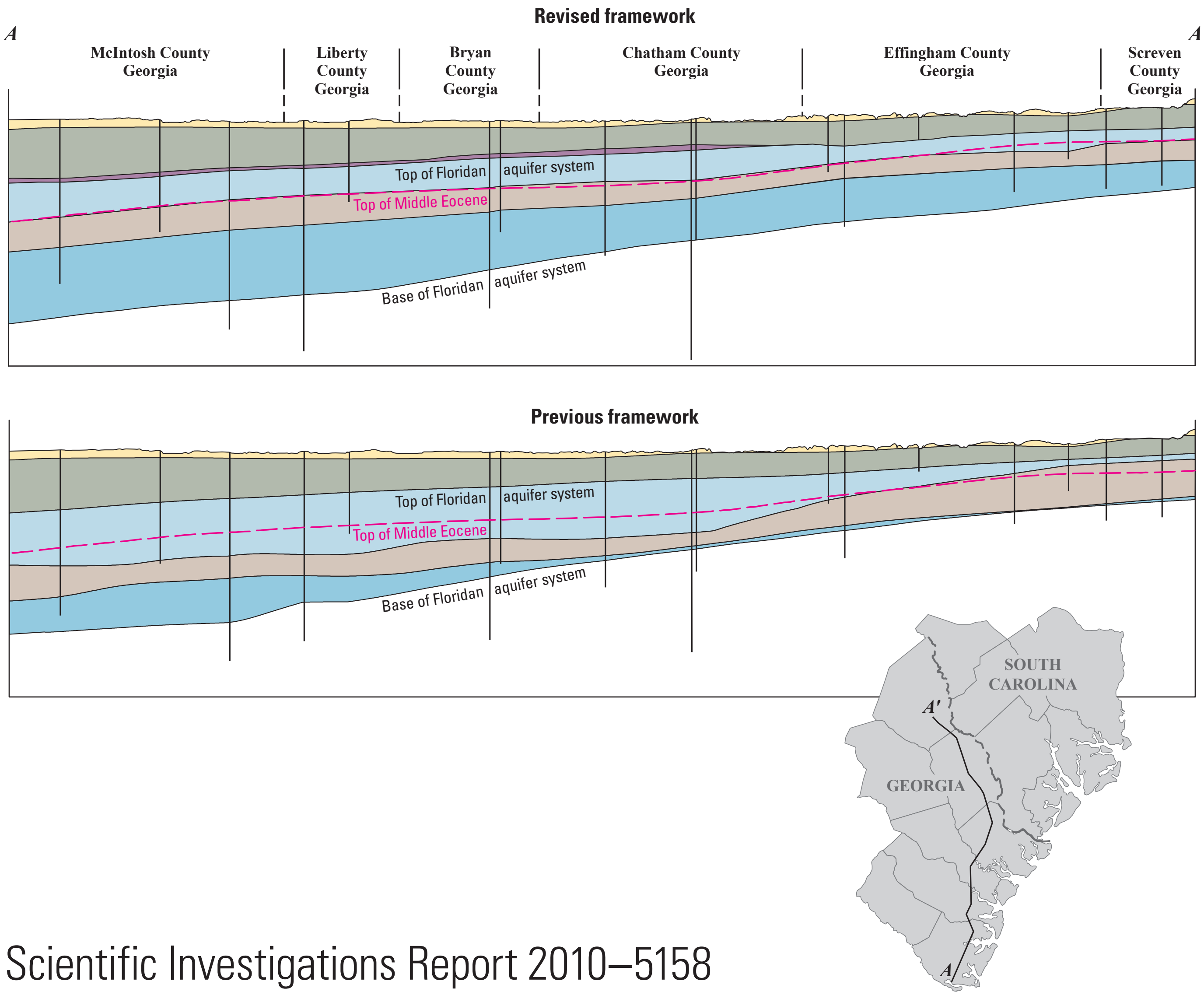
# Revised Hydrogeologic Framework of the Floridan Aquifer System in the Northern Coastal Area of Georgia and Adjacent Parts of South Carolina




Scientific Investigations Report 2010–5158


**U.S. Department of the Interior**
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**Cover.** See figure 21 of this report.

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By Lester J. Williams and Harold E. Gill

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U.S. Geological Survey, Reston, Virginia: 2010

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## Figures

## Figures—Continued



## Tables

# Conversion Factors and Datums

| Multiply | By | To obtain |
|---|---|---|
| | **Length** | |
| inch | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | **Area** | |
| square mile ($mi^2$) | 259.0 | hectare (ha) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | **Flow rate** | |
| foot per day (ft/d) | 0.3048 | meter per day (m/d) |
| gallon per minute (gal/min) | 0.06309 | liter per second (L/s) |
| inch per year (in/yr) | 25.4 | millimeter per year (mm/yr) |
| | **Transmissivity*** | |
| foot squared per day ($ft^2$/d) | 0.09290 | meter squared per day ($m^2$/d) |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) / 1.8$$

Vertical coordinate information is referenced to National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

*Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [($ft^3$/d)/$ft^2$]ft. In this report, the mathematically reduced form, foot squared per day ($ft^2$/d), is used for convenience.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

# Revised Hydrogeologic Framework of the Floridan Aquifer System in the Northern Coastal Area of Georgia and Adjacent Parts of South Carolina

By Lester J. Williams and Harold E. Gill[1]

## Abstract

The hydrogeologic framework for the Floridan aquifer system has been revised for eight northern coastal counties in Georgia and five coastal counties in South Carolina by incorporating new borehole geophysical and flowmeter log data collected during previous investigations. Selected well logs were compiled and analyzed to determine the vertical and horizontal continuity of permeable zones that make up the Upper and Lower Floridan aquifers and to define more precisely the thickness of confining beds that separate these aquifers.

The updated framework generally conforms to the original framework established by the U.S. Geological Survey in the 1980s except for adjustments made to the internal boundaries of the Upper and Lower Floridan aquifers and the individual permeable zones that compose these aquifers. The revised boundaries of the Floridan aquifer system were mapped by taking into account results from local studies and regional correlations of geologic and hydrogeologic units. Because the revised framework does not match the previous regional framework along all edges, additional work will be needed to expand the framework into adjacent areas.

The Floridan aquifer system in the northern coastal region of Georgia and parts of South Carolina can be divided into the Upper and Lower Floridan aquifers, which are separated by a middle confining unit of relatively lower permeability. The Upper Floridan aquifer includes permeable and hydraulically connected carbonate rocks of Oligocene and upper Eocene age that represent the most transmissive part of the aquifer system. The middle confining unit consists of low permeability carbonate rocks that lie within the lower part of the upper Eocene in Beaufort and Jasper Counties, South Carolina, and within the upper to middle parts of the middle Eocene elsewhere. Locally, the middle confining unit contains thin zones that have moderate to high permeability and can produce water to wells that tap them. The Lower Floridan aquifer includes all permeable strata that lie below the middle confining unit and above the base of the aquifer system. Beneath Hilton Head Island, South Carolina, the middle Floridan aquifer is now included as part of the Lower Floridan aquifer. The base of the Floridan aquifer system generally is located at the top of lower Eocene rocks in Georgia and the top of Paleocene rocks in South Carolina.

The Upper and Lower Floridan aquifers are interconnected to varying degrees depending on the thickness and permeability of the middle confining unit that separates these aquifers. In most places, hydraulic head differences between the two aquifers range from a few inches to a few feet or more. Monitoring at several vertically clustered well-point sites where wells were set at different depths in the aquifer revealed variations in the degree of hydraulic separation with depth. In general, the head separation between the Upper and Lower Floridan aquifers increases with depth, which indicates that the deeper zones are more hydraulically separated than the shallower parts of the Lower Floridan aquifer.

## Introduction

Concern over saltwater encroachment in the Savannah, Georgia, and Hilton Head Island, South Carolina, area (Savannah–Hilton Head area) has led water managers in Georgia and South Carolina to limit increased pumpage from the Upper Floridan aquifer. This has led to competing demands for the available water supply and increased interest in developing alternative sources of groundwater supply from other aquifers in the area.

Over the past 10 years (2000–2010) a number of deep test wells have been drilled to investigate the potential of using the Lower Floridan aquifer as an alternative source of water supply to the Upper Floridan aquifer (Falls and others, 2005). The results of this drilling indicate that previous definitions of the Floridan aquifer system could be improved by incorporating the new data collected from the deep test holes. Because the

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original definition of the Floridan aquifer system was based on widely-spaced stratigraphic and borehole geophysical data over the region, the new data provide the necessary information to revise the framework in the northern coastal region of Georgia and adjacent areas of South Carolina.

In the fall of 2009, the U.S. Geological Survey (USGS) began a regional assessment of the Floridan aquifer system in Alabama, Georgia, Florida, and South Carolina as part of the USGS Groundwater Resources Program (*http://water.usgs.gov/ogw/gwrp/activities/regional.html*). A primary goal of the regional assessment is to develop groundwater-flow models built with the most up-to-date hydrogeologic framework and hydrologic information for use in evaluating water budgets, groundwater flow, effects of climate, and water-management scenarios. This study was conducted primarily in support of that program.

## Purpose and Scope

This report describes a revised hydrogeologic framework of the Floridan aquifer system in northern coastal areas of Georgia (GA) and parts of South Carolina (SC). The framework incorporates new deep test-well drilling data and detailed information on water-bearing zones into a regionally based framework of the Floridan aquifer system.

The new hydrogeologic framework includes (1) hydrogeologic and water-quality data from selected well sites in the study area; (2) updated maps of the top of the Upper Floridan aquifer (top of aquifer system), base of the Upper Floridan aquifer (top of middle confining unit), top of the Lower Floridan aquifer, and base of the Lower Floridan aquifer (base of aquifer system); (3) maps of the thicknesses of the aquifers and confining unit; (4) compilations of hydraulic properties of various aquifers and confining units; (5) hydrogeologic cross sections; (6) discussions of aquifer interconnections; and (7) regional correlations.

## Description of Study Area

The study area lies within the Coastal Plain Physiographic Province and covers an area of 7,375 square miles that includes the counties of Bryan, Bulloch, Chatham, Effingham, Liberty, Long, McIntosh, and Screven in Georgia; and Allendale, Beaufort, Colleton, Hampton, and Jasper in South Carolina (fig. 1). Altitude ranges from 0 feet (ft) along the coast to 150 ft above the National Geodetic Vertical Datum of 1929 (NGVD 29) in the northernmost part of the study area. In the Savannah–Hilton Head area, land use is mostly urban and residential; outside of this area, land use is a mixture of forestland, grassland, wetland, and cropland or pastureland (U.S. Geological Survey, 2009). The mean annual temperature in Savannah is about 77 degrees Fahrenheit for the period 1971–2000 (National Oceanic and Atmospheric Administration, 2002). The mean annual precipitation in Savannah for the period 1971–2000 is about 50 inches per year (in/yr; Priest, 2004). The greatest rainfall amounts generally occur during the months of June, July, and August. Evapotranspiration is estimated to be about 34 in/yr in the study area (Krause and Randolph, 1989).

## Previous Studies

Numerous hydrologic studies of water resources and saltwater encroachment have been conducted in the Savannah–Hilton Head area. Concern about saltwater encroachment in the study area began as early as 1903 when a well on Parris Island, SC (fig. 1), was abandoned because of saltwater contamination. Warren (1944) reported that artesian water levels declined appreciably during the 1930s throughout the coastal counties of Georgia and especially in Chatham, Effingham, Bryan, and Liberty Counties. Warren (1944) noted that the lowering of water levels in Savannah to 50 ft or more below sea level suggested the possibility of contamination of the aquifer by inflow of saltwater from areas where the aquifer contained saltwater. He also reported that the hydraulic gradient sloped toward Savannah for a distance of 20 miles (mi) on all sides. In 1946, a Beaufort, SC, supply well was abandoned because of saltwater contamination (Warren, 1944).

