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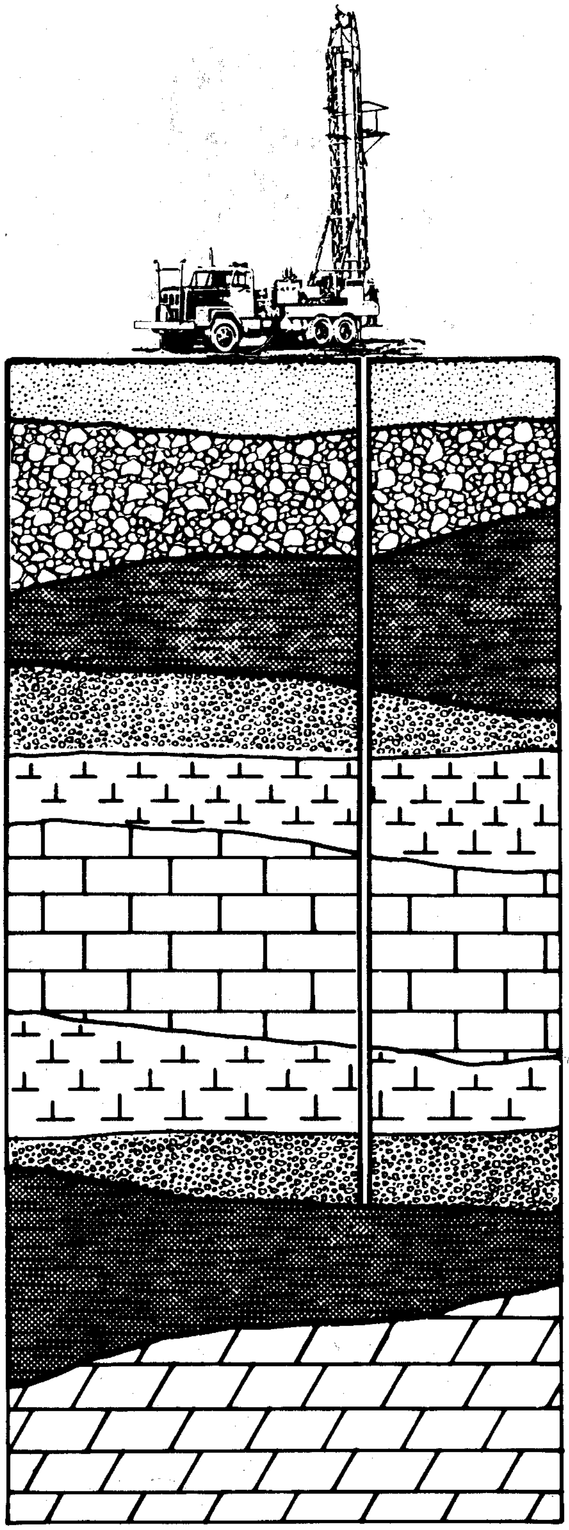


GROUNDWATER RESOURCES OF AUGUSTA COUNTY, VIRGINIA

by

Kenneth R. Hinkle
and
R. McChesney Sterrett

VALLEY REGIONAL OFFICE

COMMONWEALTH OF VIRGINIA

STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

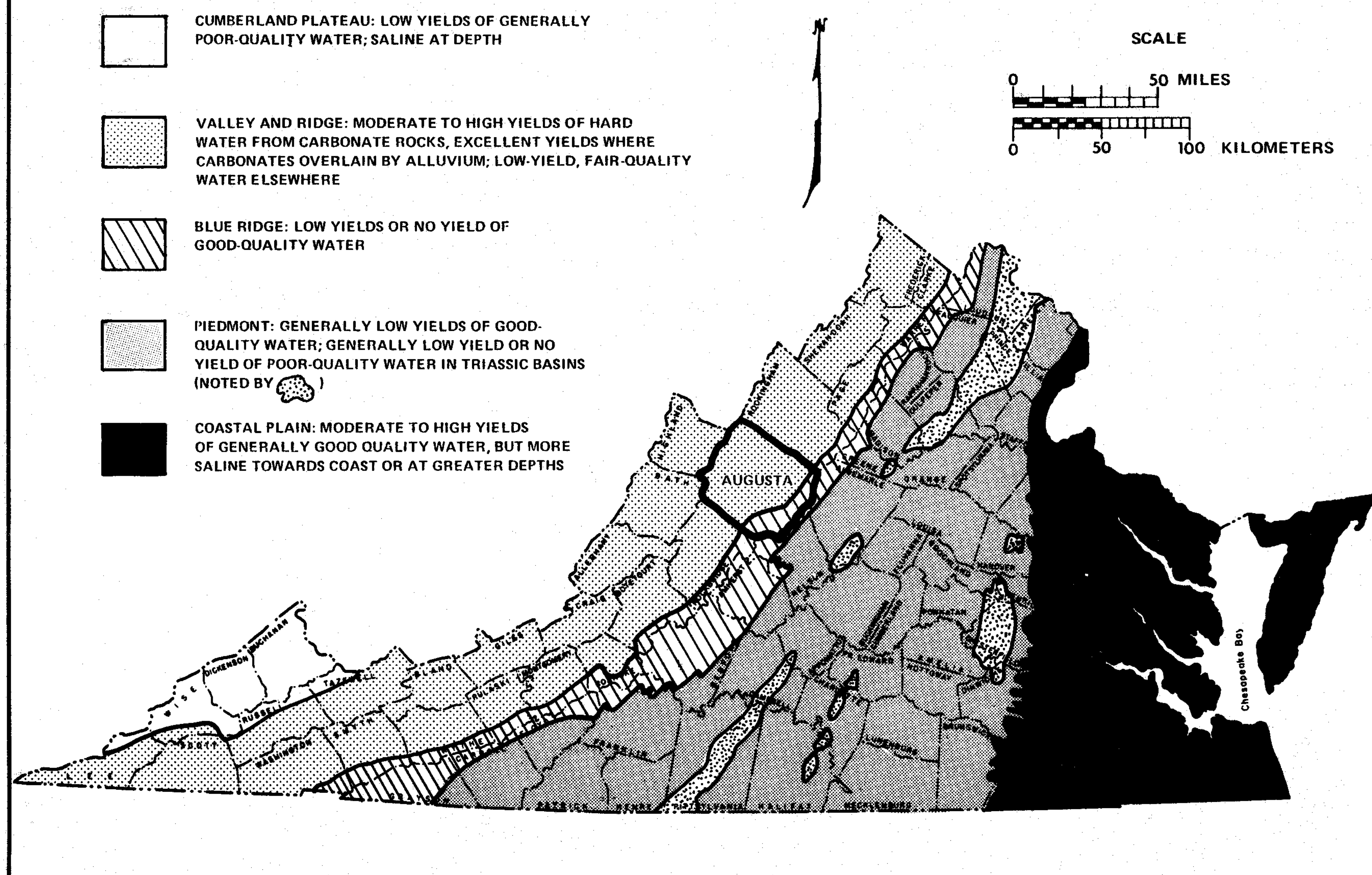
Richmond, Virginia

Planning Bulletin 310

July 1978

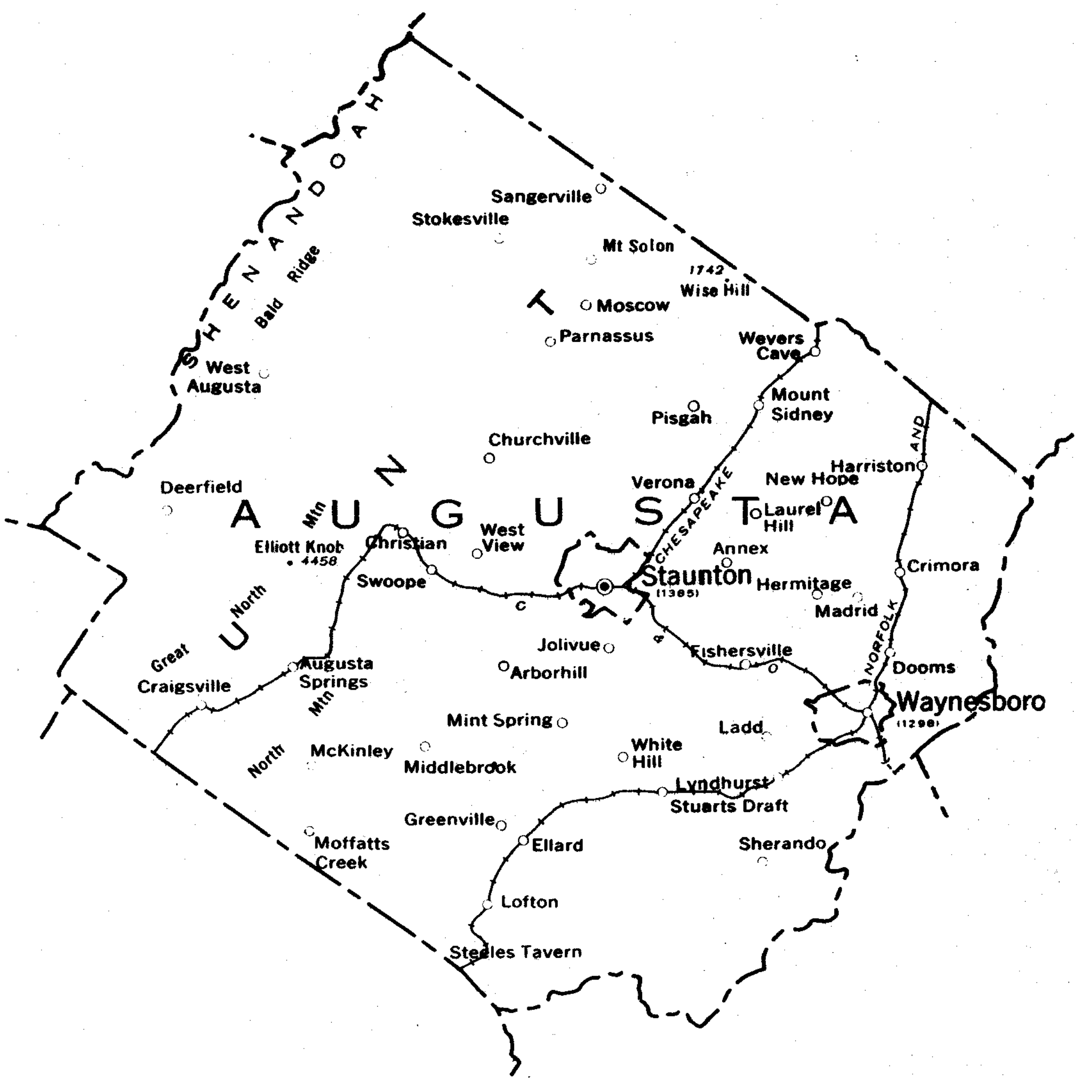
VA DEQ

GROUNDWATER CHARACTERISTICS OF THE GEOLOGIC PROVINCES IN VIRGINIA



Frontispiece

GROUNDWATER RESOURCES OF AUGUSTA COUNTY, VIRGINIA



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FOREWORD

This report is one of a series intended to inventory the groundwater resources of each county in the Commonwealth. The purpose is to provide all groundwater users, including private citizens, developers, investors, well drilling contractors, government officials, professionals and consultants, with an overview of the groundwater situation as it presently exists throughout Virginia.

Prospective groundwater users and others interested in the development and protection of groundwater hopefully will gain insight into the opportunities and advantages inherent in this invaluable natural resource.

The State Water Control Board remains available for information, assistance and governmental action.

ACKNOWLEDGEMENTS

Appreciation is extended to the citizens of Augusta County for permitting water samples to be collected from their wells and springs and for supplying much of the well information contained in this report. Representatives of area industries and municipal water supplies served by groundwater were most helpful in supplying information on their water systems. Quality data for public groundwater supplies were obtained from the Virginia Department of Health. Well drilling contractors who have been especially cooperative in supplying information include Burner Well Drilling, Caldwell Well Drilling, R. S. Law Well Drilling and C. R. Moore Well Drilling. The authors wish to express special thanks to Ms. Karen T. Frey for devoting many long hours to the tedious job of correlating and verifying all well and spring data used in compiling this report.

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SELECTED CONVERSION FACTORS

ENGLISH UNITS TO INTERNATIONAL SYSTEM (METRIC UNITS)

This report uses a dual measurement system based on English units and the International System (SI) of metric units. SI is a consistent system of units adopted in 1960 by the Eleventh General Conference of Weights and Measures. Selected conversion factors are listed below:

Multiply English Units	By	To Obtain SI Units
Feet (ft)	0.3048	metres (m)
Gallons	0.003785	cubic metres (m^3)
Gallons per day (gpd)	0.003785	cubic metres per day (m^3/d)
Gallons per minute (gpm)	0.06309	litres per second (l/s)
Inches (in)	25.4	millimetres (mm)
Miles	1.609	kilometres (km)
Million gallons per day (MGD)	3,785.0	cubic metres per day (m^3/d)
Square miles (mi^2)	2.590	square kilometres (km^2)

GROUNDWATER RESOURCES OF AUGUSTA COUNTY, VIRGINIA

by

Kenneth R. Hinkle and R. McChesney Sterrett

ABSTRACT

Augusta County is located in northwestern Virginia and encompasses an area of 986 square miles (2,554 km^2). The county includes portions of the Blue Ridge and Valley and Ridge physiographic provinces and is contained within the Unglaciated Appalachian Groundwater Region.

Three groundwater sectors have been identified, each having distinct groundwater availability and quality characteristics. The Central Valley Sector is composed of Cambro-Ordovician carbonate formations and the clastic Martinsburg Formation. This sector offers the greatest groundwater availability, particularly where carbonate rocks are overlain by thick alluvial and terrace deposits along the west toe of the Blue Ridge. Water is generally of good quality from the carbonates, although hardness tends to be very high. The Martinsburg offers less potential than the carbonates but is still a reliable source for most needs. Total dissolved solids and hardness concentrations tend to be somewhat greater in the Martinsburg Formation. The North Mountain Sector and the Blue Ridge Sector offer less potential for groundwater development. Iron and sulfate occasionally render mildly objectionable qualities to groundwater in the North Mountain Sector. Groundwater in the Blue Ridge Sector is very low in mineralization, and well yields usually are very small.

A corridor of high groundwater potential extending from Lyndhurst to Grottoes likely can be developed to yield 75 MGD (283,875 m^3/d) with minimal well interference and moderate decline of the regional water table.

Springs are numerous throughout the county and generally offer water of lower mineralization than can be developed from wells in corresponding rock units. Several major springs are utilized for municipal, public and industrial water supplies.

Approximately 98 percent of the county's population is supplied wholly or partially by groundwater. Total daily groundwater withdrawal is approximately 23 MGD (87,055 m^3/d). Public and municipal usage is about 8 MGD (30,280 m^3/d), and industrial pumpage is in excess of 14 MGD (52,990 m^3/d).

Isolated cases of groundwater contamination have been reported in Augusta County, but these cases are the result of local conditions and do not represent regional contamination of the groundwater resource. The most common causes are septic tank failure, agricultural runoff, and spills and leaks of petroleum products. Areas underlain by carbonate bedrock, particularly where sinkholes and bedrock exposures are prevalent, are very susceptible to groundwater contamination.

INTRODUCTION

Purpose and Scope of Report

This report is intended to acquaint the public with the groundwater conditions in Augusta County and the cities of Staunton and Waynesboro. In addition to providing general information about the area, the report introduces new hydrogeologic data collected by the State Water Control Board and compiles previous geologic and hydrologic investigations carried out under the auspices of the Board and other state agencies. The report is intended to be a planning and management reference for citizens, governmental officials, professionals and those in the business sector.

Location and Background Information

Augusta County is located in the northwest portion of Virginia (Plate 1), bounded on the northwest corner by West Virginia (Pendleton County). Bordering counties in Virginia include Bath and Highland on the west, Rockbridge and Nelson on the south, Albemarle on the east and Rockingham on the north.

The second largest county in the state at 986 square miles (2,554 km^2), Augusta was formed from Orange County in 1738. The independent cities of Staunton and Waynesboro are located within the county's boundaries.

The 1975 population was 49,100 according to data furnished by the Tayloe Murphy Institute at the University of Virginia; Staunton's population was recorded as 22,900, and that of Waynesboro at 16,700. Projections by the Division of State Planning and Community Affairs for the year 2000 place the figures at 77,800 for the county, and 24,100 and 18,700 for the cities of Staunton and Waynesboro, respectively.

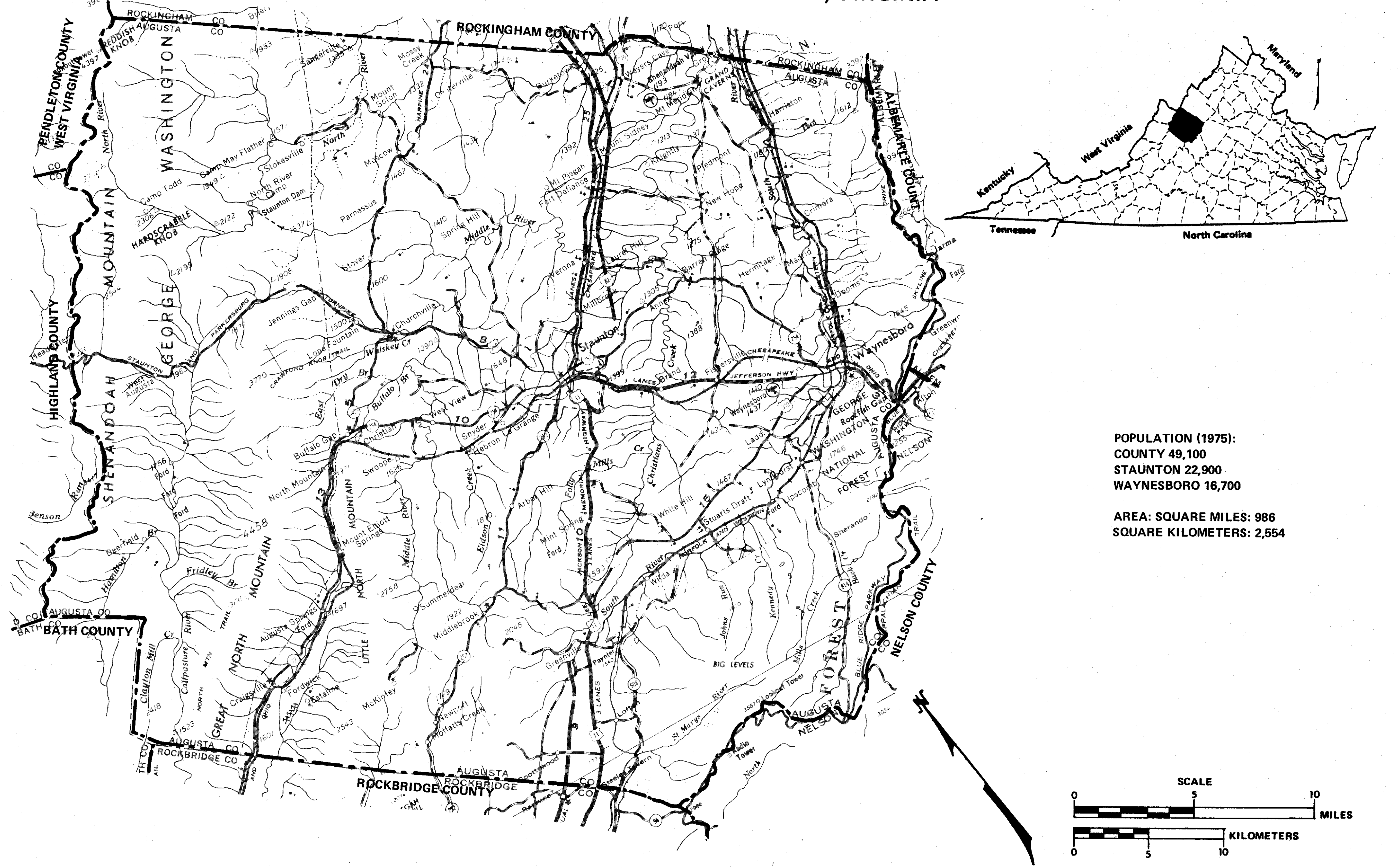
Manufacturing and agriculture are the most important sources of income and revenue. Manufactured products include synthetic fibers, equipment controls, razors and blades, air conditioning units and clothing. Livestock and poultry encompass the major agricultural emphasis.

Previous Investigations

A report by Hack (1965) gives detailed explanations of alluvial deposits along the west toe of the Blue Ridge. Five recent reports published by the Virginia Division of Mineral Resources give comprehensive treatment to the geology of Augusta County. These include: Rader (1967); Rader (1969); Kozak (1970); Bartholomew (1977); and Gathright and others (1977).

Groundwater reports of the area include works by R. C. Cady, R. H. DeKay and R. B. Leonard. Cady's report, Ground-Water Resources of the Shenandoah Valley, Virginia, is quite comprehensive and is the only major hydrologic report to incorporate virtually all of the county. In Development of Ground-Water Supplies in Shenandoah National Park, Virginia,

INDEX MAP OF AUGUSTA COUNTY, VIRGINIA



POPULATION (1975):
COUNTY 49,100
STAUNTON 22,900
WAYNESBORO 16,700

AREA: SQUARE MILES: 986
SQUARE KILOMETERS: 2,554

Source: U. S. Geological Survey (Base Map)

PLATE NO. 1

DeKay touches lightly upon some of the groundwater resources of the Blue Ridge region. Leonard's 1962 unpublished thesis, Ground-Water Geology Along the Northwest Foot of the Blue Ridge Between Arnold's Valley and Elkton, Virginia, gives in-depth treatment to the groundwater resources of the Waynesboro and Grottoes areas. Collins and others authored the report, Springs of Virginia, in 1930. Frank Reeves discussed another aspect of the subsurface water resource in his 1932 report, Thermal Springs of Virginia. The Virginia Division of Water Resources report on the Potomac-Shenandoah River Basin (Volumes I and III, 1968-69) included the major portion of Augusta County as did Trainer and Watkins' report, Geohydrologic Reconnaissance of the Upper Potomac River Basin, published in 1975.

Methods of Investigation

The bulk of the background and geologic information in this report is a summary of previous work. Most of the water well construction information and the groundwater quality data have been collected by the State Water Control Board, although some have been supplied by the Virginia Division of Mineral Resources and the Virginia Department of Health, respectively. All groundwater withdrawal information has been collected by the State Water Control Board.

Much of the previously unpublished information pertaining to individual well construction and groundwater quality has been collected as a result of the Groundwater Act of 1973. This Act requires that a Water Well Completion Report (Form GW-2) be submitted to the Board for all wells drilled, and that owners of industrial and public groundwater supplies submit quarterly reports (Form GW-6, Groundwater Pumpage and Use) to the Board detailing groundwater withdrawal. In addition, the Board requires that drill cuttings be collected at ten-foot (3.05-m) intervals on all public and industrial water wells.

Another source of groundwater quality information is the Pollution Response Program (PReP), maintained by the Board for the sole purpose of responding to citizen complaints of water pollution of any type. This includes pollution of both groundwater and surface water by accidental or intentional discharges of hazardous chemicals, oil, gasoline, refuse, and industrial wastes.

All well information, well completion reports and records of groundwater quality cited in this report are on permanent file at the State Water Control Board Headquarters Office in Richmond and at the Valley Regional Office in Bridgewater. These data are computerized for storage and retrieval and were used to compile Appendixes B and C.

Water Well Numbering System

Water Well Completion Reports are assigned a unique number by which the reported well is thereafter identified. Water quality and withdrawal information for that particular well is also identified by that number.

Each county in Virginia is assigned a three-digit county code, the code for Augusta County being 107. Within each county, wells are numbered sequentially with a few exceptions. For example, a report received on a particular day might be numbered 107-16, while a report received the following day would become 107-17. All wells are assigned numbers as they are received and, therefore, appear at random throughout the summary. The well numbers do not represent a grid system for locating specific areas of the county. When citing specific wells in this report, the well number will be given in parentheses without the county code. For example, Reynolds #5 (101). Well numbers may be cross-referenced with various plates and Appendixes B and C for additional information.

PHYSICAL SETTING

Physiography

Augusta County lies within two physiographic provinces: the Blue Ridge and Valley and Ridge (Plate 2). The eastern and western borders of the county are the Blue Ridge Mountains and Shenandoah Mountain, respectively. Plate 3 is a satellite image recorded by LANDSAT-1 from an altitude of 570 miles (917 km).

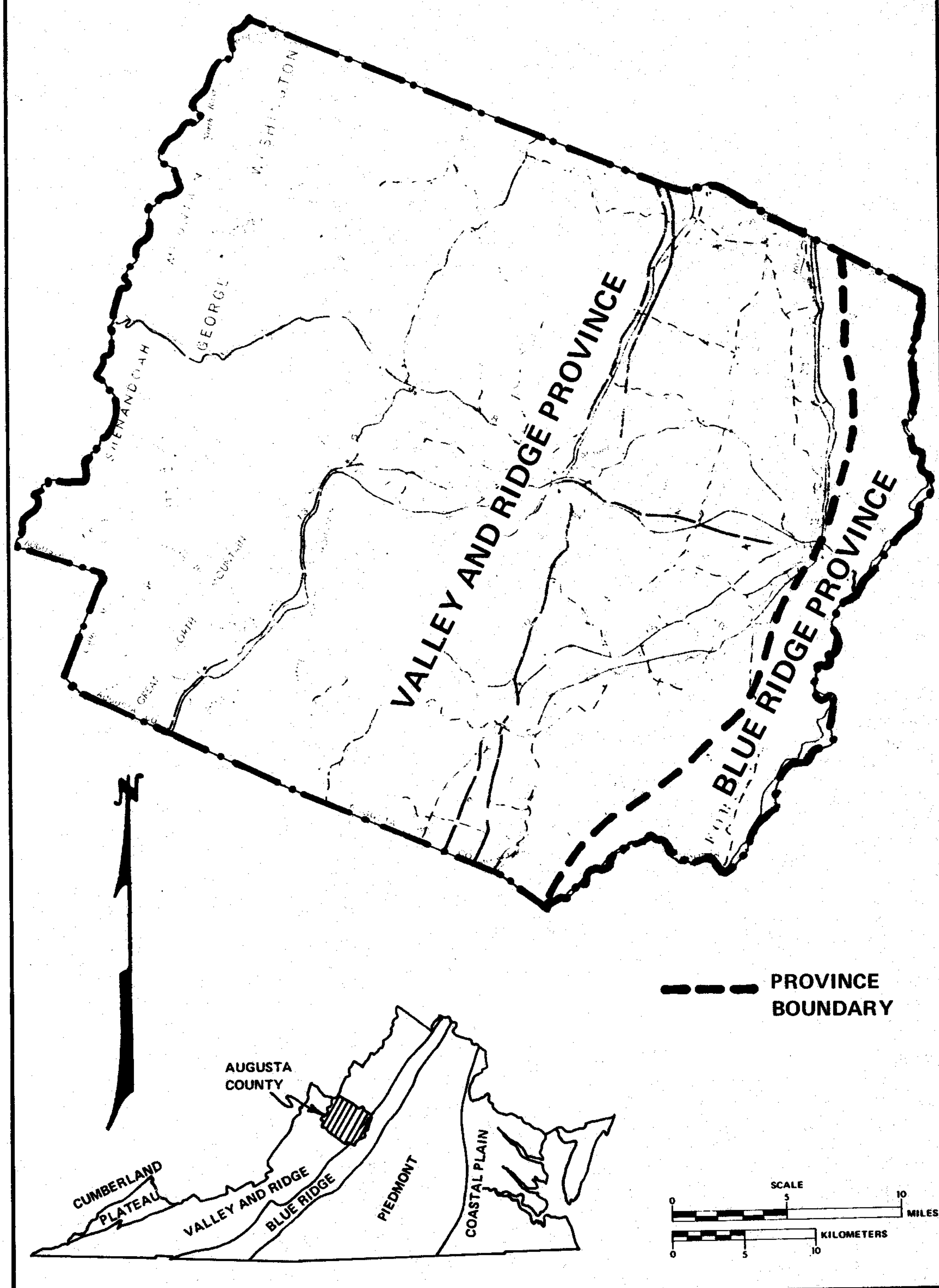
The lowest point in the county, approximately 1,060 feet (323 m) above sea level, is at the confluence of Middle River and North River at the Rockingham County line just west of Grottoes (Plate 4). The highest elevation is Elliott Knob at 4,463 feet (1,360 m). Elevations at Staunton and Waynesboro are 1,480 feet (451 m) and 1,295 feet (395 m), respectively.

Caves and caverns, formed by the solution action of groundwater, are abundant in the county. In addition to Grand Caverns at Grottoes, which is possibly the oldest commercial cave now open in the United States, Holsinger (1975) indicates that approximately 90 other caves are known to exist (Plate 5). An abundance of sinkholes, found almost exclusively in limestone regions, indicates the area is riddled with subsurface solution channels and caves, a typical feature of karst terrains.

Drainage

Drainage in Augusta County is divided into two major river basins: the Potomac-Shenandoah Basin and the James Basin. Most of the area is within the Potomac-Shenandoah River Basin which drains northward to the Potomac River. Stretching from the Virginia-West Virginia border in the west to the Chesapeake Bay in the east, the basin covers 5,706 square miles (14,779 km^2) in Virginia alone and extends into West Virginia, Maryland and Pennsylvania. The southern portion of the county is in the James River Basin which drains southward to the James River. This basin also stretches from the Virginia-West Virginia border to the Chesapeake

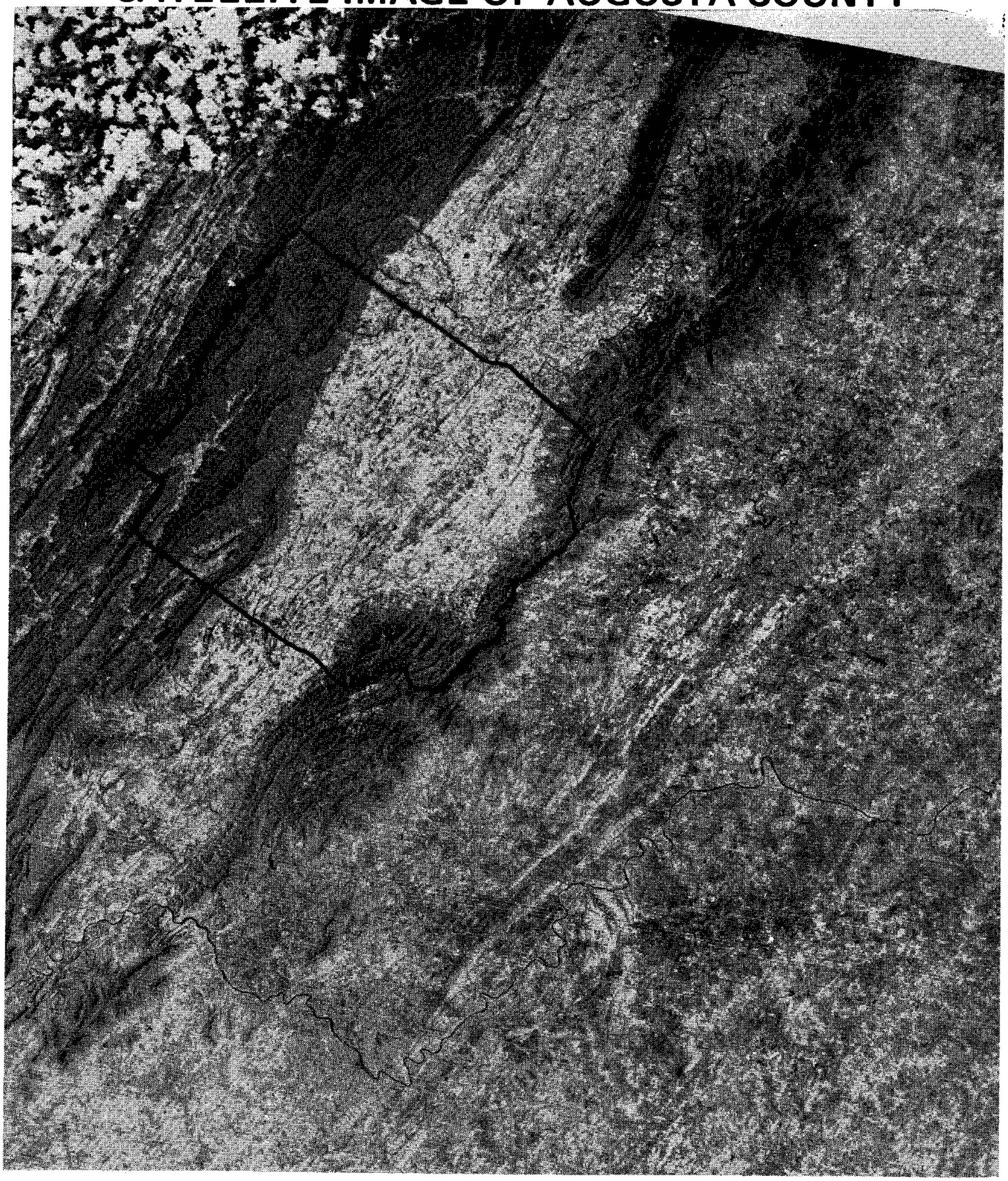
PHYSIOGRAPHIC PROVINCES OF AUGUSTA COUNTY

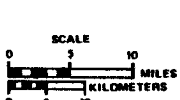


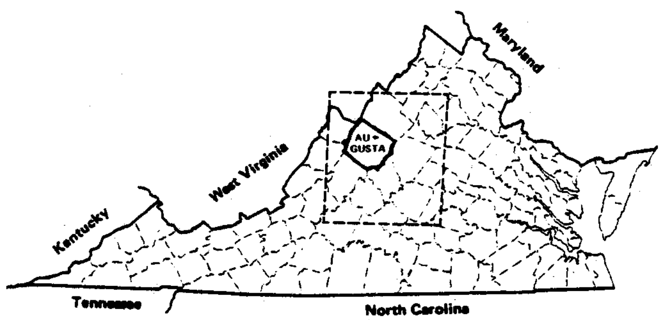
Source: Butts (1940)

PLATE NO. 2

SATELLITE IMAGE OF AUGUSTA COUNTY







Source: U. S. Geological Survey

PLATE NO. 3

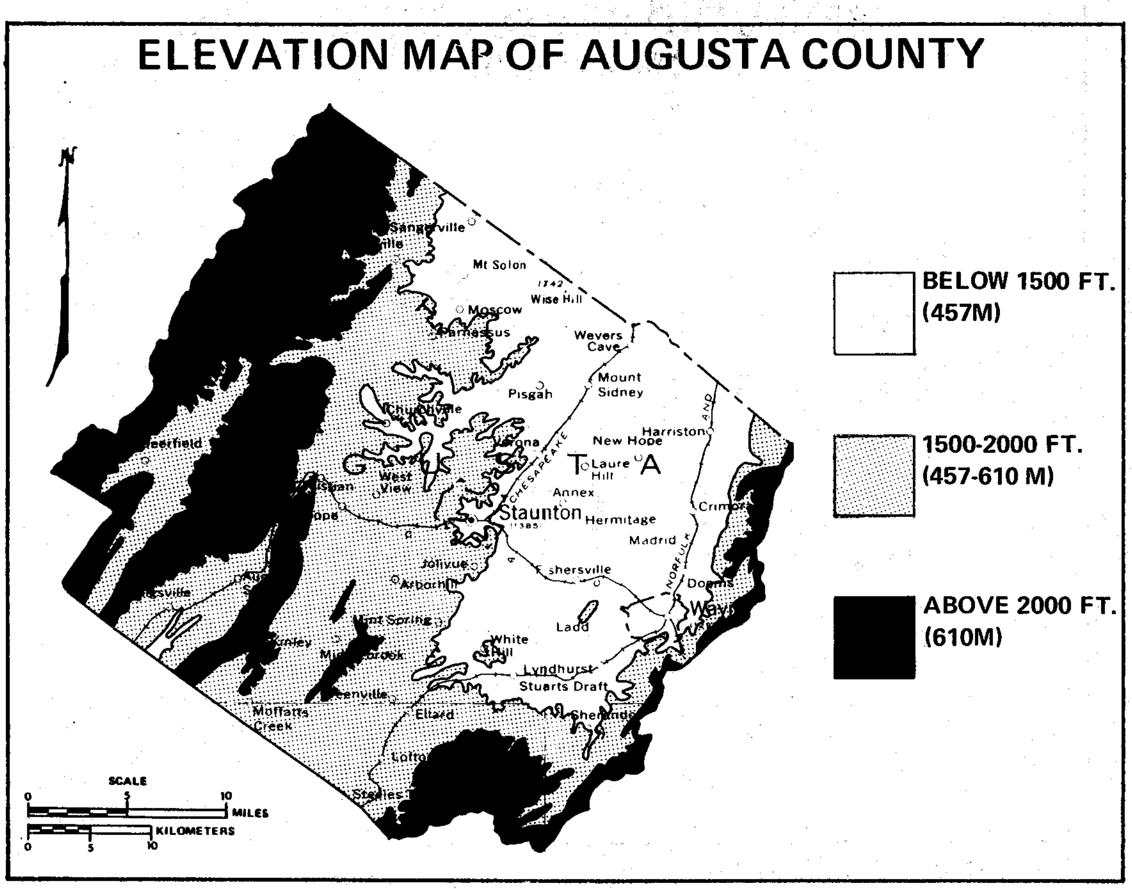


PLATE NO. 4

Bay but encompasses 10,102 square miles (26,164 km^2), or just over 25 percent of the state's total land area.

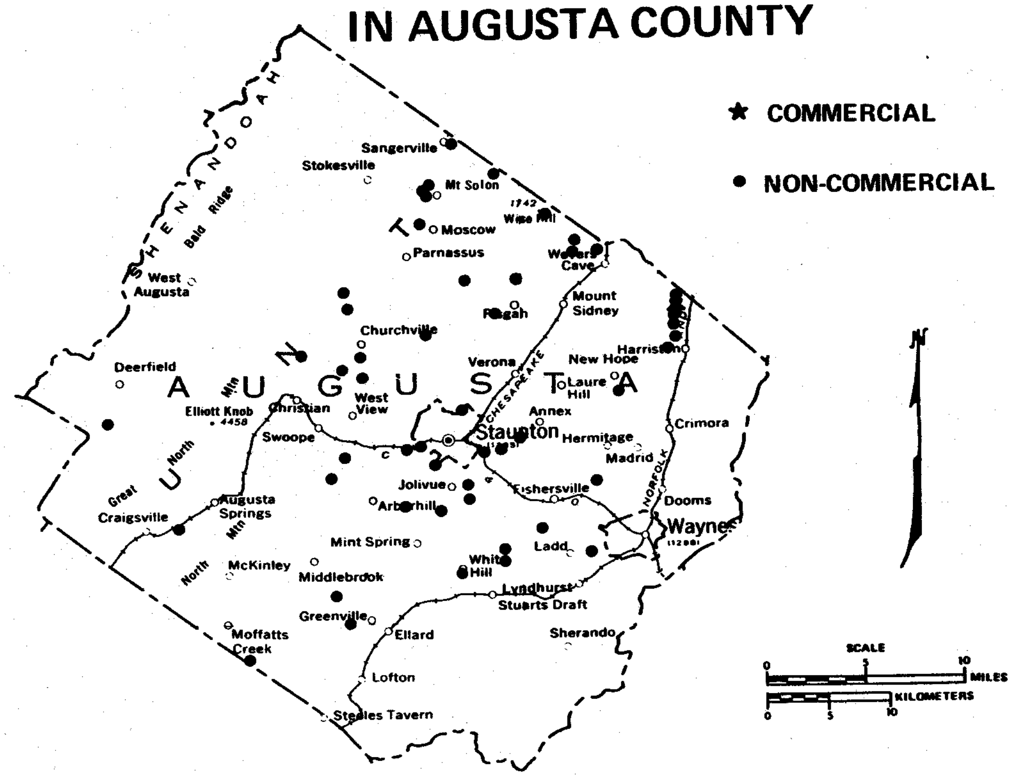
Major streams in Augusta County include Middle River, North River and South River, all in the Potomac-Shenandoah Basin. The Calfpasture River is the largest stream in the James Basin portion of the county. Plate 6 shows the two basins and the major drainage systems. Table 1 lists average stream flows for the major streams in the Potomac-Shenandoah Basin.

Climate

Warm summers and mild winters characterize Augusta County. According to Crockett (1972), the mountainous regions and the wide range in elevation are major factors controlling the climate in addition to the latitude and location on the North American continent.

Records from the non-recording weather station at Staunton maintained by the National Weather Service indicate that the average annual temperature is approximately 54°F (12°C). Extremes have been recorded as high as 102°F (39°C) in July, 1954, and as low as -10°F (-23°C) in January, 1942. The average annual precipitation is approximately 35 inches (889 mm). Rainfall is the dominant form of precipitation. Summer rainfall is provided principally by showers and thunderstorms, the

SELECTED CAVES AND CAVERNS IN AUGUSTA COUNTY



Source: Douglas (1964), Holsinger (1975)

PLATE NO. 5

RIVER BASINS AND STREAMS IN AUGUSTA COUNTY

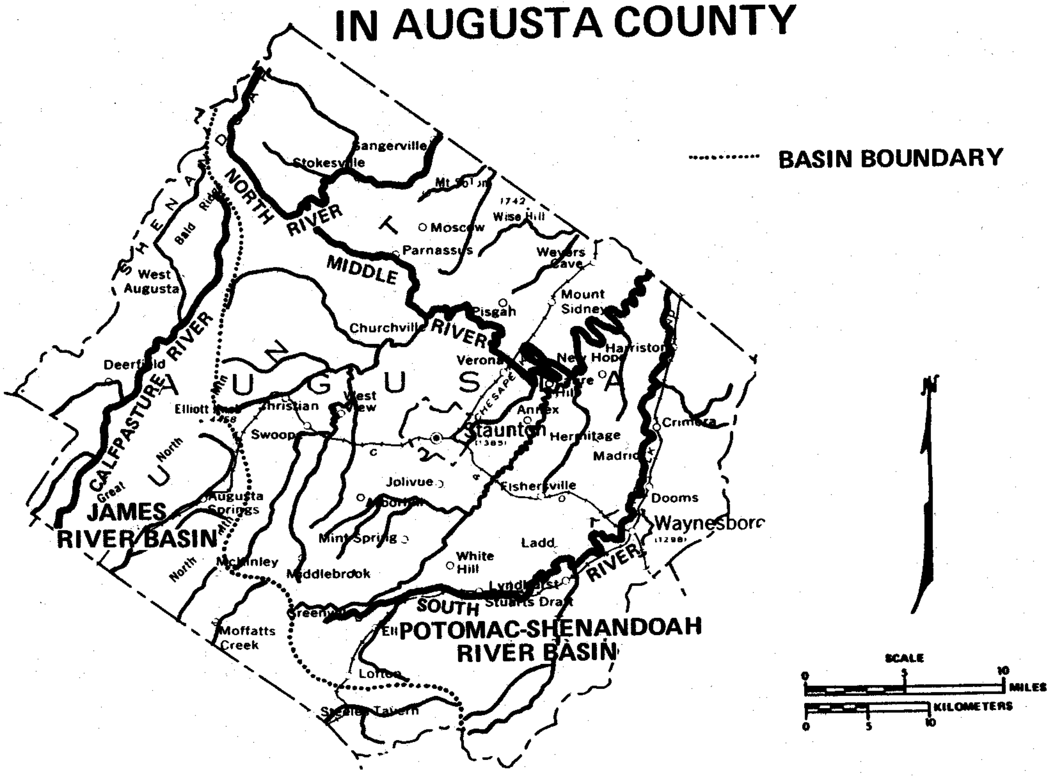


PLATE NO. 6

TABLE 1

FLOW MEASUREMENTS AT
AUGUSTA COUNTY STREAM GAGING STATIONS

Average Discharge in Cubic Feet Per Second

	Middle River[a]			North River[b]			South River[c]		
	1973	1974	1975	1973	1974	1975	1973	1974	1975
January	542	743	399	24.4	48.9	40.0	437	492	259
February	767	332	673	48.9	17.2	53.0	647	273	361
March	809	399	1134	67.0	29.4	83.1	605	247	970
April	949	349	357	65.1	25.5	22.7	606	314	279
May	554	288	424	41.6	26.5	54.2	376	297	268
June	280	277	207	12.9	51.4	14.1	199	169	124
July	185	120	173	3.1	3.8	4.8	108	88.5	185
August	144	153	154	6.3	2.4	1.5	92.9	120	160
September	128	195	423	3.3	4.6	9.6	83.8	148	392
October	139	101	463	9.2	3.4	20.0	95.5	77.8	390
November	129	93.5	248	22.1	5.5	14.2	97.6	73.5	233
December	853	347	209	99.5	45.4	14.2	619	236	198
Annual Average	456.6	283.1	405.3	33.6	22.0	27.6	330.6	211.3	318.3

a-Near Grottoes (Highway 769)
b-Near Stokesville (Highway 730)
c-At Harriston (Highway 778)

Source: U. S. Geological Survey

latter occurring on an average of 40 days throughout the season. Although the average annual snowfall is around 22 inches (559 mm), measurements between 1941 and 1971 varied from 7.5 inches (191 mm) to 55 inches (1397 mm).

