North Carolina
Department of Conservation and Development
George R. Ross, *Director*

Division of Mineral Resources
Jasper L. Stuckey, *State Geologist*

Bulletin Number 63

GEOLOGY AND GROUND WATER

IN THE

Charlotte Area, North Carolina

By

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Prepared cooperatively by the Geological Survey,
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LETTER OF TRANSMITTAL

Raleigh, North Carolina

February 14, 1952

To His Excellency, HONORABLE W. KERR SCOTT
Governor of North Carolina

SIR:

I have the honor to submit herewith as Bulletin 63, a report entitled, "Geology and Ground Water in the Charlotte Area, North Carolina," by H. E. LeGrand and M. J. Mundorff.

This report is one of a series being prepared as a part of the cooperative study of the ground water resources of the State by the North Carolina Department of Conservation and Development and the United States Geological Survey. In most parts of the State, ground water supplies are becoming more important and it is believed that reports such as this will prove of assistance in the development and use of these resources.

Respectfully submitted,

GEORGE R. ROSS,
Director

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GEOLOGY AND GROUND-WATER RESOURCES OF THE CHARLOTTE AREA, NORTH CAROLINA

By H. E. LeGrand and M. J. Mundorff

ABSTRACT

The Charlotte area is in the southwestern part of North Carolina and comprises Cabarrus, Cleveland, Gaston, Lincoln, Mecklenburg, Polk, and Rutherford Counties. It includes 2,834 square miles and according to the 1950 census has a population of 505,638. The area lies in the Piedmont province, the western part extending to the Mountain province. The undulant topography of the Piedmont represents an alternation of valleys and rounded hills. In the western part of the area the topography is mountainous and relief features are sharp and commonly precipitous. The major streams have high but decreasing gradients to the southeast. Streams and the resultant topography have adjusted themselves to the underlying structure in many places, but in a part of the area the drainage and structure have discordant relations.

The area is underlain by igneous and metamorphic rocks, consisting chiefly of schists, gneisses, granites, and slates. The slates and volcanic rocks to which they are related have a restricted occurrence in the extreme eastern part of the area. The mica schists and the mica and hornblende gneisses represent the chief country rocks which have been pervaded by granite. Local variations in types of rocks are common, and large homogeneous masses of a single type of rock are rare. The rocks trend northeastward and are tipped on edge.

Ground-water supplies are obtained through drilled wells, which get water from fractures in the bedrock, and through dug wells, which get water from the weathered material above bedrock.

Wells drilled in schist have a slightly higher average yield than wells in other rock units. The average yield of municipal and industrial wells in this rock is 31 gallons a minute; in the remainder of the rocks it is about 28 gallons a minute.

Topographic location has an important bearing on the amount of water yielded by wells. The average yield of wells drilled in valleys and draws is more than twice as much as that of wells drilled on hills.

The amount of water contained in the rocks decreases with depth. The yield per foot of well generally decreases with depth to a point—perhaps at 250 or 300 feet—below which it is not advisable to drill if the desired yield has not been approached.

Included in the report are several tables showing the relation of yield to type of rock, to topographic location, and to depth of wells. The report contains a discussion of the ground-water resources of each of the seven counties, with tables of well data and chemical analyses. Also included is a geologic map of each county.

INTRODUCTION

This report, one of a series on the ground-water resources of the State, gives the results of an investigation in a part of the south-central Piedmont of North Carolina.

The investigations are being made through a continuing cooperative agreement between the North Carolina Department of Conservation and Development and the Geological Survey, United States Department of the Interior. The program is under the direction of Dr. J. L. Stuckey, State Geologist, and Dr. A. N. Sayre, Chief, Ground Water Branch, U. S. Geological Survey.

The first report of these cooperative investigations, published as Bulletin 47 of the North Carolina Department of Conservation and Development, is a progress report giving general information on groundwater resources of the entire State, with particular emphasis on the Coastal Plain.

The second report, published as Bulletin 51, gives the results of an investigation of the ground-water resources of Edgecombe, Halifax, Nash, Northampton, and Wilson Counties.

The third report, Bulletin 55, covers the investigation of the ground-water resources of Alamance, Caswell, Forsyth, Guilford, Rockingham, and Stokes Counties.

In addition, a brief outline of the water-bearing formations of the Coastal Plain and the logs of 52 wells were published by the North Carolina Department of Conservation and Development as Information Circular 3. Also, chapters on ground-water resources were included in bulletins on the water resources of the Neuse River basin, Cape Fear River basin, Yadkin-Pee Dee River basin, and Catawba and Broad River basins published by the North Carolina Department of Conservation and Development.

Because of the many military establishments constructed in North Carolina during the World War II, most of which utilized ground water, a considerable amount of time from 1941 to 1945 was devoted to special investigations and reports regarding ground-water supplies for military bases, war plants, and contiguous civilian housing areas. A large amount of valuable data was obtained, including well samples, well logs, and data on the quantity and quality of water available from the various aquifers.

The field work in the Charlotte area was done chiefly in August 1944, during the summer and autumn of 1945, and in November 1946. Some observations on the geology were made at intervals during 1949. The field work consisted of obtaining data on 981 wells, several of springs, and municipal supplies, collecting samples of water, and studying the geology and topography of individual well locations. Information concerning the wells was obtained chiefly from the well owners and drillers. Because much of the information was given from memory some of it may be inaccurate.

The chemical analyses were made chiefly by members of the Quality of Water Branch, U. S. Geological Survey. The names of the analysts are given in the tables of analyses.

The writers wish to acknowledge the courteous and generous assistance of the well owners, well drillers, superintendents of public water-supply systems, and many others, without whose aid the project could not have been successfully completed.

GEOGRAPHY

AREA AND POPULATION

The Charlotte area is in the south-central part of the State, bordering the South Carolina line, and includes Cabarrus, Mecklenburg, Gaston, Lincoln, Cleveland, Rutherford, and Polk Counties, with a total area of 2,834 square miles. The location of the Charlotte area is shown in figure 1.

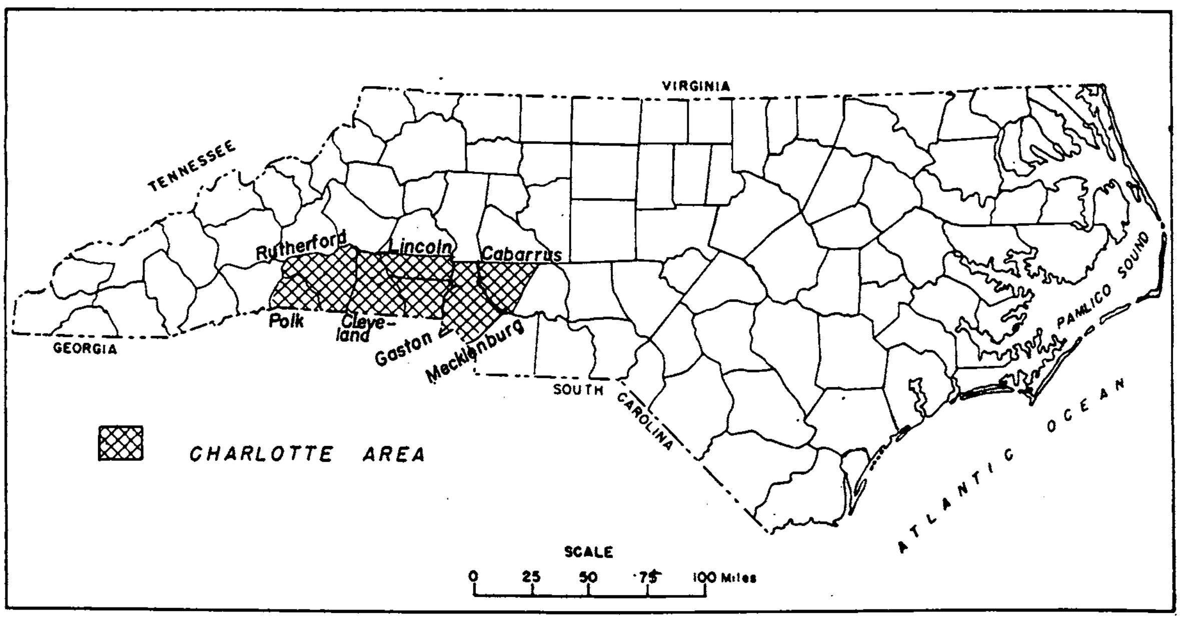

FIGURE 1.—*Index map of North Carolina showing the location of the Charlotte area.*

The population of the area is 505,638, according to the U. S. Census Bureau. There are 40 incorporated cities and towns with an aggregate population of 207,231, which is nearly half the total population of the area. Four cities, Charlotte, Concord, Gastonia, and Shelby each have a population of more than 10,000.

AGRICULTURE AND INDUSTRY

More than 77 percent of the area is in farms. The total value of farm products is considerable, cotton accounting for nearly 40 percent. Other important products in their order of importance are hay, dairy products, corn, poultry, and eggs.

Manufacturing is the most important industry in the area. The textile industry, almost entirely cotton, employs over 75 percent of all factory workers. Other industries are iron and steel, printing, processing of food, and the manufacture of machinery, chemicals, automobiles, and furniture.

MINERAL RESOURCES

Crushed stone for use on roads and in general construction work is the most important mineral resource in the area at the present time. A limestone quarry at the town of Kings Mountain produces a large quantity of crushed limestone. Granite quarries produce crushed rock at several places in the area.

Brick and tile are manufactured from residual clays at Mount Holly and Lattimore.

Considerable mica was mined in Cleveland County during World War II, and some mining of mica has continued since the end of the war.

Spodumene was mined near the town of Kings Mountain in a large operation by the Solvey Corporation of America although the plant was shut down at the end of the war. The Foote Mineral Co., recently has leased considerable property containing spodumene and plans for early development.

Other minerals mined in the past but not now being produced include tin, in the vicinity of Kings Mountain; monazite, in the vicinity of Shelby; iron ore, near Lincolnton; and gold and copper, in Mecklenburg and Cabarrus Counties.

CLIMATE

Precipitation.—Records of precipitation are obtained at four U. S. Weather Bureau Stations in the Charlotte area. The oldest station, at Charlotte, was established in 1878. The youngest station, at Concord, was established in 1933. Three other stations, at Lincolnton, Mount Holly, and Mount Pleasant, are no longer maintained. The average monthly and annual precipitation for all stations in the area is given in the following table.

TABLE 1.—*Average Monthly and Annual Precipitation, in inches, at U. S. Weather Bureau Stations in the Charlotte Area*

Town	Elevation (feet above sea level)	Length of record (years)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Charlotte	741	70	3.97	4.20	4.15	3.32	3.60	4.19	5.32	5.04	3.12	2.93	2.55	3.91	46.10
Concord	705	14	3.68	3.53	4.47	3.93	3.26	3.05	5.16	4.42	4.75	2.91	2.39	3.35	44.57
Gastonia	810	16	3.84	3.81	4.27	3.84	3.34	3.51	5.62	4.27	4.07	3.45	2.68	4.55	47.24
Shelby	895	22	4.20	4.20	4.60	3.40	3.40	3.80	6.20	4.40	3.20	3.80	2.90	4.60	48.60
Average of 4 Stations	----------	----------	3.92	3.93	4.37	3.62	3.40	3.64	5.57	4.53	3.78	3.27	2.63	4.10	46.63
Lincolnton	994	23#	3.79	4.17	3.97	3.37	4.80	4.52	5.95	4.64	3.47	3.10	2.31	3.94	48.03
Mt. Holly	616	39†	4.11	4.41	4.45	3.35	4.53	4.56	5.44	5.60	4.14	3.31	2.55	4.22	50.67
Mt. Pleasant	650	16‡	3.66	4.61	4.10	2.83	3.78	4.64	5.45	5.24	3.41	3.61	2.64	3.04	47.01

From 1884 to 1887 and 1904 to 1922, inclusive.
† From 1885 to 1893 and 1904 to 1933, inclusive.
‡ In 1874 and 1875 and from 1887 to 1900, inclusive.

The average annual precipitation for the four stations now maintained is 46.63 inches. July is the wettest month, having an average rainfall of 5.57 inches at the four stations, and November is the driest month having an average precipitation of 2.63 inches. Precipitation is rather uniform over the entire area, there being only a slightly greater rainfall in the western part. The greatest average annual precipitation is at Shelby and the least is at Concord. The maximum annual precipitation averaged for the entire area was 65.82 inches in 1929 and the minimum was 31.41 inches in 1925. The greatest annual rainfall recorded at any station was 75.59 at Mount Holly in 1908, and the least was 29.71 at Charlotte in 1925. The maximum recorded rainfall in a single month was 18.47 inches at Lincolnton in July 1916.

The average annual snowfall is about 7 inches.

Temperature.—Records of daily maximum and minimum temperatures for the station at Charlotte are published by the U. S. Weather Bureau. In addition, mean monthly temperatures are available for the stations at Concord, Gastonia, and Shelby. The average mean annual temperature is 60.6° F. at Charlotte, which probably is representative of the area as a whole. The coldest month is January, which has an average mean temperature of 41.8° F., and the warmest month is July, which has an average mean temperature of 78.8° F.

PHYSIOGRAPHY

The Charlotte area lies within the upland section of the Piedmont physiographic province which is an uplifted, submaturely to maturely dissected peneplane on somewhat resistant rocks.[1]

In the Charlotte area the upland surface, which generally slopes south or southeast, is interrupted by a number of monadnock-type hills and ridges, some of which rise as much as 1,600 feet above the surrounding uplands.

The area is drained by three major drainage systems. All of Cabarrus County and the eastern part of Mecklenburg County is drained by the Rocky River which flows into the Pee Dee River. The western and southern parts of Mecklenburg County, practically all of Lincoln and Gaston Counties, and a small strip along the eastern edge of Cleveland County are drained by the Catawba River and its tributaries. All of Rutherford and most of Cleveland and Polk Counties are drained by the Broad River and its tributaries. The three drainage systems extend southeastward through South Carolina to the Atlantic Ocean, although the courses of the individual streams within the area are quite diverse. The courses of some of the streams are determined by the geology of the area, and all of them reflect its geologic history.

GEOLOGY

INTRODUCTION

The Charlotte area is underlain by ancient igneous and metamorphic rocks. As the existing geologic maps were entirely inadequate for use in determining the quantity and quality of water available from the different rock units, mapping of the geology of the area represented a part of the field program. Considering the large size of the area and the short time spent in mapping, it is readily apparent that the geology was necessarily generalized and that the map is only a reconnaissance map. The rock classifications chosen are discretionary and often include several kinds of rocks. For example, the intrusion of granite into most of the preexisting country rocks has resulted in types displaying many variations and gradations.

The gradations between the rocks are of two types. The first is that in which the progressive change from one petrographic type to another occurs within a few inches or a few feet. This type of gradation is readily apparent and is seen in one outcrop. The other type, of greater magnitude, may represent a zone of many feet or of a few miles in which two rocks are interpenetrated and a progressive change in the dominant rock can be generally observed. In the latter case granite everywhere represents one of the rock types, and précise local contacts may occur. It follows that generally the various rocks are so intimately interlayered or interpenetrated that only the dominant rock can be shown except on very large scale maps. Insofar as small-scale mapping is concerned, most geologic boundaries are indeterminate. Best use of the accompanying geologic maps can be made by considering the contacts approximate or arbitrary. The classification of rocks in the Charlotte area used in this report is based on lithology and physical appearance and not necessarily on stratigraphic relations.

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[1]Fenneman, N. M., Physiographic divisions of the United States: Assoc. *Am. Geographers* Annals, vol. 18, no. 4, p. 290, 1928.

The sequence of events that have produced the complex pattern of the rocks is not altogether clear. Very old sedimentary and igneous rocks were folded and faulted and were metamorphosed by pressure and heat into schists of various types. Sedimentary tuffs and other volcanic materials mantled part of the area and were also metamorphosed to some degree. After these events igneous rocks, especially granite, were intruded in the preexisting rocks. The emplacement of the granite was preceded or accompanied by a general metamorphism of the crystalline schists. The high temperatures and directed pressures related to this metamorphism allowed granitic material to intimately penetrate the country rocks. The granite occurs as rather large homogeneous bodies, as veins and sheets, and as hybrid or granitized country rock. The intrusion of granite into the older rocks prevailed extensively in the area west of the slates that crop out in eastern Cabarrus and Mecklenburg Counties.

At least two complexes formed by injection of granite into the country rock can be readily recognized. The first, occurring west of Cabarrus and Mecklenburg Counties, is formed with mica schist as the chief host rock. In this relationship the granite is interlayered with schist and thus, occurring as sheets, is generally conformable to the schistosity which trends northeastward. The zone in which the rock is predominantly schist grades into a zone in which the rock is predominantly granite. The other complex, occurring in Cabarrus and Mecklenburg Counties, consists of two igneous rocks—diorite and granite. The diorite and granite are interpenetrated in an intricate manner. In most places it is apparent that the diorite was emplaced before the granite although they may have been derived from the same magma at almost the same time. Contacts between the dioritic and granitic rocks generally are distinct. Areas that are predominantly diorite grade into areas that are predominantly granite.

It is generally believed that the last great earth movements in this area and much of the granite emplacement occurred near the close of Paleozoic time. The most recent intrusive rocks of the area are diabase dikes which cut all other rocks and are generally regarded as of Triassic age. Having been elevated for many geologic periods, the rocks have been subjected to weathering and erosion. As a result much rock material has been stripped from above the existing beveled surface. A thick layer of soil mantles the bedrock in most places showing that the action of erosion, though powerful, lags behind the action of weathering.

AREAL DISTRIBUTION AND CHARACTER OF THE ROCKS

Mica schist.—Fine- to medium-grained rocks showing strong schistose structure and containing large amounts of mica are abundant in the area and are interlayered with many other types of rocks. The schist is a common country rock in Lincoln, Gaston, and Cleveland Counties where it occurs in northeast trending belts. Although much of the original physical character of the schist has been altered by metamorphism both before and at the time of the intrusion of granite, it is generally regarded that the schist has been derived, in part, from sedimentary rocks—chiefly shale.

Injection complex.—A large area, including Lincoln, Gaston, and Cleveland Counties, is composed of many types of mixed rocks that result from the injection of granitic material into the country rock. The dominant country rock involved in the injection complex is mica schist, along whose planes of schistosity the movement of the granitic material was generally directed. In some places the granitic material pervaded the schist, assimilated it, and altered it into a composite gneiss. Although this type of gneiss is a part of the injection phenomena it is mapped as gneiss and not as schist-granite complex. The most conspicuous relations of the schist and granite are as alternating and discrete bands ranging from a fraction of an inch to many hundreds of feet in width. For the sake of convenience in mapping and description of the rocks, the resulting products are classified according to the amount of granitic material present. The subdivision of the complex is similar to that used by Read[2] in describing the Lock Choire injection complex of Scotland.

The following subdivisions of the schist-granite complex can be conveniently distinguished:

1. Mica schist containing little or no granitic material.
2. Injection area with mica schist dominant.
3. Injection area with granite dominant.
4. Granite, more or less homogeneous.

[2]Read, H. H., The geology of central Sutherland: Scotland Geol. Survey Mem., His Majesty's Stationery Office, p. 91, 1931.

To some extent the schist is dominant in the injected areas near the schist proper, and granite is dominant in injected areas near homogeneous granite, but this gradation of dominant rock is not everywhere apparent. Perhaps the reason for this is that the emplacement of granite occurred over large areas of the Appalachian Piedmont, and rather large homogeneous granite masses are so common that it is not generally possible to relate one of these masses to a particular injection area.

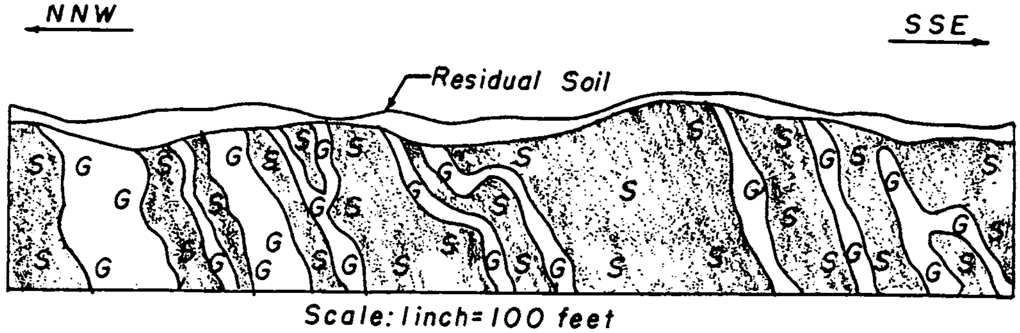

FIGURE 2.—*Diagrammatic sketch showing the relation of granite (G) and mica schist (S) in area west of Mecklenburg County.*

Under such a classification most of the contacts mapped are gradational and therefore should not be regarded as distinct boundaries between rock types. For example, in Lincoln County a belt of mica schist 2 miles east of Lincolnton passes imperceptibly eastward through an injected zone, schist dominant, into more or less homogeneous granite near Iron Station.

Granite.—The granite of the injection complex and that forming the large homogeneous masses are regarded as of the same age[3] although evidence to that effect has not been completely assembled. The granites vary considerably in texture and physical appearance and this is due, in part, to the type of country rock penetrated, the degree of assimilation by the granite, and conditions of cooling of the granitic solutions. Much of the granitic material occurs as coarsely crystalline rock, or pegmatite, which may contain an additional suite of minerals such as tourmaline, beryl, cassiterite and spodumene, not generally present in normal granite. The normal constituents of the granite are quartz and several varieties of feldspar, mostly rich in potash and soda. In some places either muscovite or biotite forms an important accessory mineral. Near certain areas of diorite and gabbro, hornblende is a common mineral in the granite, but large areas of hornblende granite are not common. The granite in Cabarrus and Mecklenburg Counties forms an intricate complex with diorite and is discussed later. Much of the rock mapped and discussed as gneiss represents a product of a country rock pervaded by granite. Thus in a broad sense, it is likely that granite, in all its types of emplacement, covers more than half of the Charlotte area.

The emplacement of the granite is thought to have occurred during late Palezoic time when the country rocks were generally metamorphosed. During this metamorphism high temperatures and prevailing earth stresses influenced the movement of the more liquid part of the magma by allowing it to be injected as veins and sheets into the country rock for great distances from the residual magma. Metamorphism resulting from the injection processes produced zones in the country rock rich in kyanite, sillimanite, and garnet. However, it is not always possible to distinguish between the effects of injection metamorphism and regional metamorphism of an earlier date.

Hornblende gneiss.—Hornblende gneiss occurs over a wide area west of Cabarrus and Mecklenburg Counties. Large, extensive bodies of this rock are not common, the general occurrence being as beds a few inches or a few feet wide interlayered with other rock. The gneiss is similar to the Roan gneiss named by Keith[4] and mapped by him in the vicinity of Kings Mountain, Cleveland County. It is composed of large quantities of hornblende with varying amounts of feldspar and quartz. In contrast to the other

[3]Kesler, T. L., Correlation of some metamorphic rocks in the central Carolina Piedmont: Geol. Soc. America Bull., vol. 55, p. 759, 1944.

[4]Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (no. 222), p. 3, 1931.

rocks with which it is associated, the hornblende gneiss is dark in color where fresh and unaltered, and deep red or brown where weathered.

The age of the hornblende gneiss is not certain, but its relation with other rocks indicates that it is older than all rocks of the area with the possible exception of the mica schist with which it is interlayered. Where the schistosity is strong it is also interlayered with granite in northeast belts, but the less schistose parts of the gneiss are cut transversely by dikes of granite. From field appearance it does not seem likely that the hornblende gneiss was modified much from the injection metamorphism. At any rate, the rocks now identifiable as hornblende gneiss are completely separate from the granite that intrudes it. Although the hornblende gneiss is a common rock it is generally subordinate to other types.

Biotite gneiss.—Rocks of the biotite gneiss group include gneisses, chiefly granitic, in which biotite is a conspicuous dark mineral. It probably represents the gneissic portion of the type of rock mapped by Keith[5] as the Carolina gneiss.. Part of Keith's description is applicable.

"A portion of the Carolina gneiss is composed of banded granular layers of feldspar, quartz, and either muscovite or biotite or both, with accessory minerals. The texture is commonly much coarser and the foliation less pronounced than those of the mica schists. Some of this gneiss has developed from homogeneous rocks and therefore has a rather uniform texture and banding. Other parts of it have been derived from rocks of variable composition that produce a strong banding with variations in texture."

Some of the biotite gneiss may represent original granite that has attained varying degrees of foliation because of earth movements; other parts of the gneiss are products of the injective phenomena in which granitic material has permeated a host rock.

The gneiss covers a large area in northwest Cleveland County and Rutherford County where it is in contact with the injection complex into which it grades and from which it is distinguished with difficulty.

Gabbro-diorite.—Rocks that range locally from gabbro to diorite but that, as a whole, are intermediate between true gabbros and diorites are common in some parts of the Charlotte area. They are typically exposed in the southwestern part of Mecklenburg County, along State Route 49 about 8 miles south of Charlotte. They also occur to a lesser extent in southern Cabarrus County near Harrisburg. Similar rocks are found as small isolated masses in other counties, but it is not known whether the small masses are related to the main bodies in Mecklenburg and Cabarrus Counties.

The gabbro-diorite is distinctly massive and not closely jointed. As is characteristic of other homogeneous igneous rocks of the area, the gabbro-diorite is commonly exposed as rounded boulders or smooth outcrops above the general surface of the ground. These exposures are not deeply weathered although the mineral components are susceptible of weathering. The rock appears to be composed chiefly of hornblende or pyroxene and feldspar and varying amounts of quartz and accessory minerals. The color is generally dark, ranging from nearly black to green. Surficial alteration of parts of the rock to epidote accounts for most of the green color. The texture is generally coarse.

Quartzite.—Quartzite is not a common rock in the Charlotte area, but its resistance to erosion makes its presence conspicuous as ridges and knobs. It is exposed in northeastward-trending lenticular belts chiefly in Cleveland and Gaston Counties. It forms such elevations as Kings Mountain Pinnacle, Crowders Mountain, Spencer Mountain, and Jackson Knob. The breadth of outcrop is generally less than 200 feet.

Keith[6] has divided the quartzite near Kings Mountain into three divisions—kyanite quartzite, white, nearly pure quartzite, and chloritic and sericitic quartzite. In the Kings Mountain area at least one belt of quartzite is in contact with crystalline limestone. Elsewhere it is in contact with mica schist, for the most part.

Limestone.—Crystalline limestone and dolomite occur in broken belts extending from Grover, Cleveland County, into Gaston County. The limestone strikes northeast and is in contact with the quartzite in

[5]Op cit., p. 3.

[6]Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (no. 222), p. 5, 1931.

most places. The limestone proper is generally less than 100 feet thick, as a result of which its areal extent is small. In contrast to the quartzite it weathers readily, forming longitudinal valleys along its strike.

Keith[7] has named this rock the Gaffney marble because of its prominence near Gaffney, S. C. It is mostly gray in color and contains, in addition to calcite and dolomite, such impurities as quartz, mica, graphite, and hornblende.

Diorite and granite complex.—Rocks of the diorite and granite group cover a large area in Cabarrus and Mecklenburg Counties, and they also occur in eastern Gaston and Lincoln Counties. They are believed to have a wide distribution outside the Charlotte area, although very little geological study has been made of rocks of this complex.

A mafic component, chiefly diorite, and a felsic component, chiefly granite, form this complex, (fig. 3), The mafic component varies in composition, being a gabbro in some places and a diorite in others, but, for convenience, it is called diorite in this report. The felsic component is granite in all places.

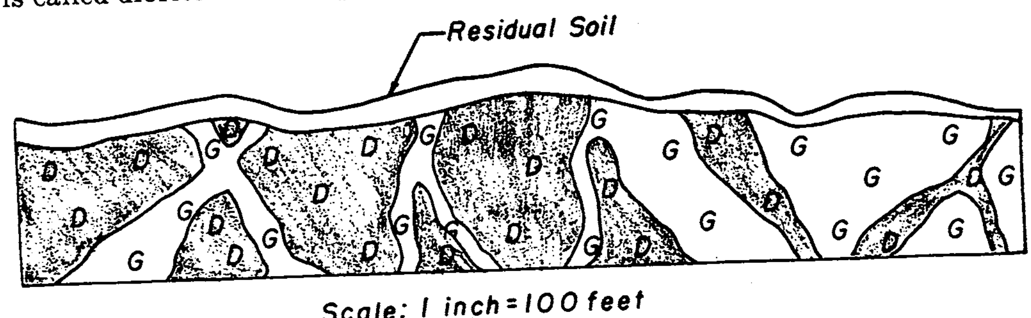

FIGURE 3.—*Diagrammatic sketch showing the relation of granite (G) and diorite (D) in Cabarrus and Mecklenburg Counties.*

So closely spaced are individual rocks within the complex that not even the larger bodies can be shown on the accompanying maps. It was decided to split the complex proper into two units, one in which the diorite predominates and the other in which the granite predominates. In using this subdivision the boundaries between these units are necessarily arbitrary and somewhat indefinite.

The most conspicuous occurrence of the granite is as discrete bodies veining and penetrating the diorite in random fashion. Thus, in most places, it is evident that granite was intruded into the diorite, although each type of rock is clearly separated from the other, without any appreciable modification of either.

The diorite in a semiweathered state, commonly seen, is a dark-blue or gray medium-textured rock composed predominantly of hornblende and feldspar and containing varying amounts of quartz, biotite, pyroxene, and other accessory minerals. The rock granulates readily near the surface of the ground, and the soil may be composed in part of individual hornblende and feldspar crystals typical of the Mecklenburg soil types.

The granite forming the complex with the diorite is light in color, being composed almost entirely of feldspar and quartz. Biotite, muscovite, and the accessory minerals common to most granites are not conspicuous. Like the diorite with which it is associated, the granite disintegrates readily near the surface, breaking down into pea-size aggregates of quartz and feldspar.

Some of the diorite is strongly schistose and much of the granite is sheared. The wide range in degree of metamorphism of the diorite suggests that basic rocks of different ages are included in this complex. Laney[8] describes a group of diorite dikes younger than the granite and diorite and cutting both.

The source of the granite forming the complex with the diorite is not known. It is in contact with a large granite mass near Kannapolis in Cabarrus County and with the syenite ring dike south of Concord. Although differing in general appearance from the other granites of the Charlotte area, general field relations suggest that the various granites may be of the same age. Where granite occurs in lesser

[7] Op cit., p. 6.
[8] Laney, F. B., Gold Hill mining district of North Carolina: North Carolina Geol. and Econ. Survey Bull. 21, p. 56, 1910.

amounts than diorite it appears that the granite was emplaced after the diorite, and this relation may exist also in areas where the granite is dominant over the diorite. It is possible that the granite and diorite are genetically related and that the emplacement of the granite followed quickly that of the diorite. Although some outcrops show that granite has assimilated the diorite locally, these two rocks normally occur as distinct bodies. In places where the granite is subordinate the basic component may be a gabbro, suggesting that the diorite of the complex is related to the gabbro-diorite rocks not included in the complex.

Syenite.—A more or less circular belt or ring dike of augite-syenite occurs about 4 miles southwest of Concord in Cabarrus County (fig. 9). Inside the ring is massive gabbro-diorite. The area is about 6 miles wide although the width of the ring averages less than 1 mile.

The rock is described[9] as "of uniformly coarse texture over the entire area, of massive structure and composed of large bluish gray feldspar individuals, without pronounced crystal outline (allotriomorphic). It contains little of the other minerals, as a rule, but is largely made up of the coarse crystallization of feldspar . . .

". . . The small amount of groundmass present in the rock is coarse-textured and dark gray from the proportion of the dark bisilicates present."

Large boulders, characteristic of the syenite, indicate that vertical joints are widely spaced. Its massiveness appears to be a factor in its resistance to erosion because it stands slightly higher than the mafic and felsic rocks along both the inner and outer edges. The syenite disintegrates readily but decomposes slowly, resulting in a granulated and crumbly weathered rock and soil composed almost entirely of feldspar crystals or aggregates.

In 1944 Dr. William A. White of the University of North Carolina and M. J. Mundorff mapped the syenite outcrop in some detail and studied its relation to adjacent rocks. At that time its concentric-ring outline was ascertained—an almost circular ring which is broken on the southeast side by gaps that total less than 2 miles. The rock within the ring is, for the most part, gabbro-diorite and that on the outside is chiefly the diorite injection complex, there being some granite in the town of Concord.

The origin and underground shape of the syenite ring dike are not known. The circular shape of the dike at the surface suggests that the syenite filled a peripheral fault after the central core had subsided, perhaps during late Palezoic time. The syenite is not interpenetrated by other rocks and is not metamorphosed. It may be younger than the granites.

Slates and related volcanic rocks.—In the eastern part of Cabarrus and Mecklenburg Counties a series of sedimentary slates is interbedded with volcanic rocks. These rocks form the western edge of a northeastward-trending belt that extends across the State and is generally known as the Carolina Slate Belt. The contained ore deposits, chiefly gold, have led to detailed study of parts of the belt. A part of the belt lying in the northeast corner of Cabarrus County and extending into Rowan and Stanly Counties has been described by Laney.[10].

The most common rock of the Slate Belt is a slate that appears to represent sedimentary beds of shale. The slate, blue and dense where fresh, shows distinct bedding planes especially near the Cabarrus-Stanly County line. The slates and the volcanic rocks that they enclose strike northeastward.

The volcanic rocks, chiefly tuffs of rhyolite and andesite, are interbedded with the slates and grade into them. The fine-grained tuff is dense and resembles chert; it grades into the slate and also into coarser tuffs which show fragments of coarse feldspar and quartz.

The rocks of the slate belt represent a period of intermittent volcanic activity. During the active intervals lavas of rhyolite and andesite were thrown out. The commingling of volcanic ash and other ejecta with some land waste led to the formation of tuffs. During the more quiet intervals beds of finer materials were deposited. Some of the beds, especially the finer tuffs and slates, are believed to have been deposited in water.

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[9]Watson, T. L., and Laney, F. B., The building and ornamental stones of North Carolina: North Carolina Geol. Survey Bull. 2, p. 94, 1906.

[10]Laney, F. B., Op. cit., pp. 25-42.

The slates are generally regarded as being of pre-Cambrian age. Detailed studies of local areas in the slate belt by Laney,[11] Pogue,[12] and Stuckey,[13] and regional investigations by King[14] indicate that the age is conjectural.

Greenstone schist.—The greenstone schist crops out in a thin belt extending northeastward through the eastern parts of Mecklenburg and Cabarrus Counties. The greenstone includes an assemblage of rocks that were mapped together because it is difficult to separate them in the field. All are green in color, are slightly to highly schistose, and are mafic rocks of igneous origin. The typical greenstone is fine-grained and in the more massive facies[15] phenocrysts of dark-green hornblende and greenish-yellow epidotized feldspars are distinguishable. The rock probably represents a basic lava flow. Along its western border the greenstone is coarser and is similar to the schistose diorite with which it is in contact on the west side. The contact was not observed, chiefly because of the thick cover of decomposed rock.

Insofar as the capacity to yield ground water is concerned, the greenstone is similar to the rocks of the slate belt in structure, showing strong schistosity and prominent joints transverse to the schistosity. It is similar to the diorite in general chemical composition and in the quality of ground water that it yields. Both the greenstone and diorite are intruded by granite, whereas the slate is not.

GROUND WATER

Ground water in the Charlotte area is derived from precipitation as rain or snow. The average annual precipitation of the area is about 47 inches.

The surficial materials at many places are relatively impermeable clays, and the fraction of precipitation that reaches the water table may be somewhat less than one-third. Thus, recharge to the ground-water reservoir probably is between 10 and 15 inches per year. Seasonal fluctuations of the water table are considerable, and there may be considerable change in water level between dry and wet years. However, over a period of many years the net change in water level is small, indicating that the average annual discharge of ground water is about equal to the average annual recharge.

Ground water is discharged by springs and seeps, by evaporation and transpiration, and by wells. Most of the water discharged by springs and seeps enters the streams and maintains their flow during periods of fair weather.

OCCURRENCE AND MOVEMENT

Large quantities of water are contained below the land surface in the openings or interstices in the rocks. These range in size from the minute pores in clays to large tunnels and caverns in lavas and limestones. The interstices in unconsolidated sedimentary rocks, such as gravel, sand, and clay, are primary interstices consisting of pores or openings between the sand or clay particles. Crystalline rocks, such as granite, diorite, gneiss, and schist, have little primary pore space between the component grains. The important interstices in these rocks are the joints, fractures, cleavage planes, planes of schistosity, bedding planes, and solution channels. Consolidated sedimentary rocks have had their primary openings reduced by compaction and cementation. However, in these rocks jointing and fracturing have produced secondary interstices in which water may accumulate.

The porosity of a rock is the percentage of the total volume that is occupied by the interstices. The porosity of the different rock materials covers a wide range, that of some clays, for example, may be more than 50 percent, whereas that of some crystalline rocks may be less than 1 percent. The porosity of clean sands and gravels generally is between 20 and 40 percent. Sands and clays that are cemented and compacted to form sandstones and shales have a much lower porosity.

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[11] Laney, F. B., Op. cit., p. 74.
[12] Pogue, J. E., Jr., Cid mining district of Davidson County: North Carolina Geol. and Econ. Survey Bull. 22, p. 95, 1910.
[13] Stuckey, J. L., The pyrophyllite deposits of North Carolina: North Carolina Dept. Cons. and Dev. Bull. 37, p. 25, 1928.
[14] King, P. B., Tectonic framework of the Southeastern States: Proc. Symposium on the mineral resources of the Southeastern United States, University of Tennessee Press, Knoxville, p. 18, 1949.
[15] Laney, F. B., Op. cit., p. 43.

Many of the secondary interstices in the igneous and metamorphic rocks are formed or enlarged by weathering processes near the earth's surface; therefore they decrease in number and size with depth. Solution of mineral constituents of the soil and decay of vegetal matter in it may result in a porosity of 50 percent or more, but the porosity decreases downward in the subsoil and the partially decomposed and disintegrated bedrock. The solid bedrock may have a very low porosity.

A material may have a high porosity and yet yield little water, even though saturated and allowed to drain for a long time. For example, a clay having a porosity of 50 percent might not yield any water because of the smallness of the pores, the water being retained because of molecular attraction. Some water may be retained in a rock also because the pores are isolated or poorly interconnected. The ratio of the volume of water that saturated material will yield to the total volume is known as the specific yield and is stated as a percentage.

One of the most important characteristics of an aquifer is its permeability, that is, its relative ability to transmit water. Permeability and porosity are not necessarily related; a clay having a porosity of 50 percent may transmit water very slowly or not at all, whereas a sand or gravel having half the porosity may transmit water with relative rapidity.

The movement of ground water generally is due to the force of gravity and the velocity of flow varies directly with the hydraulic gradient. Normally the places at which ground water discharges are at lower altitudes than the areas of recharge. In a humid region such as the Charlotte area, recharge occurs in the interstream areas and the discharge is into streams, lakes, and swamps. Rain falling on the land surface percolates downward to the water table and then moves laterally toward the points of discharge. During the winter and spring, when the water table is higher, the head is greater; therefore the velocity is higher and the volume of ground water discharged is greater than in summer and autumn when the water table is lower.

THE WATER TABLE

A part of the rain falling on an area percolates downward through the soil until it reaches the zone of saturation. In this zone all the pores and interstices are completely filled with water. The top of the zone of saturation is known as the water table, which is not a stationary surface, but one which is continually fluctuating, rising during and immediately after periods of rainfall and declining during periods of fair weather. In humid regions such as the Charlotte area, the water table is an undulating surface reflecting in a subdued way the irregularities of the topography. The relief, that is the difference in altitude between high and low points of the water table, generally is much less than the relief of the topography.

The depth to the water table depends chiefly upon the climate, the topography, and the character of the rocks. In the Charlotte area the climate is fairly uniform and the various rocks are similar in regard to porosity and permeability, so that differences in depth to the water table depend largely upon topography. In valleys the water table generally is at or near the surface; on wide flat uplands the water table generally is not more than a few tens of feet below the surface; and on sharp hills the water table may be more than 100 feet below the surface. The relation of the water table to the topography, in homogeneous materials, is shown in figure 4.

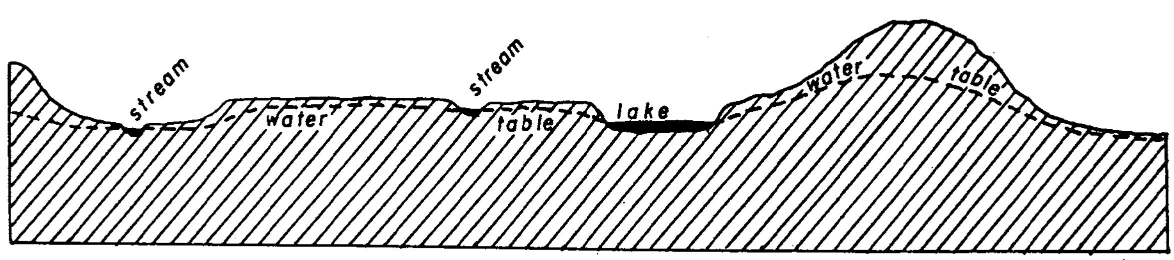

FIGURE 4.—*Diagrammatic section illustrating the relation of the water table to the topography.*

FLUCTUATIONS OF THE WATER TABLE

As the source of ground water is precipitation, the water table fluctuates in response to rainfall. However, correlation of the fluctuations with the rainfall is complicated by a number of factors.

The intensity and duration of the rainfall have a considerable effect on the proportion of water that reaches the water table. A heavy rainfall of short duration may result in a large percentage of surface runoff because of the inability of the soil to transmit the water rapidly to the water table. The same amount of rain, falling during a longer period, may result in a much larger proportion of water reaching the water table. However, during the longer period of rainfall there may be an increase in the total amount of water evaporated, reducing to that extent the amount of water reaching the water table.