In April 1954, the USGS began one of the first major studies focusing on saltwater encroachment in the Savannah–Hilton Head area, which eventually resulted in publications by Counts and Donsky (1963) and McCollum and Counts (1964). The first two test wells drilled for these studies were CHA-357 (renamed 38Q003) on Cockspur Island in Chatham County, GA, about 18 mi east of Savannah, and test well BFT-101 on Hilton Head Island in Beaufort County, SC (fig. 2, plate 1). These wells were drilled to determine the position of saltwater in the Floridan aquifer system (referred to then as the *principal artesian aquifer*) and to determine the geologic age, character, and thickness of the rocks composing the aquifer and the confining layers above and below. McCollum and Counts (1964) presented down-hole current-meter tests (flowmeter tests) on five wells in the Savannah area (four in GA and one in SC). Several of these wells were open to the full thickness of the Floridan aquifer system and were pumped at rates ranging from 800 to 1,940 gallons per minute (gal/min). The tests indicated that the aquifer system contained five major permeable zones in the Savannah area. Zone 1 occurs in upper Eocene rocks at or near the top of the Ocala Limestone, zone 2 lies about 50 ft beneath zone 1, and zone 3 lies at the base of the Ocala Limestone (Herrick, 1961). The bottom two zones occur in rocks of middle Eocene age; zone 4 is located at or near the top of middle Eocene rocks, and zone 5 is about 70 ft below zone 4. The thickness of the zones varied throughout the area; the upper zones were reported to be thicker than the lower zones. On average, more than 70 percent of the water pumped during the current-meter tests came from zones 1 and 2. The two lower-most zones yielded between 10 and 20 percent of the total flow, while zone 3 yielded less than 8 percent. McCollum and Counts (1964) also found that

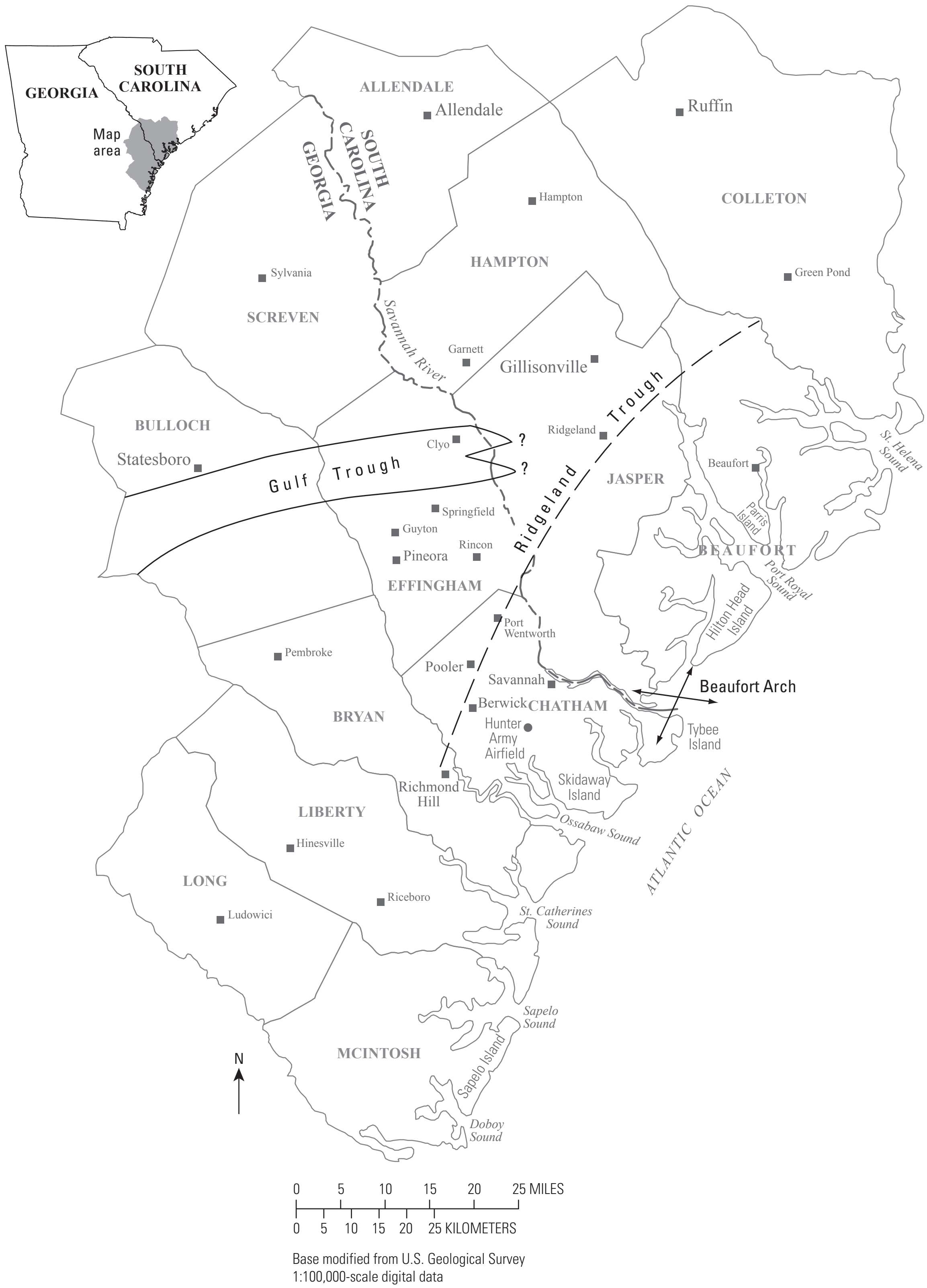



**Figure 1.** Location of the study area in eight northern coastal counties of Georgia and five southern coastal counties of South Carolina. (Structural features: Gulf Trough from Applied Coastal Research Laboratory, 2002; Beaufort Arch from Clarke and others, 1990.)

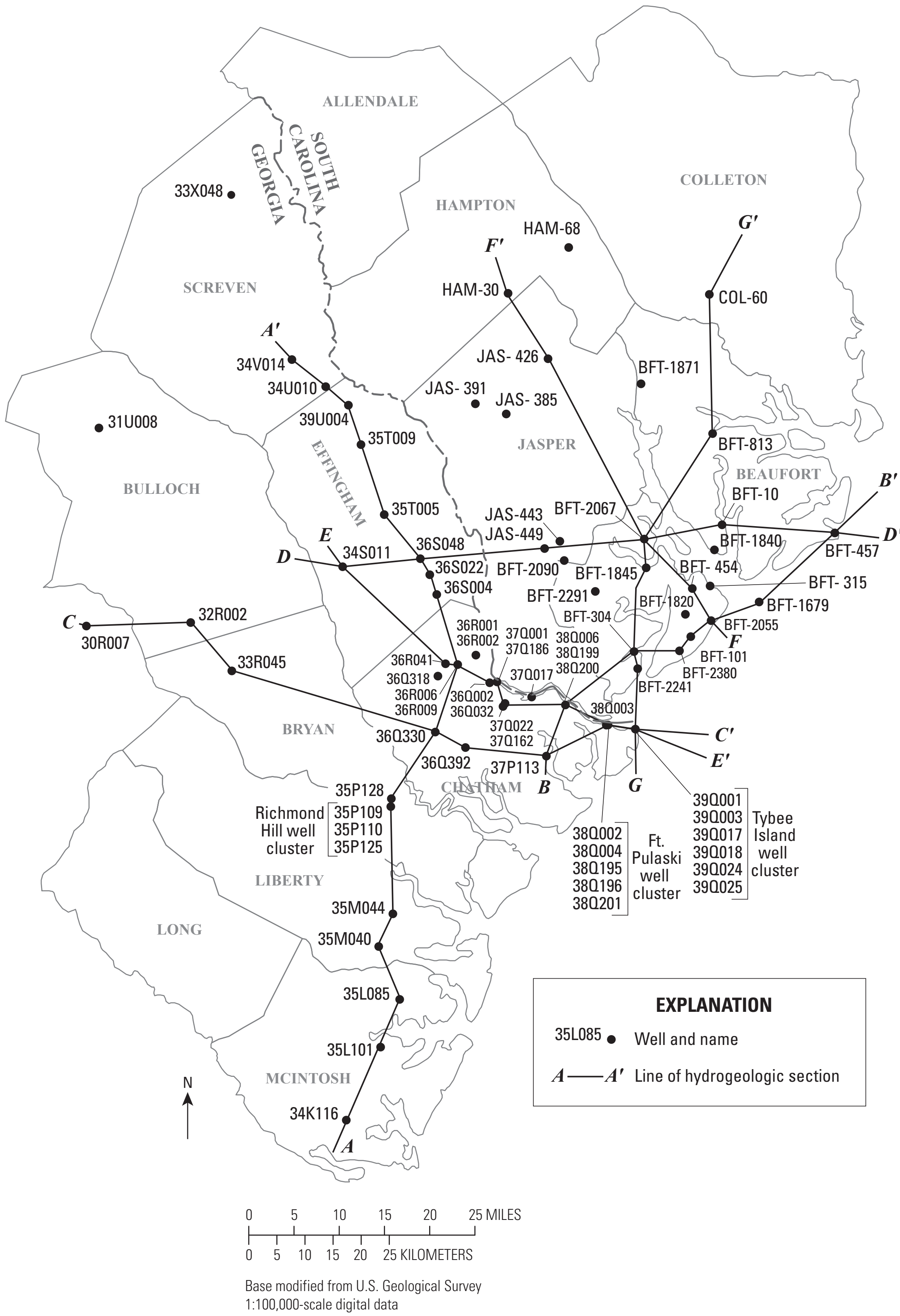



**Figure 2.** Locations of selected wells used in this study in relation to hydrogeologic cross-section lines.

the chloride content of water in each zone increased eastward and northeastward from the center of pumping in Savannah. The chloride concentration also increased with increasing depth in most of the study area.

Hayes (1979) reported on the groundwater resources of Beaufort, Colleton, Hampton, and Jasper Counties, SC. He identified the Santee Limestone and lower part of the Cooper Marl as the principal sources of groundwater supply in that area. Hayes (1979) divided the principal artesian aquifer into three zones: (1) an upper permeable zone that furnished about 75 percent of the water pumped from the aquifer in Hampton County and nearly all of the water pumped from the aquifer in Beaufort and Jasper Counties; (2) a middle zone of relatively low permeability, which yielded small amounts of water to wells in Hampton and Colleton Counties; and (3) a lower permeable zone that supplied most of the water pumped from the aquifer in Colleton County. Hayes (1979) also reported that water containing about 50 milligrams per liter (mg/L) of chloride was present in the upper permeable zone at Hilton Head Island. He reported that salty water was moving laterally toward Hilton Head Island from the northeast and east and vertically upward from the middle and lower permeable zones.

In 1986, the USGS revised Stringfield's (1966) regional framework of the Floridan aquifer system in Florida and in parts of Georgia, Alabama, and South Carolina (Miller, 1986). This work was completed as part of the Regional Aquifer System Analysis (RASA) of major aquifers in the United States. To be consistent with regional nomenclature, the *principal artesian aquifer* in Georgia and South Carolina was renamed the Floridan aquifer system and subdivided into the Upper and Lower Floridan aquifers. Miller (1986) remapped the top and base of the aquifer system and the confining units within the aquifer based on descriptions of well cuttings and geophysical logs.

Huddlestun (1988) revised the lithostratigraphic units of the Coastal Plain of Georgia. In his report, he presented the Miocene through Holocene strata in a cross section drawn along the Savannah River from Screven County through Chatham County and Tybee Island and to the inner continental shelf. This cross section showed the Ridgeland Trough extending into the Savannah area with Miocene rock units thickening toward the axis of the trough and thinning toward the Beaufort Arch where the Ocala Limestone (Upper Floridan aquifer) is overlain by a thin Miocene confining layer.

Krause and Randolph (1989) developed a numerical flow model of the Floridan aquifer system in Georgia and included in the overall framework updip, largely clastic beds that are time-stratigraphic equivalents of the carbonate sequence. They also moved the position of the Upper and Lower Floridan aquifers on the basis of permeability contrasts but did not provide maps showing the thicknesses or altitudes of the aquifers and confining units.

Clarke and others (1990) mapped the top of the Upper Floridan aquifer in a 10-county area of coastal Georgia and identified the base of the Upper Floridan aquifer, thickness of the middle confining unit, and the top of the Lower Floridan aquifer in test wells at Hutchinson Island (37Q186), Fort Pulaski (38Q201), and Skidaway Island (37P113; fig. 2). The definition of the Floridan aquifer system used by Clarke and others (1990) was similar to that described by Krause and Randolph (1989) and placed the Upper Floridan aquifer in Oligocene and upper Eocene rocks and the Lower Floridan in middle Eocene rocks. The confining layer was identified in rocks of middle Eocene age. As was the case in the Krause and Randolph (1989) report, Clarke and others (1990) did not provide maps showing the thicknesses or altitudes of the tops of units beneath the Upper Floridan aquifer.

Gawne and Park (1992) described the water-supply potential of the middle Floridan aquifer in southern Beaufort County, SC, and evaluated the aquifer as a potential source of irrigation water for Hilton Head Island. They defined the middle Floridan aquifer as consisting of one or more permeable units within the middle zone of low permeability recognized by Hayes (1979). The name *middle Floridan aquifer* was used to distinguish the unit from the lower permeable zone discussed by Hayes (1979). Gawne and Park (1992) stated that if the "lower permeable zone" referred to by Hayes (1979) occurs on Hilton Head Island, it lies near the base of the Floridan aquifer, several hundred feet below zone 4.

Falls and others (1997) described the geology and hydrology of Cretaceous and Tertiary strata and confinement in the vicinity of the U.S. Department of Energy Savannah River Site in South Carolina and Georgia. This study provided new information on stratigraphy and hydrogeology in Burke and Screven Counties, GA. Logs and stratigraphic data were presented for select wells throughout the area.

Edwards (2001) compiled a series of papers that provide detailed descriptions of the geology and paleontology from five cores collected in Screven and Burke Counties, GA, including the stratigraphy at the Millhaven core site (33X048; fig. 2) in Screven County.

From 1995 to 2000, the South Carolina Department of Natural Resources (SCDNR) and the USGS collaborated on studies to re-evaluate the stratigraphy of the Atlantic Coastal Plain in North and South Carolina for improved knowledge of the hydrogeologic framework (Harrelson and Fine, 2006). Detailed studies on cores from Jasper County, SC, (JAS-426, fig. 2; Self-Trail and Bybell, 1997) and Beaufort County, SC (BFT-2055, fig. 2) improved the time-stratigraphic framework and aquifer designations for South Carolina in those areas.