Table 2 lists temperature and precipitation data from the National Weather Service non-recording weather station at Staunton.

TABLE 2

1977 WEATHER DATA
RECORDED AT STAUNTON, VIRGINIA

Month	Average Temperature		Total Precipitation	
	°F	°C	Inches	Millimeters
January	31.2	-0.4	3.37	94.74
February	42.0	5.5	0.75	19.05
March	46.6	8.1	1.87	47.50
April	52.3	11.3	0.93	23.62
May	58.3	14.6	3.97	100.84
June	68.5	20.3	2.47	62.74
July	70.8	21.6	2.08	52.83
August	68.7	20.4	0.57	14.48
September	62.2	16.8	4.03	102.36
October	48.3	9.1	9.65	245.11
November	37.7	3.2	0.83	21.08
December	31.1	-0.5	1.53	38.86
Annual	51.46	10.83	32.41	823.21

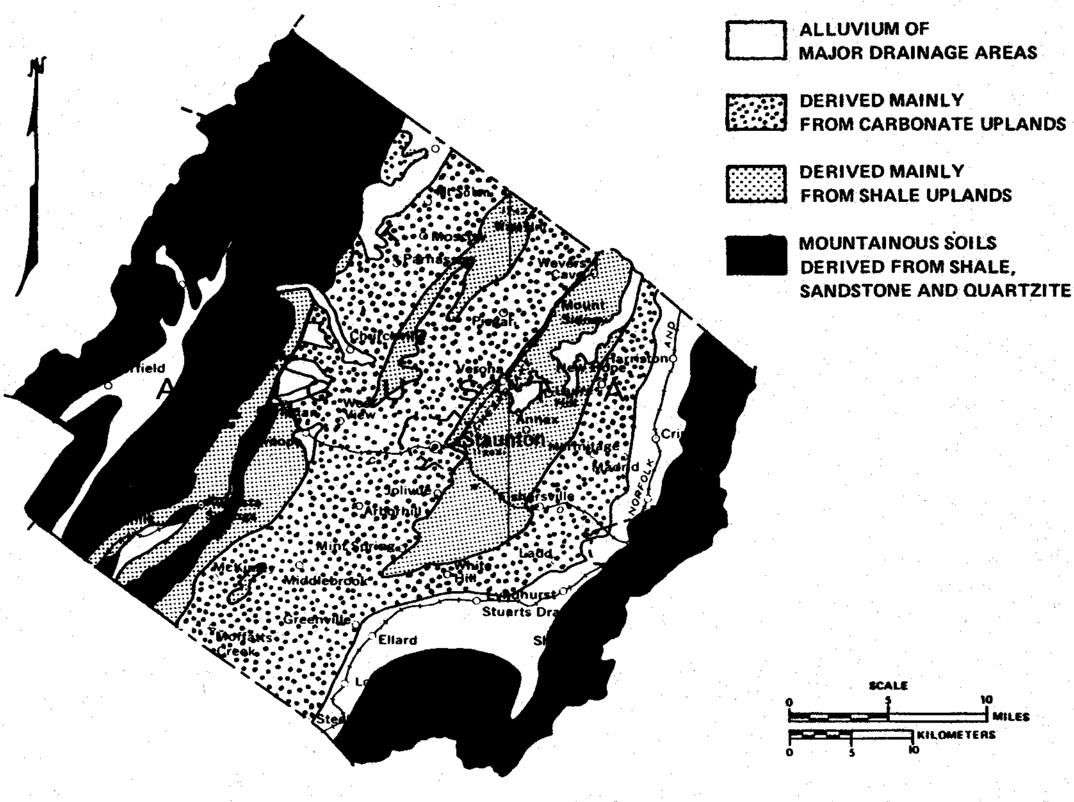
Source: National Oceanic and Atmospheric Administration

Soils and Vegetation

Soil types in the county can be grouped broadly into three major categories: mountainous soils, valley soils, and terrace and alluvial deposits. As evidenced by Plate 7, approximately two-thirds of the county is covered by valley soils. Valley soil overlying limestone uplands tends to be deep and well drained, whereas soil overlying the shale uplands tends to be somewhat more shallow and well to excessively drained.

Mountainous soils are underlain for the most part by shale, sandstone and quartzite. These soils tend to range from shallow to deep and are generally well to excessively drained. Elevation, degree of slope, and vegetative cover are some factors which can determine soil depth.

The terrace and alluvial deposits are the most important soils from a hydrogeologic standpoint. Significant deposits can be found along the South River, Middle River, Calfpasture River, North River, and Jennings



GENERALIZED SOILS MAP OF AUGUSTA COUNTY

Source: Soil Conservation Service **PLATE NO. 7**

Branch. All of these deposits are deep and well drained and are extremely important in the storage and transmission of groundwater.

Vegetation is mainly of two types: forest lands and agricultural grasses. The central valley area is mostly pasture and cropland. The northwestern and southeastern portions of the county (55 percent of the land area) are forested, mostly by the oak-hickory type of woods. The George Washington National Forest (192,128 acres or 77,754 hectares) and Shenandoah National Park (11,302 acres or 4,574 hectares) account for the majority of the forested lands. Such major forest areas provide large watersheds to replenish and maintain both the groundwater and surface water resources.

HYDROGEOLOGY

The county is underlain by igneous, sedimentary and metamorphic rocks ranging in age from older than 600 million years to about 345 million years old. Surficial deposits from the last two million years are also present. Structural features include two major thrust faults and several significant folds. Such diverse geology gives rise to varied groundwater conditions throughout the county.

Geologic History

The geologic history of Augusta County is closely related to that of the entire Appalachian Valley extending roughly from Newfoundland, Canada, southwestward to Alabama. During Precambrian time (older than 600 million years) this area was an extensive lowland caused by eons of erosion. This lowland began to undergo burial, deformation, and metamorphism. Approximately 600 million years ago, there was concurrent deposition of sedimentary rocks and volcanic activity, followed by a period of uplift and subsequent erosion.

Following the erosional period, a very large trough began to form along the entire length of the present-day Appalachian Valley. Thousands of feet of sediments were deposited in the trough by invading seas and by rivers and streams flowing from the surrounding uplands. Occasionally the trough filled with sediment, causing the seas to retreat for a period of time. The trough continued to subside, however, so that eventually the seas again invaded the area and, along with the streams and rivers, once more carried sediments to the trough.

This deposition occurred for about 300 million years, at which time extreme horizontal deformation with resultant uplift began. From that time until the present, a period of about 300 million years, the dominant forces have been those of weathering and erosion. During the last two million years, surficial deposits of sand, gravel and boulders have been deposited throughout the entire Appalachian Valley, with significant deposits being present in Augusta County.

Geologic Formations and Their Water-Bearing Properties

The following discussion of the groundwater potential of the various geologic formations present in Augusta County is based on a broad grouping of related rock types. Four major rock groups have been identified, each having their own lithologic and hydrologic properties (Table 3). In addition, discussions of unconsolidated sediments and igneous rocks have been included. Plate 8 is a generalized geologic map of the county and Plate 9 shows several cross sections referred to on Plate 8.

Cambrian and Precambrian (?) Formations

Minor exposures of the Catoctin Greenstone, an altered basaltic lava flow of igneous origin, are present near the crest of the Blue Ridge. The Catoctin is quite resistant to weathering and caps much of the Blue Ridge. Cady (1936) indicates that this type of ancient lava rock probably possessed excellent water-bearing potential shortly after it was formed. Over the years, however, weathering, pressure and other factors have obliterated the openings which would have contributed to the high

TABLE 3

FORMATION GROUPS AND THEIR WATER-YIELDING PROPERTIES IN AUGUSTA COUNTY

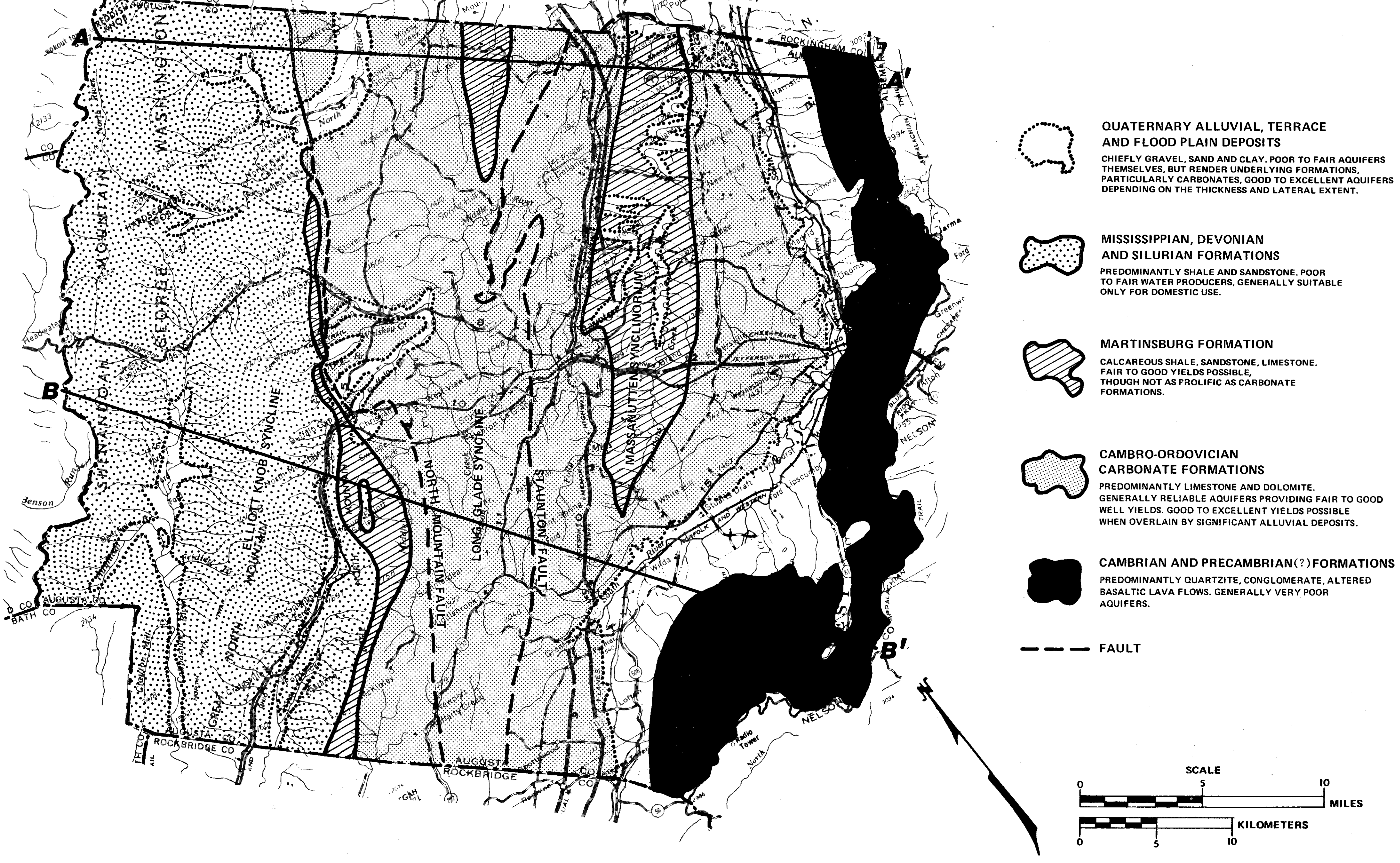
Age	Estimated Years Since Present	Formation Group	Lithology	Individual Formations	Formation Symbol	Thickness (ft and m)	Water-Yielding Properties	Groundwater Sector
QUATERNARY	10 to 1 million	Quaternary Alluvial and Terrace Deposits	Clayey sand and silt, sand, gravel, cobble, boulders and angular blocks	Alluvium Talus deposits Alluvial fan deposits Terrace deposits	Qat	0 - 500 ft (0 - 152 m)	Considered alone, these sediments are relatively poor aquifers. Main function is to capture recharge water for underlying bedrock. May significantly increase yield of underlying strata.	Blue Ridge Central Valley North Mountain
JURASSIC	135 million to 181 million	Mesozoic Igneous Rocks	Dikes, sills and plugs of syenite, hornfels, olivine diabase	Not applicable	Not applicable	Not applicable	No well records available, but probably very poor aquifers. Generally have low porosity and permeability.	Blue Ridge Central Valley North Mountain
TRIASSIC	181 million to 230 million							
MISSISSIPPIAN	310 million to 345 million	Mississippian, Devonian and Silurian Formations	Shale, sandstone, some limestone, conglomerate, mudrock	Pocono	Mpo	Combined thickness in excess of 11,000 ft (3353 m)	Poor to fair water producers, generally suitable only for small domestic needs. Good yields possible locally. Some wells flow naturally at completion. Groundwater stored and transmitted along bedding planes and joints. Water is moderately hard and may be high in iron, sulfur and manganese.	North Mountain
DEVONIAN	345 million to 405 million			Hampshire Chemung Brallier Millboro and Needmore Ridgely (Oriskany)	Dhs Dch Db Dmn Dri			
				Licking Creek, Healing Springs, Coeymans, Keyser	DS			
SILURIAN	405 million to 425 million			Tonoloway Bloomsburg				
				Keefer Cacapon Tuscarora *Juniata and Oswego	Ske Sca Stu Ojos			
ORDOVICIAN	425 million to 500 million	Martinsburg Formation	Slate, minor amounts of limestone and sandstone; often classified as shale with sandstone, some limestone, conglomerate, mudrock	Martinsburg	Omb	1,500-2,600 ft (457-792 m)	Fair to good yields possible from joints, bedding planes, cleavage partings. Water very hard, high in total dissolved solids. Iron, sulfur and manganese may be high.	Central Valley
		Cambro-Ordovician Carbonate Formations	Limestone, dolomite, shale, sandstone, chert, dolomite	Edinburg Lincolnshire and New Market Beekmantown Chepultepec	Oe Oln Ob Och	900-1,200 ft (274-366 m) 0-400 ft (0-122 m) 1,700-3,000+ ft (518-914+ m) 175-400 ft (53-122 m)	Good yields from solution channels in most areas, excellent yields possible where overlain by unconsolidated sediments in proximity to major streams. Extremely high potential along west toe of Blue Ridge from Lyndhurst to Grottoes. Water very hard and high in total dissolved solids.	
CAMBRIAN	500 million to 600 million			Conococheague Elbrook Waynesboro (Rome) Shady (Tomstown)	Cco Ce Cwb Ct	1,600-2,500 ft (488-762 m) 1,000-3,000 ft (305-914 m) 1,000+ ft (305+ m) ?		
		Cambrian and Pre-Cambrian (?) Formations	Altered basaltic lava flows, quartzite, conglomerate, sandstone, shale	Antietam (Erwin) Harpers Weverton	Ca Ch Cw	600+ ft (183+ m) 1,500-3,500+ ft (457-1,067 m) 350-500+ ft (107-152+ m)	Poor groundwater producers; low yields from joints, fractures, faults and shear zones at fairly shallow depths (usually less than 300 ft or 91 m). Soft, high-quality water, low in total dissolved solids.	Blue Ridge
PRE-CAMBRIAN (?)	Older than 600 million (?)			Catoctin	CpCc	1,500-3,000 ft (457-914 m)		

*Upper Ordovician units included here in order to simplify map units

Source: Geology compiled from various publications of the Virginia Division of Mineral Resources, geohydrology from Virginia State Water Control Board - VRO

HYDROGEOLOGIC MAP OF AUGUSTA COUNTY

(REFER TO PLATE 9)

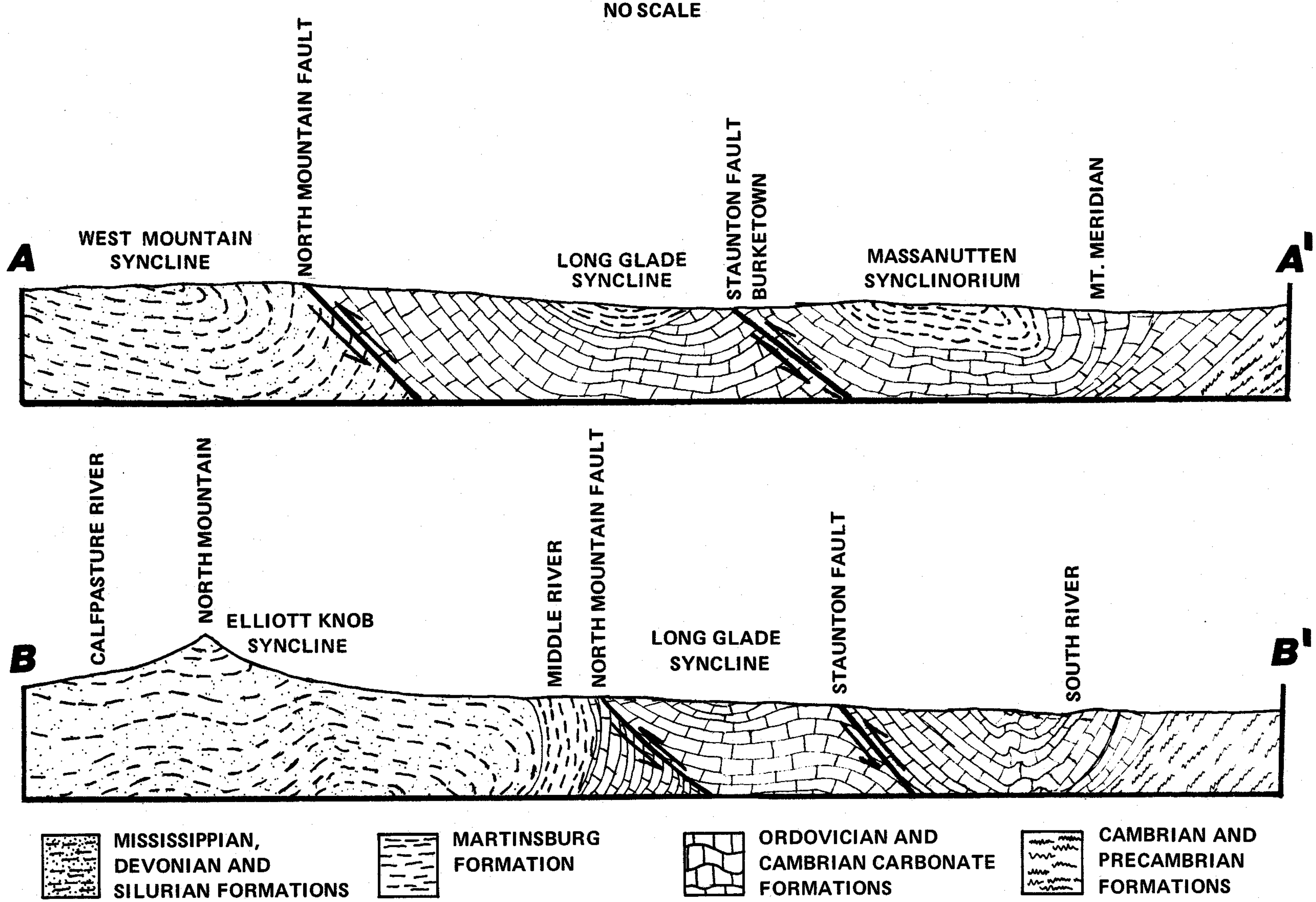


Source: Compiled From Various Publications of the Virginia Division of Mineral Resources

PLATE NO. 8

CROSS SECTIONS FROM HYDROGEOLOGIC MAP OF AUGUSTA COUNTY

(REFER TO PLATE 8)
NO SCALE



Source: Compiled From Various Publications of the Division of Mineral Resources   PLATE NO. 9

potential. The greenstone in its present condition is a very poor water producer, and the chances of obtaining water below a few hundred feet are minimal. Joints, shear zones and faults provide the only openings for water storage and movement. Leonard (1962) suggests the formation's poor reputation as a groundwater producer may be attributable as much to its high topographic position as to its lithology.

The Chilhowee Group consists of the Antietam (Erwin) Formation, a quartzite, and the Harpers and Weverton Formations, the latter two composed mostly of conglomerate, sandstone, shale and quartzite. These formations occupy the western flank of the Blue Ridge and extend to the foot of the mountain. The metamorphic quartzites and the sedimentary conglomerates and sandstones make poor aquifers due to the high degree of cementation. As in the Catoctin, water is to be found only in joints, faults and shear zones.

Cambro-Ordovician Carbonate Formations

This group of formations comprises the major portion of the valley floor and consists mainly of limestone and dolomite with minor amounts of shale, sandstone, and chert. Included are the Shady (Tomstown), Waynesboro (Rome), Elbrook, Conococheague, Chepultepec, Beekmantown, New Market, Lincolnshire and Edinburg formations.

The Shady (Tomstown) Formation is not exposed at the surface (Gathright and others, 1977) but remains an important aquifer in Augusta County. The unit is basically dolomite which is less soluble than limestone, but Cady (1936) indicates it appears to be highly susceptible to solution activity, not unlike limestone beds in the area. Review of drill logs available for several industrial wells developed in the Shady Formation confirms a high incidence of solution activity. The size and number of solution channels intersected by carbonate wells directly influence water production.

The Waynesboro (Rome) Formation occupies a major continuous belt along the west toe of the Blue Ridge and a minor area bordering the North Mountain Fault west of Greenville. The unit is principally shale, siltstone, sandstone, dolomite and limestone. Cady (1936) notes that bedding planes and shaly partings, both of which act as conduits for groundwater movement, are numerous. Leonard (1962) has determined that the shaly portions of the formation are poor aquifers. However, he notes that the carbonate sections are often prolific aquifers, and deep wells penetrating the beds are highly productive.

The Elbrook, Conococheague, Chepultepec, Beekmantown, New Market, Lincolnshire and Edinburg formations occupy the central area of the valley floor, extending westward from outcrop areas of the Waynesboro (Rome) Formation along the western foot of the Blue Ridge to Little North Mountain. A portion of their exposure is contained in the Massanutten Synclinorium, a major trough structure extending between Rockbridge County to the southwest and West Virginia to the northeast, and bounded in Augusta County by the Blue Ridge and the Staunton Fault. These carbonate formations have undergone extensive solution activity as evidenced by the numerous caves which have been catalogued. Holsinger (1975) states that three of the largest caves are developed in the Conococheague, one of which is Grand Caverns at Grottoes. Rader (1967) has identified much intraformational folding and faulting in the Edinburg Formation, with calcite and dolomite mineralization in associated fractures.

Groundwater movement and storage in the carbonates is restricted to solution channels. Solution channels are formed as water percolating downward enters joints, fractures and bedding planes and slowly dissolves the rock. Though larger and more numerous near the ground surface and in the vicinity of the water table, some water-bearing channels have been encountered at great depths. Cady (1936) theorizes this may be associated with artesian circulation through synclines.

Martinsburg Formation

The Martinsburg Formation is a hydrogeologically significant unit due to its lithology, thickness and areal extent. The unit has been variously described as shale, sandstone and limestone, but Gathright and others (1977) indicate it is basically slate with minor amounts of limestone and sandstone.

The Martinsburg is a fairly reliable, though not overly productive, water source in Augusta County. The presence of some water in the Martinsburg Formation may be due in part to solution channels in the thin limestone beds present in the unit. Butts (1940), Rader (1967), Kozak (1970) and Gathright and others (1977) attest to the thin-bedded nature of the Martinsburg, and Cady (1936) notes joints and slaty cleavage. Solution activity within the formation is increased by these features, although the numerous water-bearing openings generally are not large.

Mississippian, Devonian and Silurian Formations

This grouping of formations is comprised of a series of sandstone and shale units, along with a few insignificant occurrences of limestone, with a combined total thickness in excess of 11,000 feet (3,353 m). Formations in this grouping are considered minor aquifers. All occurrences are west of the North Mountain Fault and begin at or near the eastern base of Little North Mountain. In the interest of simplifying map units, the Ordovician-aged Oswego and Juniata sandstones have been included in this grouping.

Units displaying a thickness of 300 feet (91 m) or less include the Oswego (sandstone), Juniata (sandstone/shale), Tuscarora (sandstone/quartzite), Cacapon (sandstone/shale), Keefer (sandstone), Bloomsburg (sandstone/shale), Tonoloway (limestone), Keyser (limestone), Coeymans (limestone), Healing Springs (sandstone), Licking Creek (limestone), Oriskany (sandstone) and Needmore (shale). Thickness of some individual formations is less than 5 feet (1.5 m), although most are 100 to 200 feet (30 to 61 m) thick. The four limestone units range from less than 10 feet (3 m) to 230 feet (70 m). Bedding ranges from thin to thick and massive, with the majority of the formations exhibiting medium to massive beds.

The remaining five formations represent nearly 10,000 feet (3,048 m) of the combined total thickness of all units included in this group. All are predominantly sandstone or shale with lesser amounts of conglomerate and mudrock. These units include the Millboro (shale), Brallier (shale), Chemung (sandstone), Hampshire (sandstone/shale), and Pocono (sandstone). The Pocono is the only formation in Augusta County of Mississippian age. Bedding in these five units is generally thick, except for the Brallier Formation which is characterized by beds ranging from only a few inches to several feet in thickness (Kozak, 1970).

Although a lack of meaningful data is apparent, records for wells drilled in the Mississippian, Silurian and Devonian sandstones and shales of Augusta County indicate the formations to be only fair water-producers, at best. Two important reasons are readily apparent: cementation and texture. Silica and calcite apparently are the most common cementing materials, both of which tend to reduce porosity. The Tuscarora, noted by Butts (1940) as being cemented with silica so that individual quartz grains are partly rebuilt into crystals, is probably the most weather-resistant formation in the county. The fine- to medium-grained texture of the majority of the formations tends to greatly reduce the overall capacity for water transmission, since fine-grained rocks typically have high porosity but very low permeability.

Groundwater occurrence in these units generally is limited to bedding planes and joints. Since the majority of the formations exhibit thick or massive bedding, the number of bedding planes is severely reduced. Price (1966) cited research which concluded the frequency of jointing is inversely related to the thickness of rock beds. The thicker the bed, the more widely-spaced, and therefore less frequent, are joints. The thick-bedded nature of rock units in this grouping would, therefore, result in a reduced number of joints available for transmitting groundwater.

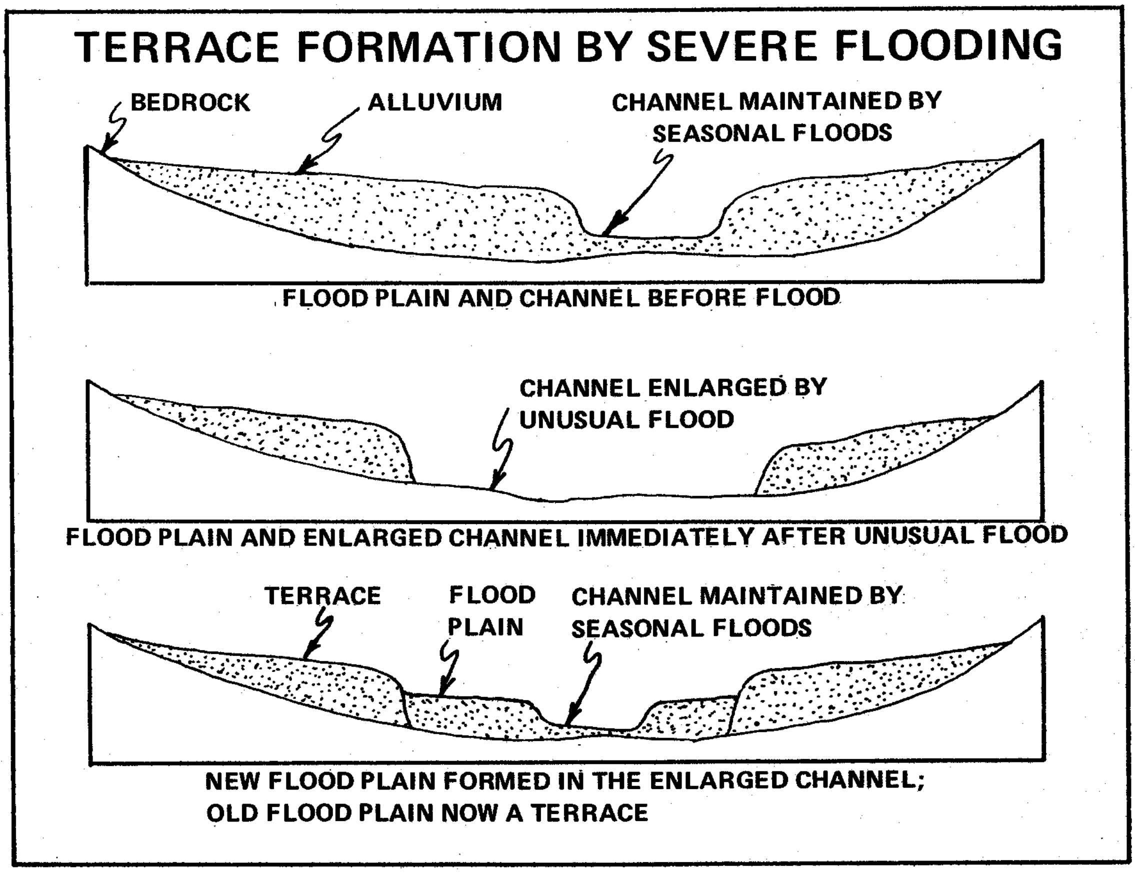
Mesozoic Igneous Rocks

Intrusive igneous rocks in Augusta County are of Jurassic or Triassic age and occur as dikes, sills and plugs. Although numerous occurrences, mostly dikes, have been noted by Rader (1967 and 1969) and Johnson and others (1971), exposures are usually only a few feet thick and less than a mile long. No records are available of wells having been drilled in these rocks, but they probably are poor aquifers. Davis and DeWiest (1966) noted that dikes have low permeability and low porosity and often act as barriers to groundwater movement.

Quaternary Alluvial and Terrace Deposits

Considered alone, alluvial and terrace deposits are relatively poor aquifers. Cady (1936) states that these deposits are poorly-sorted, fine-grained, and in many places lacking in groundwater, "and even where it is saturated it is likely to have low permeability." The main function of these deposits is to capture recharge water for underlying bedrock, particularly in areas where the bedrock consists of carbonate formations. Leonard (1962) states that the basic alluvial unit (residuum or fine-grained collivium) is an aquiclude. It prevents downward percolation of surface water to the underlying strata, can store up to 40 percent of its volume, and maintains groundwater in the underlying bedrock at a mild artesian head.

Several areas of the county are covered by appreciable expanses of alluvial and terrace deposits. A terrace is a step-like arrangement of alluvial material which represents former flood plains. Hack (1965) reports that terraces occur only along streams whose bedrock is less resistant than the coarse fragments of the alluvial material, and are therefore more common and better formed where streams cross the Martinsburg shale than they are in carbonate rock areas. This theory would account for the extensive terrace and alluvial-fan deposits identified by Bartholomew (1977) and Gathright and others (1977) as overlying carbonate rocks along the west toe of the Blue Ridge. Resistant sandstone, quartzite and greenstone derived from the mountains make up these deposits. Hack (1965) theorizes that terraces along the Middle River might have been caused by severe flooding (Plate 10).



Source: Hack (1965) PLATE NO. 10

Gathright and others (1977) divide the deposits along the west toe of the Blue Ridge into five units: high-level terraces and alluvial-fan deposits; talus deposits; upland alluvium; lowland alluvium; and residual soils. Terrace and alluvial-fan deposits are the most significant unconsolidated sediments relative to groundwater availability due to their areal extent and thickness. These same researchers have reported alluvial-fan thicknesses of up to 500 feet (152 m) in the Dooms area northeast of Waynesboro. Rader (1969) notes the presence of extensive gravel deposits south of Stuarts Draft with a thickness in excess of 165 feet (50 m). Lesser deposits, though still notable, may be found along the Calfpasture River where it passes through the Deerfield Valley (Kozak, 1970), along North River east of North River Gap (Rader, 1969) and along Middle River (Hack, 1965).

Geologic Structure

The geologic structure of Augusta County is characterized by parallel anticlines and synclines and two major fault systems. The Staunton Fault and the North Mountain Fault slice through the county in a general northeasterly trend and extend far beyond its northern and southern boundaries. These features probably exert effective control upon groundwater.

The Staunton Fault roughly divides the county in half, passing approximately 3 miles west of Spottswood, northeastward through Gypsy Hill Park in Staunton and on to Quick's Mill. At this point it loops to the southwest toward Huckleberry Hill and loops again northeast to Burketown. In this county the fault is developed only in the carbonate formations, thrusting older rocks from the southeast over younger rocks in the northwest. Rader (1967) identifies a major breccia zone along the fault trace.

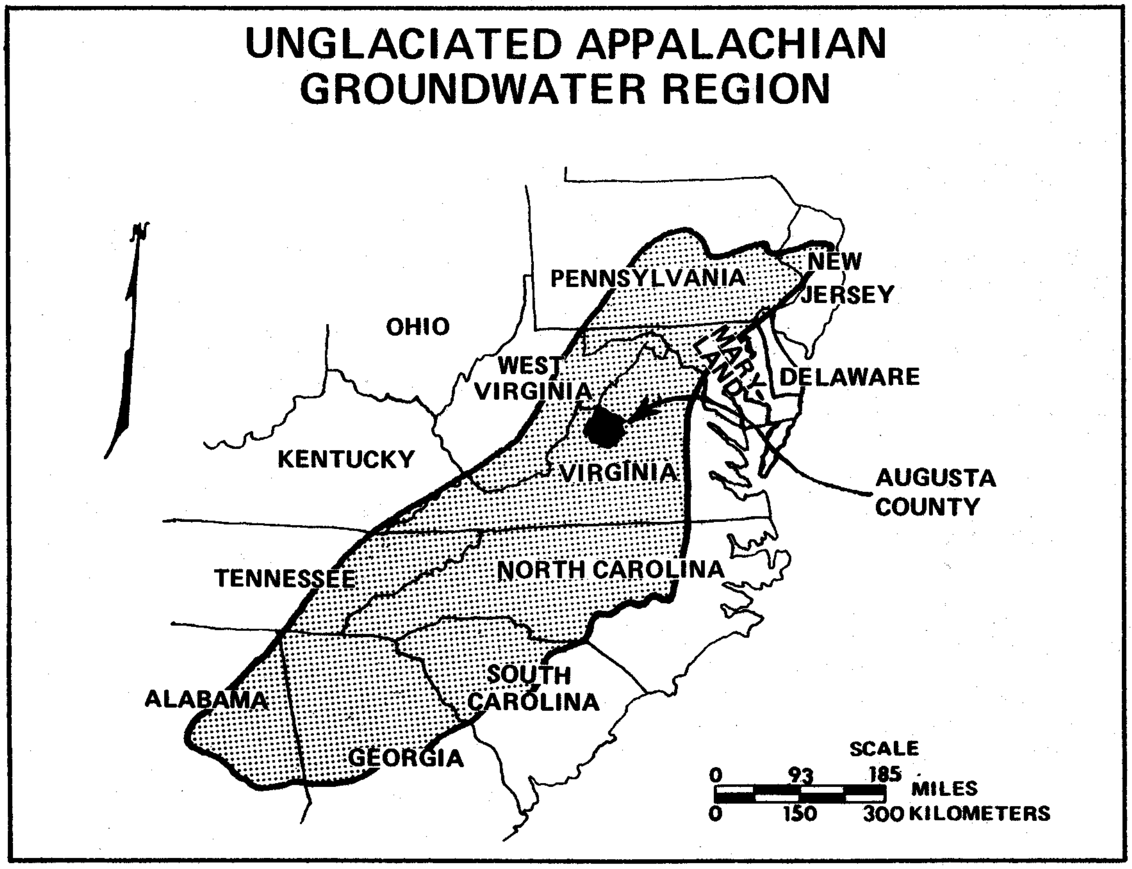
The North Mountain Fault lies to the northwest of the Staunton Fault, following a path through Newport and north through Swoope, where it makes a westward loop to Buffalo Gap. From there it extends northward through Jennings Gap and Stokesville. This fault brings older carbonate rocks over younger carbonate formations for most of its length, except from Stokesville north to the Rockingham County line where older carbonates are thrust over younger shales.

The controlling fold feature east of the Staunton Fault is the Massanutten Synclinorium. The Martinsburg Formation occupies the synclinorium axis in Augusta County. West of the fault the Long Glade Syncline is the prominent fold structure. The axis of this fold is in the Martinsburg in the northeast and in carbonate formations in the southwest. West of the North Mountain Fault folding is less intense and poorly developed. A major synclinal feature is the Elliott Knob Syncline, whose axis is occupied by Devonian and Mississippian shale and sandstone formations.

AVAILABILITY AND QUALITY OF GROUNDWATER

Augusta County has vast groundwater reserves which have been developed to a very limited extent. Groundwater availability and quality are dependent on a host of factors including rock type, geologic structure, soil depth, topography and climate. Geologic setting is the critical factor to consider when searching for groundwater in Augusta County, since well production and groundwater quality vary significantly in the three major groundwater sectors identified below. Topography is especially important when considering groundwater availability. Augusta County is located within the Unglaciated Appalachian Groundwater Region (Plate 11), characterized by mountains and hilly uplands separated by broad valleys. Mountains and upland areas channel surface runoff to lower elevations where the water can infiltrate to recharge the groundwater system.

Depth to bedrock in Augusta County is highly variable. Some areas have bedrock exposed at the surface, particularly in the carbonate areas. However, depth to bedrock in the Lyndhurst-Grottoes corridor indicates thickness of the unconsolidated sediments to be as great as 365 feet (111 m) (wells 124 and 132). The depth to bedrock in most cases is directly related to the amount of casing needed in constructing a water well, since soil zones and unconsolidated sediments must be cased off to prevent caving in the bore hole. Plate 12 depicts depth to bedrock based on well drillers' logs.



Source: Modified after Johnson (1972) PLATE NO. 11

Static water levels have been reported as deep as 379 feet (116 m) (well 478). Several flowing wells have been drilled in scattered parts of the county, though flowing artesian conditions are probably local phenomena. Most static water levels, however, are less than 100 feet (30 m) below land surface. Levels less than 50 feet (15 m) are extremely common. Plate 13 is a very generalized map showing depth to water based on static water level records. These depths probably represent local water table conditions in many areas, and periods of wet weather or drought may significantly affect these conditions.

Wells throughout the county consistently yield less than 50 gpm (3 l/s) except for the Lyndhurst-Grottoes alluvial corridor and a few other isolated areas (Plate 14). Factors such as casing diameter, length of well bore open to an aquifer, depth to water, and pump size all affect the actual yield of a well. It often is possible to develop greater yields, since Plate 14 is based on yields reported by well drillers and well owners. In most cases drilling is terminated after a satisfactory yield has been developed for the intended use. Additional drilling and development frequently will result in increased water production.

Groundwater quality in Augusta County is very good. The concentration of total dissolved solids (an indication of the degree to which water is mineralized) rarely exceeds 500 milligrams per liter (mg/l), as is evidenced by Plate 15. Most sampling points averaged between 150 and 500 mg/l. Groundwater in the western and eastern sections of the county typically is low in total dissolved solids; most wells were recorded at less than 150 mg/l.

Hardness trends are very similar to total dissolved solids trends. Degrees of hardness are defined as: soft - 0-60 mg/l; moderately hard - 61-120 mg/l; hard - 121-180 mg/l; and very hard - above 180 mg/l. Lower hardness is to be expected in the North Mountain and Blue Ridge areas, while extremely hard water is common in the valley (Plate 16). Only a few isolated areas, usually associated with alluvial overburden, yield "soft" water in Augusta County.

Iron concentrations are very acceptable for the majority of wells sampled. Concentrations above 0.3 mg/l (the limit recommended by the Virginia Department of Health) are rare (Plate 17). Isolated cases have been noted in all areas except for the Blue Ridge. Manganese, on the other hand, tends to run above the 0.05 mg/l limit established by the Virginia Department of Health in all areas of the county.

Groundwater Availability and Quality by Sector

The three sectors depicted in Plate 18 represent broad divisions which delineate general groundwater conditions by area. Although conditions generally are consistent within each sector, local variations are to be expected and do occur. The sectors are discussed below as they occur from east to west. Table 4 gives yield versus depth for the different groundwater sectors, and Table 5 lists groundwater quality variations by sector.

