Geology and Ground-water Resources of the Elizabethton-Johnson City Area Tennessee

By ROBERT W. MACLAY

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GEOLOGY AND GROUND-WATER RESOURCES OF THE ELIZABETHTON-JOHNSON CITY AREA, TENNESSEE

By Robert W. Maclay

ABSTRACT

The area treated in this report, in Carter and Washington Counties, northeastern Tennessee, comprises about 250 square miles. The western two-thirds of the area lies within the Valley and Ridge province and the remainder in the Blue Ridge province. Most of the area is underlain by consolidated sedimentary rocks ranging from Precambrian to Ordovician. Unconsolidated deposits of late Tertiary and Recent age are present in the stream valleys and beneath terraces along these valleys.

The Shady and Honaker formations and the Knox group are the principal water-bearing rocks of the area. Wells drilled into these formations yield an average of about 10 gallons per minute (gpm) in most places. Perched water is common in the residuum of the Shady dolomite and in the Rome formation. Wells that tap perched water generally yield less than 2 gpm and many of them go dry in the late summer or early fall.

The Honaker dolomite is the most productive aquifer. Near the Watauga River, wells of two rayon plants at Elizabethton yield as much as 2,500 gpm each. These plants use about 17 million gallons of water per day, of which 12 million gallons is pumped from the wells.

The ground water in the area is suitable for most purposes, except that the water from the Sevier shale commonly is highly mineralized. Most of the ground water has a hardness of more than 100 parts per million (ppm).

Data relating to 141 springs and 235 wells within the area are listed in the report.

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

The United States Geological Survey and the Tennessee Division of Geology have been engaged in a cooperative investigation of the ground-water resources of east Tennessee since 1947. A reconnaissance ground-water study was begun in that year and the results are published in Tennessee Division of Geology Bulletin 58. Upon completion of the reconnaissance investigation, certain areas in east Tennessee were chosen for detailed studies. The author has made such a study of the Elizabethton-Johnson City area.

This area was chosen because the industrial use of ground water, by two rayon mills, is the heaviest in east Tennessee. The study was designed to determine the source, amount, and quality of ground water in the area and the effects of the heavy pumping, as a guide to the potentialities of ground water here and in other similar areas in east Tennessee.

PREVIOUS INVESTIGATIONS

No previous ground-water investigations, other than isolated water-level and spring-discharge measurements, had been made in the area. The geology of the area has been studied and described by Safford (1869), Campbell (1899), Keith (1903), King and others (1944), and most recently by Rodgers (1953). The Tennessee Division of Geology is studying the crystalline rocks in northeast Tennessee.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the aid and advice given by his colleagues in the Geological Survey and the Tennessee Division of Geology. Particular thanks are given to Mr. J. P. Fuller of the American Bemberg Division, Beaunit Mills, Inc., for his cooperation in this study. Many residents of the area supplied information and permitted measurement of their wells.

WELL-NUMBERING SYSTEM

Each well or spring was numbered consecutively in the field. If the owner had more than one well a second number followed the field number. This second number is the same as that assigned by the owner. Springs are indicated by the letter "S."

GEOGRAPHY

LOCATION AND SIZE OF AREA

The Elizabethton-Johnson City area is in Carter and Washington Counties in northeastern Tennessee. (See fig. 50.) It includes two cities, Elizabethton and Johnson City, and several rural communities. The area resembles a flattened "V", the longer dimensions extending in an eastward direction. Holston Mountain forms a natural boundary on the north; on the other three sides the boundaries are arbitrary. The area is north of latitude 36°15′ N. and between longitude 82°00′00″ and 82°22′30″ W. and comprises approximately 250 square miles.

TOPOGRAPHY AND DRAINAGE

The western two-thirds of the area lies within the Valley and Ridge province and the remainder—comprising part of Holston Mountain, Iron Mountains, and Buffalo Mountain—is in the Blue Ridge province.

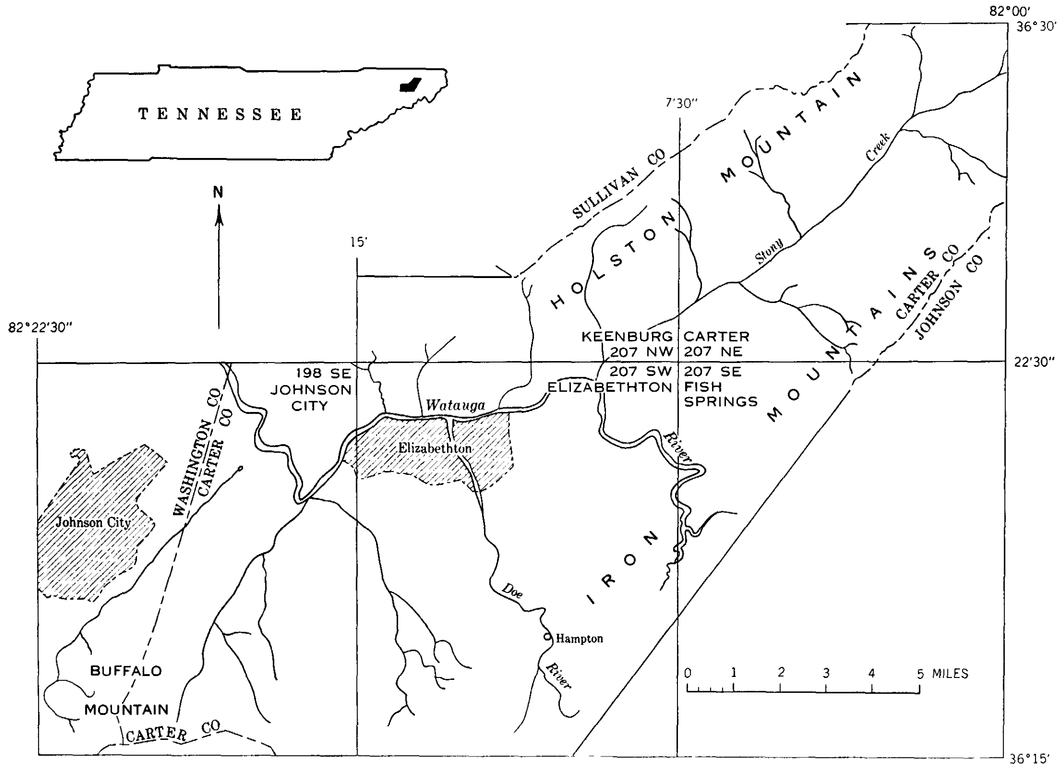

Figure 50.—Location map of the Elizabethton-Johnson City area, Tennessee.

Most of the ridges of the Valley and Ridge province are northeastward-striking monoclines. The higher ridges are composed of resistant sandstone and the lower ones of cherty limestone and dolomite. Chert and clay weathered from the limestone and dolomite form a residual cover that to some extent protects the bedrock from surface erosion. Several prominent ridges, such as Bryant Ridge south of Elizabethton and Tannery Knob near Johnson City, are as high as 2,000 feet above sea level.

Floors of the valleys occupy less than half of the area. The long, narrow valley of Stony Creek (plate 14) extends northeastward for about 12 miles from Hunter to the upper end of the valley near the juncture of Iron Mountains and Holston Mountain. In this distance the valley floor narrows from a little less than 2 miles to a few hundred feet in width at the northern end. The valley of Stony Creek is approximately 2,300 feet above sea level at the northern end and 1,700 feet above sea level in the southern part. The valleys of the Watauga and Doe Rivers, which transect the major ridges, are distinct from the structurally controlled erosional valleys of the Valley and Ridge province.

Holston Mountain and Iron Mountain are a part of the Blue Ridge province. The even-crested tops of both mountains are nearly accordant. The highest point within the area is on Holston Mountain, at the county line between Carter and Sullivan Counties, and is slightly more than 4,200 feet above sea level. Buffalo Mountain, a few miles south of Johnson City, also is a prominent land feature. It is not directly related to Holston Mountain and Iron Mountain, and only the northern part of Buffalo Mountain is within the area.

Areas underlain by limestone and dolomite, such as those south of Elizabethton and east of Johnson City, have an early stage of karst topography. A few of the larger sink holes south of Elizabethton cover more than 10 acres and have depths of approximately 80 feet. Within the older sinks recent collapse features are common. Some of the drainage outlets of the sinks are plugged, and as a result water collects in the bottoms to form small lakes during periods of extended precipitation. Some of these sink lakes have drained suddenly as a result of washing out of the soil plugs.

Surface drainage is well formed in most of the area. All the streams eventually flow into the Watauga River, which in turn flows northwestward and joins the Holston River near Kingsport, Tenn.

CLIMATE

The climate of the area is humid, middle latitude and is characterized by summers having no extended dry period. The winters are mild, except for erratic cold periods that generally last less than a week. The temperature during the summer commonly exceeds 90° F during the day but is lowered during the night by breezes from the nearby mountains.

The average growing season is 183 days and extends from April 20, the average date of the last killing frost in the spring, to October 20, the average date of the first killing frost in the fall. The average July temperature is 74° F and the average January temperature is 38° F.

The average annual precipitation is about 42 inches. (See fig. 51.) It is fairly evenly distributed throughout the winter, spring, and summer, but it is slightly less during the fall. (See fig. 52.) The rainfall is generally sufficient to supply needs of crops, but infrequent droughts substantially lessen crop yields.

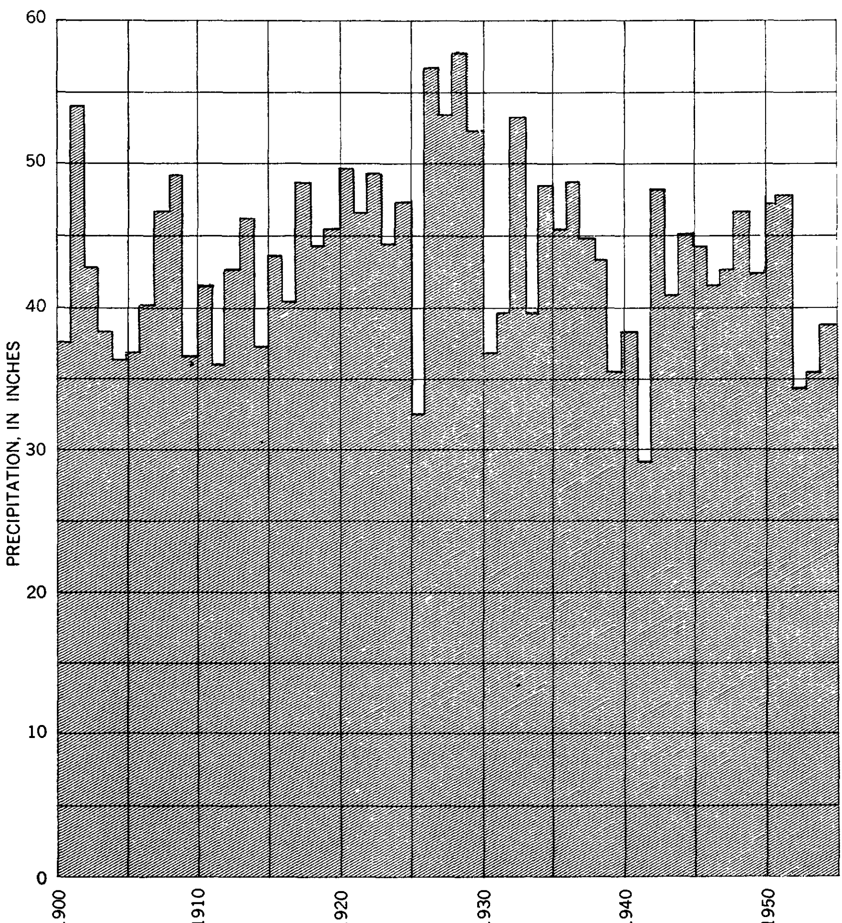

FIGURE 51.—Annual precipitation at Elizabethton, Tenn., 1900–54.

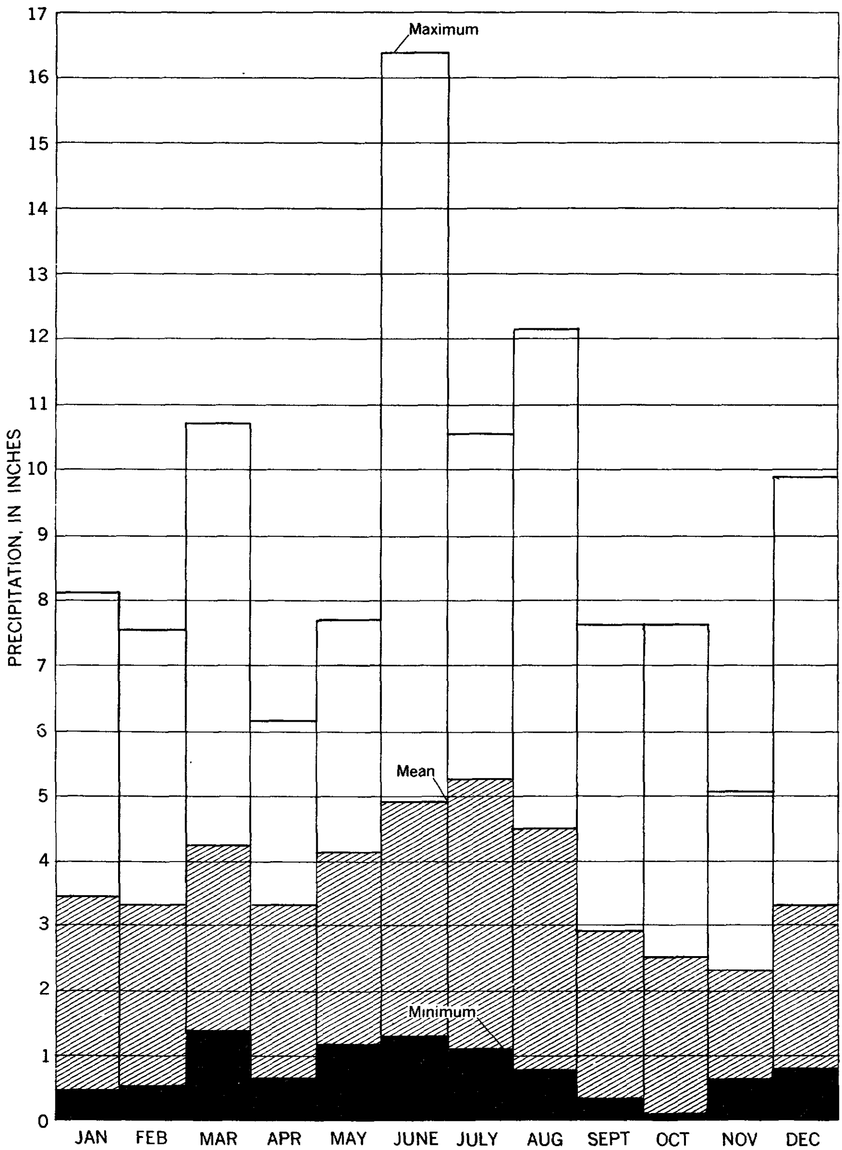

FIGURE 52.—Monthly precipitation at Elizabethton, Tenn., 1891–1953, period of record from 1891–1953 U.S. Weather Bureau.

