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DEPARTMENT OF CONSERVATION AND DEVELOPMENT
WILLIAM P. SAUNDERS, *Director*

Division of Mineral Resources
JASPER L. STUCKEY, *State Geologist*

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GEOLOGY AND GROUND-WATER RESOURCES
IN THE
GREENVILLE AREA, NORTH CAROLINA

By

PHILIP M. BROWN
Geologist, Geological Survey
United States Department of the Interior

PREPARED COOPERATIVELY BY THE GEOLOGICAL SURVEY
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Letter of Transmittal

To His Excellency, HONORABLE LUTHER H. HODGES
Governor of North Carolina

SIR:

I have the honor to submit herewith manuscript for publication Bulletin No. 73, "Geology and Ground-Water Resources in the Greenville Area, North Carolina", by Philip M. Brown.

This is another in the series of reports being prepared on ground water and geology in North Carolina by the Department of Conservation and Development in cooperation with the United States Geological Survey. In most parts of North Carolina, ground water is becoming increasingly important as a source of supply for industries, municipalities and schools. It is believed that this report will be of value to those interested in the geology and ground-water resources of the Greenville area.

Respectfully submitted,

WILLIAM P. SAUNDERS
Director

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GEOLOGY AND GROUND-WATER RESOURCES

in the

GREENVILLE AREA, NORTH CAROLINA

By

PHILIP M. BROWN

ABSTRACT

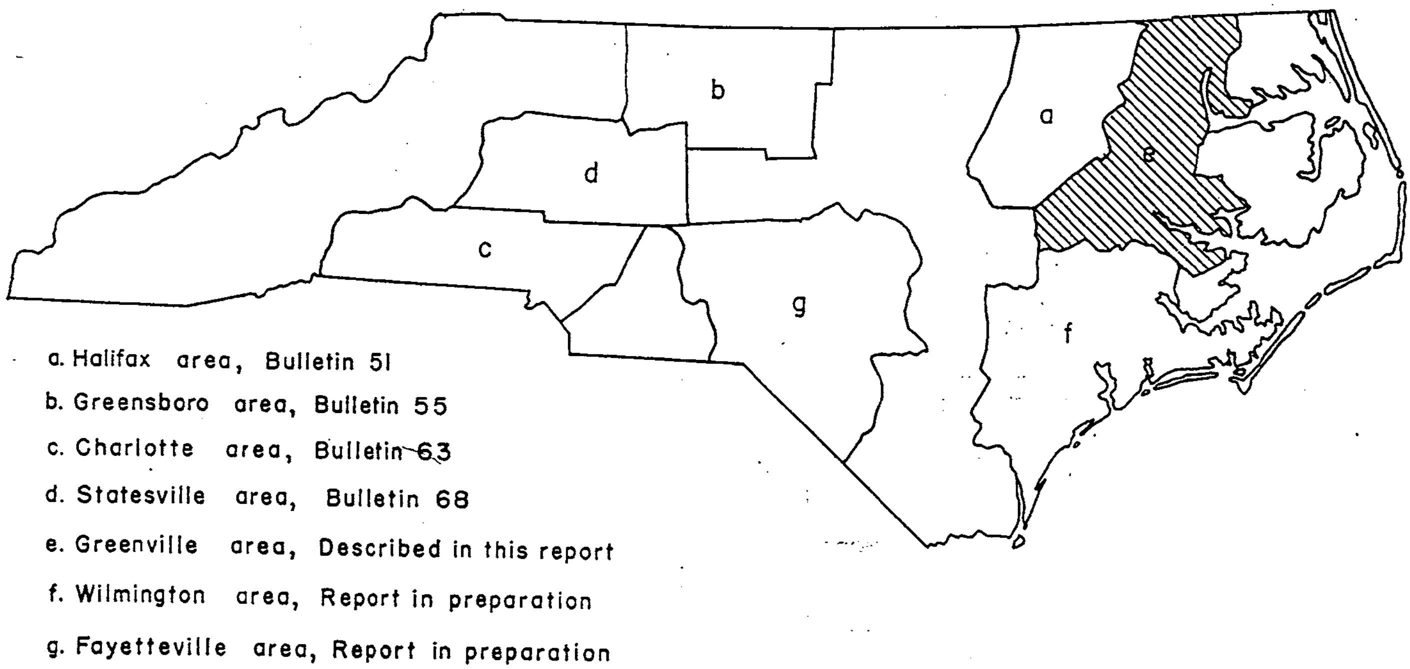
The area described in this report, the Greenville area, includes the following counties: Beaufort, Bertie, Chowan, Gates, Greene, Hertford, Martin, and Pitt. These counties lie in the north-central Carolina Coastal Plain and extend in a north-south direction from the Virginia State line south to the Neuse River.

The area is underlain by a group of sedimentary formations that thicken in a southeast direction and slope toward the southeast at a rate of 15 to 30 feet per mile, forming a simple monocline. The stratigraphic relationships are more complex; the oldest sediments, exposed at the surface in the southwest and central sections of the area, are transgressively buried by younger sediments in a northeast direction along the prevailing strike.

The hydrology of the area is controlled by sediments of Mesozoic and Cenozoic age: sands, clays, marls, and limestones of Early Cretaceous, Late Cretaceous, Paleocene, Eocene, Miocene, and Quaternary age. Ground water in the area is largely undeveloped in terms of the ultimate potential supply. Generally speaking, no one section in the area is presently using more than one-fourth or one-fifth of the available and replenishable supply of ground water. There are sections where little of the large potential supply available is being used.

The majority of wells throughout the area are shallow dug or driven wells that yield from several to 20 gpm. Drilled municipal and industrial wells may yield from 200 to 1,000 gpm, according to their location and depth.

The water obtained from most wells is generally of adequate quality. It ranges from the relatively hard calcium bicarbonate waters emanating from shallow marls and limestones to the soft sodium bicarbonate waters in the deeper "greensands." Saline waters occur progressively nearer the land surface toward the present coastline. Waters having high concentrations of fluoride occur in some areas of Bertie, Gates, Hertford, and Martin Counties.



Index map of North Carolina showing areas covered by major ground-water investigations

FIGURE 1.

INTRODUCTION

The purpose of the investigation on which this report is based was to determine the lithic character, areal extent, thickness, and water-bearing properties of the stratified rocks underlying the eight counties in the Greenville area, the potentiality for the development of additional water supplies from those rocks, and the chemical quality of the water they contain. This information was obtained by reviewing the available geologic and hydrologic literature on the area; by examining wells and recording pertinent data, by making chemical analyses of water samples from representative wells, and by conferring with well owners, well drillers, and town officials in regard to ground-water conditions in the area. The information was synthesized and arranged by counties in a report describing the entire area.

Location of Area

The Greenville area is in the northeastern section of the State (see fig. 1), a section that is predominantly rural. The report takes its name from the city of Greenville in Pitt County, the largest city in the area of investigation. It includes the following counties: Beaufort, Bertie, Chowan, Gates, Greene, Hertford, Martin, and Pitt.

Cooperation and Direction

The investigation was made by the Ground Water Branch, U. S. Geological Survey, in cooperation with the Division of Mineral Resources, North Carolina Department of Conservation and Development. The report was prepared under the general supervision of A. N. Sayre and P. E. LaMoreaux, former and pressent Chiefs, Ground Water Branch, U. S. Geological Survey, and J. L. Stuckey, State Geologist. Field investigations and preparation of the report were under the supervision of H. E. LeGrand, former District Geologist, Ground Water Branch, U. S. Geological Survey.

Previous Work

This report is the fifth in a series of areal reports (fig. 1) that are designed to give a preliminary or reconnaissance appraisal of ground-water conditions in the entire State. Emphasis has been placed on ground-water appraisals in areas of immediate economic interest. Previous information concerning the ground-water resources of the Greenville area is included in volume III of the North Carolina Geological and Economic Survey, entitled, "The Coastal Plain of North Carolina" (Clark, Miller, Stephenson, Johnson, and Parker, 1912).

[1]Information relative to the subsurface geology of the Greenville area is taken largely from Bulletin 71 of the North Carolina Division of Mineral Resources, entitled "Well Logs from the Coastal Plain of North Carolina", which was prepared by the writer in 1954-55 and published in 1958.

Acknowledgments

Many well drillers and town officials cooperated in making well data available during the course of the investigation. Officials and employees of the Heater Well Drilling Co., the Carolina Drilling and Equipment Co., the Layne Atlantic Co., and the Magette Well Drilling Co. were especially cooperative.

GEOGRAPHY

Area and Population

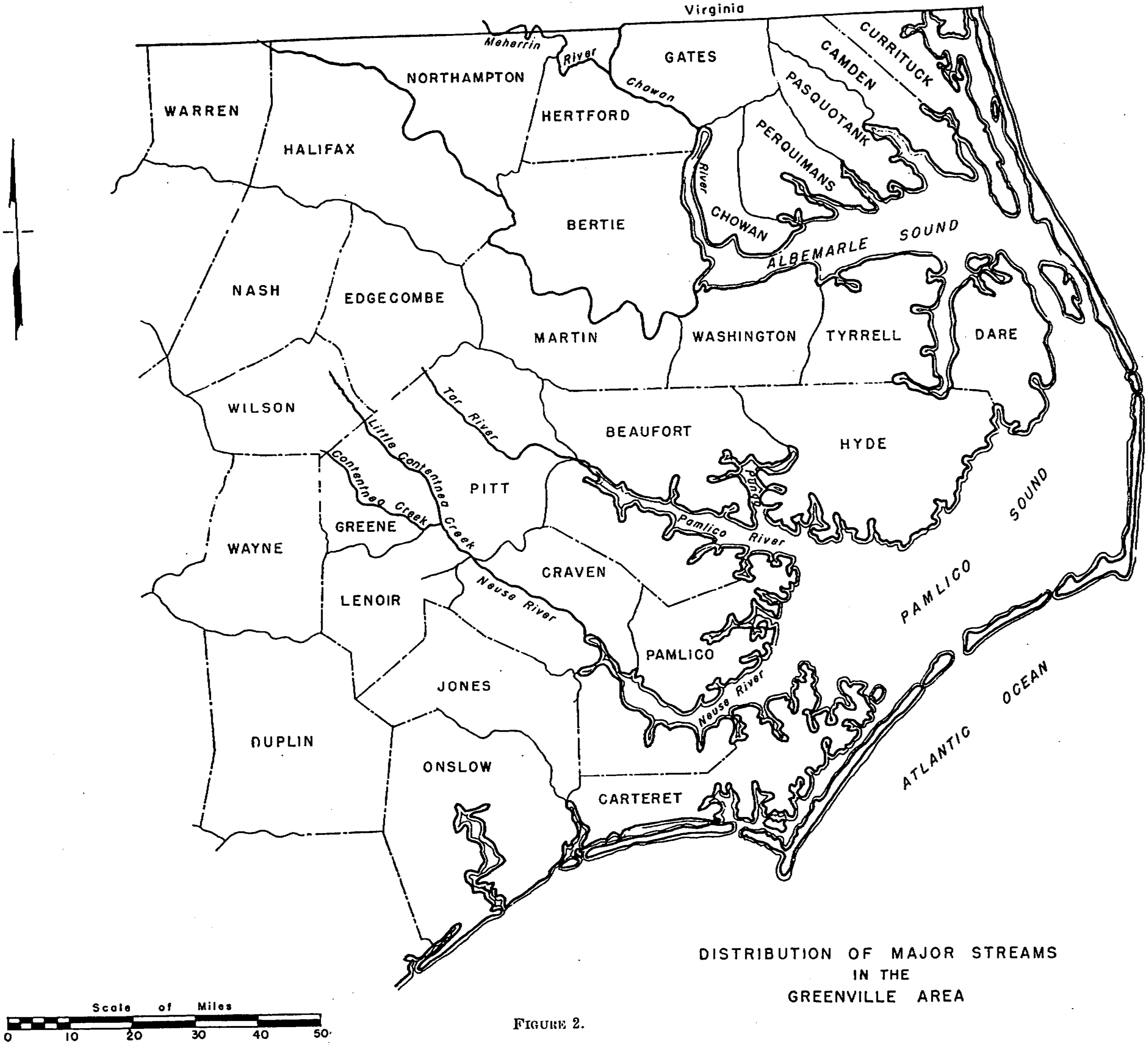
The area described in this report totals 3,589 square miles. Roughly classified, this total area consists of 1,319 square miles of cleared land and 2,270 square miles that is forested.

Total population in the eight counties of the area, according to the 1950 census, was 216,872, an average of 60.4 people per square mile. Urban population is centered in seven cities or towns that have a population in excess of 2,500. Total urban population is 44,914, or about 20 percent of the total population for the area. The remaining 80 percent of the total population is rural and is centered in and around some 40 incorporated and unincorporated towns and villages in the area. Population in the area has remained relatively static during the past decade. Six of the counties have gained slightly in population and two have lost.

Physiography

The Greenville area lies entirely within the Atlntic Coastal Plain province, which in North Carolina is characterized by a broad, flat surface that slopes gently toward the southeast. This surface represents an emerged ocean floor, a landward extension of the present ocean floor which forms the surface of the continental shelf. Marked topographic variations are lacking on the emerged surface; broad, flat interstream areas are the dominant topographic features; moderately dissected portions of the surface are confined to narrow belts bordering the major streams. Elevations in the area of investigation range from about 135 feet along the western border to sea level along Albemarle and Pamlico Sounds.

[1]References are on p. 197-200.



DISTRIBUTION OF MAJOR STREAMS
IN THE
GREENVILLE AREA

FIGURE 2.

The major rivers that drain the area all rise or flow through the Piedmont province, which lies to the west. These rivers—the Chowan, the Roanoke, the Tar, and the Neuse—follow subparallel courses and flow in a southeasterly direction down the prevailing slope of the Coastal Plain, debouching into either Albemarle or Pamlico Sound (fig. 2). The river valleys in the area are all first-cycle valleys, and the rivers have not, as yet, become deeply incised in the flat plain or established significant delta systems. Broad, featureless flood plains and poorly drained swamps bordering large estuaries are characteristic of the area. The most extensive of these swamps is the Dismal Swamp, whose western boundary lies in Gates County, and the East Dismal Swamp, which extends into Martin and Beaufort Counties.

Climate

Comparison of records from four stations of the U. S. Weather Bureau located at Edenton, Greenville, Washington, and Williamston show that the average yearly precipitation ranges from a maximum of 50 inches at Edenton in Chowan County to a minimum of 47 inches at Williamston in Martin County. Monthly distribution of precipitation at the Edenton station is plotted in figure 3. This is the only official station in the area for which a current 10-year record is available.

The average annual temperature at the same four recording stations varies slightly and averages 61.0°F. Average, maximum, and minimum monthly temperatures at the Edenton station are plotted in figure 3.

Agriculture

All eight counties in the area are predominantly rural. The agricultural products that provide the main source of income are tobacco, corn, peanuts, cotton, soy beans, sweet potatoes, and livestock. Annual cash value of these products ranges from about $4,000,000 in Gates County to more than $30,000,000 in Pitt County. Total annual cash income from agricultural products is slightly in excess of $130,000,000 in the eight-county area.

Industry

The larger towns are marketing and processing centers for the agricultural products grown on nearby farms. Except in Greenville, industrial development consists mainly of small, locally owned operations engaged in the packaging and processing of farm products. Commercial fishing and seafood processing are major industries in several communities bordering on Albemarle and Pamlico Sounds. Small lumbering operations and sawmills are common throughout the area, there being one large pulp mill in Martin County, Greenville, the largest population center in the area, has the largest and most diversified group of industries.

Transportation

The area is served by three principal railroads, the Atlantic Coast Line Railroad, the Seaboard Air Line Railroad, and the Norfolk and Southern Railroad. All counties are traversed by at least one main or branch line.

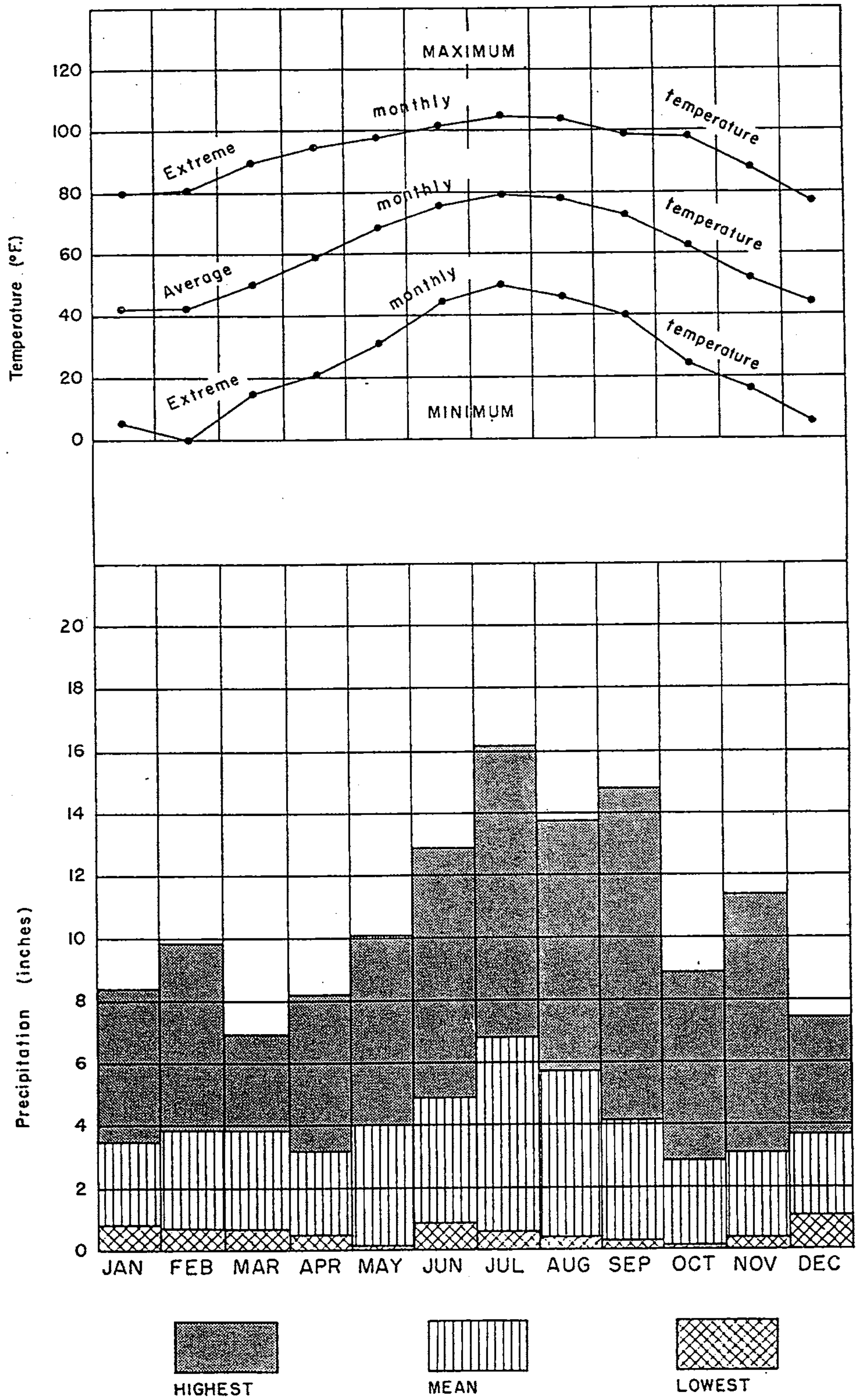
Several of the major rivers are important avenues for commercial transportation within the practicable limits of navigation as controlled by depth of channel and fluctuating water levels. In the past, the Chowan, Roanoke, Tar, and Neuse Rivers were all open to commercial navigation. At present, the Chowan and Roanoke Rivers are maintained for commerical navigation throughout their extent in the Greenville area.

An adequate network of State and Federal roads is maintained in the area. However, some difficulty is experienced in crossing the broad estuaries and sounds, where bridge and ferry service is limited.

GENERAL GEOLOGY

For a clear concept of the occurrence, availability, and chemical quality of the ground water in the Greenville area, one first must gain an understanding of the processes by which the rocks are formed and then in part destroyed, of the composition of the rocks, and of those physical properties of the rocks that govern their ability to store and transmit water.

Except where granite is exposed at Fountain, in Pitt County, the entire Greenville area is underlain by an eastward-thickening succession of sand, silt, and clay beds that were deposited, for the most part, in sea water. The sources of these sediments were the crystalline rocks in the areas now known as the Blue Ridge and Piedmont provinces. The crystalline rocks were fragmented through the processes of weathering and were transported to the sea by streams, there to be sorted by wave action and currents, mixed with seashells and with chemical precipitants, and eventually buried beneath later sediments. From time to time the sea retreated, each time exposing the latest sediments laid down on its floor. Streams extended their courses across the exposed area and deposited, in times of flood, layers of



Climatic Summary
for
Edenton, Chowan County, North Carolina
(1921 to 1955)

FIGURE 3.

sediment on their flood plains, and when the sea again encroached on the land the stream-deposited sediments became buried beneath and mixed with new accumulations on the sea floor. Thus the composition and distribution of the rock units that underlie the Greenville area are the end result of all the geologic processes to which the area has been subjected since the beginning of time.

The stratified rocks have been subdivided into formations, or other units, that can be identified from their position in the sequence of sediments, their lithic composition, and their contained fossils; each stratigraphic unit consists of deposits laid down during a unit of geologic time. The planes separating stratigraphic units from each other are referred to as contacts. If there was no significant lapse of time between the deposition of two units, their contact with each other is said to be conformable; if there was a significant lapse of time, their plane of contact is said to represent an unconformity. An unconformity represents a period of either erosion or nondeposition and in profile view generally is an undulating line. If the bedding in a stratigraphic unit above an unconformity is parallel to that in the unit below, the contact is termed a disconformity, whereas if the bedding in the two units is not parallel, the contact is termed a nonconformity. That each type of formational contact is present in the Greenville area will be shown in the discussion that follows.

The geologic history of the Greenville area, prior to the deposition of the sediments, is largely unknown. The basement rocks, presumed to be of Precambrian or early Paleozoic age and to be analogous to similar types of rock in the Piedmont province to the west, underlie the sedimentary units and slope toward the southeast. That the slope increases beyond a point near the present coast and that the basement floor is very uneven are inferred from geophysical data in the Greenville area and from the logs of wells in the area that have fully penetrated the sedimentary cover. Further evidence of the uneven nature of the basement floor is the presence of a granite monadnock surrounded by more than 400 feet of sediments at Fountain in Pitt County (Mundorff, 1947, p. 103). Well cuttings, representative of the basement floor beneath the sediments, generally consist of weathered granite, gneiss, schist, and slate.

Unconformably overlying the basement rocks are sediments of both Early Cretaceous and Late Cretaceous age. The presence of Lower Cretaceous sediments in the Greenville area was established only recently by examination of cuttings from a deep well at Greenville in Pitt County. The extent of these Lower Cretaceous sediments is unknown; they are confined to the subsurface and may extend over a broad area. Unconformably overlying the basement rocks in parts of the Greenville area are sediments of Late Cretaceous age, the Tuscaloosa formation.

Unconformably overlying the Tuscaloosa formation are strata that compose the Black Creek formation. The unconformity separating the two formations may be observed along Contentnea Creek in Greene County and along the Tar River in Pitt County. The Black Creek formation, consisting of an unnamed lower member and an upper member (the Snow Hill marl) is overlain by the Peedee formation, which is the youngest Cretaceous formation in the Greenville area. The Peedee formation is conformable with the upper member of the Black Creek formation in some parts of the area; where the upper member is absent the Peedee lies unconformably on the lower member of the Black Creek formation.

At the close of the Cretaceous period a partial withdrawal of the sea toward the southeast was followed by extensive erosion of the exposed land surface. During the Paleocene epoch which followed, the sea again encroached upon the land and deposited sediments, which in this report are named and defined (p. 26) as the Beaufort formation. The Beaufort formation lies unconformably on the Peedee formation and exhibits a pseudo-offlap relationship to that formation. The Paleocene sediments have not been recognized at the surface, but are widespread in the subsurface.

The withdrawal of the Paleocene sea was followed again by an extensive period of erosion prior to deposition of the Castle Hayne limestone, a limestone that includes both middle and upper Eocene sediments (LeGrand and Brown, 1955, p. 9). The Castle Hayne limestone lies unconformably on rocks of both Cretaceous and Paleocene age in the Greenville area. After deposition of the Castle Hayne limestone the sea again withdrew from the area and was absent during all of Oligocene and early Miocene time. Isolated remnants of the Castle Hayne limestone that occur at a distance of 50 or 60 miles inland from the main body attest to the great quantity of limestone that was removed from the exposed surface during this period.

Later in Miocene time the sea again encroached upon the land, and phosphorites, referred to in this report as middle(?) Miocene in age, were deposited in a shallow, partially restricted, marine basin. The phosphorites are largely confined to Beaufort Coun-

Table 1. Geologic units and their water-bearing characteristics in the Greenville area.

System	Series		Indicated correlation	Formations and members	Description	Origin	Distribution	Hydrologic properties
Quaternary	Pleistocene and Recent			Surficial deposits	Usually light-colored fine to coarse-grained sheet sand and lenticular sand occurring with interbedded clay. Occasionally, marls and shell beds are present in eastern Beaufort County.	Aqueous and eolian — include both marine and nonmarine deposition, with no clear division between these two types.	Occurs as a thin blanketing material throughout the Greenville area, where it generally ranges in thickness from 10 to 40 feet.	Supplies ground water to shallow dug and driven wells. Small yield per well but has excellent water-bearing properties. Water contains large amounts of iron and may be corrosive. Adequate water for domestic and farm use.
Tertiary	Miocene	Upper		Yorktown formation	Light-colored sandy shell beds and marls in upper part. Lower part consists of blue-gray marls shell beds and massive interbedded marine clays.	Marine deposition in an embayment or area of subsidence covered by transgressive seas that encroached upon the crystalline rocks exposed to the west of the Greenville area.	Occurs throughout the Greenville area as a continuous deposit or as scattered outliers. Thickness in most places is between 10 and 250 feet.	Lenticular sand and shell beds supply small to moderate amounts of water for domestic and farm use. Not extensively developed as an aquifer except in the northeastern section of the Greenville area where large to moderate artesian supplies are available.
Tertiary	Miocene	Middle (?)	Rocks of Calvert (?) age	Sand and sandy silt	Brown to chocolate-colored phosphatic sands and sandy silts containing collophane and quartz with shell-limestone intercalations.	Formed as a chemical precipitate and *in situ* replacement in a restricted basin. Precipitation controlled largely by pH of the basin waters.	Not known to occur at the surface. Subsurface distribution in the Greenville area is restricted to Beaufort, Gates and Chowan Counties. Thickness generally ranges from 1 foot to 90 feet.	Not extensively developed as an aquifer. Running sands which clog screens is a common complaint of well drillers. Potential yields good. Quality of water excellent.
Tertiary	Eocene	Middle and late	Rocks of Claiborne and Jackson age	Castle Hayne limestone	White to gray sand and marl facies predominant. Sandy calcitic and dolomitic shell limestones prominent. Glauconite, pyrite, and phosphate occur as prominent accessories.	Marine—shallow, open-water deposition. Remains of sedentary marine organisms predominate locally.	Crops out in southern Pitt County. Confined to subsurface in Beaufort and eastern Martin Counties.	Calcareous sands and shell limestones supply water to artesian wells in Pitt, Martin, and Beaufort Counties. High permeability and large potential yields throughout its extent. Good municipal and industrial supply. Water generally hard and may contain objectionable amounts of H_2S.
Tertiary	Paleocene		Rocks of Midway age	Beaufort formation	Variable in composition, ranging from green glauconite sands containing ±90 percent glauconite to gray argillaceous sands containing ±5 percent glauconite. Indurated shell-limestone intercalations common. Euhedral pyrite occurs as a common accessory.	Marine—deposition in a moderately deep basin characterized by bottom conditions that were oxidizing. Pyrite is authigenic.	Not known to occur at the surface. Extensive subsurface distribution in Beaufort, Gates, Martin, Bertie, Hertford, and Chowan Counties. Limited distribution in eastern Pitt County. Thickness generally ranges from several feet to 400 feet.	Supplies small to moderate amounts of artesian water for domestic and farm wells. Large potential artesian supplies available for industrial and municipal consumption in northeastern counties of the Greenville area. Water is generally a soft sodium bicarbonate water and may contain excessive fluoride.

Cretaceous	Upper Cretaceous	Rocks of Navarro age	Pedee formation		Dark-gray coarse-grained glauconite sands in upper part. Drab-black massive marine clays in lower part. Indurated shell beds throughout section.	Marine — shallow shelf-type deposition. Deltaic deposits that are not fossiliferous are correlated with the Peedee formation in Hertford and Bertie Counties.	Exposed along major streams in Pitt and Greene Counties. Extensive subsurface distribution throughout the Greenville area. Thickness ranges from 300 to 500 feet or more.	Sand beds in the formation are very good aquifers and supply water for municipal, industrial, domestic, and farm use. Water, generally of good quality, may be moderately hard at shallow depths.
		Rocks of Austin and Taylor age	Black Creek formation	Snow Hill marl member	Black to gray interbedded clays and marls. Marls are locally indurated to form impure shell-limestones.	Marine—shallow water deposition.	Exposed along major streams in parts of Pitt and Greene Counties. In the subsurface not adequately delimited from the unnamed member of the Black Creek formation.	Marls and indurated shell beds supply fair to moderate amounts of water to domestic and farm wells.
				?				
				Unnamed member	Gray to black micaceous sands and clays, thinly bedded to massive; variable amounts of lignite, marcasite, and glauconite. Cross-bedding prominent. Sand and clay components predominantly lenticular.	Near-shore marine and continental deposition. Origin is masked by transgressive and regressive movements of the sea resulting in littoral, sublittoral, and paludal deposition.	Exposed along major streams in parts of Pitt and Greene Counties. Subsurface distribution widespread throughout the Greenville area. Thickness ranges from 300 to 400 feet or more.	Sand beds in the formation yield large supplies to industrial, municipal, domestic, and farm wells in Greene, Pitt, Martin, Hertford, and Bertie Counties. Contains saline waters in Gates, Chowan, and Beaufort Counties.
		Rocks of Woodbine and Eagle Ford age	Tuscaloosa formation		Tan, red, and gray arkosic sands and interbedded clays. Hematite is a common accessory mineral, siderite being less common. Massive to lenticular aspect in all sections.	Marine and nonmarine origin. Marine facies indicate near-shore deposition. Continental facies indicate deposition along the inner margins of bays and estuaries. Coursely graded fossil stream deposits are common.	Exposed along major streams in Pitt, Greene, and Bertie Counties. Lies unconformably on crystalline rocks in the western part of the Greenville area. Subsurface distribution widespread. Thickens progressively coastward.	A very good aquifer; supplies large amounts of water to industrial and municipal wells in Pitt, Greene, Martin, Bertie, and Hertford Counties. Probably contains saline waters in Gates, Chowan, and Beaufort Counties. Water is generally of good quality.
	Lower Cretaceous	Rocks of Trinity age and older	Sand and clay (subsurface only)		Green clay and tan sand. Mica is a common accessory mineral.	Marine — shallow-water deposition.	According to present information the formation has limited subsurface occurrence in Pitt and Martin Counties but may extend over broad areas throughout subsurface of the Greenville area.	Contains saline waters in central Pitt County. May contain potable waters in the western parts of Pitt and Martin Counties.

ty where they lie unconformably on the Castle Hayne limestone.

Lying unconformably above the phosphorites are sediments of late Miocene age, the Yorktown formation, which were deposited in a transgressive sea that extended to cover crystalline rocks west of the Greenville area. No sediments of Pliocene age were recognized in the area of investigation.

Unconformably overlying the Yorktown formation are thin deposits of Quaternary age. These deposits may correspond in part to the so-called marine terrace deposits of Pleistocene age and in part, may represent fluviatile deposits.

The sequence of events which took place during the deposition of the sedimentary rocks in the Greenville area, and which have been only briefly outlined in this section of the report, is not evident in every part of the area. As shown in the majority of the well sections included with the county descriptions, one or more of the stratigraphic units in the depositional sequence are missing.

GEOLOGIC FORMATIONS IN THE GREENVILLE AREA

Cretaceous System

Lower Cretaceous Series

Unnamed Unit

The presence of sediments of Early Cretaceous age was recently established in a well at Greenville, Pitt County. On the basis of a well-preserved ostracode fauna the sediments were determined to be roughly equivalent to sediments of Trinity age and older as recognized in the Gulf Coast Province.

The sediments consist principally of chocolate-colored argillaceous quartz sand and green calcareous clay. Common accessory minerals include hematite and mica, siderite and pyrite occurring less commonly. Data are insufficient to determine the strike or dip of this unit, but the faunal evidence indicates that the unit, though roughly contemporaneous with Lower Cretaceous sediments in several of the deeper oil tests to the southeast of the Greenville area, is not a traceable updip extension of those Lower Cretaceous sediments.

Upper Cretaceous series

Tuscaloosa formation

The name Tuscaloosa was proposed by Smith and Johnson (1887, p. 95-116) for sediments of Cretaceous age exposed at Tuscaloosa, Tuscaloosa County, Ala. The name Tuscaloosa was applied first to Cretaceous equivalents in North Carolina by Cooke (1936, p. 19).

The Tuscaloosa formation in the Greenville area is variable lithologically, but over large areas it is composed predominantly of interbedded lenses of pinkish to drab-gray micaceous sand and clay. Coarse to medium-grained sand and gravel occur at all horizons but are generally more prevalent below the uppermost 150 feet of the formation at any one locality. The uppermost 150 feet of the formation invariably is composed of layers of compact lenticular clay.

The Tuscaloosa formation in outcrop is confined to narrow bands along several of the major streams in Greene, Pitt, and Bertie Counties. Outcropping sections of the formation can be observed in Greene County along Contentnea Creek from a point above Contentnea to the Greene-Wilson County line, in Pitt County along the Tar River above Bruce, and in Bertie County along the Roanoke River above Lewiston.

The strike of the formation is northeast and roughly parallel to the outcrop belt. The dip of the formation cannot be accurately determined at the surface. However, subsurface information indicates a dip slightly greater than 20 feet per mile toward the southeast.

In the western part of the Greenville area the Tuscaloosa formation lies unconformably on crystalline rocks of Precambrian or early Paleozoic age and, at least in the vicinity of Greenville, on sediments of Early Cretaceous age.

In the Greenville area the formation contained no fossils and correlation is based on lithology and stratigraphic position.

Black Creek formation

The Black Creek formation consists of a lower unnamed member and an upper member, the Snow Hill marl. The term Black Creek was used by Sloan (1907, p. 12, 13, 14) for typical exposures of black laminated sand and clay along Black Creek in Darlington and Florence Counties, S. C. Stephenson (1923, p. 10) proposed the name Snow Hill marl member for the upper 100 to 200 feet of the formation, which consists of calcareous layers and interbedded glauconitic and micaceous sand and clay. The type locality for the Snow Hill marl is along Contentnea Creek near Snow Hill, Greene County, N. C. At this locality the Snow Hill marl member consists of "drab-black arenaceous and micaceous clays containing an abundant but fragile assemblage of megafossils" (LeGrand and Brown, 1955, p. 24).

The Black Creek formation is exposed along streams in the northern part of Greene and Pitt Counties, particularly along Contentnea Creek, Little Contentnea Creek, and the Tar River. North and east of Pitt County the formation has been recognized only in the subsurface. The formation strikes north-northeast in the outcrop area, whereas subsurface information from Martin, Bertie, and Hertford Counties indicates that the strike of the formation is east-northeast in that area.

The dip of the formation cannot be determined with any degree of accuracy, because of the flat-lying nature of the beds, the lenticular and thinly-laminated nature of the sediments, and the lack of topographic expression in the outcrop area. Subsurface formational contacts in water wells establish an average dip of about 15 feet per mile for the formation in Pitt and Greene Counties. When a dip of 15 feet per mile is transposed to the outcrop areas the thickness of the formation exposed along the Tar River is about 150 feet, the thickness along Little Contentnea Creek about 75 feet, and the thickness along Contentnea Creek about 135 feet. The fossiliferous Snow Hill marl member is exposed for a distance of about 2 miles, normal to the strike, in the Snow Hill area. The Snow Hill member, therefore, is about 30 feet thick in the type area.

The Black Creek formation lies unconformably on the Tuscaloosa formation, exhibiting a transgressive offlap relationship to that formation.

According to Stephenson (1923, p. 10) "Paleontologically the Snow Hill marl member belongs to the upper part of the zone of *Exogyra ponderosa* of the Atlantic and Gulf Coastal Plain". The indicated correlation, therefore, is with the Taylor group of the Gulf Coastal Plain and with the Matawan group (or formation) of the Atlantic Coastal Plain (Stephenson, 1923, pl. VIII). No faunal evidence for the age of the lower unnamed member of the Black Creek has been recognized in outcropping sections in the Greenville area. However, subsurface evidence based on Ostracoda and Foraminifera indicates that the lower member is pre-Taylor in age and should be correlated with Austin equivalents of the Gulf Coastal Plain and with the Magothy formation of the Atlantic Coastal Plain.

The paleontologic hiatus between the upper and lower members of the formation is not sharp in subsurface sections and is characterized mainly by the relative abundance of diagnostic species in the upper member in contrast with their scarcity in the lower member.

The following ostracodes have been identified in samples of the Black Creek formation from water wells in the Greenville area:

Brachycythere ledaforma (Israelsky)
Brachycythere sphenoides (Reuss)
Brachycythere nausiformis Swain
Cytheridea (Haplocytheridea) monmouthensis Berry
Cytherella bullata Alexander
Cytheropteron (Eocytheropteron) striatum Brown
Cytherura glossensis Brown
Orthonotacythere sulcata Brown
Orthonotacythere hannai (Israelsky)
Orthonotacythere tarensis Brown
Protocythere paratriplicata Swain
Trachyleberis gapensis (Alexander)

Pedee formation

The name Peedee was proposed by Ruffin (1843, p. 6-7) for a sedimentary unit of Cretaceous age in Florence and Horry Counties, South Carolina. Stephenson (in Clark and others, 1912, p. 45) used the name Peedee for equivalent sediments in North Carolina that he previously (1907, p. 93-99) had referred to the Ripley formation.

In the Greenville area the Peedee formation, at the surface, is confined to small segments of Greene and Pitt Counties, where it is characteristically exposed along some of the streams, especially along Contentnea and Little Contentnea Creeks. To the north and east of Pitt County the formation is transgressively overlapped by younger sediments and is known to extend in the subsurface to the North Carolina-Virginia State line (LeGrand and Brown, 1955, fig. 2).

The lithologic character of the Peedee formation is not uniform either laterally or vertically throughout the Greenville area. In the upper part, green to light-gray glauconitic sands predominate, with minor occurrences of gray interbedded and lenticular micaceous clays, whereas in the lower part of the formation black massive marine clays predominate, with minor occurrences of glauconitic sands. Coarse to medium-grained calcareous and indurated sands, together with indurated shell beds, occur at all horizons within the formation, but owing to their lenticular nature they cannot be traced or assigned to any particular horizon over large areas.

The strike of the Peedee formation is in a general northeast direction. The dip of the formation, like that of the underlying Black Creek formation, is difficult to determine at surface exposures. However, subsurface formational contacts in water wells indicate that the Peedee formation in Greene and Pitt Counties slopes toward the coast at a rate of about 15 feet per mile. This dip when transposed to the outcrop area indicates that the formation, as exposed along Contentnea Creek, is about 130 feet thick, and as exposed along Little Contentnea Creek, slightly in excess of 100 feet thick. Southeast of Greene and Pitt Counties, toward the coast, the formation thickens considerably; more than 500 feet of the formation was recognized in a well at Richlands, Onslow County.

The Peedee formation throughout much of the Greenville area lies conformably on the upper Snow Hill marl member of the Black Creek formation or, where that unit is absent, unconformably on the lower unnamed member of the Black Creek formation. In parts of Bertie, Hertford, and Gates Counties there is some evidence, as inferred from lithology and stratigraphic position, that nonfossiliferous material of deltaic origin may be contemporaneous with definitely recognizable sediments of the Peedee that lie downdip and to the east (LeGrand and Brown, 1955, fig. 2). These deltaic sediments lie unconformably on the Tuscaloosa formation. Unconformably overlying the Peedee formation are sediments of Tertiary age. Subsurface contacts established from well cuttings have shown the formation to be overlain by transgressive deposits of Paleocene, middle and late Eocene, and late Miocene age. The contact relationships of the Peedee formation with these younger Tertiary units are discussed in the sections dealing with the geology of the individual counties.

Stephenson (1943, p. 13) states that "Paleontologically the Peedee formation falls within the zone of *Exogyra costata* of the Atlantic Coastal Plain, though probably the uppermost part of the zone is not represented. Approximately the lower half of the formation is embraced within the *Exogyra cancellata* subzone." Stephenson (1923, p. 48-58) discusses in detail the correlation of the Peedee formation, which is equivalent in part to the Navarro group of the Gulf Coastal Province and in part to the Monmouth group of the Atlantic Coastal Province. Recent studies by Brown (1957, p. 1-24) of the Ostracoda in the Peedee formation substantiate Stephenson's correlation.