DEPTH TO BEDROCK IN AUGUSTA COUNTY

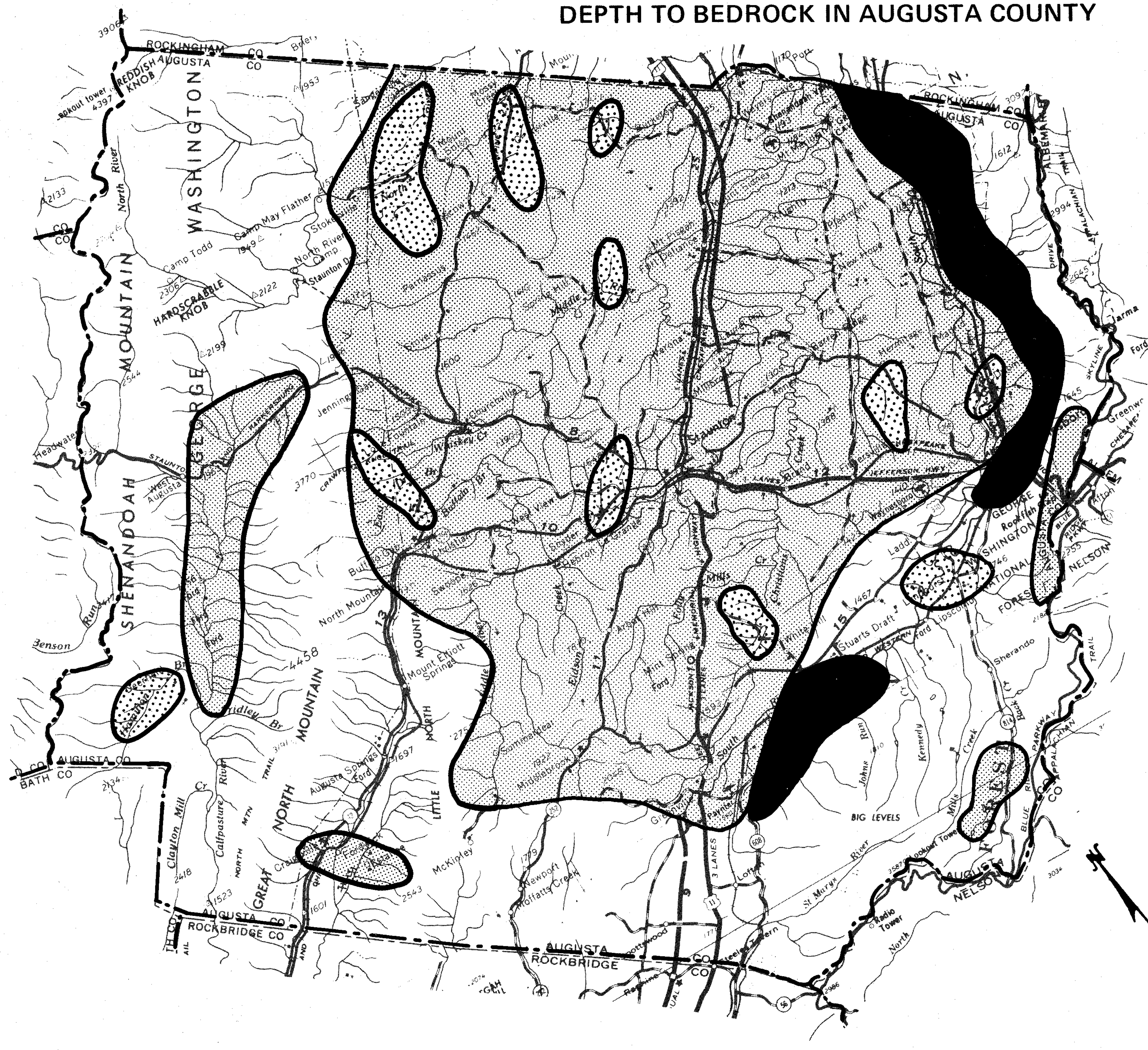


PLATE NO. 12

DEPTH TO WATER IN AUGUSTA COUNTY

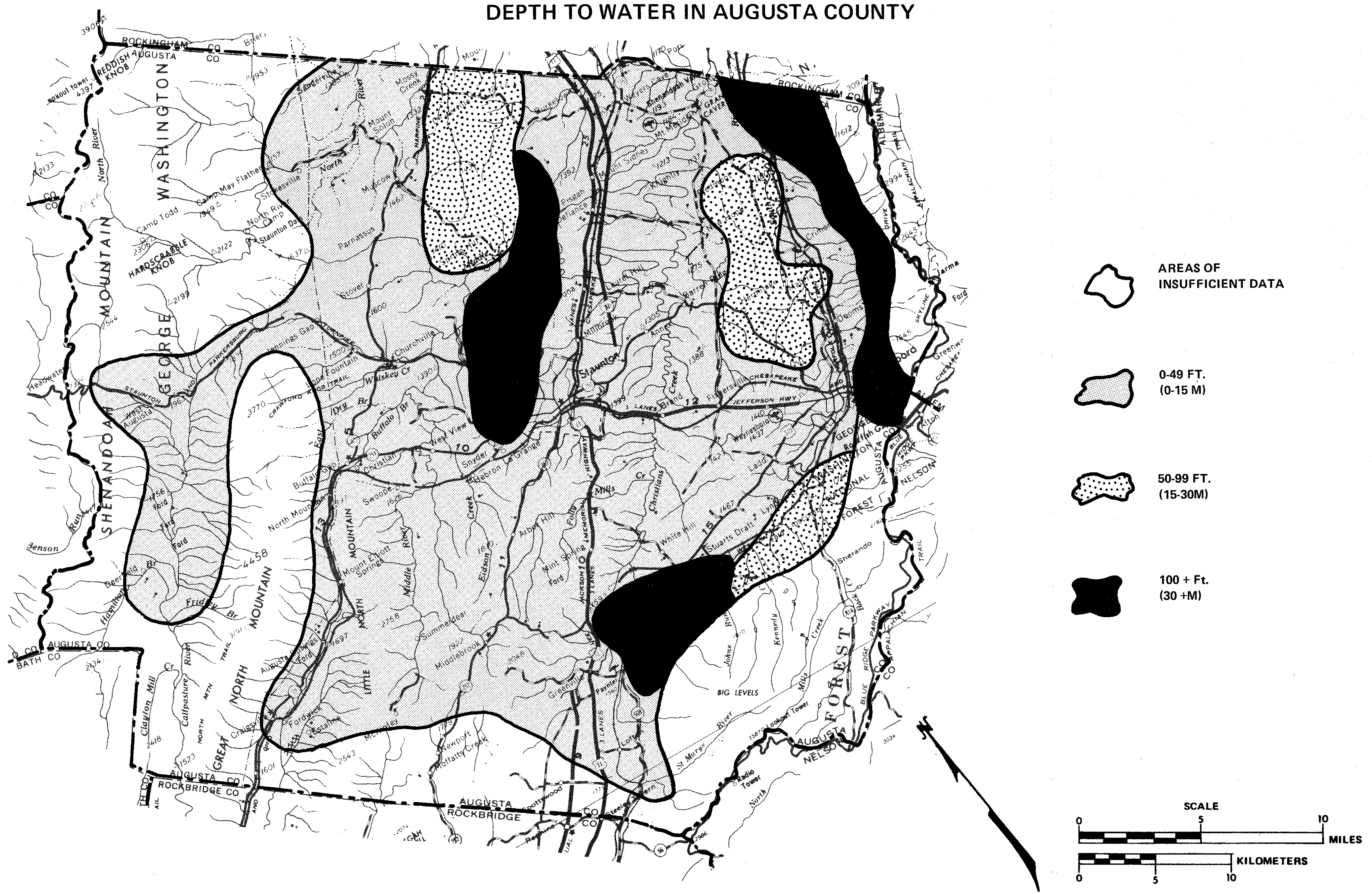
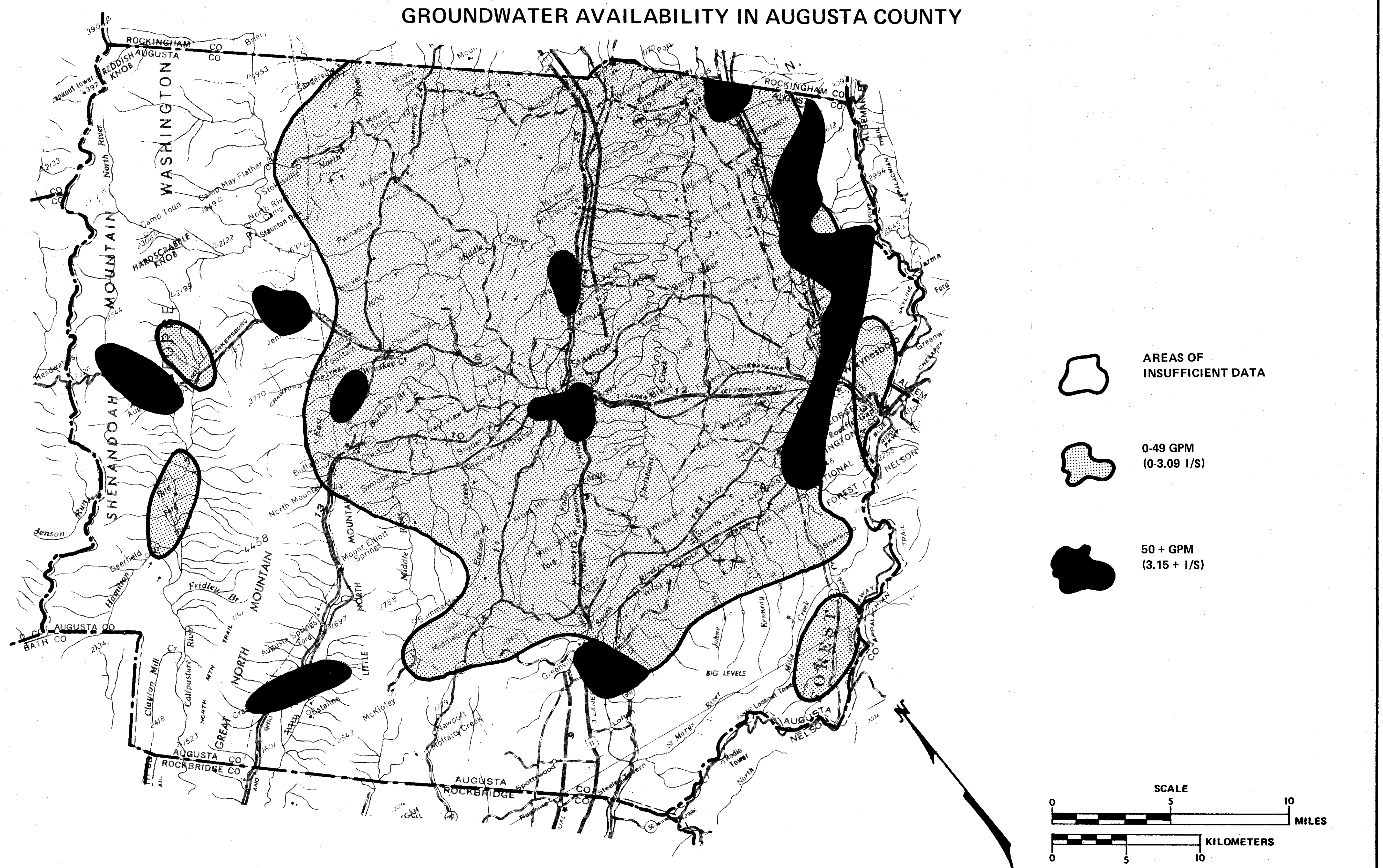


PLATE NO. 13

GROUNDWATER AVAILABILITY IN AUGUSTA COUNTY



CONCENTRATION OF TOTAL DISSOLVED SOLIDS IN GROUNDWATER IN AUGUSTA COUNTY

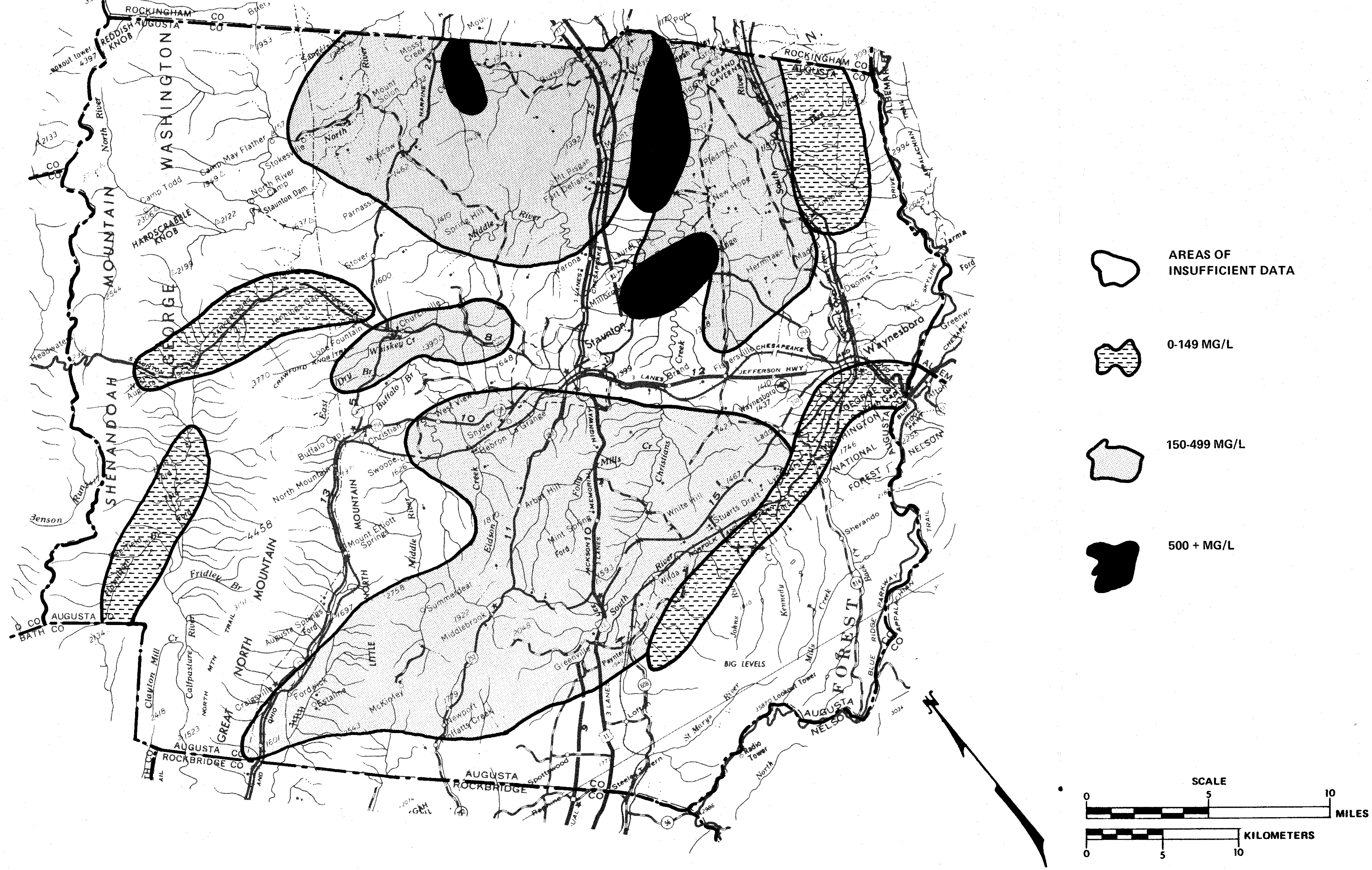


PLATE NO. 15

DEPTH TO BEDROCK IN AUGUSTA COUNTY

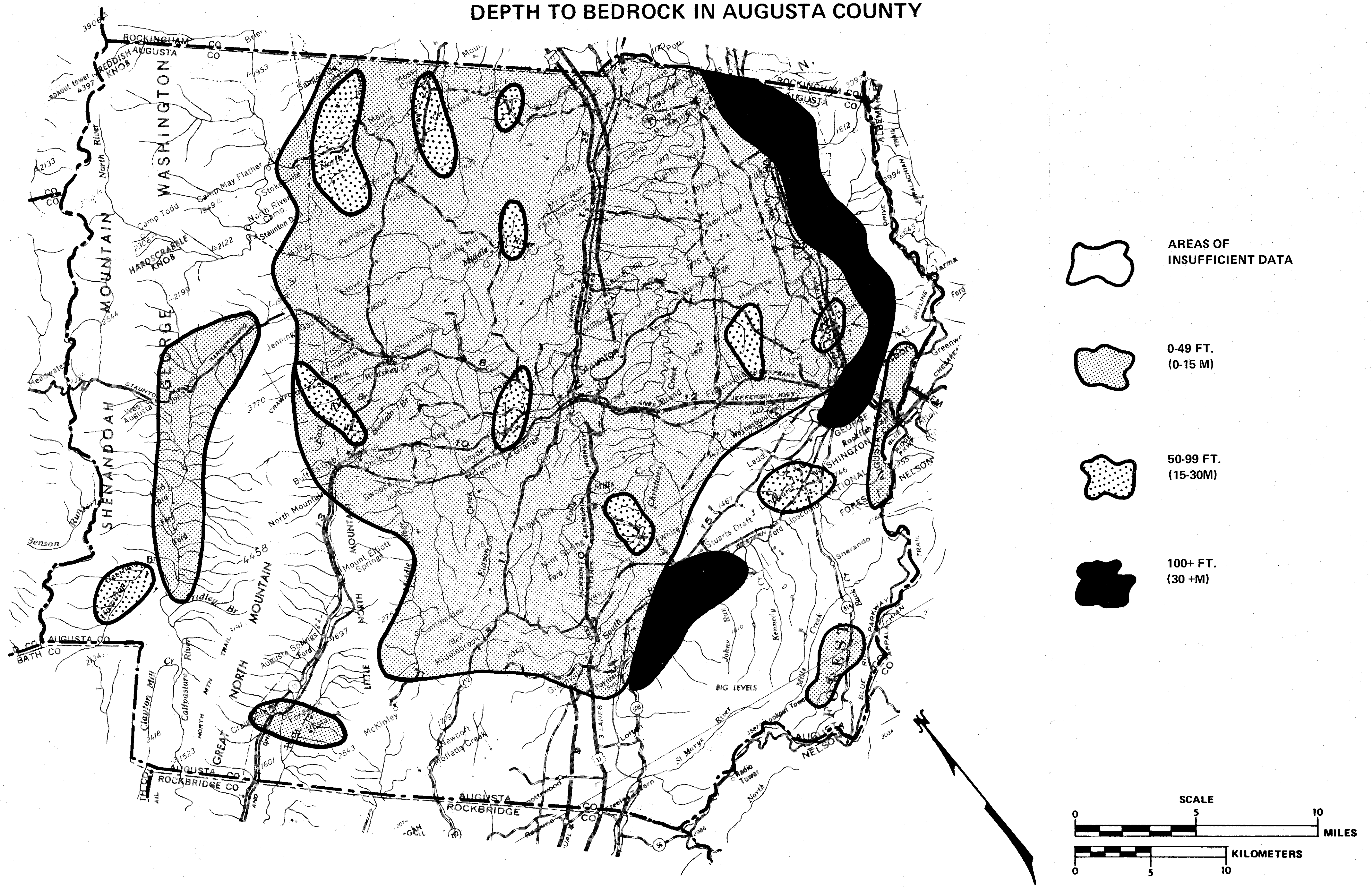


PLATE NO. 12

DEPTH TO WATER IN AUGUSTA COUNTY

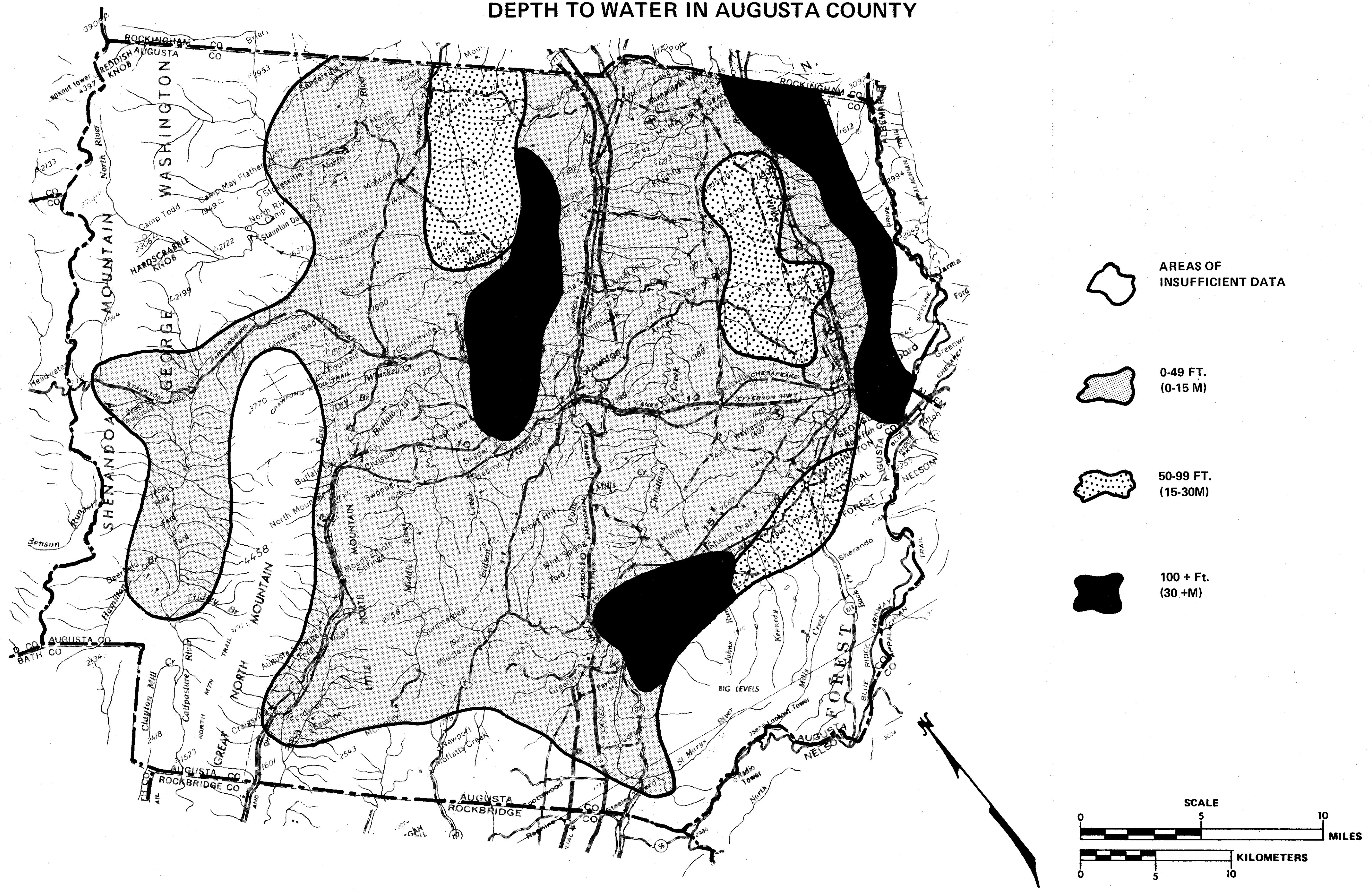


PLATE NO. 13

GROUNDWATER HARDNESS TRENDS IN AUGUSTA COUNTY

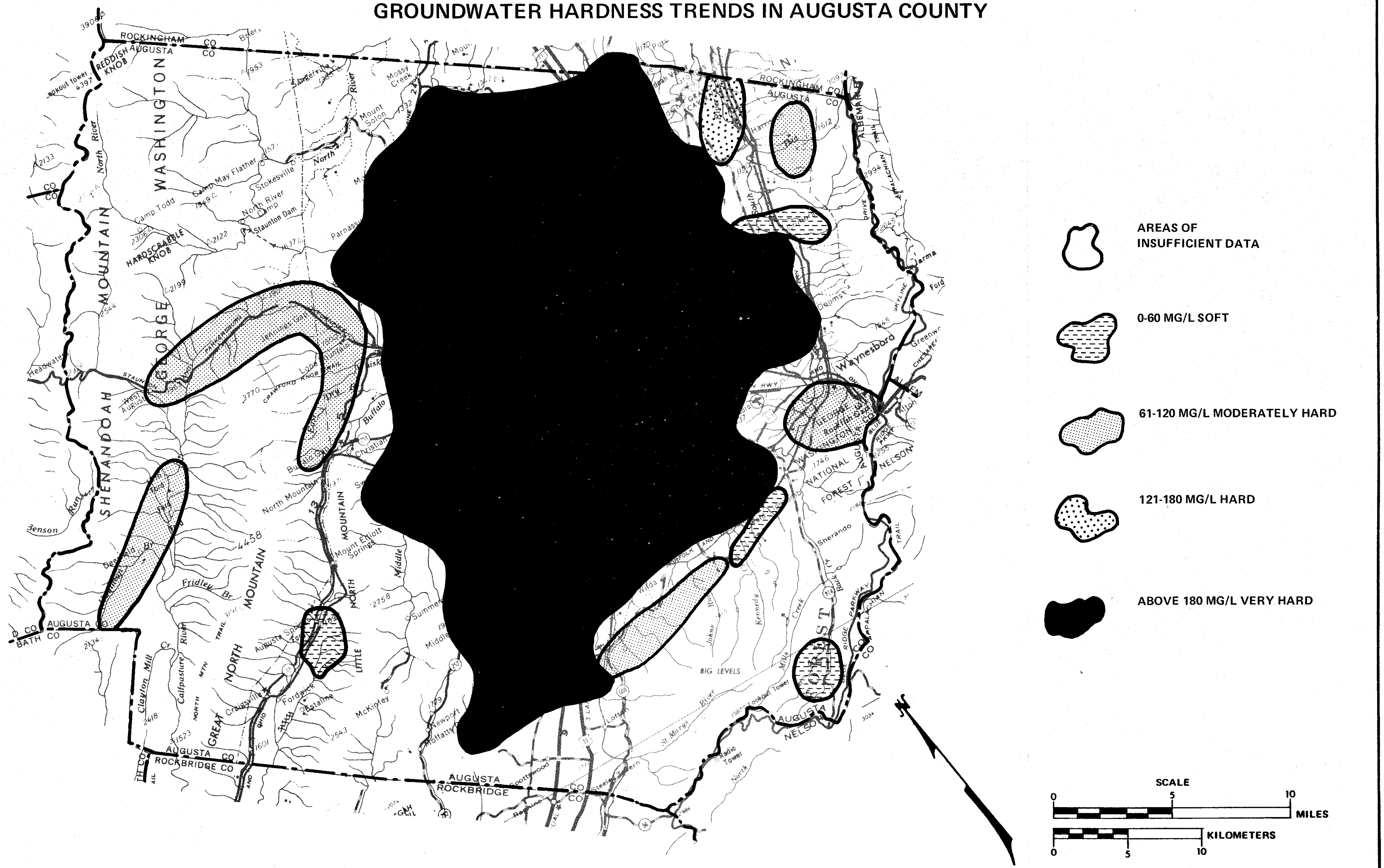
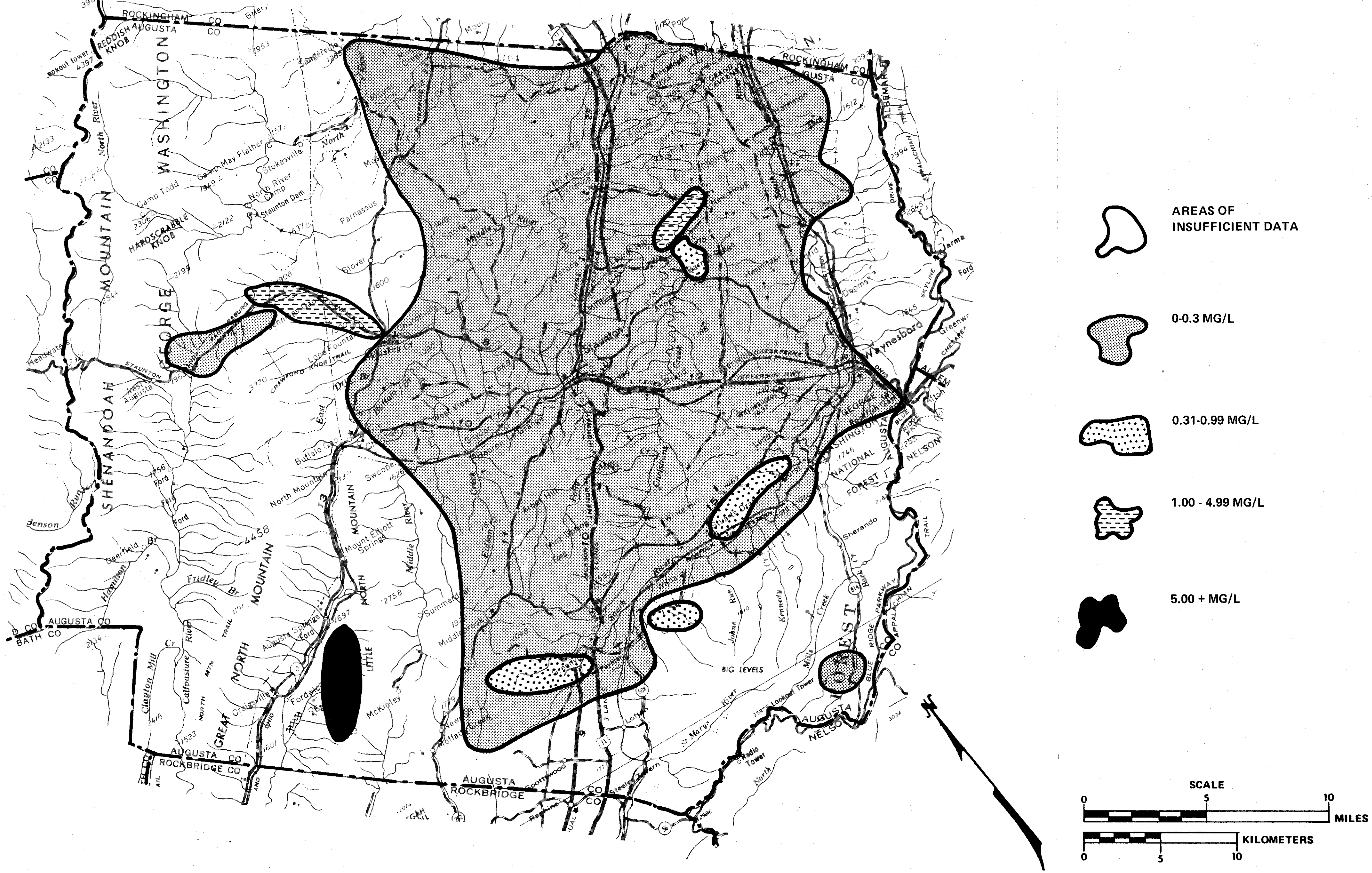


PLATE NO. 16

CONCENTRATION OF IRON IN GROUNDWATER IN AUGUSTA COUNTY



GROUNDWATER HARDNESS TRENDS IN AUGUSTA COUNTY

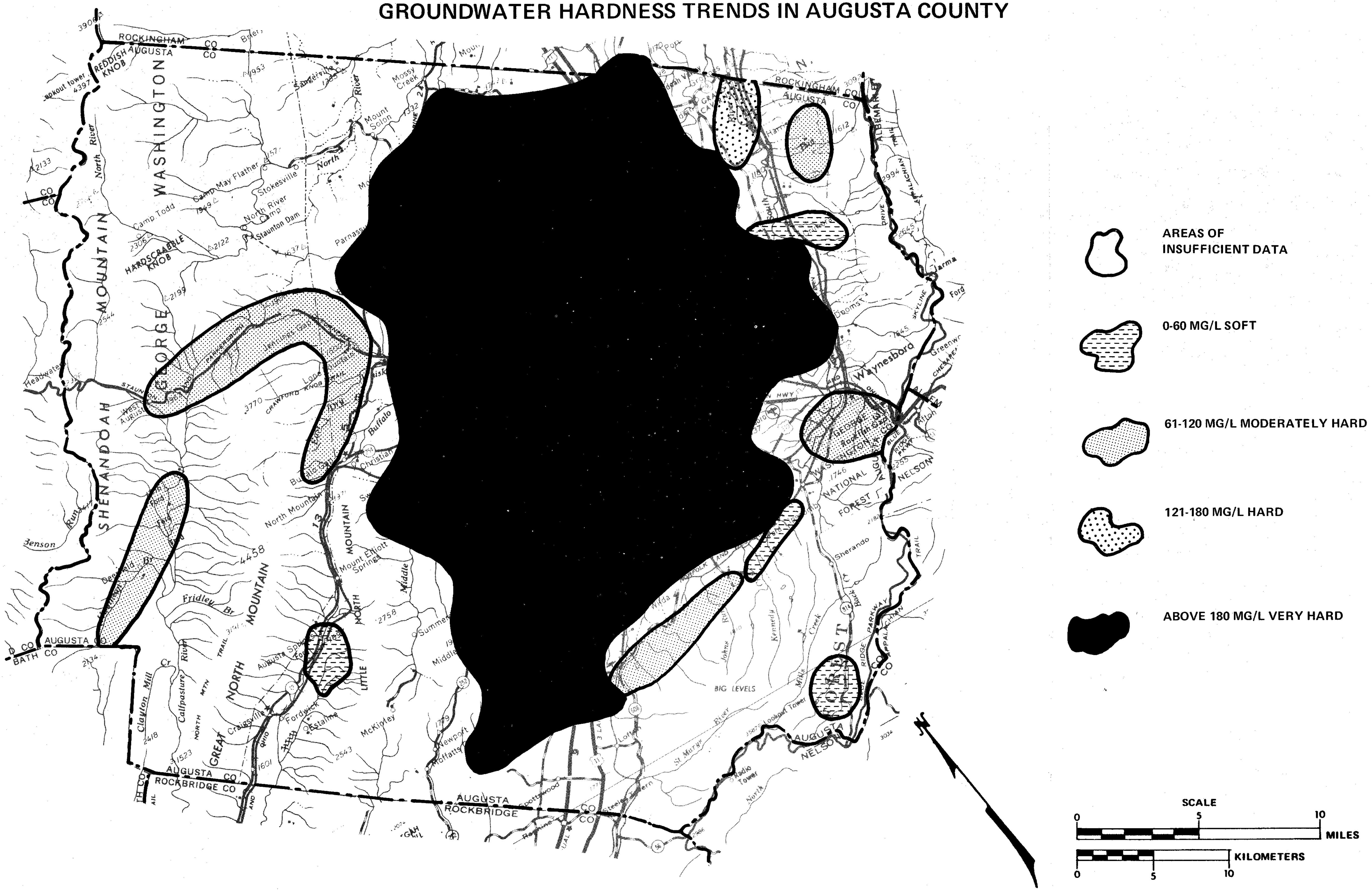


PLATE NO. 16

CONCENTRATION OF IRON IN GROUNDWATER IN AUGUSTA COUNTY

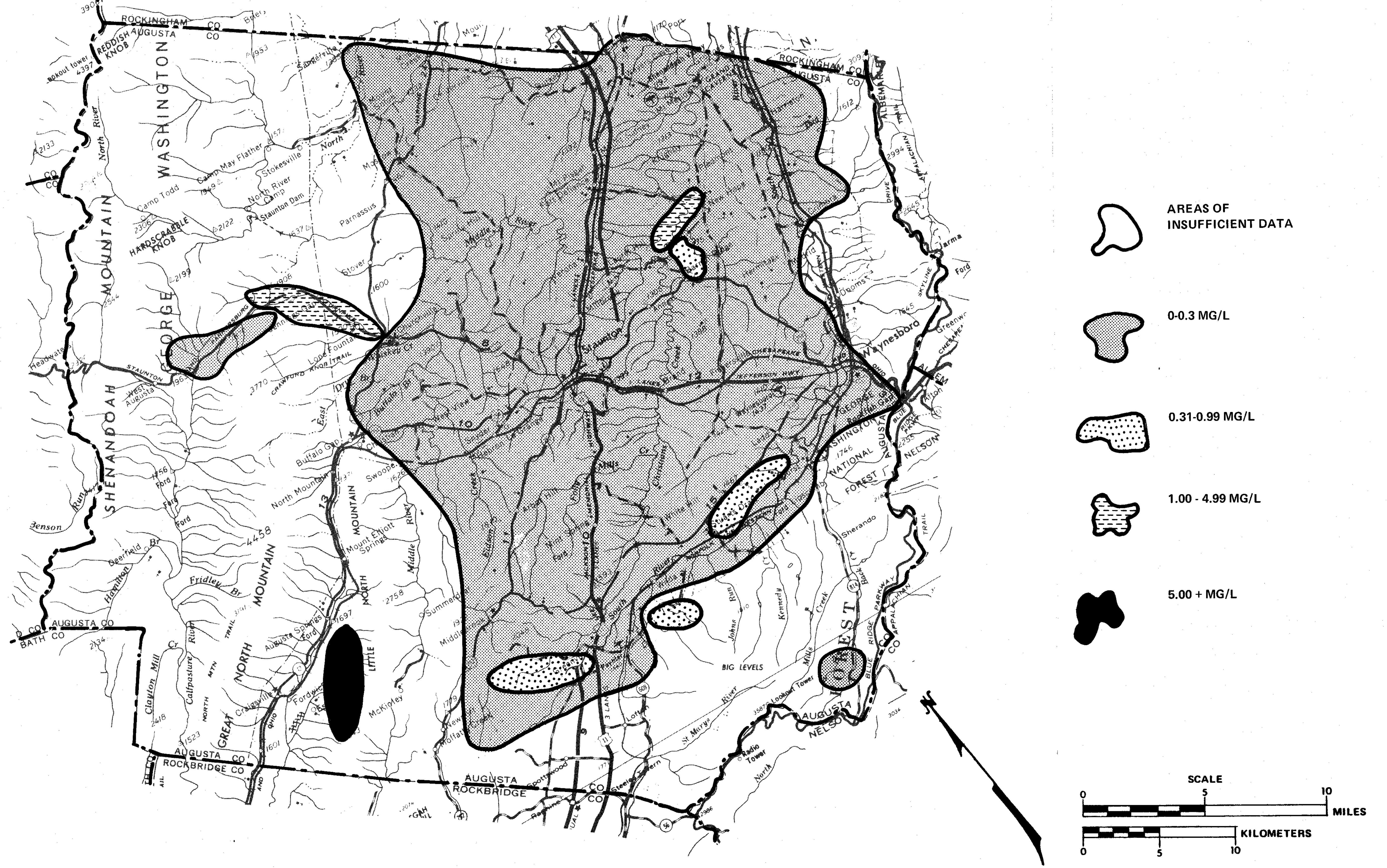


PLATE NO. 17

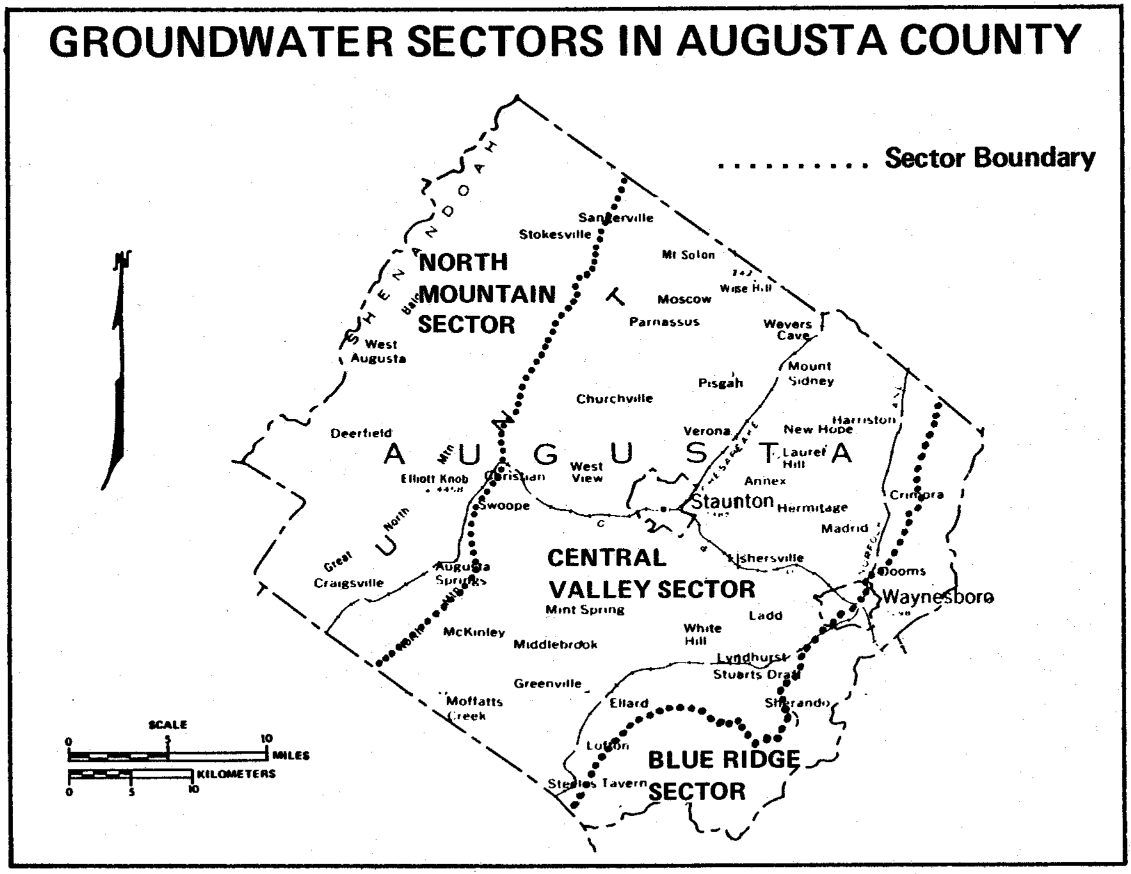


PLATE NO. 18

Blue Ridge Sector

The Blue Ridge Sector includes the area from the crest of the Blue Ridge to the contact with Cambro-Ordovician carbonate rocks just east of Waynesboro. Igneous, sedimentary and metamorphic rocks of the Blue Ridge are represented by the Catoctin greenstone and the Chilhowee Group. The sector generally is considered to be a very poor groundwater producer, but records on file indicate reliable wells have been developed there. However, a significant number of unsuccessful wells have been reported by well drillers. Plate 19 shows water well development in the Blue Ridge Sector.

Virtually all wells drilled in this sector are domestic wells. The mountainous terrain discourages development, and only one known public groundwater supply has been developed in the sector (Skyline Swannanoa, Inc.). Well yields are developed solely from fractures which store and transmit water. The steep slopes and resultant shallow soil cover afford little chance for recharge in the mountain elevations.

Reported well depths in the Blue Ridge Sector range from 122 to 1001 feet (37 to 305 m), while reported yields range from 1 gpm to 100 gpm (0.06 to 6.3 l/s). Table 6 gives the number of wells producing at specific rates. The most prolific well (112) was drilled at Rockfish Gap near the mountain crest. Probably the best well in the area, it

TABLE 4

GROUNDWATER YIELDS RELATIVE TO WELL DEPTHS
IN THE GROUNDWATER SECTORS OF AUGUSTA COUNTY

Sector	Depth: 0-99 ft (0-30 m) gpm	0-99 ft (0-30 m) l/s	100-199 ft (30-61 m) gpm	100-199 ft (30-61 m) l/s	200-299 ft (61-91 m) gpm	200-299 ft (61-91 m) l/s	300-399 ft (91-122 m) gpm	300-399 ft (91-122 m) l/s	400-499 ft (122-152 m) gpm	400-499 ft (122-152 m) l/s	500+ ft (152+ m) gpm	500+ ft (152+ m) l/s
BLUE RIDGE												
Maximum	20	1.26	50	3.15	18	1.14	412	25.99	100	6.31	35	2.21
Minimum	20	1.26	8	0.50	2	0.13	12	0.76	2	0.13	1	0.06
Average	20	1.26	33	2.08	14	0.88	148	9.34	51	3.22	14	0.88
No. Wells	(2)		(3)		(5)		(3)		(2)		(5)	
CENTRAL VALLEY Cambro-Ordovician Carbonate Formations												
Maximum	37	2.33	650	41.01	1200	75.71	1800	113.56	1557	98.23	3500	220.82
Minimum	2	0.13	1	0.06	2	0.13	2	0.13	1	0.06	1	0.06
Average	14	0.88	45	2.84	90	5.68	156	9.84	187	11.80	520	32.81
No. Wells	(17)		(56)		(38)		(42)		(22)		(24)	
Martinsburg Formation												
Maximum	50	3.15	50	3.15	37	2.33	20	1.26	10	0.63	12	0.76
Minimum	10	0.63	4	0.25	2	0.13	2	0.13	1	0.06	4	0.25
Average	27	1.70	18	1.14	15	0.95	8	0.50	5	0.32	8	0.50
No. Wells	(3)		(7)		(11)		(7)		(4)		(2)	
NORTH MOUNTAIN												
Maximum	60	3.79	150	9.46	40	2.52	No Data		No Data		110	6.94
Minimum	6	0.38	3	0.19	2	0.13					110	6.94
Average	20	1.26	60	3.79	14	0.88					110	6.94
No. Wells	(8)		(8)		(5)						(1)	

TABLE 5

GROUNDWATER QUALITY COMPARISONS FOR
THE GROUNDWATER SECTORS OF AUGUSTA COUNTY*

Parameter	Blue Ridge	Sector: Central Valley Carbonates	Sector: Central Valley Martinsburg	North Mountain
Calcium	(3)	(126)	(26)	(19)
Maximum	25.40	137.00	450.00	48.00
Minimum	2.00	1.00	1.00	2.00
Average	13.93	56.18	111.25	21.90
Hardness (Ca-Mg)	(3)	(113)	(26)	(17)
Maximum	92.00	520.00	1320.00	149.00
Minimum	8.00	2.00	3.00	36.00
Average	48.00	225.76	346.00	85.00
Iron	(3)	(105)	(21)	(16)
Maximum	0.23	22.16	4.10	10.00
Minimum	0.10	0.00	0.00	0.00
Average	0.14	0.37	0.58	2.58
Magnesium	(2)	(123)	(26)	(19)
Maximum	7.10	67.00	53.00	14.70
Minimum	0.80	0.00	0.20	0.00
Average	5.50	20.48	16.75	6.99
Manganese	(3)	(82)	(23)	(16)
Maximum	0.26	5.70	1.63	3.70
Minimum	0.01	0.00	0.00	0.00
Average	0.09	0.14	0.18	0.51
Nitrate (as NO_3)	(3)	(61)	(13)	(3)
Maximum	8.00	155.10	5.30	5.30
Minimum	0.00	0.00	0.00	0.20
Average	2.67	15.64	0.78	3.43
pH	(3)	(131)	(27)	(21)
Maximum	8.2	8.6	8.0	8.0
Minimum	6.2	5.5	6.5	6.2
Average	7.4	7.6	7.3	7.2
Solids (Total Dissolved)	(2)	(107)	(27)	(19)
Maximum	121.00	628.00	872.00	270.00
Minimum	53.00	78.00	133.00	99.00
Average	87.00	305.94	475.26	150.37
Sulfate	(2)	(108)	(19)	(21)
Maximum	10.60	295.70	113.20	37.20
Minimum	6.60	0.30	0.00	1.70
Average	8.60	14.49	46.26	9.79

*All values in milligrams per liter (mg/l) except pH; parentheses ( ) enclose number of analyses used in making calculations

WATER WELL DEVELOPMENT IN THE BLUE RIDGE GROUNDWATER SECTOR

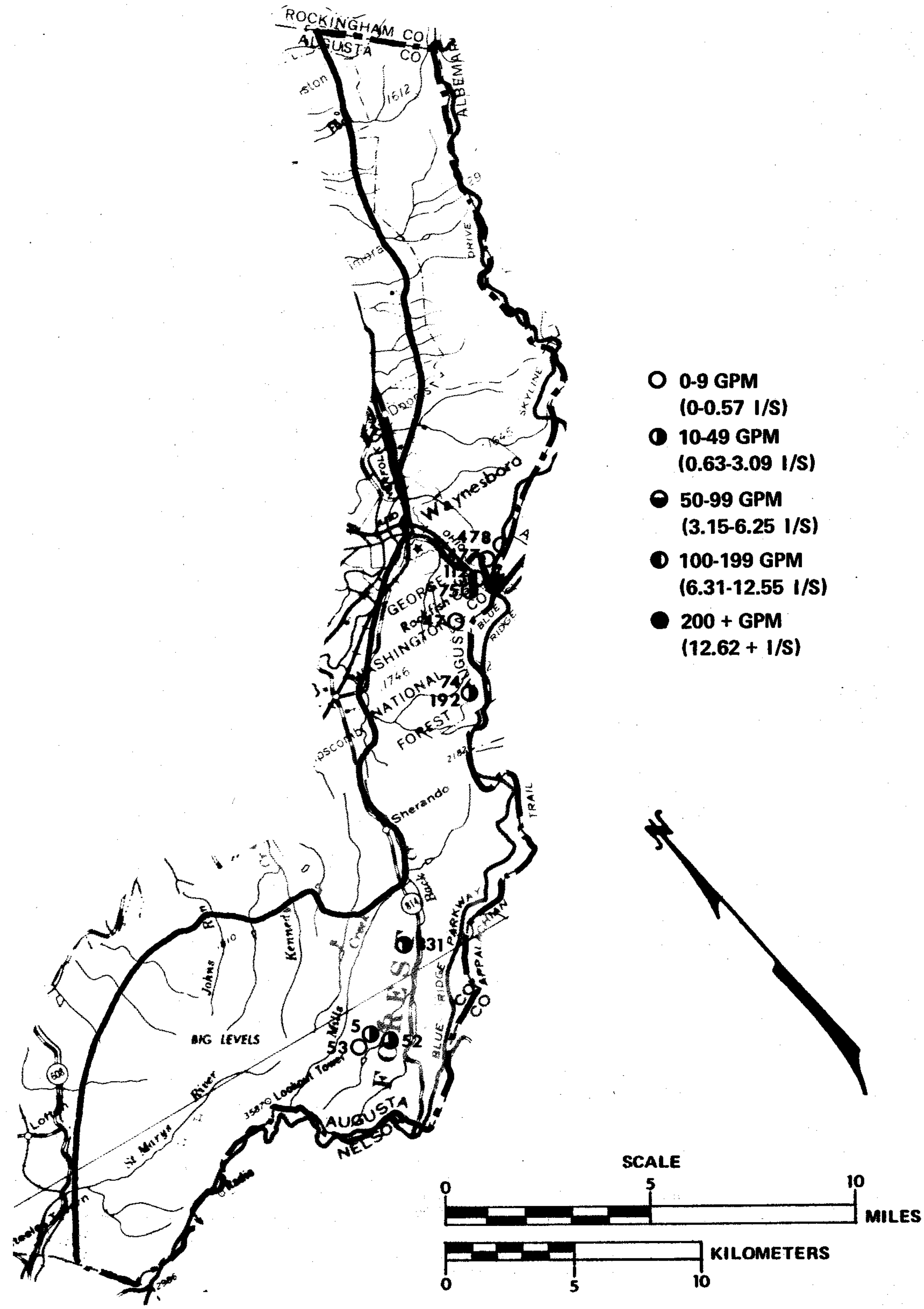


PLATE NO. 19

produced 100 gpm (6.3 l/s) with a 220-foot (67-m) drawdown after a 48-hour pump test. Static water levels and depth to bedrock are highly variable thoughout the sector, sometimes varying by as much as 100 feet (30 m) within a very short distance.