CULTURE

AGRICULTURE

In Carter and Washington Counties there are many small farms of less than 10 acres on the flanks of the ridges or paralleling narrow creek valleys that wind sharply down the slopes. A few large farms occupy areas along a wide fertile flood plain of the Watauga River. The agriculture census of 1950 shows that income from farms within the area is small. In Carter County farm income from all products was only $1,221,325, or $420 per farm. Income from most of the farms was less than $250, and no farm produced commodities valued at more than $10,000 in one year. Small farm income, however, is not indicative of poverty, as many of the farms are owned by people who have other employment.

Corn, green beans, and tobacco are the most common field crops. Tobacco is the main money crop. Livestock and dairy farms, which are not as common as field-crop farms, are found in the lower, wider valleys. Irrigation is not generally practiced.

TRANSPORTATION

Johnson City is the transportation center for the area. The Southern Railway System and the Clinchfield Railroad Company have stations in Johnson City. The former connects the area with other areas to the south and north. The latter, extending from Spartanburg, S.C., to Elkhorn City, Ky., is a bridge line from the Middle West through the Kentucky and Virginia coal fields to the Piedmont section of the Carolinas.

Commercial airlines that regularly serve the Tri-Cities (Bristol, Johnson City, and Kingsport) Airport are Capital Airlines and American Airlines.

The area has a good system of Federal and State highways and secondary roads. State Routes 67 and 91 cross the area from the east and intersect U.S. Highway 11E at Johnson City. U.S. Highway 19E trends northward and passes through Elizabethton.

INDUSTRIES

The North American Rayon Corp. and American Bemberg Division, Beaunit Mills, Inc., are the largest industries within the area. The plants employ more than 1,000 people. In addition to textiles and textile products, boxes, lumber, furniture, twine, flour, chewing gum, lime, brick, and tile are manufactured. Ample supplies of labor, electric power, and water have made the Elizabethton-Johnson City area favorable for industry.

MINERAL PRODUCTS

In the past both Carter and Washington Counties have produced manganese. Carter County contains more than 28 manganese mines and prospects, about half of which have been productive. Many of them lie along the contact between the Shady dolomite and the Erwin formation on the northwest slopes of Iron Mountains and eastern slopes of Holston Mountain. The manganese occurs principally in residual clays of the Shady dolomite near its contact with the Erwin formation.

From 1917 to 1942 the two counties produced 55,519 long tons of manganese, which represented more than three-quarters of the total production of the State (King and others, 1944). Most of the production came from the Bumpass Cove district in Washington County, 15 miles southwest of the Elizabethton-Johnson City area, which produced 26,531 long tons.

Bauxite occurs in Carter County in small isolated deposits on the southwest end of Holston Mountain, about 1 mile northeast of Keenburg and about 4 miles north of Elizabethton. These deposits have been mined intermittently but not in recent years.

Iron and pyrite were mined and smelted in the Stony Creek and Bumpass Cove districts during the 19th century and the early part of the 20th century. Most of the iron was used locally in the manufacture of farm implements. Small deposits of zinc and lead are found in Carter County, one near Elizabethton on the north side of the Watauga River. (King and others, 1944.) Limestone is quarried in both counties, mainly for road metal and agricultural lime. Recently there has been considerable prospecting for uranium in the rocks of the Precambrian complex but as yet no production has resulted (Tennessee Division Geology, oral communication).

WATER

The municipal water supplies of Elizabethton and Johnson City are obtained from springs. Those that supply Elizabethton are at Hampton, about 7 miles south of Elizabethton. The springs that supply Johnson City are along Indian Creek approximately 10 miles south of that city. These springs provide adequate quantities of water for present municipal requirements. During August 1953, Elizabethton and its outlying districts used 1.2 million gallons of water daily. The municipal springs of Johnson City supply more than 5 mgd to users within the city during the summer.

In addition to those supplied by the municipal systems, several industries have their own sources of water. The rayon plants at Elizabethton use about 17 mgd, of which 12 mgd is pumped from wells and 5 million from the Watauga River. Note that figure 55 shows the pumpage at the plant of American Bemberg Division but does not include that of the North American Rayon Corp.

GEOLOGY

The consolidated rocks that underlie the area are mostly sedimentary and range from Precambrian to Ordovician. Unconsolidated deposits of late Tertiary and Recent age are present in the stream valleys beneath and on terraces along these valleys. The structure of the area is complex, having features of both the Blue Ridge and the Valley and Ridge types. The Shady Valley thrust sheet, which contains a complete sequence of rocks ranging from the Precambrian basement complex to the Sevier shale of Ordovician age, covers most of the eastern part of the area. This thrust sheet is folded into the Stony Creek syncline. The features in the western part of the area are of the Valley and Ridge type and are less complex than those of the Blue Ridge type.

The stratigraphy is well described by Rodgers (1953) and King and others (1944), and for more detailed information the reader is referred to these sources. The geology of the area as compiled by Rodgers is shown on plate 14.

ROCK FORMATIONS AND THEIR WATER-BEARING PROPERTIES

PRECAMBRIAN COMPLEX

The oldest rocks in the area, which are Precambrian or of Proterozoic age, are a sequence of granites and metamorphic rocks of unknown origin. This sequence of rocks is a part of the thrust sheet forming the mountainous terrain south and east of Elizabethton. Good exposures occur along U.S. Highway 19E between Hampton and Roan Mountain village.

Rocks of the Precambrian complex underlie only a small part of the area covered by this investigation. They were not studied by the writer, as there are no wells in them.

CHILHOWEE GROUP

The Chilhowee group, also locally termed the "basal clastics", overlies the crystalline complex unconformably. It is thought to be of Early Cambrian age and is approximately 4,000 feet thick (King, 1950). The group consists of the Unicoi, Hampton, and Erwin formations. This sequence grades from arkosic sandstone and conglomerate at the base, through shale in the middle part, to siltstone at the top. It probably represents a continuous depositional sequence. The rocks of the Chilhowee group, especially the quartzites and conglomerates, form bold topographic features such as Holston Mountain and Iron Mountain.

The rocks of the basal clastic group are poor aquifers, and few wells exist within their outcrop area. None were found in the Unicoi and Hampton formations. The Erwin formation, which contains some sandy shale, siltstone, and very fine grained sandstone, yields small quantities of water to wells in the Stony Creek district. In the areas where quartzite and slate crop out, springs are used as sources of water rather than wells.

SHADY DOLOMITE

The Shady dolomite of Early Cambrian age is widely distributed in northeastern Tennessee and underlies much of the Elizabethton-Johnson City area. The dolomite crops out in the lowland formed by the Stony Creek syncline between Iron Mountain and Holston Mountain. In Stony Creek valley and near Hampton it is about 1,150 feet thick. The Shady dolomite is extensively jointed and in many places brecciated. Brecciation of limestone and dolomite beds has resulted from movement along the faults, but subsequent mineralized solutions have precipitated secondary calcite in some of the fractures.

The Shady dolomite includes several types of dolomite. Blue dolomite is the most common and it occurs in massive beds, 5 feet or more thick, and in thin beds that contain silty partings. Nodules of chert are abundant in some layers. White dolomite also is present but is not as common as the blue dolomite. Ribboned dolomite is common in the Stony Creek district, the ribboned appearance being the result of alternating layers, half an inch thick or less, of dark- and light-blue-gray dolomite.

The Shady dolomite is very susceptible to weathering and in most places is overlain by a thick residual clay mantle containing insoluble material, part of which is quartz dolocasts.

Drilled wells in the Shady dolomite commonly yield 10 gpm. The yields of wells are larger in the Stony Creek valley, where the Shady dolomite is more highly fractured. Dug wells in the residuum commonly obtain water from perched bodies of water. These wells generally yield less than 2 gpm, and many of them are dry in the late summer and early fall.

ROME FORMATION

The Rome formation of Early Cambrian age crops out extensively in east Tennessee, where it forms many of the lower hills. It is difficult to determine the exact thickness of the Rome formation because of its complex structure and the general absence of complete sections. At Valley Forge the Rome is about 1,200 feet thick (King and others, 1944).

The Rome formation is lithologically heterogeneous. In northeastern Tennessee substantial parts of the formation are carbonate rock and the remaining parts are siltstone, variegated shale, and minor amounts of fine-grained sandstone.

Interbedded with the shale, especially with the green shale, are many beds of light-gray shaly dolomite, generally less than 2 feet thick. Blue-gray fine-grained crystalline dolomite commonly occurs in the formation in massive beds, 15 to 100 feet thick. The shale of the Rome formation in most places is greatly deformed. Primary structures, such as ripple marks and raindrop imprints, are common in the shale beds. The dolomite of the Rome weathers to a yellow clay, which contains chert nodules in a few places. The shale weathers into small chips; the siltstone weathers to silty clay.

The Rome formation yields only small quantities of water. Perched water bodies, generally within 20 feet of the land surface, are common. Many small springs or seeps occur along the flanks of the hills and mountains where the Rome is the underlying formation. These springs are found where a perched water table intersects the land surface.

HONAKER DOLOMITE

The Honaker dolomite of Middle Cambrian age is widely distributed in northeastern Tennessee and southwestern Virginia. Within the area studied it underlies Elizabethton and much of the area to the south. The thickness of the formation averages about 1,200 feet. Exposures of the upper part of the formation are sparse. However, a good section is exposed along the east side of the Doe River between Elizabethton and Valley Forge. The Honaker dolomite forms lowlands upon which an early-mature stage of karst topography has developed in some areas.

The formation is predominantly dolomite. It contains some beds of limestone and the beds of the lower part of the formation are shaly. The dolomite and limestone are light to dark gray, fine to coarse grained, and thin to massively bedded. The dolomite weathers to a clay soil, and chert is abundant in the soil derived from the dolomite in the lower part of the formation. The shaly limestone weathers to a thin soil containing chips of silty clay.

The Honaker dolomite is the most productive aquifer within the area. The yields of wells in the formation vary considerably. Wells near the Watauga River at the rayon plants in Elizabethton yield as much as 2,500 gpm, whereas those in higher areas away from surface streams yield about 10 gpm.

UPPER PART OF THE CONASAUGA GROUP

The upper part of the Conasauga group of Middle and Late Cambrian age underlies only a small part of the area considered. It crops out in a narrow loop-shaped band between the Honaker dolomite and the Knox group and forms the lower slopes of ridges composed of cherty siltstone or dolomite. Its thickness varies. North of Johnson City it is more than 500 feet thick; south of Elizabethton it is about 250 feet thick.

The upper part of the Conasauga group is composed of calcareous shale and shaly limestone. Beds of massive blue limestone occur in the upper portion. The shale and shaly limestone are bluish gray and gray and weather to a yellowish green silty-clay soil that is commonly rather thin. Few unweathered exposures are available.

This part of the Conasauga group is a relatively unimportant aquifer in the area because of its limited areal extent. Wells with small to moderate yield generally are obtainable. Larger yields are obtained from wells in the limestone beds.

KNOX GROUP

The Knox group of Late Cambrian and Early Ordovician age underlies a larger area in east Tennessee than any other stratigraphic unit. The cherty beds within the Knox underlie ridges and the less cherty ones underlie valleys. The Knox group has been divided in some localities in northeast Tennessee into the Conococheague limestone in the lower part and the Jonesboro limestone in the upper part. The thickness of the Knox ranges from 3,000 to 4,000 feet in northeastern Tennessee.

The lower part of the Knox consists of dark-blue-gray limestone containing thin layers of silty dolomite that produce a ribboned appearance on weathered surfaces. Interbedded with the ribboned limestone are beds of light- and medium-gray dolomite. Chert occurs as dark nodules in the lower part, and coarse-grained sandstone occurs near the base. The upper part of the Knox is predominantly dark-blue limestone. Beds of gray dolomite, a few feet thick, also are present. The limestone and dolomite weather deeply and produce a dark-red soil.

Many springs and wells in the area tap the Knox group as it is an important aquifer for domestic supplies, yielding generally more than 10 gpm. In some areas underlain by the Knox, where sinkholes are many, the chances of obtaining a water-yielding well are less than in other areas, as the ground water generally is confined to widely spaced large channels. Hence, the chance that a well will intersect a saturated space in the rock is small.

Big Spring, 526–S, shown on plate 14, and several other large-yield springs derive water from the Knox. The discharges of these springs vary with the season. For example, the measured flow of Big Spring (fig. 53) has ranged from less than 2 cubic feet per second (cfs) or about 900 gpm in the dry fall months to more than 19 cfs or about 8,500 gpm in the early spring. During periods of high discharge the water becomes turbid.

SEVIER SHALE

The Sevier shale of Middle Ordovician age underlies part of the area north of Johnson City. The knobby and hilly landforms are typical of areas underlain by this formation. The thickness of the Sevier in the area is not known, but north of Johnson City it is more than 1,000 feet thick.

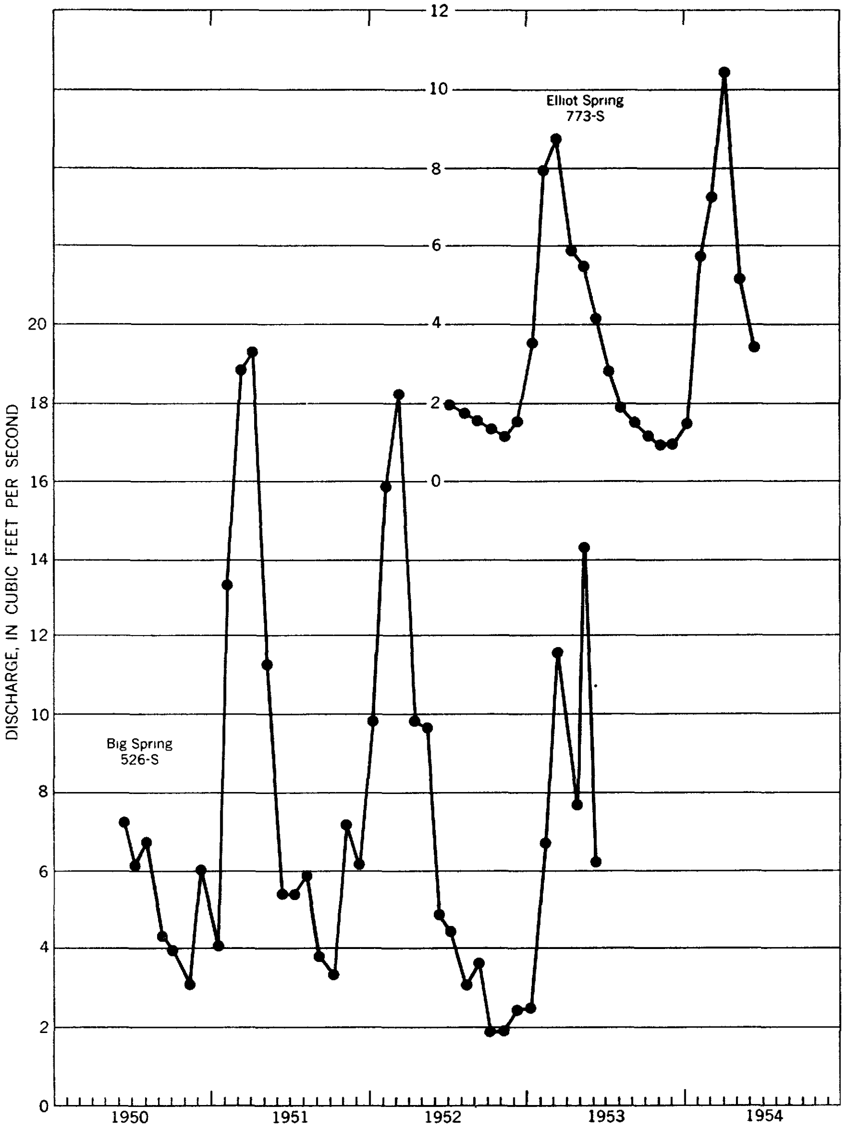

FIGURE 53.—*Monthly discharge from springs in carbonate rock.*

A large part of the Sevier shale consists of blue, silty to sandy, calcareous shale. Black carbonaceous fissile shale beds containing graptolites compose a minor part of the formation. Intraformational conglomerate has been found in several areas outside the Elizabethton-Johnson City area. Scattered beds of gray limestone and calcareous shale also are present. The formation has an extensive joint system.