The following ostracodes have been identified in well cuttings from the Peedee formation in the Greenville area:

Alatacythere alata atlantica (Schmidt)
Bairdia pittensis Brown
Bairdoppilata pondera Jennings
Bairdoppilata postextensa (Swain)
Brachycythere raleighensis Brown
Brachycythere ledaforma (Israelsky)
Brachycythere rhomboidalis (Berry)
Brachycythere plena Alexander
Cytheridea (Haplocytheridea) monmouthensis Berry
Cytheridea (Haplocytheridea) ulrichi (Berry)
Cytheridea (Haplocytheridea) fabaformis (Berry)
Cytheridea (Haplocytheridea) councilli Brown
Cytheridea (Haplocytheridea) plummeri Alexander
Cytheridea (Haplocytheridea) wilmingtonensis Brown
Cytherella tuberculifera Alexander
Cytherella herricki Brown
Cytherelloidea swaini Brown
Cytherelloidea sohni Brown
Cytherelloidea inflata Brown
Cytherura glossensis Brown
Eucytherura curta (Jennings)
Loxoconcha neusensis Brown
Loxoconcha seraphae Brown
Monoceratina biloba Schmidt
Orthonotacythere hannai (Israelsky)
Platycythereis costatana angula (Schmidt)
Trachyleberis bassleri (Ulrich)
Trachyleberis communis (Israelsky)
Trachyleberis gapensis (Alexander)
Trachyleberis pidgeoni (Berry)
Velarocythere arachoides (Berry)
Velarocythere cacumenata Brown
Velarocythere eikonata Brown
Velarocythere scuffeltonensis Brown

Tertiary System
Paleocene series
Beaufort formation

The existence of strata of Paleocene age in the North Carolina Coastal Plain was first postulated by Spangler (1950, p. 131), who stated that "Tentatively faunas from the Eocene beds in Hatteras Light No. 1 (well) have been identified as indicating Midway, Wilcox, Claiborne, and Jackson ages." Presumably, Spangler based his statement on examinations of the Foraminifera. McLean (1951, p. 22) stated that "Two wells were drilled in the Washington, North Carolina area, both of which contain a definite Paleocene fauna." McLean's statement was based on an examination of the Foraminifera. Swain (1952, p. 5) states, concerning well samples from North Carolina tentatively identified as representing Paleocene strata, that "The assignment to the Paleocene (?) is based on lithologic similarity to the Clayton formation of Georgia (Cooke, 1943, p. 39-47) and not on paleontologic evidence." The writer (Brown, 1958, p. 6), in describing well samples from the North Carolina Coastal Plain, called attention to the existence of Paleocene strata and stated: "Strata of Paleocene and early Eocene age, not known to occur in surface exposures, can be differentiated both faunally and lithologically in the subsurface." In Brown's report lithologic intervals were described and Ostracoda were listed from many water wells. Correlation with the Midway group (Paleocene) was based on the Ostracoda.

The name Beaufort formation is here proposed for sediments of Paleocene age that occur in the Greenville area. The name is derived from Beaufort County, where extensive deposits of Paleocene age occur in the subsurface. The formation has been recognized also in wells in Martin, Bertie, Hertford, Gates, and Chowan Counties. The formation has not been recognized at the surface; therefore, the selected type locality is a well 215 feet deep, drilled in 1952 for the Nelson Motel at Chocowinity, Beaufort County, North Carolina. The land-surface elevation of the well is 44 feet above sea level, and the well penetrated 65 feet of Paleocene strata between the depths of 150 and 215 feet. The type lithology for the Beaufort formation is designated as that described by the writer (1958, p. 7) for the aforementioned well between the depths of 150 and 215 feet (p. 7). Ostracoda identified by the writer from the type section are as follows:

Bairdia magna Alexander
Brachycythere interrasilis Alexander
Brachycythere plena Alexander
Brachycythere verrucosa Harris and Jobe
Trachyleberis midwayensis (Alexander)
Trachyleberis prestwichiana (Jones and Sherborn)
Trachyleberis bassleri (Ulrich)
Trachyleberis spiniferrima (Jones and Sherborn)
Cytheridea (Haplocytheridea) ruginosa Alexander
Cytheromorpha scrobiculata Alexander
Loxoconcha corrugata Alexander
Orthonotacythere cristata Alexander

Mr. Richard Page of the U. S. National Museum kindly identified the following Foraminifera from the 150-215-foot interval of the type well:

Spiroplectammina wilcoxensis Cushman and Ponton
Robulus midwayensis (Plummer)
Dentalina virginiana Cushman
Dentalina wilcoxensis Cushman
Dentalina naheolensis Cushman and Todd
Dentalina pseudo-obliquestriata (Plummer)
Citharina plummoides (Plummer)
Nodosaria affinis Reuss
Vaginulina gracilis Plummer
Rectoglandulina tenuistriata (Franke)
Siphogenerinoides elongata (Plummer)
Bulimina virginiana Cushman
Bulimina cacumenata Cushman and Parker
Pseudovalvulineria midwayensis (Plummer)
Pseudovalvulineria umbonifera (Schwager)
Eponides lotus (Schwager)
Gyroidinoides octocamerata (Cushman and Hanna)
Alabamina midwayensis Brotzen
Globigerina triloculinoides Plummer
Globigerina compressa Plummer
Globigerina pseudobbulloides Plummer
Globigerinoides daubjergensis (Broniman)
Anomalinoides vulgaris (Plummer)
Anomalinoides umbonata (Cushman)
Cibicides irenae Van Bellen

Eocene series

Castle Hayne limestone

The name Castle Hayne limestone was proposed by Miller (Clark, and others, 1912, p. 185) for deposits of late Eocene age typically exposed near the town of Castle Hayne, New Hanover County, North Carolina.

Surface exposures of this limestone unit in the Greenville area are limited to the southeastern part of Pitt County. The surface exposures are generally characterized by light-colored, iron-stained shell-limestones or cream to green-colored calcareous sands and clays reflecting different degrees of decomposition and induration. The limestone unit has a widespread occurrence in the subsurface in the Greenville area, especially in Beaufort and Martin Counties. Typical subsurface sections have a lithology as follows: gray to white shell-limestones and dolomitic shell-limestones interbedded with and underlain by fine to medium-grained calcareous sands and clays.

The thickness of the formation as determined from the examination of well cuttings ranges from about 20 feet to as much as several hundred feet, the thickest sections of the formation occurring in wells in eastern Beaufort County. In the Greenville area the formation strikes east-northeast and dips toward the coast at the rate of 10 to 30 feet per mile, the dip progressively increasing in a southeast direction.

Cooke (1916), Canu and Bassler (1920), Kellum

(1926), and Richards (1950) have cited evidence substantiating the late Eocene age of the Castle Hayne limestone. Cooke and MacNeil (1952, p. 25), following a study of Tertiary deposits in South Carolina restricted the Castle Hayne limestone to the middle Eocene. LeGrand and Brown (1955, p. 9) and Brown (1958, p. 7) recognize both upper and middle Eocene biofacies in the Castle Hayne limestone and consider the formation in North Carolina to have been deposited during both middle and late Eocene time.

The Castle Hayne limestone throughout much of the Greenville area lies unconformably on the Beaufort formation of Paleocene age or, where that unit is absent, unconformably on the Peedee formation of late Cretaceous age.

The Castle Hayne limestone as it occurs in the subsurface throughout the Greenville area is predominantly of middle Eocene age, and correlation, based on Ostracoda and Foraminifera, shows it to be generally equivalent to sediments of middle Eocene age in the Gulf Coast Province. No attempt was made to correlate the Castle Hayne limestone with recognized Eocene sediments north of North Carolina.

The following ostracodes have been identified in well samples from the Castle Hayne limestone in the Greenville area:

Paracypris franquesi Howe and Chambers
Cytheridea (H.) montgomeryensis Howe and Chambers
Cytheridea (C.) virginica (Schmidt)
Cytheridea (C.) caldwellensis Howe and Chambers
Paracytheridea belhavenensis Howe and Chambers
Cytherura washburni Stephenson
Brachycythere watervalleyensis Howe and Chambers
Brachycythere martini Murray and Hussey
Brachycythere bernardi Murray and Hussey
Alatacythere ivani Howe
Trachyleberis rukasi (Gooch)
Trachyleberis montgomeryensis (Howe and Chambers)
Trachyleberis broussardi (Howe and Chambers)
Trachyleberis pellucinoda (Swain)
Trachyleberis bassleri (Ulrich)
Pterygocythereis washingtonensis Swain
Actinocythereis davidwhitei (Stadnichenko)
Actinocythereis stenzeli (Stephenson)
Actinocythereis hilgardi (Howe and Garrett)
Loxoconcha creolensis Howe and Chambers
Loxoconcha jacksonensis Howe and Chambers
Loxoconcha claibornensis Murray
Cytheromorpha eocenica Stephenson
Cytheretta alexanderi Howe and Chambers
Monoceratina alexanderi Howe and Chambers
Buntonia howei (Stephenson)

Miocene series

Middle (?) Miocene deposits

Phosphorite deposits that contain substantial amounts of the mineral collophane (probably carbonate-fluorapatite) occur mainly in eastern and central Beaufort County with minor occurrence in Gates and Chowan County. In Beaufort County the deposits lie unconformably on the Castle Hayne limestone, and are unconformably overlain by late Miocene marl. Questionable designation of the phosphorites as middle Miocene is based on the identification of foraminifers that occur in the top few feet of the material as encountered in water wells. The following list is reproduced from a paper by the writer (Brown, 1958, p. 90).

Siphogenerina lamellata Cushman
Siphogenerina spinosa Bagg
Cibicides concentricus (Cushman)
Discorbis cavernata Dorsey
Nonion pizzarense W. Berry
Nonion grateloupi (d'Orbigny)
Cassidulina crassa d'Orbigny
Uvigerina kernensis Barbat and von Estoroff
Bolivina calvertensis Cushman
Ellipsonodosaria calvertensis Cushman

The phosphorite section consists of layers of phosphatic sand and thin intercalated shell-limestone. The overall section ranges from several feet to more than 90 feet in thickness. Average thickness, throughout an area approximating 450 square miles, is estimated to be 30 feet.

The lithology of the phosphorites is surprisingly consistent over long distances. The deposits consist of a variable mixture of quartz sand and collophane. The collophane occurs in the form of brown spherules showing oolitic or banded structure; less commonly the collophane occurs as shards.

Evaluation of available subsurface data suggest that the phosphatic sands do not represent a facies that grades laterally into adjacent material of comparable age. The origin of the deposits (Brown, 1958, p. 96) is attributed to chemical precipitation and *in situ* replacement in a restricted basin, where the pH of the basin's waters acted as the controlling depositional factor.

Yorktown formation

The name Yorktown was first used in North Carolina for deposits of late Miocene age by Miller (Clark, and others, 1912, p. 229). Miller stated that "The formation with few changes does extend from Virginia southward into the State of North Carolina." Gardner (1943) defined certain faunal zones in the Yorktown formation as it occurred north of the Neuse River in North Carolina. These zones form the basis for the correlation of late Miocene deposits in the Greenville area.

The lithology of the formation in the Greenville area consists chiefly of gray-colored shell marls, indurated or unconsolidated shell beds, and massive marine clays with interbedded sands. The predominant lenticular character of the strata in any given locality obviates the possibility of uniform hydrologic characteristics even in small localized areas.

The formation strikes northeast and dips toward the southeast. The dip is generally less than 15 feet per mile in the outcrop area and rarely more than 25 feet per mile in the subsurface. At the surface the exposed thickness of the formation, as observed by the writer at any one place, is everywhere less than 60 feet. In Greene, Pitt, Hertford, and Martin Counties the subsurface thickness rarely exceeds 90 feet, although to the east in Beaufort, Bertie, Gates, Chowan, and Martin Counties the formation may increase in thickness to as much as 250 feet. At Edenton, Chowan County, the Yorktown formation, as shown by examination of well cuttings, attains a thickness of 195 feet and lies unconformably on phosphatic sands of middle(?) Miocene age.

From east to west, the Yorktown formation overlaps and lies unconformably on successively older deposits of the Coastal Plain sequence. Some previous evidence indicates that the Yorktown formation as herein defined includes strata at its base that is equivalent to the St. Marys formation of middle Miocene age (Gardner, 1943, p. 11). This evidence is not substantiated by current studies of the microfaunal assembleges.

Deposits in the southern part of the State (south of the Neuse River and outside of the Greenville area) have been referred to the Duplin marl, which is considered to be equivalent to the uppermost Yorktown as it occurs north of the Neuse River (Gardner, 1943, p. 2). Edwards (1944, p. 505-528) has described many species of Ostracodes from the Duplin marl, nearly all of which have been recognized by the writer in Yorktown material north of the Neuse River. In addition, Mansfield (1936, p. 173) has shown that stratigraphically the Yorktown, in part, is equivalent to the Cancellaria zone of the Choctawhatchee formation of former usage in Florida.

The following ostracodes have been identified in well cuttings from the Yorktown formation in the Greenville area:

Cytheridea (H.) probocsidiala Edwards
Paracytheridea vandenboldi Puri
Paracytheridea cf. *P. wetherelli* (Jones)
Cytherura elongata Edwards
Cytheropteron subreticulatum van den Bold
Leguminocythereis whitei Swain
Puriana rugipunctata (Ulrich and Bassler)
Actinocythereis exanthemata (Ulrich and Bassler)
Actinocythereis mundorffi (Swain)
Echinocythereis evax (Ulrich and Bassler)
Echinocythereis garretti (Howe and McGuirt)
Echinocythereis planibasilis (Ulrich and Bassler)
Murrayina martini (Ulrich and Bassler)
Orionina vaughani (Ulrich and Bassler)
Hemicythere conradi Howe and McGuirt
Hemicythere confragosa Edwards
Hemicythere laevicula Edwards
Hemicythere schmidtae Malkin
Loxoconcha purisubrhomboidea Edwards
Loxoconcha reticularis Edwards
Cytheromorpha warneri Howe and Spurgeon
Cytheretta reticulata Edwards
Basslerites giganticus Edwards
Cushmanidea ashermani (Ulrich and Bassler)

Quaternary system
Pleistocene and Recent Series
Surficial sands

Quaternary deposits include those underlying the three lowermost Pleistocene terraces designated by Stephenson (Clark and others, 1912, p. 27) as the Wicomico, Chowan, and Pamlico terraces of the Columbia group. In the Greenville area there is no lithologic or faunal control that will permit the separation into individual units of that material which is younger than late Miocene, the Yorktown formation.

This undifferentiated material consists of sand, sandy clay, clay, and scattered gravel units that show little evidence of stratification other than local cross-bedding. The thickness of the material ranges from a few feet to as much as 60 feet with no definite thickness trend in any one compass direction. Deposition of the material as a thin, discontinuous, blanketing layer precludes the determination of a local or regional strike.

Inasmuch as the origin, definition, and delineation of the terrace deposits throughout the Atlantic Coastal states have been the subject of continuous controversy, it is not advisable to attempt any correlation between the Quaternary deposits in North Carolina and similar deposits elsewhere without substantial evidence. The absence of original lithologic contrast between so-called terrace formations, coupled with the changes effected by subaerial erosion would make any attempted correlation discretionary and of limited value.

Some of the material of Quaternary age in North Carolina probably is analogous to material included in the Pleistocene marine terraces elsewhere, although in the Greenville area the great bulk of the material represents nonmarine fluviatile deposition.

GROUND-WATER HYDROLOGY

Hydrologic Cycle

The earth has a fixed supply of water that is kept in unending circulation between the earth and the atmosphere; the energy for this circulation is supplied by the sun. The continuous circulation of water in its various forms has been termed the hydrologic cycle, and the study of the many complex and interrelated phases of the hydrologic cycle is the science of hydrology.

Oceans are by far the largest storage components of this circulatory water system, lesser amounts of water occurring in the atmosphere, on the land surface, and beneath the land surface. Climatic forces, oceans, and landforms exert modifying influences on the hydrologic cycle. This report describes some of the modifying physical and geologic influences that govern the amount, availability, and quality of water in that limited part of the circulatory system which occurs beneath the land surface in the Greenville area.

Source of Ground Water

Ground water, the water occurring beneath the land surface in the zone of saturation, is usable only when it is brought to the surface by natural or artificial means. Ground water in the area of investigation is derived from precipitation, either rain or snow, that infiltrates the soil cover and percolates downward to the zone of saturation. The proportion of precipitation that reaches the zone of saturation is controlled, in part, by the topographic relief of the land surface, and by the permeability of the soil cover above the zone of saturation. Soil cover throughout the Greenville area has about the same average permeability; topographic relief in the area ranges from 130 feet to sea level.

Occurrence of Ground Water

A rock formation that yields sufficient water to serve as a source of supply for human consumption is called an aquifer. The term aquifer is relative and denotes no fixed volume of recoverable water. Thus a rock formation of low yield may be considered an aquifer in an area where other rock formations yield even less. The same rock formation would not necessarily be considered an aquifer if it occurred in an area where other rocks had relatively high yields. Basically, then, the designation of a rock formation as an aquifer lies in its ability to store and transmit usefull quantities of water, in relation to other rock formations in its area of occurrence.

The quantity of water that may be safely withdrawn from any aquifer is dependent upon the transmissibility, the storage capacity, and the amount of water available for recharge to the acquifer. If discharge of water from an aquifer exceeds recharge to it over a period of time, the ground-water level or piezometric surface of the aquifer declines.

The two major classes of aquifers are the water-table aquifer and the artesian aquifer.

A water-table aquifer is a rock containing an unconfined zone of saturation. The surface of the zone of saturation is the water table. However, the water table does not represent a flat table-like surface as the name implies. If viewed in profile, its peaks and troughs would represent a subdued likeness to the overlying land configuration.

The water table is not static but fluctuates in response to changes in the ratio of recharge to and discharge from the zone of saturation. Natural forces causing fluctuations of the water table would include variations in precipitation, transpiration, evaporation, temperature, and atmospheric pressure. Artificial forces that cause variations in the water table would include withdrawal of water from the ground-water reservoir either by pumping or by artificial drainage through ditches and canals or other man-made channels.

A zone of saturation in which water is confined under pressure is termed an artesian aquifer. Water entering an artesian aquifer where it crops out or is overlain by permeable material percolates downdip by gravity, eventually passing a line beyond which the aquifer is filled to capacity and is both overlain and underlain by relatively impermeable beds. Because the weight of the water updip in an artesian aquifer exerts pressure on the water downdip in the same aquifer, the hydrostatic pressure increases progressively in a downdip direction. Thus, the water level in a well that taps an artesian aquifer stands above the top of the aquifer and the weight of the column of water in the well counterbalances the hydrostatic pressure in the aquifer at the point where entered by the well. The level at which the water stands in the well coincides with an imaginary surface known as the piezometric, or pressure, surface of the aquifer and if that surface is above the land surface water will flow from the well. In the Greenville area wells that will flow can be drilled throughout most of the eastern third of Beaufort County and elsewhere in the valleys of the major streams and their principal tributaries.

Water-Bearing Properties of Rocks

In the zone of saturation all space not occupied by solid material is occupied by water. The capacity of a rock to store water is governed by its porosity, which is the ratio of the volume of voids, or pore spaces, to the volume of solid material. Porosity is a function of the size, shape, assortment, and cementation of the solid components of the rock.

The rate at which a rock will transmit water is determined by its permeability and the hydraulic gradient. Permeability is the rock's capacity for transmitting fluids in response to variations in hydrostatic pressure or gravity, and is measured volumetrically as a function of time. In general, the permeability of a rock is determined by the size and shape of its pore spaces and the manner in which they are connected. Porosity and permeability are not necessarily proportional. A clay may have a high porosity because of its large volume of pore space. However, because the individual pore spaces are small only a little water is transmitted under the hydraulic gradients that exist in nature. Specific yield, a function of both porosity and permeability, is the difference between the total amount of water in the voids of a saturated rock and the amount that is retained by tht rock after it is drained by gravity.

Recharge and Discharge

Ground waters generally move at rates varying from a few feet a day to a few feet a year as suggested by Meinzer (1949, p. 449). The movement of ground water is along arcuate lines and results from differences in head between any two points in the direction of movement. In the Greenville area, under natural conditions, the watertable aquifer discharges water by effluent seepage into streams and ponds laterally and into adjacent aquifers vertically. Recharge to the water-table aquifer comes from precipitation that infiltrates the zone of aeration and reaches the zone of saturation.

Locally recharge may be effected by artifically induced infiltration of water from streams into an aquifer. This reversal of the normal ground-water gradient is brought about by creation, through pumping, of a cone of depression in the water table that intersects a surface stream and results in the establishment of an artificial hydraulic gradient from the stream to the aquifer.

An artesian aquifer is recharged by precipitation in areas where permeable beds crop out at the surface or by leakage of water through overlying and underlying confining beds in the subsurface. In the southeastern section of the Greenville area, in Greene and Pitt Counties, there are extensive areas where the Cretaceous aquifers (Tuscaloosa, Black Creek, and Peedee formations) are at the surface or at shallow depths beneath a thin mantle of predominantly sandy soil. Precipitation in this area is about 47 inches yearly.

In that part of the Greenville area lying north of the Tar River, except near Lewiston and Bruce, geologic factors preclude the possibility of the artesian aquifers being recharged by direct precipitation. North of the Tar River, artesian aquifers of Cretaceous, Paleocene, and Eocene age are buried beneath Miocene strata at depths of from 25 to 200 feet. The Miocene strata, consisting of nearly impermeable sandy clays containing lenticular shell beds, are in turn overlain by Quaternary strata, predominantly sands and sandy clays. The artesian aquifers are effectively sealed off insofar as direct recharge by precipitation is concerned. Recharge to these artesian sand and limstone aquifers is believed to result in part from upward leakage from the basal Cretaceous beds and in part by downward leakage from and through overlying Miocene and Quaternary beds.

The Tuscaloosa formation also crops out west of, and updip from, the Greenville area. The formation, composed of lenticular sands and clays, is an important source of ground-water supply in its outcrop area. Downdip, chemical analyses of water from this aquifer and statigraphically higher aquifers indicate that the Tuscaloosa formation is an important source of recharge to the overlying aquifers of the Black Creek and Peedee formations.

Water levels in strata of late Miocene and Quaternary age are generally within a few feet of the surface throughout the Greenville area. The land surface is relatively flat, resulting in a low hydraulic gradient, and consequently the lateral movement of water toward the streams, the natural discharge points, is very slow. This material is saturated with water at all times, but because of its low transmissibility it is not generally tapped as an aquifer except locally where small to copious supplies of water are obtained from lenticular sand or shell beds of relatively high permeability. However, strata of low permeability, particularly those in the Yorktown formation, assume major hydrologic importance as a source of recharge to the underlying sand and limestone aquifers of Cretaceous, Paleocene, and Eocene age.

Recovery of Water

General Features

Ground water may be recovered from wells, springs, or seeps. So far as the writer knows all ground-water supplies in the Greenville area are obtained from wells. Wells can be most conveniently classed according to their method of construction. Such a classification would include dug wells, bored wells, driven wells, and drilled wells.

Dug Wells

Dug wells are large-diameter holes that are deep enough to intersect the water table. The dug well is excavated manually, and cribbing consisting of wood, tile, brick, cement, or stone is placed to prevent slumping of unstable material from the wells into the hole. Curbing is installed at the top of the hole to prevent the direct seepage into the well of surface water or the entry of foreign matter that might otherwise pollute the ground-water supply. Dug wells in the Greenville area, usually 15 to 30 feet deep, are generally constructed during the summer and fall months when seasonal ground-water levels are at their lowest point.

Bored Wells

Bored wells are excavated by means of hand or power augers. The depth of such excavations is dependent upon the nature of the material penetrated and upon the depth to the water table. The larger holes are lined with tile or stone, whereas the smaller holes are cased with a metal pipe that is perforated opposite the water-bearing formation. Bored wells are uncommon in the Greenville area, and few exceed a depth of 45 feet.

Driven Wells

In constructing a driven well, a screened well point attached to a length of pipe is driven into the ground either manually or mechanically. Successive lengths of pipe are attached as the driving continues until the desired depth is reached. The wells range from 1 to 3 inches in diameter and few are more than 40 feet deep. These wells, commonly equipped with pitcher pumps, are common in the Greenville area and generally yield 2 to 30 gpm.

Drilled Wells

Drilled wells are of three main types as follows: the jetted well, the cable-tool well, and the rotary well. In all three types, penetration of the rock is accomplished, in whole or in part, by the percussion or rotary action of a drill bit against rock.

Jetted wells.—Jetted wells are constructed by forcing water down a drill stem, out through a drill bit, and back up the hole to the surface. In unconsolidated material, the force of the water as it passes out of the bit loosens material which is then carried by the water to the surface and deposited in a conveniently located sump. In drilling through consolidated formations the bit is alternately raised and dropped in the hole. The cutting action of the bit augments the jetting action of the water and the drill stem is "rocked" back and forth during the drilling operation in order to insure a straight hole. Casing is sunk around the drill stem as the hole becomes progressively deeper, or it may be sunk in one complete operation after drilling ceases.

Cable-tool wells.—In a well that is constructed by the cable-tool method a bit and a string of tools attached to a cable is alternately raised and dropped in the hole. The percussion action of the bit, motivated by a walking beam, causes the rock to be broken and crushed in the hole. When sufficient cuttings have accumulated in the hole the tools are withdrawn and cuttings are removed by a bailer or sand pump. As drilling progresses casing is sunk until competent rock is reached and caving is no longer a danger.

Rotary wells.—In a well that is constructed by the rotary method a bit is attached to a length of drill pipe which is then rotated in the hole. Drilling fluid is pumped down the drill pipe, out through the bit and up to the surface alongside the drill stem. The drilling fluid brings the cuttings to the surface and because it contains clay, also serves to seal the sides of the hole and to prevent caving during drilling. Casing may be sunk behind the bit as drilling progresses or it may be installed in one complete operation after drilling ceases.

A common type of rotary well in the Greenville area is referred to as a "gravel-wall" well. This well is a standard rotary hole of a diameter greater than the desired diameter of the casing. Sized gravel is forced or fed by gravity into the hole and forms a gravel envelope around the casing. The advantage of this method is that it minimizes some of the error involved in placing the screens and in determining the correct size of screen opening. Generally speaking, however, a well with screens advantageously placed and of correct magnitude will yield as much water as a gravel-wall well in the same location. However, owing to the thin, lenticular nature of the sediments in the Greenville area, difficulty is experienced in placing screens most advantageously, and screened wells rarely yield as much water as gravel-walled wells of comparable depth.

Hydrologic Principles Affecting Recovery

The natural level of water in a well, prior to pumping, is in equilibrium with the water level in the surrounding aquifer and is called the static water level. When pumping commences, the water level in the well drops, ceasing to be a static water level and becoming a pumping water level. The distance between the normal static water level and the pumping water level, at any one time, is a measurable distance called the drawdown. The lowering of water in the well causes water to flow from the surrounding aquifer into the well. This flow of water into the well causes the ground-water levels in the aquifer to be drawn down in the shape of an inverted cone whose apex is at the wall. The cone is called the "cone of depression" and the area within the perimeter of the cone is termed the "area of influence". Both the extent and the growth of the cone of depression and its corresponding area of influence are directly proportional to the amount of water being pumped from the well and to the coefficient of transmissibility of the aquifer.

The capacity of a well may be defined as the amount of water, measured in gallons per minute, that a well will yield continuously over a period of time. The specific capacity of a well is the amount of water measured in gallons per minute per foot of drawdown that a well will produce. A numerical value for specific capacity is obtained by dividing the yield by the drawdown at any given time.

Some of the features discussed for both water-table and artesian aquifers are illustrated in figure 4.

QUALITY OF WATER

Information relative to the chemical quality of ground waters is necessary in an appraisal of the ground-water resources of the Greenville area. Such information will be a strong influencing factor in the industrial development of the area, particularly in regard to locating those industries that, because of the nature of their processes, must be selective in their choice of a water supply. The satisfactory and economic treatment of domestic, municipal, and industrial supplies for consumptive use also is dependent on a knowledge of the chemical quality of ground waters. In addition, the chemical characteristics of ground waters are a valuable aid in mapping subsurface water-bearing formations.

The best results are achieved in a ground-water appraisal when the recognized chemical characteristics of the ground waters are correlated with the available geologic information in the area. Otherwise, the observed chemical characteristics of ground waters have only local significance in application.

Mineral Composition of Ground Waters

The chemical quality of ground water is governed by the amount and type of dissolved solids and absorbed gases that it contains. Rain water absorbs gases, mainly carbon dioxide and oxygen. Water containing these gases becomes a strong weathering agent capable of reacting with mineral compounds found in the soil and rocks of the earth's crust. The quantities of absorbed gases and dissolved solids that occur in a ground water at any one time are chiefly dependent upon such factors as the gases and dissolved solids already in solution, the temperature of the water, the hydrostatic and atmospheric pressures present in the system, the chemical composition and physical nature of the host rock or rocks, and the duration of the contact between the water and the individual mineral grains in the host rock.

The salts of the common metals, which include potassium, sodium, calcium, magnesium, and iron, make up a large percentage of the dissolved solids in ground waters. True salts are ionic in character; that is they are composed of cations and anions. Chemical analyses of ground water are a quantitative measure of the individual cations and anions present in the aqueous solution. The proportionate amounts and chemical relationships of the anions and cations present in the solution, in turn, determine such reported factors as hardness, specific conductance, and hydrogen-ion concentration.

In this report the chemical analyses of ground waters are expressed in parts per million (milligrams per kilogram). To classify waters according to their chemical character it is advisable to report the ionic constituents in chemical equivalent quantities

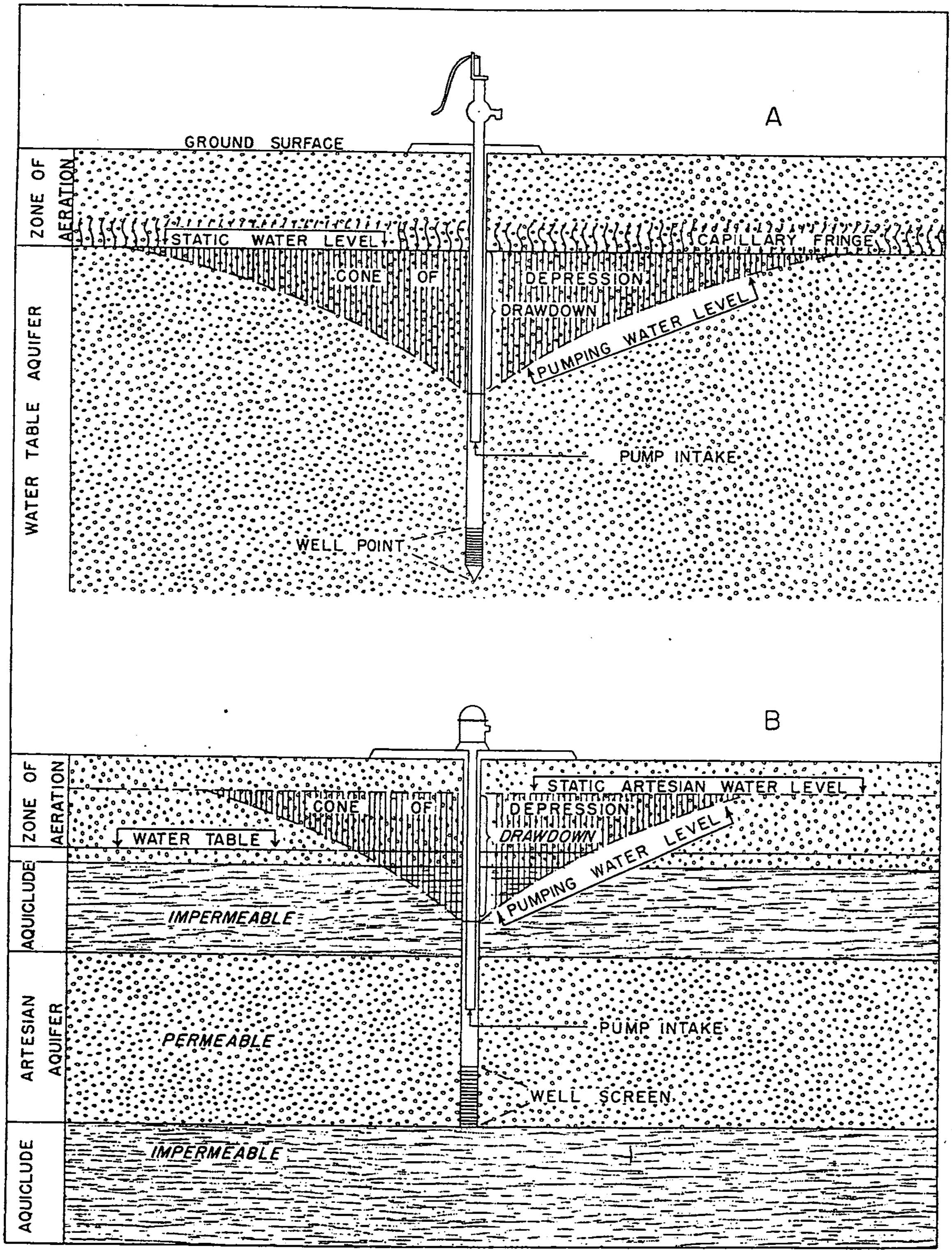


Diagram showing wells in (A) a water-table aquifer and (B) an artesian aquifer

FIGURE 4.

(equivalents per million). Such expression, while useful in comparing waters having wide ranges of dissolved solids, is not readily applicable to use by the layman, and is, therefore, omitted from this report.

The following discussion concerns the chemical constituents of ground water in the Greenville area, as commonly reported in water analyses, in relation to their occurrence.

Silica (SiO_2).—Silica in ground water results from the weathering of silicate minerals that are abundant in nearly all rocks. It is generally believed that silica in natural waters is in the colloidal state and, therefore, is not involved in the chemical equilibrium between acids and bases.

The concentration of silica in water samples from the Greenville area ranges from about 3 to 65 ppm. Silica concentration was highest in water samples from dolomitic limestone, and commonly was less than 15 ppm from other water-bearing material.

Iron (Fe).—Iron compounds are common in nearly all rocks and soils, and iron is readily taken into solution by ground water, particularly by water that is acidic. Water containing as much as 0.3 ppm of iron is acceptable for most domestic uses, whereas most industrial uses require water that contains less than 0.1 ppm. of iron. A common complaint in the Greenville area is that well water stains fixtures and utensils yellow, brown, or red. This condition is due to the presence of iron in the water when it came from the well or the "pickup" of iron by corrosive waters passing through iron pipes in the water—distribution system. A water containing dissolved iron may look perfectly clear when it comes from a well, but upon exposure to air the salt is oxidized and ferric hydroxide forms; the latter is responsible for the staining condition. Ferric hydroxide can generally be removed by attachng one of several commercial types of sand filters to the water system.

The occurrence of iron in the ground-water samples from the Greenville area follows no generally predictable pattern, except that the amount of iron present in waters from the surficial aquifers is greater than that present in the deeper aquifers and, therefore, is roughly proportionate to the acidity of ground waters in the area. In places in the Greenville area where shallow ground water contains objectionable amount of iron, water that is low in iron may be obtained from deeper aquifers.

Calcium and magnesium (Ca and Mg).—Compounds of calcium and magnesium are common in the sediments of the Greenville area. Ground water circulating through the sediments dissolves calcium from the limestones and calcareous sands and clays. The calcium passes into solution as calcium bicarbonate which may be precipitated as calcium carbonate and then may pass again into solution as calcium bicarbonate. This reversible reaction is caused by the changes in the carbon dioxide content of the water that result from changes in pressure and temperature within the aquifer. Ultimately, this continuing cycle would be expected to remove all the calcium from the sediments, final deposition occuring in the ocean. Because magnesium is similar to calcium in chemical reaction insofar as most water usage is concerned, the two ions generally are considered together. The salts of calcium and magnesium account for most of the hardness of ground waters and their effect is discussed in the paragraph dealing with hardness.

Sodium and potassium (Na and K).—Compounds containing sodium and potassium are present in nearly all types of soil and rock. In the Greenville area these constituents generally are present in waters in small to moderate amounts, not exceeding 50 ppm. However, samples of water from some of the deeper aquifers contained as much as 650 ppm of these constituents. In general, high concentrations of sodium and potassium may reflect such conditions as follows:

1. Contamination of fresh water by infiltration of brackish water.

2. The presence of connate (fossil) saline water.

2. The presence of strata containing alkali salts.

4. Intimate contact of the ground water with base-exchange minerals.

Some of the above listed conditions are probable causes for excessive amounts of sodium and potassium in some of the water in the Greenville area. Near the towns of Washington and Belhaven wells adjacent to bodies of brackish surface water yield water that contains increasing amounts of sodium, potassium, and chloride when they are pumped continuously over long periods of time. The increases in concentration are due largely to induced lateral infiltration of the brackish surface water into the aquifer when the wells are pumped. Connate water is present at several localities in the area. An excellent example is the occurrence of such water in a well at Sunbury, Gates County. Water containing a little more than 500 ppm of chloride and a little more than 650 ppm of sodium and potassium is present between the depths of 390 and 450 feet. Above and below this interval water generally contains less than 50 ppm of chloride and less than 300 ppm of sodium and potassium. The presence and action of base-exchange minerals in the water-bearing formations of the area are commonly recognized. Base-exchange minerals such as the various clay minerals, the micas, and glauconite have the capacity for exchanging cations and anions in their crystal structure with cations and anions in an aqueous solution when they are in intimate contact. Little is known of the anion-exchanging capacity of these minerals or of their capacity for regeneration under natural conditions. However, it is known that water containing the cations calcium and magnesium, when in contact with base exchange minerals such as glauconite, are generally enriched in sodium and potassium at the expense of their calcium and magnesium. In this manner the relatively hard calcium and magnesium bicarbonate waters are changed to the soft sodium bicarbonate waters under natural conditions. The natural softening of waters by base exchange is common in the water-bearing formations of Cretaceous and Paleocene age throughout the Greenville area. Water containing as much as 50 ppm of sodium and potassium may be used for most domestic purposes. Water containing more than 50 ppm of sodium and potassium may cause foaming in high-pressure boilers. Sodium and potassium do not impart a noticeable taste to ground water unless their concentration is greater than several hundred parts per million.

Bicarbonate and carbonate (HCO_3 and CO_3).—Very few ground waters in the Greenville area contain measureable amounts of carbonate. Generally the water is of the bicarbonate type and contains as the principal cations either calcium and magnesium or sodium and potassium. The bicarbonate content of the water samples collected in the Greenville area ranges from less than 4 ppm to 812 ppm. Bicarbonate has little effect on either the domestic or industrial utilization of the water. The Castle Hayne limestone in Beaufort and Martin Counties yield water that is high in calcium bicarbonate. When this hard water is heated, the carbon dioxide is driven off and a residue of relatively insoluble calcium carbonate is formed. This residue coats cooking vessels and is cause for common complaint by residents in those counties. The residue-producing hardness can be relieved by the use of zeolite water softeners on the water distribution system.

Sulfate (SO_4).—Most sulfate minerals, such as gypsum ($CaSO_4.2H_2O$), are soluble and will yield sulfate ions upon solution. The insoluble sulfides of iron (pyrite and marcasite) are partially oxidized during the normal weathering processes to soluble sulfates and are a common source of the sulfates in the ground waters of the Greenville area. Reduction of sulfates by bacterial action may produce hydrogen sulfide (a weak acid) and (or) sulfur, which in turn may be oxidized by bacteria to produce sulfates.

The occurrence of sulfates in ground waters in the Greenville area follows no generally predictable pattern. Water from the shallow water-bearing sands and limestones of intermediate depth generally contain more sulfate than do waters from the deeper greensands. Ground water containing a higher than normal concentration of chloride due to salt water contamination also contains a high concentration of sulfate. Hydrogen sulfide generally is present in water from the Castle Hayne limestone, where it occurs below a depth of about 150 feet, and imparts a noticeable taste and odor to the water.

Chloride (Cl).—Chloride, in small amounts, dissolved from rocks during the normal weathering processes is responsible for some of the chloride noted in ground waters of the Greenville area. Other possible sources are sewage, industrial waste, fertilizers used in predominantly agricultural areas, and salt spray blown inland during heavy storms along the coast. Back-flooding of low coastal areas during the hurricanes of 1955 left a residual deposit high in chloride which made much of the land unfit for agricultural use until it had been treated with gypsum. A large part of this residual chloride will eventually be dispersed through the ground water in the near coastal areas.

However, the normal chloride content of ground water from any of the above-mentioned sources in the Greenville area is generally less than 25 ppm. A chloride concentration much in excess of this figure indicate the presence of connate water, intrusive brackish water, or strata containing saline salts through which the ground water had passed. Both connate and intrusive chloride waters are recognized in the area of investigation. At Sunbury, Gates County, connate water containing 500 to 600 ppm of chloride is encountered between the depths of 425 and 475 feet. Above and below this zone ground water containing less than 100 ppm. is encountered. At the towns of Belhaven and Washington wells tapping porous limestone adjacent to brackish surface waters yield water high in chloride upon continual pumping. This high chloride content is probably due to lateral intrusion of the surface water into the limestone. No evidence is available concerning the presence of beds containing saline salts in the area of investigation.

Fluoride (F).—Fluoride in ground water is due to the solution of fluoride-bearing minerals such as the apatites, the fluorapatites, the phosphates, the micas, and the hornblendes, as well as organic matter such as shells. Of these, the micas, the phosphates, and the organic matter are the most prevalent in the sediments of the Greenville area and are thought to account for most of the fluoride in the ground water.

Fluoride in concentrations between 1.0 and 1.5 ppm in drinking water aids in reducing tooth decay in children. Fluoride in concentrations in excess of 1.5 ppm may cause permanent mottling of the teeth (dental fluorosis) when used by children (Dean, 1936, pp. 1269-1272).

The fluoride content of ground water in the Greenville area generally is less than the acceptable amount of 1.5 ppm. However, in parts of some counties, especially in the vicinity of Gatesville and Sunbury in Gates County, water from the Cretaceous and Paleocene aquifers contains as much as 8.0 ppm of fluoride. To minimize the effect in this high concentration it would be necessary to dilute waters that are high in fluoride with waters containing little or no fluoride.

Nitrate (NO_3).—Nitrate in ground water is generally considered to be the final oxidation product of nitrogenous (organic) waste. A nitrate concentration in excess of 3.0 ppm generally would indicate a nearby source of pollution. Shallow dug wells and well points are most often subject to pollution from such influences as sewage, fertilizers, and polluted surface waters. Water from all types of wells that are adequately cased so as to exclude the surface sources of contamination will generally have a nitrate content of less than 3.0 ppm.

