GEOHYDROLOGY OF BARTOW, CHEROKEE, AND FORSYTH COUNTIES, GEORGIA

by

C.W. Cressler, H.E. Blanchard, Jr., and W.G. Hester

Georgia Department of Natural Resources

Georgia Geologic Survey

INFORMATION CIRCULAR 50

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GEORGIA DEPARTMENT OF NATURAL RESOURCES
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The following factors may be used to convert the inch-pound units published herein to the International System of Units (SI).

Multiply inch-pound	By	To obtain SI units
inch (in.)	2.54	centimeter (cm)
foot (ft)	.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
million gallon (Mgal)	3785	cubic meter (m^3)
gallon per minute (gal/min)	.06309	liter per second (L/s)
millon gallon per day (Mgal/d)	.04381	cubic meter per second (m^3/s)

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ABSTRACT

Bartow, Cherokee, and Forsyth Counties border the Atlanta Metropolitan Area, and are experiencing a rapid growth in urban and industrial development. Large areas not served by public water distribution systems rely on ground water to meet their requirements. Many new industries, resort communities, subdivisions, and private homes depend on ground water, most of which comes from wells.

The western part of Bartow County lies in the Valley and Ridge physiographic province, where rocks range in age from Early Cambrian to Middle Ordovician. The principal water-bearing units are shale, limestone, dolomite, and quartzite. In this area, well supplies of 3 to 25 gal/min (0.2 to 1.6 L/s) can be obtained nearly everywhere and, with rare exceptions, the water is moderately mineralized and is suitable for domestic and stock supplies.

Carbonate aquifers furnish industrial and municipal wells with 50 to 1,500 gal/min (3.2 to 95 L/s), and similar quantities may be available from selected sites in broad areas of Bartow County. The well water is moderately mineralized and is suitable for many industrial and other uses.

Springs in the carbonate aquifers discharge 25 to 3,000 gal/min (1.6 to 189 L/s). The spring water is of good chemical quality and can be used with minimum treatment for industrial supplies. Most of the springs are unused and represent a valuable untapped resource.

Well and spring pollution is widespread in the Valley and Ridge part of Bartow County. More than 20 percent of the drilled wells, 80 percent of the dug wells, and 80 percent of the large springs tested were polluted. The main causes of well polution are improper well construction and poor site selection. Many large springs are polluted because they are favorite watering places for wildlife. Similar percentages of wells and a large percentage of springs in the Piedmont part of the report area also may be polluted.

Barite mining in the Cartersville area left numerous open-pit mines in the residual soil of the Shady Dolomite. The Bartow County landfill occupies one of the mines, and others are being considered for landfill sites. Most of these mines are hydraulically connected with the aquifer that supplies water to the industrial wells in Cartersville. Use of the mines for disposing of solid waste possibly can contaminate large areas of this important ground-water reservoir.

The Cartersville fault, generally believed to be a single thrust that crosses northwest Georgia from Tennessee to Alabama, has been found to be two thrust faults that intersect near Emerson, Bartow County: One fault extends southward from Tennessee to Emerson and is a continuation of the Great Smoky fault. The other fault trends northeastward from Alabama to Emerson, where it overrides the Great Smoky fault and continues northeastward across Lake Allatoona. To avoid confusion with the old Cartersville fault, the south-trending thrust is named the Great Smoky fault and the northeast-trending thrust is named the Emerson fault for the town of Emerson, near where it is well exposed.

The eastern one-fourth of Bartow County and all of Cherokee and Forsyth Counties lie in the Piedmont physiographic province, which is underlain by a variety of crystalline rocks including schist, gneiss, amphibolite, phyllite, and quartzite of uncertain age. The availability of ground water in the crystalline rock area is highly variable. Well supplies of 2 to 25 gal/min (0.1 to 1.6 L/s) generally can be obtained in areas having low to moderate relief. In some areas of moderate relief, and in many areas of high relief, well supplies may be unavailable. Although water from a few isolated wells contains some constituents in concentrations that greatly exceed the limits set for drinking water, most well water is moderately mineralized and is satisfactory for domestic and stock use.

Yields of 25 to 200 gal/min (1.6 to 13 L/s) are available from a few wells in the crystalline rocks. Yields of this size come from fault zones, zones of fracture concentration, and contact zones between rocks of contrasting character.

INTRODUCTION

Bartow, Cherokee, and Forsyth Counties border the Atlanta Metropolitan Area, and as a result are experiencing rapid growth in population and development. Many new industries, resort communities, and subdivisions being developed in the area need water supplies. For most, surface-water treatment is too costly and springs are either too small or inconveniently located, so nearly all of the water requirements are met by wells. The quantities needed generally range from 25 to 1,500 gal/min (1.6 to 95 L/s).

Developing adequate and dependable industrial and public water supplies from wells has been a problem in the three-county area for a long time. Problems arose because: (1) development sites were often acquired without first considering the availability of water, and (2) the potential yield of the water-bearing units was largely unknown prior to this study. Attempting to obtain large ground-water supplies in areas where the water-bearing units have a low yield potential resulted in costly and unproductive drilling, and ultimately in the abandonment of several developmental projects. Drilling sites that offered the greatest potential for ground-water supply were difficult to select without information about the water-bearing units. As a result, most existing large-capacity wells resulted from chance, rather than from careful site selection.

Purpose and Scope

The purpose of this study was to: (1) delineate all aquifers in the area; (2) determine the range of the yields of these aquifers and the chemical quality of their water; (3) map the direction of ground-water flow in the carbonate aquifers at Cartersville to determine the potential direction of movement of leachate from solid waste disposal sites; (4) measure and sample all large springs to determine their minimum annual flows and the chemical quality of the spring water; and (5) to produce geologic maps of sufficient detail to be useful in developing additional well supplies in the area. This study was designed to provide information that industries, consultants, city and county officials, land developers, and others may use to locate and develop ground-water supplies in the three-county area.

In making this study, records for industrial and other high-yielding wells and a representative sample of residential and farm wells were collected to determine their depths, yields, static water levels, and types of construction. Water samples were collected from several of these wells to determine the chemical quality of water from the water-bearing units. Aquifers in Forsyth County and in eastern Cherokee County were delineated mainly from geologic maps furnished by the Georgia Geologic Survey of the Georgia Department of Natural Resources. The geology of most of Bartow County and western Cherokee County was mapped during this study. Water levels were measured in 100 wells and auger holes in the Cartersville area to determine the slope of the water table.

Data for springs having recorded discharges of 50 gal/min or more were collected and their discharges measured to determine their approximate minimum annual flows. Samples from eight springs were analyzed to determine the chemical quality of the spring water.

Surface geophysical techniques (resistivity and gravity) were used to map a highly permeable fault zone that supplies 100 to 1,500 gal/min (6.3 to 95 L/s) of water to industrial wells in Cartersville. Knowing the location of this conduit and the area that it drains is essential to the proper management of this valuable water resource. A gravity survey also was used to verify the identification of a thrust sheet in northern Bartow County.

The geologic structure and, so far as possible, the hydrology of the open-pit mines in the Cartersville area were studied to determine how disposing of solid waste in the mines could affect the ground-water reservoir. The water table was contoured near the Bartow County landfill to learn the direction of ground-water movement, and to predict the probable path of leachate flow.

Location and Extent of Area

Bartow, Cherokee, and Forsyth Counties include an area of 1,147 mi^2 (2,971 km^2) in northern Georgia (fig. 1). The western part of Bartow County is in the Valley and Ridge physiographic province where the topography is dominated by north-south trending, low, generally rounded ridges and uplands, separated by both narrow and broad valleys. The uplands and higher ridges range in altitude from about 900 to 1,400 ft (274 to 427 m) above sea level; valleys generally are between 700 and 800 ft (213 and 244 m) above sea level.

The eastern part of Bartow County and all of Cherokee and Forsyth Counties are in the Piedmont physiographic province. The topography varies from steep, high ridges to rolling uplands and broad stream valleys. The altitude of the area ranges between 850 and 1,200 ft (259 and 366 m) above sea level.

Bartow County is drained by the Etowah River and its tributaries except for the extreme northern border of the county that is drained by the Oostanaula River. All of Cherokee County and the northwest half of Forsyth County are drained by the Etowah River system. The remainder of Forsyth County is drained by the Chattahoochee River system.

The counties have a mild climate. Their average January temperature is about 41°F and their average July temperature is about 77°F. The average annual

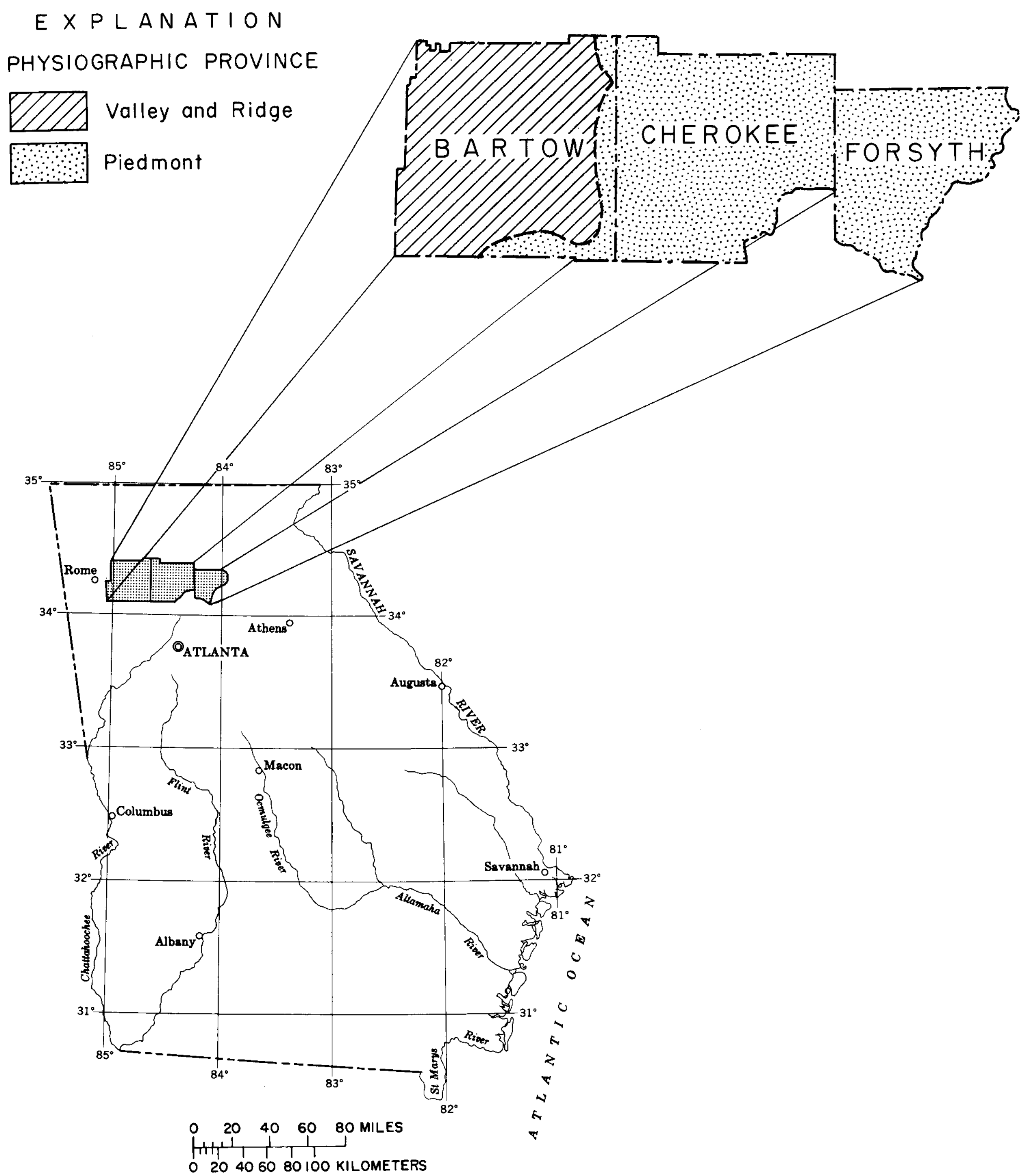


Figure 1. Location of report area.

precipitation in the three counties is about 53 in. (1,350 mm), including only a small amount of snow.

Rainfall in this part of the State has two peaks, one in winter and one in midsummer, separated by periods of lighter rains in spring and autumn. Autumn is the driest season of the year. Large variations can occur in the amount of rainfall received from year to year, and amounts from the wettest years may be about double those for the driest years. Nearly half of the rainfall comes in amounts of 1 in. (25 mm) or more within 24 hours.

Dry spells occasionally cause heavy damage to crops and pastures and result in shortages in water supplies. Droughts of this severity are, however, usually limited to rather small areas so that any given locality, on the average, is not likely to have a serious drought more often than once in 10 to 15 years.

Previous Studies

Butts and Gildersleeve (1948) reported on the general geology and the mineral resources of the Valley and Ridge part of Bartow County. The geology and mineral resources of the Cartersville Mining District, in eastern Bartow County, were studied in detail by Kesler (1950).

Croft (1963) investigated the geology and ground-water resources of Bartow County, and the generalized availability of water supplies is treated by Cressler and others (1976). The water resources of Cherokee and Forsyth Counties were examined by Thomson and others (1956).

Chemical analyses of water from several wells in the report area were tabulated by Grantham and Stokes (1976), and summarized by Sonderegger and others (1978).

Acknowledgements

This study was made by the U.S. Geological Survey in cooperation with the Georgia Geologic Survey of the Georgia Department of Natural Resources. The Georgia Geologic Survey provided a geologic map of Cherokee County by Mr. David E. Lawton, and of Forsyth County by Dr. Joseph B. Murray, for use as a base for the ground-water study.

The writers wish to acknowledge the many people in Bartow, Cherokee, and Forsyth Counties who gave assistance during this investigation. Property owners willingly supplied information about their wells and springs and permitted them to be measured and sampled.

Mr. Jimmy Fowler, Fowler Well Drilling Co., Canton, Ga., furnished construction and yield data on a large number of wells in Cherokee County. Mr. Paul Helms, All Purpose Boring, Inc., Cumming, Ga., and his staff supplied similar data for wells in Forsyth County.

Mr. John Thomas and Mr. Bob Aiken of the Lake Arrowhead resort community in Cherokee County made available comprehensive engineering reports that contained construction data, lithologic logs, electric logs, and chemical analyses for wells on the property.

Mr. Pete Murray of Thompson, Weinman and Co., Cartersville, Ga., supplied information about the depth to bedrock and arranged access to company property for resistivity and gravity surveying.

The contacts between the quartzite-phyllite-shale sequence and the overlying dolomite unit, and the outcrop pattern of part of the gneiss body known as Corbin Granite (Precambrian) in eastern Bartow and western Cherokee Counties, were taken from a geologic map of the Cartersville Mining District by Mr. T. L. Kesler (1950). This map, made during a period of widespread mining in the Cartersville area prior to the filling of Allatoona Lake, shows these contacts more accurately than could be determined from present exposures in the time allotted.

Mr. Charles Adams and others of the Union Carbide Corp. furnished an engineering report that contained foundation boring data needed to trace the permeable fault zone beneath the industrial park in south Cartersville. They also opened unused company wells so water levels could be measured.

Dr. Thomas J. Crawford of West Georgia College, working in cooperation with the Georgia Geologic Survey and the U.S. Geological Survey, supplied geologic maps and lithologic descriptions of the Piedmont part of the Burnt Hickory Ridge and Taylorsville quadrangles and parts of the Acworth and Allatoona Dam quadrangles, including the area underlain by the Corbin Granite. He also correlated the crystalline rock units south of Cartersville with ones to the east, and spent many hours discussing the lithologic relationships and the geologic structure of the Cartersville area. Dr. Crawford worked in the field with the senior author to confirm that the Cartersville fault of former usage consists of two intersecting faults (Cressler and Crawford, 1976), and agreed to name the northeast-trending fault the Emerson fault for the town of Emerson, Bartow County, near where it is well exposed.

Dr. L. T. Long of the Georgia Institute of Technology planned and interpreted resistivity and gravity surveys in Bartow County to locate ground-water conduits and delineate major water-bearing units. The field work for these surveys was done by Mr. Wes Champion.

Mr. Paul A. Smith, Jr., graciously furnished construction data and chemical analyses, allowed the

installation of water-level recorders, and permitted the use of his equipment and power to conduct an aquifer test on his property in Dawson County, adjacent to the study area.

OCCURRENCE AND AVAILABILITY OF GROUND WATER

Ground water in Bartow, Cherokee, and Forsyth Counties occupies joints, fractures, and other secondary openings in bedrock and pore spaces in the overlying mantle of residual soil. Water recharges the underground openings by seeping through the soil or by flowing directly into openings in exposed rock. This recharge is from precipitation that falls in the area.

Unweathered and unfractured bedrock in the report area has very low porosity and permeability. Thus, the quantity of water that a rock unit can store is determined by the capacity and distribution of joints, fractures, and other types of secondary openings. The quantity of stored water that can be withdrawn by wells, or that is free to discharge from springs, depends largely on the extent to which the rock openings are interconnected.

The size, spacing, and interconnection of openings differs greatly from one type of rock to another and with depth below land surface. Open joints and fractures tend to become tighter and more widely spaced with increasing depth. Joints and other openings in soft rocks such as shale and phyllite tend to be tight and poorly connected; wells and springs in rocks of this character generally have small yields. Openings in more brittle rocks such as quartzite and graywacke tend to be larger and are better connected; wells and springs in these rocks normally supply greater yields. Other rocks, including amphibolite, schist, and gneiss, are variable in the size and connection of secondary openings and generally yield small to moderate quantities of water to wells and springs.

Carbonate rocks, which include limestone, dolomite, and marble, contain much larger and more extensively interconnected fracture systems. Openings in carbonate rocks commonly are enlarged by solution, and are capable of transmitting large quantities of water.

Fractures in slate, shale, sandstone, quartzite, and similar rocks in the Valley and Ridge province area tend to be concentrated within 250 ft (76 m) of the surface. Most solution-enlarged fractures in carbonate rocks are found at depths of less than 350 ft (106 m). Therefore, when drilling for water in the Valley and Ridge province, it is rarely worthwhile to drill deeper than 350 ft (106 m) in carbonates, or deeper than 250 ft (76 m) in other kinds of rock. If a well fails to produce the desired yield at these depths, it generally is best to try a new location.

In the Piedmont area, where the rocks have been subjected to greater deformation, water-yielding joints and fractures commonly occur deeper than 400 ft (122 m). A significant number of wells obtain water from openings about 500 ft (152 m) deep, and a few produce water from as deep as 700 ft (213 m). However, a comparison of drilling costs with the probability of obtaining the required yield of about 5 gal/min (0.3 L/s) indicates that it is seldom advisable to drill deeper than about 400 ft (122 m) for a residential supply. Well records show that drilling deeper than about 700 ft (213 m) cannot be justified unless geologic evidence indicates that openings extend to greater depth.

DESCRIPTION OF THE WATER-BEARING UNITS AND THEIR HYDROLOGIC PROPERTIES

The report area is underlain by more than 30 different kinds of rock, many of which have similar physical properties and yield water of comparable quantity and chemical quality. Thus, for convenience, the rocks in the report area have been grouped into 10 major water-bearing units and assigned letter designations. The areal distribution of the water-bearing units is shown on the accompanying maps, plates 1, 2, and 3. The physical characteristics and the hydrologic properties of each water-bearing unit are described in the following section.

Because large ground-water supplies are essential to continued industrial growth in Cartersville and along the Interstate 75 corridor in eastern Bartow County, a detailed geologic map is included of that area. (See plate 4.) This map delineates the high-yielding and low-yielding water-bearing units, and thus should facilitate the development of additional well supplies, especially where the underlying rock is obscured by a deep cover of soil and alluvium.

Water-Bearing Unit A

Character of the rock—Unit A has the largest areal extent of any aquifer in Bartow County, but because it is generally overlain by a thick residual mantle, the bedrock rarely crops out. For this reason, its lithology is inferred from adjacent areas where it is better exposed. The bulk of the unit consists of thickly to massively bedded dolomite, mainly brown or tan in the lower part, and medium to light gray in the middle and upper parts. The unit throughout most of the county is made up of the Knox Group of Cambrian and Ordovician ages. Near Taylorsville and

Stilesboro, where the youngest part of the unit occurs, thick to massive layers of light- to medium-gray limestone locally account for about 50 percent of the section. The upper limestone-bearing section belongs to the Newala Limestone of Ordovician age.

The unit probably is between 2,500 and 3,500 ft (762 and 1,070 m) thick in southwest Bartow County where the entire section is present. In the northern part of the county, the unit occupies narrow synclinal belts and probably ranges from 100 to 2,000 ft (30 to 610 m) thick.

The dolomite is highly siliceous and upon weathering produces a cherty, silty, clay residuum that generally ranges from 25 to 200 ft (7.6 to 61 m) thick. The residuum is highly permeable and readily absorbs precipitation, which it holds in temporary storage and slowly releases to bedrock openings. It is this steady supply of water from the residuum that sustains the high yields of wells and springs in the aquifer and minimizes the adverse effects of droughts.

Water-bearing character—Unit A is one of the most productive aquifers in the report area. Farm and home supplies generally are available everywhere except on steep slopes and narrow ridges. Drilled wells in the unit are very dependable and rarely decline in yield, even during periods of prolonged drought. Twenty-one wells having known yields furnish 4 to 92 gal/min (0.3 to 5.8 L/s). (See Appendix.) The chance of obtaining 5 gal/min (0.3 L/s) from a randomly located well in unit A, such as at most farms and homesites, is about 80 percent.

In adjacent counties of northwest Georgia where more wells have been drilled in the aquifer, supplies as large as 1,500 gal/min (95 L/s) are obtained from wells in favorable locations. Selected sites in Bartow County can be expected to furnish between 100 and 1,500 gal/min (6.3 to 95 L/s). (See the section on evaluating well sites.)

Sixty-four residential and farm wells in Bartow County have an average depth of 132 ft (40 m), and their casing depths range from 35 to 134 ft (11 to 41 m). The shallowest well recorded is 55 ft (17 m) deep; the deepest, 331 ft (101 m). Most wells in the unit are cased to bedrock, leaving the remainder of the well an open hole in limestone and dolomite.

In areas where the depth to bedrock is greater than about 100 ft (30 m), a few wells are finished above the bedrock and derive water solely from the overlying residual soil. The soil contains permeable layers that yield 5 to 15 gal/min (0.3 to 0.9 L/s) or more to wells.

In developing a well in residual soil, it is common practice to drill until a water-bearing zone is reached and measure the yield. If the yield is adequate, casing is set to total depth, leaving only the open hole in the bottom of the pipe to admit water. Thus, because of the small intake area, the full potential of the water-bearing zone rarely is utilized by this well-construction method. For wells that penetrate a thick layer of water-bearing material, or more than one layer, the yield generally can be increased by the use of slotted casing. This method is rarely employed, however, possibly because of increased cost. Gravel-packed wells also are successful and they commonly yield 10 to 25 gal/min (0.6 to 1.6 L/s).

The chemical quality of the well water generally meets the standards set by the Georgia Department of Natural Resources (1970) and the Environmental Protection Agency (1975). (See tables 1 and 2.) Water from wells in bedrock is hard to very hard and most contains low concentrations of iron. Of 64 wells inventoried, only two were reported to supply water containing objectionable amounts of iron. The iron concentration in water sampled from three bedrock wells ranged from 10 to 70 μg/L (micrograms per liter), which is fairly low.

Wells that obtain water solely from the residual soil above the bedrock yield soft water that is low in iron. Well owners refer to the water as "freestone", and report that it is very good for drinking and other domestic uses.

The largest springs in the report area discharge water from unit A. Fifteen springs discharge between 50 and 3,000 gal/min (3.2 and 189 L/s). The spring locations are shown in plate 1, and their discharge rates are listed in table 3. Nearly all the springs are unused and represent a potentially important undeveloped resource.

The spring water is hard to very hard, and most is of good chemical quality suitable for many industrial uses. With chlorination, water from some springs can be used for public and private supplies. Chemical analyses of water sampled from representative springs in Bartow County are listed in tables 2 and 4.

Water-Bearing Unit C

Character of the rock—Unit C consists mainly of shale, but in some areas it includes significant thicknesses of limestone, dolomite, siltstone, and sandstone. The broad belts of the unit near Adairsville, Cassville, and Pine Log are mostly greenish, gray, and slightly purplish shale that weathers to various shades of tan, pink, and orange. Scattered throughout these areas are layers and lenses of limestone and dolomite a few feet to 100 ft (30 m) or more thick. The thicker carbonate layers generally underlie narrow valleys in the shale. The unit in these areas belongs to the Conasauga Formation of Middle and Late Cambrian age.

Table 1. Chemical analyses of well water, Bartow, Cherokee, and Forsyth Counties. (Analyses by U. S. Geological Survey, except as noted. tr, trace)

Well No.	County	Water-bearing unit[1]	Name or owner	Depth of well (feet)	Date of collection	Silica (SiO_2) milligrams per liter	Micrograms per liter: Iron (Fe)	Micrograms per liter: Manganese (Mn)	Milligrams per liter: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaCO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (N)	Dissolved solids: Residue at 180°C	Dissolved solids: Sum of constituents	Hardness[2]: Calcium-magnesium	Hardness[2]: Noncarbonate	Specific conductance micromhos at 25°C	pH	Temperature, degrees Celsius	Color, platinum-cobalt units	Carbon dioxide (CO_2)
Environmental Protection Agency (1975) Drinking Water Standards							300	50							250	250	[4]1.2		500							15	
58	Bartow	A	Dolph Nelson	85	01-04-60	12	70	—	34	19	3.5	1.9	204	—	2	4.5	0.1	—	188	—	163	—	—	7.4	—	—	—
63		A	Joe Brandon	86	03-21-47	—	—	—	—	—	—		233		7	4	.2	—	—	—	184	—	—	—	—	—	—
68		A	J. W. Pickelsimer	331	03-27-48	10	50	—	33	26	2	—	153	0	2	1.5	.0	—	203	—	180	—	—	8.4	—	—	10
75		A	C. C. Strain	79	01-05-60	7.9	10	—	41	12	1.4	.4	172	—	3.2	2.0	.2	—	166	—	152	—	—	7.5	—	—	—
79		A	City of Taylorsville	119	01-04-60	7.2	1,600	—	96	5.5	9.4	2.4	301	—	14	16	.2	—	337	—	262	—	—	7.0	—	—	—
80		A	Taylorsville School	116	03-21-47	—	—	—	—	—	—	—	172	—	3	2	.2	—	—	—	140	—	—	—	—	—	—
61		C	Minnie Rodgers	100	01-04-60	12	50	—	32	18	3.6	24	180	—	.8	4.0	.1	—	178	—	154	6	300	7.9	—	5	—
72		C	Buford Kay	87	12-31-59	8.3	40	—	41	20	2.6	.6	212	—	8	5.0	.2	—	201	—	184	—	—	7.6	—	—	—
02		C	M. C. Watts	111	12-31-59	8.6	40	—	10	4.1	.5	.3	52	—	4.4	2.0	.2	—	63	—	42	—	—	6.9	—	—	—
63		D	Goodyear Clearwater, 1	510	09-22-52	6.0	0	—	43	25	.2	.1	178	—	10	4	.0	—	163	—	210	—	—	7.4	—	—	—
Do.		D	Goodyear Clearwater, 2	320	do.	7.0	0	—	44	29	tr.	tr.	210	—	8	3	.0	—	182	—	229	—	—	7.8	—	—	—
63a		D	Goodyear Clearwater, 3	510	11-13-75	85	0	40	39	20	3.8	.7	193	0	8.9	5.2	.1	1.7	182	189	180	22	301	7.4	18	1	12
99		D	GAF Corp.	240	03-19-47	—	—	—	—	—	—	—	118	—	9	4	.2	—	—	—	—	—	—	—	—	—	—
104		D	J. E. King	80	01-04-60	13	40	—	54	4.3	1.9	2.6	174	—	5.6	3	.1	—	180	—	152	—	—	7.8	—	—	—
141		D	Kingston, Ga.	350	09-22-52	6.0	0	—	50	tr.	1.0	—	117	0	1	tr.	.01	—	252	—	125	—	—	7.0	—	—	—
38		F	Thompson, Weinman & Co.	140	11-12-75	7.8	0	50	30	16	3.5	1	151	0	3.6	4.8	.1	1.9	162	150	140	17	255	7.4	17.5	3	9.6
Do.		F	do.	140	05-28-75	8.4	0	0	29	16	4.2	1	153	0	3.8	5	.1	2.1	136	152	140	13	244	6.5	17	0	77
Do.		F	do.	140	12-30-59	8.8	—	—	27	16	2.9	.7	148	0	3.2	4	.1	1.7	153	143	134	12	254	7.7	17	5	4.7
39a		F	Chemical Products Co.	300	11-13-75	9.2	0	15	27	15	3.5	1.1	148	0	4	4.2	.2	.56	147	141	130	8	237	7.4	16	5	9.4
40		F	Union Carbide Co.	113	12-22-59	8.9	70	—	26	12	6.6	.7	128	0	2.4	11	.0	2.0	146	140	114	10	244	8.0	17	3	2
Do.		F	do.	—	12-22-59	10.4	70	—	22.3	16	—	—	—	—	0	14.5	.1	—	151	—	121.5	—	—	8.3	—	—	—
41		F	New Riverside Ochre Co.	140	11-13-75	9.8	0	40	27	15	.8	1.3	156	0	2.4	1.6	.4	.21	129	137	130	2	224	7.3	16.5	1	13
Do.		F	do.	136	06-19-75	—	0	0	—	—	—	—	—	—	2.6	1.4	—	—	—	—	—	—	222	—	—	—	—
Do.		F	do.	111	10-29-74	—	20	5	—	—	—	—	—	—	3.1	—	—	—	128	—	—	—	70	—	—	—	—
27		F&G	Emerson, Ga.	250	09-22-52	6	250	—	30	2.0	tr.	tr.	127	0	0	3	.0	—	225	—	83	—	—	7.7	—	—	—
100		J	Otto Townsend	159	12-31-59	22	100	—	53	6.3	5.5	3.6	188	—	11	2.5	.1	—	205	—	158	—	—	7.6	—	—	—
3		K	Frank McEver	102	12-30-59	39	90	—	6.4	1.0	7.8	2.0	38	—	.4	1	.1	—	103	—	20	—	—	6.6	—	—	—
8		K	Effie White	150	12-30-59	42	40	—	13	8.1	6.1	.3	78	—	9.2	5.5	.2	—	136	—	65	—	—	7.1	—	—	—
19a		K	YMCA, Lake Allatoona	—	05-13-54	6.0	280	—	15.7	5.1	.9	—	—	—	—	5.4	—	—	104	—	60	—	—	8.0	—	—	1.0
46		K	L. N. Jenkins	65	03-02-50	20	450	—	15	6.0	tr.	tr.	60	—	14	3	.0	—	83	—	62	—	—	7.1	—	—	—
49		K	T. A. Jenkins	190	12-30-59	48	50	—	3.2	.7	8.1	4	39	—	.4	1	.2	—	94	—	11	—	—	6.2	—	—	—
21		K&G	Red Top Mtn. State Park	338	09-30-58	26	0	—	6.8	1.2	3.3	2.4	36	0	.4	1	.1	.16	65	60	22	0	65	6.4	17	3	23
9a		K&L	Hoyt Green	127	12-30-59	30	4	—	30	7.5	9.2	1.6	144	—	7.6	5	.2	—	167	—	106	—	—	7.1	—	—	—
30	Cherokee	J	J. Jordan	147	01-21-74	5.8	100	33	.4	.4	3.1	.3	2	0	.9	3.8	.0	1.4	16	22	3	1	33	4.8	15.5	7	—
47		J	V. O. Poss	142	01-21-74	9.4	250	67	.7	.6	4.2	.4	2	0	3.6	4.1	.0	.49	20	27	4	3	36	4.8	17	7	—
63		J	E. W. Owen	—	08-20-62	24	—	—	7.2	1.3	4.6	.9	22	0	13	1.5	.2	—	66	64	24	6	78	6.4	—	—	—
14		L	Fowler Trailer Park	—	11-13-75	34	0	40	8.5	2.0	6.5	1.5	53	0	.3	1.2	.1	.01	78	81	30	0	97	6.9	16	5	11
65		N&K	Gilbert Reeves	—	11-12-75	34	0	50	7.8	1.8	6.1	1	20	0	.5	5.2	.2	3.3	94	81	27	11	83	6.3	—	1	16
32		K	Woodstock, Ga.	500	11-04-63	41	—	—	22	3.9	10	2.4	86	0	3.2	10	.2	—	152	135	71	0	200	6.9	—	—	—
62		M	Ball Ground, Ga.	400	04-18-74	13	0	17	40	4.3	1.8	1.5	137	0	3.9	3.2	.1	.63	122	138	120	5	228	7.7	16.5	2	—
Do.		M	do.	—	06-14-72	12	0	0	36	3.7	1.4	1.2	130	0	1.6	2	.2	—	124	120	110	0	225	8.0	—	—	—
Do.		M	do.	—	05-03-60	13	—	—	35	3.3	.9	1.1	124	0	1.6	1	.3	—	119	118	101	0	190	7.3	—	—	—
12		N	Little River Landing, 2	532	01-21-74	22	0	17	22	9.5	2.5	3.3	164	0	14	3.4	.2	0	168	180	94	0	288	7.9	16	7	—
46	Forsyth	J	W. F. Griffin, Sr.	68	—	10	0	0	8.2	1.3	1.4	2.3	36	0	.3	2	.0	1.3	54	49	26	0	70	6.7	—	4	12
4		J&G	N. Ga. Rendering Co., 3	—	11-18-75	16	50	20	15	.8	3.0	1.3	51	0	3.6	1.1	.2	.02	66	67	41	0	93	6.5	18	0	26
9		K	J. Stiner	98	03-28-66	29	—	—	3.0	.6	4.7	1.1	26	0	.0	.8	.1	—	—	53	10	0	42	6.5	—	—	—
14		K	D. J. Hood	53	01-23-74	15	0	14	4.9	.6	1.8	.7	19	0	.1	.8	.0	.62	41	36	15	0	38	6.6	16	10	7.6
1		N	E. Sherrill	239	—	21	0	0	8.8	2.5	2.8	1.1	45	0	3.1	1.8	.0	.71	67	67	32	0	79	8.1	—	1	.6
32		N	Shadow Park North, 1	—	11-18-75	24	10	60	10	2.4	5.2	1.8	40	0	2.0	2.9	.3	1.4	70	75	35	2	88	5.4	17	0	25
17		P	Dixon Trailer Park	—	11-18-75	33	0	20	11	3.0	5.7	2.3	51	0	.5	3.6	.1	1.4	89	91	40	0	104	6.5	16	0	26
34		P	Shadow Park North, 3	—	11-18-75	12	14,000	1,500	7.2	1.6	3.0	1.4	30	0	.9	3.9	.3	.01	30	63	25	0	106	6.2	—	0	—
40		P	C. B. Mansell	177	11-04-63	37	—	—	5.2	1.5	5.7	1.9	32	0	3.6	1.5	.2	—	74	74	19	0	70	6.8	—	—	—
47		P	Chestatee School	—	11-18-75	12	10	90	5.0	4.2	6.7	2.6	0	0	.3	7.4	.1	9.9	84	83	32	32	118	5.5	18	0	0
42		P&J	N. Ga. Rendering Co., 1	—	11-18-75	14	0	60	5.5	.5	1.6	1.6	20	0	3.5	1.2	.1	.36	39	40	16	0	52	6.5	18	1	10
43		Q	Habersham Marina	545	—	21	310	29	72	1.2	78	4.4	58	0	310	1.7	.2	.01	573	518	180	140	727	7.2	16.5	2	5.9
45		Q&J	D. E. Nalley	175	01-23-74	19	0	14	7.5	1.6	4.6	1.7	26	0	2.1	4.2	.0	2.3	70	64	25	4	83	6.2	16	3	26
53		G	Lake Arrowhead, 16[3]	252	04-16-73	32	100	200	1.0	.05	.5	.95	6.3	0	0	1.77	.3	—	45	—	4	1	—	5.3	—	3	—
54		G	Lake Arrowhead, 17	309	04-27-73	4.0	100	10	1.2	.5	.53	.97	6.0	0	1	.1	.3	—	69.3	—	3.5	0	—	5.7	—	1	—
57		G	Lake Arrowhead, 24	288	05-29-73	5.0	230	90	36	10.5	2.2	3.3	136	0	7.0	.1	.3	—	144.0	—	142	136	—	7.2	—	5	—
58		G	Lake Arrowhead, 26	248	05-29-73	3.6	1,000	210	16	.21	.74	3.4	88	0	8.0	.1	.3	—	79	—	98	88	—	6.8	—	5	—
59		G	Lake Arrowhead, 27	330	05-04-73	2.4	100	50	.9	.40	.55	.53	3.6	0	.1	.1	.3	—	25	—	4.2	0	—	5.5	—	5	—
61		G	Lake Arrowhead, 31	248	05-29-73	1.5	50	10	1.4	.35	.6	1.6	3	0	.1	.1	.3	—	8	—	40	0	—	5.9	—	—	—