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On weathered exposures the Sevier shale appears to be cut by many minor joints. However, on a fresh surface the joints are not apparent. The Sevier shale generally weathers to a thin pale-yellow soil.

The formation yields 10 gpm to wells in some localities. No wells of large yield are known. The water derived from the formation commonly is highly mineralized.

ALLUVIUM AND TERRACE DEPOSITS

In the Elizabethton-Johnson City area ground water occurs in openings along fractures and bedding planes in the consolidated rocks underlying the area, and in the pore spaces between the particles that make up the residuum, alluvium, and terrace deposits. Where limestone and dolomite are traversed by permanent streams, the openings in these rocks apparently have been enlarged considerably by solution. Wells having the largest yields generally are near streams

WATER TABLE

The water table is the upper surface of the zone of saturation except where that surface is formed by an impermeable body. Under water-table conditions the static water level in a well coincides approximately with the water table. Ground water is said to be perched if it is separated from an underlying body of ground water by unsaturated rock. Perched water belongs to a different zone of saturation from that occupied by the underlying ground water. Its water table is a perched water table, in contrast to that of the lower zone of saturation, which is called the main water table. In the area considered in this report, water-table conditions exist. In areas underlain by the Rome formation and in areas where the Shady dolomite is weathered deeply and a thick cover of residual clay exists, perched bodies of water, generally within 20 feet of the land surface, are common.

The water table is not level or uniform but is a warped, sloping surface conforming in a very general way to the land surface. Irregularities in slope and in direction of slope are caused by differences in the thickness or permeability of the water-bearing material or by unequal additions or withdrawals of water. Ground water moves in the direction of the slope of the water table, and the rate of movement through a uniform cross section is proportional to that slope (hydraulic gradient) and to the permeability of the water-bearing material. The configuration of the water table can be shown by contour lines. Sufficient information was not collected during this study to permit constructing a water-table contour map.

Most of the observation wells are in the Rome formation and Shady dolomite; however, several were in the Honaker dolomite and the Knox group. More than half were dug wells less than 30 feet deep.

Of the wells measured, well 571 in the Rome formation had the greatest fluctuation in water level during the 14-month period—64.11 feet. The water level was lowest in this well in November 1952 and the highest in February 1953. There was no seasonal change in the water level in well 817 (fig. 54), which is within 150 feet of the Watauga River and reflects changes in the river stage. Well 885 is near the top of a steep hill underlain by the Rome formation. The water level in this well was not affected appreciably by precipitation except during the winter when the moisture was adequate to bring the soil to field capacity and water could percolate to the water table. Wells 525 and 808 are in rolling limestone terranes. Local precipitation is quickly reflected by a rise in the water level in these wells. Other miscellaneous measurements of water levels in wells penetrating the different formations of the Elizabethton-Johnson City area are given in table 2.

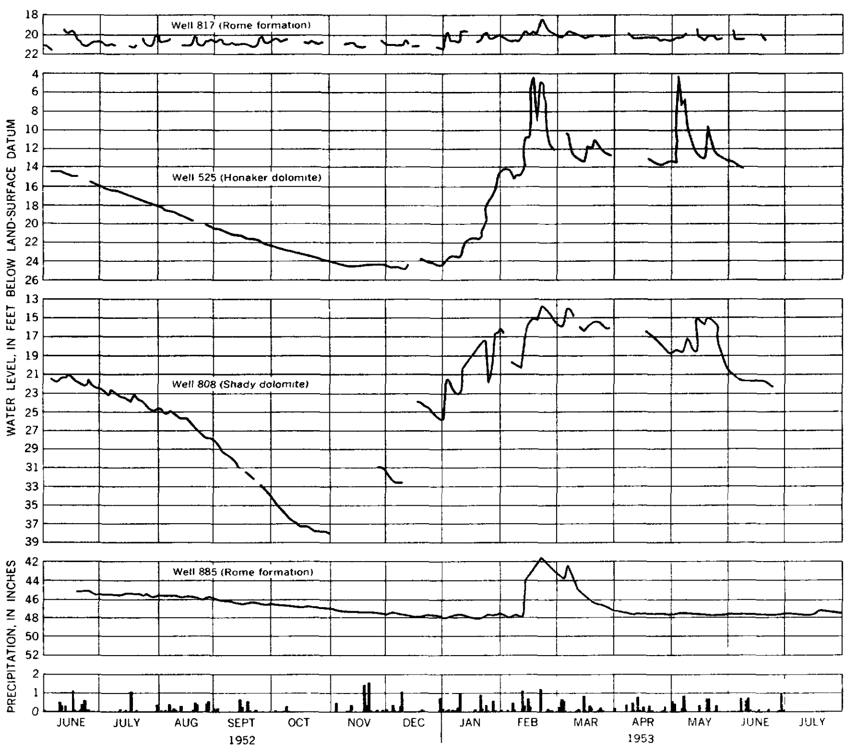

FIGURE 54.—Fluctuations of water levels in wells in the Elizabethton-Johnson City area and precipitation at Elizabethton.

The water table is lowest during the late fall. Water levels in the wells in the Rome formation respond more slowly to precipitation than those in the carbonate rocks. Within the area some of the dug wells, especially those in the Rome, go dry during the late fall. Water levels in drilled wells generally were lower than those in dug wells. Many dug wells probably are finished in zones of perched water.

RECHARGE AND DISCHARGE

In the Elizabethton-Johnson City area the direct infiltration of precipitation, and seepage from streams at high stages, are the principal means of recharge to the ground-water reservoirs. Ground water is discharged from the area by evapotranspiration, by seepage into streams except when they are at high stages, and by springs and wells. The rates of recharge and discharge are affected by many factors, such as the depth to the water table, the nature of the vegetative cover, and the season of the year. No attempt was made to determine the total amounts of recharge and discharge in the area, but, as a part of the investigation, a study was made to determine whether the wells at the North American Rayon Corp. and the American Bemberg Division, Beaunit Mills, Inc., derive part of their water from the Watauga River. These rayon plants use about 12 mgd of ground water (fig. 55). Seven wells within an area of half a square mile supply the major part of the water for the plants. The well diameters range from 18 to 30 inches, and the depths range from 180 to 700 feet. The yields of the wells range from 450 to 2,500 gpm, and the drawdown in each well is less than 50 feet. The wells are in the Honaker dolomite, which, at this location contains numerous large solution openings.

For the following reasons it is believed that the ground-water reservoir at the plant site is partly recharged by the Watauga River. First, a hydraulic gradient appears to exist from the river to the wells. The surface elevation of the Watauga River just north of the rayon plants is slightly less than 1,500 feet above sea level and the pumping levels in the wells are about 1,440 feet. Second, two wells have been abandoned because they were polluted by water that could have come only from the river. Channels between the river and the wells probably were flushed of clay owing to the increased movement of river water to the wells. Third, chemical analyses of water samples taken from the Watauga River and Honaker dolomite indicate that the well water is intermediate in composition between river water and normal ground water. Water samples from the Honaker dolomite were taken at two places, one remote from the Watauga River and the other near the stream. A graphic presentation of the chemical data is shown in figure 56. The analysis of water from

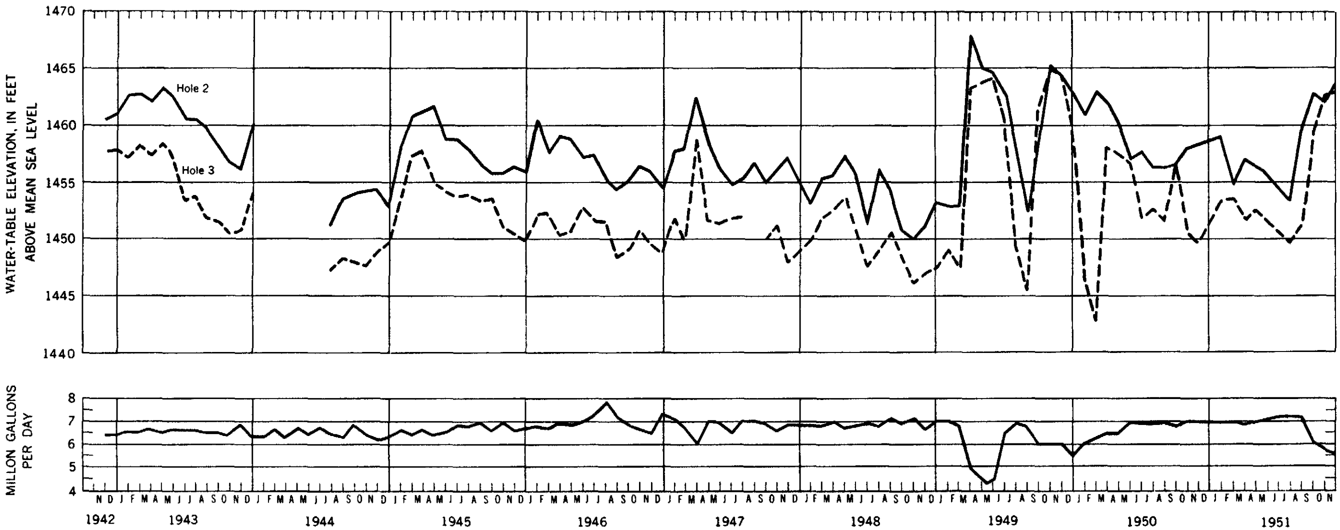

FIGURE 55.—Hydrographs of observation wells at American Bemberg Division, Beaunit Mills, Inc., and graph of average daily pumpage of well water, 1942–51.

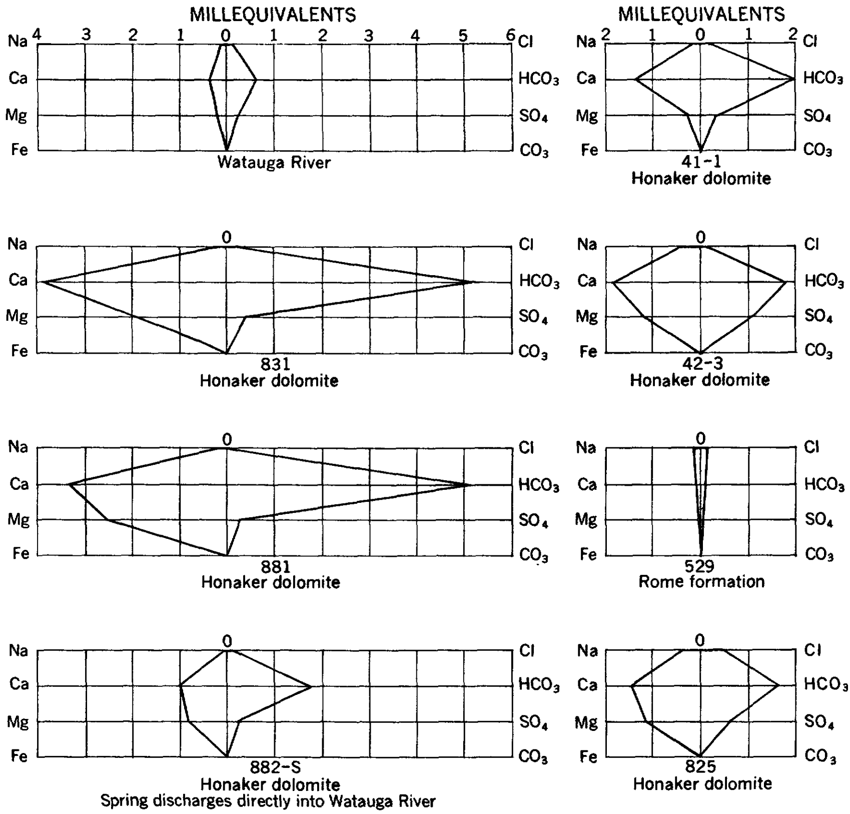

FIGURE 56.—Graphic diagrams of water analyses.

well 831, shown in figure 56, is considered representative of normal water from the Honaker, whereas that from the spring 882–S represents ground water diluted by water from Watauga River. Fourth, the comparison of the hydrographs of the two wells with the daily average pumpage at the American Bemberg show no general lowering of the water table for the years 1943 through 1951. This fact indicates a recharge boundary exists which is almost certainly the Watauga River.

Several other methods to determine the source of recharge were attempted, but the results were inconclusive. Fluorescein dye was used to color the Watauga River for a period of 2 hours, but no dye was visible in the water from the wells at the plant 96 hours after introduction of the dye. Failure to find the dye in the well water does not necessarily indicate that there is no movement of water from the river to the wells, as the fluorescein dye may have been absorbed by clay particles, or the dilution in the river water may have been too great. The temperature of the water obtained from the wells varies slightly but does not conclusively indicate a surface-water source. A calculation of seepage loss from the river in the reach near the wells could not be made because the river discharge is so large that any seepage loss would be within the limit of error of the stream-gaging measurements.

CHEMICAL QUALITY OF THE WATER

All ground water contains some dissolved mineral substances. The most common are sodium, potassium, calcium, magnesium, iron, aluminum, bicarbonate, carbonate, sulfate, chloride, fluoride, and nitrate compounds. Silica, which is assumed to be present in colloidal form, is an important constituent also. These substances are derived from the air and soil and from the decomposition of rocks. The amount and kind of dissolved matter contained in ground water differ greatly from place to place, depending upon the amount and type of organic material in the soil zone, the types of rocks through which or over which the water moves, the length of time that the water is in contact with the rocks, and the temperature of the water. Some rocks contain easily soluble salts, and water from such rocks may be so highly charged with minerals that it cannot be used for some purposes. In contrast, other rocks may be composed of relatively insoluable minerals, and water from them will be low in mineral content.

Analyses of samples of water collected in the Elizabethton-Johnson City area are given in table 3.