Phosphate (PO_4).—Phosphate of ground waters in the Greenville area has been determined for only a few samples. No phosphate was recorded in excess of 0.3 ppm.

Dissolved solids.—Dissolved solids are the residue remaining after a given volume of water has evaporated, and has been dried at some definite temperature (180°C by U. S. Geol. Survey). The calculation of the dissolved solids is approximately half the bicarboante plus the sum of the other mineral constituents.

In public water supplies dissolved solids preferably should not exceed 500 ppm, but if water of such quality is not available dissolved solids of 1,000 ppm may be permitted. However, comparatively few supplies having a dissolved-solids content in excess of 500 and 1,000 ppm are known in the Greenville area.

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 chemical constituents that produce hardness in ground waters are compounds containing calcium and magnesium.

To list the hardness tolerances acceptable to various domestic and industrial users is not within the scope of this report. However, the U. S. Geological Survey classifies water with respect to hardness as follows:

Hardness as $CaCO_3$	Classification
0-60	Soft water
61-120	Moderately hard water
121-200	Hard water
200+	Very hard water

Hydrogen-ion concentration (pH). — The hydrogen-ion concentration, expressed as the pH, is a measure of the degree of acidity or alkalinity of the water. The pH of a solution is represented by a number which is the negative logarithm of the concentration of hydrogen ions in moles per liter. Numerically the pH scale extends from 0 to 14. A water having a pH value of 7 is assumed to be neutral and the concentration of hydrogen ions is equal to the concentration of the hydroxyl ions. A water with a pH value less than 7 is said to be acid (the concentration of H+ ions is greater than the concentration of OH— ions), and the acidity increases as the numerical pH value decreases toward 0. A water with a pH value greater than 7 is said to be alkaline (the concentration of OH— ions is greater than the concentration of H+ ions) and the alkalinity increases as the numerical pH value increases toward 14. 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 a water with a pH of 4, and conversely a water with a pH of 9 is ten times as alkaline as a water with a pH of 8.

The pH values given for ground waters are important as an indication of their corrosive potential. Generally speaking, acid waters have a much greater corrosive potential than do the alkaline waters.

PRINCIPAL FORMATIONS AND THEIR HYDROLOGIC CHARACTERISTICS

Strata of Early Cretaceous age

A formation of Early Cretaceous age was encountered at a depth of 608 feet at Greenville, Pitt County. An examination of the cuttings and the electric log of this unnamed formation show it to consist of interbedded sands and clays; the sands are capable of furnishing large amounts of water. However, in the well in which the formation was encountered it yielded brackish water that was unsuitable for further development. Updip, this formation may contain water of suitable quality so as to serve as a source of ground water to deep wells in the area west of Greenville and Williamston.

The water in this formation is under artesian head and recharge is probably in the form of downward leakage from overlying beds. The formation lies unconformably on basement rocks and is thought to be confined to the subsurface.

No quantitative data regarding the storage capacity and water-yielding potential of this formation are available.

Tuscaloosa formation

Large quantities of ground water are stored in the lenticular gravels, sands, and clays of the Tuscaloosa formation. This formation is a major aquifer in Hertford, Bertie, Martin, Pitt, and Greene Counties. To the east of these counties no water wells have penetrated the Tuscaloosa formation and it is believed that the entire potential aquifer contains saline waters in Beaufort, Chowan, and Gates Counties.

The water in the Tuscaloosa formation is normally under artesian head throughout the Greenville area, with the exception of limited segments of western Greene and Pitt Counties where water-table conditions exist in the outcrop area. Lenticular sands and gravels occur at all horizons within the formation but are more prevalent below the upper 150 feet. Many of the wells that utilize the Tuscaloosa formation as a source of water are "gravel-wall" wells that also obtain waters from the younger Cretaceous formations. These gravel-walled wells yield from 500 to 1,000 gpm with specific capacities that range from 4 to 15 gpm per foot of drawdown. Single-screen wells in the Tuscaloosa formation obtain water from beds of sand and produce from 10 to 300 gpm with specific capacities ranging from 1 to 5 gpm per foot of drawdown. To the writer's knowledge there are no multiple-screened tubular wells that tap the Tuscaloosa formation in the Greenville area.

Water levels in this aquifer are variable, depending upon the head in the various sand and gravel lenses at depth. The piezometric surface is generally constant in local areas in sand strata of similar depths. The pressure head generally increases with depth in any given area. In the valleys of the major streams and their main tributaries the piezometric surface is above land surface, resulting in artesian flows.

In general the chemical quality of water from this aquifer is adequate for most domestic and industrial uses. However, shallow wells in the outcrop area of the aquifer may yield water that contains a realtively high concentration of iron.

Black Creek formation

The Black Creek formation is one of the most productive aquifers in the Greenville area. Like the underlying Tuscaloosa formation, its use is limited in the outer coastal counties where it lies at great depth and presumably contains saline water. The formation is developed as an aquifer in Bertie, Martin, Pitt, and Greene Counties.

The lower part of the formation, the unnamed member, is predominantly composed of sands and clays. Except in shallow sands in the outcrop area, the contained water is under artesian pressure in lenticular, flat-lying beds confined between lenticular beds of clay. There is a little uniformity to these sands. Where one well may penetrate one or two of these lenticular sands, a well less than 2 miles away and drilled to a comparable depth may penetrate as many as five water-producing sands. The upper part of the Black Creek formation, the Snow Hill marl member, is composed of black clays and interbedded sands and sandy marls. Lenticular sands are rarely as thick or as extensive as in the lower part of the formation. Drillers seeking large amounts of water generally bypass this member. Locally, however, many small-diameter domestic wells obtain adequate supplies from thin strata of sand and sandy marl in the Snow Hill marl member.

"Gravel-wall" wells that tap both the Black Creek and Tuscaloosa formations are capable of yielding as much as 1,000 gpm. with specific capacities that range from 4 to 15 gpm. per foot of drawdown. Single-screen wells and open-end wells generally yield 5 to 50 gpm. The water-yielding capacity of the Black Creek formation increases to the east and southeast because the formation becomes more sandy in a downdip direction.

Artesian or pressure head is farly constant in sand beds at comparable depth over large areas. Artesian flows are common in wells penetrating the formation, some flows occurring from wells less than 40 feet deep. These artesian flows are largely confined to the lower river terraces in the major stream valleys.

The chemical quality of water from this aquifer is generally satisfactory for most purposes. However, relatively hard waters can be expected from wells that obtain water from the calcareous beds in the Snow Hill marl member.

Peedee formation

The Peedee formation is one of the major aquifers in Beaufort, Greene, Pitt, Martin, Bertie, Hertford, and Gates Counties. In Chowan County the formation lies at a depth in excess of 450 feet and presumably contains saline water in all but the northernmost part of the county adjacent to Gates County.

Water in the Peedee formation is under artesian pressure, except in local areas at or near the surface in its area of outcrop. In common with the older Cretaceous formations, the Peedee formation has no single water-bearing zone that can be traced over long distances. Permeable water-bearing sands that are confined between relatively impermeable clays occur at all horizons throughout the formation. In addition, indurated layers composed largely of shells and shell fragments occur above and below the water-bearing sands.

The majority of wells tapping this formation are single-screened or open-end wells that yield 5 to 50 gpm. The open-end wells are constructed so that the casing is firmly seated in an indurated layer. The well is then drilled through this layer and a large cavity is created by forcing compressed air down the well and blowing out large quantities of sand. This type of well construction probably is the most common in wells that tap the Peedee formation. In addition, gravel-wall wells in the area obtain a portion of their water from this formation.

The piezometric surface remains nearly uniform in sands of comparable depth over most of the area, the deeper sands containing water under a greater pressure head than the shallower sands. Artesian flows are common from wells that tap the Peedee formation and that lie adjacent to or in the major stream valleys.

The chemical quality of waters from the Peedee formation is not uniform. Water from wells less than 100 feet deep are relatively hard (high in calcium and magnesium). Wells penetrating the formation at depths in excess of 100 to 150 feet obtain waters that are relatively soft (high in sodium and potassium). This difference in the chemical quality of the water in the formation is largely due to base exchange (p. 57).

Beaufort formation

The Beaufort formation is utilized as an aquifer in parts of the following counties: Gates, Hertford, Bertie, Martin, Chowan, Pitt, and Beaufort. The formation, according to present observation, is confined to the subsurface and is composed of glauconitic sand, argillaceous sand, indurated shell, and impure limestone facies. Unlike the underlying Cretaceous formations it has not been found to contain any large number of lenticular clay beds. All strata within the formation are water bearing, the most important being the glauconitic sands that lie beneath the argillaceous sands and impure limestones.

However, the strata are lenticular and have not been traced from well to well over long distances. Water in the various sand layers is everywhere under artesian head and the piezometric surface even in the interstream areas of greatest relief is rarely more than 30 feet below the land surface. Artesian flows from this aquifer are common at low elevations in and adjacent to the major stream valleys.

Most of the wells tapping the Beaufort formation are single-screen or open-end wells that yield from 15 to 150 gpm. In addition, several gravel-walled wells obtain all or part of their water from this aquifer and yield as much as 750 gpm.

The chemical quality of water from the Beaufort formation is satisfactory for most purposes. Locally the water may contain as much as 6 or 7 ppm of fluoride and water derived from shell beds or impure limestones may be objectionably hard. Typical water from the Beaufort formation is soft and of the sodium bicarbonate type.

Castle Hayne limestone

The Castle Hayne limestone of middle and late Eocene age is an important aquifer in Beaufort County and in parts of Martin County. The formation is at or near the surface in the southeastern corner of Pitt County. Throughout the rest of the Greenville area the formation is confined to the subsurface, being buried progressively deeper in an easterly direction. The limstone normally contains fresh water. However, in eastern Beaufort County it is probable that the limestone in its lower parts contains saline waters unsuitable for development.

The yield of wells penetrating the formation is variable. Small-diameter (1 inch to 4 inch) wells yield from 5 to 150 gpm. Gravel-wall wells 10 to 12 inches in diameter yield as much as 1,000 gpm with specific capacities of 10 to 30 gpm per foot of drawdown.

Water in the Castle Hayne limestone is under artesian pressure and the piezometric surface is generally within 20 feet of the land surface. Locally, this pressure surface may be as much as 15 feet above the land surface, accounting for many strong artesian flows, especially in eastern Beaufort County. Recharge to the Castle Hayne limstone occurs as both upward and downward leakage from underlying and overlying confining beds. There is no direct recharge from precipitation because the formation, covered by younger material, does not crop out in most of the area and is not near the surface except in a small area in Pitt County.

The chemical quality of the water is adequate for most domestic purposes, although objectionably hard, and large amounts of hydrogen sulfide may give the waters an objectionable taste and odor in local areas.

Locally, the aquifer has been contaminated by lateral infiltration of brackish surface waters from the sounds and estuaries bordering the eastern segments of the Greenville area.

Yorktown formation

The Yorktown formation of late Miocene age transgressively covers nearly all the Greenville area. Individual wells in all the counties described in this report obtain small to large supplies of water from the formation. The predominant lithology is that of thick, massive marine clays interbedded with lenticular sands, shell beds, and indurated shell limestones. These water-bearing beds occur at all horizons within the formation and cannot be traced from well to well over long distances or predicted at any given locality on the basis of present information.

The water in the formation generally is under artesian pressure, except at shallow depths at or near the outcrop area. Most of the wells that obtain water from this formation are jetted, driven, or dug wells. Both the jetted and driven wells obtain water from the sands and shell strata. Dug wells of large diameter obtain water from the clays in the form of slow seepage and rarely penetrate to the sand or shell beds. Individual wells yield 5 to 300 gpm. No reliable information is available as to the specific capacities of these wells. General observations suggest that specific capacities average less than 5 gpm per foot of drawdown over most of the area. No large diameter drilled wells or "gravel-wall" wells obtain water from this formation, with the exception of the municipal wells at Edenton in Chowan County.

The artesian head is uniform at comparable depths over most of the area of investigation and increases with depth at any given locality. The artesian head in this formation is above the land surface in the major stream valleys and flowing wells may be expected. The formation is recharged by direct precipitation in outcrop areas or by downward leakage from thin overlying sands and clays of Quaternary age.

The chemical quality of the water is generally adequate for most domestic purposes. Where wells obtain water from shell beds or impure limestones, the water may be noticeably hard.

Hydrologically, the Yorktown formation is important largely as a source of water to the underlying aquifers of Eocene, Paleocene, and Cretaceous age. Enormous quantities of water are stored in the clays of the Yorktown formation. This water moves slowly as downward leakage into the more permeably underlying formations and serves as their main source of recharge.

Surficial sands

Surficial sands of Quaternary age blanket the interstream areas throughout the Greenville area. These sands furnish water to more individual wells than any other water-bearing unit. Sands in this unit, occurring between thin beds of clay, range from coarse to fine-graned and well sorted to poorly sorted sands of all sizes. Generally speaking, the sand-clay ratio in any given section is about 2:3.

Water in these sands ocurs under water-table conditions, and water levels show great variation in response to seasonal variations in rainfall and evapotranspiration. Wells that obtain water from this material are shallow driven or dug wells that rarely exceed 25 or 30 feet in depth. This type of well may yield from 2 to 10 gpm, according to the amount of water desired. Such wells are commonly equipped with hand-operated pitcher pumps or buckets.

Water-level records indicate that, although seasonal variations in the water table in this material are marked, over a period of years there has been no long-term rise or decline in water levels.

The chemical quality of water from this unit is suitable for most domestic uses. The water is soft but generally is corrosive and may contain considerable iron.

The surficial sands are the main source of water for small tenant farms, but the present trend in the Greenville area is toward abandonment of this source of water in favor of deeper wells that obtain water of better quality, both chemically and bacteriologically, below the surficial sands.

QUANTITATIVE MEASUREMENTS OF GROUND WATER

In the Greenville area few data are available upon which to base an estimate of the amount of ground water that may be available in the aquifers in any given section. The emphasis in a reconnaissance investigaton is to delineate and describe the physical characteristics of the water-bearing formations and their contained water.

Current and previous measurements of ground-water levels in the area suggest that, in most places, only a very small part of the available ground-water supply is being utilized. Future ground-water investigations in the area should be directed toward securing detailed data concerning the water-bearing capacity of the ground-water reservoirs. Current statements regarding quantitative withdrawal of ground water and the effects of this withdrawal on future supplies in the Greenville area are largely empirical.

COUNTY DESCRIPTIONS

Beaufort County
(Area 831 square miles, population 37,134)

Beaufort County, the largest and easternmost county in the area of investigation, is roughly divided in an east-west direction by the Pamlico River, an inland extension of Pamlico Sound. The county is bounded to the north by Martin and Washington Counties, to the east by Hyde County and Pamlico Sound, to the south by Pamlico and Craven Counties, and to the west by Pitt County. Washington, the county seat, is the second largest town in the Greenville area. Other population centers in the county include Aurora, Bath, Belhaven, Chocowinity, and Pantego.

The county is drained by broad, slow-moving creeks that flow into the Pungo and Pamlico River; these in turn flow into Pamlico Sound. Large areas of the county consist of broad swamps, locally termed "pocosins". In the area north and west of the communities of Terra Ceia and Swindell, large segments of swamp land have been reclaimed through construction of deep drainage ditches. This reclaimed land is among the most fertile in the State. Agriculture and seafood processing are the main sources of income in the county.

Geology—The entire county is mantled by surficial sands and clays of Quaternary age. This surficial material is rarely more than 30 feet thick and in many places less than 10 feet thick. Underlying the surficial deposits are beds of blue clay, marl, shells, and impure shell limestone that constitute the Yorktown formation of late Miocene age. The Yorktown formation ranges in thickness from about 40 feet in the extreme western part of the county to as much as 200 feet in the extreme eastern part of the county. In the central and eastern parts of the county the Yorktown formation is underlain by layers of phosphatic sand that are separated by one or more indurated shell beds. This unit, which has been designated in this report as middle(?) Miocene, ranges from a few feet to more than 90 feet in thickness. Individual beds of phosphatic sand are as much as 20 feet thick. Underlying the upper and middle(?) Miocene deposits are shell limestones and interlayered calcareous sands of the Castle Hayne limestone of late and middle Eocene age. This formation is about 60 feet thick near the western border of the county and perhaps as much as 250 feet thick along the eastern border of the county. The Beaufort formation of Paleocene age, composed of argillaceous sand, glauconitic sand, and marl, underlies the Castle Hayne limestone throughout most of the county. Few data are available concerning the thickness of the Beaufort formation. Two miles north of Washington, the formation is 35 feet thick and, according to limited data, the formation thickens rapidly and is buried progressively deeper toward the east. Underlying the Beaufort formation are glauconitic sands and micaceous clays of the Peedee formation of Late Cretaceous age. No data regarding the total thickness of this formation in Beaufort County are available. One mile west of Washington the top of the Peedee was penetrated at a depth of 158 feet below sea level. In eastern Beaufort County extrapolated data indicate that the top of the Peedee formation lies about 700 to 800 feet below sea level. Beneath the Peedee formation are older Cretaceous sediments that are believed to contain saline waters, and are not, therefore, discussed in this section.

Ground water.—With the exception of the supply for the town of Washington, all public and private water supplies in Beaufort County are obtained from wells. Surficial sands of Quaternary age and near-surface sand and shell beds of the Yorktown formation furnish water to shallow dug wells and driven wells that extend to a depth of 30 feet. A yield of 2 to 30 gpm can be expected from shallow wells in this material. Such wells are commonplace throughout the entire county. In central and eastern Beaufort County drilled wells obtain water from lenticular sands and shell beds in the Yorktown formation and from shell limestones and calcareous sands in the underlying Castle Hayne limestone. These wells range in depth from 100 to 300 feet and yield as much as 300 gpm. The depth of an individual well is largely determined by the area in which it is drilled, by the quantity and quality of water desired, and by individual driller's preference. Several wells in central Beaufort County obtain water from the Beaufort formation. However, this aquifer is seldom utilized in the eastern and central sections of the county because of the abundance of water in overlying aquifers. Water below a depth of 30-50 feet in this area is under artesian pressure and flowing wells are very common. Much of the land is only a few feet above sea level and the piezometric surface is generally within 15 feet of land surface or higher. In western Beaufort County, water is obtained from the Castle Hayne limestone, the Beaufort formation, and less commonly from the Peedee formation. The relative thinness of the Castle Hayne limestone in this part of the county limits its value as an aquifer. Where large quantities of water are desired, wells must be of large diameter, if tapping the Castle Hayne limestone, or must tap the Beaufort and Peedee formations. Yields of several hundred gallons per minute may be expected from deep wells in this area.

The chemical quality of ground water in Beaufort County is not uniform. Water from the surficial sands contains objectionable iron and is generally corrosive. Water from the shell beds and impure limestone layers of the Yorktown formation is moderately hard. Water from the shell limestone layers and calcareous sand layers of the Castle Hayne limestone is moderately hard to very hard and may contain objectionable amount of hydrogen sulfide, particularly in the eastern sections of the county. Most of the water from the Beaufort and Peedee formations is soft, but may be hard if the water is emanating from calcareous strata. At Washington and Belhaven several wells yield waters relatively high in chloride. Available data indicate that the chloride probably results from a lateral infiltration of brackish surface water into the aquifer as the wells are pumped. Relocation of supply wells at a greater distance from brackish surface waters in these areas would result in a lower incidence of chloride content.

Large supplies of ground water are available throughout the county from aquifers of Mesozoic and Cenozoic age. Present use of ground water in the county is only a small amount of the total water available.

The following well logs describe the physical characteristics of the principal aquifers in Beaufort County (see figure 5 for location).

Beaufort County

Number 32

Location: South shore of the Pungo River at Woodstock Point. 2.4 miles north of Winsteadville, North Carolina.
Owner: Walter Johnson
Date drilled: 1952
Driller: Truman Sawyer
Elevation of well: 6 feet above sea level

Hydrologic Information

Diameter of well: 2 inches
Depth of well: 240 feet
Cased to: 230 feet
Finish: open end
Static (nonpumping) water level: 5 feet above land surface
Temperature: 62°F
Yield: 10 gallons per minute (flow, 1954)
Chemical analysis of water available
Remarks: Very strong odor of hydrogen sulphide around the well. Water tastes very strongly of hydrogen sulphide.

Log of Well

Depth (feet)	
0-65	No sample.
	Upper Miocene—Yorktown formation
65-75	Sand, white; 80 per cent fine-grained angular to subangular quartz sand. 15 percent light-gray to white calcareous clay matrix, loosely consolidated. 5 percent broken shell and limestone fragments. Ostracoda and Foraminifera abundant.
75-85	Sand, white; Same 65-75-foot interval.
85-95	Sand, white; 90 percent fine-grained subangular quartz sand; grain surfaces predominantly etched and frosted. 10 percent gray calcareous clay matrix, loosely consolidated. Trace of broken abraded shell and limestone fragments. Abundant Ostracoda and Foraminifera.
95-105	Sand, white; Same as 85-95-foot interval, with trace of medium-grained black phosphate nodules. Abundant Ostracoda and Foraminifera.
105-115	Sand, white; Same as 95-105-foot interval.
115-125	Marl, white; 55 per cent fine-grained angular quartz sand. 35 percent cream-colored shell fragments. 10 percent white to light-gray calcareous clay matrix. loosely consolidated. Trace of black phosphate nodules. Ostracoda and Foraminifera abundant.
135-145	Marl, white; Same as 115-125-foot interval.
145-165	Marl, gray; same as 115-125-foot interval with matrix changing from white to gray in color. Ostracoda and Foraminifera abundant.

Ostracoda from 65-165-feet include:
Cytheridea (Haplocytheridea) proboscidiala Edwards
Leguminocythereis whitei Swain
Actinocythereis exanthemata (Ulrich and Bassler)
Echinocythereis garretti (Howe and McGuirt)
Murrayina martini (Ulrich and Bassler)
Orionina vaughani (Ulrich and Bassler)
Hemicythere conradi Howe and McGuirt
Loxoconcha purisubrhomboidea Edwards
Cushmanidea ashermani (Ulrich and Bassler)

Middle(?) Miocene—unnamed unit

168-180 Phosphatic sand, brown to gray; 50 percent fine-grained angular quartz sand. 30 percent fine-grained tan black collophane spherules and shards. 20 percent brown silt and clay matrix, unconsolidated.

200-210 Phosphatic sand, brown; Same as 168-180-foot interval with 5 percent increase in collophane percentage. No microfossils.

Middle Eocene—lower part of Castle Hayne limestone

230-240 Sandy limestone; white; 30 percent fine-grained angular water-polished quartz sand. 70 percent white chalky limestone moderately indurated and hard in streaks. Ostracoda and Foraminifera rare.
Ostracoda from 230-240-feet include:
Cytheridea (Haplocytheridea) montgomeryensis Howe and Chambers
Trachyleberis rukasi (Gooch)
Trachyleberis pellucinoda (Swain)
Trachyleberis bassleri (Ulrich)

Beaufort County

Number 100

Location: Stratigraphic test hole 0.6 mile west of bridge crossing Cherry Run on U. S. Route 17, 2.4 miles northeast of Washington, North Carolina.
Owner: American Metals Co.
Date drilled: 1952
Driller: Heater Well Co.
Elevation of well: 30 feet above sea level

Hydrologic Information

Diameter of test hole: 4 inches
Depth of test hole: 310 feet
Sampled to: 235 feet
Static (nonpumping) water level: 16 feet below land surface (reported 1952)

Log of Test Hole

Depth (feet)

Quaternary—sand and clay

10-20 Sand and clay, tan; 60 percent fine to medium-grained angular to subangular quartz sand. 40 percent tan clay matrix, unconsolidated. No microfossils.

20-30 Sand, tan; 80 percent coarse to medium-grained subrounded quartz sand. 20 percent tan clay matrix, unconsolidated. Limonitic staining of quartz grains predominate. No microfossils.

30-40 Sand, tan; Same as 20-30-foot interval. No microfossils.

Upper Miocene—Yorktown formation

40-50 Marl, gray; 40 percent medium-grained subrounded quartz sand. 30 percent blue-gray clay matrix, unconsolidated. 30 percent broken shell fragments. Ostracoda and Foraminifera very rare.

50-70 Clay, dark-gray; 20 percent very fine-grained angular quartz sand. 80 percent gray clay matrix, unconsolidated. Ostracoda and Foraminifera rare.

70-80 Marl, light-gray; 40 percent medium-grained subrounded quartz sand. 35 percent gray clay matrix, unconsolidated. 25 percent broken abraded shell fragments. Ostracoda rare and Foraminifera common.
Ostracoda from 40-70-feet include:
Puriana rugipunctata (Ulrich and Bassler)
Actinocythereis exanthemata (Ulrich and Bassler)
Murrayina martini (Ulrich and Bassler)
Hemicythere conradi Howe and McGuirt

Middle Eocene—lower part of Castle Hayne limestone

80-90 Sandy limestone, white; 35 percent medium-grained subangular water-polished quartz sand. 65 percent white shell and limestone fragments in a calcareous clay matrix, loosely consolidated to hard in streaks. Trace of glauconite and phosphate. Ostracoda and Foraminifera abundant.

90-100 Sandy limestone, white; Same as 80-90-foot interval. Ostracoda and Foraminifera abundant.

100-110 Sandy limestone, white; Same as 80-90-foot interval with glauconite limestone increasing to ±5 percent. Ostracoda and Foraminifera abundant.

110-120 Sandy limestone, white; Same as 80-90-foot interval. Ostracoda and Foraminifera abundant.

120-130 Sandy limestone, white; Same as 80-90-foot interval. Ostracoda and Foraminifera abundant.

130-140 Sandy limestone, white; Same as 80-90-foot interval but indurated and very hard. Ostracoda and Foraminifera common.

140-145 Sand and clay, green; 60 percent fine-grained angular quartz sand. 30 percent green clay matrix, unconsolidated. 10 percent light-green fine-grained glauconite. Ostracoda rare, Foraminifera common.
Ostracoda from 80-140-feet include:
Cytheridea (Haplocytheridea) montgomeryensis Howe and Chambers
Cytheridea (Clithrocytheridea) virginica (Schmidt)
Cytherura sp. aff. *C. washburni* Stephenson
Trachyleberis pellucinoda (Swain)
Trachyleberis rukasi (Gooch)
Trachyleberis bassleri (Ulrich)
Pterygocythereis washingtonensis Swain
Butonia howei (Stephenson)

Paleocene—Beaufort formation

145-150 Glauconitic sand, "salt and pepper"; 40 percent coarse to medium-grained subrounded quartz sand. 30 percent dark-green medium-grained glauconite. 15 percent green clay matrix, unconsolidated. 15 percent large broken shell fragments, primarily brachiopods. *Nodosaria* sp. prominent in hand specimen. No Ostracoda, Foraminifera common.

155-165 Sand, gray; 70 percent coarse to medium-grained subangular to subrounded quartz sand. 20 percent gray clay and silt matrix, unconsolidated. 10 percent dark-green medium-grained glauconite. Ostracoda and Foraminifera rare.

165-175 Sand, gray; Same as 155-165-foot interval with trace of coarse broken shell fragments. Ostracoda and Foraminifera common.

Ostracoda from 155-165-foot include:

Cytheridea (Haplocytheridea) ruginosa Alexander
Brachycythere interrasilis Alexander
Trachyleberis spiniferrima (Jones and Sherborn)
Trachyleberis cf. T. *prestwichiana* (Jones and Sherborn)
Trachyleberis midwayensis (Alexander)
Trachyleberis bassleri (Ulrich)

No Ostracoda were obtained from samples between 140 and 155 feet. The top of the Paleocene is placed at 145 feet on the basis of lithology. The first Paleocene Ostracoda occur in the 155-foot sample.

Upper Cretaceous—Peedee formation

175-185 Sand, gray; 70 percent fine to medium-grained subangular quartz. 30 percent gray silt and clay matrix, unconsolidated. Light-green fine-grained glauconite prominent. Ostracoda and Foraminifera very abundant.

185-195 Sand, gray; Same as 175-185-foot interval. Ostracoda and Foraminifera abundant.

195-200 Sand, gray; Same as 175-185-foot interval. Ostracoda and Foraminifera abundant.

200-205 Sand, gray; 80 percent coarse to medium-grained subrounded to rounded quartz sand. 20 percent gray clay matrix, unconsolidated. Trace of dark-green glauconite.

205-210 Sand, gray; Same as 200-205-foot interval with addition of 5 percent authigenic euhedral feldspar crystals which generally show twinning and which are partially kaolinized. Ostracoda and Foraminifera common.

210-221 Sand, gray; Same as 200-205-foot interval. Ostracoda and Foraminifera common.

221-225 Glauconitic sand; "salt and pepper"; 55 percent coarse to medium-grained subrounded to subangular quartz sand. 30 percent dark-green medium-grained glauconite. 15 percent silt and clay matrix, unconsolidated. Ostracoda and Foraminifera rare.

230-235 Glauconitic sand, green; 20 percent medium-grained subangular quartz sand. 60 percent dark-green medium-grained glauconite. 20 percent gray-green silt and clay matrix, unconsolidated. Ostracoda rare, Foraminifera common.

Ostracoda from 175-235-feet include:

Cytheridea (Haplocytheridea) ulrichi (Berry)
Eucytherura curta (Jennings)
Brachycythere rhomboidalis (Berry)
Trachyleberis pidgeoni (Berry)
Trachyleberis communis (Israelsky)
Velarocythere arachoides (Berry)

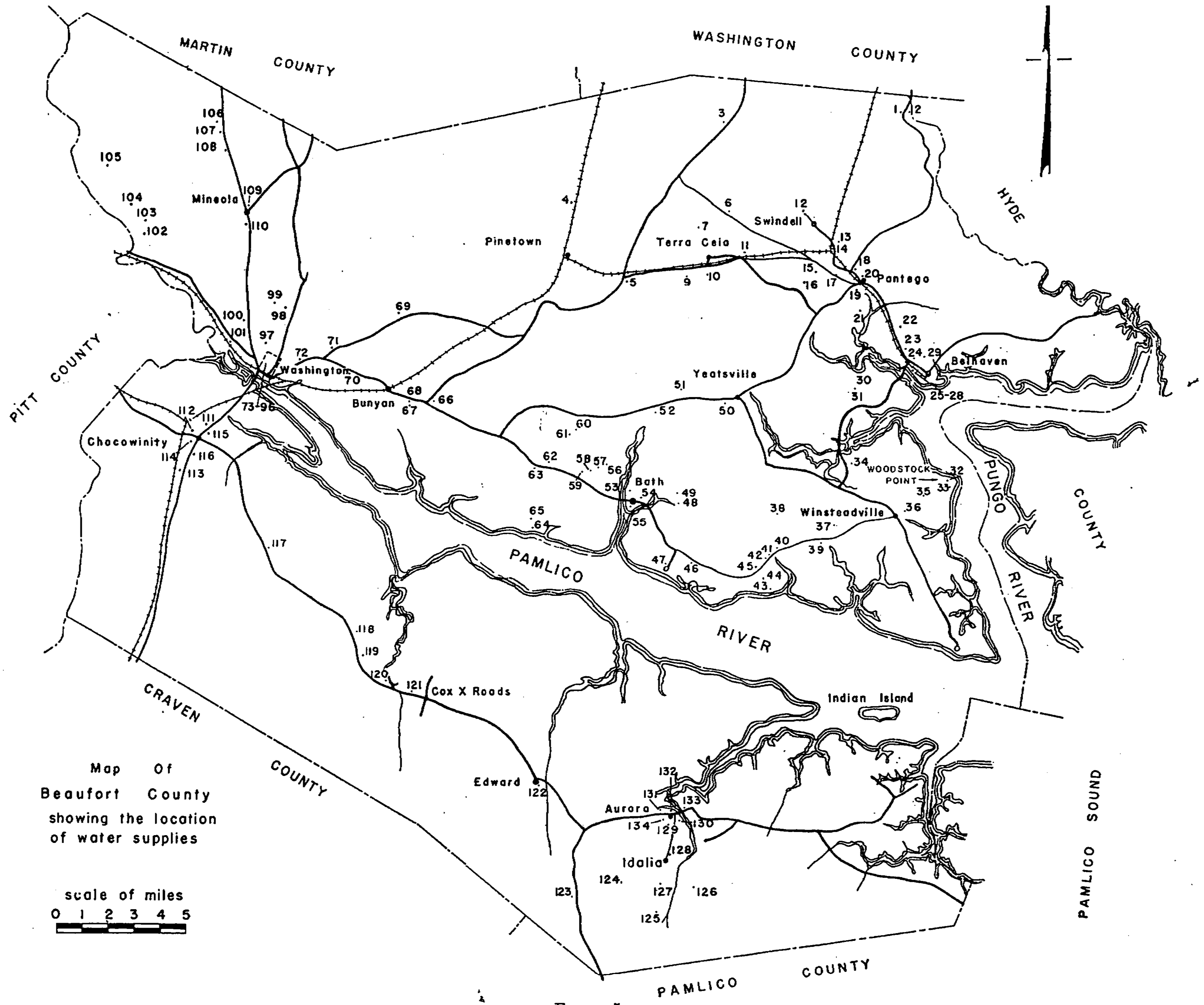

Map Of
Beaufort County
showing the location
of water supplies
scale of miles
0 1 2 3 4 5
MARTIN COUNTY
WASHINGTON COUNTY
HYDE
PITT COUNTY
CRAVEN COUNTY
PAMLICO COUNTY
PAMLICO SOUND
PUNGO RIVER
COUNTY
PAMLICO RIVER
Mineola
Pinetown
Terra Ceia
Swindell
Pantego
Belhaven
Yeatsville
Washington
Bunyan
Chocowinity
Bath
WOODSTOCK POINT
Winsteadville
Indian Island
Cox X Roads
Edward
Aurora
Idalia

FIGURE 5.

TABLE 2. Record of Wells in Beaufort County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
1	6½ miles NNE of Pantego	J. Adams	Open-end	231	2	220	Limestone	Flows			Analysis Temperature 62°F.
2	do	D. Liverman	do	244	2	240	do	+8.9			Water level measured, 1954
3	8 miles NNE of Pinetown	L. Sullivan	do	140	2	140	do				
4	2 miles N of Pinetown	R. Bowen	do	175	2	160	do				
5	2½ miles E of Pinetown	G. Bowen	do	179	2	179	do	—9.0			Water level reported by driller, 1952. Temperature 61°F.
6	2 miles NE of Terra Ceia	M. Respess	do	225	2	220	do				Analysis.
7	1¼ miles N of Terra Ceia	J. Respess	do	360	4-2	285	Greensand	Flows			
8	Terra Ceia	M. Ratcliff	do	402	2	402	do	Flows			Analysis.
9	do	Dutch Reformed Church	do	300	1¼	300	Limestone				
10	do	Van Staaldwinen	do	300	1¼	250	do				
11	1½ miles E of Terra Ceia	L. Pilly	do	265	2	265	do				
12	¾ miles NW of Swindell	A. Swindell	do	190	2	165	Phosphatic sand				Analysis. Temperature 61°F.
13	1¼ miles SE of Swindell	American Metals Co.	do	200			Limestone				
14	do	Orville Jones	do	231	2	220	do				Analysis. Temperature 61°F
15	2 miles S of Swindell	Mrs. L. Harris	Open-end	235	2	230	Limestone				
16	2¼ miles S of Swindell	M. Ratcliff	do	380	4	305	Greensand				
17	Pantego	R. Y. Wilkinson	do	250	6	250	Limestone				
18	do	T. Doyle	do	232	2	230	do				
19	do	Beaufort County Board of Education	do	260	2	245	do				
20	do	D. Lupton	do	285	2	285	do	Flows	5		Water level measured, 1956. Analysis. Temperature 61°F.
21	1¼ miles S of Pantego	R. Hamilton	do	275	2	260	do	Flows			
22	2 miles NW of Belhaven	N. C. State Highway Dept.	do	230	2.5	210	do	Flows			
23	Belhaven	Town of Belhaven	do	410	8	265	do	Flows			Analysis. Public supply.
24	do	do	do	185	2	180	Marl	Flows			Abandoned.
25	do	do	Screen	101	8	97	do				Analysis. Public supply.
26	do	do	Open-end	100	3	97	do				Public supply.
27	do	do	do	100	3	80	do				Public supply.
28	do	do	Screen	306	6	280	Limestone	Flows			
29	do	do	Open end	225	3	220	do	Flows			Analysis. Abandoned. Analysis.
30	3 miles SW of Belhaven	J. L. Walls	do	285	2	280	do	Flows			
31	do	R. O. Smith	do	230	2	230	do	Flows			Analysis.
32	2½ miles NE of Winsteadville	W. Johnston	Open end	270	2	265	Limestone	Flows			Analysis.
33	do	W. Taylor	Point	30	1¼	30	Sand				
34	2½ miles NW of Winsteadville	W. Boshen	Open end	213	2½	213	Limestone				
35	1¼ miles NE of Winsteadville	F. Winstead	Point	30	1¼	30	Sand				
36	Winsteadville	W. F. Winstead	Open end	350	3-2	260	Limestone	Flows			Temperature 62°F.
37	2 miles SW of Winsteadville	R. C. Moore	do	311	3	300	do	Flows			
38	4½ miles W of Winsteadville	J. B. Brinn	do	180	2	180	do				Temperature 62°F.
39	3 miles SW of Winsteadville	A. N. Roper	Point	50	1¼	50	Marl				
40	6 miles SE of Bath	St. Clair Church of Christ	Open end	250	1¼	180	Limestone	Flows			Analysis.
41	do	G. D. Ross	do	250	1¼	180	do	Flows			Water has very strong H2S odor and taste
42	do	W. R. White	do	225	2	180	do	Flows			Water has very strong H2S odor and Taste. Temperature 62°F
43	do	B. Godley	do	269	2	210	do	Flows			do
44	do	do	do	293	2	190	do				
45	do	do	do	168	2	168	do				
46	3 miles SE of Bath	B. Selby	Screen	90	3	90	Marl				
47	3 miles SE of Bath	B. F. Bowers	Point	20	2	20	Sand				
48	1½ miles E of Bath	T. A. Brooks	Open end	200	2	200	Limestone				Temperature 63°F.
49	do	Harold Ormond	do	145	2	130	Sand				
50	Yeatsville	J. M. Tankard	do	185	2	185	Limestone				
51	2 miles W of Yeatsville	J. Waters	do	195	2	195	do				Temperature 63°F.
52	3 miles SW of Yeatsville	L. P. Harris	do	190	2	190	do				Analysis.
53	Bath	T. Brooks	do	120	2	85	Sand				
54	do	Bath School	do	265	2	265	Limestone				
55	do	T. A. Brooks	Point	20	1¼	20	Sand				

TABLE 2. Record of Wells in Beaufort County—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
56	1½ miles NW of Bath	W. T. Wallace	Open end	228	2	228	Limestone				Analysis.
57	do	American Metals Co.		130		130	do				
58	do	W. Wallace, Jr.	Open end	100	2	87	Sand				
59	do	R. Bowen	Point	30	1¼	30	Marl				
60	3½ miles NW of Bath	L. C. Jefferson	Open end	150	2	145	Limestone				
61	do	T. Sawyer	do	145	1½	140	do				Analysis. Temperature 62°F.
62	3½ miles WNW of Bath	H. Gurganus	do	101	1¼	85	Sand				
63	do	B. Davis	do	110	1¼	90	do				
64	4 miles WSW of Bath	Camp Leech	do	115	2	105	do				
65	do	do	do	93	2	90	do				
66	2 miles E of Bunyan	C. Sheppard	do	200	1¼	200	Limestone				
67	1 mile E of Bunyan	R. Warner	Open end	95	1¼	95	Sand				Temperature 62°F.
68	do	J. Ward	do	110	1¼	105	do				
69	2¾ miles NNE of Bunyan	John Singleton	do	340	2	300	Greensand				Analysis.
70	1½ miles W of Bunyan	H. Williamson	Point	35	1¼	35	Sand				
71	2½ miles W of Bunyan	Ethel Rhodes	Open-end	180	4	180	Limestone	−20.3			Analysis. Water level measured, 1956.
72	1 mile NE of Washington	County Home	do	74	2	70	Marl	−21.7			Water level measured, 1956.
73	Washington	Colonial Ice Co.	do	60	4	60	do				
74	do	do	do	65	4	60	do				
75	do	Dr. Pepper Bottling Co.	do	142	6	140	Limestone				
76	do	do	Screen	152	8	152	do	−8.0	180	6	Water level measured, 1956.
77	do	F. Mayo & Co.	do	145	8	138	do				
78	do	do	do	152	6	145	do				
79	do	C. F. Cowell	do	121	4	115	do				
80	do	do	do	158	6	87	do	Flows			
81	do	Maola Ice Cream Co.	do	150	8	99	do				
82	do	Adams Wholesale Co.	do	147	6	91	do				
83	do	R. Whisnant	do	74	4	70	do				
84	do	A. Moore	do	120	6	70	do				
85	Washington	W. J. Edwards	Screen	107	6	99	Limestone				
86	do	Sullivan's Hatchery	Open end	60	1¼	60	do				
87	do	S. M. Lee	Open end	140	1¼	140	do				
88	do	F. Caraway	do	108	1¼	100	do				
89	do	Washington Light & Power Co.	do	160	8	160	do				
90	do	do	do	113	6	100	do				
91	do	do	do	141	6	141	do				
92	do	do	do	103	8	100	do				
93	do	City of Washington	Gravel wall	273	12-8	273	Limestone				Analysis. Public supply.
94	do	do	Open end	168	6	100	do				Analysis. Public supply.
95	do	do	do	168	6	100	do				Public supply.
96	do	do	Gravel wall	173	10-8	160	Sand				Public supply.
97	1 mile N of Washington	A. T. Williams	Open end	65	1¼	65	Limestone				
98	1½ mile N of Washington	Airport	Screen	215	8	210	do				
99	do	American Metals Co.		245			Sand				
100	2¼ miles NW of Washington	do		310			do				
101	1½ miles NW of Washington	R. Harrison	Open end	120	1½	120	Greensand				Temperature 62°F.
102	7 miles NW of Washington	N. Cherry	do	170	2	170	do				
103	7¼ miles NW of Washington	W. Cherry	do	130	2	130	do				Analysis.
104	7½ miles NW of Washington	K. B. Dixon	Open end	135	2	55	Limestone				
105	10 miles NW of Washington	R. Leggett	do	185	2	130	Greensand				
106	3½ miles NNW of Mineola	J. J. Wynn	do	179	2	179	do				
107	3 miles NNW of Mineola	W. Leggette	do	112	2	90	Limestone				Analysis.
108	2½ miles NNW of Mineola	R. Leggette	do	165	2	160	Greensand				
109	Mineola	Old Ford School	do	100	2	90	Sand				
110	do	G. Wollard	do	80	1¼	80	do	Flows			
111	Chocowinity	Norfolk Southern Railroad	do	125	4	125	do				
112	do	P. A. Taylor	do	160	2	160	do				Analysis.
113	do	Nelson Motel	do	215	4	210	Greensand				