The evaporation capacity of the air which is dependent upon temperature, humidity, and rate of air movement, determines the rate of evaporation and thus has considerable bearing on the proportion of rainfall that may reach the water table. Evaporation records are available for a floating pan on Lake Michie, near Durham.[16] Average monthly evaporation ranges from 1.44 inches in January to 6.39 inches in July.

Transpiration is an important factor with respect to recharge and discharge of ground-water. During spring and summer months large quantities of water are used by plants and a considerable part of the rainfall is taken from the soil before it can reach the water table. Also, large quantities of ground water are withdrawn by plants growing in lowlands and swamps. During fall and winter months vegetation requires much less water. Transpiration probably has greater effect on the proportion of rainfall that reaches the water table at various seasons than any other factor in this area.

The porosity and permeability of the soil differs from place to place and thus variously affects the proportion of rainfall that recharges the ground-water reservoir. The porosity and permeability may be changed by rainfall, heavy rains beating down and compacting the soils. Type of vegetation and land usage also have considerable effect on the porosity and permeability; intensive cultivation usually reduces both.

In the Charlotte area water levels begin to decline in April or May, owing to the increasing amount of evaporation and transpiration by plants. Generally this decline continues, interrupted only by minor rises due to heavy rainfall, through summer and early autumn, in spite of the fact that the greatest average monthly rainfall occurs in July and August. In late autumn, generally in November or December, when most of the vegetation is dormant and the evaporative capacity of the air is low, the water levels begin to rise. The winter rains generally are slow and steady in comparison with the summer rains and are more favorable for infiltration than the summer rainstorms. The first rains in winter often do not have as much effect on the water table as the later winter and spring rains because of the general deficiency in soil moisture prevailing by late autumn. Soil, which consists of varying proportions of fine sand, silt, and clay, holds considerable amounts of water in its pore space by molecular attraction of the particles, and this water does not percolate downward to the water table. After a long dry period this moisture is depleted, perhaps for many feet below the surface, by evaporation and transpiration. Before any water can reach the water table, this soil-moisture deficiency must be made up, and sometimes several weeks of winter rains are needed.

UTILIZATION OF GROUND WATER

In the Charlotte area water is obtained through dug, bored, or drilled wells or springs.

Dug wells.—Dug wells listed in this report range in depth from 17 to 100 feet, although the majority are from 25 to 60 feet. The diameter of the curbed wells ranges from 18 to 36 inches, and the diameter of uncurbed wells is somewhat larger. The well with the largest diameter, 120 inches, was dug as a shaft for a mine.

Many dug wells are curbed with stone, brick, clay, or concrete tile, and occasionally wood. Many are not curbed or lined in any way, and others have only a few joints of tile placed in the bottom, generally extending a short distance above the water table.

The chief advantage of a dug well is its large storage capacity, which helps to afford an adequate supply for domestic use if the yield is low.

[16]Hydrologic data on the Neuse River basin, 1866-1945, North Carolina Dept. Cons. and Devel., 1947.

Dug wells have certain disadvantages. Because of the difficulty of digging below the water table, or because rock or hard subsoil is encountered, most wells are not dug many feet below the water table. Therefore, in long periods of fair weather the water table may fall below the bottom of a well, in which case the well becomes dry. Another disadvantage is their susceptibility to pollution, caused by the entrance of contaminated surface material and water.

Several precautions can be taken to decrease the danger of contamination of dug wells. The well should be curbed with tile or concrete pipe or similar material and the joints should be cemented, preferably to a point a few feet below the water table, but certainly to a depth of 10 feet below the land surface. The space between the earth wall and the curbing, in that portion above the water table, should be filled with clay, and a tight cover should be placed over the mouth of the well. Dug wells should be located several hundred feet from any source of contamination, and up the ground-water slope from any nearby source of contamination.

Bored wells.—Bored wells are similar to dug wells, but instead of being dug by hand the material is removed with an earth auger operated by a machine. They are quickly constructed and are relatively inexpensive. They are almost always cased with terra cotta or concrete pipe and tightly covered. In the Charlotte area they range from about 30 to 60 feet in depth and from 12 to 24 inches in diameter. Bored wells are not so likely to go dry as dug wells because they usually are deeper. They are less susceptible to contamination because they are cased and are tightly covered. Wells cannot be bored in material containing boulders or rocks; therefore flat uplands, where weathering of the soil is fairly deep and the water table is not too far below the surface, are best suited to this type of well construction. Many wells have been bored in the Charlotte area in recent years.

Drilled wells.—Two methods of drilling wells are used in the Charlotte area. The cable-tool (percussion) method is used for drilling the larger wells, usually 4 to 10 inches in diameter. The smaller wells, 2 to 4 inches in diameter, are drilled by coring with chilled shot. These two methods of drilling are described in the report on the Greensboro area.[17] Nearly all drilled wells are cased, and usually the casing is driven to solid rock to prevent caving of the well and settling of the casing. Proper placement of casing also prevents surface or shallow ground water from running down the outside of the casing into the well.

Most domestic wells that are drilled by the cable-tool method are 5 to 6 inches in diameter, although there are a few 4-inch wells. Most industrial and municipal wells are 5⅝ to 8 inches in diameter; a few 10-inch wells have been drilled. The majority of shot-drilled wells are 2 or 3 inches in diameter; a few 4- and 6-inch wells also have been drilled by this method.

For domestic uses a supply of a few hundred to a thousand gallons of water a day per family is generally sufficient. However, as the demand is not distributed uniformly throughout the day a well of larger capacity than would otherwise be necessary is required.

Springs.—Springs occur at all levels above the valley floors except within several tens of feet of the hilltops. They are fairly common in the Charlotte area because the slope of the ground in many places is steeper than the slope of the water table and transects it. The outstanding feature of these springs is the fact that practically all of them yield less than 10 gallons a minute and the majority yield 1 to 3 gallons a minute. Most of these springs show little fluctuation in yield although some springs emerging from the upper slopes of the hills show a diminution in yield during dry seasons.

In addition to springs naturally present, others may be developed from seeps at numerous places in hills where the surface slope is close to the water table. Joints in the otherwise impermeable rocks at the junction of the water table and the surface slope permit the discharge of ground water as springs or diffuse seepage. If the soil zone is extremely thin or absent at this junction the flow of water from the fractures is concentrated, and a spring occurs. However, a moderately thin layer of soil permits water emerging from the fractures to spread through it and it is quickly lost by evaporation. Most springs occur in the coves at the heads of valleys where the ground is steep and emerging ground water will have less chance of being dispersed. Springs would probably be larger and more common in these coves if it were not for the fact that soil migrates toward them and tends to cover the apertures through which springs might otherwise issue.

[17]Mundorff, M. J., Ground water in the Greensboro area, N. C.: North Carolina Dept. Cons. and Devel. Bull. 55, pp. 24-25, 1946.

Springs in the Charlotte area represent a source of water for some rural dwellings. Their low yields limit the extent to which they can be used for large municipal and industrial purposes. Available analyses are too few to permit definite conclusions about the quality of spring water. However, it has been noted that spring water generally contains fewer dissolved solids than well water, owing to its more rapid circulation and shorter time of contact with rock material. For example, water from spring A, in Gaston County, contains only 59 parts per million of total solids and has a hardness of only 21 parts per million, yet this water flows from hornblende gneiss which commonly yields well water containing more than 150 parts per million of total solids.

QUALITY OF GROUND WATER

The chemical composition of ground water in the Charlotte area depends on the character of the rock through which the water flows and the length of time it is in contact with the rock. From the standpoint of chemical character of the rocks and of the water derived from them, the rocks of the Charlotte area may conveniently be divided into two groups. The first includes granite, mica schist, slate, and rhyolite flows and tuffs, these rocks approximating granite in composition. The second group includes diorite, gabbro, hornblende gneiss, and andesite flows and tuffs, these rocks approximating diorite in composition. The group of rocks which include granite contain water that is normally low in dissolved mineral matter. The diorite group of rocks contain water that is appreciably higher in mineral matter than that of the granite group. Ground water in most places in the Charlotte area, even in rocks of the diorite group, is satisfactory for most uses without treatment. Iron in undesirable quantities occurs in some places, especially in rocks of the diorite group.

The chemical quality of ground water in the Charlotte area is more adequately discussed under the section of county descriptions, where chemical analyses of representative samples of ground water are listed. Results of field test for hardness of some of the wells are given in the well tables.

FACTORS TO BE CONSIDERED IN SELECTING A WELL SITE

Introduction.—One who has had experience with wells in the Charlotte area knows that two wells a short distance apart may differ greatly in the amount of water yielded. One may be an excellent producer and the other a poor producer. The apparent inability to predict the yield of a well suggests that locating a well may be left to luck or chance; although precise knowledge concerning all the factors that govern the occurrence of ground water in any one place may not always be clear, a careful analysis of observations and data on hand generally leads to good results in selecting well sites.

Three considerations are generally in mind when a well is located—convenience of location, quantity of water available, and quality of water.[18] Most well sites are chosen for their convenience of access and are as close as possible to the place where the water is to be used. Many of these wells, however, are poor producers. Such a practice is poor economy if a large supply of water is needed, inasmuch as convenience of location and quantity of water available may not go hand in hand.

Much thought is generally given to locating a well where the water will be free from pollution, and, of course, this is a primary consideration. The sanitary quality of well water can be assured if water moving toward the well does not pass through contaminated material. Thus, freedom from pollution depends on the absence of polluted material in the well area, the movement of the water, and the filtering capacity of the water-bearing material. Almost everywhere in the Charlotte area a heavy blanket of residual rock material acts as a natural filter that largely prevents the entrance of polluted water into the well or into the fissures of the rocks feeding the well. If the residuum is thin or if the fractures in the rocks feeding the well are exposed the chance of contamination is increased. Inasmuch as the general movement of both surface and ground waters is toward the lowlands there is a tendency for pollution to be greater in the valleys. However, where wells in the lowlands are properly constructed there is little chance of getting polluted water, except under conditions of heavy pollution.

[18]Herrick, S. M., and LeGrand, H. E., Geology and ground-water resources of the Atlanta area, Ga.: Georgia Dept. Mines, Mining, and Geology Bull. 55, p. 18, 1949.

The chemical character of ground water varies from place to place, chiefly according to the rock material penetrated by a well. The ground water in the Charlotte area is generally of good chemical quality, and therefore the quality of water desired is seldom an important consideration in well location. As a rule, the granites and other light-colored felsic rocks yield water very low in mineral matter, whereas hornblende gneiss and diorite yield more highly mineralized water.

As the quantity of water obtainable is often the major consideration in locating wells, criteria for selecting well sites with this in mind deserve much thought. Certain factors, chiefly geologic, that relate to yield of wells are discussed below.

Rock texture.—Coarse-textured rocks generally are better aquifers than fine-textured ones. The probable reason is that any slippage along joints, cleavage planes, or fractures produces a certain amount of rotation of the mineral grains. Rotation of the grains in a coarse-grained rock naturally produces larger and more continuous openings than in a fine-grained rock.

Cleavage and schistosity.—In the Charlotte area cleavage planes and planes of schistosity serve as important avenues for the movement of ground water. The bedding planes of the original sedimentary rocks of the area have been obliterated for the most part by earth movements which formed the planes of schistosity now prominent in the schistose and gneissose rocks. As most of the rocks are tipped on edge, water seeps through the soils into the schistose partings and is thus deflected down the dip. Where the schistosity forms the major partings the yield of wells penetrating them will depend largely on the size and number of these partings, their continuity with sources of recharge from the soil and from the surface, and with the constancy of infiltration into them. Most of the intake area for such wells is where the penetrated schistose partings crop out. If this intake area is on a steep hill where runoff is great and influent seepage is slight, the wells in all probability will have small yields. Hence, it follows that a well should be located where it will intersect water-laden schistose partings that have adequate access to influent seepage.[19] (See fig. 5.)

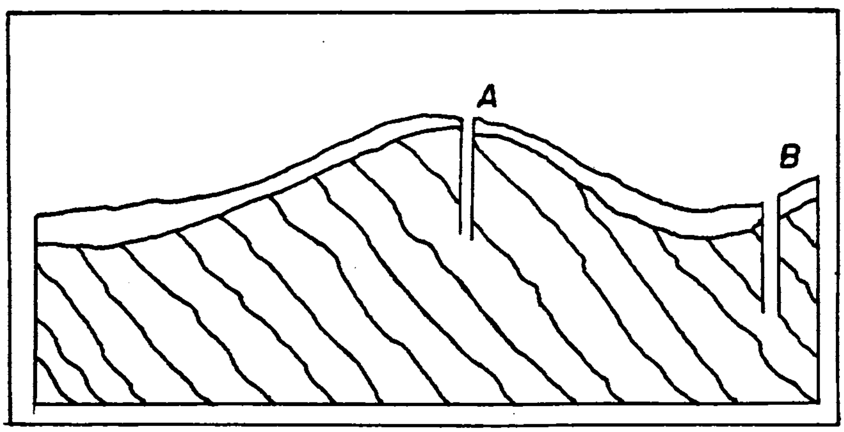

FIGURE 5.—*Diagram showing the importance of schistose planes in the yield of wells drilled in schist and gneiss. Well B has a better chance of being successful than well A. Because of rapid surface runoff of precipitation on hill, only a limited amount of water is accessible through seepage into well A. Well B derives seepage from adjacent valley through connecting schistose openings (after Herrick and LeGrand).*

Joints and fractures.—In wells that are cased to the bedrock the entrance of water is through joints and fractures. Therefore, wells drilled into rocks that are closely jointed, sheared, or fractured will generally yield more water than wells drilled into massive rocks. Joints cut the rocks at various angles, and many of them have patterns of alinement. The intersection of these joints is necessary for the circulation of water in the rocks.

In many places granites and other rocks that show a tendency toward massiveness have a pronounced system of nearly horizontal joints called sheeting or exfoliation, the joints being subparallel to surface

[19]Herrick, S. M., and LeGrand, H. E., op. cit., p. 21.

topography but flatter. As this sheeting is somewhat convex on hills and apparently concave in valleys, the natural movement of water in the rocks is from the convex joints of the uplands to the concave joints of the lowlands.[20] Rocks that show pronounced sheeting yield considerably more water to wells in lowlands than on hills.

Quartz veins.—Quartz veins form avenues for the storage and movement of ground water and thus are an important factor in locating productive wells. Fractures resulting from earth stresses are, in most places, more prominent in the quartz veins than in the adjacent rocks. Wells intersecting one or more quartz veins generally are much more productive than wells that do not.

Thickness of weathered material.—Another factor to consider in the choice of a well site is the thickness of the mantle, that is, the thickness of the soil and weathered material above solid rock. Because the extent of chemical weathering of a rock depends largely upon the ease of access of water to the rock, a thick mantle of weathered material overlying the bedrock from which it was derived is an indication that the rock is jointed and fractured or has interstices of some other type through which water can move. Furthermore, the thick mantle, which is generally porous although not necessarily very permeable serves as a reservoir to feed water into the fractures. From simple observation it may be impossible to ascertain the thickness of the mantle. The extent to which bedrock is present at the surface in the general area may indicate the approximate thickness.

Most drilled wells are cased to hard rock. The depth of casing, therefore, generally is directly related to the thickness of the mantle. In the Charlotte area 45 wells with 30 feet or less of casing had an average yield of 9.8 gallons a minute; 114 wells with 31 to 65 feet of casing had an average yield of 17.4 gallons a minute; and 128 wells with 66 feet or more of casing had an average yield of 20.5 gallons a minute.

Rock type.—The type of rock penetrated by a well may have much to do with the quantity of water yielded. The rocks have been subjected to structural forces and weathering since their formation, and openings developed as a result thereof are capable of transmitting water. As different rocks react differently to forces that produce the fracturing, they yield unlike quantities of water to wells penetrating them. Thus, if a choice exists, a well should be located in a type of rock that yields adequate supplies to existing wells. The types of rock in the Charlotte area and their individual water-bearing properties are discussed in a later section.

Spacing of wells.—Care should be taken to space wells in such a way as to avoid mutual interference through pumping. Inasmuch as rigid pumping tests are seldom made, little is known about the area of influence of individual pumping wells. In the Charlotte area the low permeability of the rock material in the well area constricts the outward growth of the cone of water-level depression around the well so that the influence of pumping may not be felt more than a few hundred feet from a pumped well. The importance of the schistose partings in transmitting water suggests that the area of influence may be elongated in the direction of the schistosity and that wells should be spaced farther apart where alined along the same planes of schistosity than where spaced at right angles to the schistosity. Where the slope of the land surface is appreciable it is inadvisable to locate a well uphill or downhill from another even though the initial cones of depression of two wells might not touch; as the natural movement of ground water is controlled by gravity the intake area for either well extends to the hilltop, and the placing of a well upslope literally robs the lower well. The correct spacing of wells depends largely on the amount of water pumped, the permeability of the water-bearing material, which controls the enlargement or constriction of the cone of depression, and on the topography. Thus local conditions largely govern the spacing of wells.

Topography.—In the location of well sites, topography ranks with rock type as an important factor determining the quantity of water obtainable. It represents a criterion useful to the layman as well as to the hydrologist. The topographic location was noted of 490 wells in the Charlotte area on which both the yield and depth were also known. The number of wells, their average depth, range in yield and average yield, and the percentage of wells yielding 1 gallon a minute or less in five different topographic locations are given in table 2, and the average yield per foot of well is shown graphically in figure 6. The

[20] LeGrand, H. E., Sheet structure; a major factor in the occurrence of ground water in the granites of Georgia: Econ. Geology, vol. 44, no. 2, p. 110, 1949.

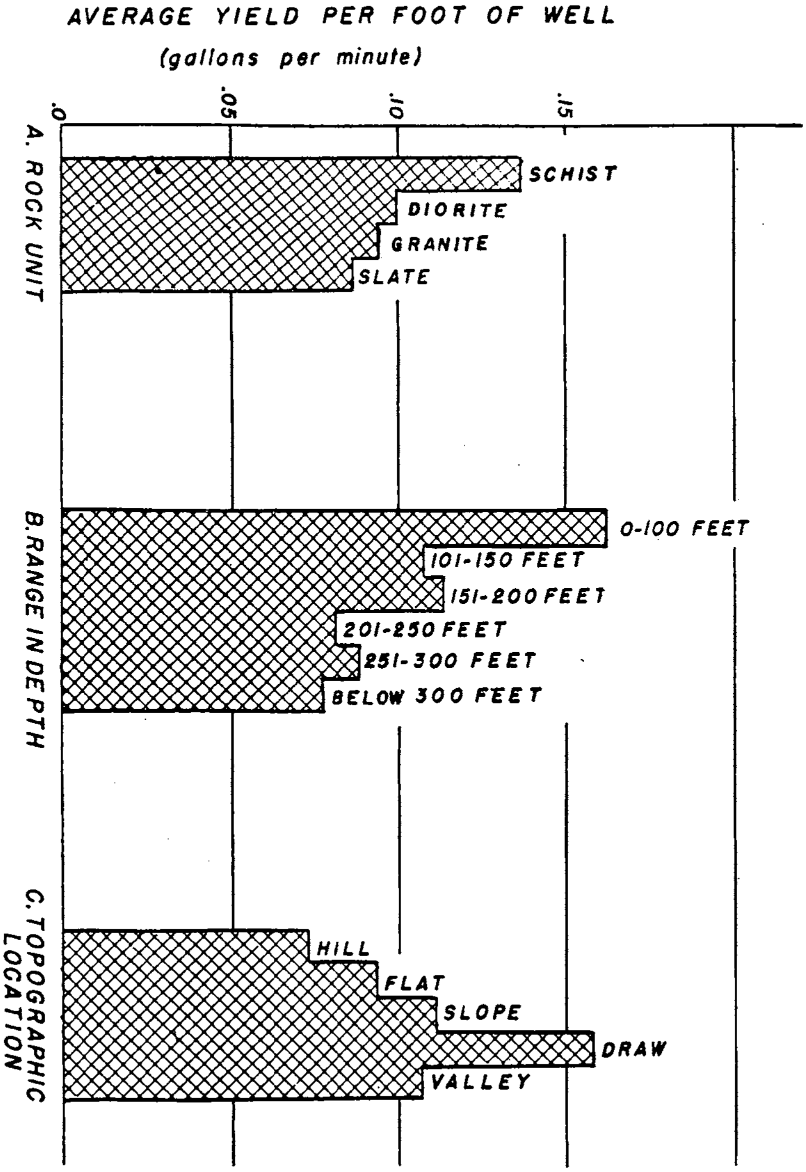

FIGURE 6.—*A, Average yield, per foot of well, of wells in the different rock units; B, Average yield, per foot of well, according to depth; C, Average yield, per foot of well, according to topographic location.*

five types of locations are hills, flats, slopes, draws, and valleys. The terms "hill" and "valley" should be clear to everyone. However, others are borderline designations and whether the location of a well on a low, gentle rise should be given as "flat" or "hill" is a matter of personal opinion. Similarly, a well a short distance from the crest of a hill might be considered to be on a hill by one observer and on a slope by another. The designation "draw" is used for any slight to moderate depression leading downward to a stream valley, but draws grade into valleys and the distinction between the two is necessarily arbitrary and is based on the personal opinion of the observer.

The most striking feature shown by table 2 is the relatively low average yield and average yield per foot of well from wells drilled on hills. According to the records the average well on hills in the Charlotte area yields less than 70 percent of the amount yielded by the average well on flats or on slopes and only about 45 percent of that yielded by the average well in draws. The difference in average yield per foot of well is as great or greater. Following are several reasons why wells drilled on hills yield less water than wells drilled in other locations.

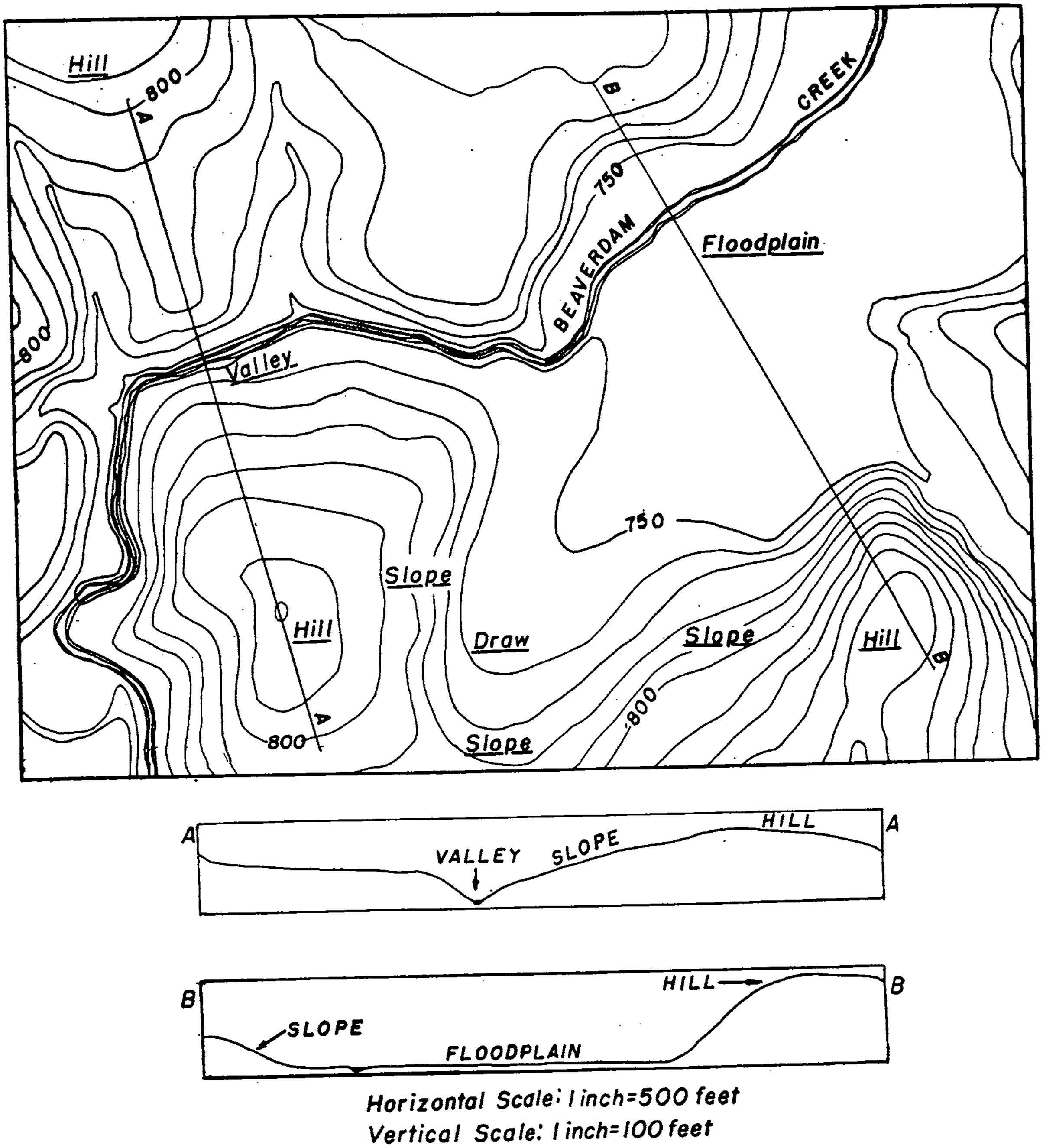

FIGURE 6a.—*Map showing typical topography in the Charlotte area and names of topographic features used in this report. [As shown in table 2, draws are the most favorable and hills the least favorable topographic locations for high-yielding wells. The order of topographic features from the most favorable to the least favorable, as far as quantity of water yielded to individual is concerned, is draw, valley, flat, slope, and hill. (Topography taken from U. S. Geol. Survey Bull. 936-J.)]*

(1) Hills and upland areas readily shed much water from precipitation as surface runoff. As a result, there is less seepage into the ground to become ground water. On the other hand, the lowlands obtain influent seepage directly from precipitation and also from upland surface runoff.

(2) The direction of movement of the ground water is toward the valleys where part of it discharges into streams. In addition, influent seepage may occur from upland rock slopes beneath the residual material. The more impervious the bedrock, the more readily is water deflected down the slope along this contact.

TABLE 2.—AVERAGE YIELD OF WELLS ACCORDING TO TOPOGRAPHIC LOCATION

Topographic Location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gal. a minute or less
			Range	Average	Per foot of well	
Hill	170	149	0–100	10.8	.072	4
Flat	36	179	1–150	16.9	.094	3
Slope	144	150	1–100	16.7	.111	2
Draw	116	157	1–90	24.8	.158	1
Valley	24	176	0–50	18.8	.107	4
All wells	490	155	0–150	16.7	.108	3

(3) Wells located in lowlands may salvage some of the water that would be lost naturally by discharge from the underground reservoir. There the depressed water level resulting from pumping, if near a discharge area, prevents further discharge out of the area.

(4) Wells on hills penetrate the water table at a greater depth than those in lowlands. When a well on a hill is pumped, the water table is lowered as a cone of depression, the center of the cone being at the well. As pumping continues the cone may grow larger and deeper but its span is limited because of the topography and because of the relatively low permeability of rocks at progressively greater depth below the surface. The yield of wells under these conditions is not great. On the other hand, wells in lowlands, even though penetrating the same rocks as those on uplands, intersect the water table near the ground surface. Thus, the water table can be lowered a greater distance by pumping than in a well of the same depth on a hill. The fact that the static and pumping water levels lie nearer the ground surface than in wells on hills results in the pumping level lying in a more permeable zone; hence the intake area is broader and the yield of the well is larger.

(5) In many places hills exist because the rocks there have a greater resistance to erosion than in the valleys, this resistance being due in many places to poor jointing. Joints and fractures facilitate entrance of ground water, which promotes chemical decay and permits mechanical erosion. Thus depressions such as draws or valleys suggest that the rock underlying the depressions has more openings through which ground water can move than the rock underlying the hills. It is not known how important this factor is in the Charlotte area. Where lowlands and highly fractured rocks coexist highly productive wells can be expected.

COMPLETION AND TESTING OF DRILLED WELLS

Generally the casing in a drilled well is driven tightly into the rock to seal out direct entrance of water from the mantle. This lessens danger of contamination and prevents entrance of turbid water into the well, which sometimes occurs, particularly after a rainfall, in wells in which the casing is not tightly sealed in the rock. The space between the outside of the casing and the soil at the surface should be filled with cement or clay to prevent any surface water from running down along the outside of the casing. Surface drainage should be away from the well. The collar of the well should be several inches above the surface and tightly closed.

The yield of only a small percentage of the wells drilled is accurately determined. The cost of adequately testing a drilled well is generally not more than about 5 percent of the cost of the well, and the information obtained is nearly always worth many times the added cost. The length of test should be 2 hours or more on a well for domestic purposes, 24 hours or more on a well for a small industrial plant or public supply such as a school, and 48 hours or more on a well for a large industrial plant or a municipality. In making a pumping test the water level of the well should be measured at regular intervals. The well should be pumped at several different rates. After pumping ceases, the water level should be measured at intervals for several hours to determine the rate of recovery. With this information the proper size of pump and the correct pump setting can be determined and an estimate of the pumping level at a future date can be made.

The majority of pumps used in the Charlotte area are deep-well pumps, although some shallow-well pumps also are used. The terms "deep-well pump" and "shallow-well pump" are somewhat misleading because the depth of the well does not determine the type of pump required. A shallow-well (suction) pump will lift water satisfactorily not more than about 25 feet and if the pumping level (distance to water level below the pumps while the well is being pumped) is less than 25 feet, a shallow-well pump will be satisfactory regardless of the depth of the well. If the pumping level is at a greater distance, a deep-well pump must be used. Many examples are known where dug wells 40 to 50 feet deep require deep-well pumps, whereas some drilled wells several hundred feet deep can be pumped by shallow-well pumps because their water levels are near the surface.

To obtain the most satisfactory service from a well, the owner or user should know certain essential facts about it. These include depth of the well, diameter of the casing and of the well below the casing, depth of the casing, static water level, quantity of water yielded, and drawdown at the maximum yield. Knowledge of the depths at which water was encountered in the well is also very helpful. Data on the pump should include type of pump and amount of suction, or jet, for a deep-well pump. With this information, the possibility of increasing the yield by changing the pump installation can readily be determined. In order to determine the static water level and pumping level from time to time the pump should be installed so that these measurements can be made.

ROCK UNITS AND THEIR WATER-BEARING PROPERTIES

INTRODUCTION

The areas in which the different rock units occur are shown on individual county maps (figs. 9, 11, 13, etc.). The reconnaissance nature of the mapping and the common variation of rock types in tens of feet and even fractions of a foot render the geologic maps less accurate than desired. An attempt was made to determine the type of rock penetrated by wells in the area, and in many cases this was possible. Data on 981 wells are tabulated and given with the county descriptions in this report. In order to compare the water-yielding properties of wells in the different rock units, tables were prepared showing the average depth, average yield, and other pertinent data available for drilled wells 3 inches or more in diameter in each rock unit. The topographic location was noted for most wells, and other tables give the same data according to topographic location. These tables are given with the description of each rock unit.

The statistical treatment of the well data reveals the importance of such factors as rock type, topography, and depth of well to yield, although the inadequacy of data places limitations on the inferences drawn. For example, the yields listed are not necessarily related to the specific capacity of wells* or to any particular lowering of the water table. The yields given for many domestic wells represent the required yields, resulting in a drawdown of the water table of only a few feet, whereas yields for industrial and municipal wells generally represents the near maximum yields resulting in a considerable drawdown of the water table. Therefore, in the tables listed the average yield of domestic wells is considerably less than that of industrial and municipal wells. Another matter to be considered in order to prevent misleading conclusions involves depths of wells. Personal factors control the depth of drilling individual wells, and these factors are not necessarily related to the depths at which water occurs. The depth of some wells represents the depth at which the desired quantity of water was obtained. Some wells are too shallow to obtain the maximum available supply, whereas others are known to be deeper than necessary to obtain the maximum supply.

RELATIVE WATER-BEARING PROPERTIES OF THE ROCK UNITS

Tables 3 to 7 show the relative merits of wells in different rock units, and figure 7 shows graphically the yield per foot of well in the different rock units.

Of 490 wells, about which the available data are considered accurate or reasonably accurate, the average depth is 155 feet, the average yield is 17 gallons a minute, and the average yield per foot of well is 0.11 gallon per minute. The lowest yield is zero and the highest yield is 150 gallons a minute. About 3 percent of the wells yield 1 gallon a minute or less.

*Gallons per minute per foot of drawdown.

The schist has by far the highest average yield, more than 50 percent greater than the average yield of wells in granites, which have the next highest average yield. Wells in diorite rank third in yield with an average of 14. Wells in slate are the poorest with an average of 10.5 gallons a minute.

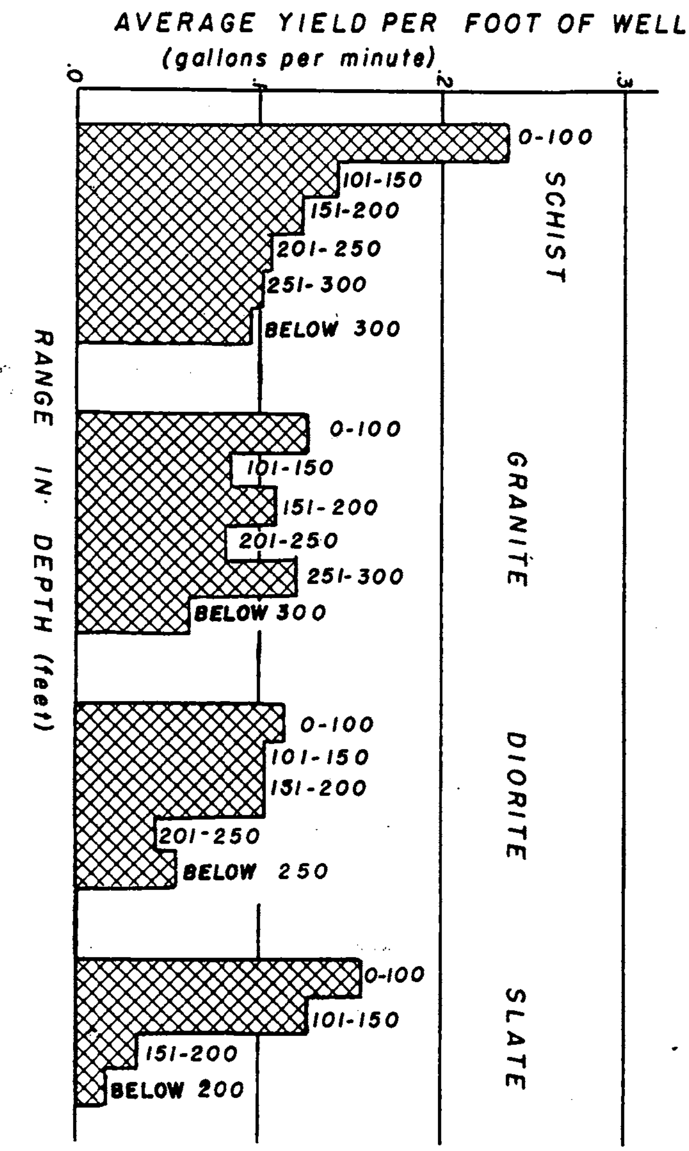

FIGURE 7.—*Average yield, per foot of well, of wells in the different rock units, according to range in depth.*

TABLE 3.—AVERAGE YIELD OF DRILLED WELLS ACCORDING TO ROCK TYPE

Rock unit	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Schist	168	161	0—150	22.0	0.14	2
Slate	19	123	0— 70	10.5	.09	16
Granite	234	159	0—150	14.5	.09	3
Diorite	69	135	0— 75	13.6	.10	7
All wells	490	155	0—150	16.6	.11	3

TABLE 4.—AVERAGE YIELD OF WELLS IN GRANITE

ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
0—100	90	75	1— 44	9	0.13	1
101—150	66	123	1— 65	11	.09	2
151—200	38	180	1—100	20	.11	2
201—250	13	223	0— 80	18	.08	7
Below—300	23	504	0—150	31	.06	10
All wells	234	159	0—150	15	.09	2

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Hill	85	149	0—100	10	0.07	5
Flat	16	215	2—150	19	.09	9
Slope	66	143	1—100	12	.08	3
Draw	55	167	2— 90	23	.14	0
Valley	12	208	0— 25	17	.08	8

TABLE 5.—AVERAGE YIELD OF WELLS IN DIORITE

ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
0—100	21	83	1—45	9	0.11	5
101—150	27	127	0—75	13	.11	4
151—200	15	176	3—60	18	.11	0
201—250	2	206	----------	9	.04	0
Below—250	4	277	----------	16	.06	0
All wells	69	135	0—75	13	.10	3

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Hill	27	132	1—28	8	0.06	7
Flat	7	129	2—40	17	.13	0
Slope	17	150	2—75	14	.09	0
Draw	14	127	4—75	24	.19	0
Valley	4	130	5—15	9	.07	0

TABLE 6.—AVERAGE YIELD OF WELLS IN SCHIST (Drilled wells 3 inches or more in diameter)

ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
0—100	61	74	3— 80	18	0.24	0
101—150	47	126	0—120	18	.14	2
151—200	29	178	1— 60	22	.12	3
201—250	9	222	1— 50	23	.11	10
251—300	4	279	6— 60	29	.10	0
Below—300	18	461	1—150	45	.10	5
All wells	168	161	0—150	22	.14	2

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Hill	55	160	0— 65	14	0.09	2
Flat	10	162	1— 40	18	.11	10
Slope	54	168	1—150	23	.14	2
Draw	42	155	3—102	29	.19	0
Valley	7	153	9— 50	23	.15	0

TABLE 7.—AVERAGE YIELD OF WELLS IN SLATE (Drilled wells 3 inches or more in diameter)

ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
0—100	9	72	0—70	11	0.16	10
101—150	4	131	1—50	17	.13	25
151—200	3	178	----------	6	.03	0
Below—200	3	208	----------	4	.02	33
All wells	19	123	0—70	11	.09	16

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Hill	3	121	0— 5	2	0.02	66
Flat	3	128	----------	6	.05	0
Slope	7	78	2—70	14	.18	0
Draw	5	158	1—10	6	.04	20
Valley	1	150	----------	50	.33	----------

Even though rocks of different types are known to vary in their capacity to yield water, certain factors make these tables of comparative average yields somewhat misleading. Wells supplying municipalities and industries, which require much larger yields than are obtained from domestic wells, are concentrated in certain of the rock units. The greater yields of municipal and industrial wells are due to a greater drawdown of the water table in the wells rather than to a difference in the specific capacity of the wells. The proportion of municipal and industrial wells in the various rock types are: schist, 51 percent; granite, 37 percent; diorite, 16 percent; and slate, 15 percent. This is the same order of average yields, from highest to lowest. It is evident that the comparatively high yield of the schist is due in part to the fact that half the wells in the schist were for municipal or industrial use. At the same time the comparatively low average yields of the diorite and slate are due partly to the low percentage of industrial wells and consequently to the high percentage of domestic wells. As many of the industrial and municipal wells are deeper than the domestic wells the average yield per foot of well partly eliminates the misleading and influencing factor caused by a disproportionate relationship between the domestic and industrial wells. The same rank in yield of water holds if average yield per foot of well is considered, but a wide difference in the productivity of each rock is not apparent. For example, the yields in gallons a minute per foot of well are: schist, 0.14; diorite, 0.100; granite, 0.09; and slate, 0.086.

Table 3 includes some wells whose diameters are less than 3 inches. The yields given for some of the 2-inch wells apparently represent the amount of water that can flow through the pipe and not necessarily the amount of water that the rocks in the well area will yield. Seven or eight gallons a minute is about the maximum amount of water that can pass through a 2-inch well equipped with a deep-well pump, and this is less than a large-diameter well will yield at the same place. All the 2-inch wells included in table 3 penetrate diorite or granite in Cabarrus and Mecklenburg Counties. Thus the average yields of these rocks are slightly lower than they would be if only wells 3 inches or more in diameter had been considered. For example, the average yield of all drilled wells in both diorite and granite in Mecklenburg County is 14 gallons a minute, whereas the average is increased to 18 gallons a minute if only 3-inch and larger wells are considered.

Table 8 summarizes the data for industrial and municipal wells drilled in four types of rocks and probably gives a more accurate estimate of the relative amounts of water that can be obtained from wells drilled in these rocks.

The 87 industrial and municipal wells in schist average 207 feet in depth and 31 gallons a minute in yield. Only the slate has a higher average yield and this may be due to the fact that only three industrial wells penetrate slate, one of which yields 70 gallons a minute. This gives the three wells in the slate an average yield of 42 gallons a minute, which is hardly representative of the slate as a whole, inasmuch as the average yield of all wells in slate is only 106 gallons a minute, the lowest of all rocks. Only 17 percent of the industrial and municipal wells in schist yield 10 gallons a minute or less.

TABLE 8.—AVERAGE YIELD OF MUNICIPAL AND INDUSTRIAL WELLS ACCORDING TO ROCK TYPE
(Wells 5 inches or more in diameter)

Type of rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 10 gallons a minute or less
			Range	Average	Per foot of well	
Granite	88	256	4—150	26	0.10	25
Schist	87	207	1—102	31	.15	17
Slate	3	145	5— 70	42	.29	33
Diorite	11	168	1— 75	31	.19	36
All wells	189	227	1—150	29	.13	23

Table 8 shows 11 wells in diorite yielding an average of 31 gallons a minute, 2 gallons more than the average from industrial and municipal wells in all rocks. However, the diorite has the highest percent (36) of wells yielding 10 gallons a minute or less. The 88 industrial and municipal wells in granite average 256 feet in depth, 26 gallons a minute in yield, and 0.10 gallon a minute in yield per foot of well. The table shows that 25 percent, or one well in four, yield 10 gallons a minute or less. The granite yields 3.4 gallons a minute per well less than the average for all industrial wells. This is in line with table 3 in which the yield of granite is shown to be 2.1 gallons a minute less than the average for all rocks.