Hardness of water is usually recognized by the soap-consuming capacity of the water, that is, the amount of soap required to make a permanent lather. Hardness causes the formation of boiler scale and an objectionable curd with soap. Hardness is due mainly to the presence of calcium and magnesium. Iron, aluminum, and some other substances cause hardness but generally are present in quantities so small that they do not contribute appreciably to hardness. Calcium, magnesium, and other substances that form hardness equivalent to the carbonate and bicarbonate, form carbonate or "temporary" hardness, which can be removed almost entirely by boiling the water. Quantities in excess of the carbonate and bicarbonate form noncarbonate or "permanent" hardness.

Water with a concentration of less than about 60 ppm (parts per million), expressed as calcium carbonate ($CaCO_3$), is considered soft. Water having a concentration of 60 to 120 ppm is rated as moderately hard. Water having a concentration of more than 120 ppm is considered hard, and of more than 200 ppm, very hard.

Various standards have been proposed to evaluate a water for drinking purposes. The United States Public Health Service (1946)

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recommended as drinking water standards for common carriers in interstate commerce the following concentration limits of chemical substances in natural or treated waters, which preferably should not be exceeded:

Constituent	*Concentration* (ppm)
Iron and manganese together	0.3
Magnesium	125
Sulfate	250
Chloride	250
Dissolved solids	500

Dissolved solids of 1,000 ppm are permitted if better water is not available. The concentration of fluoride must not exceed 1.5 ppm.

Water derived from carbonate rocks, such as the Shady and Honaker formations and Knox group, has a relatively high bicarbonate content. (See table 3.) Water from the siltstone, mudstone, and sandstone of the Rome formation is not as hard as that from the carbonate rocks.

Water from the wells in the Honaker dolomite at the rayon plants is not as hard as most water from this formation. Because of the proximity of these wells to the Watauga River, surface water of less hardness apparently has mixed with the ground water and the hardness of the well water has been reduced.

A graph of chemical analyses of water demonstrates the types of water and the relative concentrations of the mineral constituents. (See fig. 56.) In the diagram soft, diluted water from the Watauga River contrasts strongly with the hard, more highly mineralized water from well 831 in the Honaker dolomite.

CONCLUSIONS

In general, the water resources of the Elizabethton-Johnson City area are adequate for present needs. An exception is the area underlain by the Rome formation near Siam, where many wells tapping perched ground water in the residuum go dry during the fall. Most of the drilled wells within the area yield adequate supplies of water during the dry part of the year.

The discharge of springs varies widely. The discharge is at a minimum during the late fall, when some springs cease to flow. Most springs within the area yield less than 20 gpm, but a few have large, though variable, flows.

Recharge is principally from precipitation. Some rains cause the water levels in areas underlain by carbonate rocks to fluctuate as much as several feet. Water is believed to be recharged to the ground from most streams at high stages, but this water (bank storage) returns to the streams rather quickly when their level falls. Recharge is believed to occur year round from the Watauga River in the vicinity of the well fields of the two rayon plants at Elizabethton.

The carbonate rocks are the most important aquifers within the area. The large-yield industrial wells at the rayon plants at Elizabethton are in the Honaker dolomite. No large-yield wells are known in the shale in the area.

The hardness of the water is of the calcium bicarbonate type and the waters are lightly to moderately mineralized.

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
501	Rome formation	2,320	36.5	18.22	Oct. 9, 1951
				5.94	Mar. 9, 1952
				6.30	Apr. 8, 1952
				6.71	June 3, 1952
507	Knox dolomite	1,790	----------	10.45	Oct. 10, 1951
				4.22	Mar. 19, 1952
				10.25	Apr. 8, 1952
				9.55	May 1, 1952
				10.41	June 3, 1952
				10.80	July 1, 1952
				13.78	Aug. 5, 1952
				13.99	Sept. 2, 1952
				13.89	Oct. 3, 1952
				14.02	Nov. 7, 1952
				10.18	Dec. 18, 1952
				10.02	Jan. 17, 1953
				3.00	Feb. 27, 1953
				6.70	Mar. 20, 1953
				9.55	Apr. 24, 1953
				10.14	May 1, 1953
528	Rome formation	1,785	22.5	16.39	Oct. 15, 1951
				10.38	Mar. 20, 1952
				11.18	Apr. 8, 1952
				10.75	May 1, 1952
				12.68	June 3, 1952
				14.22	July 1, 1952
				17.67	Aug. 5, 1952
				19.00	Sept. 3, 1952
				20.12	Oct. 3, 1952
				22.41	Nov. 8, 1952
				15.71	Dec. 19, 1952
				13.21	Jan. 17, 1953
				9.20	Feb. 21, 1953
				10.42	Mar. 21, 1953
				12.14	Apr. 25, 1953
				12.60	June 2, 1953
529	do	1,990	58	46.82	Oct. 15, 1951
				39.60	Mar. 20, 1952
				39.74	Apr. 8, 1952
				39.52	May 1, 1952
				40.63	June 3, 1952
				42.42	July 1, 1952
				43.92	Aug. 5, 1952
				44.55	Aug. 13, 1952
				45.20	Sept. 3, 1952
				48.35	Oct. 3, 1952
				51.39	Nov. 8, 1952
				53.27	Dec. 12, 1952
				54.62	Jan. 17, 1953
				51.22	Feb. 21, 1953
				47.10	Mar. 21, 1953
				45.40	Apr. 25, 1953
				44.60	June 2, 1953

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
530	Rome formation		28.4	19.08	Oct. 15, 1951
				5.95	Mar. 20, 1952
				7.40	Apr. 8, 1952
				5.80	May 1, 1952
				8.22	June 3, 1952
				11.29	July 1, 1952
				16.67	Aug. 5, 1952
				20.98	Sept. 3, 1952
				25.97	Oct. 3, 1952
				dry	Nov. 18, 1952
				10.35	Dec. 19, 1952
				7.00	Jan. 17, 1953
				1.40	Feb. 21, 1953
				5.80	Mar. 21, 1953
				7.70	Apr. 25, 1953
				7.76	June 2, 1953
534	do	1,825	10.3	4.68	Oct. 16, 1951
				3.35	Mar. 20, 1952
				3.75	Apr. 8, 1952
				3.54	May 1, 1952
				3.60	June 3, 1952
				3.91	July 1, 1952
				5.62	Aug. 5, 1952
				5.33	Sept. 3, 1952
				9.60	Oct. 3, 1952
				dry	Nov. 8, 1952
				3.42	Dec. 19, 1952
				3.41	Jan. 17, 1953
				2.60	Feb. 21, 1953
				3.43	Mar. 21, 1953
				3.60	Apr. 25, 1953
				3.70	June 2, 1953
536	do	1,590	23.6	9.76	Oct. 17, 1951
				1.00	Mar. 20, 1952
				0.70	May 1, 1952
				3.05	June 3, 1952
				6.85	July 1, 1952
				8.11	Aug. 5, 1952
				10.72	Sept. 3, 1952
				13.86	Oct. 3, 1952
				16.20	Nov. 7, 1952
				4.05	Dec. 18, 1952
				1.86	Jan. 17, 1953
				0.80	Feb. 21, 1953
				0.80	Mar. 21, 1953
				1.10	Apr. 25, 1953
				1.90	June 2, 1953
561	do	1,515	31.2	21.21	Oct. 28, 1951
				15.11	Mar. 20, 1952
				16.68	Apr. 8, 1952
				16.91	May 1, 1952
				17.95	June 4, 1952
				18.77	July 2, 1952
				21.60	Aug. 5, 1952
				22.10	Sept. 4, 1952
				22.42	Oct. 9, 1952
				23.41	Nov. 8, 1952
				23.48	Dec. 19, 1952
				23.96	Jan. 17, 1953
				17.04	Feb. 21, 1953
				14.74	Mar. 21, 1953
				16.82	Apr. 25, 1953
				18.47	June 2, 1953
562	Honaker dolomite	1,530	14.2	7.20	Nov. 28, 1951
				5.73	Mar. 20, 1952
				6.16	Apr. 8, 1952
				6.62	May 1, 1952
				7.91	June 4, 1952
				9.19	July 2, 1952
				10.20	Aug. 5, 1952
				10.40	Sept. 4, 1952
				10.95	Oct. 4, 1952
				12.02	Nov. 8, 1952
				8.61	Dec. 19, 1952
				7.42	Jan. 17, 1953
				3.76	Feb. 21, 1953
				4.90	Mar. 21, 1953
				6.17	Apr. 25, 1953
				7.30	June 2, 1953

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
563	Honaker dolomite	1,540	18.0	9.80	Nov. 23, 1951
				6.24	Mar. 20, 1952
				7.75	Apr. 18, 1952
				7.40	May 1, 1952
				9.13	June 4, 1952
				9.60	July 2, 1952
				12.52	Aug. 5, 1952
				13.58	Sept. 4, 1952
				15.08	Oct. 4, 1952
				15.73	Nov. 8, 1952
				14.97	Dec. 19, 1952
				13.81	Jan. 17, 1953
				3.44	Feb. 21, 1953
				7.50	Mar. 21, 1953
				10.20	Apr. 25, 1953
				11.70	June 2, 1953
567	Rome formation	1,665	125	56.00	Nov. 28, 1951
				51.22	Mar. 20, 1952
				52.00	Apr. 8, 1952
				53.49	June 4, 1952
				55.12	July 2, 1952
				55.74	Aug. 4, 1952
				56.72	Sept. 4, 1952
				59.45	Oct. 4, 1952
568	Quarternary alluvium	1,563	20.3	13.55	Nov. 28, 1951
				15.11	Mar. 20, 1952
				14.82	Apr. 8, 1952
				13.18	May 1, 1952
				14.57	June 4, 1952
				13.92	July 2, 1952
				13.63	Aug. 5, 1952
571	Rome formation	1,630	70.2	16.88	Nov. 29, 1951
				7.00	Mar. 20, 1952
				10.32	Apr. 8, 1952
				12.52	May 1, 1952
				46.67	June 4, 1952
				55.15	July 21, 1952
				60.74	Aug. 5, 1952
				62.35	Sept. 3, 1952
				64.97	Oct. 3, 1952
				67.48	Nov. 8, 1952
				48.22	Dec. 19, 1952
				23.89	Jan. 17, 1953
				3.37	Feb. 2, 1953
				5.48	Mar. 21, 1953
				18.28	Apr. 25, 1953
609	Shady dolomite	2,395	30.0	9.08	Dec. 5, 1951
				9.80	Mar. 18, 1952
				11.08	Apr. 9, 1952
				9.12	May 1, 1952
				9.84	June 3, 1952
				12.08	July 1, 1952
				12.99	Aug. 4, 1952
				15.78	Sept. 13, 1952
				21.35	Oct. 4, 1952
				27.51	Nov. 8, 1952
				7.44	Dec. 19, 1952
				8.64	Jan. 17, 1953
				8.13	Feb. 2, 1953
				8.38	Mar. 21, 1953
				9.80	Mar. 24, 1953
614	do	2,428	17.2	9.15	Dec. 5, 1951
				7.16	Mar. 18, 1952
				6.88	Apr. 8, 1952
				6.98	May 1, 1952
				8.49	June 3, 1952
				9.48	July 1, 1952
				11.18	Aug. 4, 1952
				12.10	Sept. 3, 1952
				12.15	Oct. 4, 1952
				14.34	Nov. 8, 1952
				8.81	Dec. 19, 1952
				7.92	Jan. 17, 1953
				2.27	Feb. 21, 1953
				5.41	Mar. 21, 1953
				7.60	Apr. 25, 1953
				8.25	June 2, 1953

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
647	Shady dolomite	2,190	57.2	43.42	Dec. 7, 1951
				12.18	Mar. 18, 1952
				11.35	Apr. 8, 1952
				20.73	May 1, 1952
				25.70	June 3, 1952
				30.64	July 1, 1952
				39.65	Aug. 4, 1952
				44.90	Sept. 3, 1952
				54.71	Oct. 4, 1952
				dry	Nov. 8, 1952
				46.03	Dec. 19, 1952
				22.59	Jan. 17, 1953
				8.20	Mar. 21, 1953
				10.16	Apr. 25, 1953
				15.83	June 2, 1953
652	do	2,330	14.2	11.02	Dec. 7, 1951
				10.34	Mar. 18, 1952
				10.70	Apr. 9, 1952
				7.80	May 1, 1952
				10.70	June 3, 1952
				11.58	July 1, 1952
				12.04	Aug. 3, 1952
				12.92	Sept. 3, 1952
				13.31	Oct. 4, 1952
				13.80	Nov. 8, 1952
				9.94	Dec. 19, 1952
				9.08	Jan. 17, 1953
				8.90	Feb. 21, 1953
				9.32	June 2, 1953
656	do	2,220	21.4	12.00	Dec. 7, 1951
				7.48	Mar. 18, 1952
				6.52	Apr. 9, 1952
				7.91	May 1, 1952
				7.83	June 3, 1952
				7.72	July 1, 1952
				9.55	Aug. 3, 1952
662	do	2,122	32.2	11.42	Dec. 7, 1951
				17.73	Mar. 18, 1952
				17.60	Apr. 9, 1952
				15.35	May 1, 1952
				21.39	June 3, 1952
				27.31	July 1, 1952
				27.60	Aug. 3, 1952
				31.20	Sept. 3, 1952
				dry	Oct. 3, 1952
				dry	Nov. 8, 1952
				16.45	Dec. 19, 1952
				7.15	Jan. 17, 1953
				6.20	Feb. 21, 1953
				8.90	Mar. 21, 1953
				12.30	Apr. 25, 1953
				16.09	June 2, 1953
664	do	2,141	42.7	25.42	Dec. 7, 1951
				35.50	Mar. 18, 1952
				35.90	Apr. 9, 1952
				34.52	May 1, 1952
				39.62	June 3, 1952
				dry	July 1, 1952
				dry	Aug. 3, 1952
				dry	Sept. 3, 1952
				dry	Oct. 3, 1952
				dry	Nov. 18, 1952
				39.84	Dec. 19, 1952
				13.37	Jan. 17, 1953
				12.22	Feb. 21, 1953
				17.64	Mar. 21, 1953
				27.90	Apr. 25, 1953
				34.75	June 2, 1953