TABLE 6

WELL PRODUCTION RATES IN THE BLUE RIDGE SECTOR

Yield	Number of Wells
0-9 gpm (0-0.57 l/s)	3
10-19 gpm (0.63-1.20 l/s)	4
20-29 gpm (1.26-1.83 l/s)	2
30-39 gpm (1.90-2.46 l/s)	3
40-49 gpm (2.52-3.09 l/s)	1
50+ gpm (3.15+ l/s)	1

One well (119) owned by Skyline Swannanoa, Inc., has penetrated to a depth of 1001 feet (305 m). Its yield, however, is only 12 gpm (0.76 l/s) and no water was encountered below a depth of 385 feet (117 m). This is the deepest water zone encountered in any well for which data are available in this sector.

Groundwater in the Blue Ridge Sector is very low in mineralization. Hardness, as a rule, falls in the "soft" category, and iron and manganese concentrations generally are lower here than in any other area of the county. Quality data are very scarce for this sector, but the few water analyses available tend to support the findings of DeKay (1972) in the Rockfish Gap area of Augusta County in the Shenandoah National Park.

Central Valley Sector

The Central Valley Sector extends roughly from the northwest foot of the Blue Ridge to Little North Mountain and encompasses three geologic settings in which the geohydrologic characteristics vary accordingly.

The greater portion of the sector is underlain by Cambro-Ordovician carbonate formations. Along the northwest toe of the Blue Ridge, a major deposit of unconsolidated alluvial and terrace material overlies these carbonate formations. The remainder of the sector is underlain by the Martinsburg Formation in three areas. The largest of these, where the Martinsburg occupies the axis of the Massanutten Synclinorium, extends from a point northwest of Stuarts Draft northeastward into Rockingham County.

The carbonate formations which are overlain by alluvium and terraces offer exceptionally-high potential yields. All carbonate units in Augusta County generally can be developed to an acceptable yield for most purposes, whereas the Martinsburg Formation occasionally proves unsuitable for industrial and public development. Well development in the Central Valley Sector is presented in Plate 20.

Two major industrial well fields have been developed in the alluvial-covered carbonates along the northwest foot of the Blue Ridge. Reynolds Metals Company, Inc., at Grottoes has developed its field in the Conococheague limestone where the unconsolidated mantle ranges in thickness from 152 to 230 feet (46 to 70 m). Depths of the Reynolds wells have ranged from 150 to 342 feet (46 to 104 m), and yields have ranged from 50 to 1800 gpm (3.2 to 113.6 l/s). The E. I. DuPont de Nemours Company, Inc., in Waynesboro has developed an extensive well field in the Shady (Tomstown) dolomite. DuPont wells have been drilled from 163 to 784 feet (50 to 239 m) deep and yield 500 to 3500 gpm (31.5 to 220.8 l/s). Alluvial cover in the DuPont field is as thick as 270 feet (25 m).

Wells deriving water from carbonate rock units overlain by unconsolidated sediments are, on the average, far more productive than wells drilled in the same formations lacking the alluvial overburden. Wells producing in excess of 100 gpm (6.3 l/s) from the alluvial-covered formations are not at all uncommon. Thirty-three percent (31 wells) of the wells on file in this category produce 100 gpm (6.3 l/s) or more, compared to less than four percent (4 wells) of those developed in carbonate areas where alluvial cover is absent. A comparison of carbonate wells penetrating alluvium in the central part of the county with those penetrating alluvium along the foot of the Blue Ridge shows that those near the Blue Ridge average 371 gpm (23.4 l/s) compared to 34 gpm (2.1 l/s) for the other alluvial areas.

Martinsburg wells, however, do not seem to exhibit increased production due to overlying alluvial sediments. This may be explained in part by the hydrologic differences between clastic rocks and limestone/dolomite, but also may be explained by the topographic location and the physical boundaries of the unconsolidated sediments. All Martinsburg wells penetrating alluvium are located in the central portions of the county. Adjacent mountainous areas, which would provide increased recharge, are absent, and the alluvial deposits themselves are not as extensive nor as thick over the Martinsburg as are the unconsolidated sediments along the west toe of the Blue Ridge. Depth and yield ranges and yield-versus-depth for wells in this sector are given in Tables 7 and 8, respectively.

WATER WELL DEVELOPMENT IN THE CENTRAL VALLEY GROUNDWATER SECTOR

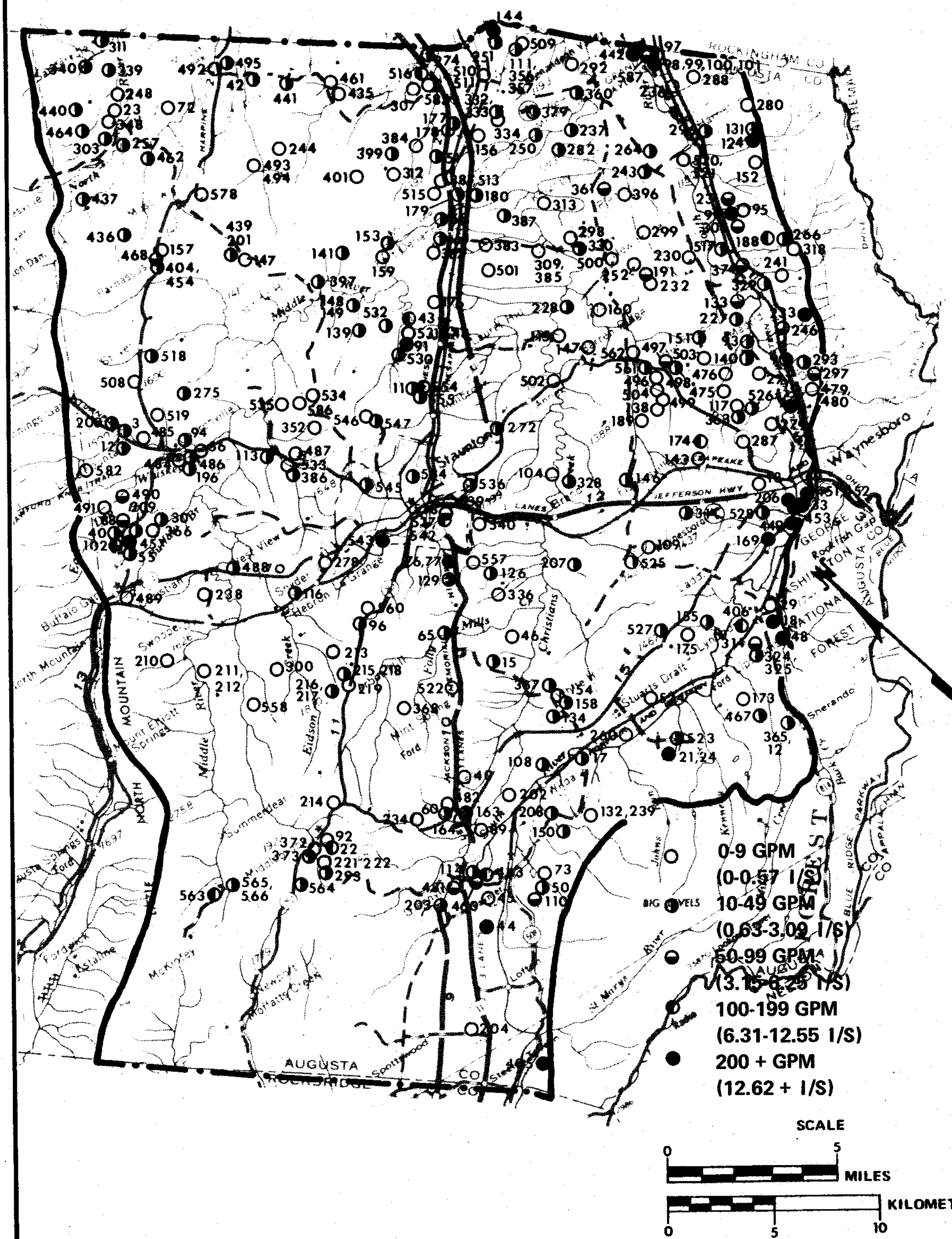


PLATE NO. 20

TABLE 7

WELL DEPTH AND YIELD RANGES
IN THE CENTRAL VALLEY SECTOR

Hydrologic Unit	Depth ft	Depth m	Yield gpm	Yield l/s
Cambro-Ordovician Carbonate Formations				
Maximum	831	253	3500	221
Minimum	25	8	1	0.06
Average	290	88	158	10
No. Wells	(197)		(175)	
Carbonate Formations Without Alluvial Cover				
Maximum	831	253	1016	64
Minimum	25	8	1	0.06
Average	275	84	37	2.30
No. Wells	(103)		(92)	
Carbonate Formations With Alluvial Cover				
Maximum	784	239	3500	221
Minimum	70	21	2	0.13
Average	299	91	294	19
No. Wells	(94)		(83)	
Martinsburg Formation				
Maximum	504	154	50	3.20
Minimum	65	20	1	0.06
Average	253	77	14	0.88
No. Wells	(36)		(33)	
Martinsburg Formation Without Alluvial Cover				
Maximum	460	140	50	3.20
Minimum	65	20	1	0.06
Average	240	73	13	0.82
No. Wells	(21)		(18)	
Martinsburg Formation With Alluvial Cover				
Maximum	504	154	50	3.20
Minimum	74	23	2	0.13
Average	272	83	15	0.95
No. Wells	(15)		(15)	

TABLE 8

AVERAGE GROUNDWATER YIELDS RELATIVE TO WELL DEPTHS IN THE CENTRAL VALLEY SECTOR

Hydrologic Unit	0-99 ft (6-30 m)		100-199 ft (30-61 m)		200-299 ft (61-91 m)		300-399 ft (91-122 m)		400-499 ft (122-152 m)		500+ ft (152+ m)	
	gpm	l/s	gpm	l/s	gpm	l/s	gpm	l/s	gpm	l/s	gpm	l/s
Cambro-Ordovician Carbonate Formations	16	1	45	2.84	100	6.31	168	6.31	179	11	567	36
No. Wells	(11)		(50)		(33)		(36)		(19)		(22)	
Carbonate Formations Without Alluvial Cover	15	0.95	19	1.20	30	1.90	73	4.61	12	0.76	32	2.02
No. Wells	(7)		(23)		(18)		(26)		(8)		(9)	
Carbonate Formations With Alluvial Cover	18	1.14	68	4.30	183	11	413	26	300	19	937	59
No. Wells	(4)		(27)		(15)		(10)		(11)		(13)	
Martinsburg Formation	35	2.21	18	1.14	15	0.95	8	0.50	5	0.32	8	0.50
No. Wells	(2)		(7)		(11)		(7)		(3)		(2)	
Martinsburg Formation Without Alluvial Cover	50	3.15	12	0.76	16	1	16	1	2	0.13	No Data	
No. Wells	(1)		(3)		(8)		(3)		(1)			
Martinsburg Formation With Alluvial Cover	20	1.26	23	1.45	12	0.76	3	0.19	6	0.38	8	0.50
No. Wells	(1)		(4)		(3)		(4)		(2)		(2)	

Groundwater production from the high-potential corridor extending from Lyndhurst to Grottoes has been a subject of speculation. Cederstrom (1971) postulated a 2-mile (3.2-km) wide zone extending 13 miles (20.9 km) upstream from Waynesboro would safely yield 240 MGD (908,400 m^3/d) of groundwater for low flow augmentation of the South Fork of the Shenandoah River. This figure is based on 100-foot (30-m) drawdown over the entire area, assuming a storage factor of 4 percent. While it is entirely possible to develop a regional yield of this magnitude, it is the opinion of the writers that such a high rate of withdrawal undoubtedly would result in interference among wells within fields and most likely between well fields themselves. Considering the whole corridor from Lyndhurst to Grottoes, however, it is conceivable that several well fields could be expected to produce around 75 MGD (283,875 m^3/d) with minimal interference and a less drastic decline of the regional water table.

The deepest carbonate well on record (584) was developed in the Beekmantown Formation at the site of the former Staunton Military Academy. The 1400-foot (427-m) well reportedly produced 40 gpm (0.16 l/s), and almost all water was encountered at depths below 600 feet (183 m).

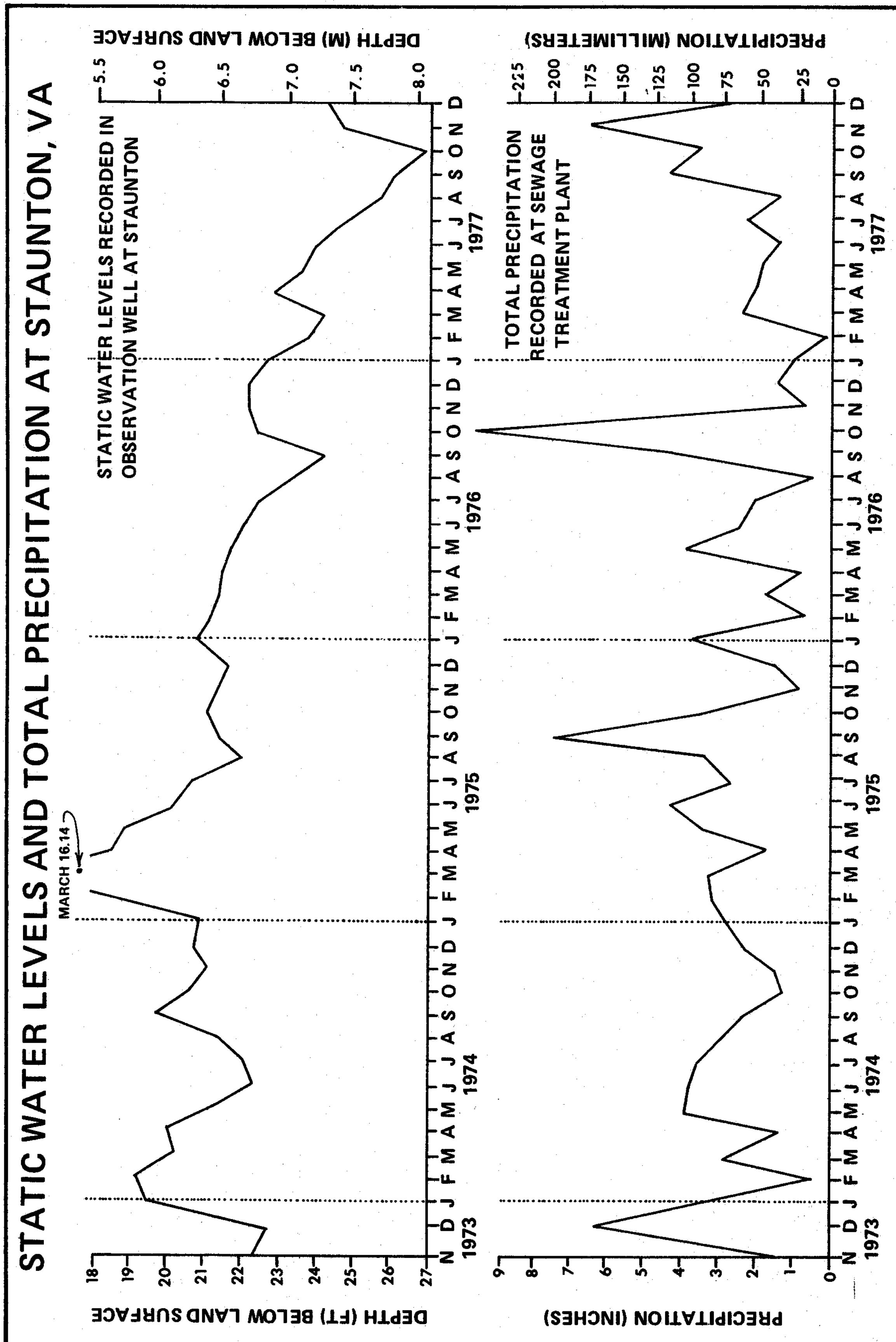
An abandoned well (127) just south of Staunton owned by the Augusta County Service Authority is maintained by the State Water Control Board as an observation well. Static water levels from a continuous water level recorder are compared with precipitation data in Plate 21.

Groundwater in the Central Valley is generally of good quality. The average concentration of total dissolved solids is much greater in the Martinsburg Formation than in the carbonate formations. This is similar to the trend recognized in Rockingham County (Hinkle and Sterrett, 1976), although the difference is far more pronounced in Augusta County. Ninety-two percent of the wells with total dissolved solids in excess of 500 mg/l are located in the Martinsburg.

Groundwater hardness in the Central Valley Sector tends to be very high. Although nearly the entire sector is characterized by groundwater classified as "very hard," Martinsburg wells tend to produce much harder water than wells developed in the carbonate formations, which is somewhat unusual. Hinkle and Sterrett (1976) found that groundwater from Martinsburg rocks in neighboring Rockingham County was an average of 35 mg/l softer than groundwater from carbonate formations in that county. The same researchers (1977) found groundwater from the Martinsburg in Shenandoah County to average approximately 55 mg/l softer than groundwater from the carbonate formations in that county.

Carbonate wells with hardness content in excess of 400 mg/l include two wells (381 and 384) in the Mt. Sidney area, one in Churchville (113), one near Stuarts Draft (367) and one south of Parnassus (415). A Martinsburg well near Barren Ridge (115) exhibited the highest hardness content on record for Augusta County: 1320 mg/l.

Average values for iron, sulfate and manganese are all greater in groundwater from the Martinsburg. Iron content tends to run higher than normal in the Barren Ridge-New Hope area. Two wells (225 and 330) in this vicinity have the highest iron values recorded in the Central Valley Sector.



Source: National Oceanic and Atmospheric Administration (precipitation data); Virginia State Water Control Board – VRO (groundwater levels)

PLATE NO. 21

Nitrate content is highly variable and is dependent on local conditions. Many wells developed in carbonate aquifers show high nitrate values due to the nature of groundwater movement through solution channels in limestone and dolomite. Nitrates from local septic tank failure and animal waste and fertilizer runoff are more likely to contaminate groundwater in carbonate rocks than in the Martinsburg Formation.

North Mountain Sector

The North Mountain Sector offers fair groundwater potential and has been developed to a limited extent. Well development is shown in Plate 22. Shale and sandstone formations predominate here, and, while normally considered to be only fair aquifers at best, local conditions frequently are very favorable. Several wells in the Jennings Gap-West Augusta area along Route 250 are reported to have flowed when drilled. At least three wells in this same vicinity (388, 403, 423) reportedly produced from 100 to 150 gpm (6.3 to (9.5 l/s) at completion. A well at the Todd Lake Recreation Area in George Washington National Forest (184) produced 131 gpm (8.3 l/s) at completion.

Domestic development accounts for the majority of the wells and springs developed in the North Mountain Sector; public and industrial development has been very sparse. Most wells are less than 100 feet (30 m) deep, and many are bored or dug rather than drilled. However, the deepest well on file for Augusta County is at Fordwick. This 1438-foot (438-m) well (585), drilled for the Lehigh Portland Cement Company and now abandoned, was reported by Cady (1936) to be the water source for the Town of Fordwick. According to driller records, the main water source was encountered below 1200 feet (366 m), and at completion the well flowed naturally at 25 gpm (1.6 l/s). Several large springs have been developed for water supplies, including Black Run Spring for the Town of Craigsville and the Stillwater Worsted Mill Spring for the community of Augusta Springs.

Water quality generally is acceptable throughout the sector, although iron and sulfate concentrations occasionally render the water mildly objectionable. Iron values between West Augusta and Jennings Gap were noted as being unusually low for the area, below the 0.3 mg/l limit established by the Virginia Department of Health. However, most wells extending from Jennings Gap east to the sector boundary have iron concentrations in the range of 1.0 to 5.0 mg/l. Iron values above 5.0 mg/l are common just east of Craigsville.

Total dissolved solids concentrations are normally below 150 mg/l throughout the sector. Most data are from the Deerfield Valley and the Jennings Gap-West Augusta corridor. Hardness in the same areas tends to be moderately high, while east of Craigsville hardness has been found to be less than 60 mg/l (soft). Manganese levels throughout the sector average about ten times above the 0.05 mg/l limit established by the Virginia Department of Health.

WATER WELL DEVELOPMENT IN THE NORTH MOUNTAIN GROUNDWATER SECTOR

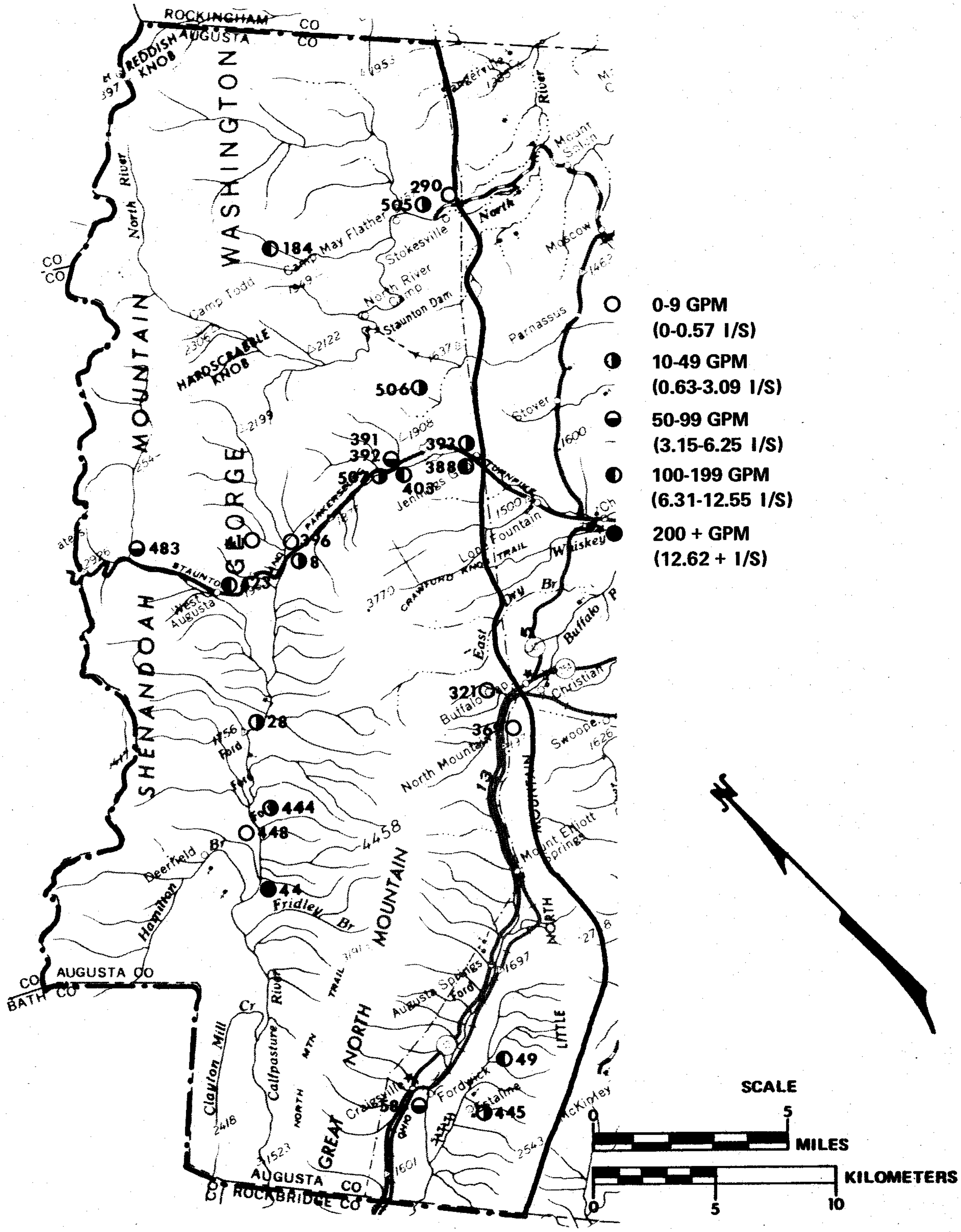


PLATE NO. 22

Springs

Springs are numerous throughout Augusta County, but by far the highest density is in the Central Valley Sector. Literally thousands of springs issue from the limestones and dolomites of the valley floor. Plate 23 gives locations of some of the more prolific springs, and Table 9 tabulates their flow measurements.

Major springs along the west toe of the Blue Ridge include Baker Spring (453), owned by DuPont. One of the largest springs in the county, Baker Spring issues from the Waynesboro (Rome) Formation and supplies process water to DuPont and Crompton. Coiner Spring (169) and District Home Spring (170), both in the Elbrook Formation, are part of the Waynesboro city water system. Dodge Spring (79) supplies water to the lake at Shenandoah Acres Resort.

The spring supplying water to the community of Augusta Springs (19) is the only spring shown on Plate 23 which is not located in the Central Valley Sector. With a flow measured at less than 1,000 gpm (63.1 l/s), it ranks as one of the smallest major springs in the county.

Of the remaining 12 springs, 9 are in the Conococheague limestone unit. This includes the largest known spring in Augusta County, Joseph's Spring, which was measured in April 1978 at 6,640 gpm (418.9 l/s), or 9,561,600 gpd (36,191 m^3/d). While no other seasonal flow measurements are available, it is reported to have a consistently strong discharge throughout the summer and early fall. At least two Conococheague springs are used for municipal water supplies: Berry Farm (Quick's) Spring (67) for the Verona Sanitary District; and Dice's Spring (66) for the Weyers Cave Sanitary District. Gardner Spring (85), which is part of the Staunton city water system, issues from the Beekmantown Formation along Middle River.

Spring water is generally much lower in mineralization than well water from corresponding rock units. Table 10 compares water quality from springs and wells in the carbonate formations of the Central Valley Sector. Total dissolved solids in the spring water averages much less than in well water samples. Hardness seems to run slightly higher in spring waters, which is unusual. This is attributable to the higher magnesium concentrations found in the spring water. Parameters such as iron, calcium, manganese and sulfate are all lower in spring water as compared to well water.

GROUNDWATER UTILIZATION

Groundwater is the major source of water for public, industrial and domestic supply in Augusta County. Three industrial well fields account for the bulk of daily industrial groundwater withdrawal. The City of Waynesboro derives all its water from two springs, and a spring supplies approximately half the daily water needs of the City of Staunton. Of the

MAJOR SPRINGS IN AUGUSTA COUNTY

(REFER TO TABLE 9 FOR FLOW MEASUREMENTS)

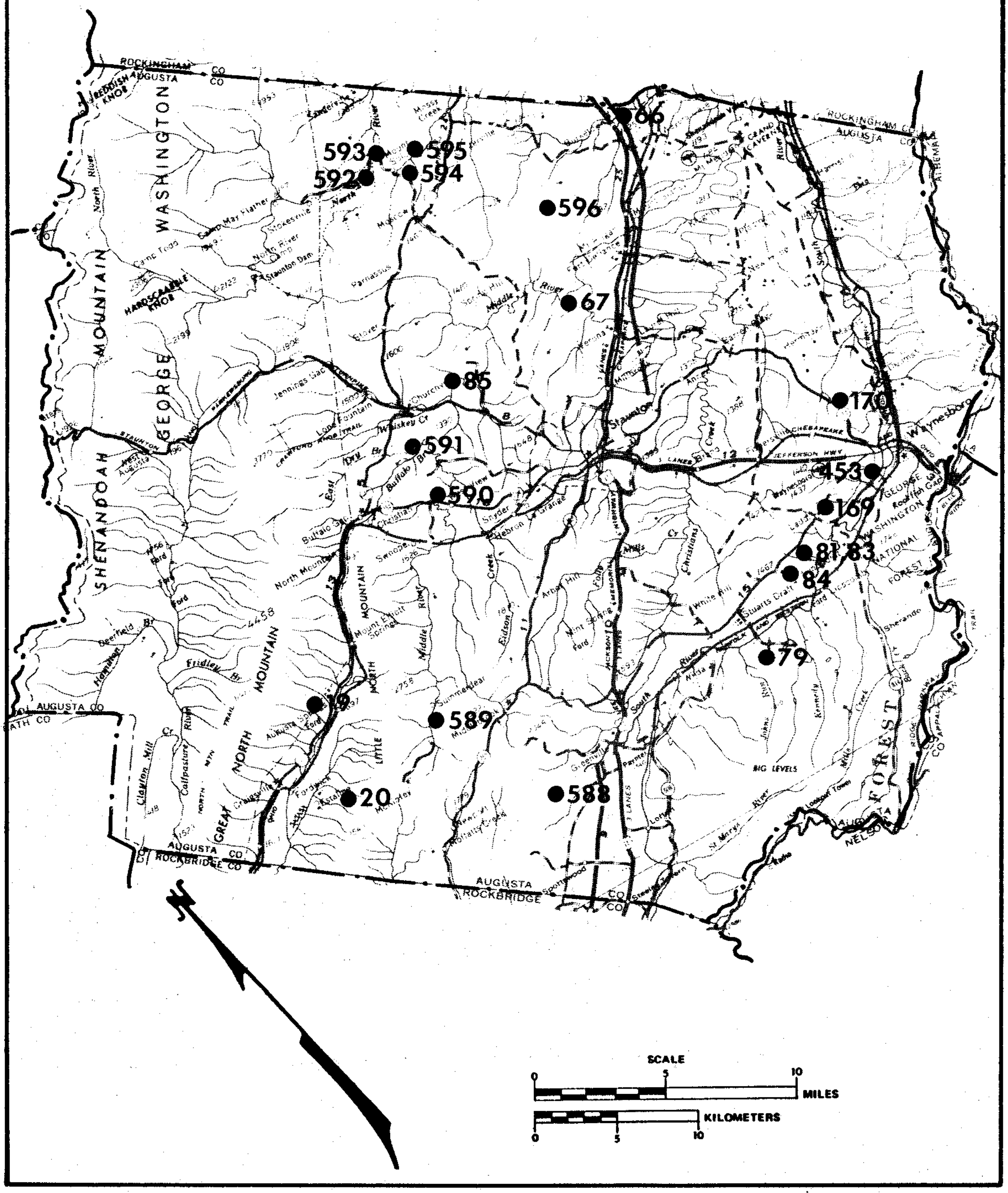


PLATE NO. 23

TABLE 9

FLOW MEASUREMENTS OF MAJOR SPRINGS IN AUGUSTA COUNTY

SWCB Number	Spring	VDMR[a] 1928 gpm	VDMR[a] 1928 l/s	VDMR[b] 1928 gpm	VDMR[b] 1928 l/s	SWCB[c] 1962 gpm	SWCB[c] 1962 l/s	SWCB[d] 1978 gpm	SWCB[d] 1978 l/s
				Date and Flow					
19	Augusta Springs	-----	---	-----	---	-----	---	808	51
453	Baker	5,300	334	5,000 (Sept.)	315	-----	---	2,500-3,500*	158-221
67	Berry Farm (Quick's)	1,000	63	1,000	63	-----	---	1,330	84
592	Big	-----	---	-----	---	-----	---	5,790	365
593	Blue Hole	2,000	126	-----	---	131	8	1,770	112
20	Black Run	-----	---	-----	---	-----	---	-----	---
588	Broadhead #2	-----	---	-----	---	-----	---	646	41
81	Brown's #1	-----	---	-----	---	-----	---	1,050	66
591	Cave	2,000	126	-----	---	758	48	2,280	144
169	Coiner	1,800	114	2,500 (Sept.)	158	431	27	603	38
589	Cochran	1,180	74	1,000	63	1,170	74	1,400	88
66	Dice's	2,000	126	1,500 (Sept.)	95	1,220	77	1,910	121
170	District Home	-----	---	-----	---	-----	---	2,540	160
79	Dodge	3,000	189	2,000	126	111	7	1,530	97
85	Gardner	-----	---	-----	---	-----	---	-----	---
83	Hartman	-----	---	-----	---	1,306	82	1,320	83
84	Houff	-----	---	-----	---	1,266	80	1,490	94
594	Joseph's	-----	---	-----	---	-----	---	6,640	419
590	Kennedy	1,500	95	1,000	63	1,310	83	1,610	102
595	Mossy Creek Church	-----	---	-----	---	-----	---	808	51
596	Seawright	1,200	76	1,000 (Sept.)	63	727	46	1,770	112

Source: Virginia Division of Mineral Resources; Virginia State Water Control Board - SWI

a Flows from Bulletin 1, Springs of Virginia, Collins et al; Virginia Division of Mineral Resources, 1930. Measured February 1928.

b Flows from Bulletin 36, Thermal Springs of Virginia, Reeves; Virginia Division of Mineral Resources. Measured February 1928 except where noted.

c Flows measured August 27-31, 1962, by Virginia State Water Control Board, Surface Water Investigations Section.

d Flows measured April 4-10, 1978, by Virginia State Water Control Board, Surface Water Investigations Section.

* Reported by E. I. duPont de Nemours, Inc., April 1978

TABLE 10

GROUNDWATER QUALITY COMPARISONS BETWEEN SPRINGS AND WELLS IN CAMBRO-ORDOVICIAN CARBONATE FORMATIONS IN AUGUSTA COUNTY

Parameter		Springs mg/1		Wells mg/1
Calcium	(17)*		(126)	
Maximum		82.00		137.00
Minimum		1.00		1.00
Average		51.55		56.18
Hardness (Ca-Mg)	(15)		(113)	
Maximum		344.00		520.00
Minimum		87.00		2.00
Average		339.47		225.76
Iron	(13)		(105)	
Maximum		0.28		22.16
Minimum		0.00		0.00
Average		0.06		0.37
Magnesium	(15)		(123)	
Maximum		40.00		67.00
Minimum		3.10		0.00
Average		23.83		20.48
Manganese	(7)		(82)	
Maximum		0.05		5.70
Minimum		0.00		0.00
Average		0.02		0.14
pH**	(15)		(131)	
Maximum		8.20		8.60
Minimum		7.20		5.50
Average		7.77		7.63
Solids (Total Dissolved)	(10)		(107)	
Maximum		374.00		628.00
Minimum		113.00		78.00
Average		263.70		305.94

*Parentheses ( ) enclose number of analyses used in making calculations
**pH values measured in units instead of milligrams per liter

TABLE 11

PUBLIC GROUNDWATER WITHDRAWAL IN AUGUSTA COUNTY

System	Source	Daily Withdrawal* gpd	Daily Withdrawal* m^3/d
Augusta Springs (ACSA)	Spring	101,549	384
Buffalo Gap High School	Well	7,500	28
Cassell Elementary School	Well	5,000	19
Churchville Elementary School	Well	3,000	11
Correctional Unit #10	Well	16,000	61
Craigsville	Spring	200,000	757
Crawford Manor	Wells	43,200	164
Crimora Elementary School	Well	2,000	7.6
Deerfield Elementary School	Well	1,000	3.8
Deerfield Water Company	Spring	7,520	28
Harriston East (ACSA)	Well	12,480	47
Interstate 81, Mt. Sidney Rest Area	Wells	8,294	31
Jollivue (ACSA)	Wells	193,446	732
Middlebrook (ACSA)	Well	25,233	96
New Hope Elementary School	Well	2,000	7.6
North River Elementary School	Well	4,000	15
Pine Bluff Park	Well	15,000	57
Riverheads High School	Well	9,000	34
Shenandoah Valley Airport	Well	3,329	13
Sherando Lake Recreation Area	Wells	5,322	20
Skyline Swannanoa	Wells	169,680	642
South River Sanitary District (ACSA)	Wells**	870,214	3,294
Staunton	Spring	2,230,000	8,441
Stuarts Draft Water Company	Well	36,411	138
Todd Lake Recreation Area	Well	1,931	7.3
Verona (ACSA)	Well, Spring	465,424	1,762
Waynesboro	Springs	3,371,010	12,759
Weyers Cave Sanitary District (ACSA)	Spring	145,567	551
	TOTAL	7,955,110	30,110.3

NOTE: ACSA is Augusta County Service Authority
*Based on highest daily average per quarter in 1977, except where that data was not available
**Auxiliary Supply

seven water systems operated by the Augusta County Service Authority, six utilize groundwater as the sole source, and the other uses groundwater as an auxiliary source. Domestic water needs are met almost exclusively by wells and springs.

Approximately 98 percent of the county's population is supplied wholly or partially by groundwater; 61 percent is supplied exclusively by groundwater. Total groundwater withdrawal is about 23 MGD (87,055 m^3/d). Self-supplied domestic use is approximately 1 MGD (3,785 m^3/d). Public and municipal use is approximately 8 MGD (30,280 m^3/d), and industrial withdrawal accounts for over 14 MGD (52,990 m^3/d).

Public Systems

Public water systems are classified by the Virginia Department of Health (1977) as either community or non-community systems. A community system serves at least 15 connections used by year-round residents or regularly serves at least 25 year-round residents. A non-community system operates at least 60 days out of the year. Public groundwater systems for which pumpage information is available are listed in Table 11. Brief discussions of several community systems follow.

Augusta Springs

The water supply for the community is a spring (19) located in Devonian shale, just south of State Route 42 (Plate 24). The system supplies water to approximately 30 connections at the rate of approximately 100,000 gpd (379 m^3/d). Operated by the Augusta County Service Authority, the spring has a reported flow of approximately 800 gpm (50.5 l/s).

Craigsville

Black Run Spring (20) supplies water for the Town of Craigsville. Located on the west slope of Little North Mountain (Plate 25), the spring issues from the Keefer Sandstone at an elevation of approximately 2250 feet (686 m). No discharge measurements are available; however, the town reports daily usage of approximately 200,000 gallons (757 m^3) to 360 connections. A 627-foot (191-m) well (49), located in Devonian shale downslope from the spring, is a stand-by source for emergency use. The well reportedly flows at 7 gpm (0.44 l/s) with a 3-foot (1-m) head and has been pumped at 110 gpm (6.9 l/s) with a 240-foot (73-m) drawdown after 48 hours.

Jollivue

This well system is operated by the Augusta County Service Authority and serves approximately 285 connections in the Jollivue-Brookwood area, including the Staunton Plaza (Plate 26). Wells 2 (76) and 4 (77) are production wells located in the Chepultepec and Conococheague formations, respectively. Well 2 is 500 feet (152 m) deep and was pump tested at 220 gpm (13.9 l/s). The 355-foot (108-m) well 4 had a test yield of 1900 gpm (119.9 l/s). Average daily pumpage is about 185,000 gpd (700 m^3/d).

LOCATION MAP OF SPRING AT AUGUSTA SPRINGS

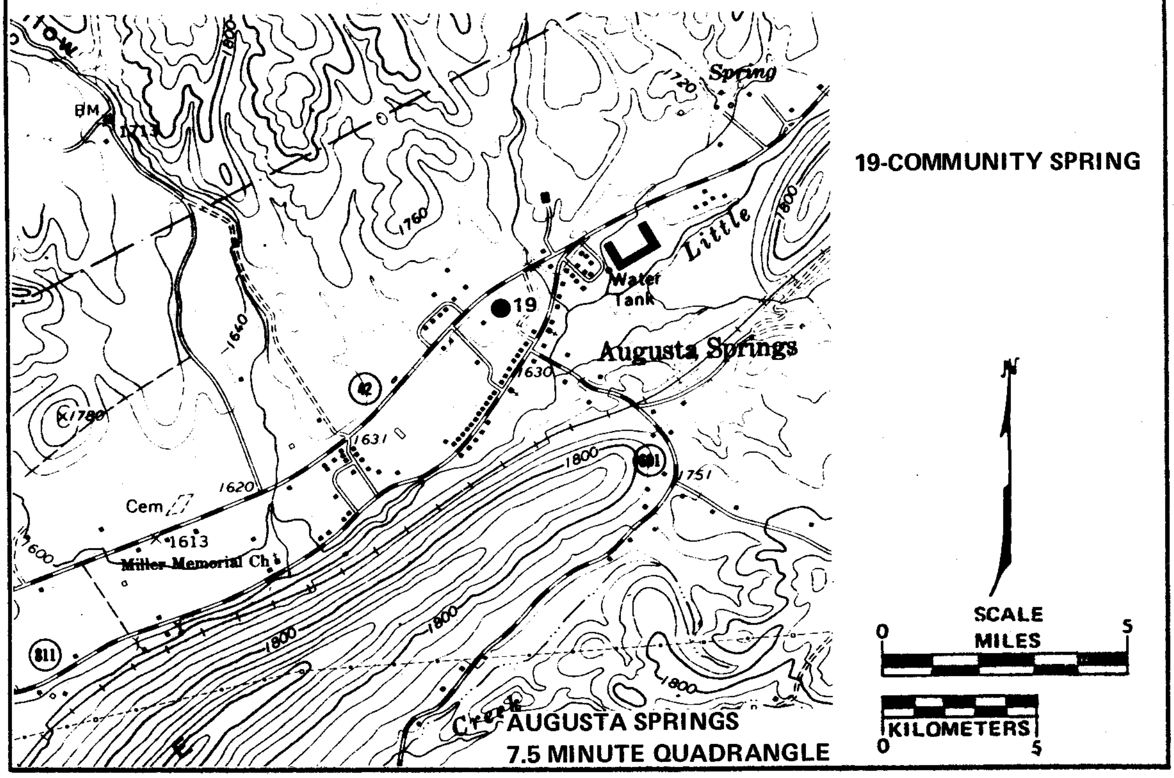


PLATE NO. 24

LOCATION MAP OF CRAIGSVILLE SPRING AND WELL

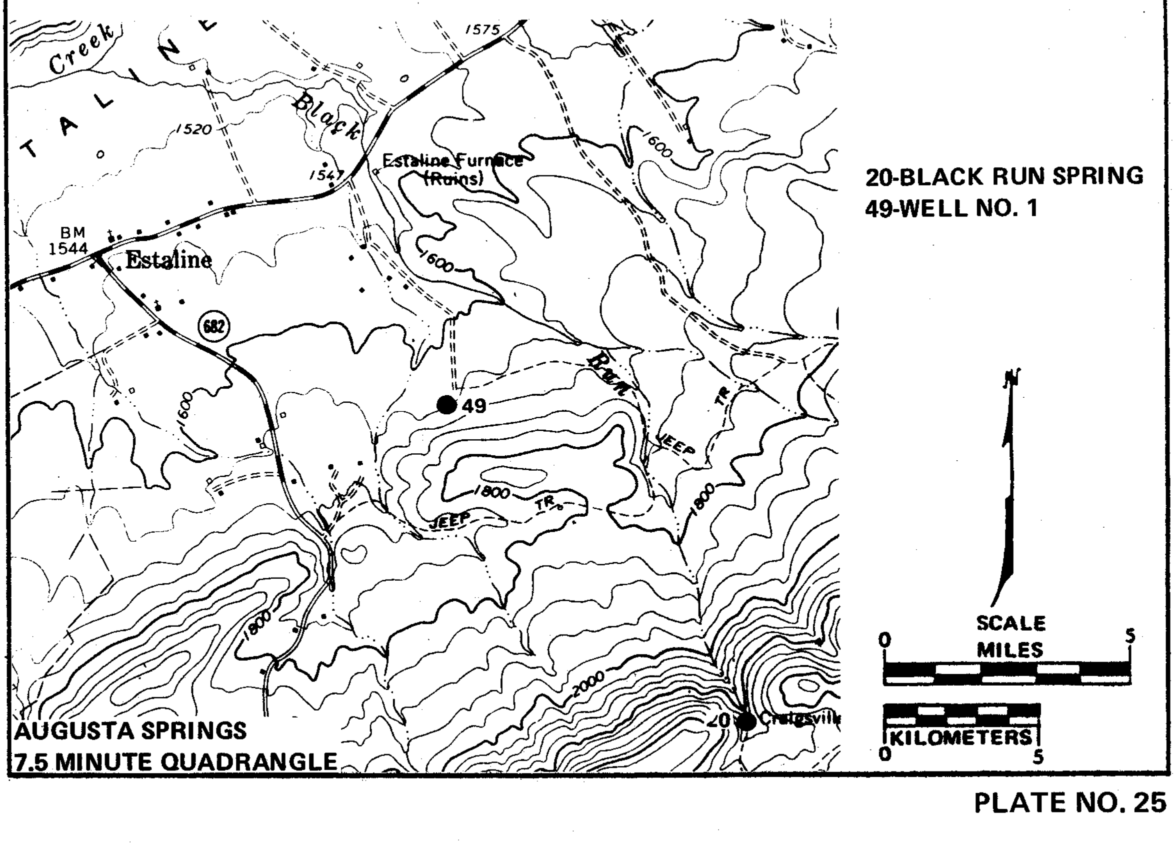


PLATE NO. 25

LOCATION MAP OF JOLLIVUE WELLS

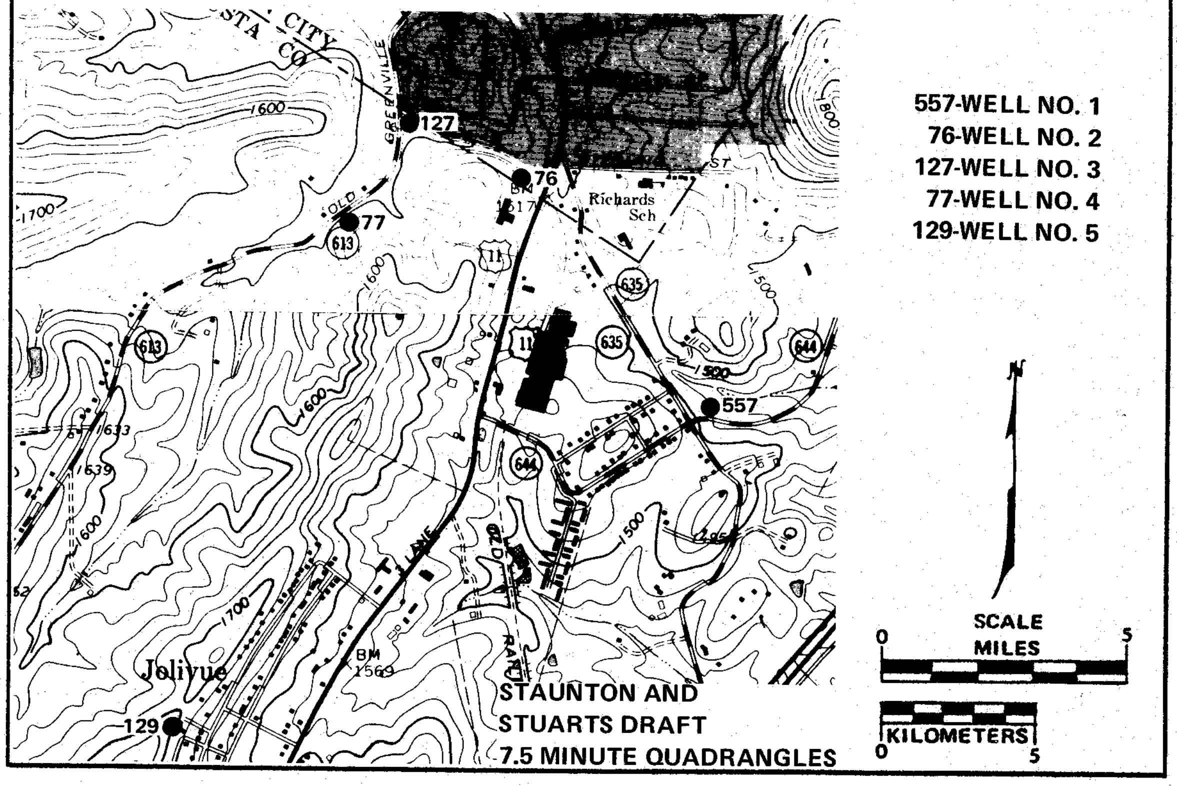


PLATE NO. 26

Well 1 (557) supplies water to the system's wastewater treatment plant. Two other wells are abandoned. One of the abandoned wells (127) presently is operated by the State Water Control Board as an observation well and is equipped with a continuous water level recorder.

