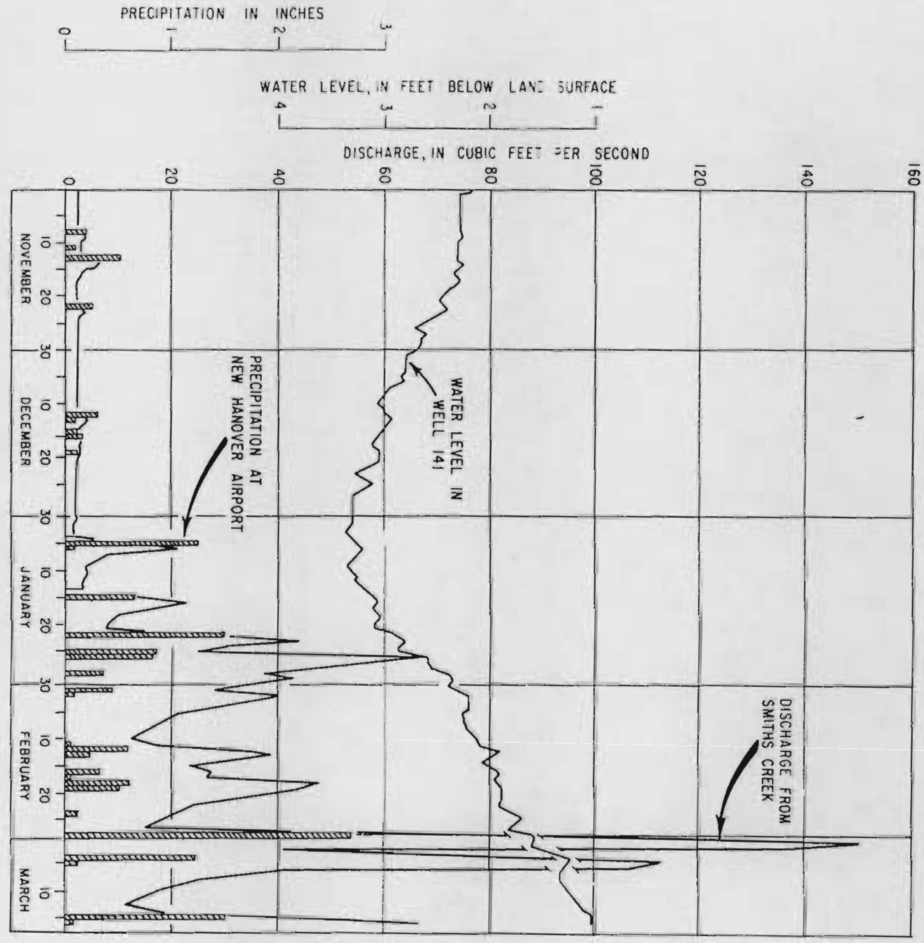


Figure 20.--Composite graph of precipitation at the New Hanover County Airport, discharge from Smiths Creek, and fluctuations of the water level in well 141.

On March 16 the water level in well 141 declined sharply possibly due to reduction of backwater effects in Smiths Creek combined with increased evapotranspiration. If it can be assumed that the evaporation losses and the precipitation from late October to January were similar to those from March 15 to April 25, then the 0.01 foot per day increase in the water-level decline in well 141 during that period can be attributed to plant transpiration.

The January 4, 1966, low-flow discharge of 1.8 cfs at the station on Smiths Creek represents about 1.2 mgd of ground-water effluent. The April 25, 1966, low flow of 1.6 cfs (1.07 mgd) is about 89 percent of its January rate.

Greenfield Lake is on the southern edge of the city of Wilmington. It has a drainage area of 4.1 square miles and was discharging 3.1 cfs (1.9 mgd) of water at the spillway on December 8, 1965. The streams draining into the lake are quite short, and their gradients range from 30 to 50 feet per mile. Thus the lake is in effect a very large spring. Although storm sewers drain into the lake, sanitary sewage lines do not.

Prince George Creek has a drainage area of 2.4 square miles above its intersection with the Blue Clay Road (rural road no. 1318). Most of the area is forest land. The December 9, 1965, discharge of 0.22 cfs represents 0.14 mgd of ground-water discharge.

Todds Creek has a forest drainage area of 0.03 square miles above its intersection with N. C. Highway 132. The December 9, 1965, discharge was 0.11 cfs (0.07 mgd).

QUALITY OF WATER

The quality of ground water in New Hanover County is influenced by the chemical and physical character of the water as it enters the ground and by the composition of the rocks through which it moves. Rainwater usually contains dissolved gases, chiefly oxygen and carbon dioxide, that make it slightly acidic and thus capable of dissolving mineral matter from the rocks comprising the aquifers. The chemical quality of water varies considerably between areas of recharge and areas of discharge. Shallow ground water in the county has a low hardness where the Pleistocene and Miocene sediments are not composed of soluble carbonates. Because of the water's acidity and the high solubility of iron in acid water, iron is leached from minerals in the aquifer. As water moves through the aquifer toward the discharge areas it tends to increase in mineral content, chiefly because of the solution of calcareous cement.

DISSOLVED MINERAL CONSTITUENTS

Chemical compounds of calcium, iron, potassium, sodium, magnesium, and most other common metals make up most of the dissolved mineral matter in ground water. Chemical analyses of water sampled from various aquifers in New Hanover County are given in table 2; partial analyses are reported in table 5. Complete analyses were made to give adequate areal and chemical representation of the individual aquifers. The sampling sites were chosen on the basis of data obtained from partial analyses.

The chemical analyses in this report are expressed in milligrams per liter (mg/l). As of October 1, 1967, the U. S. Geological Survey reports results of chemical analyses in milligrams per liter (mg/l) instead of in parts per million (ppm). In the fresh through moderately saline water range, mg/l are virtually equal to ppm. The following discussion gives pertinent information concerning the geologic source of dissolved mineral constituents, the recommended limits of the U. S. Public Health Service, methods of treatment, and their significance in relation to use.

SPECIFIC CONDUCTANCE

Specific conductance is a measure of the capacity of water to conduct an electric current. The conductance is primarily dependent upon the amount of dissolved constituents and their degree of ionization. Therefore, specific conductance values may be used to estimate the total amount of solids in solution. They are expressed in reciprocal ohms times 10^6 (micromhos) at a standard temperature of 25°C.

HYDROGEN-ION CONCENTRATION (pH)

The hydrogen-ion concentration, expressed in pH units, is the degree of acidity or alkalinity of the water. The pH of a solution is the negative logarithm of the concentration of the hydrogen ion in moles per liter. Numerically, the pH scale extends from 0 to 14. A water having a pH value of 7 is said to be neutral, and the concentration of hydrogen ions is equal to the

Table 2.--Chemical analyses of water

(Results in milligrams per liter except as indicated)

Well Number	Date of collection	Sample Depth	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Aluminum (Al)	Iron (Fe)	Manganese (Mn)	Dissolved solids (calculated)	Hardness: Calcium, magnesium	Hardness: Noncarbonate	Color
22	09/22/65		360	6.9 a/	65	12	64	3.3	7.0	1.1	190	10	9.3	0.3	1.9	0.0	0.1	0.32	0.02	202	174	18	0
23	05/20/52		737	7.1	--	41	84	8.5	58 b/		305	2.4	84	.1	.7	--	--	.92	.07	446	245	--	2
29	10/21/65		427	6.8 a/	65	24	83	2.1	8.0	1.4	264	.4	11	.2	.2	.16	.1	2.9	.08	261	217	0	10
34	09/27/65		400	6.8 a/	64	29	72	1.1	12	1.4	230	.4	16	.1	.3	.1	.1	2.7	.09	246	186	0	5
38	09/23/65		456	7.1 a/	66	26	87	3.8	7.8	2.3	282	.4	12	.2	.3	.0	.2	1.6	.10	279	233	2	5
50	09/27/65		242	7.5	65	12	45	1.3	4.2	.8	129	8.4	7.0	.2	.2	.3	.1	.64	.03	143	117	10	5
51	06/11/65		33	6.5	66	5.9	3.4	.2	1.8	.6	11	2.4	1.6	.0	.4	.00	.1	.03	.03	21	10	1	0
53	06/11/65		195	7.2	68	5.9	17	.7	18	2.2	52	8.6	27	.0	.4	.01	.1	.57	.03	106	45	20	5
68	09/24/65		511	6.6 a/	66	12	101	2.9	8.6	1.0	310	.8	16	.2	.6	.1	.2	2.0	.05	297	264	10	70
70	09/24/65		540	6.7 a/	68	28	103	4.4	11	1.3	327	2.6	19	.2	.4	.0	.1	4.9	.08	331	276	8	10
86	09/23/65		447	7.1 a/	66	15	77	5.3	13	1.8	267	.6	16	.2	.3	.0	.1	1.0	.00	260	214	0	5
87	08/02/65	599	26100	7.7	68	8.8	195	233	5350	200	406	546	8780	.5	.2	.0	.5	6.0	.10	15600	1450	1110	7
87	08/12/65	320	10480	7.9	68	9.8	67	84	2330	90	408	58	3350	.1	1.1	.0	.3	.61	.04	6700	512	177	4
87	08/06/65	220	331	7.5	--	--	19	1.6	40	--	75	--	47	--	--	--	--	--	.00	--	54	0	--
96	09/23/65		582	7.2 a/	68	--	89	5.8	--	--	322	--	36	--	--	--	--	2.8	.09	--	246	0	5
108	09/27/65		29	5.1 a/	67	4.5	1.8	.5	2.1	.5	6	3.2	4.4	.1	.5	.0	.0	.02	.02	21	6	2	0
111	06/10/65		31	6.9	68	4.1	3.0	.4	1.8	1.9	10	2.2	3.0	.0	.3	.00	.0	.08	.03	22	9	1	0
115	08/04/65		174	6.5	66	6.9	18	1.5	7.8	1.9	14	9.4	14	.1	40	.0	.0	.89	.07	107	52	40	4
131	05/16/65		325	8.2		17	35	9.1	19	2.4	164	3.8	27	.1	.3	.0	.0	.19	.03	195	126	0	2
134	09/23/65		452	7.5	64	18	81	3.6	12	1.6	265	.4	18	.2	.3	.1	.1	2.2	.08	265	218	0	5
147	09/27/65		465	6.8 a/	68	--	90	2.9	--	--	284	--	13	--	--	--	--	2.7	.13	--	236	4	8
154	10/21/65		603	7.2 a/	66	22	86	12	32	3.8	333	1.4	39	.3	.3	.03	.2	.02	.00	361	264	0	12
155	09/24/65		450	7.0 a/	66	10	70	4.3	15	1.2	184	10	38	.2	13	.2	.1	.02	.01	252	193	42	5
160	09/27/65		774	7.0	66	30	100	10	50	5.1	359	1.4	78	.4	.5	.0	.2	.03	.01	452	293	0	15
167	12/06/65		677	7.6	--	23	80	14	44	6.3	322	8.8	61	.4	.2	.07	.2	.02	.00	396	256	0	7
177	09/24/65		361	7.1 a/	68	20	49	12	8.6	5.0	210	.4	15	.4	.1	.0	.1	.02	.02	214	170	0	5
178	09/24/65		369	6.7 a/	65	10	71	1.4	6.6	.8	220	.6	12	.1	.3	.0	.1	.71	.04	211	184	3	5
209	06/10/64		502	7.8	--	16	52	4.6	44	4.8	178	15	58	.2	.2	.0	--	.42	--	283	150	4	--
230	09/12/61		390 c/	7.4	--	12	200	12	--	--	--	70	20	--	.0	.0	.8	1.8	--	312	212	--	10
249	10/14/65		337	7.1 a/	--	8.7	60	2.8	8.7	.6	190	1.2	15	.1	.3	.36	.2	.67	.03	191	161	4	8
253	04/20/65		590	7.9	66	18	54	12	58	8.4	226	8.2	87	.3	.2	.0	.0	.85	.01	357	184	0	5
255	04/20/65		730	7.9	64	18	60	13	63	6.6	234	9.2	107	.3	.3	.0	.1	.85	.00	393	203	11	9
256	04/20/65		840	8.0	64	18	20	38	85	8.8	236	14	136	.3	.2	.0	.1	.32	.01	436	206	13	12
257	04/20/65		3050	8.0	64	18	69	64	392	22	228	86	800	.2	.1	.1	.2	.93	.00	1560	438	251	7
258	04/20/65		920	7.9	64	17	54	16	95	9.8	207	17	170	.4	.1	.1	.1	.43	.01	482	200	30	7
259	04/19/65		830	8.1	60	17	32	25	86	9.6	204	16	147	.4	.0	.0	.1	.09	.00	433	182	15	5

a/ Field pH meter value. b/ Calculated Na plus K, reported as Na. c/ Fulbright Laboratories, Inc.