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
667	Shady dolomite	2,120	18.4	6.78	Dec. 11, 1951
				6.89	Mar. 18, 1952
				6.36	Apr. 9, 1952
				4.95	May 1, 1952
				7.20	June 3, 1952
				11.15	July 2, 1952
				10.45	Aug. 4, 1952
				10.40	Sept. 3, 1952
				12.53	Oct. 4, 1952
				12.58	Nov. 8, 1952
				7.68	Dec. 19, 1952
				5.95	Jan. 17, 1953
				2.74	Feb. 21, 1953
				7.29	Mar. 21, 1953
				8.80	Apr. 25, 1953
				13.70	June 2, 1953
679	do	2,170	22.50	13.12	Dec. 11, 1951
				9.59	Mar. 18, 1952
				8.95	Apr. 9, 1952
				8.20	May 1, 1952
				14.15	June 3, 1952
				15.90	July 1, 1952
				17.01	Aug. 4, 1952
				17.95	Sept. 3, 1952
				18.25	Oct. 4, 1952
				22.24	Nov. 8, 1952
				15.22	Dec. 19, 1952
				8.97	Jan. 17, 1953
				8.02	Feb. 21, 1953
				8.15	Mar. 21, 1953
				10.10	Apr. 25, 1953
				13.05	June 2, 1953
686	do	2,100	60.9	59.62	Dec. 11, 1951
				49.10	Mar. 18, 1952
				49.02	Apr. 9, 1952
				49.11	May 1, 1952
				49.26	June 3, 1952
				49.70	July 1, 1952
				53.51	Aug. 5, 1952
				57.41	Sept. 3, 1952
				58.49	Oct. 4, 1952
				58.62	Nov. 8, 1952
				58.71	Dec. 9, 1952
				58.13	Jan. 17, 1953
				47.92	Feb. 21, 1953
				48.28	Mar. 21, 1953
				49.60	Apr. 25, 1953
				49.90	June 2, 1953
710	do	1,995	45.2	29.29	Jan. 8, 1952
				27.43	Mar. 19, 1952
				26.74	Apr. 9, 1952
				26.70	May 1, 1952
				30.32	June 3, 1952
				34.48	July 1, 1952
				39.67	Aug. 4, 1952
				40.06	Sept. 3, 1952
				49.59	Oct. 4, 1952
				41.01	Nov. 8, 1952
				38.15	Dec. 19, 1952
				35.38	Jan. 17, 1953
				20.90	Feb. 21, 1953
				16.12	Mar. 21, 1953
				27.70	Apr. 25, 1953
				30.34	June 2, 1953

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
714	Shady dolomite	1,935	86	31.50	Jan. 8, 1952
				31.51	Mar. 19, 1952
				30.31	Apr. 9, 1952
				32.43	June 3, 1952
				32.34	July 1, 1952
				32.70	Aug. 4, 1952
				32.79	Sept. 3, 1952
				34.28	Oct. 4, 1952
				33.86	Nov. 3, 1952
				35.81	Dec. 19, 1952
				28.43	Jan. 17, 1953
				21.75	Feb. 21, 1953
				21.48	Mar. 2, 1953
				*38.40	Apr. 25, 1953
				33.95	June 2, 1953
715	Quaternary alluvium	1,890	7.2	3.22	Jan. 8, 1952
				5.24	Mar. 19, 1952
				4.42	Apr. 9, 1952
				5.60	May 1, 1952
				6.25	June 3, 1952
				6.70	July 1, 1952
				6.91	Aug. 4, 1952
				7.16	Sept. 3, 1952
				dry	Oct. 4, 1950
				6.98	Dec. 19, 1952
				5.61	Jan. 17, 1953
				2.40	Feb. 21, 1953
				3.78	Mar. 21, 1953
				5.60	Apr. 25, 1953
				6.20	June 2, 1953
734	Shady dolomite	2,120	15.1	3.75	Jan. 9, 1952
				3.70	Mar. 19, 1952
				3.87	Apr. 9, 1952
				2.75	May 1, 1952
				4.10	June 3, 1952
				4.41	July 1, 1952
				3.87	Aug. 4, 1952
				4.10	Sept. 3, 1952
				4.65	Oct. 4, 1952
				4.60	Nov. 8, 1952
				3.93	Dec. 19, 1952
				2.40	Jan. 17, 1953
				3.18	Feb. 21, 1953
				2.31	Mar. 21, 1953
				2.00	Apr. 25, 1953
				3.40	June 2, 1953
735	do	2,095	38.3	17.59	Jan. 9, 1952
				17.25	Mar. 19, 1952
				17.62	Apr. 9, 1952
				20.68	May 1, 1952
				20.65	June 3, 1952
				23.18	July 1, 1952
				26.50	Aug. 4, 1952
				28.47	Sept. 3, 1952
				28.52	Oct. 4, 1952
				29.74	Nov. 8, 1952
				28.91	Dec. 19, 1952
				24.51	Jan. 17, 1953
				13.88	Feb. 21, 1953
				15.44	Mar. 21, 1953
				19.31	Apr. 25, 1953
				21.46	June 2, 1953

Well had been pumped.

TABLE 1.—*Water levels in wells in the Elizabethton-Johnson City area*—Continued

Well No.	Stratigraphic unit	Approximate elevation (feet)	Depth of well (feet)	Depth to water below land surface (feet)	Date
738	Shady dolomite	2,125	21.2	11.31	Jan. 9, 1952
				12.50	Mar. 19, 1952
				12.65	Apr. 9, 1952
				11.66	May 1, 1952
				15.88	June 3, 1952
				13.86	July 1, 1952
				15.37	Aug. 4, 1952
				16.10	Sept. 3, 1952
				16.17	Oct. 4, 1952
				18.87	Nov. 8, 1952
				15.65	Dec. 19, 1952
				11.71	Jan. 7, 1953
				9.54	Feb. 7, 1953
				10.20	Mar. 21, 1953
				13.15	Apr. 25, 1953
				13.50	June 2, 1953
740	do	2,062	22.0	17.13	Jan. 9, 1952
				17.60	Feb. 19, 1952
				17.81	Apr. 9, 1952
				17.40	May 1, 1952
				17.97	June 3, 1952
				18.34	July 1, 1952
				19.48	Aug. 4, 1952
				19.99	Sept. 3, 1952
				20.63	Oct. 4, 1952
				21.40	Nov. 8, 1952
				18.50	Dec. 19, 1952
				17.04	Jan. 17, 1953
				16.22	Feb. 21, 1953
				16.20	Mar. 21, 1953
				18.00	Apr. 25, 1953
				18.70	June 2, 1953
771	do	1,775	17.4	12.65	Jan. 23, 1952
				12.20	Mar. 19, 1952
				11.80	May 1, 1952
				14.02	July 1, 1952
				14.13	Aug. 4, 1952
				14.25	Sept. 3, 1952
				14.79	Oct. 4, 1952
				14.81	Nov. 8, 1952
				13.41	Dec. 19, 1952
				12.27	Jan. 17, 1953
				10.53	Feb. 21, 1953
				10.95	Mar. 21, 1953
				12.23	Apr. 25, 1953
				13.20	June 2, 1953

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
1-S	710, 300 N 3, 127, 100 E	Hampton Spring	Valley	1, 780				Rome formation				P	Spring used by Elizabethton for municipal supply. See fig. 4.
4-S	721, 700 N 3, 106, 900 E	Big Spring	do	1, 700				Knox dolomite				D, S	
8-S	713, 500 N 3, 090, 500 E	Milligan College Spring.	do	1, 520				do				P	Estimated yield 50 gpm 8/30/55.
34-S	698, 600 N 3, 097, 500 E	C. W. Tucker	do	1, 860				Shady dolomite				D	Estimated yield 5 gpm 9/20/49.
35-S	707, 200 N 3, 067, 700 E	Anderson Spring	Slope	1, 600				Knox dolomite				D, S	Estimated yield 25 gpm 9/20/55.
36	724, 700 N 3, 090, 900 E	— — Bowers	do	1, 620	Dr	302	6	do			J	D	
37	725, 300 N 3, 091, 700 E	Mrs. Hite	do	1, 620	Dr	284	6	do			J	D	
38	740, 300 N 3, 100, 200 E	Range School	do	1, 720	Dr	180	6	do			Cy	P	
39	715, 100 N 3, 102, 150 E	Oak Grove School	do	1, 700	Dr	96	6	do			Cy	P	
40	704, 100 N 3, 097, 150 E	Green Pine School	Valley	1, 900	Dr	75	6	do			Cy	P	
41-1	735, 500 N 3, 107, 200 E	American Bemberg Div., Beaunit Mills, Inc.	do	1, 520	Dr	600	18	Honaker dolomite.	34		T	Ind	Water sample analyzed.
41-2	735, 400 N 3, 107, 300 E	do	do	1, 525	Dr	305	18	do	38		T	Ind	Well No. 1 and No. 2 are pumped simultaneously.
41-3	735, 500 N 3, 107, 400 E	do	do	1, 528	Dr	700	18	do	41		T	Ind	
42-1	734, 700 N 3, 105, 700 E	North American Rayon Corp.	do	1, 500	Dr	180	30	do	42		T	Ind	
42-2	734, 680 N 3, 105, 750 E	do	do	1, 501	Dr	305	18	do				Ab	Well abandoned because polluted by water from the river.
42-3	733, 650 N 3, 106, 200 E	do	do	1, 512	Dr	700	20	do	54		T	Ind	Water sample analyzed.
42-4	734, 300 N 3, 106, 200 E	do	do	1, 517	Dr	483	20	do	62			Ab	Well abandoned because polluted by water from the river.
42-5	734, 900 N 3, 105, 750 E	do	do	1, 509	Dr	305	20	do	51		T	Ind	
42-6	733, 300 N 3, 105, 800 E	do	do	1, 509	Dr	304	20	do	62		T	Ind	

42-7	733,700 N 3,104,800 E	do	do	1,500	Dr	311	20	do	46		T	Ind	
500-S	698,600 N 3,106,500 E	N. Lyons	Slope	2,210				Rome formation.				D, S	Estimated yield half a gpm 10/10/51.
501	697,800 N 3,106,200 E	S. Lyons	Valley	2,320	Du	36.5	18	do	18.22	10/ 9/51	B	D	Observation well.
503-S	701,900 N 3,111,150 E	William Wright	Slope	2,060				do				D	Estimated yield half a gpm 10/10/51.
504-S	702,250 N 3,114,650 E	Tennessee Forest Service.	do	2,360				do				D	Do.
505	706,800 N 3,110,800 E	R. Smith	Valley	1,910	Du	34.2	18	Shady dolomite	33.31	10/10/51	J	D, S	
506	707,000 N 3,108,100 E	Earl Taylor	Slope	2,060	B	185	18	do	15.55	10/10/51	Cy	D, S	
507	711,800 N 3,106,000 E	J. B. Fair	Valley	1,790	Du		30	Knox dolomite	10.45	10/10/51		D	Observation well.
508	708,900 N 3,111,900 E	B. G. Pate	Slope	1,990	Du			Rome formation.	10		Cy	D, S	
509	701,300 N 3,122,300 E	Clyde Clark	Valley	1,875	Du	15.4	30	Shady dolomite	10.94	10/11/51	B	D, S	
510	702,400 N 3,122,800 E	J. W. Street	do	1,870	B	108	12	do	45		J	D	
511	702,500 N 3,118,050 E	G. Stanley	Slope	2,100	Dr	203	8	Rome formation.			J	D, S	
512	702,500 N 3,125,000 E	Helen Norris	Valley	2,070	Du	32.7		do	10.79	10/11/51	B	D	
513	707,400 N 3,125,000 E	Charles Nave	do	1,840	Du	45.1	24	do	39.60	10/11/51	B	D	
514	712,300 N 3,134,650 E	T. H. Saults	Slope	1,920	Dr	185	8	Shady dolomite.	27		J	D	
515	714,700 N 3,136,850 E	—— Johnson	do	2,000	Du	31.8	36	do	14.62	10/13/51	B	D	
516	716,100 N 3,138,150 E	B. H. Peters	Valley	2,030	Du	19.0	30	Rome formation.	7.59	10/13/51	P	D	
517	718,900 N 3,139,000 E	J. M. Hinkle	Slope	2,070	Dr	180	6	do	120			Ab	
518-S	718,200 N 3,139,000 E		do	2,010				do					Estimated yield 3 gpm 10/13/51.
519-S	717,500 N 3,121,850 E	McEtheren Spring	Valley	1,690				Shady dolomite.					Estimated yield 20 gpm 10/14/51.
520	716,000 N 3,120,900 E	R. R. Jenkins	Slope	1,660	Dr	43	6	do	20		Cy	D, S	
521-S	716,350 N 3,120,750 E		Valley	1,645				do				D	Estimated yield 4 gpm 10/14/51.
522-S	716,700 N 3,118,900 E	M. C. Ward	do	1,780				Rome formation.				D	Do.
523	711,400 N 2,113,350 E	—— McKinney	do	1,910	Du	13.6	30	do	10.28	10/14/51	P	D	
524-S	711,100 N 3,113,850 E		do	1,950				do					Estimated yield 3 gpm 10/14/51.
525	713,600 N 3,112,400 E	—— Greenville	do	1,820	Du	31.0	24	Honaker dolomite.	17.86	10/14/51		Ab	Recording gage on well.

TABLE 2.—*Records of wells and springs in the Elizabethton-Jonson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
527	719,500 N 3,124,100 E	J. Wilson	Slope	1,615	Dr	108	6	Rome formation.	50		J	D	
528	719,800 N 3,124,300 E	M. C. Williams	Valley	1,785	Du	22.5		do	16.39	10/15/51	B	D	Observation well.
529	723,300 N 3,128,100 E	R. M. Morrel	Slope	2,010	Du	58	30	do	46.82	10/15/51	B	D	Observation well. Water sample analyzed.
530	726,200 N 3,127,500 E	Floyd Bowers	Valley	1,790	Du	28.4	36	do	19.08	10/15/51		Ab	Observation well.
531-S	726,500 N 3,127,500 E	do	do	1,790				Honaker dolomite.				S	Estimated yield 5 gpm 10/15/51.
532	722,300 N 3,123,800 E	Charles Trivett	do	1,705	Dr	100	8	do	72		J	D	
533	733,500 N 3,132,200 E	G. Nave	do	1,650	Du	51	18	Rome formation.	30		J	D	
534	727,250 N 3,132,000 E	O. Harden	do	1,825	Du	10.3	48	do	4.68	10/16/51	J	D,S	Observation well.
535	741,150 N 3,128,000 E	Harrel & Co.	do	1,560	Dr	127	4	do	48		J	D	
536	742,250 N 3,123,200 E	R. S. Depew	Slope	1,590	Du	23.8	48	do	9.76	10/16/51		Ab	Do.
537	741,000 N 3,124,450 E	do	Valley	1,540	Dr	100		do	28		J	D	
538	738,300 N 3,122,000 E	R. C. Nidiffer	do	1,530	Du	36.2	48	do	20.60	10/17/51	Cy	D,S	
539	738,400 N 3,119,850 E	B. Wilson	Slope	1,560	Dr	90	6	do	64.57	10/17/51	Cy	D,S	
540	738,600 N 3,120,200 E	T. R. Byers	Valley	1,560	Dr	136	6	do	50.18	10/17/51	Cy	D,S	
541-S	740,500 N 3,106,700 E		do	1,560				Honaker dolomite.				D	Estimated yield 4 gpm 10/18/51.
542	745,500 N 3,108,400 E	American Refrigeration Co.	do	1,550	Dr	155	6	do	26		T	Ind	Well pumped at rate of 133 gpm continuously.
543	752,000 N 3,113,350 E	Paul Carr	Slope	1,740	Dr	50	6	do			Cy	D	
544	747,000 N 3,110,600 E	W. G. Woods	do	1,715	B	82	18	Rome Formation.			Cy	D,S	
545-S	751,500 N 3,105,900 E	Charles Campbell	Valley	1,555				Sevier shale				D,D	
546	750,250 N 3,105,700 E	—— Perry	do	1,565	Dr	125	6	do	4–10		Cy	D,S	