TABLE 2. Record of Wells in Beaufort County—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
114	Chocowinity	G. B. Smith	Point	30	1¼	30	Sand				
115	do	T. H. Moore	Open end	90	2	90	Marl				
116	do	J. B. Winfield	Open end	165	2½	160	Sand				
117	5 miles SE of Chocowinity	do	do	165	2½	165	do				Analysis.
118	9½ miles SE of Chocowinity	R. Mayne	do	190	2¼	180	do				
119	10 miles SE of Chocowinity	J. C. Cayton	do	100	1¼	100	Limestone				
120	12 miles SE of Chocowinity	N. C. State Highway Dept.	do	140	1¼	98	do				
121	Coxs Cross Roads	A. O. Mason	Open end	125	1¼	125	Sand				
122	Edward	Bennett and Sawyer	Point	50	1¼	50	do				
123	4½ miles SSE of Edward	C. T. Allen	Open end	209	2	209	Limestone				
124	Idalia	C. M. Hardy	Point	18	1¼	18	Sand				
125	do	Harvey Bros.	Open end	210	2	210	Limestone	Flows			
126	do	B. Thompson	do	200	2	200	do				
127	do	A. Baker	do	215	2	205	do	Flows			
128	do	B. Thompson	do	200	2	------	do	Flows			
129	Aurora	Max Thompson	do	323	2	204	do	Flows			
130	do	A. C. Lupton	do	235	2	200	do				
131	do	Town of Aurora	do	180	2	180	do				
132	do	Beaufort Co. Board of Education	do	200	2	190	do				
133	Aurora	Atlantic Coast Line Railroad	Screen	100	6	100	Marl				
134	do	Aurora Potato Co.	Open end	200	4	190	Limestone				

TABLE 3. Chemical Analyses of Ground Water from Beaufort County
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	1	6	8	12	14	20
Silica (SiO_2)		53	37	2.7	52	54
Iron (Fe), total	0.08	.35	.14	.01	1.1	.04
Iron (Fe), in solution	.00	.01	.02		.00	
Calcium (Ca)		75	59	34	49	43
Magnesium (Mg)		21	29	10	28	29
Sodium and potassium (Na+K)	29	34	45	20	51	65
Bicarbonate (HCO_3)	396	417	427	178	400	365
Sulfate (SO_4)		.1	.1	21	.1	2.3
Chloride (Cl)		6.8	15	10	19	29
Fluoride (F)		.4	.4	.6	.6	.8
Nitrate (NO_3)		.5	1.0	.8	1.5	.2
Dissolved solids		395	411	243	395	412
Hardness as $CaCO_3$	212	275	268	138	240	226
pH	7.3	7.7	7.6	7.5	7.7	
Water-bearing material	Limestone	Limestone	Greensand	Phosphatic sand	Limestone	Limestone
Date of collection	6-21-55	3-18-55	3-8-55	9-17-56	3-18-55	12-1-43

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

TABLE 3. CHEMICAL ANALYSES OF GROUND WATER FROM BEAUFORT COUNTY—*Continued*
(Numbers at heads of columns correspond to well numbers in table of well data)
(Parts per million)

	23	25	29	31	32	40
Silica (SiO_2)	40	46		39	26	
Iron (Fe), total	.09	.39		.14	.02	
Iron (Fe), in solution	.04			.00	.00	
Calcium (Ca)	41	90		56	28	
Magnesium (Mg)	30	11		29	31	
Sodium and potassium (Na+K)	538	154		82	369	
Bicarbonate (HCO_3)	514	459	448	417	509	435
Sulfate (SO_4)	80	29	4	2.1	39	1
Chloride (Cl)	655	138	98	65	382	50
Fluoride (F)	1.3	.5	1.2	.7	1.0	
Nitrate (NO_3)	.1	1.6		.0	.0	
Dissolved solids	1630	702		512	1150	
Hardness as $CaCO_3$	263	270	231	250	197	302
pH	7.5	7.3		7.4	7.5	7.2
Water-bearing material	Limestone	Marl	Limestone	Limestone	Limestone	Limestone
Date of collection	2-26-51	11-10-47	1-6-42	4-21-54	4-21-54	4-21-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	52	56	61	69	71	93
Silica (SiO_2)		64	62			9.7
Iron (Fe), total		.65	.39			.13
Iron (Fe), in solution		.00	.01			.09
Calcium (Ca)		98	74			33
Magnesium (Mg)		10	17			15
Sodium and potassium (Na+K)		18	10			154
Bicarbonate (HCO_3)	430	384	327	442	234	378
Sulfate (SO_4)	9	1.4	.1	1	1	17
Chloride (Cl)	13	5.8	5.4	52	4.2	110
Fluoride (F)		.5	.6	.8	.0	.7
Nitrate (NO_3)		.0	1.5			.9
Dissolved solids		399	347			545
Hardness as $CaCO_3$	331	286	255	234	181	144
pH	7.1	7.1	7.5	7.8	7.5	7.4
Water-bearing material	Limestone	Limestone	Limestone	Greensand	Limestone	Limestone
Date of collection	4-21-54	3-31-54	3-18-55	3-30-54	3-30-54	10-19-56

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	94	103	107	112	117	
Silica (SiO_2)	15					
Iron (Fe), total	.38					
Iron (Fe), in solution	.01					
Calcium (Ca)	73		71			
Magnesium (Mg)	6.3		15			
Sodium and potassium (Na+K)	50					
Bicarbonate (HCO_3)	200	277	317	199	252	
Sulfate (SO_4)	29	1	1	1	2	
Chloride (Cl)	88	4.8	4.8	4.2	5	
Fluoride (F)	.1	.5	.5	.5	0.2	
Nitrate (NO_3)	2.7					
Dissolved solids	373					
Hardness as $CaCO_3$	208	190	239	147	192	
pH	7.4	7.7	7.5	7.8		
Water-bearing material	Limestone	Greensand	Limestone	Sand	Sand	
Date of collection	10-19-56	3-30-54	3-31-54	3-29-54	12-4-43	

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Bertie County
(Area 691 square miles, population 26,440)

Bertie, the second largest county in the area of investigation, is bordered on three sides by rivers; the Chowan River to the east and the Roanoke River to the south and west. Northampton and Hertford Counties form the northern boundary. Windsor, the county seat, is the largest town; other population centers in the county include Aulander, Colerain, Kelford, Lewiston, and Powellsville.

The southern third of the county is drained by the Roanoke River, the central third by the Cashie River, and the northern third drains through Hertford County into the Chowan River. Although the Chowan River forms the eastern boundary of the county there is no direct drainage along the boundary into the river; this eastern county boundary is characterized by prominent river bluffs along its entire extent.

The sale of agricultural products provides the major source of income in the county; tobacco is the chief crop. Several small industries, such as lumber and sawmill operations, are located mainly in and near Windsor.

Geology.—Surficial sand, clay, and gravel of Quaternary age form a mantling deposit over the county. Only where major streams and tributaries have cut down through this surficial material are older formations exposed. The light-colored surficial materials range in thickness from a few feet to as much as 40 feet and generally are thinnest in the interstream areas.

Underlying the surficial material throughout most of the county are clays, sands, and marls of the Yorktown formation of late Miocene age. Individual beds in this formation are lenticular and cannot be traced laterally for any great distance. Massive blue-gray clays with subordinate occurrences of interbedded sands and marls are widespread in the central and eastern sections of the county. The Yorktown attains its maximum thickness in the eastern part of the county and becomes thinner to the west. It is 48 feet thick in a well at Windsor and is 120 feet thick in a well near Mount Gould.

Underlying the Yorktown formation in central and eastern Bertie County are greensands and impure shell limestones of the Beaufort formation of Paleocene age. The thickness and subsurface extent of this formation west of Windsor are unknown, because of the scarcity of well samples. At Windsor, in a well drilled for the town, the formation was 78 feet thick. At Mount Gould the formation was more than 250 feet thick. There seems to be little change in the lateral continuity of this stratigraphic unit in Bertie County. Greensands predominate at any one locality, with impure shell limestones occurring at several horizons. Chronologically, the Beaufort formation in Bertie County is represented by a younger facies than in other parts of the Greenville area. Although containing a dominant Paleocene microfauna, in this area, it also contains faunal elements common to lower Eocene (Wilcox) sediments elsewhere, particularly to the microfauna of the Aquia formation of Virginia and Maryland.

Underlying the Beaufort formation in central and eastern Bertie County are formations of Late Cretaceous age, the Peedee, Black Creek, and Tuscaloosa formations. The Cretaceous sediments are composed of lenticular clays and interbedded sands that have little lateral continuity. Water-bearing beds in both the Peedee and Black Creek formations of this area are generally composed of finer sands and more clay than in comparable water-bearing beds of the same age in Martin, Pitt, and Greene Counties. The Tuscaloosa formation is the only Cretaceous formation that is exposed in Bertie County. Intermittent exposures of the arkosic sands and clays of this formation can be seen along the banks of the Roanoke River from a point opposite Lewiston to the Bertie-Northampton County line to the north. Both the Peedee and the Black Creek formations are overlapped by the Yorktown formation and finally pinch out between the overlying Yorktown formation and underlying Tuscaloosa formation. According to incomplete subsurface data the Beaufort, Peedee, and Black Creek formations, which consist of marine facies in south-central Bertie County, interfinger with predominately deltaic facies of comparable age in the northwestern part of the county. The Peedee formation at Windsor is 82 feet thick and the underlying Black Creek formation at least 179 feet thick. Sediments of Tuscaloosa age are presumed to underlie the younger Cretaceous sediments in the eastern and central sections of the county. The writer believes that deep wells in the county will encounter Lower Cretaceous sediments beneath the Tuscaloosa sediments, as was the case in Pitt County to the south.

Ground water.—Surficial sands and gravels of Quaternary age furnish more water to individual wells than any other aquifer in the county. Dug wells and driven wells, ranging in depth from 10 to 40 feet, obtain from 2 to 15 gpm from this material in most parts of the county.

Driven wells deeper than 40 feet and jetted wells as deep as 120 feet obtain water from the sand and marl beds in the Yorktown formation. Inasmuch as no single water-bearing horizon is recognized in this formation, the depths of individual wells is quite variable. No adequate figure for the yield of wells tapping the Yorktown formation can be given. Individual wells yield 5 to 50 gpm, and several times the maximum figure might be obtained at specific sites.

Many jetted and drilled wells up to 4 inches in diameter obtain water from the Beaufort formation at depths as great as 450 feet; the depth depends upon the location within the county. This formation is utilized as an aquifer in the central and eastern sections of the county. West and northwest of Windsor jetted and drilled wells obtain the bulk of their water from the Cretaceous formations at depths as great as 300 feet. Because no single water-bearing horizon is present in these formations, again the depths of individual wells cannot be determined in advance of the drilling.

Several of the municipal wells at Windsor are gravel-walled wells that are 12 inches in diameter and obtain water from the Beaufort, Peedee, and Black Creek formations. These wells, tapping multiple aquifers, have specific capacities ranging from 4 to 8 gpm per foot of drawdown and generally yield 300 gpm or more.

The chemical quality of ground water in Bertie County is adequate for most purposes. Water in shallow surficial sands, although soft, may be corrosive and have objectionable concentrations of iron. Water in shell beds of the Yorktown formation and impure shell limestones of the Beaufort formation may be hard but is otherwise of good quality. The waters in any one area generally become more soft with depth below a minimum of 100-125 feet. Brackish waters are commonly present in the deeper Cretaceous aquifers in all parts of the county below an arbitrary depth of 500 feet. Fluoride in excess of the maximum concentration (1.5 ppm) recommended in drinking water is present in waters from several acquifers below a depth of 300 feet, particularly in the vicinity of Windsor.

The present rate of withdrawal of ground water in the county is only a small fraction of the total available supply.

The following well log describes the physical characteristics of some of the principal acquifers in Bertie County (see figure 6 for well location).

Bertie County
Well Number 64

Location: Windsor, North Carolina. Well at rear of water treatment plant.

Owner: Town of Windsor
Date drilled: 1953
Driller: Layne Atlantic Co.
Elevation of well: 46 feet above sea level

Hydrologic Information

Diameter of well: 10 inches
Depth of well: 405 feet
Cased to: 405 feet
Finish: Gravel-wall and screens
Static water level: 6.7 feet above sea level (1953)
Yield: 250 gallons a minute

Log of Well

Depth (feet)	
	Quaternary—surficial sands
0-22	Sand, tan; 75 percent fine-grained angular to subangular quartz sand. 15 percent tan clay matrix, unconsolidated. 10 percent coarse blocky grains of potash feldspar. Trace of coarse mica flakes. No microfossils.
	Upper Miocene—Yorktown formation
22-42	Sand and clay, gray; 65 percent medium to fine-grained subrounded to subangular quartz sand. 25 percent blue-gray clay matrix, unconsolidated but tight. 10 percent fine broken shell fragments. Trace of coarse mica flakes. Ostracoda and Foraminifera common.
42-57	Sand and clay, gray; 55 percent fine to medium-grained subangular quartz sand. 35 percent blue-gray clay matrix, unconsolidated. 10 percent fine broken shell fragments. Trace of dark-green fine-grained glauconite. Ostracoda and Foraminifera common.
57-70	Sand and clay, gray; Same as 42-57-foot interval with slight increase in percentage of shell fragments. Ostracoda and Foraminifera abundant. Ostracoda from the 22-57-foot intervals include: *Puriana rugipunctata* (Ulrich and Bassler) *Murrayina martini* (Ulrich and Bassler) *Orionina vaughani* (Ulrich and Bassler) *Hemicythere schmidtae* Malkin *Hemicythere confragosa* Edwards *Hemicythere conradi* Howe and McGuirt
	Paleocene—Beaufort formation
70-83	Sand, gray; 70 percent coarse to medium-grained subrounded quartz sand. 20 percent light-gray calcareous clay matrix, indurated and moderately consolidated. 10 percent dark-green coarse-grained glauconite. Authigenic pyrite and pyrite aggregates prominent. Trace of coarse broken abraded shell fragments. Ostracoda and Foraminifera common.
83-96	Glauconitic sand, "salt and pepper"; 50 percent coarse-grained subrounded to subangular quartz sand. 25 percent dark-green coarse-grained glauconite. 25 percent white calcareous clay matrix indurated and moderately consolidated. Trace of coarse broken abraded shell fragments. Ostracoda and Foraminifera common.
96-134	Glauconitic sand, "salt and pepper"; 30 percent medium-grained subrounded to subangular quartz sand.

50 percent dark-green medium-grained glauconite. 20 percent calcareous clay and silt matrix, unconsolidated. Ostracoda and Foraminifera common.

134-144 Glauconitic sand, "salt and pepper"; 40 percent coarse-grained subangular quartz sand. 25 percent dark-green coarse-grained glauconite. 35 percent calcareous clay matrix, indurated and well consolidated. Ostracoda from the 70-134-foot intervals include:
Cytheridea (Haplocytheridea) ruginosa Alexander
Brachycythere interrasilis Alexander
Brachycythere plena Alexander
Trachyleberis midwayensis (Alexander)
Trachyleberis prestwichiana (Jones and Sherborn)
Trachyleberis bassleri (Ulrich)

Upper Cretaceous—Peedee formation

144-165 Clay and sand, gray; 25 percent fine to medium-grained angular to subangular water-polished quartz sand. 75 percent gray clay matrix, unconsolidated but compact. Dark-green fine-grained glauconite prominent. Trace of coarse mica flakes. Ostracoda and Foraminifera common.

165-185 Clay and sand, gray; Same as 144-165-foot interval with slight increase of coarse mica flakes. Ostracoda and Foraminifera common.

185-206 Sand, gray; 70 percent medium-grained subrounded to subangular well-sorted clay matrix, unconsolidated. 10 percent dark to light-green fine-grained glauconite. Trace of broken abraded shell fragments. Ostracoda and Foraminifera common.

206-226 Sand, gray; 90 percent very fine-grained angular quartz sand. 10 percent gray micaceous clay matrix, unconsolidated but compact. Pyrite aggregates prominent. Trace of dark-green fine-grained glauconite and phosphate spherules. Ostracoda and Foraminifera rare.
Ostracoda from the 144-226-foot intervals include:
Cytherella herricki Brown
Cytherelloidea swaini Brown
Cytherelloidea sohni Brown
Brachycythere rhomboidalis (Berry)
Trachyleberis pidgeoni (Berry)
Trachyleberis praecursora Brown

Upper Cretaceous—Black Creek formation

226-246 Sand and gravel, tan; 50 percent coarse to fine-grained subrounded to angular quartz sand. 30 percent fine rounded gravel. 20 percent tan clay and silt matrix, unconsolidated. Pyrite aggregates and coarse blocky potash feldspar grains prominent. Trace of dark-green glauconite. Ostracoda and Foraminifera very rare.

246-266 Sand, tan; 80 percent medium to coarse-grained subrounded quartz sand. 15 percent tan clay matrix, unconsolidated. 5 percent light-green fine-grained glauconite. Pyrite aggregates and coarse-grained potash feldspar prominent. Ostracoda and Foraminifera very rare.

266-288 Sand, tan; Same as 246-266-foot interval with the addition of hematite aggregates prominent. Ostracoda common, Foraminifera very rare.

288-308 Sand and clay, tan to gray; 60 percent coarse to fine-grained subrounded to angular poorly sorted quartz sand. 35 percent tan to gray clay matrix, unconsolidated. 5 percent light-green medium-grained glauconite. Pyrite and hematite aggregates prominent. No microfossils.

308-330 Sand and clay, tan to gray; Same as 288-308-foot interval. No Ostracoda, Foraminifera very rare.

330-350 Sand and clay, tan to gray; Same as 288-308-foot interval. No microfossils.

350-370 Sand and clay, tan to gray; Same as 288-308-foot interval. No microfossils.

370-400 Sand and clay, gray; 60 percent very coarse to fine-grained subrounded to angular poorly-sorted quartz sand. 35 percent gray clay matrix, unconsolidated but compact. 5 percent light-green medium-grained glauconite. Pyrite and hematite aggregates prominent. trace of broken abraded shell fragments. No microfossils.

400-405 Clay, brick-red; 10 percent subrounded medium gravel. 90 percent brick-red clay matrix, unconsolidated but very compact. Hematite aggregates prominent in washed residue. Trace of dark to light-green fine-grained glauconite and coarse mica flakes. Ostracoda and Foraminifera rare.
Ostracoda occurring in the 226-400-foot intervals include:
Cytheridea (Haplocytheridea) cf. *H. berryi* (Swain)
Cytheridea (Haplocytheridea) monmouthensis (Berry)
Trachyleberis? austinensis (Alexander)
Protocythere paratriplicata Swain

Remarks: The occurrence of *Citharina texana* Cushman in 266-288-foot interval and the occurrence of *Trachyleberis(?) austinensis* (Alexander) in the 400-405-foot interval indicates an Austin age, and it seems probable that the upper Snow Hill marl member of the Black Creek formation, which is of Taylor age, is absent in this well.

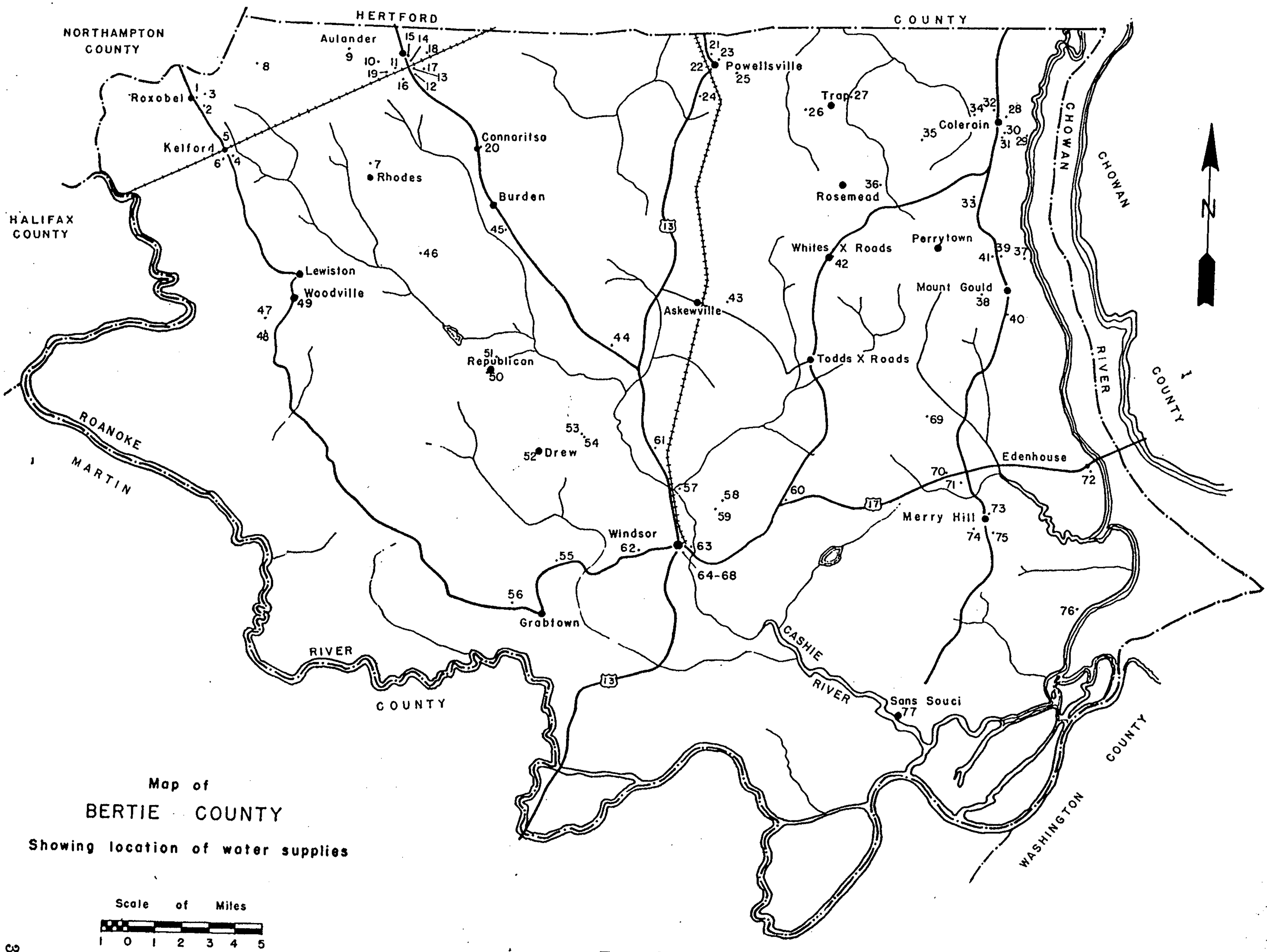

Map of
BERTIE COUNTY
Showing location of water supplies
Scale of Miles
1 0 1 2 3 4 5
HERTFORD COUNTY
NORTHAMPTON COUNTY
HALIFAX COUNTY
ROANOKE
MARTIN
RIVER
COUNTY
CHOWAN
CHOWAN RIVER
COUNTY
WASHINGTON COUNTY
CASHIE RIVER
N
Aulander
Roxobel
Kelford
Rhodes
Connaritsa
Burden
Lewiston
Woodville
Republican
Drew
Grabtown
Windsor
Askewville
Powellsville
Trap
Rosemead
Coleraine
Whites X Roads
Perrytown
Mount Gould
Todds X Roads
Edenhouse
Merry Hill
Sans Souci
13
17
64-68

FIGURE 6.

TABLE 4. Records of Wells in Bertie County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Drawdown (ft.)	Remarks
1	Roxobel	Farmville-Woodard Lumber Co.	Open end	22	1¼	22	Sand				
2	do	do	do	150	4	150	do				
3	do	do	do	330	3	330	do				Abandoned.
4	Kelford	Coca Cola Plant	do	196	6	196	do				
5	do	Esso Gas Station	Dug	13	36		Sand and clay	—9.9	5		Water level measured, 1956
6	do	Texaco Gas Station	do	20	36		do	—13.0			Water level measured, 1956.
7	½ mile N of Rhodes	E. A. Outlaw	Open-end	105	1¼	99	Sand	—8.98			Water level measured periodically by the U. S. Geological Survey.
8	2½ miles E of Roxobel	W. C. Tester	Dug	16	36		Sand and clay	—11.8			Water level measured, 1943.
9	1½ mile W of Aulander	H. D. Thomas	do	12.8	36		do	—10.9			Water level measured, 1956.
10	Aulander	W. D. Rawls	Screen	255	4–2	255	Sand	—30	±20	±40	Reported by driller.
11	Aulander	Town of Aulander	Gravel Wall	354	8	354	do		550		Analysis. Public Supply.
12	do	do	Open end	187	2	187	do				Abandoned.
13	do	do	do	164	2	164	do				do
14	do	do	do	132	2	132	do				do
15	do	do	do	160	2	160	do				do
16	Aulander	Town of Aulander	Open end	140	3	140	Sand				Abandoned.
17	do	do	do	160	3	160	do				do
18	do	do	do	135	3	135	do				do
19	do	Seaboard Airline R. R.	do	45	2	45	Gravel		10		Yield reported by driller.
20	Connaritsa	J. W. Howard	Dug	11.2	36		Sand and clay	—9.7			Water level measured, 1956.
21	Powellsville	Town of Powellsville	Screen	310	4–2	310	Sand		50		Analysis. Public Supply.
22	do	B. Reynor	Open end	46	1¼	46	do	—16.8			Abandoned.
23	do	H. Harrell	do	52	1¼	52	do		10		Water level measured, 1955.
24	1½ miles S. of Powellsville	J. W. Holloman	Dug	13			do	—11.8	10		Water level measured, 1955.
25	1 mile E of Powellsville	Lee Freeman	Screen	255	4–2	255	Greensand	—32			
26	¾ mile W of Trap	C. W. Wade	do	335	4–2	335	do				Analysis.
27	¾ mile E of Trap	Trap Lumber Co.	Open end	105	1½		Sand	Flows			Reported to flow periodically.
28	Colerain	Town of Colerain	Screen	170	8	170	Greensand	—32	65		Analysis. Water level and yield reported by driller.
29	do	Perry, Belch, Fish Co.	do	192	4	192	do	Flows	15		
30	do	Town of Colerain	do	264	8–4	264	do		200		Public Supply.
31	do	do		189	21	184	do				Abandoned.
32	do	F. McCrary	Screen	238	4	238	do		55		Yield reported by driller.
33	2½ miles SW of Colerain	F. W. Leary	Open end	115	2	115					
34	¾ mile WNW of Colerain	Zion Hill Baptist Church	Screen	338	4–2		Sand	—33			Water level measured, 1956.
35	2½ miles WSW of Colerain	Charles Brinkley	Screen	360	4–2	360	Sand	—32			Water level reported by driller.
36	1¼ mile of Rosemead	Bertie County Board of Education	do	139	4	134	do				
37	1 mile NE of Mount Gould	W. R. Lawrence	do	150	4	150	do	—6			Temperature. 61.5°F.
38	1 mile W of Mount Gould	M. W. Britt	do	382	4–2	382	do	—36			
39	1½ miles NW of Mount Gould	J. D. Raynor	do	341	4–2	341					
40	1 mile S of Mount Gould	Bertie County Board of Education	Open end	52	1¼	52					
41	1½ miles NW of Mount Gould	W. G. Baker	Dug	15.8			Sand	—13.5			
42	Whites X-Roads	Hugh White	Open-end	260	2	260	do	—17.46			Water level measured periodically by the U. S. Geological Survey.
43	¾ mile E of Askewville	J. H. Cowan	Screen	306	4–2	306	do	—30			Water level reported by driller, 1956.
44	4½ miles E of Republican	N. C. State Highway	Open end	20	1¼	20	do	Flows	5		Flow measured, 1954.
45	1 mile SE of Burden	C. Cowan	do	30	1¼		do				
46	3½ miles SE of Rhodes	J. D. Francis	Screen	210	2	210	do				
47	1 mile SW of Woodville	Bertie County Board of Education	do	171	4–2	171	do	—31			Water level reported by driller, 1956.
48	1½ miles SW of Woodville	Bertie County Board of Education	Screen	170	4–2	170	Sand	—31	5		Water level and yield reported by driller, 1956.
49	Woodville	C. B. Griffin	do	169	6	169	do				
50	Republican	J. R. Bazemore	Open end	130	4	130	do				

TABLE 4. RECORDS OF WELLS IN BERTIE COUNTY—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
51	Republican	Clifton Ward	Screen	175	4	175	Sand				
52	Drew	V. L. Jones	do	195	2	195	do	—25			Water level reported by well owner, 1955
53	1½ miles ENE of Drew	W. S. Austin	Open end	100	1½	100	do				
54	do	do	do	100	1½	100	do				
55	2 miles NE of Grabtown	J. J. Ethridge	do	220	2	220	do				
56	½ mile W of Grabtown	F. H. Harden	Driven	18	1¼	18	do				
57	1½ miles N of Windsor	Thompson Lumber Co.	Open end	256	2	256	do	Flows	12		Yield measured, 1956.
58	2 miles NE of Windsor	Roy V. Thompson	do	190	4	120	Greensand				Analysis. Temperature 63°F
59	do	do	Screen	231	4-2	231	do				Analysis.
60	4 miles E of Windsor	Green Cross Baptist Church	Open end	60	1¼	60	Sand				
61	3½ miles NW of Windsor	Lea Lumber Co.	Screen	130	6	130	do				
62	1¼ miles W of Windsor	Lewis Powell	do	130	6	130	do	—12			Water level reported by well owner, 1956
63	Windsor	Town of Windsor	Gravel wall	286	8	286	do	Flows			Public Supply. Analysis.
64	Windsor	Town of Windsor	Gravel wall	375	10	375	Sand				Analysis. Public supply.
65	do	do	do	350	8	350	do				Analysis. Public supply.
66	do	do	Screen	350	4	350	do	Flows			Abandoned.
67	do	do	Gravel wall	334	8	334	do	Flows			Public supply Temperature 63°F.
68	do	do	Screen	370	10	370	do				Abandoned.
69	4¼ miles NW of Merry Hill	T. S. Taylor	Open end	120	3-2	120	do				
70	2¼ miles NW of Merry Hill	Cecil White	Screen	398	4-2	398	do				Analysis.
71	1½ miles NW of Merry Hill	C. Beasely	do	42	1¼	42	do				
72	Eden House, 190 feet W of Chowan River		Screen	400	4-2	400	do				Analysis.
73	Merry Hill	Will Perry	do	378	4-2	378	do				
74	do	R. J. Mitchell	Driven	75	1¼	75	do				
75	do	Bertie County Board of Education	Screen	103	4	103	do				
76	4½ miles SE of Merry Hill	R. L. Askew	do	420	4-2	420	do	14.6			Water level measured periodically by the U. S. Geological Survey.
77	Sans Souci Ferry Crossing	N. C. State Highway Dept.	do	150	4-2	150	do	Flows			

TABLE 5. CHEMICAL ANALYSES OF GROUND WATER FROM BERTIE COUNTY
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	11	21	26	28	58	59
Silica (SiO_2)	49	20	16	51		
Iron (Fe), total	.21	.58				
Iron (Fe), in solution	.02	.37	.00	.26		
Calcium (Ca)	47	2.8	7.7	24		
Magnesium (Mg)	3.6	2.2	6.6	13		
Sodium and potassium (Na+K)	15	150	96	27		
Bicarbonate (HCO_3)	175	387	311	198	447	457
Sulfate (SO_4)	5.3	5.8	.6	3.3	23	11
Chloride (Cl)	12	14	4.0	3.2	14	23
Fluoride (F)	.1	1.2	.4	.7		
Nitrate (NO_3)	1.6	1.6	.3	.0		
Dissolved solids	230	396		224		
Hardness as $CaCO_3$	133	16	50	113	6	116
pH	7.0	7.8	7.6	7.4	8.2	7.5
Water-bearing material	Sand	Sand	Greensand	Greensand	Greensand	Greensand
Date of collection	9-27-55	9-27-55	9-28-55	7-3-47	6-54	6-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

TABLE 5. CHEMICAL ANALYSES OF GROUND WATER FROM BERTIE COUNTY—*Continued*
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	63	64	65	70	72
Silica (SiO_2)	19	15	26	8.7	38
Iron (Fe), total	.79	.10	-----------	1.8	-----------
Iron (Fe), in solution	.53	.07	.89	.12	.27
Calcium (Ca)	3.3	.8	17	2.4	29
Magnesium (Mg)	1.8	.4	4.0	2.3	18
Sodium and potassium (Na+K)	240	273	95	256	107
Bicarbonate (HCO_3)	413	420	216	475	403
Sulfate (SO_4)	52	56	24	33	11
Chloride (Cl)	115	137	42	85	24
Fluoride (F)	2.5	3.4	1.3	3.3	.8
Nitrate (NO_3)	1.0	.1	.1	1.0	1.3
Dissolved solids	664	720	316	649	-----------
Hardness as $CaCO_3$	16	4	59	15	144
pH	7.8	8.0	6.9	8.1	7.8
Water-bearing material	Sand	Sand	Sand	Sand	Sand
Date of collection	9-27-55	9-27-55	5-17-49	3-29-50	9-27-55

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Chowan County

(Area 180 square miles, population 12,540)

Chowan County, the smallest county in the Greenville area, is elongate in a north-south direction. It is bordered to the north by Gates County, to the east by Perquimans County, to the south by Albemarle Sound, and to the west by the Chowan River. Edenton, the county seat, is the largest town in the county; other population centers include Yeopim and Rocky Hock.

The county, nowhere more than 45 feet above sea level, is drained by several small creeks that flow into the Yeopim and Chowan Rivers. Low swampy flats occur along the eastern and southern margins of the county.

The chief source of income in the county is from the sale of agricultural products and from commercial fishing. Several fish-processing plants are located in the southern part of the county, adjacent to Albemarle Sound.

Geology.—The entire county is covered with a thin mantling deposit of Quaternary sands and clays. Several former beach ridges are developed in this material. The most prominent ridge is at an elevation of about 35 feet above sea level and roughly bisects the county in a general north-south direction. The surficial material, composed of light-colored sands and clays, is believed to be less than 45 feet thick in all parts of the county.

Underlying the surficial material are sands, clays, and shell beds of the Yorktown formation, of late Miocene age. This formation, like the overlying surficial sands, is widespread over the entire county. The thickness of this unit generally increases progressively from north to south, and in a test well at the Edenton Naval Air Base the formation was 195 feet thick.

In the northern and central parts of the county, the Yorktown formation is underlain by greensands and impure limestones that compose the Beaufort formation of Paleocene age. In the southern part of the county, phosphatic sands of middle(?) Miocene age occur between the Yorktown and Beaufort formations. Lithologic data suggest that the Castle Hayne limestone of Eocene age also may occur between the middle(?) Miocene and Paleocene sediments in a small area in the southeastern part of the county. However, no faunal evidence for the occurrence of the Castle Hayne limestone in Chowan County is presently available. The total thickness of the Beaufort formation in Chowan County is unknown. However, the formation is several hundred feet thick and it lies upon sediments of Cretaceous age in all parts of the county.

Ground water.—All public and private water supplies in the county are obtained from wells. The largest consumers of ground water are the city of Edenton and the nearby Edenton Naval Air Base. Large to moderate supplies of ground water are available throughout the county. However, the depth and yield of individual wells is dependent upon the depth to saline waters throughout the county.

Surficial sands of Quaternary age furnish water to more individual wells in the county than does any other formation. Dug wells and driven wells in the surficial sands range in depth from 10 to 30 feet, and yield from 2 to 25 gpm.

Jetted wells, either open-end or single-screen, obtain water from sands and shell beds of the Yorktown formation at depths as great as 250 feet. The yield from this type of well ranges from 5 to 40 gpm. None of these wells have been pumped beyond 40 gpm, but much larger yields probably could be obtained from the Yorktown formation.

The Beaufort formation of Paleocene age is a source of water for jetted wells at depths of 250 feet or more. Yields from jetted wells tapping the Beaufort formation are comparable to the yields obtained form similarly constructed wells tapping the Yorktown formation. However, few data are available concerning the physical and hydrologic properties of the Beaufort formation in Chowan County.

Several large-diameter gravel-wall wells supply the city of Edenton. These wells obtain most of their water from the Yorktown formation at depths of less than 200 feet. The city wells are pumped at rates ranging from 500 to 750 gpm and their specific capacity is in excess of 10 gpm per foot of drawdown. Wells at the nearby Edenton Naval Air Base obtain water from sands and shell beds in the Yorktown formation at depths generally less than 100 feet. The majority of the wells at the Air Base are 6-inches in diameter and yield 20 to 30 gpm. The depth of individual wells in this area is limited by the occurrence of saline water with depth.

The water level in the surficial sands is generally within 5 to 10 feet of the land surface. Water in the aquifers lying beneath the surficial sands is under artesian head and the piezometric surface is within 20 feet of the land surface throughout the county. Artesian flows, from wells 60 feet or more in depth, are common on the low lands bordering the rivers and Albemarle Sound.

The ground water in Chowan County is not of uniform chemical quality. Water from surficial sands is generally corrosive and often contains objectionable amounts of iron. Water from the sand and shell beds of the Yorktown formation is moderately hard, but otherwise of good chemical quality. The Beaufort formation contains waters that range from soft to moderately hard.

The chloride content of waters from both Miocene and Paleocene strata is often very high in areas adjacent to Albemarle Sound. According to Mundorff (1945, p. 33) a test well drilled at the Edenton Naval Air Base tapped water with a chloride content of 900 ppm. at a depth of 250 feet, 2,400 ppm. at a depth of 290 feet, and 3,000 ppm. at a depth of 420 feet. The upper sample (250 feet) was obtained from middle(?) Miocene strata, the middle sample (290) feet from middle(?) Eocene strata, and the lower sample (420 feet) from Paleocene strata. The fresh water-brackish water boundary at Edenton has not been accurately determined, but available data indicate that this boundary lies between 250 and 300 feet below land surface. A well at the Chowan County High School, 13 miles north of Edenton, yields water containing 900 ppm. of chloride at a depth of 320 feet. A recently drilled well at the same location yields water containing 220 parts per million at a depth of 420 feet. Fresh water may underlie brackish waters in other parts of the county also.

The following well log gives a physical description of the principal aquifers in Chowan County (see figure 7 for location).

Chowan County

Well Number 42

Location: Test well at Edenton Naval Air Base, 4 miles east of Edenton, North Carolina.
Owner: U. S. Navy
Date drilled: 1943
Driller: Heater Well Co.
Elevation of well: 14.8 feet above sea level

Hydrologic Information

Diameter of well: 6 inches
Depth of well: 420 feet
Cased to: 420 feet
Static (nonpumping) water level: Unknown
Yield: Unknown
Finish: Abandoned due to poor yield and and excessive chloride below 180 feet.

Log of Well

Depth (feet)	
	Quaternary—surficial sands and clays
0-10	Sand and clay, gray; 60 percent fine-grained angular quartz sand. 40 percent gray clay matrix, unconsolidated. Trace of fine-grained ilmenite. No microfossils.
20-30	Sand, gray; 85 percent medium-grained subrounded well-sorted quartz sand. 15 percent gray clay matrix, unconsolidated. No Ostracoda, Foraminifera very rare.
30-36	Sand, white; 95 percent medium to fine-grained subangular quartz sand. 5 percent tan clay matrix, unconsolidated. No Ostracoda, Foraminifera very rare.
36-45	Sand, gray; 80 percent medium to fine-grained subrounded to subangular quartz sand. 20 percent gray clay matrix, unconsolidated. No Ostracoda, Foraminifera very rare.
	Upper Miocene—Yorktown formation
45-60	Marl, gray; 55 percent medium to fine-grained subangular quartz sand. 25 percent coarse broken abraded shell fragments. 20 percent blue-gray clay matrix, unconsolidated but compact. Ostracoda common, Foraminifera abundant.
60-72	Marl, gray; 45 percent fine-grained angular quartz sand. 20 percent fine broken shell fragments. 35 percent blue-gray clay matrix, unconsolidated but compact. Ostracoda common, Foraminifera abundant.
72-80	Marl, gray; 30 percent medium-grained subangular quartz sand. 50 percent coarse broken abraded shell fragments. 20 percent blue-gray clay matrix, unconsolidated. Ostracoda common, Foraminifera abundant.
80-90	Marl, gray; 60 percent medium to fine-grained subrounded quartz sand. 10 percent fine broken shell fragments. 30 percent blue-gray clay matrix, unconsolidated. Ostracoda and Foraminifera common.
90-100	Marl, gray; Same as 80-90-foot interval. Ostracoda and Foraminifera abundant.
100-110	Marl, gray; Same as 80-90-foot interval. Ostracoda and Foraminifera abundant.
110-120	Marl, gray; Same as 80-90-foot interval, with a slight increase in percentage occurrence of clay. Ostracoda and Foraminifera abundant.
120-140	Marl, gray; Same as 110-120-foot interval. Ostracoda and Foraminifera abundant.
150-170	Marl, gray; 20 percent very fine-grained angular quartz sand. 15 percent fine broken shell fragments. 65 percent blue-gray clay matrix, unconsolidated. Ostracoda and Foraminifera abundant.
170-180	Clay, gray; 10 percent fine to very fine-grained angular quartz sand. 90 percent blue-gray clay matrix, unconsolidated but very compact. Trace of broken shell fragments. Ostracoda and Foraminifera common.
180-200	Clay, gray; Same as 170-180-foot interval. Ostracoda and Foraminifera common.
200-220	Clay, gray; Same as 170-180-foot interval. Ostracoda and Foraminifera common.
220-240	Clay, gray; Same as 170-180-foot interval with a 10 percent increase in quartz sand. Ostracoda and Foraminifera common.