[1] Water sampled from water-bearing units shown in plates 1, 2, and 3.
[2] Water having a CaCO hardness of 0 to 60 mg/L is classified, "soft"; 61 to 120 mg/L, "moderately hard"; 121 to 180 mg/L, "hard"; and more than 181 mg/L, "very hard".
[3] Analyses of water from Lake Arrowhead wells by XEPOL ONE, INC. Laboratory.
[4] Based on average annual air temperature.

Table 2. Minor chemical constituents in well and spring water, Bartow, Cherokee, and Forsyth Counties. (Analyses by U. S. Geological Survey)

Well No.	County	Water-bearing unit 1/	Name of owner	Depth of well (feet)	Date of collection	Aluminum (Al)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Selenium (Se)	Strontium (Sr)	Zinc (Zn)
						Micrograms per liter												
Environmental Protection Agency (1975) Drinking Water Standards							10	1,000	10	50		1,000	50			10		5,000
			Wells:															
63	Bartow	D	Goodyear Clearwater	510	11-13-75	0	0	0	0	0	0	3	0	0.1	0	0	240	10
38		F	Thompson, Weinman & Co.	140	11-12-75	6	0	30	0	0	0	0	2	.3	0	0	210	0
39a		F	Chemical Products Corp.	300	11-13-75	6	0	600	0	0	0	3	0	.2	0	0	210	20
41		F	New Riverside Ochre Co.	140	11-13-75	9	0	600	0	0	0	0	2	.3	0	0	220	9
65	Cherokee	K	Gilbert Reeves	91	11-12-75	0	0	—	0	0	0	15	2	.2	0	0	200	20
14		L	Fowler Trailer Park	225	11-13-75	6	0	—	1	0	0	2	12	.3	0	0	250	530
4	Forsyth	J&G	N. Ga. Rendering Co., 3	503	11-18-75	0	0	—	0	0	0	10	0	.2	0	0	370	7
2		P&J	N. Ga. Rendering Co., 1	225	11-18-75	6	0	—	1	0	0	14	23	.2	0	0	190	10
17		P	Dixon Trailer Park	144	11-18-75	0	0	—	0	7	0	0	12	.1	0	0	190	7
47		P	Chestatee School	140	11-18-75	20	0	—	0	0	0	14	8	.1	0	0	260	10
32		T	Shadow Park North, 1	284	11-18-75	0	0	—	0	1	0	3	0	.2	5	1	300	40
34		P	Shadow Park North, 3	266	11-18-75	0	0	—	0	0	17	0	9	.3	0	0	190	2,200
	Bartow		Springs:															
SP.2		A	Jones Spring	--	11-13-75	6	0	—	0	0	0	0	0	.3	0	0	210	0
SP.7		A	Rodgers Spring	--	11-11-75	9	0	—	0	0	0	0	0	.2	0	0	160	0
SP.8		A	Connesena Spring	--	11-11-75	9	0	—	2	0	0	0	35	.2	0	0	220	5
SP.10		A&D	Adairsville, Ga., Spring	--	11-11-75	0	0	—	0	0	0	2	0	.2	0	0	300	0
SP.11		A&D	Mosteller Spring	--	11-11-75	3	0	—	0	0	0	0	0	.1	0	0	210	10
SP.16		A&D	Crowe Springs Church	--	11-11-75	6	0	—	1	0	0	0	18	.2	0	0	220	8
SP.17		A&D	Crowe Springs	--	11-11-75	6	0	—	0	0	0	1	0	.1	0	0	270	10
SP.25		D	Funkhouser Spring	--	11-11-75	6	0	--	0	0	0	0	2	.2	0	0	250	7

1/ Water was sampled from water-bearing units shown in plates 1, 2, and 3.

Table 3. Measured or estimated flow of springs, Bartow County. (E, estimated)

Spring No.	Spring name or owner	Water-bearing unit[1/]	Location	Date measured or estimated	Flow Mgal/d	Flow Gal/min	Remarks
1	Davis Estate	A	1.5 miles NW. of Taylorsville, 1.1 miles N. of Polk County line.	09-26-50 11-04-74	1.73 .94	1,200 655	
2	C. C. Cox (Jones Spring)	A	2.8 miles N. of Taylorsville, E. side of road.	09-26-50 11-04-74	1.4 -	960 -	Nov. 4, 1974, could not measure because of flooding by beaverdam.
3	Wallace Moore	A	2.7 miles NE. of Taylorsville, 2.1 miles N. of Polk County line.	09-26-50 11-04-74	.25 dry	170	
4	Blue Hole Spring	A	3.65 miles NNE. of Taylorsville, 3.42 miles N. of Polk County line.	09-26-50 11-04-74	4.6 -	3,200 -	Nov. 4, 1974, could not measure because of flooding by beaverdam.
5	Boiling Spring	A	2.6 miles NNE. of Euharlee, N. bank of Euharlee Creek.	09-27-50 11-05-74	.72 .36	500 250	Flows from rocks.
6	Gillam Spring	A	3.0 miles N. of Euharlee, N. bank of Etowah River.	09-27-50 11-05-74	1.08 .16	750 108	
7	Roger Gordon (Roger's Spring)	A	1.97 miles NNE. of Kingston, N. side of Ga. Highway 20.	09-27-50	2.9	2,000	In streambed.
8	Connesena Spring	A	1.45 miles SW. of Halls, 0.2 mile N. of road.	09-27-50 11-05-74	1.44 -	1,000 -	Nov. 5, 1974, could not measure because of flooding by beaverdam.
9	Kerr Spring	A	0.6 mile W. of Halls, N. of road.	12- -59 11-05-74	.29E .35	200E 243	Pool spring.
10	City of Adairsville	A	0.9 mile NW. of center of Adairsville at city waterworks.	09-27-50 11-05-74	5.9 4.1	4,100 2,870	Public supply.
11	Mosteller Spring	A	5.05 miles ENE. of Adairsville, 0.2 mile S. of Ga. Highway 140.	09-28-50 11-06-74	3.0 1.5	2,100 1,060	Pool spring.
12	Hayes Spring	C	6.64 miles ENE. of Adairsville, N. side of Ga. Highway 140.	09- -59 11-06-74	.07E .12	50E 84	Flows from rock opening.
13	Orma Adcock	A	4.72 miles NW. of Pine Log, 0.93 mile S. of Ga. Highway 140.	12- -59 11-06-74	.29 E .03	200E 20	Seep spring.
14	Harvey Lewis	A	3.9 miles W. of Pine Log, 2.05 miles S. of Ga. Highway 140.	09- -59 11-06-74	.07E .10	50E 70	Seep spring.
15	Pratt Spring	C	8.2 miles NE. of center of Kingston, 3.4 miles E. of U.S. Highway 41, and E. side of Mud Creek.	09-28-50 11-06-74	.34 .01	235 7	Developed.
16	Crowe Spring Church	A	5.5 miles WSW. of Pine Log, 8.34 miles SE. of Adairsville.	09-28-50 11-06-74	1.44 .46	1,000 320	Flows from rock opening.
17	Crowe Spring	A	5.21 miles WSW. of Pine Log, 8.7 miles SE. of Adairsville.	09-28-50 11-06-74	.74 .44	517 300	Developed.
18	H. H. Lipscomb	C	2.95 miles SW. of Pine Log, 1.8 miles W. of U.S. Highway 411.	08- -59	.08	60	
19	Cartersville Spring	F	1.99 miles NW. of Emerson, NW. bank of Etowah River.	11- -74 11-06-75	.5E dry	350E	Dry when Thompson, Weinman Co. well is pumping.
20	Mrs. W. B. Moss	F	1.7 miles SW. of Emerson, 2.0 miles N. of Paulding County line.	12- -59 11-04-74	.29E .18	200E 125	
21	Mrs. W. B. Moss	F	1.6 miles SW. of Emerson, 1.99 miles N. of Paulding County line.	12- -59 11-04-74	.29E .79	200E 550	
22	W. M. Vaughan	D	1.25 miles SSE. of Pine Log, 0.7 mile W. of U.S. Highway 411.	08- -59 11-07-74	.07E .03	50E 18	
23	Wiley Vaughan	D	1.0 mile SSE. of Pine Log, 0.7 mile W. of U.S. Highway 411.	08- -59 11-07-74	.07E .07	50E 50	
24	Copper Hill Mining Co. Oak Hill Spring	C	2.75 miles ENE. of Pine Log, 0.08 mile S. of Ga. Highway 140.	08- -59 11-06-75	1.0E .3E	700E 200E	Pool spring.
25	Funkhouser Spring	D	3.74 miles NNE. of Pine Log, 0.35 mile W. of U.S. Highway 411.	09-29-50 11-07-74	.32 .21	220 148	Industrial supply.

[1/] Water-bearing units are shown in plate 2.

Table 4. Chemical analyses of spring water, Bartow County. (Analyses by U. S. Geological Survey. tr, trace)

Spring No.	Water-bearing unit[1]	Name or owner	Date of collection	Silica (SiO_2) milligrams per liter	Micrograms per liter – Iron (Fe)	Micrograms per liter – Manganese (Mn)	Milligrams per liter – Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaCO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (N)	Nitrate (NO_3)	Dissolved solids – Residue at 180°C	Dissolved solids – Sum of constituents	Hardness[2] – Calcium-magnesium	Hardness[2] – Non-carbonate	Specific conductance, micromhos at 25°C	pH	Temperature, degrees Celsius	Color, platinum-cobalt units	Carbon dioxide (CO_2)
	Environmental Protection Agency (1975) Drinking Water Standards				300	50							250	250	[3]1.2		45	500							15	
SP-2	A	Jones Spring (C. C. Cox)	11-13-75	7.8	0	40	29	14.0	0.6	0.4	146	0	1.5	1.4	0	0.37	1.6	142	129	130	11	206	7.3	16	5	12
SP-5	A	Boiling Spring (Dunken)	07-26-43	18.0	.1	--	31	14.0	1	1	--	-	4.0	6.0	--	--	--	150	--	--	--	--	8.0	--	--	--
SP-7	A	Rodgers Spring	11-11-75	6.6	0	40	13	6.0	.5	.3	60	0	2.0	1.1	.1	.02	.09	70	59	57	8	94	6.6	15.5	10	24
SP-8	A	Connesena Spring	11-11-75	7.8	20	30	26	13.0	.7	.6	133	0	2.7	2.0	.3	.19	.84	121	120	120	10	186	7.2	16	3	13
SP-10	A	City of Adairsville	11-11-75	8.0	0	20	28	14.0	.8	.8	143	0	2.0	1.6	0	.48	21	129	128	130	11	196	7.3	15.5	0	11
		do.	03-12-59	8.8	.04	--	24	12.0	.6	--	133	-	2.4	1.0	--	--	1.4	124	--	110	--	--	8.2	--	--	--
		do.	09-22-52	6.0	tr.	--	31	14.0	--	--	142	-	4.0	2.0	--	--	.5	112	--	134	--	--	7.7	--	--	--
SP-11	A	Mosteller Spring	11-11-75	6.8	30	40	16	8.2	.8	.5	79	0	2.2	1.6	0	.10	.44	76	76	74	9	112	7.0	15	0	13
SP-16	A	Crowe Springs Church	11-11-75	7.2	0	30	24	11.0	.6	.5	114	0	2.1	1.1	.8	.17	.75	103	105	110	12	163	6.9	15.5	3	23
SP-17	A&D	Crowe Spring	11-11-75	11.0	0	40	37	7.2	1.6	1.1	134	0	3.2	2.3	.1	.88	3.9	128	134	120	12	206	6.6	16	5	54
SP-24	C	Oak Hill Spring	12-31-59	17.0	.04	--	33	12.0	1.8	2.6	152	-	6.4	1.0	.3	--	.5	150	--	132	--	--	7.7	--	--	--
SP-25	D	Funkhouser Spring	11-11-75	7.5	0	40	47	10.0	2.4	.6	169	0	16.0	3.4	.1	1.10	4.9	171	176	160	20	270	6.6	16	3	68

[1] Water sampled from water-bearing units shown in plate 1.
[2] Water having a CaCO hardness of 0 to 60 mg/L is classified, "soft", 61 to 120 mg/L, "moderately hard", 121 to 180 mg/L, "hard"; and more than 181 mg/L, "very hard".
[3] Based on average annual air temperature.

Two isolated exposures of unit C in southwest Bartow County consist mainly of clay shale in the lower part and silty, micaceous shale and siltstone in the upper part. The exposure north of Taylorsville is of Ordovician age and belongs to the Rockmark Slate. A sample of shale from the west edge of the outcrop (USGS Loc. No. 8813-CO) is interesting because it contains fish fragments. According to Dr. Richard Lund of Adelphi University, "* * * an occasional chip seems to indicate that the structures visible are composed of isolated odontodes. This suggests an affinity with *Astraspis* and the other Ordovician *Heterostraci*, rather than with anything later. The * * * condition of the material makes this very tentative, however."

Shale from this same locality also contained one fragment of a scandodiform conodont element, one orthograptid (?) graptolite mold, and several indeterminate phosphatic brachiopod fragments. Dr. Robert B. Neuman of the U.S. Geological Survey stated that the graptolite mold is of a large biserial form, possibly an orthograptid, which indicates that the sample probably is of Middle Ordovician age.

The exposure of unit C south of the Cartersville airport is lithologically similar to the one north of Taylorsville and probably belongs to the Rockmart Slate.

Near Adairsville, the unit is about 700 ft (213 m) thick (Spalvins, 1969, p. 46). It seems to thicken toward the east, and in the Pine Log area the width of the outcrop belt indicates that it probably is more than 1,000 ft (305 m) thick.

The easternmost outcrop belt of the unit, which extends from south of Cartersville northward through White, past Rydal, is composed of gray shale that weathers to shades of tan, pink, and purple. Much of the shale displays a distinctive silver sheen and locally is referred to as silver shale or slate. This part of the unit contains layers of sandstone and siltstone that generally are gray, purple, white, or tan. East of Rydal the sandstone is very hard and occurs in accumulations 30 ft (9.1 m) or more thick and forms low ridges. Poor exposures make determining the thickness of the unit in this area very difficult, but it probably is several hundred feet thick.

The outcrops of the unit that include Johnson Mountain and adjacent ridges 4 mi (6.4 km) northwest of Cartersville, and the ridges west and southwest of Aubrey Lake, are made up of purple, greenish, and dark-gray shale and thin to thick layers of fine- to medium-grained sandstone that weathers to brownish or purple. Cuts made during construction of Interstate 75 revealed that the fresh rock is very calcareous and occurs in a variety of colors including purple, pale red, white, gray, and green.

This outcrop area of the unit is irregular in shape, because it forms the upper plate of a flat-lying thrust fault that displaced the shale and sandstone of unit C westward into a position above the younger dolomite of unit D. A gravity survey conducted along the valley of Pettit Creek (plate 4) revealed that the shale and sandstone in that area are thin—probably less than 100 ft (30 m) thick—and the outcrop pattern of the unit indicates that the thrust sheet probably ranges between 100 and 400 ft (30 and 122 m) thick. This means that in the thinner parts of the thrust sheet it may be practical to drill through the low-yielding rocks of unit C and derive as much as several hundred gallons per minute from the underlying dolomite of unit D.

The easternmost outcrop belt of the unit and the overthrust sheet at Johnson Mountain are both part of the Rome Formation of Early and Middle Cambrian age.

Water-bearing character—Most wells yield between 2 and 15 gal/min (0.1 and 0.9 L/s). Domestic and stock supplies generally are available in valley areas and on gentle slopes where randomly located wells have about a 60-percent chance of furnishing 5 gal/min (0.3 L/s). Wells on hills, ridges, and steep slopes commonly have inadequate yields, and some property owners in these areas have found it necessary to drill two or three wells.

Experience has shown that yields of 20 to 70 gal/min (1.3 to 4.4. L/s) can be developed from selected sites in the few areas where the unit includes thick sections of dolomite or limestone. These areas generally can be identified by the presence of limestone or dolomite cropping out in stream channels or along a valley floor. Well 97 (plate 1), which is in the valley north of Pine Log, yields 70 gal/min (4.4 L/s) from limestone.

Wells in the unit range in depth from 50 to 558 ft (15 to 170 m) and have an average depth of about 182 ft (55 m). Casing depths range from about 18 to 235 ft (5.5 to 72 m).

Depending upon the type of rock from which it comes, the well water varies from soft to very hard. Most of the water probably contains low to moderate concentrations of iron, as only a few well owners voiced objections about the amount of iron in their water.

Water-Bearing Unit D

Character of the rock—The composition and thickness of unit D varies greatly from one outcrop belt to another. In the belt that lies adjacent to water-bearing unit A (plate 1), it ranges from about 50 to 300 ft (15 to 91 m) thick and consists of thinly to massively bedded dolomite, commonly interlayered with clayey limestone. In a few places, dark-gray limestone becomes the dominant rock type, and in others a few feet of dark-gray shale occurs near the top. The upper part of the unit contains abundant layers and nodules of black chert that contrast sharply with the light-gray chert in the overlying unit A, a fact that is helpful in distinguishing the two units.

The belt of the unit that crops out next to unit A is a rough equivalent of the Maynardville Limestone Member of the Conasauga Formation. The remainder of the unit belongs to the middle and lower parts of the Conasauga of Middle and Late Cambrian age.

The unit D that is exposed within the outcrop belts of unit C, north and west of Cassville and at Adairsville, consists of thin- to thick-bedded gray limestone. It has a maximum thickness of about 600 ft (183 m), but may be much thinner where it is bounded by a major fault (Spalvins, 1969, p. 47).

The eastern outcrop belt of the unit that extends from Cartersville and Rodgers northeastward, nearly to the Gordon County line, is composed mainly of thin- to massive-bedded, light- to medium-gray dolomite and some brown dolomite, probably between 500 and 1,000 ft (152 and 305 m) thick. The dolomite locally is oolitic and nearly all exposures are distinctively marked by pink or reddish bedding, joint planes, and stylolites. Some of the dolomite contains layers and nodules of dark, rarely oolitic chert. Good exposures of the dolomite can be viewed in the quarry north of White and along Nancy Creek at Rodgers. Southeast of Bolivar, thin- to massive-bedded gray impure limestone makes up sections 100 ft (30 m) or more thick at the top of the dolomite. In a few places, such as in the valley of Pine Log Creek near U.S. Highway 411, beds of gray limestone are interlayered with beds of dolomite to produce a banded rock similar in appearance to that in the belts farther west.

Much of the dolomite in the eastern belt contains abundant silica that chemical weathering converts to a hard chert-like rock called jasperoid. Small pieces of dense gray jasperoid are scattered about most of the outcrop area, and where faulting or tight folding has produced appreciable rock fracturing, masses as large as automobiles accumulate in the soil and locally form sizable ridges. North of Cartersville, and in Peoples Valley, massive jasperoid produces ridges of moderate relief. In some areas, especially in the southern part of the outcrop area, the jasperoid is recrystallized, has a fine- to medium-grained texture, and is easily mistaken for quartzite.

Because the jasperoid in unit D has a somewhat similar appearance to that in unit F, the two are sometimes confused. As a rule, however, freshly broken pieces of jasperoid from unit D are gray, whereas those from unit F tend to be tan or brown.

Water-bearing character—Unit D furnishes ample water nearly everywhere for domestic and stock supplies. Randomly located wells have about an 80-percent chance of producing 5 gal/min (0.3 L/s). The unit also is an important source of industrial and municipal supplies. Nineteen wells in the unit have an average yield of about 70 gal/min (4.4 L/s); the largest yield reported is 200 gal/min (13 L/s).

The only problems reported in developing well supplies in the unit were in the Bolivar area, where a resident had to drill two wells before he found enough water for a home supply. Wells east and southeast of Bolivar are reported to remain muddy for long periods after being drilled, and some never clear.

Thirty wells inventoried in the unit have an average depth of about 153 ft (47 m). About 90 percent of these wells are less than 250 ft (76 m) deep; the deepest well reported is 510 ft (155 m). The wells are cased to bedrock, generally 10 to 314 ft (3 to 96 m) deep, and the bottom of the well is left an open hole that admits water from joints, fractures, and solution openings.

Water in the unit is moderately hard to very hard, generally contains low concentrations of iron, and is suitable for most uses.

Water-Bearing Unit F

Character of the rock—Unit F is between 300 and 500 ft (91 and 152 m) thick, consists of thinly to massively bedded light-gray to dark-gray dolomite and dolomitic limestone, and belongs to the Shady Dolomite of Early and Middle Cambrian age. The upper part of the unit includes thin layers and laminations of dark-gray shale (or phyllite?) that weather to shades of pink and have a silvery sheen nearly identical to some of the shale in overlying unit C.

The dolomite is highly siliceous, and in a weathering environment the silica accumulates in the soil as generally hard jasperoid. Pieces of this material can be seen scattered about the area and, where deformation is intense, it occurs in dense masses that form hills and ridges. The jasperoid is similar in character and appearance to that in unit D, except that it commonly weathers to tan or brown, rather than gray.

Most, if not the entire section, of dolomite contains barite ($BaSo_4$) that has weathered out of the rock and been concentrated by erosional processes in the thick residual soil that is prevalent over the unit. Recovery of this barite has left the Cartersville area dotted with circular and elongate open-pit mines, some of the larger ones extending to depths of 50 and 100 ft (15 to 30 m). Most of the larger mines are hydraulically connected with the underlying dolomite.

The Bartow County landfill occupies one of these abandoned mines and several others are being considered for use as disposal sites for solid waste. The use of the mines for this purpose may contaminate ground water in the area, and the problem is discussed more fully in other sections of this report.

Water-bearing character—Unit F is the principal source of industrial ground-water supplies in Cartersville. Seven industrial wells in the city yield 150 to 1,500 gal/min (9.5 to 95 L/s). The aquifer underlies much of eastern and southern Cartersville where it seems to has large undeveloped potential. Broad, level areas underlain by the unit (indicated as ϵs on plate 4) south of Oakland Heights and south of Buford Mountain have intermittent surface drainage with large catchment areas, and should supply sizable yields to wells.

Outside the city limits of Cartersville, most of the area underlain by unit F is devoted to farming and mining, or is woodland, so that the unit is little used as an aquifer. It is tapped in this area by only a few dug wells and two drilled wells, all of which are used for domestic supply. As the surface of the unit is fairly flat-lying, however, it seems likely that farm and home supplies should be readily available nearly everywhere. Judging from aquifers of similar nature, randomly located wells probably will have about an 80-percent chance of furnishing 5 gal/min (0.3 L/s).

Wells in the unit range from 80 to 300 ft (24 to 91 m) deep and have an average depth of 150 ft (46 m). Their casing depths range from 30 to 70 ft (9.1 to 21 m) and are set in solid rock. All the wells derive water from solution-enlarged openings in dolomite, some of which are rather large and supply 300 gal/min (19 L/s) or more with almost no drawdown. Well 38 (plate 1) obtains water from an opening 29 ft (8.8 m) high.

Water from the unit is moderately hard to hard and contains small concentrations of iron. The water is suitable for drinking and for many industrial uses.

The residual soil developed on unit F commonly is 50 to 100 ft (15 to 30 m) or more thick, is porous, and absorbs large quantities of precipitation, which it holds in storage for gradual release to solution openings in the underlying dolomite. The continual release of water from the residuum enables the aquifer to sustain large yields to wells, even through prolonged droughts. It is the thickness and character of the residuum that makes this unit the area's highest yielding aquifer. During 1976, wells in the unit supplied industries with a total of more than 3,000 gal/min (189 L/s).

Water-Bearing Unit G

Character of the rock—Unit G, in Bartow and western Cherokee Counties, consists mainly of quartzite, phyllite, shale, and arkose. West of the Great Smoky fault (plate 4) the quartzite is light to dark gray, buff to brown weathering, mostly fine grained, and locally conglomeratic. On natural exposures the thicker quartzite layers are resistant, forming ledges and low cliffs. In quarries and road cuts, on the other hand, the quartzite generally is close jointed and breaks up into small angular fragments, producing an abundance of rubble. Near the top of the unit the quartzite has a high clay and feldspar content, and generally is friable enough to be easily worked by earth-moving equipment. Decomposed quartzite and weathered shale are used for cover material in the Bartow County landfill. The part of the unit west of the Great Smoky fault belongs to the Chilhowee Group of Early Cambrian age.

East of the Great Smoky fault, quartzite in the unit is fine to coarse grained, locally conglomeratic and commonly feldspathic, particularly on the lower west slope of Pine Log Mountain where it contains feldspar in crystals more than 1 in. (25 mm) across. This quartzite tends to be very massive and remains so in both natural and manmade exposures. The basal part of the quartzite in several areas is arkosic, and the belt of the unit that passes along the east side of Lake Arrowhead in northwest Cherokee County is largely arkose.

Phyllite and shale in the unit west of the Great Smoky fault are dark gray and locally contain graphite. They are rather hard and brittle where fresh, but become conspicuously light gray to white and very soft upon weathering. East of the fault the phyllite is dark gray to black where fresh, and becomes medium gray to tan or pink when weathered; it rarely, if ever, assumes a light-gray to white character.

Much of the dark phyllite east of the fault in Bartow and western Cherokee Counties, particularly in the lower two-thirds of the section, weathers to a distinctive copper color. Copper-colored phyllite characterizes the unit east of the fault from the southernmost exposures near Emerson in Bartow County, along the full length of Hanging, Pine Log, and Dry Pond Mountains in Cherokee County, and beyond into Pickens County. The rocks in this belt of the unit probably belong to the Ocoee Supergroup of Precambrian age.

Belts of the unit in eastern Cherokee County and in Forsyth County consist of highly feldspathic and micaceous to almost pure fine- to coarse-grained quartzite that is thinly to massively bedded. The quartzite is steeply inclined to the southeast and as a result, forms narrow ridges that have high, vertical cliffs at several places along their northwest sides.

The total thickness of the unit has never been determined, largely because faulting and folding cause duplication of the section. Judging from the width of the outcrop belts, the unit probably ranges from 100 ft (30 m) thick on narrow ridges to 1,000 ft (305 m) or more thick on broad exposures.

Water-bearing character—The rocks that make up unit G are very resistant to erosion and form narrow ridges and mountainous areas dissected by steep-sided "V"-shaped valleys. This rugged terrane is largely uninhabited; consequently, aquifer development has occurred only in a few isolated places.