560	736,100 N 3,118,250 E	L. R. Hartley	do	1,522	Dr	44	6	Rome formation.	13		J	D	
561	735,800 N 3,117,500 E	Thomas & Lewis	do	1,515	Du	31.2	24	do	21.21	11/28/51	B	D	Observation well.
562	736,300 N 3,121,800 E	R. Wallace	do	1,530	Du	14.2	24	Honaker dolomite.	7.20	11/28/51	Cy	D	Do.
563	736,350 N 3,122,800 E	N. Elliot	do	1,540	Du	18.0	30	do	9.80	11/28/51		Ab	Do.
564-S	736,200 N 3,123,050 E	W. Johnson	Slope	1,550				do					Estimated yield 100 gpm 11/28/51.
565	738,800 N 3,127,900 E	M. Nidiffer	Valley	1,565	Dr	92	6	Rome formation.	42		J	D	
566	740,450 N 3,127,800 E	G. G. Rosenbaum	do	1,562	Dr	87	6	do	40		Cy	D	
567	738,800 N 3,130,000 E	T. W. Wagner	do	1,565	Dr	125	6	do	56.00	11/28/51	Cy	D	Observation well.
568	739,000 N 3,131,800 E	R. G. Cress	do	1,565	Du	20.3	24	Quarternary alluvium.	13.55	11/28/51		Ab	Do.
569	741,700 N 3,129,700 E		do	1,550	Du	62.2	40	Rome formation.	54.48	11/28/51		Ab	
570	741,900 N 3,132,000 E	F. Profitt	do	1,565	Dr	150	6	do	100		J	D	
571	740,200 N 3,135,800 E	Elmer Rash	do	1,630	Dr	70.2	8	do	16.88	11/29/51	B	D	Observation well.
572	747,100 N 3,135,400 E	J. L. Willis	Slope	1,650	Du	21		do	12		J	D	
573	737,750 N 3,135,750 E	Thomas Tredway	do	1,665	Dr	200	6	do	60		J	D,S	
574	737,200 N 3,133,100 E	C. B. Tredway	do	1,570	Dr	105	6	do			J	D	
575	735,750 N 3,133,600 E	Dr. R. C. Collins	Valley	1,580	Du	41.0	40	do	37.95	11/29/51	B	D	
601	778,800 N 3,175,560 E	M. Stout	do	2,365	Dr	26	8	Shady dolomite			J	D	
602-S	777,700 N 3,174,800 E	B. D. Shoun	do	2,340			8	do				D	Estimated yield 30 gpm 12/5/51.
603-S	777,600 N 3,174,000 E	do	do	2,330				do				D	Estimated yield 50 gpm 12/5/51.
604-S	778,200 N 3,174,800 E	T. Shoun	do	2,340				do				D	Estimated yield 150 gpm 12/5/51.
605-S	778,100 N 3,174,150 E		do	2,320				do				D	Estimated yield 25 gpm 12/5/51.
606-S	777,600 N 3,173,750 E	G. Parker	do	2,320				do				D	Estimated yield 15 gpm 12/5/51.
607-S	777,400 N 3,174,220 E	N. R. Holder	do	2,320				do					Estimated yield 50 gpm 12/5/51.
608-S	777,600 N 3,173,150 E	Harry Campbell	do	2,305				do				D	Estimated yield 15 gpm 12/5/51.
609	779,800 N 3,173,000 E	Jesse Hurley	do	2,395	Du	30.0	24	do	9.08	12/ 5/51	B	D	Observation well.
610-S	780,000 N 3,172,800 E	do	do	2,390				do				D	Estimated yield 10 gpm 12/5/51.

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
611-S	777,600 N 3,172,600 E	Pauline Estep	Valley	2,295				Shady dolomite				D	Estimated yield 10 gpm 12/5/51.
612-S	777,500 N 3,172,200 E		do	2,280				do					Estimated yield 15 gpm 12/5/51.
613	778,220 N 3,171,620 E	S. M. Taylor	Slope	2,340	Du	110		do	80		Cy	D	
614	779,200 N 3,171,600 E		do	2,430	Du	17.2		do	9.15	12/ 5/51	P	D	Observation well.
615	772,100 N 3,173,500 E	Robert Hurley	do	2,485	Du	31	18	Quaternary alluvium.	25		Cy	D	
616	774,000 N 3,173,800 E		do	2,475		4.5			4.3	12/ 5/51			Natural well.
617	774,800 N 3,173,600 E	Pearl Estep	do	2,395	Du	21	18	Quaternary alluvium.	15		Cy	D	
618	775,500 N 3,173,100 E	Orville Richardson	do	2,355	Du	29.8	20	Shady dolomite	10.92	12/ 5/51	B	D	
619-S	776,600 N 3,172,900 E	Elmer Richardson	Valley	2,295				do				D	
620-S	776,900 N 3,173,200 E	J. C. Estep	do	2,310				do				D	Estimated yield 15 gpm 12/6/51.
621-S	776,500 N 3,171,200 E	Roy Asher	do	2,265				do				D	Estimated yield 25 gpm 12/6/51.
622	776,000 N 3,171,600 E	R. Campbell	do	2,270	Dr	18	6	Quaternary alluvium.	16		Cy	D	Well goes dry in summer.
623	776,800 N 3,170,800 E	J. A. Myers	do	2,242	Dr	74	6	Shady dolomite	3.08	12/ 6/51	J	D	
624	776,850 N 3,171,200 E	Orville Myers	do	2,240	Dr	67	6	do	3.22	12/ 6/51	J	D	
625-S	776,900 N 3,170,220 E	Charles Cole	do	2,235				do					Estimated yield 10 gpm 12/6/51.
626	776,800 N 3,170,600 E	L. Estep	do	2,230	Dr	83	6	do	5			D	
627	776,100 N 3,170,800 E	Luther Bayers	do	2,230	Dr	152	6	do	15		P	D	
628	775,900 N 3,170,450 E	J. L. Shoun	do	2,235	Dr	200	6	do			J	D	
629-S	779,400 N 3,168,800 E	L. Cole	Slope	2,360				do				D	Estimated yield 25 gpm 12/6/51.
630-S	776,200 N 3,169,300 E		Valley	2,210				do					Estimated yield 40 gpm 12/6/51.

631	775,950 N 3,775,600 E	R. Garland	do	2,210	Dr	20	6	do			J	D	
632-S	776,000 N 3,168,800 E		Slope	2,205				do					Estimated yield 25 gpm 12/6/51.
633-S	774,800 N 3,169,350 E		Valley	2,185				do				D	Estimated yield 5 gpm 12/6/51.
634-S	774,300 N 3,169,250 E	John Taylor	do	2,210				do					Estimated yield 10 gpm 12/6/51.
635-S	772,100 N 3,169,300 E	do	do	2,215				do				D	Estimated yield 20 gpm 12/6/51.
636-S	773,800 N 3,170,050 E		do	2,240				do				D	Estimated yield 10 gpm 12/6/51.
637-S	773,700 N 3,170,500 E	Henry Campbell	do	1,281				do				D	Estimated yield 200 gpm 12/6/51.
638-S	773,800 N 3,171,800 E		Slope	2,365				do					Estimated yield 5 gpm 12/6/51.
639	773,700 N 3,178,200 E	Dewey Grindstaff	Valley	2,170	Du	15.6	18	do	6.01	12/ 6/51	B	D	
640-S	775,420 N 3,170,300 E		Slope	2,395				do				D	Do.
641	773,400 N 3,167,200 E		Valley	2,150	Du	13	24	do	8		J	D	
642	773,750 N 3,166,800 E	A. Hodge	do	2,145	Dr	95	6	do	50		J	D	
643	774,600 N 3,167,000 E	Crawford Taylor	do	2,155	Dr	146	6	do	30		J	D	
644	774,300 N 3,166,500 E	Earl Grindstaff	do	2,145	Du	32	18	do	24		Cy	D	
646	774,400 N 3,165,800 E	Floyd Asher	do	2,135	Du	23	18	do	12		P	D	Observation well.
647	775,900 N 3,166,100 E	Burley Bevins	Slope	2,190	Du	57	30	do	43.42	12/ 7/51	B	D	Do.
648	776,300 N 3,164,550 E	B. Smith	do	2,315	Du	48.0	30	do	47.21	12/ 7/51	Cy	D	
649	776,300 N 3,165,400 E	R. S. White	do	2,245	Du	18	30	do	4		P	D	
650	776,600 N 3,165,200 E	Foster Cole	do	2,260	Du	16	18	do			P	D	
651	777,500 N 3,166,600 E	—— Heatherly	do	2,270	Du	12.0	20	do	9.55	12/ 7/51	P	D	
652	779,150 N 3,165,800 E	Jocie Blevins	do	2,330	Du	14.2	18	do	11.02	12/ 7/51		Ab	Observation well.
653	779,150 N 3,166,450 E	W. Blevins	do	2,460	Dr	35.1	18	do	28.97	12/ 7/51	B	D	
654	773,750 N 3,165,000 E	—— Pritchard	Valley	2,122	Du	12	18	do	6		P	Ab	
655-S	773,800 N 3,164,800 E	James Taylor	do	2,116				do				D	Estimated yield 100 gpm 12/ 7/51.
656	774,600 N 3,162,200 E	Robert Campbell	Slope	2,220	Du	21.4	20	do	12.00	12/ 7/51	P	D	Observation well.
657-S	773,000 N 3,164,350 E	Stony Creek Water Co.	Valley	2,090				do				P	Estimated yield 500 gpm 12/ 7/51.

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*—Continued

Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
658-S	772,200 N 3,164,000 E		Valley	2,080				Shady dolomite					Estimated yield 15 gpm 12/ 7/51.
659	770,900 N 3,162,700 E		do.	2,070	Du	12	18	do.	5		P	D	
660-S	771,000 N 3,163,600 E	Clyde Richardson	do.	2,068				do.					Estimated yield 25 gpm 12/ 7/51.
661-S	771,100 N 3,163,900 E	H. D. Taylor	do.	2,070				do.				D	Do.
622	771,100 N 3,165,000 E	James Hurley	Slope	2,122	Du	32.2	20	do.	11.42	12/ 7/51	B	D	Observation well.
633	770,900 N 3,165,700 E	Herman Bishop	do.	2,155	Du	58	20	do.	40±		Cy	D	
664	771,050 N 3,165,600 E	James Hurley	do.	2,140	Du	42.7	20	do.	25.42	12/ 7/51	B	Ab	Observation well.
665-S	770,550 N 3,168,600 E	Fred Johnson	do.	2,320				do.					Estimated yield 5 gpm 12/ 7/51.
666-S	771,250 N 3,162,700 E	Quinton Richardson.	do.	2,090				do.				D	Estimated yield 5 gpm 12/11/51.
667	771,800 N 3,162,400 E	J. N. Taylor	do.	2,120	Du	18.4	20	do.	6.78	12/11/51	J	D	Observation well.
668-S	769,400 N 3,162,900 E	Paul White	Valley	2,040				do.					Estimated yield 10 gpm 12/11/51.
669-S	769,100 N 3,163,350 E	W. W. Estep	Slope	2,050				do.					Estimated yield 15 gpm 12/11/51.
670	768,800 N 3,165,400 E	Noah Richardson	do.	2,145	Du	18		do.	10		Cy	D	
671-S	768,750 N 3,165,500 E	do.	do.	2,140				do.				D	
672	768,600 N 3,166,100 E	Connie Cole	do.	2,175	Du			do.	6.27	12/11/51	B	D	
673-S	768,700 N 3,167,750 E	M. P. Garland	do.	2,300				do.					Estimated yield 5 gpm 12/11/51.
674-S	767,600 N 3,166,650 E	Granville White	do.	2,240				do.					Estimated yield 10 gpm 12/11/51.
675-S	767,350 N 3,167,000 E	Raymond Arnold	do.	2,325				do.				D	Estimated yield 15 gpm 12/11/51.
676-S	766,800 N 3,163,100 E	Reuben Taylor	do.	2,100				do.					Estimated yield 5 gpm 12/11/51.
677-S	766,600 N 3,163,100 E	Joe Taylor	do.	2,130				do.					Do.

678-S	766,600 N 3,164,100 E	Jess Taylor	do	2,160				do				D	Do.
679	766,800 N 3,164,300 E	E.C. Bishop	do	2,170	Du	22.5	20	do	13.72	12/11/51	J	D, S	Observation well.
680-S	766,500 N 3,161,000 E	Clyde Smith	Valley	2,040				do					
681-S	766,200 N 3,161,700 E	H. J. Heatherly	do	2,060				do					
682-S	765,550 N 3,162,600 E	Vester Grindstaff	Slope	2,085				do				D	Estimated yield 5 gpm 12/11/51.
683	765,100 N 3,162,300 E	Robert Grindstaff	do	2,120	Du	20.0	48	do	8.18	12/11/51	J	D	
684-S	764,200 N 3,163,300 E	Raymond Grindstaff.	do	2,160				do				D	Estimated yield 4 gpm 12/11/51.
685-S	763,600 N 3,165,000 E	Sam Clovers	do	2,345				do				D	Estimated yield 3 gpm 12/11/51.
686	767,100 N 3,159,950 E	Lawrence Davis	do	2,100	Du	60.0	36	do	59.62	12/11/51	J	D	Observation well.
687-S	767,400 N 3,159,850 E	W. J. Markland	do	2,075				Erwin formation.				D	Estimated yield 5 gpm 12/13/51.
688-S	768,000 N 3,159,400 E	M. C. Peters	do	2,090				Shady dolomite.					Do.
689	768,500 N 3,158,800 E	Walter McCloud	do	2,142	Du	24.9	20	do	13.02	12/13/51	Cy	D	
690-S	766,400 N 3,159,950 E		do	2,040				do					Estimated yield 8 gpm 12/13/51.
691	766,200 N 3,159,900 E	Sam Taylor	do		Du	20	20	do	10		J	D	
692-S	767,300 N 3,158,400 E		do	2,100				do				D	Estimated yield 10 gpm 12/13/51.
693	768,100 N 3,157,900 E	M. Arnold	do	2,200	Du	22.9	24	do	4.92	12/13/51		Ab	
694-S	766,000 N 3,159,000 E		do	2,040				do				D	Estimated yield 5 gpm 12/15/51.
695	766,800 N 3,157,800 E	D. Taylor	do	2,110	Du	33.5	24	Erwin formation.	32.15	12/13/51		Ab	
696-S	763,200 N 3,159,300 E	R. H. Taylor	do	1,980				do				D	Estimated yield 10 gpm 12/13/51.
697-S	765,200 N 3,158,200 E	C. G. Taylor	do	2,095				Shady dolomite.				D	Estimated yield 5 gpm 12/13/51.
698	766,000 N 3,157,400 E	J. V. Taylor	do	2,140	Du	25		do	19.11	12/13/51	P	D	
699-S	766,100 N 3,157,800 E	do	do	2,120				do					Do.
700	765,750 N 3,156,550 E	Sherman Taylor	do	2,210	Du	30	24	do	25		B	D	
701-S	766,700 N 3,155,850 E	Virginia Iron & Coke Co.	do	2,320				do				D	Estimated yield 10 gpm 12/13/51.
703-S	764,800 N 3,156,600 E	George Vaughn	do	2,100				Erwin formation.					Estimated yield 5 gpm 12/13/51.
704-S	763,300 N 3,157,650 E		Valley	1,965				do				D	Do.