Ostracoda from the 45-220-foot intervals include:
Paracytheridea vandenboldi Puri
Murrayina martini (Ulrich and Bassler)
Orionina vaughani (Ulrich and Bassler)

Hemicythere conradi Howe and McGuirt
Hemicythere confragosa Edwards
Loxoconcha purisubrhomboidea Edwards
Cytheretta reticulata Edwards
Cushmanidea ashermani (Ulrich and Bassler)

Middle(?) Miocene—unnamed unit

240-245 Phosphatic sand, dark-brown; 20 percent fine to medium-grained, angular to subangular quartz sand. 35 percent medium-grained brown collophane spherules and shards. 45 percent dark-brown silt and clay matrix, unconsolidated. Trace of broken shell fragments. No Ostracoda, Foraminifera very rare.

245-255 Phosphatic sand, dark-brown; Same as 240-245-foot interval with a slight increase in shell content. No Ostracoda, Foraminifera very rare.

Middle(?) Eocene—Castle Hayne(?) limestone

255-270 Calcareous sand, gray; 60 percent medium-grained subangular to subrounded quartz sand. 40 percent gray shell limestone matrix, indurated and moderately consolidated. Dark-green medium-grained glauconite prominent. No Ostracoda, Foraminifera very rare.

270-280 Sandy limestone, white; 35 percent medium to fine-grained angular quartz sand. 65 percent white limestone matrix, indurated and moderately hard. Trace of dark-green fine-grained glauconite. No Ostracoda, Foraminifera very rare.

280-290 Sandy limestone, white; Same as 270-280-foot interval, but very hard. No microfossils.

290-310 Sand, white; 95 percent coarse to medium-grained subangular to subrounded quartz sand. 5 percent white calcareous clay matrix, unconsolidated. No Ostracoda, Foraminifera very rare.

Paleocene—Beaufort formation

310-320 Sand and clay; light-gray; 45 percent fine to medium-grained angular quartz sand. 40 percent gray clay matrix, unconsolidated. 15 percent dark-green fine-grained glauconite and coarse mica flakes. Ostracoda and Foraminifera common.

320-340 Sand and clay, light-gray; Same as 310-320-foot interval. Ostracoda and Foraminifera common.

340-360 Clay and sand, gray; 30 percent medium-grained subrounded water-polished quartz sand. 60 percent gray micaceous clay matrix, unconsolidated but very compact. 10 percent dark-green medium to coarse-grained glauconite. Ostracoda and Foraminifera common.

360-370 Clay and sand, gray; Same as 340-360-foot interval. Ostracoda and Foraminifera common.

370-380 Glauconitic sand, "salt and pepper"; 45 percent fine to medium-grained angular quartz sand. 30 percent dark-green medium-grained glauconite. 25 percent gray calcareous clay matrix, indurated and loosely consolidated. Trace of authigenic pyrite aggregates. Ostracoda and Foraminifera rare.

380-400 Glauconitic sand and clay, light-green; 40 percent medium to coarse-grained subrounded quartz sand. 30 percent dark-green medium-grained glauconite. 30 percent green clay matrix, unconsolidated. Ostracoda and Foraminifera rare.

400-420 Glauconitic sand and clay, light-green; Same as 380-400-foot interval. Ostracoda and Foraminifera rare.
Ostracoda from the 310-400-foot intervals include:
Cytheridea (Haplocytheridea) hopkinsi Howe and Garret
Cytheridea (Haplocytheridea) moodyi Howe and Garrett
Cytheridea (Clithrocytheridea) virginica (Schmidt)
Cytherura sp. aff. *C. oxycruris* Munsey
Brachycythere interrasilis Alexander
Brachycythere formosa Alexander
Trachyleberis prestwichiana (Jones and Sherborn)
Trachyleberis bassleri (Ulrich)
Cytheromorpha sp. aff. *C. scrobiculata* Alexander

Remarks: No Ostracoda were recovered from the interval designated as middle(?) Miocene or middle(?) Eocene. Correlation is based on lithologic similarity to middle(?) Miocene and Middle (?) Eocene strata in nearby wells. The interval designated as the Beaufort formation of Paleocene age carries an ostracode faunule having many lower Eocene forms and is regarded by the writer as somewhat younger than other Paleocene units recognized in this study. The top of the Paleocene unit is marked by the first occurrence of *Brachycythere interrasilis* Alexander.

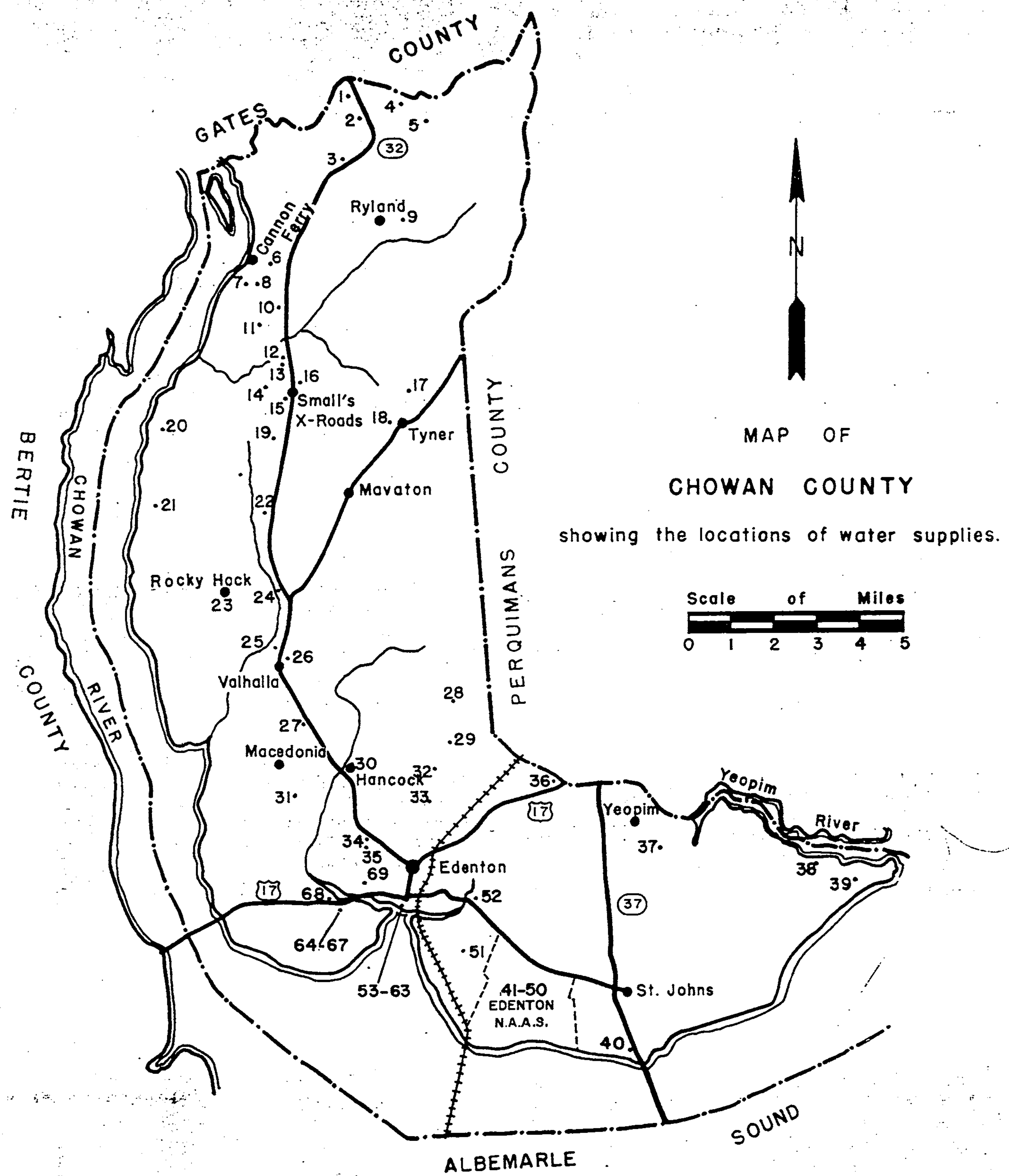

MAP OF
CHOWAN COUNTY
showing the locations of water supplies.
Scale of Miles
0 1 2 3 4 5
N
GATES COUNTY
BERTIE COUNTY
CHOWAN RIVER
PERQUIMANS COUNTY
ALBEMARLE SOUND
Yeopim River
Cannon Ferry
Ryland
Small's X-Roads
Tyner
Mavaton
Rocky Hock
Valhalla
Macedonia
Hancock
Edenton
Yeopim
St. Johns
EDENTON N.A.A.S.
41-50
64-67
53-63
32
17
37

FIGURE 7.

TABLE 6. RECORDS OF WELLS IN CHOWAN COUNTY

Well no.	LOCATION	OWNER	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	REMARKS
1	Rt. 32, ½ mile S of Gates-Chowan County Line	C. A. White	Screen	415	4-2	415	Sand				
2	Rt. 32, 1 mile S of Gates-Chowan County Line	T. Berryman	do	432	4-2	430	do				
3	2 miles NW of Ryland	G. H. Baker	do	416	4-2	416	do				
4	Rt. 31, Gates-Chowan Co. Line	J. Spivey	Dug	11.0	36	10	do	—7.0			Water level measured. 9/23/43
5	do	I. Bynum	Screen	320	4-2	320	do				Chloride, 1300 ppm. (State Board of Health, 7/12/37)
6	¼ mile SE of Cannon Ferry	O. Cline	do	438	4-2	438	do				Abandoned.
7	½ mile S. of Cannon Ferry	A. Ward	do	424	4-2	424	do				
8	do	R. C. Nixon	Dug	10	36	10	do	—8.4			Water level measured, 9/18/43.
9	½ mile E of Ryland	W. J. Outland	do	8	36	7	do	—6.7			Water level measured 9/23/43.
10	1 mile SE of Cannon Ferry	E. Elliot	Screen	412	4-2	412	do				
11	do	R. Howerwell	do	403	4-2	403	do				
12	¼ mile N of Small's X-Roads	County High School	do	320	6	320	do				Analysis. Abandoned.
13	¼ mile N of Small's X-Roads	County High School	Screen	420	4-2	420	Sand	—31			Water level measured 9/27/55
14	½ mile W of Small's X-Roads	Conroy Perry	do	416	4-2	416	do				
15	do	J. Ward	do	414	4-2	414	do				
16	Small's X-Roads	Z. W. Evans	do	30	1¼	30	do				
17	Tyner	Tyner School	do	30	1½	30	do	—6.3			Abandoned. Water level measured 9/22/43
18	do	C. Beleh	do	30	1½	30	do				
19	1 mile S of Small's X-Roads	Negro County School	do	216	4	216	do				
20	3 mile W of Small's X-Roads	Oak Grove School	do	35	2	35	do	—6.9			Abandoned. Water level measured 9/18/43.
21	4 mile W of Mavaton	J. Lane	do	219	4-2	219	do				
22	2 miles W of Mavaton	B. W. Evans	do	13	24	10	do				
23	Rocky Hock	Rocky Hock Church	do	35	2	35	do				
24	1 mile SW of Mavaton	Chowan County Home	Screen	10	1½	10	Sand				
25	2 miles S of Rocky Hock	W. Bynum	do	280	4-2	280	do				
26	Valhalla	Valhalla Esso Station	do	50	2	50	Shell				
27	1 mile S of Valhalla	D. R. Hare	Dug	13	36	12	Sand and Clay	—8.1			Water level measured 9/17/43.
28	3 miles NE of Hancock	C. H. Barber	Open end	75	1¼	75	Shell				
29	2½ miles E of Hancock	H. Boss	Screen	15	1¼		Sand				
30	Hancock	C. T. Dixon	do	210	4-2	210	do	—27.0			Water level reported by driller, 1955.
31	0.7 mile S of Macedonia	C. E. Beleh	do	35	2	35	do				
32	2 miles E of Hancock	D. Jones	Dug	9.1	36	4	Sand and Clay	—6.6			Water level measured. 1955.
33	do	J. R. Peele	Open end	250	4	225	Shell	—9.0			Water level reported by driller, 1944.
34	1½ miles S of Hancock	W. Morris	Screen	236	2	236	Sand	19.0			Water level reported by driller, 1955.
35	1½ miles S of Hancock	B. C. Hare	do	240	2	240	do				
36	2 miles NW of Yeopim	J. Sawyer	Dug	8	36	4	Sand and Clay	6.6			Water level measured, 1943.
37	½ mile SE of Yeopim	J. Webb	do	22	36	4	do	8.4			Water level measured, 1943.
38	4 miles SE of Yeopim	M. Jethro	Screen	20	1¼	20	do				
39	5 miles SE of Yeopim	J. G. Wood	Open end	75	2	75	Shell				
40	1¼ miles S of St. Johns	J. C. Cobb	Screen	25	1¼	25	Sand				
41	Edenton Naval Air Base	U. S. Navy	do	269	8	269	Shell Limestone				Analysis.
42	do	do	do	420	6	420	do				
43	do	do	do	80	6	80	Sand and Shell				
44	Edenton Naval Air Base	U. S. Navy	Screen	40	6		Sand and Shell				
45	do	do	do	55	2	55	do				Analysis. Abandoned.
46	do	do	do	55	4	40	do				
47	do	do	do	52	8	32	do				
48	do	do	do	112	8	112	do				
49	do	do	do	114	8	114	do				
50	do	do	do	105	18.8	105	do				Analysis. Abandoned.
51	½ mile W of Naval Air Base	A. L. Gray	do	65	2	65	do				
52	1½ miles E of Edenton	T. E. Harrell	do	175	3	175	do				
53	Edenton, Virginia Rd	City of Edenton	Gravel wall	358	10-8	358	Shell limestone		500		Analysis. Public supply. Yield measured, 1956.
54	Edenton, Freemason Street	do	do	290	24-12	290	Sand and Shell		750		Analysis. Public supply.
55	Edenton	do	Open end	212	8	212	do	Flows			Analysis. Public supply.
56	do	do	do	214	8	214	do	Flows			

TABLE 6. Records of Wells in Chowan County—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
57	Edenton	Edenton Peanut Company	Open-end	90	1¼	90	Sand and Shell				Analysis.
58	do	C. Y. Parrish	do	22	1¼	22	do				
59	do	D. Pruden	do	55	1¼	45	do				
60	do	Conger Ice Plant	do	60	5-3	60	do		200		Water yield measured, 1956.
61	do	do	Screen	100	6	100	do				
62	do	Albemarle Peanut Co.	Open-end	70	1¼	65	do				
63	do	G. S. Harrem	Screen	65	2	65	do				
64	1½ miles W of Edenton	U. S. Fish and Wildlife Fish Hatchery	Open-end	236	4	88	do				Chloride, 153 ppm., 1945.
65	do	do	do	236	3	195	do				Chloride, 203 ppm., 1945.
66	do	do	do	208	4	208	do				Chloride, 22 ppm 1945.
67	do	do	do	60	2	60	do				
68	2 miles W of Edenton	J. W. Bembridge	Screen	35	2	35	do				
69	1 mile W of Edenton	Edenton Bay Packing Co.	do	212	6	212	do				

TABLE 7. Chemical Analyses of Ground Water from Chowan County
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	12	41	45	50	53	54
Silica (SiO_2)		46	60	51	50	52
Iron (Fe), total		.05	5.4	7.1	.33	.05
Iron (Fe), in solution						
Calcium (Ca)		58	104	102	58	59
Magnesium (Mg)		45	7.8	6.6	13	14
Sodium and potassium (Na+K)		547	23	13	174	134
Bicarbonate (HCO_3)	249	524	374	355	477	464
Sulfate (SO_4)	10	83	1.8	2.6	32	31
Chloride (Cl)	890	710	23	11	106	85
Fluoride (F)		.6	.2	0.3	1.0	.8
Nitrate (NO_3)			.1	.0	.2	.3
Dissolved solids		1738	408	366	690	639
Hardness as $CaCO_3$	297	330	292	282	198	205
pH			7.1	6.9	7.4	8.3
Water-bearing material	Sand	Shell limestone	Sand and shell	Sand and shell	Shell limestone	Sand and shell
Date of collection	6-27-44	10-21-42	3-20-45	9-19-45	5-24-47	1-16-56

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	55	57
Silica (SiO_2)		
Iron (Fe), total		
Iron (Fe), in solution		
Calcium (Ca)	65	
Magnesium (Mg)		
Sodium and potassium (Na+K)		
Bicarbonate (HCO_3)	480	227
Sulfate (CO_4)	28	70
Chloride (Cl)	120	75
Fluoride (F)		.0
Nitrate (NO_3)	.10	.0
Dissolved solids		
Hardness as $CaCO_3$	210	228
pH		
Water-bearing material	Sand and shell	Sand and shell
Date of collection	1-20-33	Jan. 1943

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Gates County

(Area 343 square miles, population 9,555)

Gates County lies in the extreme northeast corner of the area included in this report. The county, which abuts Virginia to the north, is bordered by Camden, Pasquotank, and Perquimans Counties to the east, by Chowan County to the south, and by the Chowan River to the west. Gatesville, the county seat, is the largest town in the county; other population centers include Sunbury, Roduco, Gates, Eure, and Hobbsville.

With the exception of Bennetts Creek, which drains into the Chowan River, there are no large streams within the county. Drainage is largely effected by short, meandering streams that feed the large swamps bordering much of the county. An extensive area along the eastern edges of the county is occupied by the Dismal Swamp, and extensive areas along the southern and western edges of the county are bordered by Chowan Swamp.

The sale of agricultural products, chiefly peanuts, is the major source of income in the county. In addition, small, local lumber and sawmill operations are common in the County.

Geology.—The entire county is mantled by sands and clays of Quaternary age, ranging in thickness from 15 to 40 feet. This material, composed of light-colored iron-stained sands and clays, occurs at elevations ranging from nearly 80 feet in the northwestern part of the county to less than 20 feet in the southeastern part of the county. Several former beach ridges are developed in this material, particularly in a northeast direction from Hobbsville and Sunbury. The height of these fossil beach ridges is everywhere less than 10 or 15 feet.

Underlying the surficial material are clays, sands, and shell beds of the Yorktown formation of late Miocene age. Individual beds within the formation are lenticular and cannot be traced from well to well in the subsurface. In any one locality the Yorktown formation consists of a blue-gray marine clay with subordinate occurrences of lenticular sand and shell beds. In a recently drilled well (1956) at Gatesville the Yorktown formation was 126 feet thick. It is thought that the formation is somewhat less than 100 feet thick west of Gatesville, and that it is not more than 150 feet thick east of Gatesville.

Underlying the Yorktown formation in central parts of the county are deposits of middle(?) Miocene age. The deposits, which are as much as 30 feet thick in the vicinity of Gatesville, are composed of brown phosphatic clays and interbedded sands. The phosphate, occurring as collophane, is in the form of brown, sand-sized spherules and shards showing banded and concentric structure. The phosphate generally amounts to less than 20 percent of the total sample and nowhere within the county is as abundant as in deposits of similar age in Beaufort and Washington Counties to the south. The deposits of middle(?) Miocene age in Gates County were not deposited in the same basin of deposition as deposits of comparable age in Beaufort and Washington Counties to the south.

The middle(?) Miocene deposits in Gates County were deposited in a less-restricted depositional environment than were deposits of comparable age in Beaufort and Washington Counties. West of Gatesville no subsurface information is presently available to indicate the presence of middle(?) Miocene deposits. These deposits are probably absent west of Gatesville.

Underlying the middle(?) Miocene deposits in the central part of Gates County and the Yorktown formation in western and eastern Gates County are deposits of Paleocene age, the Beaufort formation. The Beaufort formation in this county is composed primarily of interbedded and lenticular sand and calcareous clay facies containing variable amounts of glauconite. The glauconite ranges from a trace in light-colored sands to as much as 70 percent in the dark to apple-green "greensands." Euhedral crystals of authigenic pyrite occur in sufficient abundance so as to give well cuttings a metallic sheen. In the absence of microfossils this authigenic pyrite serves as a guide to the presence of Paleocene strata; euhedral pyrite is noticeably absent from underlying and overlying sediments. The thickness of the Beaufort formation in Gates County increases from west to east across the county. In the central part of the county, according to a study of well cuttings the formation is more than 300 feet thick, and in the western part of the county it is no more than 150 feet thick. Examination of incomplete samples from several wells suggests that the formation may be more than 400 feet thick in the eastern part of the county.

Underlying the Beaufort formation within the county are sediments of Late Cretaceous age, the Peedee formation. The Peedee formation is composed of drab-black lenticular sands and clays that contain lignitized wood fragments and minor amounts of glauconite. No wells have been drilled deep enough in this area to pass entirely through the Peedee formation and, therefore, no information is available regarding its total thickness. According to LeGrand and Brown (1955, fig. 2), the top of the Peedee formation lies about 300 feet below sea level in the western part of the county and about 700 feet below sea level in the eastern part of the county. Older Cretaceous formations underlie the Peedee formation throughout the county.

Ground water.—Gates County is the only county in the Greenville area that has no public water systems. All domestic supplies are obtained from wells, and as many as 7 or 8 families often obtain their water supply from a single well.

Surficial sands of Quaternary age and near-surface shell and sand beds of the Yorktown formation are tapped by large numbers of dug and driven wells that range in depth from 10 to 60 feet. The yield from this type of well ranges from several to 20 gpm. Sand and shell beds in the Yorktown formation and middle(?) Miocene strata below depths of 60-80-feet are infrequently utilized as aquifers. However, Miocene strata are capable of yielding small to copious supplies of water throughout the county.

Jetted and drilled wells obtain water from the Beaufort formation and the upper beds of the Peedee formation at depths of as much as 300 feet in the western part of the county and at depths slightly more than 600 feet in the eastern part of the county. Such wells, rarely greater than 4 inches in diameter, yield 5 to 50 gpm throughout the county.

Water occurring at depths greater than 40 to 50 feet throughout the county is under artesian pressure and will rise to within 5 to 30 feet of the land surface at most places. Flowing wells are common along the low land bordering the Chowan River, and several flows occur in and near Gatesville.

The chemical quality of the water is adequate for most domestic purposes. Water from the shallow sands is soft but may be corrosive and may contain objectionable quantities of iron. Water from the deeper aquifers is soft sodium bicarbonate water. Water from the Paleocene and Cretaceous aquifers, particularly in the vicinity of Gatesville and Sunbury, contains excessive amounts of fluoride, as much as 6 to 8 ppm, but otherwise the water is of acceptable quality. In the vicinity of Hobbsville, brackish waters occur at a depth of about 600 feet.

The following log describes the physical characteristics of the aquifers that occur above the Upper Cretaceous formations in Gates County. (See figure 8 for location.

Gates County

Well Number 49

Location: County Office Building, Gatesville, North Carolina.
Owner: Gates County
Date drilled: 1956
Driller: Magette Well and Pump Co.
Elevation well: 27 feet above sea level

Hydrologic Information

Diameter of well: 4-2 inches
Depth of well: 483 feet
Cased to: 483 feet
Finish: screens
Static (nonpumping) water level: 5.5 feet below land surface, 1956
Temperature: 63°F

Log of Well

Depth (feet)	
	Quaternary—undifferentiated
0-10	Sand and clay, yellow; 60 percent fine to very fine-grained angular quartz sand. 40 percent yellow clay matrix, unconsolidated. Limonitic staining of quartz grains predominant. No microfossils.
10-20	Sand, white; 80 percent very fine to medium-grained angular to subangular quartz sand. 20 percent white clay and silt matrix, unconsolidated. Trace of light-green glauconite and black opaques. No microfossils.
	Upper Miocene—Yorktown formation
20-30	Sand, tan; 85 percent very fine to fine-grained angular feldspathic quartz sand. 15 percent tan silt and clay matrix, unconsolidated. Trace of broken and abraded shell fragments. Ostracoda and Foraminifera rare.
30-42	Marl, gray; 45 percent fine to medium-grained angular quartz sand. 30 percent blue-gray clay and silt matrix, unconsolidated. 25 percent broken and abraded shell fragments. Trace of dark-green glauconite. Ostracoda and Foraminifera abundant.
42-52	Marl, gray; Same as 30-42-foot interval. Ostracoda and Foraminifera abundant.
52-63	Marl, gray; 35 percent fine to medium-grained angular quartz sand. 40 percent blue-gray silt and clay matrix, unconsolidated. 25 percent broken shell fragments; sponge spicules prominent. Trace of dark-green glauconite and mica flakes. Ostracoda and Foraminifera abundant.
63-73	Marl, gray; Same as 52-63-foot interval. Ostracoda and Foraminifera abundant.
73-84	Clay, blue-gray; 15 percent very fine to fine-grained angular quartz sand. 70 percent blue-gray clay matrix, unconsolidated but compact. 15 percent white broken and abraded shell fragments; sponge spicules prominent, trace of dark-green glauconite. Ostracoda and Foraminifera abundant.

84-94 Clay, blue-gray; Same as 73-84-foot interval. Ostracoda and Foraminifera abundant.

94-105 Marl, blue-gray; 40 percent very fine to medium-grained angular to subangular quartz sand. 30 percent blue-gray micaceous clay matrix unconsolidated. 30 percent broken and abraded shell fragments; sponge spicules prominent. Trace of dark-green glauconite. Ostracoda and Foraminifera abundant.

105-115 Clay, blue-gray; 20 percent very fine to fine-grained angular quartz sand. 70 percent blue-gray clay matrix, unconsolidated but compact. 10 percent broken shell fragments; sponge spicules prominent. Trace of dark-green glauconite. Ostracoda and Foraminifera abundant.

115-126 Clay, blue-gray; Same as 105-115-foot interval. Ostracoda and Foraminifera abundant.

126-136 Clay, blue-gray; Same as 105-115-foot interval. Ostracoda and Foraminifera abundant.

136-147 Marl, blue-gray; 25 percent very fine to medium-grained angular quartz sand. 40 percent blue-gray clay matrix, unconsolidated. 20 percent broken shell fragments; sponge spicules prominent. 15 percent dark-green fine-grained glauconite. Ostracoda and Foraminifera abundant.

147-157 Marl, blue-gray; Same as 136-147-foot interval, but with a trace of brown spherulitic collophane. Microfossils rare.

Ostracoda from the 20-157-foot interval include:

Cytherura elongata Edwards
Puriana rugipunctata (Ulrich and Bassler)
Actinocythereis mundorffi (Swain)
Actinocythereis exanthemata (Ulrich and Bassler)
Orionina vaughani (Ulrich and Bassler)
Hemicythere laevicula Edwards
Hemicythere conradi Howe and McGuirt
Hemicythere confragosa Edwards
Loxoconcha purisubrhomboidea Edwards
Cytheretta sp. aff. *C. karlana* Howe and Pyeatt
Cushmanidea ashermani (Ulrich and Bassler)

Middle(?) Miocene—unnamed unit

157-168 Phosphatic sand and clay, brown; 45 percent medium to fine-grained angular water-polished quartz sand. 35 percent brown clay matrix, unconsolidated. 20 percent brown medium-grained spherulitic collophane. No Ostracoda, Foraminifera rare.

168-178 Phosphatic sand and clay, brown; Same as 157-168-foot interval, but containing indurated streaks. No Ostracoda, Foraminifera very rare.

No ostracodes were recovered from the 157-158-foot interval. Age determination is based on the presence of *Siphogenerina lamellata* Cushman, the only Foraminifera recovered from the 157-178-foot interval.

Paleocene—Beaufort formation

178-189 Glauconitic sand and clay, green; 40 percent fine to coarse-grained angular to subangular quartz sand. 35 percent green to gray clay matrix, unconsolidated to indurated in streaks. 25 percent dark-green medium to coarse-grained glauconite with pyrite filled fissures. Trace of coarse broken shell fragments. Ostracoda and Foraminifera rare.

189-200 Glauconitic sand and clay, green; Same as 178-189-foot interval, but with prominent euhedral pyrite crystals. Ostracoda and Foraminifera common.

200-216 Glauconitic sand and clay, green; Same as 189-200-foot interval. Ostracoda and Foraminifera common.

210-220 Glauconitic sand, green; 25 percent medium to fine-grained subrounded to subangular quartz sand. 20 percent gray to white calcareous clay matrix, unconsolidated to indurated in streaks. 40 percent dark-green coarse to medium-grained glauconite. 15 percent broken shell and sandy limestone fragments. Euhedral pyrite crystals prominent. Ostracoda and Foraminifera abundant.

220-231 Glauconitic sand, green; Same as 210-220-foot interval. Ostracoda and Foraminifera abundant.

231-241 Glauconitic sand, green; Same as 210-220-foot interval. Ostracoda and Foraminifera abundant.

241-252 Glauconitic sand, green; Same as 210-220-foot interval. Ostracoda and Foraminifera abundant.

252-262 Glauconitic sand, "salt and pepper"; 55 percent medium to coarse grained angular to subrounded quartz sand. 20 percent gray to white calcareous clay matrix, unconsolidated to indurated in streaks. 25 percent dark-green medium-grained glauconite. Pyrite prominent as euhedral crystals and as a fine-grained mass filling fissures in glauconite grains. Trace of shell and sandy limestone fragments. Ostracoda and Foraminifera common.

262-273 Glauconitic sand, "salt and pepper"; Same 252-262-foot interval. Ostracoda and Foraminifera common.

273-283 Glauconitic sand, "salt and pepper", Same 252-262-foot interval. Ostracoda and Foraminifera common.

283-294 Glauconitic sand, "salt and pepper", Same 252-262-foot interval. Ostracoda and Foraminifera common.

294-304 Glauconitic sand, "salt and pepper"; Same as 252-262-foot interval, with a slight increase in clay matrix. Ostracoda and Foraminifera abundant.

304-315 Glauconitic sand, "salt and pepper"; Same 294-304-foot interval. Ostracoda and Foraminifera abundant.

315-326 Glauconitic sand, "salt and pepper"; Same as 294-304-foot interval. Ostracoda and Foraminifera common.

326-336 Sand, "salt and pepper"; 65 percent coarse to fine-grained subrounded to subangular quartz sand. 20 percent gray silt and clay matrix, unconsolidated. 15 percent dark-green coarse-grained glauconite. Euhedral pyrite crystals prominent. Trace of broken shell and limestone fragments. Ostracoda and Foraminifera rare.

336-347 Sand, "salt and pepper"; Same as 326-336-foot interval. Ostracoda and Foraminifera very rare.

347-352 Sand, "salt and pepper"; Same as 326-336-foot interval. Ostracoda and Foraminifera very rare.

352-358 Sand, "salt and pepper"; Same as 326-336-foot interval. Ostracoda and Foraminifera very rare.

358-367 Sand and clay, gray; 60 percent coarse to fine-grained subrounded to subangular quartz sand. 35 percent gray clay matrix, unconsolidated. 5 percent dark-green coarse-grained glauconite. Trace of euhedral pyrite crystals. Red hematite staining of sand matrix prominent. Ostracoda and Foraminifera common.

367-378 Sand and clay, gray; Same as 358-367-foot interval. Ostracoda and Foraminifera common.

378-388 Sand and clay, gray; Same as 358-367-foot interval. Ostracoda and Foraminifera common.

388-399 Sand and clay, gray; Same as 358-367-foot interval. Ostracoda and Foraminifera common.

399-410 Sand and silt, gray; 65 percent coarse to fine-grained subrounded to angular quartz sand. 30 percent gray silt matrix, unconsolidated. 5 percent dark-green coarse-grained glauconite. Euhedral pyrite crystals prominent. Trace of broken and abraded shell fragments. Ostracoda and Foraminifera rare.

410-420 Sand and silt, gray; Same as 399-410-foot interval. Ostracoda and Foraminifera rare.

420-430 Sand and silt, gray; Same as 399-410-foot interval. Ostracoda and Foraminifera rare.

430-441 Sand and silt, gray; Same as 399-410-foot interval. Ostracoda and Foraminifera rare.

441-452 Sand, gray; 85 percent coarse to medium-grained rounded to subangular quartz sand. 10 percent gray silt and clay matrix, unconsolidated. 5 percent dark-green coarse-grained glauconite. Broken shell fragments and euhedral pyrite crystals prominent. Trace of red hematite aggregates and black lignitized wood fragments. Ostracoda and Foraminifera common.

452-462 Sand, gray; Same as 441-452-foot interval. Ostracoda and Foraminifera common.

462-472 Sand, gray; Same as 441-452-foot interval. Ostracoda and Foraminifera rare.

472-483 Sand, gray; Same as 441-452-foot interval. Ostracoda and Foraminifera very rare.

Ostracoda from the 178-483-foot interval include:

Cytheridea (Haplocytheridea) ruginosa Alexander
Brachycythere interrasilis Alexander
Brachycythere verrucosa Harris and Jobe
Brachycythere plena Alexander
Trachyleberis midwayensis (Alexander)
Trachyleberis spiniferrima (Jones and Sherborn)
Trachyleberis prestwichiana (Jones and Sherborn)
Trachyleberis bassleri (Ulrich)
Actinocythereis siegristae (Schmidt)
Loxoconcha corrugata Alexander
Orthonotacythere cristata Alexander

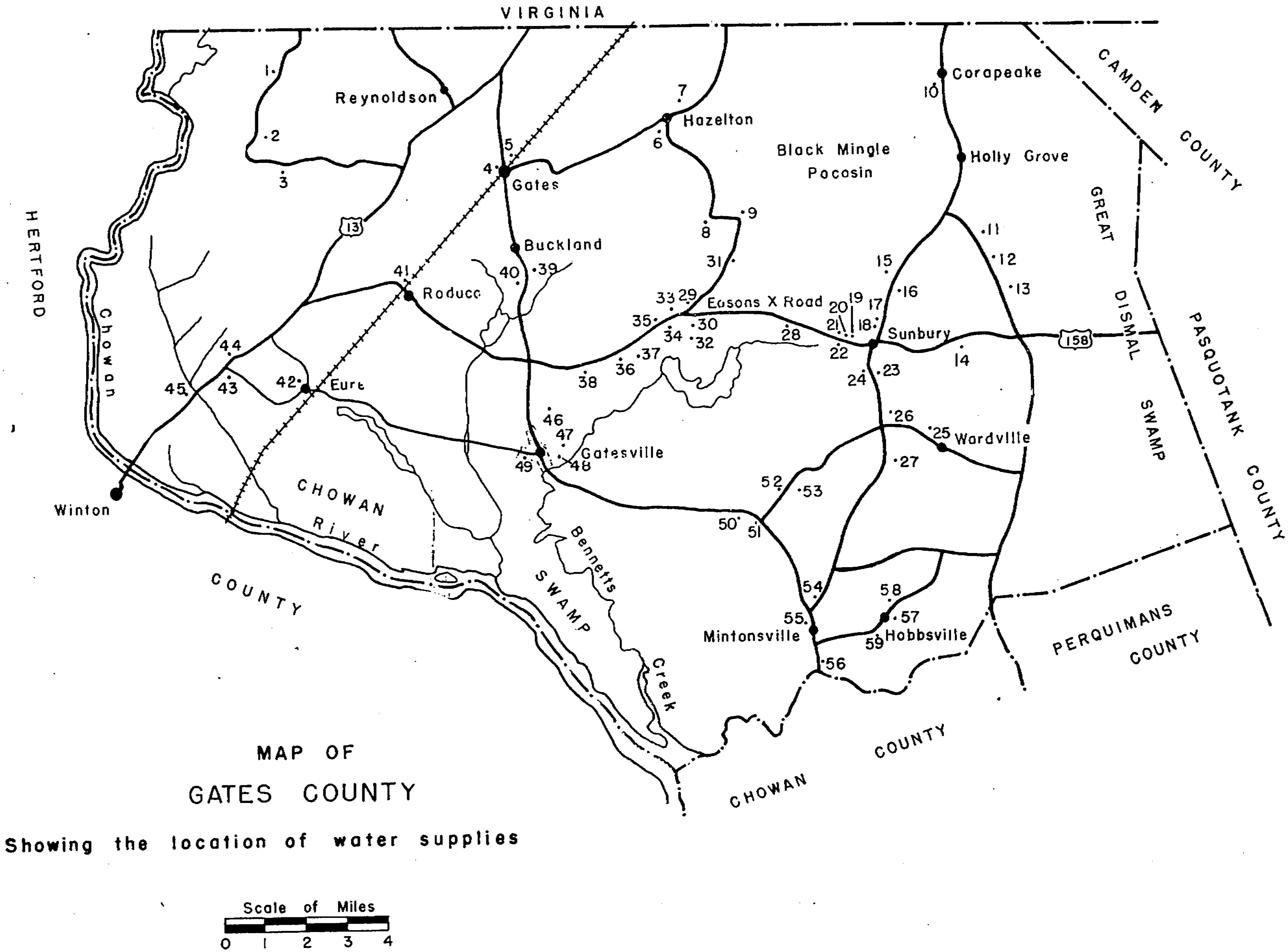

VIRGINIA
CAMDEN COUNTY
HERTFORD
Chowan
Reynoldson
Gates
Hazelton
Black Mingle
Pocosin
Corapeake
Holly Grove
GREAT
DISMAL
SWAMP
PASQUOTANK COUNTY
13
Buckland
Roduco
Easons X Road
Sunbury
158
Eure
Gatesville
Wardville
Winton
CHOWAN
River
COUNTY
Bennetts
SWAMP
Creek
Mintonsville
Hobbsville
PERQUIMANS
COUNTY
CHOWAN
COUNTY
N
MAP OF
GATES COUNTY
Showing the location of water supplies
Scale of Miles
0 1 2 3 4

Figure 8.

TABLE 8. Records of Wells in Gates County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
1	4 miles W of Reynoldson	D. G. Freeman	Screen	276	4-2	276	Sand				Temperature 58°F.
2	4¼ miles WSW of Reynoldson	G. C. Dodd	do	300	4-2	300	do	Flows			Analysis.
3	5 miles NW of Roduco	D. G. Freeman	do	274	4-2	274	do				Temperature 59°F.
4	Gates	do	do	450	4-2	450	do				Supplies 3 stores and 5 houses.
5	do	T. E. Pitman	do	416	4-2	416	do				
6	Hazelton	C. King	do	462	4-2	462	do				
7	½ mile NE of Hazelton	E. Mullin	do	455	4-2	455	do				
8	2½ miles SE of Hazelton	L. Taylor	do	470	4-2	470	do				
9	3 miles SE of Hazelton	Mrs. Effie Wheedee	do	493	4-2	493	do				
10	¼ mile SW of Corapeake	J. Rogers	do	578	4-2	578	do				
11	1½ miles S of Holly Grove	W. K. Parker	Screen	538	4-2	538	Sand	−23			Analysis. Water level reported in 1947.
12	2½ miles S of Holly Grove	F. C. Copeland	do	606	4-2	606	do	−11			Analysis. Water level measured 10/8/53.
13	3¼ miles S of Holly Grove	Paul Rountree	do	592	4-2	592	do	−14			Water level measured 4/18/54.
14	2 miles E of Sunbury	G. E. Rountree	do	620	4-2	620	do				
15	1½ miles N of Sunbury	F. E. McCoy	do	552	4-2	552	do	−4.5			Analysis. Water level measured 8/3/48.
16	do	R. Kellogg	do	565	4-2	565	do	−6			Water level reported in 1948.
17	Sunbury	G. Hathaway	do	595	4-2	595	do				
18	do	J. M. Byrum	do	591	4-2	591	do	-10			Analysis. Water level measured 8/53.
19	Sunbury	C. C. Edwards	Screen	560	4-2	560	Sand				
20	do	Gates County Board of Education	do	350	3	350	do				Analysis.
21	do	Tom Morgan	do	405	2	405	do				Analysis.
22	do	D. C. Griffin	do	585	4-2	585	do				
23	½ mile S of Sunbury	Mrs. E. Brooks	Open-end	20	1¼	20	do				
24	¼ mile S of Sunbury	H. C. Benton	do	45	1¼	45	do				
25	¼ mile W of Wardsville	T. Hobbs	Screen	550	4-2	550	do				
26	1½ miles S of Sunbury	W. H. Hofler	Dug	17.6	24	17.0	do	−16.6			Water level measured 10/16/55.
27	2½ miles S of Sunbury	J. L. Hofler	do	9.2	24	9.0	do	−8.5			do
28	2 miles W of Sunbury	J. Hunter	do	11.0	24	8	do	−10.6			Water level measured 10/2/43.
29	5 miles W of Sunbury	W. E. Hinton	Screen	120	1¼	120	Marl				Temperature 64°F.
30	do	L. B. Lawrence	Open-end	42	1¼	42	do				
31	1½ miles N of Easons X-Roads	C. W. Jones	Screen	372	3	372	Sand	−17			Water level reported in 1944.
32	do	J. B. Rountree	do	375	3	375	do				
33	do	R. W. Jones	do	372	4-2	372	do	−15			Water level reported in 1941.
34	Easons X-Roads	R. Turner	Screen	376	4-2	376	Sand				
35	do	C. E. Lang	do	380	3	380	do	−9.24			Water level measured 5/5/46.
36	3 miles NE of Gatesville	Prison Camp No. 108	do	318	4	318	do	−12			Analysis. Water level measured 10/22/49.
37	do	do	Open-end	42	2	42	do				
38	2 miles NE of Gatesville	Mrs. O. C. Turner	do	130	3	130	do	−12			Water level measured 9/43.
39	Buckland	W. C. Rawls	Screen	424	4-2	424	do	−10			Water level reported in 1949.
40	do	Gates County Board of Education	do	360	4-2	360	do	−6			Water level reported in 1949.
41	Roduco	Mrs. Lucy Brown	do	400	4-2	400	do				Analysis.
42	Eure	E. D. Eure	do	155	1¼	155	Marl				Analysis.
43	1½ mile W of Eure	Mr. Parker	do	321	3	321	Sand	−4			Water level reported in 1945.
44	2 miles NW of Eure	G. Tinkham	do	315	4-2	315	do				
45	2½ miles W of Eure	Mr. Felton	do	114	3	114	do				Analysis.
46	Gatesville	Claude Bundy	Screen	471	4-2	471	Sand	Flows			Analysis.
47	do	Gatesville Hotel	do	455	3	455	do	+10			Analysis. Water level measured 10/2/43.
48	do	Conger Ice Co.	do	450	4	450	do	Flows			Water used for cooling.
49	do	Gates County Office Bldg.	do	483	4-2	483	do	Flows			Temperature 63°F.
50	3 mi. NW of Mintonsville	H. W. White	do	480	4-2	480	do				
51	2½ miles NW of Mintonsville	W. A. Brown	Driven	32	1¼	32	Marl				
52	3½ miles NW of Mintonsville	W. E. Brown	Screen	490	4-2	490	Sand	−8			Water level reported in 1948.
53	do	S. E. Spivey	do	396	4-2	396	do				
54	Mintonsville	Pure Oil Co.	Open-end	18	1¼	18	do				
55	do	E. L. Winslow	Dug	11.3	36	11.3	Clay	−9.9			Water level measured 10/2/43.
56	½ mile S of Mintonsville	W. C. Winslow	Dug	12.1	36	8.2	Clay	−10.0			Water level measured 10/2/43.
57	Hobbsville	Clyde Jones	Screen	375	4-2	375	Sand	Flows			Abandoned.
58	do	Gates County Board of Education	do	490	4-2	490	do				Abandoned.
59	do	Dr. Blanchard	do	494	4-2	494	do				Abandoned.