In the localities where the topography is flat enough for farming, or level enough for home building, randomly located wells probably have about a 40-percent chance of supplying 5 gal/min (0.3 L/s). Wells drilled on steep slopes, narrow-crested ridges, and near scarp slopes are likely to be unsatisfactory for a residential supply, although domestic wells have been developed on the long dip slopes of moderately high ridges in Forsyth County.

The development of a water supply for the Lake Arrowhead resort community in northwest Cherokee County provided the first information to become available about the water-yielding potential of the western outcrop belts of unit G. Fifteen wells drilled on the property range in yield from 1 to 200 gal/min (0.06 to 13 L/s) and have an average yield of about 60 gal/min (4 L/s). Six of the wells yield 40 gal/min (2.5 L/s) or more. The wells range in depth from 92 to 338 ft (28 to 103 m) and are cased to depths of 25 to 64 ft (7.6 to 20 m).

In Forsyth County where the unit is comparatively thin and steeply dipping, it forms long, narrow ridges. Wells on the ridge crests yield very little water, but those drilled at or near the east (down-dip) base of the ridges yield as much as 150 gal/min (9.5 L/s).

Large capacity wells in unit G have been developed thus far only in specific geologic and topographic settings. Methods of locating favorable well sites are discussed in detail in a later section of this report dealing with high-yielding wells.

Water from unit G ranges from soft to hard and generally is of good chemical quality. The low iron content of most of the well water makes it suitable for household use and for many other purposes.

Water-Bearing Unit J

Character of the rock—In Bartow County, unit J consists of silvery and dark-gray phyllite and fine-grained schist that commonly contain graphite. The age of the unit is uncertain. The dark phyllite layers generally contain abundant pyrite cubes. Thin beds of quartzite and graywacke are widespread, and locally occur in sections 10 to 20 ft (3 to 6.1 m) thick that form ledges on steep slopes. South of Cartersville the unit includes thick layers of mylonite (rock ground to a fine texture) and light-colored phyllite and fine-grained schist. That area also is marked by layers, probably several hundred feet thick, made up of dark-gray to black graphite schist.

The belts of the unit in western Cherokee County (plate 2) are of similar character to those in Bartow County, but toward the east the proportion of quartzite and graywacke lessens and the schist develops a distinctive knobby appearance due to the inclusion of large garnets. In central and eastern Cherokee County and in Forsyth County (plate 3) the outcrop areas of the unit are far less rugged than those farther west. The land is more suitable for farming and, thus, is much more populated.

The thickness of unit J varies greatly from one belt to another, but it probably ranges from several hundred to more than a thousand feet thick.

Water-bearing character—Ten wells in unit J produce between 1.5 and 25 gal/min (0.09 and 1.6 L/s). The quantity of water available in the unit is determined largely by the topography. In the rugged terrane of the western outcrop belt, dependable domestic supplies can be obtained only on the broader ridge crests and hilltops and in saddles and valleys between ridges. In central and eastern Cherokee County and in Forsyth County, where the unit is characterized by rounded hills and gentle slopes, residential and stock wells can be developed nearly everywhere. Randomly located wells in these areas probably have about a 40-percent chance of supplying 5 gal/min (0.3 L/s). The highest yields are obtained from wells that penetrate fractured layers of quartzite or graywacke.

Although the wells in the unit that were measured range from 86 to 450 ft (26 to 137 m) deep, all that supply more than 5 gal/min (0.3 L/s) are less than 166 ft (51 m) deep. Casing depths range between 29 and 85 ft (8.8 and 25 m), below which the wells are finished as open holes in rock.

Water from unit J generally is soft and has low concentrations of total dissolved solids. The water from most wells is somewhat corrosive, having a pH less than 7 (table 1). In addition, it is moderately mineralized but is suitable for household use and for many other purposes.

Water-Bearing Unit K

Character of the rock—Unit K is composed chiefly of gneiss. One large area that extends from southeast Bartow County into Cherokee County past the west side of Lake Arrowhead is an augen gneiss, commonly known as Corbin Granite (plate 4). In the southeast corner of Bartow County and in Cherokee and Forsyth Counties, unit K includes bodies of granite gneiss and biotite gneiss, all of uncertain age.

The thickness of the unit has never been accurately determined. It is thought to vary greatly in thickness from one outcrop belt to another, but everywhere it probably is several hundred feet thick and, in places, may be several thousand feet thick.

Water-bearing character—Inventoried wells in unit K yield from 2 to 35 gal/min (0.1 to 2.2 L/s). Twenty-one measured wells are between 40 and 500 ft (12 and 152 m) deep, and have an average depth of about 147 ft (45 m). Nearly 90 percent of the wells are less than 250 ft (76 m) deep. The wells are cased from as little as 5 ft (1.5 m) to as much as 130 ft (40 m) deep, the remainder being finished as open holes in rock.

Domestic and stock supplies can be developed in nearly all areas of the unit except on narrow ridges, and public-supply wells yielding more than 20 gal/min (1.3 L/s) are common. Yields of 15 to 20 gal/min (0.9 to 1.3 L/s) can be expected from wells in favorable topographic settings. The chance of obtaining 5 gal/min (0.3 L/s) from randomly located wells probably is about 60 percent.

The well water generally is soft and most is reported to be satisfactory for household use and stock watering. The concentration of iron in the water generally is low, although water from two wells contained 280 and 450 μg/L (table 1).

Water-Bearing Unit L

Character of the rock—The unit is predominantly a garnet-mica schist, but between Waleska and Sharptop it also contains much mica schist speckled with minute grains of opaque minerals, interlayered with thin-bedded graywacke. In the belt that passes through North Canton and in other exposures north of there, the garnet-mica schist is interlayered with thinly to thickly bedded quartzite that occurs in masses 10 to 20 ft (3 to 6.1 m) or more thick. The rocks in this unit probably correlate with the Great Smoky Group, the age of which has not been determined.

The presence of thick layers of quartzite and graywacke in the mica schist may be indicated by the presence of rock fragments in the soil, or by the occurrence of narrow ridges that stand in relief above the surrounding country. Thinner layers may not be apparent from debris in the soil, but are exposed in road cuts and along stream banks.

Water-bearing character—Twenty wells in unit L yield from 2 to 32 gal/min (0.1 to 2.0 L/s), and are used almost exclusively for farm and home supply. Yields of 3 gal/min (0.2 L/s) or more generally can be developed anywhere in the area that is level enough for farming and in most places that people choose for homesites. However, randomly located wells probably have only about a 40-percent chance of furnishing 5 gal/min (0.3 L/s), so special construction problems may be involved in developing an adequate home supply. Wells supplying larger yields probably obtain water from fractured rocks, such as quartzite and graywacke, that are scattered throughout much of the unit. The brittle rock layers dip steeply to the south or southeast, thus the chance of obtaining 5 gal/min (0.3 L/s) or more should be substantially increased by selecting drilling sites where the wells will penetrate these layers at some depth between about 100 and 200 ft (30 and 60 m). The largest yields will come from rock layers that project toward the surface beneath some potential source of recharge, such as a stream valley or a relatively flat area covered by deep soil.

The wells range from 72 to 400 ft (22 to 122 m) deep, having an average depth of about 160 ft (49 m). Casing depths range from 15 to 112 ft (4.6 to 34 m), below which the wells are finished as open holes.

The well water generally is soft, contains low concentrations of iron and other constituents, and meets drinking water standards. Only one well in the unit was reported to produce water containing excess iron.

Water-Bearing Unit N

Character of the rock—In southeast Bartow County and in Cherokee County, unit N is chiefly hornblende gneiss and schist interlayed with amphibolite. In Forsyth County it is mainly amphibolite and hornblende gneiss. The amphibolite generally is a massive homogeneous rock that locally contains zones of closely spaced joints and fractures that increase permeability and supply large quantities of water.

Water-bearing character—Fourteen wells in unit N yield between 0.5 and 15 gal/min (0.03 and 0.9 L/s). Domestic supplies can be developed in most outcrop areas, but owing to the homogeneous character of the rock, topographic position is critical. For this reason, randomly located wells have only about a 40-percent chance of supplying 5 gal/min (0.3 L/s). The wells range in depth from 50 to 240 ft (15 to 73 m).

Three public supply wells drilled in favorable topographic and structural sites each furnish 200 gal/min (13 L/s). Two of the wells, Forsyth County 32 and 33, derive water from a highly permeable zone of fracture concentration that appears as a straight valley segment on topographic maps. The presence of similar valley segments in the area indicates that it may be possible to locate wells of comparable yield in other places underlain by the unit, and this is discussed further in the section about high-yielding wells.

The other high-yielding well, Cherokee County 12, penetrated massive bedrock and remained dry for the first 525 ft (160 m), at which point it intersected a water-filled fracture that yielded 200 gal/min (13 L/s). The fracture probably is related to a fault that passes west of the well site.

Water-Bearing Unit P

Character of the rock—Unit P consists of gneiss, schist, and amphibolite of uncertain age interlayed in varying thicknesses and proportions. The rocks are steeply dipping and, consequently, most wells in the unit derive water from two or more lithologies. As thick soil obscures the bedrock in most areas, there generally is no easy way to predict in advance what type of rock a well will penetrate.

The thickness of the unit has never been measured. It probably is hundreds, if not thousands of feet thick.

Water-bearing character—Thirty-one wells for which records were collected in unit P yield from 0 to 90 gal/min (0 to 5.7 L/s). Domestic supplies can be obtained in most of the area, although several wells, mainly on steep slopes and narrow ridges, are reported to have insufficient yields. Randomly located wells probably have about a 60-percent chance of furnishing 5 gal/min (0.3 L/s).

The wells range in depth from 68 to 985 ft (21 to 300 m) and have an average depth of about 329 ft (100 m). Casing depths range from 20 to 139 ft (6.1 to 42 m), and the wells are completed as open holes in rock.

About 30 percent of the wells, for which records were collected in unit P, are deeper than 500 ft (152 m). This is by far the highest percentage of wells this deep found in any of the water-bearing units. As all of these wells furnished less water than their owners needed, drilling apparently was continued to great depths in the hope of increasing the yield. Most wells in the unit that are deeper than 500 ft (152 m) supply between 0 and 6 gal/min (0 and 0.4 L/s). For example, Forsyth County well 10 is 505 ft (154 m) deep and yields almost no water; well 27 is 755 ft (230 m) deep and yields only 0.5 gal/min (0.03 L/s); well 19 is 820 ft (250 m) deep and supplies only 6 gal/min (0.4 L/s); and, well 23 is 985 ft (300 m) deep and furnishes 5 gal/min (0.3 L/s).

The limited productivity of these wells indicates that drilling deeper than 500 ft (152 m) has only a slight chance of increasing the yield beyond the 0 to 5 gal/min (0 to 0.3 L/s) range. In general, a 500-ft well (153 m) that has not produced the required amount of water should be abandoned in favor of a new location.

The well water from unit P generally is soft and moderately mineralized and is suitable for domestic and farm use. Wells that penetrate local mineralized zones may yield water very high in some constituents. Water from well 34 in Forsyth County had an iron concentration of 14,000 µg/L and a manganese concentration of 1,500 µg/L, both of which greatly exceed the recommended limits for drinking water. The presence of such mineralized zones generally is not detectable in advance of drilling.

USE OF GROUND WATER

The distribution of water by public utilities is limited to the larger towns and to areas along some of the main roads, leaving thousands of rural residents totally dependent upon ground water. In addition, many dairies, poultry houses, farms, churches, schools, industries, and others also rely on ground water.

Wells

Well water is used by the towns of Kingston and White and by most rural residences and farms in the area. Wells are used by many industries, chiefly because the water is economical and has a realtively constant temperature and chemical quality.

Recreation areas around Lake Sidney Lanier and Allatoona Lake, and the Lake Arrowhead resort community, are totally dependent upon well supplies. Hundreds of permanent and vacation homes, numerous subdivisions, trailer parks, campgrounds, and marinas also use well water.

Springs

The largest single source of ground water in Bartow County is springs in the Valley and Ridge province (table 4 and plate 1) that discharge between 200 and 3,000 gal/min (13 and 190 L/s). The city of Adairsville derives its municipal supply from a spring, and the town of Emerson reportedly is developing a spring supply. Several springs in the county furnish water to homes, farms, and churches.

Spring water offers the advantages of being readily available, inexpensive to develop, and fairly constant in temperature, chemical quality, and rate of discharge. Most springs in Bartow County are unused and represent potentially valuable undeveloped resources.

The crystalline rocks in the Piedmont part of the report area are characterized by a large number of small springs, nearly all of which are being used for domestic supplies or for stock watering. Although the springs experience yearly fluctuations in flow, their yields are reported to be very dependable.

CHEMICAL QUALITY OF GROUND WATER

The chemical quality of ground water in the study area varies significantly, depending mainly on the type of rock that forms the water-bearing units. In general, the water is moderately mineralized and is suitable for drinking and for most other purposes. Some of the water can be treated chemically to improve its taste, prevent it from staining, or make it softer.

Analyses of water from 61 wells and 10 springs in the study area are listed in tables 1, 2, and 4. These analyses show that a few wells yield water containing one or more constituents in concentrations greater than the limits recommended for drinking water by the Environmental Protection Agency (1975). Of the 61 wells sampled, five contain excessive concentrations of iron, eight contain excessive maganese, one contains excessive sulfate, and one contains excessive dissolved solids (as residue at 180°C).

The quality of ground water in the sedimentary rocks in Bartow County is strongly dependent upon the composition of the water-bearing units. Sandstones and shales of units C and G produce water that ranges from soft [0 to 60 mg/L (milligrams per liter)] to very hard (greater than 180 mg/L), and that generally is slightly acidic to near neutral (4.5 to 7.5 pH). Limestones and dolomites of units A, D, and F produce water ranging from hard (121 to 180 mg/L) to very hard (greater than 180 mg/L) and from slightly acidic to alkaline (greater than 6.5 pH).

Ground water from the crystalline rocks of Cherokee and Forsyth Counties and eastern Bartow County is generally soft (0 to 60 mg/L) to moderately hard (61 to 120 mg/L), and acidic to near neutral (3.8 to 7.5 pH). Some of this water contains enough iron to cause staining of fixtures and clothing. Ground water from isolated mineralized zones is high in sulfate, hardness, and specific conductance.

FLUCTUATIONS IN SPRING FLOW

Spring flows in northwest Georgia fluctuate throughout the year in response to seasonal variations in precipitation. Most springs reach a period of maximum discharge sometime during the winter or early spring and decline steadily to a period of minimum discharge that generally occurs in autumn. The minimum discharge may be 20 to 90 percent less than the maximum discharge. A potential user may need to know a spring's minimum rate of discharge in order to determine whether or not it will meet his year-round needs.

Measurements and estimates of spring discharge in Bartow County are given in table 3. Nearly all the measurements were made in late summer or autumn, so the smallest discharge listed for a spring generally will be close to its lowest discharge for the year of measurement. If the smallest flow listed for a spring approaches the quantity of water required for an intended use however, additional measurements should be made to insure that the supply will remain adequate all year. Measurements made on a spring biweekly from August through December should indicate the lowest discharge for that year. Some variation in lowest discharge can be expected from year to year, but it generally will be small unless rainfall is far heavier or lighter than normal.

Periodic measurements spanning more than 25 years in the Valley and Ridge area of Georgia indicate that the lowest discharge for most springs comes in late October or early November (Cressler and others, 1976). The time and duration of a spring's lowest discharge each year is largely determined by the character and thickness of the soil layer that overlies the spring's source. In general, the thicker the soil that overlies the rock unit supplying the spring, the greater the lag time between changes in precipitation and corresponding changes in spring flow. Lag time may range from as short as a few hours to as long as several months.

LAND SUBSIDENCE AND SINKHOLE FORMATION

The possibility of creating conditions that could lead to ground collapse should be considered in developing well supplies. The major water-bearing units in Bartow County consist of carbonate rocks that are deeply weathered and blanketed by a thick layer of residual soil. Ground-water solutioning has formed cavities in the carbonate rocks, and some of these cavities have thin soil roofs. Many of these cavities extend below the water table and their roofs are partially supported by the ground water. Any decline in the water table that removes this support can result in a sudden collapse. A lowering of the water table also can cause a gradual downward migration, or spalling, of soil into openings in the underlying carbonate rocks, leaving dome-shaped cavities between the bedrock and the land surface (fig. 6). Upward enlargement of these cavities by the continued loss of soil into rock openings can result in the eventual collapse of the surface and the formation of a sinkhole (Newton and Hyde, 1971). Also, water-level declines unbalance the pore water pressures, resulting in the spalling of the base of clay plugs. Repeated declines cause stoping action and collapse.

Land subsidence and sinkhole formation also may result where large quantities of sediment or rock fragments are removed from water-yielding formations during drilling, well development, and production pumping. Subsidence is most likely to occur where: (1) the water table stands within the residual soil, or near the top of highly weathered bedrock, (2) well casing does not extend deep enough into the top of the bedrock, (3) large volumes of water are pumped from shallow depths, and (4) violent surging occurs during drilling. Collapse resulting from drilling is more common where the water table stands in residual soils (Parizek, 1971, p. 141-142). The relative risk of sinkholes forming near pumping centers in Bartow County is shown in figure 2.

GROUND-WATER POLLUTION

Pollution of Wells

A study of the private water supplies in Bartow County (Davis, 1969, p. 11-12) revealed that bacterial pollution of private wells is widespread. Davis found coliform bacteria in 84 percent of the 55 dug wells he sampled, and in 22 percent of the 101 drilled wells sampled. Morever, 8 percent of these drilled wells showed evidence of fecal coliform bacteria, an indicator of comparatively recent, potentially dangerous pollution.

According to Davis, improper well construction was found to be the major cause of pollution in the drilled wells, even though their casings were set in carbonate or shale. The wells surveyed by Davis ranged in depth from 47 to 328 ft (14 to 100 m). He found that 52 percent of the polluted wells had no apparent sanitary seal between the well casing and the surrounding soil, and 69 percent lacked a sanitary seal at the top of the casing. Thus, many poorly constructed wells are contaminated by surface water that leaks down between the casing and the surrounding soil.

The widespread pollution of wells results, in part, from the common practice of locating drilling sites for convenience rather than for protection of the water supply. Generally, wells are located as close as possible to homes or barns without regard to potential sources of pollution. Located in this manner, many poorly constructed or shallow wells are subject to pollution.

The well sites that are least likely to become polluted are those located, as far as practical, upgradient from sources of contamination. Sealing wells against the entry of surface water and fitting pump caps tightly to keep out insects, rodents, and other impurities, are also necessary safety measures to protect wells from contamination.

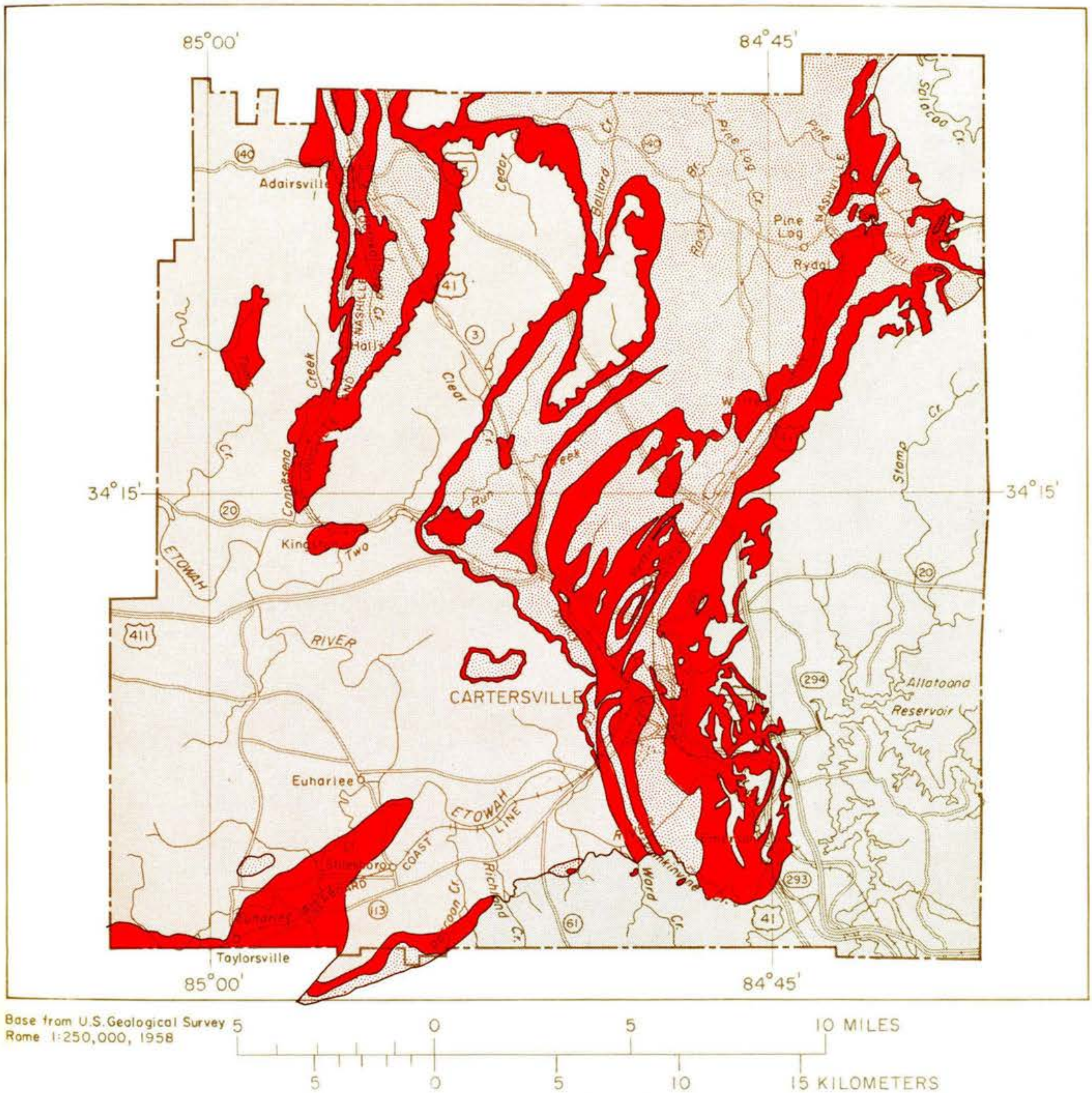
No detailed study has been made of well pollution in Cherokee and Forsyth Counties, but wells there are subject to contamination in much the same way as those in Bartow County. Faulty well construction and improper site selection may result in about the same percentage of polluted wells.

A common practice in the area is to sterilize newly completed wells with laundry bleach, pump them until the bleach is removed, and then test the water for bacterial contamination. Nearly all new wells tested in this manner are found to be free of bacteria. The risk of contamination increases, however, after wells have been in use for a while, because pumping lowers the water table and this may eventually cause septic-tank effluent, barnyard runoff, or other contaminants to be drawn toward the well. Furthermore, lowering of the water table in carbonate rock aquifers such as units A, D, and F may cause sinkholes to form, thereby increasing the potential for polluted surface water to reach the ground-water reservoir. Some sinkholes are so small they go unnoticed, but they can quickly contaminate a water supply. Periodic testing for bacteria is the best means for detecting contamination of a water supply.

Pollution of Springs

Pollution of springs is widespread in Bartow County. Davis (1969, p. 17) sampled 19 springs in the county and found that 15 were contaminated by coliform bacteria, three of which contained fecal coliform bacteria.

All spring pools probably are contaminated at least part of the time, because they are favorite watering places for livestock and wildlife. In general, springs that discharge from rock fractures, through gravel, or from cave entrances protected from entry by humans or animals, are the least likely to be polluted. Nearly all springs in Cherokee and Forsyth Counties are of this type, so contamination is not as likely there as it is in Bartow County. A safe practice is to test spring water before using it for drinking or for water supply. County health departments will provide information and assistance for having spring water tested. Because uncontaminated springs may become polluted with changing conditions, such as when



EXPLANATION

RELATIVE RISK OF SINKHOLES FORMING NEAR HIGH-YIELDING WELLS

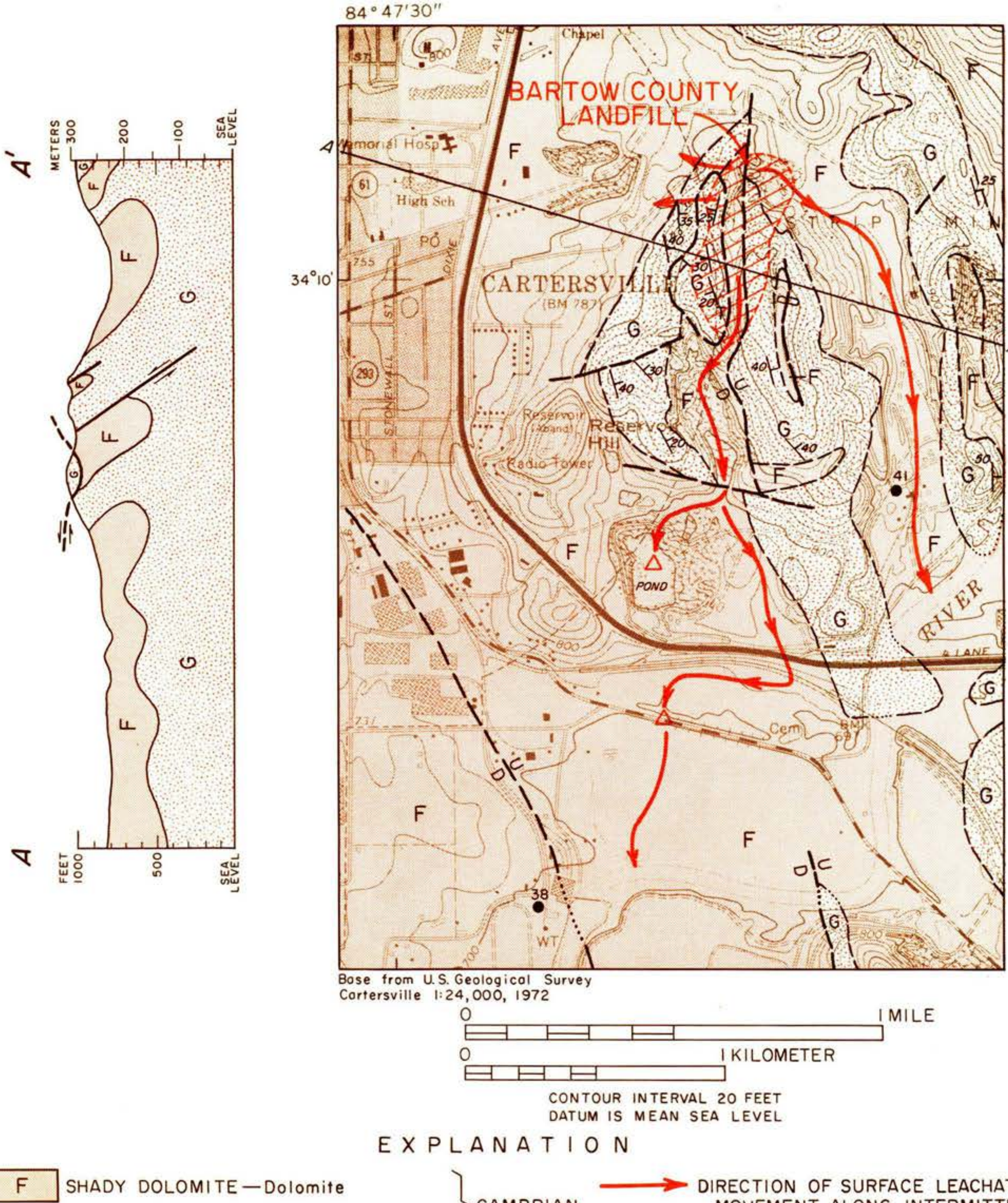
MODERATE TO HIGH—During development and production

LOW TO MODERATE—Most likely to occur after weeks or months of pumping

SLIGHT—Except where carbonate rock occurs in or beneath unit, making the risk MODERATE, mainly after long pumping period

NONE—Sinkholes are not know to occur

Figure 2. Relative risk of sinkholes forming near high-yielding wells in Bartow County.



Base from U.S. Geological Survey
Cartersville 1:24,000, 1972

0 — 1 MILE

0 — 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

F	SHADY DOLOMITE—Dolomite	CAMBRIAN
G	CHILHOWEE GROUP—Quartzite and shale	

Letter indicates water-bearing unit referred to in plate I

CONTACT—Approximately located. Dotted where concealed

FAULT—Approximately locately. Dotted where concealed. U, upthrown side; D, downthrown side

DIRECTION OF SURFACE LEACHATE MOVEMENT ALONG INTERMITTENT STREAMS

△ SAMPLE SITE

●38 WELL

25 STRIKE AND DIP OF BEDS

Figure 3. Geology of Bartow County landfill area, and direction of surface leachate movement.

sources of contamination are located upgradient, periodic retesting commonly is desirable.

GROUND-WATER POLLUTION BY LANDFILL LEACHATE

Potentially, landfills could be a major source of ground-water pollution in the study area. Water percolating through landfills dissolves soluble materials, producing a leachate that may be highly charged with metal ions, organic and inorganic compounds, and pathogenic organisms. Leachate from improperly located, constructed, and maintained landfills can contaminate both suface- and ground-water supplies. Contamination occurs as leachate enters streams or infiltrates soil and rock openings and reaches the ground-water reservoir.

Bartow County Landfill

Extensive barite mining in the Cartersville area left more than 20 large open pits that range from 20 to more than 100 ft (6.1 to 30 m) deep. The Bartow County landfill occupies one of these mines, and several others are proposed as possible landfill sites. However, as all of the mines overlie and are hydraulically connected with water-bearing unit F, their use for solid waste disposal has the potential for contaminating substantial parts of this important ground-water reservoir.

The Bartow County landfill, which has been in operation since 1967, occupies an abandoned open-pit mine on top of a high hill just east of the Cartersville city limits (fig. 3). The north and south ends of the landfill are so steep that rainfall runoff produces gully-type erosion of the cover material and during wet weather, leachate seeps from both ends. A mixture of waste material and leachate is being washed by overland runoff into the adjacent valleys that serve as recharge areas for water-bearing unit F. Thus, leachate seeping from the landfill can be a potential threat to the quality of surface water in the area of the landfill and to water recharging the ground-water reservoir.

Movement of leachate overland

During periods of heavy rainfall, leachate seeping from the ends of the landfill mixes with other surface runoff and is carried by intermittent streams to the Etowah River (fig. 3). The stream carrying leachate from the north end of the landfill flows east, then south for about a mile to the river. The stream valley is underlain by a thick layer of residual soil and, provided no sinkholes develop near the channel and the residuum remains undisturbed, leachate may be years in reaching the ground-water reservoir in that area.

From the south end of the landfill, leachate flows through a mined-out valley where excavation has exposed dolomite of water-bearing unit F on the valley floor, about 0.2 mi (0.3 km) downstream from the landfill. During periods of low flow, most of the water moving down the valley disappears into the streambed just above the dolomite outcrop, and some polluted water may be recharging the aquifer through bedrock openings.

Water flowing past the dolomite outcrop continues south another 0.1 mi (0.2 km) to the mouth of the valley, where the stream channel divides. During lowest flow, all the water follows the main channel along an irregular route under U.S. Highway 41, the Louisville & Nashville Railroad, and Georgia Highway 293, and finally empties into the Etowah River about 1,000 ft (305 m) east of industrial well 38.

During periods of increased flow, part of the stream water follows the secondary channel westward for about 0.1 mi (0.2 km) and spills into a pond at the bottom of a large open-pit mine (fig. 3). The fact that the water level in the pond fluctuates only a few feet throughout the year and is affected very little by periods of heavy rainfall, indicates that the mine is hydraulically connected to the ground-water reservoir. Thus, pollutants reaching the pond may recharge or percolate into the ground-water reservoir.