Table 2.--Chemical analyses of water--Continued

(Results in milligrams per liter except as indicated

Well Number	Date of collection	Sampled Depth	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Aluminum (Al)	Iron (Fe)	Manganese (Mn)	Dissolved solids (calculated)	Hardness: Calcium, magnesium	Hardness: Noncarbonate	Color
260	04/20/65		980	7.8	56	17	60	19	100	9.3	223	16	187	0.4	0.1	0.0	0.0	2.5	0.02	519	226	44	7
262	04/21/65		671	7.6	--	17	56	12	67	8.9	222	9.6	109	.3	.2	.2	.1	1.9	.02	389	188	6	5
264	10/04/65		355	7.2 a/	--	--	61	4.2	--	--	204	--	16	--	--	--	--	2.0	.07	--	168	2	--
275	10/15/65		261	7.4 a/	--	--	48	2.3	--	--	152	--	11	--	--	--	--	.25	.02	--	128	4	--
281	10/20/65		260	7.3 a/	65	11	47	2.6	4.3	.8	154	1.4	7.0	.2	.1	.05	.2	.20	.01	151	128	2	10
287	09/30/65		195	7.4 a/	67	5.6	37	1.3	3.5	.5	110	7.2	7.6	.1	.1	.22	.2	.25	.15	117	98	8	8
288	09/29/65		218	7.7 a/	67	--	28	7.1	--	--	131	--	9.6	--	--	--	--	.06	.01	--	98	0	--
316	10/14/65		658	7.5 a/	--	18	50	17	64	6.8	260	2.6	90	.3	.2	.05	.2	.28	.01	377	196	0	14
317	10/14/65		598	7.5	--	30	55	22	32	2.4	237	1.0	72	.1	.3	.02	.1	1.3	.04	332	228	34	10
331	10/21/65		374	7.1 a/	66	3.1	72	2.3	5.9	.4	218	8.0	11	.2	.3	.24	.1	.05	.04	211	188	10	10
335	09/30/65		297	7.6 a/	67	--	31	6.1	--	--	126	--	62	--	--	--	--	.11	.02	--	102	0	--
340	09/30/65		426	6.8 a/	67	--	33	7.9	--	--	172	--	52	--	--	--	--	.14	.01	--	116	0	--
343	10/19/65		952	7.9 a/	67	12	31	12	142	12	147	12	219	.4	.1	.09	.1	1.4	.03	513	126	6	7
345	09/30/65		--	6.4 a/	65	--	48	1.6	--	--	151	--	16	--	--	--	--	4.0	.08	--	126	2	--
346	09/30/65		--	7.0 a/	68	--	72	6.0	--	--	245	--	13	--	--	--	--	6.3	.08	--	205	4	--
347	09/02/65	332	10500	6.8 a/	69	9.0	81	69	2000	70	365	545	2860	1.5	3.8	.01	.2	2.7	.05	5830	486	187	5
347	08/30/65	622	25300	7.3 a/	70	7.4	232	153	5110	.5	346	405	8310	1.1	1.9	.00	.4	15	.14	14600	1210	927	5
349	09/30/65		384	7.5 a/	66	18	35	13	25	4.8	178	2.0	38	.3	.2	.17	.2	.10	.02	225	142	0	12
362	10/16/65		552	7.3 a/	--	27	46	33	17	19	344	1.6	21	.5	.3	.10	.2	.81	.02	335	248	0	15
368	10/21/65		181	7.8 a/	69	--	33	.7	--	--	104	--	5.0	--	--	--	--	.26	.01	--	84	0	--
371	10/14/65		192	7.8 a/	--	9.1	35	1.8	3.7	.5	111	.8	6.9	.1	.2	.16	.2	.10	.01	114	94	3	10
372	09/30/65		324	7.3 a/	66	8.6	57	4.1	7.3	.7	190	1.4	12	.1	.2	.18	.2	.09	.03	185	158	3	15
381	10/26/65		271	7.5 a/	67	13	46	1.9	8.0	.6	152	1.6	12	.1	.2	.09	.0	1.3	.10	159	124	0	7
383	10/14/65		274	7.8 a/	--	12	35	7.8	10	1.4	144	2.4	15	.0	.2	.01	.1	.01	.01	155	118	0	1
388	10/14/65		374	7.4 a/	67	38	40	16	8.7	9.2	208	.6	22	.3	.1	.06	.1	.03	.01	237	168	0	11
390	10/21/65		129	6.8 a/	67	5.2	17	1.8	5.7	.9	50	5.2	10	.1	2.3	.05	.0	.14	.02	73	48	8	6
396	11/09/64		445	7.9	--	22	40	16	17	16	204	.6	37	.1	.1	.0	.1	.48	.00	249	166	0	10
397	11/10/64		522	8.0	--	27	39	24	22	18.	243	.4	47	.1	.4	.0	.1	.96	.00	297	196	0	18
398	11/10/64		422	7.8	--	21	42	12	14	17.	190	1.4	35	.1	.0	.0	.1	.25	.00	236	155	0	18
399	11/10/64		530	7.7	--	29	45	21	24	19.	244	1.0	49	.1	.1	.0	.2	.22	.00	308	200	0	17
400	11/09/64		535	8.0	--	29	38	25	24	20.	247	.2	50	.1	.0	.0	.2	.57	.00	308	200	0	7
405	10/22/64		675	7.8	67	43	87	13	28	17.	354	.8	64	.2	1.1	.0	.3	.42	.00	428	274	0	25
406	10/19/65		490	7.5 a/	68	--	82	6.0	--	--	272	--	27	--	--	--	--	.60	.01	--	229	6	--
407	10/22/64		419	7.6	67	45	33	21	14	16.	221	.4	34	.2	.3	.0	.1	.16	.00	273	170	0	10
409	02/07/63		397	7.7	--	40	30	22	6.6	17.	207	.8	20	.2	.0	.0	.2	.13	.00	239	167	0	5
410	02/08/63		938	7.7	68	34	46	24	86	20	223	7.6	163	.2	1.1	.0	.2	.35	.00	493	215	32	5
411	02/08/63		419	7.6	66	32	65	3.6	15	1.8	205	4.0	26	.1	.0	.0	.1	.25	.03	249	178	10	5
412	10/11/65		1440	7.3 a/	68	22	60	16	197	18	195	1.6	360	.2	.3	.05	.2	.52	.02	771	217	57	10

a/ Field pH meter value.

concentration of hydroxyl ions. A water having a pH value greater than 7 is referred to as basic; that is, the concentration of hydroxyl ions exceeds the concentration of hydrogen ions. Conversely, if the pH is less than 7 the hydrogen ions exceed the concentration of hydroxyl ions and the water is said to be acidic. Inasmuch as the pH values are the numerical change to the logarithmic base, a water with a pH of 3 is ten times as acid as water with a pH of 4, and conversely a water with a pH of 9 is ten times as basic as a water with a pH of 8. The pH values are important indicators of the corrosive potential of ground water. Acid waters generally are more corrosive than alkaline waters.

The pH of ground water was determined by the author using a pH meter calibrated by standard buffer solution before each measurement. The water was pumped until its temperature stabilized, and then it was conducted by closed system to the pH cell. Most artesian water in the county had a field pH slightly greater than 7.0. The pH of waters that remained in sample bottles for several days ranged up to 8.2.

TEMPERATURE

The temperature of most water samples from New Hanover County ranged from 64 to 66°F. The average annual air temperature at the Wilmington weather station is 63.8°F for a 30-year period of record. Higher temperatures noted in table 2 were caused by warming of the water by the sampling pump or while in above-ground storage tanks. The higher temperatures of water from wells 87 and 347 are related to the relatively great depths to the aquifers at these wells.

SILICA (SiO_2)

Silica in ground water is derived from the weathering of silicate minerals that are common in the Coastal Plain materials. Except when present in high-pressure boiler feed or steam-turbine water, high concentrations of silica in ground water are not objectionable for most industrial processes. The concentrations of silica range from 4.1 to 45 mg/l and are highest in water from the limestone aquifer in New Hanover County.

CALCIUM (Ca) AND MAGNESIUM (Mg)

Compounds of calcium and magnesium are abundant in the limestones, marls, calcareous sands, and sandstones in the county and impart most of the hardness to the water. The ions of calcium and magnesium are similar in chemical reaction insofar as most water uses are concerned and are considered together in this report. Circulating acidic water dissolves calcium carbonate and carries it in solution as calcium bicarbonate. The quantity in solution is directly related to the carbon dioxide content of the water. The reaction is reversible so that where carbon dioxide is being released, such as at the screen and well head where there is a decrease in pressure, calcium carbonate is redeposited. In one well near Myrtle Grove, carbon dioxide (identified by chemical test) is occasionally released in sufficient quantities to cause cavitation of a 1/2-horsepower centrifugal pump.

The calcium and magnesium concentrations of well water in New Hanover County are given in table 2.

SODIUM (Na) AND POTASSIUM (K)

Concentrations of sodium and potassium in New Hanover County are low in ground water, except in wells 300 feet or more in depth, and in shallow wells near the coast. Along the sounds and beaches brackish water contains relatively high concentrations of sodium as well as chloride.

Water containing as much as 50 mg/l of sodium and potassium may be used for most domestic purposes; however, greater concentrations may cause foaming in high-pressure boilers. Sodium and potassium do not impart a noticeable taste to water in concentrations of less than several hundred milligrams per liter.

BICARBONATE (HCO_3 AND CARBONATE (CO_3)

Ground water in New Hanover County is principally the bicarbonate type with calcium and magnesium as the dominant cations. Where the chief cations are calcium and magnesium the water is usually hard. As demonstrated by water from well 87, the sodium ion is sometimes exchanged for the calcium and magnesium ions to produce a soft sodium bicarbonate water. This ion exchange principle is used in the zeolite softeners for domestic and industrial water supplies.

Bicarbonate has little effect on the domestic use of water, but it may cause foaming and scale formation in some industrial uses.

SULFATE (SO_4)

Sulfur-bearing minerals such as pyrite and marcasite are present in the sediments beneath the county. These minerals, and the calcium and magnesium sulfates frequently associated with shell and limestone beds, are soluble in ground water. Sulfate is also contributed to rainwater from airborne salt spray and industrial pollutants. Except in the deep test holes (wells 87 and 347), sulfate in water tested in the county did not exceed the U. S. Public Health Service recommended limit of 250 mg/l. However, sulfate may be reduced by bacteria and decaying organic matter to produce hydrogen sulfide and sulfur. The gas, hydrogen sulfide, a common nuisance in coastal counties, has an offensive rotten-egg odor; and when dissolved in water, forms a weak acid and imparts a characteristically disagreeable taste. The odor of these reduced waters can usually be remedied by chlorination to prevent bacterial growth. The effectiveness of both aeration and chlorination in the removal of H_2S is dependent upon the pH of the raw water.

CHLORIDE (Cl)

Small amounts of chloride are available from the decomposition of igneous rocks. However, the original source of most oceanic chloride is probably from volcanic gas and hot spring emanations associated with volcanic activity. More than 90 percent of the dissolved solids in the oceans are chloride salts, and the chloride ion concentration ranges from 19,000 to 20,000 mg/l in sea water. Chloride salts are incorporated within the porous sediments when they are deposited or submerged beneath the ocean. Airborne salt spray also contributes chloride to the aquifers in coastal areas (Wait and Callahan, 1965). The rate of flushing of these aquifers by fresh water depends on time, the hydraulic head, and the composition of the flushing water.

Chloride concentrations are less than 40 mg/l in waters from the water-table aquifer. Chloride concentration is less than 20 mg/l in the limestone aquifer (fig. 18), except along the estuaries and sounds where it ranges from 50 to 400 mg/l due to lateral encroachment of brackish water. Encroachment of brackish water is a problem, especially where dredging of the Intracoastal Waterway along Middle Sound has breached the permeable Castle Hayne Limestone. Chloride concentration in the sandstone aquifer (fig. 15) is less than 50 mg/l everywhere within the interior of the county at depths of less than about 200 feet. Except in areas of heavy pumping, chloride concentrations in this aquifer along the sounds and at Wrightsville Beach range from 50 to 260 mg/l. No information is available from the southern end of the county where the sandstone aquifer lies below a depth of 200 feet. In test wells 87 and 347 the chloride content of the water is about 3,000 mg/l at a depth of 300 feet and more than 8,000 mg/l at a depth of 600 feet.

The U. S. Public Health Service recommends that the chloride content not exceed 250 mg/l in water used for domestic and public supplies. The chloride-contamination problem is further discussed in a following section.

FLUORIDE (F)

Fluoride in ground water is due to the solution of fluoride-bearing minerals such as apatite, fluorapatite, the phosphates, the micas, hornblende, and organic matter such as shells. The micas, phosphates, and shells are prevalent in the sediments of the county and probably contribute most of the fluoride in the ground water.

Fluoride in concentrations between 1.0 and 1.5 mg/l in drinking water aids in reducing tooth decay in children. In concentrations greater than 1.5 mg/l fluoride may cause permanent mottling of the teeth (dental fluorosis) when used by children (Maier, 1950, p. 1120-1132. Fluoride concentrations averaged 0.2 mg/l and ranged from 0 to 0.5 mg/l in all ground water tested in wells as much as 200 feet deep.

NITRATE (NO_3)

Nitrate in ground water is generally considered to be the final oxidation product of nitrogeneous (organic) waste. A nitrate concentration in excess of 3.0 mg/l generally would indicate a nearby source of pollution. Shallow dug wells and well points are most often subject to pollution from sewage, fertilizers, and polluted surface waters.