TABLE 9. CHEMICAL ANALYSES OF GROUND WATER FROM GATES COUNTY
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	2	11	12	15	18	20	21
Silica (SiO_2)	10			13			13
Iron (Fe), total	.92			.76			6.0
Iron (Fe), in solution	.07			.33			.02
Calcium (Ca)	3.7			1.0			5.4
Magnesium (Mg)	3.3			1.2			4.9
Sodium and potassium (Na+K)	257			315			657
Bicarbonate (HCO_3)	416	643	12	636	686	657	812
Sulfate (SO_4)	36	17	1	24	22	20	60
Chloride (Cl)	140	50	7.2	62	72	60	512
Fluoride (F)	1.6	4.5	1.3	3.4	4.8	4.0	4.8
Nitrate (NO_3)	2.2			1.0			.4
Dissolved solids	680			775			1690
Hardness as $CaCO_3$	23	6	17	7	9	14	34
pH	7.8	8.2	5.6	8.5	8.2		8.1
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	10-7-53	10-8-53	10-8-53	8-3-48	10-8-53	10-2-43	3-2-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	36	41	42	45	46	47
Silica (SiO_2)	10	12				
Iron (Fe), total	.51	1.5				
Iron (Fe), in solution	.18	.23				
Calcium (Ca)	1.9	1.9				
Magnesium (Mg)	1.4	2.1				
Sodium and potassium (Na+K)	268	282				
Bicarbonate (HCO_3)	545	454	471		597	477
Sulfate (SO_4)	46	40	2		23	40
Chloride (Cl)	61	148	9	20	178	156
Fluoride (F)	4.4	1.8	1.0		2.6	1.7
Nitrate (NO_3)	1.9	.4				
Dissolved solids	676	722				
Hardness as $CaCO_3$	10	13	82	120	13	14
pH	8.1	8.2			7.8	
Water-bearing material	Sand	Sand	Marl	Sand	Sand	Sand
Date of collection	10-22-49	3-2-54	10-12-43	10-4-44	1953	10-2-43

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Greene County

(Area 267 square miles, population 18,550)

Greene County, one of the smallest counties in the State, lies in the southwest corner of the Greenville area. The county is bounded by Wilson County to the north, Pitt County to the east, Lenoir County to the south, and Wayne County to the west. Snow Hill, the county seat, is the largest town in the county; other population centers include Hookerton, Maury, and Walstonburg.

The county is drained by Contentnea Creek and Little Contentnea Creek, which in turn drain into the Neuse River. The youthful stage of drainage accounts for several swampy areas within the county.

The sale of agricultural products provides the major source of income in the county; tobacco is the chief marketable crop. Small local industry is centered largely in Snow Hill and Maury.

Geology.—The entire county is covered by sands, clays, and gravels of Quaternary age, except in dissected areas bordering the major stream valleys, where erosion has exposed older formations. The Quaternary deposits occur at elevations ranging from 130 feet above sea level in the western part of the county to 30 feet above sea level in the eastern part of the county and probably are no more than 35 feet thick in any section of the county.

In large, scattered areas the surficial material is underlain by the Yorktown formation of late Miocene age. This formation was deposited in a transgressive sea that probably covered the entire county. Post-depositional erosion has removed or thinned the originial sediments so that the formation, as it now occurs in Greene County, is largely confined to depressions in the surface of the underlying Cretaceous formations. The thickness of the Yorktown formation is variable, from less than a foot to as much as 15 feet in most areas of its occurrence.

Underlying both the Quaternary and late Miocene sediments are sediments of Late Cretaceous age—the Peedee, Black Creek, and Tuscaloosa formations. The Cretaceous formations, which strike northeast and dip toward the southeast at a rate of 15 to 20 feet per mile, have a regressive offlap relationship that results in younger formations successively outcropping toward the southeast.

The uppermost Cretaceous unit, the Peedee formation, is at or near the surface in the southern third of the county. Typical exposures of the formation along major streams show it to be composed of interbedded and lenticular glauconitic sands and clays. Massive clay beds are most abundant in the lower third of the formation, and indurated shell beds a foot to several feet in thickness are present throughout the formation. The total exposed thickness of this formation in the outcrop area is about 100 to 130 feet and probably no greater than 140 feet in subsurface sections in the extreme southeast corner of the county.

Underlying the Peedee formation is the Black Creek formation, which is at or near the surface in the central third of the county. The formation consists of a lower unnamed member and an upper member (the Snow Hill marl), the latter having its type locality in Greene County (p. 18). The lithology of the Black Creek formation is not uniform. The upper member is composed of drab-gray marls interbedded with thin layers of glauconitic sand and micaceous clay; indurated layers are common throughout. The lower member consists of interbedded sands and black micaceous clays that are generally thicker and of greater lateral extent than those occurring in the upper member. Black lignitized wood fragments are prominent throughout the formation. The formation is about 165 feet thick in its outcrop area, and the maximum thickness in the subsurface is 220 feet.

Underlying the Black Creek formation is the Tuscaloosa formation. This formation crops out updip from the Peedee and Black Creek formations and is at or near the surface in the northern third of the county. The Tuscaloosa formation is composed of lenticular and interbedded layers of drab-gray to pink feldspathic quartz sand and dense micaceous clay. Lenticular gravel deposits occur throughout the formation, but commonly are more prevalent toward the base of the formation. The total thickness of the formation within the county is about 120 feet; total thickness in the outcrop area, which includes several counties, is probably between 250 to 300 feet. The formation thickens progressively downdip and may be as much as 400 to 500 feet thick in the subsurface in the southeastern part of the county.

It is not known whether sediments of Early Cretaceous age underlie Greene County. It is probable that deeper drilling will penetrate Lower Cretaceous sediments underlying the Tuscaloosa formation, as was the case in adjoining Pitt and Lenoir Counties.

Ground water.—All public and private water supplies in the county are obtained from wells. Supplies of several millions of gallons a day of potable ground water can be developed anywhere in the county.

Surficial sands and gravels and near-surface sands of the Cretaceous formations are tapped by shallow dug wells and driven wells in all sections of the county. These wells, few of which are deeper than 35 feet, yield from 2 to 10 gpm.

Jetted wells, either open-end or single-screen, at depths of 60 to 200 feet obtain water from sands of the following Cretaceous formations; the Tuscaloosa formation in the northwestern third of the county, the Black Creek and Tuscaloosa formations in the central third of the county, and the Peedee and Black Creek formations in the southeastern third of the county. Jetted wells range in diameter from 1½ to 4 inches and yield from 2 to 60 gpm. No information is available regarding specific capacities and maximum yields from jetted wells.

Several gravel-wall wells in the area tap multiple sands in one or more of the Cretaceous aquifers and supply water for irrigation or municipal use. These wells range from 8 to 12 inches in diameter, yield 200 to 500 gpm or more, and have specific capacities of 4 to 10 gpm per foot of drawdown. The Cretaceous sands are lenticular and have little lateral continuity. For this reason wells in any one area that have comparable yields may show considerable variation in depth even though they obtain water from the same formation.

Water levels in the surficial sands are generally within 10 to 20 feet of the land surface. Water in the Cretacous aquifers, below a depth of 40 to 60 feet, is under artesian pressure and will generally rise in wells to within a few few of the surface. Flowing wells are common in areas bordering Contentnea Creek, especially in the vicinity of Lindell and northeast of Hookerton.

The chemical quality of ground water is adequate for domestic purposes throughout most of the county. The artesian waters are generally soft sodium bicarbonate waters. Locally, indurated shell beds may impart moderate hardness to some water. Water from the surficial sands and gravels may be corrosive and may contain objectionable amounts of iron but is otherwise acceptable for domestic use.

The following well log describes the physical characteristics of the principal aquifers in Greene County (see figure 9 for well location).

Greene County

Well Number 11

Location: Moye Farm on an unnumbered county road, 2 miles northeast of Maury, North Carolina

Owner: George Moye

Date drilled: 1954

Driller: Heater Well Co.

Elevation of well: 73 feet above sea level

Hydrologic Information

Diameter of well: 10 inches

Depth of well: 341 feet

Cased to: 341 feet

Finish: Gravel wall and screens

Static (nonpumping) water level: 20 feet below land surface (1954)

Yield: Tested at 550 gallons a minute with a 122-foot drawdown (1954)

Log of Well

Depth (feet)

Quaternary—surficial sands

8-31 Sand, white; 90 percent coarse-grained subrounded quartz sand. 10 percent tan clay matrix, unconsolidated. No microfossils.

31-41 Sand, tan; Same as 8-21-foot interval with limonitic staining of quartz grains predominant. No microfossils.

Upper Cretaceous—Peedee formation

41-58 Sand, tan; 80 percent coarse to medium-grained subangular quartz sand. 20 percent tan silt and clay matrix, unconsolidated. Trace of light-green weathered glauconite. No microfossils.

58-61 Sand, tan; Same as 41-58-foot interval. No microfossils.

61-71 Sand, tan; Same as 41-58-foot interval. No microfossils.

71-81 Sand, tan; Same as 41-58-foot interval. No microfossils.

81-87 Sand, tan; Same as 41-58-foot interval. No microfossils.

Upper Cretaceous—Black Creek formation

87-91 Clay and sand, black; 30 percent fine-grained angular quartz sand. 65 percent black micaceous clay matrix, unconsolidated. 5 percent black lignitized plant fragments. Dark-green fine-grained glauconite prominent. Trace of broken shell fragments and marcasite aggregates. Ostracoda and Foraminifera common.

91-101 Clay and sand, black; Same as 87-91-foot interval. Ostracoda common, Foraminifera rare.

101-136 Clay, black; 10 percent fine-grained angular quartz sand. 85 percent black micaceous clay matrix, unconsolidated. 5 percent dark-green fine-grained glauconite. Black lignitized plant fragments prominent. Trace of marcasite aggregates and broken shell fragments. Ostracoda common, Foraminifera rare.

136-141 Clay, black; Same as 101-136-foot interval. Ostracoda and Foraminifera rare.

141-151 Clay, black; Same as 101-136-foot interval. Ostracoda and Foraminifera rare.

151-162 Clay and sand, black; 30 percent fine-grained angular quartz sand. 60 percent black micaceous clay matrix, unconsolidated. 10 percent black lignitized plant fragments. Trace of glauconite and shell fragments. Ostracoda and Foraminifera rare.

162-180 Sand, gray; 85 percent medium to coarse-grained subrounded to subangular quartz sand. 15 percent black micaceous clay matrix, unconsolidated. Trace of glauconite marcasite aggregates and fine broken shell fragments. Ostracoda common, Foraminifera rare.

Ostracoda from the 87-162-foot interval include:

Cytheropteron (Eocytheropteron) striatum Brown
Brachycythere leadforma (Israelsky)
Brachycythere sphenoides (Reuss)
Brachycythere nausiformis Swain
Alatacythere sp. aff. *A. gulfensis* (Alexander)
Orthonotacythere tarensis Brown
Orthonotacythere sulcata Brown

Upper Cretaceous—Tuscaloosa formation

180-193 Clay and sand, light-gray; 30 percent medium-grained subrounded quartz sand. 70 percent gray micaceous clay matrix, unconsolidated but tight.

193-201 Clay and sand, light-gray; Same as 180-193-foot interval.

201-213 Clay and sand, light-gray; Same as 180-193-foot interval.

213-220 Sand, gray; 90 percent coarse to medium-grained subrounded quartz sand. 10 percent gray silt and clay matrix, unconsolidated. Trace of mica flakes.

220-227 Sand and clay, gray; 60 percent coarse-grained subrounded quartz sand. 40 percent gray clay matrix, unconsolidated.

227-241 Sand and clay, gray; Same as 220-227-foot interval.

241-251 Sand and clay, gray; Same as 220-227-foot interval.

251-261 Sand and clay, gray; Same as 220-227-foot interval.

261-278 Sand and clay, gray; Same as 220-227-foot interval.

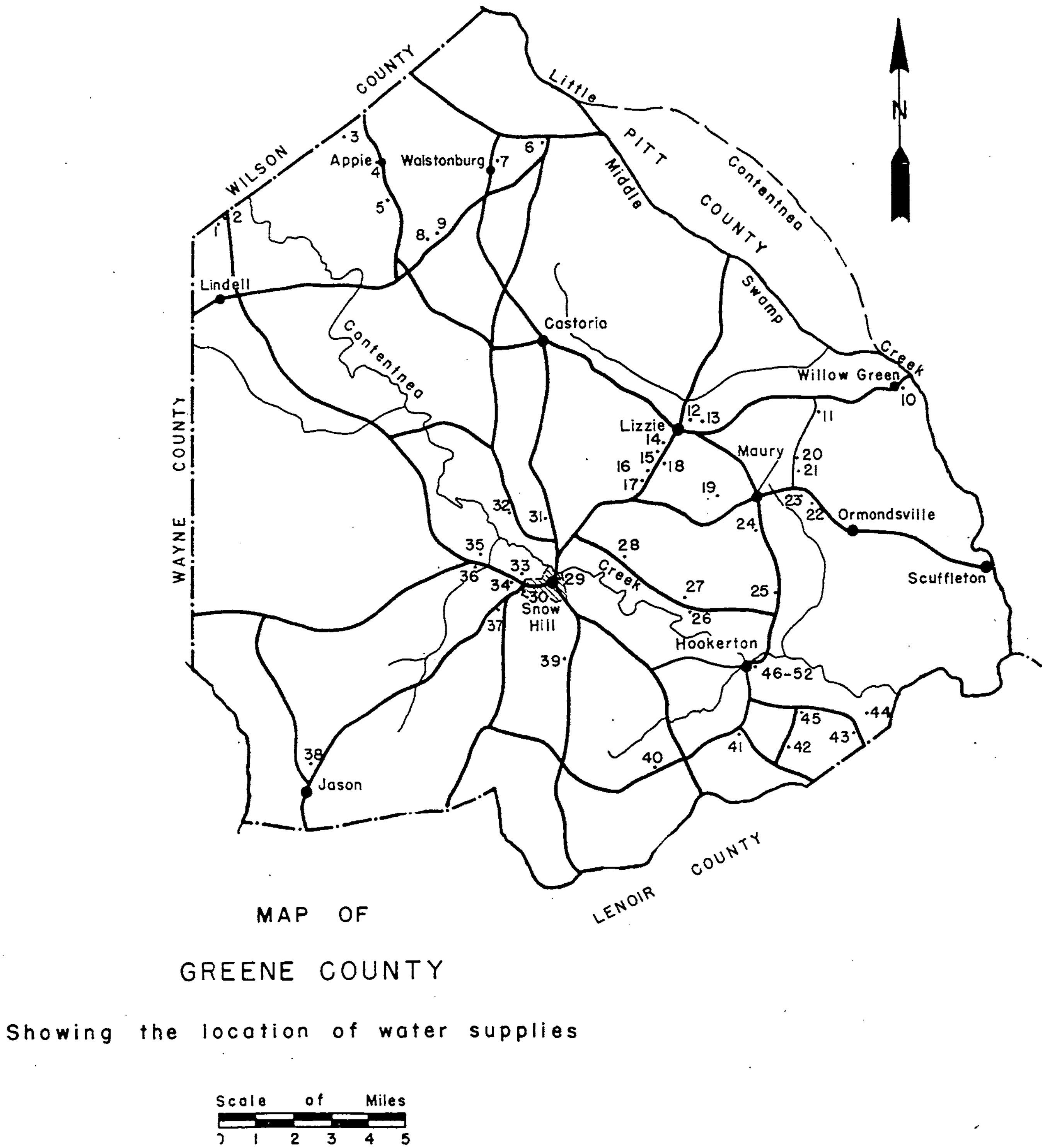
278-289 Sand, gray; 80 percent coarse-grained subrounded quartz sand. 15 percent gray clay matrix, unconsolidated. 5 percent coarse-grained blocky potash feldspar.

289-296 Sand, gray; Same as 278-289-foot interval.

296-308 Sand, gray; Same as 278-289-foot interval.

308-330 Sand, gray; Same as 278-289-foot interval.

Remarks: No microfossils were recovered from the 41-to 87 and 180-to 330-foot intervals. Correlation of these intervals is based upon lithology and stratigraphic position as inferred from nearby outcropping sections.



WILSON COUNTY
WAYNE COUNTY
PITT COUNTY
LENOIR COUNTY
N
Little
Contentnea
Middle
Swamp
Creek
Contentnea
Creek
Appie
Walstonburg
Lindell
Castoria
Lizzie
Maury
Willow Green
Ormondsville
Scuffleton
Snow Hill
Hookerton
Jason
46-52
MAP OF
GREENE COUNTY
Showing the location of water supplies
Scale of Miles
0 1 2 3 4 5

FIGURE 9.

TABLE 10. Records of Wells in Greene County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
1	2 miles N of Lindell	C. A. Dawson	Open-end	105	4	105	Sand				Temperature 60°F.
2	do	do	Screen	50	1¼	50	do				do
3	1 mile NW of Appie	L. Byrum	do	180	6	180	do				
4	Appie	H. Herring	do	165	6	165	do	—40.4			Analysis. Water level measured 1/23/54.
5	1 mile S of Appie	H. Herring, Jr.	do	185	6	183	do				
6	1½ miles NE of Walstonburg	E. L. Jones	do	175	6	171	do				Analysis.
7	Walstonburg	Town of Walstonburg	Gravel-wall	240	8	240	do				Analysis.
8	2½ miles SW of Walstonburg	Frank Walston	Screen	139	4	139	do	—29.6			Analysis. Water level measured 2/15/55.
9	do	do	Open-end	90	2	90	do	—27.3			Analysis. Water level measured 2/15/55.
10	Willow Green	H. Darden	Screen	360	2	360	do				
11	2 miles W of Willow Green	G. Moye	Gravel-wall	341	10	341	do		550	122	Used for irrigation. Yield and draw-down measure, 1957.
12	Lizzie	W. T. Eason	Screen	91	4	89	Sand				Abondaned.
13	do	do	do	285	6	279	do				Analysis.
14	½ mile SW of Lizzie	E. A. Rasberry	do	223	4	223	do				Abandoned.
15	½ mile SW of Lizzie	E. A. Rasberry	Screen	41	6	41	Sand				Abandoned.
16	1 mile SW of Lizzie	do	do	220	4	218	do				
17	1½ miles SW of Lizzie	do	do	158	4	156	do				
18	1 mile SW of Lizzie	do	do	182	4	180	do	35.3			Water level measured 3/18/53.
19	1 mile W of Maury	State Highway Dept.	do	165	6	165	do	40.2			Analysis. Water level measured, 1955.
20	1¼ miles NE of Maury	W. Soggs	do	185	2	185	do				
21	do	P. Frizel	do	178	4	178	do				
22	1¼ miles E of Maury	E. Soggs	do	170	2	170	do				
23	1 mile E of Maury	E. Jackson	do	177	4	177	do				Analysis.
24	½ mile S of Maury	R. Wood	Dug	17	36	8	Sand and Clay	13.4			Water level measured 1/23/54.
25	2½ miles S of Maury	J. C. Jones	Screen	102	1¼	102	Sand				Analysis.
26	3½ miles SW of Maury	L. Daniels	Open-end	85	2	85	do	Flows	15		Flow measured, 1955.
27	do	E. Nellican	do	75	1¼	75	do				Flows periodically.
28	1¼ miles E of Snow Hill	A. Beddard	Screen	87	4	85	do				
29	Snow Hill	Carolina Power and Light Co.	do	260	8–5	260	do	Flows			Analysis. Public Supply.
30	do	Greene County Board of Education	do	169	6	165	do	23.5			Water level measured, 1955.
31	½ mile N of Snow Hill	J. Beaman	Screen	152	4	150	Sand				
32	¾ mile N of Snow Hill	J. Exum	do	50	4	45	do				
33	¼ mile NW of Snow Hill	A. Warren	do	80	4	76	do				
34	¼ mile NW of Snow Hill	A. Mewborn	do	85	4	85	do				
35	1¼ miles NW of Snow Hill	G. F. Thomas	do	125	4	123	do				
36	do	G. Thomas	do	67	4	67	do				
37	½ mile SW of Snow Hill	Snow Hill Tape Co.	do	84	4	76	do				
38	Jason	W. D. Cobb	do	209	4	209	do				
39	2 miles S of Snow Hill	W. Ginn	do	156	6	154	do	24			Water level reported by owner, 1955.
40	3½ miles SW of Hookerton	J. Crews	do	130	4	130	do				Analysis.
41	1½ miles S of Hookerton	J. Creech	Open-end	50	2	50	do				
42	2¼ miles S of Hookerton	A. Haddock	do	85	4–2	85	do				Analysis.
43	3¼ miles SW of Hookerton	L. Worthington	Screen	140	4	140	do				
44	3¼ miles W of Hookerton	D. Dixon	do	109	4	109	do				Analysis.
45	1½ miles SW of Hookerton	W. Cary	Open-end	78	4	78	Sand				
46	Hookerton	Town of Hookerton	do	105	1¼	105	do	Flows			Abandoned.
47	do	do		105	1¼	105	do	Flows			Abandoned.
48	do	do		105	2	105	do	Flows			Abandoned.
49	do	do		105	4	105	do	Flows			Analysis. Abandoned.
50	do	do		200	2	200	do	Flows			Abandoned.
51	do	do		339	6	339	do	Flows			Analysis. Abandoned.
52	do	do		380	8	360	do	Flows			Analysis. Public supply.

TABLE 11. CHEMICAL ANALYSES OF GROUND WATER FROM GREENE COUNTY
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	4	6	7	8	9	13
Silica (SiO_2)	--	--	26	--	--	13
Iron (Fe), total	--	--	.47	1.3	0.68	.10
Iron (Fe), in solution	--	--	--	--	--	.05
Calcium (Ca)	--	--	8.7	--	--	2.2
Magnesium (Mg)	--	--	5.2	--	--	2.8
Sodium and potassium (Na+K)	--	--	41	7.4	4.9	81
Bicarbonate (HCO_3)	174	192	142	44	20	211
Sulfate (SO_4)	2	2	5.5	7.8	7.8	6.4
Chloride (Cl)	5.2	2.8	6.4	--	--	10
Fluoride (F)	--	--	.3	.6	.7	.0
Nitrate (NO_3)	--	--	.4	--	--	.3
Dissolved solids	--	--	164	--	--	229
Hardness as $CaCO_3$	47	99	43	34	21	17
pH	7.2	7.3	7.0	6.6	6.2	7.5
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	--	--	7-28-49	2-15-55	2-15-55	11-11-53

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	19	23	25	29	40	42
Silica (SiO_2)	19	--	--	11	18	--
Iron (Fe), total	.08	--	--	.09	2.1	--
Iron (Fe), in solution	--	--	--	--	.12	--
Calcium (Ca)	10	--	--	4.4	13	--
Magnesium (Mg)	5.2	--	--	2.8	1.1	--
Sodium and potassium (Na+K)	46	--	--	91	6.9	--
Bicarbonate (HCO_3)	167	206	213	204	52	141
Sulfate (SO_4)	1.9	1	1	11	4.1	9
Chloride (Cl)	4.5	4.2	5.8	28	3.2	3.5
Fluoride (F)	.4	--	--	.4	.1	--
Nitrate (NO_3)	.1	--	--	.3	.3	--
Dissolved solids	174	--	--	255	76	--
Hardness as $CaCO_3$	46	98	47	22	37	122
pH	7.1	7.2	7.2	7.9	6.6	7.3
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	1-5-50	1-22-54	1-22-54	5-26-47	1-22-54	1-22-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	44	49	51	52		
Silica (SiO_2)	--	27	12	13		
Iron (Fe), total	--	3.1	.15	.12		
Iron (Fe), in solution	--	--	.04	.08		
Calcium (Ca)	--	13	.3	.2		
Magnesium (Mg)	--	2.3	.3	.2		
Sodium and potassium (Na+K)	--	14	94	94		
Bicarbonate (HCO_3)	141	74	181	181		
Sulfate (SO_4)	7	4.7	14	15		
Chloride (Cl)	4.0	4.8	30	30		
Fluoride (F)	--	.2	.4	.0		
Nitrate (NO_3)	--	.3	.3	.8		
Dissolved solids	--	112	243	247		
Hardness as $CaCO_3$	122	42	2	2		
pH	7.4	6.8	7.8	7.9		
Water-bearing material	Sand	Sand	Sand	Sand		
Date of collection	1-19-54	7-24-47	9-6-49	1-4-55		

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Hertford County

(Area 356 square miles, population 21,453)

Hertford County lies in the northern part of the Greenville area. The county abuts Virginia to the north and is bordered by the Chowan River to the east, Bertie County to the south, and Northampton County and the Meherrin River to the west. Ahoskie is the largest town in the county; other population centers include Winton (the county seat), Cofield, Harrellsville, Mapleton, Menola, and Murfreesboro.

The county is drained by the Meherrin River, the Wiccacon River, and Potecasi Creek, all of which drain into the Chowan River.

The sale of agricultural products provides the chief source of income in the county; tobacco and peanuts are the chief marketable crops. Small local industries are centered, for the most part, in and around Ahoskie and Murfreesboro.

Geology.—The county is covered by clays, sands, and gravels of Quaternary age which occur at elevations of from 80 to less than 15 feet above sea level. This material ranges in thickness from a few feet to more than 60 feet, the thickness generally being greatest in and adjacent to the Meherrin River and Chowan River valleys.

Underlying the surficial deposits are blue-gray clays, sands, marls, and shell beds of late Miocene age, the Yorktown formation. This formation is exposed intermittently along the major streams and occasionally in marl pits of the interstream areas. Individual beds in the Yorktown formation are lenticular and cannot be traced for long distances either at the surface or in the subsurface. Massive clay beds are predominant in the formation. Lenticular sand and shell beds, less common than the clays, are more prominent in the lower third of the formation. The thickness of the formation is variable and increases progressively from west to east across the county. In a well at Murfreesboro total thickness of the formation was 58 feet, a well at Ahoskie had a total thickness of 25 feet, and a well at Cofield had a total thickness of 70 feet. Data from adjoining counties indicates that the formation attains a thickness of 125 to 150 feet in eastern Hertford County. Underlying the Yorktown formation in eastern and central Hertford County are deposits of Paleocene age, the Beaufort formation. This formation typically is composed of beds of glauconitic sand and calcareous clay containing thin zones of indurated shells. The total thickness of this stratigraphic unit increases progressively from west to east. The Beaufort formation is 40 feet thick at Ahoskie and 200 feet thick at Colerain. West of a line through Ahoskie and Winton there is apparently an abrupt facies change in the Beaufort formation. Well cuttings in the western part of the county, from beneath the Yorktown formation and from bove the Tuscaloosa formation, are composed typically of coarse clastics containing a large percentage of relatively fresh feldspar grains and variable amounts of light-colored clays, silts, and lignitized wood fragments. This material is of deltaic origin and contemporaneous with downdip marine facies of the Beaufort, Peedee, and Black Creek formations. The manner or extent by which the downdip marine facies interfinger with the updip deltaic facies cannot be determined from available subsurface data. In a recently drilled well at Murfreesboro, 230 feet of nonfossiliferous material of deltaic origin was penetrated beneath the Yorktown and above the Tuscaloosa formations. At Winton, 10 miles downdip from Murfreesboro, a well penetrated more than 350 feet of fossiliferous marine strata, representing the Beaufort and Peedee formations.

Underlying the Beaufort formation in central and eastern Hertford County are sediments of Late Cretaceous age, the Peedee formation. According to LeGrand and Brown (1955, fig. 2) the Peedee formation lies at an elevation of about 150 feet below sea level in the central part of the county and at an elevation of about 400 feet below sea level in the extreme eastern part of the county.

The Black Creek formation or the Tuscaloosa formation underlies the Peedee formation in all parts of the county. The only available well samples from the county that indicate the presence of the Tuscaloosa formation are from a well at Murfreesboro. In this well 110 feet of the Tuscaloosa formation was penetrated, and the top of the formation is 255 feet below sea level. Deeper wells in the county will probably penetrate Lower Cretaceous sediments beneath the Tuscaloosa formation.

Ground water.—All public and private water supplies in the county are obtained from wells. Surficial sands and gravels of Quaternary age and near-surface sand and shell beds of late Miocene age yield 2 to 10 gpm to dug wells and driven wells that range in depth from 10 to 40 feet in all sections of the county.

In central and eastern Hertford County open-end and single-screen wells obtain water from sand and shell beds of the Yorktown formation and similar material in the Beaufort and Peedee formations at depths of from 60 to 300 feet. Inasmuch as no single water-bearing horizons is recognized in the lenticular strata comprising these formations, the depth of individual wells, even in small localized areas, is quite variable. The jetted wells, generally 2 to 4 inches in diameter and rarely as much as 6 inches in diameter, yield 5 to 25 gpm in most localities. In the western part of the county jetted wells are common and generally average less than 200 feet in depth. The yield from wells in this area ranges between 10 and 25 gpm.

Several municipalities obtain water from drilled gravel-wall wells, 8 to 12 inches in diameter, that tap multiple aquifers of Paleocene and Cretaceous age. Wells of this type yield 200 to more than 1,000 gpm and have specific capacities ranging from 6 to 15 gpm per foot of drawdown.

The water level in the surficial material generally is within 10 to 20 feet of the land surface. Water in the deeper aquifers is under artesian pressure and rises in wells to within 30 to 40 feet of the land surface. However, flowing wells are common in the vicinity of Murfreesboro, north of Murfreesboro to the Virginia State line, and in topographically low areas bordering the major rivers and streams. Several wells in the vicinity of Como and Barretts Crossroads, which had previously flowed, are reported to have stopped flowing when large-capacity wells at Franklin, Virginia were placed in production.

The chemical quality of ground water in the county is adequate for most domestic purposes. However, water in some of the shallow aquifers may be corrosive and may contain objectionable amounts of iron. Water from shell beds of the Yorktown and Beaufort formations may be objectionably hard. The deeper "greensand" aquifers contain soft sodium bicarbonate waters. Several analyses of ground waters from aquifers below a depth of 300 feet show a fluoride concentration in excess of 2.0 ppm. However, the fluoride concentration, in most waters analyzed to date, is less than 1.0 ppm through the county. The depth to brackish waters ranges from more than 500 feet below the surface in the western part of the county to as little as 400 feet in the extreme eastern part of the county.

The following well logs describe the physical characteristics of the principal aquifers in Hertford County (see figure 10 for well location).

Hertford County

Well Number 13

Loation: City well at Murfreesboro, North Carolina, located at the high school athletic field.

Owner: City of Murfreesboro

Date drilled: 1954

Driller: Heater Well Co.

Elevation of well: 64 feet above sea level

Hydrologic Information

Diameter of well: 12 inches

Depth of well: 432 feet

Cased to: 432 feet

Finish: Gravel wall and screens

Static (nonpumping) water level: 62 feet below land surface (1954)

Yield: 1,000 gallons a minute

Log of Well

Depth (feet)

Quaternary—surficial sands and clays

0-6 Sand and clay, tan; 70 percent fine to very fine-grained angular quartz sand. 30 percent tan clay matrix, unconsolidated but compact.

6-30 Sand and clay, gray; 55 percent fine to medium-grained angular to subangular quartz sand. 45 percent gray clay matrix, unconsolidated but compact.

Upper Miocene—Yorktown formation

30-40 Clay and sand, gray; 25 percent fine to medium-grained angular quartz sand. 65 percent blue-gray clay matrix, unconsolidated but very compact. 10 percent fine broken shell fragments. Trace of fine mica flakes. Ostracoda and Foraminifera common.

40-50 Clay and sand, gray; Same as 30-40-foot interval. Ostracoda and Foraminifera common.

50-58 Clay and sand, gray; Same as 30-40-foot interval. Ostracoda and Foraminifera common.

58-62 Marl, gray; 30 percent fine to medium-grained angular quartz sand. 35 percent fresh shell and shell fragments. 35 percent blue-gray clay matrix, unconsolidated. Ostracoda and Foraminifera common.

62-88 Marl, gray; Same as 58-62-foot interval. Ostracoda and Foraminifera common.

Ostracoda from the 30-62-foot intervals include:

Cytherura elongata Edwards
Puriana rugipunctata (Ulrich and Bassler)
Actinocythereis exanthemata (Ulrich and Bassler)
Actinocythereis mundorffi (Swain)
Orionina vaughani (Ulrich and Bassler)
Hemicythere confragosa Edwards
Hemicythere schmidtae Malkin
Cushmanidea ashermani (Ulrich and Bassler)

Paleocene (?) and *Upper Cretaceous(?)*—undifferentiated

88-105 Sand and clay, gray; 65 percent medium to fine-grained subrounded to angular quartz sand. 35 percent gray clay matrix, unconsolidated but tight. Trace of black lignitized wood fragments.

105-118 Sand and clay, gray; Same as 88-105-foot interval.

118-149 Sand and clay, brown; 60 percent medium to fine-grained subangular to angular quartz sand. 30 percent reddish-brown clay matrix, unconsolidated but very compact. 10 percent red hematite aggregates. Coarse mica flakes prominent.

149-159 Sand and clay, brown; Same as 118-149-foot interval but well cemented in streaks.

159-161 Sand, white; 90 percent fine to very fine-grained angular quartz sand. 10 percent white clay matrix, unconsolidated. Trace of fine mica flakes and black lignitized wood fragments.

161-173 Sand and clay, brick-red; 55 percent medium to fine-grained subangular quartz sand. 35 percent brick-red clay matrix, unconsolidated but very compact. 10 percent red hematite aggregates. Trace of pyrite.

173-192 Clay and sand, gray; 30 percent very fine-grained angular quartz sand. 70 percent gray micaceous clay matrix, unconsolidated and very compact.

192-195 Clay and sand, gray; Same as 173-192-foot interval.

195-217 Sand, light-gray; 90 percent coarse to fine-grained subrounded to angular poorly-sorted quartz sand. 10 percent light-gray clay matrix, unconsolidated. Trace of black lignitized wood fragments.

217-225 Clay, gray; 15 percent fine-grained angular quartz sand. 85 percent gray micaceous clay matrix, unconsolidated but very compact. Trace of red hematite aggregates and black lignitized wood fragments.

225-255 Clay, gray; Same as 217-225-foot interval.

255-275 Clay, gray; Same as 217-225-foot interval.

275-320 Sand, gray; 90 percent very coarse to medium-grained rounded to subrounded quartz sand. 10 percent gray clay matrix, unconsolidated.

Upper Cretaceous—Tuscaloosa formation

320-334 Sideritic sand, brown; 20 percent medium-grained subangular quartz sand. 65 percent brown spherulitic siderite pellets and aggregates. 15 percent brown clay matrix, unconsolidated.

334-403 Sand and clay, gray; 60 percent coarse to medium-grained subrounded quartz sand. 35 percent gray micaceous clay matrix, unconsolidated but very compact. 5 percent red hematite aggregates and black lignitized wood fragments.

403-432 Sand, gray; 90 percent very coarse to medium-grained subrounded to subangular quartz sand. 10 percent gray clay matrix, unconsolidated. Black lignitized wood fragments prominent.

Remarks: On the basis of information from downdip wells the intervals between 88 and 320-feet are thought to be of Paleocene age in part and of Late Cretaceous (Peedee and Black Creek) age in part. No microfossils were recovered from below 88 feet. The entire interval below 88 feet is thought to be of continental or deltaic origin. The top of the Tuscaloosa formation is placed at 320 feet and is based on the occurrence of abundant siderite pellets which mark the top of the Tusaloosa in other wells.

Hertford County

Well Number 60

Location: Ahoskie, North Carolina, City well number 3.
Owner: City of Ahoskie
Date drilled: 1950
Driller: Layne Atlantic Co.
Elevation of well: 53 feet above sea level

Hydrologic Information

Diameter of well: 8 inches
Depth of well: 245 feet, filled back to 202 feet
Cased to: 202 feet
Finish: gravel wall and screens
Static (nonpumping) water level: 37 feet below land surface (1950)
Yield: 330 gallons a minute
Chemical analysis of water available

Log of Well

Depth (feet)

Quaternary—surficial sands and clays

0-10 Sand and clay, yellow; 65 percent fine to very fine-grained angular quartz sand. 35 percent yellow clay matrix, unconsolidated but very compact. Trace of fine-grained ilmenite and fine mica flakes. No microfossils.

10-20 Sand, yellow; 85 percent coarse to fine-grained subrounded to angular poorly-sorted quartz sand. 10 percent yellow clay matrix, unconsolidated. 5 percent medium-grained potash feldspar. Trace of coarse gravel. Limonitic staining of quartz sand predominant.

20-31 Sand, yellow; 90 percent medium-grained subangular well-sorted quartz sand. 10 percent light-gray clay matrix, unconsolidated. Limonitic staining of quartz grains prominent.

31-55 Sand, yellow; Same as 20-31-foot interval.

Upper Miocene—Yorktown formation

55-80 Sand, gray; 80 percent medium to fine-grained subangular to angular quartz sand. 20 percent gray clay matrix, unconsolidated. Trace of phosphate, shell fragments and sponge spicules.

Paleocene—Beaufort formation

80-110 Glauconitic sand and clay, dark-gray; 45 percent very coarse to medium-grained subrounded to subangular quartz sand. 30 percent dark-green medium to coarse-grained glauconite. 25 percent dark-gray micaceous clay matrix, indurated. Coarse broken shell fragments prominent.

110-118 Sand, light-gray; 65 percent coarse to medium-grained subrounded to subangular quartz sand. 20 percent gray to yellow clay matrix, indurated and moderately consolidated. 10 percent rounded medium gravel. 5 percent dark-green medium-grained glauconite. Trace of coarse broken abraded shell fragments.

118-124 Sand, light-gray; Same as 110-118-foot interval with slight increase in percentage of gravel.

Upper Cretaceous—deposits

124-133 Sand, yellow; 70 percent coarse to medium-grained subrounded to subangular quartz sand. 15 percent yellow clay matrix, unconsolidated. 10 percent dark-green medium-grained glauconite. 5 percent fine rounded gravel. Coarse broken shell fragments prominent. Trace of coarse mica flakes.

133-147 Clay and sand, light-gray; 35 percent medium to very fine-grained subangular to angular poorly-sorted quartz sand. 65 percent gray clay matrix, unconsolidated but very compact. Dark-green medium to fine-grained glauconite prominent.

147-160 Sand and clay, mottled-pink; 60 percent medium to fine-grained angular quartz sand. 25 percent mottled-pink to yellow clay matrix, unconsolidated but very compact. 15 percent coarse blocky calcic feldspar grains. Trace of coarse abraded shell fragments fine gravel and dark-green glauconite.

160-203 Sand, gray; 85 percent very coarse to medium-grained subangular quartz sand. 5 percent gray clay matrix, unconsolidated. 10 percent coarse blocky calcic feldspar grains.

203-228 Sand, pink; 65 percent very coarse to medium-grained subangular quartz sand. 20 percent pink clay matrix, unconsolidated but compact. 15 percent coarse blocky calcic feldspar grains. Trace of dark-green fine-grained glauconite and hematite aggregates.

228-239 Sand, pink; Same as 203-228-foot interval, but with medium-grained quartz sand predominant.

239-245 Sand, pink; Same as 228-239-foot interval.

Remarks: No microfossils were recovered from the intervals sampled in this well. Correlation is based on stratigraphic position and lithologic similarity to downdip sections which carry a diagnostic fauna. The interval designated Upper Cretaceous in this well is thought to represent a marginal deltaic deposit of the Peedee formation.