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
705	762,350 N 3,158,000 E		Slope	1,950	Du	14.0	24	Erwin formation	12.32	12/13/51	B	Ab	
706-S	761,700 N 3,157,700 E		Valley	1,915				Shady dolomite					Estimated yield 5 gpm 12/13/51.
707-S	761,800 N 3,158,000 E	— — Cole	do	1,915				Erwin formation.				D	Estimated yield 10 gpm 12/13/51.
709	761,800 N 3,159,850 E	C. C. Grindstaff	do	1,990	Du	36	30	Shady dolomite	12		P	D, S	
710	760,650 N 3,159,700 E	I. W. Grindstaff	do	1,995	Du	45.2	30	do	29.29	1/ 8/52	B	D	Observation well.
711-S	759,650 N 3,150,600 E		do	2,065				do					Estimated yield 5 gpm 1/8/52.
712	760,000 N 3,159,940 E	Jim Cabel	Slope	2,030	B	128	18	do	70		J	D, S	
713-S	761,300 N 3,156,750 E		Valley	1,920				do					Estimated yield 4 gpm 1/8/52.
714	766,000 N 3,156,200 E	Dan Estep	Slope	1,935	Dr	86		do	31.50	1/ 8/52	J	D	Observation well.
715	760,600 N 3,155,400 E	L. Grindstaff	Valley	1,890	Du	7.2	36	Quarternary alluvium.	3.22	1/ 8/52	B	D	Do.
716-S	758,700 N 3,156,600 E		do	1,960				Shady dolomite					Estimated yield 4 gpm 1/8/52.
717	758,100 N 3,157,500 E	Charles Shelton	Slope	2,005	Du	7.5	24	do	3.44	1/ 8/52		D	
718	758,700 N 3,159,650 E	— — Tanner	do	2,120	Du	15.2	30	do	4.55	1/ 8/52		D	
719-S	761,500 N 3,153,900 E	R. L. Mabe	do	2,030				Erwin formation.				D	Do.
720-S	762,600 N 3,155,000 E	Dewey Taylor	do	2,110				Shady dolomite				D	Estimated yield 5 gpm 1/8/52.
721	762,500 N 3,154,200 E	T. Taylor	do	2,070	Du	20	30	Erwin formation.	10		P	D	
722	763,200 N 3,154,000 E	J. N. Markland	do	2,180	Du	17	24	do				D	
723	760,400 N 3,154,500 E	W. L. Culbert	Valley	1,890	Du	11	24	do	5		P	D	
724	760,800 N 3,154,650 E	Melvin Markland	do	1,890	Dr	108		do	15		J	D	
725-S	760,000 N 3,153,600 E		do	1,895				do				D, S	Do.

726	759,400 N 3,154,500 E	S. C. Davis	do	1,870	Dr	100	---	do	---	---	J	D	
727	759,000 N 3,153,500 E	L. Nidiffer	do	1,868	Dr	90	---	do	---	---	---	---	
728-S	757,350 N 3,156,400 E	W. Rambo	Slope	1,990	---	---	---	do	---	---	---	D	Do.
729-S	756,900 N 3,157,400 E	Robert Peters	do	2,040	---	---	---	Shady dolomite	---	---	---	D	Do.
730-S	756,750 N 3,155,000 E	R. B. Peters	do	1,980	---	---	---	do	---	---	---	---	Estimated yield 5 gpm 1/9/52.
731-S	756,500 N 3,156,000 E	W. M. Branch	do	2,070	---	---	---	do	---	---	---	D	Do.
732-S	756,100 N 3,156,650 E	Gilbert Hardin	do	2,045	---	---	---	do	---	---	---	D	Estimated yield 4 gpm 1/9/52.
733	756,800 N 3,156,700 E	---	do	2,050	Du	20	---	do	10	---	P	D	
734	755,700 N 3,157,500 E	Paul Garbard	do	2,120	Du	15.1	30	do	3.75	1/9/52	B	D	Observation well.
735	754,300 N 3,156,200 E	Dan Peters	do	2,095	Du	38.3	24	do	17.59	1/9/52	B	D	Do.
736-S	752,900 N 3,158,400 E	John Peters	do	2,250	---	---	---	Erwin formation.	---	---	---	D	Estimated yield 10 gpm 1/9/52.
737	753,600 N 3,156,700 E	M. Wilson	do	2,160	Du	32.7	24	Shady dolomite	26.28	1/9/52	B	D	
738	753,500 N 3,156,500 E	Joe Blevins	do	2,125	Du	21.2	24	do	11.31	1/9/52	B	D	Observation wel
739	758,750 N 3,152,800 E	J. I. Bowers	Valley	1,845	Du	44	30	do	36	---	---	---	
740	754,750 N 3,156,100 E	Jim Peters	Slope	2,060	Du	22.0	30	do	17.13	1/9/52	B	D	Do.
741	758,350 N 3,153,600 E	Gene Bradley	Valley	1,835	Dr	84.5	6	do	10	---	J	D	
742	758,600 N 3,152,100 E	Robert Taylor	do	1,840	Dr	109	6	do	15	---	J	D	
743	758,600 N 3,151,650 E	W. C. Cole	do	1,860	Du	26	30	do	19	---	P	D	
744	758,350 N 3,151,700 E	Alex Hardin	do	1,825	Du	18.1	30	do	18.18	1/9/52	---	Ab	
745-S	758,800 N 3,151,500 E	---	do	1,875	---	---	---	do	---	---	---	D	Estimated yield 4 gpm 1/9/52.
746-S	760,100 N 3,150,900 E	W. C. Cole	Slope	1,980	---	---	---	do	---	---	---	D	Do.
747	759,850 N 3,149,750 E	S. V. Grindstaff	do	2,040	Du	35	30	do	---	---	P	D	
748-S	757,500 N 3,151,150 E	Robert Scott	Valley	1,805	---	---	---	do	---	---	---	---	Estimated yield 150 gpm 1/9/52.
749-S	757,100 N 3,151,000 E	— — Hardin	do	1,800	---	---	---	do	---	---	---	---	Estimated yield 100 gpm 1/9/52.
750-S	757,250 N 3,149,200 E	C. A. Ritchie	Slope	1,890	---	---	---	do	---	---	---	---	Estimated yield 5 gpm 1/9/52.
751-S	757,450 N 3,150,450 E	S. Lewis	Valley	1,785	---	---	---	do	---	---	---	D	Do.

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
752–S	757,350 N 3,150,700 E		Valley	1,785				Shady dolomite.				D	Estimated yield 15 gpm 1/23/52.
753	757,900 N 3,151,200 E	Pan-Am Service Station	do	1,810	Dr	39.5	6	do	4				
754	755,700 N 3,148,200 E	Walter Lewis	do	1,870	Du	65	30	do	30		J	D	
755	755,500 N 3,149,400 E	S. B. Taylor	do	1,795	Dr	143	6	do	12		J	D	
756–S	754,150 N 3,150,400 E	R. E. Harrel	Slope	1,820				do				D	Estimated yield 5 gpm 1/23/52.
757–S	755,150 N 3,150,800 E	J. S. Backles	do	1,815				do					Estimated yield 6 gpm 1/23/52.
758–S	755,000 N 3,150,600 E	Katharine Pierce	do	1,815				do				D	Estimated yield 5 gpm 1/23/52.
759	755,800 N 3,151,500 E	Walter Frazier	do	1,830	Du	18	30	do	9		P	Ab	
760–S	756,100 N 3,152,200 E	W. P. Taylor	do	1,840				do					Estimated yield 20 gpm 1/23/52.
761	755,500 N 3,152,550 E		do	1,860	Du	15		do			P	Ab	
762–S	755,000 N 3,152,700 E	H. B. Smith	do	1,865				do					Estimated yield 15 gpm 1/23/52.
763–S	752,600 N 3,154,300 E		do	2,000				do					Estimated yield 3 gpm 1/23/52.
764	751,200 N 3,152,500 E	S. D. Nidiffer	do	2,080	Du		30	do	14.88	1/23/52	B	D	
765	753,350 N 3,147,000 E	J. L. Hyder	Valley	1,790	Dr	169	6	do	25		J	D	
766	753,400 N 3,147,200 E	C. Hyder	do	1,780	Du	20	30	do	5		J	D	
767	753,450 N 3,146,300 E	G. W. Cole	do	1,760	Du	30		do	20		J	D	
768–S	754,300 N 3,146,800 E		do	1,765				do				D	Estimated yield 10 gpm 1/23/52.
769–S	754,800 N 3,144,100 E	Walter Nidiffer	do	1,840				do					Estimated yield 5 gpm 1/23/52.
770–S	755,150 N 3,145,400 E	S. H. Williams	Slope	1,920				Erwin formation.				D	Estimated yield 30 gpm 1/23/52.
771	754,300 N 3,147,400 E	W. Ritchie	Valley	1,755	Du	17.4	20	Shady dolomite.	12.65	1/23/52	B	D	Observation well.

772-S	753,000 N 3,144,800 E		do.	1,715				do.					Estimated yield 10 gpm 1/24/52.
773-S	752,450 N 3,145,400 E	James Elliot	do.	1,740				do.					Estimated yield 10 cfs 1/24/52.
774	750,050 N 3,144,500 E	Crumley Buckles	Slope	1,860	Dr	200	6	do.			J	D	
775	749,400 N 3,144,200 E	W. A. Buckles	do.	1,845	Dr	400	6	do.	80		J	D	
776-S	748,050 N 3,143,600 E	E. Williams	do.	1,800				do.					Estimated yield 15 cfs 1/24/52.
777	747,900 N 3,143,700 E	Harley Greer	do.	1,915	Dr	173	6	do.			J	D	
778-S	746,500 N 3,143,700 E	Myrtle Pierce	do.	1,860				do.				D	Estimated yield 15 gpm 1/24/52.
779-S	746,100 N 3,142,500 E		do.	1,840				do.					Estimated yield 6 gpm 1/24/52.
780-S	745,300 N 3,144,600 E		do.	1,900				do.					Estimated yield 15 gpm 1/24/52.
781	752,800 N 3,144,000 E		Valley	1,745	Du	16	20	do.	10		J	D	
782	754,100 N 3,144,500 E	— — Williams	Slope	1,910	Dr	56	6	do.	15.56	4/ 9/52	J	D	
783-S	752,550 N 3,144,200 E		Valley	1,730				Erwin formation.					Estimated yield 10 gpm 4/9/52.
784	750,800 N 3,140,800 E		do.	1,700	Du			do.	10.38	4/ 9/52	P	Ab	
785	754,450 N 3,139,850 E	Lester Smith	do.	1,705	Du	28.6	30	Shady dolomite	15.06	4/ 9/52		Ab	
786	747,200 N 3,140,900 E	Danton Campbell	do.	1,678	Du	55		Erwin formation.	30		J	D	
787-S	748,400 N 3,149,800 E	W. A. Price	do.	1,670				Shady dolomite					Estimated yield 25 gpm 4/9/52.
788	747,300 N 3,149,450 E	C. E. Murray	do.	1,680		40.7		do.	12.54	4/ 9/52	P	D	
789	746,350 N 3,136,500 E	J. N. Hatley	do.	1,635	Du	30		do.	4.65	4/ 9/52	P	D	
790	745,100 N 3,136,850 E	R. D. Richardson	do.	1,670	Du		20	Rome formation.	6.88	4/ 9/52	P	S	
791-S	748,000 N 3,136,800 E	Mrs. Zeb Bowers	do.	1,630				do.					
792	749,400 N 3,137,500 E	Mrs. Dorothy Bowles.	do.	1,670	Du	17.8	30	Shady dolomite	6.66	4/ 9/52	B	D	
793	750.000 N 3,138,850 E	Grant Younce	do.	1,670	Dr	62.5		do.			J	D	
794	752.500 N 3,138,700 E	J. C. Morrell	Slope	1,820	Du	11.8		do.	6.42	5/ 5/52	P	D	
795	749,750 N 3,138,250 E	W. L. Nave	Valley	1,665	Du	12	10	do.			P	D	
796	749,400 N 3,138,200 E	Dan White	do.	1,665	Du	15		do.				Ab	
797	742,700 N 3,135,800 E	Roy Frazier	do.	1,655	Du	23.6	24	do.	17.88	5/ 6/52	P	D	

TABLE 2.—*Record of wells and springs in the Elizabethton-Johnson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
798	747,700 N 3,135,800 E		Valley	1,630	Du	15		Shady dolomite	9		P	D	
799	747,600 N 3,134,000 E	J. W. Williams	do	1,670	Du	22.9	30	do	14.80	5/6/52	B	D	
800	745,750 N 3,132,750 E	R. Peters	do	1,630	Du	23.1	30	do	18.10	5/6/52	B	D	Well goes dry in summer.
801	747,900 N 3,131,650 E	Eston Barrells	Slope	1,760	Du	26.5		do	16.15	5/6/52	B	D	
802	745,400 N 3,131,100 E	A. B. Cole	Valley	1,620	Du	24.5	30	do	10.23	5/6/52	B	D	
803	745,200 N 3,129,600 E	George Barrells	do	1,640	Du	74.4	30	do	46.55	5/6/52	B	D	Water sample analyzed.
804	745,950 N 3,129,400 E	J. W. Perry	Slope	1,710	Du	36.7	30	do	23.16	5/6/52	B	D	
805	746,150 N 3,128,200 E	W. J. Davidson	do	1,725	Du	43.4	30	do	18.64	5/6/52	B	D	
806	743,800 N 3,127,100 E	Ruth D. Hughes	Valley	1,630	Dr	102	3	do	40		J	D	
807	743,100 N 3,127,100 E	Ruth D. Hughes	do	1,570	Du	24.0	30	do	6.26	5/6/52	B	D	
808	743,300 N 3,123,700 E	B. Allen	do	1,615	Du	36	30	do	18.57	5/6/52		Ab	Recording gage on well.
809-S	745,000 N 3,120,300 E		Slope	1,790				do					Estimated yield 1 gpm 5/6/52.
810-S	746,800 N 3,118,500 E	Wylie Blevins	do	1,900				do				D	Do.
811-S	744,600 N 3,116,700 E		do	1,780				do					Do.
812	746,300 N 3,117,400 E	John Blevins	do	1,845	Dr	117	5	do	28.31	5/6/52	Cy	D	
813	746,750 N 3,117,300 E	J. Slagle	do	1,880	Du	48.2	30	do	24.91	5/7/52	B	D	
814	747,300 N 3,116,050 E	E. Carrier	do	1,980	Du	19.5	30	do	6.52	5/7/52	B	D	
815-S	747,000 N 3,112,500 E	D. A. Simerle	do	1,760				do					Estimated yield 2 gpm 5/7/52.
816	747,250 N 3,113,100 E	do	do	1,800	Du	22.1		do	16.76	5/7/52	P	S	
817	736,900 N 3,112,300 E	R. Renfro	Valley	1,515	Du	25.1	36	Rome formation.	19.30	5/7/52		Ab	Recording gage on well.