The so-called "blue-baby" condition is a possible hazard when water containing nitrate concentrations in excess of 45 mg/l is mixed in feeding formulas. Water from all but one of the wells tested in the county had nitrate concentrations less than the U. S. Public Health Service recommended maximum of 45 mg/l. Well 115, which draws water from beds of permeable sand, is probably contaminated by nitrogen fertilizers.

PHOSPHATE (PO_4)

Phosphate in ground water may result from the solution of apatite or phosphate fertilizers. Phosphate concentrations in ground water tested in New Hanover County were below 0.4 mg/l.

ALUMINUM (Al)

Aluminum is a very common element in the earth's crust. However, high concentrations of aluminum are not common in ground water because this metal is only slightly soluble in water under the conditions that prevail in New Hanover County.. Aluminum concentrations in ground water tested were below 0.5 mg/l.

IRON (Fe) AND MANGANESE (Mn)

Iron in excess of 0.3 mg/l is objectionable for many uses. Excessive amounts of iron and manganese impart a reddish-brown color to utensils, plumbing fixtures, and laundry. It also interferes with dyeing and the manufacturing of some products, such as paper and photographic film.

Excessive iron concentrations are common in water in the shallow sediments in the county. The shallow ground water generally is more corrosive than deeper water. Oxygen and carbon dioxide are the principal constituents of ground water causing corrosion. As the shallow water moves downward through the soil and other sediments, the oxygen is used up in the oxidation of organic and inorganic matter; the carbon dioxide reacts with carbonates to form bicarbonates.

it is not always apparent whether the iron is in the water as it enters the well, or whether it is dissolved from the well casing and pipes. It is important to determine the source of the iron, whether dissolved from the rocks or the pipes, before methods for its removal are employed.

Iron concentrations in the water sampled are generally more than 1 mg/l from wells in the water-table aquifer, between 0.3 and 4.0 mg/l for water from the limestone aquifer, and less than 0.3 mg/l in the sandstone aquifer in areas along the Atlantic coast and the Cape Fear and the Northeast Cape Fear Rivers.

The chemical behavior of manganese in water resembles that of iron. However, since manganese is much less abundant in rocks, its concentrations in ground water are generally lower than iron concentrations. The U. S. Public Health Service recommends that manganese not exceed 0.05 mg/l in drinking and cooking water. Ninety-one percent of the water samples analyzed for manganese contained less than 0.05 mg/l. Manganese ranged from 0.0 to 1.5 mg/l in ground water in New Hanover County.

DISSOLVED SOLIDS

Total dissolved solids are the residue after a given volume of water has been evaporated and dried at a definite temperature (180°C by the U. S. Geological Survey methods). Computed dissolved solids are equal to approximately one-half the bicarbonate plus the sum of the other chemical constituents in milligrams per liter. Computed dissolved solids are used in the report, unless stated otherwise.

The U. S. Public Health Service recommends that dissolved solids in public water supplies not exceed 500 mg/l. Except in cases of chloride contamination, dissolved solids are less than 500 mg/l in ground water in New Hanover County.

HARDNESS

Hardness of water is usually recognized by the increased amount of soap necessary to form and maintain a lather. Hard water is objectionable not only because of its soap-consuming properties, but also because it forms scale in boilers and, to a lesser degree, encrustations in cooking utensils. The principal ions that produce hardness in ground water are calcium and magnesium, which have been discussed in a previous section. The following classification of water hardness is used by the U. S. Geological Survey.

Hardness as $CaCO_3$ (mg/l)	Classification
0 - 60	Soft water
61 - 120	Moderately hard water
121 - 200	Hard water
More than 200	Very hard water

Figure 14 shows the areal distribution of the hardness in the sandstone aquifer. Most of the water in the county with the exception of that from the water-table aquifer would be classed as hard to very hard water of the calcium-bicarbonate type.

Hardness in excess of that equivalent to the carbonate and bicarbonate present in the water is referred to as noncarbonate hardness.

OCCURRENCE OF SALTY WATER AND ITS POSSIBLE ENCROACHMENT

In New Hanover County it is important to know where the salty water occurs in the ground as well as in the major rivers so that fresh water can be developed without encroachment of salty water. The county is underlain by aquifers containing brackish to highly saline sea water. The overlying reservoir of fresh water exists in dynamic equilibrium with the underlying and surrounding salt water.

The contact between fresh water and the underlying salt water lies within the Peedee Formation everywhere in the county except in the limestone near the sound at Porters Neck. The upper part of the Peedee contains fresh water. The data from several deep wells indicate that saline water progressively increases in chloride concentration to basement. Figure 6 shows the general configuration of the top of a sand bed in the Peedee Formation that contains more than 3,000 mg/l chloride, and indicates that the top ranges from about 180 feet below mean sea level in the western part of the county to about 340 feet below sea level in the eastern part.

The chloride and other pertinent data from two deep test wells drilled during this investigation and the available data from all previously known exploratory wells are summarized below in table 3.

Table 3.--Summary of deep test well data

Table 3.--Summary of deep test well data

Name	Date Drilled	Well No.	Depth of sample below msl (ft)	Formation	Elevation of land surface (ft)	Water level above sea level (ft)	Chloride (mg/l)	Temperature (°F)	pH	Remarks
Olsen, near Murraysville	1965	87	278 557	Peedee Peedee	32	18 40	3,350 8,780	67.5 69		
Edwards, about 2 miles NW of Myrtle Grove	1965	347	300 596	Peedee Peedee	22	12 40	2,860 8,310	68.9 70	6.8 7.3	
Wrightsville Beach	1953	261	235 350	Peedee Peedee	5		650 1,000+			Brown, 1958a
Allied Kennecot		342	294	Peedee	17					Brackish water reported
Carolina Power & Light		Near 108	380	Peedee	8					Brackish water reported
Swart Dairy		97	335	Peedee	35	28	5,000 approx.			
Fort Caswell	1903		1,540	Tuscaloosa			8,000+	89		Salty from 365 to 1,540
Carolina Trucking Development Co.	1905	Near #15	250-318 318-350	Peedee Peedee	20 20	Nonflowing Flowing				Reported salty, Clark and others, 1912

Saline waters from these aquifers are possible sources of bromine and other rare salts. Too, the chloride-total hardness ratios in these waters are such that they possibly may be used to regenerate sodium cation water softeners. With suitable noncorrosive plumbing, their high temperatures could be employed for heating. There is a possibility that these aquifers could be used for disposal of industrial wastes.

Ocean water lies everywhere off the county's eastern shore and moves with the tides up and down the Cape Fear and Northeast Cape Fear Rivers and most of the larger creeks. The distance traveled depends upon the volume of downstream flow and the height of the tides. The denser sea water moves wedge-like along the stream bottom, and the fresh water flows out above it; however, turbulence causes some mixing along the salt-water interface. Where infiltration occurs, the quality of water from wells located near the ocean and river estuaries is dependent on the salt content of the water that infiltrates and the proportion it represents of the water pumped.

The position of the salt-water interface beneath New Hanover County depends upon the height of the fresh water above sea level and the density of the sea water. Due to the difference in density between fresh water and salt water, fresh water floats upon salt water much as oil does upon water in accordance with Archimedes' principle. In a small land body composed of homogeneous sand and surrounded by water a reduction in the fresh water level of one foot will theoretically cause a corresponding rise in the underlying sea water of 40 feet. Although exact conformance with the above principle does not occur in New Hanover County or in most coastal aquifers due to diffusion or mixing along the salt-water interface (fig. 21) (Kohout, 1961, and Cooper and others, 1964) variation in vertical and horizontal aquifer permeabilities, and incomplete encirclement of the county by sea water, a small decrease in the height of the fresh water above sea level may result in a much larger upward movement of the salt-water interface. Thus, a reduction in rainfall or an increase in the withdrawal of water by pumping, swamp drainage, or dredging reduces the hydrostatic head and results in a corresponding encroachment of the salt water.

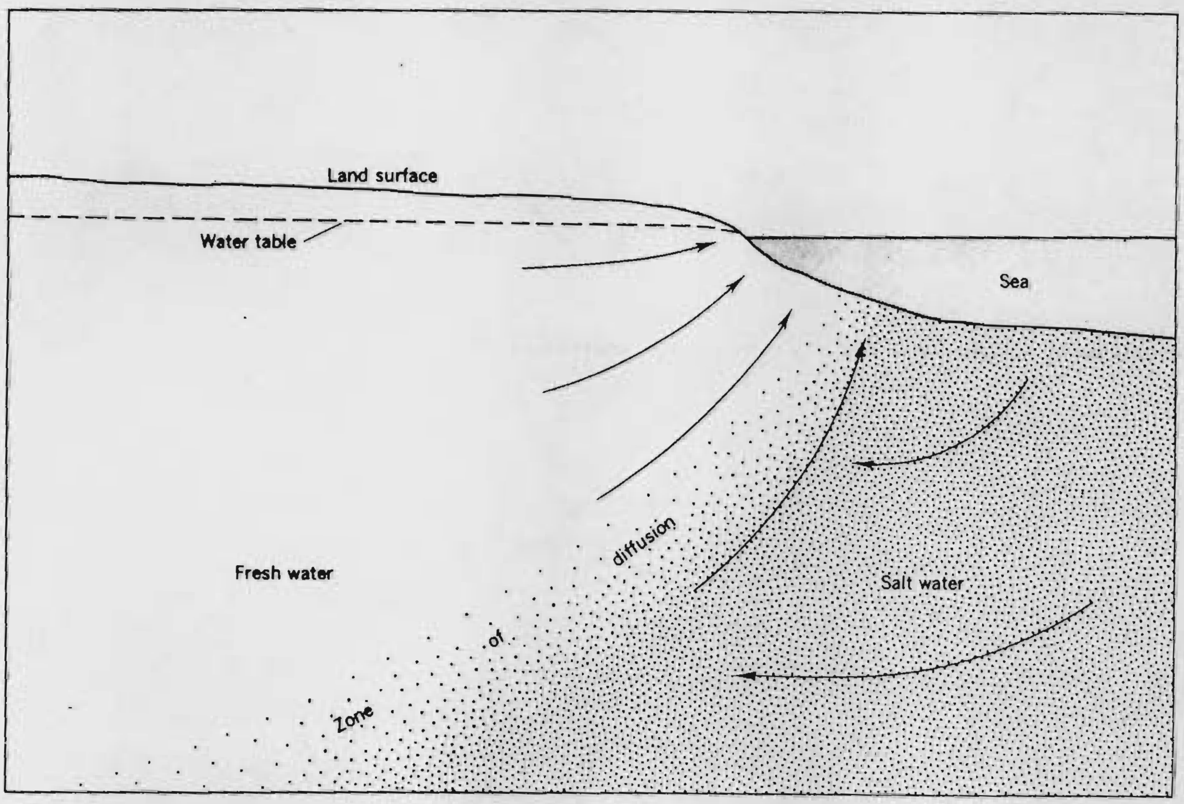


Figure 21.--Diagram showing the circulation of salt water and fresh water in a coastal aquifer. (Include credit in title).

Figures 15 and 18 show that the chloride concentrations are greater in the vicinity of creeks, sounds, and estuaries where the hydrostatic head approaches zero. This is shown also at Kure, Carolina, and Wrightsville Beaches where the hydrostatic head has been lowered by pumping. The result has been a slight upward movement of salt water or lateral movement of sea water from the ocean and estuary, or both. Where lateral encroachment of saline water occurs in the shallow aquifers, such as along the Cape Fear River and the sound at Porters Neck, entrance of salt water to the well may be prevented by extending the well casing through the contaminated zones and deriving water from the fresh zones below. Vertical encroachment can be controlled by well-field design and management practices that decrease the drawdown of the water level and spread the cones of depression over a wider area. Proper practices include pumping more wells at lower rates and using multiple well points and infiltration galleries for shallow installations.

Although chloride contamination is not a serious problem in New Hanover County, the fact that it can happen is borne out by the increased chloride content of the Wilmington wells pumped at high rates during the drought of 1940, and by the recent increase of chloride in wells 342 and 257.

Data are insufficient for making quantitative determinations of safe yields for wells in the several aquifers at any specific point in the county. In areas of heavy pumping it is advisable to monitor the chloride content of the water at the point of pumping and in surrounding observation wells. This method is being used by the Superior Stone Company for advanced warning of contamination.

The quality of ground water near the rivers may be influenced by the quality of the river water. Chloride concentrations and other chemical data collected by the U. S. Geological Survey on the Cape Fear and Northeast Cape Fear Rivers are given in Bulletin 1, volume 7, of the North Carolina Department of Water Resources (Woodard and Phibbs, 1965). A typical chemical analysis of sea water is given in table 4 for those constituents that occur in excess of 1 mg/l.

Table 4.--The composition of sea water

Constituent	Concentration (mg/l)
Chloride (Cl)	18,980
Sodium (Na)	10,560
Sulfate (SO_4)	2,560
Magnesium (Mg)	1,272
Calcium (Ca)	400
Potassium (K)	380
Bicarbonate (HCO_3)	142
Bromide (Br)	65
Strontium (Sr)	13
Boron (B)	4.6
Fluoride (F)	1.4

(Adapted from Rankama and Sahama as given in Hem, 1959.)