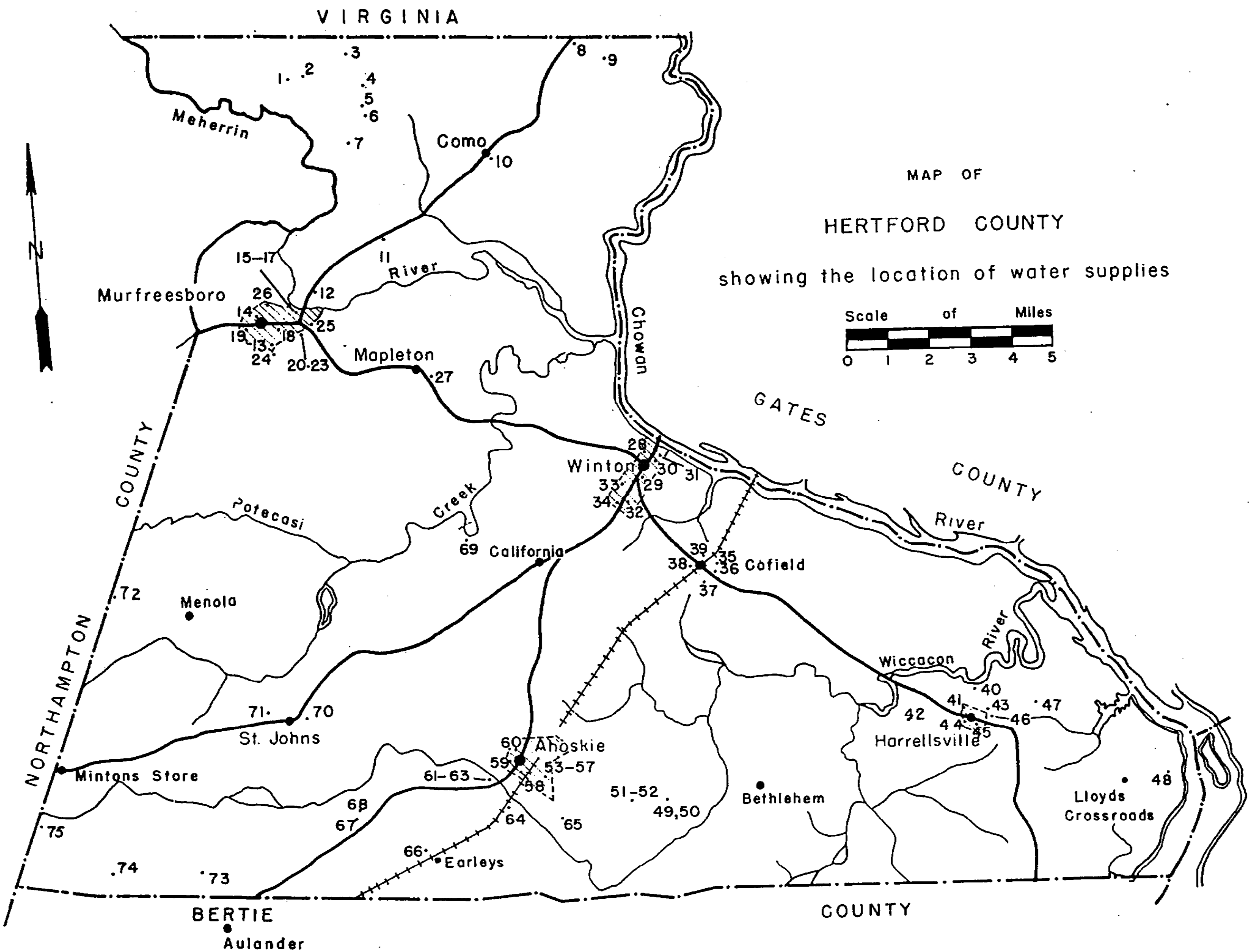

MAP OF
HERTFORD COUNTY
showing the location of water supplies
Scale of Miles
0 1 2 3 4 5
VIRGINIA
GATES COUNTY
NORTHAMPTON COUNTY
BERTIE COUNTY
Meherrin River
Chowan River
Potecasi Creek
Wiccacon River
Murfreesboro
Como
Mapleton
Winton
California
Cofield
Menola
St. Johns
Mintons Store
Ahoskie
Earleys
Bethlehem
Harrellsville
Lloyds Crossroads
Aulander
N

FIGURE 10.

TABLE 12. Records of Wells in Hertford County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
1	5 miles NW of Como	E. W. Evans	Open-end	100	3	100	Sand	Flows			Analysis. Temperature 61°F.
2	do	do	Screen	127	4-2	127	do				Analysis. Temperature 61°F.
3	4 miles NW of Como	Mrs. A. J. Bryant	do	150	2	150	do				Temperature 62°F.
4	3¼ miles NW of Como	Cyrus D. Howell	do	120	4-2	120	do				Analysis.
5	do	Mrs. W. L. Britt	do	117	4	117	do				Analysis.
6	do	do	Dug	28	36	24	Blue Clay				
7	3¼ miles W of Como	Mrs. Zola Drake	Screen	140	4-2	140	Sand				Analysis.
8	3¼ miles NE of Como	J. H. Stephenson	Dug	40	48	30	do				
9	3½ miles NE of Como	do	Open-end	110	1¼	110	do	+3.8			Water level measured, 1956.
10	Como	Jones and Raynor	do	175	4	175	do				
11	4 miles NE of Murfreesboro	Hotel Court	Screen	126	2	126	do	—0.5			Water level measured, 1956
12	1½ miles NE of Murfreesboro	State Highway Dept.	do	120	2	120	do	+10.3			Analysis, Water level measured, 1956.
13	Murfreesboro	Town of Murfreesboro	Gravel-wall	432	12	432	Sand and Gravel	—65.4	1000	67	Analysis. Public supply. Temperature 63°F.
14	Murfreesboro	Town of Murfreesboro	Gravel-wall	320	8	320	Sand				Analysis. Public supply Temperature 63°F.
15	do	do	Open-end	228	3	228	do	Flows			
16	do	do	do	228	3	228	do	do			
17	do	do	do	228	3	228	do	do			
18	do	do	do	115	3	115	Shell limestone	do			
19	do	O. L. A. Chitty	do	225	3	225	Sand	do	28		Flow measured.
20	do	M. E. Worrell	do	228	2	228	Gravel	do	16		Flow measured.
21	do	do	do	228	2	228	do	do			
22	do	do	do	228	2	228	do	do			
23	do	do	do	228	2	228	do	do			
24	do	V. T. Underwood	Screen	99	4	93	Sand				
25	do	Hertford County Board of Education	do	170	4	165	do				
26	do	Mrs. H. Carier	Dug	20	36		Clay				
27	¼ mile SE of Mapleton	E. Dixon	do	15.1	36		do				
28	Winton	Town of Winton	Gravel-wall	415	24.8	415	Sand				Analysis. Public supply
29	do	do	do	260	28.8	260	do				Abandoned.
30	do	do	do	314	28.8	314	do				Abandoned.
31	do	do	do	180	6	180	do				Analysis.
32	do	Hertford County Board of Education	Screen				do				
33	Winton	Rufus Reynolds	Dug	34	48		Sand and Clay				
34	do	C. L. Everett	do	36	36	36	do				
35	Cofield	A. B. Bazemore	Screen	151	4.2	151	Sand				Temperature 63°F.
36	Cofield	Mr. Delaware	do	195	4.2	195	do				
37	do	W. E. Perry	do	160	4	149	do	—26			Water level reported by driller, 1944.
38	do	Bazemore Bros.	do	152	4	152	do	—17			do
39	do	Tom Bazemore	do	134	4	118	do				
40	½ mile N of Harrellsville	N. C. State Highway Dept.	Dug	12	36	10	Clay				Analysis.
41	Harrellsville	D. N. Evans	Screen	260	4.2	260	Sand	—36			Water level reported by driller, 1953.
42	1½ miles W of Harrellsville	D. N. Evans and Son	do	296	4.2	296	do	—34			do
43	Harrellsville	J. S. Windborn	do	288	4.2	288	do	—35			do
44	do	A. C. Rountree	do	230	4	202	do	—40			Water level reported by driller, 1944.
45	do	Harrellsville Lumber Co.	do	166	6	162	do	—5			Water level reported by driller, 1944.
46	½ mile E. of Harrellsville	Bud Gillam	do	257	4-2	257	do	—44			Water level reported by driller, 1954.
47	1½ miles E of Harrellsville	R. C. Mason	do	312	4-2	312	do				Analysis.
48	5 miles WSW of Harrellsville	W. H. Basnight	do	255	4	244	do				
49	2½ miles W of Bethlehem	R. F. Wiggins	Screen	182	4-2	182	Sand				
50	do	do	do				do				
51	3½ miles W of Bethlehem	Willard Earley	do	171	4-2	171	Gravel				
52	do	do	do		4-2		do				
53	Ahoskie	Barrow Mfg. Co.	do	68	6	65	Sand				
54	do	H. Sherman Boone	do	250	4	223	do				
55	do	J. Roy Parker	do	54	4	52	Sand	—20			Water level reported by driller, 1944.

TABLE 12. Records of Wells in Hertford County—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
56	Ahoskie	W. H. Basnight	Screen	151	4	145	Sand	—26			Water level reported by driller, 1944
57	do	Ahoskie Ice Co.	do	170	8	170	do	—25	60		do
58	do	Town of Ahoskie	Gravel-wall	265	38–13	265	do	—26	325	80	Analysis. Public supply. Water level reported by driller, 1927.
59	do	do	do	265	18	265	do				Analysis. Public supply.
60	do	do	do	202	8	202	do	—37	330		Analysis. Public supply. Water level reported by driller, 1950.
61	do	Lewis Barbecoe	Screen	128	4–2	138	do	—13			Water level reported by driller, 1950.
62	do	Mrs. A. E. Lewis	Screen	183	2	183	do	—21.37			Water level measured, 1957.
63	do	do	do				do				
64	½ mile S of Ahoskie	Dick Foreman	do	157	3	157	do	—15			Water level reported by driller, 1949
65	2 miles SE of Ahoskie	State Highway Patrol	Open-end	42	1¼	42	do				Analysis.
66	Earley	Bertrane Earley	Screen	371	4–2	371	do				Analysis.
67	2 miles NW of Earley	Mrs. Winburne	Open-end	119	1¼	119	do	—30.7			Water level measured, 1957.
68	do	do	Screen	131	2	131	do				
69	2 miles WNW of California	Beechwood Country Club	do	326	4–2	326	do	Flows			Temperature 61°F.
70	St. Johns	Emma Parker	do	151	4–2	151	do	—19			Water level reported by driller, 1952
71	½ mile W of St. Johns	C. Vaughn	do	166	4–2	166	do	—16			Water level reported by driller, 1953.
72	2 miles WNW of Menola	Walter Burkett	do	155	3	155	Sand	—20			Analysis. Water level reported by driller, 1947.
73	5 miles SE of Mintons Store	H. C. Futrell	do	180	4–2	180	do				Analysis.
74	3¼ miles SE of Mintons Store	H. Hauls	do	152	4–2	152	do				Analysis.
75	1½ miles SSW of Mintons Store	L. T. Odom	Open-end	219	2	219	do				Abandoned.

TABLE 13. Chemical Analyses of Ground Water from Hertford County
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	1	2	4	5	7	12
Silica (SiO_2)		20	29			33
Iron (Fe), total						.19
Iron (Fe), in solution		.26	.30			.05
Calcium (Ca)		10	12			.9
Magnesium (Mg)		4.8	3.9			.5
Sodium and potassium (Na+K)		66	48			51
Bicarbonate (HCO_3)	204	223	182	239	230	128
Sulfate (SO_4)	3.8	3.1	2.1	.9	15	5.2
Chloride (Cl)	4.0	5.0	1.5	4.0	47	3.6
Fluoride (F)	.6	.6	.4	.2	1.4	.2
Nitrate (NO_3)	.6	.1	.3	1.3	.6	.1
Dissolved solids						158
Hardness as $CaCO_3$	38	46	47	107	26	4
pH	8.1	7.6	7.5	8.0	7.8	7.1
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	8-14-56	8-14-56	8-14-56	8-14-56	8-14-56	3-29-50

Analyzed by the Quality of Water Branch. U. S. Geological Survey.

TABLE 13. CHEMICAL ANALYSES OF GROUND WATER FROM HERTFORD COUNTY—*Continued*
(Numbers at heads of columns correspond to well numbers in table of well data)
(Parts per million)

	13	14	28	31	40	48
Silica (SiO_2)	15	30	12	13	23	----------
Iron (Fe), total	.17	----------	----------	----------	5.6	----------
Iron (Fe), in solution	.01	.42	.34	5.6	.03	----------
Calcium (Ca)	1.3	1.8	.8	3.1	160	----------
Magnesium (Mg)	.5	.8	.9	.9	2.0	----------
Sodium and potassium (Na+K)	74	70	145	143	23	----------
Bicarbonate (HCO_3)	164	183	271	278	451	379
Sulfate (SO_4)	8.6	4.1	1.3	13	10	.2
Chloride (Cl)	15	4.0	48	48	55	7.8
Fluoride (F)	.9	.3	1.3	1.3	.2	.2
Nitrate (NO_3)	.3	.4	.7	.5	.2	----------
Dissolved solids	202	201	369	370	506	----------
Hardness as $CaCO_3$	5	8	6	11	407	11
pH	8.1	7.4	8.2	8.1	6.9	7.5
Water-bearing material	Sand and gravel	Sand	Sand	Sand	Clay	Sand
Date of collection	3-12-54	5-1-48	12-28-48	12-28-48	6-22-49	3-31-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	58	59	60	65	66	72
Silica (SiO_2)	33	32	33	27	13	32
Iron (Fe), total	----------	----------	.43	6.5	.88	----------
Iron (Fe), in solution	.23	.22	.02	.43	.05	.35
Calcium (Ca)	7.7	8.7	26	6.8	2.2	18
Magnesium (Mg)	5.9	6.7	9.5	1.7	2.0	4.9
Sodium and potassium (Na+K)	79	86	43	6	184	69
Bicarbonate (HCO_3)	247	268	225	70	381	230
Sulfate (SO_4)	3.5	5.2	3.2	9.8	73	4.4
Chloride (Cl)	5.2	6.2	6.0	5.2	14	4.5
Fluoride (F)	.4	.5	.2	.0	2.3	1.0
Nitrate (NO_3)	1.0	1.2	.4	.2	.2	.3
Dissolved solids	261	283	245	121	515	----------
Hardness as $CaCO_3$	43	49	104	63	14	66
pH	7.2	7.2	7.3	6.5	8.1	8.7
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	5-25-48	5-25-48	6-16-54	11-4-55	10-8-53	8-13-56

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	73	74
Silica (SiO_2)	----------	----------
Iron (Fe), total	----------	----------
Iron (Fe), in solution	----------	----------
Calcium (Ca)	----------	----------
Magnesium (Mg)	----------	----------
Sodium and potassium (Na+K)	----------	----------
Bicarbonate (HCO_3)	263	145
Sulfate (CO_4)	3.5	2
Chloride (Cl)	7.5	6.8
Fluoride (F)	----------	----------
Nitrate (NO_3)	----------	----------
Dissolved solids	----------	----------
Hardness as $CaCO_3$	47	25
pH	8.4	7.1
Water-bearing material	Sand	Sand
Date of collection	9-20-55	12-54

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Martin County

(Area 481 square miles, population 27,938)

Martin County, elongated in an east-west direction, lies approximately in the geographical center of the Greenville area. The county is bounded by Pitt, Bertie, Washington, Beaufort, Edgecombe, and Halifax Counties. Williamston, the county seat and largest town in the county, is located on the banks of the Roanoke River, which forms the northern boundary of the county. Other population centers include Bear Grass, Hamilton, Jamesville, Oak City, and Robersonville.

The entire county is drained by the Roanoke River and several of its small tributaries. A high escarpment broken by numerous low swampy areas extends along the Roanoke River for most of its length.

The county is largely agricultural, tobacco being the chief crop. A large pulp mill and a chemical manufacturing plant are the major industries in the county.

Geology.—Surficial clay, sand, and gravel of Quaternary age occur as a thin layer over the entire county. Along the Roanoke River and its tributaries this material is as much as 40 feet thick; in the interstream areas it is rarely more than 15 feet thick.

The surficial deposits are underlain by the Yorktown formation of late Miocene age, which consists of blue clay, marl, and sand. The Yorktown formation is exposed intermittently along the Roanoke River, where the stream has cut down through overlying material, and is exposed in many shallow marl pits in the interstream areas. The formation is commonly less than 80 to 100 feet thick throughout the county.

The Castle Hayne limestone of Eocene age underlies the Yorktown formation in the eastern part of Martin County. Wells east of Jamesville and Smithwick obtain water from the Castle Hayne limestone formation which in this part of the Greenville area consists of a very hard shell-limestone. Wells at Williamston and Bear Grass do not encounter the formation, indicating that the formation pinches out along a line west of Jamesville and Smithwick. Total thickness of the formation in the county is unknown.

Glauconitic sands and shell beds of the Beaufort formation of Paleocene age underlie the eastern and central thirds of the county. The formation, confined to the subsurface, has not been recognized west of Williamston and Bear Grass. Total thickness of this unit in a well at Williamston was 27 feet, where the top of the unit was 59 feet below sea level. Its total thickness and its depth below sea level would be expected to increase in an easterly direction.

The Upper Cretaceous Pedee and Black Creek formations, composed of dark-colored lenticular sands and clays, underlie the central and eastern sections of Martin County. The western extent of these formations has not been determined. It is probable that marine sediments of these two formations interfinger with deltaic sediments of comparable age in the western part of the county. The Peedee formation at Williamston is 129 feet thick and the top of the formation is 86 feet below sea level. The Black Creek formation is 259 feet thick at Williamston.

The basal Upper Cretaceous unit, the Tuscaloosa formation, underlies the Peedee and Black Creek formations in the eastern and central parts of Martin County. In western Martin County this formation lies unconformably beneath Paleocene and Miocene sediments. The Tuscaloosa formation, composed of light-colored lenticular clays and arkosic sands, lies within 40 to 50 feet of the land surface in the western part of the county and is buried progressively deeper in an easterly direction. Estimated thickness of the formation in the eastern part of the county is about 400 feet.

Sediments of Early Cretaceous age probably underlie the Tuscaloosa formation in the eastern and central parts of Martin County, whereas in the western part of the county the formation is underlain by crystalline rocks.

Ground water.—All public and private water supplies in Martin County are obtained from wells. Martin County is favorably situated as to ground-water supply. Several millions of gallons per day of ground water may be obtained at any one place in the county. Larg-diameter gravel-wall wells will yield as much as 1,000 gpm in most localities.

Surficial sands and gravels of Quaternary age and near-surface sand and shell beds of the Yorktown formation yield 2 to 10 gpm. Rural supplies in the county are obtained largely from dug or driven wells that tap the aquifers of Miocene or Quaternary age.

Small-diameter jetted wells in eastern and central Martin County draw water from sand lenses and shell beds of Miocene age, limestone of Eocene age, and greensand of Paleocene age at depths ranging from 60 to 200 feet. These wells, either open-end or single-screen, yield as much as 50 gpm. Jetted wells in western Martin County obtain water from sand lenses and shell beds of Miocene age and from sands of Cretaceous age. These wells, generally less than 400 feet deep, yield from 10 to 300 gpm.

Large-diameter gravel-wall wells 300 to 500 feet deep obtain water from lenticular sands of Paleocene and Cretaceous age. They yield as much as 700 gpm, and their specific capacities generally range from 4 to 10 gpm per foot of drawdown.

All water-bearing strata beneath the surficial deposits are artesian. Water levels in wells penetrating these strata are generally within 30 to 40 feet of the land surface throughout the county. Artesian flows are common along the lowlands bordering the Roanoke River and its tributaries.

The chemical quality of the ground water in Martin County is not uniform. Surficial sands and gravels yield water that is slightly corrosive and that contains objectionable amounts of iron. Shell beds and limestones of the deeper formations yield water of objectionable hardness. Generally, the sand beds throughout the county at depths greater than 50 feet yield water adequate for most domestic purposes, the waters becoming softer with depth at any one location owing to the base exchange process.

The following log describes the physical composition of some of the principal aquifers in Martin County. (See figure 11 for location).

Martin County

Well Number 49

Location: Williamston, North Carolina, corner of Pearl and Church Streets
Owner: Town of Williamston
Date drilled: 1957
Driller: Heater Well Co.
Elevation of well: 63.5 feet above sea level

Hydrologic Information

Diameter of well: 12 inches
Depth of well: 702 feet
Cased to: 470 feet, cemented off below 470 feet
Finish: Gravel wall and screens
Static water level: 66.2 feet below land surface (1957)
Yield: 700 gpm
Temperature: 62°F

Log of Well

Depth (feet)

Quaternary—surficial sand and clay

0-2 No sample.

2-6 Sand, yellow; 85 percent very fine-grained angular quartz sand. 15 percent yellow clay and silt matrix, unconsolidated. No microfossils.

6-14 Sand, yellow; Same as 2-6-foot interval.

14-27 Clay and sand, gray; 45 percent very fine to fine-grained angular quartz sand. 55 percent gray clay matrix, unconsolidated. Fine-grained black opaques prominent. No microfossils.

Upper Miocene—Yorktown formation

27-37 Sand and clay, gray: 65 percent very fine to fine-grained angular quartz sand. 30 percent gray clay matrix, unconsolidated. 5 percent fresh broken shell fragments. Ostracoda and Foraminifera rare.

37-52 Clay and sand, gray: 40 percent fine to very fine-grained angular quartz sand. 60 percent gray clay matrix, unconsolidated. Trace of fresh broken shell fragments. Ostracoda and Foraminifera common.

52-68 Marl, blue-gray; 45 percent fine to medium-grained angular to subangular quartz sand. 35 percent gray clay matrix, unconsolidated. 20 percent fresh fragments. Black medium-grained phosphate spherules prominent. Trace of light-green glauconite. Ostracoda and Foraminifera abundant.

68-77 Marl, blue-gray; Same as 52-68-foot interval. Ostracoda and Foraminifera abundant.

77-89 Clay, blue-gray; 20 percent very fine-grained angular quartz sand. 80 percent blue-gray clay matrix, unconsolidated but very compact. Trace of fresh broken shell fragments and light-green glauconite. Ostracoda and Foraminifera abundant.

89-102 Clay, blue-gray; Same as 77-89-foot interval. Ostracoda and Foraminifera abundant.

102-115 Marl, blue-gray; 20 percent fine-grained angular to subangular quartz sand. 55 percent blue-gray clay matrix, unconsolidated. 25 percent fresh shell fragments. Black phosphatic spherules prominent. Trace of dark-green glauconite. Ostracoda and Foraminifera common.

115-125 Marl, blue-gray; Same as 102-115-foot interval. Ostracoda and Foraminifera common.
Ostracoda from the 14-125-foot intervals include:
Trachyleberis triplistriata (Edwards)
Leguminocythereis whitei Swain
Actinocythereis mundorffi (Swain)
Actinocythereis exanthemata (Ulrich and Bassler)
Hemicythere schmidtae Malkin
Hemicythere conradi Howe and McGuirt
Hemicythere confragosa Edwards
Cytheromorpha warneri Howe and Spurgeon
Cytheromorpha curta Edwards
Loxoconcha purisubrhomboidea Edwards

Paleocene—Beaufort formation

125-137 Glauconitic sand, dark-green; 30 percent very fine to medium-grained angular quartz sand. 55 percent dark-green to black medium to fine-grained glauconite. 15 percent green clay matrix, unconsolidated. Trace of broken abraded shell fragments and mica flakes. Ostracoda and Foraminifera abundant.

137-152 Glauconitic sand, dark-green; Same as 125-137-foot interval. Ostracoda and Foraminifera abundant.
Ostracoda from the 125-152-foot intervals include:
Cytheridea (Clithrocytheridea) ruida Alexander
Trachyleberis midwayensis (Alexander)
Trachyleberis prestwichiana (Jones and Sherborn)
Trachyleberis spiniferrima (Jones and Sherborn)
Trachyleberis bassleri (Ulrich)
Actinocythereis siegristae (Schmidt)
Cytheromorpha scrobiculata Alexander
Loxoconcha corrugata Alexander

Upper Cretaceous—Peedee formation

152-169 Clay and sand, dark-green; 25 percent very fine to fine-grained angular quartz sand. 60 percent green to gray clay matrix, unconsolidated. 15 percent dark-green fine-grained glauconite. Broken and abraded shell fragments prominent. Trace of fine mica flakes. Ostracoda and Foraminifera abundant.

169-177 Sand and clay, dark-green; 50 percent very fine to coarse grained angular to subrounded quartz sand. 35 percent dark-green to gray waxy-clay matrix, unconsolidated but compact. 15 percent dark-green medium to fine-grained glauconite. Broken shell fragments prominent. Trace of fine mica flakes. Ostracoda and Foraminifera abundant.

177-190 Clay and sand, dark-green; 30 percent very fine to medium-grained angular to subangular quartz sand. 60 percent dark-green to gray waxy-clay matrix, unconsolidated but compact. 10 percent dark-green fine to medium-grained glauconite. Broken shell fragments prominent. Trace of mica flakes and marcasite aggregates. Ostracoda and Foraminifera abundant.

190-202 Clay and sand, dark-green; Same as 177-190-foot interval. Ostracoda and Foraminifera abundant.

202-214 Sand and clay, dark-green; 45 percent very fine to fine-grained angular quartz sand. 40 percent dark-green to gray clay matrix, unconsolidated. 15 percent dark-green fine-grained glauconite. Broken shell fragments and mica flakes prominent. Ostracoda and Foraminifera abundant.

214-227 Sand and clay, dark-green; Same as 202-214-foot interval with a slight increase in clay content. Ostracoda and Foraminifera abundant.

227-239 Sand and clay, dark-green; Same as 214-227-foot interval. Ostracoda and Foraminifera abundant.

239-252 Sand and clay, dark-green; Same as 214-227-foot interval. Ostracoda and Foraminifera abundant.

252-264 Sand and clay, dark-green; Same as 214-227-foot interval. Ostracoda and Foraminifera common.

264-275 Sand and clay, dark-green; Same as 214-227-foot interval. Ostracoda and Foraminifera rare.

275-281 Sand and clay, dark-green; Same as 214-227-foot interval. Ostracoda and Foraminifera rare.

Ostracoda from the 152-281-foot interval include:

Cytherella herricki Brown
Cytherelloidea sohni Brown
Cytheridea (Haplocytheridea) monmouthensis (Berry)
Cytheridea (Haplocytheridea) councilli Brown
Brachycythere rhomboidalis (Berry)
Velarocythere arachoides (Berry)
Velarocythere cacumenata Brown
Trachyleberis pidgeoni (Berry)
Loxoconcha neusensis Brown
Eucytherura curta (Jennings)

Upper Cretaceous—Black Creek formation (lower member)

281-297 Sand, gray; 90 percent fine to medium-grained angular to subangular quartz sand. 10 percent gray clay matrix, unconsolidated. Trace of black lignitized wood fragments mica flakes and dark-green glauconite. Ostracoda and Foraminifera rare.

297-302 Sand and clay, dark-gray; 65 percent fine-grained angular quartz sand. 25 percent gray clay matrix, unconsolidated. 10 percent dark-green fine-grained glauconite. Black lignitized wood fragments and mica flakes prominent. Trace of broken abraded shell fragments. Ostracoda and Foraminifera rare.

302-314 Sand and clay, dak-gray; Same as 297-302-foot interval. Ostracoda and Foraminifera rare.

314-327 Clay and sand, gray; 40 percent fine to very fine-grained angular quartz sand. 55 percent gray clay matrix, unconsolidated. 5 percent very fine-grained dark-green glauconite. Trace of black lignitized wood fragments. Ostracoda and Foraminifera rare.

327-342 Clay and sand, brown; 35 percent fine to medium-grained angular to subangular quartz sand. 65 percent brown clay matrix, unconsolidated but very compact. Trace of mica flakes. No microfossils.

342-352 Sand, light-gray; 85 percent fine-grained angular quartz sand. 15 percent light-gray clay matrix, unconsolidated. Trace of light-green glauconite. No microfossils.

352-366 Sand and clay, brown; 60 percent very fine to fine-grained angular quartz sand. 40 percent brown micaceous clay matrix, unconsolidated but very compact. Black lignitized wood fragments prominent. Trace of red hematite aggregates, pyrite aggregates and dark-green glauconite. No microfossils.

366-371 Sand and clay, brown; Same as 352-366-foot interval. No microfossils.

371-379 Sand, white; 95 percent medium-grained subangular to subrounded quartz sand. 5 percent gray clay matrix, unconsolidated. Trace of dark-green glauconite and mica flakes. No microfossils.

379-394 Sand and silt, light-gray; 70 percent fine to coarse grained angular to subrounded quartz sand. 30 percent light-gray silt matrix with some clay, unconsolidated. Trace of dark-green glauconite and broken shell fragments. Ostracoda and Foraminifera very rare.

394-402 Sand, light-gray; 90 percent very fine to medium-grained, angular to subangular quartz sand. 10 percent gray clay and silt matrix, unconsolidated but compact. Fine mica flakes prominent. Trace of dark-green glauconite and pyrite aggregates. Ostracoda and Foraminifera rare.

402-410 Sand and clay, brown; 70 percent very fine to medium-grained angular to subrounded quartz sand. 30 percent brown silty clay matrix, unconsolidated. Mica flakes and black litgnitized wood fragments prominent. Trace of red hematite aggregates, light-green glauconite and pyrite aggregates. No microfossils.

410-427 Sand, light-gray; 85 percent medium-grained subangular to subrounded quartz sand. 15 percent gray silt and clay matrix, unconsolidated. Trace of black lignitized wood fragments. No microfossils.

427-442 Sand, light-gray; Same as 410-427-foot interval. No microfossils.

442-448 Sand and clay, gray; 55 percent coarse to fine-grained subrounded to angular quartz sand. 45 percent gray silty-clay matrix, unconsolidated but compact. Red hematite aggregates and dark-green glauconite prominent. Trace of mica flakes, black lignitized wood fragments and pyrite aggregates. Ostracoda and Foraminifera rare.

448-462 Sand, gray; 90 percent coarse to medium-grained subrounded to subangular quartz sand. 10 percent gray clay matrix, unconsolidated. Trace of light-green glauconite and pyrite aggregates. No microfossils.

462-473 Sand and silt, gray to yellow. 60 percent coarse to fine-grained subrounded to angular quartz sand. 40 percent gray to mottled-yellow silt matrix, unconsolidated. Dark-green glauconite, mica flakes and shell fragments prominent. Limonitic staining of quartz and matrix common. Ostracoda and Foraminifera common.

473-487 Sand, gray; 80 percent medium to fine-grained subrounded to subangular quartz sand. 20 percent gray silt matrix, unconsolidated. Dark-green medium-grained glauconite prominent. Trace of coarse broken shell fragments and pyrite aggregates. Ostracoda and Foraminifera very rare.

487-497 No sample.

497-511 Sand, gray; 85 percent medium to fine-grained subangular quartz sand. 15 percent gray silt and clay matrix, unconsolidated. Trace of fine mica flakes and broken shell fragments. No microfossils.

511-515 Sand and silt, gray; 65 percent fine to medium-grained angular to subangular quartz sand. 35 percent gray micaceous clay matrix, unconsolidated. Trace of dark-green glauconite, pyrite aggregates, and broken shell fragments. No microfossils.

515-525 Sand and silt, gray; Same as 511-515-foot interval. No microfossils.

525-537 Sand and silt, dark-gray; 60 percent fine to medium-grained subangular quartz sand. 50 percent dark gray silt matrix, unconsolidated but compact. Mica flakes and broken shell fragments prominent. Trace of black lignitized wood fragments. Ostracoda and Foraminifera rare.

537-552 No sample.

552-562 Sand, gray; 95 percent medium-grained angular to subangular quartz sand.. 5 percent gray clay matrix, unconsolidated. Trace of black lignitized wood fragments. Ostrcaoda and Foraminifera rare.

562-573 Sand, gray; Same as 552-562-foot interval. Ostracoda and Foraminifera rare.

Ostracoda from the 281-573-foot intervals include:

Cytheridea (Haplocytheridea) monmouthensis Berry
Cytheridea (Haplocytheridea) berryi Swain
Brachycythere ledaforma (Israelsky)
Brachycythere sphenoides (Reuss)
Brachycythere nausiformis Swain

Upper Creteaceous—Tuscaloosa formation

573-582 Sand and silt, brown to pink; 70 percent coarse to medium-grained subrounded to subangular feldspathic quartz sand. 30 percent brown to pink clay matrix, unconsolidated but compact. Soft chloritic-type mineral prominent. Trace of very fine-grained glauconite and mica flakes. Hematitic staining of interstitial material common.

582 590- Sand and silt, brown to pink; Same as 573-582-foot interval.

590-602 Sand and silt, brown to pink; 75 percent coarse to fine-grained subrounded to angular quartz sand. 25 percent reddish-brown silt matrix, unconsolidated but compact. Black lignitized wood fragments prominent. Traces of a soft chloritic-type mineral and drak-green fine-grained glauconite. Hematitic staining of interstitial material common.

602-605 Sand and silt, brown to pink; Same as 590-602-foot interval.

605-622 Sand and silt, gray; 75 percent fine to coarse grained angular to subangular feldspathic quartz sand. 25 percent brown micaceous silt matrix. Dark-green medium-grained glauconite and broken shell fragments prominent. Hematite and pyrite aggregates common.

622-639 Sand, gray; 85 percent medium to coarse grained angular to subrounded feldspathic quartz sand. 15 percent gray silt and clay matrix unconsolidated. Trace of hematite aggregates and dark-green glauconite.

639-652 Sand and clay, mottled pink to gray; 65 percent very coarse to medium-grained rounded to subangular feldspathic quartz sand. 35 percent pink to gray clay matrix, unconsolidated but compact. Hematite aggregates prominent. Trace of coarse mica flakes and abraded shell fragments.

652-662 Sand, gray to yellow; 90 percent coarse to medium grained, subrounded to angular, feldspathic quartz sand. 10 percent gray to yellow clay matrix, unconsolidated. Hematite staining of sand grains predominant. Hematite aggregates prominent. Trace of light-green very fine-grained glauconite.

662-682 Sand and clay, pink. 60 percent medium to very fine-grained subangular to angular feldspathic quartz sand. 40 percent red to pink micaceous clay matrix, unconsolidated but very compact. Hematite aggregates prominent. Trace of broken shell fragments and dark-green glauconite.

682-692 Sand and clay, pink; Same as 662-682-foot interval.

692-702 Sand, pink; 80 percent coarse to fine-grained subrounded to angular feldspathic quartz sand. 20 percent pink to red micaceous clay matrix, unconsolidated. Hematite staining of sand predominant. Trace of hematite aggregates and dark-green very fine-grained glauconite.

Remarks: No microfossils were recovered from the 573-702-foot interval. This interval is placed in the Upper Cretaceous Tuscaloosa formation on the basis of lithology and stratigraphic position.

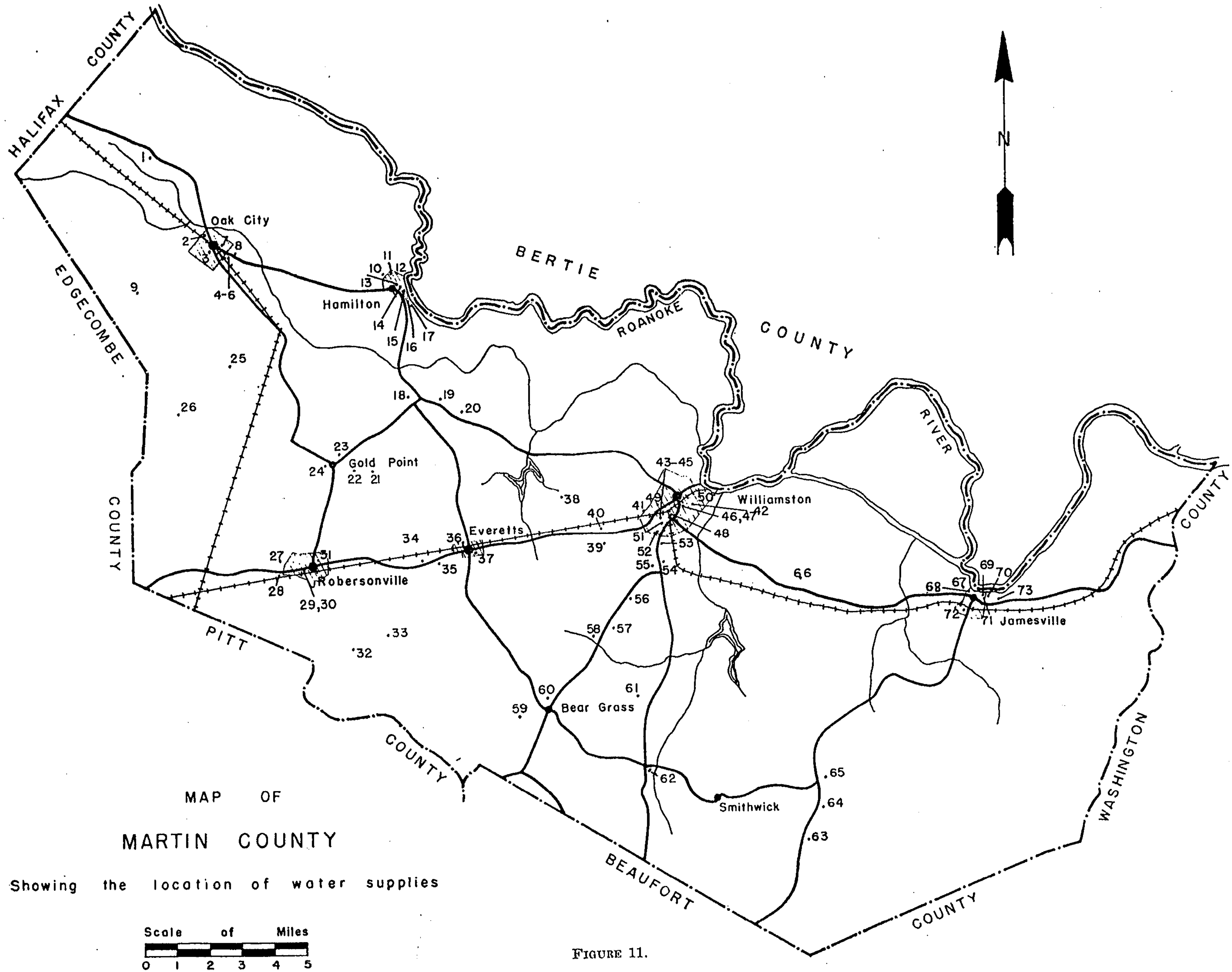

MAP OF
MARTIN COUNTY
Showing the location of water supplies
Scale of Miles
0 1 2 3 4 5
N
HALIFAX COUNTY
EDGECOMBE COUNTY
PITT COUNTY
BEAUFORT COUNTY
WASHINGTON COUNTY
BERTIE COUNTY
ROANOKE RIVER
Oak City
Hamilton
Gold Point
Robersonville
Everetts
Williamston
Bear Grass
Smithwick
Jamesville

FIGURE 11.