Effect of topographic location.—Evidence has already been produced to show that topography is a factor to be considered in selecting a well site. The effects of topography may obscure the true significance of rock type as a factor in the yields of wells. In general the topography is a reflection of the type of underlying rock. In some places an inherent feature of the rock makes it more or less resistant to erosion; in other places mere chance of geographic location results in greater erosion during the same interval of geologic time.

Although too few wells were drilled into it to determine an average, the ridge-making quartzite in Gaston County produces yields that reflect hilly topography, and this will definitely mask the significance

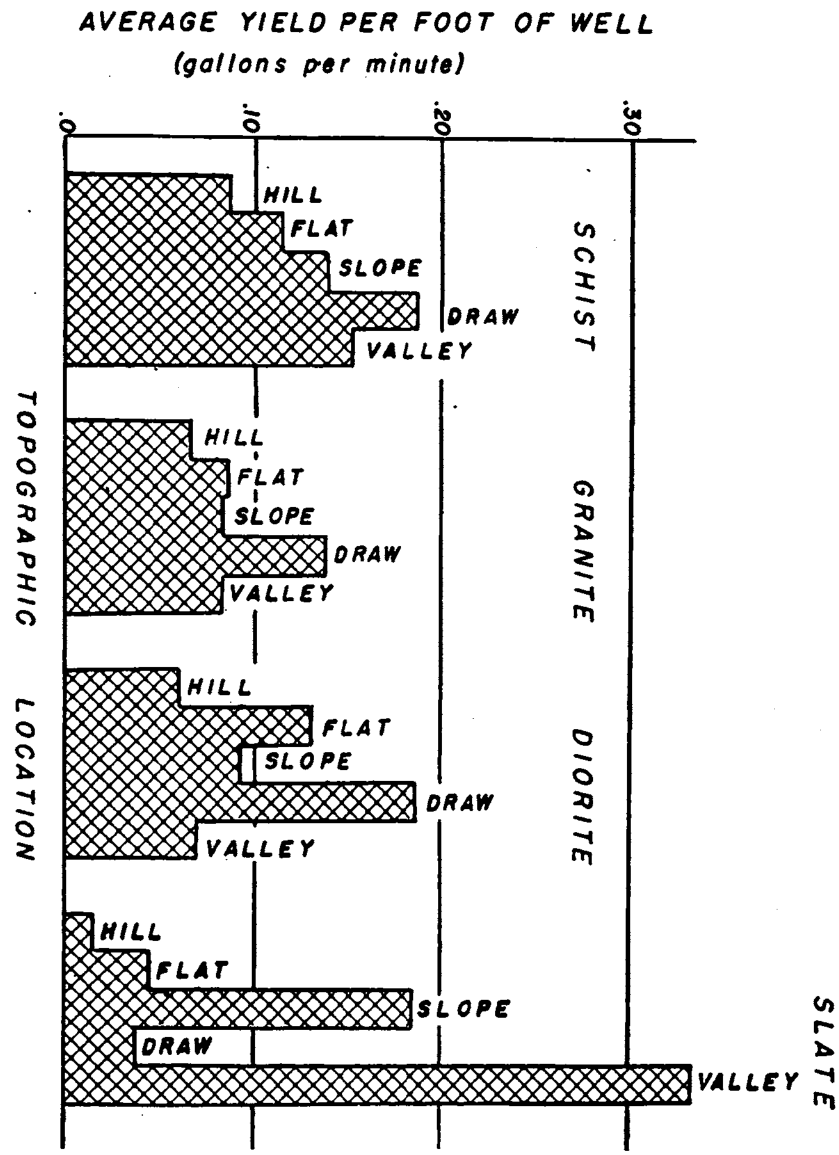

FIGURE 8.—*Average yield, per foot of well, of wells in the different rock units according to topographic location.*

of yield to quartzite as a rock type. The hornblende gneiss in the plains of Lincoln County can hardly be expected to have the same yields as the well-drained hornblende gneiss in the hills of Rutherford County. Inasmuch as topography is such an important factor in relation to yield and as certain topographic features are characteristic of certain rocks, average yields determined according to topography tend to mask the average yields according to rock type. The effect of topographic location on the yield of wells in the various rock types is shown in tables 4 to 7 and in figure 8. Figure 6a explains topographic terms as used in the report.

RELATION OF DEPTH OF WELL TO YIELD

The relation of the depth of wells to the yield of water, on the basis of available information, is given in table 9, and is shown graphically in figure 7.

Table 9 shows that wells less than 100 feet deep have a greater average yield per foot of well below the water table than wells in any greater depth range. It also shows that the yield per foot of well for wells more than 300 feet deep is much less than in wells of shallower depth.

It is evident that the rocks below 250 feet are much poorer aquifers than the rocks at shallower depths. Actually the difference in the water-yielding properties above and below 250 feet is even greater than is apparent from the table. The average yield, per foot ofwell below the water table, of all wells between 150 and 250 feet deep is 0.131 gallon a minute. If the average yield per foot of well below the water table of the upper 250 feet of the deep wells is assumed to be 0.131 gallon a minute, the yield per foot of well of that part of the well below 250 feet is only 0.033 gallon a minute. Expressing the same relationship in gallons a minute per well, it can be shown if all wells between 150 and 250 feet deep were 250 feet deep the average yield should be 28.17 gallons a minute; this can be compared with wells more than 250 feet deep averaging 34 gallons a minute at a depth of 439 feet. Thus, with an additional drilling of 189 feet below 250 feet only 6.24 gallons a minute additional water appears to be the average gain.

TABLE 9.—AVERAGE YIELD OF WELLS ACCORDING TO DEPTH

Range in depth (feet)	Number of wells	Average depth (feet)	Average depth below water table[1]	Yield (gallons a minute)				Percent of wells yielding 1 gallon a minute or less
				Range	Average	Per foot of well	Per foot of well below water table[1]	
0—100	180	75	40	0— 80	12.2	0.163	0.305	2
101—150	144	125	90	0— 75	13.4	.107	.148	4
151—200	85	178	143	1—100	20.4	.114	.142	3
201—250	27	220	185	0— 80	17.8	.081	.096	11
251—300	16	279	244	6— 60	24.8	.089	.101	0
Below 300	36	510	475	1—150	39.4	.077	.083	8
All wells	488	155	----------	0—150	16.7	.108	----------	----------

[1] Assuming the water table to be an average of 35 feet below the surface.

The reason for the decrease in yield per foot with increase in depth is that fewer fractures, joints, and other openings through which the water moves exist at depth and the weight of the overlying rock causes the fractures and joints to be tighter and narrower.

Drilling to great depth in the rocks of the Charlotte area is seldom sound policy; if an adequate supply of water is not obtained within 250 or 300 feet of land surface there generally is little chance of obtaining a large amount at greater depth. However, if a well yields 40 gallons a minute at 250 feet and a yield of 50 gallons a minute is desired, the chances are fair that the additional amount can be obtained by drilling 75 or 100 feet more.

FLOOD-PLAIN DEPOSITS

Many of the streams in the Charlotte area flow over sand and gravel deposited by them as alluvium. These deposits generally are not thick or extensive because the streams, for the most part, are removing a greater amount of material than is being deposited; nevertheless, discontinuous deposits of varying thickness and as much as a quarter of a mile wide are common along most of the streams.

These deposits have not been utilized as a source of ground-water supply. In 1947 Mundorff, with the assistance of G. E. Siple of the Geological Survey, made a preliminary investigation of the flood-plain deposits of the streams in the Piedmont and Mountain provinces of North Carolina to determine in a general way their location, extent, thickness, and water-bearing character. These deposits were specifically tested in only two localities (in Cabarrus County) within the Charlotte area, but they are believed to constitute a potentially important source of water, especially where they could be recharged by infiltration of river water. Results of tests made in Cabarrus County are listed below.[21]

T_1

Date	: June 9, 1947
Location	: Concord, 1.5 miles northeast of, 50 feet north of State Highway 73, 10 feet west of Coldwater Creek.
Width of flood plain	: About one-fourth mile
Elevation of hole	: 9.7 feet above water level at 6:45 p.m.

Thickness (feet)	LOG OF HOLE
0 — 1.5	: Sand, fine-grained, dark-brown.
1.5— 6.2	: Clay, sandy, rather hard, dark brown.
6.2— 9.0	: Sand, very fine, clayey, dark-gray to blue-gray ("salt and pepper" appearance)
19.7—21.2	: Granite, disintegrated.
Total depth	: 21.2 feet; cased to 20 feet to prevent loss of circulation in sand between 9.0 and 19.7 feet.

T_2

Date	: June 10, 1947
Location	: Concord, 5.5 miles northwest of, 100 yards north of State Highway 73, 10 feet east of Coddle Creek.
Width of flood plain	: About one-fourth mile.
Elevation of hole	: 4.95 feet above water level at 5:25 p.m.

Thickness (feet)	LOG OF HOLE
0 — 2.8	: Clay, silty, very micaceous, reddish brown.
2.8— 4.3	: Sand, medium-grained, reddish-brown.
4.3—13.0	: Sand, coarse, gray, green and black, and gravel (permeability 2,700).
13.0—14.7	: Sand, fine-grained, lightgray, (contains wood).
14.7—15.6	: Silt and clay, dark-blue and black.
15.6—16.0	: Schist (?), very fine sandy micaceous material, very hard.
Total depth	: 16.0 feet, cased to 13.0 feet to prevent loss of circulation.

[21]Mundorff, M. J., Flood-plain deposits of North Carolina Piedmont and Mountain streams as a possible source of ground-water supply: North Carolina Dept. Cons. and Devel. Bull. 59, p. 4, 1950.

COUNTY DESCRIPTIONS

INTRODUCTION

In the following pages the geography, geology, and ground-water conditions of the Charlotte area are described by counties in alphabetical order. With each county description are included two maps, one showing the geology mapped by the writers and the other the location of wells discussed in this report. At the end of each county description are tables of well data.

In the tables, the first column gives the well number which corresponds to the number shown on the county map. The second column gives the distance and direction from the nearest city, town, or village. The distance was scaled from county maps of the State Highway Department and is accurate to a quarter of a mile. The third column gives the name of the owner of the well. The fourth column gives the name of the driller; some of the names are abbreviated to save space and the complete names given in footnotes. Column 5 shows the type of well, that is, the manner in which it was constructed. This column is also abbreviated and the complete type name is given in footnotes. Columns 6 and 7 give the depth of the well and the depth of the casing. The diameter is given in column 8. Another column gives the depth to water below the land surface. This is the level of the water when the well is not being pumped, and is known as the static level.

Figures followed by the letter "R" are reported depths and some may be inaccurate. Some of the figures show the depth to water when the well was completed; others are the depth at some subsequent time when the pump was repaired. Figures followed by the letter "M" are the depths measured during the investigation. Another column gives the yield in gallons a minute. The figures in this column differ greatly in degree of accuracy. Many of them are based on bailer tests by the driller. Some of these may be inaccurate because the test was of short duration. In others the drawdown was very small and the capacity of well is much greater than is shown. In some wells the figure for yield is based on the capacity of the pump and the length of time necessary to draw the water level down to the suction or intake of the pump. Some wells have had accurate pumping tests ranging from a few to 48 hours duration. Where such tests were made, the essential facts are given in column 12, headed "Remarks." A column headed "Character of material," gives the type of rock in which the well is drilled. This information is based on areal geologic mapping done during the course of the investigation, and statements of the driller, owner, and others. Because of the thick layer of soil and disintegrated rock in many places and the complexity of the geology, the rock into which the well was drilled may not actually be that as given in the table. The column headed "Remarks" gives the type of topographic location. Five types are included: hills, flats, slopes, draws, and valleys. This column also gives information regarding pumping tests, quantity of water, field tests or reported hardness of water, temperature of the water, and other information. If an analysis of the water is given following the table of well data, it is so stated in this column.

After the table of well data is a table of analyses of water from wells and springs in the county. The numbers at the heads of the columns are the numbers of the wells from which the water samples were taken.

Population figures given are from the 1950 census.

CABARRUS COUNTY

(Area 360 square miles; population in 1950, 63,783)

Geography and physiography.—Cabarrus County forms the northeastern corner of the Charlotte area (figs. 1 and 10). Its economy includes agriculture and the manufacture of textiles. During the nineteenth century gold mining was an important industry, but the present sporadic operations are not important to the economy of the county. Concord, the county seat, and Kannapolis are industrial centers, the remainder of the county being devoted chiefly to farming. One of the important arteries of highway traffic, U. S. Route 29, passes through the county and is joined by other paved roads. Railroads serve the more thickly populated areas.

The topography is similar to that in adjacent counties of the Piedmont Province. The county is an upland plain moderately dissected by streams. The highest land is in the northwest corner of the county where the altitude is approximately 800 feet. The land slopes southeastward, the lowest altitude being along Rocky River in the south.

The county is drained by Rocky River which enters along the northwest border, flows southeastward to the vicinity of Georgeville where it is apparently deflected southwestward by the southwest-striking slates. Many large creeks flowing into Rocky River are so closely spaced that the interstream areas are generally low and local relief is not great. Most of the streams have sinuous courses bordered by rather wide flood plains.

Geology.—Rocks of the Carolina slate belt trend southwestward, forming a belt about 4 miles wide along the southeastern border. About half of this belt includes slates that have a pronounced southwest lineation. These slaty rocks are composed of admixtures of volcanic ash and land waste. Both acid and basic volcanic rocks, including lava flows and volcanic ejecta, are interlayered with the slates. The acid rocks are composed chiefly of fine to coarse tuffs, chiefly rhyolitic. The basic rocks are composed of tuffs and flows of andesitic character. Along the western edge of the slate belt is an area composed of metamorphosed basic igneous rock, conveniently called greenstone.[22] It is locally both massive and schistose and has a prevailing green color. Laney considers it to have been, according to its character, a surface flow of basic lava and a tuff. It is the only rock of the slate belt that granite intrudes. The rocks of the slate belt have been subjected to a period of mineralization that brought in gold and tungsten as important minerals.

West of the greenstone belt and including the northern two-thirds of the county is a complex group of igneous rocks ranging in character from granite to gabbro. Although these rocks are metamorphosed in some places they are not strongly foliated as are other rocks of the area.

Probably the most striking feature of the geology of Cabarrus County is the outcrop of syenite, which forms a "ring dike" north of Harrisburg. The outer circumference of the ring is about 22 miles. At its thickest portion along its western border where Rocky River crosses it, the syenite exposure is slightly more than 1 mile wide. Along its southern border on U. S. Route 29 it pinches out although several elongated lenses of syenite conform to the ring structure. The syenite contrasts sharply with the diorite and gabbro with which it is in contact along its outer and inner borders. It is more resistant to erosion than the gabbro and diorite and thus stands out slightly in relief. Its area of outcrop is generally marked by huge rounded boulders or pedestal rocks surrounded by a light colored arkosic soil formed from granular disintegration of the syenite. The rock is largely homogeneous and unmetamorphosed.

The syenite is a coarse-grained rock consisting almost entirely of a bluish gray feldspar high in soda content. The conspicuous dark mineral is augite. The absence of a fine-grained matrix permits the syenite to disintegrate into residual granular feldspar crystals that make excellent road metal.

Dark-colored, mafic rocks ranging in composition from gabbro to diorite occur within the ring dike and in some places outside the dike. The gabbro-diorite is not resistant to erosion although the soil overlying it is generally much thinner than that derived from other rocks. The soil, representing the Iredell and Mecklenburg soil types, is dark brown or black. The gabbro-diorite shows a considerable range in texture and composition. The chief minerals are augite, hornblende, and plagioclase feldspars. Much of the surface rock has a green or yellow tint from the presence of epidote.

It is possible that all rocks west of the belt of greenstone in Cabarrus County, except the syenite and gabbro-diorite, are related to the diorite-granite complex. The diorite and granite of this complex completely surround the ring structure and form the country rocks in the western two-thirds of the county. The rocks consist of interpenetrated diorite and granite, diorite predominating here and granite there. It is difficult to understand the complex state of these two rocks without postulating at least two intervals of intrusions of one or the other rock. In this connection, it is clear that the granite penetrates a part of the diorite. Where the granite predominates, the diorite appears as intrusive, suggesting that some of the diorite is younger than the granite. The possibility of two periods of emplacement of diorite is increased by the fact that in some places the diorite is considerably more metamorphosed than in other places.

The country rock is predominantly diorite in the area surrounding the ring dike and in the area immediately west of the greenstone. In the northwest corner of the county and in the basin of Little Cold Water Creek the rock is almost entirely granite.

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[22] Laney, F. B., op. cit., p. 42.

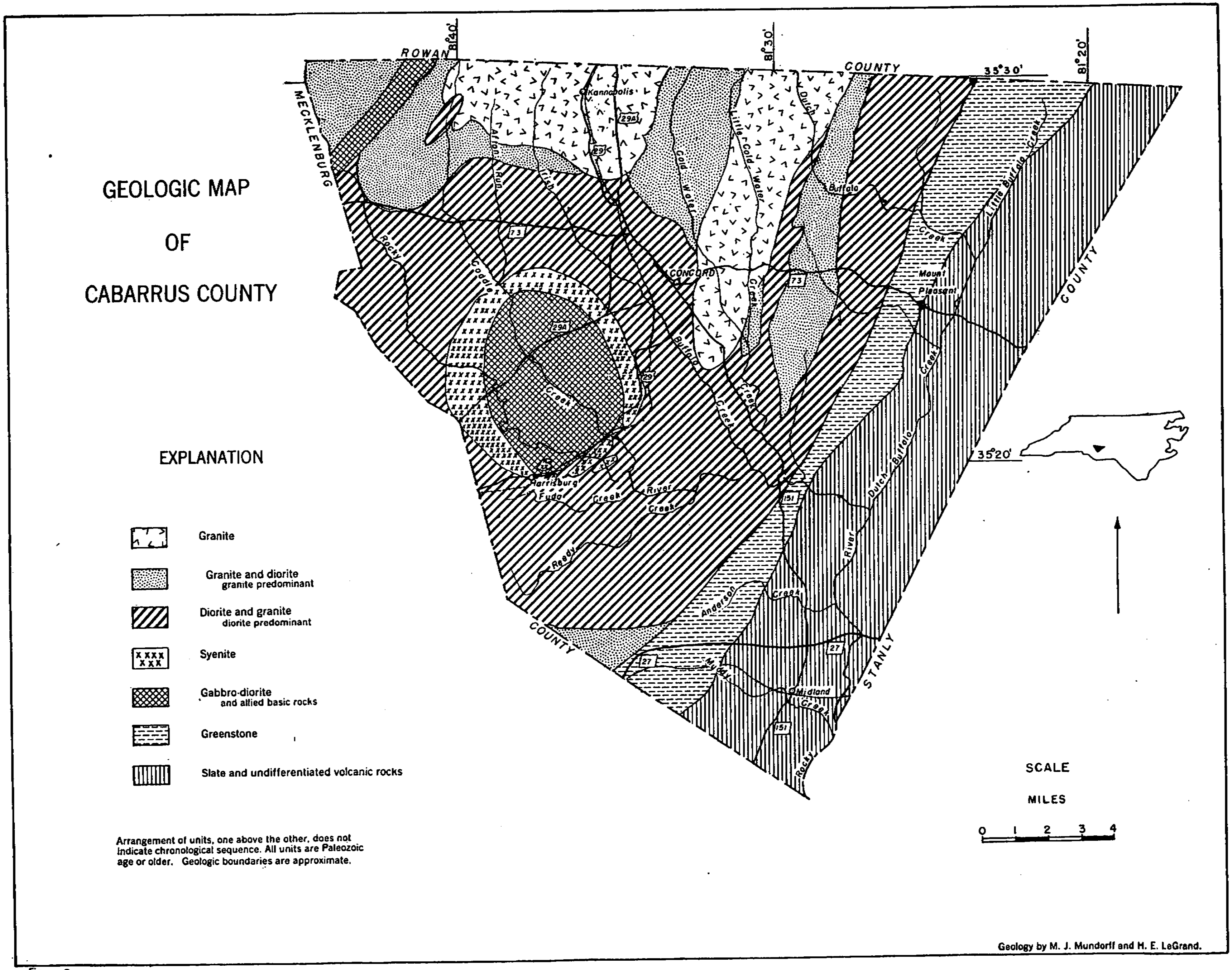

Figure 9

FIGURE 9.—*Geologic map of Cabarrus County.*

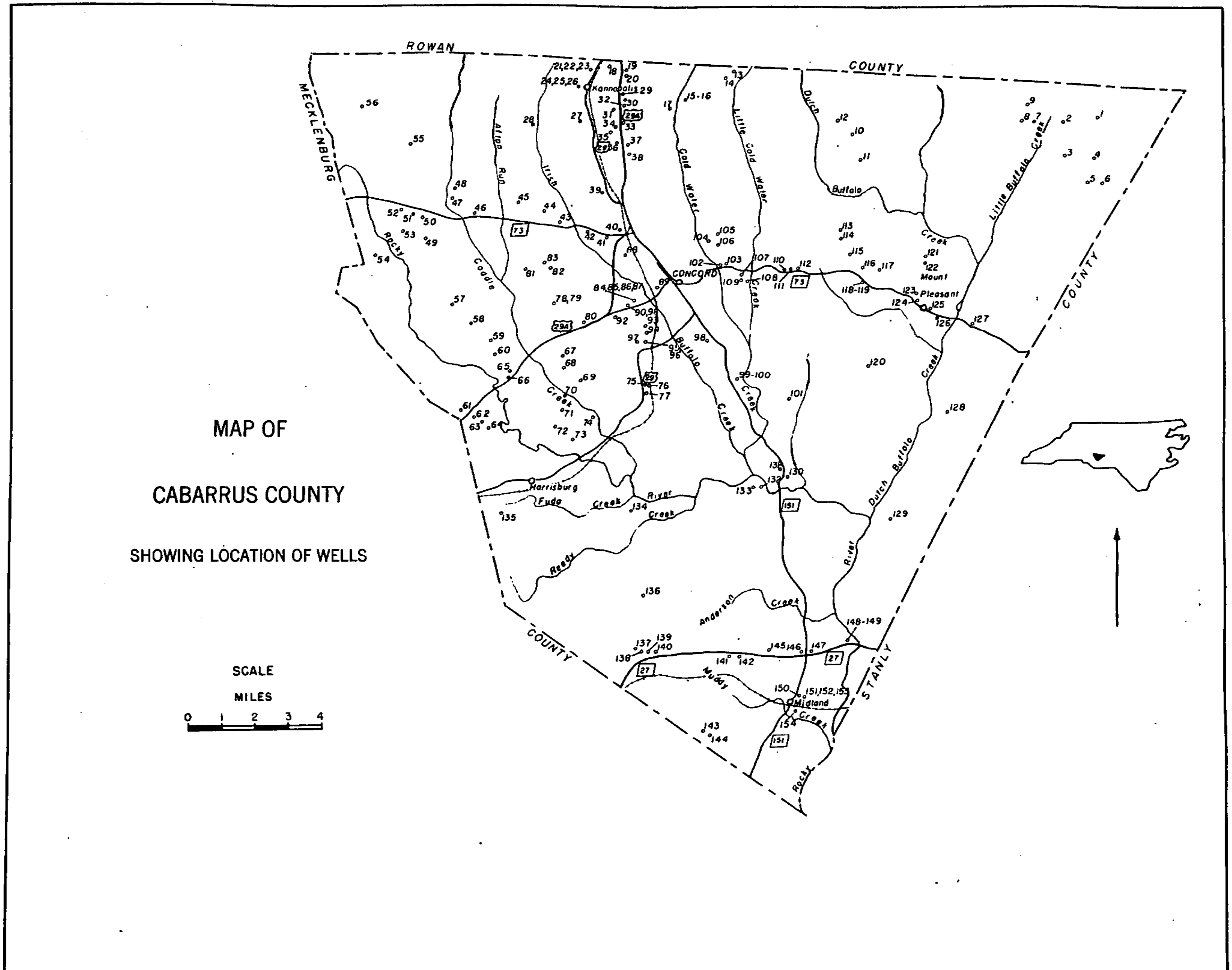

FIGURE 10.—*Map of Cabarrus County showing location of wells.*

Ground water.—Practically all domestic water supplies, many industrial supplies, and one municipal supply are obtained from wells in Cabarrus County. Dug wells, used extensively in the rural areas, obtain water from the weathered residual material above the hard bedrock. As the rocks differ in the extent to which they weather, the dug wells that penetrate them also vary in yield. The soils covering the syenite, gabbro, and diorite are generally thin on the upland areas. If the water table lies in the bedrock below the soil zone or if it is lowered into bedrock during a dry season, dug wells under such conditions cannot be dependable. Wells dug near an outcrop of bedrock may fail.

Drilled wells are used for many domestic and industrial water supplies. Table 10 gives a summary of the data on drilled wells in Cabarrus County.

TABLE 10.—SUMMARY OF DATA ON WELLS IN CABARRUS COUNTY

ACCORDING TO ROCK TYPE

Type of rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Diorite	27	124	0—20	7	0.06	4
Granite	65	186	1—150	14	.07	1
Slate	19	123	0—70	11	.09	15
Schist	5	207	9—50	26	.13	0
All wells	116	162	0—150	12	.08	4

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less
			Range	Average	Per foot of well	
Hill	33	152	0—30	8	0.05	8
Flat	10	260	2—150	23	.09	0
Slope	43	111	1—70	11	.10	2
Draw	17	164	1—75	15	.09	6
Valley	13	199	5—50	17	.08	0

The table shows that the average yield of all wells in Cabarrus County is 12.5 gallons a minute, or 4.1 gallons a minute less than the average yield of all drilled wells in the Charlotte area. This low average yield is due, in part, to the fact that some of the wells averaged, being less than 3 inches in diameter, show the maximum yield of water from the pipe, which may be less than that which could be yielded by the rocks if a larger diameter well were used.

Another factor that may contribute to the lower yield of wells is the thinness of the soil zone which is characteristic of the several rocks in Cabarrus County; as the soil zone acts as a storage area from which wells may draw water, a thin soil zone contains less storage space than a thick zone of the same material.

Table 10 shows that the schist, in this case greenstone schist, is the best water-bearing formation in Cabarrus County although the five wells drilled into it may not be representative. The wells in the greenstone schist have an anomolous average yield of 26 gallons a minute. The granite[23] has an average yield of 14 gallons a minute as compared with an average of 12.5 gallons a minute for all wells in the county. The average depth of wells in the granite and syenite is 186 feet or about 30 feet more than the average drilled

[23] Syenite included with granite in table 10.

well in the Charlotte area. This is due chiefly to the fact that several wells are approximately 500 feet deep. The low yields from the slate, 11 gallons a minute per well, is attributed chiefly to the poor water-yielding capacity of the slate and, in part, to the fact that most of these wells are of small diameter and used for domestic purposes. Diorite is the poorest water-bearing formation, yielding only 7 gallons a minute per well or 0.06 gallon a minute per foot of well.

As in other counties, topography is an important factor in so far as yield is concerned. Wells on hills in Cabarrus County have an average yield of 8 gallons a minute, which is considerably less than on other topographic features.

Analyses of water from 11 wells in Cabarrus County are given in the table of analyses. Wells 33, 36, and 52 penetrated granite and yield water low in mineral matter. Well 58, obtaining water from syenite, also yields water low in dissolved solids. The water from diorite (wells 16 and 70) is generally more mineralized than that from granite; in many places it has a total hardness of more than 200 parts per million. Analyses of water from wells 7, 122, and 123, in greenstone schist, indicate that the water from the greenstone is only slightly more mineralized and is of good quality. The only analysis of water from the slate (well 151) shows a total hardness of 378 parts per million and a chloride content of 101 parts per million. It is not known whether this water is typical of the waters that occur in the slates.

Temperatures range from 61° to 63°F. in individual wells.

Municipal supplies.—Mount Pleasant, population 1,019, has the only municipal ground-water supply in Cabarrus County. The supply is obtained from four drilled wells, ranging in yield from 30 to 50 gallons a minute. Two of the wells have shown an appreciable decline in yield since being drilled. The water, obtained from greenstone schist, ranges from soft to moderately hard in different wells. Treatment of the water consists of aeration and chlorination.

RECORDS OF WELLS IN CABARRUS COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Character of material	Water level (feet below surface)	Yield (g.p.m.)	Remarks
1	7 miles NE of Mount Pleasant	Mrs. G. A. Barringer		Dug	40		24	Slate			Hill.
2	6½ miles NE of Mount Pleasant	W. A. Hammiel	Arne Ridenhour	Cr–Dr	62	26	4	Slate	20	5	Water contains some iron. Slope.
3	6 miles NE of Mount Pleasant	B. E. Dry	Charles Petree	Cr–Dr	55	20	4	Slate	20		Water hard, contains iron.
4	do	R. H. Mammiel	Morris	Cr–Dr	100	38	4	Slate	28	1–2	Soft water.
5	do	James A Culp		Cr–Dr	80		2	Slate		5	Slope.
6	do	Mrs. O. S. Culp		Cr–Dr	133		4	Slate	20	6–7	Hard water. Slope.
7	6½ miles NE of Mount Pleasant	Harley Wagoner	Arne Ridenhour	Cr–Dr	144	28	4	Greenstone		1–2	do
8	do	Walter Cline	do	Cr–Dr	185	28	4	do	55	5	Hill.
9	do	W. J. Cline	do	Cr–Dr	116	20	4	do		2	
10	7 miles NE of Concord	R. A. Safrit	Beaver	Cr–Dr	144	44	2	Diorite	30		Hard water. Slope.
11	do	Cline School	Boston	Cr–Dr	200		4	do		8–10	Water is moderately soft. Flat.
12	do	J. S. Safrit	Beaver	Cr–Dr	123	102	2	Granite	23	7	Flat.
13	4 miles NE of Kannapolis	Mrs. Annie S. Cline	Ben Aycock	Cr–Dr	80	55	2½	do	18	10	Water is hard.
14	do	Mt. Mitchell Methodist Church	do		80 to 90		2½	Granite		7–8	
15	2 miles E of Kannapolis	P. B. Hileman	do	Dr	202	26	6	do		8–10	Water is hard. Slope.
16	1½ miles E of Kannapolis	City of Concord	do	Cr–Dr	135	40	2½	Diorite		6	Water somewhat hard. Slope
17	do	A. B. Patterson	do	Dr	56	50	4	Granite		10	Water is soft. Valley.
18	Kannapolis	A. L. Moose		Cr–Dr	160		2	do		3	Supplies three families. Water slightly hard. Slope.
19	do	A. F. Walters	Boston	Cr–Dr	155	105	4	do	20	30	Supplies 28 houses. Hill.
20	do	A. W. Holbrook	Aycock	Cr–Dr	101		2½	do		10	Water soft. Slope.
21	do	Cannon Mills Co. Plant 1	Sydnor Well Co.	Dr	750		10	do		30	At the lake; not in use. Flat.
22	do	do	do	Dr	750		8	do		75	North of plant one-fourth mile. Not in use. Draw.
23	do	do	do	Dr	750		8	do		150	In mill yard; not used. Flat.
24	do	Cannon Mills Co. Plant 4	do	Dr	750		8			35	Not used.
25	do	do	do	Dr	750		8	Granite		35–40	Not used.
26	do	do	do	Dr	750		8	do		3–4	do
27	do	Page Hager	Ben Aycock	Cr–Dr	135	85	2½	do		17	Supplies 26 houses. Soft water. Draw.
28	2 miles E of Kannapolis	H. E. Ketchie	do	Cr–Dr	100	40	2½	do		9	Hard water.
29	Kannapolis	J. G. Lowe		Cr–Dr	107	80±	2½	do		8	Lowe well No. 4. Slope.
30	do	do	Arthur Matlock	Cr–Dr	116		2½	do		10	do 5. 61½° F. Hill
31	do	do		Cr–Dr	190		2	do		15	do 62° F. Slope.
32	do	do		Cr–Dr	180		2	do		7–8	do Slope.
33	do	do	Ellis	Cr–Dr	180		3	do		18	do Hill.
34	do	do	Arthur Matlock	Cr–Dr	104	40	2½	do		6	do 6. Flat.
35	do	Herman Cook	Ben Aycock	Cr–Dr	67	27	2½	do		7+	Supplies 20 houses. Soft water, no iron. Slope.
36	do	Ben Aycock	Ben Aycock	Dr	180	54	6	do	3	57½	Supplies about 80 houses. Soft water. Draw.
37	do	do	do	Dr	180	80	4	do	30	30	Water slightly hard.
38	do	Cobert Wilson	do	Cr–Dr	101	60	2½	do		10	Supplies six houses. Soft water.
39	3 miles S. of Kannapolis	B. L. Umberger	do	Cr–Dr	109	70	2½	do		6	
40	2 miles NW. of Concord	J. A. Lowe	Overcash	Cr–Dr	36	36	2	do		8–10	Soft water. Hill.
41	2 miles NW. of Concord	F. E. Funderburk	Ben Aycock	Cr–Dr	240	40	2½	do		4	Hill.
42	3 miles NW. of Concord	N. M. Starnes, Mr. Shoe	Will Fortner	Cr–Dr	49½		2	do		8	Draw.
43	4½ miles NW. of Concord	W. A. Buff	do	Cr–Dr	112		2½	Diorite		2–3	Soft water. Hill.
44	4 miles SW. of Kannapolis	W. T. Lane	do	Cr–Dr	83	60	2	do		6+	Soft water. Valley.
45	4½ miles SW. of Kannapolis	R. B. Lee	Ben Aycock	Cr–Dr	200	60	2½			8	Moderately soft water.
46	5 miles SW. of Kannapolis	Ray Smith	do	Cr–Dr	120	45	2½	Diorite		6	Hard water. Slope.
47	5½ miles SW. of Kannapolis	W. J. Irvin	Sam Fortner	Cr–Dr	76	50	2	Granite	20	4	Soft water; no iron. Hill.
48	do	G. M. Faggert	Morrison	Cr–Dr	105		2	Granite	20	4–5	Soft water. Slope.
49	7 miles SW. of Kannapolis	F. F. Allison	Will Fortner	Cr–Dr	120		2	Granite		5	Soft water. Slope.
50	do	R. B. Johnston	do	Cr–Dr	77	60	2	do		6	Moderately soft water; no iron. Slope.
51	do	F. L. Johnston	Sam Fortner	Cr–Dr	93		2	do		4	Soft water. Hill.
52	do	W. R. Odell School	Will Fortner	Cr–Dr	200±		3	do			
53	7½ miles SW. of Kannapolis	W. L. Goodnight		Cr–Dr	110	80	2	do	45	10–15	Soft water.
54	8½ miles SW. of Kannapolis	J. M. Cannon		Cr–Dr	125		2	do		5±	Hill.
55	6 miles W. of Kannapolis	Mason Goodman	Sam Fortner	Cr–Dr	100	60–70	2	Diorite	30	4	Moderately soft water. Draw.
56	7½ miles W. of Kannapolis	M. M. & J. J. Morrison	Morrison	Cr–Dr	165	80	2	Granite		6	Soft water. Flat.
57	7 miles W. of Concord	J. Ivey Cline	B. R. Bowers	Cr–Dr	139	23	2½	Schistose diorite	18	6	Draw.

[1] Dr+Drilled, Br+Bored, Cr–Dr+Core Drilled, B–Dr+Bored and Drilled, D–Dr+Dug and Drilled.

RECORDS OF WELLS IN CABARRUS COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Character of material	Water level (feet below surface)	Yield (g.p.m.)	Remarks
58	6½ miles W. of Concord	S. W. Cline	Will Fortner	Cr-Dr	100	20	2	Syenite	16		Adequate supply; soft water. Flat.
59	6 miles W. of Concord	R. C. Fisher		Cr-Dr	50-60		2	do	20	3	Water rather hard. Hill.
60	do	J. C. Penniger	Will Fortner	Cr-Dr	102	20	2	do		3	Soft water.
61	2½ miles NW. of Harrisburg	E. G. Little	Barrs	Cr-Dr	37	15	2	do	12	10	Soft water. Slope.
62	2 miles NW. of Harrisburg	W. P. Harry, J. M. Motley (tenant)		Cr-Dr	59		2	do		12	Draw.
63	do	W. P. Harry	Will Fortner	Cr-Dr	225	40	2	do		5	Hill.
64	do	W. A. Yates	do	Cr-Dr	90	40	2	do	25 to 30	9	Soft water. Slope.
65	5½ miles SW. of Concord	N. M. Starnes	do	Cr-Dr	49		2	Gabbro-diorite		9-10	Soft Water. Valley
66	do	do	Byers	Cr-Dr	198½		2	do	9		do
67	4¼ miles SW of Concord	J. H. Simpson	Ben Aycock	Cr-Dr	99	40	2½	do		6	Rock reported at 6 feet below surface. Hard water. Slope.
68	do	A. G. McLaughlin	Moss	Dr	28	18	6	do		2	Rock is very close to surface. Hard water. Flat.
69	4 miles SW. of Concord	P. L. Easley	Will Fortner	Cr-Dr	123	22	2	do	12	3½	Moderately hard water. Slope.
70	5 miles SW. of Concord	Roberta Mfg. Co.	Ben Aycock	Dr	276		6	do		15	Rock is near surface. Hard water. Valley.
71	do	do	Will Fortner	Cr-Dr	125		2	do		5	Hill.
72	6 miles SW. of Concord	Zeb Cochran	Ben Aycock	Dr	83		6	do		15	Hard water. Hill.
73	5½ miles SW. of Concord	J. W. Blackwelder	Ben Aycock	Dr.	135		6	Gabbro-diorite		20	Moderately hard water. Hill.
74	4½ miles SW. of Concord	J. J. Barnhardt	do	Dr	125	40	4	do		0	Not used. Hill.
75	3 miles SW. of Concord	Jackson Training School	Sydnor Well Co.	Dr	500		8	Syenite		15	Not in use. Slope.
76	do	do	do	Dr	300	175	8	do		35	Yielded 75 g.p.m. when drilled. Moderately hard water. Valley.
77	do	do		Dr	940		8	do		10	Rock at 40 feet. Well abandoned. Hill.
78	3¼ miles W. of Concord	Z. A. Morris, N. E. Queen (tenant)		Dug	39	0	24	Gabbro-diorite	23		Hard water. Hill.
79	3 miles W. of Concord	Clear Springs Farm		Dr	157	40	4	do	10 to 12	22	Wells 140, 170 and 180 feet deep. Yield 0 to 4 gallons a minute each Slope.
80	do	do	Ben Aycock	Dr	140	30	4	do	Above surface	3	
81	4¼ miles W. of Concord	L. E. Polk	Will Fortner	Cr-Dr	47	42	2½	Syenite	20	6	Soft water well 130 feet deep on hill. Yielded 1 gallon a minute. Valley.
82	3 miles W. of Concord	J. D. Deal		Dug	40	40	36	do	28.48		Soft water. Hill.
83	do	J. E. Mainer	Ben Aycock	Cr-Dr	45	40	2½	do		3	Rock at 3 feet, moderately soft water.
84	Concord	Brown Mfg. Co.		Cr-Dr	150		2	Granite		8-10	Slope.
85	do	do	Ben Aycock	Dr	259	80	6	do		37	Water slightly hard. Slope
86	do	do		Cr-Dr	175		2½	do		12	do Slope.
87	do	do		Cr-Dr	200		2	do		15	Valley.
88	do	Cannon Mills Co. Plant 6		Dr	612		8	do	50	25	62° F. Hard water. Used for making ice. Valley.
89	do	Cannon Mills Co. Plant 2		Dr	300	100	6	do	25	20-25	Abandoned. Valley.
90	do	Cannon Mills Co. Plant 10	Va. Mach. Co.	Dr	740		8	do		0	Had 1 to 2 gallons a minute before blasting, 0 after.
91	do	do	Ben Aycock	Dr	170	40	4	do		22	Use several other wells 2" to 4" diameter. Depths and yields not known. Slope.
92	do	County Home		Cr-Dr	300		2	Syenite			63°F. Hard water. Hill.
93	do	The Stead & Miller Co.		Dr	88		4	Granite	50	20-25	do Hill.
94	do	Cannon Mills Co. Plant 9		Cr-Dr	170		2	do		3½	Well at welding room. Slope.
95	do	do		Dr	173		4	do		3	Well on Robeson street. Slope.
96	do	do		Cr-Dr	112		2	do		5	
97	do	do		Cr-Dr	150		2	do		4½	Used in mill village.
98	2 miles S. of Concord	Cook Packing Co.	Ben Aycock	Dr	185	84	6	do		20	Draw.
99	3½ miles SE. of Concord	A. T. Allen School		Dr	90		4	do		1½	Hill.
100	do	do		Dr	180		4	do		6½	do.
101	5 miles SE. of Concord	M. E. Cline	Bowers	Cr-Dr	107	30	2½	Schistose diorite	30	3	Rock at 3 feet. Hard water. Valley.