WELLS AND WELL CONSTRUCTION

Existing privately owned wells and test wells drilled for or by the U. S. Geological Survey were the source of most of the data used in this report. Data for these wells are given in table 5 at the end of the report. The 412 wells inventoried are numbered horizontally across the map of the county and are shown in figure 3.

The well data indicate that problems encountered in obtaining adequate supplies of well water of good chemical quality may result from inadequate well construction. Wells frequently have a low specific capacity because of poor construction or development methods, and they may produce water of undesirable chemical quality because they tap the least desirable of several aquifers. The following section on well construction, adapted in part from Wyrick (1966) is included to help minimize some of the problems by improved well design.

Water-well construction is usually governed by the owner's water needs and the cost of the well. As the owner must determine what his requirements are, the following discussion describes the various methods of well construction and the advantages and disadvantages of each. The types of wells constructed in New Hanover County are shown in figure 22. These wells fall into three categories; bored wells, driven wells, and drilled wells. In figure 22 diagram A is a large dug well, the next one (B) is a driven well, and the others shown are drilled wells.

Where large quantities of water are needed for irrigation, ponds are frequently dug and used as wells. The chemical quality of the water is comparable to that from shallow driven wells. Infiltration galleries and multiple well-point installations also may be constructed where domestic needs preclude the use of open ponds or where caving is a problem.

Driven wells are constructed by driving a length of steel well casing with a pointed drive-screen into a sandy water-bearing zone. The well is developed to clear the finer sandy material from the screen area and then equipped with a pump. Driven wells in New Hanover County are usually 1-1/4- to 2-inches in diameter and less than 30 feet in depth.

Several types of drilled wells are constructed in New Hanover County. Among these types are: open-end wells, single- or multiple-screened natural-development wells, and the single- or multiple-screened gravel-pack wells. Multiple-screen wells may also be naturally developed, but none of this type were found in the county.

Well C in figure 22 illustrates the open-hole type of well. This type is constructed by drilling into consolidated rock, such as the Castle Hayne Limestone, and setting a steel casing in the top of the consolidated rock. Usually the well is then deepened to the sandstone aquifer of the Peedee Formation and cleaned by pumping. This type of construction is restricted to areas which are underlain by materials sufficiently consolidated to insure

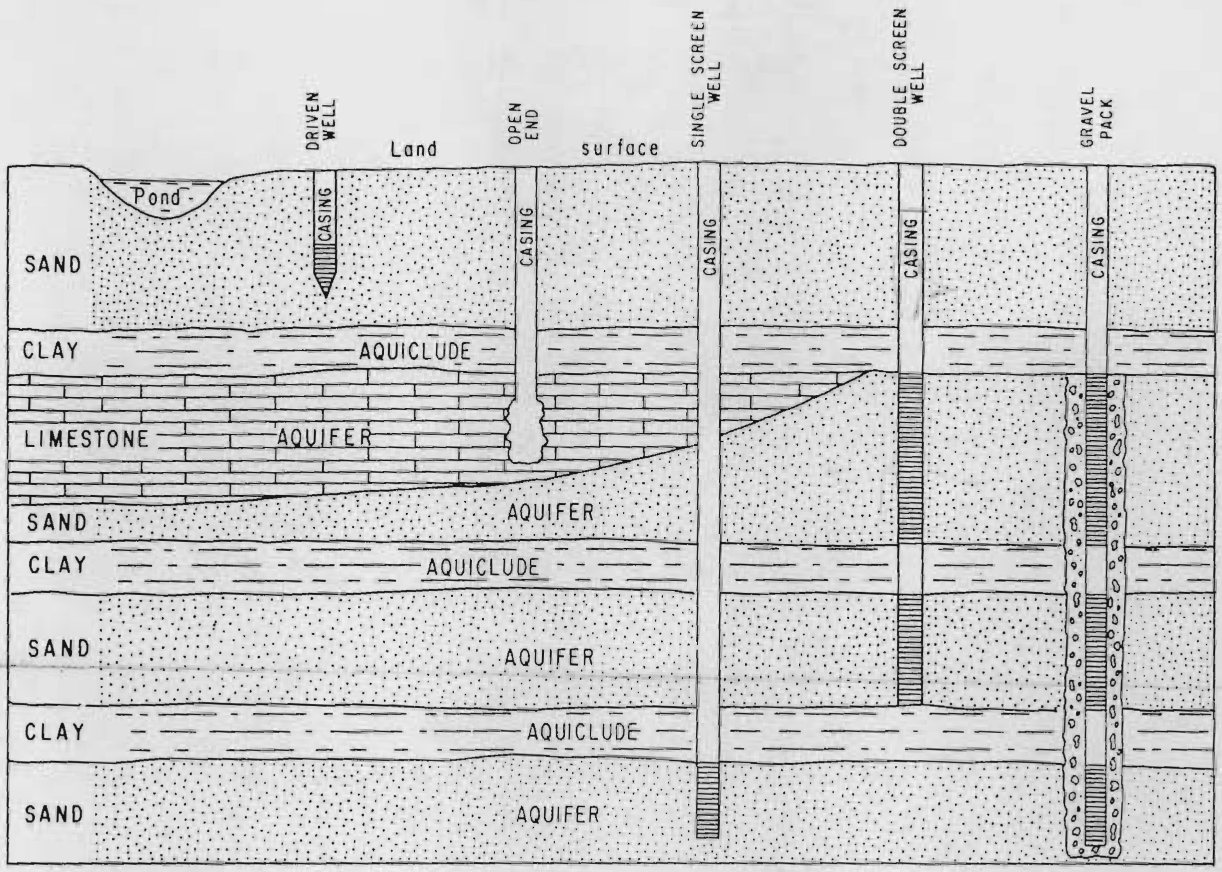


Figure 22.--Diagram showing types of wells constructed in New Hanover County.

that the hole will remain open below the bottom of the casing. This is the most common type of construction for domestic wells in the county.

The screened naturally developed well is illustrated by diagram D in figure 22. This type of well is constructed by drilling into a sandy aquifer and setting a steel casing with one or more screens on the lower end so that the screens are in the sandy aquifers. The well is developed by washing fine sand and clay particles from the aquifer around the screen. In this method of construction it is important that the screen openings be large enough to allow about 50 to 70 percent of the fine sand in the aquifer to wash into the well. In developing the well by pumping and surging, the fine material of the aquifer is washed out of the well and the nearby formation, leaving coarse, more permeable material packed around the screen. Common problems in this type of well construction usually include (1) poor well development due to improper screen size or insufficient surging and pumping, and (2) setting the screen so that part of the screen openings are blocked by clay layers.

Screened gravel-packed wells are illustrated by diagrams E and F in figure 22. This type of well is constructed by drilling a hole through one or several aquifers, reaming or washing a large diameter hole in each aquifer to be screened, setting a casing with screens spaced in the casing at each reamed aquifer, pumping gravel into the large diameter holes outside of the screens, and developing the well to remove drilling clay and fine material from the gravel zones. The gravel packing effectively increases the radius of the well in each aquifer. This, in turn, increases the specific capacity of the well. Generally, only municipal or industrial wells are constructed in this manner because of the greater cost.

CONCLUSIONS

New Hanover County is underlain by sediments ranging in age from Cretaceous to Holocene. These sediments occur in layers most of which tend to slope at low angles toward the Atlantic coast. They are composed of sands, clays, and limestone, and lie on a floor of hard consolidated rocks at a depth greater than 1,000 feet. A very large volume of water is stored in the sediments of the Coastal Plain, but sediments below depths of approximately 300 feet contain water that is too salty for normal use.

The usable ground water in the county occurs in three major aquifers. The uppermost aquifer is that of the surface sands, of Miocene and Pleistocene age, that extend over the county. This aquifer is especially important along the western edge of the county where sand dunes overlie coarse sand of Pleistocene(?) age. This aquifer is replenished by precipitation directly, and the water table is near land surface in much of the county. Water from this aquifer discharges into streams and into low swampy areas and into the underlying aquifers. Many shallow well points obtain water easily from this aquifer. The water is low in mineral matter but tends to be corrosive.

Below the surface sand in the eastern, central, and northern parts of the county is the Castle Hayne Limestone of Eocene age. This limestone is in most places less than 40 feet thick. It yields as much as 600 gallons per minute to a few wells, 150 to most, and is considered a good aquifer. Specific capacities of existing wells range from 3 to 60 gpm per foot of drawdown. The water is of the calcium bicarbonate type, being moderately hard to very hard in quality.

Underlying the Castle Hayne Limestone and separated from it by some relatively impermeable clays is the sandstone aquifer in the Peedee Formation. It yields 200 gpm to many wells and in excess of 400 to some; in most places it is used in conjunction with the Castle Hayne Limestone aquifer. Specific capacities range from one to 75 gpm per foot of drawdown.

Although each of the aquifers is to a great degree a separate unit, the less permeable materials between the aquifers allow some interchange of water. Heavy withdrawals from either the Castle Hayne or the Peedee sandstone aquifers will tend to affect movement of water to or from the other.

The development of ground water on a large scale in New Hanover County should be considered with care because of the possibility of encroachment of salty water into the fresh-water beds. This encroachment may occur vertically upward from beds containing salty water. Near the coast and along the Cape Fear and Northeast Cape Fear Rivers lateral encroachment of brackish water or sea water into the fresh-water formations is possible when the water level is drawn down appreciably by pumping.

If heavy withdrawal is contemplated the following considerations may prove helpful:

1. A more detailed investigation of the local hydrologic conditions is needed to determine the positions and character of impermeable beds that could prevent or retard encroachment.

2. Periodic determinations of chloride in water from one or more observation wells that yield water from an area between the producing wells and the salt-water body, would be helpful in detecting increase in chloride content. This would give sufficient warning so that the rate of pumping could be decreased and an orderly evaluation of the water problem could be made.

3. Properly spaced producing wells would prevent excessive drawdown at the apex of the cone of depression.

4. The draining of swamps in recharge areas would lower the water table and have other effects upon the ground-water reservoir.

5. Capping flowing wells in the county would help to preserve the hydrostatic head necessary to prevent salt-water encroachment.

6. Introduction of contaminants into the aquifer would pollute the water supply.

7. Long-lived radioactive waste would make the water unsafe for generations. Plugging all abandoned salt-water wells with clay or concrete (from the bottom up) would prevent the contamination of fresh-water aquifers in the event that corrosion causes eventual rupture of the well casing.

So long as care is taken to prevent the encroachment of salty water into the fresh-water aquifers, a fuller use of the ground-water resources can be made. The county has not yet approached an optimum development of its ground-water resources.

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Table 5.--Records of wells in New Hanover County, N. C.

Ownership: C-County; F-Federal Government; M-Municipal; N-Corporation or Company; P-Private; S-State agency; Use: A-Air Conditioning; C-Commercial; H-Domestic; I-Irrigation; N-Industrial; P-Public supply; S-Stock supply; T-Institutional; U-Unused. Type of QW analysis available: P-Partial; C-Complete. Log data available: D-Driller's log; E-Electric log; G-Geologist log; J-Gamma-ray log. Well finish: G-Gravel with screen; S-Screen; T-Sand point; X-Open hole. Quality of water: Iron, pH, Chloride, Hardness, and Specific conductance are coded according to range in concentration. Explanation of code given on last page of tables. Aquifer: Kpd-Peedee; Tch-Castle Hayne; TQ-Undifferentiated late Tertiary and Quaternary sands

Well No.	Well location: Lat	Well location: Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
1	342216N	0775403	1	USGS	F	U	P	G	29	30	2	T	5				5	7	1	4	2	Kpd	Temp. 65°F.
2	342205N	0775154	1	SUPERIOR STONE	N	U		J	50		2	X	5	5					2			Tch	
3	342147N	0775145	1	LEWIS NIXON	P	H	P		60		1	X	25	23								Tch	
4	342239N	0775048	1	IDEAL CEMENT	N	N	C	D	160	23	24	G		15	322	30						Tch-Kpd	
5	342225N	0775049	1	IDEAL CEMENT	N	N	C	D	164		24	G	27	19	325	20						Tch-Kpd	
6	342222N	0775045	1	IDEAL CEMENT	N	U			75		7	X										Tch-Kpd	Obs. well
7	342213N	0775051	1	IDEAL CEMENT	N	N	C	D	160		24	G		18	329	29						Tch-Kpd	
8	342209N	0774930	1	HARLEY SMITH	P	H			40		1	X	23	7			7		0	5	3	Tch	
9	342130N	0775008	1	J B WILCOX	P	I	P	J	117	54	6	X	26	29	125		8		0	6	3	Tch-Kpd	
10	342115N	0775309	1	E NIXON	P	H			50	21	2	X	24	12								Tch-Kpd	
11	342112N	0775306	1	W A PENDER SR	P	H			35		1	X	23	12								Tch-Kpd	
12	342111N	0775329	1	NEGRO BAPT CH	P	T			26		1	X	23	10								Tch	
13	342133N	0775353	1	QUEEN TIRE SER	P	C			50	30	2	X	19	9	90		2		1	6	3	Kpd	
14	342116N	0775402	1	RAINBOW END MOT	P	C			50	36	2	X	19	11			3		1	6	3	Kpd	
15	342123N	0775414	1	JOHN LOREK	P	I			30	12	3	X	13	8	80							Tch-Kpd	
16	342127N	0775427	1	JOHN LOREK	P	I	P		21		4	X	14	8	100		5		1	6	4	Tch-Kpd	
17	342129N	0775418	1	JOHN LOREK	P	H			18		1	X										Tch-Kpd	
18	342051N	0775529	1	W H JONES	P	H			37		2	X	15	7			2		0	5	2	Kpd	