818	738,500 N 3,117,600 E	— — Sutton	do	1,590	Dr	150	3	do	30		J	D	
819	738,650 N 3,114,200 E	L. M. Vines	Slope	1,705	Du	8.9		do	5.37	5/ 7/52	B	D	
820	738,200 N 3,112,200 E	Nathan Smith	Valley	1,560	Du	19.0		do	11.10	5/ 7/52	J	D	
821	741,200 N 3,113,900 E	C. S. Carter	Slope	1,690	Du	22.8	48	do	6.94	5/ 7/52	B	D	
822	741,650 N 3,114,350 E	Alice Daniels	do	1,680	Dr	140	6	do	75		Cy	D	
823	736,950 N 3,109,700 E	John Colbaugh	Valley	1,520	Du	35		do	8		P	D	
824	736,700 N 3,109,300 E	Charles Scalf	do	1,495	Du	18		do	12.07	5/ 7/52	P	D	
825	736,800 N 3,108,500 E	W. T. Peterson	do	1,490	Dr	62	6	Honaker dolomite.	24.00	9/17/52	Cy	D	Water sample analyzed.
826	738,850 N 3,106,850 E	T. W. Scott	Slope	1,565	Dr	97		do	60		J	D	
827	739,350 N 3,107,500 E	Omar Sluder	do	1,615	Dr	155	6	do	100		J	D	
828	739,900 N 3,106,200 E	Grant Anderson	do	1,600	Dr	87	5	do			J	D	
829-S	736,500 N 3,106,250 E		Valley	1,490				do					Estimated yield 5 gpm 5/7/52.
830-S	736,400 N 3,105,350 E		do	1,500				do				D	Estimated yield 50 gpm 5/7/52.
831	737,250 N 3,105,500 E	Earnest Honeycutt	Slope	1,520	Dr	95	6	do	2.00	5/ 7/52	Cy	D	Water sample analyzed.
832	740,850 N 3,148,800 E	Fuller Campbell	do	2,180	Dr	247		Shady dolomite.			J	D	
833-S	740,250 N 3,145,100 E	B. C. Bowers	Valley	1,820				do					Estimated yield 1,000 gpm 5/8/52.
834-S	739,300 N 3,144,300 E	Miss Oliver	do	1,790				do				D	Estimated yield 10 gpm 5/8/52.
835-S	738,350 N 3,143,100 E	— — Pierce	do	1,750				do				D	Do.
836-S	738,800 N 3,141,550 E		Slope	1,725				Rome formation.				D	Do.
837-S	739,800 N 3,138,700 E		do	1,660				do				D	Do.
838-S	738,200 N 3,135,500 E		Valley	1,600				do					Estimated yield 5 gpm 5/8/52.
839	739,200 N 3,134,750 E	R. L. Campbell	do	1,590	Dr	175	6	do	100	5/ 8/52	J	D	
840-S	732,700 N 3,139,650 E	Jim Crow	do	1,615				Shady dolomite.				D	Estimated yield 1,000 gpm 5/8/52.
841	732,600 N 3,138,850 E	W. Estep	Slope	1,720	Du	47	24	do	20.49	5/ 8/52	B	D	
842	738,500 N 3,135,000 E	Luther Bowers	Valley	1,665	Dr	146	5	do	120		J	D	
843	733,750 N 3,137,900 E	W. A. Nave	Slope	1,700	Du	17.5	30	do	11.15	5/20/52		Ab	

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No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
844	734,500 N 3,137,200 E	E. A. Morrell	Slope	1,625	Dr	109	5	Rome formation.	83.14	5/20/52	J	D, S	
845	734,300 N 3,136,750 E	N. M. Harris	Valley	1,590	Du	42.4	36	do	38.90	5/20/52		Ab	Well goes dry in summer.
846	731,350 N 3,134,450 E	D. Tredway	do	1,715	Du	31.7	30	do	21.48	5/21/52		Ab	
847	733,900 N 3,134,200 E	E. C. Nave	do	1,590	Du	32.0	30	do	17.19	5/21/52		Ab	
848	734,300 N 3,132,750 E	Guy Nave	do	1,590	Du	16.9	30	do	7.85	5/21/52	B	D	
849	734,000 N 3,132,250 E	M. D. Allen	do	1,600	Dr	70	5	do	50		J	D	
850	734,000 N 3,131,300 E	H. Nave	do	1,620	Du	41.9	30	Honaker dolomite.	22.52	5/21/52	B	D	
851	733,450 N 3,132,150 E	do	do	1,600	Du	31.2		Rome formation.	6.47	5/21/52		Ab	
852	731,800 N 3,132,150 E		do	1,640	Du	14.6	30	do	6.38	5/21/52	B	Ab	
853	729,250 N 3,132,200 E	J. K. Heaton	Slope	1,745	Dr	80	5	do			J	D	
854-S	725,850 N 3,134,100 E	John Elliot	do	1,980				Shady dolomite.				P	Estimated yield 5 gpm 5/21/52.
855	726,450 N 3,130,900 E	T. Hipps	do	1,890	Du	24.1	36	Rome formation.	8.08	5/21/52		Ab	
856	726,200 N 3,130,250 E	R. F. Hardin	do	1,880	Du		30	do	15.37	5/21/52	P	D	
857	727,300 N 3,130,350 E	Dale Hamilton	do	1,855	Du	34.5	30	do	19.71	5/21/52	P	D	
858	726,000 N 3,130,000 E		do	1,860	Du	33.0	36	do	12.15	5/21/52	J	D	
859	725,150 N 3,128,900 E	Roy Scalf	do	1,915	Du	33.0	36	do	7.12	5/21/52	Cy	D	
860	726,200 N 3,129,150 E	Pat Heaton	do	1,870	Dr	228	6	do	104		J	D	
861	728,650 N 3,129,400 E	E. Shelton	do	1,760	Du	24.5		do	10.98	5/21/52	J	D	
872	728,000 N 3,129,700 E	Nancy Heaton	do	1,775	Du	33.0	30	do	8			Ab	
863	729,100 N 3,128,300 E	Warner Shell	do	1,755	Dr	192	5	Honaker dolomite.			J	D	

864	728,700 N 3,128,100 E	Thomas Martin	do	1,760	Dr	140	5	do	10		J	D	
865	730,000 N 3,128,700 N	Luther Collins	do	1,740	Dr	194	5	do			J	D	
866-S	728,900 N 3,126,500 E	G. O. Collins	do	1,800				do				S	Do.
867-S	727,200 N 3,126,000 E		do	1,805				do					Do.
868	726,000 N 3,127,000 E	J. W. Ellis	do	1,755	Dr	90	5	do			J	D	
869	730,800 N 3,128,250 E	John Billing	do	1,760	Dr	140	5	do			J	D	
870	732,100 N 3,129,700 E	Rita Nave	do	1,680	Du	12		do	5		B	D	
871	732,000 N 3,128,500 E	Jane Grindstaff	do	1,725	Dr	140	5	do	70		J	D,S	
872-S	727,350 N 3,125,800 E		do	1,800				do				D	Estimated yield 10 gpm 5/22/52.
873	728,600 N 3,123,700 E	— — Duff	do	1,820	Dr	260	5	do	60		J	D	
874-S	730,700 N 3,125,500 E	Paul Nave	do	1,960				do				D	Estimated yield 5 gpm 5/22/52.
875	732,350 N 3,127,350 E	George Grindstaff	do	1,810	Du	45.1	30	do	31.94	5/22/52	B	D	
876-S	724,300 N 3,126,800 E	Grant Ellis	do	1,970				Rome formation				D	Do.
877-S	723,300 N 3,125,700 E	Frank Trevitt	do	1,960				do				D	Estimated yield 1 gpm 5/22/52.
878-S	723,600 N 3,119,600 E	L. Hyder	Valley	1,600				Honaker dolomite.				D	Estimated yield 25 gpm 5/22/52.
879-S	731,500 N 3,117,350 E		do	1,520				do					Estimated yield 10 cfs 5/22/52.
880	715,100 N 3,117,450 E	Arthur Hubbard	Slope	1,820	Dr	200	5	Rome formation	100		J	D	
881	714,000 N 3,112,900 E	J. W. Ford	do	1,820	Dr	135	5	Honaker dolomite.	76.28	8/13/52	B	D	Water sample analyzed.
882-S	736,200 N 3,109,000 E	American Bemberg Div., Beaunit Mills, Inc.	Valley	1,490				do					Do.
885	738,000 N 3,112,600 E	— — Edwards	Slope	1,640	Du	65	24	Rome formation.				Ab	Recording gage on well.
886-S	722,400 N 3,096,100 E		Valley	1,485				Honaker dolomite.				D	Estimated yield 200 gpm 98/30/55.
887	721,700 N 3,096,200 E	Dr. A. E. Miller	do	1,495	Dr	160	6	do			J	D	
888-S	713,400 N 3,094,500 E		Slope	1,615				do					Estimated yield 5 gpm 8/30/55.
889	720,300 N 3,098,900 E	E. Hyder	Valley	1,575	Dr	97	6	do	20		J	D	Well log: 0–72 shale, 72–97 limestone.
890-S	716,800 N 3,100,850 E	— — Blitch	Slope	1,590				Knox dolomite				D	Estimated yield 200 gpm 8/30/55.
891	709,750 N 3,102,200 E	Alfred Mosley	do	1,850	Dr	50	6	do	20		P	D	Water derived from three water-bearing shale zones.

TABLE 2.—*Records of wells and springs in the Elizabethton-Johnson City area*—Continued

[Type of well: B, bored; Dr, drilled; Du, dug. Method of lift: B, bucket; C, centrifugal; Cy, cylinder pump; J, jet pump; P, pitcher pump; T, turbine pump. Use of water: Ab, abandoned; D, domestic; Ind, industrial; P, public supply; S, stock.]

No. on plate	Location (Tennessee rectangular coordinates)	Owner or name	Topographic situation	Altitude (feet)	Type of well	Depth (feet)	Diameter (inches)	Stratigraphic unit	Depth to water (feet)	Date of measurement	Method of lift	Use of water	Remarks
892	706,500 N 3,102,800 E	Francis Maricle	Slope	1,950	Dr	200	6	Knox dolomite			Cy	Ab	
893	706,100 N 3,096,700 E	— — Shell	do	1,815	Dr	74	6	do			J	D,S	
894-S	709,000 N 3,096,000 E	— — Sinkler	do	1,730				do				D	Estimated yield 100 gpm 8/30/55.
895	711,900 N 3,095,309 E	— — Minton	do	1,705	Dr	111	6	do	70		J	D	
896	709,800 N 3,090,800 E	William Straub	do	1,615	Dr	80	6	do	30		B	D	
897-S	706,500 N 3,090,000 E	Rock House Spring	do	1,790				do				P	Estimated yield 2,500 gpm 8/30/55. Spring used by utility district.
898	711,350 N 3,088,400 E	S. S. Cole	Valley	1,570	Dr	46	6	do			J	D	
899	725,800 N 3,088,200 E	P. H. Sisk	Slope	1,520	Dr	80	6	do			J	D	
900	729,800 N 3,090,100 E	W. R. Grindstaff	do	1,560	Dr	114	6	do			J	D	
901-S	729,950 N 3,089,900 E	do	do	1,550				do				S	Estimated yield 10 gpm 8/30/55.
87-S	709,600 N 3,072,300 E	City of Jonesboro	Valley	1,770				do				P	Estimated yield 500 gpm.
89	734,700 N 3,085,100 E	Barnes School	Slope	1,560	Dr	100	6	do			Cy	P	
100	720,300 N 3,075,350 E	Southern Maid Dairy.	Valley	1,650	Dr	385	6	do	17.98	9/ 1/53		Ab	
101	761,600 N 3,076,000 E	Walker Bros. Ice & Coal Co.	do	1,630	Dr	165	6	do	18		C	Ind	
102	719,900 N 3,068,100 E	Harman Ice & Coal Co.	do	1,650	Dr			do	14		T	Ind	Well reported to yield 80 gpm continuously.

TABLE 3.—*Chemical analyses of water from wells, springs, and the Watauga River*

[Chemical constituents in parts per million. Analyses by U.S. Geological Survey]

Well or spring No.	Owner or name	Date of analysis	Source of water	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate	Dissolved solids	Hardness as $CaCO_3$	pH
1-S	Hampton Spring	3/17/48	Rome formation	16	----	----	----	[1] 15		0	70	2	1	----	0.8	----	29	----
4-S	Big Spring	3/17/48	Knox dolomite	12	----	38	9.8	[1] 4.2		4	154	3	3	----	5.1	----	135	----
8-S	Milligan College Spring.	3/18/48	do	14	----	46	5.8	[1] 12		16	158	2	3	----	3.8	192	139	----
41-1	American Bemberg Div., Beaunit Mills, Inc.	10/28/52	Honaker dolomite.	11	0.20	29	14	2.0	1.9	0	124	19	2.5	0.1	10	137	130	7.5
42-3	North American Rayon Corp.	10/28/52	do	11	.03	36	14	7.6	1.6	0	117	47	5.5	.1	8.9	205	147	7.4
529	R. M. Morrel	10/28/52	Rome formation	8.8	.16	.8	.3	1.1	1.1	0	6	.3	1.5	.0	1.0	18	3	5.8
803	George Barrells	3/ 6/53	Shady dolomite	7.4	.18	16	8.1	6.8	5.5	0	90	1.6	3.4	.0	14	98	73	6.6
825	W. T. Patterson	3/23/53	Honaker dolomite.	9.4	.12	31	15	6.7	3.5	0	102	18	14	.0	36	192	139	6.7
831	Earnest Honeycutt	3/24/53	do	11	.27	80	23	4.9	2.9	0	324	16	8.5	.4	14	333	294	7.8
881	J. W. Ford	10/28/52	do	11	.06	70	26	1.1	2.7	0	318	4.6	2.5	.3	12	280	282	7.3
882-S	American Bemberg Div., Beaunit Mills, Inc.	3/ 3/53	do	10	.21	21	11	.9	1.4	0	108	6.3	1.5	.1	3.6	105	98	6.7
----	Johnson City municipal supply, 10 miles south of Johnson City.	----	Shady dolomite	20	.00	----	----	[1] 2.9		----	66	2	5	0	.2	----	57	7.4
----	Watauga River at Elizabethton.	3/23/53	Watauga River	6.2	.03	6.8	3.2	1.4	1.4	0	34	4.1	1.2	.2	1.7	42	30	6.4

[1] Figure represents both Na and K as Na.

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