RECORDS OF WELLS IN CABARRUS COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Character of material	Water level (feet below surface)	Yield (g.p.m.)	Remarks
102	1½ miles E. of Concord	J. W. Propst	----	Dr	100±	----	6	do	----	----	----
103	do	J. T. Blackwelder	----	Cr-Dr	113		2	do	----	5	Soft water. Valley.
104	2 miles NE of Concord	M. W. Murph	Ben Aycock	Cr-Dr	221	60	2½	Granite	30	6+	Valley.
105	do	William Cook	do	Cr-Dr	128	90	2½	do	40	5	Soft water. Hill.
106	do	V. M. Murph	do	Cr-Dr	119	83	2½	do	70?	6+	do.
107	2 miles E. of Concord	J. C. Query	D. R. Bowers	Cr-Dr	145	44	2½	do	----	5	61½° F. Hill.
108	do	Lee Blackwelder	Beaver	Cr-Dr	122	----	2	do	----	6	63½° F. Soft water, no iron. Slope.
109	do	J. C. Query, Lewis Green (tenant)	----	Cr-Dr	87	40±	2	do	----	4-5	Soft water. Slope.
110	3½ miles E. of Concord	J. A. Burris	----	Dug	42	42	24	Schistose diorite	35	----	Adequate supply; soft water. Slope.
111	do	W. C. Calvin	Byers	Cr-Dr	110	45	2	Granite	----	----	----
112	do	J. W. Propst Cold Springs Ser. Sta.	----	Cr-Dr	110	80	4	do	----	18	Slope.
113	5 miles E. of Concord	Mrs. Annie Ridenhour	----	Cr-Dr	64	5(?)	2	do	----	2	Hard water; contains iron. Hill.
114	do	J. D. Ballard	Will Fortner	Cr-Dr	80	----	2	do	----	3	Hard water. Slope.
115	do	Victor L. Petree	do	Cr-Dr	78	57½	2	Schistose-diorite	30	5+	Hill.
116	5½ miles E. of Concord	St. Johns E. Lutheran Church	----	Cr-Dr	110	----	2½	Granite	----	----	----
117	2 miles NW. of Mount Pleasant	Hubert Waller	----	Bored	50	50	10	do	33	----	Adequate supply; soft water. Hill.
118	2 miles W. of Mount Pleasant	Theodore Burleyson	----	Dr	47	22	4	do	8 to 10	1	Moderately hard water. Slope.
119	do	Roy Shoe	----	Cr-Dr	85	----	2	do	----	2	Well was blasted to increase yield. Draw.
120	2 miles SW. of Mount Pleasant	Mrs. John Linker	Holacker	Dr	95	----	4	do	16.5	2	Soft water. Hill.
121	Mount Pleasant	Town	----	Dr	350	75	8-6	Greenstone schist	----	30	Originally yielded 40 gallons a minute. Hill.
122	do	do	----	Dr	250	150?	8-6	do	----	50	63° F. Originally yielded 40 gallons a minute. Slope.
123	do	do	Ben Aycock	Dr	200	73	6	do	----	37	Analysis in table. Slope.
124	do	Kindley Cotton Mill	Bost	Dr	181	60	6	do	----	9	Tested at 15 gallons a minute. Moderately soft water. Valley.
125	do	Mount Pleasant Hosiery Mill	Ben Aycock	Cr-Dr	200	100	4	Slate	----	4-5	Hard water. Flat.
126	do	Tuscarora Cotton Mill	----	Cr-Dr	150	----	4	do	----	50	Valley.
127	1½ miles E. of Mount Pleasant	Prison Camp	----	Dr	85	----	6(?)	do	----	60-70	Well not used; water too corrosive. Slope.
128	3½ miles S. of Mount Pleasant	Lipe Barrier	Barringer	Cr-Dr	160	8	4	do	----	5+	Very hard water. Hill.
129	6½ miles S. of Mount Pleasant	Miss Ivey Shinn	Bowers	Cr-Dr	40	----	2	do	----	5±	Very good supply; hard water. Slope.
130	6½ miles SE. of Concord	F. T. Martin	Efird	Cr-Dr	55	----	4	Schistose diorite	23.7	6	Soft water. Draw.
131	do	Earl Caudle	----	Cr-Dr	158	----	4	do	17	5-6	Do
132	7 miles SE. of Concord	P. M. Lafferty	Efird & Honeycutt	Cr-Dr	160	120?	4	Granite	----	4-5	Soft water. Slope.
133	do	M. A. Boger	do	Cr-Dr	102	18	4	do	21.3	3-4	Soft water. Draw.
134	3¼ miles SE. of Harrisburg	W. K. Alexander	Arthur Beaver	Cr-Dr	163	----	2	Schistose diorite	----	5+	Very hard water. Hill.
135	1½ miles SW. of Harrisburg	Earnest Query	Ben Aycock	Dr	110	----	6	do	----	6	Hill.
136	4½ miles SE. of Harrisburg	F. M. Bryant	----	Cr-Dr	100	----	2	Diorite	----	8	Moderately soft water. Slope.
137	2½ miles NW. of Cabarrus	H. N. Biggers	H. N. Biggers	Cr-Dr	54	35	3	Slate	----	2	----
138	do	do	do	Cr-Dr	204½	19	3-2	Slate	----	1/8	Draw.
139	do	H. N. Biggers, at tenant house	Bowers	Cr-Dr	68	----	2	do	----	1/10	Drilled to 143, but blasting filled to 68 feet. Hill.
140	do	J. L. Flowe	do	Cr-Dr	135	----	2	Slate	----	1/4	Hill.
141	1 mile N. of Cabarrus	N. B. Conner	Carter	Cr-Dr	56	----	3	do	----	5-10	Drilled 100 feet deep, bottom filled in by blasting to increase yield. Slope.
142	do	Bethel School	Will Fortner	Cr-Dr	175	30-40	2½	do	----	8	Had well 200 feet deep which which was ruined by dynamiting. Draw.
143	1½ miles S. of Cabarrus	B. J. Polk	Ben Aycock	Dr	106	94	6	do	----	10	Hard water. Draw.
144	do	Mrs. W. F. Black	----	Cr-Dr	72	68	2	Dike	----	8	Soft water. Hill.
145	2 miles NW. of Midland	S. B. Turner	----	Cr-Dr	127	----	4	Slate	----	7½	----

RECORDS OF WELLS IN CABARRUS COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Character of material	Water level (feet below surface)	Yield (g.p.m.)	Remarks
146	1½ miles N. of Midland	John R. Beatty		Cr-Dr	90±		4	Slate	30	5	Supplies three houses and shops. Hard water. Draw
147	do	E. P. Godfrey		Cr-Dr	160		3	do		4-5	Hard water.
148	2¼ miles NE. of Midland	Baker Brooks	Will Morgan	Cr-Dr	85	42	4	do	25	5	Water slightly hard.
149	do	do	do	Cr-Dr	115	64	4	do	25	5	Do.
150	Midland	do		Cr-Dr	314		4	do			Adequate supply; hard water.
151	do	Black Hosiery Mills Co.	Efird & Honeycutt	Cr-Dr	208		4	do	20	6	62° F. Flat.
152	do	do		Cr-Dr	75		4	do	20	7	Flat.
153	do	do		Cr-Dr	128		4	do	20	4-5	Draw.
154	do	A. C. Widenhouse, S. B. Turner Ser. Sta.		Cr-Dr	214		4	do		5+	Large supply reported; water slightly hard.

ANALYSES OF GROUND WATER FROM CABARRUS COUNTY, N. C.

(Numbers at heads of columns correspond to numbers in tables of well data)
(parts per million)

	7	16	33	36	52	58	70	88	122	123	151
Silicia (SiO_2)				27			51		35		
Iron (Fe)		.22		.03			.80b		.30c		
Calcium (Ca)				4.3			53		10		
Magnesium (Mg)				.9			21		3.0		
Sodium and potassium (Na+K)				5.2			17		9.2		
Carbonate (CO_3)				0			0		0		
Bicarbonate (HCO_3)	242	270	44	26	90	20	146	216	58	171	258
Sulfate (SO_4)	4	26		.9	2	4	103	36	2.3	10	120
Chloride (Cl)	20	24		2.0	5	10	19	128	3.8	12	101
Fluoride (F)	.1	.2		.0	.1	.1	.3	.3	.0	.1	
Nitrate (NO_3)				.8			1.6		2.5		
Dissolved solids							366		100		
Total hardness as $CaCO_3$	207	258	24	14	63	26	219	279	37	138	378
Date of collection	8/7/44	8/15/44	8/16/44	8/15/44	8/11/44	8/16/44	8/18/44	8/10/44	8/8/44	8/8/44	8/31/44

a Analyses made by U. S. Geological Survey.
b Fe in solution .02.
c Fe in solution .03

CLEVELAND COUNTY

(Area 466 square miles; population 64,357 in 1950)

Geography and physiography.—Cleveland County, bordered on the south by South Carolina, has two large towns in Shelby and Kings Mountain and several smaller towns and villages. Shelby, in the center of the county, is the largest town and the county seat. Much of the activity in the county centers around the manufacture of textiles although agriculture is also a leading occupation.

The county is typically a part of the Piedmont province. The southern two-thirds of the county is characterized by a broadly flat and gently rolling plateau, but this gives way to mountainous conditions northward. The plateau is about 900 feet above sea level in the southern part of the county; several elongated northeast-trending ridges rise above the general surface.

Cleveland County lies entirely within the drainage basin of Broad River. The main channel of Broad River enters Cleveland County near the southwest corner, flows east a few miles and then southward into South Carolina and thus has less than a 12-mile course in the county. The eastern and northern boundaries of the county form the divide between Broad River and Catawba River. This interstream area is rather low and not particularly noticeable on the east, but on the north a pronounced mountainous barrier separates these two major drainage areas. First Broad River, which flows through the center of the county, joins Broad River about 2 miles north of the South Carolina boundary. The tributaries of First Broad River, which drains most of the county, form a dendritic pattern.

Geology.—Several types of rock crop out in Cleveland County (fig. 11) and most of these recur in numerous places or bands that results in an irregular and complicated pattern. Most of the rocks occur in northeast-trending bands.

Biotite gneiss (granite gneiss) crops out in a belt extending north of U. S. highway 74 along the western boundary of the county. Although the rock is here termed a gneiss it is, for the most part, composed of layers of granite, chiefly porphyritic, interlayered with thin bands of biotite. The rock is generally light in color except locally where sheets of hornblende gneiss or mica schist occur.

Mica schist in Cleveland County forms the most extensive country rock and is subordinate in extent only to the granite which intrudes it. As the extent of intrusion by granite varies widely the composite rock is a schist only in part. In some places the mica of the schist appears to have been recrystallized by action of the invading granite; the kyanite which is prominently developed in the northern part of the county in the schist may have formed during the intrusion of the granite. The intrusion of granite resulted in varying degrees of intercalation between the schist and granite, and in most places both rocks are distinctive in the field. The granite bodies, especially the smaller ones, lie roughly accordant with the schist in a general northeast direction. Layers of hornblendic rocks, which also follow the trend of the other rocks, form a subordinate part of this injection complex.

Bodies of granite containing little or no schist occur throughout the county. The largest of these lies just west of the town of Kings Mountain, and it is this body of white coarsely crystalline granite that is believed to be the source of the pegmatites which contain such noteworthy minerals as cassiterite and spodumene, the former containing tin and the latter, lithium. Both the granites and pegmatites contain as their chief mineral constituents feldspar and quartz, the leading accessory mineral being muscovite. Granite, including the injected bodies in the mica schist and that in the biotite gneiss and the pegmatites, comprises the greater part of Cleveland County.

Bodies of hornblendic rocks are common but occur in large mappable units in only a few places. Most of the occurrences are sheet-like bodies conformable with the regional schistosity and interlayered with other rocks in subordinate amounts.

At least two belts of quartzite occur in the county, both forming northeast-trending ridges south of the town of Kings Mountain. In each belt the quartzite exposure is less than 1 mile wide. The rock is typically a rather white pure quartzite, but a conglomerate bed and beds of kyanite and sericitic quartzite and schist also compose the unit.

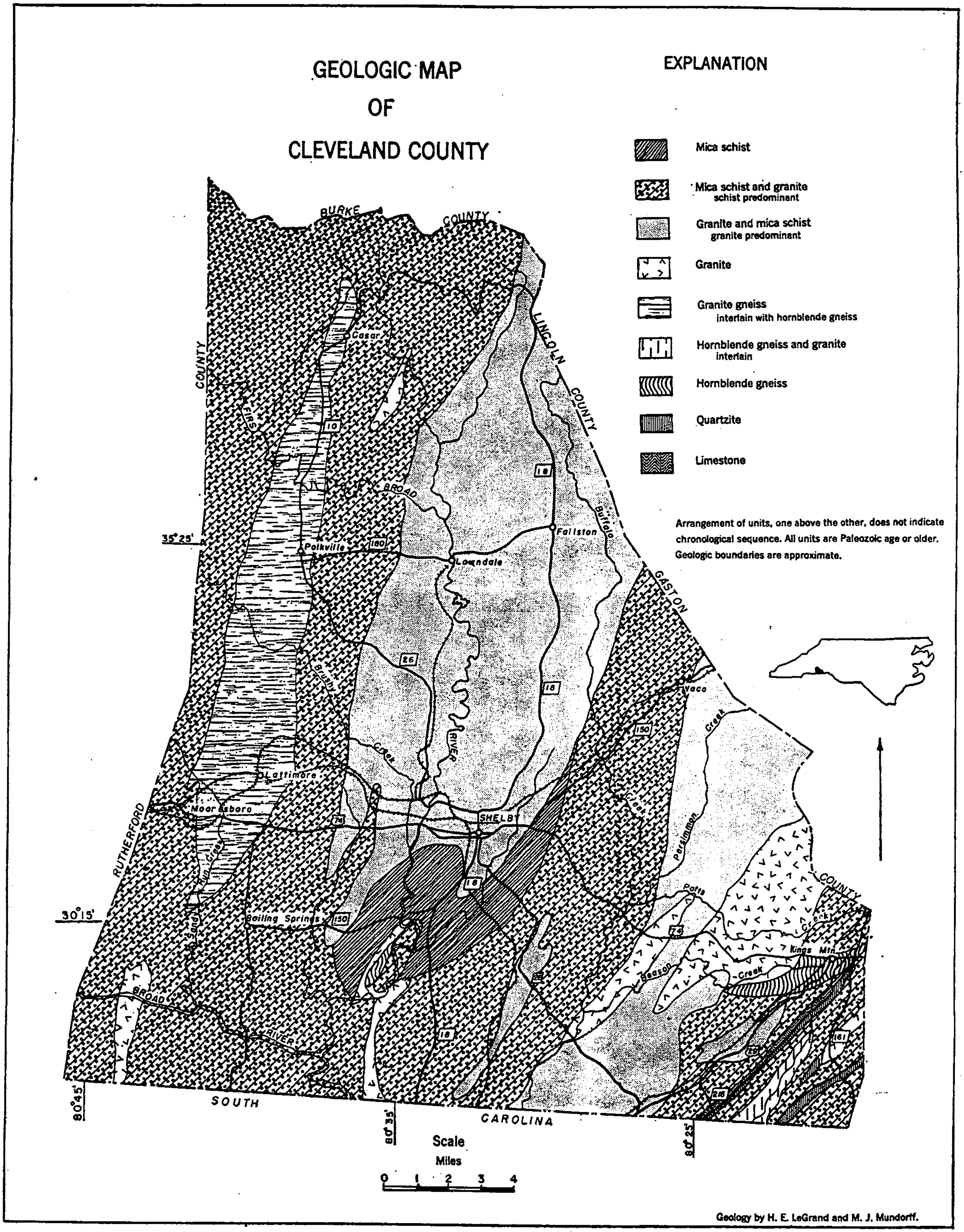

FIGURE 11.—GEOLOGIC MAP OF CLEVELAND COUNTY.

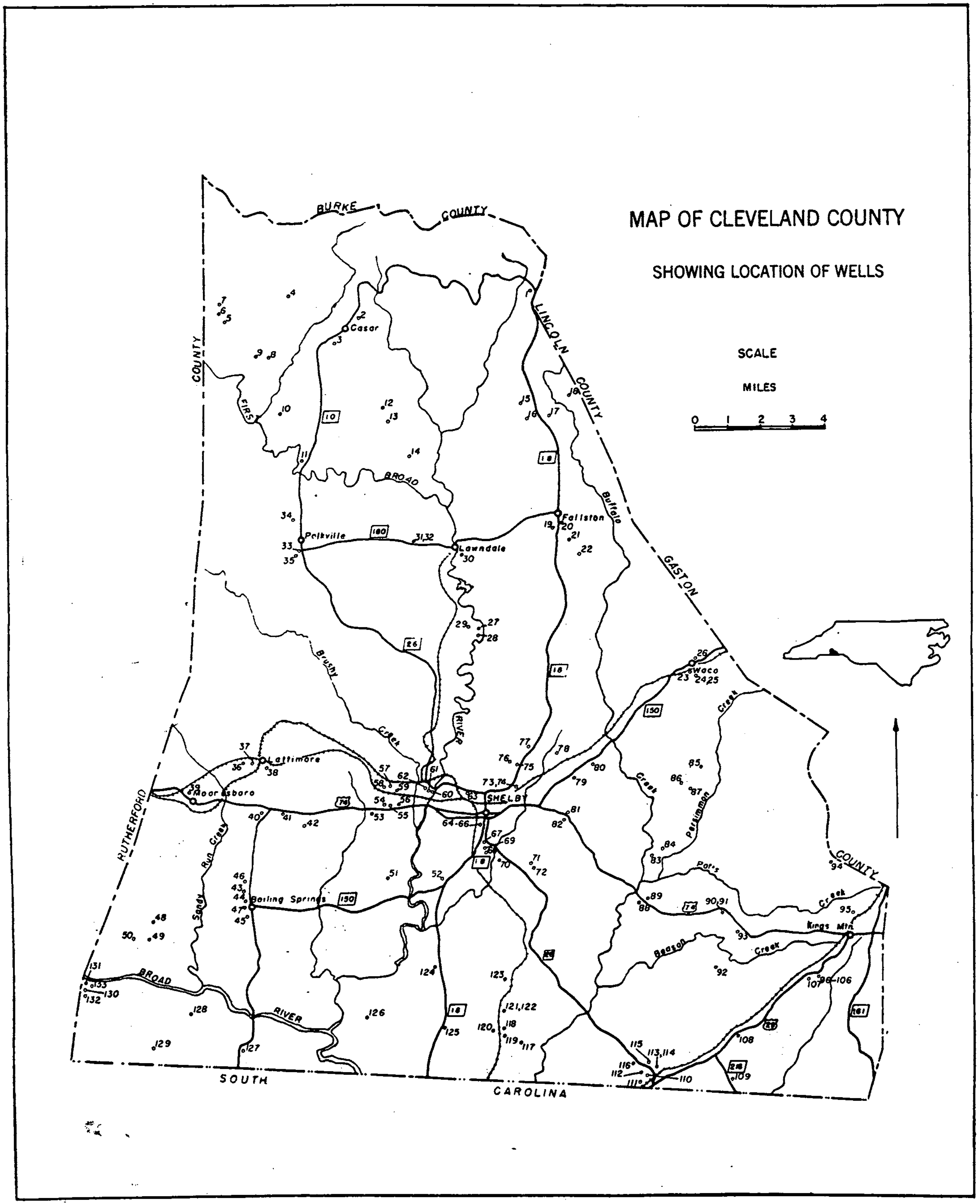

FIGURE 12.—MAP OF CLEVELAND COUNTY SHOWING LOCATION OF WELLS.

South of the town of Kings Mountain and in juxtaposition with the quartzite is a belt of crystalline limestone generally less than a quarter of a mile wide. It is known as the Gaffney marble[24] and consists of fine- to medium-grained gray limestone showing a banded structure that results from the presence of mica and hornblende. It is not exposed north of U. S. Highway 74.

Ground Water.—Most of the domestic supplies, many of the industrial supplies, and three of the smaller municipal water supplies are obtained from wells. A few domestic supplies are obtained from springs.

Most of the domestic supplies come from dug wells ranging from about 20 to 60 feet in depth. The depth to which these wells are dug is governed by the depth of the water table or the depth to solid rock. The wells are generally dug a few feet below the water table to insure an adequate supply of water in long dry seasons when the water table drops. Where solid rock lies above the water table dug wells are not successful unless the well can be excavated in the rock to the water table.

Records of more than 130 drilled wells were obtained in Cleveland County (fig. 12) although complete information about many of them is lacking. The average yield is 24.2 gallons a minute. This is almost 6 gallons a minute more than the average of all wells in the Charlotte area. The yield in gallons a minute per foot of well is 0.15 as compared with 0.11 for the average of all wells in the Charlotte area.

Virtually all wells in Cleveland County penetrate granite or mica schist (table 11). As these rocks are closely interlayered in most places, it is probable that many wells were drilled into both. Although records do not indicate that beds of hornblende gneiss were penetrated in wells, their common occurrence suggests that many wells were drilled into them. The schist is a good water-bearing rock, as the average yield of 25 gallons a minute indicates. The granite is also considered to be a good water-bearing rock where a zone of decomposed rock mantles the solid rock. The granite disintegrates into granules of feldspar and quartz that make a porous surface layer capable of absorbing precipitation readily.

The limestone and quartzite, occurring in the southeastern part of the county, are not important as water bearers because of their limited occurrence. As the limestone is a dense fractured rock containing no interconnecting caverns it probably does not differ much from other rocks of the county as far as ground water is concerned. The quartzite generally forms pronounced ridges from which runoff is a relatively large percentage of the precipitation, and the consequent influent seepage is small. However, wells drilled into the quartzite along its lower slopes may obtain moderate to large supplies, and under certain conditions flowing wells may be realized.

TABLE 11.—SUMMARY OF DATA ON WELLS IN CLEVELAND COUNTY
(Drilled wells 3 inches or more in diameter)

ACCORDING TO ROCK TYPE

Type of Rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Schist	37	156	2—80	25	0.16	
Granite	3	174	1—30	18	.11	33
All wells	40	161	1—80	24	.15	2

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Hill	13	196	1—47	21	.11	7
Flat	3	181	5—35	17	.10	0
Slope	13	131	2—60	17	.13	0
Draw	8	144	15—80	39	.27	0
Valley	3	165	20—50	37	.22	0

[24]Keith, Arthur, and Sterrett, D. C., U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (no. 222), 1931.

Analyses of water from nine wells, one spring, and one quarry were made for Cleveland County. (See table of analyses.) The dissolved solids in well waters ranged from 58 to 242 parts per million and averaged 122 parts per million. As most of the water comes from granite and schist that, as a rule, contain very little soluble material, it is generally of good quality. In a few places, as at Boiling Springs (well 47), the water contains an undesirable amount of iron. The water from well 112 at Grover contained 242 parts per million of dissolved solids of which 107 parts per million was chloride. The source of the mineral matter in the water from this well is not known. As the country rocks in the vicinity of this well are the relatively insoluble mica schist and granite, it is likely that a bed of hornblende gneiss is penetrated by the well.

The water analyzed from the spring was low in mineral matter. The water is thought to be typical of spring water in the Charlotte area.

Municipal supplies.—Three municipal water supplies in Cleveland County are obtained from wells.

Boiling Springs, population 1,147, obtains its water supply from two wells, one yielding 5 and the other 125 gallons a minute. The water is of good quality except for the high iron content, 1.3 parts per million in well 47. The water is not treated.

Grover, population 469 (1940 census), has a central water supply owned by Minette Mills, Inc. Three wells with individual yields of 7, 40, and 50 gallons a minute furnish the supply. The water is of good quality in general although the water from well 112 contains considerable mineral matter. The water is not treated.

Lawndale, population 1,006 (1940 census), uses two of six wells yielding about 30 gallons a minute each. The wells are owned by the Cleveland Mill and Power Co. The wells, drilled in granite, yield water of good quality. It is not treated.

RECORDS OF WELLS IN CLEVELAND COUNTY.

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field (tests) (p.p.m.)	Remarks
1	Toluca	F. D. Edwards	Va. Mach. Co.	Dr	410		8		15	55	Schist. Draw.
2	Casar	A. A. Richards J. L. McNeilly	R. E. Faw	Dr	522	62	6		9	20	Do.
3	do	School		Dr	190		5 5/8		7		Schist. Hill.
4	2 miles NW. of Casar	A. A. Richards Lin Smith	R. E. Faw	Dr	245		6				Do.
5	3½ miles W. of Casar	J. R. Price	Linsey Bros.	Dr	259		6			40	Do.
6	do	R. C. Fortonberry	do	Dug-Dr	70		6	46.22	4½		Schist. Dug 46½ feet. Hill.
7	do	Ottis Wall	do	Dug-Dr	92	50	6		35		Dug 50 feet. Schist. Hill.
8	2½ miles SW. of Casar	A. H. Logan	Cecil Linsey	Dug-Dr	110		6	54R	20	40	Dug 39 feet. Schist. Hill.
9	3 miles SW. of Casar	Claude Linsey	R. E. Faw	Dug-Dr	126	40	6	40R	1½		Dug 40 feet. Schist. Slope.
10	3½ miles SW. of Casar	Sam Proctor	Linsey Bros.	Dr	70		6		4		Schist. Slope.
11	2½ miles N. of Polkville	Brackets Cedar Park	do	Dr	70		6		15		Schist. Slope.
12	5 miles NW. of Lawndale	C. R. Turner	Kirby	Dr	149		6(?)		½–1		Granite. Just enough water for household use. Hill.
13	4½ miles NW. of Lawndale	J. C. Downs	Will Barrow	Dr	80		6				Adequate supply.
14	3 miles NW. of Lawndale	Seth Ivester		Dug	50		24	47R		30	Adequate Supply. Hill.
15	3½ miles N. of Fallston	Belwood School		Dr	185		6			30	Adequate Supply. Flat.
16	2½ miles N. of Fallston	Reed Wilson		Dr	100+		5/8				Adequate supply. Hill.
17	do	M. L. Lutz, Jr. & Bill Lutz	Hickory Pump Co.	Dug-Dr	165		6		25		Schist. Drilled in botton of 56 foot dug well. Hill.
18	4 miles N. of Fallston	Lathan Wilson	Claude Hoke	Dr	190	50	4		25–30	70	Granite. Very large supply reported. Slope.
19	do	J. S. Cline	A. B. Taylor	Dug-Dr	122½	45	6		801	40	Schist.
20	do	School		Dr	57		6		30		Schist. Reported to have been bailed at 30 g.p.m for 1½ hours without lowering water level. Hill.
21	1 mile SE. of Fallston	Yates Beam	Va. Mach. Co.	Dug-Dr	130		6	25R	7		Schist. Drilled in bottom of 28 foot dug well. Slope.
22	1½ miles SE. of Fallston	W. A. Royster	do	Dr	139		6		4–5	35	Schist. Slope.
23	Waco	Town	Charlie Boggs	Cr-Dr	110		3	12R	9+	40	Schist. Slope.
24	do	School	Ralph Robbins	Dr	148		5 5/8		23	30	Schist. Hill.
25	Waco	A. W. Black	Charlie Boggs	Cr-Dr	106		3	20R	1	30	61¼° F. Well can be pumped dry. Slope.
26	do	M. C. Whitworth	Ralph Robbins		158		5 5/8	34R	30	55	Drawdown 20 feet at 23 gallons a minute.
27	2½ miles S. of Lawndale	Double Shoals Mill Co.		Dr	42		6		3–4		Schist. Slope.
28	do	do	Va. Mach. Co.	Dr	190		6		10		Well near river. Valley.
29	do	do	do	Dr	200		6		12	45	Several other wells ranging from 300 to 1,000 feet deep were drilled with little or no water obtained. Draw. Analysis.
30	do	Lawndale Cotton Mill	Ralph Robbins	Dr	150		6		60		Using two of six wells that are all about same depth, the 2 wells yield 60 gallons a Minute to a vacuum pump. Valley.
31	1½ miles W. of Lawndale	Palm Tree Church	Claude Hoke	Dr	480		4		0		Hill.
32	do	do	do	Dr	140		4		2		Dug pit 12 feet square, 40 feet deep, cut off casing so that water runs into pit. Placed cover 12 feet above bottom of pit. Hill.
33	Polkville	School	Robbins	Dr	147		5 5/8		10		Satisfactory supply. Hill.
34	do	Miss Sarabelle Elliott		Dr	119		6	19R	40		Large supply reported formerly used for cotton gin. Draw.
35	do	J. L. Hunt	Linsey Bros.	Dr	204	45	6	54R	47		Schist. Reported to have been bailed at 47 g.p.m. without lowering level. Hill.
36	Lattimore	P. D. Crowder	A. B. Taylor	Dr	485		6	30R			Plenty or water reported. Flat.
37	do	J. B. Lattimore		Dr	230		6				Small supply, can be pumped out in 30 minutes. Hill.
38	do	School		Dr	110		6		15+		Flat.
39	Mooresboro	School		Dr	70		5 5/8	25R	10+		Slope.
40	2 miles S. of Lattimore	G. L. Hamrick		Dr	128		6		6		Hill.
41	2 miles SE. of Lattimore	Mrs. Mary B. Hasting		Dug	18	18	24	7.17		45	Draw.

RECORDS OF WELLS IN CLEVELAND COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
42	2½ miles SE of Lattimore	T. B. Webb		Dr	75		6		50		Pumped by 2 H.P. electric-jet pump with 4 or 5 faucets opened wide. Water level was not lowered.
43	Boiling Springs	Town	R. E. Faw & Sons	Dr	250	100	8	50R	125		Slope. Analysis.
44	do	do	do	Dr	357	110	8	50R	50		Pumps muddy water. Not used. Slope. Analysis.
45	do	Gardner Webb College		Dr	125		6		20		Abandoned. Slope.
46	do	Mrs. A. K. Green		Dr	110		6				Flat.
47	do	Town		Dr	220	75	8		50		Analysis.
48	3 miles W. of Boiling Springs	C. P. Hambrick J. S. Bagwell		Dr	140		6	70.12	2	30	60° F. Adequate Supply. Hill.
49	3½ miles SW. of Boiling Springs	A. B. Hambrick		Dr	38		6	18.29		25	Plenty of water reported. Slope.
50	do	Eldon Hambrick		Dr	108		6	44.60		40	62° F. Schist. Hill.
51	4 miles W. of Shelby	G. Hambrick Mrs. B. L. Poston		Dug	35		48	30.99		25	
52	2½ miles W. of Shelby	M. L. Spake		Dug	24		24	21.00		20	Adequate Supply. Flat.
53	3½ miles W. of Shelby	C. C. Blanton W. C. Davidson		Dr	100		6	45.50			Schist. Adequate Supply. Hill.
54	2½ miles W. of Shelby	S. E. Jones		Dug	75	75	18	65R			
55	2¼ miles W. of Shelby	George Blanton, Dairy		Dr	210		6		10+		Slope.
56	2 miles W. of Shelby	George Blanton C. H. Church		Dr	54		6	25.12			Slope.
57	2½ miles W. of Shelby	Ora Mill Co.		Dr	180		6		20	30	Schist and gneiss. Near power plant. Slope.
58	do	do		Dr	150		6	11R	30	15	Schist and gneiss. 61¾° F. Draw.
59	do	do		Dr	150		6	do	30	35	Schist and gneiss. 61° F. Draw.
60	1¾ miles W. of Shelby	Dover Mill Co.	A. B. Taylor	Dr	165		6	10 to 20R	40	65	Schist and gneiss. Valley.
61	do	do	do	Dr	165		6	do	20	45	Schist and gneiss. 60½° F. Valley.
62	do	do	do	Dr	165		6	above surface	50		Schist and gneiss. 61° F. Reported to flow 25 gallons a minute. Analysis in table. Valley.
63	1 mile NW. of Shelby	Carnation Co.		Dr	200±		6		30	40	Schist and gneiss. Slope.
64	Shelby	Shelby Cotton Mill		Dr	100		6		2		Slope.
65	do	do	Va. Mach. Co.	Dr	1,213		8		10		Not used.
66	do	do	A. B. Taylor	Dr	288		5 5/8		10		
67	do	Belmont Mills		Dr	200-300		6		5	15	Used for drinking; humidifying. Flat.
68	do	Lily Mills Co.	Robbins	Dr	186		5 5/8	5.25	5		Not in use, Nov. 1946. Slope.
69	do	do	do	Dr	104	48	5 5/8	+½	20	40	61½° F. Flows 3 to 4 gallons a minute. Draw.
70	2 miles S. of Shelby	Paid & Dewey Hawkins		Dug	30	30	30	25.00		15	Hill.
71	2 miles SE. of Shelby	Weldon Gant		Dr	429		6			15	Small yield reported; inadequate. Hill.
72	do	Z. V. Cline, Jr.	Va. Mach. Co.	Dr	108		6			30	Schist. Supplies farm and five families. Hill.
73	Shelby	Esther Mills, Corp.		Dr	262	35	5 5/8	15R	50		Not used because it pumps muddy water. Casing not seated in rock. Slope.
74	do	do	A. B. Taylor	Dr	150	40	5 5/8	17.54	15		Slope.
75	2 miles NE. of Shelby	Geo. E. Sperling	Ralph Robbins	Dr	95-100		5 5/8	44.60	3-4	30	Slope.
76	do	E. P. McSwain, Rev. Lewis E. Ludlum		Dr	260		6(?)				Supplies nine families. Flat.
77	3 miles NE. of Shelby	F. S. Dedmon		Dr	100		6				Adequate supply; used by five families and at livestock barns. Flat.
78	3½ miles NE. of Shelby	L. R. Walker		Dug	50	50	30	34.57		40	
79	3½ miles NE. of Shelby	G. A. Spake		Dug	25	25	24	20.72		30	Hardly adequate. Hill.
80	4½ miles NE. of Shelby	Harrison and Walker Mill Co.		Dug	35	35	30	30.02		30	Used for humidifying and drinking. Slope.
81	2½ miles E. of Shelby	U. L. Patterson	Va. Mach. Co.	Dr	504	80	6	30-35R	23		Schist. Hill.
82	do	do	Ralph Robbins	Dr	83		5 5/8		20	30	Schist. Draw.

RECORDS OF WELLS IN CLEVELAND COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
83	5½ miles E. of Shelby	Mrs. C. Austel Mrs. G. Carpenter		Dr	265		6				Schist. Adequate supply. Hill.
84	do	do		Dr	92		6	53.46		30	Schist. Adequate supply. Hill.
85	3½ miles S. of Waco	C. C. Rhyne		Dug	46	46	24	38.42		45	60° F. Hill.
86	5 miles E. of Shelby	Frank Harmon	Robbins	Dr	128		6	46	20		Large supply; water level could not be lowered with bailer. Draw.
87	4½ miles E. of Shelby	Grigg Estate		Dr	92	60	6			35	Adequate supply. Hill.
88	6 miles SE. of Shelby	Frank Shytle at tenant house	Ralph Robbins	Dr	185	115	5 5/8		15	30	62° F. Hill.
89	do	Frank Shytle	do	Dr	145	10	5 5/8		15	49	Hill.
90	4 miles W. of Kings Mountain	Bethware School		Dr	332		6		18		Granite. Slope.
91	do	do		Dug	62	62	24				Small supply; used as reserve well. Slope.
92	4½ miles W. of Kings Mountain	P. E. Hayes	Ralph Robbins	Dr	40	20	5 5/8	28½R	20		Slope.
93	3½ miles W. of Kings Mountain	Z. F. Crawford		Dr	200		6				Plenty of water. Hill.
94	2 miles N. of Kings Mountain	J. W. Black	Ralph Robbins	Dr	111½	90	5 5/8	13R	28		Slope.
95	Kings Mountain	Kings Mountain Manufacturing Co.		Dug	60		120	32.00	60		Schist. Well formerly shaft for tin mine, 15 feet drift at bottom. Drawdown 20 feet after pumping 60 g.p.m. for 37 hours. Slope.
96	1½ miles SW. of Kings Mountain	Park Yarn Mills, Inc.		Dr	78	23	4		19		Schist. Draw.
97	1½ miles SW. of Kings Mountain	Neisler Mills, Inc. Margrace Plant	Va. Mach. Co.	Dr	430		8	57R	25–30		Behind Mauney residence. Hill.
98	do	do	do	Dr	262	50±	8	53R	15		West of finishing plant. Hill.
99	do	do	Ralph Robbins	Dr	90	90	8–6		80		South well, east of Southern Railway; drawdown of 11 ft. at 80 g.p.m. Draw.
100	do	do		Dr	211		6		5		Schist; not used. Flat.
101	do	do		Dr	220		6				Schist. North end of dye house. Flat.
102	do	do	Ralph Robbins (?)	Dr	181¾	120	6		35		Schist. Cardroom well. Flat
103	do	do		Dr	151		6				Schist. Abandoned well in boiler room. Flat.
104	do	do	Ralph Robbins	Dr	147½	32	8	15R	55		North well, east side of Southern Railway. Drawdown 45 ft. at 40 gallons a minute. Draw.
105	do	do	Va. Mach. Co.	Dr	750		8		60		Schist. North west of finishing plant. Draw.
106	do	do		Dr	150 or 200		6		10–12		Schist. Patricia mill well. Flat.
107	2 miles SW. of Kings Mountain	Park Grace School		Dr	100		5 5/8				Schist. Adequate supply.
108	3 miles NE. of Grover	Archdale Farm	Guy Robbins	Dr	169	70	5 5/8	51R	18	30	Drawdown 50 ft. at 18 gallons a minute. Hill.
109	2½ miles E. of Grover	J. B. Ellis		Dug	98		24	85.00			Schist and gneiss. Hill.
110	Grover	Minette Mills, Inc.		Dr	100		4		7	30	Hill.
111	do	do	Ralph Robbins	Dr	84	72	8	27R	40		Two wells supply 100 houses in village besides mill use. Analysis: Draw analysis.
112	do	do	do	Dr	48	36	8	27R	50		Draw.
113	do	School	do	Dr	48½	37	5 5/8		15	25	Slope.
114	do	do	do	Dr	301	65	5 5/8		6		Not used; insufficient water. Slope.
115	½ mile N. of Grover	J. B. Ellis	Hickory Drilling Co.	Dr	155	44	6	22R	20	25	Draw.
116	1 mile N. of Grover	V. J. Hardin	Va. Mach. Co.	Dr	110		6		20	30	Flat.
117	1 mile SE. of Earl	W. C. Larratt, Dairy	Easler (?)	Dr	153	85	6		25		Water level did not lower bailing at 12 gallons a minute. Hill.
118	Earl	W. C. Sarratt	do	Dr	232½	110	6		20		61½° F. Drawdown 20 feet bailing at 12 gallons a minute Hill.

RECORDS OF WELLS IN CLEVELAND COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
119	Earl	Runyans Gin Co.	Bridges	Dr	98		6		15		Not in use. Slope.
120	do	Baxter Bettis		Dr	102		6	15R			Cannot be pumped out with vacuum pump. Flat.
121	do	School		Dug	60	60	24	30R		55	Main supply. Slope.
122	do	do		Dug	40½	40½	24	35.97			Auxiliary supply; not much water. Hill.
123	1 mile N. of Earl	No. 3	Va. Mach. Co.	Dr	700		6		6		20 feet deep, not much water.
124	5 miles S. of Shelby	C. C. Brooks		Dug	30		48	19.12		20	Adequate supply for four houses and cotton gin. Slope
125	2 miles SW. of Earl	L. P. Davis		Dug	23½		36	17.54			61½° F. Hill.
126	4 miles W. of Earl	Bryon Bailey		Dug	30		30	22.83		30	61½° F.
127	4½ miles S. of Boiling Springs	G. D. Jolley		Dug	43		48	40.78			Dug 38 feet in rock. Hill.
128	4 miles SW. of Boiling Springs	R. L. Humphries		Dug	62½		72	43.17			Schist. Adequate supply. Slope.
129	5½ miles SW. of Boiling Springs	U. Davis		Dug	28½		48	23.80		20	60° F. Hill.
130	6 miles SW. of Boiling Springs (1½ miles S. of Cliffside)	Duke Power Co. Cliffside Plant	Ralph Robbins	Dr	247		6		8–10		Well 1, abandoned. Draw.
131	do	do	do	Dr	174		6		15		Well 3, at power plant, supplies plant and village. Draw.
132	do	do		Dr	280		6		20		61½° F. Well 4, 200 feet from well 1. Draw.
133	do	do	A. B. Taylor	Dr	72	40±	6		16		Well 5, east of construction office (other wells of Duke Power Co. in Rutherford County). Slope.

ANALYSES OF GROUND WATER FROM CLEVELAND COUNTY,* N. C.

(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	29	30	43	44	47	62	111	112	Spring**	*** Quarry
Silicia (SiO_2)	19	14	32	33	42	22	28	25	11	12
Iron (Fe)	.10	.21	.5a	.70	1.3	.21b	.09	.38	.09	.34
Calcium (Ca)	1.8	6.0	8.2	8.6	14	28	3.2	6.6	1.7	19
Magnesium (Mg)	3.2	2.3	2.8	2.7	1.5	2.6	1.7	2.4	.9	6.5
Sodium and potassium (Na+K)	13	5.3	9.1	8.6	13	7.7	17	68	3.5	4.0
Carbonate (CO_3)	0	0	0	0	0	0	0	0	0	0
Bicarbonate (HCO_3)	45	20	47	48	71	86	10	17	11	12
Sulphate (SO_4)	23	3.4	9.7	8.4	8.4	13	1.0	1.4	1.2	72
Chloride (Cl)	17	7.0	1.8	1.6	1.5	9.2	24	107	2.2	1.6
Fluoride (F)	.0	.0	.1	.2	.2	.1	.0	.1	.1	.3
Nitrate (NO_3)	2.2	7.5	.5	.4	.0	.0	12	10	2.4	.1
Dissolved solids	123	58	92	90	113	129	106	242	30	123
Total hardness as $CaCO_3$	58	24	32	33	41	81	15	26	8	74
Date of collection	12/8/48	12/8/48	11/19/46	9/16/47	9/16/47	11/13/46	11/15/46	7/23/47	11/21/46	1/11/50

* Analyses made by U. S. Geological Survey.

** Spring owned by T. P. Hamrick—yield 15 g.m. flow.

*** Collected from Spodumene Quarry 2 miles south of Kings Mountain to determine quality of water from lithia-bearing rocks. (lithium 0.4 ppm).

a Fe in solution .05

b Fe in solution .02

GASTON COUNTY

(Area, 358 square miles; population in 1950, 110,836)

Geography and physiography.—Gaston County lies in the south-central part of the Charlotte area. Gastonia, with a population of 23,003, is the largest municipality and the county seat. Textile manufacturing is the largest industry in the county although there is considerable farming activity. The county is well served by railroads and paved roads.

Gaston County is a rolling upland portion of the Piedmont province, the general altitude being slightly more than 800 feet. Some of the streams have incised their valleys as much as 200 feet below the upland, and as a result the topography near the streams is quite hilly. Rising several hundred feet above the general level of the country are several pronounced northeast trending ridges, all of which are composed of resistant quartzite. Prominent among these are Kings Mountain Pinnacle, Crowders Mountain, and Spencer Mountain.