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
19	342045N	0775404	1	SMITH BARBER	P	H	P		40		1	X					6		0	6	3	Kpd	
20	342043N	0775402	1	MELLO ICE CREAM	N	C	P		10		30	X					0	7	0	5	3		Spring flow 10 gpm
21	342030N	0775427	1	ST STANISLAUS	P	T	P		180		2	X					4		0	5	3	Kpd	
22	342033N	0775413	1	WILM PACKING	N	C	C		68		4	X	18		80+		3	6'	1	5	3	Kpd	
23	342033N	0775409	1	WILM PACKING	N	A	C		21		6	X	*15	9			4		2	6	4	Tch	
24	342033N	0775326	1	REASOR CHEMICAL	N	N		DJ	150	30	10	G	22	9	400	75			2			Tch-Kpd	3 screens between 30'-120'
25	342045N	0775336	1	REASOR CHEMICAL	N	N		D	148	34	10	G		8	300	20						Tch-Kpd	Screened 33'-148'
26	342034N	0775323	1	REASOR CHEMICAL	N	U		D	212	14	6	X	22	11								Tch-Kpd	Stratigraphic test
27	342035N	0775324	1	REASOR CHEMICAL	N	N		D	150	33	6	G		4	200	12	5		2	6	4	Tch-Kpd	Screened 33'-133'
28	342025N	0775245	1	HENRY BAND	P	I			69	26	2	X	16	1			6		2	4	3	Tch-Kpd	
29	342028N	0775216	1	R D TARDUGNO	P	H	C	G	60	20	2	X	29	11	*30		5	6'	1	6	3	Tch-Kpd	Temp. 65°F.
30	342C43N	0775207	1	A H PARKER	P	H			60	20	2	X	29		*40		7		1	6	4	Tch-Kpd	
31	342012N	0774925	1	USGS	F	U		J	94	92	1	T	33	7								Kpd	Auger hole No. 6
32	342012N	0774925	2	USGS	F	U		J	42	40	1	T	33	4								Tch	Auger hole No. 6
33	342036N	0774755	1	USGS	F	U		J	75	73	1	T	22	0								Kpd	Auger hole No 45
34	342019N	0774727	1	JOSEPH WENEUT	P	H	C		42		2	X	40	9			5	6'	1	5	3	Tch	Temp. 66°F.
35	341948N	0775147	1	C LITTLEJOHN JR	P	H			50		2	X					5		0	5	3	Tch	Much iron reported
36	341933N	0775205	1	RAEFORD TRASK	P	I			87		6	X	39	12								Kpd	
37	341934N	0775253	1	ARTHUR KAUFMAN	P	U			29		1	X	28	4								Tch	
38	341954N	0775316	1	K E KORNEGAY	P	H	C		58	52	2	X					5	7'	1	6	3	Kpd	
39	341959N	0775312	1	MR HILL	P	H			52	24	2	X		9	*100							Tch-Kpd	
40	342015N	0775323	1	H A BRANCH JR	P	H	P		40		2	X					5		1	6	3		
41	342001N	0775431	1	S C STRICKLAND	P	U	P		24		1	X	21	7			7					Tch	
42	342003N	0775434	1	S C STRICKLAND	P	H			90	81	2	X	21	6	45							Kpd	

* Estimated. ' pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
43	342010N	0775441	1	J W SAVAGE	P	H	P		44		2	X	*21	5	*60		6		1	4	2	Tch-Kpd	
44	342017N	0775436	1	J S CAMERON	P	U			40		4	X		8								Kpd	
45	342018N	0775441	1	J S CAMERON	P	U			179		4	X		8			3	7	5			Kpd	
46	342018N	0775445	1	J S CAMERON	P	H			55		1	X					3	7	1	6		Kpd	
47	342007N	0775504	1	HUGH OOSTERWYK	P	I			71		3	X	21	6								Kpd	
48	342000N	0775524	1	HUGH OOSTERWYK	P	I	P		74		8	X	21				5		2	6	4	Kpd	
49	341936N	0775527	1	S J SZCZERBIAK	P	H			100		1	X	25	1			4		2	6	3	Kpd	
50	341926N	0775658	1	USGS	F	U	C	GJ	54	52	2	T	34				4	7'	0	4	2	Kpd	Obs., Temp. 65°F, Auger #32
51	341928N	0775939	1	USGS	F	U	C	GJ	48	46	1	T	18	15			0		0	0	0	TQ	Obs., Auger #[illegible]
52	341957N	0775957	1	USGS	F	U		J	38	36	2	T	7									TQ	
53	341932N	0780127	1	USGS	F	U	C	G	20	18	2	T	3	1									Auger #41
54	341832N	0775904	1	USGS	F	U		GJ	65	62	2	T	17									TQ	
55	341910N	0775634	1	USGS	F	U		GJ	75	73	2	T	39									Kpd	Obs., Auger #25
56	341919N	0775526	1	JOHN G OWENS	P	H			40		1	X	25	7								Kpd-Tch	
57	341847N	0775531	1	MAGGIE L ALLEN	P	H			46		1	X		8								Kpd	
58	341844N	0775524	1	ST JAMES AME CH	P	T	P		54		2	X	36	10			5		1	6	3	Kpd	
59	341912N	0775510	1	US DEPT OF AGRI	F	I			45	35	3	X		5	100		6		0	5	3	Tch	
60	341920N	0775458	1	US DEPT OF AGRI	F	U		J	31		3	X	35	5								TQ	Observation well
61	341839N	0775352	1	RAEFORD TRASK	P	U			27		1	T	35	5								TQ	
62	341918N	0775303	1	PAULINE CORE	P	H			72		2	X	28	6								Kpd	
63	341904N	0775208	1	RAEFORD TRASK	P	I		J	119		4	X	38	11								Kpd	
64	341912N	0775153	1	RAEFORD TRASK	P	I			64		4	X	40	4	*100							Kpd	
65	341845N	0775153	1	RAEFORD TRASK	P	I		J	98	84	6	X	38	8	250							Kpd	
66	341856N	0774628	1	E C BRINKLEY	P	H	P		14		36	X	48	11			1	6	2	3		TQ	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location: Lat	Well location: Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	Quality of water: pH	Quality of water: Cl	Quality of water: Hardness	Quality of water: Sp.Cond.	Water-bearing unit	Remarks
67	341902N	0774617	1	USGS	F	U		GJ	74	72	1	T	48									Tch	Obs. well, Auger #47
68	341905N	0774618	1	J C WELLS	P	H	C		70	60	1	X	50	26			5	6'	1	6	4	Tch	Temp. 66°F.
69	341913N	0774615	1	J F SWAN SR	P	H			100		2	X	50	28			8		1	6	3	Tch	
70	341911N	0774611	1	J F SWAN JR	P	H	C		172	130	2	X	46				6	6'	1	6		Kpd	
71	341816N	0774458	1	RALPH MOORE	P	H			30	22	2	X	24	11	15							Tch	Temp. 66°F.
72	341819N	0774450	1	HARRY L SMITH	P	H			20	18	1	T	20	9			0		2	5	3	TQ	Cl 2280 at [illegible]
(14) 73	341754N	0774440	1	MR ORNESBY	P	H		JD	165	159	2	X	18	9			3	7				Kpd	
74	341753N	0774441	1	R G JOHNSTON	P	H	P		60		2	X					1	7	4	7		Tch	
75	341747N	0774444	1	E E CASTEEN	P	H	P		47	27	2	X		17			1	7	5	7		Tch	
76	341743N	0774611	1	COR-DAVIS HOME	N	T	P		181	131	6	X	25	10	*450			7'	3			Kpd	
77	341738N	0774634	1	JOHN F MURRAY	P	H	P				1	X	23	12			1	7	1	4		Tch	
78	341755N	0774628	1	C E RIVENBARK	P	I	P		75		6	X		17	450		1		0	4	2	Tch	
79	341820N	0774646	1	C E RIVENBARK	P	I		J	60	38	2	X	40	12								Tch	
80	341800N	0774714	1	R D DREW JR	P	H			55		2	X	42	21			5		0	5	3	Tch	
81	341741N	0774655	1	W J WILSON	P	H	P		21	19	1	T	24	15			7		0	2	2	TQ	
82	341731N	0774704	1	W J WILSON (9)	P	I			81	32	6	X	29	18	275	23	6		1	5	3	Tch	
83	341738N	0774752	1	A L SOUTHERLAND	P	H			56	52	1	X	36	12			5		1	6	3	Tch	
84	341722N	0774803	1	G P WILSON	P	U			41		1	X	37	20								Tch	
85	341746N	0775048	1	JOHN D MURRAY	P	H	P		123		2	X	42	16			5		0	7	3	Kpd	
86	341745N	0775123	1	JOHN D OLSEN	P	H	C		120	105	2	X	34	13			4	7'	1	6	3	Kpd	
87	341741N	0775123	1	USGS	F	U	C		740	120	4	X	32									Kpd	Test well
(15) 88	341722N	0775223	1	ALEXENDER WEIDE	P	H			109	78	2	X	42	17						5		Kpd	
89	341817N	0775414	1	USGS	F	U		GJ	55	53	1	T	38									Tch	Obs. well
(16) 90	341734N	0775406	1	RAEFORD TRASK	P	I		J	83		6	X	31									Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in).	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
91	341711N	0775401	1	RAEFORD TRASK	P	I		J	90		8	X	28		300		4	7'	2	6	3	Kpd	Temp. 65°F.
92	341724N	0775436	1	CORNELIUS MOORE	P	C			21	19	1	T	34	12								TQ	
93	341720N	0775443	1	USGS	F	U		GJ	130	128	1	T	34	11								Kpd	
94	341722N	0775448	1	J C LONG	P	H		G	55	51	2	S	35	13	*20		1		1	2	1	TQ	
95	341751N	0775451	1	J L SMITH	P	H		J	62		2	X	34	13								Tch-Kpd	
96	341758N	0775456	1	REED SMITH SR	P	H	P		55	42	2	X	30	9				7'				Kpd	
97	341818N	0775459	1	SWART SONS INC	N	U	P		367	309	8	X	35	1	*30			9	8			Kpd	Temp. 67°F., Br 22 ppm
98	341815N	0775512	1	A D COX	P	I			63		4	X	28	13	*50							Kpd	
99	341816N	0775516	1	A D COX	P	H			45		1	T	33	14								TQ	
100	341759N	0775507	1	G PLOTT	P	H			70	52	2	X	30	9								Kpd	
101	341754N	0775512	1	TINGA NURSERY	P	I			80	35	4	X	32		100+		6		1	5	3	Kpd	
102	341806N	0775530	1	E M STANLEY	P	H	P		67		2	X	*20	8	*100		7		1	6	4	Kpd	
103	341738N	0775532	1	C R WATTS	P	U			29	27	1	T	23	12								TQ	
104	341755N	0775612	1	ROY BROWN	P	H			26	24	1	T	26	20								TQ	High Fe content rept.
105	341811N	0775630	1	E H TINGA	P	U			28	26	1	T	26	10								TQ	
106	341753N	0775836	1	USGS	F	U		GJ	57	47	2	S	14									TQ	
107	341700N	0775921	1	USGS	F	U		GJ	50	47	2	T	11									TQ	
108	341705N	0775902	1	CAROLINA POWER	N	N	C	D	53	33	10	G	8	9	480	7		5'				Kpd-TQ	Temp. 67°F.
109	341706N	0775849	1	CAROLINA POWER	N	N			55		10	G	12									Kpd-TQ	
110	341701N	0775831	1	USGS	F	U		GJ	57	54	2	T	18									TQ	
111	341706N	0775748	1	USGS	F	U	C	G	56	53	2	T	20				1	7	0	0	0	Kpd-TQ	
112	341651N	0775738	1	CAROLINA NITRO	N	N		D	84	56	8	G	44		280							Kpd-TQ	
113	341642N	0775734	1	CAROLINA NITRO	N	N	P	J	65	30	8	G	33	27	200	18						Kpd-TQ	
114	341634N	0775732	1	CAROLINA NITRO	N	N		D	60	40	8	G	24	23	200	13						Kpd-TQ	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
115	341631N	0775721	1	CAROLINA NITRO	N	N	C	D	72	47	8	G	24	23	80	20						Kpd	
116	341619N	0775741	1	JOHNNY MALPASS	P	H	P		25	23	1	T	12	5			5		0	1	1	TQ	
117	341619N	0775727	1	SWIFT AGRI CHEM	N	N			55	35	8	G		6	*100							Kpd	
118	341609N	0775719	1	ROBERTSON CHEM	N	H			21	18	2	T		4				5'	1			TQ	Reported high Fe
119	341605N	0775718	1	ROBERTSON CHEM	N	U			47		4	X	5	3			5		0	1	0	Kpd	
120	341558N	0775719	1	HORTON IRON MET	N	H			20	15	2	T	6									TQ	
121	341558N	0775713	1	HORTON IRON MET	N	N			40		4	X	5	2	*50		8		1	4	2	Kpd	
122	341613N	0775609	1	GROVER SCOTT	P	H			60	42	2	X		14								Kpd	
123	341623N	0775604	1	FRED TOWNSEND	P	H	C		60	42	2	X	24	17	*100		6	6'	1	4	3	Kpd	Temp. 66°F.
124	341706N	0775544	1	W F INGOLD	P	U			20	18	1	T	25	9								TQ	
125	341646N	0775524	1	EDGAR MCKOY	P	H		D	75	72	2	X			*50							Kpd	
126	341644N	0775517	1	M K MALPASS	P	H			78	70	2	X	28	12	*100							Kpd	
127	341624N	0775452	1	NEW HAN AIRPORT	M	U	P	DJ	89		8	X	29	15								Kpd	Specific cap. 34 gpm/ft.
128	341623N	0775455	1	NEW HAN AIRPORT	M	P			105	65	8	X		15	211	9						Kpd	
129	341616N	0775505	1	NEW HAN AIRPORT	M	P			102	93	8	X		17	300	8						Kpd	
130	341605N	0775523	1	PILOT FRGT INC	N	C			75	51	2	X	25	12								Kpd ?	
131	341550N	0775355	1	ADC DIS COMPLEX	F	P	C				8	X		8	425	13						Kpd	12" in 5x6 orifice
132	341545N	0775339	1	ADC DIS COMPLEX	F	P			96	74	8	X		1	445	8	5		2	5	3	Kpd	13" in 5x6 orifice
133	341623N	0775357	1	S H FEENSTRA	P	H	P		20	17	1	T	21	5			6		1	0	1	TQ	H_2S
134	341628N	0775357	1	S H FEENSTRA	P	I	C		113		8	X	20	0			5	7'	1	6	3	Kpd	Temp. 64°F.
135	341629N	0775351	1	S H FEENSTRA	P	I		J			4	X		2								Kpd	H_2S
136	341622N	0775332	1	FRED A JORDAN	P	U			25	23	1	T	21	6			5		1	2	1	TQ	H_2S
137	341649N	0775329	1	DOROTHY PEOPLES	P	H	P		22	20	1	T	24	4			7		1	2	1	TQ	H_2S
138	341652N	0775248	1	J N CORBETT	P	U			36	34	1	T	40	9								TQ	