TABLE 14. Records of Wells in Martin County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
1	3¼ miles NW of Oak City	Martin Co. Board of Education	Screen	119	4	115	Sand	--------	--------	--------	
2	Oak City	L. J. Davenport	do.	225	4	225	do.	--------	--------	--------	
3	do.	Wersley and Ayers	do.	100	5	100	do.	--------	--------	--------	
4	do.	Martin Co. Board of Education	do.	295	3	295	do.	--------	--------	--------	Analysis. Temperature 63°F.
5	do.	do.	do.	125	4	120	do.	--------	--------	--------	
6	do.	do.	do.	88	4	84	do.	--------	--------	--------	
7	do.	Town of Oak City	Gravel-wall	374	8	340	do.	—53.42	400	--------	Analysis. Public supply. Water level and yield measured.
8	do.	E. Hyman	Screen	100	4	100	do.	--------	--------	--------	
9	2¼ miles SW of Oak City	L. Ross	do.	100	4	100	do.	--------	--------	--------	
10	Hamilton	F. Everett	do.	218	4	218	do.	--------	--------	--------	
11	do.	Town of Hamilton	do.	180	6	180	do.	--------	--------	--------	
12	do.	do.	do.	135	5	135	do.	--------	--------	--------	
13	do.	do.	do.	150	2	140	Sand	--------	--------	--------	Analysis. Public supply Temperature 63°F.
14	do.	do.	Open-end	140	1¼	140	do.	--------	--------	--------	
15	Hamilton	Town of Hamilton	Screen	295	8	255	Sand	--------	300	--------	Analysis. Public Supply. Yield measured.
16	do.	G. Oglesby	do.	100	4	91	do.	--------	--------	--------	
17	do.	W. Beach	do.	150	4	145	do.	--------	--------	--------	
18	3 miles of Hamilton	Martin Co. Board of Education	do.	120	4	116	do.	--------	--------	--------	
19	3½ miles S of Hamilton	J. H. Lillard	Dug	29	36	10	Marl	—8.4	--------	--------	Water level reported by driller 1953.
20	4 miles SE of Hamilton	Taylor's Dairy	Point	75	1¼	75	Sand	--------	--------	--------	
21	2 miles E of Gold Point	L. Winslow	Open-end	65	1¼	65	Marl	Flows	--------	--------	
22	do.	do.	do.	68	4	54	do.	Flows	8	--------	Yield measured, 1956.
23	Gold Point	J. Everett	do.	60	2½	60	do.	Flows	--------	--------	
24	do.	E. Vandiford	do.	40	1¼	40	do.	Flows	--------	--------	
25	3½ miles S of Oak City	R. H. Salisbary	Screen	165	4	165	Sand	--------	--------	--------	
26	5 miles S of Oak City	W. Purvis	Point	15	1¼	15	Sand and Clay	--------	--------	--------	
27	1 mile W of Robersonville	C. D. Jenkins	Open-end	138	1¼	138	Sand	--------	--------	--------	Analysis.
28	do.	Grimes Dairy	do.	121	1¼	121	do.	Flows	--------	--------	Analysis.
29	Robersonville	Town of Robersonville	Screen	390	10-8	390	do.	--------	--------	--------	Analysis. Public supply. Temperature 64°F.
30	Robersonville	Town of Robersonville	Screen	390	10-8	390	Sand	--------	--------	--------	Analysis.
31	do.	Robersonville Coal & Ice Co.	do.	300	6	300	do.	--------	--------	--------	
32	2½ miles SE of Robersonville	S. Cherry	Dug	23	40	8	Sand and clay	—16.2	--------	--------	Water level measured.
33	do.	S. Everett	Open-end	185	1¼	185	Sand	Flows	--------	--------	Analysis.
34	1½ mile W. of Everetts	V. Bunton	do.	180	3	180	do.	Flows	--------	--------	Analysis.
35	1 mile W of Everetts	W. Ausbon	do.	236	4	123	do.	--------	--------	--------	
36	Everetts	Barnhill and Taylor	Screen	300	6	300	do.	--------	--------	--------	Analysis.
37	do.	Martin Co. Board of Education	do.	325	6	325	do.	--------	--------	--------	
38	3¼ miles W of Williamston	do.	do.	112	4	108	do.	--------	--------	--------	
39	2½ miles SW of Williamston	Prison Camp No. 111	do.	165	6-2	165	do.	--------	--------	--------	Analysis.
40	2 miles W of Williamston	County Home	do.	300	6-4	300	Sand	--------	--------	--------	Analysis.
41	½ mile W of Williamston	Van Taylor	do.	280	4	272	do.	—35.0	--------	--------	Water level reported by driller, 1953.
42	Williamston	Town of Williamston	Gravel-wall	500	18-8	500	do.	--------	--------	--------	Analysis. Public supply. Not in use.
43	do.	do.	Screen	450	6	450	do.	--------	--------	--------	
44	do.	do.	do.	440	6	440	do.	--------	--------	--------	
45	do.	do.	do.	440	6	440	do.	--------	--------	--------	
46	Williamston	Town of Williamston	Gravel-wall	360	20-8	360	Sand	--------	--------	--------	Analysis. Public supply.
47	do.	do.	do.	360	20-8	360	do.	--------	--------	--------	
48	do.	do.	do.	460	8	460	do.	--------	450	--------	Yield measured.
49	do.	do.	do.	470	12	470	do.	--------	700	70	Yield and drawdown measured.
50	do.	Mathieson Chemical Co.	do.	440	6	440	do.	--------	--------	--------	
51	1 mile S of Williamston	Roanoke Country Club	Screen	420	4	420	do.	--------	--------	--------	
52	1 mile S of Williamston	Town and Country Restaurant	do.	410	4	410	do.	--------	--------	--------	
53	1½ miles S of Williamston	J. R. Everett	do.	200	4¼	200	do.	—37.54	--------	--------	Water level measured.

TABLE 14. RECORDS OF WELLS IN MARTIN COUNTY—*Continued*

Well no.	LOCATION	OWNER	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Drawdown (ft.)	REMARKS
54	1¾ miles S of Williamston	A. Boyce	Dug	14.4	36	10	Sand	−10.1			Water level measured.
55	2 miles S of Williamston	Martin Co. Board of Education	Screen	220	4	215	do	−20.0			Water level reported by driller, 1952.
56	3 miles S of Williamston	W. C. Corey	do	423	4–2	423	do	−29.0			Analysis. Water level measured.
57	4 miles S of Williamston	J. Hadley	do	196	4–2	196	do				Analysis.
58	do	H. Biggs	do	198	4–2	198	do	−34.46			Water level measured.
59	1 mile W of Williamston	G. Harrison	do	400	2½	400	do	−12.7			Water level measured.
60	Beargrass	Martin Co. Board of Education	Screen	235	4	235	Sand				Analysis.
61	2½ miles E of Beargrass	B. Harrison	do	311	4	311	do	−35			Water level reported by driller, 1954.
62	3¼ miles SE of Beargrass	H. Peale	Open-end	110	2	110	do	Flows			
63	3 miles E of Smithwick	J. J. Robinson	Point	20	2	20	Marl				
64	do	F. T. Hardison	Dug	26	36	18	do	−13.6			Water level measured, 1956.
65	do	M. Gurkin	Open-end	110	2	90	Limestone				Analysis.
66	5 miles E of Jamesville	Martin Co. Board of Education	Screen	130	4	128	Limestone				
67	Jamesville	H. J. Hardison	Open-end	127	1¼	127	do	Flows	15		Analysis. Flow measured 1956. Temperature 63°F.
68	do	do	do	130	3	130	do	Flows			Analysis. Flow measured 1956.
69	do	do	do	97	1¼	97	do	Flows			
70	do	C. C. Fleming	do	100	3	100	do	Flows	35		Flow measured 1956.
71	do	H. T. Hardison	do	140	1¼	140	do				
72	Jamesville	Jamesville School	Open-end	180	4–2	126	Limestone				Analysis.
73	3 miles E of Jamesville	W. Cherry	do	165	2	165	do				

TABLE 15. CHEMICAL ANALYSES OF GROUND WATER FROM MARTIN COUNTY—*Continued*
(Numbers at heads of columns correspond to well numbers in table of well wata)

(Parts per million)

	4	7	13	15	27	28
Silica (SiO_2)		37	28	28		
Iron (Fe), total		1.1	.35	.52		
Iron (Fe), in solution		.04	.11	.15		
Calcium (Ca)		28	9.6	4.9		
Magnesium (Mg)		9.0	4.4	4.7		
Sodium and potassium (Na+K)		33	99	98		
Bicarbonate (HCO_3)	279	211	305	296	252	258
Sulfate (SO_4)	1	.7	2.0	2.1	1	1
Chloride (Cl)	4	4.8	5.5	6.0	6	5
Fluoride (F)	.3	.2	.5	.5	.3	.3
Nitrate (NO_3)		.0	1.2	1.2		
Dissolved solids		211	302	292		
Hardness as $CaCO_3$	111	106	42	37	130	147
pH		7.3	7.8	7.3		
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	11-29-43	11-19-56	11-20 56	11-19-56	11-22-43	11-22-43

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

TABLE 15. CHEMICAL ANALYSES OF GROUND WATER FROM MARTIN COUNTY
(Numbers at heads of columns correspond to well numbers in table of well wata)

(Parts per million)

	29	30	33	34	36	39
Silica (SiO_2)	24	22	----------	----------	----------	10
Iron (Fe), total	.13	.39	----------	----------	----------	.13
Iron (Fe), in solution	.05	----------	----------	----------	----------	.03
Calcium (Ca)	1.3	2.0	----------	----------	----------	8.8
Magnesium (Mg)	.5	3.7	----------	----------	----------	8.2
Sodium and potassium (Na+K)	164	386	----------	----------	----------	125
Bicarbonate (HCO_3)	404	444	370	318	358	387
Sulfate (SO_4)	7.8	156	4	2	30	.9
Chloride (Cl)	18	235	3	2	7	3.2
Fluoride (F)	1.1	.9	1.6	.7	2.8	.9
Nitrate (NO_3)	.1	.2	----------	----------	----------	2.4
Dissolved solids	422	1047	----------	----------	----------	356
Hardness as $CaCO_3$	6	20	18	15	16	56
pH	7.9	7.8	----------	----------	----------	7.8
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	9-26-55	2-16-48	11-24-43	11-24-43	11-22-43	----------

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	40	42	46	56	57	60
Silica (SiO_2)	----------	17	10	14	16	----------
Iron (Fe), total	----------	.50	.07	.53	.26	----------
Iron (Fe), in solution	----------	----------	----------	.34	.00	----------
Calcium (Ca)	----------	1.8	1.1	1.4	24	----------
Magnesium (Mg)	----------	2.7	1.2	1.0	17	----------
Sodium and potassium (Na+K)	----------	326	153	225	67	----------
Bicarbonate (HCO_3)	387	368	365	392	324	275
Sulfate (SO_4)	2	63	4.8	30	.5	1
Chloride (Cl)	3	250	7.5	99	4.8	3
Fluoride (F)	.9	1.5	2.0	1.7	.4	.5
Nitrate (NO_3)	----------	1.2	1.2	.0	3.1	----------
Dissolved solids	----------	872	386	582	299	----------
Hardness as $CaCO_3$	22	16	8	8	127	150
pH	----------	7.9	8.2	7.9	7.4	----------
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	11-24-43	10-15-47	10-15-47	3-9-54	2-17-55	11-22-43

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	65	67	69	72		
Silica (SiO_2)	----------	32	----------	----------		
Iron (Fe), total	----------	.54	0.56	----------		
Iron (Fe), in solution	----------	.02	----------	----------		
Calcium (Ca)	----------	67	----------	----------		
Magnesium (Mg)	----------	8.8	----------	----------		
Sodium and potassium (Na+K)	----------	13	----------	----------		
Bicarbonate (HCO_3)	288	265	258	255		
Sulfate (SO_4)	2	2.4	2	2		
Chloride (Cl)	6	7.5	6	6.0		
Fluoride (F)	.2	.1	.2	----------		
Nitrate (NO_3)	----------	.4	----------	----------		
Dissolved solids	----------	270	----------	----------		
Hardness as $CaCO_3$	201	203	171	186		
pH	----------	7.0	----------	7.4		
Water-bearing material	Limestone	Limestone	Limestone	Limestone		
Date of collection	11-29-43	9-23-53	11-29-43	----------		

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

Pitt County

(Area 656 square miles, population 63,789)

Pitt County is a roughly rectangular area that lies in the south-central section of the Greenville area. It is bounded by Edgecombe, Martin, Beaufort, Craven, Greene, and Lenoir Counties. Greenville, the county seat, is the largest town in the county as well as in the area of investigation. Other population centers in the county include Ayden, Bethel, Falkland, Farmville, Grifton, and Grimesland.

The central and northern parts of the county are drained by the Tar River and its tributaries. The southern part of the county is drained by Contentnea Creek, Little Contentnea Creek, and Swift Creek; all of which drain into the Neuse River. The county, chiefly agricultural, is the largest producer of tobacco in the State. Most industries are in and near Greenville.

Geology.—Surficial clays, sands, and gravels of Quaternary age occur as a thin layer of sediments over most of Pitt County. They overlie sediments of Miocene, Eocene, Paleocene, and Cretaceous age. Only in the major stream valleys and in artificial excavations are older formations exposed. The surficial deposits range in thickness from a few feet to as much as 25 feet. Their greatest thickness is in or adjacent to the present stream valleys and not in the interstream areas, suggesting a comparatively recent fluviatile origin, rather than a marine origin, for much of the material. Underlying the surficial deposits are blue clays and marls of the Yorktown formation of late Miocene age. This unit, like the overlying surficial material, overlies formations of Eocene, Paleocene, and Cretaceous age over large areas of the county. The Yorktown formation in Pitt County ranges from less than a foot to as much as 60 feet thick; the greatest thickness is recognized in the northeastern part of the county. In outcrop, thickness of less than a foot to as much as 15 feet have been recognized. Underlying the Yorktown formation are impure shell limestones and calcareous sands and calcareous clays of the Castle Hayne limestone of Eocene age. This formation at one time probably covered large segments of Pitt County but is now confined to the southern and eastern segments of the county. The Castle Hayne limestone is exposed in several marl pits in the southern part of the county near Quinerly and is penetrated sporadically in wells along the eastern county line as far west as Pactolus. Present information indicates that the formation is everywhere less than 30 feet thick in Pitt County.

The Beaufort formation of Paleocene age underlies the Castle Hayne limestone along the eastern edge of the county and underlies the Yorktown formation as far west as a line joining Shelmerdine, Simpson, and Stokes. The presence of the Beaufort formation in Pitt County is based entirely on microfaunal analysis of well cuttings. Total thickness of the formation in the county is no greater than 60 feet.

The Tertiary sediments in Pitt County are underlain by lenticular sands and clays that comprise the Peedee, Black Creek, and Tuscaloosa formations of Late Cretaceous age. These formations, the younger being deposited as regressive offlaps on the older, are exposed along Little Contentnea Creek and the Tar River. Typical exposures occur along Little Contentnea Creek, north of Scuffleton to the Wilson County line, and along the Tar River, north of Greenville to the Edgecombe County line. In the interstream areas the Cretaceous formations are not exposed, being covered by younger Miocene and Quaternary material. The combined thickness of the Upper Cretaceous sediments in a well at Greenville, the geographic center of the county, is 570 feet. The Upper Cretaceous sediments thicken southeastward from Greenville and thin toward the northwest.

Sediments of Early Cretaceous age were encountered beneath Upper Cretaceous strata in a well drilled for the city of Greenville. This well penetrated 146 feet of Lower Cretaceous clays and sands. The total thickness of this unit and its areal extent are unknown. It is probable that Lower Cretaceous sediments underlie most of Pitt County.

At Fountain, Pitt County, a granite monadnock of pre-Cretaceous age is exposed at the surface along the eastern edge of the town (Mundorff, 1947, p. 103). This body of granite is surrounded by sediments at least 400 feet thick, and is the only body of igneous or metamorphic rock known to crop out in the Greenville area.

Ground water.—Except for part of the municipal water supply for Greenville, all public and private water supplies in Pitt County are obtained from wells. Greenville's municipal supply, obtained from the Tar River for a number of years, is now being supplemented by ground water. Large ground-water supplies of several million gallons per day probably could be pumped from wells in any part of Pitt County. Deep gravel-wall wells in the county are capable of yielding 400 to 1,000 gpm, with specific capacities ranging from 4 to 10 gpm per foot of drawdown or better.

Quaternary sands and gravels, tapped by dug and driven wells, are the major source of water for the county. Occasionally these wells, which range in depth from 10 to 30 feet and yield from 1 to 20 gpm, obtain water from near-surface sand and shell beds of the Yorktown formation.

Small-diameter jetted wells obtain water from sands of Paleocene and Cretaceous age. These wells, either open-end or single-screen, have been drilled as deep as 400 feet in the county. Their yields range from 5 gpm to as much as 100 gpm.

The large municipal and industrial wells, as well as the larger irrigation wells, are usually gravel-wall wells with multiple screens. Depending on the location in the county, these wells obtain water from several sands in two or more of the Cretaceous aquifers and yield 400 to 1,000 gpm.

Water-table conditions prevail at shallow depths in all material from Cretaceous to Recent age throughout the county. The water table fluctuates seasonally in response to variation in the amount of precipitation and degree of evapotranspiration. The normal ground-water cycle observed over a period of several years indicates that water levels are at a peak in late winter and early spring, and at their lowest point in late summer and early fall. Even at its lowest seasonal point the water level generally is within 15 to 20 feet of the land surface throughout the county. Water in all material below a depth of about 50 feet is under artesian pressure and generally rises in wells to within 30 feet of the surface in interstream areas. Along the major streams and their tributaries the piezometric surface is very close to, or above, the land surface, and most of the wells tapping artesian aquifers flow at the land surface. At any given locality the pressure head increases with depth.

The chemical quality of water in the aquifers in Pitt County is not uniform. The shallow aquifers usually contain waters that is slightly corrosive and may contain objectionable amounts of iron, but is otherwise acceptable. The deep artesian water in the sands of Cretaceous age generally is soft and of the sodium bicarbonate type. The water from aquifers that contain beds of impure limestone is moderately hard but otherwise is of good quality. Water in the aquifer of Lower Cretaceous age is saline and unsuitable for domestic purposes.

The following well log describes the physical composition of the Cretaceous acquifers in Pitt County (see figure 12 for well location).

Pitt County

Location: Thirteenth and Washington Streets, Greenville, North Carolina.

Owner: City of Greenville

Date drilled: 1956

Driller: Heater Well Co.

Elevation of well: 59 feet above sea level

Hydrologic Information

The following log is given for the test well (number 26) that penetrated to a depth of 754 feet. The production well (number 27) was finished in the same hole to a depth of 460 feet.

Diameter of well: 12-10 inches
Depth of well: 460 feet
Cased to: 460 feet, plugged below 460 feet
Finish: Gravel wall and screens
Static (nonpumping) water level: 50 feet below land surface
Yield: 750 gpm with a drawdown of 132 feet, 1956
Temperature: 63°F

Log of Well

Depth (feet)

Quaternary—sand and clay

0-6 No sample.

6-9 Sand and clay, light-tan. 65 percent fine-grained subangular quartz sand. 35 percent tan clay matrix, unconsolidated. Trace of black opaques. No microfossils.

9-18 Clay and sand, mottled-yellow; 40 percent fine-grained angular qurtz sand. 60 percent mottled-yellow clay matrix, unconsolidated. Limonite staining of sand and matrix prominent. No microfossils.

Upper Miocene—Yorktown formation

18-28 Clay, gray; 15 percent fine-grained angular quartz sand. 85 percent gray clay matrix, unconsolidated but compact. Microfossils very rare.

28-38 Clay, gray; Same as 18-28-foot interval with the addition of fine mica flakes. Microfossils very rare. Microfossils from the 18-38-foot interval consist mostly of unidentified diatoms. The only ostracode recovered was
Actinocythereis mundorffi (Swain)

Upper Cretaceous—Peedee formation

38-53 Sand and clay, gray; 75 percent coarse to medium-grained rounded to subrounded quartz sand. 25 percent gray clay matrix, unconsolidated. Trace of black phosphate pebbles and gray shell fragments. Ostracoda and Foraminifera rare.

53-66 Sand and clay, gray; Same as 38-53-foot interval. Ostracoda and Foraminifera rare.

66-78 Sand, gray; 85 percent fine to coarse-grained angular to subrounded quartz sand. 15 percent gray clay matrix, unconsolidated. Trace of dark-green glauconite, black phosphate pebbles, and gray shell fragments. Ostracoda and Foraminifera rare.

78-91 Sand, gray; Same as 66-78-foot interval. Ostracoda and Foraminifera rare.

91-101 Sand, gray; Same as 66-78-foot interval. Ostracoda from the 38-101-foot interval include:
Brachycythere rhomboidalis (Berry)
Velarocythere cacumenata Brown
Velarocythere arachoides (Berry)
Trachyleberis communis (Israelsky)
Trachyleberis pidgeoni (Berry

Upper Cretaceous—Black Creek formation
(Snow Hill marl member)

101-116 Clay and sand, black; 25 percent very fine to fine-grained angular quartz sand. 75 percent black micaceous clay matrix, unconsolidated but very compact. Trace of glauconite marcasite aggregates, black lignitized wood fragments and white chalky shell fragments. Ostracoda and Foraminifera common. *Inoceramus* prisms.

116-128 Clay and sand, black; Same as 101-116-foot interval. Ostracoda and Foraminifera common. *Inoceramus* prisms.

128-139 Clay and sand, black; Same as 101-116-foot interval with a slight increase in glauconite content. Ostracoda and Foraminifera common.

139-163 Sand and clay, dark-gray; 65 percent fine-grained angular to subrounded quartz sand. 30 percent gray to black silty-clay matrix, unconsolidated. 5 percent dark-green fine-grained glauconite. Trace of gray shell fragments marcasite aggregates and black lignitized wood fragments. Ostracoda and Foraminifera common.

Ostracoda from the 101-153-foot interval include:
Cytheridea (Haplocytheridea) monmouthensis Berry
Trachyleberis gapensis (Alexander)
Brachycythere ledaforma (Israelsky
Cytheropteron pendercnsis Brown
Orthonotocythere sulcata Brown
Protocythere paratriplicata Swain

Upper Cretaceous—Black Creek formation (lower member)

163-178 Sand, light-gray; 85 percent coarse to medium-grained subrounded to subangular quartz sand. 15 percent gray clay matrix, unconsolidated. Trace of glauconite and black lignitized wood fragments. Ostracoda and Foraminifera rare.

178-187 Sand, gray; Same as 163-178-foot interval. Ostracoda and Foraminifera rare.

187-200 Sand and clay, gray; 60 percent very fine to fine-grained angular quartz sand. 40 percent gray clay matrix, unconsolidated but very compact. Dark-green fine-grained glauconite prominent. Trace of red hematite staining. Ostracoda and Foraminifera very rare.

200-212 Sand, gray; 80 percent medium to fine-grained subangular to angular quartz sand. 20 percent gray silt and clay matrix, unconsolidated. Mica flakes and dark-green glauconite prominent. Trace of red hematite aggregates. Ostracoda and Foraminifera rare.

212-222 Sand and clay, gray; 65 percent very fine to medium-grained angular quartz sand. 35 percent gray clay matrix, unconsolidated but compact. Trace of dark-green glauconite and black lignitized wood fragments. No microfossils.

222-241 Clay and sand, brown; 40 percent very fine to fine-grained angular quartz sand. 60 percent mottled-brown to gray clay matrix, unconsolidated. Dark-green glauconite and black lignitized wood fragments prominent. Trace of marcasite aggregates and mica flakes. Ostracoda and Foraminifera rare.

241-253 Sand and silt, tan; 65 percent fine-grained angular quartz sand. 30 percent tan silt matrix, unconsolidated. 5 percent light-green fine-grained glauconite. Trace of mica flakes. Ostracoda and Foraminifera very rare.

253-263 Sand, tan; 85 percent medium to fine-grained angular quartz sand. 15 percent tan clay matrix, unconsolidated. Trace of black lignitized wood fragments. No microfossils.

263-275 Sand and silt, brown; 70 percent fine to medium-grained angular to subangular quartz sand. 30 percent brown silt matrix, unconsolidated. Trace of marcasite and hematite aggregates. Ostracoda and Foraminifera rare.

275-278 Sand, light-gray; 85 percent very coarse to medium-grained subrounded to subangular quartz sand. 15 percent gray silt and clay matrix, unconsolidated. Trace of glauconite and black lignitized wood fragments. Ostracoda and Foraminifera rare.

278-295 Sand and clay, brown; 70 percent coarse to fine-grained subrounded to angular quartz sand. 30 percent brown clay matrix, unconsolidated. Trace of glauconite marcasite and hematite aggregates. No microfossils.

295-309 Sand, tan; 80 percent medium to fine-grained subangular to angular quartz sand. 20 percent tan silt and clay matrix, unconsolidated. Marcasite aggregates and black lignitized wood fragments prominent. Trace of light-green glauconite.

309-328 Sand and clay, tan; 65 percent coarse to fine-grained subrounded to angular quartz sand. 35 percent tan clay matrix, unconsolidated. Marcasite aggregates prominent. Trace of black, lignitized wood fragments. No microfossils.

328-338 Sand, tan; 90 percent coarse to medium-grained subrounded to subangular feldspathic quartz sand. 10 percent tan silt and clay matrix, unconsolidated. Trace of dark-green glauconite, shell fragments, and black lignitized wood. Ostracoda and Foraminifera very rare.

338-365 Sand, tan; Same as 328-338-foot interval. No microfossils.

365-377 Sand, tan; Same as 328-338-foot interval. No microfossils.

377-390 Sand and silt, tan; 70 percent medium to fine-grained angular quartz sand. 30 percent tan silt matrix, unconsolidated. Dark-green fine-grained glauconite prominent. Trace of chalky shell fragments black lignitized wood and mica flakes. Ostracoda and Foraminifera rare.

390-403 Sand and silt, tan; Same as 377-390-foot interval. Ostracoda and Foraminifera very rare.

403-423 Sand and silt, tan; Same as 377-390-foot interval. Ostracoda and Foraminifera very rare.

423-442 Sand, white; 95 percent very coarse to medium-grained rounded to subrounded quartz sand. 5 percent gray clay matrix, unconsolidated. Trace of marcasite aggregates. No microfossils.

Ostracoda from the 163-442-foot interval include:
Cytheridea (Haplocytheridea) monmouthensis Berry
Brachycythere cf. *B. nausiformis* Swain
Brachycythere sphenoides Reuss
Cythereis quadrialira Swain
Upper Cretaceous—Tuscaloosa formation

442-453 Sand and clay, pink to red; 70 percent coarse to medium-grained subangular feldspathic quartz sand. 30 percent red clay matrix, unconsolidated but very compact. Dark-red hematite aggregates prominent. Staining of quartz grains 80-90 percent. No microfossils.

453-463 Sand, pink; 85 percent medium to fine-grained subangular to angular quartz sand. 15 percent pink clay matrix, unconsolidated. Trace of coarse mica flakes hematite aggregates and dark-green very fine-grained glauconite. No microfossils.

463-478 Sand, pink; Same as 453-463-foot interval. No microfossils.

478-492 Sand, light-brown; 80 percent coarse to fine-grained angular and abraded feldspathic quartz sand. 20 percent brown silt and clay matrix, unconsolidated. Dark-green glauconite prominent. Trace of coarse mica flakes and hematite aggregates. No microfossils.

492-510 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

510-518 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

518-538 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

538-558 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

558-583 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

583-592 Sand, light-brown; Same as 478-492-foot interval. No microfossils.

592-608 Sand and clay, light-gray; 75 percent medium to fine-grained subangular feldspathic quartz sand. 25 percent gray clay matrix, unconsolidated but very compact. Dark-green glauconite mica flakes and hematite aggregates prominent. No microfossils.

Lower Cretaceous—undifferentiated

608-638 Sand, gray; 85 percent very coarse to medium-grained subrounded quartz sand. 10 percent gray clay matrix unconsolidated. 5 percent coarse blocky grains of green feldspar. Trace of marcasite aggregates and black lignitized wood fragments exhibiting partial filling and replacement by marcasite. Ostracoda rare.

638-650 Sand, gray; Same as 608-638-foot interval. Ostracoda rare.

650-662 Sand, gray; Same as 608-638-foot interval. Ostracoda rare.

662-685 Clay and sand, green; 40 percent very fine to fine-grained angular quartz sand. 60 percent green clay matrix, unconsolidated but very compact. Broken shell fragments and dark-green glauconite prominent. Trace of black lignitized wood fragments. Ostracoda abundant.

685-710 Clay and sand, green; Same as 662-685-foot interval. Ostracoda abundant.

710-735 Sand and clay, green; 70 percent fine to very-fine grained angular feldspathic quartz sand. 30 percent green clay matrix, unconsolidated to indurated in streaks. Broken shell fragments and dark-green glauconite prominent. Ostracoda abundant.

735-754 Sand and silt, reddish-brown; 70 percent coarse to fine-grained subangular feldspathic quartz sand. 30 percent reddish-brown silt and clay matrix, unconsolidated to indurated in streaks. Coarse broken shell fragments and dark-green glauconite prominent. Trace of hematite aggregates. Ostracoda common.

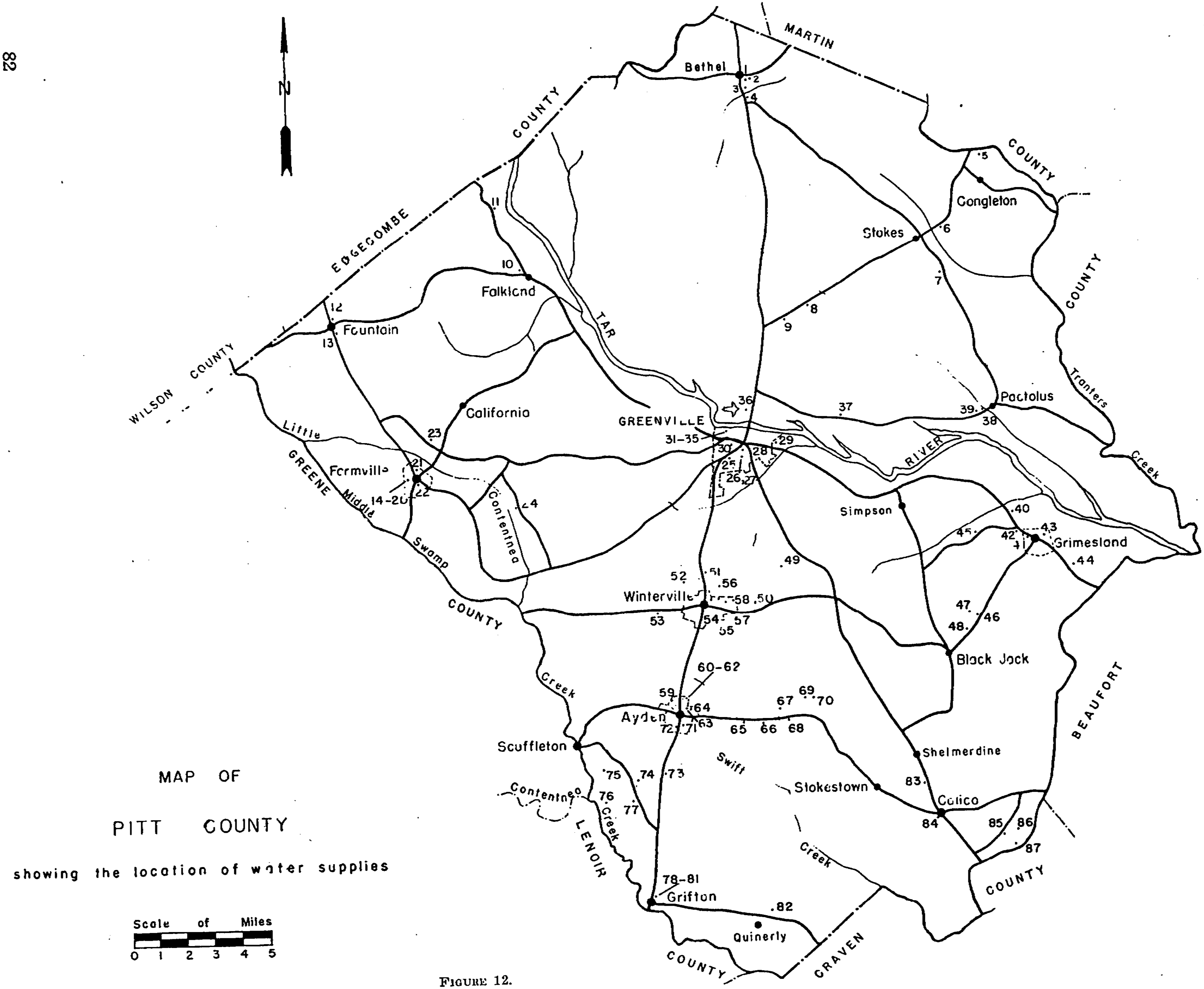

N
MAP OF
PITT COUNTY
showing the location of water supplies
Scale of Miles
0 1 2 3 4 5
MARTIN
COUNTY
EDGECOMBE
COUNTY
WILSON COUNTY
GREENE COUNTY
LENOIR COUNTY
CRAVEN
BEAUFORT
COUNTY
Bethel
Congleton
Stokes
Falkland
Fountain
California
GREENVILLE
Farmville
Pactolus
Simpson
Grimesland
Winterville
Black Jack
Ayden
Scuffleton
Shelmerdine
Stokestown
Calico
Grifton
Quinerly
TAR
RIVER
Tranters Creek
Little
Middle
Swamp
Contentnea
Creek
Swift
Creek

Figure 12.

TABLE 16. Records of Wells in Pitt County

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level ft.	Yield (gpm)	Draw-down (ft.)	Remarks
1	Bethel	Town of Bethel	Screen	445	8	445	Sand				Analysis. Public supply.
2	do	do	Gravel-wall	376	8	376	do				do
3	do	do	do	383	8	380	do				do
4	1 mile S of Bethel	J. Gurganus	Screen	192	4.5		do				
5	½ mile NE of Congleton	J. Taylor	Open-end	97	1¼	97	Marl	Flows			Temperature 61°F.
6	Stokes	M. Whichard	do	225	1¼	195	Sand	Flows			Analysis.
7	1½ miles SE of Stokes	H. Wooland	do	250	1¼	100	do				
8	5 miles NE of Greenville	Mrs. Brewer	do	200	2	200	do	Flows			Analysis.
9	do	J. W. Rawls	do	350	4	350	do				Analysis. Temperature 61°F.
10	Falkland	J. Morrill		180	4	180	do				
11	½ mile NW of Falkland	K. Wooden		195	1½	195	do				Temperature 61°F.
12	Fountain	Town of Fountain	Open-end	194	8	190	do				Analysis. Public supply.
13	½ mile S of Fountain	L. R. Bell	Dug	13	48		do				Dug in 1850 and still in use.
14	Farmville	Town of Farmville	Screen	480	10-8	480	do				Analysis. Public supply.
15	do	do	do	472	8	472	do				Public supply.
16	Farmville	do	do	503	18-8	503	Sand				Analysis. Public supply.
17	do	do		500	8	500	do				
18	do	do	Screen	435	8	435	do				
19	Farmville	Farmville Oil & Fertilizer Co.	Screen	140	4	140	Sand				
20	do	do	do	100	3	100	do				
21	do	A. C. Monk Co.	do	87	6	85	do				
22	do	E. W. May	do	57	4	53	do				
23	1¼ miles NNE of Farmville	W. Barrett	do	211	2	211	do				
24	3½ miles ESE of Farmville	L. B. Johnson	Gravel-wall	370	8	370	do				Used for irrigation only.
25	Greenville	Pepsi Cola Bottling Plant	do	373	10	373	do				Analysis.
26	do	City of Greenville	Test	637	8		do				Analysis, Drill stem test.
27	do	do	Gravel-wall	460	10	460	do				Public supply. Temperature 63°F.
28	do	American Tobacco Co.	Screen	71	4.5	66	do				
29	do	G. Honeycutt	do	100	4	86	do				
30	do	S. Crisp	do	92	4	73	do				
31	do	W. Hollowell	do	77	4	75	do				
32	do	B. Whitley	do	98	4	91	do				
33	do	C. Sheppard	do	100	4	87	do				
34	do	H. T. Brown	do	70	4	68	do				
35	do	J. Smith	do	98	4	96	do				
36	Greenville	Northside Lumber Co.	Screen	128	6	128	Sand	Flows			
37	2 miles NE of Greenville	H. Forbes	do	116	4	111	do				
38	Pactolus	C. Satherwaite	do	293	1¼	293	do	Flows			
39	Pactolus	Pitt County Board of Education	Screen	164	3	164	do				
40	1 mile NW of Grimesland	H. Edwards	do	60	4	55	do				
41	Grimesland	L. Edwards	do	190	6	190	do				
42	do	A. Hudson	do	125	4-2	125	do				
43	do	M. Griffin	Driven	17	1¼	17	Marl				
44	1½ miles SE of Grimesland	J. Winfield	Open-end	165	1¼	165	Sand				
45	2 miles W of Grimesland	J. L. Edwards	Screen	180	3	180	do	Flows			Analysis.
46	1½ miles NW of Black Jack	L. Buck	Open-end	93	2	93	do	Flows			
47	do	do	do	85	2	85	do	Flows			
48	do	do	do	320	4-1¼	320	do				
49	2 miles E of Winterville	Pitt County Home	Screen	45	2	45	do				
50	1 mile E of Winterville	G. Worthington	Open-end	65	1¼	65	do	Flows			
51	1¼ miles N of Winterville	D. Langston	Screen	378	12	378	do				Used for irrigation.
52	1 mile W of Winterville	W. Moye	do	86	4	84	do				
53	1½ miles W of Winterville	G. Dail	Screen	86	4	85	do				
54	Winterville	Town of Winterville	do	157	6	157	do				Analysis. Public supply. Temperature 63°F.
55	do	do	Gravel-wall	306	24-8	300	do				Analysis. Public supply.
56	Winterville	Winterville School	Screen	87	6	87	Sand				
57	do	J. E. Jones	do	87	6	83	do				
58	do	Mrs. J. Cox	do	112	4	105	do				
59	Ayden	Cory Stokes	do	51	4	51	do				

TABLE 16. Records of Wells in Pitt County—*Continued*

Well no.	Location	Owner	Type of Well	Depth (ft.)	Diameter (in.)	Depth of casing (ft.)	Water-bearing material	Water level (ft.)	Yield (gpm)	Draw-down (ft.)	Remarks
60	Ayden	Town of Ayden	Gravel-wall	152	8	152	Sand				Analysis. Public supply.
61	do	do	do	155	8	153	do				Public supply.
62	do	do	Screen	600	10-6	600	do				
63	do	do	Gravel-wall	436	8	395	do				Public supply.
64	do	do	do	505	10-8	500	do				Analysis. Public supply.
65	2 miles E of Ayden	J. H. Sutton	Screen	123	4	121	do				
66	2¼ miles E of Ayden	T. J. Cannon	do	57	6	52	do				
67	3 miles E of Ayden	R. Wilkerson	Open-end	110	1¼	110	do	Flows			
68	3¼ miles E of Ayden	R. L. Cox	Point	15	1¼	15	do				
69	4 miles E of Ayden	R. Harris	Screen	135	3	135	do				
70	do	do	Open-end	105	1¼	105	do				
71	¼ mile S of Ayden	Jenkins Motor Co.	Screen	165	2	165	do				Analysis.
72	½ mile S of Ayden	Fred Little	do	240	4-2	240	do				
73	2 miles S of Ayden	J. C. Jackson	do	134	4	83	do				
74	2½ miles SSW of Ayden	W. C. Gaspins	Screen	134	4	100	Sand				
75	3¼ miles SW of Ayden	J. Turnage	do	65	4	65	do				
76	4 miles SW of Ayden	J. B. Patrick	Dug	14	48	6	do				
77	do	L. Gaspins	Open-end	130	4	90	do				
78	Grifton	Town of Grifton	do	280	1¼	280	do	Flows	8.0		Yield measured, 1943. Public supply. Temperature 65°F
79	do	do	Screen	135	3	120	do				Public supply.
80	do	do	do	135	8-6	135	do				Analysis. Public supply.
81	do	do	Gravel-wall	150	8	135	do				
82	4¼ miles E of Grifton	J. Quinerly	Screen	137	1¼	137	Sand				
83	1½ miles E of Stokestown	A. Haddock	Open-end	57	1¼	57	do				
84	2 miles SE of Calico	O. James	Point	18	1¼	18	do				
85	2¼ miles ESE of Calico	R. Adams	Open-end	90	2	57	Marl				
86	do	F. Lancaster	do	60	2	50	do				
87	do	do	do	100	2	50	do				

TABLE 17. Chemical Analyses of Ground Water from Pitt County
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	1	2	3	6	8	9
Silica (SiO_2)	26	11	13		18	13
Iron (Fe), total	.18	.30	.38		.07	.02
Iron (Fe), in solution			.22		.00	.00
Calcium (Ca)	1.8	3.6	7.5		1.0	.4
Magnesium (Mg)	3.2	1.1	1.0		.8	.4
Sodium and potassium (Na+K)	301	13	13		88	118
Bicarbonate (HCO_3)	354	4	34	388	172	234
Sulfate (SO_4)	129	7.5	7.0	12	8.6	15
Chloride (Cl)	172	19	9.8	14	32	32
Fluoride (F)	1.3	.1	.1	1.1	.4	2.0
Nitrate (NO_3)	1.2	4.6	2.6		.3	.5
Dissolved solids	826	68	77		244	312
Hardness as $CaCO_3$	18	14	23	66	6	3
pH	7.8	5.4	7.7		7.4	8.1
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	4-28-47	7-11-49	4-29-53	11-17-43	2-17-55	2-17-55

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

TABLE 17. CHEMICAL ANALYSES OF GROUND WATER FROM PITT COUNTY—*Continued*
(Numbers at heads of columns correspond to well numbers in table of well data)

(Parts per million)

	12	14	16	25	26	45
Silica (SiO_2)	20	6.1	16	19	10	----------
Iron (Fe), total	.19	.20	.13	.13	.14	----------
Iron (Fe), in solution	----------	.11	.05	----------	.03	----------
Calcium (Ca)	36	1.2	2.0	2.3	3.0	----------
Magnesium (Mg)	6.8	.8	.2	.7	3.3	----------
Sodium and potassium (Na+K)	57	143	156	89	603	----------
Bicarbonate (HCO_3)	137	227	238	224	711	306
Sulfate (SO_4)	7.1	27	30	6.7	217	2
Chloride (Cl)	86	72	85	8.3	320	8
Fluoride (F)	.2	1.0	1.0	1.3	1.6	1.3
Nitrate (NO_3)	.4	1.2	1.0	.0	.4	----------
Dissolved solids	285	379	410	----------	1520	----------
Hardness as $CaCO_3$	118	6	6	9	21	88
pH	7.6	7.5	7.5	8.0	8.4	----------
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	1-12-48	9-28-56	9-28-56	2-27-56	7-2-56	11-17-43

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

	54	55	60	64	72	80
Silica (SiO_2)	31	28	19	16	9.2	20
Iron (Fe), total	1.5	2.3	.68	.20	.47	.23
Iron (Fe), in solution	----------	----------	----------	.01	.05	.09
Calcium (Ca)	69	73	42	9.1	6.8	40
Magnesium (Mg)	2.9	1.7	2.9	.9	4.1	6.3
Sodium and potassium (Na+K)	8.2	8.7	9.2	85	118	17
Bicarbonate (HCO_3)	227	213	155	219	296	186
Sulfate (SO_4)	2.4	8.9	4.5	7.1	14	2.6
Chloride (Cl)	9.2	17	3.4	15	22	5.0
Fluoride (F)	.1	.1	.1	.9	1.1	.3
Nitrate (NO_3)	.1	.2	.0	.4	.5	.2
Dissolved solids	237	249	157	249	326	186
Hardness as $CaCO_3$	184	189	117	26	34	126
pH	7.2	7.3	7.5	7.9	8.1	7.5
Water-bearing material	Sand	Sand	Sand	Sand	Sand	Sand
Date of collection	7-11-49	7-11-49	2-9-48	5-3-55	2-2-54	12-18-52

Analyzed by the Quality of Water Branch, U. S. Geological Survey.

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