Because tracing the possible spread of leachate from the landfill site exceeded the scope of this project, no plans were included for sampling streams that drain the landfill area. However, when it was learned that the stream originating at the south end of the landfill carries leachate past bedrock exposures of water-bearing unit F and to areas where direct recharge to the aquifer is possible, samples were collected at two sites to provide background data on water quality. One sample was collected from the pond at the bottom of the large open-pit mine into which the stream sometimes empties, and another from where the stream crosses Georgia Highway 293. (See fig. 3.) The stream samples were analyzed for selected metals that commonly are concentrated in landfill leachate, and for chloride, which is a good indicator of leachate movement (U.S. Environmental Protection Agency, 1975). The analyses are listed in table 5.

The analyses listed in table 5 show that the concentrations of metals and chloride in the stream samples generally are low and comparable to levels found in water from the Etowah River and from nearby wells. Thus, the presence of leachate in the stream water was not verified by these analyses. The possibility that surface pollution may be occurring

Table 5. Concentrations of metals and chloride in water sampled downstream from the Bartow County landfill.

Sample sites	Date of collection	Micrograms per liter							
		Aluminum (Al)	Chloride (Cl)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Strontium (Sr)	Zinc (Zn)
Headwaters of stream at north end of Bartow County landfill (fig. 3)--undiluted leachate seepage. 1/	03-14-75	7	210,000	9	79,000	10	57,000	2,400	250
Pond, open-pit mine (fig. 3). 1/	02-28-75	0	--	2	130	4	200	60	20
Stream at bridge on Georgia Highway 293, 0.55 mi north northeast of well 38 (fig. 3). 1/	03-14-75	230	2,300	1	440	6	110	70	40
Etowah River near Cartersville. 1/	01-31-73	--	--	-	900	--	50	--	--
Etowah River near Euharlee, Ga. 1/	01-17-74	--	4,000	-	3,400	--	290	--	--
New Riverside Ochre Company, well 41 (fig. 3). 2/	11-13-75	9	1,600	0	0	2	40	220	9
Thompson, Weinman Company, well 38 (fig. 3). 2/	11-12-75	6	4,800	0	0	2	50	210	0

1/ Unfiltered sample - results are for dissolved plus suspended constituents.
2/ Filtered sample - results are for dissolved constituents.

downstream from the landfill is not ruled out, however, because dilution and sorption of metals on stream sediments may reduce dissolved concentrations, but transport may continue on suspended sediment particles. A variety of organic compounds and biological agents not tested for during this study also may be present in significant quantities. Moreover, the potential for contamination by leachate may increase as expansion of the landfill continues, resulting in a possible increase in leachate discharge and the introduction of larger quantities of some pollutants. Periodic testing of streams that originate in the landfill area could determine if potentially harmful substances are reaching places where they may be contacted by unwary humans or animals.

Movement of leachate underground

A potentially serious problem of the Bartow County landfill is related to its geologic setting. The open-pit mine occupied by the landfill was excavated in the residual soil that overlies water-bearing unit F, the major aquifer at Cartersville. Dolomite making up the aquifer transmits water through solution-enlarged secondary openings, and pollutants reaching these openings can move rapidly for hundreds of feet without undergoing significant changes. Should leachate escape through the bottom of the landfill and enter bedrock openings, it might travel down the hydraulic gradient and spread through a large part of the aquifer.

To protect ground-water supplies from contamination by leachate, a minimum of 5 ft (1.5 m) of clayey residuum is needed between the base of a landfill and the top of the bedrock; if possible, a much thicker layer should be left in place (Miller and Maher, 1972, p. 18; Brunner and Keller, 1972, p. 24). The slow seepage of leachate through a layer of clayey residuum allows time for filtration, absorption and adsorption, and other reactions to remove some of the undesirable components. Passage through 5 to 10 ft (1.5 to 3.0 m) of residuum should remove most readily decomposed organic matter and coliform bacteria. However, mineral pollutants and possibly viruses introduced to the landfill can pass through a much greater thickness of residuum (Miller and Maher, 1972, p. 18; Brunner and Keller, 1972, p. 24).

There seems to be no record of the character and thickness of the residuum over the bedrock in the Bartow County landfill. According to T. L. Kesler (oral commun., 1976), the mine occupied by the landfill originally extended deep enough to expose dolomite bedrock. This means that almost certainly the mine did not hold water, but drained through the bottom into bedrock openings, the same as all other mines of this type in the area. Therefore, if a compacted layer of clayey residuum 5 ft (1.5 m) or more thick was spread over the bottom of the mine, it may temporarily prevent most pollutants from reaching bedrock openings. It rarely is possible, however, to totally contain leachate in a landfill. Even where the residuum is very thick in carbonate terrane, the possibility always exists that liquids in a landfill may suddenly escape (fig. 6) through a rupture in the bottom material (Brunner and Keller, 1971, p. 53-54). When this happens, leachate will move down the hydraulic gradient toward points of discharge (fig. 4).

The hydraulic gradient at the landfill, and hence the direction that leachate will migrate out of the landfill area, is controlled by the distribution of rock permeability. Quartzite and shale forming the east and west sides of the landfill have low permeability and should effectively prevent leachate movement in those directions. The dolomite underlying the landfill probably has much greater permeability and may transmit leachate northward and southward into the adjacent valleys. Leachate reaching the valleys then would be free to move in any direction down the hydraulic gradient toward points of natural or manmade discharge. Natural discharge is into the Etowah River; substantial manmade discharge is occurring in the heavily pumped unit F at the industrial park in Cartersville.

More than 10 years of industrial pumpage in the southern part of Cartersville has lowered the water table about 20 ft(6 m) and produced an elongate cone of depression (fig. 5). The water-level configuration shown in figure 5 reflects the maximum depression produced as of 1976 by ground-water withdrawal. Arrows on the map indicate the direction that ground water, along with any leachate it may contain, could be moving from the landfill area downgradient to the Etowah River and toward the center of industrial pumpage.

Owing to a lack of data, it was not possible to accurately locate the 700-foot water-level contour in the flat ground east of the cone of depression and north of the Etowah River. If the 700-foot contour reaches no farther southeast than the map indicates, leachate-bearing ground water could be moving from the area south of the landfill toward the pumping wells. Even if the contour extends farther southeast than the figure shows, continued (or increased) pumping may eventually expand the cone of depression eastward far enough to divert leachate toward the wells.

Continued pumpage at Cartersville also may cause the cone of depression to expand into the valley northwest of the landfill. This could reverse the ground-water gradient at the north end of the landfill

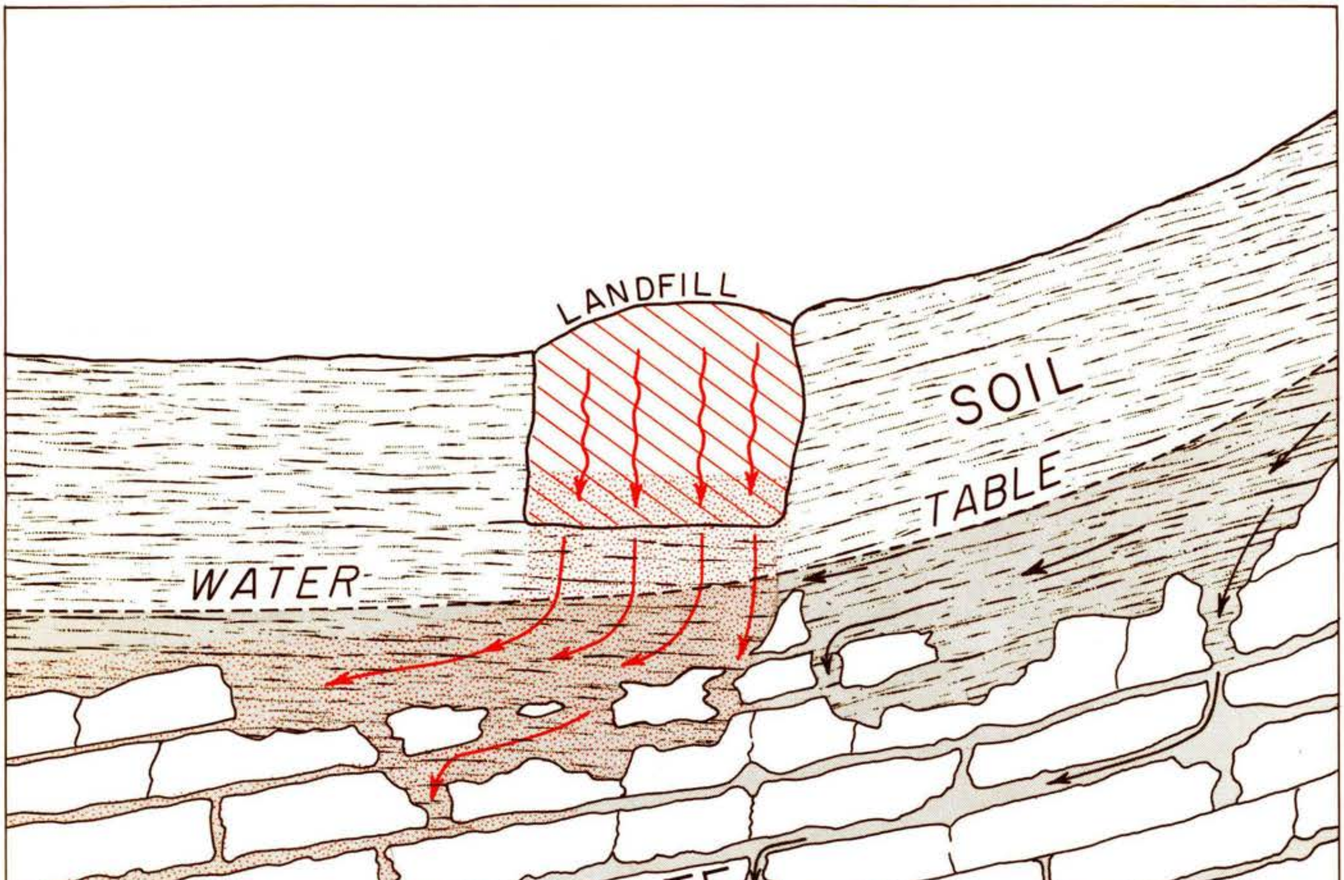
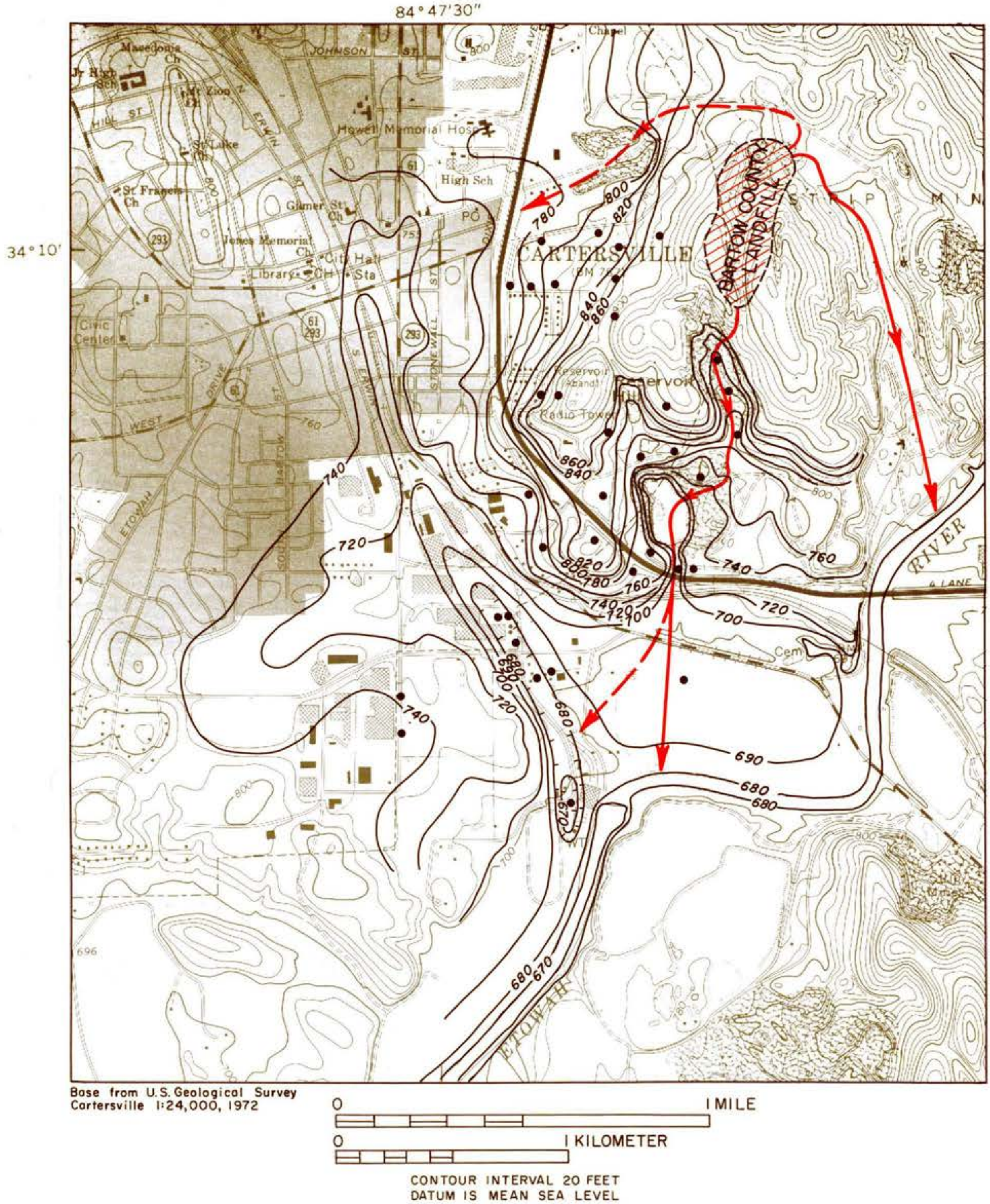


Figure 4. Leachate escaping from a landfill moves down the hydraulic gradient.



EXPLANATION

—— 700 —— WATER-TABLE CONTOUR—Shows altitude of water table. Contour interval is 10 and 20 feet. Datum is mean sea level

• DATA POINT

LINE OF LEACHATE MOVEMENT—Solid line indicates probable direction of movement in 1976. Dashed line indicates possible direction of movement if cone of depression expands eastward and northward.

Figure 5. Water-level configuration in Cartersville, 1976, and direction that leachate may move underground from the Bartow County landfill.

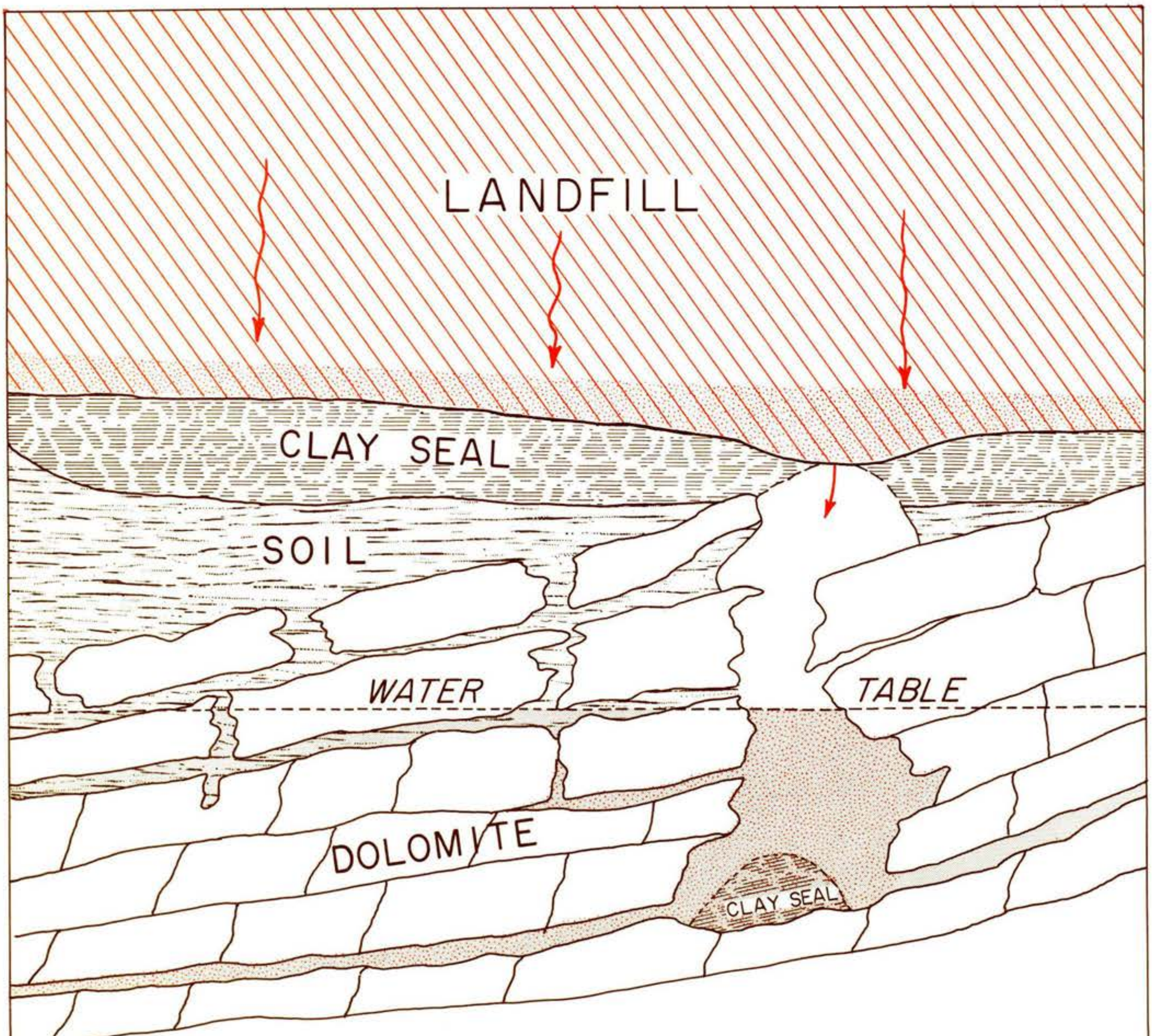


Figure 6. Escape of landfill leachate through breach of bottom material.

and draw leachate toward the center of pumpage, as shown in figure 5.

Movement of leachate from the landfill could be detected by sampling monitoring wells strategically placed along the lines of probable ground-water movement. Samples from these wells could be collected periodically for chemical analysis and compared with analyses of water from other wells in the same aquifer and with the analyses listed in this report (tables 1, 2, 4, and 5). The samples could be analyzed for metals such as lead, mercury, selenium, arsenic, strontium; for trace organic substances including pesticides, herbicides, phenols, industrial chemicals used in the area; and for bacteria. Increases in the concentration of any of these substances in the ground water could be an indication that leachate had reached the monitoring well.

Other Open-Pit Mines in the Cartersville Area

Most large mines in the Cartersville area extend down to carbonate bedrock and, as a consequence, do not hold water but drain through the bottom into bedrock openings. If any of the mines are used for waste disposal, even if lined with clay, leachate could eventually reach the ground-water reservoir either by percolating through the clay bottom seal or by sudden entry through a collapse of the bottom material (fig. 6).

The larger open-pit mines in the Cartersville area are shown in plate 5. The plate also shows the direction that ground water and leachate originating in the mines would likely follow down the hydraulic gradient, and indicates the extent of the aquifer that leachate emanating from the mines would likely contaminate.

As the plate indicates, disposing of solid waste in any of the large mines has the potential of contaminating substantial parts of water-bearing unit F. Most areas of the aquifer subject to contamination are either being used for industrial supply or are likely to be used for that purpose in the future. Only the mines southeast of Emerson are surrounded by rocks of low permeability that would confine leachate spread to a small area. Leachate generated in these mines probably would discharge into Pumpkinvine Creek after flowing about half a mile in the subsurface.

METHODS FOR EVALUATING WELL SITES

Because yields of individual wells in the area vary greatly within short distances, estimating the potential yield of prospective well sites is very difficult. A method for estimating, on a percentage basis, the chances for obtaining certain size yields from wells under different geologic and topographic conditions was developed by LeGrand (1967). He based his method on a statistical study of hundreds of wells in the Piedmont and Blue Ridge provinces of eight Southeastern States.

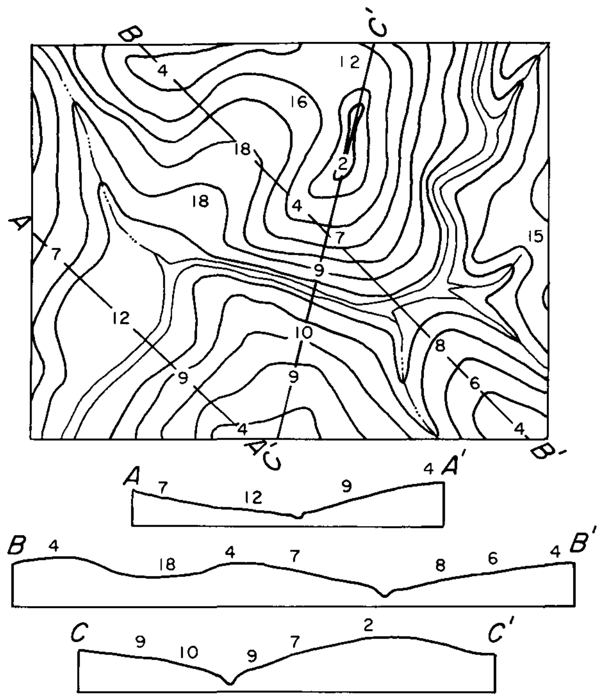
Even though LeGrand's method for evaluating well sites was developed primarily for use in metamorphic and igneous rocks found in the Piedmont and Blue Ridge areas, the same basic principles also apply to the sedimentary rocks of the Valley and Ridge area. The method is especially applicable to water-bearing units C and G composed of clastic rocks, but it also can be an aid to locating well sites in units A, D, and F, which consist of carbonate rock. By applying the method, a landowner or developer should be able to evaluate the yield potential of particular sites. The succeeding text is quoted directly from LeGrand (1967), but his figure numbers have been changed to fall in sequence with the other figures in this report. In LeGrand's text, "gpm" is an abbreviation for gallons per minute.

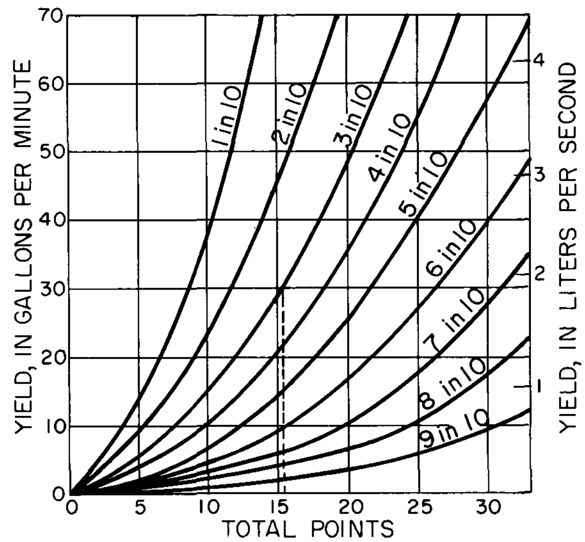
Evaluating Sites

"Although many factors determine the yield of a well, two ground conditions when used together serve as a good index for rating a well site. These conditions are topography and soil thickness. The ratings are based on the following statement: High-yielding wells are common where thick residual soils and relatively low topographic areas are combined, and low-yielding wells are common where thin soils and hilltops are combined. By comparing conditions of a site according to the topographic and soil conditions one gets a relative rating value. For example, the following topographic conditions are assigned point values:

Points	Topography
0	Steep ridge top
2	Upland steep slope
4	Pronounced rounded upland
5	Midpoint ridge slope
7	Gentle upland slope
8	Broad flat upland
9	Lower part of upland slope
12	Valley bottom or flood plain
15	Draw in narrow catchment area
18	Draw in large catchment area

"Figure 7 shows values for certain topographic conditions. Figure 8 shows rating values for soil thickness. The soil zone in this report includes the normal soils and also the relatively soft or weathered

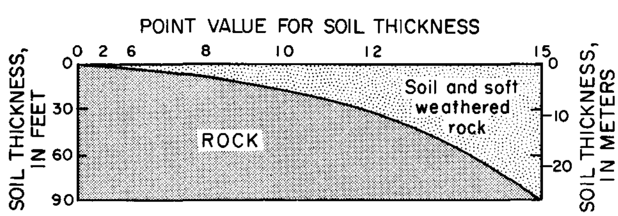




Example: A site with 16 points has 3 chances in 10 of yielding at least 30 gallons per minute (1.9 liters per second) and 6 chances in 10 of yielding 10 gallons per minute (0.6 liters per second)

Figure 7. Topographic map and profiles of ground surface showing rating in points for various topographic positions. (LeGrand, 1967)

Figure 9. Probability of getting a certain yield from a well at different sites having various total-point ratings. (LeGrand, 1967).



POINT VALUE	CHARACTER OF SOIL AND ROCK
0–2	Bare rock—almost no soil
2–6	Very thin soil—some rock outcrops
6–9	Soil thin—a few rock outcrops
9–12	Moderately thick soil—no fresh outcrops
12–15	Thick soil—no rock outcrops

Figure 8. Rating in points for various conditions of soil thickness. (LeGrand, 1967)

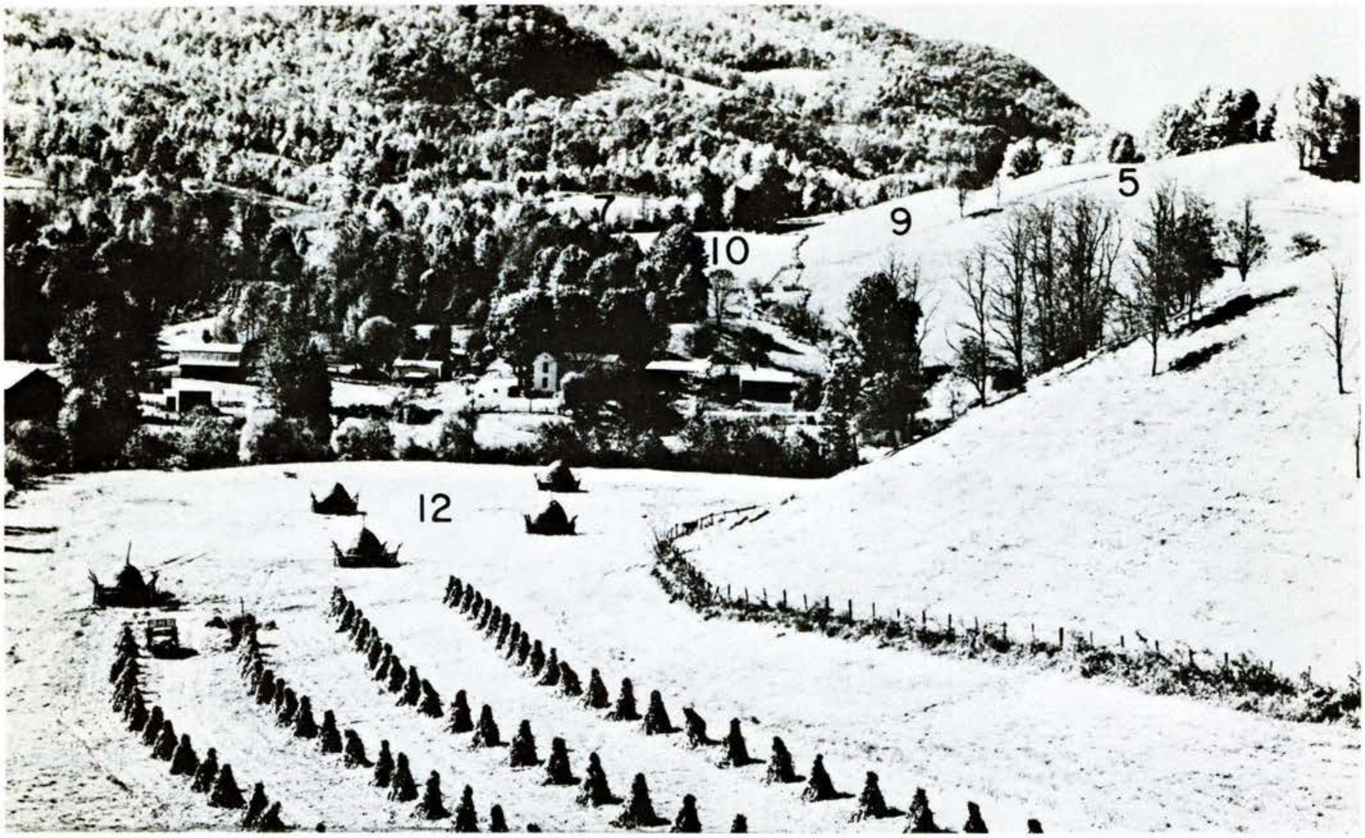
rock. The topographic and soil conditions are separately rated, and the points for each are added to get the total points which may be used in table 6 to rate a site.

"Using two wells sites, A and B as examples, we can evaluate each as the potential yield of a well. Site A, a pronounced rounded upland (4-point rating for topography in figure 7) having a relatively thin soil (6-point rating for soil characteristics in figure 8), has a total of 10 points. In table 6 the average yield for site A is 6 gpm (0.4 L/s). This site has a 65-percent chance of yielding 3 gpm (0.2 L/s) and a 40-percent chance of yielding 10 gpm (0.6 L/s). Site B, a draw or slight sag in topography (18-point rating) having a moderately thick soil (12-point rating), has a total of 30 points, an average yield of 50 gpm (3.2 L/s). Referring to figure 9, we see that the 10-point site has less than 1 chance in 10 of yielding 40 gpm (2.5 L/s), whereas the 30-point site has better than an even chance of yielding 40 gpm (2.5 L/s).

Table 6. Use of numerical rating of well site to estimate the percent chance of success of a well (LeGrand, 1967).

[Data are based on maximum depth of 300 feet or maximum drawdown of water level of about 200 feet. No interference from pumping is assumed. Numerical rating is obtained by adding rating in points for topography and soil thickness; gpm, gallons per minute.]

Total points of a site	Average yield (gpm)	Chance of success, in percent, for a well to yield at least-- 3 gpm	10 gpm	25 gpm	50 gpm	75 gpm
5	2	48	18	6	2	--
6	3	50	20	7	3	--
7	3	55	25	8	3	--
8	4	55	30	11	3	--
9	5	60	35	12	4	--
10	6	65	40	15	5	--
11	7	70	43	19	7	--
12	9	73	46	22	10	--
13	11	77	50	26	12	--
14	12	80	52	30	14	--
15	14	83	54	33	16	--
16	16	85	57	36	18	--
17	17	86	60	40	20	12
18	20	87	63	45	24	15
19	23	88	66	50	25	18
20	26	89	70	52	27	20
21	28	90	72	54	30	22
22	31	91	74	56	35	24
23	34	92	76	58	38	26
24	37	92	78	60	40	29
25	39	93	80	62	43	32
26	41	93	81	64	46	36
27	43	94	82	66	48	40
28	45	95	83	68	50	42
29	46	95	84	71	53	44
30	50	96	87	73	56	47
30+	50	97	91	75	60	50



From LeGrand, 1967

Figure 10.— Countryside showing approximate ratings for topography.

"Some topographic conditions of the region and a few topographic ratings are shown in figure 10. Wells located on concave slopes are commonly more productive than wells in convex slopes or straight slopes. Broad but slight concave slopes near saddles in gently rolling upland areas are especially good sites for potentially high-yielding wells. On the other hand, steep V-shaped valleys of the gully type may not be especially good sites, and they should be avoided if surface drainage near the well is so poor that contamination is possible.