* Estimated.　'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
139	341649N	0775249	1	E E LEWIS	P	H	C		121	90	2	X	41	5	*130		3	7	0	5	3	Kpd	Temp. 66°F.
140	341641N	0775240	1	G W SHEARON	P	H	P		115	110	2	X					5		0	5	3	Kpd	
29 -141	341626N	0775241	1	HARRELLS BLDG (6)	N	I		J	87		6	X	29	3			6	7'	0	5		Tch-Kpd ?	Temp. 65°F.
142	341635N	0775147	1	HERBERT NEWTON	P	H					2	X	38	19			5	8	0	5	4	Kpd ?	
143	341629N	0775139	1	RAYMOND MCKOY	P	H	P		20	17	1	T	45	5								TQ	
144	341610N	0775045	1	E F PRIDGEN	P	P		D	146	92	2	X	41	21			5		0	5	3	Kpd	
145	341608N	0774923	1	NEGRO CHURCH	P	T		J	87		4	X	46	6								Tch	
146	341616N	0774907	1	J W COVIL	P	C	P		75		2	X		18	*60		6		1	6	3	Tch	High Fe
147	341613N	0774857	1	CHRISTIAN CH	P	T	C		65	50	2	X	45	12				7'				Tch	Temp. 68°F.
148	341646N	0774858	1	FRANK PARKER	P	H		J	155	60	2	X	47									Tch-Kpd	
149	341646N	0774842	1	BAYSHORE EST	N	U		J	68		2	X	44	9								Tch	
150	341639N	0774830	1	E K CARTER JR	P	H	P				1		31				4		0	4	2		
151	341634N	0774758	1	M L HONEYCUTT	P	H		G	80	40	2	X	16	12								Tch	
152	341641N	0774750	1	M P RAINES	P	H		G	90		2	X	20	13	*30		5		1	5	3	Tch	
153	341637N	0774747	1	D P HERBERT	P	H			50	41	2	X		15	*20							Tch	
154	341654N	0774739	1	M MARSHBURN	P	H	C		150	110	2	X	23					7'				Kpd	Tem. 66°F., much H_2S
155	341648N	0774642	1	W J ROBINSON	P	H	C		60	55	1	X	10				2	7'	2	5	3	Tch	Temp. 66°F.
156	341723N	0774503	1	C M DAVIS	P	H	P		85			X					0		3	4	3	Tch	
157	341712N	0774510	1	M H BELL	P	H	P		120		2	X					0	8	2	5		Tch	
158	341659N	0774522	1	G A RYALS	P	H			180	126	2	X	20	15	*50		5		2	6	4	Kpd	
159	341654N	0774525	1	J N MCCARTNEY	P	H	P		42	40	1	X					0	8	5	7		Tch	
160	341652N	0774526	1	G D FARMER	P	H	C		180	127	2	X	20	15				7'				Kpd	Temp. 66°F.
161	341631N	0774548	1	CAMERON - TRASK	P	H	P		38		1	T					1		1	5	3	TQ	
162	341629N	0774552	1	CAROLINA POWER	N	H	P		70		2	X					0		1	4	2	Tch ?	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location: Lat	Well location: Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
163	341613N	0774628	1	J N CORBETT	P	U		J	65		2	X	5									Tch	Reported brackish
164	341613N	0774624	1	P R MASON	P	H	P		42		1	X	8	9	*20		2		4	7	5	Tch	H_2S odor
165	341539N	0774700	1	ROBERT JAMES	P	H			60		2	X	23	17	15		5	7	0	4	2	Tch	Temp. 67°F.
166	341530N	0774653	1	GEORGE HULBERT	P	H			48	42	2	X	27	27								Tch	
167	341525N	0774643	1	DR HK THOMPSON	P	H	C		165		3	X		30								Kpd	
168	341515N	0774653	1	L M MERRILL	P	A	P		186	124	4	X	6	8	250		2	7	2	6		Kpd	1.1 ppm H_2S
169	341512N	0774735	1	DR WC VONGLAHN	P	H		D	83	64	4	X	24	16	*40		5		1	6	3	Tch	
170	341557N	0774837	1	OGDEN SCHOOL	C	P		D	93	68	6	X	31	12	250		4		1	6	3	Tch	
171	341527N	0774910	1	W E COVIL	P	I			204		6	X	19	2	400		2		1	6	4	Tch-Kpd	H_2S odor
172	341535N	0774941	1	E B TOWLES	P	P			163	81	4	X	*39	19								Tch-Kpd	
173	341537N	0774944	1	E B TOWLES	P	P		J	157	64+	2	X	44									Tch-Kpd	
174	341549N	0774949	1	J D HENEGAR SR	P	H			162	95	2	X	46				4		1	6	4	Kpd ?	
30 —175	341531N	0774958	1	NC HWY PATROL (H)	S	H	C	D	180	86	6	X		30	165		5	7	1	6	4	Tch-Kpd	
176	341515N	0775040	1	CHARLES WELLS	P	H		G	153	63	2	X	44	17	*70		5		0	5	3	Tch-Kpd	Temp. 67°F.
177	341426N	0775115	1	RICHARD NAPIER	P	H	C		160	130	4	X	47					7				Kpd	Temp. 68°F.
178	341454N	0775128	1	COLL VIEW TRLR	P	P	C		62		2	X		8	60+		4	7	1	5	3	Tch	Temp. 65°F.
179	341457N	0775144	1	JOHN TAYLOR	P	H	P		130	60	2	X	38	7			5		1	2	1	Tch-Kpd	
180	341457N	0775144	2	JOHN TAYLOR	P	U	P		30	24	1	T	38	6			5		1	2	1	TQ	
31 —181	341508N	0775213	1	CORNING GLASS	N	U		DJ	140		8	G	27	7	250	60	5	8	2	6	3	Kpd	Temp. 66°F., H_2S odor
182	341522N	0775218	1	HOME REALITY	N	C	P		25	21	2	T	31	8			3		0	2	1	TQ	
183	341446N	0775220	1	B W PARSONS	P	P			25	21	2	T		9								TQ	
184	341444N	0775241	1	W K RHODES	P	H		D	96	53		X		8	10	10						Tch-Kpd	
185	341526N	0775304	1	J D DILL	P	H	P		80		2	X					0	8	2	4	3	Kpd	Temp. 65°F.
186	341551N	0775311	1	M L BLAKE	P	H	P	D	87	79	4	X	17	6	*100		3		1	5	3	Kpd ?	

* Estimated.

'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location		Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water					Water-bearing unit	Remarks
	Lat	Long															Iron	pH	Cl	Hardness	Sp.Cond.		
187	341525N	0775315	1	ALLENDALE DEV	P	U			29		1	T	21	11								TQ	
188	341526N	0775325	1	E C AKERS	P	H			70	43	2	X	15									Kpd	Flows
189	341519N	0775328	1	H C JOHNSTON	P	H			92		2	X	28	15								Kpd	
190	341438N	0775321	1	LEON SULLIVAN	P	P			129	42	3	X	38	16	100+							Tch-Kpd	
191	341432N	0775313	1	SANDRE - BASS	P	H			151	57	2	X	40	22								Tch-Kpd	
192	341431N	0775320	1	BECKERS BLDS	N	C	C		150	105	2	X	42		*40		5	7'	1	6	3	Kpd	Temp. 67°F.
193	341405N	0775426	1	D L SNEEDEN	P	S			130	35	2	X	36	10								Tch-Kpd	
194	341402N	0775434	1	JOS FREEDLAND	P	A		D	89	72	4	X		12	*100							Tch-Kpd	
195	341405N	0775435	1	B W NEWKIRK	P	H		D	87	40		X		19	*60							Tch-Kpd	
196	341430N	0775448	1	BNAI ISR SYNAG	P	A		D	94	15		X	35	8	100	14						Tch-Kpd	
197	341411N	0775512	1	RUDOLPH KONIG	P	H		D	75	27	4	X					1		1	6	3	Tch-Kpd	
198	341441N	0775511	1	J FRED MURRAY	P	I		D	97	75	4	X	28	25	*100		5		1	5	3	Kpd	
199	341438N	0775515	1	R L DAVIS	P	I		G	90	34	2	X	28	24								Tch-Kpd	
200	341517N	0775544	1	SOUTHERN BOX	N	N	P		85		6	X	21	20	185				2	5		Kpd	
201	341507N	0775621	1	BOYLE ICE CO	N	C			65		8	X			650				2			Kpd	
202	341530N	0775651	1	HILTON PARK CO	M	U	P	G	1330		6	X	9		*50		5	8	8	5	8	Kpd ?	Temp. 70°F., Br 31 ppm
203	341512N	0775653	1	HILTON PARK CO	N	U			80		10	X	10	6	400							Kpd	
204	341437N	0775636	1	INDEPENDENT ICE	N	U			120	75	12	X			325	6			2	6		Kpd	
205	341417N	0775616	1	COCA COLA BOTT	N	C	P		180		4	X	44	19	*80		2		1	5	3	Kpd	
206	341413N	0775618	1	WARDS FUNERAL	N	U		J	82		4	X	53									Tch-Kpd	
207	341407N	0775644	1	PEOPLES SAVINGS	N	A			86		6	X	38	31	100	12						Kpd	Fe bacteria rptd.
208	341407N	0775644	2	PEOPLES SAVINGS	N	A		D	122	108	8	G	38	44	96		2	8	2	4	3	Kpd	
209	341407N	0775644	3	PEOPLES SAVINGS	N	A	C	D	133	110	8	G	36	41	97	13						Kpd	
210	341430N	0775655	1	WILM COLD STOR	N	C		J	104		10	X	21	26								Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location: Lat	Well location: Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
211	341412N	0775702	1	WACHOVIA BANK	N	U			80		6	X							3			Kpd	Test well
212	341409N	0775738	1	USGS	F	U	P	G	93	91	1	T	4				5	7	3	6		Kpd	Auger hole #40
213	341403N	0775818	1	TERMINAL CITY	N	C			63		3	S	4	8	*6							Kpd	
214	341407N	0775609	1	ROSE ICE CO	N	C			96		6	X										Tch-Kpd	Cl rept. 62 ppm in 1942
215	341407N	0775605	1	NEW HAN HIGH SC	C	P		D	122	50	6	X		18	165							Kpd	
216	341349N	0775637	1	5TH AVE BAPT CH	P	T		D	90	58	6	X	45	18	*35							Kpd	
217	341331N	0775646	1	BRIGADE BOYS CL	P	T		J	115	40	4	X	47	42								Kpd	
218	341330N	0775522	1	PEPSI COLA BOTT	N	C		D	75	41	8	X	37	11	220	20	5		0	5	3	Tch-Kpd	
219	341324N	0775521	1	WHITEBROOK FARM	N	C					8	X	38		150							Tch-Kpd	Rept. Cl 62 ppm, Hard. 210
220	341314N	0775442	1	ALBERT PERRY	P	I	P		163	58	3	X	35		*80		5		0	5	3	Tch-Kpd	
221	341327N	0775434	1	L B FINBERG	P	I			135		4	X			*100							Tch-Kpd	
222	341306N	0775356	1	R A YOPP	P	H		G	135	100	4	X	40	2								Kpd	
223	341329N	0775341	1	J D PRIDGEN	P	H			25	21	1	T	28	7	*10							TQ	
224	341302N	0775352	1	D E JOHNSON	P	H	P	G	140	50	2	X	38	9	*40		4		1	6	3	Tch-Kpd	
225	341243N	0775331	1	W S ARTHURS	P	H			98	58	2	X	42	10								Tch	
226	341337N	0775312	1	L J MINTZ	P	H		D	140	86	4	X	38	28	165		5		1	6	3	Kpd	
227	341416N	0775206	1	W D MCKEE	P	H		J	135	60	2	X	41									Tch-Kpd	
228	341337N	0775239	1	WILM COLLEGE	S	A	P	D	165	80	10	G		12	340	80	2	8	2	6	3	Tch-Kpd	Temp. 66°F.
229	341330N	0775236	1	WILM COLLEGE	S	U		J	84		4	X	42									Tch	
230	341336N	0775232	1	WILM COLLEGE	S	A	P	D	180	80	10	G		7	360	50						Tch-Kpd	
231	341303N	0775236	1	M J PIERCE	P	H	P	D	170	80	2	X	42		*60		4		0	5	3	Tch-Kpd	
232	341255N	0775231	1	MRS EARL BIGGS	P	H			35	31	1	T	40	13			4		1	1	1	TQ	
233	341237N	0775252	1	ANDY MASON	P	H		G	159	76	2	X	*42									Tch-Kpd	
234	341233N	0775231	1	E R WILSON	P	H		D	163	82	4	X	41	30			3		1	5	3	Kpd	