Middlebrook

One production well (22) owned by the Augusta County Service Authority serves approximately 30 connections in this area (Plate 27). Drilled in the Conococheague Formation, the 240-foot (73-m) well has a reported yield of 150 gpm (9.5 l/s). A pump test at 115 gpm (7.3 l/s) for 8 hours resulted in only a 9-foot (3-m) drawdown. However, two springs in the area used for livestock watering reportedly ceased to flow while the test was being conducted. Average pumpage from the well is approximately 24,000 gpd (91 m^3/d). A 400-foot (122-m) abandoned well (92) had a yield of only 10 gpm (0.64 l/s).

South River Sanitary District

The main source of water for this system serving the communities of Stuarts Draft, Lyndhurst, Ladd and Fishersville (approximately 3500

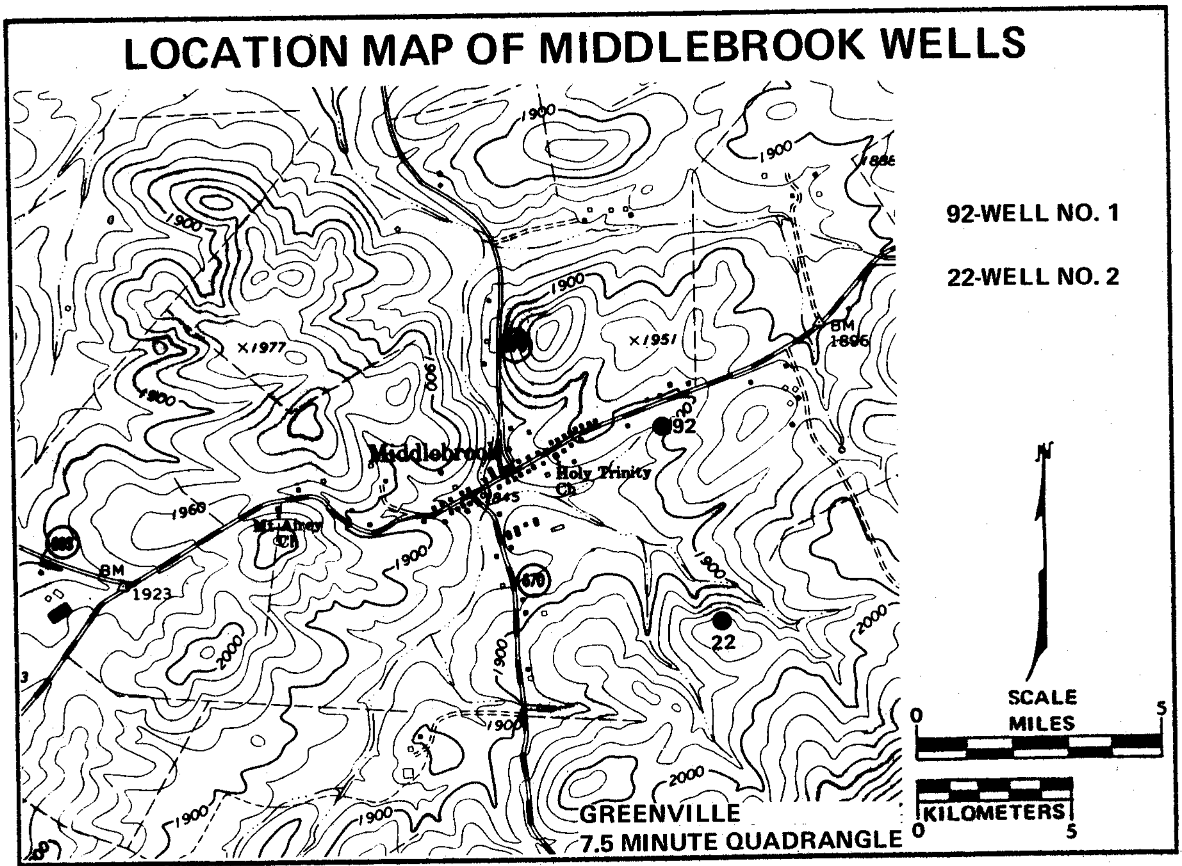


PLATE NO. 27

connections), is Coles Run Reservoir in the George Washington National Forest. The system is operated by the Augusta County Service Authority. Two wells (Plate 28) act as auxiliary sources and are used only on an as-needed basis. The Stuarts Draft well (2), 363 feet (111 m) deep, has been pump-tested at 457 gpm (28.8 l/s) over a 48-hour period with only a 4 1/2-foot drawdown. The Lyndhurst well (48) is 449 feet (137 m) deep and was pumped for 24 hours at 1557 gpm (474.6 l/s). Both wells are developed in the Waynesboro (Rome) Formation. The Stuarts Draft well is used occasionally during the summer months. The Lyndhurst well was pumped for a total of 7 days during the extended drought of the summer of 1977. Prior to this it had not been used since it was placed in operation in 1972 (oral communication, W. Clarke, Augusta County Service Authority).

Staunton

The main water supply for the city is North River Dam northwest of Staunton in the George Washington National Forest. Gardner Spring (85), located west of Staunton (Plate 29), furnishes about 2 MGD (7,570 m^3/d) of the approximately 5 MGD (18,925 m^3/d) used by the city. Flow measurements cannot be made due to its close proximity to Middle River. The spring issues from the Beekmantown Formation.

LOCATION MAPS OF SOUTH RIVER SANITARY DISTRICT WELLS

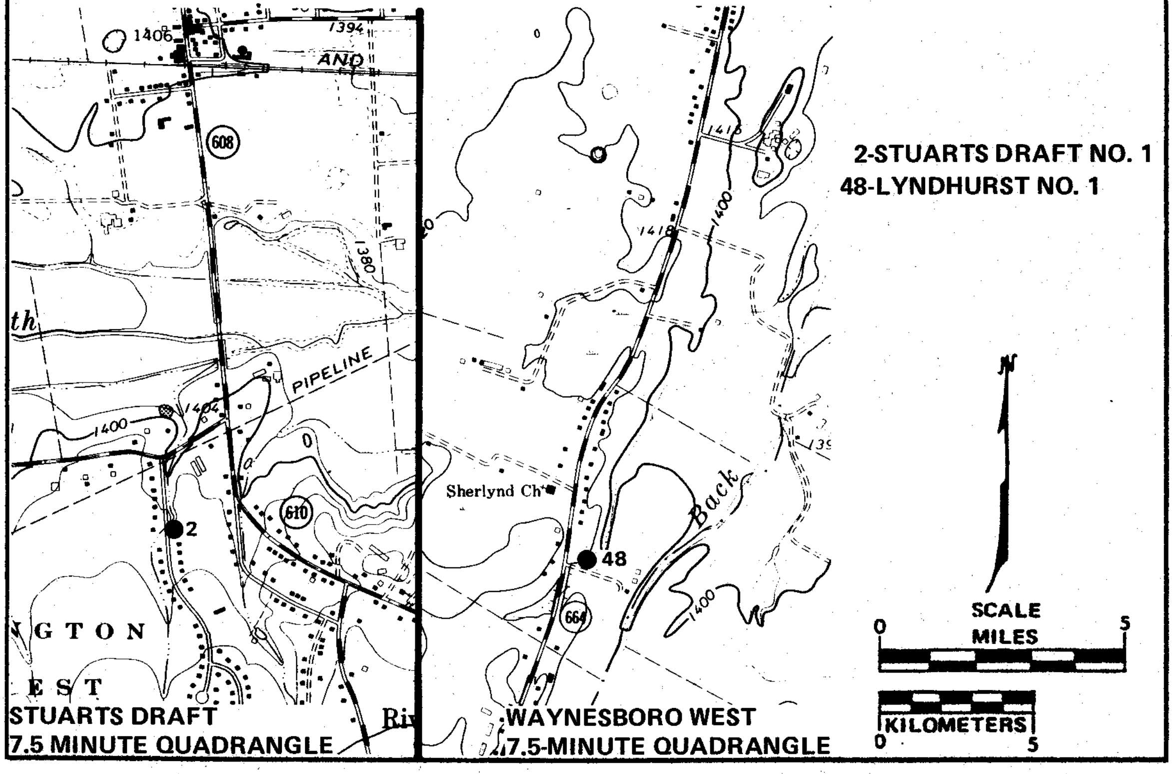


PLATE NO. 28

LOCATION MAP OF GARDNER SPRING NEAR STAUNTON

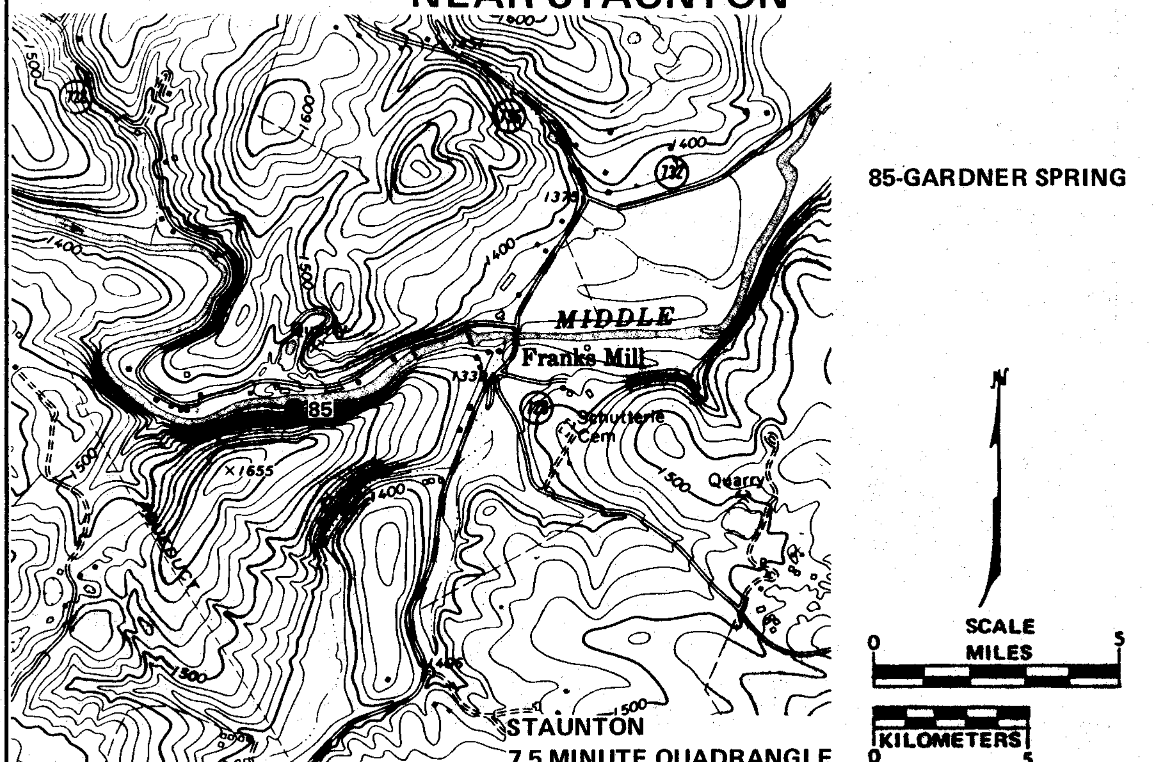


PLATE NO. 29

Verona Sanitary District

This district encompasses the communities of Verona, Fort Defiance and Mount Sidney. The system is operated by the Augusta County Service Authority and consists of Berry Farm Spring (67), also known as Quick's Mill Spring, and a well (Plate 30). The spring is the main source of water and is reported to have a flow of approximately 1,300 gpm (82 l/s). The well is 363 feet (111 m) deep and was pump-tested for 24 hours at 1016 gpm (64.1 l/s) with 62 feet (19 m) of drawdown. The well is an auxiliary source and is used only on an as-needed basis. Approximately 450,000 gpd (1,703 m^3/d) are withdrawn from the spring and distributed to about 1100 connections. An abandoned well (43) 370 feet (113 m) deep had a reported yield of 150 gpm (45.7 l/s). Both wells and the spring are in the Conococheague Formation.

Waynesboro

The City of Waynesboro presently receives water from two springs and in the near future will have two wells as an auxiliary source (Plate 31). Daily usage from Coiner Spring (169) is well over 2 MGD (7,570 m^3/d), and pumpage from District Home Spring (170) is usually somewhat less than 1 MGD (3,785 m^3/d). Flow measurements on Coiner

LOCATION MAP OF VERONA SANITARY DISTRICT WELLS AND SPRING

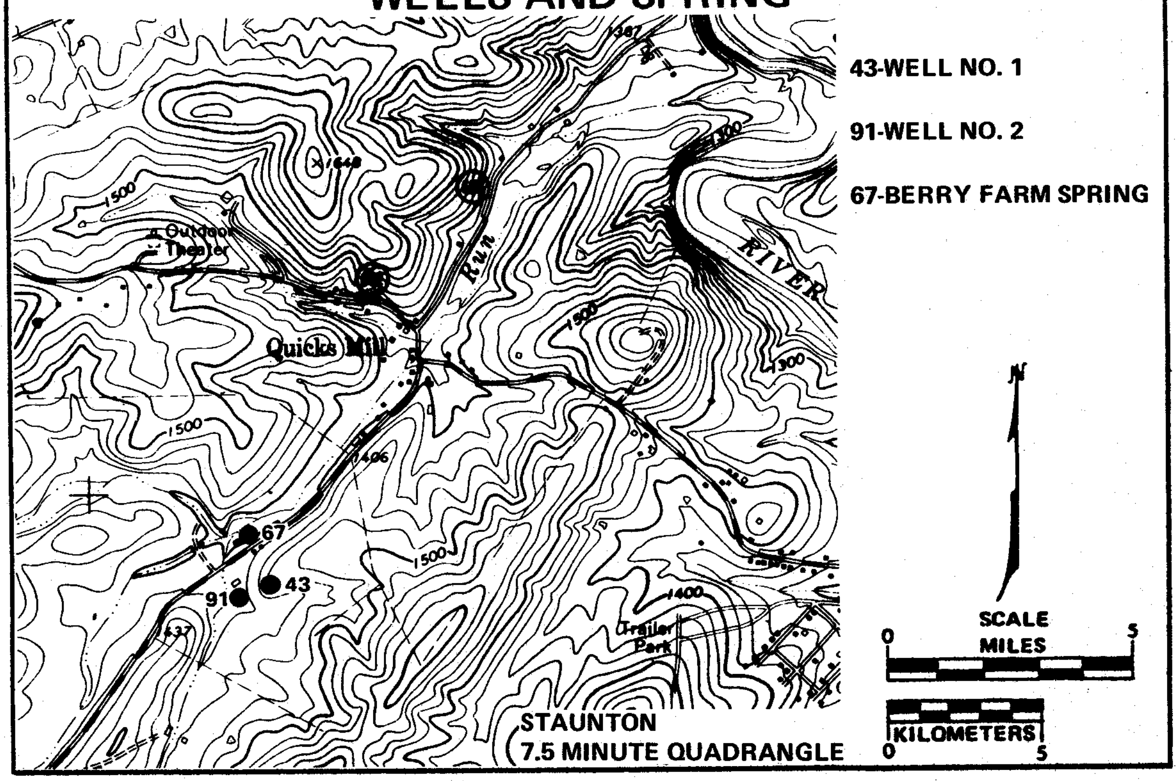


PLATE NO. 30

LOCATION MAPS OF WAYNESBORO WELLS AND SPRINGS

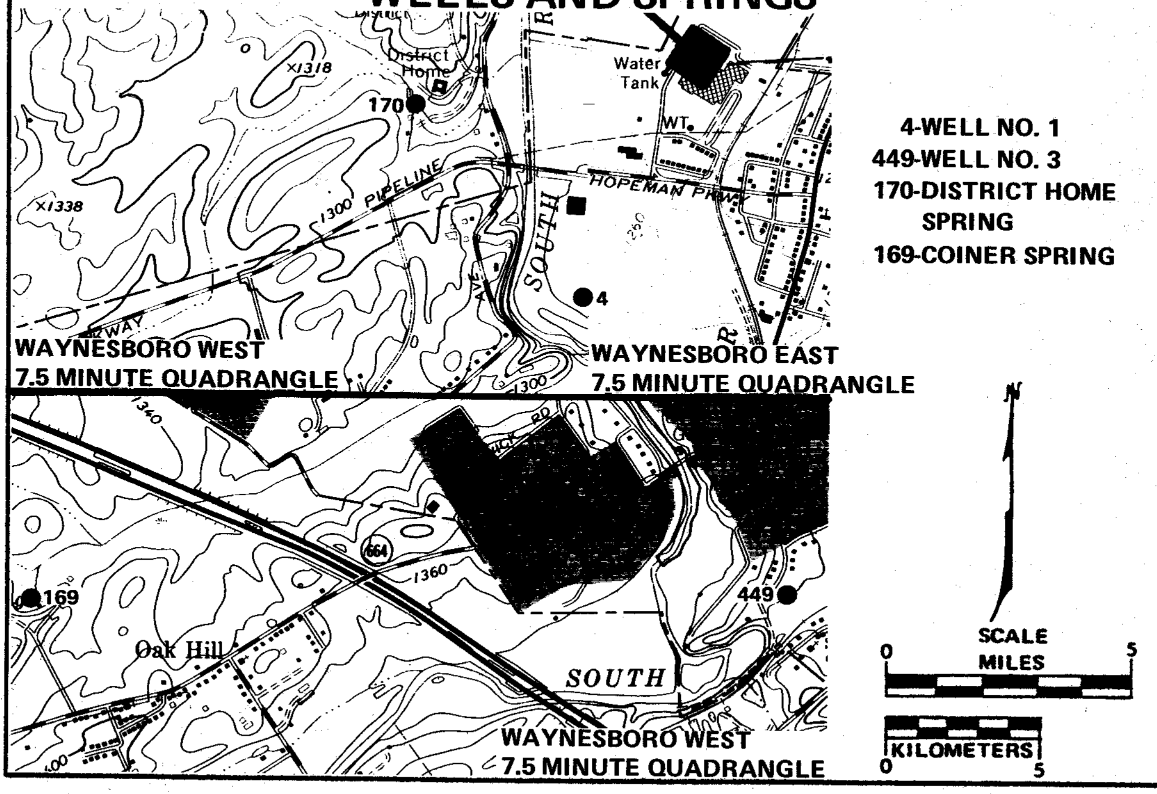


PLATE NO. 31

Spring have varied from 400 to 2,500 gpm (25.2 to 157.7 l/s). District Home Spring has been measured in excess of 2,500 gpm (157.7 l/s). Well 1 (4) drilled in the Elbrook Dolomite and known as the "Industrial Park Well," is 404 feet (123 m) deep and was pumped at 575 gpm (36.3 l/s) for 48 hours with a 210-foot (64-m) drawdown. The 432-foot (132-m) well 3 (449), developed in limestone of the Waynesboro (Rome) Formation, was initially pump-tested at 703 gpm (44.4 l/s) with 16 feet (5 m) of drawdown after 48 hours. It reportedly was tested at 975 gpm (61.5 l/s) for a short period of time with very little increase in drawdown noted. The system serves approximately 5,635 connections.

Weyers Cave Sanitary District

This system is operated by the Augusta County Service Authority and serves the community of Weyers Cave, including Blue Ridge Community College. The water source is Dice's Spring (Plate 32) which has a natural discharge of approximately 1,500 to 2,000 gpm (94.6 to 126.2 l/s). Approximately 120,000 gpd (454 m^3/d) are distributed to about 190 connections.

LOCATION MAP OF DICE'S SPRING AT WEYERS CAVE

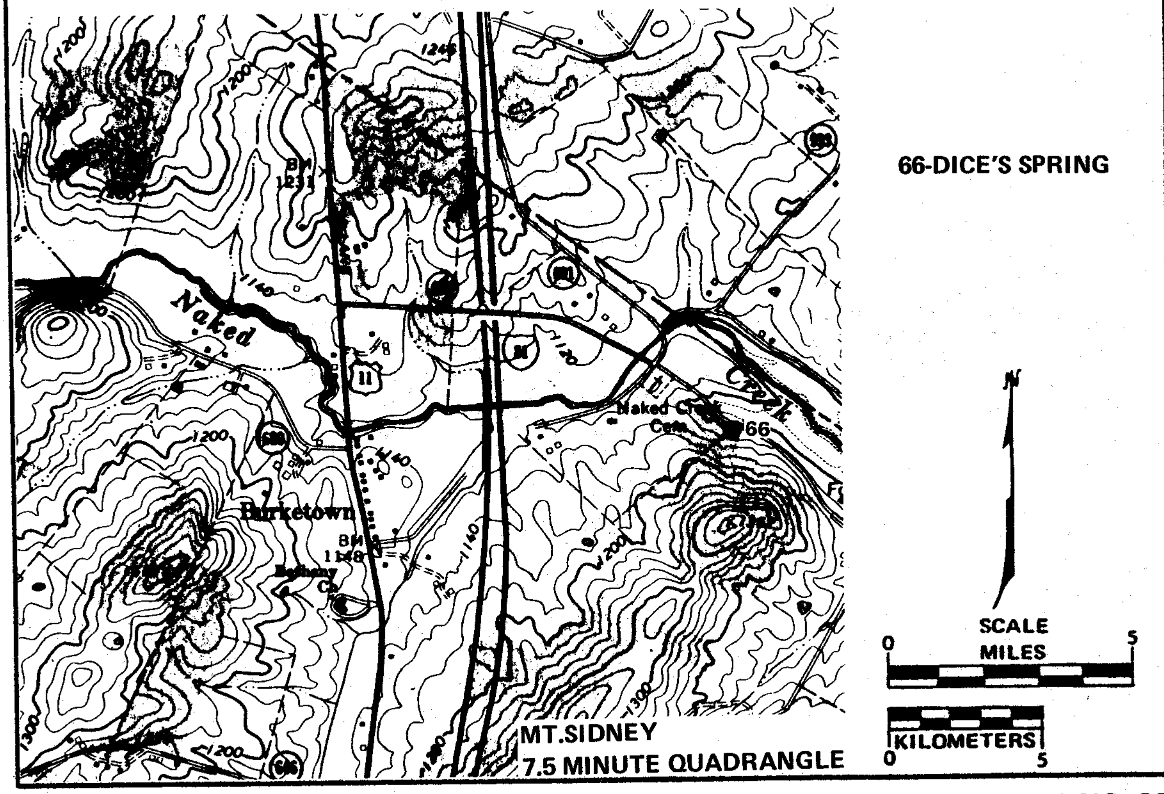


PLATE NO. 32

Industrial Systems

Only a few self-supplied industrial groundwater systems have been developed in Augusta County, and most of them withdraw minor amounts of groundwater. Three industries, however, do have significant daily groundwater withdrawals which total nearly 14 MGD (52,990 m^3/d).

Crompton

The Crompton Company in Waynesboro receives production water from Baker Spring (Plate 33) which is owned by E. I. duPont de Nemours and Co., Inc. Crompton's daily use during 1977 averaged slightly over 1 MGD (3,875 m^3/d). The average daily withdrawal for the period 1971 through 1977 was 1.34 MGD (5,072 m3/d).

E. I. du Pont de Nemours

The DuPont well field in Waynesboro is the largest in Augusta County and is developed in the Shady (Tomstown) dolomite formation. Groundwater withdrawals in 1977 averaged approximately 6.4 MGD (24,224 m^3/d), although the average daily withdrawal in March 1977 was 9.4 MGD (35,579 m^3/d). The highest average daily withdrawal recorded in the past five years was 10.9 MGD (41,257 m^3/d) in May 1974.

LOCATION MAP OF BAKER SPRING AND DuPONT WELL FIELD

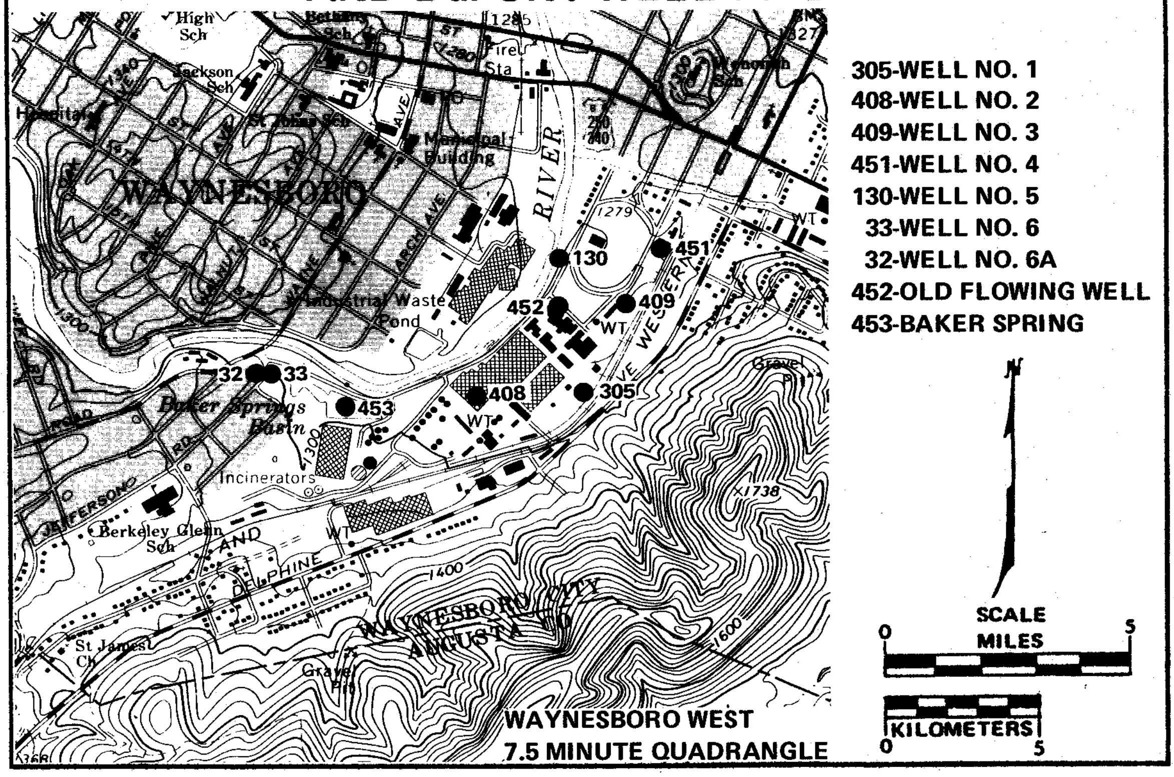


PLATE NO. 33

The DuPont well field consists of two active wells, three stand-by wells, two abandoned wells, and one spring. Well 5 (130), 752 feet (229 m) deep, is now the main well and has a reported maximum production of 3,500 gpm (220.8 l/s). Pumpage from this well for the period 1971 through 1977 averaged 3.3 MGD (12,604 m^3/d). Well 2 (408), 732 feet (223 m) deep, is an auxiliary well and is pumped on an as-needed basis. It was tested at 500 gpm (31.5 l/s) at completion, although the present yield is reported to have increased.

Baker Spring is the main water source with pumpage for the period 1971 through 1977 averaging 3.44 MGD (13,020 m^3/d). Combined with Crompton's average withdrawal for the period of 1.34 MGD (5,072 m^3/d), this could make the average daily withdrawal approach 5 MGD (18,925 m^3/d), or 3,472 gpm (219 l/s). The spring's natural discharge has been reported as 5,300 gpm (334.4 l/s) in February 1928 (Collins and others, 1930). Discharge rates recorded by DuPont during the period October 1965 to July 1967 range from 2,700 to 4,270 gpm (170.3 to 269.4 l/s) (oral communication, O. Bilkins, DuPont). The most recent flow data supplied by DuPont indicates that total Baker Spring discharge tends to fall within the 2,500 to 3,500 gpm (157.7 to 220.8 l/s) range depending on seasonal fluctuations (oral communication, T. W. Mullen, DuPont).

A 784-foot (239-m) well, initially referred to as well 6, was drilled 140 feet (43 m) northwest of Baker Spring in March, 1949. It was pump-tested at 1,500 gpm (94.6 l/s) for three minutes but had a drawdown of 196 feet (60 m). The stabilized production rate was only 15 gpm (0.9 l/s). In April, 1949, another well, initially called 6A, was drilled 50 feet (15 m) closer to the spring to a depth of 163 feet (50 m). This second well, now referred to by DuPont as 6 (33), yielded 650 gpm (41 l/s) with 14 feet (4 m) of drawdown after a 24-hour test. The major water zone is variously reported as 32 to 50 feet (10 to 15 m) and as 50 to 68 feet (15 to 21 m). Regardless, the water encountered by well 6 is at far shallower depths than zones for the other wells, which range from 124 to 734 feet (38 to 224 m) deep. Well 6 (33) is now on stand-by.

Interference among the wells and with Baker Spring is known to occur. Leonard (1962) reports that Baker Spring is unaffected by withdrawals from well 6 (33) but is affected by pumping of wells 1 (305) and 5 (130). He further notes that Loth Spring, located between well 5 (130) and Baker Spring, ceases to flow when all wells are pumped simultaneously. In 1966 all wells were pumped simultaneously at a rate of approximately 6,600 gpm (416.4 l/s) in an effort to meet water demands. Decreased water levels were noticed in all wells; the level in one was pulled down to the pump intake. Baker Spring flow recorded on July 29, 1966, was 2,700 gpm (170.3 l/s). The company's water requirements have since decreased so that one well and Baker Spring generally meet demands (oral communication, O. Bilkins, DuPont).

Well 1 (305), formerly used as a stand-by for emergency use, was removed from service in 1970. In addition to well 6 (33), wells 3 (409) and 4 (451) are both on stand-by. Well 3 is 676 feet (206 m) deep and has a reported maximum yield of 2,000 gpm (126.2 l/s). Well 4 is 674 feet (205 m) deep with a reported maximum yield of 1,800 gpm (113.6 l/s).

A well (452) drilled about 1929, shortly after the plant opened, is referred to as the "Old Flowing Well". As the name suggests, it reportedly flowed at the time of completion. Cady (1936) reports that it was pump-tested at 680 gpm (42.9 l/s), and the static water level dropped to 15 feet (5 m) below land surface when well 2 (408) was pumped at 350 gpm (22.1 l/s). The well supposedly was drilled for the purpose of monitoring water levels in the well field and apparently has never been used as a water source. The lowest level recorded since October 1971 was 72 feet (22 m) in October 1973. However, DuPont records indicate a static water level of 88 feet (27 m) on July 26, 1967, and of 130 feet (40 m) on July 29, 1966 (oral communication, O. Bilkins, DuPont). It is likely that the 130-foot (40-m) drawdown was recorded during the period of heavy withdrawal in 1966 referred to above. Levels appear to normally remain around 40 to 50 feet (12 to 15 m) below land surface. Plate 34 is a hydrograph of static water levels in the Old Flowing Well.

Several other wells in the field are reported to have flowed when drilled (Leonard, 1962). This is attributed to the fact that the northern portion of the well field had been a swamp before the wells were developed.

DuPONT WELL FIELD PUMPAGE AND WATER LEVEL FLUCTUATIONS

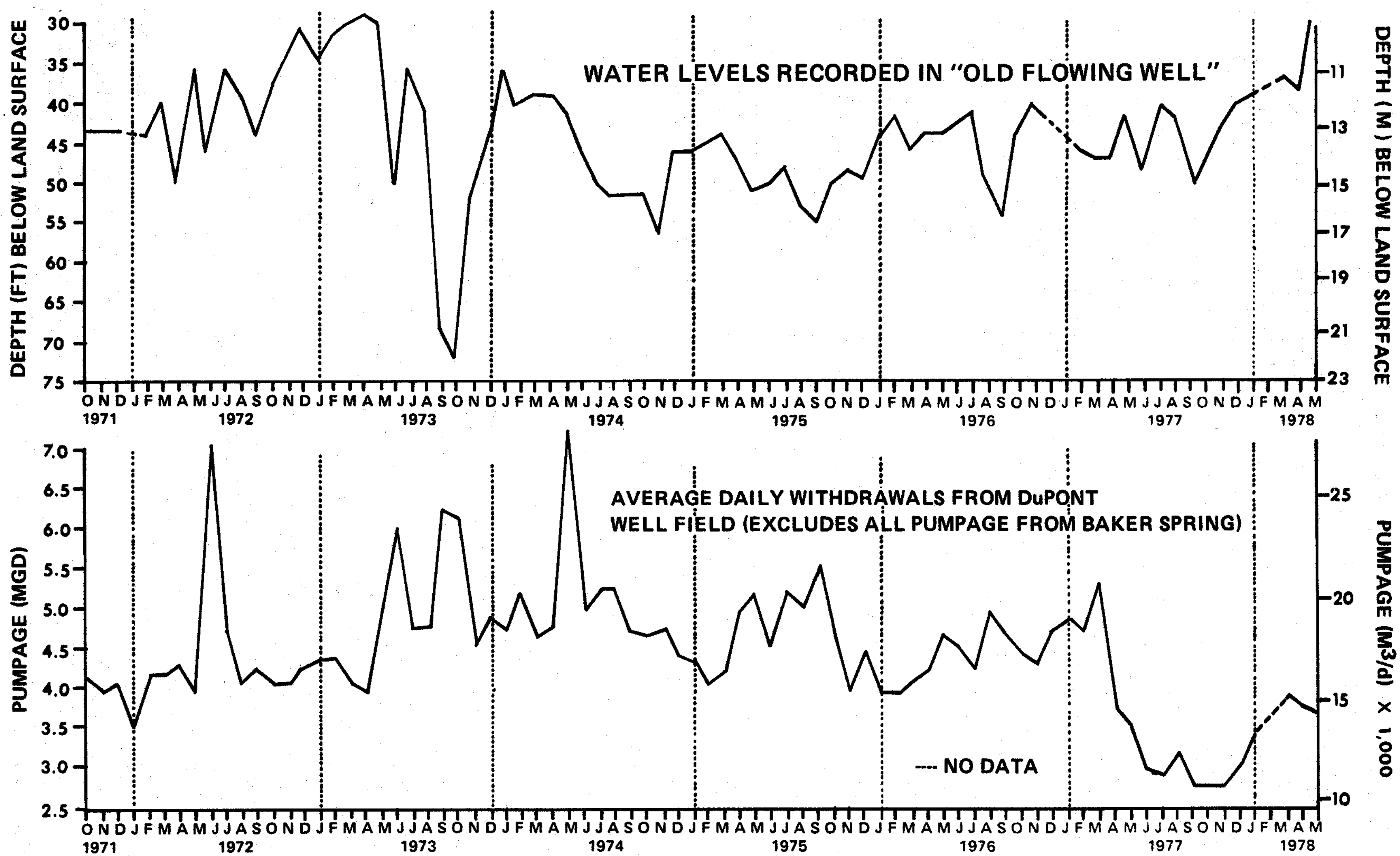


PLATE NO. 34

Reynolds Metals

The Reynolds Metals Company, Flexible Plastics Division, at Grottoes presently withdraws nearly 3 MGD (11,355 m^3/d) from a well field developed in the Conococheague Formation (Plate 35). In 1956 Reynolds moved into the plant formerly occupied by the Duplan Silk Company. Three wells already on the property are now referred to as 1, 2 and 3 (97, 98, 99). Reynolds has since drilled three additional wells.

The Reynolds field consists of five operating wells and one abandoned hole. Well 4 (100), 315 feet (96 m) deep, is the main production well and was pump-tested at 1800 gpm (113.6 l/s) with 103 feet (31 m) of drawdown after 168 hours. Wells 3 (99) and 5 (101) are the other production wells and were drilled to depths of 260 feet (79 m) and 342 feet (104 m), respectively. Well 3 (99) reportedly produced 1200 gpm (76 l/s) at completion with a 10-foot (3-m) drawdown after 48 hours. However, maximum steady production from well 3 increased to 2000 gpm (126 l/s) (Leonard, 1962). The 342-foot (104-m) well 5 was tested at 1254 gpm (79 l/s) with 70 feet (21 m) of drawdown after 72 hours. Well 2 (98), 226 feet (69 m) deep, is a stand-by production well pump-tested at 250 gpm (16 l/s) for 24 hours with a 40-foot (12-m) drawdown. The recently-completed well 6 (587) was tested at 50 gpm (3 l/s) with 14.5 feet (4.4 m) of drawdown after 48 hours. This well is used for potable water at the rate of

LOCATION MAP OF REYNOLDS METALS WELL FIELD

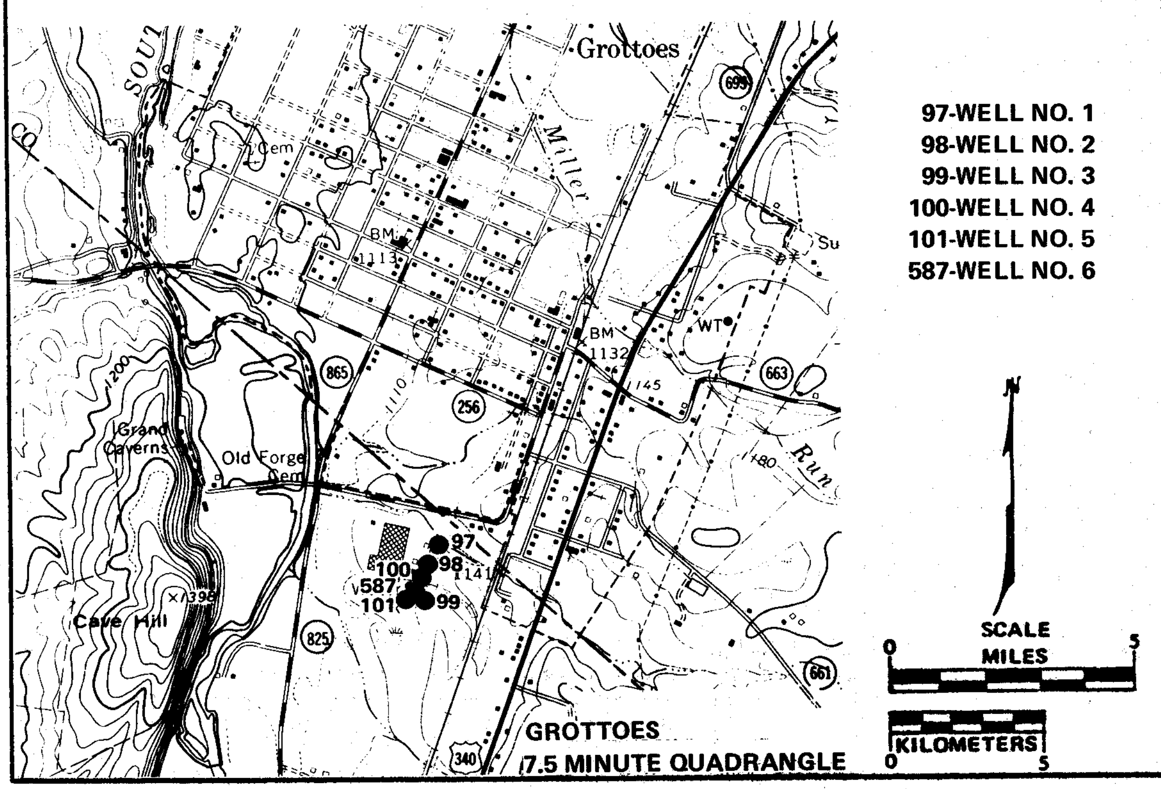


PLATE NO. 35

approximately 4,000 gpd (14 m3/d) (oral communication, J. W. Moore, Reynolds).

Well 1 (97) has never been put into service, either by Duplan or Reynolds. The reason for this is unknown, but it is assumed that the yield, 100 gpm (6 l/s) at completion, was not satisfactory. According to hearsay over the years, the well is reported to have been dynamited in an attempt to increase the yield, but supposedly was never tested after having been shot (oral communication, J. W. Moore, Reynolds). In 1975 the State Water Control Board placed a continuous water level recorder on this well. A hydrograph for the period of record compared to groundwater withdrawals from the Reynolds field and precipitation records from the Waynesboro sewage treatment plant (Plate 36) fails to reveal any significant relationship between the observation well and the Reynolds well field. Static water levels in the observation well seem to reflect the normal seasonal water-table fluctuation. In addition, the precipitation graph relates directly to the observation well hydrograph with a 63 percent frequency over the period of record, whereas the groundwater withdrawal graph correlates with the hydrograph only 44 percent of the time. Groundwater withdrawal at Reynolds varies so little from one quarter to the next that the large fluctuation in water levels noted in the observation well cannot be attributed solely to the well field. While pumpage from the field undoubtedly has some effect on the levels, it apparently is minor.

Interference between wells 2 (98) and 4 (100) has been reported by Leonard (1962). This interference has been substantiated in 1978 (oral communication J. W. Moore, Reynolds).

Water zones in wells 2 through 6 were encountered at depths ranging from 181 to 342 feet (55 to 104 m) and are in carbonate bedrock underlying alluvial deposits. Numerous mud seams were encountered in well 6 (587) between 10 and 180 feet (3 and 55 m). Leonard (1962) reports that mud-filled cavities were encountered in wells 2 (98), 3 (99) and 4 (100). No information of this type is available for wells 1 (97) and 5 (101).