"More difficulty is likely to occur in rating character of soil and rock than in rating topography. Everyone should be able to determine by observation if the soil is thin and if the soil is fairly thick (more than 10 soil and rock points), but the intermediate ratings are difficult to make. If the observer is unsure of the soil and rock rating above the 6-point (thin soil) value, he may choose a 10-point value for the site with assurance that he is fairly correct. White quartz or flint is not considered a true rock in this report, because it persists in the soil zone; a quartz vein, in many cases, is considered to be a slightly favorable indication of a good well site.

"The numerical rating system is not intended to be precise. One person may rate a particular site at 15 points, whereas another person may rate it at 17 points; such a small difference in rating would not be misleading. Almost everyone's rating will be within 5 points of an average rating for a site."

Other factors affecting well yields

Although most rocks in the Piedmont display vertical jointing, some of the more homogeneous types, such as granite and massive gneiss, exhibit a nearly horizontal jointing known as exfoliation, or sheeting. The sheeting surfaces are somewhat curved and are essentially parallel to the surface of the ground. Near the surface the sheet joints tend to be closely spaced and divide the rock into relatively thin slabs. The interval between joints increases with depth, and a few tens of feet beneath the surface the visible sheeting disappears.

Experience has shown that beneath valleys and depressions the joints tend to be nearly horizontal and form excellent receptacles for collecting and storing ground water. Figure 11 illustrates how topography plays an important role in determining well yields in this type of rock. Well "A", on top of a hill, penetrates joints that slope off toward the valley and, consequently, hold only small quantities of water. Thus, wells on hills and steep slopes are likely to have low yields and may fail during dry weather. Wells "B" and "C", on the other hand, are in a low-lying area and penetrate nearly horizontal joints that form good ground-water reservoirs. Moreover, these joints are overlain by a thick layer of saturated soil that can supply constant recharge. Wells drilled in broad, soil-covered valleys and depressions generally furnish the largest yields available in the area and are dependable throughout the year.

HIGH-YIELDING WELLS

High-yielding wells in the study area—ones that supply 100 to 1,500 gal/min (6.3 to 95 L/s)—can be developed only where aquifers possess localized increases in porosity and permeability. This occurs mainly in association with certain structural and stratigraphic features, such as: (1) fault zones that produce abundant fracturing, (2) zones of fracture concentration, and (3) contact zones between rocks of contrasting character.

Fault Zones

Fracture zones associated with certain types of faults are very permeable and supply large quantities of water to wells and springs. Other fault zones are tight and impede ground-water circulation.

A highly permeable fault zone is the principal source that supplies thousands of gallons of water per day to wells in the Cartersville Industrial Park. A gravity survey conducted as part of this study revealed that a zone of deep rock weathering extends from the center of Cartersville, southeastward beneath the industrial park to the Etowah River, and possibly beyond. Abrupt changes in gravity across the weathered zone showed that the rock on either side has a different density, and this was interpreted to mean that the deep weathering is centered along a steeply inclined fault that uplifted quartzite and shale of water-bearing unit G into contact with dolomite of water-bearing unit F. (See plates 1 and 4.)

This interpretation was substantiated by foundation borings made in the industrial park, that revealed the underlying rock consists of highly fractured dolomite mixed with angular pieces of quartzite. Intense fracturing produced by movement along this fault created a zone of increased permeability that led to deep weathering and extensive solutioning of the dolomite. This highly permeable zone collects water from the areas in central and eastern Cartersville underlain by water-bearing unit F, and carries it southward to the Etowah River. A natural discharge point for this water was Cartersville Spring (spring 19), which went dry due to diversion of its ground-water supply with the advent of heavy pumpage in the industrial park.

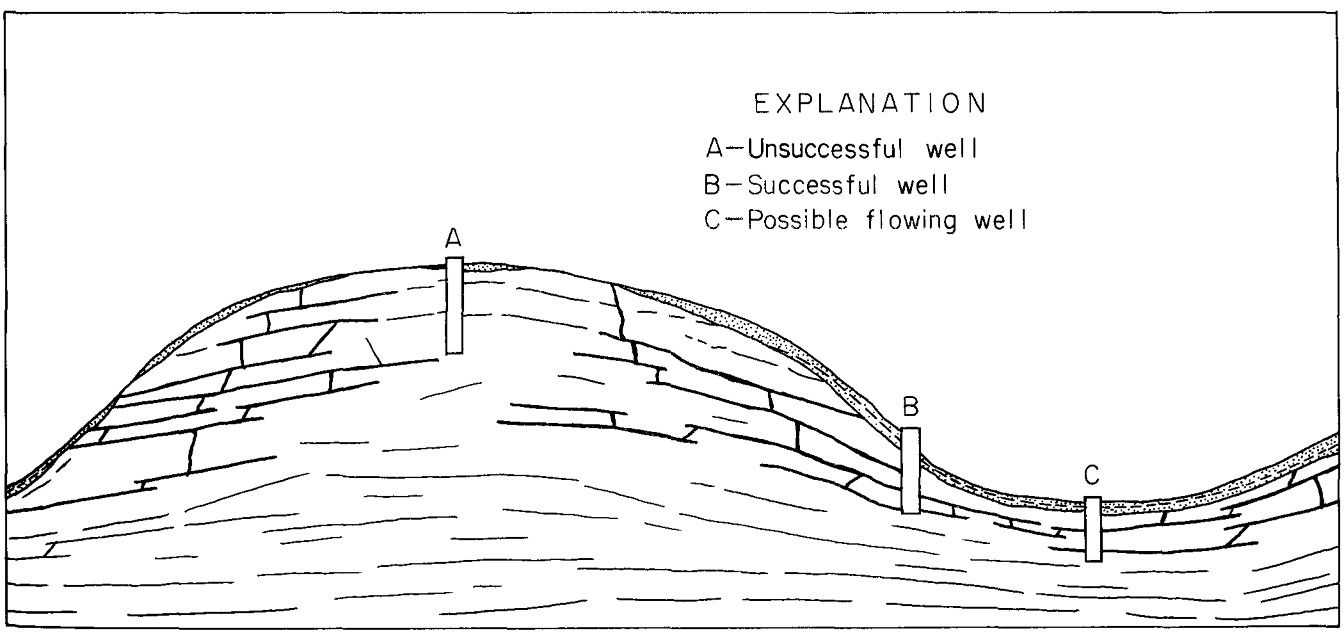


Figure 11. Cross section of sheeted terrane showing water-filled joints in heavy dark lines. Modified from Herrick and LeGrand (1949).

Other steep faults in Bartow County involving carbonate rocks probably produced permeable zones that have large yield potential. The White fault that passes through the valley at Atco (plates 1 and 4) probably is responsible for the fracturing in water-bearing unit D that accounts for the large yields of wells 63 and 63a (plate 1 and table 7). The Cassville fault created extensive brecciation of the shale through which it cut north of Ladds, and it very likely caused fracturing in the underlying dolomite of water-bearing unit D. The potential for high-yielding wells may exist along the trace of this fault.

Kesler (1950) mapped several steep faults in the Cartersville area, and these are shown in plate 4. Exposures indicate that where these faults are confined to quartzite of water-bearing unit G, the associated fractures are healed by depositions of iron oxide and appear to be impermeable. However, where these same faults project into the dolomite of water-bearing unit F, they may have produced open fractures capable of supplying large yields to wells. The traces of these faults could be located by surface geophysical techniques.

Mapping done during the period of the present study revealed that the Cartersville fault, well entrenched in the literature as a single fault that crosses Georgia from Alabama to Tennessee, is in reality two intersecting faults of different character (Cressler and Crawford, 1976). The north-trending segment of the Cartersville fault, as mapped by Butts and Gildersleeve (1948), was found to be a continuation of the Great Smoky fault that extends into Georgia from Tennessee. The Great Smoky fault, which separates the Valley and Ridge province from the Piedmont in eastern Bartow County, is a relatively high-angle thrust that dips east at about 40 to 45 degrees.

In contrast, the southwest-trending segment of the old Cartersville fault is a nearly horizontal thrust that locally dips north at a low angle. This fault, which forms the southern boundary of the Valley and Ridge province in Georgia, extends from the Alabama State line across Polk and southern Bartow Counties to a point about 1 mile (1.6 km) southeast of Emerson where it overlaps the Great Smoky fault. From that point the fault continues northeastward across Allatoona Lake into Cherokee County and possibly beyond. (See plate 4.) To avoid confusion with former usage, this fault is herein renamed the Emerson fault for the town of Emerson, Bartow County, near where it is well exposed.

Westward movement along the Great Smoky fault resulted in intense shattering of the quartzite in water-bearing unit G. Although exposures of shattered quartzite examined during this study were cemented by iron oxide and seem to be impermeable, the healing of fractures may be less complete below the water table, leaving the quartzite a potentially important aquifer. Where the fault is in contact with dolomite of water-bearing unit F, fracturing may have created permeable zones capable of supplying large yields of wells.

Northerly movement along the Emerson fault produced intense shearing in the underlying rocks, and the growth of mica on the shear planes impedes the downward movement of ground water. Wells drilled in the shear zone near the fault may have low yields.

Zones of Fracture Concentration

Aquifers of low to moderate productivity may yield large quantities of water to wells from localized zones of increased porosity and permeability created by the concentration of fractures. These zones of fracture concentration generally are between 30 and 200 ft (9.1 and 61 m) wide. Along them the bedrock is shattered to an indefinite depth by numerous, nearly vertical, closely spaced fractures or faults of small displacement that are aligned approximately parallel to the long axis of the fracture zone (fig. 12). The zones of fracture concentration extend in straight or slightly curved lines that range in length from a few hundred feet to several miles. Straight or slightly curved linear features a mile or more long, associated with these fracture zones, are visible on aerial photographs and topographic maps and are known as lineaments.

Zones of fracture concentration tend to localize valley development, especially in areas underlain by carbonate rocks, but also in other types of rock. Rock weathering is greatest along these fracture zones because they transmit large quantities of moving water. The increased chemical weathering, coupled with the erosive action of surface water, localizes the valleys over these fracture zones (fig. 13). The chances of obtaining a high-yielding well are greatest in the floors of valleys developed over a fracture zone (Parizek, 1971, p. 28-56).

Valleys developed over fracture zones commonly possess distinctive characteristics that make them recognizable by their linearity on topographic maps and aerial photographs. Among the features most easily recognized are: (1) straight stream and valley segments, (2) abrupt, angular changes in valley alignment, and (3) alignment of gullies, small depressions, or sinkholes. The way some of these features appear at the land surface is shown in figure 14.

The water supply for the Lake Arrowhead resort community in northwest Cherokee County was successfully developed in rugged terrain characterized by

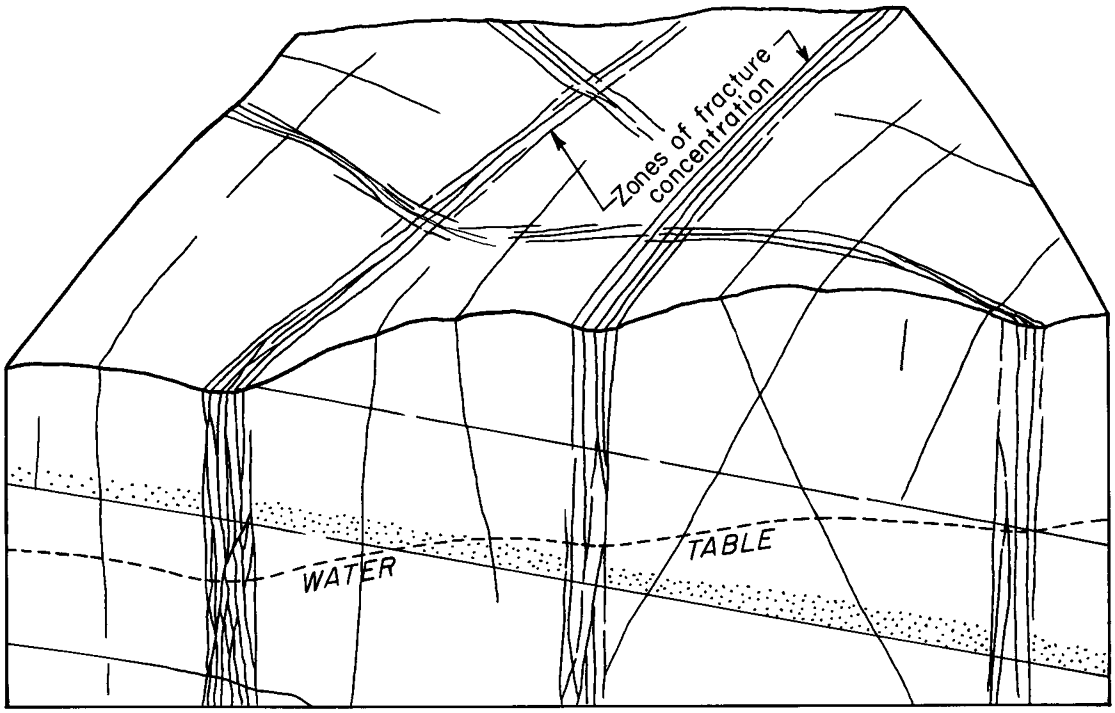


Figure 12. Zones of fracture concentration consist of nearly vertical closely spaced fractures. Modified from Parizek (1971).

generally low-yielding wells, by drilling into zones of fracture concentration. More than 15 wells were drilled in stream valleys that topographic maps and aerial photographs indicate probably are developed over fracture zones. Drillers' logs revealed that all the wells having yields between 50 and 200 gal/min (3.2 and 13 L/s) penetrated sizable fracture systems consisting of one or more large fractures or zones of closely spaced fractures. The largest yields came from zones of closely spaced fractures.

All the high-yielding wells occupy sites along straight stream segments, or where valleys make abrupt, angular change in direction. Figure 15 is a map of part of the Lake Arrowhead area showing the locations of high-yielding and low-yielding wells, to illustrate how yields relate to topographc settings. All of the high-yielding wells are in settings that strongly suggest the presence of zones of fracture concentration.

As most zones of fracture concentration in that area are rather narrow—30 to 200 ft (9.1 to 61 m) wide—precision in locating wells is required to insure penetration of the water-bearing fractures. For example, wells 53 and 61 penetrate a fracture zone and yield 80 and 200 gal/min (5.0 and 13 L/s), whereas well 50, which is situated slightly off the fracture zone, penetrates mainly solid rock and yields only 13 gal/min (0.8 L/s).

The employment of aerial photographs and topographic maps to locate zones of fracture concentration resulted in six production wells that supply a combined total yield of about 560 gal/min (35 L/s). The wells are in terrane that normally supplies less than 5 gal/min (0.3 L/s) per well. By searching out zones of fracture concentration, it should be possible to develop large ground-water supplies in most of the water-bearing units in the report area.

In water-bearing units A, D, and F, which are composed of thickly to massively bedded dolomite and limestone overlain by thick residual soil, zones of fracture concentration develop into highly permeable reservoirs capable of supplying large quantities of water to wells. Such permeable zones typically underlie broad, gently sloping valleys of intermittent streams. Larger ones having catchment areas greater than 1 mi^2 (2.6 km^2) supply 100 to 1,500 gal/min (6.3 to 95 L/s) to wells in several areas of northwest Georgia. Similar topographic settings in Bartow County can be expected to yield comparable quantities of water to wells. Examples of the topographic expression of such valleys are shown in figure 16.

Zones of fracture concentration in the more brittle types of crystalline rocks in the Piedmont also have proved to be highly productive aquifers. Wells 32 and 33 in Forsyth County derive 200 gal/min (13 L/s) from a zone of fracture concentration that appears as

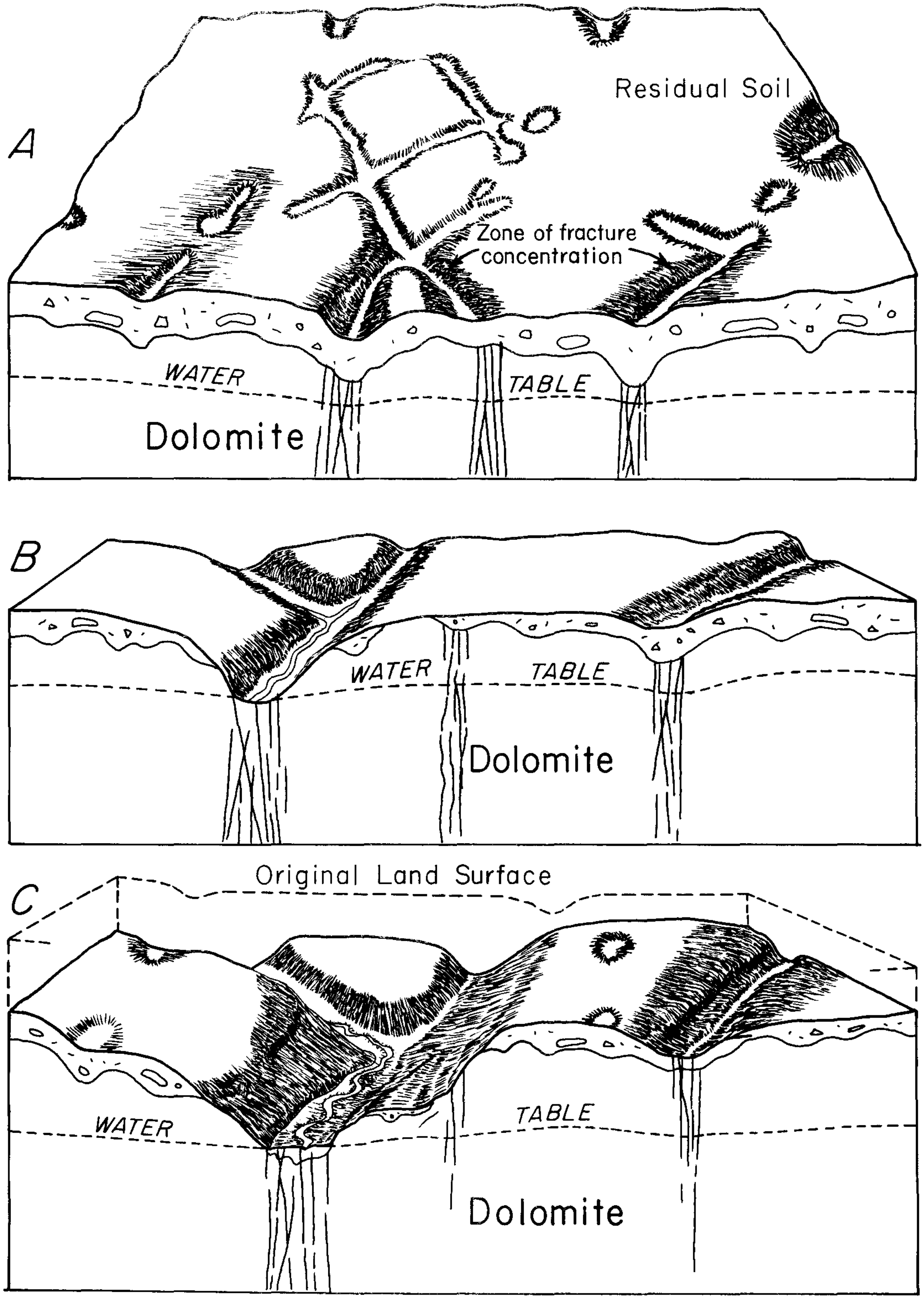


Figure 13. Valley development localized along zones of fracture concentration. Modified from Parizek (1971).

a straight valley segment on a topographic map (fig. 17). Similar straight valley segments are scattered across much of Forsyth and Cherokee Counties, and many of them may be developed over zones of fracture concentration that will supply large yields.

Contact Zones Between Rocks of Contrasting Character

Contact zones between rocks having different physical properties, especially in the Piedmont province, commonly are sites of concentrated fracturing and may yield large quantities of water to wells. In Forsyth County, for example, drilling records show that wells penetrate highly fractured rock when located on the lower east slope of ridges underlain by quartzite of water-bearing unit G, and near the contact with schist, gneiss, and amphibolite. Well 44, which supplies water to the city of Cumming, furnishes 150 gal/min (9.5 L/s) from fractured quartzite near the east base of Sawnee Mountain. Forsyth County wells 2 and 3 begin in schist of unit J and derive water from fractured quartzite at the contact with unit G.

Yields of 20 to 200 gal/min (1.3 to 13 L/s) probably can be obtained at numerous places along the east slope of the ridges formed by unit G at the contacts with rocks of different character. The quantity of water obtainable depends largely on the size and type of catchment area that supplies recharge to the well site, on the thickness of the residual soil layer that is available to hold recharge water in storage for resupplying the fracture systems, and on the lithology of the rock units involved.

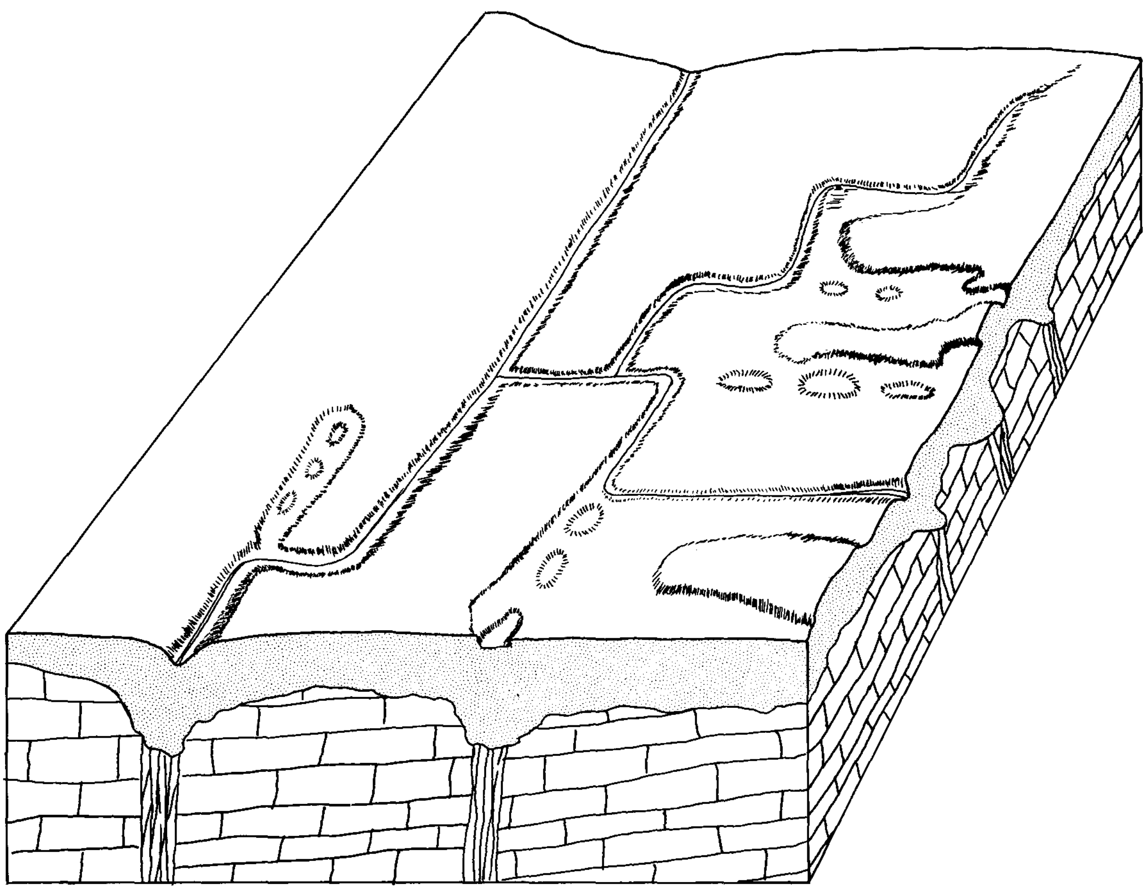
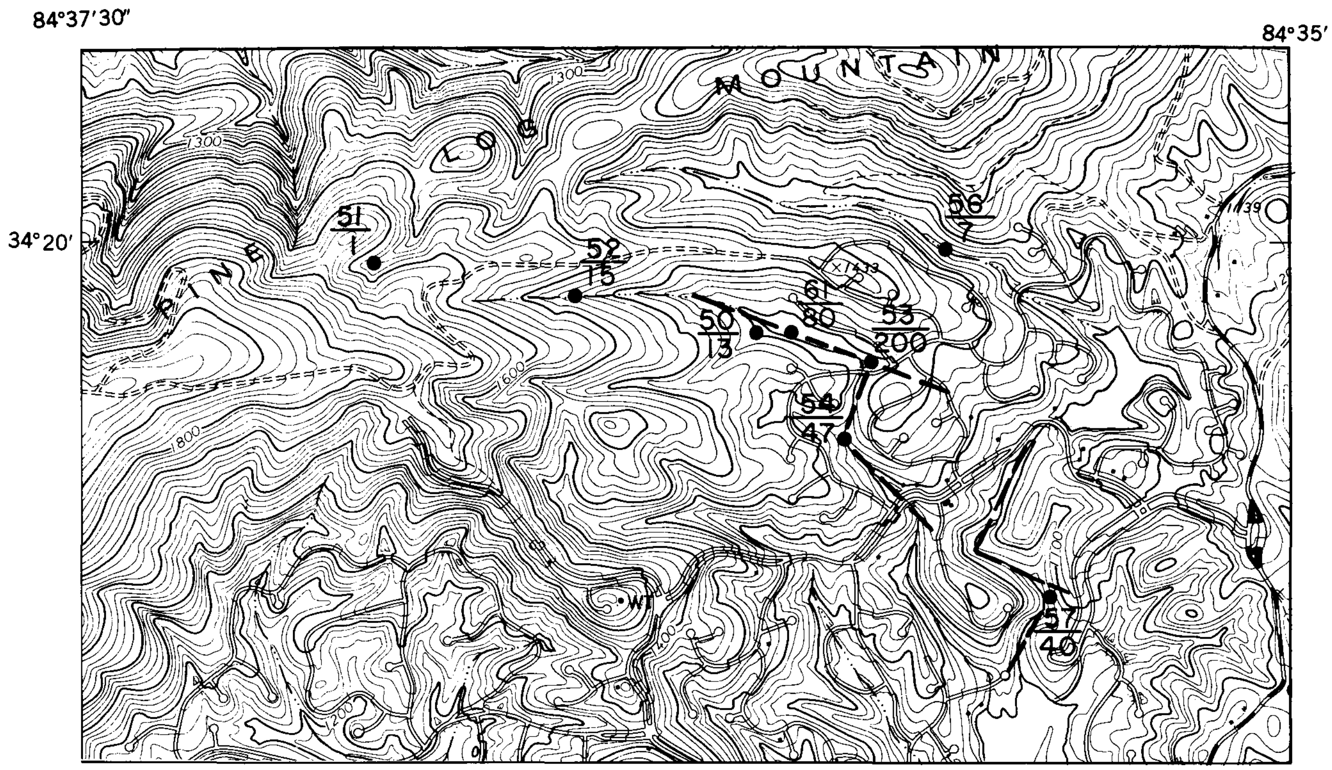


Figure 14. Straight stream segments, abrupt angular changes in valley alignment, and alignment of sinkholes indicate the presence of zones of fracture concentration.



Base from U.S. Geological Survey
Waleska 1:24,000, 1974

0 1 MILE

0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

E X P L A N A T I O N

——— ——— ——— ZONE OF FRACTURE CONCENTRATION

● 53/200 WELL—Top number refers to plate 2 and table 8.
Bottom number indicates yield, in gallons per minute.

Figure 15. Relation of zones of fracture concentration to well yields, Lake Arrowhead area.

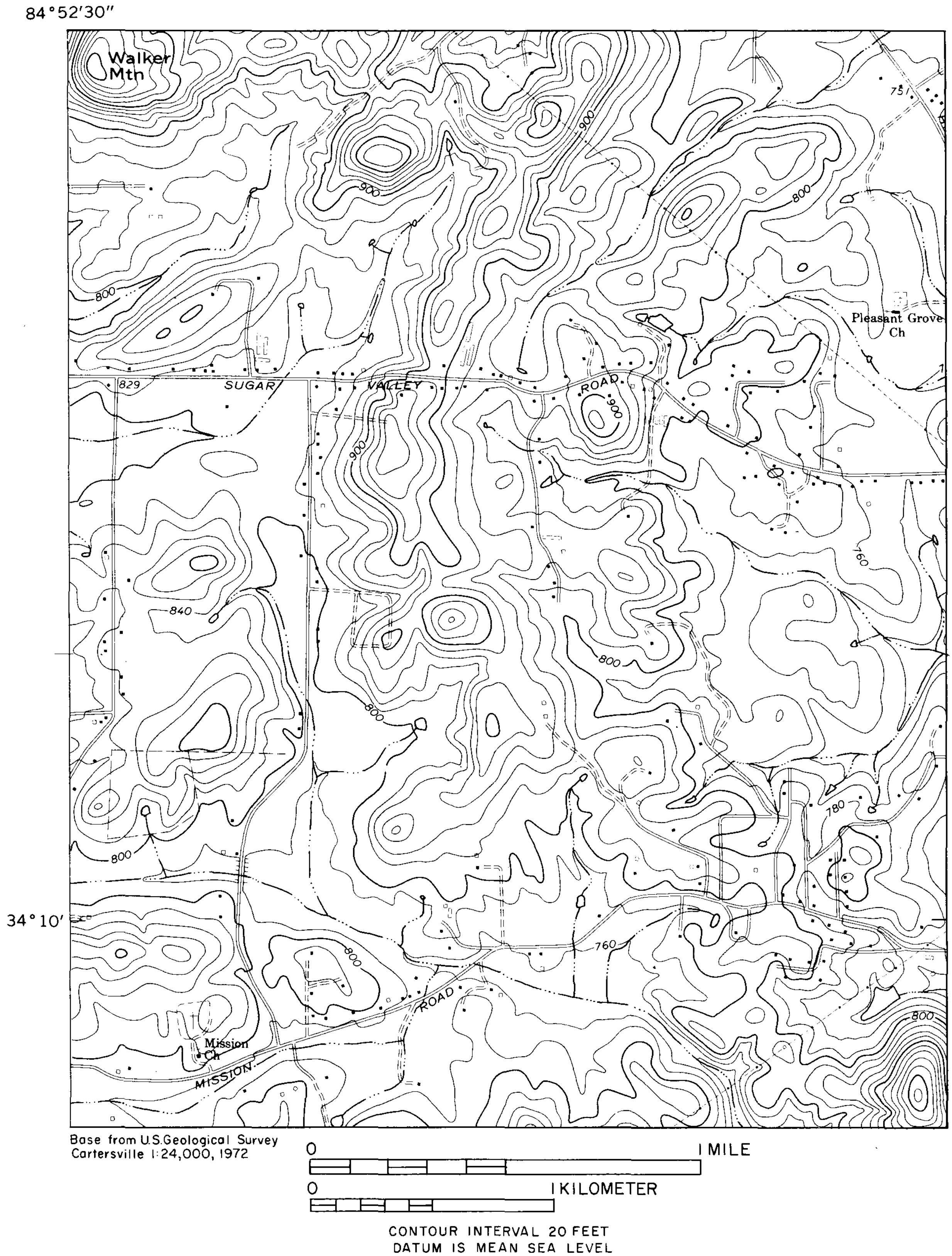


Figure 16. Typical intermittent stream valleys in carbonate terrane, Bartow County.