* Estimated.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location: Lat	Well location: Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
235	341236N	0775216	1	RUSSELL KEY	P	H		D	147	71	4	X	*35	15			3		0	5	3	Kpd	
236	341253N	0775211	1	EVA BERKLEY	P	H			160	78	2	X	39	16								Tch-Kpd	
237	341250N	0775203	1	LESTER ROBINSON	P	H			87	79	4	X		8	*35							Tch	
238	341251N	0775158	1	D W BENNETT	P	H		G	165	86	2	X	*32	16	*60		3		0	4	2	Kpd	
239	341244N	0775150	1	CAPE FEAR HOSP	P	T		J	154		6	X	34				2		2	5	3	Tch-Kpd	
240	341253N	0775148	1	B L FOWLER	P	H			146	70	2	X	34	14								Tch-Kpd	
241	341259N	0775139	1	L A BARNES	P	H			150	60	2	X	30	6	*40		1		0	5	3	Tch-Kpd	
242	341258N	0775134	1	R E HARRELL	P	H		G	159	64	2	X	30		75		3		1	5	3	Tch-Kpd	Obs. well
243	341257N	0775127	1	E C ORRELL	P	H		J	139	60	2	X	25									Tch-Kpd	
38 - 244	[illegible]	0775050	1	J P ELLINGTON (16)	P	H	P	P	145	60	2	X	8	6			0	7'	2	5	4	Tch-Kpd	Temp. 65°F., Flows 12 [illegible]
245	341248N	0775029	1	A B POWLASS	P	H			160	59	2	X	15	15								Tch-Kpd	
246	341314N	0774956	1	J J DENNING	P	H			170	120	2	X	34	16			2	8'	2	5	4	Kpd	
247	341240N	0774958	1	BRAD CK MARINA	N	C			178	65	8	X	21	17	500							Tch-Kpd	Rept. yield
248	341246N	0774917	1	WSR BEANE	P	H			175	74	4	X		17								Tch-Kpd	
249	341318N	0774906	1	EARL MILLER	P	H	C		100	64	2	X	15	9				7'				Tch	
250	341316N	0774902	1	BABIES HOSPITAL	P	T		D	136	72	6	X		8	250							Tch	
251	341313N	0774859	1	BABIES HOSPITAL	P	T		D	107	62	6	X		8	650							Tch	
252	341308N	0774856	1	WATERWAY MOTEL	P	C		J	172		6	X	10									Tch-Kpd	
253	341248N	0774813	1	WRIGHTSVILLE BE	M	P	C		182	140	8		3	40	200							Kpd	
39 -254	341253N	0774753	1	JOHN ANDERSON	P	U		GJ	169	128	2	X	5	15	60	15	3		2	5	4	Kpd	
255	341303N	0774717	1	WRIGHTSVILLE BE	M	P	C		179	163	10		8	40	150							Kpd	
256	341253N	0774730	1	WRIGHTSVILLE BE	M	P	C		176	146	10		10		150							Kpd	Has yielded 300 [illegible]
257	341239N	0774736	1	WRIGHTSVILLE BE	M	P	C		193	156	8		10		140							Kpd	Tested at 430 gpm for 10 hrs.
258	341227N	0774749	1	WRIGHTSVILLE BE	M	P	C		180				6	35	175							Kpd	

* Estimated.

'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
259	341207N	0774804	1	WRIGHTSVILLE BE	M	P	C		180		8		6		175							Kpd	
260	341148N	0774813	1	WRIGHTSVILLE BE	M	P	C		178				10	30	175	23						Kpd	
261	341140N	0774820	1	WRIGHTSVILLE BE	M	U	P	GE	412			X	5									Kpd	Stratigraphic test
262	341118N	0774837	1	WRIGHTSVILLE BE	M	P	C		174	160	10		8	32	150	90						Kpd	
263	341135N	0775024	1	L M WALLACE	P	H		J	165		2	X	19	24								Tch-Kpd	
264	341216N	0775046	1	U R CARROLL	P	H	C	G	70	54	2	X	25	12			5	7'	1	5	3	Tch	
265	341216N	0775046	2	U R CARROLL	P	U	P		29	25	1	T	25	14			6		1	2	1	TQ	
266	341209N	0775114	1	M E ROGERS	P	H			150	80	2	X	18	12			4		1	5	3	Tch-Kpd	Temp. 66°F.
267	341209N	0775114	2	M E ROGERS	P	U			34	30	1	T	18	13								TQ	
268	341139N	0775114	1	DR W A PHILLIPS	P	S			110	45	2	X										Tch	
269	341222N	0775134	1	A H HARRELL	P	H			100	70	2	X		16								Tch	
270	341217N	0775136	1	J O PETTET	P	H			100	72	2	X	18	8								Tch	
271	341215N	0775144	1	W H RIVENBARK	P	H			100	70	2	X	23	10								Tch	
272	341201N	0775146	1	W S SLATER	P	H			140	70	2	X	14	2								Tch-Kpd	
273	341215N	0775149	1	A M FOSTER	P	H			100	73	2	X	21									Tch	
274	341221N	0775157	1	V K PAINTER	P	H		J	134		2	X	26									Tch-Kpd	
275	341202N	0775151	1	ROBERT MEADOWS	P	H			85	63	2	X	15	3				7'				Tch	
276	341135N	0775202	1	RAY HOLLAND	P	H	P		177	80	2	X	12	+ 2			1	7'	2	5	4	Tch-Kpd	Flows 1-6 gpm
277	341200N	0775227	1	W GRANEY	P	H		J	149	130	2	X	27	8								Kpd	
278	341202N	0775309	1	JACK ROGERS	P	H	P	G	162	81	2	X	44				3		0	5	3	Tch-Kpd	
279	341223N	0775403	1	GILBERT PARRISH	P	H			150	110	2	X	45	21								Kpd	
280	341227N	0775408	1	W F ELMORE	P	H		G	150		2	X	48	11								Tch-Kpd	
281	341231N	0775412	1	R P BROWN	P	H	C		140	100?	2	X	41					7'				Tch-Kpd	Temp. 65°F.
282	341245N	0775412	1	W F ANDERSON	P	H			140		2	X	41	21								Tch-Kpd	

'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
283	341238N	0775452	1	DR S V ALLEN	P	I	P		19	16	1	T			*15		7		2	2	2	TQ	
284	341234N	0775502	1	W B BEERY III	P	I			155		6	X	33									Kpd	
285	341230N	0775450	1	MR STALLWORTH	P	H			158	66	3	X	45	29	*100							Kpd	
286	341206N	0775457	1	C R BRINDELL	P	H			160	60	2	X	55	46	*20							Tch-Kpd	
287	341238N	0775547	1	GEORGE LAMICA	P	H	C		30	24	2	X	22				2	7'	0	4	2	Tch	
288	341220N	0775553	1	JOHN W DIXON JR	P	H	C		110	90	2	X	*7	1			1	8'	0	4	2	Kpd	Temp. 67°F, H_2S odor
289	341220N	0775613	1	LEE E MORROW	P	H			26	22	1	T	10	3								TQ	
42 – 290	341207N	0775630	1	SUNSET PK METH	P	T		D	82		8	X	19	15								Kpd	
291	341202N	0775638	1	SUNSET CO 3	N	U	P		140		6	G			132				2	3		Kpd	Temp. [illegible]
292	341214N	0775639	1	SUNSET CO 4	N	U			140		6	G			150	18						Kpd	
293	341210N	0775654	1	BILL CANNON	P	U			20	16	1	T	23	11								TQ	
43 – 294	341146N	0775703	1	WILM SHIPYARD	F	C		D	123	70	10	G		20	275	58						Kpd	
295	341141N	0775703	1	WILM SHIPYARD	F	U	P							13								Kpd	
296	341132N	0775702	1	WILM SHIPYARD	F	A	P		103	81	10	G		28	300	48	1	8	1	3	2	Kpd	
297	341126N	0775708	1	SHELL OIL CO	N	C	P		76	36	8	X		6	*325	6	7	7	2	4		Kpd	
298	341125N	0775630	1	WECT TV	N	A			133	55	4	X	52	26	100+							Tch-Kpd	
44 – 299	341127N	0775609	1	MOFFIT VILLAGE (17)	N	P		G	175		10		43	9	140	37						Tch-Kpd ?	
300	341138N	0775606	1	L W CARROLL	P	H			57	44	4	X	*30	14			7		0	4	2	Tch	
301	341120N	0775555	1	NATL YOUTH ASSN	P	U		D			6		56	24								Tch-Kpd	
45 – 302	341112N	0775559	1	HANOVER MILLS (18)	N	N			157	79	8	X	57	30	*100	17		8	1			Tch-Kpd	
303	341058N	0775555	1	H B LUDLUM	P	H		G	140	76	2	X	56	17								Tch-Kpd	
304	341134N	0775406	1	J R KUTRON	P	H	P		160	60	2	X	40		*40		5		0	5	3	Tch-Kpd	
305	341139N	0775357	1	H M DANIELS	P	H	P		160		4	X	48		100+		6		0	6	3	Tch-Kpd	
306	341124N	0775357	1	FRED CONNER	P	H	P		160	60	3	X	50	19			5		0	6	3	Tch-Kpd	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
307	341107N	0775406	1	G L KEIFER	P	H		J	146		2	X	39	14								Tch--Kpd	
308	341115N	0775340	1	S FOREST JR	P	H	C		150	79	2	X	50	21			3	7'	0	5	3	Tch--Kpd	H_2S odor
309	341114N	0775334	1	W H BANNERMAN	P	H	C		80	70	2	X	50	18	*17		3	7'	0	5	3	Tch	
310	341113N	0775331	1	MARGARET JONES	P	H	P		170	94	2	X	50	27	*60							Tch-Kpd	
311	341116N	0775316	1	J D MCFAYDEN	P	H			170	84	2	X	*51	18								Tch-Kpd	
312	341110N	0775318	1	D W NOBLES	P	H		J	154		2	X	50		*40							Tch-Kpd	
313	341103N	0775318	1	J M GAITHER	P	H		G	170	89	2	X	50	29								Tch-Kpd	
314	341045N	0775142	1	PARSLEY ESTATE	P	U			158		4	X	28	23								Tch-Kpd	
315	341103N	0775137	1	HERMAN WALTON	P	C	P		62		2	X	15	4	*80		5		1	5	4	Tch	
316	341101N	0775042	1	C R MALOTT	P	H	C		163	125	3	X	*12	9	*100		2	8'	2	5	4	Kpd	
317	341052N	0775036	1	H V REID	P	H	C	D	94	90	4	X	12	10	100		5	8	2	6	4	Tch	Partial f[illegible]
318	341042N	0775043	1	A D HURST	P	H	P		44		1	T	12	11			3		1	6	3	TQ	
319	341040N	0775044	1	A D HURST	P	U			66		2	X	15	13								TQ	
320	341030N	0775054	1	JAMES FERGER	P	I	P		185		2	X	*21		*60		2		2	5	3	Tch-Kpd	H_2S odor
321	341000N	0775105	1	C H MCALLISTER	P	I	P		144	85	3	X		10			2		1	6	3	Tch-Kpd	
322	340938N	0775119	1	R E JULIAN	P	H	P		150	85	2	X		30			3		1	5	3	Tch-Kpd	
323	340935N	0775134	1	B F SUTHERLAND	P	H	P	D	124	86	6	X		18			2		1	5	3	Tch-Kpd	
324	340950N	0775146	1	R C FOWLER	P	H			80	72	2	X		22								Tch	
325	340939N	0775155	1	A B JENKINS	P	H			100	70	2	X		15								Tch	
326	340926N	0775152	1	H H HODGIN	P	H	P		140	105	2	X	*18	19			5		0	5	3	Tch	
327	340914N	0775212	1	M EMHART JR	P	H	P		140		2	X		20			0		1	5	3	Tch	
328	340954N	0775235	1	W J HODDER	P	U			175		2			6								Tch-Kpd	
329	340958N	0775239	1	W J HODDER	P	I		J	170		4	X	21	14								Tch-Kpd	
330	341018N	0775320	1	M R SOMERSETT	P	H			160	84	2	X	44	17								Tch-Kpd	Obs. well