The county is drained by Catawba River, which flows south along the east boundary. The main tributaries of the Catawba flow southeastward across the general trend of the rocks and for the most part are not noticeably influenced by any differential resistance of rocks to erosion. The tributaries are closely spaced, resulting in a fine-textured drainage pattern and the absence of extensive, flat interstream areas. With the exception of South Fork Catawba River, the streams have fairly short steep courses, and consequently are rather swift.

Geology.—Numerous types of rocks occur in Gaston County (fig. 13), and their relations one with another are complex. The general northeast schistose structure prevails so that rocks of eastern Cleveland County extend northeastward into the western part of Gaston.

Mica schist forms the dominant host rock into which the granite was injected in Gaston County. Naturally enough, the granite did not intrude the schist evenly and in a few areas granite is either scant or absent in the schist. The belt of schist 2 miles east of Gastonia and parts of the schist near Kings Mountain Pinnacle and Crowders Mountain contain very little granite. Muscovite or sericite, and quartz are generally the chief components of the schist although manganese and chlorite are not uncommon.

Composite rocks in which mica schist and granite are interlayered, generally in northeast trending belts, are widespread in the western two-thirds of the county. The largest belt in which the schist is predominant surrounds Kings Mountain Pinnacle and extends through the western side of Bessemer City to High Shoals in the northern part of the county. The schist is subordinate in quantity to the granite in the area between Dallas and Stanley and along the Cleveland County line southeast of Cherryville.

Several masses or belts of homogeneous or nearly homogeneous granite occur in Gaston County. The largest of these extends northward from the basin of South Crowders Creek at the South Carolina line, through Gastonia to Lincoln County east of High Shoals. One finger of this mass extends southwestward to Bessemer City where it is the type locality for Keith's Bessemer granite.[25] Another large mass of granite occurs southeast of Cherryville.

The granites are not uniform in appearance and mineral constituents. The granite at Bessemer City is locally more gneissic and contains more biotite than most of the granite in the county. The granites for the most part have a light color and medium texture, although small bodies within the complex proper are coarse textured and may be called pegmatite.

Gneisses and schists, containing hornblende as a prominent dark mineral, are common in Gaston County. In addition to the numerous lenses of hornblendic rocks interlayered with other country rocks, several large areas of hornblende gneiss occur. One of these, in the vicinity of Beaverdam Creek in the northwestern part of the county, has been studied in some detail.[26] Soils derived from the hornblende gneiss are generally dark brown or red in color and are more fertile than those from other rocks.

A composite rock in which diorite and granite appear as intermixed bodies occurs in a general north-south belt along the eastern border of the county. This belt extends eastward into Mecklenburg County

[25]Keith, Arthur, op. cit., p. 4.
[26]Kesler, T. L., Correlation of some metamorphic rocks in the central Carolina Piedmont: Geol. Soc. of America Bull., vol. 55, p. 773, 1944.

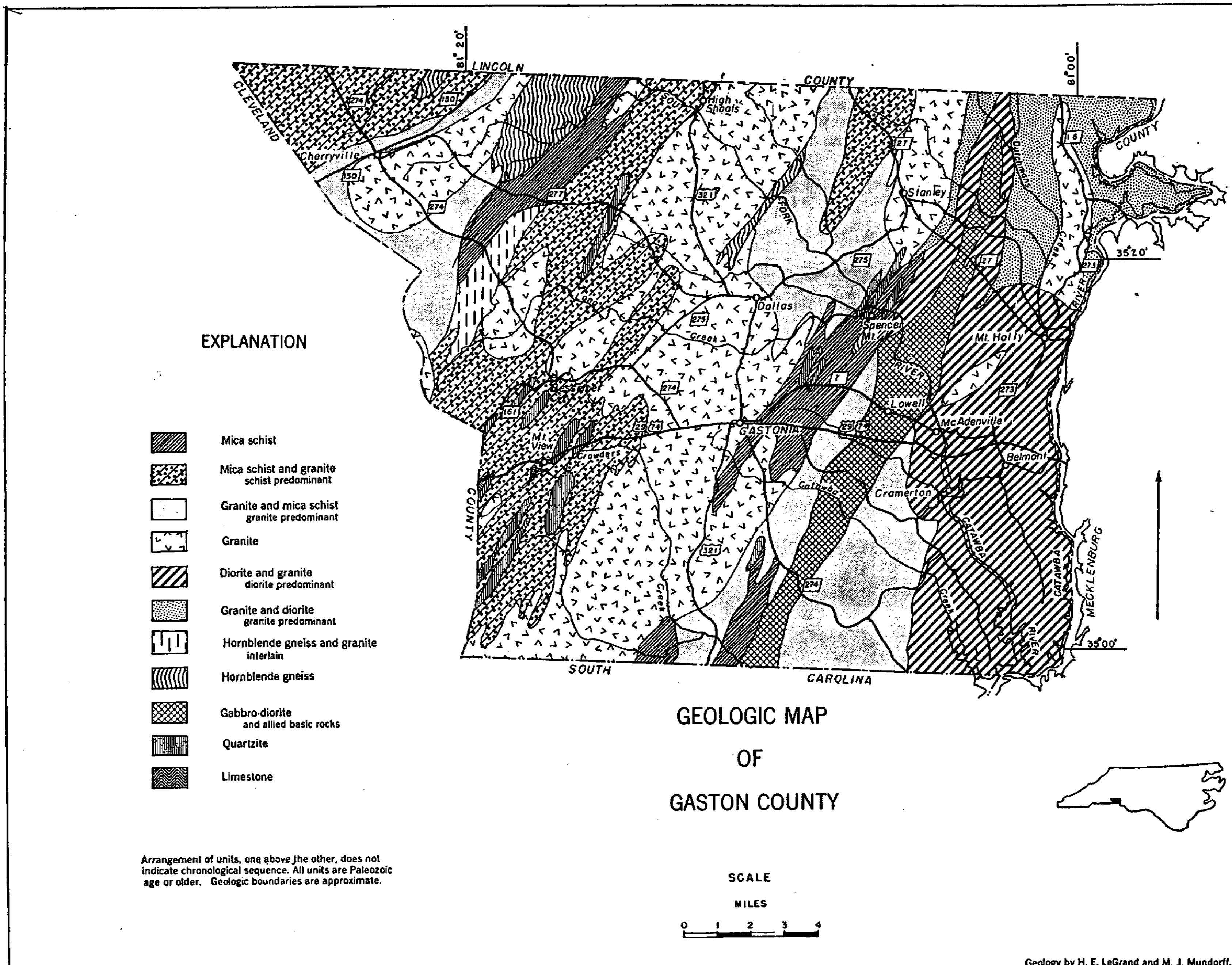

Figure 13

FIGURE 13.—GEOLOGIC MAP OF GASTON COUNTY.

where it is of greater prominence. The rocks of the complex are not well exposed, and as a consequence their relation with adjacent rocks to the west is not certain. In this connection, a zone of diorite and diorite gneiss extending northeastward through Lowell is adjacent to the complex and may be genetically related to it. South of Mt. Holly the amount of granite appears to be subordinate to diorite but northward the diorite is subordinate in amount. Pronounced granular disintegration is characteristic of both components of the complex in the Charlotte area.

Several northeast-trending belts of quartzite occur in the central part of Gaston County. The ridges that they form by their resistance to erosion serve to show the broad structural trends of the rocks. In the area south of Crowders Mountain, Keith[27] has noted three divisions of the quartzite, namely kyanite quartzite, white, nearly pure quartzite, chloritic quartzite, and seritic quartzite. The beds of quartzite are considered to be of the same general age, but the relation of one with another is not clear.

Ground Water.—Most of the domestic water supplies, many of the industrial supplies, and two of the municipal supplies in Gaston County are obtained from wells (fig. 14). Most of the water in rural sections comes from dug wells that derive water from the weathered and disintegrated zone between the soil and the underlying unweathered rock. Where the unweathered rock lies near the surface difficulty may arise in digging a well deep enough to obtain a dependable well. The failure of dug wells is not confined to any one rock type although attempts to dig wells on upland areas underlain by quartzite are likely to be unsuccessful.

Records of more than 200 drilled wells are included in the table of well data. The records of 151 wells were complete enough for use in compiling table 11 below.

TABLE 11.—SUMMARY OF DATA ON WELLS IN GASTON COUNTY
(Drilled wells 3 inches or more in diameter)

ACCORDING TO ROCK TYPE

TYPE OF ROCK	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Schist	73	180	0—150	23	.13	4
Granite	78	165	0—100	18	.11	4
All wells	151	172	0—150	21	.12	4

ACCORDING TO TOPOGRAPHIC LOCATION

TOPOGRAPHIC LOCATION	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Hill	43	153	0— 45	11	.07	7
Flat	8	143	5— 40	18	.13	0
Slope	44	191	1—150	25	.13	4
Draw	53	179	2—102	26	.14	0
Valley	4	143	0— 25	15	.10	25

[27]Keith, Arthur, op. cit., (folio 222) p. 5.

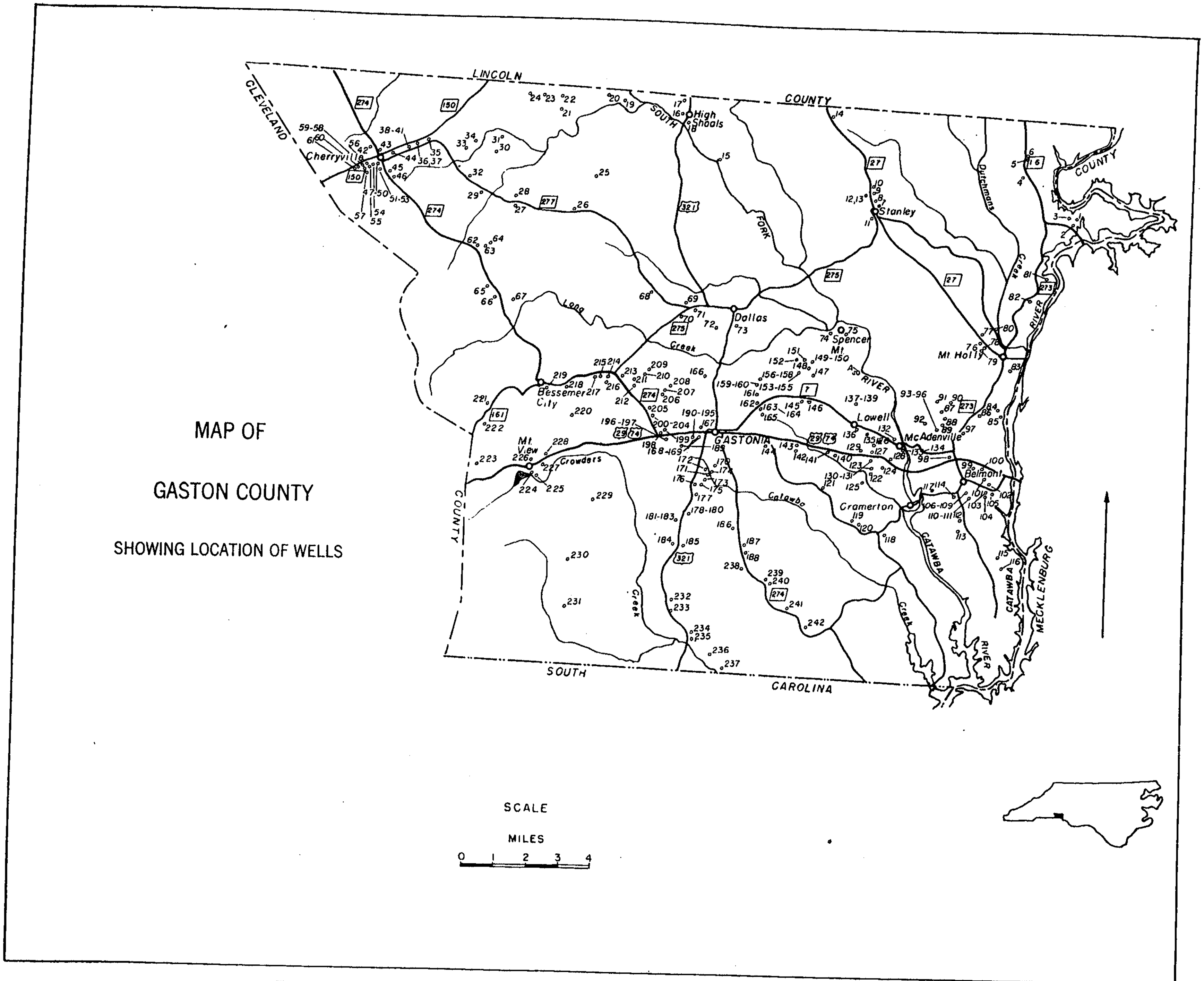

FIGURE 14.—MAP OF GASTON COUNTY SHOWING LOCATION OF WELLS

Although the wells in table 11 were drilled in schist and granite, some of the wells probably penetrated other types of rocks also. As the spacing between the different rocks can be measured in terms of feet and inches it is inevitable that many wells pass through rocks other than that indicated at the top of the well. The schist is composed of muscovite and quartz in most places, but it may contain beds of hornblende gneiss and schist, pegmatites, and other rocks.

Table 11 indicates that the average depth of wells in schist is 180 feet and that the average yield is 23 gallons a minute; this compares with an average depth of 165 feet in granite and an average yield of 18 gallons a minute. If average yield per foot of well is considered, the water-yielding characteristics of the schist is only slightly greater than that of granite. The average yield of wells in both schist and granite is 21 gallons a minute, which is 4 gallons a minute higher than the average for all wells in the Charlotte area. It is not certain that the higher yield of wells in Gaston County is significant because the same general geology and topography occur also in Lincoln and Cleveland Counties.

The part of table 11 showing the relation of average yield and average yield per foot of well to the topography is significant. Wells located on hills have by far the smallest average yield and average yield per foot of well. In addition 7 percent of the wells on hills in the county yield 1 gallon a minute or less. As is the case in the Charlotte area as a whole, the wells on hills yield only about half as much water per foot of well as wells in draws.

Analyses of samples of water from nine wells and one spring in Gaston County are given in a table following the well records. All but well 97 penetrated schist or granite or both schist and granite. Well 97 penetrated both granite and diorite. The water ranged in hardness from 26 to 158 parts per million. The iron content ranged from 0.08 to 8.6 parts per million. Water from different wells in the towns of Cherryville and Stanley showed a considerable local variation in content of iron.

Analysis of water from one spring is shown in the table. This water contained only 59 parts per million of dissolved solids, despite the fact that it flows from hornblende gneiss, one of the most readily soluble rocks of the Charlotte area. The low mineral content of this spring water is thought to be typical inasmuch as water from springs normally flows through the rocks more rapidly than water from wells.

Temperatures of waters ranged from 60° to 66° F. and averaged 62° F. The water having a temperature of 66° F. is pumped from a well 1,053 feet deep.

There are two municipally owned ground-water supplies in Gaston County; in addition the town of McAdenville is supplied with water from a well owned and operated by a mill.

Cherryville, population 3,486, obtains its water from eight wells in various parts of the town. All the wells penetrate granite. The wells range from 132 to 238 feet in depth and from 10 to 75 gallons a minute in yield. Six of the wells yield approximately 20 gallons a minute each. The chemical quality of the water is good. The total dissolved solids of the water from any of the wells does not exceed 115 parts per million. The water receives no regular treatment.

Stanley, population 1,645, obtains its supply from four wells. Three of the wells are at least 350 feet deep. They vary in yield from 15 to 45 gallons a minute. The water from the four wells contains more than the average amount of mineral matter for all wells in the county and is slightly hard; the water from well 10 contained 4.9 parts per million of iron on November 20, 1947. The water is not treated.

McAdenville, population 1,059, is supplied with water from a well owned by Stowe Mills, Inc. The well, 132, is 523 feet deep and yields in excess of 100 gallons a minute. A field test showed the water had a total hardness of 230 parts per million. The water is not treated.

RECORDS OF WELLS IN GASTON COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
1	5 miles NE. of Mount Holly	Duke Power Co.	H. L. Lazer	Cr-Dr	437½	3	75+		6-8		Granite. Well at water tank. Flat.
2	do	do	do	Cr-Dr	219	3	30+		3-4	20	Granite. Well at commissary. Slope.
3	do	do	do	Cr-Dr?	305	6					Not used.
4	Lucia, 6 miles N. of Mount Holly	Mrs. W. T. Beatty	Julius Hager	Cr-Dr	36	2			8-10	50	Supplies water to school, farm and home. Granite. Draw.
5	do	J. A. McIntosh		Dug	23	24		18		60	Granite. Slope.
6	do	W. C. McIntosh		Dug	34	18	34	24			Granite. Good yield reported. Hill.
7	Stanley	G. K. Derr		Cr-Dr	98	2	60	30	8	30	Granite. Hill.
8	do	H. C. Mungo		Cr-Dr	130	2			10	35	Granite. At one time supplied 13 families and several stores Draw.
9	do	Town	Va. Mach. Co.	Dr	350	8			45		62° F. Granite. Analysis. Well is at tank. Hill.
10	do	do	do	Dr	500	8			28	95	62½° F. Granite. Analysis. Well is one-fourth mile north of tank. Hill.
11	do	do	do	Dr	350	8			15	45	62½° F. Granite. Analysis. Well is SW. of town. Hill.
11a	do	do		Dr	400	8			21		Granite. Pump setting at 150 feet; drawdown rapid but held at 20 g.p.m. at 150 foot setting. Slope.
12	do	Lola Mills, Inc.		Dr	70	6	25	25	8-9	50	Granite. Well at reservoir. Hill.
13	do	do		Dr	85	6			9		Dye house well. Hill.
14	Alexis, 3 miles NW of	B. D. Bradshaw		Dr	80	6				35	Schist. Formerly used by saw-mill; large yield reported. Slope.
15	2 miles SE. of High Shoals	Hardin Mfg. Co.		Dr	226	8		26	25	110	Granite. Use 5 h.p. pump. Valley.
16	High Shoals	Carolinian Mill		Dr	319	8 & 6			30	75	Granite. Use 5 h.p. pump. draw.
17	do	do	R. E. Faw	Dr	351	8		20	45	45	Schist. Use 10 h.p. pump. Slope.
18	do	do			100	4			20-45		Granite. Valley.
19	2 miles W. of High Shoals	P. A. Kiser	Va. Mach. Co.	Dug-Dr	160	6	120±	66	5-6	50	Dug 61 ft., drilled 99.
20	2¾ miles W. of High Shoals	Mrs. M. A. Carpenter	do	Dr	404	6		60	10-15		Hill.
21	4 miles W. of High Shoals	A. M. Kiser	Robbins	Dr	78	5 5/8				40	Schist. Good yield reported. Slope.
22	do	D. C. Kiser	do	Dr	83	5 5/8	73		30-40	40	60° F. Schist. Could not lower water level with bailer. Flat.
23	4½ miles W. of High Shoals	Forrest Dallinger	do	Dr	105½	5 5/8			5		Schist. Hill.
24	5 miles W. of High Shoals	W. E. Kiser	do	Dr	90	5 5/8			4-5	30	Hill.
25	4 miles SW. of High Shoals	A. L. Barbee	Robbins	Dr	128	5 5/8			10	50	Slope.
26	6 miles E. of Cherryville	F. F. Allen	do	Dr	143	5 5/8					Hill.
27	4½ miles E. of Cherryville	G. A. Bell		Dug	34	48		24	adequate	20	Slope.
28	do	G. W. Beam	Robbins	Cr-Dr	80	3		40	1		Hill.
29	3½ miles E. of Cherryville	B. R. Beam	Hickory Pump Co.	Dr	121	6	100	45	7	50	
30	4 miles E. of Cherryville	S. C. Carpenter	Coffee?	Cr-Dr	94	3		30	5		Water reported soft, with no iron. Hill.
31	do	B. H. Carpenter	Costner & Davis	Cr-Dr	127	3			10		Water reported soft. Slope.
32	3 miles E. of Cherryville	Mrs. Verna Paysour		Cr-Dr	100±	3			adequate	50	Slope.
33	do	C. G. Beam	Hickory Pump Co.	Dr	225	5 5/8			10	40	Hill.
34	do	do	do	Dr	100	6			6	45	Hill.
35	1½ miles NE. of Cherryville	do	do	Dr	458	6			35	55	Well supplies six houses. Slope.
36	Cherryville	Carlton Mills	Robbins	Dr	97	5 5/8			25-30		Well by wash house. Draw.
37	do	do	do	Dr	118	5 5/8			25-30	55	61½° F. Well at west end of waste house. Draw.
38	do	Carolina Freight Carriers	Hickory Pump Co.	Dr	300	6			15	35	Draw.
39	do	Rhyne-Hauser Co.	do	Dr	170	8			28	25	61¾° F. Draw.
40	do	do		Dr	190?	6			20	35	63¾° F. Draw.
41	do	do		Dr	200±	6			25		62¼° F. Draw.

RECORDS OF WELLS IN GASTON COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
42	Cherryville	Dora Yarn Mills	Ralph Robbins	Dr	250	5 5/8	46	5.5	10		Not used; insufficient yield.
42a	do	do		Dr	300				40		Draw.
43	do	Town	Lee	Dr	180	8		0	50	60	61° F. Draw.
44	do	do		Dr	200	6			30	40	On East Main Street. Flat.
45	do	do		Dr	200±	5 5/8			25		At old Cherryville Mfg. Co. Slope.
46	do	do	Lee		238	8			75		Analysis. Well 200 yds. S. of Cherryville Cotton Mill. Analysis in table. Draw.
47	do	do			182	6		75	30		Analysis. Under water tank. Hill.
48	do	do	Robbins		177	5 5/8		100			At tool house. Capped. Hill.
49	do	do		Dr	150–200	5 5/8			20	40	At the pump station. Hill.
50	do	do		Dr	150–200	5 5/8		90	20		At tank; in yard. Hill.
51	do	do		Dr	132	5 5/8			20–25		Analysis. Behind Cannery. Slope.
52	do	do		Dr	143	5 5/8		58	20–25		At cannery. Slope.
53	do	do		Dr	150	5 5/8		90	20–25		Analysis. South of tank, on cannery lot. Draw.
54	do	do		Dr	210	5 5/8		40	25		Near Nu-Way mills.
55	do	Nuway Spinning Co.	Ralph Robbins	Dr	178½	5 5/8	118	41	18	65	Draw.
56	do	do	do	Dr	150½	5 5/8			10–12	65	Draw.
57	do	Rhyne-Hauser Mfg. Co.	do	Dr	196½	5 5/8	80	8	80	35	Plant 2. Draw.
58	do	do	do	Dr	145	5 5/8	118		10		Plant 2, not used; insufficient water. Hill.
59	do	Howell Mfg. Co.	do	Dr	139	5 5/8			26	30	Company well 1. Hill.
60	do	do	Robbins	Dr	90	5 5/8			18		Company well 2. Hill.
61	do	do	do	Dr	90	5 5/8			5		Hill.
62	4½ miles SE. of Cherryville	Tryon School	do	Dr	125	5 5/8	75		25		Schist. Hill.
63	do	Fred Biggerstaff	do	Dr	119	5 5/8	90		20		Schist. Draw.
64	do	Anderson Hager	do	Dr	157	5 5/8	54	29	4		Water reported to contain iron. Schist.
65	3½ miles NW. of Bessemer City	D. L. Kiser	do	Dr	142	5 5/8					Schist. Large yield, soft water and no iron reported. Hill.
66	3 miles NW. of Bessemer City	C. C. Harrelson	do	Dr	120	5 5/8		20			Soft water reported. Schist. Slope.
67	2½ miles NW. of Bessemer City	R. V. Guiton	Hickory Pump Co.	Dr	330	6			0		Well drilled on granite ledge. Granite. Hill.
68	3 miles W. of Dallas	Joe Holland		Dug	55	30	55	47.48		45	Granite. Good yield reported. Slope.
69	1¾ miles W. of Dallas	R. E. Summey	Robbins	Dr	142	5 5/8	120		12	25	Granite. Slope.
70	2 miles SW. of Dallas	E. D. Pasour	do	Dr	146	5 5/8	102	35	18	45	
71	1¼ miles W. of Dallas	County Home		Dr	95	6			10	45	Granite. Slope.
72	1 mile SW. of Dallas	C. S. Vincent	Robbins	Cr–Dr	82	2	20		5	35	Granite. Hill.
73	Dallas	Moroweb Cotton Mills Co.		Dr	65	6			7	50	Draw
74	Half-mile W. of Spencer Mountain	Sam Love	Ralph Robbins	Dr	130	5 5/8	101½	62½	40	35	Just below top of sharp hill. Schist.
75	Spencer Mountain	Spencer Mountain Mill	R. E. Faw	Dr	82	6	14	18	6	25	Quartzite. Draw.
76	1¼ mile NW. of Mount Holly	Globe Mills, Inc.		Dr	65±	3			18	55	Used by mill and village. Slope.
77	do	do		Dr	143	8		29?	15	40	Used by mill and village. Hill.
78	1 mile NW. of Mount Holly	Kendrick Brick & Tile Co.		Dr	60	6				45	Diorite. Hill.
79	do	do		Cr–Dr	185	2			10	45	61° F. Diorite. Slope.
80	1 mile N. of Mount Holly	American Yarn, Inc Nims Plant	J. S. Hinson	Dr	208	8			0		Well not used; no water obtained. Diorite. Valley.
81	3 miles N. of Mount Holly	Duke Power Co. Mountain Island Dam		Cr–Dr	70±	3			2–3	60	Granite. Supplies 11 families. Slope.
82	2½ miles N. of Mount Holly	Duke Power Co. Supply Yard	H. L. Laser	Cr–Dr	300+	2			5–6	55	Granite. Hill.
83	Mount Holly	Duke Power Co.			65	2					Supplies 3 houses.
84	2 miles S. of Mount Holly	Superior Yarn Mills Tuckasegee Plant	R. E. Faw	Dr	223	8			46	85	62° F. Schist? Supplies village. Slope.

RECORDS OF WELLS IN GASTON COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
85	2 miles S. of Mount Holly	Superior Yarn Mills, Tuckasegee Plant	Carter	Cr–Dr	37	3			10+	145	Schist. Valley.
86	2½ miles SW. of Mount Holly	J. W. Byrd	J. W. Robbins	Cr–Dr	144	2	90		2	60	Flat.
87	North Belmont	Acme Spinning Co.		Dr	193	6			10	60	62° F. Schist. Hill.
88	do	do		Dr	390	8			30	60	63° F. Schist. Company well 2; north side of plant. Draw.
89	do	do		Dr	527	8			45	60	Schist. Company well 1; east end of mill. Hill.
90	do	Linford Mills, Inc.		Dr	300	8			35	85	62¾° F. Schist. Slope.
91	do	Perfection Spinning Co.		Dr	284	8			60	40	63¼° F. Schist. Slope.
92	do	F. E. Bradshaw	Harkness	Cr–Dr	200	3–2			2½	50	Schist. Hill.
93	do	Stowe Spinning Co.	Hickory Drilling Co.	Dr	1,053	10–8–6	45 (of 10 inch)		85	80	66° F. Schist. Well is crooked and turbine can't be set lower than 85 ft. so pumps only 35 g.p.m. Slope.
94	do	do	Robbins	Dr	85	6			5		Schist. Behind church. Hill.
95	do	do	Wine	Dr	300	10			12–15	50	Schist. Yielded 60 gallons per minute when drilled. Draw
96	do	do	Wine (?)	Dr	225	8			14	60	Schist. Slope.
97	1½ miles N. of Belmont	Belmont Abbey	Va. Mach. Co.	Dr	340	8	60	23	116		Draw. Analysis.
98	1 mile NW. of Belmont	South Fork Mfg. Co.	Sydnor Well Co.	Dr	325	8			60	50	64¼° F. Schist. Pump set to yield 45 g.p.m. Draw.
99	Belmont	Climax Spinning Co.		Cr–Dr	170	3			1½	45	Schist. Ridge.
100	do	Sterling Spinning Co.	Sydnor Well Co.	Dr	375	10		40	4	60	Schist. Yielded 18 g.p.m. when drilled. Draw.
101	do	Crescent Spinning Co.		Cr–Dr	100+	3			12	30	62° F. Schist. Hill.
102	do	do	R. E. Faw	Dr	132	10	85		5		Schist. Well abandoned; not enough water. Hill.
103	do	National Yarn Mills		Cr–Dr	128	3	90		7	40	Schist. 62° F. At upper end of mill. Slope.
104	do	do		Cr–Dr	118	3	80		3½		Across road from mill. Slope.
105	do	do		Cr–Dr	132	3	80		3½		Schist. At lower end of mill. Slope.
106	do	Imperial Yarn Mills, Inc.	Kirkley	Cr–Dr	148	3		35 to 40	6		Schist. Hill.
107	do	do	do	Cr–Dr	160	3		35	5		Schist. Slope.
108	do	do		Dr	103	6			8	75	Do.
109	do	do		Cr–Dr	65	3		10	11	90	Schist. Draw.
110	do	Montbell Ice & Fuel Co.		Dr	80	6			30	65	Do.
111	do	do		Cr–Dr	100	3			15		Do.
112	1 mile S. of Belmont	Henry Lineberger P. W. Muss (Tenant)	Robbins	Dr	112½	5 5/8		42	25		Schist.
113	1¼ miles S. of Belmont	Mr. Matherson	do	Dr	86	5 5/8	70	40	15	35	Granite. Slope.
114	1 mile SW. of Belmont	Miss Florence Abee R. L. Brooks (Tenant)	do	Dr	62	5 5/8	49	24	35	35	Supplies six houses. Draw.
115	4 miles SE. of Belmont	W. G. Drennan	do	Dr	71½	5 5/8		54	5	40	Schist. Hill.
116	do	J. M. Bowen S. B. Benfield	do	Dr	142½	5 5/8	141½	40	15	35	Schist. Slope.
117	1¼ miles SW. of Belmont	Eagle Yarn Mills	Wine (?)	Dr	365	8			27	125	63° F. Schist. Draw.
118	1½ miles SW. of Cramerton	H. R. Lane	Burris	Dug–Dr	39	18–6	31	22.40	2–3	140	Schist. Dug 31 feet. Rock is fine grained; green to gray schist. Hill.
119	2 miles W. of Cramerton	W. S. Quinn	Robbins	Dr	105	5 5/8			7	25	Granite. Slope.
120	do	Arthur Suggs	do	Dr	72½	5 5/8	50		15	35	63° F?. Granite. Hill.
121	4 miles SE. of Gastonia	Plantation Pile	Hamilton	Dr	500	8			100	30	Schist. Slope.
122	1½ miles NW. of Cramerton	L. W. Faries	Ralph Robbins	Dr.	55½	5 5/8				40	Hill.
123	do	Church of God		Cr–Dr	83	2					Supplies 9 houses. Hill.
124	do	W. E. Mitchell	Ralph Robbins	Dr	101	5 5/8			½		Schist. Not used; not enough water. Slope.
125	do	do	do	Dr	83	5 5/8	50	37	20		Slope.
126	do	W. J. Sherer	do	Dr	95	5 5/8			3		Slope.
127	do	R. Q. McAteer	do	Dr	121	5 5/8	82	22	3¼	25	A well 85 feet deep, 50 feet from well 127—Yields 1 gallon per minute. Slope.
128	do	Reece Brandon		Cr–Dr	39	2	4		1½		Soft water. Slope.

RECORDS OF WELLS IN GASTON COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
129	2 miles NW. of Cramerton	T. Hope	Ralph Robbins	Dr	47	5 5/8	35		8		Slope.
130	do	L. C. Hoard	do	Dr	66	5 5/8	50		8	40	Schist. Hill.
131	do	do	do	Dr	114	5 5/8	80		0		Schist. Not used. No water. Hill.
132	McAdenville	Stowe Mills, Inc.	Hickory Pump Co.	Dr	523	10–8	60	21	100+	230	63¾° F. Supplies mills and town. Slope.
133	do	do	Robbins	Dr	80	5 5/8			11		Schist. Used only in emergency. Slope.
134	do	do	(?)	Cr–Dr	120	3			5		Schist. Used only in emergency.
135	¾ mile E. of Lowell	Dr. J. W. Reid H. T. Hawk (tenant)	Ralph Robbins	Dr	71	5 5/8	32		20	45	Schist. Draw.
136	Lowell	J. R. Hudson		Dr	140	6			40	45	Supplies 35 houses and several businesses. Draw.
137	do	National Weaving Co.		Dr	100	6			22		Not in use. Water reported to be hard. Draw.
138	do	do		Dr	100	6			14		Do. Slope.
139	do	do		Dr	180	6			60		Schist. Slope.
140	1 mile SW. of Lowell	W. A. Froneberger	Ralph Robbins	Dr	96	5 5/8	55		20	50	
141	do	Setzer's Camp	do	Dr	52	5 5/8		5	52	40	Schist. Water reported to be corrosive. Draw.
142	2½ miles E. of Gastonia	Gaston Country Club	do	Dr	60	6			20		Schist. Draw.
143	do	do	do	Dr	225	6	142		1		Not used; not enough water. Schist. Slope.
144	2 miles E. of Gastonia	Akers Motor Lines Co.	do	Dr	105½	5 5/8	76	26	18	35	Schist. Slope.
145	3¼ miles NE. of Gastonia	A. M. Smyre Mfg.	Ralph Robbins	Dr	140	5 5/8			14		2 other similar wells at mill and village. Flat.
146	do	do	do	Dr	251	6	123	42	12	30	Yielded 27 gallons a minute when drilled. Hill.
147	4 miles NE. of Gastonia	Ranlo Mfg. Co.	do	Dr	130			19.1	20	25	Draw.
148	do	Textiles, Inc. Priscilla Plant	Sydnor Well Co.	Dr	585	6			20		Not used. Tested at 65 g.p.m. when drilled. Yield decreased to 20 g.p.m. when abandoned. Hill.
149	do	do	Ralph Robbins	Dr	79	5 5/8	48	38	8		Schist. Not used; capped. Hill.
150	do	do	do	Dr	178	5 5/8	60	18	10		Schist. Not used; capped. Draw.
151	do	do	Va. Mach. Co.	Dr	500	8	85	42	102	80	62½° F. Schist and quartzite. Draw.
152	do	do		Dr	200	5 5/8			10		Schist. Yielded 25 to 30 g.p.m. when drilled. Draw.
153	do	Rex Spinning Co.	Ralph Robbins	Dr	130	5 5/8			10	50	Schist. Hill.
154	do	do	do	Dr	191	5 5/8	87	50	18		Schist. Abandoned because water became muddy. Draw
155	do	do	(?)	Dr	242	8			15		Hill.
156	2½ miles NE. of Gastonia	Groves Thread Co.	Ralph Robbins	Dr	165	6			90	115	Granite. Water obtained at 80 feet. Draw.
157	do	do	do	Dr	145	5 5/8			35	45	61½° F. Granite. Draw.
158	do	do	do	Dr	85	5 5/8			15		Granite. Draw.
159	do	do	do	Dr	90	6			20		Granite. Well at reservoir. Draw.
160	do	do	do	Dr	85	6			16		Granite. Draw.
161	do	do	do	Dr	132	6			12		Granite. Draw.
162	do	do	do	Dr	60	6			12		Granite. Hill.
163	do	Flint Mfg. Co.	do	Dr	69½	5 5/8		50	11	45	Granite. Draw.
164	do	do	do	Dr	61	5 5/8			8		Do.
165	do	do	do	Dr	167	5 5/8		44	30	30	Do.
166	1¾ miles N. of Gastonia	C. A. Barkley	do	Dr	133	5 5/8	97	28	20	25	Supplies 9 houses. Schist. Slope.
167	Gastonia	Grenton Mills	(?)	Dr	265(?)	6			30		Schist. Draw.
168	do	Sunrise Dairy	Ralph Robbins	Dr	136	6	15	25	15		Schist. Water obtained at 70 feet. Slope.
169	Gastonia	Sunrise Dairy	Ralph Robbins	Dr	96	6	43	15	21		Granite. Draw.
170	1 mile S. of Gastonia	Textiles, Inc. Seminole Plant		Dr	120	6			5		Granite. Slope.
171	1¼ miles S. of Gastonia	Ruby Cotton Mill		Dr	135	6		30	8	30	62° F. Granite. Draw.
172	do	do		Dr	185	6			8		Granite. Draw.
173	do	do		Dr	185	6		30	5		Granite. Hill.

RECORDS OF WELLS IN GASTON COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
174	1¼ miles S. of Gastonia	Textiles, Inc. Osceola Plant	----------	Dr	122	6	----------	----------	----------	35	Granite. Use a 3 H.P. pump. Hill.
175	1½ miles S. of Gastonia	Dixon Mills	Ralph Robbins	Dr	185	5 5/8	----------	15	35	----------	Granite. Draw.
176	----do	----do	----do	Dr	53	5 5/8	----------	10	16	35	Do.
177	2 miles S. of Gastonia	Textiles, Inc. Victory Plant	----------	Dr	135	6	----------	----------	12	20	Granite. Originally yielded 25 g.p.m. Flat.
178	2½ miles S. of Gastonia	Textiles, Inc. Myers Plant	Ralph Robbins	Dr	110	5 5/8	----------	----------	5	----------	Granite. Well at mill. Flat.
179	----do	----do	----do	Dr	103½	5 5/8	----------	----------	16	35	61½° F. Granite. Originally yielded 29 g.p.m. Draw.
180	----do	----do	----do	Dr	120	5 5/8	----------	----------	6	----------	Granite. Well in village. Hill
181	2¾ miles S. of Gastonia	Rex-Hanover Mills, Inc. (Hanover Plant)	----do	Dr	180	6	----------	40	20	40	62½° F. Granite. Wells 181 182 and 183 supply water for plant and village. Analysis of water from well 182 in table. Temperature well 182, 64° F.
182	----do	----do	Ware	Dr	267	8	112	----------	30	----------	
183	----do	----do	Robbins	Dr	140	5 5/8	----------	----------	5	----------	Granite. Draw.
184	3½ miles S. of Gastonia	Textiles, Inc. Ridge Plant	----do	Dr	185	5 5/8	35	10	20+	35	Granite. Draw.
185	----do	----do	----do	Dr	120	5 5/8	----------	----------	5	----------	Granite crops out 50 feet from well. Hill.
186	2½ miles SE. of Gastonia	J. A. Bradshaw	----do	Dr	42	5 5/8	27	13	8	25	Granite. Draw.
187	3½ miles SE. of Gastonia	Robert M. Brandon	----do	Dr	55	5 5/8	40	24	40	20	Schist. Flat.
188	----do	H. R. Kendrick	----do	Dr	35	5 5/8	27	----------	6	55	Schist. Flat.
189	Gastonia	Firestone Mills, Inc.	----do	Dr	80±	6	----------	----------	44	----------	Granite. Water reported soft. Draw.
190	----do	----do	Robbins (?)	Dr	214	8	----------	.13	80	----------	Granite. Well 1; not in use. Draw.
191	----do	----do	----do	Dr	125	6	----------	10.2	20	----------	Granite. Well 2; not in use. Draw.
192	----do	----do	Guy Robbins	Dr	145	6	----------	10.6	18	----------	Granite. Well 3. Draw.
193	----do	----do	----------	Dr	107	6	----------	----------	33	----------	Well 4; not in use. Granite. Draw.
194	----do	----do	----------	Dr	92	6	----------	5.07	15	----------	Granite. Well 5. Draw.
195	----do	----do	Robbins	Dr	(?)	6	----------	----------	12	----------	Granite. Well 6.
196	1½ miles W. of Gastonia	Parkdale Mill, Inc.	----do	Dr	180	5 5/8	100	----------	10	35	Granite. Draw.
197	----do	----do	----do	Dr	210	5 5/8	100	----------	35	----------	Granite. Slope.
198	----do	Bloom Mills, Inc.	----------	Dr	98	6	----------	58	8	35	64½° F. Granite. Hill.
199	----do	Textiles, Inc. Arlington Plant	----------	Dr	160	6	----------	----------	18	30	62½° F. Granite. Hill.
200	2 miles W. of Gastonia	Threads, Inc.	Robbins	Dr	105	8	44	10	10	----------	Granite. Not in use. Draw.
201	----do	----do	J. S. Hinson	Dr	490	8	----------	----------	2	----------	Granite. Abandoned. Draw.
202	----do	----do	Robbins	Dr	76½	8	----------	----------	12	----------	Granite. Not in use. Slope.
203	----do	----do	J. S. Hinson	Dr	490	8	80	----------	15	45	63¾° F. Granite.
204	----do	----do	----do	Dr	900–1000	8	----------	----------	----------	----------	Granite. Draw.
205	2¼ miles W. of Gastonia	Textiles, Inc. Myrtle Plant	----------	Dr	160	6	----------	----------	10	30	Granite. Slope.
206	1¾ miles NW. of Gastonia	Clyde Bradford	Ralph Robbins	Dr	53	5 5/8	38	31	8	----------	Granite. Slope.
207	----do	D. W. Dawn	----do	Dr	64½	5 5/8	35	20	10	35	Granite. Supplies 4 houses. Slope.
208	----do	O. L. Rhyne	----do	Dr	100	5 5/8	----------	----------	6	20	Granite. Hill.
209	2½ miles NW. of Gastonia	O. R. Jenkins	----do	Dr	100	5 5/8	15	----------	25	25	Granite. Hill.
210	----do	M. B. Jenkins	----do	Dr	110½	5 5/8	40	35	15	25	Granite. Hill.
211	----do	D. L. Wyont	----do	Dr	77	6	15±	----------	4	35	Slope.
212	----do	J. Froneberger	----do	Dr	132	6	80	----------	4	40	----------
213	3¼ miles NW. of Gastonia	D. G. Burns	Va. Mach. Co.	Dr	110	6	----------	----------	----------	----------	Supplies large farm. Slope.
214	2 miles E. of Bessemer City	Ragan Spinning Co.	----------	Dr	271½	6	----------	----------	6	----------	Schist. Old well in field, not used. Slope.
215	----do	----do	Ralph Robbins	Dr	168	6	106	50	50	45	62¼° F. Schist. Company well 1. Draw.
216	----do	----do	----do	Dr	238½	6	76¾	32½	12	----------	Company well 2 (at school house). Hill.
217	1¾ miles E. of Bessemer City	Ideal Machine Shop	Ralph Robbins	Dr	130	5 5/8	110	27	12	50	Schist. Draw.