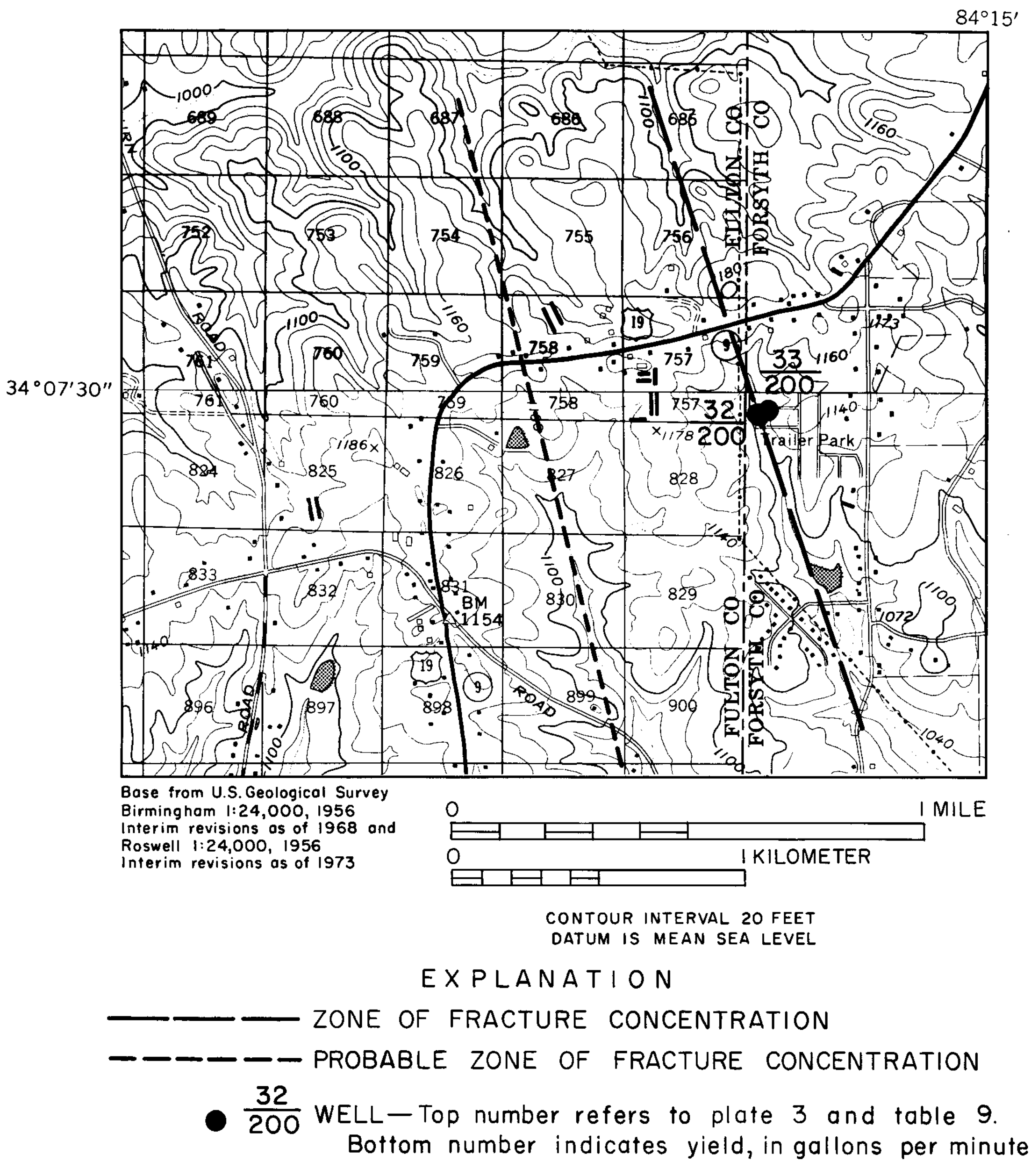


Figure 17. Permeable zones of fracture concentration commonly lie along straight valley segments.

CONCLUSIONS

In the Valley and Ridge part of the report area, wells nearly everywhere supply water of adequate quality and quantity for domestic and farm purposes. In Bartow County, wells in water-bearing units D and F can furnish 100 to 1,500 gal/min (6.3 to 95 L/s), and yields of 50 to 1,500 gal/min (3.2 to 95 L/s) should be available from wells in selected sites in units A, D, and F.

Open joints and fractures tend to become tighter and more widely spaced with increasing depth. Fractures in slate, shale, sandstone, quartzite, and similar rocks in the Valley and Ridge area tend to be concentrated within 250 ft (76 m) of the surface. Most solution-enlarged fractures in carbonate rocks are found at depths of less than 350 ft (106 m). Therefore, when drilling for water in the Valley and Ridge province, it is rarely worthwhile to drill deeper than 350 ft (106 m) in carbonates, or deeper than 250 ft (76 m) in other kinds of rock. If a well fails to produce the desired yield at these depths, it generally is best to try a new location.

Springs in water-bearing units A and D discharge 100 to 3,000 gal/min (6.3 to 189 L/s). The water is moderately mineralized and is satisfactory for many industrial and other uses. Most of the springs are unused and represent a potentially valuable untapped resource.

Well and spring pollution is widespread in the Valley and Ridge part of Bartow County. More than 20 percent of the drilled wells, 80 percent of the dug wells, and 80 percent of the large springs tested were polluted. The main causes of well pollution are improper well construction and poor site selection. Many large springs are polluted because they are favorite watering places for wildlife. Similar percentages of wells and a large percentage of springs in the Piedmont part of the report area also may be polluted.

Some abandoned open-pit mines in the Cartersville area of Bartow County have been used for solid waste disposal and others are being considered by local authorities for landfill development. However, the mines are hydraulically connected with underlying water-bearing unit F that supplies water to industrial wells in Cartersville. Thus, leachate from solid waste disposed of in these mines is a possible threat to contaminate large areas of this major ground-water reservoir. No leachate has been observed in the subsurface as yet, because sampling wells are not available in the critical areas.

In general, ground water is available in smaller quantities in the Piedmont province than it is in the Valley and Ridge. The largest yield obtained in the crystalline rocks of eastern Bartow and in Cherokee and Forsyth Counties is 200 gal/min (13 L/s). Only 11 wells in this area are known to yield more than 50 gal/min (3.2 L/s), and most wells yield less than 15 gal/min (0.9 L/s). In some areas of moderate relief, and in many areas of high relief, well supplies adequate for residential or farm needs are either unavailable or very difficult to obtain.

In the Piedmont area, where the rocks have been subjected to severe deformation, water-yielding joints and fractures commonly occur deeper than 400 ft (122 m). A significant number of wells obtain water from openings about 500 ft (152 m) deep, and a few produce water from as deep as 700 ft (213 m). However, a comparison of drilling costs with the probability of obtaining the required yield of about 5 gal/min (0.3 L/s) indicates that it is seldom advisable to drill deeper than about 400 ft (122m) for a residential supply. Well records show that drilling deeper than about 700 ft (213 m) cannot be justified unless geologic evidence indicates that openings extend to greater depth.

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APPENDIX

Table 7. Record of wells in Bartow County

Well No.	Water-bearing unit	Owner	Date completed	Type of well	Diameter (inches)	Depth (feet)	Cased to (feet)	Water level below land surface (ft)	Date measured	Yield (gal/min)	Use	Remarks
105	A	G. W. Lancaster	1957	Drilled	6	160	--	125	Reported	7.5	Domestic and stock	
106	A	Alan Boswell	1956	do.	6	172	--	46.3	09-11-59	12	Domestic	
107	A	D. C. Rice	1959	do.	6	109	109	55.5	09-14-59	--	do.	
108	A	E. O. Davis	--	do.	6	135	35	70.7	09-28-59	--	Domestic and stock	Large cavity at 135 ft
111	A	W. Sparks	1954	do.	6	128	--	75.5	09-30-59	--	do.	
112	A	J. C. Hall	1958	do.	6	106	--	43.4	09-11-59	--	do.	
116	A	Bailey Murphy	1955	do.	6	128	--	86	Reported	20	Domestic	
117	A	Earl McStetts	1955	do.	6	155	--	75	do.	15	do.	
118	A	L. Murphy	1953	do.	6	110	--	40	do.	20	do.	
119	A	Arnold Conway	1956	do.	6	103	--	63	do.	8	do.	
120	A	Frank Dickey	1957	do.	6	198	--	31	09-15-59	40	do.	
121	A	A. R. Edwards	1957	do.	6	131	--	65	Reported	--	do.	
122	A	Glenn Ellison	1948	do.	6	80	--	28	do.	20	do.	
123	A	J. W. Fowler	1958	do.	6	102	--	17	do.	--	do.	
126	A	Woodrow Fowler	1959	do.	6	126	--	97	do.	36	Domestic and stock	
127	A	Fred Lee	1957	do.	6	206	--	119	do.	--	do.	Sand in cavity
142	A	J. L. Bailey	1955	do.	6	200	--	27	do.	--	Domestic	High mineral content
143	A	E. C. Porder	1954	do.	6	121	--	100	do.	20	Domestic and stock	
144	A	W. C. Moore	1959	do.	6	55	--	20	do.	60	Domestic	
145	A	G. C. Phillips	1953	do.	6	75	--	40	do.	--	do.	
146	A	do.	1959	do.	6	284	134	147	do.	--	Domestic and stock	
147	A	R. F. Jolly	1942	do.	6	110	--	60.2	09-28-59	--	do.	
148	A	--	1957	do.	6	137	--	125	do.	--	do.	
149	A	Odell Ames	1954	do.	6	175	--	131.9	Reported	--	do.	High iron content
150	A	do.	1957	do.	6	86	--	51.7	do.	--	do.	
151	A	Gale Ross	1954	do.	6	96	--	58.7	09-29-59	--	do.	
152	A	Paul Dodd	--	do.	6	170	55	45	Reported	--	do.	2-ft cavity at bottom
153	A	Hubert Wade	1957	do.	6	235	100	135	do.	10	do.	
157	A	Clarence Head	1953	do.	6	98	--	58	09-28-59	--	Domestic	
158	A	Dolph Nelson	1952	do.	6	85	--	63	09-24-59	--	Domestic and stock	
159	A	J. C. Nelson	1950	do.	6	58	--	46.7	Reported	--	do.	
160	A	Dolph Nelson	1952	do.	6	260	60	16	09-24-59	--	do.	High bacteria count
161	A	G. H. Uren	1949	do.	6	86	--	42.2	Reported	--	do.	
161a	A	Mary Ragsdale	1958	do.	6	79	--	67.9	09-25-59	--	do.	
162	A	Brandon Bros.	1957	do.	6	98	--	63	09-24-59	--	do.	
163	A	Joe Brandon	--	Dug	--	86	--	21	12-24-59	--	do.	
164	A	H. H. Carroll	1957	Drilled	6	262	81	70	Reported	--	Domestic	
165	A	Hugh Keown Grocery	--	do.	6	82	--	43	09-29-59	--	do.	
166	A	J. Davis	1957	do.	6	99	--	77.8	Reported	--	Domestic and stock	
167	A	W. L. Brown	1948	do.	6	100	--	89	09-22-59	--	Domestic	
168	A	J. W. Pickelsimer	1945	do.	6	331	50	--	--	--	Domestic and stock	
169	A	Howl Smith	--	do.	6	65	--	56	08-25-59	--	do.	
170	A	J. J. Hill	--	do.	6	114	--	67	09-23-59	--	Domestic	
171	A	H. L. Jackson	1954	do.	6	300	--	--	--	--	Domestic and stock	Insufficient water
172	A	Kary Taff	1959	do.	6	99	--	79.9	Reported	30	Domestic	
173	A	--	1956	do.	6	144	--	77.8	do.	20	Domestic and stock	
174	A	Joe Brandon	1954	do.	6	212	46	50	do.	--	do.	
175	A	Dave Taft	--	do.	6	79	--	41.2	09-24-59	--	Domestic	
175a	A	C. C. Strain	1955	do.	6	91	--	--	--	92	Domestic and stock	
176	A	Lamar Cox	1951	do.	6	185	--	31.5	09-24-59	60	do.	
177	A	W. M. Gibbs	1947	do.	6	149	--	68.5	Reported	4	do.	
178	A	Paul Gibbs	1952	do.	6	65	65	46.0	do.	--	Domestic	
179	A	City of Taylorsville	1934	do.	6	119	--	52	09-24-59	--	Industrial	
180	A	Bartow Consolidated School	1939	do.	6	116	--	--	--	--	Domestic	
181	A	W. R. Williams	--	do.	4	172	--	87	Reported	10	do.	
182	A	Homer Tilley	--	do.	6	73	--	27.9	09-25-59	--	Domestic and stock	
183	A	W. T. Ingram	1956	do.	6	86	--	40	Reported	--	do	Large cavity at 84 ft
184	A	John W. Little	1956	do.	6	64	--	42.2	do.	--	do.	
185	A	John W. Williams	1957	do.	6	120	--	67.5	09-28-59	60	do.	
186	A	E. L. Sutton	1956	do.	6	125	--	23.6	Reported	--	do	
187	A	C. C. Sewell	1956	do.	6	60	--	19.3	09-28-59	--	Stock	
188	A	J. L. Maxwell	1959	do.	6	175	--	50.0	Reported	30	Domestic and stock	Large cavity at 175 ft
189	A	Carl Maxwell	1952	do.	6	170	--	77.8	09-24-59	--	do.	
190	A	Charles Kay	1954	do.	--	175	--	150	09-29-59	20	do.	
59	C	H. L. Barton	--	Drilled	--	52	--	41.8	08-26-59	--	Domestic	
61	C	Minnie Rodgers	1933	do.	6	100	--	--	--	--	do.	
62	C	D. F. Otting	1954	do.	6	235	235	45.0	09-18-56	--	do.	
67	C	Forrest Ellis	--	do.	--	19	--	12.6	08-20-59	--	do.	
68	C	Grady Vaughn	--	do.	--	39	--	26.9	do.	--	do.	
71	C	Bill Vaughn	--	do.	--	68	--	60.1	08-27-59	--	Stock	Insufficient water
72	C	Buford Kay	1954	do.	6	87	--	6.2	09-30-59	--	Domestic and stock	
75	C&D	Eliza Richards	1956	do.	6	157	115	--	--	15	do.	
76	C	Flora P. Dysart	--	do.	--	47	--	32.3	08-26-59	--	Domestic	
78	C	G. R. Tatum	--	do.	6	56	--	32	08-27-59	--	do.	
79	C	Bill Raines	1945	do.	6	215	--	--	--	--	Domestic and stock	Sulfurous taste in water
80	C	Elmer Vincent	1957	do.	6	470	--	18.8	08-27-59	--	--	Highly charged - mineral
81	C	Cox	1957	do.	6	420	40	40.2	do.	--	--	Insufficient water
82	C	L. W. Crowe	1958	do.	6	140	--	36.8	do.	--	Domestic	
83	C	V. L. Doss	1957	do.	6	369	90	75	Reported	5	do.	
84	C	Everett Long	1956	do.	6	50	--	16.8	08-26-59	--	Domestic and stock	
85	C	Hayes Barnes	1954	do.	6	90	--	17.3	do.	--	Domestic	
86	C	Robert Cornwall	1954	do.	6	102	--	21.4	do.	--	do.	
87	C	J. B. Mahan	1957	do.	6	558	--	92.2	do.	--	Domestic and stock	
88	C	Pine Log School	--	do.	6	300	--	--	--	--	Domestic	

Table 7. Record of wells in Bartow County - Continued.

Well No.	Water-bearing unit	Owner	Date completed	Type of well	Diameter (inches)	Depth (feet)	Cased to (feet)	Water level below land surface (ft)	Date measured	Yield (gal/min)	Use	Remarks
91	C	H. E. Smith	--	Drilled	6	12	--	7.6	08-26-59	--	Domestic	
93	C	Wesley Smith	--	do.	6	69	--	46.3	do.	--	do	
94	C	P. H. Garland	--	do.	--	30	--	18.8	do.	--	Domestic and stock	
95	C	Hoyt Mauldin	--	do.	6	97	--	29.7	08-28-59	--	do.	
97	C	Sid Cogle	1955	do.	6	112	--	40.0	Reported	70	do.	
98	C	F. H. Bradford	1954	do.	6	81	--	30.0	do.	33	Domestic	
102	C	M. C. Watts	1959	do.	6	111	--	--	--	8	do.	
103	C	A. W. Mealer	1958	do.	6	212	--	28	09-11-59	--	do.	
109	C	Tate Hall	1959	do.	6	70	--	14.9	09-30-59	--	do.	
113	C	W. M. Adcock	1953	do.	6	105	18	30.7	10-16-59	--	do.	
114	C	Clarence King	1957	do.	6	53	--	17	Reported	--	do.	
115	C	George Lanham	1948	do.	6	102	--	35	do.	--	Domestic and stock	
125	C	J. D. Farmer	1957	do.	6	129	30	48	do.	--	Domestic	
130	C	Joe Shropshire	1959	do.	6	134	--	45	do.	30	do.	
131	C	Gordon Holt	1957	do.	6	675	--	35	09-30-59	6	Domestic and stock	
132	C	Bill Davidson	1953	do.	6	100	--	32.1	do.	--	do.	
133	C&D	Felton Bishop	1958	do.	6	95	24	24.6	do.	--	do.	
134	C	F. W. Fortenburg	1953	do.	6	160	--	13.1	do.	7	Domestic	
138	C	W. C. Arnold	1951	do.	6	82	--	40	Reported	11	Domestic and stock	
139	C	N. R. Epps	1959	do.	6	104	--	44	do.	9	Domestic	
63	D	Goodyear Clearwater, 3	1903	Drilled	10	510	60	--	--	200	Industrial	
63a	D	Goodyear Clearwater, 2	1929	do.	6	320	--	--	--	150	do.	
64	D	Jerome Smith	1957	do.	6	93	--	42	09-18-59	13	Domestic	
65	D	do.	1957	do.	6	43	--	20	Reported	13	do.	
66	D	Jack Smith	1946	do.	6	158	--	43.9	09-30-59	--	do.	
73	D	W. D. Smith	1954	do.	6	180	--	23.8	08-27-59	--	Domestic and stock	
74	D	City of White	1957	do.	6	105	--	--	--	55	Public supply	
74a	D	do.	1957	do.	6	105	--	--	--	55	do.	
77	D	Ben Maxwell	1956	do.	6	155	--	--	--	--	Domestic	
90	D	J. Neal	--	do.	--	67	--	28.1	08-25-59	--	do.	
92	D	Dave Vaughn	1954	do.	6	105	--	22.5	Reported	--	do.	
96	D	H. W. Howard	--	do.	6	113	--	42.4	08-25-59	--	do.	
99	D&C	GAF Corp.	--	do.	4.5	240	--	--	--	200	Industrial	Probably in fault zone
101	D	Knight	1959	do.	6	65	--	38.2	09-10-59	--	Domestic	
104	D	J. E. King	1957	do.	6	80	19	35	Reported	60	Domestic	
110	D	J. A. Swindell	1946	do.	6	60	37	39	do.	20	do.	
124	D	Claude Richard	1958	do.	6	129	--	33.5	09-30-59	--	do.	
128	D	Lindsey Vance	--	do.	6	30	--	18.5	10-15-59	--	do.	
129	D	General Abrasive Min. Co.	1952	do.	6	75	--	45	do.	--	do.	
130	D&C	Joe Shropshire	1954	do.	6	134	--	45	do.	30	do.	
135	D	E. E. Kirkman	1938	do.	6	170	--	12	Reported	--	do.	
135a	D&C	Cass Consolidated School	1937	do.	8	82	30	10	do.	37	Public supply	
136	D	E. D. Kirkman	1944	do.	6	160	--	15	do.	--	Domestic	
137	D	C. J. Arnold	1957	do.	6	210	--	50	do.	--	Domestic and stock	
140	D	Marquette Cement Co.	1957	do.	6	40	--	--	--	--	Industrial	
141	D	Kingston, Georgia	1940	do.	8	350	80	30	Reported	115	Public supply	
141a	D	Kingston Consolidated School	1937	do.	5	215	10	65	do.	50	do.	
154	D	Sam Wade	1958	do.	6	221	--	100	do.	--	Domestic	
155	D	Milford James	1956	do.	6	205	--	95.8	09-30-59	5	Domestic and stock	
156	D	Ellis Hubbard	1957	do.	8	155	--	41	Reported	25	Domestic	
25	F	Lamar Puckett	--	Dug	--	40	--	27.2	08-20-59	--	Domestic	
26	F	Charlie Puckett	--	do.	--	14	--	7.7	do.	--	Domestic and stock	
27	F&G	City of Emerson	1935	Drilled	--	250	--	--	--	25	Public supply	
28	F	Moss	--	do.	6	196	--	114.8	08-19-59	--	Domestic	
29	F	do.	--	Dug	--	35	--	25.7	do.	--	Domestic and stock	
30	F	Maxwell	--	do.	--	35	--	23.0	do.	--	Domestic	
32	F	Jack Hill	--	do.	--	67	--	33.4	do.	--	do.	
33	F	Thompson, Weinman Co.	--	do.	--	21	--	11.8	do.	--	Domestic	
34	F	Harris	--	do.	--	40	--	22.1	do.	--	do.	
35	F	Thompson, Weinman Co.	--	do.	--	68	--	53.2	do.	--	do.	
36	F	Scott McCrary	--	do.	--	50	--	20.6	do.	--	do.	
37	F&G	Dewey Chasteen	--	do.	--	67	--	34.6	do.	--	do.	
38	F	Thompson, Weinman Co.	1958	Drilled	21	140	30	12.4	10-28-58	3,000	do.	Cavern from 86 - 115 ft
39	F	Chemical Products Corp.	1942	do.	--	150	--	--	--	200	do.	
39a	F	do.	1952	do.	--	300	--	--	--	300	do.	
40	F	Union Carbide Co.	1959	do.	10	108	153	26.9	12-21-59	300	Industrial	
40a	F	do.	1960	do.	--	113	70	27	Reported	500	do.	
41	F	New Riverside Ochre Co.	--	do.	8	140	--	--	--	200	do.	
42	F	Southland Ice Co.	1903	do.	8	80	--	--	--	150	Not used	
60	F	Hubert Howell	--	do.	6	105	--	81.2	08-31-59	--	Domestic and stock	
50	G	B. F. Wood	1953	Drilled	6	95	--	6.6	09-01-59	--	Domestic	
54	G	Kenneth Housman	--	do.	6	106	--	70.5	08-31-59	--	do.	
55	G	C. H. Simpson	1956	do.	6	250	--	30.0	Reported	--	do.	
57	G	J. W. Pickelsimer	1956	do.	6	146	--	31.4	09-01-59	--	Domestic	
58	G	Stripland Grocery	1958	do.	6	224	--	84	do.	--	do.	
59	G	Ben Brandon	1950	do.	6	100	--	72.8	08-31-59	--	do.	
24	J	C. W. Jordan	--	Drilled	6	--	--	24.8	08-20-59	--	Domestic	
31	J	C. D. Shaw	--	Dug	--	36	--	21.1	08-20-59	--	Domestic and stock	
100	J	Otto Townsend	1957	Drilled	6	159	--	60.8	09-10-59	2	do.	

Table 7. Record of wells in Bartow County - Continued.

Well No.	Water-bearing unit	Owner	Date completed	Type of well	Diameter (inches)	Depth (feet)	Cased to (feet)	Water level below land surface (ft)	Date measured	Yield (gal/min)	Use	Remarks
3	K	Frank McEver	1957	Drilled	6	102	--	--	--	--	Domestic	
4	K	C. C. Castleberry	1957	do.	6	107	--	36	Reported	6	do.	
8	K	Effie White	1946	do.	8	150	--	23.4	09-02-59	14	do.	
9	K	Will Smith	1951	do.	6	104	--	18.7	do.	--	do.	
9a	K&S	Hoyt Green	1951	do.	6	127	--	--	--	--	Domestic and stock	
11	K	U.S. Army Corps of Engrs.	1960	do.	6	--	--	63	05-12-60	35	Public supply	
20	K	Red Top Mtn. State Park	--	do.	6	203	--	--	--	6	do.	
21	K&G	do.	1958	do.	6	150	--	--	--	30	do.	
22	K	do.	1951	do.	6	208	--	18	Reported	13.5	do.	
23	K	Camp Marina	--	do.	6	203	--	--	--	17	do.	
43	K	C. B. Guyton	1951	do.	6	40	--	30	Reported	--	Domestic	
44	K	Luthern Knight	1957	do.	6	41	--	13	09-01-59	--	do.	
45	K	James Temples	1958	do.	6	52	--	5.6	do.	--	do.	
46	K	L. N. Jenkins	--	do.	6	65	5	--	--	5	do.	
47	K	L. F. Starkebaun	1959	do.	6	65	--	28.7	09-01-59	--	do.	
48	K	Homer Davis	1956	do.	6	130	--	16.5	do.	--	do.	
49	K	T. A. Jenkins	1953	do.	6	190	--	13.7	do.	--	do.	
51	K	J. Y. Ross	1958	do.	6	50	--	22.2	08-31-59	--	do.	
52	K	N. E. Norris	1957	do.	6	162	--	--	--	--	do.	
53	K	Daisy Stripland	1955	do.	6	115	--	--	--	--	do.	
69	K	Bob Segers	--	Dug	--	26	--	9.1	08-31-59	--	do.	
70	K	Dr. Howell	--	do.	--	37	--	25.6	Reported	--	do.	
19	L	Geo. Wash. Carver St. Park	1952	Drilled	6	140	54	--	--	10	Not being used	
1	N	J. P. McPherson	1954	Drilled	6	50	--	15.4	09-02-59	--	Domestic and stock	Cavity at 41 ft
2	N	O. J. Arrington	1955	do.	6	128	--	35	Reported	13	Domestic	
5	N	W. E. Biddy	1954	do.	6	91	--	20	09-02-59	--	do.	
6	N	J. F. Groover	1950	do.	6	100	--	--	--	--	Public supply	
7	N	S. N. Thurmond	1959	do.	6	139	--	38	Reported	.5	Domestic	
10	N	R. V. Pendley	1959	do.	6	120	--	--	--	3	do.	
12	N	L. D. Wright	1958	do.	6	157	--	13.0	Reported	--	Domestic and stock	
13	N	R. N. Keys	1958	do.	6	128	--	13.0	do.	6	Domestic	
14	N	H. T. Alford	1955	do.	6	85	--	--	--	15	do.	
15	N	Allatoona Landing	1952	do.	6	113	--	63	Reported	--	Public supply	
16	N	King Camp	1950	do.	6	106	--	35	do.	15	do.	
17	N	Ballard Estate	--	Dug	--	13	--	9.3	09-02-59	--	Domestic	
18	N&K	Norman Cox	1958	Drilled	6	145	--	41.3	do.	--	do.	

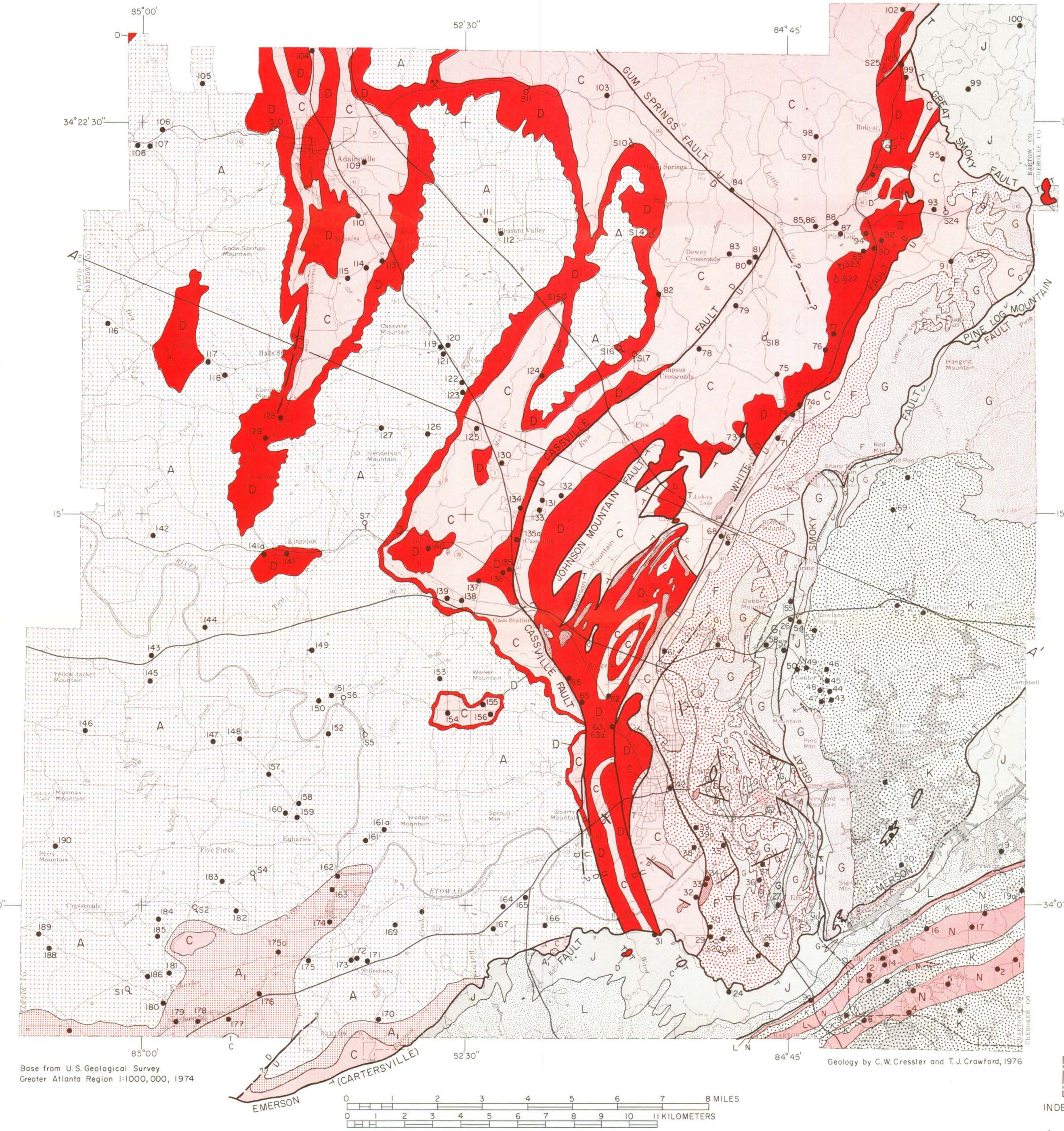
Table 8. Record of wells in Cherokee County.