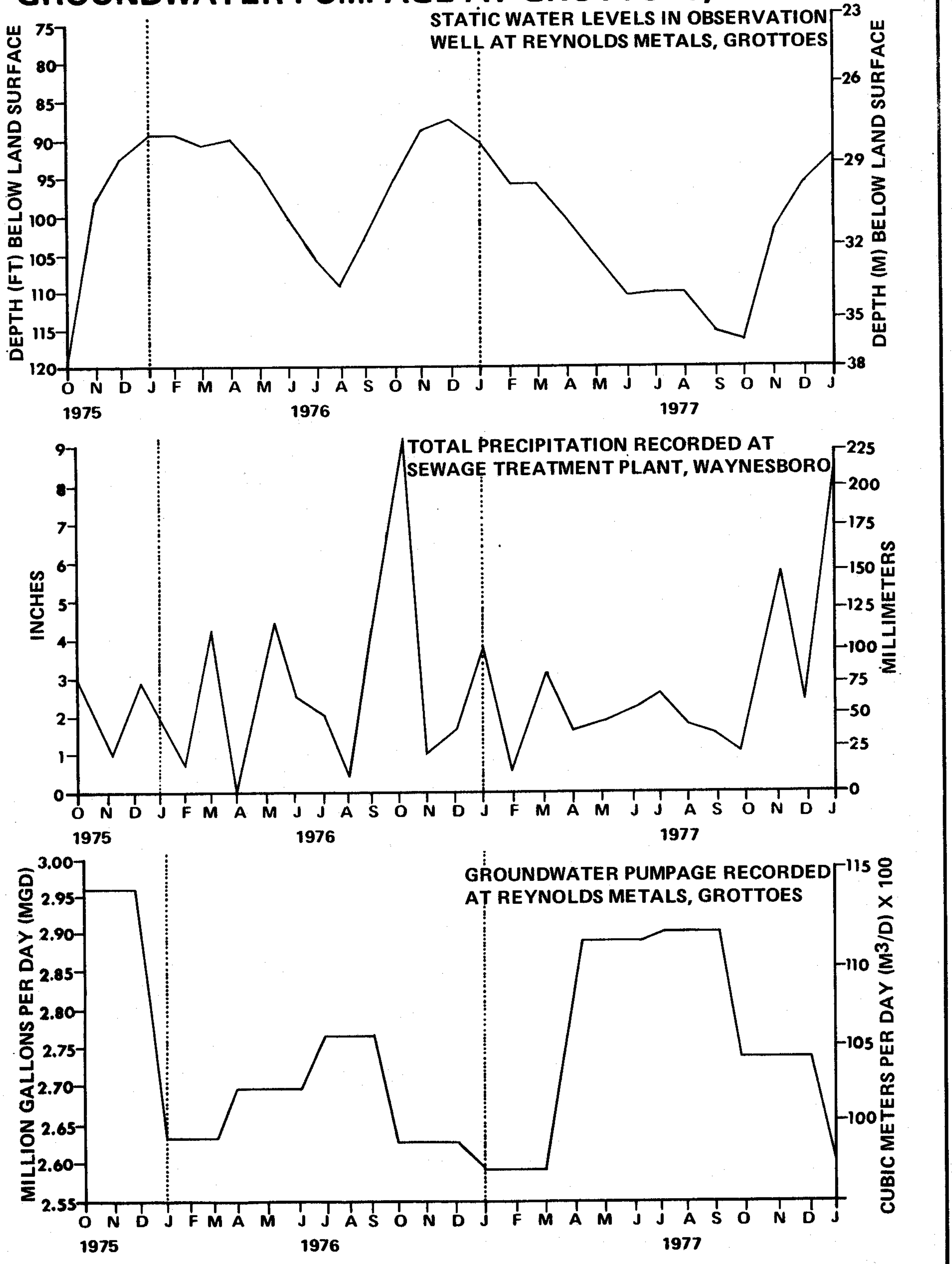
PROTECTION AND CONSERVATION OF GROUNDWATER

Water Quality Protection

Protecting the quality of the groundwater resources of an area is of prime importance. Groundwater contamination exists when foreign matter of any nature enters the groundwater system and alters the natural quality. Water percolating downward through soil can be purged of harmful constituents before it reaches the groundwater reservoir. However, if contaminants and pollutants do enter the groundwater reservoir, the chances of the aquifer system cleansing itself are very slight.

The degree of natural purification of water as it moves through soil depends on the soil type, size and shape of the individual soil particles,

STATIC WATER LEVELS, PRECIPITATION AND GROUNDWATER PUMPAGE AT GROTTOES, VIRGINIA



Source: National Oceanic and Atmospheric Administration (Precipitation Data) PLATE NO. 36

thickness of the soil material, rate of percolation, and type and degree of contamination. Pollutants may be removed by mechanical straining and settling out between individual soil particles. Chemical changes in the soil may also account for significant pollutant removal. The rate of percolation determines the contact time water has with the soil. A soil whose percolation rate is rapid may not allow sufficient contact time for the mechanical and chemical processes to act effectively in contaminant removal. Further, if a soil zone is too thin to purify the water percolating through it, contaminated water may enter the aquifer.

Methods of Contamination

The most common groundwater contamination mechanism in Augusta County involves the introduction of contaminants into solution channels via sinkholes and into bedrock exposed at the surface. For this reason the areas underlain by carbonate bedrock are highly susceptible to contamination.

Sinkholes are a major threat to groundwater quality because people tend to use these depressions in the land surface for the disposal of dead animals, trash and other wastes. Additionally, sinkholes are collection areas for surface runoff which may carry other pollutants. The absence of an adequate soil cover at the bottom of the sinkhole means that water passing through the overlying rubble will not be filtered of harmful constituents before it enters solution channels beneath the depression. Once the pollutants have entered the groundwater regime, they may spread in unpredictable patterns to areas being tapped as water sources by unsuspecting well owners (Plate 37). The distribution of sinkholes in Augusta County is illustrated in Plate 38.

Exposures of carbonate bedrock on the land surface, and areas in which only a very thin soil cover overlies carbonate bedrock, afford excellent opportunities for groundwater contamination. As with sinkholes, the key factor is the lack of adequate soil cover to filter wastes from surface runoff.

Sources of Contamination

Although there have been no major areas of groundwater pollution identified in Augusta County, local contamination occurs occasionally. The most significant potential sources of groundwater contamination are septic tank drainfields, spillage and leakage of petroleum and hazardous chemicals, leakage from sanitary landfills and waste treatment facilities, and agricultural runoff from croplands, barnyards and feedlots.

Septic tank systems are a common form of domestic sewage treatment in this county. If an inadequate soil cover houses the septic tank drainfield, pollutants will not be filtered out before they enter the groundwater. Nitrates and coliform bacteria are the most common contaminants from septic systems.

Rainfall runoff from agricultural lands may be a source of nitrate contamination derived from fertilizers. Herbicides and pesticides may

GROUNDWATER CONTAMINATION THROUGH SINKHOLES

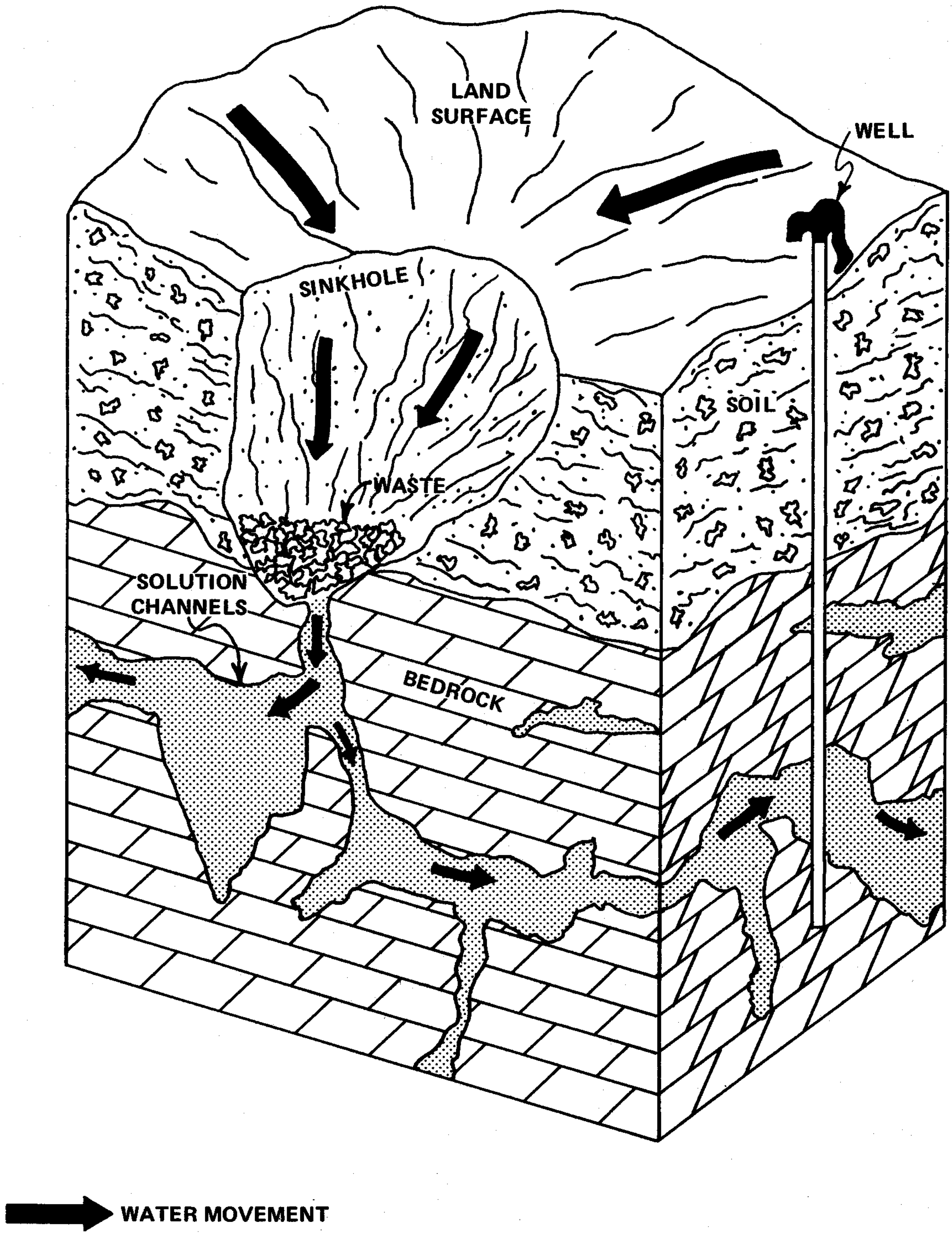
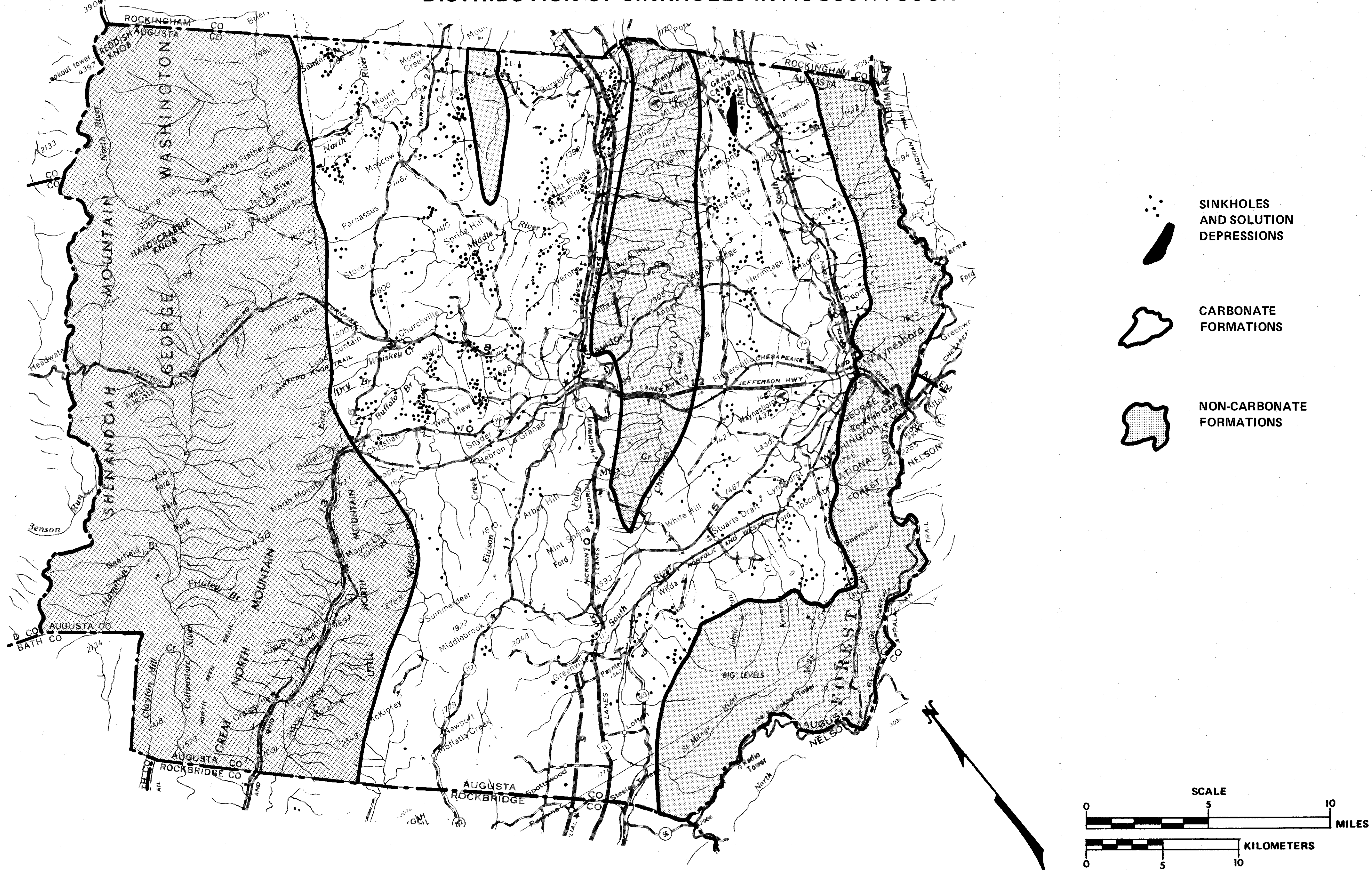


PLATE NO. 37

DISTRIBUTION OF SINKHOLES IN AUGUSTA COUNTY



Source: Modified After Hack (1965)

PLATE NO. 38

be present in runoff from croplands. Barnyards and feedlots are a common source of bacterial contamination.

Hydrocarbon contamination caused by spillage and leakage of petroleum products has been reported in several areas of the county. Minute amounts of petroleum in groundwater may cause foul tastes and offensive odors. Occasionally the water returns to a normal state in a reasonable time if the source can be identified and eliminated. In many cases, however, it is impossible to determine the source of the contamination because petroleum products undergo changes once they come in contact with rocks and soil. Even where a source can be identified and removed, objectionable residual effects may be noticeable for decades. Clean-up operations usually are inadequate and can be prohibitively expensive.

Many incidents of petroleum contamination have recently been reported in Augusta County. Most have involved leakage from underground gasoline storage tanks which have resulted in the contamination of a few domestic wells. The effects of these underground spills potentially may spread to other areas and adversely affect groundwater quality over a large area.

Sanitary landfills and waste treatment facilities are potential sources of groundwater contamination. Industrial wastes often contain heavy metals which can be highly toxic in sufficient quantities. Landfills produce leachate, a "grossly polluted liquid characterized by high concentrations of dissolved chemicals, chemical and biological demand, and hardness" (Zaporozec, 1974). The key to preventing pollution from these sources is responsible site selection, design, operation and management of waste disposal facilities. Groundwater monitoring is an effective method of identifying the presence, nature and extent of contamination. Augusta County has exhibited no known groundwater pollution from any waste disposal sites, although most facilities have been in operation for many years.

Groundwater Conservation

Responsible management of groundwater withdrawals is the key to conservation and effective utilization of the resource. Overdrafting can cause a decline in local and regional water levels which, in turn, can create both temporary and permanent adverse affects.

A significant lowering of the water table can cause interference between wells and within well fields. Heavy pumpage from one or several wells may cause such a decline that water levels in nearby wells may be pulled below pump intakes. This necessitates lowering pump intakes and often requires drilling the well deeper or abandoning it altogether. Lowering the pumping level in a well causes a reduction in the efficiency of the system.

Lowered water levels can reduce the storage capacity of an aquifer, depending on whether or not the aquifer is unconsolidated or consolidated. Removing water from unconsolidated materials, such as those which recharge the aquifer system along the west toe of the Blue Ridge, may cause the individual particles to assume a greater degree of compaction. At some later time, when groundwater recharge is increased or withdrawal is reduced, the aquifer may not store as much water as it did prior to being dewatered. In carbonate rock terranes, however, lowered water levels generally will not result in a decrease in storage capacity since the rock is consolidated.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Augusta County has abundant groundwater resources of good quality. Carbonate rocks overlain by alluvial and terrace deposits between Lyndhurst and Grottoes offer the highest potential for good well yields, whereas carbonate rocks throughout the rest of the Central Valley Sector offer less potential. Groundwater in this sector is generally of good quality but exhibits high hardness and occasional high iron and manganese concentrations. Water in the North Mountain Sector is available to fulfill most needs with the exception of large industrial demand. While hardness is moderate, iron and manganese tend to run much higher than in other areas of the county. The Blue Ridge Sector offers limited groundwater of very high quality.

Approximately 98 percent of the county's population is served wholly or partially by groundwater. All but two municipal and community systems are supplied exclusively by groundwater, and two major industrial well fields have been developed at Waynesboro and Grottoes. Total daily groundwater withdrawal is around 23 MGD (87,055 m^3/d).

No major groundwater contamination problems are known to exist. The potential for contamination is greatly increased in the carbonate rocks of the Central Valley Sector due to the presence of sinkholes and exposed bedrock.

Recommendations

(1) Carbonate rocks overlain by alluvial and terrace deposits along the west toe of the Blue Ridge extending from Lyndhurst to Grottoes offer the highest groundwater potential. It is estimated that the corridor could yield up to 75 MGD (283,875 m^3/d) with minimal adverse effects.

(2) In the Central Valley Sector, carbonate formations have greater groundwater production potential than the clastic rocks of the Martinsburg Formation.

(3) Hardness should be a factor when considering groundwater supplies anywhere in the Central Valley Sector.

(4) The North Mountain Sector can be developed to yield supplies sufficient for most uses excepting large industrial demands. Iron and manganese concentrations must be taken into account when groundwater is being considered as a water supply.

(5) The Blue Ridge Sector is suitable for development of small domestic and commercial water supplies. Water quality is very good.

(6) When the need to develop groundwater arises:

(a) consulting hydrogeologists, well drillers and representatives of the State Water Control Board are available for information and advice;

(b) the Virginia Department of Health must be contacted pursuant to developing a public supply well and should be contacted when developing a domestic drinking water supply;

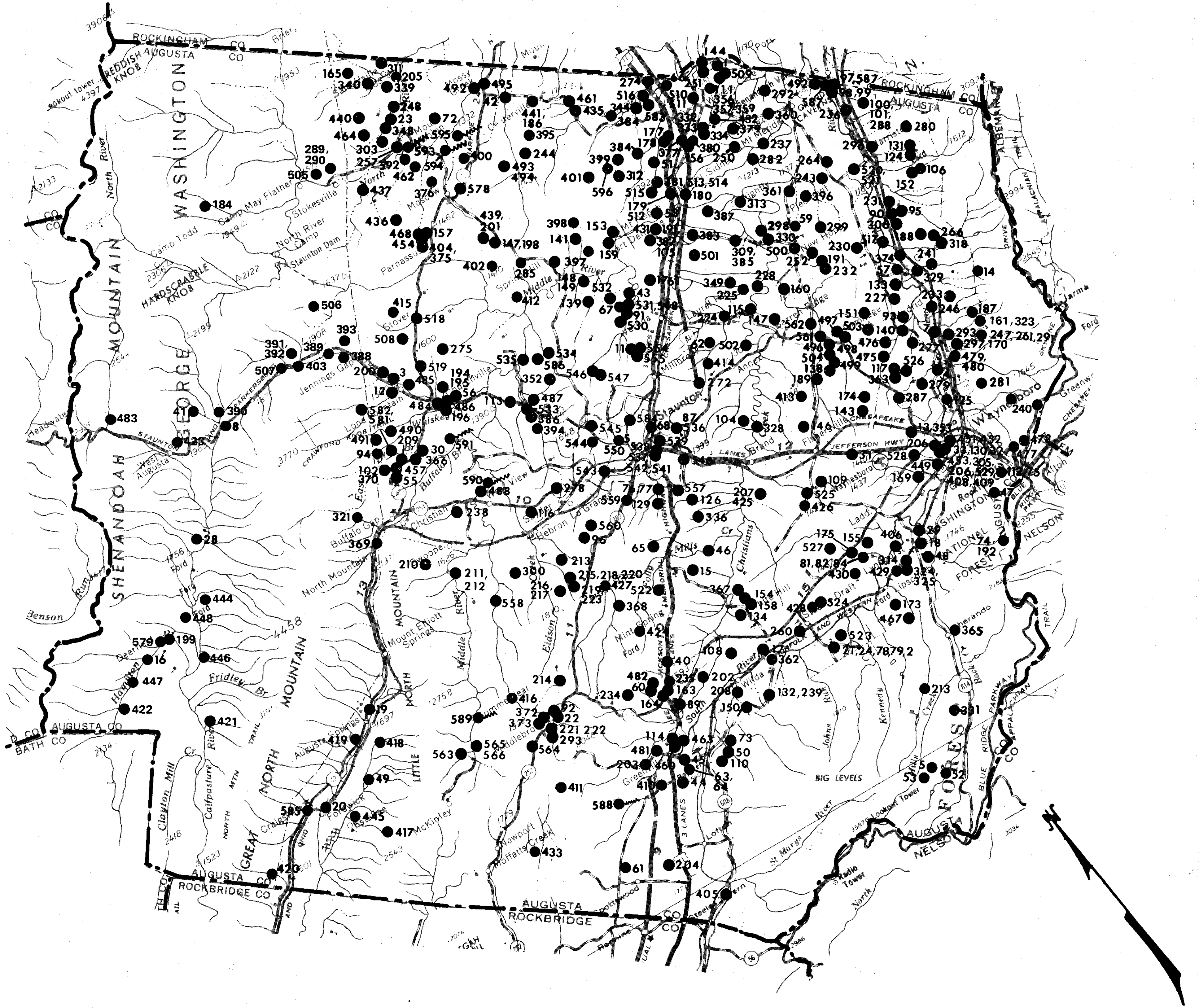
(c) Water Well Completion Reports, Groundwater Pumpage and Use Reports, and drill cutting samples required by the Groundwater Act of 1973 must be submitted to the State Water Control Board.

APPENDIX A

Groundwater Development in Augusta County

The accompanying map of Augusta County (Plate 39) is a composite of well and spring locations from Plates 19, 20, and 22 and may be cross-referenced with water well construction and groundwater quality data in Appendixes B and C.

GROUNDWATER DEVELOPMENT IN AUGUSTA COUNTY



● WELL

SPRING

WELL AND SPRING NUMBERS ARE KEYED TO APPENDIXES B AND C.

SCALE

0 5 10 MILES

0 5 10 KILOMETERS

APPENDIX B

Summary of Water Well Data for Augusta County

The computer printout on the following pages lists basic data for more than 600 wells and springs in Augusta County. This printout is updated periodically to include information from new Water Well Completion Reports which are continually being submitted by water well contractors and well owners. Most well and spring numbers in this printout are keyed to Appendixes A and C.

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

****

THE FOLLOWING LIST OF WELL DATA SUMMARIZES BASIC DATA OBTAINED FROM WATER WELL COMPLETION REPORTS WHICH ARE ON PERMANENT FILE IN THE OFFICES OF THE VIRGINIA STATE WATER CONTROL BOARD. ADDITIONAL INFORMATION FOR MANY OF THE WELLS IS AVAILABLE AND CAN BE OBTAINED BY CONTACTING THE APPROPRIATE REGIONAL OFFICE OR THE BUREAU OF WATER CONTROL MANAGEMENT AT THE AGENCY HEADQUARTERS IN RICHMOND.

************ EXPLANATION OF PARAMETERS ************

SWCB NO: STATE WATER CONTROL BOARD NUMBER - A SEQUENTIAL NUMBERING SYSTEM USED WITHIN A COUNTY; WHEN REFERRING TO A SPECIFIC WELL USE THIS NUMBER

OWNER AND/OR PLACE: IDENTIFIES ORIGINAL OR CURRENT WELL OWNER AND/OR LOCATION OF WELL

YEAR COMP: YEAR IN WHICH WELL CONSTRUCTION WAS COMPLETED

LOG: TYPE OF LOG ON FILE FOR WELL; D = DRILLERS, E = ELECTRIC, G = GEOLOGIC

ELEV: ELEVATION - MEASURED IN FEET ABOVE MEAN SEA LEVEL

TOTAL DEPTH: TOTAL DEPTH DRILLED, IN FEET, WITH RESPECT TO LAND SURFACE

BEDROCK: DEPTH TO BEDROCK, IN FEET, WITH RESPECT TO LAND SURFACE

CASING: MAXIMUM AND MINIMUM DIAMETER OF CASING, IN INCHES, USED IN WELL

DEVEL ZONE: DEVELOPED ZONE - INTERVALS, IN FEET, WHERE AQUIFERS TAPPED AND/OR SCREENED

AQUIFER: WATER-BEARING UNIT; ABBREVIATIONS USED INDICATE GEOLOGIC AGE OF UNIT AND ARE CONSISTENT WITH "GEOLOGIC MAP OF VIRGINIA" (DIVISION OF MINERAL RESOURCES - 1963)

STATIC LEVEL: DEPTH, IN FEET, TO WATER WITH RESPECT TO LAND SURFACE; MEASUREMENTS TAKEN WHEN WELL IS NOT PUMPED AND ARE GENERALLY THOSE RECORDED ON COMPLETION DATE

YIELD: REPORTED OR MEASURED PRODUCTION, IN GALLONS PER MINUTE

DRAWDOWN: DIFFERENCE, IN FEET, BETWEEN STATIC LEVEL AND PUMPING LEVEL; I.E., REPORTED OR MEASURED DROP, IN FEET, IN WATER LEVEL DUE TO PUMPING

SPEC CAPAC: SPECIFIC CAPACITY - YIELD PER UNIT OF DRAWDOWN EXPRESSED AS GALLONS PER MINUTE PER FOOT OF DRAWDOWN

HRS: HOURS - DURATION OF PUMP TEST, IN HOURS, FROM WHICH THE PRECEDING THREE ITEMS WERE DERIVED

USE: USE OF WATER OR WELL UNDER CONSIDERATION; DOM = DOMESTIC, PUB = PUBLIC, GOV = GOVERNMENT, IND = INDUSTRIAL, COM = COMMERCIAL, INS = INSTITUTIONAL, ABD = ABANDONED, DST = DESTROYED, IRR = IRRIGATION, RCH = ARTIFICIAL RECHARGE

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
1	ACSA-WEYERS CAVE SAN	67		1080	305	25	6		.32	46	OMBQAT	14	20	34	.58	24	PUB
2	ACSA-STUARTS DRAFT #1	68	D G	1425	363	270	12	10	330	350	CWBQAT	93	457	5	91.40	48	PUB
3	M L MCMANAWAY	62	G	1510	242	28	5		165	166	CE/QAT	17	30	220	.13	7	DOM
4	CITY OF WAYNESBORO #1	67	D G		505	54	10		160	170	CE/QAT	10	575	210	2.73	48	PUB
5	SHERANDO LAKE #2	61	D	1880	355	19	5		272	273	CUNQAT		21	305	.06	2	PUB
6	V R FARRY	60	D		170	12	5		42	43		12	2			3	DOM
7	TABOR-NURSERY SCHOOL	65	D	1265	159	57	7		86	87	CE/QAT	50	20				COM
8	DENNIS P ARGENBRIGHT	65	D	1910	65	24	5				OB	26	20	39	.51		DOM
10	BEVERLY MANOR ELEM #2	60	D	1670	541	17	5		270	274	OB	96	4	330	.01	4	ABD
11	INGLESIDE HOTEL	48	D	1395	270	35	8				OB	40	11	180	.06	27	ABD
12	BELLMONTE FARMS	61	D	1560	148	69	5		75	79	CE/QAT	37	30	88	.34	19	COM
13	WANV RADIO STATION	64	D	1360	250	26	5				CE	24	8				COM
14	VIRGINIA ORE CORP	44	D	1585	372	24	10	8				175	412	75	5.49	31	ABD
15	AMOCO SERVICE STATION	68	D	1505	171	58	10	6	155	165	OE	100	40				COM
16	RALPH HAMILTON	62		1800	93	60					DS/QAT						COM
17	DAMES & MOORE #2	69	D		378	109	14	7	92	107	CE/QAT	35	40	65	.61	2	DST
18	ACSA-LYNDHURST	69	D	1415	265	130	6		90	100	CWBQAT	70	350	120	2.91	3	ABD
19	ACSA-AUGUSTA SPRINGS			1645							DMN		108				PUB
20	CRAIGSVILLE TOWN SPR			2245							SKE						PUB
21	DAMES & MOORE #1	70	D		505	291	14	10	290	305	CWBQAT	60	1000	49	20.40	15	IND
22	ACSA-MIDDLEBROOK #2	72		1990	240		6		220	240	CCOQAT	90	115	9	12.77	8	PUB
23	TOWERS RURITAN CLUB	62	D	1360	138	25	6				CCOQAT	22	10	130	.07	6	PUB
24	DAMES & MOORE #3		D		340	142	10	7	144	145	CE/QAT	65	150				DST
25	VDH-SWOOPE #1	69		1540	245		6		181	182	CE/QAT		30				DOM
26	J WARD TRESSEL	49		1300	310	10	6		300	301		27	2				COM
27	FITZHUGH ELDER JR	49		1400	80	20	6		75	76	DB/QAT	23	17				DOM
28	GUY HAMILTON	49		1400	85	15	6		40	41	DB/QAT	7	20	38	.52	1	COM
29	GROVES	49		1300	78	78	6		75	76	CE/QAT	8	8				DOM
30	A F BLACKWELL	50			149	126	6		40	42		22	7	9	.77	2	DOM
31	CARL & EDWARD COINER	49			63	30	6		55	56	CCO	40	13			3	PUB
32	DUPONT #6A	49		1286	784		24	18			CT/QAT	6	1500	196	7.65		ABD
33	DUPONT #6	49		1286	163		26	20	5	14	CT/QAT	5	650	14	46.42	24	IND
34	DAMES & MOORE #4	70	D		410	60	8				QAT						ABD
35	DAMES & MOORE #5	70	D		305	127	8		150	160	QAT	40	300			13	ABD
36	DAMES & MOORE #6	70	D		405	280	8		294	300	QAT	75	650			13	ABD
37	DAMES & MOORE #7	70	D		423	174	8	6	130	131	CE/QAT		175			6	ABD
38	DAMES & MOORE #8	70	D		425	149	18	8	180	200	CWBQAT		500				ABD
39	DAMES & MOORE #9	70	D		490	190	8				CWBQAT		2				ABD
40	VDH-GREENVILLE SHED	70	D	1610	465	45	6		210	211	OB		8			7	DOM
41	BRALLEY POND CAMP	70	D	2060	288	11	6		58	60	DB	18	2			8	PUB
42	VICTOR E GLICK	70	D	1320	570	29	6		209	210	OE	50	12			3	COM
43	ACSA-BERRY FARM #1	71		1450	370		6		97	170	CCO		150			9	PUB
44	FIELD UNIT NO 10 #4	71	D	1680	455	41	6		454	455	CCOQAT	40	200			8	INS
45	FIELD UNIT NO 10 #3	71	D	1680	498	36	6		280	281	CCOQAT	30	3			6	ABD

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SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
46	A CO LANDFILL	71	D	1420	460	1	6				OMB	15	2				DOM
47	SWANNANOA SKYLINE	71	D	1980	605	18	6		30	40	CPCC	30	1				DST
48	ACSA-LYNDHURST #1	72	D	1415	449	94	24	10	220	380	CWBQAT	59	1557	35	44.48	24	PUB
49	TOWN OF CRAIGSVILLE	57		1400	627		8	6			DLMU		110	240	.45	28	PUB
50	SENGERS MTN LAKE #2	69		1710	620		6		250	251	CWBQAT	250	12				ABD
51	BLUE RIDGE CONCRETE	58		1300	51	32	8				OB	17	37			27	IND
52	SHERANDO LAKE #1	36		1870	250		6				CUN		18				PUB
53	SHERANDO LAKE #3	36		1920	258						CUNQAT		2				ABD
55	BUFFALO GAP HI SCHOOL	60		1670	353	24			138	141	CE/QAT	61	22	289	.07	8	PUB
56	CHURCHVILLE SCHOOL	29		1440	140	40	6				CCOQAT						ABD
57	CRIMORA SCHOOL	35		1240	102		6				CE/QAT						ABD
58	FT DEFIANCE HI SCHOOL	60		1340	397	12	6		231	232	OB	39	25			6	ABD
59	NEW HOPE SCHOOL	38		1230	104	20	6				OMUU	30		50			INS
60	RIVERHEADS HI SCHOOL	60		1640	290	4	6		60	62	OB	17	15	283	.05	2	ABD
61	SPOTTSWOOD SCHOOL			1890	360		6				CCO						ABD
62	AUGUSTA CONCRETE CORP				175						QAT						ABD
63	FIELD UNIT NO 10 #1			1700	240						CCO						ABD
64	FIELD UNIT NO 10 #2			1690	377						CCO						ABD
65	ACSA-FOLLY MILLS WELL	73	D	1460	300	14	20	12			CCO	6	19	146	.13	9	PUB
66	WEYERS CAVE-DICE SPR	69		1100							CCO		500				PUB
67	BERRY FARM SPRING			1400							CCO		1330				PUB
68	AUGUSTA BLOCKS SPRING			1320							OL/OE		30				IND
69	STANCRETE CORP SPRING												50				IND
71	UNITED BROTHERS																ABD
72	NAT CHMNY REG PARK #1	70									CCO		6				PUB
73	SENGER MTN LAKE #1	61	D	1680	568	130	5				CE/QAT	170	7	390	.01	3	PUB
74	SWANNANOA GOLF CRS #1	3			800						CW		18				PUB
75	SWANNANOA SKYLINE #1	55		1880	545		6				CPCC		35				PUB
76	ACSA-STAUNTON PLAZA#2	74		1535	500		6				OCH	65	220	250	.88	72	PUB
77	ACSA-STAUNTON PLAZA#4	67	D	1520	355	61	10	8			CCO	65	190	116	1.63	49	PUB
78	SHENANDOAH ACRES	64	D	1680	386						QAT	180					PUB
79	DODGE SPRING			1565							QAT		1530				PUB
81	WYNSBORO-BROWN SPR #1			1365							CE/QAT		1050				PUB
82	WYNSBORO-BROWN SPR #2										QAT						PUB
83	WYNSBORO-HARTMAN SPR			1365							CE/QAT		1320				PUB
84	WYNSBORO-HOUFF SPR			1360							CE		1490				PUB
85	STAUNTON-GARDNER SPR			1400							OB						PUB
86	T F CLEMMER FARM																DOM
87	STATE LIME GRND PLANT										OE						IND
88	CRAWFORD MANOR #1	72		1615	360		6		38	100	CE/QAT	38	60	100	.60	168	PUB
89	JOHN M MOORE	72			360		6		300	310		28	5				COM
90	HARLEY GOCHENOUR	72	D	1265	240	225	10	6	230	231		50	300			2	PUB
91	ACSA-BERRY FARM #2	72	D	1410	363	16	20	8	145	156	CCO	7	1016	62	16.38	24	PUB
92	ACSA-MIDDLEBROOK #1	72		1890	400		6				CCO	25	10				PUB

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SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
93	H K CASSELL SCHOOL	73	D	1280	550	3	6		76	78	CE/QAT	80	30	171	.17	48	PUB
94	CRAWFORD MANOR #2	72	D	1710	600	60	6		150	152	CE/QAT	80	10	200	.05	72	PUB
95	ROGER GOCHENOUR	73	D	1265	365	105	6		123	125			45			2	PUB
96	J H SHOMO	73	D	1675	180	30	6				CCOQAT		40				DOM
97	REYNOLDS METALS CO #1			1130	150		10				CCOQAT	100	100	40	2.50	48	ABD
98	REYNOLDS METALS CO #2			1130	2260	1581	10		2040	226	CCOQAT		250	40	6.25	24	IND
99	REYNOLDS METALS CO #3			1130	260	152	20	12	185	260	CCOQAT	90	1200	10	120.00	48	IND
100	REYNOLDS METALS CO #4	59		1130	315	180	16	12	268	277	CCOQAT	97	1800	103	17.47	168	IND
101	REYNOLDS METALS CO #5	62	D	1125	342	230	20	12	247	342	CCOQAT	81	1254	70	17.91	72	IND
102	CRAWFORD MANOR #3	74	D	1605	145	86	6		118	145	CE/QAT	30	100	90	1.11	72	PUB
104	ACSA-FISHERSVILLE	74		845	500		6		90	100	OMBQAT	40	4				ABD
105	WILLOW SPOUT SPRING										OB						PUB
106	JOLLIETT TRAILER PARK										CWBQAT						PUB
108	PAUL D BLACKARD	74	D	1640	360	34	6				CCOQAT	130	10			2	DOM
109	BRIAN J GALLAGHER	74	D	1375	400	20	6				OB	30	3				DOM
110	SENGER MTN LAKE #3	74	D	1740	485	280	6		340	341	CWB/CE	200	60			5	PUB
111	CHARLES W WRIGHT	74	D	1170	300		6				OMBQAT		15			1	COM
112	SKYLINE SWANNANOA #3	74		1860	450		6		190	195	CPCC	180	100	220	.45	48	PUB
113	PARMER H BRADLEY JR	75	D	1420	140	37	6				OB	40	30	100	.30		DOM
114	REV C B DICKERSON	74	D	1622	320	30	6				OB/CCO	60	13				DOM
115	R B EARLY	75	D	1270	400		6				OMBQAT	8	2	392		2	DOM
116	JOHN T ROWE	75	D	1595	50	5	6		24	28	OCH	10	12	40	.30		DOM
117	VA UNITED BANK	74	D	1375	170	34	6				CCO	40	5				DOM
120	RIDGEVIEW SUBDIVISION				96		6										COM
121	B R FAUBER #1	54			48	35	6		48	49							DOM
122	B R FAUBER #2	54			18								15				DOM
123	LEE-JACKSON SUB #1	65			268		6										ABD
124	HARRISTON EAST SUB #1	68	D	1285	400	365	6		316	321	CWBQAT	200	200	150	1.33	5	PUB
125	GENERAL ELECTRIC CO	60			750						CWBQAT						IND
126	ACSA-STNTN PLAZA STP	67	D	1385	300	4	5		64	65	OE	21	25			24	DOM
127	ACSA-STAUNTON PLAZA#3	76		1485	250		8	6	95	96	4CCO	20	284	150	1.89	48	ABD
129	ACSA-JOLLIVUE	58		1705	706	44	8				CCOQAT	70	16	311	.05	24	ABD
130	DUPONT #5	40		1282	752		20	12			CT/QAT	117	3500	10	350.00		IND
131	ROBERT V KING	75	D	1295	305		6				CT/QAT	265	15				DOM
132	ANDREW BROWN	75	D	1775	435	365	6		365	435	CWBQAT	120	2			1	DOM
133	CLAUDE W CLINE	75	D	1300	170	30	6				CCOQAT	30	50				DOM
134	ADAM A MILLER	75	D	1550	365	10	7				CCO	90	15			1	DOM
135	KENNETH ROBERTSON #1	75	D		100	10	6					50	20				DOM
136	DEERFLD VALLEY CAMP#2	75	D		405		6										DOM
137	DEERFLD VALLEY CAMP	75	D		305	20	6					100	1				DOM
138	REEVES SHIFFLETT	75	D	1310	350	50	6				OB	60	2			2	DOM
139	DENNIS R SIMMONS	75	D	1460	95	36	7				CE	40	30			1	DOM
140	ROGER WILSON	75	D	1275	80	34	5					20	10			1	DOM
141	CARROLL D FAUBER	75	D		275	50					CE	70	20			1	DOM

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SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
142	STUART WASHINGTON	75	D	1375	170	48	6				CCO						DOM
143	MARY S COYNER	75	D	1435	500	60	6				CCO	40	1				DOM
144	GLENN R DRIVER	75	D	1500	140	80					OMBQAT	40	50			1	DOM
145	NELSON AILER	75	D		405	104	6					150	2				DOM
146	HARRY H HANGER	75	D		95	1	6				OMB	20	10	75	.13	1	DOM
147	DAVID HEMP	75	D	1305	300	1	6				OMB	20	2				DOM
148	D R IRVING	75	D		185	57	6					130	20				DOM
149	GEORGE MCCURE	75	D		185	39	6					130	10				DOM
150	OLDEN J RADER JR	75	D	1595	260	206	6				CWBQAT	120	10			1	DOM
151	LESS STEWART	75			315		6				CCO	100	30				DOM
152	JOHN GRIMM	75	D	1295	210		6				CWBQAT	60	6	180	.03	3	DOM
153	R F KIMMELL JR	75	D	1490	305	125	6				CCO	200	10			1	DOM
154	ED BRENNAMAN	75	D	1475	275	55	6				OB	40	5			1	DOM
155	HOWARD P HESTON	75	D	1365	80	70	6				CE/QAT	30	20			1	DOM
156	SUPERIOR CONCRETE INC												4				IND
157	RICHARD E FAWLEY	75		1495	375		6				CE	17	6				DOM
158	W F CALDWELL III	75	D	1595	125	10	6				OB	80	30			1	DOM
159	GLORIA STOWERS	75	D		305	10	6					90	4				DOM
160	IVAN R DIEHL	75	D	1260	200	5	6				OMB	20	2				DOM
161	ROBERT H SNIVELY	75	D	1440	335	193					CA/QAT	100	12				DOM
163	ACSA-GREENVILLE #1	75	D		831	3	6		761	762	CCO	125	20	705	.02	10	ABD
164	ACSA-GREENVILLE #2	75	D		400	55	6		219	233	CCO	110	2	289		1	ABD
165	PHILLIP KIRACOFE	60		1370	25												DOM
169	WYNSBORO-COINER SPR			1320							CE		603				PUB
170	WYNSBORO-DIST HOME SP			1260							CE		2540				PUB
173	JOHN D GROVE	76			275						CE/QAT	60	8				DOM
174	B C HOPEMAN		D	1425	340	326	6				CCO	70	100				DOM
175	D R BEYELER	76	D		305	24	10	6			CCO	30	8				DOM
176	LEE-JACKSON SUB #2	55			110		6				OE		8			100	ABD
177	BLUE RIDGE COMM COL#2	67	G	1260	550				204	207	OB	125	12	425	.02	8	INS
178	BLUE RIDGE COMM COL#1	66	G		300				250	275			1				DST
179	VDH-I-81 MT SIDNEY #2	67	G		298	3					OMB	10	11				PUB
180	VDH-I-81 MT SIDNEY #1	67	G		280	1			55	56	OMB	50	37				PUB
181	KENNETH JONES	66	G		83	12			10	12		2	12	75	.16		DOM
182	ROBERT DINKLE	68	G		225	60			200	205		40	40				DOM
184	U S FOR SER-TODD LAKE	66	G	1960	147	40			37	42	DCHQAT		131				PUB
185	R R SMITH	67			600				284	285			25				DOM
186	JANET WINSTEAD	75		1485	182						OMB						DOM
187	R C SULLIVAN	76	D	1395	185	177	6				QAT	90	50			1	DOM
188	T B FITZGERALD	76	D		195	162	6				CWBQAT		100			1	DOM
189	T D BARTLEY	76	D		500	38	6				OB	70	5			1	DOM
191	PINE BLUFF PARK	64	D	1280	393	72	5		277	278	OB	75	50				PUB
192	SWANNANOA GOLF CRS #2	62	D		262	30	6		62	65	CW	33	15	229	.06		COM
194	MRS TURNER ASHBY #1	47	D	1425	158	13					CCOQAT	12	20				DOM