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
331	341012N	0775320	1	A L TODD	P	H	C		100		2	X						7'				Tch	Temp. 66°F.
332	341025N	0775520	1	W J LANGLEY	P	P	P		117		2	X	30		60+		4		0	5	2	Tch-Kpd	
333	341037N	0775528	1	ONIETA DAVIS	P	H	P		120		2	X					4		0	4	2	Tch-Kpd	
334	341034N	0775539	1	E J BELLAMY	P	H		J	108		2	X	30	12								Tch-Kpd	
335	341036N	0775607	1	TENNY ENGINEERS	N	N	P	D	120	104	6	X		9	226		2	8'	2	4	2	Kpd	Temp. 67°F.
336	341037N	0775611	1	TENNY ENGINEERS	N	N		D	122		6	X		11								Kpd	
337	341030N	0775619	1	USGS	F	U		G	38	36	1	T	36									TQ	Obs. Well, auger hole #19
338	341015N	0775654	1	STACKHOUSE INC	N	N	P		135		4	X					1		2	4	3	Kpd	H_2S odor
339	341006N	0775519	1	ECHO DAIRY	P	C	P		160	70	6	X			150		4		1	5	3	Kpd	
340	340949N	0775522	1	ECHO DAIRY	P	H	P		160	70	4	X		10	100+		2	7'	2	4	3	Kpd	Temp. 67°F.
341	340939N	0775533	1	ECHO DAIRY	P	I	P		48		10	X	3	+5			0	8	2	4	3	Kpd	Flows
342	340909N	0772620	1	ALLIED KENNECOT	N	U	P	GJE	142		10	G	17	13	600				2			Kpd-TQ	
343	340909N	0775628	1	ALLIED KENNECOT	N	N	C	J	151		8	S	12	6	60	15		8'	3			Kpd	Obs. well, Temp. 67°F.
344	340907N	0775440	1	G H COOK	P	H	P		132	72	2	X	10	1			0		2	4	3	Kpd	
345	340905N	0775406	1	J A EDWARDS	P	H	P		30		1	T	22				6	6'	1	4		TQ	Temp. 65°F.
346	340905N	0775406	2	J A EDWARDS	P	I	P		62		1	T	22				7	7'	1	6		TQ	
347	340905N	0775406	3	USGS	F	U	C	GJE	630		6	X	22									Kpd	Test well
348	340905N	0775413	1	W I MILLER	P	U			35		1	T	23	8								TQ	
349	340902N	0775410	1	J A EDWARDS	P	H	C		165	130	4	X	23	14			1	8'	2	4	3	Kpd	
350	340842N	0775426	1	HUGH NOFFSINGER	P	H	P		37	33	2	T	*20	8	8		5		0	1	0	TQ	Much H_2S
351	340829N	0775344	1	MR PRESLEY	P	P		D	161	74	4	X	20	7	250							Tch-Kpd	
352	340802N	0775351	1	N W DINKINS	P	H		G	130	112	2	X	36	21	*15		4		0	4	2	Kpd	
353	340802N	0775351	2	N W DINKINS	P	U			18		1	T	36	11								TQ	
354	340811N	0775334	1	W E HARRIS	P	H	P		140	92	2	X	37	16	*50		4		0	4	2	Tch-Kpd	

* Estimated.   'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
355	340803N	0775337	1	GEO W JAMES	P	H			155	107	2	X	42	20								Tch-Kpd	
356	340807N	0775246	1	OTTIE SULLIVAN	P	H	P		200+		4	X	28	16			2		1	6	3	Tch-Kpd	
357	340815N	0775243	1	FERGER NURSERY	P	C	P		57		2	T	28	11			6		1	6	4	TQ	
358	340825N	0775236	1	M S EMMART	P	H			50		1	T	29	17								TQ	
359	340803N	0775234	1	W G SUTHERLAND	P	U			18	16	1	T	26	6								TQ	High Fe rept.
360	340800N	0775234	1	USGS	F	U		GJ	161	159	.2	T	26	15								Kpd	Obs. well, auger hole #29
361	340756N	0775203	1	M K LOUGHLIN (21)	P	C	P	D	185	119	4	X	5	6	50	7			3	6	5	Tch-Kpd	
362	340755N	0775209	1	JOHN HINEBUCKLE	P	H	C		135	115	2	X	10	4	5	19		7'				Tch	
363	340739N	0775210	1	T E RUSS	P	U			150	75	1	X	5	13								Tch	
364	340745N	0775238	1	C K JOHNSON	P	U			85		2	X	23	14								TQ	
365	340733N	0775212	1	JULIAN GRISSOM	P	H	P	D	125	120	4	X	5		50+		3		0	5	3	Tch	Flows
366	340727N	0775246	1	W T BRYAN	P	H	P		148	116	2	X		18								Tch	
367	340710N	0775243	1	ROBERT B LONG	P	H	P		137		1	X		15			2		0	3	2	Tch	
368	340732N	0775423	1	USGS	F	U	P		65	63	1	T	38	15			2	8'	0	3	2	TQ	
369	340720N	0775352	1	MR ROLLER	P	H			121	85	2	X	40	26								Tch	H_2S odor
370	340716N	0775354	1	A E ROLLER	P	H			140	123	2	X	34									Kpd	
371	340714N	0775356	1	R H DINGLER JR	P	H	C		119	104	2	X	40	15				8'				Tch	
372	340638N	0775258	1	HAMP BOWEN	P	H	C	G	147	128	2	X	28	18				7'				Tch-Kpd ?	Temp. 66°F.
373	340636N	0775308	1	PAUL GRIFFIN	P	H	P	D	135	122	4	X	28	18	100		5		0	5	2	Tch	
374	340622N	0775312	1	C L BOWDEN	P	H	P		112	100	2	X	22	9			1	8'	0	5	2	Tch	
375	340622N	0775312	2	C L BOWDEN	P	U	P		17		1	T	22	7			7	6	2	1	1	TQ	
376	340624N	0775357	1	J L ENGLISH	P	C	P		23	20	1	T	40	4	10		5		0	1	0	TQ	H_2S odor
377	340614N	0775403	1	K L KYE	P	U		J	133		2	X	35	14								Tch-Kpd	
378	340611N	0775403	1	W H BLACKLEDGE	P	C	P		25		1	T	31				1		0	0	0	TQ	

'pH measured in field.

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Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
379	340530N	0775346	1	LEE DAVIS	P	H	P		133	105	4	X	26	15	*200		0		1	4	2	Tch	
380	340528N	0775346	1	LEE DAVIS	P	U			17		1	T	24	6			2		2	3	3	TQ	
381	340530N	0775325	1	H H HARWARD	P	I	C	D	75	52	1	X	26	14	100							TQ	
382	340527N	0775327	1	C K STALLINGS	P	H		D	70	58	4	X	22									TQ	
383	340447N	0775347	1	ALFRED MITCHELL	P	H	C		132	91	2	X	22	12	*20		0	9'	1	4	2	Tch	
384	340420N	0775325	1	A M GOODSON	P	H			140	113	2	X	11	15								Tch	
385	340421N	0775340	1	W L BURNETT SR	P	H	P		90		2	X	15		30+		6		0	3	2	Tch	
386	340416N	0775342	1	G T FOWLER	P	U			29	26	1	T	15	6								TQ	High Fe rept.
387	340342N	0775332	1	RICHARD DAILY	P	C			55		1		6	2								TQ	
388	340340N	0775330	1	RICHARD DAILY	P	C	C	G	150	119	2	X	6	2	*20		0	7'	1	5	3	Tch	
389	340340N	0775359	1	A FREEMAN	P	U		J	104		2	X	22	14								Tch	
390	340336N	0775454	1	USGS	P	U	C	G	49	47	1	T	16	6			2	7'	0	2	1	TQ	Obs. well, auger hole #[illegible]
391	340313N	0775404	1	MCMEEKIN CONST	N	U			105	104	2	X	19	8	*30							TQ	
392	340317N	0775347	1	OCEAN REALTY	N	H		J	83		2	X	9	4								TQ	
393	340218N	0775355	1	V MARTIN	P	U		J	143		2	X	16	21								Tch	
394	340213N	0775419	1	R E WEEKS	P	H		J	167	159	2	X	26	38								Tch	
395	340210N	0775350	1	CAROLINA BEACH	M	P	C		201	96	8	X										Tch	
396	340159N	0775351	1	CAROLINA BEACH	M	P	C		195	125	8	X										Tch	
397	340158N	0775437	1	CAROLINA BEACH	M	P	C		161		8	X		27	150	33						Tch	
398	340151N	0775411	1	CAROLINA BEACH	M	P	C		189		10	X		23	150	50						Tch	
399	340147N	0775357	1	CAROLINA BEACH	M	P	C		195	125	8	X			300							Tch	
400	340143N	0775343	1	CAROLINA BEACH	M	P	C		180	125	8	X										Tch	
401	340138N	0775344	1	GRAHAM HARWARD	P	H		J	140		4	X	8	10								Tch	
402	340109N	0775412	1	WILMINGTON BCH	N	P	P		147	90	10	X			80+		2		2	7	4	Tch	

* Estimated.

'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
403	340145N	0775414	1	WILMINGTON BCH	N	P	P		153	90	10	X			100^{+}							Tch	
404	340123N	0775418	1	INTERNATL NICKE	N	U		J	126		1	X	18	23								Tch	Salty water rept.
405	340110N	0775421	1	KURE BEACH	M	P	C		202	115	8	X	17	26	265		3		2	7	4	Tch	
406	340122N	0775501	1	ETHYL DOW (24)	N	U	C	J	158		6	X	18		150			8'				Tch	Obs. well
407	335941N	0775435	1	KURE BEACH (25)	M	P	C	GJ	180	120	8	X	17	21	170	30			2	6	3	Tch	Temp. 67°F.
408	335933N	0775433	1	JAMES TEETER	P	U			15		1	T	14	11								TQ	
409	335913N	0775506	1	701ST RADAR SQ	F	A	C	D	150	109	4	X			*35							Tch	
410	335850N	0775503	1	701ST RADAR SQ	F	A	C	D	201	112	10	X	21	21	250		3		3	6	4	Tch	
411	335849N	0775506	1	701ST RADAR SQ	F	P	C		172	150	10	X			250							Tch	
412	335735N	0775628	1	FT FISHER FERRY (27)	S	P	C	D	170		6	X	10	12	30	10						Tch	

* Estimated. 'pH measured in field.

Explanation of Quality of Water Code

Constituent	Range (mg/l)	Code Number	Constituent	Range (mg/l)	Code Number	Characteristic	Range (Micromhos)	Code Number
Iron	0.00-0.05	0	Chloride	26-100	2	Sp. Cond.	0-50	0
Do	0.06-0.1	1	Do	101-250	3	Do	51-150	1
Do	0.11-0.30	2	Do	251-500	4	Do	151-300	2
Do	0.31-0.50	3	Do	501-1000	5	Do	301-500	3
Do	0.51-1.0	4	Do	1001-2000	6	Do	501-1000	4
Do	1.1 -3.0	5	Do	2001-5000	7	Do	1001-2000	5
Do	3.1 -5.0	6	Do	5001-20,000	8	Do	2001-5000	6
Do	5.1 -10	7	Hardness	0-10	0	Do	5001-10,000	7
Do	11 -15	8	Do	11-20	1	Do	10,001-20,000	8
Do	More than 15	9	Do	21-50	2			
pH	4.0 -4.9	4	Do	51-100	3			
Do	5.0 -5.9	5	Do	101-150	4			
Do	6.0 -6.9	6	Do	151-200	5			
Do	7.0 -7.0	7	Do	201-300	6			
Do	8.0 -8.9	8	Do	301-500	7			
Chloride	0 -10	0						
Do	11 -25	1						

Air Force Base