Well No.	Water-bearing unit	Owner	Date completed	Type of well	Diameter (inches)	Depth (feet)	Cased to (feet)	Water level below land surface (ft)	Date measured	Yield (gal/min)	Use	Remarks
20	D	Nelson, Ga.	1947	Drilled	10	505	28	20	Reported	31	Public supply	Well in 40 ft of marl
21	D	do.	1962	do.	8	450	77	20	do.	32	do.	
62	D	Ballground, Ga.	—	do.	8	400	314	100	do.	85	do.	Penetrates marble
62a	D	do.	1936	do.	8	240	238	Flows	—	84	—	do.
50	G	Lake Arrowhead 14	1973	Drilled	6	328	49.6	Flowing	03-30-73	13	Public supply	
51	G	do. 11	do.	do.	6	268	30	—	—	1	—	
52	G	do. 13	do.	do.	6	309	48.2	Flowing	03-20-73	12-15	Public supply	
53	G	do. 16	do.	do.	6	252	30	—	—	200	do.	Drawdown 55 ft pumping
54	G	do. 17	do.	do.	6	309	30	Flowing	04-11-73	47	do.	Drawdown 64 ft pumping
56	G	do. 20	do.	do.	—	310.5	30	—	—	7	—	
57	G	do. 24	do.	do.	10	288	25	—	—	40	Public supply	Drawdown 75 ft pumping
58	G	do. 26	do.	do.	—	248	25	Flowing	05-04-73	89	do.	Drawdown 84 ft pumping
59	G	do. 27	do.	do.	—	330	35	do.	05-23-73	78-105	do.	Drawdown 62 ft pumping
61	G	do. 31	do.	do.	—	248	64	—	—	80	do.	Drawdown 96 ft pumping
11	J&N	M. Burns	1963	Drilled	6	96	70	—	—	5	Domestic and stock	
22	J	D. W. Stripling	—	do.	—	185	173	—	—	4.5	Domestic	
23	J	Tim Jenkins	—	do.	—	305	65	—	—	1.5	do.	
24	J	Lyn Jenkins	—	do.	—	125	45	—	—	8	do.	
29	J	Mrs. J. Land	1974	do.	—	450	30	—	—	5	do.	
30	J	J. Jordan	1966	do.	—	122	85	—	—	20	—	High iron content
31	J	Lake Arrowhead	—	do.	6	122	77	—	—	20	Public supply	
47	J	V. D. Poss	—	do.	—	142	—	—	—	—	Domestic	High iron content
60	J	Lake Arrowhead	1973	do.	6	166	29	—	—	25	Public supply	
32	K	Woodstock, Ga.	1950	Drilled	8	500	84	35	Reported	6.5	Public supply	
45	K	L. G. Leach	—	do.	—	225	130	—	—	30	do.	
48	K	Coffee Enterprises	—	do.	—	225	—	—	—	15	do.	
49	K	do.	1973	do.	—	500	87	—	—	10	do.	
55	K	Lake Arrowhead	1973	do.	6	248	25	Flows	05-17-73	2	—	Not developed
64	K	Woodstock, Ga., School	1940	do.	6	90	70	—	—	26	—	
1	L&P	Lawrence West	1973	Drilled	6	145	55	—	—	10	Domestic	
2	L	Lloyd Green	1974	do.	6	95	42	—	—	12	do.	
3	L	Lee Fowler	1973	do.	6	85	53	—	—	5	do.	High iron content
5	L	Wayne Hillhouse	1973	do.	6	105	67	—	—	25	do.	
6	L	Mt. Carmel Church	1974	do.	6	165	83	—	—	3	Public supply	
7	L	J. W. Langston	1974	do.	6	165	15	—	—	9	Domestic	
9	L&J	E. Young	1973	do.	6	225	46	—	—	5	do.	
10	L	Allen Roland	1974	do.	6	225	105	—	—	8	do.	
13	L	Jean Honea	1974	do.	6	165	58	—	—	2	do.	
14	L	Jimmie Fowler	—	do.	6	225	112	30	Reported	15	do.	
15	L	Reggie Hines	1973	do.	6	130	75	—	—	6	do.	High iron contnt
16	L	Grady Ghorley Co.	1974	do.	6	165	70	—	—	4	do.	
17	L	Roy Millwood	1973	do.	6	185	43	—	—	3.5	do.	
18	L	E. L. Pittman	1972	do.	6	400	80	—	—	3.5	do.	Water appears dingy
19	L	USACE, Fields Landing	1953	do.	8	168	—	—	—	—	do.	
38	L	R. L. Anthony	1973	do.	6	185	55	—	—	7	do.	
39	L	Larry Dobson	1973	do.	6	85	28	—	—	8	do.	
40	L	F. E. Blackwell	1973	do.	6	62	33	25	Reported	32	do.	
41	L&N	L. D. Inbody	1951	do.	6	126	30	12	do.	12	do.	
42	L	Miguel Gorge	1973	Drilled	6	145	35	—	—	5	do.	
4	N	Whispering Pines Park	1974	Drilled	—	225	35	—	—	12	Domestic	Water fracture at 525 ft
12	N	Little River Landing	—	do.	6	532	6	—	—	200	do.	
25	N	Van Allstine	1973	do.	6	105	55	—	—	5	do.	
26	N	Tony Wilson	1973	do.	6	85	43	—	—	10	do.	
27	N&P	George Drennon	1973	do.	6	205	62	—	—	8	do.	
28	N	Sam Williams	1973	do.	6	240	68	—	—	5	do.	
44	N	J. J. Cotter	—	do.	—	105	75	—	—	10	do.	
46	N	Paul Anderson	1973	do.	6	105	60	—	—	7	do.	
33	P	Mark Yother	1974	Drilled	6	125	90	—	—	15	Domestic	
34	P	Jerry Cantrell	1973	do.	6	145	60	—	—	3.5	do.	
35	P	Fred Haily, 6	1974	do	6	165	80	—	—	10	do.	
36	P	Joe Motes	1974	do.	6	185	63	—	—	7	do.	
37	P	Jack Collett	1954	do.	6	90	30	—	—	5	do.	
43	P	C. Worshum	1974	do.	6	85	18	—	—	3	do.	

Table 9. Record of wells in Forsyth County.

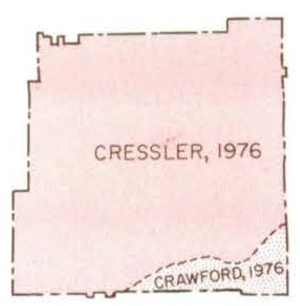
Well No.	Water-bearing unit	Owner	Date completed	Type of well	Diameter (inches)	Depth (feet)	Cased to (feet)	Water level below land surface (ft)	Date measured	Yield (gal/min)	Use	Remarks
5	G&J	W. Beck	1972	Drilled	6	225	43	--	--	40	Domestic	
6	G&J	C. Martin	--	do.	6	250	60	--	--	40	do.	
7	G	T. T. Wright	1969	do.	6	500	51	--	--	45	do.	
8	G	Habersham Drydock Marina	1973	do.	6	545	42	--	--	6	--	
28	G	Robert Lawton	1970	do.	5	250	80	--	--	1	--	
43	G	P. Helms	--	do.	6	261	17	--	--	9	--	
44	G	Cumming, Ga.	1967	do.	8	172	36	12.16	07-25-74	150	Public supply	
45	G&J	D. E. Nalley	--	do.	6	175	175	--	--	--	Domestic	
4	J&G	N. Ga. Rendering Co., 3	1971	Drilled	6	503	139	11	--	17	Industrial	
46	J	W. F. Griffin	1971	Bored	30	68	65	--	--	--	Domestic	
9	K	John Stiner	1959	Drilled	6	98	57	22	Reported	25	Domestic	
14	K	D. J. Hood	1967	Bored	30	53	53	20	do.	5	do.	
1	N	E. Sherrill	--	Drilled	6	239	100	--	--	--	Domestic	
12	N	H. Thomson	1968	do.	--	215	30	10	Reported	15	Public supply	
32	N	Shadow Park North, 1	1969	do.	6	284	31	24	do.	200	do.	
33	N	Shadow Park North, 2	1970	do.	6	270	37	23	do.	200	do.	
2	P&J&G	N. Ga. Rendering Co., 1	1966	Drilled	6	225	20	Flows	--	30	Industrial	
3	P&J&G	N. Ga. Rendering Co., 2	1967	do.	6	265	52	do.	--	15	do.	
10	P	R. E. McAllester	1968	do.	6	505	40	--	--	0	Not in use	
11	P	do.	1968	do.	6	205	40	40	Reported	1	Domestic	
13	P	Creek Point Cove	1968	do.	6	248	60	38.17	08- -74	20	Public supply	
15	P	Cullen Const. Co., 2	--	do.	6	660	75	--	--	6	--	
16	P	Cullen Const. Co., 1	--	do.	6	401	51	--	--	24	--	
17	P	Ivous Dixon	1969	do.	6	144	42	20	Reported	15	Public supply	
18	P	Rieves Subdivision	1962	do.	6	275	50	--	--	15	do.	
19	P	Frank Tiller	1972	do.	6	820	52	--	--	6	Not used	
20	P	do.	1971	do.	6	305	52	--	--	5.5	Public supply	
21	P	do.	1973	do.	6	500	86	--	--	8	do.	
22	P	Bench Mark	--	do.	6	195	42	--	--	60	do.	
23	P	do.	--	do.	6	985	49	--	--	5	--	
24	P	J. Bellamy	1962	do.	6	68	40	6	Reported	30	--	
25	P	H. Evans	1968	do.	6	153	22	50.88	07-26-74	90	Domestic	
26	P	R. P. Douthat	1973	do.	6	705	23	--	--	2	do.	
27	P	Griswell	--	do.	--	755	49	--	--	.5	--	
29	P	Wm. T. Knight	1970	do.	6	175	59	--	--	12	Domestic	
30	P	T. L. Francis	1965	do.	--	184	90	--	--	7	Domestic and stock	
31	P	H. Martin	--	do.	6	365	40	--	--	11	do.	
34	P	Shadow Park North, 3	1972	do.	6	266	33	--	--	50	Public supply	
35	P	Deerwood Subdivision	1974	do.	6	600	68	--	--	2	Not used	
36	P	do.	--	do.	6	500	94	--	--	6	--	
37	P	Hicks	--	do.	6	305	90	--	--	12	--	
38	P	H. F. Palmer	1969	do.	6	100	40	45	Reported	10	--	
39	P&Q	M. Holland	1956	do.	6	70	20	--	--	18	--	
40	P	C. B. Mansell	1958	do.	6	177	42	--	--	15	--	
41	P	Galloway	--	do.	--	195	45	--	--	30	--	
42	P	L. Pindley	1969	do.	6	463	51	50	Reported	13	Public service	Supplies mobile home
47	P	Chestatee School	--	do.	--	140	--	50	do.	12	do.	

The Department of Natural Resources is an equal opportunity employer and offers all persons the opportunity to compete and participate in each area of DNR employment regardless of race, color, religion, sex, national origin, age, handicap, or other non-merit factors.



Base from U.S. Geological Survey
Greater Atlanta Region 1:1000,000, 1974

Geology by C.W. Cressler and T.J. Crawford, 1976



INDEX TO GEOLOGIC MAPPING

EXPLANATION

JASPEROID--Concentrations of large blocks that may interfere with well drilling.

A₁ / A

YIELD--Wells yield from 4 to 92 gal/min (0.3 to 5.9 L/s). Farm and home supplies are readily available, as randomly located wells have about an 80 percent chance of yielding 5 gal/min (0.3 L/s). Yields as large as 1,000 gal/min (63 L/s) should be obtainable at favorable sites in A, and as large as 1,500 gal/min (9.5 L/s) in A_1.

Fourteen springs have minimum annual discharges of 50 to 3,000 gal/min (3.2 to 189 L/s), and most are unused.

DEPTH--Wells range in depth from 55 to 331 feet (17 to 101 m), and average 132 feet (40 m) deep.

QUALITY--The well and spring water is moderately mineralized, meets the drinking-water standards, and is suitable for many industrial uses. Water from wells in bedrock and from springs is hard to very hard. Water from wells in residuum is soft.

ROCK TYPE--The unit consists of thickly to massively bedded brown and gray dolomite (A), and gray dolomite interlayered with tan and gray limestone at the top (A_1).

GEOLOGIC HAZARDS--Danger of ground collapse near centers of heavy pumpage is moderate to high. Likelihood of well and spring pollution resulting from contaminants entering sinkholes is very high.

GEOLOGIC CORRELATION--Includes Knox Group (Cambrian and Ordovician age) and overlying Newala Limestone (Ordovician age) at the top.

C

YIELD--Most wells yield between 2 and 15 gal/min (0.1 and 0.9 L/s). Farm and home supplies generally can be obtained without difficulty in flat lying and gently sloping areas, but essentially dry wells are reported on steep slopes and higher elevations. Randomly located wells probably have less than a 60 percent chance of yielding 5 gal/min (0.3 L/s). Yields as large as 70 gal/min (4.4 L/s) have been obtained from thick layers of limestone within the unit.

DEPTH--Wells range in depth from 50 to 558 feet (15 to 170 m), and average 182 feet (55 m) deep.

QUALITY--Water from most wells meets drinking-water standards, although some constituents approach the upper limits. The water varies from soft to very hard, and most contains low concentrations of iron. Water from a few wells contains hydrogen sulfide and has the odor of rotten eggs.

ROCK TYPE--The unit is mainly shale, but locally includes sections of limestone and dolomite 10 to 50 feet (3 to 15 m) or more thick. In the eastern outcrop belt, the shale is interlayered with sandstone and thinly layered dolomite.

GEOLOGIC HAZARDS--Danger of ground collapse near wells is small except for ones in thick limestone sections, where the danger is low to moderate.

GEOLOGIC CORRELATION--Includes predominantly shale parts of Conasauga Formation and the Rome Formation (Cambrian age); Rockmart Slate (Ordovician age).

D

YIELD--Wells yield from 5 to 200 gal/min (0.3 to 13 L/s). Yields as large as 300 gal/min (19 L/s) may be obtained at favorable sites. Domestic and farm supplies are available nearly everywhere; randomly located wells have about an 80 percent chance of yielding 5 gal/min (0.3 L/s).

Three springs have minimum annual discharges of 18 to 150 gal/min (0.5 to 9.5 L/s) and the water is largely unused.

DEPTH--Thirty-four wells range in depth from 30 to 150 feet (9 to 46 m) and average 181 feet (55 m) deep.

QUALITY--The well and spring water is hard to very hard, generally contains low concentrations of iron and other dissolved constituents, and is suitable for most uses.

ROCK TYPE--The unit is mainly thinly to massively bedded gray and brown dolomite, but it commonly includes layers of limestone and locally contains thick units of gray limestone.

GEOLOGIC HAZARDS--Danger of ground collapse near centers of heavy pumpage is moderate to high. Well and spring pollution may result from contaminants entering the ground through sinkholes.

GEOLOGIC CORRELATION--Includes dolomite and limestone facies of the Maynardville Limestone Member of the Conasauga Formation, units of the Conasauga Formation composed mainly of limestone, and the lower dolomite unit of the Conasauga Formation (Cambrian age).

F

YIELD--The unit is the principal source of industrial water supply in Cartersville. Seven industrial wells yield from 150 to 3,000 gal/min (9.5 to 189 L/s). Farm and home supplies probably can be developed without difficulty in most of the outcrop area.

DEPTH--The wells range in depth from 80 to 300 feet (24 to 91 m), and average 158 feet (48 m) deep.

QUALITY--The well water is moderately hard to hard and contains small concentrations of iron and most other constituents. The water is suitable for drinking and for many industrial uses.

ROCK TYPE--The unit consists of thinly to massively bedded light- to dark-gray dolomite that contains thin layers and laminations of pink and silver phyllite in the upper part. The dolomite is siliceous and yields abundant jasperoid.

GEOLOGIC HAZARDS--Danger of ground collapse near centers of heavy pumpage is high. Likelihood of pollution resulting from contaminants entering the ground through sinkholes or through the bottom of open pit mines is very high.

GEOLOGIC CORRELATION--Includes Shady Dolomite (Cambrian age).

G / G_1

YIELD--In the few areas level enough for farming and home construction, wells generally supply between 2 and 10 gal/min (0.1 and 0.6 L/s). On steep slopes, narrow-crested ridges, and scarp slopes, well supplies normally are unavailable. Yields as large as 200 gal/min (13 L/s) can be developed at selected sites where wells penetrate fracture zones in quartzite that are recharged by large catchment areas. Fifteen wells drilled in fracture zones have an average yield of 60 gal/min (3.8 L/s), but such sites are widely scattered and are absent in some areas.

DEPTH--Wells range in depth from 92 to 330 feet (28 to 101 m), and have an average depth of 241 feet (73 m).

QUALITY--The well water ranges from soft to hard, generally contains low to moderate concentrations of iron, and is suitable for drinking and many other purposes.

ROCK TYPE--The unit consists of interlayered quartzite and phyllite. The quartzite is thinly to massively bedded, fine to coarse grained, commonly feldspathic, locally conglomeratic, and varies from very light gray to dark gray. The phyllite varies from light gray to nearly black and occurs in layers a few inches to several feet thick. Much of the phyllite east of the Great Smoky fault weathers to a distinctive copper color. In some areas (G), quartzite is the predominant rock type; in others (G_1), phyllite is more abundant.

GEOLOGIC CORRELATION--Includes Chilhowee Group (Cambrian age) and Ocoee Supergroup (Precambrian).

J

YIELD--Wells supply between 1.5 and 25 gal/min (0.09 and 1.6 L/s). The largest yield that can be expected from the unit is about 30 gal/min (2 L/s). Randomly located wells probably have less than a 40 percent chance of supplying 5 gal/min (0.3 L/s).

DEPTH--Wells range in depth from 86 to 450 feet (26 to 137 m). All the wells that supply 5 gal/min (0.3 L/s) or more are shallower than 166 feet (51 m). The casing in most wells is between 29 and 85 feet (8.8 and 26 m) deep.

QUALITY--The well water generally is soft and has a low concentration of total dissolved solids. Much of the water has a pH of less than 7.0 and may corrode plumbing. The concentration of iron in four wells sampled ranged from 0 to 250 µg/L, which is within the limits set for drinking water. Water from part of the unit contains hydrogen sulfide and reportedly has the odor of rotten eggs.

ROCK TYPE--The unit consists mainly of phyllite and schist, some of which is dark colored and graphitic. Layers of quartzite and graywacke are common in some areas, and locally form ledges and low ridges.

K

YIELD--Wells yield between 2 and 35 gal/min (0.1 and 2.2 L/s). Domestic and farm wells can be developed nearly everywhere and public supplies of 20 gal/min (1.2 L/s) are common. Yields of 15 to 20 gal/min (0.9 to 1.3 L/s) can be expected from favorable sites. Randomly located wells probably have about a 60 percent chance of furnishing 5 gal/min (0.3 L/s).

DEPTH--Inventoried wells range between 40 and 500 feet (12 to 152 m) deep, for an average depth of about 155 feet (47 m). About 90 percent of the wells are less than 250 feet (76 m) deep. Casing ranges from as little as 5 feet (2 m) to as much as 130 feet (40 m).

QUALITY--The water is soft and reported to be good for household use. The concentration of iron in most well water is low, although water from two wells contained 280 and 450 µg/L of iron.

ROCK TYPE--The unit is composed chiefly of gneiss, including augen gneiss, granite gneiss, and biotite gneiss. The rock varies from massive to highly sheared.

GEOLOGIC CORRELATION--Includes Corbin Granite (Precambrian) in western outcrops.

L

YIELD--Most existing wells yield only enough water for domestic or farm supply. The largest yield known in the unit is 32 gal/min (2 L/s). Larger than average yields should be the rule in parts of the unit that contains brittle rock (L_1). Randomly located wells have about a 40 percent chance of yielding 5 gal/min (0.3 L/s).

DEPTH--The wells range from 62 to 400 feet (19 to 122 m) deep, and average about 160 feet (49 m) deep. They are cased from 15 to 112 feet (5 to 34 m) deep.

QUALITY--The water generally is soft, and most contains low concentrations of iron and other constituents.

ROCK TYPE--The unit consists mainly of sericite and quartz-muscovite schist and interlayered metagraywacke (L). Quartzite in layers 10 to 30 feet (3 to 9 m) thick, and graywacke in layers of similar thickness, make up a significant part of the section in northern Cherokee County (L_1).

N

YIELD--The unit is used almost exclusively for domestic and farm supplies. Wells generally furnish less than 15 gal/min (0.9 L/s). Randomly located wells have about a 40 percent chance of supplying 5 gal/min (0.3 L/s). Three wells in the unit supply 200 gal/min (13 L/s), apparently from highly permeable zones produced by intense fracturing of the brittle rock. Two of the wells are along a linement, probably developed on a zone of fracture concentration.

DEPTH--Wells range in depth from 50 to 532 feet (15 to 162 m), and average about 137 feet (42 m) deep. The depth of casing in most wells is between 30 and 100 feet (9 and 30 m).

QUALITY--The water is soft to moderately hard, contains low concentrations of iron, and generally is satisfactory for domestic use.

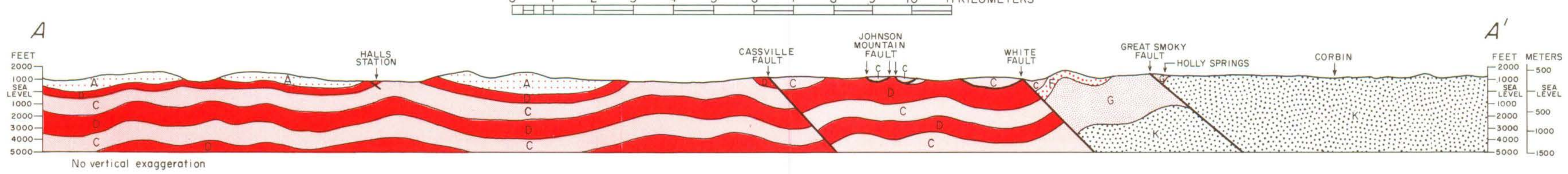
ROCK TYPE--The unit in Cherokee County consists mainly of hornblende gneiss and schist interlayered with amphibolite. In Forsyth County it is mainly amphibolite.

CONTACT--Approximately located; dotted where concealed

FAULT--Approximately located; dotted where inferred; queried where doubtful. U, upthrown side; D, downthrown side; T, upper plate.

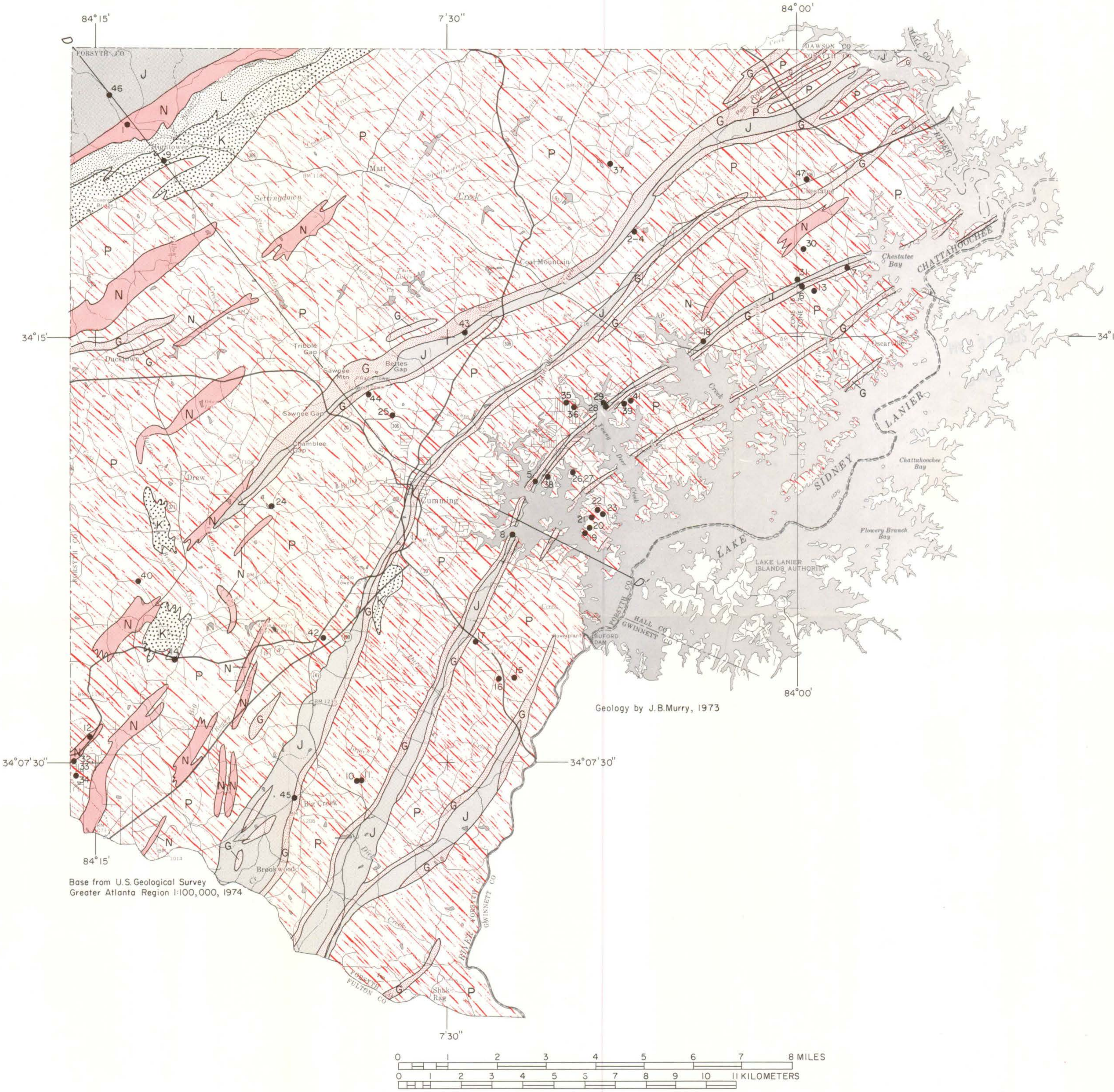
60 WELL AND IDENTIFICATION NUMBER

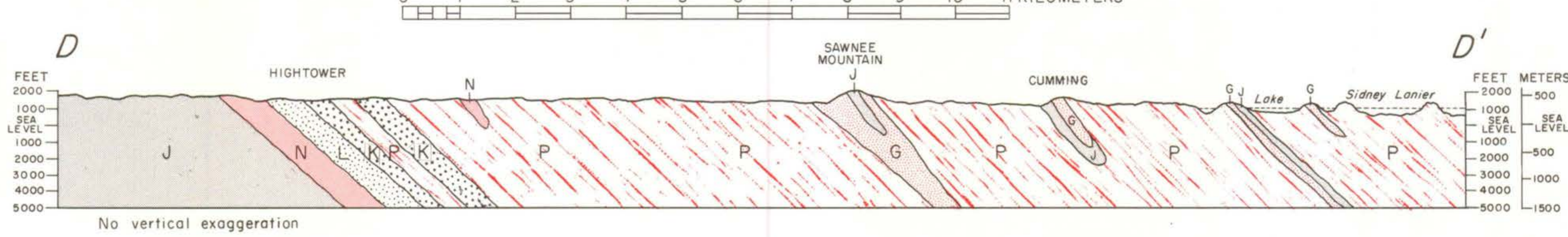
S4 SPRING AND IDENTIFICATION NUMBER



No vertical exaggeration

WATER-BEARING UNITS AND LOCATIONS OF SELECTED WELLS AND SPRINGS, BARTOW COUNTY, GEORGIA.





EXPLANATION

G

YIELD--In the few areas level enough for farming and home construction, wells generally supply between 2 and 10 gal/min (0.1 and 0.6 L/s). On steep slopes, narrow-crested ridges, and scarp slopes, well supplies normally are unavailable. Yields as large as 200 gal/min (13 L/s) can be developed at selected sites where wells penetrate fracture zones in quartzite that are recharged by large catchment areas. Fifteen wells drilled in fracture zones have an average yield of 60 gal/min (3.8 L/s), but such sites are widely scattered and are absent in some areas.

DEPTH--Wells range in depth from 92 to 330 feet (28 to 101 m), and have an average depth of 241 feet (73 m).

QUALITY--The well water ranges from soft to hard, generally contains low to moderate concentrations of iron, and is suitable for drinking and many other purposes.

ROCK TYPE--The unit consists of interlayered quartzite and phyllite. The quartzite is thinly to massively bedded, fine to coarse grained, commonly feldspathic, locally conglomeratic, and varies from very light gray to dark gray. The phyllite varies from light gray to nearly black and occurs in layers a few inches to several feet thick. Much of the phyllite east of the Great Smoky fault weathers to a distinctive copper color. In some areas (G), quartzite is the predominant rock type; in others (G_1), phyllite is more abundant.

GEOLOGIC CORRELATION--Includes Chilhowee Group (Cambrian age) and Ocoee Supergroup (Precambrian).

J

YIELD--Wells supply between 1.5 and 25 gal/min (0.09 and 1.6 L/s). The largest yield that can be expected from the unit is about 30 gal/min (2 L/s). Randomly located wells probably have less than a 40 percent chance of supplying 5 gal/min (0.3 L/s).

DEPTH--Wells range in depth from 86 to 450 feet (26 to 137 m). All the wells that supply 5 gal/min (0.3 L/s) or more are shallower than 166 feet (51 m). The casing in most wells is between 29 and 85 feet (8.8 and 26 m) deep.

QUALITY--The well water generally is soft and has a low concentration of total dissolved solids. Much of the water has a pH of less than 7.0 and may corrode plumbing. The concentration of iron in four wells sampled ranged from 0 to 250 µg/L, which is within the limits set for drinking water. Water from part of the unit contains hydrogen sulfide and reportedly has the odor of rotten eggs.

ROCK TYPE--The unit consists mainly of phyllite and schist, some of which is dark colored and graphitic. Layers of quartzite and graywacke are common in some areas, and locally form ledges and low ridges.

K

YIELD--Wells yield between 2 and 35 gal/min (0.1 and 2.2 L/s). Domestic and farm wells can be developed nearly everywhere and public supplies of 20 gal/min (1.2 L/s) are common. Yields of 15 to 20 gal/min (0.9 to 1.3 L/s) can be expected from favorable sites. Randomly located wells probably have about a 60 percent chance of furnishing 5 gal/min (0.3 L/s).

DEPTH--Inventoried wells range between 40 and 500 feet (12 to 152 m) deep, for an average depth of about 155 feet (47 m). About 90 percent of the wells are less than 250 feet (76 m) deep. Casing ranges from as little as 5 feet (2 m) to as much as 130 feet (40 m).

QUALITY--The water is soft and reported to be good for household use. The concentration of iron in most well water is low, although water from two wells contained 280 and 450 µg/L of iron.

ROCK TYPE--The unit is composed chiefly of gneiss, including augen gneiss, granite gneiss, and biotite gneiss. The rock varies from massive to highly sheared.

GEOLOGIC CORRELATION--Includes Corbin Granite (Precambrian) in western outcrops.

L

YIELD--Most existing wells yield only enough water for domestic or farm supply. The largest yield known in the unit is 32 gal/min (2 L/s). Larger than average yields should be the rule in parts of the unit that contains brittle rock (L_1). Randomly located wells have about a 40 percent chance of yielding 5 gal/min (0.3 L/s).

DEPTH--The wells range from 62 to 400 feet (19 to 122 m) deep, and average about 160 feet (49 m) deep. They are cased from 15 to 112 feet (5 to 34 m) deep.

QUALITY--The water generally is soft, and most contains low concentrations of iron and other constituents.

ROCK TYPE--The unit consists mainly of sericite and quartz-muscovite schist and interlayered metagraywacke (L). Quartzite in layers 10 to 30 feet (3 to 9 m) thick, and graywacke in layers of similar thickness, make up a significant part of the section in northern Cherokee County (L_1).

N

YIELD--The unit is used almost exclusively for domestic and farm supplies. Wells generally furnish less than 15 gal/min (0.9 L/s). Randomly located wells have about a 40 percent chance of supplying 5 gal/min (0.3 L/s). Three wells in the unit supply 200 gal/min (13 L/s), apparently from highly permeable zones produced by intense fracturing of the brittle rock. Two of the wells are along a linement, probably developed on a zone of fracture concentration.

DEPTH--Wells range in depth from 50 to 532 feet (15 to 162 m), and average about 137 feet (42 m) deep. The depth of casing in most wells is between 30 and 100 feet (9 and 30 m).

QUALITY--The water is soft to moderately hard, contains low concentrations of iron, and generally is satisfactory for domestic use.

ROCK TYPE--The unit in Cherokee County consists mainly of hornblende gneiss and schist interlayered with amphibolite. In Forsyth County it is mainly amphibolite.

P

YIELD--Well yields range from 0 to 90 gal/min (0 to 6 L/s). Although domestic supplies can be obtained from most of the area, some "dry" holes are reported, and several very deep wells supply minimal quantities. Less than 5 gal/min (0.3 L/s) is supplied by 19 percent of the wells inventoried. Randomly located wells have about a 60 percent chance of yielding 5 gal/min (0.3 L/s).