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
195	MRS TURNER ASHBY #2	74		1420	85						CCOQAT						DOM
196	CLARENCE WEESE			1435	240			20			CCOQAT						DOM
197	MRS G VANCE-SPRING #1			1495							OB						DOM
198	MRS G VANCE-SPRING #2			1490							OB						DOM
199	DEERFLD-GW NAT FOR-SP			1755							DS/QAT						DOM
200	MR H M ECKARD	62	D	1505	148	12					CE	6	20				DOM
201	VDH-VERONA	76	D		305	37	6					94	20	206	.09	48	DOM
202	E STEVEN WAMPLER	76		1530	395		6		320	321	OB	40	3				DOM
203	JAMES E WILLIAMS	67		1630	160		6		120	121	OCHQAT		22				DOM
204	BILL MCCLURE	76		1820	440		6		320	321	OB	40	6				DOM
205	TOM LONG			1295							CCOQAT						DOM
206	CROMPTON CO INC	44		1320	250	78	8		115	128	CWBQAT	15	400			50	ABD
207	PETER A PEDERSEN	76		1360	160	40	6		80	81	OMB	5	20				DOM
208	W D MINTON	75		1610	165		6		140	165	CWBQAT	100	10				DOM
209	ROBERT M MARCUM	76		1560	240	25	6		200	201	CE/QAT	30	12				DOM
210	R R SMITH	75		1680	240	21	6				OMB	34	8				DOM
211	W C ROBERSON #1	74		1660	400	21	6				OMB		1				ABD
212	W C ROBERSON #2	74		1660	300	21	6		180	181	OMB	18	6				DOM
213	JAMES D TATE	72		1810	300	26	6		100	300	CCO	25	6				DOM
214	CHURCH OF GOD	75		2010	300	43	6		250	251	CCO	40	6				PUB
215	MRS ELMER ARMSTRONG	76		1840	200	63	6				CCO	52	30				DOM
216	CARLTON YOUNG #1	65		1835	235	60	6		235	236	CCO	40	20				DOM
217	CARLTON YOUNG #2	75		1930	360	20	6		320	360	CCO	50	12				DOM
218	RANDOLPH B GLOVER #1	75		1870	280	18	6		260	261	CCO	18	15				DOM
219	R B GLOVER #2	75		1845	300	93	6		200	201	CCO	83	4				DOM
220	G DAYTON HODGES	70		1840	325	20	6		325	326	CCO	42	300				DOM
221	ROBERT LAW #1	48		1880	92		6				CCO	30	2				ABD
222	ROBERT LAW #2			1880	300		6				CCO	20	3				DOM
223	JOHN BROWN	76		1820	200	140	6		150	151	CCO	60	25				DOM
224	JOHN R SIMONETTI	40		1170							OMBQAT						DOM
225	HEARN	75		1270							OMBQAT						DOM
227	MELVIN GREGORY	76		1350	225						CCOQAT		10				DOM
228	J V DAVIS	75		1155	101		6				OMBQAT		20				DOM
229	E R HUMPHRIES	74	D		170		6				CE	40	4				DOM
230	ANTHONY ALDIERI	69	D	1365	448	18	6				CCO	65	1				DOM
231	ALFRED L ALLHISER JR	75	D	1230	124	120	6				CE/QAT	50	60				DOM
232	GEORGE ANDERSON	72		1235	152	105	6				OB	5	6				DOM
233	VESPER VIEW SUB #1	64		1310	360	225	6		245	247	CWBQAT	79	330	3	110.00		PUB
234	JOHN E ATKINSON	75	D		292	266	6		266	267	CCO		4				DOM
235	ACSA-GREENVILLE #4	76	D		300	135	6				CCO	6				3	ABD
236	H G BARNHART	76	D		160	120	7				CE/QAT	125	7				DOM
237	BOBBY BEARD	75	D	1185	425	40	6				OMBQAT	60	10				DOM
238	ROBERT G BENNETT	74	D	1660	390	15	6				OE		3				DOM
239	DENNIS BRADLEY	75	D		225	197	6				CE/QAT	40	9				DOM

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
240	SHIRLEY BREEN	75	D		425	48	6				CH	19	2				DOM
241	JAMES BROOKE	72	D	1315	185						CWBQAT	30	10				DOM
242	JAMES BROWN	73	D		165		6				OB	40	20				DOM
243	CARL BULLE	73	D		165		6		72	77			15				DOM
244	JOHN CALABRIA	71	D	1435	298	65	6		165	166	OMB	90	2				DOM
245	JACK G CARTER	73	D		258	70	6						30				DOM
246	CHRISTIAN MANOR INC	76	D		190	110	6		186	190	CE/QAT	53	50				COM
247	CALVIN CLEMENTS	71	D		122	102	6				CWBQAT	97	15				DOM
248	CHARLES D CLINEDINST	71	D		115	65	6				CCOQAT		2				DOM
249	E H COFFEY INC	75	D		116	45	6						20				PUB
250	CARL CRAIG	76	D	1165	280	15	6				OMB	30	30				DOM
251	S E CRICKENBERGER	73	D	1140	240	2	6				OMBQAT		30				DOM
252	THOMAS CRICKENBERRY	76	D	1270	515	430	6				OB	65	4				DOM
253	JAMES CRISSMAN #1	73	D		240		6				CT		30				DOM
254	JAMES CRISSMAN #2	74	D		115		6				CT		25				DOM
255	H R DAGGY & SON	74	D		130	65	6						15				DOM
256	RUSSELL DAGGY	73	D		100	42	6						60				DOM
257	RUSSELL DAGGY JR	71			80		6				CCOQAT	8	30				DOM
258	TONY DEFABIO	70			80		6					28	20				DOM
259	RUBY DRIVER	74	D		90		6					22	15				DOM
260	ROSCOE MILLER	74	D		490		6				CWBQAT		5				DOM
261	RUSSELL EAVEY	72	D		160	138					CWBQAT	30	30				DOM
262	CARROLL EPPARD	72	D		82	72	6					7	40				DOM
264	ROLLIN L EUSTLER	73	D	1180	140						CCO		12				DOM
265	EARL N FISHER JR	73	D		279		6					190	30				DOM
266	JAMES S FITZGERALD	74	D	1350	215		6		170	171	CWBQAT	130	20				DOM
267	TRENT GARRETT	72	D		165	158	6						60				DOM
268	CALVIN GOCHENOUR	71	D		115		6					45	5				DOM
271	WILLIAM B GOCHENOUR	73	D		130	127							50				DOM
272	JENNINGS L GODBY	75	D		165	65	6				OMBQAT		12				DOM
273	CHARLES GROVE	74	D		180		6				CWBQAT		8				DOM
274	JAMES S GUYER	72	D		122	7	6		95	96	CE	25	30				DOM
275	JOHN HALTERMAN	76	D		160		6		97	98	CCO	65	25				DOM
276	JULIAN HALTERMAN	74	D		80	72						55	20				DOM
277	GARY R HANEY	72	D		178	7	6				CCO	26	1				DOM
278	WILLIAM HARDEN	74	D	1750	465	122	6				OB	160	5				DOM
279	DEBBIE HARLOW	72	D		75	17	6				CWB/CE	6	6				DOM
280	BARRY HARNER	71	D	1410	400	265	6				CT/QAT	320	10				DOM
281	WAYNE HENSLEY	75	D		260	120					CA	170	30				DOM
282	CARL HINDGARDNER	71	D		74	14			33	34	OMBQAT	25	20				DOM
283	M A HOOVER	71			128		6		84	85		20	40				DOM
284	RAYMOND C HOY	72	D		265	10	6				CER	10	4				DOM
285	FRANK L JOHNSON	75	D		628		6				OB	290					DOM
286	BILL KELLY		D		100	32	6		96	97		15	10				DOM

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
287	WILLIAM J KNEBEL	76	D		160	53	6		93	96	CCO	60	8				DOM
288	CHARLES LAYMAN	75	D		70		6				CE/QAT	30	10				DOM
289	C W LLOYD #1	75	D		97	17	6				DCHQAT	10	6				DOM
290	C W LLOYD #2	75	D		130	11					DCHQAT		4				DOM
291	WILLIAM MATHIAS	72	D		190	169	6				CA		40				DOM
292	CHARLES MATTESON	75	D	1180	240	55					OMBQAT	60	5				DOM
293	LARRY T MAY	73	D		140		6				CWBQAT		20				DOM
294	HAYWOOD MCCAULEY	72	D		99		6					30					DOM
295	SIDNEY MCCAULEY	72	D		164	160	6		163	164			100				DOM
296	HUGH MCCHESNEY	75	D		128						CE/QAT		20				DOM
297	A N MCLAUGHLIN	72	D		235		6				CWBQAT		60				DOM
298	LESTER L MEADOWS	76	D		644		6				QAT		2				DOM
299	MARC MEHLER	74	D		115	12							8				DOM
300	R A MILLER	73	D	1640	165	136	6		155	156	CCO	40	8				DOM
301	DONNY MICHAEL	71			55				45	46			12				DOM
302	JACK MICHAEL	72	D		90		6						60				DOM
303	JIM MICHAEL	74	D		88	59	6		65	66	CCOQAT		15				DOM
304	JOHN L MILLER	73	D		196	90						55	8				DOM
305	DUPONT #1		D	1282	592	190	12	10	385	388	CT/QAT		560	27	20.74		ABD
306	GILBERT MONGER	74	D		135		6				CE/QAT		75				DOM
307	CHARLIE A MOORE	75	D	1255	320		6		190	195	CE	80	5				DOM
308	JENNINGS MORRIS	73	D		155	72	6						8				DOM
309	LARRY MORRIS	73	D	1200	380	30	6				OMB	100	2				DOM
310	RONALD MUNSEN	74	D		200	163	6					120	7				DOM
311	TOM NEIL	72	D		40		6				QAT	10	30				DOM
312	RICHARD E OREBAUGH	76	D								CCO						DOM
313	THOMAS W OSCAR	73	D		165	18	6				QAT		5				DOM
314	RAY PANGLE #1	73	D		125	73	6				CE/QAT	40	60				DOM
315	LYNN PARR	71	D		145		6					75	10				DOM
316	S J PAYNE	74	D		220								20				DOM
317	WOODROW F PAYNE JR	72	D		140	114	6					50	50				DOM
318	ELIZA PHILLIPS	72	D		185	150	6				CWBQAT		10				DOM
319	NOAH PLAUGHER	76	D		403	15	6					80	2				DOM
320	EMORY D PLUMMER		D		125		6					70	30				DOM
321	RAYMOND PUFFENBARGER	76	D	1170	99	40	6				DCH		6				DOM
322	K D PUGH JR	71	D		128	100	9					100	10				DOM
323	JACOB QUICK	72	D		140		6				CA		50				DOM
324	RAY PANGLE #2	72	D		75		6				CE/QAT	35	20				DOM
325	RAY PANGLE #3	72	D		70		6				CE/QAT		15				DOM
326	RAY PANGLE #4	72	D		75	23	6					30	5				DOM
327	DONALD RANSOM	74	D		240		6						25				DOM
328	JACK RAYBOURNE	72	D		103		6						20				DOM
329	HENRY ROADCAP	71	D		125	117	6				OMBQAT	80	10				DOM
330	MARGARET ROADCAP	74	D		90	24	6						30				DOM
331	C WILSON REXRODE	74	D		90	38	6				QAT	40	20				DOM

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   W A T E R   C O N T R O L   M A N A G E M E N T

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
332	JOHN H RUBUSH JR	73	D		115	20	6				OB		30				DOM
333	J H RUBUSH & SON	74	D		190	20	6				OB		18				DOM
334	JOHN RUEBUSH	71			178		6				OB		3				DOM
335	LLOYD E RUONA	71	D		120		6					98	14				DOM
336	RURITAN CLUB	75	D		565		6					35	2				DOM
337	FRANK SCROUGHAM	71	D		95	92	6					75	8				DOM
338	WILLIAM D SHEETS	76	D		302		6						5				DOM
339	ERNEST W SHEFFER	75	D		117		6		100	117	QAT	8	30				DOM
340	WILSON SHEFFER	71	D		28	17	6					15	20				DOM
341	ROGER SHIFFLETT	72			297		6						60				DOM
342	JOHN SHIELDS	73	D		352	80	6					155	60				DOM
343	PAUL SMALLWOOD	71	D		328	35	6		145	146			2				DOM
344	C E SMILEY	74	D	1345	190	110	6				CCO	100					DOM
345	FOREST A SMITH				70		6					7	28				DOM
346	FREDERICK SORRELL	75	D		138		6						4				DOM
347	PAUL STEVENS	72	D		60	7	6					10	50				DOM
348	STOKESVILLE COMM CNTR	74	D		70	20	6				CCOQAT	15	5				PUB
349	WILLIAM STRICKLER	74	D	1265	315	40	6				OMB	75	2				DOM
350	THOMPSON	73	D		125	110	6					50	20				DOM
351	VESPER VIEW SUB #2	72	D		115		6						12				DOM
352	CHARLES VARNER	74		1535	240		6				OE	130	8				DOM
353	GUY WILLIAMS	72			89						CE	16					DOM
354	FRANCIS WOOD	70	D		84	18	6						6				DOM
355	JAMES WOODSON JR	72	D		75		6						15				DOM
356	CHARLES W WRIGHT #1	71	D		307	10	6				OMBQAT	7	12				DOM
357	CHARLES W WRIGHT #2	73	D		504	8	6				OMBQAT	19	12				DOM
359	GARLAND WRIGHT	73	D		138	12	6				OMB		12				DOM
360	NELSON WRIGHT	71	D		253	16	6		78	79	OMBQAT		2				DOM
361	PAUL WRIGHT	71			78		6				OMB		50				DOM
362	JESSE YOUNT JR	72	D		290		6				CWBQAT	200					DOM
363	ZION LUTHERAN CHURCH	75	D	1340	470	12	6		465	466	CE		15				PUB
364	W R ZWART		D		216		6					62	20				DOM
365	KENNETH LUISFORD	76			230		6				CT/QAT	120	12			1	DOM
366	CARL W LANDES #1	76			350		6				CE/QAT	40	2			1	ABD
367	MENNO J KINSINGER	76		1430	230		6				OB	50	24			1	DOM
368	L S CASH	76			305		6				CCO	40	4			1	DOM
369	GEORGE FULTZ	76	D	1900	200	35	6				DB/QAT	35	3				DOM
370	CRAWFORD MANOR #4	75			385		6				CE/QAT	50	40				PUB
371	GARY ARGENBRIGHT	76			65		6					10	20				DOM
372	PAUL LAW	76		1910	300		6				CE		7				DOM
373	BEN LAW	68		1890	300		6				CCO	30	20				DOM
374	PAUL CRISSMAN	66		1250	116		6				CE/QAT		50				DOM
375	FLOYD CRUMMETT #1			1525							CE						DOM
376	MIKE CHUMBLEY			1420							CCO						DOM

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   W A T E R   C O N T R O L   M A N A G E M E N T

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
377	J C DELL	52		1230	91		6				OB						DOM
379	SHEN VALLEY AIRPORT	56		1135	230		6				OMB		20				PUB
380	WILLIAM A HOUFF JR	75		1175	25		48				OB	5					DOM
381	STANLEY R ALEXANDER	54		1360	258	18	6		245	246	OB	42	2				DOM
382	SAMUEL A CARTER	55		1460	305						OB	50	7				DOM
383	WILLIS L CLEMMER	68		1300	125	5	6				OB	15	8				DOM
384	M HOYE SOURS			1350	200		6		65	66	CCO		2				DOM
385	E BURWELL HAWPE	42		1140	130		6				OMB		4				DOM
386	KEITH MORRISON	76		1420	220	8	6				OB	40	20				DOM
387	MARGARET MCCUE	66		1140	200	20	6				OMB	30	15				DOM
388	ROBERT CLAY	76			260		6				DB	20	100				DOM
389	WILLIAM E CURRY SR #2	77		1620	125	15	6		80	81	DB	15					DOM
390	HANKEY MTN CAFE			1960	129	15	6				DB						COM
391	WHITE WAY LUNCH #1	32		1720	52		6				DCH	3	60				COM
392	WHITE WAY LUNCH #2	74		1710	140		6				DCH		60				DOM
393	JAMES J HALL	73		1600	180		6		50	51	DB/QAT		20				DOM
394	R BRUCE CAMPBELL-SPR			1480							OE						DOM
395	L D LAMBERT			1470	65		6				OMB						DOM
396	DAVID R SHIFLETT	75	D	1200	500	32	6		100	101	OB	75	4				DOM
397	SWITZER BROS	64		1320	216						OE		20				DOM
398	DR PAXTON P POWERS	74		1390	105		6				OMB						DOM
399	GLEN F WINE	71		1410	200	2	6		190	191	CCO	60	15				DOM
400	J A MOHLER-MOSCOW SPR			1350							OB						DOM
401	LEWIS GARRETT			1320	42		36				CE		4				DOM
402	BRUCE WIGGIN-SPR			1410							OCH						DOM
403	WALLACE P WADE	74		1720	140		6		130	131	DCH	5	150				DOM
404	FLOYD CRUMMETT #2	75		1520	160		6		60	61	CE		30				DOM
405	DANIEL H DUFF JR	76	D		119		6				CWBQAT	30	100				DOM
406	JAY N WHITESELL	76	D		110	88	6				CE/QAT	50	100			1	DOM
407	WILLIAM T BAYLOR	76	D		410	40	7					90	4			1	DOM
408	DUPONT #2		D	1284	732	230	10	8	495	500	CT/QAT	157	500	13	38.46		IND
409	DUPONT #3		D	1281	676	270	16	8	280	290	CT/QAT		2000	10	200.00		IND
410	FIN MISH			1660	200		19										DOM
411	FLOYD HEISER			2070	400						CCO						DOM
412	A T WENGER			1420							OE						DOM
413	GLENN W DOTSON			1400							OMB						DOM
414	JOHN NITZ			1360							OMBQAT						DOM
415	RHONDA GILL			1560							CCO						DOM
416	BOBBY N CLINE			1800							CE						DOM
417	WALLACE W SPROUSE	61		1780	65						DS						DOM
418	ALBERT ELLINGER-SPR			1590							DMN						DOM
419	JAMES COLVIN			1610							DMNQAT						DOM
420	C R TURNER	45		1580	46						DMN						DOM
421	DEWEY A BYERLY			1600							DS						DOM

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
422	J L MCWHORTER			1950							DMN						DOM
423	CHARLES S HUNTER III	70		2020	100						DB		100				DOM
424	P R CASH			1805							CCO						DOM
425	PETER PEDERSEN			1390							OB						DOM
426	EDWARD C BUNCH			1420	80						CCO						DOM
427	A C HEIZER			1595							OB						DOM
428	ROBERT C NEWMAN			1410							CE/QAT						DOM
429	FILMORE BELL	72		1405	75		6				CE/QAT						DOM
430	DAVID WENGER	45		1370							CE/QAT						DOM
431	RICHARD A COINER			1340	125						OB						DOM
432	ANDREW L MCCASKEY			1220							OMB						DOM
433	SILVERBROOK FARMS			1920							CE						DOM
435	HUNTLEY	75	D		145	90	7					42	5			3	DOM
436	RICHARD STUTZMAN	75	D		145	58	7					30	15			3	DOM
437	WEEKLEY	75	D		105	85	7				CE/QAT	40	20				DOM
439	THOMAS DAGGY	76	D		152	110	7		148	149	OB	55	35			3	DOM
440	ISAAC RISSER	76	D		245	55	7		160	230		50	10			6	DOM
441	STEVE RIGGLEMAN	77	D		345	18	7		330	331	OB	60	12			6	DOM
442	UVRPA-GRAND CAVERNS	77	D		135	23	14	8			CCOQAT	24	230	34	6.76	48	PUB
443	DEERFIELD FIRE DEPT	77	D		242	8					DMNQAT	12	14	140	.10	2	DOM
444	JOANNE TANNEHILL	75	D		179	12	6				DB/QAT	14	12	165	.07		IRR
445	JACK BOGAN	75	D		50	15	6				DMN	7	15	35	.42	21	DOM
446	AL CRANE	75	D		71	12	6				DMNQAT	16	12	60	.20	1	DOM
447	A E SMITH	75	D		72		6				DMNQAT						DOM
448	MARY DEVORE	75	D		100	4	6		64	65	DMNQAT	5	3	95	.03	1	DOM
449	CITY OF WAYNESBORO #3	77	D	1345	432	185	10	6			CWB	57	703	16	43.93	48	PUB
451	DUPONT #4		D	1281	674		20	8	362	433	CT/QAT		1800	10	180.00		IND
452	DUPONT--FLOWING WELL	30		1285	560						CT/QAT		680				ABD
453	BAKER SPRING			1295							CWB		3500				IND
454	WAYNE FAIRBURN	77		1500	90						CCO		12				DOM
457	CARL W LANDES #2	77	D		110	27	6					50	200			1	DOM
458	NAT CHMNY REG PARK #2	70			145	3			87	89	CCO		11				PUB
459	NAT CHMNY REG PARK #3	76			127						CCO		25				PUB
460	ACSA-GREENVILLE #5	77	D		419		6		156	159		50	50			2	ABD
461	GLENDON SHANK	76			203	85	6					64	6	145	.04	4	DOM
462	EARL KISAMORE SR.	76	D		100	38	6				CCO		10			1	DOM
463	ACSA-GREENVILLE #3	76	D		390	47	6		98	106		29	118	390	.30	2	ABD
464	HARVEY SHEFFER	77	D		105	35	6					20	15	60	.25	3	DOM
465	ROTHERMEL ASSOCIATES	66			220												IND
466	MILLER METAL FABRICAT	50			92							15	40				INS
467	P M GROVE	00	D		170	161	6					60	15			1	IND
468	EARL REEVES	00	D		140	8	6					60	50			1	DOM
469	LEO FOSTER #1	63	DEG		258	25	5					47	5	247	.02		DOM
470	YANCY PITTS #1	63	DEB	1740	183	42	5				QAT	42	8	180	.04	1	DOM

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   W A T E R   C O N T R O L   M A N A G E M E N T

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
471	WADE E WILLS #1	64	EG		265	39	5									DOM
472	PAUL Q SIMMONS	64	EG		357	20	5	175	176		35	6	215	.02		DOM
473	RALPH E MUSGRAVES #2	64	DEG		330	20	5				216	9				DOM
474	RUDOLPH BUMGARDNER #1	64	DEG		304	48	5	167	168		130	3	230	.01		DOM
475	RONNIE DAMERON	00			305	28	6				30					DOM
476	H I TODD	00			260	28	6				30	5			1	DOM
477	OAK BOWER MOTEL	64	G	1760	155	8	6	60	61	CPCC	48	7				PUB
478	SNP-ROCKFISH GAP #1	64	G	2200	535		6			CPCC	379	3	79	.03	24	PUB
479	HARRY A SMITH	66		1285	300					QAT	9	1			2	DOM
480	B D CARTER	63		1285	114		6			QAT						DOM
481	DR J H THOMAS	61	D	1562	146	33	5	130	135	OB	70	60	50	1.20	7	DOM
482	CANNING LAND & CATTLE			1630	75	12	6			OB	20	8			48	DOM
483	G W NATIONAL FOREST	67	D G	2240	143		6	80			6	73			4	DOM
484	SIDNEY BEAR	62	G	1436	303		5			QAT	6	1	294		2	DOM
485	L F MADER	60		1460	103	25	5	60	80	QAT	40	1	60	.01	1	DOM
486	CHARLES W GRANT	63		1430	110	55	5			QAT	36	20	60	.33	3	DOM
487	N W SISSON	64	G	1500	578	51	5	188	189	OB	180	8	250	.03	2	DOM
488	R H PUFFENBERGER	62	G	1620	123	4	5			CCO	65	10	34	.29	20	DOM
490	L P SANDY	61		1680	103	37	5			CE	54	25			6	DOM
492	LYNN SLAVEN	63	G	1320	138		5			OCH	45	4	125	.03	1	DOM
493	HUGH P BELL #1	25		1465	108		6			OB	44	1	20	.05	1	ABD
494	HUGH P BELL #2	65	G	1465	406	71	5			OB		1	250		2	DOM
495	W AREY & SON	65	G	1290	181	104	5	151	156	OB	70	20	60	.33	2	IND
496	M C DAHMER	65	D G	1340	257	15	5	225			77	6			2	DOM
497	E A EYE #1	65	G	1330	593	10	5	110	112		90	60	300	.20	2	IND
498	ROSA SUIT	64		1360	220	60	6	160			80	12	20	.60	2	DOM
500	NEW HOPE METHODIST CH	63	G	1203	135	44	5				55	8			2	INS
501	MARY WILLEY	64	D	1265	176	7	5	68	69		45	1	120		2	DOM
502	J R PALMER	61		1280	258	5	5	161	220		27	1	220		2	DOM
503	HARPER K PHILLIPS	65	D G	1320	350	40	5	106	107		31	1				DOM
504	THOMAS D BARTLEY #2	61	D	1265	500	87	5	341	342		96	1	300		2	DOM
505	MRS DOROTHY WITHERS	64	G	1600	335	1	6	108	109	DHS	18	23	200	.11	2	IND
506	HAROLD J MURPHY	65	G	2100	175	40	5	145	157	DCH	118	12			2	DOM
507	J A ARGENBRIGHT	64	G	1760	63	4	5			QAT	15	10	30	.33	1	DOM
508	ANN MEEKS	64	G	1600	332	12	5	172	173	CCO	31	1	280		2	DOM
509	OAKLAND FARMS	66	G	1140	433		5	160	161		65	4	200	.02	2	DOM
510	FARMERS MILLING CO			1190	73							7				DOM
511	KING COLA BOTTLING WK			1190	50							2				DOM
512	SHIPPLETTS CLEANERS			1305	60											DOM
513	HARRIET J FAUBER #1	60		1300	592	19		344			30	3	550		2	PUB
514	HARRIET J FAUBER #2	60		1300	147	19	5	134								PUB
515	DAVID W BYER	66	G	1490	425											DOM
516	SALLY SIMMONS	61		1120	250	11	5	173	175		24	150	206	.72	4	DOM
517	VA DIV FORESTRY	67	D G	1210	88		6	12	15		18	36	6	6.00	2	DOM

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF WATER CONTROL MANAGEMENT

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
518	UNION PRESBYTERIAN CH	63		1507	123	27	5		63	64	CCO	24	12	38	.31	7	PUB
519	UNION PRESBYTERIAN #2	63	D	1560	198	25	5		138	139	CCO	72	8	108	.07	2	PUB
520	CUSTARD PATTERSON FAR	64		1240	236		6					38	4				PUB
521	CUSTARD BYERS FARM	59		1200	270		6					60	6				DOM
522	ARTHUR R WARE JR	64	G	1580	310		9	5	83	84	OB	15	6	2	3.00	2	DOM
523	W T DAMERON	64		1440	166		6		154	155	QAT	126	20				DOM
524	JUSTICE CLINE	28		1420	172						CE	20	3				DOM
525	AARON D HUBER	62	G	1410	177		5				OB	67	10	165	.06	2	DOM
526	THOMAS J WHEELER	66	D G	1360	178	70	5		146	147	CE	50	15				DOM
527	WILLIAM DRIVER	20		1520	198				18		CCO	12	16				DOM
528	H D DAWBURN	63	G	1320	183	26	5		123	124	CE	66	37	117	.31	2	DOM
529	WAYNESBORO CIVIL DFEN	66		1280	300		6		240	260		40	60	40	1.50	10	PUB
530	MARY M BERRY	63	G	1480	288	19	5				CCO	71	40	209	.19	13	DOM
531	H SPENCER	14		1415	796						CCO		2				DOM
532	J C RITCHIE	64		1580	200	68	6				OB	100	10				DOM
533	F S BLACK	64	G	1415	228	18	5		124	125	OE	102	9	60	.15	2	DOM
534	RALPH E MUSGRAVES #2	64		1660	330	20	5				OE	216	9			2	DOM
535	AUGUSTA STONE CORP #1	65	D	1465	700	8	7		8	465	OE	20	5				IND
536	C E RODEFFER #1	62	G	1400	123	5	5		90	91	OE	21	12	102	.11	1	DOM
537	WESTERN STATE HOSP #1	05		1410	426	20	10	8	86	87	OB	17	160	15	10.66	7	DOM
538	WESTERN STATE HOSP #2	60	D	1410	415	17	7				OB		60			1	DOM
539	WESTERN STATE HOSP #3	61		1400	550	13	7		164	166	OB		3				DOM
540	WESTERN STATE HOSP #4	61	D	1420	500	1					OE		3				ABD
541	WESTERN STATE HOSP #5	61		1410	400	13	6				OB						ABD
542	WESTERN STATE HOSP #6	61		1410	185	45	6				OB	4	175	23	7.60		ABD
543	C & O RAILROAD	05		1510							OB		200				ABD
544	BERNARD OREBAUGH	16		1660	180		6				OB						ABD
545	L D ALLANSON	59		1600	210	70	6				CCO	140	15				DOM
546	JOSEPH A SMITH	63	G	1595	303	20	5		190	192	CE	161	1				DOM
547	J A SMITH #2	64	G	1540	256	35	5		151	152	CE	122	12	80	.15	2	DOM
548	BOYD E CUPP	61	D	1370	101	4	5		92	98	CCO	80	9	95	.09	2	DOM
550	WM L MORRISON	40	D	1540	100						OB	60					DOM
551	L GRIEF & BROS #1	61	D		515	26	7		140	141		43	10	106	.09	24	ABD
552	L GRIEF & BROS #2	61	D		350	11	7		82	85		10	30	245	.12	24	ABD
553	L GRIEF & BROS #3	61	D		300	25	7		71	72		47	1	250		2	ABD
554	INGLESIDE GOLF CRS #2	67	D G	1420	118	53	6		8	36	OB	3	150				ABD
555	INGLESIDE MOT INN #3A	67	G	1420	300	4	5		64	65	OB	21	25			24	COM
557	ACSA-STAUNTON PLAZA#1	64		1480	612	8	8		94	95	OB	14	7				ABD
558	W O VARNER	77	ROT		440	10	6		350	351	OE	40	3				DOM
559	KIM KYLE	77			440	20	6		240	241		70					DOM
560	FRED BOWERS	77			400	36	6		300	301	OB	35	6				DOM
561	EARLY	77			200	150	6					100	12				DOM
562	R L CRICKENBERGER	77			300	36	6		270	271		30	10				DOM
563	BOB NUTT	77			100	6	6		50	51	OL	30	100				PUB

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   W A T E R   C O N T R O L   M A N A G E M E N T

SUMMARY OF WATER WELL DATA FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	YEAR COMP	LOG	ELEV	TOTAL DEPTH	BED-ROCK	CASING MAX	CASING MIN	DEVEL FROM	ZONE TO	AQUIFER	STATIC LEVEL	YIELD	DRAW DOWN	SPEC CAPAC	HRS	USE
564	HELEN K GROVES	77	ROT		300	30	6		250	251	OE	80	30				DOM
565	THOMAS H TULLIDGE #1	77	D		340	30	6					35	30				DOM
566	THOMAS H TULLIDGE #2	77	D		240	30	6		70	71		20	20				DOM
567	DOMINION MANGANESE #1	44	E		372	190	10	8	218	220		175	412	250	1.64		IND
568	VIRGIL GORE & CO #2	65	DEG		451	30	5		236	237		40	5			2	PUB
574	HI MEADOWS FARM #1	64	DEG		335	1	6		108	203		18	23	218	.10		IND
577	WEYERS CAVE ELEM SCH			1190	130							10					ABD
578	NORTH RIVER ELEM SCH			1480	211						CCO		2				PUB
579	DEERFIELD ELEM SCH			1750	96						DMNQAL	9					PUB
580	BEVERLY MANOR ELEM #1	60		1670	480	23	5		270	271	OB		1	480		2	ABD
581	MARK HANGER	77	D		200	40	8	6				40	12			1	DOM
582	JAMES H VASS	77	D		260	60	8	6				40	5			1	DOM
583	ERIK AMATO	77	D		460	55			395	396		215	8			3	DOM
584	STAUNTON MILITARY ACD			1500	1400		8				OB		40	150	.26		ABD
585	LEHIGH PORTLAND CEMNT	23	D	1400	1438	6	14	12	295	315	DS/QAT		50			44	ABD
586	AUGUSTA STONE CORP #2	61		1520	100		4				OE	12	5				DOM
587	REYNOLDS METALS #6	76	D	1130	201	180	12	6	181	201	CCO	114	50	14	3.57	48	IND
588	BROADHEAD SPRING #2			1810							CE		646				IND
589	COCHRAN SPRING			1730							OE		1400				IND
590	KENNEDY SPRING			1540							CCO		1610				IND
591	CAVE SPRING			1495							CCO		2280				IND
592	BIG SPRING			1330							CCO		5790				IND
593	BLUE HOLE SPRING			1315							CCO		1770				IND
594	JOSEPH SPRING			1290							CCO		6640				IND
595	MOSSY CREEK CHURCH SP			1270							CCO		808				IND
596	SEAWRIGHT SPRING			1270							CCO		1770				IND
597	DALE L GRIMM	78	D		500	40	6		490	491		100	4				DOM
598	BRIGHT CONSTRUCTION	78	D		300	20	6				OE	20	12				DOM
599	DAVID LOTTS	78	D	1755	500	10	6		230	240	OB	30	4				DOM
600	DOUGLAS R DAVIS	78	D	1725	460	20	6				OB		5				DOM
601	WILLIAM A KOINER	78	D		275	85	6				QAT	100	15				DOM
602	JOHN D HAZZARD	78	D		95	29	6				DCH	25	30			1	DOM
603	DIEHL ENTERPRISES INC	78			110		6					40	10			1	DOM
604	JOHN JARVIS	78	D		110	10	6				CCO	10	40			1	DOM
605	J E RUSH	78	D		395	70	6				OB	120	7			1	DOM
606	HOMETOWN RADIO SERVCE	61	G		213	138	5		158	185	CE	57	20	153	.13	2	DOM

APPENDIX C

Summary of Groundwater Quality Analyses for Augusta County

The computer printout on the following pages lists basic groundwater quality data for approximately 170 of the wells and springs included in the water well data summary (Appendix B). The information contained in this printout is keyed to Appendixes A and B.

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

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THE FOLLOWING LIST OF GROUNDWATER QUALITY DATA SUMMARIZES BASIC DATA OBTAINED FROM ANALYSES OF GROUNDWATER, COLLECTED FROM WELLS AND SPRINGS, WHICH ARE ON PERMANENT FILE IN THE OFFICES OF THE VIRGINIA STATE WATER CONTROL BOARD. ADDITIONAL GROUNDWATER QUALITY INFORMATION FOR MANY OF THESE WELLS AND SPRINGS IS AVAILABLE AND CAN BE OBTAINED BY CONTACTING THE APPROPRIATE REGIONAL OFFICE OR THE BUREAU OF SURVEILLANCE AND FIELD STUDIES AT THE AGENCY HEADQUARTERS IN RICHMOND.

************ EXPLANATION OF PARAMETERS ************

SWCB NO: STATE WATER CONTROL BOARD NUMBER - A SEQUENTIAL NUMBERING SYSTEM USED WITHIN A COUNTY; WHEN REFERRING TO A SPECIFIC WELL USE THIS NUMBER

OWNER AND/OR PLACE: IDENTIFIES ORIGINAL OR CURRENT WELL OWNER AND/OR LOCATION OF WELL.

DATE SAMP: DATE SAMPLED - MONTH AND YEAR IN WHICH WATER SAMPLE WAS COLLECTED.

PH: HYDROGEN ION CONCENTRATION - BASED ON A SCALE OF 1 THROUGH 14. WATER WITH A PH GREATER THAN 7.0 IS CONSIDERED TO BE BASIC OR ALKALINE; THE LARGER THE PH VALUE, THE MORE ALKALINE THE WATER. WATER WITH A PH LESS THAN 7.0 IS CONSIDERED TO BE ACIDIC; THE SMALLER THE PH VALUE, THE MORE ACIDIC THE WATER.

SPEC COND: SPECIFIC CONDUCTIVITY - AN INDICATOR OF THE RELATIVE AMOUNT OF DISSOLVED MINERALS IN WATER; HIGHER VALUES INDICATE GREATER AMOUNTS OF DISSOLVED MINERALS; UNIT OF MEASUREMENT IS MICROMHO

T-DIS SOLID: TOTAL DISSOLVED SOLIDS - INDICATES TOTAL AMOUNT OF DISSOLVED MINERALS IN WATER; UNIT OF MEASUREMENT IS MILLIGRAMS PER LITER

HARDNESS TOTAL: TOTAL HARDNESS - CAUSED BY THE PRESENCE OF CALCIUM, MAGNESIUM, IRON, ZINC , AND OTHER TRACE METALS. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

HARDNESS CA,MG: CALCIUM-MAGNESIUM HARDNESS - INDICATES THAT PORTION OF TOTAL HARDNESS CAUSED BY CALCIUM AND MAGNESIUM, WHICH ARE GENERALLY RESPONSIBLE FOR ALMOST ALL HARDNESS IN WATER. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

THE AMOUNT OF HARDNESS IN WATER WILL AFFECT THE ABILITY OF SOAP TO LATHER OR CLEANSE BECAUSE OF THE TENDENCY OF THE IONS CAUSING HARDNESS TO REACT WITH SOAP. THE HIGHER THE HARDNESS OF WATER, THE MORE DIFFICULT IT IS FOR SOAP TO LATHER.

NOTE: TOTAL HARDNESS IS GENERALLY DETERMINED BY CHEMICAL TITRATION WHEREAS CALCIUM-MAGNESIUM HARDNESS IS GENERALLY DETERMINED BY MATHEMATICAL CALCULATION FROM CHEMICALLY-DETERMINED VALUES FOR CALCIUM AND MAGNESIUM. BECAUSE OF THIS DIFFERENCE IN DETERMINATION, THE CALCIUM-MAGNESIUM HARDNESS VALUES FOR SOME ANALYSES WILL BE LARGER THAN THE TOTAL HARDNESS VALUE.

******** PARAMETERS LISTED BELOW ARE MEASURED IN MILLIGRAMS PER LITER ********

FE: IRON	MN: MANGANESE	CA: CALCIUM
MG: MAGNESIUM	NA: SODIUM	K: POTASSIUM
HCO3: BICARBONATE	SO4: SULFATE	CL: CHLORIDE
	NO3: NITRATE (AS NO3)	

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

****

SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
2	ACSA-STUARTS DRAFT #1	10 71	8.2			80	80	0.09	0.02	25.7	3.9	0.6	2.0		2.2	5.0	
2	ACSA-STUARTS DRAFT #1	4 69	7.3			76	74	0.02	0.00	17.0	7.8	2.2			1.0	3.0	0.4
2	ACSA-STUARTS DRAFT #1	11 68	8.2			53	52		0.01	12.0	5.6	0.7			1.5	0.5	
3	M L MCMANAWAY	8 76	6.7	130	90	54	68	1.10	0.25	18.0	5.7	15.0	0.1		7.3	3.0	0.0
4	CITY OF WAYNESBORO #1	6 74	7.8			165	165	0.02	0.04	27.8	23.4	23.3			38.3	13.0	
5	SHERANDO LAKE #2	8 71	8.2			45	44	0.23	0.01	14.4	2.2	10.5	0.4		10.6	1.0	0.0
7	TABOR NURSERY SCHOOL	4 76	6.7	160	124		96	0.10	0.00	22.0	10.2	6.0	2.2			4.0	12.0
8	DENNIS P ARGENBRIGHT	8 76	7.0	210	130	113	120	0.10	0.00	27.0	12.8	2.0	0.9		1.9	2.0	5.3
14	VIRGINIA ORE CORP	6 67	7.1				61	0.50	0.08	15.5	5.5	6.6		83	1.4	5.0	1.3
14	VIRGINIA ORE CORP	6 67	7.5				66	2.10	0.40	17.5	5.6	2.9		85	1.6	4.0	1.3
16	RALPH HAMILTON	7 76	6.8	106	104	97	62			23.0	1.3	1.0	0.4		3.1	0.0	2.2
19	ACSA-AUGUSTA SPRINGS	3 72	7.3			49	48	0.72	0.01	16.0	2.2	4.9	1.0		14.8	7.0	89.0
22	ACSA-MIDDLEBROOK #2	10 73	7.8				207	0.04	0.00	40.3	25.9	24.0		253	7.4	31.0	8.9
23	TOWERS RURITAN CLUB	4 76	6.7	200	159		106	5.70	0.00	22.0	12.5	7.0	1.0			12.0	25.7
28	GUY HAMILTON	1 77	7.2	160	122	90	66	6.40	0.62	13.0	8.3	48.0	0.4		5.3	5.0	
28	GUY HAMILTON	7 76	6.8	150	113	40	4	0.70	0.00	2.0	0.0	42.0	0.0		7.0	6.0	0.0
32	DUPONT #6A	7 56	8.0			67	67	0.03		15.0	7.2				11.4	1.3	
33	DUPONT #6	7 56	7.9				53	0.03		11.3	6.2				0.3	0.8	
40	VDH-GREENVILLE SHED	12 76	7.9	540	335	340	326	0.10	0.00	70.0	37.0	16.0	1.4		15.0	13.0	0.0
41	BRALLEY POND CAMP	7 76	7.1	150	99	95	61	0.00	0.07	16.0	5.2	22.0	0.1		6.3	0.0	0.0
42	VICTOR E GLICK	4 76	6.3	540	521		310	0.10	0.01	75.0	30.0	14.0	1.2			8.0	4.9
44	FIELD UNIT NO 10 #4	5 76	7.1	300	198		179	0.10	0.00	53.0	11.6	3.0	0.9			1.0	9.3
44	FIELD UNIT NO 10 #4	11 71	8.0			166	167	0.00	0.00	51.3	9.5	1.1	1.0		9.2	4.5	37.2
46	AUGUSTA CO LANDFILL	12 77	7.2	567	418	246	352	0.50	0.35	110.0	19.0	21.0			23.0	47.0	
46	AUGUSTA CO LANDFILL	9 77	7.5	610	427	304	299	0.40	0.30	92.0	17.0	20.0			19.0	49.0	
46	AUGUSTA CO LANDFILL	12 76	7.3	470	381	256	197	0.50	0.34	77.0	1.3	53.0	0.4		19.4	31.0	0.0
48	ACSA-LYNDHURST #1	1 72	8.6			400	399	22.16	1.22	74.1	52.3				2.5	3.0	

NOTE--ALL ZEROS (00.00) - ANALYSED, NOT DETECTED; ALL NINES (99.99) - COULD NOT BE STORED, REFER TO ANALYSIS

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   S U R V E I L L A N C E   A N D   F I E L D   S T U D I E S

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

****

SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
50	SENGERS MTN LAKE #2	10 74	7.5	91	192										2.4	2.0	0.0
52	SHERANDO LAKE #1	5 76	6.2	72	53		8	0.10	0.26	2.0	0.8	3.0	2.3			1.0	0.0
56	CHURCHVILLE SCHOOL	7 76	7.4	400	248	285	263	0.00	0.00	56.0	30.0	2.0	1.2		6.1	1.0	2.2
57	CRIMORA SCHOOL	4 76	6.7		131		222	0.00	0.00	60.0	17.7	4.0	1.4			2.0	5.3
60	RIVERHEADS SCHOOL	12 76	8.1	390	289	240	166	0.00	0.00	64.0	1.6	14.0	1.9		9.9	3.0	5.8
63	FIELD UNIT NO 10 #1	3 71	8.1			162	161	0.17	0.01	46.5	11.0		0.1		11.7	4.0	12.0
63	FIELD UNIT NO 10 #1	1 71	7.1			268	273	0.08	3.80	82.6	16.4				11.4	20.0	0.4
64	FIELD UNIT NO 10 #2	11 73	8.0			169	168			51.8	9.5	8.9	1.1		6.2	4.5	8.9
64	FIELD UNIT NO 10 #2	11 71	8.0			166	167	0.00	0.00	51.3	9.6	1.2	1.1		9.2	4.5	8.4
64	FIELD UNIT NO 10 #2	3 71	7.8			344	349	0.10	0.01	84.2	34.0				13.5	75.0	4.9
66	WEYERS CAVE-DICE SPR	10 71	8.0			307	328	0.01	0.02	76.9	33.3	2.6	3.4		41.2	3.5	3.5
67	BERRY FARM SPRING	10 71	8.2			293	292	0.02	0.05	69.7	28.9	1.2	1.6		1.4	0.5	
67	BERRY FARM SPRING	1 69	7.7			300	182			68.1	3.1				3.5	0.5	
67	BERRY FARM SPRING	2 63	7.7		280	289	197			34.6	27.1	39.4			4.1	1.0	
75	SWANNANOA SKYLINE #1	3 73	7.9		121		92	0.10	0.01	25.4	7.1	5.5	0.7		6.6	9.4	8.0
76	ACSA-STAUNTON PLAZA #2	2 73	8.1		275		250	0.16	0.02	87.5	7.9	10.3	2.0		4.1	14.6	9.3
76	ACSA-STAUNTON PLAZA #2	3 69	7.7			275		0.09	0.01	93.8						5.5	
76	ACSA-STAUNTON PLAZA #2	6 67	7.6		260		206	12.80		70.5	7.4	5.4	0.6		5.8	17.5	4.9
77	ACSA-STAUNTON PLAZA #4	2 73	8.1		208		234	0.68	0.01	77.5	10.0	0.9	1.4		2.1	2.0	4.4
77	ACSA-STAUNTON PLAZA #4	6 67	7.7		128	239	190	0.39	0.00	60.9	9.4	1.0	0.0		7.5	6.0	5.3
78	SHENANDOAH ACRES	5 72	8.1			89	88	0.12	0.01	20.5	9.0	2.4			5.8	0.5	
85	STAUNTON-GARDNER SPR	4 69	8.1			243	243	0.06		57.7	24.1	1.3			2.3	1.0	3.1
87	STATE LIME GRND PLANT	10 71	7.8			304	303	0.07	0.09	77.8	26.7	4.1	1.4		20.7	7.5	60.7
88	CRAWFORD MANOR #1	12 72	8.0		155	132	131	0.10	0.01	27.3	15.5	1.6	1.6		2.6	3.1	16.4
88	CRAWFORD MANOR #1	6 72	7.8			156	156	0.06		31.3	19.1	0.6			4.1	7.0	
94	CRAWFORD MANOR #2	12 72	8.3		230	233	232		0.01	51.3	25.5	2.1	1.4		14.7	1.0	0.4
97	REYNOLDS METALS CO #1	11 74	8.4	258	156	145	143			40.5	10.4	1.4	3.1		6.3	1.5	2.2
97	REYNOLDS METALS CO #1	3 73	8.4		159	153	153			43.8	10.8	1.3	1.7		4.7	1.0	2.2