Falls and others (2005a) described the hydrogeology, water-quality, and water-supply potential of the Lower Floridan aquifer in coastal Georgia. Data from several deep test wells drilled during this study were used to define more precisely characteristics of water-bearing zones of the Floridan aquifer system. The report includes data for test wells at Richmond Hill (35P109, fig. 2) and Pembroke (33R045, fig. 2) in Bryan County, GA, at Shellman Bluff (35L085, fig. 2) in McIntosh County, GA, and at Pineora in Effingham County, GA (34S011, fig. 2).

Falls and others (2005b) described the hydrogeologic and water-quality results of offshore drilling near Hilton Head Island and in Calibogue Sound west of Hilton Head Island. Four test wells were drilled in the offshore area located 7, 8, 10, and 15 mi northeast of a core reference site on the north end of Tybee Island. Physical properties of the materials collected in the test borings and results of water sampling were presented.

During 2002–2005, under contract with various municipalities, Carter & Sloope, Inc., constructed and tested Lower Floridan aquifer test wells in Bryan, Chatham, and Effingham Counties, GA (Gill, 2002, 2004, 2005, 2007, 2009). These wells were drilled to evaluate the Lower Floridan aquifer as a potential water supply, and the work included collecting borehole geophysical logs and aquifer testing.

## Methods

The hydrogeologic framework presented in this report was developed in a two-step process that included evaluating the depths of individual water-bearing zones within the Floridan aquifer system, and grouping these zones into major aquifers and mapping the thicknesses and areal extent of the confining units that separate the aquifers.

Zones of enhanced permeability influence groundwater flow within the thick section of carbonate rocks that compose the Floridan aquifer system. Determining the depth, stratigraphic position, and continuity of these zones was necessary for the development of the hydrogeologic framework. In this study, water-bearing zones were evaluated by analyzing borehole geophysical and flowmeter logs. Original flowmeter data (McCollum and Counts, 1964) were obtained from USGS files and re-analyzed. Once all of the flowmeter data were compiled, flow zones were plotted onto stick cross sections and then onto more detailed stratigraphic cross sections to evaluate the position of these zones with respect to time-stratigraphic units.

Electrical resistivity logs also were used to evaluate water-bearing zones. In some cases, electric logs were used in conjunction with flowmeter logs, and in other cases electric logs were used alone to provide a qualitative evaluation of permeable zones. For these evaluations, a comparison of shallow and deep (16- and 64-inch) resistivity logs was used to obtain information about drilling-fluid invasion. If shallow and deep resistivity curves are the same, no invasion has occurred and the interval is probably of low permeability. Where the resistivity curves separate, the most probable reason is fluid invasion into more permeable zones; with mud-based drilling fluids this results in development of a thicker mud cake on the borehole wall and causes the shallow resistivity curve to be higher or lower than the resistivity curve obtained from deeper logs. The use of this technique is not restricted to mud-based drilling fluids. Resistivity-log separation and invasion profiles commonly develop in logs from boreholes drilled with reverse-air rotary and water-filled boreholes. In these boreholes, the resistivity of the water in the borehole may be higher or lower than the formation water resistivity; invasion of the drilling fluids into permeable zones results in the same effect as mud-based drilling fluids, although the magnitude of the differences may be subdued and harder to detect.

The second step in the framework development was to map the distribution and thicknesses of the Upper and Lower Floridan aquifers and the confining unit that separates the two aquifers. Mapping horizons were based on the same scheme used by Miller (1986) with some slight modifications. To facilitate the mapping, geophysical marker C (Clarke and others, 1990) was used to define the top of the Floridan aquifer system. Geophysical marker C approximates the top of Oligocene-age rocks and, therefore, the top of the Floridan aquifer system. Geophysical marker D, which approximates the top of the upper Eocene, also was used as a mapping horizon; rocks of upper Eocene age are commonly the most permeable part of the Upper Floridan aquifer and, thus, this provided a mapping horizon to identify the more permeable part of the aquifer. The depth, thickness, and character of the middle confining unit were mapped with geophysical and flowmeter logs from deep test holes and wells drilled in the area. The base of the middle confining unit, or top of the Lower Floridan aquifer, was mapped at the first permeable zone below the middle confining unit. The base of the Floridan aquifer system was re-evaluated by using data from deep test holes.

## Acknowledgments

This report would not have been possible without the work of many people who in recent years have been investigating the water-supply potential of the Lower Floridan aquifer, leading to an improved understanding of the aquifer systems in the area. Carter & Sloope, Inc. provided data from wells drilled at Berwick Plantation, Richmond Hill, Rincon, and several others that were crucial to the improved understanding of the Lower Floridan aquifer. Several water utilities provided funding for drilling and implementing the exploration programs, including Consolidated Utilities, City of Richmond Hill, and the City of Rincon.

We gratefully acknowledge Drennan Park, Constance Gawne, and Joseph Gelleci of the SCDNR and Camille Ransom of South Carolina Department of Health and Environmental Control (SCDHEC), all of whom provided valuable data, advice, and review comments for this publication. William F. (Fred) Falls, USGS South Carolina Water Science Center, collected important information on the Lower Floridan aquifer, including well logs at Pineora, Pembroke, Richmond Hill, and Shellman Bluff. He also provided many constructive comments that improved this report substantially. David C. Prowell, USGS emeritus, provided geologic insight and support for correlating time-stratigraphic units between South Carolina and Georgia in the Savannah River Basin. Prowell correlated geologic units from selected test wells in South Carolina (Jas- 426, C-15) to wells in Georgia (Pineora and Rincon). Robert E. Faye, USGS retired, developed and calibrated groundwater flow models at the three test sites in Georgia to estimate leakage of the middle confining unit.

Mark Hall of Georgia Environmental Protection Division (GAEPD) and numerous employees from the USGS Georgia Water Science Center assisted the investigation by collecting borehole geophysical logs throughout the area. Stephen J. Lawrence, USGS Georgia Water Science Center, prepared the water-quality Piper diagrams used in this report. John S. Clarke, Assistant Director of the USGS Georgia Water Science Center, provided invaluable support and numerous comments during the preparation of this manuscript.

Robert M. Massey of Rowe Drilling Company provided technical support during drilling activities at the Rincon well site and valuable data from the Jenkins Island well site at Hilton Head Island, South Carolina. David Campbell, a consulting hydrogeologist from Columbia, South Carolina, shared much of his data from middle Floridan aquifer wells in Beaufort and Jasper Counties, South Carolina. His support and data were extremely helpful and much appreciated.

The authors are especially grateful to James E. Miller, retired USGS; Harlan B. Counts, retired USGS; and M.J. McCollum, retired USGS, who conceptualized and developed the hydrogeologic framework of the Floridan aquifer system and carefully documented all of their findings. The revised hydrogeologic framework in this report closely conforms to the frameworks they described.

Finally, we thank Jerry Price of Southern Resource Exploration for providing digital copies of geophysical logs collected from the Lower Floridan wells at Rincon and Richmond Hill and logs collected at the deep Cretaceous well on Hilton Head Island.

# Geologic Setting

The coastal areas of Georgia and South Carolina are underlain by a thick sequence of unconsolidated to semi-consolidated layers of sand and clay, and poorly indurated to very dense layers of limestone and dolomite. These rocks and sediments range in age from Paleocene to Recent. The descriptions provided in this report mainly focus on rock units ranging from middle Eocene through Miocene age that compose the Floridan aquifer and its confining units (fig. 3) Descriptions of other units are derived from published reports. Geologic units in the study area include, in ascending order, the following: Paleocene, lower Eocene, middle Eocene, upper Eocene, Oligocene, Miocene, and post-Miocene. The relations of these geologic units to the hydrogeology are shown on the hydrogeologic sections on plates 2 and 3.

To maintain consistency with previous reports prepared by the USGS, stratigraphic nomenclature and age assignments used in this study conform to those used by Miller (1986) and Clarke and others (1990). Detailed stratigraphic studies conducted by the Georgia Geologic Survey (GGS) and SCDNR and SCDHEC have resulted in revised correlations and age assignments of some Coastal Plain stratigraphic units (Huddlestun and Hetrick, 1985; Huddlestun, 1988, 1993; Edwards, 2001; Falls and Prowell, 2001; Weems and Edwards, 2001).

## Geologic Units

### Paleocene Unit

Only a few deep test wells have penetrated rocks of Paleocene age in the study area and, therefore, the descriptions of the Paleocene unit are mostly from the work of Herrick (1961), Herrick and Vorhis (1963), and Miller (1986). Clarke and others (1990) show the stratigraphic position of this unit at the Hutchinson Island and Fort Pulaski well sites.

The Paleocene age rocks can be divided into a northern clastic facies and a southern carbonate-evaporite facies (Clarke and others, 1990). The northern clastic facies was called the Clayton Formation by Herrick and Vorhis (1963, p. 36) and Miller (1986, p. B19). The southern carbonate-evaporite facies was assigned to the Cedar Keys Limestone by Herrick and Vorhis (1963, p. 36) and was named the Cedar Keys Formation by Miller (1986, p. B18–B19). The top of the Clayton Formation is marked by a hard, sandy, glauconitic fossiliferous limestone that commonly contains casts of pelecypods and gastropods. The Clayton Formation generally consists of glauconitic sand, argillaceous sand, and small amounts of medium- to dark-gray clay; in eastern Georgia near Savannah, the amount of dark clay increases. The Clayton Formation grades laterally into rocks of the Black Mingo Group of South Carolina and consists of dark, carbonaceous clay and thin beds of sand (Miller 1986). The Cedar Keys Formation is characterized by anhydrite and dolomite. The Paleocene unit conformably overlies Upper Cretaceous marl and carbonate sediments.

### Lower Eocene Unit

The lower Eocene unit over most of the study area is composed of calcareous, glauconitic, argillaceous sand, cream- to gray-colored calcareous clay, and sandy glauconitic limestone (Miller, 1986). In Chatham County, GA, at Hutchinson Island (37Q186) and at Fort Pulaski (38Q002, 38Q004, 38Q196, 38Q201), the lower Eocene unit consists of relatively low-permeability glauconitic limestone and dolomite of the Oldsmar Formation (Clarke and others, 1990; fig. 3).

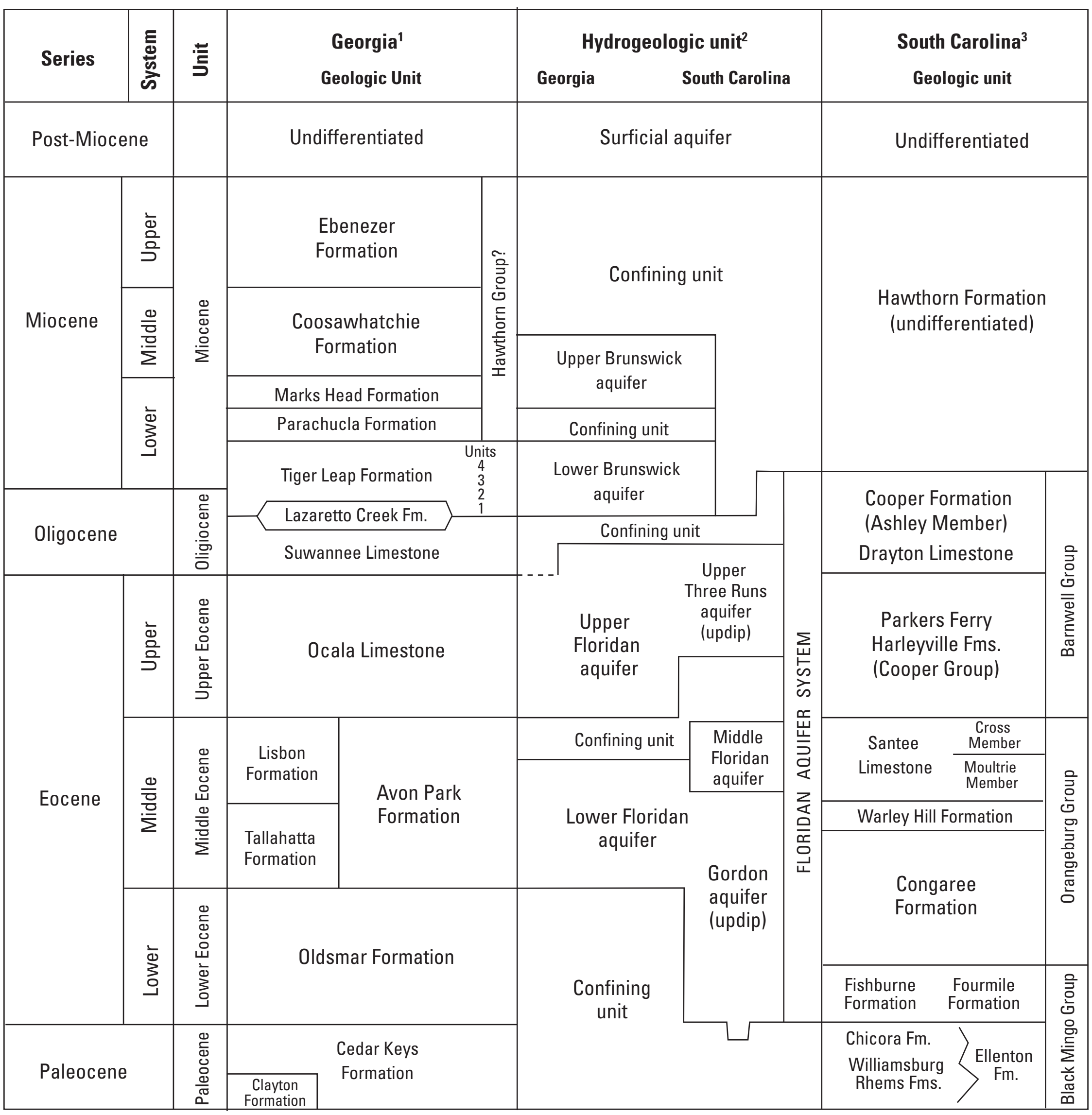
Moving north from Chatham County into the updip areas of Georgia and South Carolina, the lower Eocene unit grades from a mostly low-permeability carbonate facies to a higher permeability clastic facies consisting of well-sorted quartz sand of the Fishburne Formation (Gohn and others, 1983) and the equivalent Fourmile Formation (Aadland and others, 1995).