RECORDS OF WELLS IN GASTON COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
218	Bessemer City	Algodon Mfg. Co.	do	Dr	143	5 5/8	104	14	25		Not used; water reported to be too hard. Flat.
219	do	Osage Mfg. Co.		Dr	150	6	50		15		Pumped at 35 g.p.m. but will not maintain this yield Flat.
220	1½ miles SE. of Bessemer City	L. A. Wolfe	Ralph Robbins	Dr	116	5 5/8	62	57	40		Slope.
221	2 miles SW. of Bessemer City	R. L. Lewis Dairy	do	Dr	160	5 5/8	134	65	16	40	Schist. Slope.
222	2½ miles SW. of Bessemer City	Pine Grove Grill	do	Dr	165½	5 5/8			20	45	Schist. Slope.
223	1 mile NW. of Kings Mountain	Earle E. Carpenter	do	Dr	100	5 5/8	80	50	5	55	Schist. Hill.
224	Mountain View	Frieda Mfg. Co.		Dug	41	24	41	37.68			Schist. Supplies village. Hill.
225	do	do		Dug	17	24	17	6.50	15		Gravel? Valley.
226	do	R. H. Hook	Ralph Robbins	Dr	101	5 5/8		61	25+	55	Schist. Slope.
227	do	Harvey Flume	do	Dr	97	5 5/8	56	43	50?	20	Schist. Draw.
228	½ mile NE. of Mountain View	Mrs. Eure Roberts		Dug	87	30	0	80.98			Schist. Hill.
229	2½ miles SE. of Mountain View	A. L. Dial	Ralph Robbins	Dr	137½	5 5/8			4–5	35	Do.
230	3 miles S. of Mountain View	J. A. Stroupe		Br	53	12		46.22		20	Schist. Supply failed during autumn of 1940 and 1941. Hill.
231	4½ miles S. of Mountain View	Wilson and Brown		Dr	70	6		40		50	Schist. Hill.
232	5 miles S. of Gastonia	T. L. Hovis	Ralph Robbins	Dr	108	5 5/8		48.00	5	45	Granite. Hill.
233	5 1/3 miles S. of Gastonia	Evan Brandon	do	Dr	65	5 5/8			15	20	Schist. Slope.
234	6 miles S. of Gastonia	C. E. Honeycutt	do	Dr	100	5 5/8			15–20	20	Schist.
235	do	W. L. Hutchison	Tom York	Cr–Dr	90	2	40	48	4		Granite.
236	7 miles S. of Gastonia	Tom Sparrow		Dug	61	36	61	56.25		35	Schist. Hill.
237	7½ miles S. of Gastonia	do	Ralph Robbins	Dr	125	5 5/8			20		62° F. Schist. Cased 65 to 75 feet. Hill.
238	4¼ miles SE. of Gastonia	Carroll Kerr	do	Dr	90	5 5/8		21	6	20	Schist. Slope.
239	4¾ miles SE. of Gastonia	W. S. Torrence Fairview Dairy	do	Dr	150	5 5/8		40	10	30	Schist. Draw.
240	do	Gastonia Airport	U. S. Army	Dr	102	6	78	15	20		Do.
241	5¾ miles SE. of Gastonia	Sandy Plain Church	Tom York	Cr–Dr	90	2			4–5		Hill.
242	6½ miles SE. of Gastonia	D. F. Harrison	George Stephenson	Cr–Dr	68	2	48		5		Water reported soft. Hill.

ANALYSES OF GROUND WATER FROM GASTON COUNTY,* N. C.
(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	9	10	11	46	47	51	53	97	182	Spring** (Gaston No. A)
Silicia (SiO_2)	32	20	31	27	35	36	35	37	34	23
Iron (Fe)	.23	4.9	.41	8.6	.15	.08	.59	.09	1.0	.21a
Calcium (Ca)	44	31	55	14	10	11	9.2	12	8.3	4.9
Magnesium (Mg)	3.7	5.0	5.1	5.9	4.4	6.2	4.5	4.7	1.3	2.2
Sodium and potassium (NA+K)	11	8.4	25	9.3	8.3	5.2	6.9	6.4	10	5.3
Carbonate (CO_3)	0	0	0	0	0	0	0	0	0	0
Bicarbonate (HCO_3)	160	124	107	84	40	52	37	71	31	31
Sulfate (SO_4)	6.7	10	113	4.1	1.9	3.9	2.9	1.2	1.3	4.3
Chloride (Cl)	7.0	2.5	2.2	4.5	13	7.4	8.4	1.6	12	1.9
Fluoride (F)	.3	.2	1.0	.0	.0	.0	.0	.1	.1	.0
Nitrate (NO_3)	.6	.0	1.1	.0	10	8.8	14	1.6	5.1	.2
Dissolved solids	166	138	290	107	111	114	107	101	96	59
Total hardness as $CaCO_3$	125	98	158	59	43	53	41	49	26	21
Date of collection	11/20/47	11/20/47	11/20/47	2/16/48	2/16/48	2/13/48	2/16/48	8/11/45	8/11/45	5/20/49

* Analysis made by U. S. Geological Survey.
** Flows one-half g.p.m. from hornblende gneiss.
a Fe in solution .01

LINCOLN COUNTY

(Area 308 square miles; population in 1950, 27,459)

Geography and physiography.—Lincoln County lies in the north central part of the area studied. It is nearly rectangular in shape, its long north and south boundaries being straight lines. Lincolnton, with a population of 5,419, is the county seat and largest town. Denver, Crouse, Iron Station, and Long Shoals are other communities. The soil and climate are favorable for the growing of crops, the most important of which are corn, cotton, wheat, oats, and hay. The development of power along some of the streams has led to the development of numerous cotton mills, most of which are centered in the area south of Lincolnton. The county is well served by highways, and it has an excellent network of county roads.

Like the other counties in the Charlotte area, Lincoln County is in the Piedmont Plateau section of the state. The topography is characterized by rather broad rolling hills separated by the declivities of stream valleys. The highest altitude is in the northwest corner of the county where several hills stand out above the general level of the upland. The lowest part of the county is in the southeast corner in the vicinity of Catawba River.

The major stream is the Catawba River which flows south forming the east border of the county. The entire county lies within the drainage basin of the Catawba although most of the streams enter the Catawba in the area to the south in Gaston County. Hence, the major tributaries of the Catawba have southeast courses across the regional rock structure. Most of these streams rise within the county, the main exceptions being Pott Creek, Clark Creek, and South Fork River that rise in Catawba County to the north. Because of the numerous headwater areas of streams, features of relatively youthful topography, such as hilliness of the land and steep gradients of streams are common. The valley of the Catawba River is not broad, owing to the fact that the major tributaries virtually parallel it in Lincoln County. A few streams enter the Catawba at right angles, but these are so short that the local divide, on which State Highway 16 is located, is only 2 or 3 miles from the river.

Geology.—The geology of Lincoln County is similar to that of Gaston County in that the same rocks, for the most part, that occur in Gaston extend northeastward into Lincoln County (fig. 15). The numerous variations of rock type across the strike are an important feature of the geology. The dip of the more schistose rocks is generally toward the southeast.

Mica schist and granite are the most prevalent rocks in Lincoln County. The schist is the chief rock that the granite penetrated, its schistose structure being favorable for the conformable emplacement of granitic sheets. The only large area of schist containing little granite extends northeastward through the center of the county. It is well exposed on State highway 150 about 3 miles east of Lincolnton. The schist is composed chiefly of muscovite, sericite, and quartz.

The broad area extending 4 or 5 miles west of Lincolnton contains granite as the injected material in a host rock varying from muscovite schist to a hornblende and biotite schist. In the valley of Clark Creek north of Lincolnton the composite rocks include hornblende schist and biotite schist intercalated with granite. These together, on weathering, yield a deep-red thick soil.

The rock in Howard Creek 1½ miles south of Reepsville is an injection-gneiss in which the granite and the sedimentary component are very closely interlaminated although separately distinct. The sedimentary component is composed chiefly of biotite. Most of the rocks of the injection complex are not as closely interlayered as the injection-gneiss on Howard Creek.

Granite occurs in a belt extending from the Gaston County line northeastward to Lincolnton, and many granitic sheets and pegmatites occur in the schist surrounding the granite. The granite is light in color and of medium to coarse texture and may be genetically related to the lithia- and tin-bearing pegmatites that parallel it on the east.

The granite in the vicinity of Iron Station and Denver contains conspicuous amounts of biotite. It shows a gneissic or banded structure in some places.

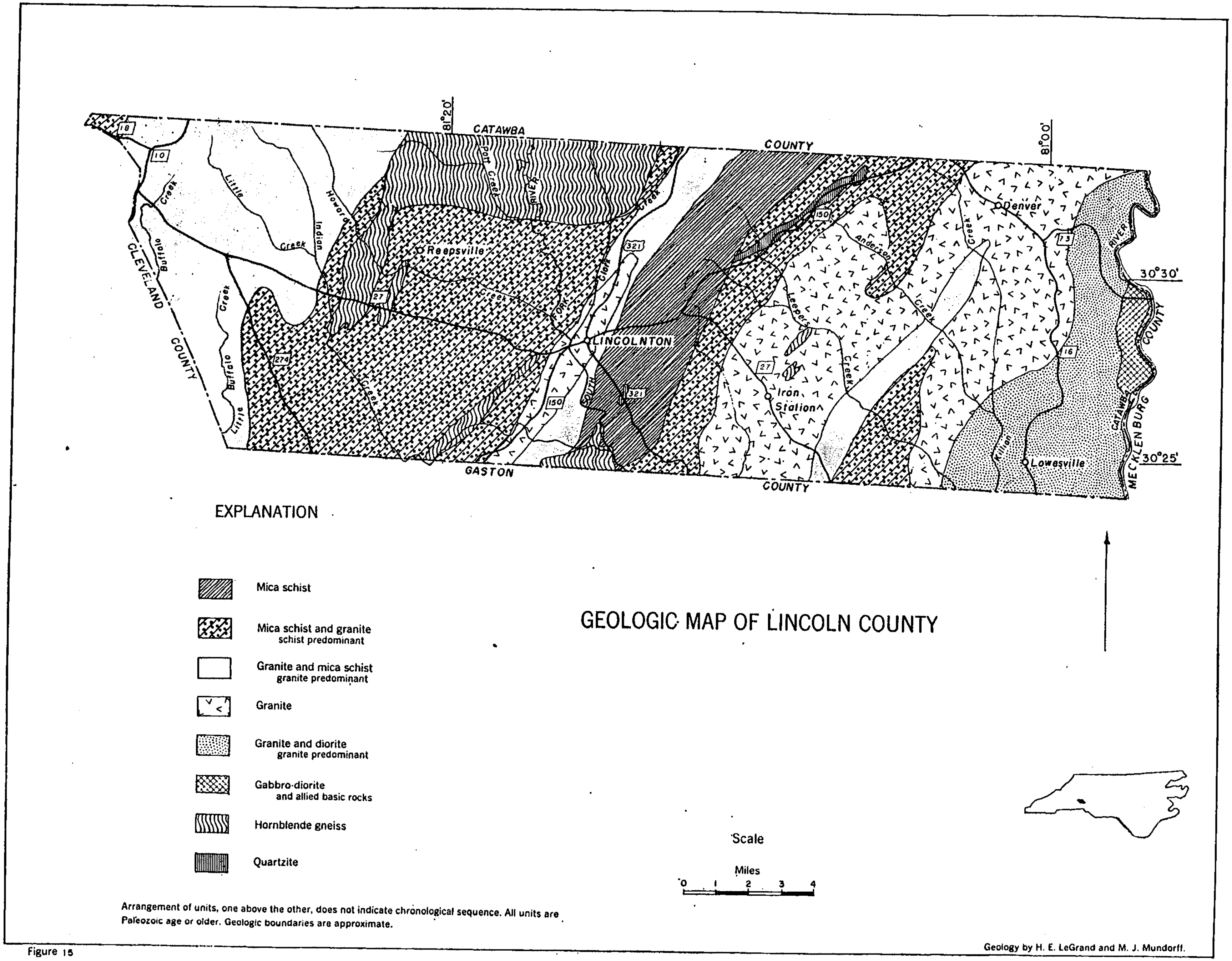

Figure 15

FIGURE 15.—GEOLOGIC MAP OF LINCOLN COUNTY.

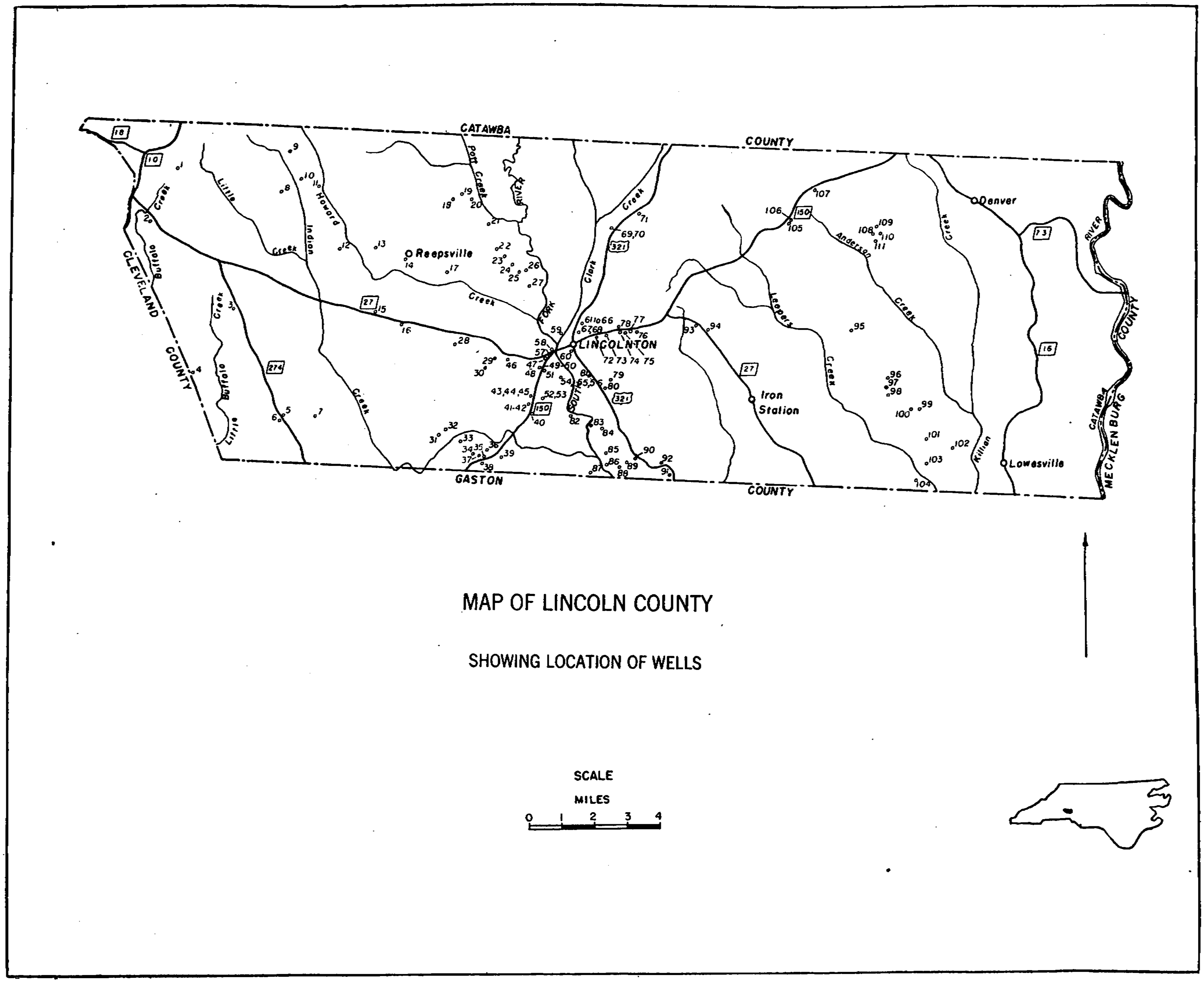

FIGURE 16.—MAP OF LINCOLN COUNTY SHOWING LOCATION OF WELLS

An area of gneissic granite occurs in the northwest corner of Lincoln County. For the most part, the rock is a moderately coarse granite in which thin layers of biotite give the rock a banded appearance. Although it contains more granitic material than the schist-granite complex, the contact between these units is arbitrary.

Hornblende gneiss occurs interlayered with other rocks in most of the county. Several areas of hornblende gneiss are large enough to be shown on the accompanying geologic map of the county. The gneiss 2 miles west of Reepsville contains granite as lenses parallel to the enclosing gneiss and as veins cutting the gneiss transversely.

Rocks of the diorite-granite complex occur in the extreme east portion of the county. Granite appears to be more prominent than diorite in the area around Lowesville where, as is characteristic of the complex in Mecklenburg and Cabarrus Counties, the diorite and granite represent an intermixed composite rock although each component is separate. Near the crossing of N. C. Route 73 and the Catawba River a quartz diorite occurs. Its field relation with the diorite-granite complex suggests that it is contemporaneous with the rocks of the complex but represents a more thorough mixing of the components.

Ground water.—Nearly all domestic water supplies and a part of the sole municipal water supply are obtained from wells (fig. 16).

Dug wells are used for most domestic purposes. They generally range in depth from about 20 to 60 feet. The deep weathering of the schist and granite allow most wells to be dug deep enough to furnish a satisfactory water supply throughout the year.

Most of the wells listed in the well tables for Lincoln County are for private use although some are for industrial and municipal use. Nearly all wells penetrate schist or granite, the relative merits of the wells in these rocks being shown in table 12.

The average yield of wells in schist is about 14 gallons a minute, almost twice as much as the average yield of wells in granite. However, the average depth of wells in schist is also somewhat greater so that the difference in average yield per foot of well between these rocks is not so great. The average yields of wells in both schist and granite are considerably less than those in the same rocks in Cleveland and Gaston Counties and are also less than the average for all schists and granites in the Charlotte area. It is apparent that the low average yields are due, in part, to the fact that a majority of the wells in table 12 represent domestic wells that are not designed for large yields and that may not have been tested at their maximum capacity. This average yield is almost doubled if only the 27 wells drilled for industrial, municipal, and school use are considered; the average for these wells is 23 gallons a minute.

As in other counties, topographic location has an important bearing on the yield of wells. The 36 wells drilled on hills have an average yield of only half that of wells drilled in draws, and the difference in the average yield per foot of well is even more marked. Wells in draws average 114 feet in depth and 23 gallons a minute in yield, whereas wells on hills average 157 feet and 11 gallons a minute respectively. It is evident from the table that draws represent the best location in which to drill wells.

TABLE 12.—SUMMARY OF DATA ON WELLS IN LINCOLN COUNTY
(Drilled wells 3 inches or more in diameter)

ACCORDING TO ROCK TYPE

Type of Rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Schist	40	139	3—58	14	0.10	0
Granite	28	114	1—100	8	.07	7
All wells	68	129	1—100	12	.09	3

ACCORDING TO TOPOGRAPHIC LOCATION

Topographic location	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Hill	36	157	1—100	11	0.07	6
Flat	1	123	----------	10	.08	0
Slope	17	130	3— 40	12	.09	0
Draw	13	114	3— 58	23	.20	0
Valley	1	300	----------	20	.07	0

Analyses of water samples from four wells are given in the table of analyses for Lincoln County. Two of these wells penetrated schist and two penetrated granite. The water is of good quality, which is to be expected as both schist and granite contain relatively insoluble mineral constituents. Where wells penetrate hornblende gneiss either as thin sheet-like bodies in the mica schist and granite or as large bodies covering many feet, the water may contain more dissolved solids. The field tests for hardness of water which were made on samples from most wells indicated that the waters from nearly all localities are soft. The average hardness is slightly less than 50 parts per million.

The average temperature of well water is 60° F.

Municipal supplies.—Lincolnton, population 5,419, has the only municipal water supply in Lincoln County. The supply is obtained chiefly from surface water impounded on Walker Branch. The town has six wells that are periodically pumped. Although the aggregate yield of these wells pumping individually is about 500 gallons a minute, it is estimated that with continuous pumping of all wells the aggregate yield might not exceed 300 gallons a minute. The wells penetrate granite for the most part.

RECORDS OF WELLS IN LINCOLN COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
1	2 miles NE. of Toluca	Northbrook School No. 3	Ralph Robbins	Dr	100	50	5 5/8	47	15		Schist. Hill.
2	¾ miles E. of Toluca	D. C. Upton		Dug	24½	24½	24	18.65		15	Schist. Slope.
3	2½ miles NW. of Flay	Northbrook School No. 2	Ralph Robbins	Dr	123	78	5 5/8	27	10		Flat.
4	2¼ miles W. of Flay	John B. Peeler		Cr-Dr	80		3	18	10-15	40	Schist. Draw.
5	1¾ miles SE. of Flay	Marshall Heavner	Claude Hoke	Dr	192	20	4		15	45	Schist. Draw.
6	2 miles SE. of Flay	Northbrook School No. 1		Dr	120		6		5-10		Schist. Hill.
7	2½ miles SE. of Flay	F. L. Hardt		Dug	35	35	24	31.04			Do.
8	1¾ miles W. of Vale	Harry Houser		Dug	34	34	24	23.14		60	Schist.
9	1¾ miles NW. of Vale	Dr. Blair Yount	R. E. Faw	Dr	218		6		10		Schist. Analysis. Draw.
10	1 mile NW. of Vale	J. L. Yount	Claude Hoke	Dr	130		4		15	30	Schist. Dug 40 feet, drilled 90 feet. Slope
11	½ mile SW. of Vale	M. F. Lutz	do	Dr	69		4	36	5	35	Schist. Hill.
12	2 miles W. of Reepvilie	Ralph Cochrane Will Leadford (tenant)	Hickory Pump Co.	Dr	203	138	6	45	25-30		Hill.
13	1 mile NW. of Reepville	Union School		Dr	90		6		4-5	30	Does not furnish adequate supply. Hill.
14	Reepville	Mrs. B. M. Bolinger	J. E. Burke	Cr-Dr	74½		3		6		Hill.
15	2 miles SW. of Reepville	G. T. Wise		Dug	42½	42½	24	34.90		65	Four tons crushed limestone placed in bottom of well. Hill.
16	2¼ miles S. of Reepvide	Dours L. Helms		Dug	45		36	32.44		50	Hill.
17	1¼ miles SE. of Reepville	M. L. Yoder	R. E. Faw	Dr	156	100	5	30	10±	40	Draw.
18	2 miles NE of Reepville	R. S. Wyant		Cr-Dr	100		3	Above surface			Flow, 6 g.p.m.
19	2½ miles NE. of Reepville	P. L. Sigmond	Richard Coffey	Cr-Dr	143		3		3	25	Hill.
20	do	do	Clyde Hoke	Dr	96		3				Water level below surface but is piped down creek where it flows. Flow, 3 g.p.m. Draw.
21	4¼ miles NW. of Lincolnton	M. S. Yoder	J. E. Burke	Dr	80		4		3	40	Draw.
22	3½ miles NW. of Lincolnton	A. S. Yount		Cr-Dr	62½		3			30	Adequate yield; has never failed. Hill.
23	3¼ miles NW. of Lincolnton	W. Ray Taylor	J. E. Burke	Cr-Dr	97		3			50	Adequate yield. Slope.
24	3 miles NW. of Lincolnton	Mrs. J. F. Seagle	Clyde Hoke	Dr	98		4		4-5	30	Slope.
25	2½ miles NW. of Lincolnton	J. E. Cansler	R. E. Faw	Dr	110+		6		10-12	40	Schist. Hill.
26	do	do	do	Dr	110±		6		14	40	Schist. Slope.
27	2 miles NW. of Lincolnton	D. A. Cline	Davis	Cr-Dr	113		4			35	Schist. Adequate Supply. Hill.
28	3¾ miles W. of Lincolnton	Howard Creek School		Cr-Dr	120		6		5-6	40	Schist. Hill.
29	2½ miles W. of Lincolnton	Lee Martin		Cr-Dr	75		3			45	Schist. Adequate supply. Slope.
30	2¾ miles SW. of Lincolnton	George M. Brown		Dug	30		18	24.61		60	Schist. Hill.
31	2 miles NW. of Crouse	John Hoover	Claude Hoke	Dr	160	160?	4			50	Schist. Adequate supply. Slope.
32	do	R. J. Hoover	Davis	Cr-Dr	66		3	35		45	Schist. Water slightly corrosive.
33	1¼ miles NW. of Crouse	J. L. Avery	Claude Hoke	Dr	90	42	4	50	10-15	70	Schist. Hill.
34	¾ mile W. of Crouse	W. H. Boring	Davis	Cr-Dr	184	80	3		8-10	45	Schist. Corrosive water contains considerable iron. Hill
35	Crouse	Mrs. Willena Boring	Ralph Robbins	Dr	93½	92	5 5/8	16	14	40	Schist. Slope
36	do	Elementary School		Dr	100		6		10	30	Schist. Hill.
37	do	Mrs. Delie Clark	Ralph Robbins	Dr	112	77½	5 5/8	21	20	40	Schist. Supplies three families. Slope.
38	do	L. B. Beam	do	Cr-Dr	100		3	15	6-8	30	Schist. Hill.
39	¾ mile E. of Crouse	T. H. Mullen	J. E. Burke	Cr-Dr	80		3		5	30	Granite. Hill.
40	2½ miles SW. of Lincolnton	E. N. Rudisill	Robert Davis	Cr-Dr	45	30	3	1.5		25	Water flows 3 g.p.m. from ¾ inch pipe, 100 feet down. Draw.
41	2¼ miles SW. of Lincolnton	do	J. E. Burke	Cr-Dr	110	73	3	28	6-8	35	Granite. Well used by Mill, Art Cotton Mills Co. Slope.
42	do	do	Richard Coffey	Cr-Dr	90		3		6-8		Granite. Hill.
43	2 miles SW. of Lincolnton	Rudisill Spinning Co.		Dr	100±		6		10±	20	Do.
44	do	do		Cr-Dr	90		3	34.27	4½		Do.
45	do	do	R. E. Faw	Dr	200		8	39.04	100		Granite. Test pump set at 125 feet. Pumped at 100 g.p.m. for 10 hours. Hill.

RECORDS OF WELLS IN LINCOLN COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
46	2 miles SW. of Lincolnton	E. N. Rudisill. Mrs. Shultz (tenant)	Claude Hoke	Dr	130	8	3		8	45	Schist. Slope.
47	1¼ miles SW. of Lincolnton	Tom Howard	R. E. Faw	Dr	80		4				Granite. Large supply reported. Hill.
48	do	Loy Reep	do	Dr	80		6		10–15	50	Granite.
49	2 miles SW. of Lincolnton	Love Memorial School	Claude Hoke	Dr	120		4		5+	20	Granite. Hill.
50	do	Tom Houser	do	Dr	98		3			25	Granite. Adequate supply. Hill.
51	1 mile SW. of Lincolnton	E. G. Schronce	R. E. Faw	Dr	122	100	4	45	10–15	45	Granite. Water level was not lowered with bailer. Hill.
52	2 miles SW. of Lincolnton	Rhodes-Rhyne Mfg. Co.		Dr	350		6		20–25	20	60½° F. Granite. Large yield reported. Slope.
53	do	do		Dr	250		6		20–25		Granite. Draw.
54	1 mile SW. of Lincolnton	Glenn Mfg. Co.	Claude Hoke	Dr	160		6		15		Draw.
55	do	do		Dr	150±		4		10		A similar well 150 feet from well 55 yields about 5 g.p.m. Draw.
56	do	do		Dr	150±		4		5	30	A similar well 25 feet from well 56 yields about the same. Slope.
57	1 mile SW. of Lincolnton	E. T. Bullard	J. E. Burke	Dr	55		4	13.40	7		Granite. Draw.
58	do	George Hoyle	do	Dr	70		3		5	35	Granite. Slope.
59	½ mile NW. of Lincolnton	Crown Converting Co.		Dr	131		6		10–15	90	Schist. Hill.
60	Lincolnton	Coble Dairy Products, Inc.		Dr	90		8		30	90	Granite. Draw.
61	do	Town		Dr	184		8	10.88			Granite. Combined yield of wells 61 to 66, inclusive, is about 500 g.p.m. but wells will not yield this amount continuously. Estimated to yield about 200 g.p.m. with continuous pumping. Wells are pumped each week to keep them in operation.
62	do	do		Dr	150±		6				
63	do	do		Dr	150±		6	5.55			
64	do	do		Dr	142		6	5.01			
65	do	do		Dr	175±		6	8			59¾° F. Valley.
66	do	do		Dr	175		6	8			Analysis. 59¾° F. Valley.
67	do	Ideal Chair Co.		Dr	200		4		6	85	Hill.
68	do	do	R. E. Faw	Dr	700		6		4		Granite. Insufficient supply; not used. Hill.
69	3¾ miles NE. of Lincolnton	S. H. Haynes	Ralph Robbins	Dr	100	40	5 5/8	8	25	105	Draw.
70	do	do	R. E. Faw	Dr	140		6		16–18	60	Hill.
71	4½ miles NE. of Lincolnton	G. H. Tucker		Dug	33	33	36–24	26.60		35	Hill.
72	¾ mile E. of Lincolnton	Cochrane Furniture Co.	Hickory Pump Co.	Dr	302	80	6	22	100	45	Draw.
73	1¼ miles E. of Lincolnton	Lineberger Ice & Fuel Co.		Dr	140		6		35	50	Draw.
74	2 miles E. of Lincolnton	Boger & Crawford Spinning Co.	Hickory Pump Co.	Dr	400	118	8	53	32	40	Company well 4, at west end of mill. Draw.
75	do	do	W. A. Kirkley	Cr–Dr	166	100	6	40	30	25	Company well 3, west end of mill. Flat.
76	2¼ miles E. of Lincolnton	do	Robbins(?)	Dr	175		6	40	16	35	Company well 1. Draw.
77	do	do	Ralph Robbins	Dr	240	90	8	42	10	25	Yielded 54 g.p.m. for several years. Flat.
78	1¾ miles E. of Lincolnton	J. E. Burke	J. E. Burke	Dr	145		6–4		6		Schist. Hill.
79	1¾ miles SE. of Lincolnton	J. A. Abernathey	W. A. Kirkley	Cr–Dr	215	50±	3		18		Schist. Corrosive water, stains fixtures yellow.
80	do	E. A. Mauney	Hickory Pump Co.	Dr	170		6	20.26	40		Schist. Slope.
81	1¼ miles SE. of Lincolnton	Miss Anna Lloyd	Lloyd	Cr–Dr	35		3	+.5		50	Schist. Flows 2 g. p. m. Flowed 15 g.p.m. when drilled.
82	2¼ miles S. of Lincolnton	D. E. Rhyne Mills Laboratory Plant	R. E. Faw	Dr	300		6		20	45	Schist. Valley.
83	2½ miles SE. of Lincolnton	D. E. Rhyne Mills Lincoln Plant	do	Dr	180		6		10	40	Schist. Dug 60 feet. Slope.
84	2¾ miles SE. of Lincolnton	C. S. Little	do	Dr	200	70	6		15	40	Schist. Dug 70 feet. Slope.

RECORDS OF WELLS IN LINCOLN COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
85	Long Shoals	Long Shoals School		Dug	35				7	50	Schist. Slope.
86	do	Long Shoals Cotton Mills, Inc.		Cr-Dr	50		3		10		Valley.
87	½ mile SW. of Long Shoals	J. E. Carpenter, Jr.	Ralph Robbins		63		6	35	15	35	
88	Long Shoals	Long Shoals Cotton Mills, Inc.	Hickory Pump Co.	Dr	710	50	8-6		17	50	Schist. Hill.
89	do	do	Ralph Robbins	Dr	129½	73	5 5/8		40		Schist. Analysis. Draw.
90	1 mile E. of Long Shoals	L. E. Hollar		Dug	46		30	37.52		50	Hill.
91	2 miles E. of Long Shoals	J. E. Robinson	Ralph Robbins	Dr	117½		5 5/8	17	58	30	Schist. Draw.
92	1¾ miles E. of Long Shoals	Howard Robinson	do	Dr	137½		5 5/8	28	11½	50	Schist. Hill.
93	3¾ miles E. of Lincolnton	Robert Link	J. E. Burke	Dr	72		4	35	8-9	55	Do.
94	4¼ miles E. of Lincolnton	Guy Hovis		Dug	48	48	24	34.35		75	Schist. Adequate yield. Flat.
95	2¼ miles NW. of Machpelah	C. A. Rudisill		Cr-Dr	72		3		1-2	45	Granite. Hill.
96	½ mile NW. of Machpelah	J. P. Sigmon	Hickory Pump Co.	Dr	105	58	6		15	55	Dug 57 feet.
97	Machpelah	B. V. Lowe	Claude Hoke	Dr	73		4	40	4-5		Granite. Soft water. Slope.
98	do	Catawba Springs School		Dr	120?		6		5	50	Granite. Hill.
99	1 mile SE. of Machpelah	R. D. Rhyne	Claude Hoke	Dr	100		4		2-3	65	Granite. Slope.
100	do	G. A. Cobb	R. E. Faw	Dr	80		4		11	50	Granite. Dug. 45 feet. Hill.
101	1 mile N. of Mariposa	John Rheinhardt	Hickory Pump Co.	Dr	150		6	41.76	5-6		Granite. Slope.
102	1½ miles NE. of Mariposa	J. G. Morrison	R. E. Faw	Dr	400	40	6		1		Granite. Analysis. Hill.
103	Mariposa	Cherryville Spinning Co.		Dr	100		3			45	Granite. Adequate Supply Hill.
104	do	do		Dr	100		3				Granite. Dug 50 feet. Adequate supply. Slope.
105	7½ miles NE. of Lincolnton	Clyde Cash	Clyde Cash	Dr	56		3		5-6	50	Slope.
106	do	L. K. Goodson	Claude Hoke	Dr	138		4		5-6		Soft water. Slope.
107	9 miles NE. of Lincolnton	R. M. Goodson		Dug	31	31	24	23.54		45	Adequate yield. Hill.
108	3 miles W. of Denver	C. C. Miller	Claude Hoke	Dr	74	40	4		45		Soft water. Granite. Hill.
109	do	H. O. Wilkinson	J. E. Burke	Dr	200+		4		1	45	Granite. Hill.
110	do	E. B. Wilkinson	Claude Hoke	Dr	104		4		4	60	Granite. Supplies two houses. Slope.
111	do	Claude Hoke	do	Dr	84		3		2		Granite. Soft water. Hill.

ANALYSES OF GROUND WATER FROM LINCOLN COUNTY,* N. C.

(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	9	66	89	102
Silicia (SiO_2)	33	28	28	18
Iron (Fe)	5.5b	.14b	.07c	.18c
Calcium (Ca)	2.4	3.6	5.0	24
Magnesium (Mg)	1.4	1.4	2.6	3.8
Sodium and potassium (NA+K)	12	7.0	4.8	12
Carbonate (CO_3)	0	0	0	0
Bicarbonate (HCO_3)	26	29	34	115
Sulfate (SO_4)	13	2.1	1.8	3.0
Chloride (C1)	1.2	2.4	1.8	2.0
Fluoride (F)	.1	.0	.0	.0
Nitrate (NO_3)	.0	.7	1.7	2.2
Dissolved solids	82	62	64	123
Total hardness as $CaCO_3$	12	15	23	76
Date of collection	10/31/45	10/3/45	10/4/45	11/2/45

a Analyzed by U. S. Geological Survey.
b Fe in solution .02
c Fe in solution .01

MECKLENBURG COUNTY

(Area 542 square miles; population in 1950, 197,052)

Geography and physiography.—Mecklenburg County, in the southeast part of the Charlotte area, is the most densely populated county in the area. Charlotte, the only city, is the county seat; it is the largest city in the State and had a population of 133,219 according to the 1950 U. S. census. The county is the center of the textile industry of the State, many of the mills lying in the close environs of Charlotte.

That part of the Piedmont Province that includes Mecklenburg County consists of a series of moderately level interstream areas which are appreciably hilly near the larger streams. No hills stand out prominently above the general level of the upland. The highest land in the county is near Davidson, in the extreme northern part of the county, where the altitude is slightly more than 850 feet above sea level, and the lowest land is on the Catawba River at the South Carolina line, where the altitude is about 520 feet.

The western part of Mecklenburg County is drained by the Catawba River, whereas the eastern part is drained by small streams tributary to Rocky River, which itself is in the drainage basin of the Pee Dee River. The major divide formed by these drainage systems extends from Davidson in the north through Derita to the vicinity of Matthews. The Catawba River flows southward along the western border of the county, whereas the Rocky River flows along the northeast part. These rivers are only 10 miles apart in the northern part of the county, and as a consequence the interstream area is narrow and much dissected. On the other hand, Catawba and Rocky Rivers in the southern part of the county are more widely spaced which results in longer tributaries of lower gradients extending to the major divide. Thus, the topography in the southern part is rather gentle.

Geology.—The most striking feature of the geology of Mecklenburg County is the near absence of schistose rocks (fig. 17). With the exception of a thin belt of slaty rocks in the extreme east, the rocks of the county are, for the most part, massive and are generally lacking in regional structural trends.

Rocks of the Carolina slate belt occur in the southeastern part of the county where they extend southward from Cabarrus County. Although several types of rock occur within the belt only two are shown on the accompanying geologic map; they are the greenstone and undifferentiated rocks, including slates and associated volcanic rocks. The slates are generally composed of dense, fine-grained siliceous material. At least a part of the slate is well bedded and resembles the slate at Monroe,[28] which is a distinctive part of the Carolina slate belt. The slates, as a rule, are well jointed and possess a gentler dip than other rocks in the Charlotte area.

With the exception of the rocks of the Carolina slate belt in the east, the rocks of Mecklenburg County belong to the diorite-granite complex or are believed to be associated with it. Gabbro-diorite is widely exposed along N. C. Route 49 south of Shopton in the southwest part of the county. It is a massive medium- to coarse-grained dark colored igneous rock composed mostly of pyroxene or hornblende and plagioclase feldspars. It is exposed in a few road cuts and as isolated boulders above the generally flat land surface. It is locally referred to as "blackjack" and is the source of the Mecklenburg soil type.[29] The extent of the gabbro-diorite to the south in South Carolina is not known, but it is bounded in Mecklenburg County by rocks of the diorite-granite complex.

The diorite-granite complex proper covers a large area around Charlotte. Bodies of diorite are locally separate from bodies of granite, but as a whole the two rocks are too closely intermixed to map separately. Outcrops are not common enough to ascertain the predominance of one type over the other except in a general way. However, the granite component is everywhere conspicuous and appears to make up the greater part of the complex. It appears to be subordinate to the diorite in a band bordering the gabbro-diorite in the south and along the Cabarrus County line in the northeast.

Rocks in the northern part of the county do not fall easily into the classification of rocks designed for the Charlotte area. They are granitic but contain considerable hornblende and biotite in places. They

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[28]Stuckey, J. L., Personal communication.

[29]Report on Mecklenburg County Soils, Agriculture, and Industry: North Carolina Dept. Agriculture County Soil Report No. 1, vol. 38, no. 4, p. 32, 1917.

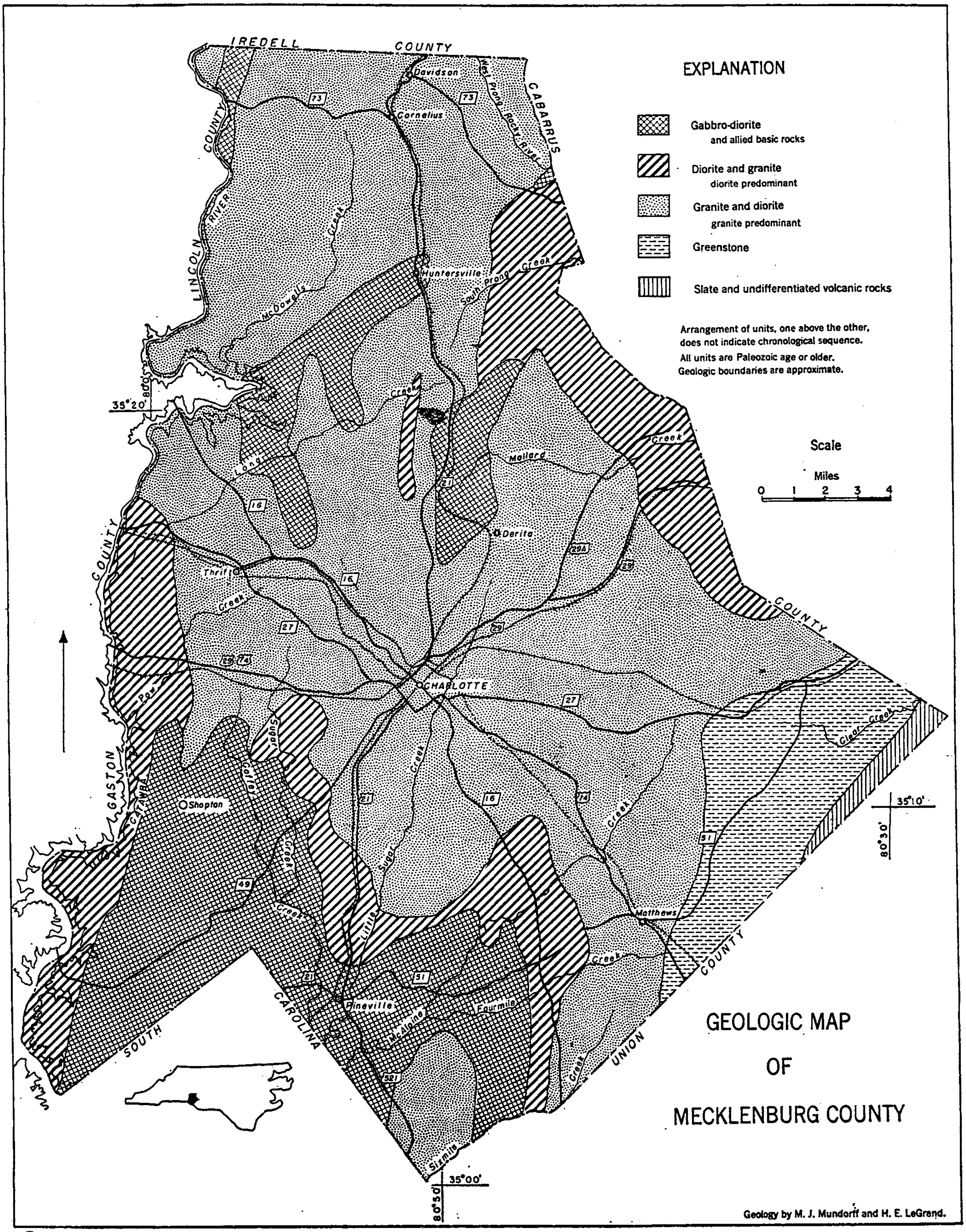

Figure 17

FIGURE 17.—GEOLOGIC MAP OF MECKLENBURG COUNTY.