DEPTH--Wells range in depth from 68 to 985 feet (21 to 300 m), averaging 352 feet (170 m).

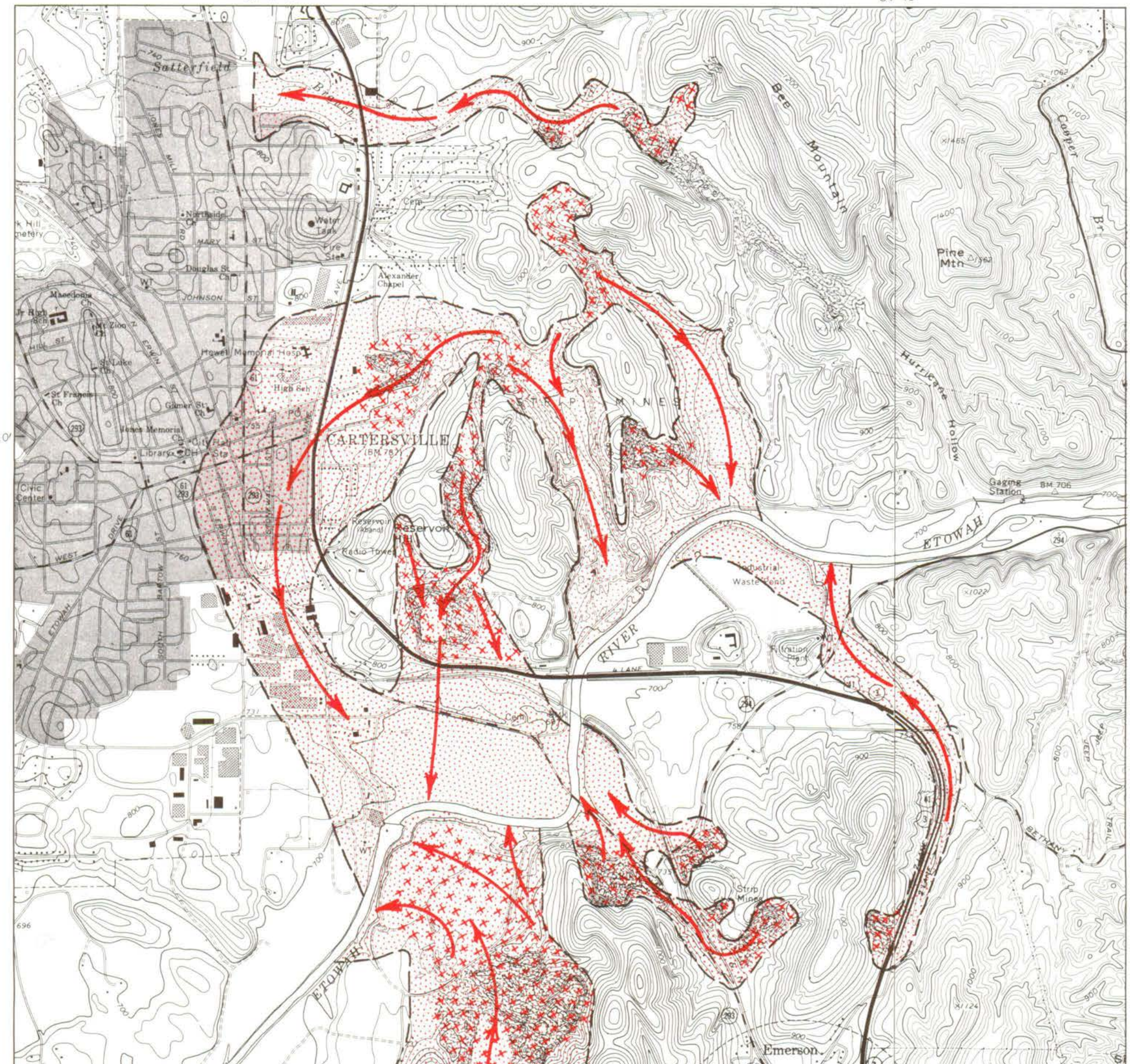
QUALITY--The water is soft and contains small concentrations of iron. It is moderately mineralized and is suitable for most uses.

ROCK TYPE.--The unit consists of hornblende gneiss, biotite gneiss, mica schist, and amphibolite interlayered in varying thicknesses and proportions. The rocks are inclined and most wells derive water from two or more kinds of rock. The unit probably is hundreds, if not thousands, of feet thick.

——— CONTACT--Approximately located

● 24 WELL AND IDENTIFICATION NUMBER

WATER-BEARING UNITS AND LOCATIONS OF SELECTED WELLS, FORSYTH COUNTY, GEORGIA.



Base from U.S. Geological Survey
Cartersville 1:24,000, 1972, Burnt Hickory Ridge 1:24,000, 1972
Allatoona Dam 1:24,000, 1961, interim revision as of 1968, and
Acworth 1:24,000, 1956, interim revision as of 1968

1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

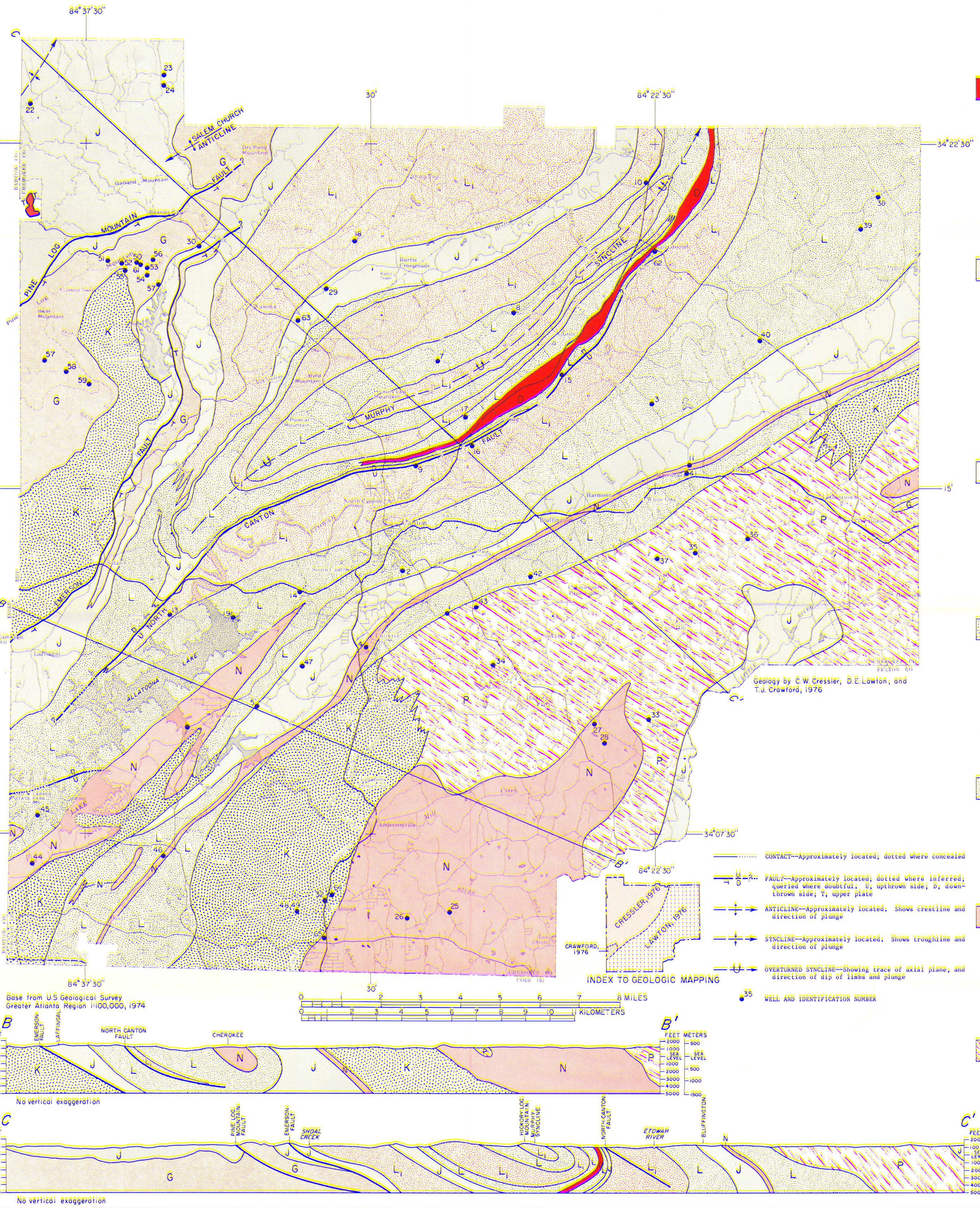
EXPLANATION

AREA OF LARGE OPEN-PIT MINES

AREA OF POSSIBLE CONTAMINATION BY LEACHATE GENERATED IN THE OPEN-PIT MINES, AT 1976 WATER-TABLE SLOPE

DIRECTION THAT LEACHATE GENERATED IN THE MINES CAN BE EXPECTED TO MOVE DOWN THE 1976 WATER-TABLE SLOPE

OPEN-PIT MINES IN THE CARTERSVILLE AREA LARGE ENOUGH TO BE POTENTIAL LANDFILL SITES.



EXPLANATION

D

YIELD--Wells yield from 5 to 200 gal/min (0.3 to 13 L/s). Yields as large as 300 gal/min (19 L/s) may be obtained at favorable sites. Domestic and farm supplies are available nearly everywhere; randomly located wells have about an 80 percent chance of yielding 5 gal/min (0.3 L/s).

Three springs have minimum annual discharges of 18 to 150 gal/min (0.5 to 9.5 L/s) and the water is largely unused.

DEPTH--Thirty-four wells range in depth from 30 to 150 feet (9 to 46 m) and average 181 feet (55 m) deep.

QUALITY--The well and spring water is hard to very hard, generally contains low concentrations of iron and other dissolved constituents, and is suitable for most uses.

ROCK TYPE--The unit is mainly thinly to massively bedded gray and brown dolomite, but it commonly includes layers of limestone and locally contains thick units of gray limestone.

GEOLOGIC HAZARDS--Danger of ground collapse near centers of heavy pumpage is moderate to high. Well and spring pollution may result from contaminants entering the ground through sinkholes.

GEOLOGIC CORRELATION--Includes dolomite and limestone facies of the Maynardville Limestone Member of the Conasauga Formation, units of the Conasauga Formation composed mainly of limestone, and the lower dolomite unit of the Conasauga Formation (Cambrian age).

G

YIELD--In the few areas level enough for farming and home construction, wells generally supply between 2 and 10 gal/min (0.1 and 0.6 L/s). On steep slopes, narrow-crested ridges, and scarp slopes, well supplies normally are unavailable. Yields as large as 200 gal/min (13 L/s) can be developed at selected sites where wells penetrate fracture zones in quartzite that are recharged by large catchment areas. Fifteen wells drilled in fracture zones have an average yield of 60 gal/min (3.8 L/s), but such sites are widely scattered and are absent in some areas.

DEPTH--Wells range in depth from 92 to 330 feet (28 to 101 m), and have an average depth of 241 feet (73 m).

QUALITY--The well water ranges from soft to hard, generally contains low to moderate concentrations of iron, and is suitable for drinking and many other purposes.

ROCK TYPE--The unit consists of interlayered quartzite and phyllite. The quartzite is thinly to massively bedded, fine to coarse grained, commonly feldspathic, locally conglomeratic, and varies from very light gray to dark gray. The phyllite varies from light gray to nearly black and occurs in layers a few inches to several feet thick. Much of the phyllite east of the Great Smoky fault weathers to a distinctive copper color. In some areas (G), quartzite is the predominant rock type; in others (G_1), phyllite is more abundant.

GEOLOGIC CORRELATION--Includes Chilhowee Group (Cambrian age) and Ocoee Supergroup (Precambrian).

J

YIELD--Wells supply between 1.5 and 25 gal/min (0.09 and 1.6 L/s). The largest yield that can be expected from the unit is about 30 gal/min (2 L/s). Randomly located wells probably have less than a 40 percent chance of supplying 5 gal/min (0.3 L/s).

DEPTH--Wells range in depth from 86 to 450 feet (26 to 137 m). All the wells that supply 5 gal/min (0.3 L/s) or more are shallower than 166 feet (51 m). The casing in most wells is between 29 and 85 feet (8.8 and 26 m) deep.

QUALITY--The well water generally is soft and has a low concentration of total dissolved solids. Much of the water has a pH of less than 7.0 and may corrode plumbing. The concentration of iron in four wells sampled ranged from 0 to 250 µg/L, which is within the limits set for drinking water. Water from part of the unit contains hydrogen sulfide and reportedly has the odor of rotten eggs.

ROCK TYPE--The unit consists mainly of phyllite and schist, some of which is dark colored and graphitic. Layers of quartzite and graywacke are common in some areas, and locally form ledges and low ridges.

K

YIELD--Wells yield between 2 and 35 gal/min (0.1 and 2.2 L/s). Domestic and farm wells can be developed nearly everywhere and public supplies of 20 gal/min (1.2 L/s) are common. Yields of 15 to 20 gal/min (0.9 to 1.3 L/s) can be expected from favorable sites. Randomly located wells probably have about a 60 percent chance of furnishing 5 gal/min (0.3 L/s).

DEPTH--Inventoried wells range between 40 and 500 feet (12 to 152 m) deep, for an average depth of about 155 feet (47 m). About 90 percent of the wells are less than 250 feet (76 m) deep. Casing ranges from as little as 5 feet (2 m) to as much as 130 feet (40 m).

QUALITY--The water is soft and reported to be good for household use. The concentration of iron in most well water is low, although water from two wells contained 280 and 450 µg/L of iron.

ROCK TYPE--The unit is composed chiefly of gneiss, including augen gneiss, granite gneiss, and biotite gneiss. The rock varies from massive to highly sheared.

GEOLOGIC CORRELATION--Includes Corbin Granite (Precambrian) in western outcrops.

L / L_1

YIELD--Most existing wells yield only enough water for domestic or farm supply. The largest yield known in the unit is 32 gal/min (2 L/s). Larger than average yields should be the rule in parts of the unit that contains brittle rock (L). Randomly located wells have about a 40 percent chance of yielding 5 gal/min (0.3 L/s).

DEPTH--The wells range from 62 to 400 feet (19 to 122 m) deep, and average about 160 feet (49 m) deep. They are cased from 15 to 112 feet (5 to 34 m) deep.

QUALITY--The water generally is soft, and most contains low concentrations of iron and other constituents.

ROCK TYPE--The unit consists mainly of sericite and quartz-muscovite schist and interlayered metagraywacke (L). Quartzite in layers 10 to 30 feet (3 to 9 m) thick, and graywacke in layers of similar thickness, make up a significant part of the section in northern Cherokee County (L_1).

N

YIELD--The unit is used almost exclusively for domestic and farm supplies. Wells generally furnish less than 15 gal/min (0.9 L/s). Randomly located wells have about a 40 percent chance of supplying 5 gal/min (0.3 L/s). Three wells in the unit supply 200 gal/min (13 L/s), apparently from highly permeable zones produced by intense fracturing of the brittle rock. Two of the wells are along a linement, probably developed on a zone of fracture concentration.

DEPTH--Wells range in depth from 50 to 532 feet (15 to 162 m), and average about 137 feet (42 m) deep. The depth of casing in most wells is between 30 and 100 feet (9 and 30 m).

QUALITY--The water is soft to moderately hard, contains low concentrations of iron, and generally is satisfactory for domestic use.

ROCK TYPE--The unit in Cherokee County consists mainly of hornblende gneiss and schist interlayered with amphibolite. In Forsyth County it is mainly amphibolite.

P

YIELD--Well yields range from 0 to 90 gal/min (0 to 6 L/s). Although domestic supplies can be obtained from most of the area, some "dry" holes are reported, and several very deep wells supply minimal quantities. Less than 5 gal/min (0.3 L/s) is supplied by 19 percent of the wells inventoried. Randomly located wells have about a 60 percent chance of yielding 5 gal/min (0.3 L/s).

DEPTH--Wells range in depth from 68 to 985 feet (21 to 300 m), averaging 332 feet (170 m).

QUALITY--The water is soft and contains small concentrations of iron. It is moderately mineralized and is suitable for most uses.

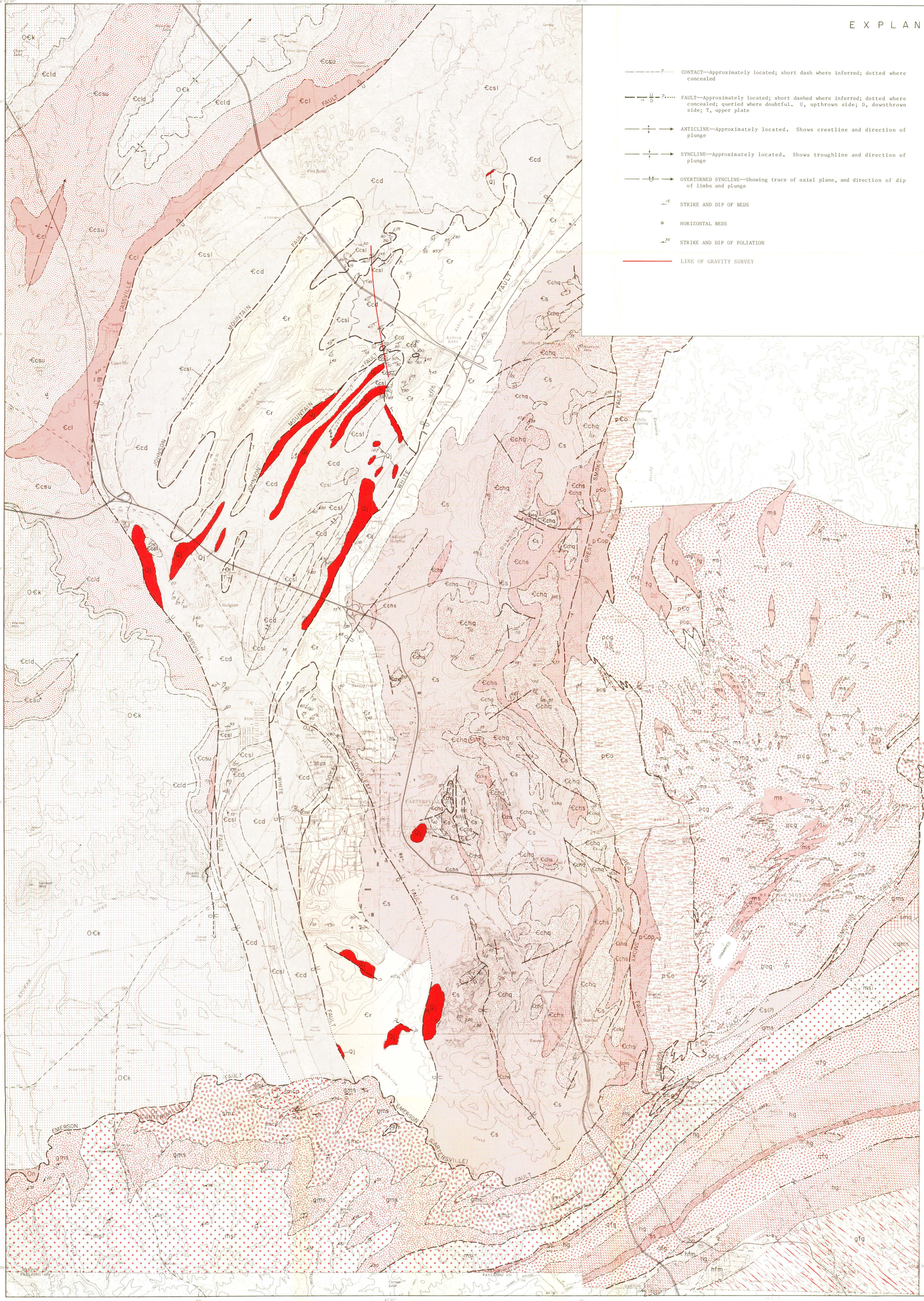
ROCK TYPE.--The unit consists of hornblende gneiss, biotite gneiss, mica schist, and amphibolite interlayered in varying thicknesses and proportions. The rocks are inclined and most wells derive water from two or more kinds of rock. The unit probably is hundreds, if not thousands, of feet thick.

WATER-BEARING UNITS AND LOCATIONS OF SELECTED WELLS, CHEROKEE COUNTY, GEORGIA.

GEORGIA DEPARTMENT OF NATURAL RESOURCES
GEORGIA GEOLOGIC SURVEY

Prepared in cooperation with the
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

INFORMATION CIRCULAR 50
PLATE 4



EXPLANATION

CONTACT--Approximately located; short dash where inferred; dotted where concealed

FAULT--Approximately located; short dashed where inferred; dotted where concealed; queried where doubtful. U, upthrown side; D, downthrown side; T, upper plate

ANTICLINE--Approximately located. Shows crestline and direction of plunge

SYNCLINE--Approximately located. Shows troughline and direction of plunge

OVERTURNED SYNCLINE--Showing trace of axial plane, and direction of dip of limbs and plunge

15 STRIKE AND DIP OF BEDS

⊕ HORIZONTAL BEDS

36 STRIKE AND DIP OF FOLIATION

LINE OF GRAVITY SURVEY

Note: Arrangement of metamorphic and igneous rock units does not imply age or stratigraphic sequence. Extensive cataclastic zones omitted from map.

Qj — JASPEROID CONCENTRATIONS (QUATERNARY)--Chiefly light- to medium-gray, tan- to brown-weathering, commonly ocher-colored jasperoid. Most has a chert-like texture, but some is very fine to medium grained and resembles quartzite. It accumulates in the soil as pieces ranging in size from a fraction of an inch to as large as an automobile.

Or — ROCKMART SLATE (MIDDLE ORDOVICIAN)--Medium- to dark-gray clay slate that weathers to tan or yellowish brown, mainly in the lower part. Tan- and brown-weathering silty, micaceous shale and siltstone are common in the upper part. The Rockmark probably is between 100 and 200 ft thick. Included in water-bearing unit C.

On — NEWALA LIMESTONE (LOWER ORDOVICIAN)--Thinly to massively bedded, light- to medium-dark-gray limestone interlayered with thick-bedded gray dolomite. Limestone locally makes up about 50 percent of the section. The Newala probably ranges from 100 to 300 feet thick. Forms water-bearing unit A_1.

O€k — KNOX GROUP (CAMBRIAN AND ORDOVICIAN)--Thinly to massively bedded dolomite, mainly brown or tan in the lower part and medium to light gray in the middle and upper parts. Gray limestone beds are interlayered with the dolomite at the top. The dolomite is highly siliceous and produces a cherty, silty, clay residuum that generally ranges from 25 to 200 ft thick. The Knox probably has a maximum thickness of 3,500 ft. Included in water-bearing unit A.

CONASAUGA FORMATION (MIDDLE AND UPPER CAMBRIAN)

€cld — Thinly to massively bedded gray dolomite about 300 ft thick. Commonly it is interlayered with dark-gray clayey limestone that in places becomes the dominant rock type. A few feet of dark-gray shale locally occurs near the top. Layers and nodules of dark-gray chert are abundant in the upper part. Included in water-bearing unit D.

€csu — Greenish, gray, and slightly purplish shale as much as 700 ft thick that weathers to shades of tan, pink, and orange. Scattered throughout the shale are layers and lenses of limestone as much as 100 ft thick. Included in water-bearing unit C.

€cl — Thinly to thickly bedded gray limestone that has a maximum thickness of about 600 ft. Included in water-bearing unit D.

€csl — Greenish, gray, tan, purplish, and black shale that weathers to shades of tan, pink, and orange. The shale probably is more than 1,000 ft thick. Included in water-bearing unit C.

€cd — Light- to medium-gray and some brown thinly to massively bedded dolomite, probably between 500 and 1,000 ft thick. The dolomite locally is oolitic and most exposures are distinctively marked by a pink or reddish coating on bedding and joint surfaces and stylolites. Some beds contain layers and nodules of dark, rarely oolitic chert. Southeast of Bolivar, thin- to massive-bedded gray impure limestone makes up sections 100 ft or more thick at the top of the dolomite. The dolomite generally yields abundant jasperoid. North of Cartersville massive jasperoid produces ridges of moderate relief. Included in water-bearing unit D.

€r — ROME FORMATION (LOWER AND MIDDLE CAMBRIAN)--Gray silty and clay shale that weathers to tan, pink, and purple and commonly displays a distinctive silver sheen. Some silty shale is dolomitic and in unweathered exposures has the appearance of massive dolomite. Scattered throughout the shale, especially in the upper part, are thin to thick layers of gray, purple, white, pale red, and green siltstone and sandstone, some of which is dolomitic. The formation probably ranges from 100 to 400 ft thick, depending on the structure. Included in water-bearing unit C.

€s — SHADY DOLOMITE (LOWER CAMBRIAN)--Light-gray to dark-gray thickly to massively bedded dolomite and dolomitic limestone between 300 and 500 ft thick. The dolomite is siliceous, weathers deeply, and yields abundant jasperoid. Forms water-bearing unit F.

CHILHOWEE GROUP (LOWER CAMBRIAN)

€chq — Mainly light- to dark-gray, buff- to brown-weathering, fine-grained, locally conglomeratic, thin- to massive-bedded quartzite. The quartzite is interlayered with dark-gray, locally graphitic shale and phyllite that becomes soft and light gray to white where weathered. In quarries and road cuts the quartzite is close jointed and breaks up into small angular fragments, producing abundant rubble. Near the top of the section the quartzite has a high clay and feldspar content and generally is soft enough to be worked by earth-moving equipment. The aggregate thickness of the quartzite layers probably is several hundred feet. Included in water-bearing unit G.

€chs — Dark gray, locally graphitic shale and phyllite, hard and brittle where fresh but very soft and conspicuously light gray to white where weathered. The shale and phyllite are interlayered with varying thicknesses of light- to dark-gray quartzite. The sequence probably is several hundred feet thick. Included in water-bearing unit G_1.

OCOEE SUPERGROUP (PRECAMBRIAN)

p€o — Largely light- to medium-gray, fine- to coarse-grained, conglomeratic and feldspathic quartzite that is massive and remains so in natural and manmade exposures. The quartzite is interlayered with varying thicknesses of hard, locally graphitic phyllite that is dark gray to black where fresh, but becomes medium gray, tan, pink, or copper colored when weathered. Included in water-bearing unit G.

p€op — Mainly phyllite as above, containing minor gray quartzite. Included in water-bearing unit J.

METAMORPHIC AND IGNEOUS ROCKS

smc — Feldspar-quartz-muscovite schist and muscovite-quartz-feldspar metagraywacke, both chloritic and calcareous. Schist is medium grained, very feldspathic and quartzose, and contains abundant quartz pods a few inches long. The metagraywacke is very feldspathic. Boundaries between the interlayered schist and metagraywacke are gradational; layering poorly developed. Abundance of quartz pods gives the rock a "rolling" texture. Weathers brownish red and dark Indian red. Included in water-bearing unit J.

smcp — In a small area of outcrop near the Emerson fault zone, a similar rock contains large feldspar porphyroblasts and stretched quartz pebbles in a fine-grained quartz-mica-feldspar matrix, mylonitic in part. In water-bearing unit J.

gms — Graphite-feldspar-quartz-muscovite schist, fine to medium grained, moderate to well-developed schistosity; graphite content highly variable but parts very rich in graphite. Lower part contains thin quartzites and layers of micaceous graphitic metaconglomerate with blue quartz pebbles up to 0.6 in. across. Part of water-bearing unit J.

msi — Quartz-muscovite schist, fine grained (phyllitic), and biotite-muscovite-quartz-feldspar metagraywacke, interlayered. Both contain fine disseminated magnetite and ilmenite. The tiny black opaques are conspicuous in the fine-grained schist; coarse platy ilmenite in residual vein-quartz litter is charactistic of this rock unit. Layers of schist and metagraywacke are highly variable in thickness, usually on the order of feet. Included in water-bearing unit L.

qfg — Biotite-muscovite-quartz-feldspar gneiss, medium grained, with small porphyroblasts in part; light colored. Generally massive; well-developed (shear) foliation in part, particularly near contacts. Contains concordant and discordant quartz veins mostly less than 18 in. thick; thin veins of sulfide-bearing "flinty crush rock"; and occasional thin (12 to 18 in.) lenticular layers of hornblende gneiss and actinolite-chlorite schist. Part of water-bearing unit K.

hg — Muscovite-biotite-feldspar-hornblende gneiss, fine grained, with very well-developed millimeter-scale layering. Contains few thin quartz veins and pegmatitic veins and pods. Fresh exposures near the Paulding-Bartow County line show small (2 to 10 in.) pods of calcite; and lenticular bodies, 6- to 10-ft thick, of medium- to coarse-grained metagabbro. Makes up water-bearing unit N.

ss — Sericite schist, with disseminated magnetite and ilmenite; interlayered with metagraywacke, hornblende schist, actinolite schist, chlorite schist, quartzite, quartz-muscovite schist, graphitic schist, and graphitic quartzite. Millimeter-scale layering is exceptionally well developed, particularly in the micaceous quartzites. Calcite is a common accessory mineral, and in much of the mafic part of the section calcite is a major mineral. Included in water-bearing unit L.

hfm — Metagabbro, coarsely crystalline hornblende and feldspar, massive; along the margins the crystals are elongate and sheared, giving the rock a "ribbon and eye" gneissic texture. Serpentine, soapstone, talc, and chlorite are common near the margins, and are dominant in some of the narrow outcrop areas. Part of water-bearing unit K.

gfg — Muscovite (minor)-biotite-quartz-feldspar gneiss, with minor garnet in part; medium to coarse grained; parts contain small feldspar porphyroblasts; foliation poorly developed except in areas of shear. Included in water-bearing unit K.

cqms — Quartz-muscovite schist, chlorite-quartz-muscovite-schist, muscovite-quartz-feldspar metagraywacke, and conglomeratic metagraywacke, all interlayered on a small scale of a few inches to a few feet; small garnets are scattered throughout and the rocks are slightly graphitic. Individual lithologies are lenticular and traceable for only a few 10's of feet to a few 100's. In Cherokee County, this unit contains lenticular masses of quartz-pebble and feldspar-pebble metaconglomerate; the pebbles, as large as 0.4 in. across, are subrounded to rounded, in a matrix of feldspar, muscovite, biotite, and quartz. Part of water-bearing unit L.

smq — Schist, metagraywacke, metaconglomerate, and quartzite, interlayered. Chlorite and garnet are common accessories; garnets more abundant and larger toward the northeast. Staurolite is present in the quartzose schists (staurolite-garnet-quartz-muscovite schist). Metaconglomerate beds are 6 in. to 8 ft thick, consisting of feldspar pebbles as large as 1 in. across and quartz rods in a matrix of quartz, feldspar, and muscovite. The quartzites are very clean, in units as much as 15 ft thick with individual layers ranging from 1 to 36 in. Included in water-bearing unit L.

mg — Metagabbro. Part of water-bearing unit K.

pcg — PORPHYRITIC CORBIN GRANITE. Included in water-bearing unit K.

ms — Metasediments intruded by, and deformed with, the Corbin Granite; various schists and gneisses. Part of water-bearing unit K.

fg — Quartz-feldspar gneiss, fine to medium grained, equigranular, with biotite, magnetite, and crystalline graphite. Included in water-bearing unit K.

Geology by C.W. Cressler and T.J. Crawford, 1976

Base from U.S. Geological Survey
Cartersville 1:24,000, 1972, White West 1:24,000, 1972,
Burnt Hickory Ridge 1:24,000, 1972, Acworth 1:24,000, 1956
Interim revision as of 1968, and Allatoona Dam 1:24,000, 1961
Interim revision as of 1968

0 1 2 3 MILES
0 1 2 3 4 KILOMETERS

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

GEOLOGY OF THE CARTERSVILLE AREA, BARTOW COUNTY, GEORGIA.