In places, lower Eocene rocks are absent. For example, lower Eocene rocks have been eroded at JAS-426 in Gillsonville, SC (Self-Trail and Bybell, 1997), at the lower Floridan well in Rincon, GA (36S048), and at the USGS core hole in Pineora, GA (34S011; David C. Prowell, emeritus, U.S. Geological Survey, written commun., 2009). These rocks probably were eroded away during the deposition of the middle Eocene sediments.

## Middle Eocene Unit

Rocks of the middle Eocene unit are present throughout the study area and can be divided generally into a downdip platform carbonate facies and an updip clastic facies. In the Savannah area, the middle Eocene consists of marine to marginal-marine clastic rocks. These rocks have been assigned to the Avon Park Formation (Miller, 1986; fig. 3) and were described by Herrick (1961) from well cuttings and cores in the Savannah area. In the upper Coastal Plain, this unit is equivalent to the Lisbon Formation, consists mostly of light-gray argillaceous limestone, and is underlain by clastic strata of the Tallahatta Formation (Miller, 1986). To the northeast, the lower part of the argillaceous limestone becomes a sandy, fossiliferous and glauconitic limestone that grades into the Warley Hill marl of South Carolina. The upper part of the argillaceous limestone grades into the Santee Limestone of South Carolina, a slightly coarse, soft, and cream- to yellow-colored fossiliferous limestone that contains minor beds of glauconitic sand and clay.

Test drilling of a core hole at Pineora, GA, in 2009 by the USGS confirmed the presence of the Santee Limestone in Georgia, similar to that previously described in South Carolina. Three members of the Santee Limestone have been identified by calcareous nano-fossils (NP; David C. Prowell, emeritus, U.S. Geological Survey, written commun., 2009). In ascending order, these rock units and their assigned NP zones are the Moultrie member (NP16), Cross 1 (NP17),




[1]Modified from Weems and Edwards, 2001; Miller, 1986; Randolph and others, 1991; Clarke and Krause, 2000
[2]Modified from Miller, 1986; Clarke and others, 2004; Randolph and others, 1991; Weems and Edwards, 2001
[3]Modified from Edwards, 2001; Self-Trail and Bybell, 1997; Falls and others, 1997; Miller, 1986

**Figure 3.** Geologic and hydrogeologic units of the northern coastal area of Georgia and parts of South Carolina. [Fm, Formation]

and Cross 2. At Pineora, the Moultrie member is not present but the Warley Hill (NP15) Formation (Fallaw and others, 1990) is present. The lower Eocene is missing, and the Paleocene directly underlies the middle Eocene sediments (David C. Prowell, emeritus, U.S. Geological Survey, written commun., 2009). From core samples, the Cross 1 and 2 members are described as moderately indurated calcarenites with sand-sized bioclasts and quartz sand. At Rincon, the Cross 1 and 2 members are described as fine-grained, glauconitic, intramicrites.

## Upper Eocene Unit

The upper Eocene unit over most of the study area consists of Ocala Limestone (fig. 3). In the Savannah area, the upper part of the Ocala Limestone is a white, generally soft, somewhat friable and porous coquina composed of large foraminifera, bryozoan fragments, and whole to broken echinoid remains all loosely bound by a matrix of micritic limestone (Clarke and others, 1990). The lower part of the Ocala consists of cream to white, generally fine-grained soft to semi-indurated micritic limestone (Miller, 1986). The lower part of the Ocala is slightly glauconitic and gives an increased response on a natural gamma-ray log that can be used for correlation purposes.

The upper part of the Ocala grades northward into South Carolina as a soft, white, argillaceous, sandy, slightly glauconitic, bryozoan-rich limestone that forms the basal part of the Cooper Group, including the Harleyville (a soft, clayey, micritic limestone that contains small amounts of glauconite and pyrite) and the Parkers Ferry (a glauconitic, clayey, highly fossiliferous limestone). The Parkers Ferry unit represents the uppermost part of the upper Eocene in South Carolina.

## Oligocene Unit

The Oligocene unit consists of the Suwannee Limestone, Lazaretto Creek Formation, and members 1, 2, 3 and 4 of the Tiger Leap Formation (fig. 3). Cores from Effingham County, GA (Weems and Edwards, 2001), indicate that the Suwannee Limestone consists of a very fine to medium calcarenite that is subrounded and partially cemented by calcite, with a porosity of approximately 5 percent. Core from a site at Richmond Hill in Bryan County, GA (Weems and Edwards, 2001), indicates the Suwannee Limestone is a matrix-supported (micritic), moldic, yellowish-gray limestone with abundant pelecypod impressions.

The Tiger Leap Formation includes sediments of latest Oligocene and (or) early Miocene age. In the northern coastal area of Georgia, the Tiger Leap Formation consists of members 2 through 4, which are irregularly distributed. Member 1 is absent in the northern coastal area of Georgia. Weems and Edwards (2001) described the Tiger Leap Formation based on cores from five sites in the northern coastal area. Core samples from Tybee Island and Fort Pulaski indicate the presence of member 3 only, whereas cores from Richmond Hill (Bryan County, GA) and northern McIntosh County indicate the presence of members 2, 3, and 4. The Tiger Leap Formation is absent at a core site in Effingham County near Rincon, GA.

At Tybee Island and Fort Pulaski Tiger Leap Formation member 3 (Weems and Edwards, 2001) is a yellowish-gray, moldic limestone containing about 20 to 40 percent medium-sized subangular to subrounded quartz sand. The rock has about 20-percent moldic porosity at the top, which decreases to 5 percent at the base. The porosity of this layer results from the dissolution of mollusk shells.

At Richmond Hill, in descending order, member 2 is a yellowish-gray, fine to coarse calcite-quartz sand. Quartz and phosphate pebbles are abundant along the basal contact with the underlying Suwannee Limestone. Member 3 is light olive-gray dolomite-cemented quartz sandstone with 5- to 10-percent porosity (Weems and Edwards, 2001).

## Miocene Unit

The Miocene unit is composed mostly of silts and clays (with some sand, dolomite, and limestone) that consist of, in ascending order, Tiger Leap Formation member 4, overlain by the Parachucla, Marks Head, Coosawhatchie, and Ebenezer Formations (Weems and Edwards, 2001). In Effingham County, GA, the Miocene unit consists of dolomitic clay, silty sand, and calcareous clay. In a core collected at Richmond Hill in Bryan County, dolomite-cemented sandstone and silty, sandy clay are the dominant lithologies overlying member 4 of the Tiger Leap Formation.

Clarke and others (1990) used four geophysical markers to delineate units of Miocene, Oligocene, and late Eocene age. The markers indicate a sharp increase in gamma radiation on natural gamma-ray logs and are identified as A, B, C, and D markers.They were identified originally in the Glynn County area by Wait (1962), in the Chatham County area by McCollum and Counts (1964), and in the area between by Clarke and others (1990).

The C marker generally occurs at or near the base of the Miocene sediments and typically lies at the contact between the shallowest limestone and an overlying phosphatic dolomite. The D marker is the uppermost point of reduced gamma radiation below the C marker. The D marker also commonly is accompanied by the first sharp rise of electrical resistance below the C marker on a single-point resistance log, which is indicative of dense, low-permeability limestone in the lower Oligocene Suwannee Limestone.

Clarke and others (1990) attempted to establish the stratigraphic position of each of these markers. They determined that marker D defined the top of the upper Eocene, and markers A, B, and C were believed to occur within Miocene sediments. Stratigraphic studies by Weems and Edwards (2001) confirmed the stratigraphic position of all of the markers with the exception of marker C, which occurs in sediments of Oligocene age.

## Structural Features

Major structural features in the study area include (1) the Ridgeland Trough (Heron and Johnson, 1966; Colquhoun and others 1969), a structural low with a northeast-trending axis through western Chatham County, GA, and extending into Jasper and Beaufort Counties, SC; (2) the Beaufort Arch near Hilton Head Island (Colquhoun and others 1968), which trends to the south parallel to the coast, and (3) the Gulf Trough, a structural low extending from central Georgia into Bulloch and Effingham Counties, GA. The locations of these structural features are shown in figure 1.

The Ridgeland Trough is a depression that lies along a line from western Chatham County, GA, into Jasper County, SC. This trough originally was named the Ridgeland Basin by Heron and Johnson (1966) and subsequently was called the Ridgeland Trough by Colquhoun and others (1969). Based on mapping the various geophysical markers, Clarke and others (1990) determined that this feature influences structural maps on the B, C, and D marker horizons in that a thicker accumulation of sediments appears to be present in the Ridgeland Trough for these units.

The Beaufort Arch is a structural high that originally was named the Beaufort High by Heron and Johnson (1966) and subsequently called the Beaufort Arch by Colquhoun and others (1968). The arch extends from south of Tybee Island, GA, to the northwest beneath Hilton Head Island, Port Royal Sound, and Port Royal Island, SC. The regional southward dip of rocks and sediments of early Eocene through Miocene age is influenced by this feature; low-permeability sediments of Miocene age are thinnest along the crest of the arch.

The Gulf Trough is a structural low that extends into Bulloch and Effingham Counties, GA (Applied Coastal Research Laboratory, 2002). Various interpretations of the Gulf Trough were presented by Patterson and Herrick (1971), including (1) a buried submarine valley, (2) graben complex, (3) syncline, or (4) buried solution valley. Miller (1986) proposed that this feature was a series of both isolated and connected grabens. Kellam and Gorday (1990) assessed the nature of this feature and its effect on the groundwater-flow system and determined that although this feature is present in the study area, its effect on groundwater flow in the study area is not as great as in the central and southwestern parts of Georgia.

## Hydrogeologic Units

The principal hydrogeologic units in the study area (fig. 3), from shallowest to deepest, include the

- Surficial aquifer (not described in this report),
- Upper confining unit (includes upper and lower Brunswick aquifers),
- Upper Floridan aquifer,
- Middle confining unit (Miller’s [1986] “middle confining unit I”), and
- Lower Floridan aquifer.

For the most part, the surficial aquifer is less than 50 ft thick and is only used for rural and domestic purposes and for golf-course irrigation. Because of its limited use, the surficial aquifer is not discussed further in this report.

The upper confining unit is composed mostly of very fine sand and clay of the Miocene unit. Locally, this confining unit contains permeable strata that form the upper and lower Brunswick aquifers (fig. 3). Only the lower Brunswick aquifer has sufficient thickness and transmissivity to be considered as a water-supply source for the northern coastal area of Georgia.

The Floridan aquifer system is the principal water-bearing unit in the area and is the primary source of groundwater for municipal and industrial use. The system is composed of a fairly thick sequence of carbonate rocks of mostly upper and middle Eocene age that are confined above and below, respectively, by low-permeability clays of the *upper confining unit* and by low-permeability carbonate and clastic rocks of the *lower confining unit* (fig. 3). In Georgia, two geologic formations compose the main part of the Floridan aquifer system—the Ocala Limestone of late Eocene age and the Avon Park Formation of middle Eocene age. The Ocala Limestone forms the principal water-bearing unit of the Upper Floridan aquifer, and the Avon Park Formation forms the principal water-bearing unit of the Lower Floridan aquifer. By way of facies changes, the largely carbonate rock section in Georgia grades laterally into beds of limestone, calcareous sand, and clay of various formations within the Orangeburg and Barnwell groups.

# Hydrogeologic Framework of the Floridan Aquifer System

Borehole-geophysical and flowmeter logs were used to update the hydrogeologic framework of the Floridan aquifer system in eight northern coastal counties in Georgia and five coastal counties in South Carolina (fig. 1). Select well logs were compiled and analyzed to determine the vertical and horizontal continuity of permeable zones that make up the Upper and Lower Floridan aquifers and to define more precisely the thickness of confining beds that separate these aquifers. Detailed hydrologic information collected at selected wells is included in the following sections to support the revised hydrogeologic framework for the area. The locations of some wells used in this study are shown in figure 3, and the locations of all wells used in this study are shown on plate 1.

## Previous Interpretation of the Hydrogeologic Framework

In the late 1950s and early 1960s, the USGS conducted one of the first major studies of water resources in the Savannah–Hilton Head area; from that, a basic understanding of the Floridan aquifer system was developed. McCollum and Counts (1964) identified five principal water-bearing zones that composed the principal artesian aquifer (currently known as the Floridan aquifer system, fig. 4). Their studies were based largely on current-meter (flowmeter) tests conducted in the area. Zones 1 and 2 were identified as the main water-bearing zones with much less production coming from zones 3 through 5.