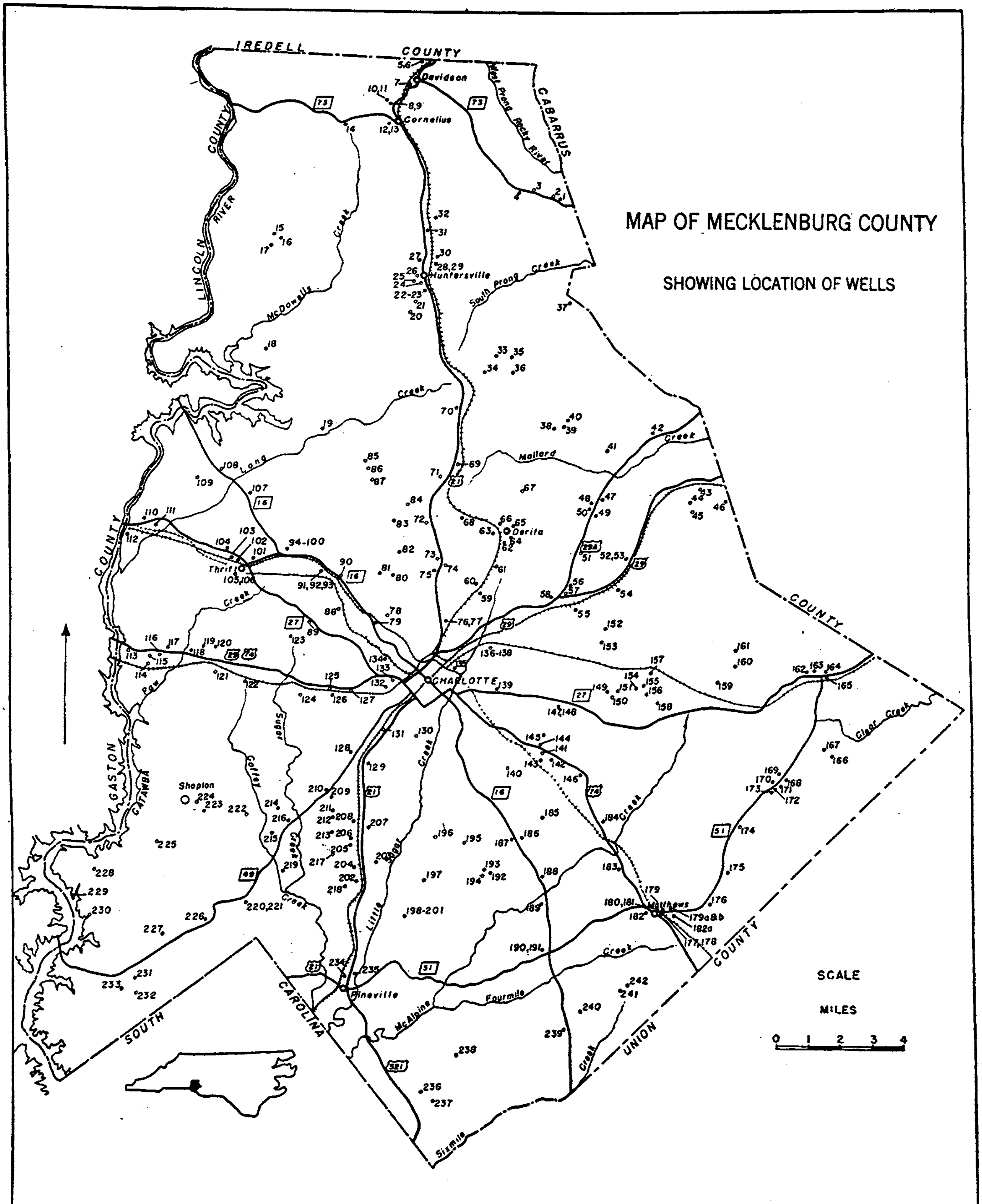

FIGURE 18.—MAP OF MECKLENBURG COUNTY SHOWING LOCATION OF WELLS.

are shown on the geologic map of Mecklenburg County as predominantly granite although they contain a greater quantity of black minerals than other granites in the Charlotte area. These rocks appear to have the same composition as those of the diorite-granite complex if a complete mixing of diorite and granite had occurred. Thus this approximate equivalence and the juxtaposition of these rocks suggest that they may be genetically related and that the hornblende-biotite granite in the northern part of the county may represent a nearly complete mixing of the diorite and granite components.

The soil derived from the hornblende-biotite granite has a deeper color than soils from other granites of the Charlotte area and contains many yellow flakes of vermiculite.

The rock weathers deeply, owing to the sharp relief in its area of outcrop, thus allowing a thick zone of weathering above the general water table.

Ground water.—Nearly all domestic water supplies and three municipal water supplies are obtained from wells (fig. 18).

Dug wells are extensively used for domestic supplies in rural districts. Normally they are from about 15 to 50 feet deep and 2½ to 4 feet in diameter. As these wells cannot easily penetrate hard rock, they generally yield adequate water as long as the water table does not fall below the surface of the hard rock, or more specifically as long as the water table does not fall below the bottom of the well. Where the bedrock lies at or near the surface, as in much of the area underlain by diorite and gabbro in the southwestern part of the county, wells may not be dug deep enough to prevent them from going dry during long periods of dry weather.

Records of more than 245 drilled wells are given in the tables of well data for Mecklenburg County. Many of these, especially in the rural areas, were core-drilled with chilled shot and are 2 or 3 inches in diameter. Their cheapness makes them suitable for domestic use, but inasmuch as 7 or 8 gallons a minute is the maximum rate at which water can be removed from a 2-inch well by a deep-well pump they are not generally used where large supplies of water are desired. Most industrial and public-supply wells are drilled with a percussion drill and are from 4 to 8 inches in diameter. The large-diameter wells might encounter fractures and cracks than missed by small-diameter wells. Also, more water can be pumped from a large-diameter well. Also, pumps with greater capacities can be installed in the larger wells.

The rocks penetrated by wells in Mecklenburg County are chiefly granite and diorite. The gabbroid rocks, occurring mostly in the southwestern part of the county, are included, for the purposes of groundwater description, with the diorite. A few wells in the eastern part of the county are drilled in slate but complete data on these wells are lacking. As the diorite and granite are rather closely intermingled, some wells doubtless penetrate both rocks. Table 13 presents characteristics of the wells as related to rock types and topographic locations.

TABLE 13.—SUMMARY OF DATA ON WELLS IN MECKLENBURG COUNTY

ACCORDING TO ROCK TYPE

Type of Rock	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Diorite	41	117	1—75	17.9	0.153	2
Granite	54	124	2—65	11.5	.092	0
All wells	95	132	1—75	14.3	.109	1

[1] Drilled wells 2 inches or more in diameter.

SUMMARY OF DATA ON WELLS IN MECKLENBURG COUNTY
(Drilled wells 3 inches or more in diameter)

ACCORDING TO ROCK TYPE

TYPE OF ROCK	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Diorite	30	155	3—75	22.6	.147	0
Granite	36	136	3—100	14.8	.109	0
All wells	66	144	3—100	18.4	.128	0

ACCORDING TO TOPOGRAPHIC LOCATION

TOPOGRAPHIC LOCATION	Number of wells	Average depth (feet)	Yield (gallons a minute)			Percent of wells yielding 1 gallon a minute or less.
			Range	Average	Per foot of well	
Hill	41	125	1–65	8.5	0.068	2
Flat	13	119	2—40	13.1	.110	0
Slope	19	144	2—75	15.9	.110	0
Draw	21	144	5—75	24.9	.173	0
Valley	1	97		8	.082	0

According to table 13 wells in diorite have greater yield and average yield per foot of well than wells in granite. The average yield of all diameters for which information is available in diorite is 17.9 gallons a minute as compared with an average of 11.5 gallons a minute for wells in granite. If only 3-inch and larger wells are considered, those in diorite yield 22.6 gallons a minute and those in granite 14.8 gallons a minute.

Although granite occurs extensively throughout the county, the data on wells do not indicate that it yields more water at one place than another, if topography is disregarded. The same condition holds true for the diorite. According to topographic location, wells on hills yield less water than wells on any other topographic site, yielding only .068 gallons a minute per foot of well. This is slightly more than one-third of the yield of wells in the most favorable locations, draws, that yield .173 gallon a minute per foot of well. Thus wells in draws have an average depth of 144 feet and an average yield of 24.9 gallons a minute. The average yield might be appreciably higher if only 3-inch and larger wells were considered.

As no particular part of the county can be designated as unusually poor and no part as exceptionally good, it appears advisable to give considerable attention to local conditions in locating a well. West of the slate belt, diorite, the best aquifer, occurs sporadically in almost every square mile. Thus in many cases it is possible to locate a well in the dark-colored diorite or gabbro without sacrificing convenience of location. As topography is an important consideration, the location of wells in lowlands or especially in draws should be attempted if relatively large yields are desired.

The quality of ground water in Mecklenburg County is good almost everywhere. (See table of analysis.) Analyses of water from wells penetrating granite in Mecklenburg County vary considerably in the concentration of dissolved mineral solids. This is doubtless due to the penetration of one or more small bodies of dioritic material in the granite. By virtue of their relatively insoluble mineral constituents the granites should contain water lower in mineral matter. Analyses of water from wells 27, 133, and 180 suggest that, although the predominant rock is granite, a large part of the mineral matter in solution comes from dioritic or mafic bodies penetrated by the wells.

Well 235, at Pineville, drilled in a large area of dark-colored gabbroid rocks, yields water containing 395 parts per million dissolved solids. Although this water is considered more or less typical of that in gabbro-diorite, it is doubtful if any of the ground waters in the county greatly exceed this in mineral matter; most of the ground waters should contain much less.

Temperatures range from 59° to 63° F and average 61° F.

Municipal supplies.—Huntersville, population 763 (1940 census), obtains its supply from deep wells. Four deep wells have been drilled for the municipal supply and yields of 5, 9, 22, and 35 gallons a minute are reported for individual wells. The well yielding 5 gallons a minute originally yielded 20, and the well yielding 9 gallons a minute originally yielded 40. The decline in yields in these two wells may be due to interference of wells. In 1945 the average daily use was 30,000 gallons. The water is not treated. The chemical quality of the water, as shown by the analysis of well 27, is good.

Matthews, population 486 (1940 census), obtains its water from a deep well drilled in greenstone, which yields 20 gallons a minute. The water is not treated.

RECORDS OF WELLS IN MECKLENBURG COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
1	4¾ miles NE. of Huntersville	H. G. Bradford	Sherril	Cr-Dr	160	2					Granite. Adequate yield, slightly hard water. Flat.
2	do	R. G. Summers	Earl Torrence	Cr-Dr	83	2	60		7		Granite. Water slightly hard. Hill.
3	4 miles NE of Huntersville	John G. Caldwell J. H. Stillwell		Cr-Dr	70	2			2-3		Granite. Moderately soft water. Hill.
4	do	R. C. Bradford		Cr-Dr	85	3			6+		Granite; 61°F. Hard water. Hill.
5	Davidson	Davidson Cotton Mills Inc.		Cr-Dr	80±	2		22	4	65	62½° F. Well at machine shop. Draw.
6	do	do		Cr-Dr	60-80				14		7 wells in group. Aggregate yield 14 g.p.m. to suction pump. When drilled 6 of the 7 wells flowed. Draw.
7	do	Davidson Ice & Fuel Co.	Jim Robbins	Cr-Dr	100	4	35		11	80	Rock at 30 feet. Slope.
8	Cornelius	Cornelius Mills, Inc.		Cr-Dr	115	3	90±		15	60	Rock reported at 90 feet. Schist. Flat.
9	do	do		Cr-Dr	127	2			8		Schist. Flat.
10	do	do	W. A. Kirkley	Cr-Dr	106	4			70		Schist. Water level 60 feet below surface when pumped at 20 g.p.m. Flat.
11	do	do	do	Cr-Dr	55	4			50		Schist. Flat.
12	do	Gem Yarn Mills		Cr-Dr	90±	2			5		Schist. Draw.
13	do	do		Cr-Dr	160	2			3¾		Do.
14	1¾ miles W. of Cornelius	Mrs. Mary C. Hager		Cr-Dr	45	2			3	40	Schist. Hill.
15	4½ miles W. of Huntersville	Mrs. J. C. Blythe		Dug	30	24	30	23.24			Schistose diorite. Hill.
16	do	Joe L. Blythe		Cr-Dr	175	3	100		5+	40	Do.
17	do	J. L. Norket		Cr-Dr	125	2			6	35	Schistose diorite. Slope.
18	5 miles SW. of Huntersville	W. O. Hollingsworth		Cr-Dr						60	Schistose diorite.
19	do	Long Creek High School	Hickory Drilling Co.	Dr	101	6			65	25	Granite. 62½° F. Hill.
20	2 miles S. of Huntersville	Prison Camp		Cr-Dr	225	3			2½	100	Granite. 60½° F. Rock at 20 feet. Hill.
21	1¾ miles S. of Huntersville	do		Cr-Dr	97	3			7½	65	Granite. 59¾° F. Valley.
22	1¼ miles S. of Huntersville	County Sanatorium		Dr	120+	8		16	15	35	62° F.
23	do	do		Dr	140+	8			11	50	63° F. Draw.
24	Huntersville	Town well 1		Dr	70	5		40	9	55	62° F. Originally 110 ft. deep, 8 in. in diameter. Yielded 40 g.p.m. Filled with sand and was redrilled. Draw.
25	Huntersville	Town well 2	Abernathy	Dr	210	8	100	30	22	65	62½° F. Draw.
26	do	Town well 3	Ralph Robbins	Dr	97	5	97		5	50	Granite. Originally yielded 20 g.p.m. Draw.

RECORDS OF WELLS IN MECKLENBURG COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
27	Huntersville	Town well 4	R. E. Faw	Dr	190	8	100±	20	35	64	Analysis. Granite. Draw.
28	do	Anchor Mills Co.		Cr-Dr	38-81	2	38 to 81	5 to 30	27½	105	62° F. Combined yield of 10 wells. 27½ g.p.m. Draw.
29	do	do	Robbins	Dr	185	5			10-12		Hard water reported. Draw.
30	do	do		Cr-Dr	300 or 400	3			12	70	63° F. Hill.
31	1¼ miles N. of Huntersville	G. R. Fleenor	Sherril	Cr-Dr	72	2			10	35	Flat.
32	1½ miles N. of Huntersville	Ralph Johnson		Cr-Dr	140	2	100		3		Flat.
33	2½ miles SE. of Huntersville	D. B. Jordan J. R. Westbrook, tenant		Dug	62	40	62	58			Granite. Hill.
34	3 miles SE. of Huntersville	Plantation Pipeline Co.		Dr	260	8				15	Granite. Draw.
35	2¾ miles SE. of Huntersville	F. M. Fite	Robbins	Cr-Dr	116½	3	20	45	3	70	61° F. Granite. Hill.
36	3½ miles SE of Huntersville	B. C. Zeigler		Cr-Dr	50+	2				55	Diorite. Water contains iron. Hill.
37	4½ miles E. of Huntersville	M. B. Wallace		Cr-Dr	69	2	45±	15	5	580	Diorite. Laboratory test. "Black jack" soil. Draw.
38	3½ miles NE. of Derita	B. W. Alexander		Cr-Dr	118	2	18		2	110	Diorite. Slope.
39	do	James I. Crenshaw	Va. Mach. Co.	Dr	85	6			12	95	Diorite. Water contains iron. Hill.
40	4 miles NE. of Derita	O. B. Cochran	do	Dr	38	6			4-5	50	Granite. Water contains iron. Hill.
41	do	Clarence Pender	Will Fortner	Cr-Dr	96	2				65	Diorite. 61¾° F. Adequate yield. Hill.
42	5½ miles NE of Derita	Henry Doster		Cr-Dr		2				237	Diorite. (Laboratory test). Adequate yield. Draw.
43	3½ miles NE. of Newell	Frank Cochran	Bowers	Cr-Dr	132	3			8	85	Diorite. Slope.
44	2½ miles NE. of Newell	L. W. Austin		Dug	32½	30		31.58			Diorite. Hill.
45	2¼ miles NE. of Newell	J. R. Austin		Cr-Dr	137	2			7½		Diorite. Slope.
46	3½ miles NE. of Newell	James Caldwell	Bostin	Cr-Dr	79	4	58	20	20		Diorite. Slightly hard water. Hill.
47	2 miles N. of Newell	County Home	Hinson	Dr	162	10			60	140	Diorite. 64° F. Use, about 35,000 to 40,000 gallons a day. Draw.
48	do	Victor Penninger	Bowers	Cr-Dr	92	2	86	23	5	45	Pump in basement. 8 feet below surface. Granite. Slope.
49	2 miles N. of Newell	N. M. Christenbury	J. Torrence	Cr-Dr	133	2	35±		5	75	Granite. Hill.
50	do	J. W. Dierstein		Cr-Dr	80	2		14.5	2½	50	Granite. 61¾° F. Slope.
51	1½ miles NW. of Newell	S. P. Moyer		Cr-Dr	90	2			½	65	Diorite. Hill.
52	Newell	High School		Cr-Dr	335	3			8	30	Granite. 62½° F. Slope.
53	do	do		Cr-Dr	80	3			8		Granite. Slope.
54	¾ mile S. of Newell	Mrs. Annie Babb	W. A. Kirkley	Cr-Dr	96½	3	35	16	8	30	Granite. Hill.
55	5 miles E. of Charlotte	Galloway Estate		Cr-Dr	113	2			7		Do.
56	5¼ miles NE. of Charlotte	F. S. Neal Estate		Cr-Dr	196	2½		22	5-10	45	Flat.
57	4¾ miles NE. of Charlotte	Mecklenburg Furniture Shop	E. Mullis	Cr-Dr	134	3	94		9	60	Flat.
58	4½ miles NE. of Charlotte	W. S. Abernathy	Montgomery	Cr-Dr	165	2			12	35	Draw.
59	1¾ miles SW. of Derita	J. E. Heafner	do	Cr-Dr	130	2	130	9	7	50	Draw.
60	1½ miles SW. of Derita	E. T. Robinson	Everett Mullis	Cr-Dr	116	3	100		7	55	Granite. Flat.
61	1 mile SW. of Derita	B. J. Hunter	Allen (?)	Cr-Dr	380	2			3	60	61¾° F. Rock at 80 feet. Hill.
62	Derita	Louis G. Ratcliffe, Inc.	Bill Brathn	Cr-Dr	92 to 135	2	92-135		11 to 35 each	55	Group of 4 wells used at greenhouses. Draw.
63	do	Bob Farington		Cr-Dr	65	3		21	12		Draw.
64	¾ mile E. of Derita	H. L. Young		Dug	38	36	36	31.5		15	60° F. Adequate supply. Hill.
65	Derita	School		Dr	90	6			20		Hill.
66	do	B. J. Hunter	Ed. Hunter	Cr-Dr	92	2	61	21	12	30	Supplies 27 houses. Hill.
67	1½ miles NE. of Derita	C. A. Seegar		Cr-Dr	99	2				20	Draw.
68	1 mile NW. of Derita	J. H. Stevens		Dug	40	36	40	23.5			
69	2½ miles NW. of Derita	P. J. Penninger		Dug	21	36	21	13	1½	55	Granite. Flat.
70	4 miles NW. of Derita	J. E. Penninger	Homer Sherril	Cr-Dr	125½	2	80	12	5	30	Granite. 62° F. Supplies 3 buildings. Flat.
71	2½ miles NW. of Derita	Clyde Hunter	Martin	Cr-Dr	146	3		20-25	7		Soft water. Flat.
72	4½ miles N. of Charlotte	C. E. Collins	Robbins	Cr-Dr	113	2	40	21	3	65	Gneiss. Flat.

RECORDS OF WELLS IN MECKLENBURG COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
73	3¾ miles N. of Charlotte	G. V. Burris	W. A. Ivester	Cr-Dr	48	2			15		Moderately soft water. Draw.
74	do	C. T. Stallings	Robbins	Cr-Dr	71½	2	31		6		Slightly hard water. Draw.
75	3¼ miles N. of Charlotte	Mrs. Eva Mae Ellis		Cr-Dr	96	2			2½		Gneiss. Hard water. Hill.
76	2½ miles NE. of Charlotte	Interstate Granite Corporation	W. A. Kirkley	Cr-Dr	165	4			35		Granite. Slope.
77	do	do	do	Cr-Dr	200	4			35		Granite. Draw.
78	2½ miles NW. of Charlotte	G. V. Keller	Hinson	Dr	190	6	190	26	10–15	65	Diorite. Hill.
79	do	Planters Fertilizers & Phosph. Co.		Dug	31	30		25	5		
80	3 miles N. of Charlotte	I. T. Hutchison		Cr-Dr	110	2		22	5	25	Hill.
81	3½ miles NW. of Charlotte	T. P. Caldwell	Montgomery	Cr-Dr	158	2	83	30	3½		Diabase dike. 63° F. Soft water. Well was dynamited to increase yield. Hill.
82	4 miles N. of Charlotte	E. C. Glenn		Cr-Dr	150	2			5±	25	Hill.
83	4¾ miles N. of Charlotte	J. W. Buchanan		Cr-Dr	85	2			7½	50	Hill.
84	5½ miles N. of Charlotte	F. W. Dotzer		Cr-Dr	82	2	78		7	35	Diorite. Hill.
85	7 miles N. of Charlotte	P. V. Humphrey	Geo. Stephenson	Cr-Dr	100	2	99		5	35	
86	do	R. W. Parker	do	Cr-Dr	140	2	85	25	6		No water until well was dynamited.
87	do	H. T. Reavis	do	Cr-Dr	130	2	100	25	5		Do. Slope.
88	3½ miles NW. of Charlotte	Chadwick-Hoskins Co.	Sydnor	Dr	549	10			100	80	63° F. Well at plant 2 supplies both plants and school. Draw.
89	4 miles NW. of Charlotte	Mecklenburg Nurseries		Cr-Dr	135	2	90		4–5	60	Dug well, nearly went dry in 1941–1942. Hill.
90	do	Godley Bros.		Cr-Dr	80	3			6		Soft water. Hill.
91	4¼ miles NW. of Charlotte	National Carbon Co.	W. A. Kirkley	Cr-Dr	150	4	100		18	35	63° F. Company well 1. Draw
92	do	do	do	Cr-Dr	135	4	102		8		62° F. Company well 2. Draw
93	do	do	do	Cr-Dr	108	4	84		7		Company well 3. Slope.
94	1¼ miles NE. of Paw Creek	Leaksville Woolen Mill Co.	Sydnor	Dr	350	10			36	55	62½° F. Company well 4. Draw.
95	do	do		Dr	300	10			60	75	59° F. Company well 5. Temperature taken after pumping 35 minutes—7/17/45. Draw.
96	do	do	do	Dr	1,166½	10			68	170	63° F. Company well 6. Pumping level 173 feet below surface in 1942. Draw.
97	1¼ miles NE. of Paw Creek	Leaksville Woolen Mills Co.	Sydnor	Dr	1,074	10			67¼	72	61½° F. Company well 7. Temperature after pumping 20 minutes. Draw.
98	do	do	do	Dr	250	8			30		Company well 1. Not in use. Draw.
99	do	do		Dr	250	10–8			50		Company well 2. Never used Water too hard.
100	do	do		Dr	250	10			25		Company well 3. Not used. Originally yielded 100 g.p.m.
101	Paw Creek	High School	Carolina Drill. Co.	Dr	140	6			30		Slope.
102	do	Standard Oil Plant	J. S. Hinson	Dr	306	6			55	40	Draw.
103	do	Shell Oil Plant	Heater Well Co.	Dr	148	6	80½	21	36	40	61½° F. Draw.
104	do	American Oil Co. Plant		Cr-Dr	85	3				80	62° F. Draw.
105	do	Kendall Mills Thrift Plant		Dr	600	10–8	60	32	55	150	63° F. Slope.
106	do	do		Cr-Dr	33 to 65	2½	33 to 65	½ to 2	14	60	59½° F. Group of 6 wells. Valley.
107	2 miles N. of Paw Creek	McClure Lumber Co.		Cr-Dr	115	3	76		4		Granite. Hill.
108	3 miles NW. of Paw Creek	M. L. Dunn	Robbins	Cr-Dr	54	2			3	50	Granite. Flat.
109	3¼ miles NW. of Paw Creek	James Costevens		Dug	30	12	30	23.0			Adequate water supply. Soft water. Flat.
110	3¼ miles NW. of Paw Creek	R. C. Beatty	Geo. Stevenson	Cr-Dr	90	3			10	80	61½° F. Granite "sand". Draw.
111	do	C. O. Hager		Dug	80	36		65			Supplies 12 houses. Soft water. Hill.
112	4 miles NW. of Paw Creek	Southern Dyestuff Corp.	Sydnor	Dr	221	6	60		38	450	61¾° F. Laboratory test.

RECORD OF WELLS IN MECKLENBURG COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
113	8¾ miles W. of Charlotte	K. M. Beaty	----------	Dug	39½	18	39½	34.7	----------	----------	----------
114	8¼ miles W. of Charlotte	Paul Thompson	Helms	Cr–Dr	115	2	----------	----------	4–5	----------	Granite. Soft water. Flat.
115	----do	C. E. Berryhill	----------	Cr–Dr	126	2	----------	----------	5–6	40	Granite. Slope.
116	8 miles W. of Charlotte	Cathey Brothers	----------	Dr	80	6	----------	----------	18	40	Granite.? Supplies house and dairy. Hill.
117	7½ miles W. of Charlotte	Otis Keeter	W. A Kirkley	Cr–Dr	136	3	----------	----------	25	45	Recreational Park. Hill.
118	7¼ miles W. of Charlotte	(Willamette Park) R. A. Suttle	Ralph Robbins	Dr	95	6	30	10 to 12	17	----------	Recreational park. Draw.
119	6¾ miles W. of Charlotte	E. E. Williams	----------	Cr–Dr	120	----------	----------	----------	----------	95	Hill.
120	6 miles W. of Charlotte	E. L. Black	Everett Mullis	Cr–Dr	77	2	25	----------	5	----------	Granite. Hill.
121	6¼ miles W. of Charlotte	Berryhill High School	Abernathy	Dr	110	6	----------	----------	12	25	Always has furnished adequate supply. Flat.
122	5 miles W. of Charlotte	Douglas Airport	----------	Dr	300	6	----------	----------	----------	----------	Not used. Slope.
123	4¼ miles W. of Charlotte	J. L. Todd	----------	Cr–Dr	181	2	----------	----------	----------	----------	Slope.
124	4 miles W. of Charlotte	Plato-Price High School	----------	Dr	90	6	----------	----------	20	----------	Slope.
125	2¾ miles W. of Charlotte	American Cyanimide Co.	Robbins	Dr	149	6	----------	----------	28	42	Diorite.
126	3 miles W. of Charlotte	Carolina Golf Course	----------	Dr	70	6	----------	1.8	----------	----------	Draw.
127	2½ miles W. of Charlotte	Southern Engineering Co.	Robbins	Dr	42½	5 5/8	40	4	25	55	Used for cooling. Draw.
128	3½ miles SW. of Charlotte	W. W. Davis	----------	Dug	21	36	21	15.9	----------	----------	Adequate supply; soft water. Slope.
129	----do	Diamond Point Grocery	W. A. Kirkley	Cr–Dr	80	3	----------	----------	30	40	----------
130	Charlotte	Scholtz Greenhouses	----do	Cr–Dr	225	4	60	20	22	60	64° F. Slope.
131	----do	Shoenith Candy Co.	----------	Dug	110	72	----------	----------	10	40	62° F. Well is abandoned mine shaft. Slope.
132	----do	Charlotte Pipe and Foundry Co.	J. S. Hinson	Dr	196	6	----------	20	10–15	105	62½° F. Slope.
133	----do	Air Reduction Sales Co.	Sydnor	Dr	200	6	85	----------	50	113	62° F. Analysis in table. Water used for cooling. Draw.
134	----do	National Welding Supply Co.	W. A. Kirkley	Cr–Dr	150	3	----------	----------	18	55	61° F. Granite. Used for cooling. Draw.
135	----do	Highland Park Mfg. Co., Plant 1	----------	Cr–Dr.	30 to 80	2	----------	----------	15	----------	Group of 13 wells yield 15 g.p.m. Draw.
136	----do	Highland Park Mfg. Co.	Ralph Robbins	Dr	75	6	----------	----------	14	----------	Slope.
137	----do	----do	----do	Dr	87	6	----------	----------	9	----------	Slope.
138	----do	----do	----do	Cr–Dr	30 to 60	2	----------	----------	40	----------	Three groups of six wells each; combined yield 40 g.p.m. Draw.
139	2½ miles E. of Charlotte	Z. E. Hargett	----------	Dr	150	6	----------	26	25	60	61°½ F. Granite. Slope.
140	4¼ miles SE. of Charlotte	A. C. Roundton	W. A. Kirkley	Cr–Dr	76	4	----------	18	20	----------	Granite. Slope.
141	4¾ miles SE. of Charlotte	Pure Oil Co.	Ralph Robbins	Dr	62	6	----------	----------	30	35	63° F. Draw.
142	----do	Sharon Memorial Park	----------	Dr	150	6	----------	----------	----------	----------	Slope.
143	----do	W. W. Covington	E. Mullis	Cr–Dr	83	2	----------	----------	6	40	Granite. Slope.
144	4½ miles SE. of Charlotte	F. C. Thompson	W. A. Kirkley	Cr–Dr	95	2	85	15	9	50	Slope.
145	4½ miles SE. of Charlotte	Hudson Hosiery Co.	W. A. Kirkley	Cr–Dr	95	4	85	18	15	30	62¾° F. Granite. Draw.
146	5½ miles SE. of Charlotte	I. G. Wallace	Clayton Cooke	Cr–Dr	60	2	55	7	4–5	50	----------
147	4¼ miles E. of Charlotte	Joe W. Yandle	----------	Dug	30	24	30	19.3	----------	----------	Well not used. Flat.
148	----do	----do	----------	Cr–Dr	180	2	----------	----------	7–8	45	Draw.
149	5¼ miles E. of Charlotte	Sam Wallace	----------	Cr–Dr	200	2	----------	----------	1½	----------	Hill.
150	----do	W. T. Harris	----------	Cr–Dr	85	2	----------	----------	5½	----------	Draw.
151	----do	D. B. Wilson	Glosson	Cr–Dr	85	2	68	8	8	----------	Soft water. Draw.
152	6 miles E. of Charlotte	H. G. Russell	----do	Cr–Dr	60	2	----------	----------	4½	30	Granite. Slope.
153	----do	C. E. Morris	----------	Cr–Dr	190	4	----------	19	12	35	Hill.
154	6 miles E. of Charlotte	S. M. Craig	Donaldson	Cr–Dr	95	2	90	20	4–5	----------	Soft water. Slope.
155	6½ miles E. of Charlotte	Harvey Morris	Ralph Robbins	Dr	184½	5 5/8	128	23	20	35	----------
156	----do	J. A. Smith	Sam Allen	Cr–Dr	195	3	100	23.6	8	----------	Hill.
157	7 miles E. of Charlotte	Hickory Grove School	W. A. Mullis	Cr–Dr	135	2	----------	----------	5	----------	Flat.
158	----do	United Arco Service	----------	Cr–Dr	149	3	----------	18	30	----------	Granite. Draw.

RECORDS OF WELLS IN MECKLENBURG COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
159	3½ miles NW. of Mint Hill	Clear Creek Negro School		Dr	91	6			60		Draw.
160	3¾ miles NW. of Mint Hill	Mrs. Montie Lucas		Cr–Dr	235	2			3		Soft water. Hill.
161	4 miles NW. of Mint Hill	Mason Wallace	Mullis	Cr–Dr	170	2			2–3		Granite. Soft water. Hill.
162	3¼ miles NE. of Mint Hill	Clear Creek High School	A. E. Beaver	Cr–Dr	110	3			12–15		Hill.
163	3½ miles NE. of Mint Hill	Allen and Brooks Ginning Co.		Cr–Dr	178	4			12		Slate. Not in use. Slope.
164	3¾ miles NE. of Mint Hill	do		Cr–Dr	134	2			5	50	Flat.
165	do	C. G. Allen		Cr–Dr	100	2			4		Slate. Soft water. Flat.
166	1¼ mile E. of Mint Hill	T. S. Houston	Glosson	Cr–Dr	100½	2			7		Hill.
167	do	R. C. Beaver		Dug	43	30		39.07			Hill.
168	Mint Hill	Kingcraft Hosiery Mill	Everett Mullis	Cr–Dr	110	2			8		
169	do	C. J. McEwen	Duncan	Cr–Dr	180	2			7		Slope.
170	do	R. J. McEwen & Son	W. C. Mullis	Cr–Dr	80	2			7	35	Draw.
171	do	C. J. McEwen		Dug	33	30	33				Hill.
172	do	W. F. Haigler	E. Mullis	Cr–Dr	155	2	100	12	5		Soft water. Slope.
173	do	Mrs. J. W. McEwen	Beaver	Cr–Dr	210	3			5–6		Dynamited well to increase yield. Slope.
174	2¼ miles SW. of Mint Hill	E. M. Gray	Mullis	Cr–Dr	105	2			5		Slope.
175	2½ miles NE. of Matthews	L. H. Yandle	E. Mullis	Cr–Dr	92	2			5	55	Hill.
176	1¾ miles E. of Matthews	D. B. Query	Sam Allen	Cr–Dr	100	2	70	25	6	50	Slope.
177	Matthews	E. M. Renfron	W. Donaldson	Cr–Dr	125	2			2½		Soft water. Slope.
178	do	L. H. Yandle	Abernathy	Cr–Dr	74	3	50	18	10–12		Do.
179	do	do	Will Mullis	Cr–Dr	75	3	40		20	35	Well at barn.
179a	do	do	Walter Abernathy	Dr	187	6		1½R	55		Used for domestic uses and swimming pool. Greenstone. Draw.
179b	do	C. L. Neal	Ben Aycock	Dr	87	4			45		Greenstone. Used for domestic uses and swimming pool. Draw.
180	do	B. D. Funderburk	W. Abernathy	Dr	200	3		18	18	61	Analysis in table. Supplies six businesses and four families. Granite. Draw.
181	do	do	do	Dr	125	3			7		Well at stable. Granite. Draw.
182	do	Matthews School	do	Dr	160	3			7	55	Well dymanited to increase yield.
182a	do	Town	Ben Aycock	Dr	275	6	110		20		Greenstone. Distribution not yet installed. Slope.
183	1¾ miles NW. of Matthews	Carlyle Thompson	Sam Allen	Dr	50	2			5		Granite. Hill.
184	3 miles NW. of Matthews	J. B. Fowler		Dr	95	3			7	60	Hill.
185	5½ miles SE. of Charlotte	J. J. Akers	Ralph Robbins	Dr	165	5 5/8	110		35	55	Diorite. Slope.
186	do	John L. Hunter	W. A. Kirkley	Dr	96	3		36.78		45	Diorite. Flat.
187	do	T. W. Pritchard	Ralph Robbins	Dr	147	5 5/8			15		Granite. Slope.
188	7 miles SE. of Charlotte	F. W. Alexander		Cr–Dr	165	2			5	95	Slope.
189	4 miles W. of Matthews	Providence School		Cr–Dr	100	3			5		
190	3¾ miles W. of Matthews	Eli B. Springs	Ben Aycock	Dr	190	6	30	17 to 20	60	150	Draw.
191	do	do	W. A. Kirkley	Cr–Dr	150	3			15		Greenstone. Flat.
192	6 miles S. of Charlotte	C. R. Collins	Montgomery	Cr–Dr	180	3			5	60	Diorite. Hill.
193	6 miles S. of Charlotte	C. R. Collins	Ralph Robbins	Dr	60	55	20	18.00	5		Slope.
194	do	do	Ben Aycock	Dr	100	6		3	18		Gabbro. Draw.
195	5¼ miles S. of Charlotte	Sharon School		Dr	65	6			15		Flat.
196	5 miles S. of Charlotte	Springside Dairy	Robbins	Cr–Dr	137	3	32		6		Soft water. Slope.
197	4¼ miles NE. of Pineville	Harkey Bros. Nursery, Inc.		Dug	25	30	25	15.02		45	Greenstone.? Flat.
198	3 miles NE. of Pineville	Dr. A. M. Whisnant		Cr–Dr	139	2			4		Diorite. Abandoned; not sufficient water. Hill.
199	do	do		Cr–Dr	209	3			8–10		Diorite. Abandoned; pumped sand. Hill.
200	do	do	Ralph Robbins	Dr	102	5 5/8		45	20	45	Diorite. Draw.
201	do	do	W. A. Kirkley	Cr–Dr	262	4–3			12		Diorite. Slope.
202	3½ miles N. of Pineville	Mrs. Eunice E. Smith		Dug	65	48	65	47.0			Soft water. Hill.
203	4¼ miles N. of Pineville	Dr. T. N. Reed		Cr–Dr	200	3			5	85	Granite. Hill.
204	4 miles N. of Pineville	H. B. Smith	W. A. Kirkley	Cr–Dr	140					35	Hill.

RECORD OF WELLS IN MECKLENBURG COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Diameter of well (inches)	Dept casing (feet)	Water level (feet below surface)	Yield (g.p.m.)	Total hardness (field tests) (p.p.m.)	Remarks
205	5¼ miles SW. of Charlotte	Ebenezer Presbyterian Church	W. A. Kirkley	Cr-Dr	156	3	60±		6	35	62° F. Slope.
206	do	H. R. Mauney		Cr-Dr	125	2					Moderately soft water. Slope.
207	4¾ miles SW. of Charlotte	C. N. Baker	W. A. Kirkley	Cr-Dr	93	4			8	35	Tested at 10 g.p.m. Hill.
208	4½ miles SW. of Charlotte	J. H. Huntley		Dug	26	36		20	2-3	30	Hill.
209	4¾ miles SW. of Charlotte	Mrs. L. J. Eller	W. A. Kirkley	Cr-Dr	145	4		14	18	30	Slope.
210	do	F. D. Hemphill	Hurley Helms	Cr-Dr	90	2			5	25	Slope.
211	5¼ miles SW. of Charlotte	E. L. Jenkins	W. A. Kirkley	Cr-Dr	92	3			10	45	Draw.
212	do	A. Y. Deal		Cr-Dr	88	2			5		Diorite. Flat.
213	5¾ miles SW. of Charlotte	Edwin Bruton	E. Mullis	Cr-Dr	108	2			7-8	45	Diorite. Draw.
214	6 miles SW. of Charlotte	R. S. Smith	W. A. Kirkley	Cr-Dr	108	4			3	50	Diorite. Hili.
215	6½ miles SW. of Charlotte	H. B. Hunter	Montgomery	Cr-Dr	204	3	60		8	60	62° F. Diorite. Hill.
216	5¾ miles SW. of Charlotte	J. N. Herron	W. A. Kirkley	Cr-Dr	127½	3	50		6-8	50	Hill.
217	6½ miles SW. of Charlotte	J. T. Greenwood		Dug	48	36		42.71			Diorite. Hill.
218	3¼ miles N. of Pineville	W.B.T. Radio Station	Montgomery	Cr-Dr	225	3			7-8		Slope.
219	4 miles NW. of Pineville	Arrowood	Abernathy	Dr	286	6	20		16	261	62¼° F. Laboratory test. Draw.
220	3¾ miles NW. of Pineville	U. S. Rubber Co. Shell Loading Plant	W. A. Kirkley	Cr-Dr	196	3		12	40		Gabbro. Well capped; not used. Flat.
221	do	do	do	Cr-Dr	145	3		12	30		Gabbro. Flat.
222	7 miles SW. of Charlotte	Miss Amanda Coffey	Tom Allen	Cr-Dr	112	2	80		5	60	61° F.
223	7¾ miles SW. of Charlotte	R. A. Grier		Cr-Dr						25	
224	do	Mrs. F. K. Byrum		Cr-Dr	100	2			6		Diorite. Flat.
225	9¼ miles SW. of Charlotte	Samuel Knox		Dug	20	24		14.54			Gabbro. Hill.
226	4½ miles NW. of Pineville	N. M. Boyd		Dug	21	30		10.55		125	Gabbro.
227	5¾ miles NW. of Pineville			Dug	17.5			11.79		185	Gabbro. Has always furnished adequate supply.
228	8 miles NW. of Pineville	O. B. Knox	Charles Montgomery	Cr-Dr	110	2			3	20	Diorite. Hill.
229	8½ miles NW. of Pineville	Island Point Club	do	Cr-Dr	100	2			2	105	Do.
230	8 miles NW. of Pineville	R. S. Smith	Ralph Robbins	Dr	181	5 5/8	83		25		Do.
231	6 miles W. of Pineville	J. R. Smith		Bored	52	12	52	43.08			Granite.
232	5¾ miles W. of Pineville	W. C. Stroup	Montgomery	Cr-Dr	128	3	80	20	15	25	62½° F. Granite. Hill.
233	6 miles W. of Pineville	H. M. Blackwelder	do	Cr-Dr	175	2			3-4	20	Granite. Hill.
234	Pineville	J. E. M. Davenport		Dr	132	6		12	75		Schistose diorite Slope.
235	do	Town		Dr	134	8		12	75	234	62½° F. Schistose diorite. Analysis. Draw.
236	4 miles SE. of Pineville	James K. Hall		Dr	90	2			5		Granite. Hill.
237	4¼ miles SE. of Pineville	R. G. Bryant	Robbins & Wilson	Cr-Dr	132	2	90	42	5	35	Do.
238	3¾ miles SE. of Pineville	Mrs. E. E. Niven		Dug	38	36	38	31.95			Adequate yield. Draw.
239	4½ miles SW. of Matthews	J. J. Grier		Bored	32	12	32	23.74		20	Hill.
240	3¾ miles SW. of Matthews	J. M. Knox		Dug	39	36		29.80		25	Well more than 50 years old; has never gone dry. Flat.
241	2½ miles SW. of Matthews	W. N. McKee	Abernathy	Cr-Dr	235	3-2	135		5	45	Granite. Hill.
242	2½ miles SW. of Matthews	Presley Smith	C. C. Montgomery	Cr-Dr	85	2	75		8-10		Granite.