NOTE--ALL ZEROS (00.00) - ANALYSED, NOT DETECTED; ALL NINES (99.99) - COULD NOT BE STORED, REFER TO ANALYSIS

V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   S U R V E I L L A N C E   A N D   F I E L D   S T U D I E S

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
97	REYNOLDS METALS CO #1	5 60	7.7			164		0.06	0.05					164			
98	REYNOLDS METALS CO #2	4' 38	7.2		148		108	0.30		40.0	2.0			164	14.7	1.9	
99	REYNOLDS METALS CO #3	11 73	8.4	258	156	145	143	0.00	0.00	40.5	10.4	14.4	3.1		6.3	1.5	2.2
99	REYNOLDS METALS CO #3	3 73	8.4		159		153	0.10	0.01	43.8	10.8	1.3	1.7		4.7	1.0	2.2
105	WILLOW SPOUT SPRING	8 76	7.2	510	374	199	344	0.00	0.00	82.0	34.0	12.0	2.1		8.9	5.0	19.9
105	WILLOW SPOUT SPRING	8 74	7.6	485	331		320	0.10		80.0	29.5	4.3	2.2			7.0	26.1
106	VOILLETT TRAILER PARK	8 74	7.7	151	111		96	0.10		22.0	10.0	1.5	1.9			0.0	0.9
108	PAUL D BLACKARD	5 75	7.2	359			245	0.00		88.0	6.4		1.6			8.0	4.9
109	BRIAN J GALLAGHER	5 76	7.2	580	382		299	0.00		87.0	20.0					1.0	1.3
110	SENGER MTN LAKE #3	5 75	7.1	179	146		120	0.00		26.0	13.5	0.9	2.4			2.0	0.0
113	PARMER H BRADLEY JR	12 77	7.2	636	459	318	350			73.0	41.0	11.0	4.0		3.0	20.5	101.9
113	PARMER H BRADLEY JR	9 77	7.7	520	373	290	300			61.0	36.0	5.0	3.0		4.0	13.0	55.4
113	PARMER H BRADLEY JR	5 75	7.4	579	491		421			80.0	54.0	8.3	3.1			18.0	155.1
114	REV C B DICKERSON	5 75	7.2	480	373		293	0.00		91.0	16.2	9.1	2.3			23.0	14.2
115	R B EARLY	5 75	7.1	901	830		1320	0.00		450.0	48.0	15.0	0.6			8.0	0.0
121	B R FAUBER #1	10 71	8.2		329	306	305	2.60	0.36	72.9	30.1	17.0	0.8		18.0	24.5	11.1
124	HARRISTON EAST SUB #1	10 71	7.9		128	108	108	0.01	0.01	26.5	10.2	0.6	3.2		10.9	3.0	0.0
124	HARRISTON EAST SUB #1	7 68	7.7		131	115	123	0.28	0.00	29.6	12.0	1.0	0.2		6.9	1.0	0.4
126	ACSA-STNTN PLAZA STP	4 68	7.2				330	0.10	0.00	115.0	10.7	171.6		436	295.7	15.0	0.4
129	ACSA-JOLLIVUE	10 57	7.2				300	0.30								4.0	
130	DUPONT #5	9 71	8.1		138	107	107	0.00	0.00	24.1	11.5	3.5	3.5		7.4	4.0	
132	ANDREW BROWN	4 76	6.6		124		103	0.70	0.00	22.0	11.7	2.0	0.7				0.0
133	CLAUDE W CLINE	4 76	6.8	337	267		91	0.00	0.00	23.0	8.3	4.0	2.5			4.0	13.7
134	ADAM A MILLER	5 76	7.0	480	355		289	0.00	0.00	100.0	9.8	3.0	1.0			1.0	15.5
137	DEERFIELD VALLEY CAMP	7 76	6.9	117	112	138	71	0.00	0.00	23.0	3.5	4.0	0.6		5.7	1.0	1.3
138	REEVES SHIFFLETT	12 76	7.6	310	222	192	102	0.00	0.00	38.0	1.8	17.0	1.1		4.7	3.0	11.1

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V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   S U R V E I L L A N C E   A N D   F I E L D   S T U D I E S

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
139	DENNIS R SIMMONS	10 76	7.8	470	341	312	352	0.00	0.00	67.0	45.0	1.0	3.6		167.1	6.0	15.9
142	STUART WASHINGTON	4 76	6.9	570	441		339	0.00	0.00	119.0	10.4	27.0	2.4			26.0	57.6
143	MARY S COYNER	4 76	6.8	490	368		97	0.10	0.01	22.0	10.4	4.0	2.3			2.0	0.0
144	GLENN R DRIVER	4 76	7.2	448	352		3	0.00	0.00	1.0	0.2	164.0	0.0			14.0	0.0
147	DAVID HEMP	4 76	6.8	940	872		130	0.90	1.63	17.6	21.0	31.0	0.5			27.0	0.0
150	OLDEN J RADER JR	12 76	8.5	210	150	126	65	0.50	0.02	24.0	1.3	16.0	1.1		7.7	1.0	
153	R F KIMMELL JR	11 76	7.9	390	317	268	363	0.00	0.00	65.0	49.0	0.0	1.8		8.2	17.0	8.9
154	ED BRENNAMAN	5 76	7.1	400	260		216	0.00	0.00	54.0	19.8	2.0	0.9			1.0	1.8
155	HOWARD P HESTON	12 77	7.1	312	222	148	169	0.40	0.00	58.0	6.0	3.0	3.0		3.0	13.0	44.3
155	HOWARD P HESTON	9 77	7.6	279	190	144	155	0.00	0.00	54.0	5.0	3.0	2.0		3.0	8.0	26.6
155	HOWARD P HESTON	5 76	7.2	300	230		149	0.40	0.00	51.0	5.3	11.0	2.0			8.0	42.1
157	RICHARD E FAWLEY	8 76	7.5	560	369	194	366	0.00	0.00	91.0	34.0	4.0	1.5		7.2	4.0	14.6
157	RICHARD E FAWLEY	8 75		520	427		293	0.10	0.01	68.0	30.0	8.4	2.5			11.0	37.7
158	W F CALDWELL III	5 76	7.4	640	406		304	0.00	0.00	84.0	23.0	114.0	0.9			1.0	4.4
160	IVAN R DIEHL	4 76	7.2	1000	852		526	0.00	0.05	165.0	28.0	32.0	0.3			23.0	0.0
169	WYNSBORO-COINER SPR	6 77					96	0.28		23.0	9.6	1.0	1.7				
169	WYNSBORO-COINER SPR	11 71	7.9		115	89	87	0.01	0.02	24.8	6.3	1.0	1.8		9.0	2.5	
169	WYNSBORO-COINER SPR	10 70	8.0		113	90	102	0.02		20.8	12.2	5.0			10.4	1.5	
170	WYNSBORO-DIST HOME SPR	6 77					229	0.00	0.00	56.7	21.3	3.5	2.1				
170	WYNSBORO-DIST HOME SPR	10 70	7.9			210		0.02		52.1					12.2	5.5	
174	B C HOPEMAN	4 76	7.1	290	211		204	3.90	0.09	63.0	11.5	3.0	1.5			2.0	13.3
186	JANET WINSTEAD	4 76	7.0	430	298		244	0.10	0.00	88.0	6.0	11.0	0.3			0.0	5.3
194	MRS TURNER ASHBY #1	7 76	7.6	540	430	299									42.7	23.0	
195	MRS TURNER ASHBY #2	7 76	7.5	560	380	341	341	0.50	5.70	89.0	29.0	22.0	2.3		3.7	24.0	1.2
196	CLARENCE WEESE	7 76	7.5	390	267	274									10.5	2.0	
197	MRS G VANCE-SPRING #1	7 76	7.7	370	257	265	223	0.00	0.02	50.0	24.0	3.0	1.4		5.0	5.0	12.0

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VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
198	MRS G VANCE-SPRING #2	7 76	7.5	370	248	267	231	0.00	0.00	50.0	26.0	2.0	1.1		5.2	3.0	12.8
199	DEERFIELD TOWN SPRING	7 76	6.9	117	112	138	71			23.0	3.5	4.0	0.6		5.7	1.0	
200	MR H M ECKARD	7 76	7.6	230	196	138	131	0.00	0.00	38.0	8.8	6.0	1.6		8.7	11.0	4.0
203	JAMES E WILLIAMS	9 76	7.0	510	388	274	337	0.40	0.01	103.0	19.5	14.0	1.9		5.5	34.0	14.2
205	TOM LONG	8 76	7.1	270	186	134	154	0.00	0.00	36.0	15.8	2.0	0.3		1.4	0.0	11.1
207	PETER A PEDERSEN	12 76	7.3	960	800	470	455	0.00	0.01	180.0	1.6	52.0	0.4		113.2	58.0	155.1
210	R R SMITH	10 76	7.1	680	529	384	387	0.60	0.04	111.0	27.0	21.0	1.5		25.2	19.0	16.8
214	CHURCH OF GOD	9 76	7.2	280	244	200	237	0.00	0.00	49.0	28.0	0.0	1.3		12.8	1.0	0.4
216	CARLTON YOUNG #1	9 76	7.1	400	308	254	452	0.10	0.00	89.0	56.0	1.0	1.5		3.7	4.0	14.6
217	CARLTON YOUNG #2	9 76	7.2	550	395	346	336	0.10	0.00	69.0	40.0	0.0	1.6		20.3	0.0	5.3
222	ROBERT LAW #2	9 76	7.1	450	392	306	400	0.10	0.00	83.0	47.0	0.0	1.2		7.2	7.0	9.7
223	JOHN BROWN	9 76	7.1	240	197	164	382	0.70	0.07	74.0	48.0	0.0	1.6		1.6	1.0	5.3
224	JOHN R SIMONETTI	4 76	7.0	375	282		204	0.10	0.01	61.0	12.7	17.0	0.3			11.0	0.0
225	HERN	4 76	6.5	197	163		96	1.50	0.41	26.0	7.6	17.0	0.4			0.0	0.0
227	MELVIN GREGORY	4 76	6.9		318		271	0.00	0.00	79.0	18.0	6.0	1.1			6.0	19.9
228	J V DAVIS	4 76	7.0	360	256		198	0.70	0.14	66.0	8.3	16.0	0.3			6.0	0.0
230	ANTHONY ALDIERI	9 76	7.3	520	425	48	32	0.00	0.00	8.0	3.1	123.0	1.2		13.3	5.0	0.4
238	ROBERT G BENNETT	10 76	7.5	390	280	248	266	0.10	0.00	77.0	18.1	0.0	0.2		35.0	4.0	0.0
241	JAMES BROOKE	9 76	5.5	195	47	34	6	2.00	0.05	2.0	0.3	3.0	0.7		2.4	5.0	0.0
243	CARL BULLE	11 76	7.8	260	221	178	184	0.10	0.01	66.0	4.8	1.0	1.6		3.2	3.0	10.6
251	S E CRICKENBERGER	9 76	7.0	610	461	344	331	0.20	0.01	109.0	14.4	15.0	0.3		39.3	26.0	0.4
252	THOMAS CRICKENBERRY	9 76	7.2	320	242	18									8.1	11.0	7.1
264	ROLLIN L EUSTLER	11 76	7.7	230	231	154	168	0.00	0.00	61.0	3.9	0.0	1.9		3.2	3.0	12.0

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V I R G I N I A   S T A T E   W A T E R   C O N T R O L   B O A R D

B U R E A U   O F   S U R V E I L L A N C E   A N D   F I E L D   S T U D I E S

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

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SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
266	JAMES S FITZGERALD	9 76	6.0	45	81	44	21	0.20	0.04	7.0	0.9	1.0	5.7		1.9	6.0	0.0
278	WILLIAM HARDEN	9 76	7.3	400	297	246	298	0.10	0.02	57.0	38.0	1.0	0.3		3.2	2.0	12.8
280	BARRY HARNER	9 76	6.9	170	147	110	104	0.00	0.00	22.0	12.0	1.0	3.2		1.6	6.0	0.0
290	C W LLOYD #2	11 76	7.3	190	173	108									13.4	0.0	0.0
300	R A MILLER	9 76	7.1	600	495	256	322	0.20	0.00	120.0	5.5	24.0	5.3		9.4	39.0	84.2
307	CHARLIE A MOORE	9 76	7.0	370	264	240	209	0.00	0.00	52.0	19.5	5.0	0.3		2.2	2.0	9.3
309	LARRY MORRIS	10 76	7.5	810	707	392	467	0.00	0.01	100.0	53.0	104.0	0.4		31.2	2.0	0.9
313	THOMAS W OSCAR	11 76	7.8	615	511	364	408	0.20	0.04	132.0	19.2	29.0	0.1		98.4	3.0	6.6
321	RAYMOND PUFFENBARGER	10 76	6.9	165	133	74	69	4.10	0.41	14.0	8.5	9.0	0.3		0.0	1.0	0.4
330	MARGARET ROADCAP	11 76	7.8	490	442	282	315	1.50	0.17	103.0	14.2	39.0	0.1		88.8	10.0	0.0
344	C E SMILEY	9 76	7.1	360	259	186									1.5	5.0	2.2
349	WILLIAM STRICKLER	9 76	6.9	315	231	178									11.8	6.0	0.0
352	CHARLES VARNER	10 76	7.5	295	224	178	198	0.00	0.00	77.0	1.6	0.0	0.1		2.8	3.0	4.4
367	MENNO J KINSINGER	12 76	7.8	520	366	300	410	0.00	0.00	87.0	47.0	13.0	1.1		4.8	5.0	15.9
372	PAUL LAW	9 76	7.1	500	414	330	364	0.90	0.00	80.0	40.0	0.0	1.5		46.3	2.0	0.0
373	BEN LAW	9 76	7.1	480	338	328	389	0.10	0.00	77.0	48.0	0.0	1.0		3.7	3.0	0.4
375	FLOYD CRUMMETT #1	8 76	7.5	620	440	256	368	0.00	0.00	77.0	43.0	15.0	2.2		16.1	17.0	70.9
376	MIKE CHUMBLEY	8 76	7.0	360	235	153	240	0.00	0.00	47.0	30.0	7.0	1.6		15.7	3.0	10.6
379	SHEN VALLEY AIRPORT	10 76	7.4	780	543	80	387	0.20	0.06	126.0	17.9	47.0	0.2		79.6	55.0	0.0
380	WILLIAM A HOUFF JR	10 76	7.2	620	440	72	387	0.20	0.00	137.0	11.0	18.0	0.3		57.2	21.0	4.9
381	STANLEY R ALEXANDER	10 76	7.3	630	436	76	461	0.90	0.10	109.0	46.0	4.0	1.5		28.7	11.0	0.0
382	SAMUEL A CARTER	10 76	7.2	690	487	14	4	0.00	0.00	1.0	0.5	350.0	1.5		8.9	10.0	28.8
383	WILLIS L CLEMMER	10 76	7.4	540	378	2	2	0.00	0.00	1.0	0.0	250.0	0.0		32.5	4.0	8.9

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384	M HOYE SOURS	10 76	7.2	700	459	84	520	0.10	0.00	98.0	67.0	4.0	2.7		6.8	5.0	28.8
385	E BURWELL HAWPE	10 76	7.2	540	385	58	316	0.30	0.08	104.0	13.8	15.0	0.2		80.8	28.0	4.4
387	MARGARET MCCUE	10 76	7.1	810	545	98	471		0.04	138.0	31.0	49.0	0.4		76.2	28.0	1.3
389	WILLIAM E CURRY SR #2	11 76	7.3	250	210	138	149	1.10	0.43	40.0	12.0	11.0	0.3		6.0	1.0	0.0
392	WHITE WAY LUNCH #2	12 77	6.7	162	101	62	76	2.90	0.49	19.0	7.0	7.0	0.0		14.0		0.0
392	WHITE WAY LUNCH #2	9 77	7.1	166	118	58	73	3.70	0.59	18.0	7.0	7.0	0.0		5.0		0.0
392	WHITE WAY LUNCH #2	11 76	7.0	140	136	72	80	3.60	0.60	19.0	8.1	6.0	0.2		1.7	1.0	0.0
393	JAMES J HALL	11 76	7.9	205	182	96	117	0.00	0.16	30.0	10.4	11.0	0.1		7.2	1.0	0.0
394	R BRUCE CAMPBELL-SPR	11 76	7.4	430	356	4	2	0.10	0.00	1.0	0.0	156.0	0.0		17.0	9.0	12.0
395	L D LAMBERT	11 76	7.6	910	751	484	526	0.00	0.00	190.0	12.8	9.0	0.1		49.7	46.0	99.7
396	DAVID R SHIFLETT	11 76	7.5	440	314	244	316	0.00	0.00	71.0	34.0	0.0	1.2		11.4	6.0	31.0
397	SWITZER BROS	11 76	7.9	515	412	34	14	0.10	0.00	5.0	0.5	260.0	0.0		16.9	8.0	17.3
398	DR PAXTON P POWERS	11 76	8.0	390	304	210	283	0.00	0.00	95.0	11.2	3.0	0.5		32.6	22.0	4.9
399	GLEN F WINE	11 76	7.8	480	328	282	361	0.00	0.00	79.0	40.0	0.0	1.7		8.4	4.0	17.3
400	J A MOHLER-SPR	11 76	7.9	415	287	246	324	0.00	0.00	64.0	40.0	1.0	1.4		17.6	3.0	12.0
401	LEWIS GARRETT	11 76	7.9	490	338	292	331	0.00	0.01	75.0	35.0	0.0	1.5		5.2	3.0	7.5
402	BRUCE WIGGIN-SPR	11 76	7.8	400	276	238	318	0.10	0.00	65.0	38.0	0.0	0.5		3.8	1.0	9.3
403	WALLACE P WADE	11 76	7.5	205	153	54	65	0.10	0.03	15.0	6.8	38.0	0.0		4.2	1.0	0.0
410	FIN MISH	1 77	7.8	410	291	262	237	0.00	0.00	64.0	18.9	0.0	1.7		5.0	4.0	22.2
411	FLOYD HEISER	1 77	7.8	420	325	286	282	0.90	0.00	57.0	34.0	0.0	1.5		21.3	2.0	0.0
412	A T WENGER	1 77	7.8	400	317	246	239	0.00	0.00	76.0	12.2	11.0	0.5		7.1	3.0	9.7
413	GLENN W DOTSON	1 77	7.7	490	394	270	284	0.30	0.01	100.0	8.5	24.0	0.1		37.8	13.0	16.8
414	JOHN NITZ	1 77	7.7	700	539	340	370	0.00	0.04	117.0	19.1	64.0	0.4		73.8	17.0	0.9
415	RHONDA GILL	1 77	7.9	820	628	432	449	0.00	0.01	101.0	48.0	64.0	9.8		49.2	43.0	64.2

NOTE--ALL ZEROS (00.00) - ANALYSED, NOT DETECTED; ALL NINES (99.99) - COULD NOT BE STORED, REFER TO ANALYSIS

VIRGINIA STATE WATER CONTROL BOARD

BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUNDWATER QUALITY ANALYSES FOR AUGUSTA COUNTY

SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	HARDNESS CA,MG	FE	MN	CA	MG	NA	K	HCO3	SO4	CL	NO3
416	BOBBY N CLINE	1 77	8.0	330	244	220	184	0.00	0.00	44.0	18.1	36.0	1.3		3.2	2.0	6.2
417	WALLACE W SPROUSE	1 77	7.5	200	179	136	110	5.10	0.56	20.0	14.7	13.0	0.3		15.6	1.0	0.0
418	ALBERT ELLINGER	1 77	6.2	140	173	66	43	9.00	0.44	11.0	3.9	27.0	1.0		37.2	19.0	6.2
419	JAMES COLVIN	1 77	6.7	120	125	60	36	10.00	3.70	4.0	6.5	10.0	1.1		11.0	9.0	0.0
420	C R TURNER	1 77	8.0	300	270	162	147	1.80	0.12	48.0	6.8	57.0	0.8		11.3	5.0	0.0
422	J L MCWHORTER	1 77	7.9	190	169	140	113	0.00	0.00	38.0	4.5	33.0	0.4		3.8	1.0	0.4
423	CHARLES S HUNTER III	1 77	7.5	230	180	122	124	2.10	0.28	34.0	9.7	48.0	0.6		25.3	1.0	0.0
424	P R CASH	12 76	8.0	380	253	242	234	0.00	0.00	48.0	28.0	12.0	1.5		17.0	1.0	1.8
426	EDWARD C BUNCH	12 76	7.3	460	349	288	222	0.10	0.00	87.0	1.4	22.0	2.4		11.5	16.0	14.6
427	A C HEIZER	12 76	7.6	390	284	280	267	0.10	0.01	61.0	28.0	16.0	1.4		5.4	0.0	8.9
428	ROBERT C NEWMAN	12 76	7.3	345	268	204	142	0.40	0.01	55.0	1.3	18.0	2.9		4.7	9.0	12.4
429	FILMORE BELL	12 76	6.6	89	90	50	26	0.20	0.04	10.0	0.4	19.0	2.0		2.8	0.0	5.8
430	DAVID WENGER	12 76	7.3	400	332	312	301	0.10	0.00	60.0	37.0	17.0	1.9		20.3	0.0	8.0
431	RICHARD A COINER	10 76	7.5	530	367	60	356	0.00	0.00	77.0	40.0	11.0	2.3		10.1	12.0	22.2
432	ANDREW L MCCASKEY	10 76	7.0	610	426	64	358	0.00	0.03	120.0	14.3	30.0	0.2		29.7	11.0	4.0
433	SILVERBROOK FARMS	1 77	7.8	370	261	236	217	0.00	0.00	46.0	25.0	16.0	2.7		19.0	7.0	7.5
449	CITY OF WAYNESBORO #3	4 77	8.1		92	72	72	0.40		13.2	9.6	2.7			7.0	3.0	
449	CITY OF WAYNESBORO #3	3 77	8.2		84	68	67	0.15	0.01	12.3	9.0	5.5			4.1	3.0	

NOTE--ALL ZEROS (00.00) - ANALYSED, NOT DETECTED; ALL NINES (99.99) - COULD NOT BE STORED, REFER TO ANALYSIS

APPENDIX D

TABLE 12

MAJOR CHEMICAL CONSTITUENTS IN GROUNDWATER

Constituent	Maximum Recommended Concentration (mg/l)*	Remarks
Calcium	200	Seldom a health concern; may be a disadvantage in washing, laundry, bathing; encrustations on utensils
Chloride	**250 (Aesthetics)	Taste is a major criterion; generally not harmful unless in very high concentrations, but may be injurious to sufferers of heart and kidney diseases; sea water is 19,000 mg/l
Fluoride	**1.4 (Health)	Presence of about 1.0 mg/l may be more beneficial than detrimental; below 0.8 mg/l may cause mottling of teeth; extreme doses (4 grams) may cause death
Hardness (as $CaCO_3$)	0-60 Soft 61-120 Mod. Hard 121-180 Hard 181+ Very Hard	Hard waters have had no demonstrable harmful effects upon the health of consumers; major detrimental effect is economic--values above 100 mg/l become increasingly inconvenient; wastes soap and causes utensil encrustation
Iron	**0.3 (Aesthetics)	Essential to nutrition and not detrimental to health unless in concentrations of several milligrams; main problems are bad taste, staining and discoloration of laundry and porcelain fixtures
Magnesium	150	Not a health hazard because taste becomes extremely unpleasant before toxic concentrations reached; may have laxative effect on new users
Manganese	**0.05 (Aesthetics)	Essential to nutrition but may be toxic in high concentrations; taste becomes problem before toxic concentrations reached; undesirable because it causes bad taste, deposits on cooked food, stains and discolors laundry and plumbing fixtures
Nitrate	**10 as N, 45 as NO_3 (Health)	May be extremely poisonous in high concentrations; may cause disease in infants ("blue baby"); irritates bladder and gastrointestinal tract, may cause diarrhea
pH	5.5-8.0	Indicates whether solution will act as an acid or base; water acquires "sour" taste below 4; high values favor corrosion control; efficiency of chlorination severely reduced when pH above 7
Potassium	1000-2000	May act as a laxative in excessive quantities
Sodium	100	May be harmful to sufferers of cardiac, circulatory, or kidney disease; concentrations as low as 200 mg/l may be injurious
Solids (Total Dissolved)	500	Not a health hazard above 500 mg/l, but may impart disagreeable taste, corrode pipes; general indicator of how highly water is mineralized
Specific Conductivity	1000	An indicator of the amount of dissolved solids in water; high concentrations can cause corrosion of iron and steel
Sulfate	**250 (Aesthetics)	Above 250 mg/l may act as laxative on new users; may impart foul taste and odor

*Recommended concentrations based on current literature; pH measured in units, Conductivity in micromhos

**Actual limits established by the Virginia Department of Health; parentheses () indicate basis for limit

Source: McKee and Wolf (1963), Virginia Department of Health (1974)

APPENDIX E

Groundwater Quality Standards and Criteria

Amendment to Water Quality Standards
Virginia State Water Control Board

Effective: August 1, 1977

Pursuant to Section 62.1-44.15(3) of the State Water Control Law (Chapter 3.1 of Title 62.1, Code of Virginia, 1950, as amended)

5.00 Groundwater Criteria and Standards

Groundwater quality standards will apply statewide, and will apply to all groundwater occurring at and below the uppermost seasonal limits of the water table. In order to prevent the entry of pollutants into groundwater occurring in any aquifer, a soil zone or alternate protective measure or device sufficient to preserve and protect present and anticipated uses of groundwater shall be maintained at all times. Zones for mixing wastes with groundwater may be allowed upon request, shall be determined on a case-by-case basis, and shall be kept as small as possible.

It is recognized that natural groundwater quality varies statewide. Four physiographic provinces have been determined for application of standards, namely the Coastal Plain, Piedmont and Blue Ridge, Valley and Ridge, and Cumberland Plateau. (See Plate 40)

If the concentration of any constituent in groundwater is less than the limit set forth by groundwater standards, the natural quality for that constituent shall be maintained; natural quality shall also be maintained for all constituents, including temperature, not set forth in any groundwater standards. If the concentration of any constituent in groundwater exceeds the standard for that constituent, no addition of that constituent to the naturally occurring concentration shall be made. Variance to this policy will not be made unless it has been affirmatively demonstrated that a change is justifiable to provide necessary economic or social development, that the necessary degree of waste treatment cannot be economically or socially justified, and that the present and anticipated uses of such water will be preserved and protected.

PHYSIOGRAPHIC PROVINCE BOUNDARIES
FOR GROUNDWATER QUALITY STANDARDS

1 Coastal Plain

2 Piedmont and Blue Ridge

3 Valley and Ridge

4 Cumberland Plateau

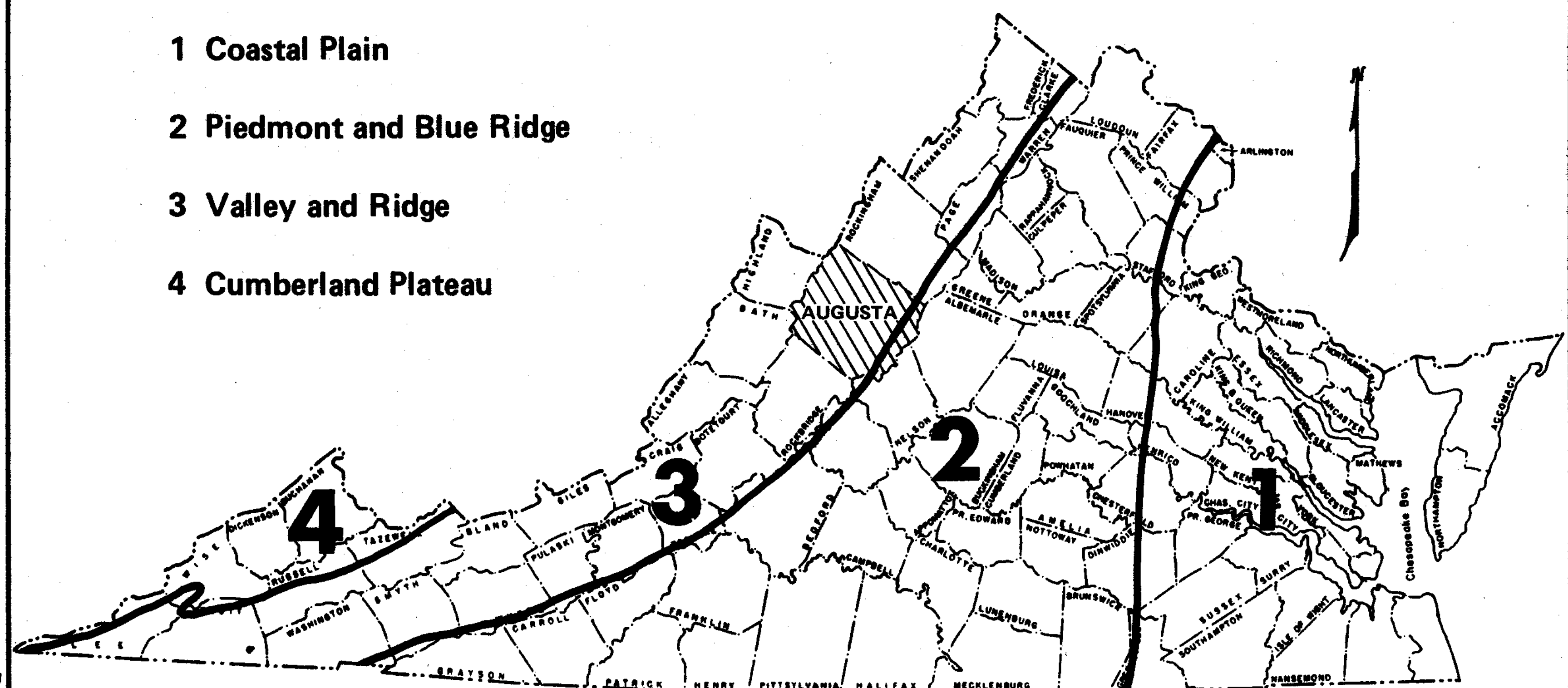

PLATE NO. 40

TABLE 13

GROUNDWATER QUALITY CRITERIA
(See Plate 40)

Constituent	Concentration in the Coastal Plain	Piedmont & Blue Ridge	Valley & Ridge	Cumberland Plateau	
Alkalinity	30-500	10-200	30-500	30-200	mg/1
Chloride	50*	25	25	25	mg/1
Color	15	15	15	15	color units
Fluoride	1.4**	1.4	1.4	1.4	mg/1
Hardness	120	120	300	180	mg/1
Iron	0.3	0.3	0.3	0.01 - 10	mg/1
Manganese	0.05	0.05	0.05	0.01 - 0.5	mg/1
Sodium	100*	25	25	100	mg/1
Sulfate	50	25	100	150	mg/1
Total Dissolved Solids	1000	250	500	500	mg/1
Total Organic Carbon	10	10	10	10	mg/1

*It is recognized that naturally occurring concentrations will exceed this limit in the eastern part of the Coastal Plain, especially toward the shoreline and with increased depth.

**Except within the Createaceous aquifer: concentration up to 5 mg/1 and higher.

TABLE 14

GROUNDWATER QUALITY STANDARDS
(See Plate 40)

Statewide Standards

Constituent	Concentration	
Arsenic	0.05	mg/l
Barium	1.0	mg/l
Cadmium	0.4	ug/l
Chromium	0.05	mg/l
Copper	1.0	mg/l
Cyanide	5.0	ug/l
Foaming Agents as Methylene Blue Active Substances	0.05	mg/l
Lead	0.05	mg/l
Mercury	0.05	ug/l
Petroleum Hydrocarbons	1.0	mg/l
Phenols	0.001	mg/l
Selenium	0.01	mg/l
Silver	0.00	
Zinc	0.05	mg/l
Chlorinated Hydrocarbon Insecticides		
Aldrin/Dieldrin	0.003	ug/l
Chlordane	0.01	ug/l
DDT	0.001	ug/l
Endrin	0.004	ug/l
Heptachlor	0.001	ug/l
Heptachlor Epoxide	0.001	ug/l
Kepone	0.00	
Lindane	0.01	ug/l
Methoxychlor	0.03	ug/l
Mirex	0.00	
Toxaphene	0.00	
Chlorophenoxy Herbicides		
2,4-D	0.1	mg/l
2,4,5-TP	0.01	mg/l
Radioactivity		
Gross Beta	1000.0	pc/l
Radium 226	3.0	pc/l
Strontium 90	10.0	pc/l

	Concentration in the			
Constituent	Coastal Plain	Piedmont & Blue Ridge	Valley & Ridge	Cumberland Plateau
Ammonia Nitrogen	0.025	0.025	0.025	0.025 mg/l
Nitrate Nitrogen	5.0	5.0	5.0	0.5 mg/l
Nitrite Nitrogen	0.025	0.025	0.025	0.025 mg/l
pH	6.5-9.0	5.5-8.5	6.0-9.0	5.0-8.5

GLOSSARY OF TERMS

ALLUVIAL FAN:	Fan-shaped deposit of alluvium made by a stream where it runs out into a level plain or meets another stream.
ALLUVIUM:	A general term for sediments deposited during recent geologic time by a stream or other body of water.
ANTICLINE:	An upward fold in rock strata.
AQUICLUDE:	A geologic formation, group of formations or part of a formation which is capable of absorbing water but cannot transmit it rapidly enough to supply a well or spring.
AQUIFER:	A geologic formation, group of formations or part of a formation capable of supplying water to wells and springs in usable quantities. An aquifer is unconfined (water table) or confined (artesian) depending on whether the groundwater level is at atmospheric pressure or greater than atmospheric pressure due to the presence of an overlying, confining geologic formation (aquiclude).
BEDDING PLANE:	The diversion plane in sedimentary or stratified rocks which separates the individual layers, beds, or strata.
BEDROCK:	Any solid rock exposed at the surface or overlain by unconsolidated materials.
CALCAREOUS:	Containing calcium carbonate.
CARBONATE ROCK:	A rock consisting chiefly of carbonate minerals such as limestone and dolomite.
CATCHMENT:	The area comprising the actual water intake area for aquifer recharge and all areas that contribute surface water to the intake area.
CHERT:	A hard, extremely dense or compact sedimentary rock which usually occurs as nodules in limestone or dolomite.
CLASTIC:	Consisting of fragments of rocks or of organic structures that have been transported mechanically to a place of deposition. Sandstone and shale are the most common clastics.

COLLUVIUM:	Loose soil material or rock fragments deposited by the action of gravity, usually at the base of a slope or cliff.
CONGLOMERATE:	A clastic rock composed of rounded pebbles cemented together by another mineral.
DIP:	The angle at which a rock bed is inclined from the horizontal.
DOLOMITE:	A carbonate sedimentary rock composed chiefly of the mineral dolomite ($CaMg(CO_3)_2$).
DRAWDOWN:	The measured difference between static level and pumping level in a well; the drop in the water level due to pumping.
EVAPOTRANSPIRATION:	A term embracing that portion of the precipitation returned to the air through direct evaporation or by transpiration of vegetation, no attempt being made to distinguish between the two.
FAULT:	A fracture or fracture zone along which there has been movement of two rock masses relative to one another parallel to the fracture. The movement may be a few inches or many miles, horizontal or vertical.
FLOOD PLAIN:	The strip of relatively smooth land adjacent to a river channel and built of alluvium carried by the river during floods. The flood plain is covered by water when the river is in flood.
FOLD:	A curve or bend in rock strata.
FORMATION:	A unit of geologic mapping consisting of a recognizable stratum or set of strata useful for mapping or description.
FRACTURE:	Any break in a rock due to mechanical failure by stress.
GROUNDWATER:	Water below the water table; water in the zone of saturation.
HYDROGEOLOGY:	The science which deals with subsurface waters and related geological aspects of surface waters.
HYDROLOGY:	The science that relates to the waters of the earth.
IGNEOUS:	Rocks or minerals that solidified from molten rock (magma).

IMPERMEABLE:	Having a texture which does not allow perceptible movement of water through rock.
INTRUSIVE:	Refers to igneous rocks which have penetrated into or between older rocks while molten but which have solidified before reaching the surface.
JOINT:	A fracture in rock along which no appreciable movement has occurred. Joints are generally perpendicular to bedding planes.
KARST TOPOGRAPHY:	Topography characterized by sinking streams, sinkholes, caves and similar features indicative of underground drainage developed through the solution of bedrock.
LIMESTONE:	A bedded sedimentary rock consisting chiefly of calcium carbonate ($CaCO_3$).
LITHOLOGY:	The composition and structure of rock.
METAMORPHIC:	Refers to any rocks derived from pre-existing rocks in response to pronounced changes of temperature, pressure and chemical environment.
PERCOLATION:	Movement of water through the interstices of rocks or soils, except movement through large openings such as solution channels.
PERMEABILITY:	The ability of a rock, sediment or soil to transmit water.
POROSITY:	The property of a rock, soil, or other material of containing spaces or voids.
PUBLIC SUPPLY:	As defined by the Virginia Department of Health, a water system serving more than 25 individuals or more than 15 residential connections.
PUMPING LEVEL:	Depth to water in a well when the well is being pumped.
QUARTZITE:	A metamorphic rock consisting principally of quartz.
RECHARGE:	The addition of water to an aquifer by natural infiltration or artificial means.
RIVER BASIN:	The area drained by a river and its tributaries.
RUNOFF:	That part of precipitation that flows in surface streams.

SANDSTONE: A sedimentary rock composed chiefly of quartz grains.

SEDIMENT: Material transported and desposited by water.

SEDIMENTARY ROCK: Rock formed from the consolidation of layered sediments that have accumulated in water.

SHALE: A fine-grained sedimentary rock formed from the consolidation of clay, silt or mud.

SINKHOLE: A funnel-shaped depression in the land surface, usually in limestone regions, developed by the dissolving action of water and connected with solution channels underlying the depression.

SLATE: A fine-grained metamorphic rock, usually formed from shale or volcanic ash.

SOLUTION CHANNEL: Joints or fractures in carbonate rocks which have been enlarged by the dissolving action of water and which are capable of transmitting large quantities of water.

STATIC LEVEL: Depth to water in a well when the well is not being pumped.

SYNCLINE: A downward fold in rock strata.

SYNCLINORIUM: A broad regional synclinal structure which contains minor folds.

TERRACE: A level or gently inclined surface bordering a stream which represents a former level of the stream. Terraces are composed of alluvium produced by renewed downcutting of the flood plain or valley floor by the stream.

UNCONSOLIDATED SEDIMENT: A sediment that is loosely arranged or unstratified, or whose particles are not cemented together.

WATER TABLE: The upper surface of the zone of saturation; the upper surface of groundwater which is at atmospheric pressure.

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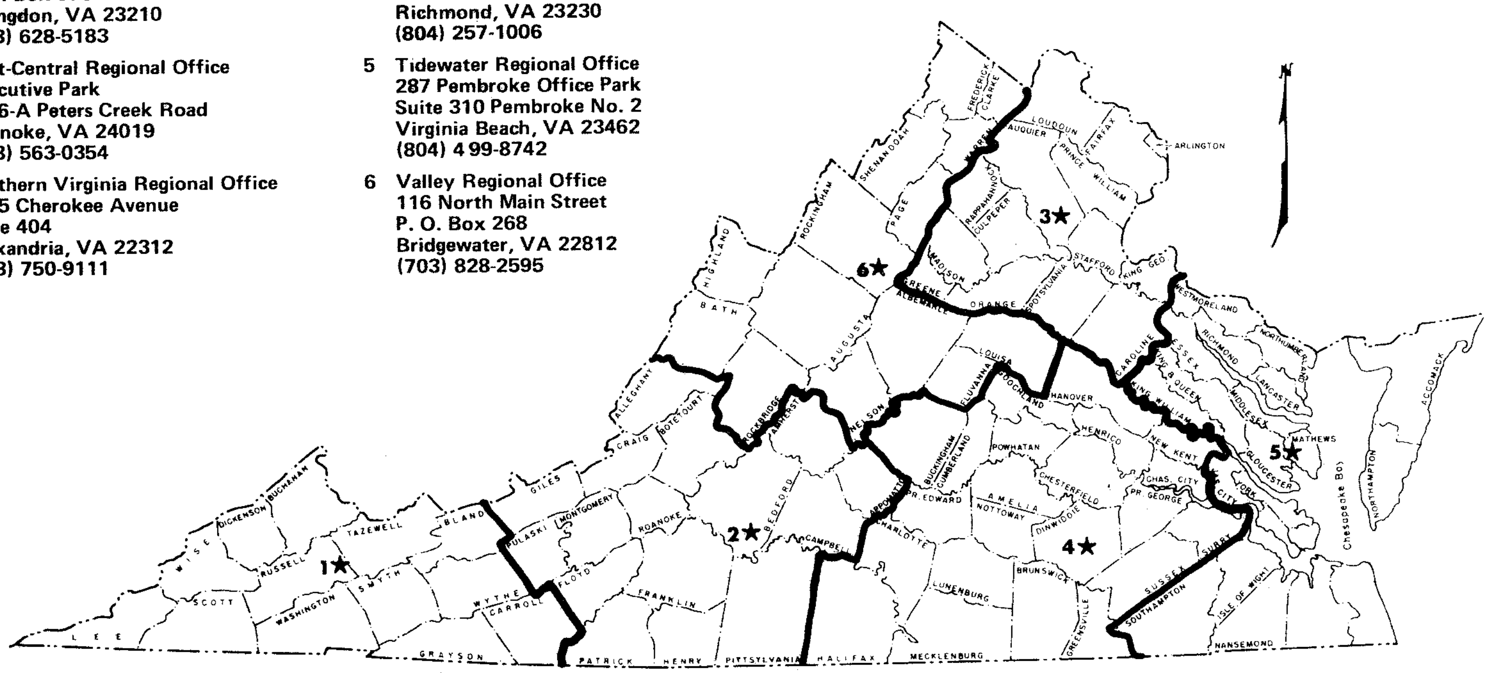

PLATE NO. 41

VIRGINIA
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PERSEVERANDO

VA
DEQ

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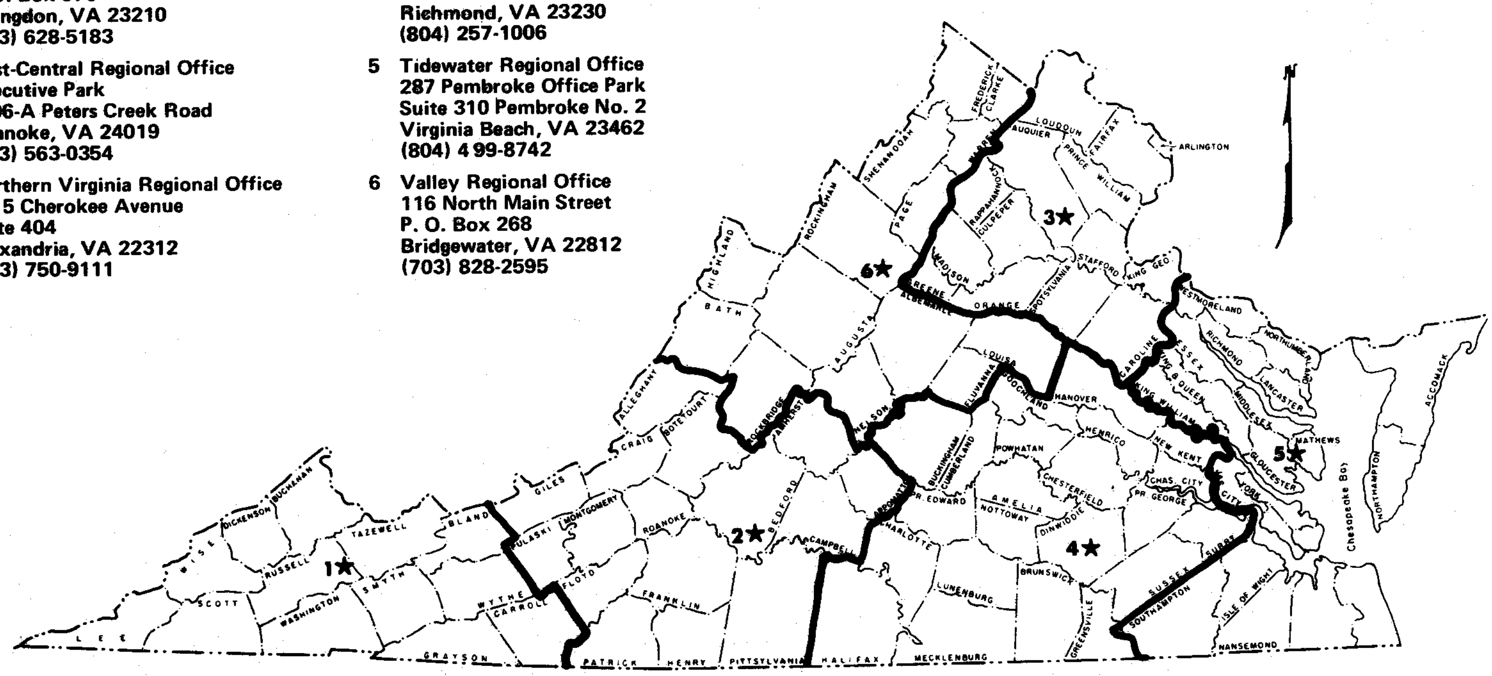

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