In the 1980s, a regional framework for the Floridan aquifer system was established by Miller (1986), which replaced the previous aquifer definitions used by Stringfield (1966), who identified it as the principal artesian aquifer in Georgia, Alabama, and South Carolina; and by Parker and others (1955), who identified it as the Floridan aquifer in Florida (fig. 4). In this earlier framework, the Floridan aquifer system was defined as a hydraulically connected sequence of carbonate rocks of Paleocene to early Miocene age, including all or parts of the Tampa Limestone, Suwannee Limestone, Ocala Limestone, Avon Park Formation, Oldsmar Formation, and Cedar Keys Formation (Miller, 1986). In some areas, the aquifer was mapped as a single vertically continuous permeable unit, and in other areas it was divided into two major permeable zones—the Upper and Lower Floridan aquifers—separated by one of seven middle confining units. The boundary of the aquifer included all of the interconnected strata containing the high and low permeable zones; aquifer boundaries were not mapped necessarily to conform to either formation contacts or time-stratigraphic units but rather were based on permeability contrasts.

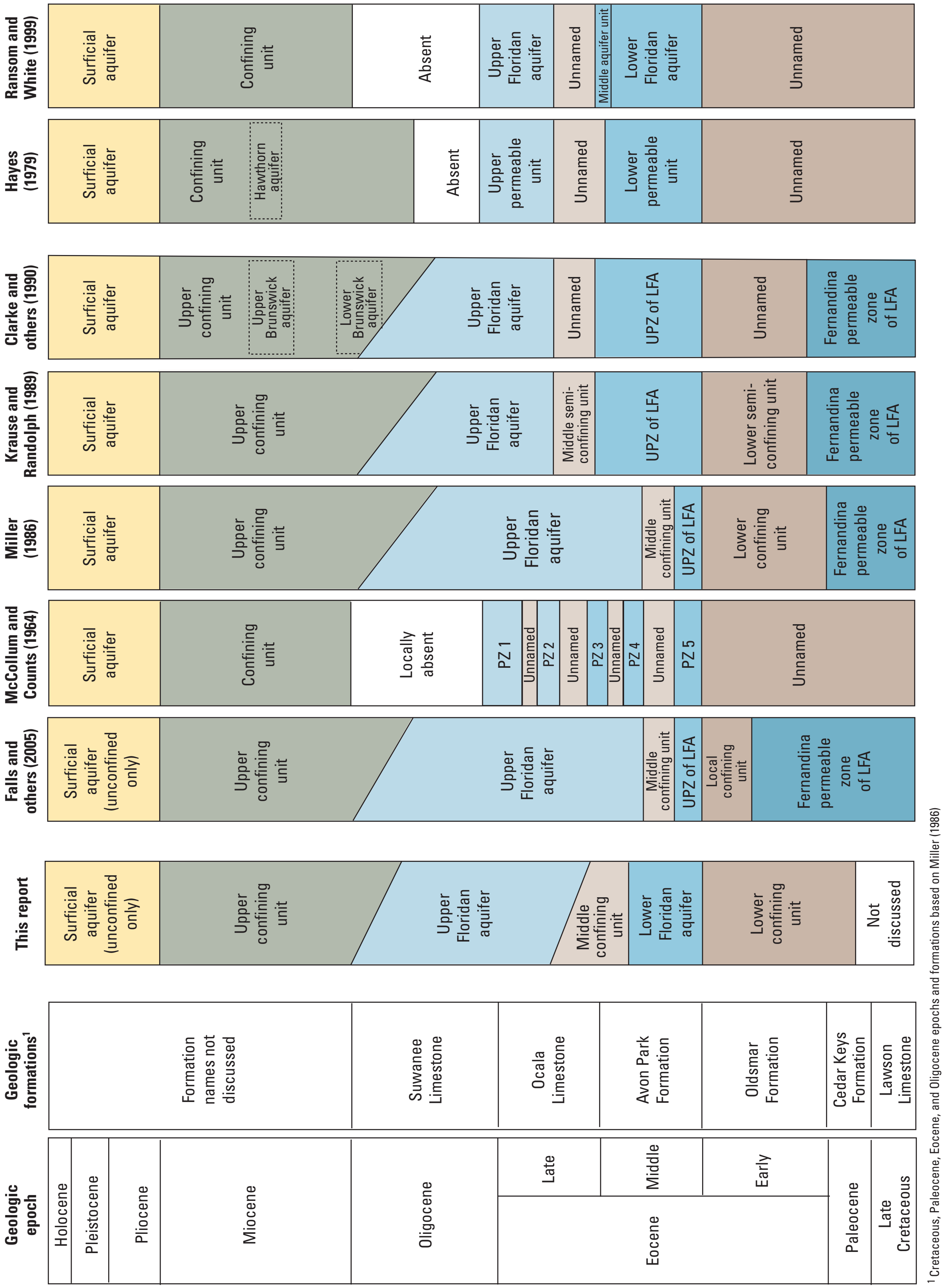
The Upper Floridan aquifer was defined by Miller (1986) to include permeable zones in all or part of the carbonate rocks of Oligocene, late Eocene, and upper Middle Eocene age. All permeable beds that lie below the base of the *upper confining unit* and above the top of one of the middle confining units were included in the Upper Floridan aquifer. Sediments of Miocene age (Hawthorn Formation) were excluded from the Upper Floridan aquifer because Miller's studies showed that, except very locally, no permeable rocks in the lower part of the Hawthorn Formation were in direct hydraulic connection with the main part of the Floridan aquifer system. Miller (1986) included zones 1-4 of McCollum and Counts (1964) as part of the Upper Floridan aquifer at Savannah.

The Lower Floridan aquifer included all permeable beds below the base of one of the middle confining units and above the base of the aquifer system. The Lower Floridan aquifer was determined to be present only where discrete permeable zones were found in the deeper part of the aquifer system and where these were separated by less-permeable rocks of one of the middle confining units (Miller, 1986). Little was actually known about the Lower Floridan aquifer at the time Miller defined it, because few wells tapped the deeper portion of the aquifer system. In most places an abundant supply of freshwater in the Upper Floridan aquifer resulted in little need to drill into this deeper aquifer. Local cavernous permeability zones, including the Boulder Zone in southern Florida (Kohout, 1967) and the Fernandina permeable zone in southern Georgia and northeastern Florida (Krause and Randolph, 1989), also were included in the Lower Floridan aquifer, but these zones are not known to extend into the present study area.

Miller (1986) defined the updip limit of the Floridan aquifer system where "the thickness of the system is less than 100 ft and where the clastic rocks interbedded with the limestone make up more than 50 percent of the rock column between the uppermost and lowermost limestone beds that can be shown to be connected downdip." Thus, Miller's definition excluded clastic updip aquifers that are hydraulically continuous with downdip carbonate units, such as the Jacksonian (Vincent, 1982) and Upper Three Runs (Aadland and others, 1995) aquifers, which are equivalent to the Upper Floridan aquifer, and the Gordon aquifer system (Brooks and others, 1985), which is equivalent to the Lower Floridan aquifer.

Using the water-bearing zones defined by McCollum and Counts (1964), Krause and Randolph (1989) identified the *middle confining unit* as the basal part of the upper Eocene and the uppermost part of middle Eocene rocks and named this unit the "middle semiconfining unit" (fig. 4). A thicker upper permeable zone of the Lower Floridan aquifer occurred in the lower half of the Avon Park Formation. Zones 1 and 2 were assigned to the Upper Floridan aquifer whereas zones 3 through 5 were assigned to the Lower Floridan aquifer. Clarke and others (1990) used a similar definition in Georgia.

In South Carolina, Hayes (1979) identified upper and lower permeable zones separated by an unnamed semiconfining layer. Gawne and Park (1992) and Ransom and White (1999) used similar definitions in South Carolina but included a middle zone of permeability that is identified as the middle Floridan aquifer.




[1] Cretaceous, Paleocene, Eocene, and Oligocene epochs and formations based on Miller (1986)

**Figure 4.** Correlation of geologic and hydrologic units in the northern coastal area of Georgia and adjacent parts of South Carolina. [Fm, Formation; LFA, Lower Floridan aquifer; UPZ, upper permeable zone; PZ, permeable zone; ⬚, aquifer recognized within the upper confining unit]

## Hydrogeologic Data from Selected Test Sites

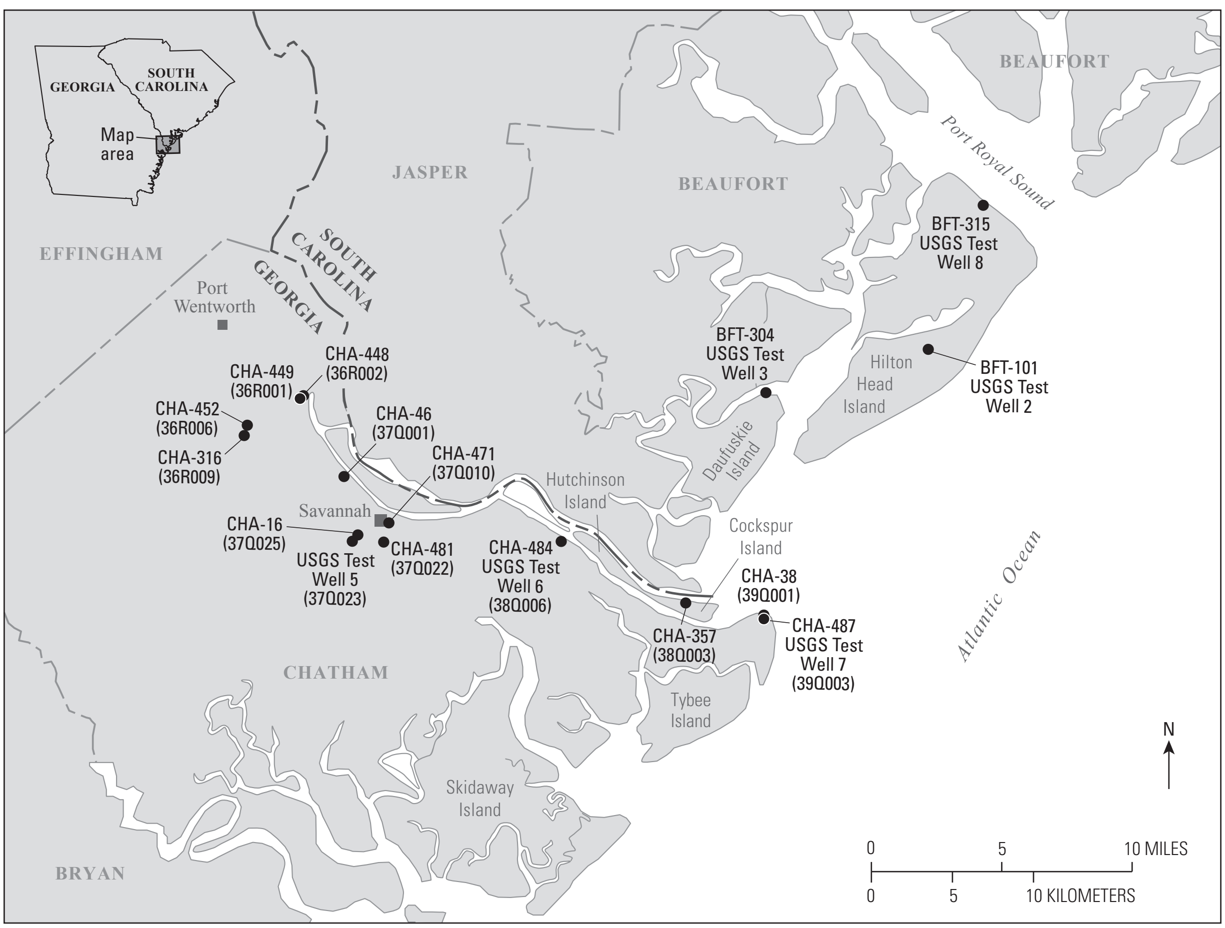
Numerous test wells have been drilled in the study area to investigate the location and nature of permeable zones and confining beds that compose the Floridan aquifer system. In the following sections, data from selected test sites are presented to document the hydraulic and water-quality characteristics of water-bearing zones identified at these test sites. Well-construction data for these sites are provided in table 1.

### Test Sites from Previous U.S. Geological Survey Studies

In 1954, the first two test wells drilled to investigate saltwater encroachment in the Savannah-Hilton Head Island area were CHA-357 (renamed to 38Q003) on Cockspur Island about 18 mi east of Savannah and test well BFT-101 on Hilton Head Island (fig. 5). These wells were drilled to determine the position of saltwater in the aquifer system and the geologic age, characteristics, and thicknesses of the permeable parts of the aquifer and its confining layers.

In 1956, CHA-357 was deepened to determine the thicknesses and characteristics of the lower confining layers of the Floridan aquifer system; this well was modified by placing well points at different depths and separating them from the rest of the test hole by neat cement plugs. In 1957, well BFT-101 was modified in the same manner but was not deepened. In 1958, a third well (BFT-304) was drilled on the north end of Daufuskie Island, Beaufort County, SC. This work provided water-quality information for the lower part of the aquifer system.

During these initial investigations, well nests CHA-357, BFT-101, and BFT-304 were sampled monthly to monitor saltwater movement in the aquifer (Counts and Donsky, 1963). The locations of these older monitoring well sites are shown in figure 5. One of the principal findings from the monitoring was that saltwater was present in the lower part of the principal artesian aquifer (identified as part of the Lower Floridan aquifer in this report) northeast of Savannah and in the Hilton Head Island area. Given a southwestern hydraulic gradient toward Savannah, the concern was that saltwater in this part of the aquifer was moving laterally toward Savannah. Based on available data at the time, Counts and Donskey (1963) believed the saltwater was moving at a slow rate.