ANALYSES OF GROUND WATER FROM MECKLENBURG COUNTY,[1] N. C.
(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	27	133	180	235
Silica (SiO_2)	35	37	39	60
Iron (Fe)	.12	.15	.06	.09
Calcium (Ca)	16	29	15	55
Magnesium (Mg)	5.8	9.8	5.8	26
Sodium and potassium (NA+K)	5.7	11	8.2	20
Carbonate (CO_3)	0	0	0	0
Bicarbonate (HCO_3)	70	108	62	185
Sulfate (SO_4)	3.9	29	2.8	94
Chloride (Cl)	4.5	10	12	22
Fluoride (F)	.1	.1	.2	.5
Nitrate (NO_3)	10	3.5	10	6.0
Dissolved solids	120	189	139	395
Total hardness as $CaCO_3$	64	113	61	244
Date of collection	6/12/45	7/21/45	6/25/45	6/25/47

[1] Analyzed by the U. S. Geological Survey.

POLK COUNTY

(Area 234 square miles; population in 1950, 11,627)

Geography and physiography.—Polk County forms the southwestern corner of the area included in this report (figs. 1 and 20). Agriculture, which is favored by the relatively high annual rainfall distributed throughout the year, is the principal industry in the county. Severe droughts are extremely rare. The water power afforded by the swift-flowing streams is an asset of the county.

The southern and eastern parts, including about three-fourths of the county, lie in the Piedmont Plateau. This section is an undulating upland which is more hilly toward the west than toward the east. The general altitude of the Plateau is about 1,000 feet above sea level.

Joining the Piedmont Plateau on the west and north and rising rather abruptly above it is a part of the Blue Ridge province. The topography of the latter area is decidedly hilly and is generally unsuited for farming. At least two of the peaks in the county are more than 3,200 feet above sea level.

As the Blue Ridge province forms a major drainage divide in the northwestern section the streams follow devious but prevailingly southeastern courses toward the Broad River. The heavy rainfall produces considerable water for the numerous streams that arise within the county. The streams have cut rather deep valleys below the general upland level and their steep gradients allow them to erode the land readily.

Geology.—A striking feature of the geology of Polk County is the absence of homogeneous rocks (fig. 19). Despite the great depth of weathering outcrops of rocks are more common than in other counties of the Charlotte area, owing to the hilly topography.

The western and eastern parts of Polk County are underlain by a great series of rocks of which biotite granite gneiss and schist are the most prevelant. These rocks have a persistent northeast trend. Granite, pegmatite, and mica schist are profusely interlayered with the granite gneiss and are locally predominant. Also common in this series is hornblende gneiss, which occurs as thin beds generally conformable with the foliation of the granite gneiss. The amount of hornblende gneiss in this series varies considerably from place to place.

Hornblende gneiss forms the predominant rock in a belt extending northeastward from Tryon through Mill Spring to the Rutherford County line. It has a prevailingly black color where fresh, but as generally

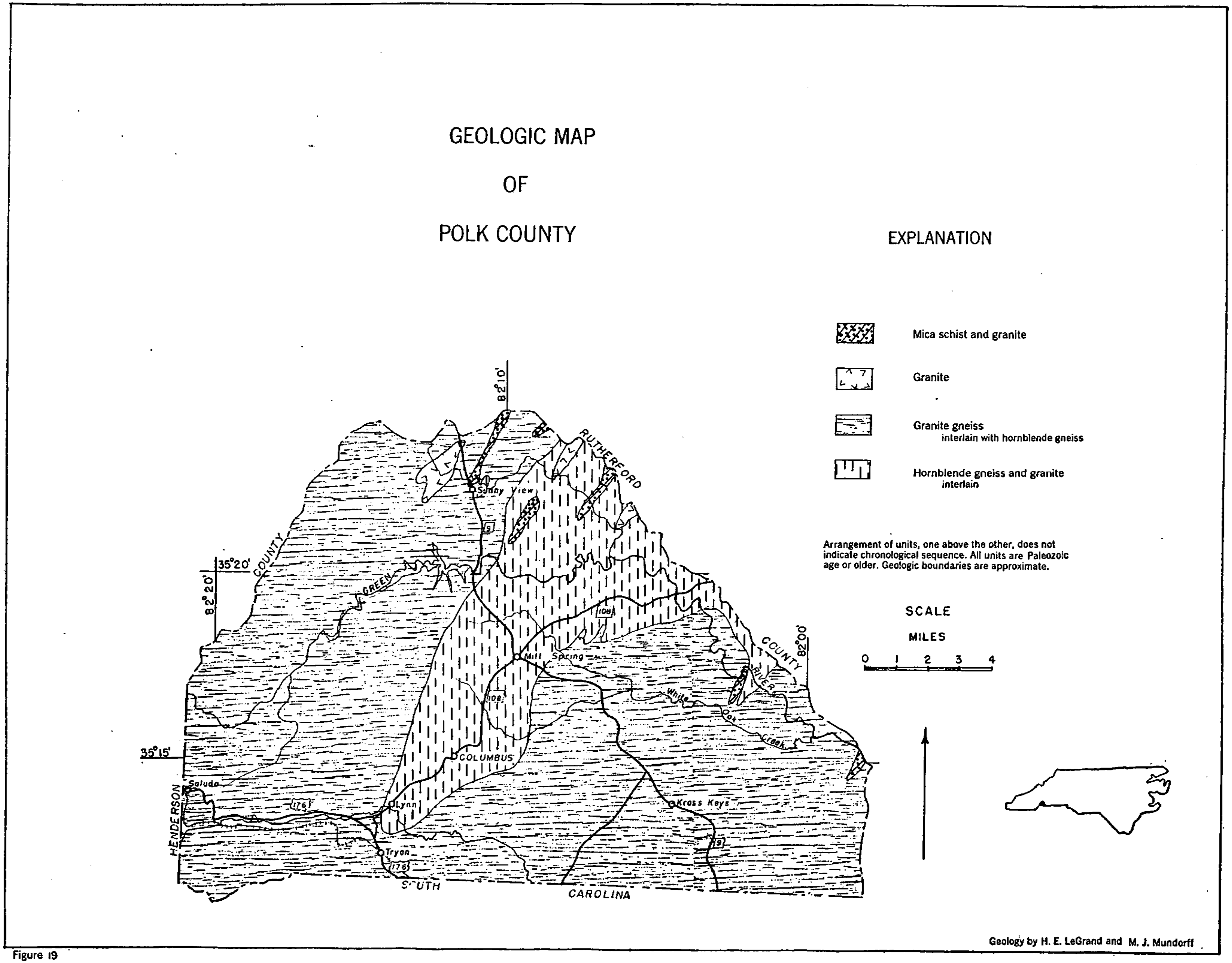

FIGURE 19.—GEOLOGIC MAP OF POLK COUNTY.

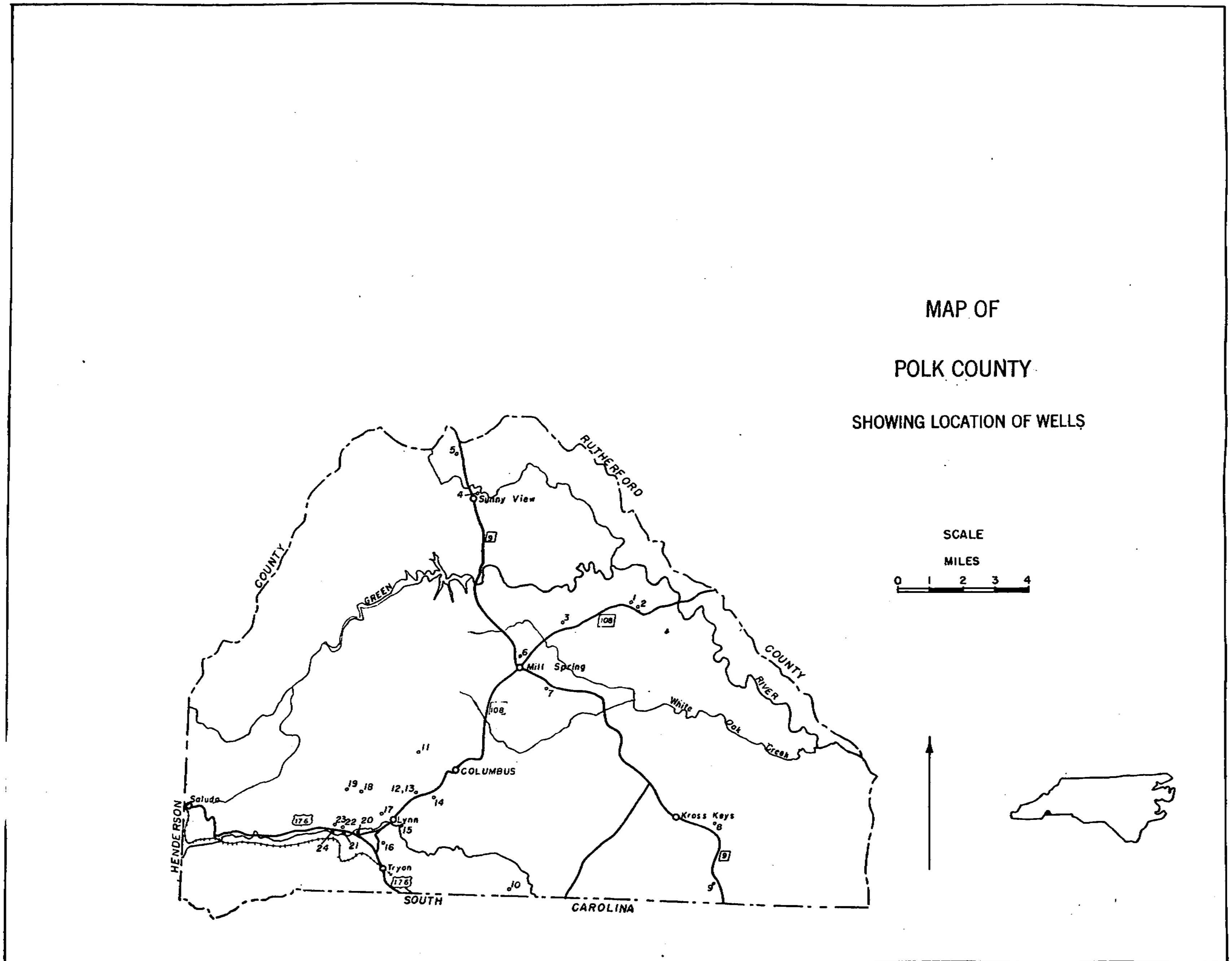

Figure 20

FIGURE 20.—MAP OF POLK COUNTY SHOWING LOCATION OF WELLS.

seen, in the weathered state, is ocherous and deep red. Granite is associated with the hornblende gneiss to the extent that perhaps as much as 40 per cent of the area mapped as hornblende gneiss may be granite. All the rocks in this belt of hornblende gneiss have a general northeast trend although cross-cutting granite and pegmatites are common.

Mica schists are common in Polk County, generally in the form of thin bands intercalated with granite and granite gneiss. The schist forms an extensive, though subordinate, part of the geology of Polk County. Almost every square yard of schist contains some granite or quartz veins or veinlets. The schists are composed chiefly of muscovite or biotite and quartz.

Although granite forms a major rock in Polk County it is shown on the map as the predominant rock in only a few areas; these lie in the northern part near the Rutherford County line. Granite occurs in varying amounts in every square mile of the county.

Ground water.—A great variety of ground-water conditions occur in Polk County, owing to the rugged topography that prevails. Ground water supplies are furnished by dug wells, springs, and drilled wells (fig. 20). Because the county is mostly rural, dug wells and springs are the most common sources of water. Springs are exceedingly common, especially in the northern and western parts of the county. Most of the springs yield less than 4 gallons a minute, but according to reports there is no appreciable fluctuation in their flows. The springs are located along steep slopes, such as in coves, where surface topography has a steeper slope than the water table and transects it. Under these conditions the springs occur only where the soil zone is absent or thin enough to allow water to flow out in concentrated seepage.

The table of well records gives data for 21 drilled wells in Polk County. These wells range in depth from 28 to 400 feet and in yield from 1 to 25 gallons a minute.

It is difficult to say which rock is the best water-bearing unit in the county. So closely interlayered are most of the rocks that many wells penetrate one or more layers of different rocks. All the rocks are extensively fractured, and they probably rate above the average in their water-bearing qualities.

Topography is an important factor in the yield of wells in Polk County. Of 10 drilled wells located on hills only 2 yield as much as 15 gallons a minute. On the other hand, of four wells in valleys all yield 15 gallons a minute or more.

A number of streams in Polk County have rather wide flood plains. Several wells have been drilled for individuals in the valley of the Pacolet River, near Tryon. The flood-plain materials[30] penetrated were reported by the well owners as having a thickness ranging from 20 to 60 feet, with several reporting sand and gravel at the base of the alluvium. Other streams in the county containing flood-plain deposits along parts of their courses are Green River, White Oak Creek, and Walnut Creek. Satisfactory water supplies may be obtained from these deposits especially where recharge from the streams through the permeable materials to the wells is possible.

The quality of the ground water (see table of analyses for Polk County) is very good. Dissolved solids are generally less than 100 and the hardness less than 25 parts per million.

[30]Mundorff, M. J., Flood-plain deposits of North Piedmont and Mountain streams as a possible source of ground-water supply: North Carolina Dept. Cons. and Devel. Bull. 59, p. 17, 1950.

RECORDS OF WELLS IN POLK COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Character of material	Water level (feet below surface)	Yield (g.p.m.)	Remarks
1	4 miles NE of Mill Springs	Oliver Taylor		Dug	38		42	Subsoil	32.49		Plenty of water. Draw.
2	4¼ miles NE. of Mill Springs	Thompson		Dr	200		6				Adequate yield. Hill.
3	2 miles NE. of Mill Springs	M. L. Merrill		Dr	250		6		130R	18	Could be pumped dry with jet pump at 175 feet. Hill.
4	Sunny View	Sunny View School		Dr	150		6		50R	10–15	Granite. Always has been adequate. Analysis. Hill.
5	1¼ miles NW. of Sunny View	Ralph Jackson	Virgil McQuery	Dr	132		5 5/8		60R	½	60° F. Hill.
6	Mill Springs	School		Dr	285		6		85R		Adequate supply, has never failed. Hill.
7	1¼ miles SE. of Mill Springs	E. B. Edwards		Dug	71		36		59.31		Do.
8	1 mile E. of Kross Keys	Green Creek School		Dr	200		6	Gneissic granite		3–5	Adequate. Anaylsis. Slope.
9	2½ miles SE. of Kross Keys	Kyle Fagan		Dug	33		48		29.47		Slope.
10	4 miles E. of Tryon	H. H. Thompson		Dr	196		6		85R	3–5	Hill.
11	1¼ miles W. of Columbus	F. L. Herron	Lee	Dr	90		6			15	Hill.
12	1¼ miles NE. of Lynn	Spartanburg T. B. Association		Dr	250		6			6	Water at 90 feet. Slope.
13	do	do		Dr	98		6		9.00		Draw.
14	1½ miles NE. of Lynn	R. L. Shuford		Dr	400		6			1	Hill.
15	¼ mile E. of Lynn	W. W. Capps	Greer	Dr	46		6			10	Slope.
16	¾ mile N. of Tryon	Southern Mercerizing Co.		Dr	38		2			45	Combined yield from three wells is 45 g.p.m. Analysis. Gravel and sand to 35 feet. Valley.
17	1¾ miles N. of Tryon	T. N. Wilcox		Dr	80		6			15	Slope.
18	2½ miles NW. of Tryon	Garey Page		Dr	194		6			8	Hill.
19	do	W. C. Bates	Lee	Dr	90		6				Hill.
20	1½ miles NW. of Tryon	R. A. Leonard	Spartanburg Well & Pump Co.	Dr	60	52	6	Gravel	1R	15	Large supply. Valley.
21	1¾ miles NW. of Tryon	John L. Edwards	do	Dr	64		6				Plenty of water. Valley.
22	do	Martin Jones		Dr	70		6				Slope.
23	2 miles NW. of Tryon	Gene Gosnell	Virgil McQuery	Dr	42		6			25	Valley.
24	do	J. L. Shields	do	Dr	94	40	6		4R	25	Drawdown 36 feet after bailing 45 min. at 25 g.p.m. Valley.

ANALYSES OF GROUND WATER FROM POLK COUNTY,* N. C.
(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	4	8	16
Silica (SiO_2)	22	23	14
Iron (Fe)	.09	.06	.29b
Calcium (Ca)	3.7	4.1	6.2
Magnesium (Mg)	1.7	1.1	2.9
Sodium and potassium (NA+K)	7.8	5.5	22
Carbonate (CO_3)	0	0	0
Bicarbonate (HCO_3)	36	29	35
Sulphate (SO_4)	2.0	1.6	32
Chloride (C1)	.9	1.0	5.6
Fluoride (F)	.1	.0	.1
Nitrate (NO_3)	.0	.0	5.9
Dissolved solids	57	52	106
Total hardness as $CaCO_3$	16	15	27
Date of collection	9/18/47	9/17/47	9/16/47

a Analyzed by the U. S. Geological Survey.
b Fe in solution .02.

RUTHERFORD COUNTY

(Area 566 sqare miles; population in 1950, 46,356)

Geography and physiography.—Rutherford County forms the northwestern corner of the area covered by this report (figs. 1 and 22). The principal rural activities include farming and lumbering. Of the industries, textile plants are the most important. Population concentrations are centered around the textile plants in Forest City, Spindale, and Rutherfordton.

The county lies in the Blue Ridge Mountains and in the Piedmont Plateau. From the northwest, where the topography is mountainous, the land slopes to the southeast. High, precipitous peaks of bald granite stand out near Chimney Rock, offering attractive scenic features for tourists. The drainage is southeastward in consequence of the regional slope (fig. 22). The entire county lies within the drainage basin of Broad River which flows through the county into Cleveland County. The streams are swift and have devious courses which may depart from any known structural weaknesses of the underlying rocks.

Geology.—The principal rocks of Rutherford County include mica schist, mica gneiss, hornblende gneiss, and granite (fig. 21). Large areas confined to any one rock type are rare; in fact the rocks, for the most part, are so intermixed that considerable differences of opinion may arise concerning the geologic mapping. Most of the rocks have a northeast-trending foliation.

The eastern half of the county is underlain by schistose rocks that strike northeastward and are tipped on edge. The schists are predominantly micaceous although hornblende schists are locally abundant. Intercalated in the schists are innumerable granite bodies of varying sizes and shapes. Kyanite occurs in the mica schist east of U. S. route 221 near the South Carolina State line and is not uncommon elsewhere.

Gneissic rocks containing an appreciable amount of hornblende occur in a wide belt extending north and south through the center of the county. For the most part the rocks are banded gneisses in which thin alternate layers of hornblende gneiss and granite occur. Large lenticular masses of granite occur parallel with the foliation. Nodules and lenticular masses of dense amphibolite occur sporadically in the gneiss. Boundaries of this unit of hornblende gneiss and granite are indefinite because of the gradational character of the component rocks.

The most common and extensive rock in the western part of Rutherford County is granite. Although several north-south bands of hornblende gneiss and mica schist occur in the granite, interlayered rocks are less common in the western part of the county than elsewhere. The granite differs little in composition and texture from other granites in the Charlotte area, although the presence of an appreciable amount of biotite produces a slightly dark color in the rock in many places. It represents an extension of the Henderson granite[31] which Keith mapped and described in the area to the north. The granite has a strong gneissic structure which increases southward to the extent that the same rock in the vicinity of Chimney Rock and southward in Polk County is considered to be a granite gneiss.

Ground water.—Practically all domestic water supplies, many industrial supplies, and two public-water supplies are obtained from wells and springs in Rutherford County (fig. 22). Dug wells and springs are used extensively in the rural areas. Springs are very common in all but the southeast corner of the county. The yield of most springs is less than 5 gallons a minute.

Although some rocks of the county doubtless yield more water to wells than other rocks, this was not ascertained. Other factors related to yield of wells such as topography and thickness of soil mantle tend to counter and conceal the importance of rock type as a factor.

The populated area east and south of Rutherfordton is considered to be an area in which wells are generally successful. This area is less mountainous than the remainder of the county; consequently there is somewhat less surface runoff and more direct influent seepage of water into the soil and rocks. Moreover, the soil mantle is generally thicker in the southeastern part of the county, resulting in greater storage space for ground water. The consolidated rocks are intermixed and highly variable in character,

[31]Keith, Arthur, U. S. Geological Survey Geol. Atlas, Mount Mitchell folio (no. 124), p. 4, 1905.

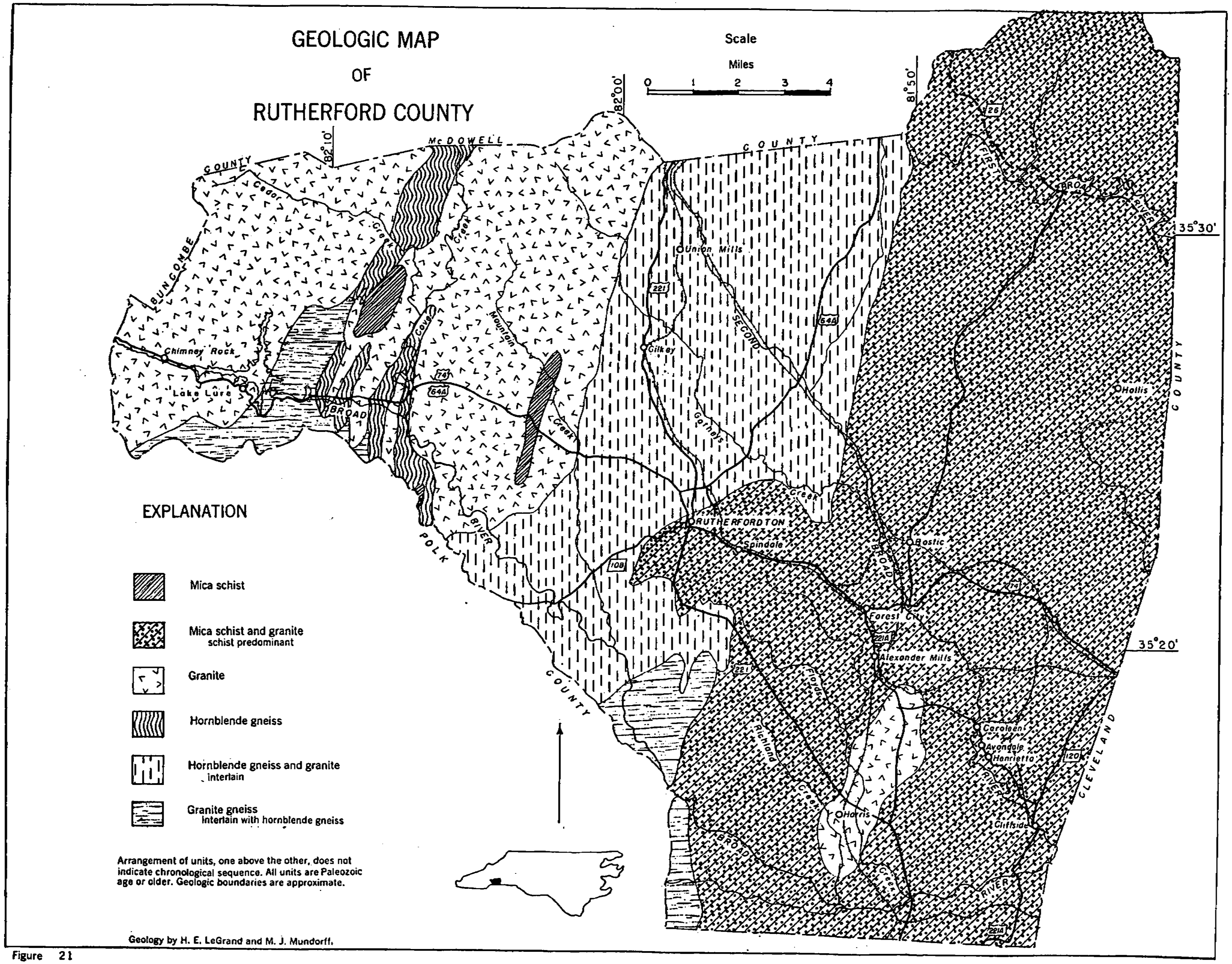

Figure 21

FIGURE 21.—GEOLOGIC MAP OF RUTHERFORD COUNTY.

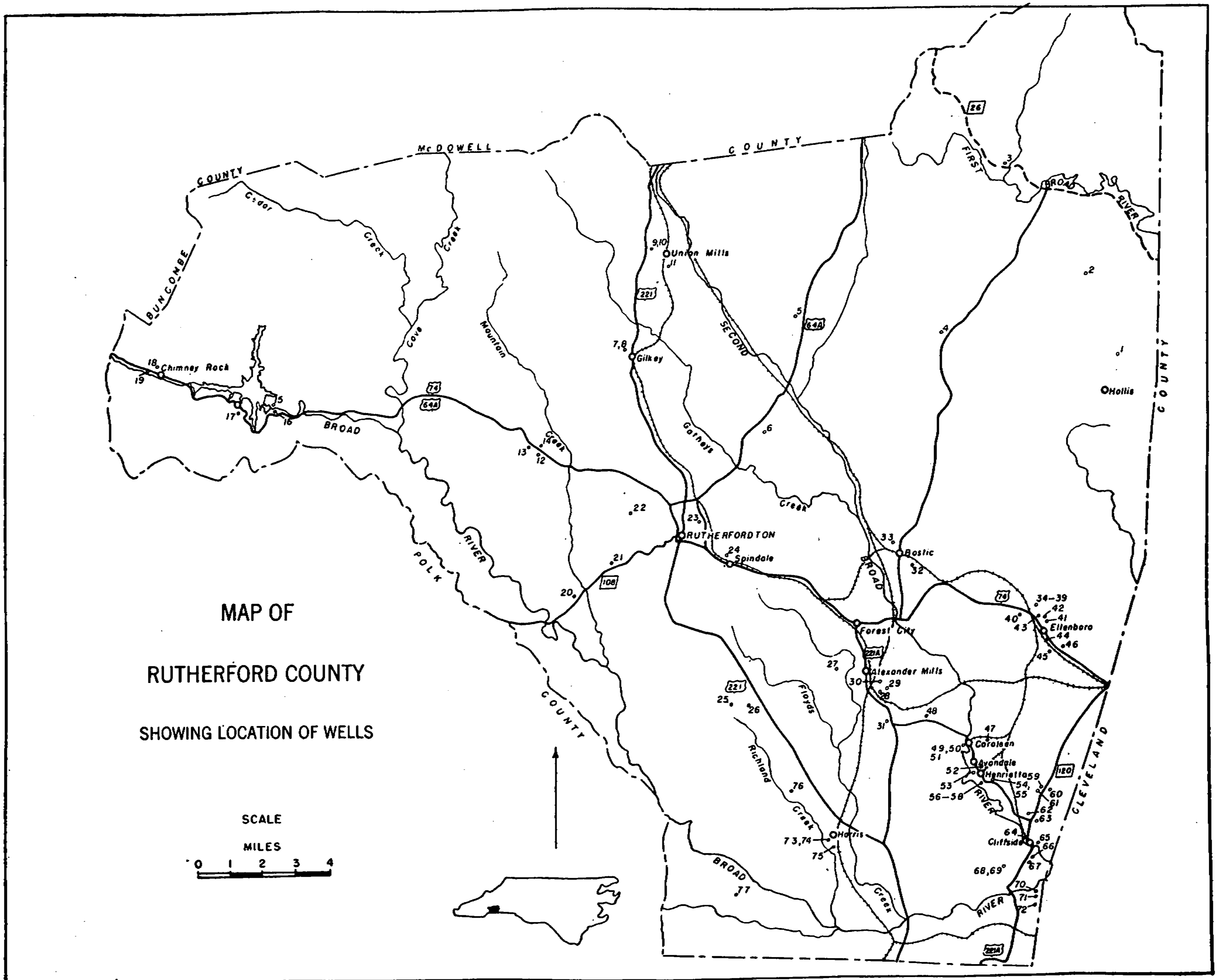

FIGURE 22.—MAP OF RUTHERFORD COUNTY SHOWING LOCATION OF WELLS.

in consequence of which joints and parting planes along which water moves are abundant. Many of the industrial wells in this area yield as much as 50 gallons a minute, and one well yields 250 gallons a minute.

In the remainder of the county no large-scale use is made of ground water. Springs and dug wells furnish adequate supplies for this, the rural area.

Most of the ground waters in Rutherford County are of excellent quality. Of the seven samples analyzed (see table of analyses for Rutherford County) none contained as much as 100 parts per million of dissolved solids. In some places where the water is not derived from granite it may contain objectionable amounts of iron, although these conditions are not believed to be common. The low mineral content in the waters is probably due to the common presence of granite from which ground water does not readily extract mineral matter, and also to the relatively rapid movement of ground water and consequently to the short time it is in contact with rock surfaces.

The two municipal water supplies in Rutherford County using ground water are Chimney Rock and Lake Lure. Chimney Rock, with a seasonal population of 300, obtains its water supply from a series of small springs. The springs flow from granite along the lower slopes of a steep mountain above the level of Broad River. The daily use of water is only about 20,000 gallons. The water is chlorinated.

Lake Lure, with a seasonal population of about 500 (1940 census), obtains its water supply from a drilled well 125 feet deep located in the main valley of the Broad River. The well yields 60 gallons a minute. The water is not treated.

RECORDS OF WELLS IN RUTHERFORD COUNTY

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Remarks
1	1½ miles N. of Hollis	W. M. Panther	A. B. Taylor	Dr	125	90±	6			Schist. Hill.
2	3½ miles N. of Hollis	Pete Sigmon	do.	Dr	132	132	6	67.43		Do.
3	6 miles N. of Sunshine	S. B. McCurry		Dug	20		36	15R		
4	Sunshine	Sunshine School	A. B. Taylor	Dr	100		5 5/8		20	
5	7 miles N. of Rutherford	J. C. Norville		Dr	117		6		10–15	Slope.
6	4 miles N. of Rutherford	Mount Vernon School		Dr	175		6		15	Gneiss. Hill.
7	Gilkey	School	Hickory Pump Co.	Dr	758		6		1–2	A little water at 150 feet—abandoned. Slope.
8	do.	do.	do.	Dr	135		6		15	Draw.
9	Union Mills	Alexander Schools, Inc.	do.	Dr	700	100±	8	64R	16	As much water at 300 as at 700 feet. Hill.
10	do.	do.		Dr	200?		6		15	Not used; reported to have gone dry when 700 foot well completed. Hill.
11	do.	D. F. Mashburn	A. B. Taylor	Dr	108		6			Adequate supply. Slope.
12	5½ miles NW. of Rutherfordton	W. M. Searcy	do.	Dr	126	50	6	60R	6	Slope.
13	do.	Green Hill School		Dr	185		6		5	Hill.
14	do.	W. C. Lynch	A. B. Taylor	Dr	151		6	77R	2	Hill.
15	Lake Lure	State Highway Patrol Lodge	do.	Dr	85		5 5/8		15	
16	do.	Garr Summer Camp	G. T. Shipman	Dr	185		5 5/8	130.13	1	Hill.
17	do.	Town	Geo. Lee	Dr	124½	38	5 5/8		60	Water from fractures at 75 and 100 feet. Valley.
18	Chimney Rock	Mountain View Inn	G. T. Shipman	Dr	87		6		6+	Granite. Slope.
19	do.	D. B. Taylor	do.	Dr	92	50	6	6R	6–8	Granite boulders from surface to 50 feet. Valley.
20	4 miles SW. of Rutherfordton	Charles O. Taylor		Dug	61		48	52M		Adequate supply. Slope.
21	2½ miles SW. of Rutherfordton	County Home	A. B. Taylor	Dr	120		5 5/8			Adequate Supply. Analysis. Hill.
22	2 miles W. of Rutherfordton	Piedmont Baptist Church		Dug	19.5		30	14.10		Slope.
23	Rutherfordton	Grace Cotton Mill Co.	A. B. Taylor	Dr	395		6		7½	Hill.
24	Spindale	Elmore Corp.	Sydnor Well Co.	Dr	650		8–6		250	Use 300,000 gallons per day. Most of water from 650 ft., reported. Analysis. Hill.
25	4½ miles S. of Spindale	H. E. Shields	A. B. Taylor	Dr	125		6	33R		Adequate supply.
26	4½ miles S. of Spindale	C. E. Wall		Dug	47		30	37.75		Adequate Supply. Flat.
27	1½ miles S. of Forest City	W. B. Harrill	A. B. Taylor	Dr	196		5 5/8			Hill.
28	Alexander Mills	Alexander Mills, Inc.		Driven	60		2		45–50	South group of nine wells pumped together 24 hours a day at 40 gallons a minute. Analysis. Draw.

RECORDS OF WELLS IN RUTHERFORD COUNTY—*Continued*

Well no.	Location	Owner	Driller	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Water level (feet below surface)	Yield (g.p.m.)	Remarks
29	Alexander Mills	Alexander Mills, Inc.		Driven	60		2		45–50	East group of eight wells, pumped 24 hours a day at 40 gallons a minute. Analysis Draw.
30	do	do	Sydnor Well Co.	Dr	340		8		60	Pumped about 6 hours a day. Analysis. Slope.
31	1½ miles SE. of Alexander Mills	A. L. Allen		Dug	48		30	40R		Adequate supply for store, home. Flat.
32	Bostic	School	A. B. Taylor	Dr	90		6		20	Schist. Hill.
33	do	Bob Smith	do	Dr					15	
34	1 mile NW. of Ellenboro	Neisler Mills Corp.	do	Dr	90		5 5/8		5	Company well 1. Schist. Slope.
35	do	do	do	Dr	59		5 5/8	20R	18	Schist. Company well 2. Reported drawdown 10 feet at 15 to 18 gallons a minute. 64° F. Analysis. Slope.
36	do	do	do	Dr	174	65	5 5/8	8R	50	Schist. Company well 3. Draw.
37	do	do	do	Dr	45	40	5 5/8	7R	30+	Schist. Company well 4. Reported 1½ feet drawdown after 9 hours at 30 gallons a minute. Draw.
38	do	do	do	Dr	48	15	5 5/8	7R	50	Company well 5. Schist. Draw.
39	do	do	do	Dr	77	15	5 5/8		8	Schist. Company well 6. Draw.
40	1 mile NW. of Ellenboro	Claude Blanton	do	Dr	65		5 5/8		5	Do. Slope.
41	Ellenboro	School	do	Dr	114		5 5/8		25	Do. Slope.
42	do	A. B. Bushong	do	Dr	74		5 5/8		10	Do. Slope.
43	do	Irving Smart	do	Dr	76		5 5/8		20	Do. Slope.
44	do	Morris Hamrick	do	Dr	180		5 5/8			Schist. Supplies four businesses and one residence.
45	do	Eldon Hamrick	do	Dr	488		5 5/8		1	Well abandoned. Schist. Flat.
46	do	Miss Betty Green	do	Dr	61		5 5/8		50	Draw.
47	Caroleen	J. W. Piercy L. L. White	do	Dr	188½	8?	5 5/8		15	Rock at 8 feet. Hill.
48	do	M. L. Lowe	do	Dr	60		5 5/8		1	Slope.
49	do	Caroleen Mills Co.	do	Dr	250		6	7R	15	Slope.
50	do	do	do	Dr	250		6		20	Draw.
51	Caroleen	Caroleen Mills Co.	A. B. Taylor	Dr	250		6		15	Slope.
52	Avondale	Cliffside Mills Haynes Plant		Dr	1,301		6		10	Maximum yield by pumping 10 g.p.m. Flows a very small quantity; not used. Draw.
53	do	do		Br	20–30		2			Group of five wells used when filter plant not operating. Draw.
54	do	do	A. B. Taylor	Dr	190		6		20	Abandoned. Slope.
55	do	do		Dr	191		6		75	Not used; water contains too much iron. Hill.
56	Henrietta	Henrietta Mill Co.	Va. Mach. Co.	Dr	750		8–6		25	All water obtained above 250 feet. Slope.
57	do	do	A. B. Taylor	Dr	125		5 5/8		25	Slope.
58	do	do	do	Dr	125		5 5/8		25	Slope.
59	2 miles N. of Cliffside	Lee Packard	do	Dr	50	44	6	24R	10–15	Slope.
60	do	Liton Proctor	do	Dr	94		6	41.83		Plenty of water. Slope.
61	1¾ miles N. of Cliffside	M. O. Proctor	do	Dr	109	85	6	37R	30	Slope.
62	1 mile N. of Cliffside	Cliffside Mills Tom Crow	do	Dr	86		6		10	
63	1¼ miles N. of Cliffside	James Tinkler	do	Dr	105	40	6	90R	15–18	Supplies three families. Schist. Hill.
64	Cliffside	Cliffside Mills	Va. Mach. Co. (?)	Dr	800(?)		10?6?			Used for cooling at the plant.
65	do	do	Va. Mach. Co.					+1½ flows	35	"Sulphur" well, not used. Flowing 2½ g.p.m. August 26, 1947. Valley.
66	do	Cliffside Mills Mr. Crocker	A. B. Taylor	Dr	302		6			Small yield. Hill.
67	½ mile S. of Cliffside	Cliffside Mills Mr. Dobbins	do	Dr	127		6		20	Slope.
68	1½ miles SW. of Cliffside	R. Z. Dedmond R. O. Cobb	do	Dr	220		6	112.78		Not used; very small supply of water, very bad odor.
69	do	do		Dug	25½			25.38		About 25 feet from well 68; not used, no water.
70	1½ miles S. of Cliffside	Duke Power Co.		Dr	189		6		7–8	Well 2; in camp for colored construction workers. Slope.
71	do	do	A. B. Taylor	Dr	47	40	6		12	Well 6, yields muddy water, will be abandoned. Draw.
72	do	do	R. E. Faw & Son	Dr	297½	61½	6	42R	24	Well 7. Draw.
73	Harris	Harris Gin & Ice Co.	A. B. Taylor	Dr	178	20?	5 5/8	15R	5	Draw.
74	do	do	do	Dr	130	20	5 5/8	15R	20	Draw.
75	do	W. C. Harris	do	Dr	60		5 5/8		12	Draw.
76	2 miles NW. of Harris	Ernest Cole	A. B. Taylor(?)	Dr	287		6			Adequate supply. Hill.
77	3½ miles SW. of Harris	E. M. Patrick		Dug	41		48	37.13		Adequate supply. Hill.

ANALYSES OF GROUND WATER FROM RUTHERFORD COUNTY,* N. C.
(Numbers at heads of columns correspond to numbers in table of well data)
(parts per million)

	21	24	28	29	30	35	Spring**
Silica (SiO_2)	26	24	13	12	20	6.3	15
Iron (Fe)	.24a	.57b	.10	.11	.10	5.2c	.34d
Calcium (Ca)	3.7	16	3.3	2.6	4.9	1.7	2.0
Magnesium (Mg)	.8	2.4	1.7	1.6	1.5	2.1	1.0
Sodium and Potassium (Na+K)	5.9	8.1	3.8	3.2	4.1	9.5	3.8
Carbonate (CO_3)	0	0	0	0	0	0	0
Bicarbonate (HCO_3)	28	63	13	18	26	20	17
Sulfate (SO_4)	.9	11	1.4	1.2	2.2	1.4	1.6
Chloride (Cl)	1.1	2.9	6.8	1.8	1.5	6.6	1.2
Fluoride (F)	.0	.1	.1	.1	.1	.1	.0
Nitrate (NO_3)	.0	.0	2.0	1.7	1.8	7.5	.0
Dissolved solids	52	98	41	32	50	47	33
Total hardness as $CaCO_3$	13	50	15	13	18	13	9
Date of collection	8/7/47	8/6/47	5/25/48	5/25/48	5/23/48	8/5/47	8/5/47

* Analyzed by U. S. Geological Survey.
** Spring owned by Grady Withrow, Hollis, N. C.—yield, 4 g.p.m.
a Fe in solution .02
b Fe in solution .16
c Fe in solution .02
d Fe in solution .02

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