Base modified from U.S. Geological Survey 1:100,000-scale digital data

**Figure 5.** Locations of test wells used in investigations of saltwater encroachment in the Savannah–Hilton Head Island area, Chatham County, Georgia, and Beaufort County, South Carolina.

**Table 1.** Well construction information for select wells in the northern coastal area of Georgia and adjacent areas of South Carolina.

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; —, no data]

| County | USGS well name (fig. 2) | Other identifier | Latitude | Longitude | Land-surface altitude (feet above NGVD 29) | Casing depth (feet) | Well depth (feet) | Hole depth (feet) | Construction date |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Georgia | | | | | |
| Bryan | 35P109 | Richmond Hill | 31.90965 | –81.31622 | 13 | — | — | 1,677 | — |
| Bryan | 35P128 | Harris Trail Lower Floridan Well | 31.9225 | –81.31556 | 21 | 755 | 1,000 | 1,000 | 05-05-2005 |
| Bryan | 33R045 | Pembroke Lower Floridan Test Well | 32.13187 | –81.61178 | 75 | 741 | 994 | 994 | 09-26-2001 |
| Bulloch | 32R002 | USGS Bulloch South Test Well | 32.21131 | –81.68733 | 120 | 420 | 804 | 804 | 09-01-1982 |
| Bulloch | 31U008 | USGS Hopeulikit No. 1 Test Well | 32.52322 | –81.85428 | 205 | 315 | 860 | 860 | 08-01-1982 |
| Chatham | 38Q003 | USGS Test Well 1 Cockspur Island (CHA-357) | 32.03105 | –80.90095 | 7.7 | 185 | 1,435 | 1,435 | 05-01-1954 |
| Chatham | 37Q001 | Hutchinson Island (CHA-46) | 32.10410 | –81.12150 | 7 | 227 | 1,010 | 1,283 | 12-14-1938 |
| Chatham | 36R006 | Port Wentworth (CHA-452) | 32.13326 | –81.18400 | 40 | 270 | 1,088 | 1,089 | 10-01-1956 |
| Chatham | 38Q006 | USGS Test Well 6 (CHA-484) | 32.06632 | –80.98094 | 7.45 | 145 | 725 | 842 | 12-09-1960 |
| Effingham | 36S048 | Rincon Lower Floridan Well | 32.30472 | –81.24944 | 70 | 565 | 1,004 | 1,004 | 10-2003 |
| Chatham | 37Q022 | Savannah No. 2 (CHA-481) | 32.06743 | –81.09650 | 40.6 | 270 | 798 | 798 | 09-16-1960 |
| Chatham | 36R001 | CHA-449 | 32.14854 | –81.14817 | 11 | 280 | 971 | 971 | 08-01-1956 |
| Chatham | 36R002 | CHA-448 | 32.14909 | –81.14706 | 15.83 | 280 | 963 | 971 | 08-01-1956 |
| Chatham | 36R009 | CHA-316 | 32.12743 | –81.18594 | 21.5 | 2,126 | 2,150 | 2,150 | 01-01-1920 |
| Chatham | 37Q010 | CHA-471 | 32.07798 | –81.09289 | 42 | 274 | 695 | 701 | 07-01-1958 |
| Chatham | 39Q001 | CHA-38 | 32.02355 | –80.85011 | 12.71 | 197 | 575 | 606 | 09-01-1942 |
| Chatham | 39Q024 | CSSI Tybee Island Lower Floridan TW-1 | 32.02438 | –80.85316 | 10 | 840 | 888 | 950 | 03-25-1996 |
| Chatham | 37P113 | Skidaway Test Well | 31.98521 | –81.01984 | 10 | 700 | 1,100 | 1,100 | 08-24-1983 |
| Chatham | 37Q023 | U.S. Geological Survey TW 05 PT 1 | 32.06799 | –81.11678 | 13.6 | 870 | 931 | 1,240 | 01-01-1917 |
| Chatham | 37Q025 | Savannah, GA 03 | 32.07160 | –81.11317 | 9.4 | 220 | 700 | 700 | 01-01-1920 |
| Chatham | 36R041 | Pooler VPI | 32.13604 | –81.20567 | 19 | | 1,000 | 1,000 | 08-10-1980 |
| Chatham | 36Q032 | Hercules #3 | 32.08798 | –81.14789 | 10 | 275 | 1,006 | 1,006 | 03-01-1956 |
| Chatham | 37Q017 | Standard Oil | 32.07882 | –81.04344 | 5.6 | 230 | 652 | 652 | 08-31-1940 |
| Chatham | 37Q162 | Savannah No. 5 | 32.06521 | –81.09817 | 41 | 265 | 903 | 903 | 11-11-1970 |
| Chatham | 39Q003 | USGS Test Well 7 (CHA-487) | 32.02299 | –80.85039 | 7 | 129 | 600 | 745 | 10-09-1961 |
| Chatham | 38Q201 | Ft. Pulaski Test Well | 32.03077 | –80.90150 | 7 | 1,358 | 1,546 | 1,546 | 02-19-1986 |
| Chatham | 37Q186 | Hutchinson Island Test Well | 32.10632 | –81.11012 | 6 | 1,380 | 1,520 | 1,520 | 10-08-1985 |
| Chatham | 36Q392 | HAAF No. 11 | 32.00139 | –81.17253 | 20 | 703 | 1,112 | 1,168 | 07-30-2009 |
| Chatham | 36Q330 | Berwick Plantation | 32.02750 | –81.22778 | 11 | 718 | 1,080 | 1,202 | 04-17-2002 |
| Chatham | 36Q002 | 36Q002 | 32.09965 | –81.12955 | 11 | 237 | 603 | 1,043 | 10-28-1936 |
| Chatham | 36Q318 | Pooler | 32.11715 | –81.22178 | 20 | 2,921 | 840 | 3,407 | 06-01-1975 |
| Effingham | 36S004 | Westwood Heights | 32.25659 | –81.22650 | 61 | 303 | 569 | 569 | — |
| Effingham | 34R071 | EFF-7 | 32.13870 | –81.38543 | 31 | — | — | 441 | — |

**Table 1.** Well construction information for select wells in the northern coastal area of Georgia and adjacent areas of South Carolina.—Continued

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; —, no data]

| County | USGS well name (fig. 2) | Other identifier | Latitude | Longitude | Land-surface altitude (feet above NGVD 29) | Casing depth (feet) | Well depth (feet) | Hole depth (feet) | Construction date |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Georgia—Continued | | | | | |
| Effingham | 36S022 | Rincon Well #2 | 32.28964 | –81.23373 | 61 | 281 | 500 | — | — |
| Effingham | 34S011 | Pineora Core Hole | 32.29520 | –81.39677 | 80 | 651 | 870 | 870 | 12-19-2001 |
| Effingham | 35T005 | Springfield | 32.37611 | –81.31667 | 40 | 92 | 190 | — | 11-01-2000 |
| Effingham | 35T009 | Seismic Line 1 Hole 3 | 32.48861 | –81.35667 | 80 | — | — | 700 | — |
| Evans | 30R007 | 30R007 | 32.20769 | –81.88595 | 155 | 450 | 500 | 500 | 04-01-1998 |
| Liberty | 35M040 | Jelks-Rodgers No. 1 | 31.68744 | –81.34594 | 26 | 163 | — | 4,264 | 01-01-1953 |
| Liberty | 35M056 | LIB-Blount | 31.74426 | –81.26759 | 5 | — | — | 590 | — |
| Liberty | 35M044 | LIB-2 | 31.73667 | –81.31694 | 16 | | | 725 | 12-21-1957 |
| McIntosh | 33M018 | Union Bag No. 45 | 31.67556 | –81.50667 | 22 | — | — | 1,360 | — |
| McIntosh | 35L085 | Shellman Bluff Lower Floridan Test Well | 31.60215 | –81.30750 | 10 | 1,144 | 1,422 | 1,863 | 02-08-2001 |
| McIntosh | 35L101 | Miller MC-5 | 31.53083 | –81.36306 | 22 | — | — | 1,000 | — |
| McIntosh | 34K116 | Union Bag #53 | 31.4225 | –81.43139 | 31 | — | — | 1,474 | — |
| Screven | 34V014 | Seismic Line 1 Hole 1 | 32.62667 | –81.48444 | 130 | — | — | 701 | — |
| Screven | 34U010 | Seismic Line 1 Hole 2 | 32.58278 | –81.42167 | 110 | — | — | 701 | — |
| Screven | 33X048 | Millhaven Core Hole | 32.89044 | –81.59511 | 110 | — | — | 1,452 | 02-27-1992 |
| | | | | South Carolina | | | | | |
| Beaufort | BFT-2055 | Test Hole (BFT-2055) | 32.19132 | –80.70399 | 12 | — | 3,850 | 3,850 | — |
| Beaufort | BFT-457 | Fripps Island | 32.3275 | –80.46167 | 7 | 2,320 | 3,127 | 3,166 | 08-01-1974 |
| Beaufort | BFT-813 | BEA-4 | 32.49194 | –80.68694 | 8 | — | — | 824 | — |
| Beaufort | BFT-1820 | Indigo Run | 32.20493 | –80.74900 | 10 | 316 | 595 | 600 | 10-09-1986 |
| Beaufort | BFT-1840 | Parris Island | 32.30576 | –80.68955 | 10 | 250 | 602 | 602 | 11-04-1986 |
| Beaufort | BFT-1845 | Spring Island | 32.28075 | –80.82150 | 12 | 600 | 600 | 600 | 11-24-1986 |
| Beaufort | BFT-454 | BEA-2 | 32.24611 | –80.73472 | 7 | 3,114 | 3,034 | 3,114 | 06-01-1974 |
| Beaufort | BFT-PI-2 | U.S. Marine Corps Parris Island | 32.34573 | –80.67512 | 7 | — | — | — | — |
| Beaufort | BFT-1675 | BFT-1675 | 32.18771 | –80.67094 | 8 | — | 212 | — | — |
| Beaufort | BFT-2380 | South Island PSD 1 | 32.14667 | –80.76194 | 10 | — | — | — | — |
| Beaufort | BFT-2291 | Hampton Hall | 32.24472 | –80.91806 | 17 | — | — | — | — |
| Beaufort | BFT-315 | USGS Test Well 8, Hilton Head Island | 32.24921 | –80.70132 | 17 | 150 | 510 | 795 | — |
| Beaufort | BFT-2090 | Del Web | 32.29103 | –80.94928 | 15 | 340 | 463 | | 05-27-1995 |
| Beaufort | BFT-2067 | Spring Island | 32.32575 | –80.82344 | 20 | 278 | 539 | 560 | 10-01-1992 |
| Beaufort | BFT-1871 | Bray's Island | 32.57466 | –80.82049 | 5 | — | 205 | — | — |
| Beaufort | BFT-2241 | Haig Point | 32.13132 | –80.84483 | 12.8 | — | 600 | — | — |
| Colleton | COL-60 | COL-4 | 32.71306 | –80.685 | 14 | 117 | 600 | 600 | — |
| Hampton | HAM-30 | Buckfield Plantation | 32.72313 | –81.07037 | 81 | — | — | 1,387 | — |
| Hampton | HAM-68 | HAM-68 | 32.79556 | –80.95306 | 81 | — | — | 721 | — |
| Jasper | JAS-449 | Tradition | 32.31547 | –81.01211 | 16 | — | — | 530 | — |
| Jasper | JAS-443 | Hampton Point | 32.32606 | –80.98381 | 20 | — | — | 530 | — |
| Jasper | JAS-385 | Calfpen Bay | 32.53213 | –81.07955 | 60 | 254 | 550 | 550 | — |
| Jasper | JAS-391 | Low Co Ag | 32.54990 | –81.13789 | 65 | 25 | 545 | — | — |
| Jasper | JAS-426 | Gillsonville/C-15 Core Hole Site | 32.61796 | –80.99567 | 59 | — | — | 2,900 | — |

In addition, although the aquifer was found to be composed of approximately 600 ft of water-bearing sediments, the geologic data collected during that study indicated that the aquifer was composed of a series of permeable zones separated by relatively impermeable zones. Because saltwater would move through the permeable zones more rapidly than through the less-permeable zones, three additional wells were drilled (CHA-484, CHA-487, BFT-315, fig. 5) to better delineate the permeable zones, and an existing well (CHA-16) at Savannah was modified for water sampling of the deep part of the aquifer (McCollum and Counts, 1964). Well CHA-484 was modified by placing a well point near the base of the aquifer, and wells CHA-487 and BFT-315 were each modified by the installation of two test points to monitor saltwater movement near the base of the aquifer.

Current-meter tests were run in several test wells prior to constructing well points. A current meter (similar to a spinner flowmeter) consists of an impeller mounted on pivots in an open-end tube and is used to delineate the location of permeable zones in the aquifer. Each current-meter traverse typically started in the casing where two or three readings were taken with a known casing diameter and known discharge rate. Beneath the casing, readings were taken at 5-ft intervals; the percentage of the total well discharge from any one zone was calculated by using a ratio of the gain in revolutions per minute (corrected for casing and hole diameter) across the zone tested to the revolutions per minute in the casing (McCollum and Counts, 1964). The current meter tests were re-analyzed for this study because the percentages from individual wells were not previously published. The results of the re-analysis are summarized in table 2.

**Table 2.** Summary of current-meter test data collected during 1961–1963 for investigations of saltwater encroachment in the Savannah, Georgia–Hilton Head Island, South Carolina, area.

[Well locations shown in fig. 5; gal/min, gallons per minute; NGVD 29, National Geodetic Vertical Datum of 1929; ft, feet; T.D., total depth of well or test hole. Note: The total flow percentages were not published in McCollum and Counts (1964) and, thus, were re-analyzed for this study using data obtained from U.S. Geological Survey files. The estimated flows and percentages of total flow were derived from this re-analysis. Depths of zones may differ slightly from those originally reported by McCollum and Counts (1964).

| Permeable zone (feet below land surface) | Estimated flow from permeable zone (gal/min) | Percent of total flow |
|---|---|---|
| **CHA-452 (36R006) Port Wentworth No. 1<br>Flow test conducted March 30, 1961,<br>at a pumping rate of 1,240 gal/min<br>Land-surface altitude above NGVD 29 = 43 ft, T.D. = 1,088 ft** | | |
| 320–340 | 328 | 26 |
| 370–410 | 448 | 36 |
| 550–560 | 109 | 9 |
| 620–625 | 27 | 2 |
| 650–660 | 55 | 4 |
| 720–750 | 71 | 6 |
| 835–872 | 202 | 16 |
| **CHA-484 (38Q006) USGS Test Well 6<br>Flow test conducted January 17, 1961,<br>at a pumping rate of 1,940 gal/min<br>Land-surface altitude above NGVD 29 = 7.45 ft, T.D. = 842 ft** | | |
| 220–240 | 237 | 12 |
| 300–310 | 43 | 2 |
| 320–340 | 981 | 51 |
| 490–520 | 172 | 9 |
| 550–580 | 75 | 4 |
| 610–620 | 431 | 22 |
| **BFT-315 Hilton Head Island<br>Flow test conducted January, 1962,<br>at a pumping rate of 800 gal/min<br>Land-surface altitude above NGVD 29 = 17 ft, T.D. = 795 ft** | | |
| 150–165 | 240 | 30 |
| 185–205 | 560 | 70 |
| **CHA-39 (36Q002) Union Bag No. 4<br>Flow test conducted May 17, 1963,<br>at a pumping rate of 800 gal/min<br>Land-surface altitude above NGVD 29 = 11 ft, T.D. = 1,043 ft** | | |
| 250–270 | 224 | 28 |
| 370–380 | 192 | 24 |
| 680–700 | 64 | 8 |
| 770–780 | 160 | 20 |
| 810–830 | 96 | 12 |
| 840–860 | 64 | 8 |
| **CHA-487 (39Q003) USGS Test Well 7<br>Flow test conducted October 11, 1962,<br>at a pumping rate of 1,200 gal/min<br>Land-surface altitude above NGVD 29 = 7 ft, T.D. = 745 ft** | | |
| 200–220 | 715 | 60 |
| 315–355 | 364 | 30 |
| 368–380 | 32 | 3 |
| 560–570 | 19 | 2 |
| 640–670 | 32 | 3 |
| 720–730 | 38 | 3 |

The current-meter tests indicated at least five separate permeable zones in the Floridan aquifer system (fig. 6; McCollum and Counts, 1964). Zones 1 and 2 were identified in the upper Eocene Ocala Limestone. The first zone was located at the top of the Ocala and was 50 ft thick in the center of the Savannah area and 15 ft thick to the east and northeast (McCollum and Counts, 1964). Zone 2 was found to lie 50 ft below zone 1 except northeast of Savannah and into Beaufort County, SC, where the upper part of the Ocala thins. These upper two zones produced as much as 70 percent of the total well yield where present. Zone 3 was found at the base of the upper Eocene and (or) at the top of the middle Eocene and was discontinuous across the area and not present in all of the wells. Where present, it ranged from 10 to 30 ft thick and generally produced less than 5 percent of the total amount of water from a given well. Zones 4 and 5, which are the deepest permeable zones in the aquifer, were in rocks of middle Eocene age, or as the authors identified it then, the Lisbon Formation (fig. 3). These deeper zones were found to be generally thin (10 to 30 ft thick) and produce between 3 and 20 percent of the total yield in wells that tap these permeable zones.

McCollum and Counts (1964) published two cross sections depicting the distribution of permeable zones within the aquifer system. Part of their cross section B–B', which extends from well CHA-452 at Port Wentworth to well CHA-487 at Tybee Island, is reproduced in figure 6 to show the distribution of permeable zones with respect to their stratigraphic positions in the Savannah area. Based on these results, and as previously stated by McCollum and Counts (1964), it was documented that most of the flow during these tests was derived from zones 1 and 2 in rocks of late Eocene age (Ocala Limestone).

The quality of water in each of the permeable zones varies in chloride concentration and hardness. The chloride concentration increased eastward and northeastward from the center of pumping at Savannah, and the chloride concentration and hardness content increased with increasing depth in the aquifer (McCollum and Counts, 1964). The saltwater in the lower permeable zones was believed to be old unflushed water, whereas saltwater in the upper permeable zones north of Savannah was probably a mixture of seawater and groundwater.

## Hilton Head Test Sites

Numerous test wells have been drilled on Hilton Head Island to investigate saltwater encroachment in the Floridan aquifer system and to explore alternative sources of water supply in this area (Hayes, 1979; Gawne and Park, 1992). Hayes (1979) identified permeable zones within the middle zone of low permeability, which was later defined as the middle Floridan aquifer by Gawne and Park (1992). McCollum and Counts (1964) first identified it as zone 4 of the five zones in well BFT-101. Zones 3 and 5 above and below zone 4 did not appear to be developed on the northern end of Hilton Head Island (McCollum and Counts, 1964). Zones 1 and 2 compose the Upper Floridan aquifer.

A study was undertaken to evaluate the potential of the middle Floridan aquifer as a source of irrigation water on Hilton Head Island (Gawne and Park, 1992). That study described the transmissivity and water quality of the middle Floridan aquifer. A groundwater-flow model was developed to address the magnitude of water-level declines under different pumping scenarios and the potential effects on rates of saltwater intrusion. Based on the results of testing, the middle Floridan aquifer on Hilton Head Island was found to be approximately 30 to 60 ft thick, and present at depths ranging between 430 and 550 ft below land surface (fig. 7). This aquifer was separated from the overlying permeable zones of the Upper Floridan aquifer by a 200 to 300 ft thick semiconfining unit. The middle Floridan aquifer was believed to be underlain by at least 500 ft of similar semiconfining material, based on previous work by Hayes (1979). Gawne and Park (1992) described the permeable zone that composes the middle Floridan aquifer as hard limestone with a high proportion of interconnected cavities and natural molds of shells and shell fragments. The semiconfining units above and below consist of fine calcarenites and calcilutites, the textural equivalent of sandstone and clay. The semiconfining unit is poorly consolidated and interbedded with thin layers of hard limestone. Laboratory analysis of a sidewall core from a depth of 382 ft below land surface in one well indicated the semiconfining material consisted mainly of calcite with 10.4 percent quartz, 9.6 percent dolomite, and 5.6 percent clay minerals. The porosity obtained from the sample was 27 percent and the hydraulic conductivity was 0.041 foot per day (ft/d).

Aquifer tests were conducted at six wells completed in the middle Floridan aquifer in Beaufort County, SC. In each test, the well was pumped for 24 hours (hrs), and drawdown was monitored in the pumped well and a nearby Upper Floridan aquifer well to observe the effects of pumping the deeper aquifer on the shallower zones. Transmissivity calculated from these tests ranged from 6,700 to 26,700 feet squared per day ($ft^2/d$). Hydraulic properties of the middle Floridan are further discussed in the section, “Hydraulic Properties.”

Since 1993 numerous middle Floridan wells have been drilled and tested in Beaufort and Jasper Counties, SC. The increased development of wells indicates the middle Floridan aquifer is capable of supplying sufficient quantities of water for irrigation purposes in these areas. The first public-supply well in the middle Floridan aquifer was completed for Hilton Head Island Public Service District No. 1 in 2006 at a depth between 510 and 600 ft (Bob Massey, Rowe Drilling, written commun.,). The chloride concentration in 2006 was reported to be 300 mg/L, which is much less than the chloride concentrations reported by Falls, Ransom, and others (2005) for the Upper Floridan aquifer. Chloride concentrations in well BFT-315 in the Upper Floridan aquifer at the northern end of Hilton Head Island, SC (fig. 5), increased from less than 100 mg/L in 1974 to greater than 600 mg/L in 1983, and the chloride concentration at well BFT-1810 (fig. 2) was greater than 1,700 mg/L in 2003 (Falls, Ransom, and others, 2005).

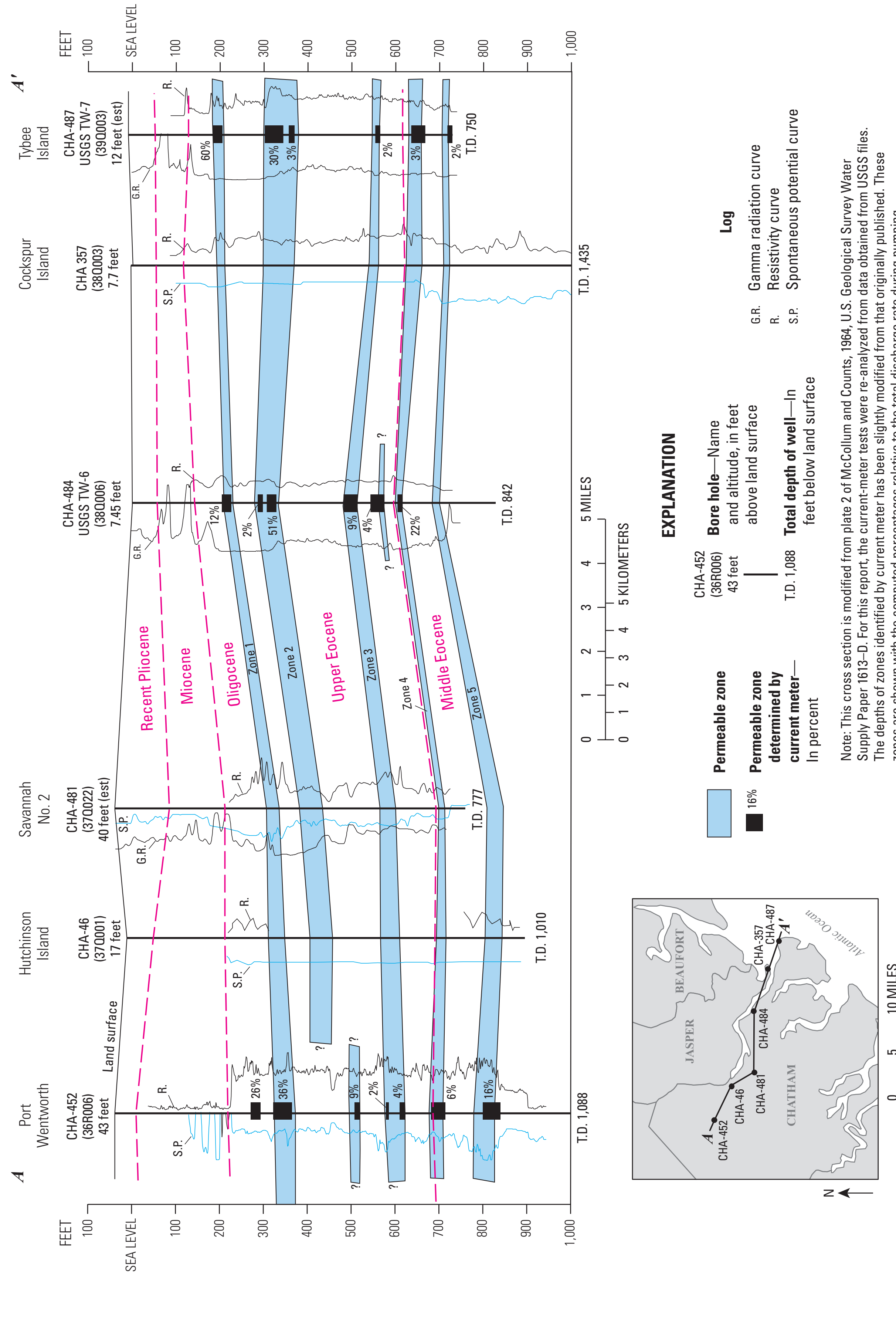



**Figure 6.** Geologic section showing permeable zones and their stratigraphic positions in the Floridan aquifer system (formerly referred to as the principal artesian aquifer) in the Savannah area of Georgia (modified from McCollum and Counts, 1964).

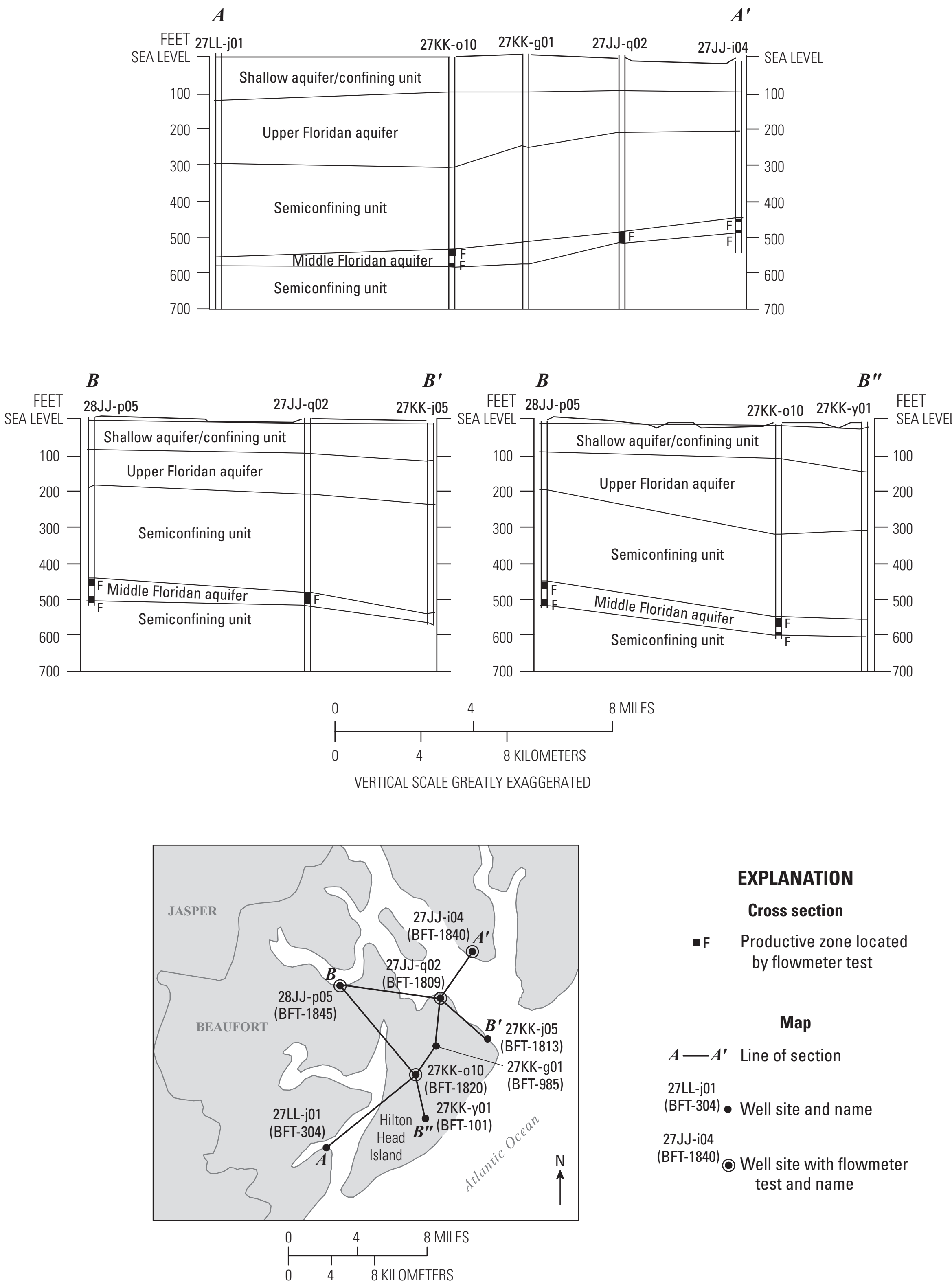



**Figure 7.** Locations of wells and hydrogeologic cross sections used to evaluate the middle Floridan aquifer in Beaufort County, South Carolina (modified from Gawne and Park, 1992).

## City of Richmond Hill Test Sites

In March 2000, the USGS in cooperation with the GAEPD completed a Lower Floridan aquifer test well (35P109, fig. 2) at Richmond Hill, Bryan County, GA. This well was one of several deep test wells drilled as part of the Georgia Coastal Sound Science Initiative (CCSI) investigation to evaluate the Lower Floridan aquifer in the coastal region of Georgia. Results of the test-drilling program were reported by Falls, Harrelson, and others (2005). This deep test well provided detailed water-quality and aquifer-test data for the Lower Floridan aquifer.

Based on resistivity logs from well 35P109 (fig. 8*A*), potential permeable zones are identified at 400–412 ft, 430–450 ft, 470–475 ft, 495–520 ft, and 530–550 ft. These zones correlate to permeable zones 1 and 2 reported by McCollum and Counts (1964) in the Upper Floridan aquifer. Deeper permeable zones also are identified in the resistivity logs below 700 ft.

Resistivity logs in the dense dolomitic beds of the Avon Park Formation and in permeable zones must be carefully examined, because the responses are similar. In the case of dense dolomitic beds (or any dense, low-permeability rock) both the shallow and deep resistivity curves typically deflect to the right and remain somewhat parallel to each other across the dense bed. This type of response is characteristic of a resistive low-permeability zone with little to no drilling-fluid invasion (even if drilled with freshwater as with reverse air rotary methods). If the curves separate, even slightly, drilling fluids of differing water quality probably have invaded the formation. Examine, for example, the resistivity log separation shown in figure 8*B* from well 35P109. In the depth interval shown, the lateral and short-normal curves separate to the right in areas of the borehole where drilling fluids (freshwater) invaded the formation, whereas the long-normal curve separates to the left, which indicates more saline water in the formation. Based on this response, a permeable zone is identified between 820 and 830 ft where the curves reach maximum separation. Because the long-normal curve deflects to the left and the lateral and short-normal curves deflect to the right, it is probable that water having higher salinity is present in this zone compared to the freshwater circulating and invading the formation.

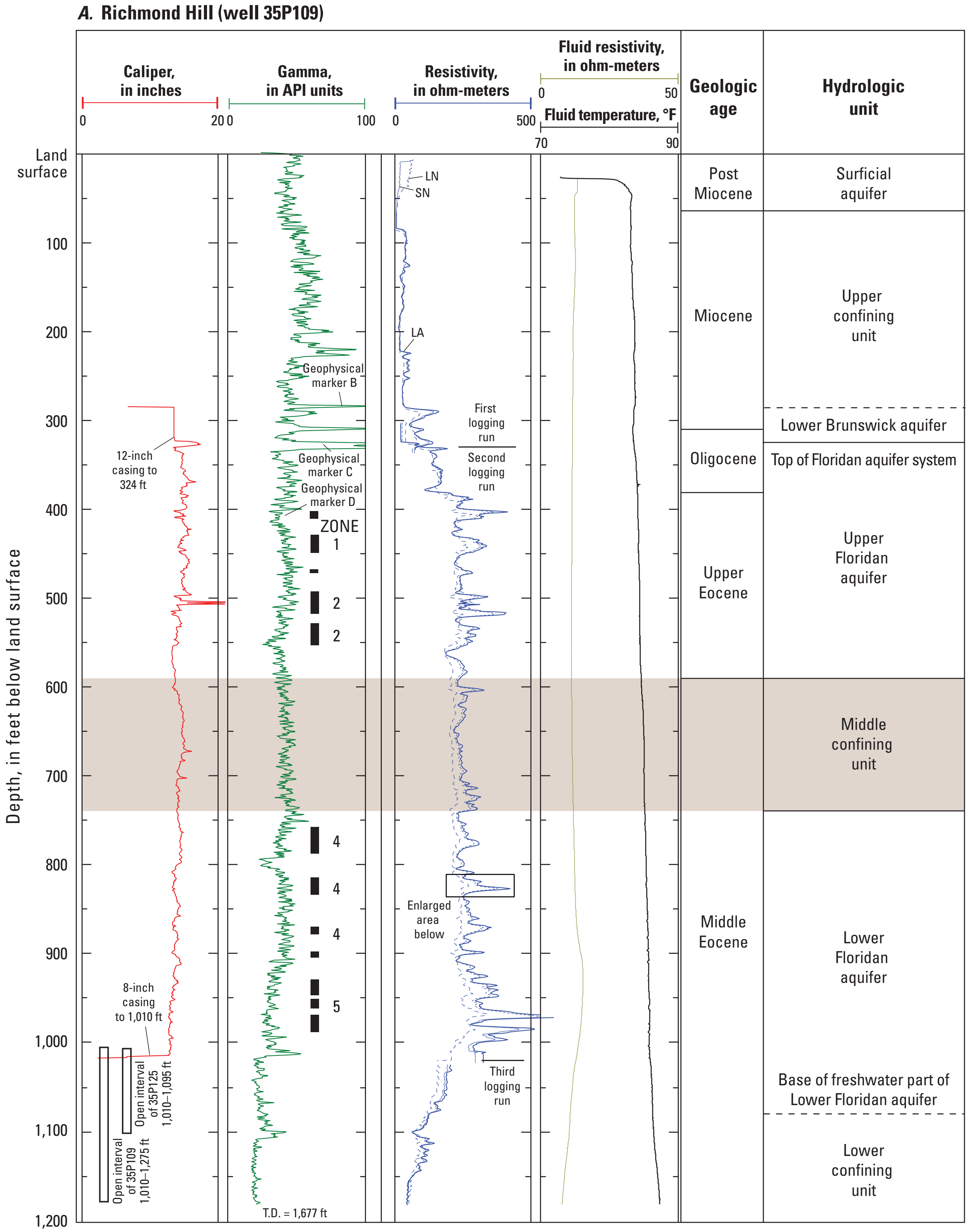
Using the invasion profiles, several potentially permeable zones can be identified between 700 and 1,130 ft. Most notably, the resistivity logs separate at 770–780 ft, 814–830 ft, 865–874 ft, and 924–996 ft in well 35P109 (fig. 8*A*); in all of these zones, the long-normal curve separates to the left indicating the presence of relatively higher salinity concentrations in the formation than in the drilling fluids. Because no flowmeter logs were collected at this stage of well construction, the relative yield from these zones could not be confirmed. Nevertheless, because all of these zones are above the Lower Floridan aquifer, as defined by Miller (1986), they were eventually cased out of this well with 8-inch steel casing set to 1,010 ft (Falls, Harrelson, and others, 2005).

The specific conductance and chloride concentrations in the drilling fluids were monitored as well 35P109 was drilled. At a depth of 1,248 ft, the chloride concentration increased to approximately 160 mg/L and remained at that concentration to the total depth of 1,650 ft. A water sample collected at a depth of 1,320 ft had a concentration of 2,170 mg/L of total dissolved solids (TDS), 1,100 mg/L of sulfate, and 280 mg/L of chloride (Falls, Harrelson, and others, 2005). Because of the relatively high TDS concentrations, the bottom part of the hole was backfilled with grout and the well was completed to 1,275 ft (believed to represent the approximate bottom of the Lower Floridan aquifer at this location). A water sample from the well (open from 1,010 to 1,275 ft) had a TDS concentration of 1,700 mg/L, 880 mg/L of sulfate, and 160 mg/L of chloride (Falls, Harrelson, and others, 2005). Because of concern about potential upward leakage of high-TDS water into a Lower Floridan aquifer production well that was being drilled at Harris Road (described below), the bottom part of well 35P109 was grouted back to 1,095 ft in August 2006. The grouting was accomplished in two stages, and well 35P109 was tested after each stage. Following the first stage of grouting to 1,130 ft, no change was observed in the specific conductance of the water (1,150 microsiemens per centimeter at 25 degrees Celsius [µS/cm]). After the second stage of grouting to 1,095 ft, the specific conductance decreased to 588 µS/cm. The well was pumped at a rate of 146 gal/min and developed a drawdown of 196 ft, which indicated a specific capacity of 0.7 (gal/min)/ft and that the well was open to a low-permeability zone. Well 35P109 then was renamed 35P125 (fig. 2) to reflect the change in well construction.

In 2005, the City of Richmond Hill drilled its first well in the Lower Floridan to expand its water supply (Gill, 2005, 2007). This well, known as the Harris Trail Road well (35P128, table 1), was completed during February–May 2005 at a site located 4,700 ft due north of well 35P109 (fig. 2). Borehole geophysical logs collected from this well are shown in figure 8*B*.

During the early stages of construction, well 35P128 was open from 382 to 754 ft, exposing upper and middle Eocene carbonate rocks to the open part of the borehole. A flowmeter log collected across this interval showed a fairly continuous 140 ft thick production zone (431–571 ft) in the rocks of upper Eocene age and a production zone (623–642 ft) in rocks of middle Eocene age. The upper zone correlate to permeable zones 1 and 2 in McCollum and Counts (1964), and the lower zone correlates to zone 3.

During the latter stages of well construction, the test well was open from 755 to 1,000 ft exposing the open part of the borehole to middle Eocene carbonate rocks. The logs from this interval revealed water-producing zones at 770–800 and 855–950 ft, which correlate to zones 4 and 5 in McCollum and Counts (1964), and a deeper (minor) zone at 980–990 ft, which correlates to permeable zone 5. Based on results of geophysical logging and flowmeter surveys, the thickest zone of low permeability was found in the 600- to 770-ft interval between zones 2 and 4.



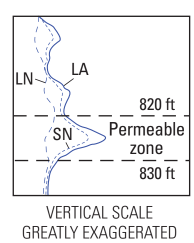




**Figure 8.** *(A)* Borehole geophysical logs from test well 35P109 in the Lower Floridan aquifer at Richmond Hill, Georgia; and *(B)* borehole geophysical logs from test well 35P128 in the Lower Floridan aquifer at Harris Trail, Georgia. Black bars denote water-bearing zones. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity; LA, lateral resistivity]

*B.* **Harris Trail (well 35P128)**

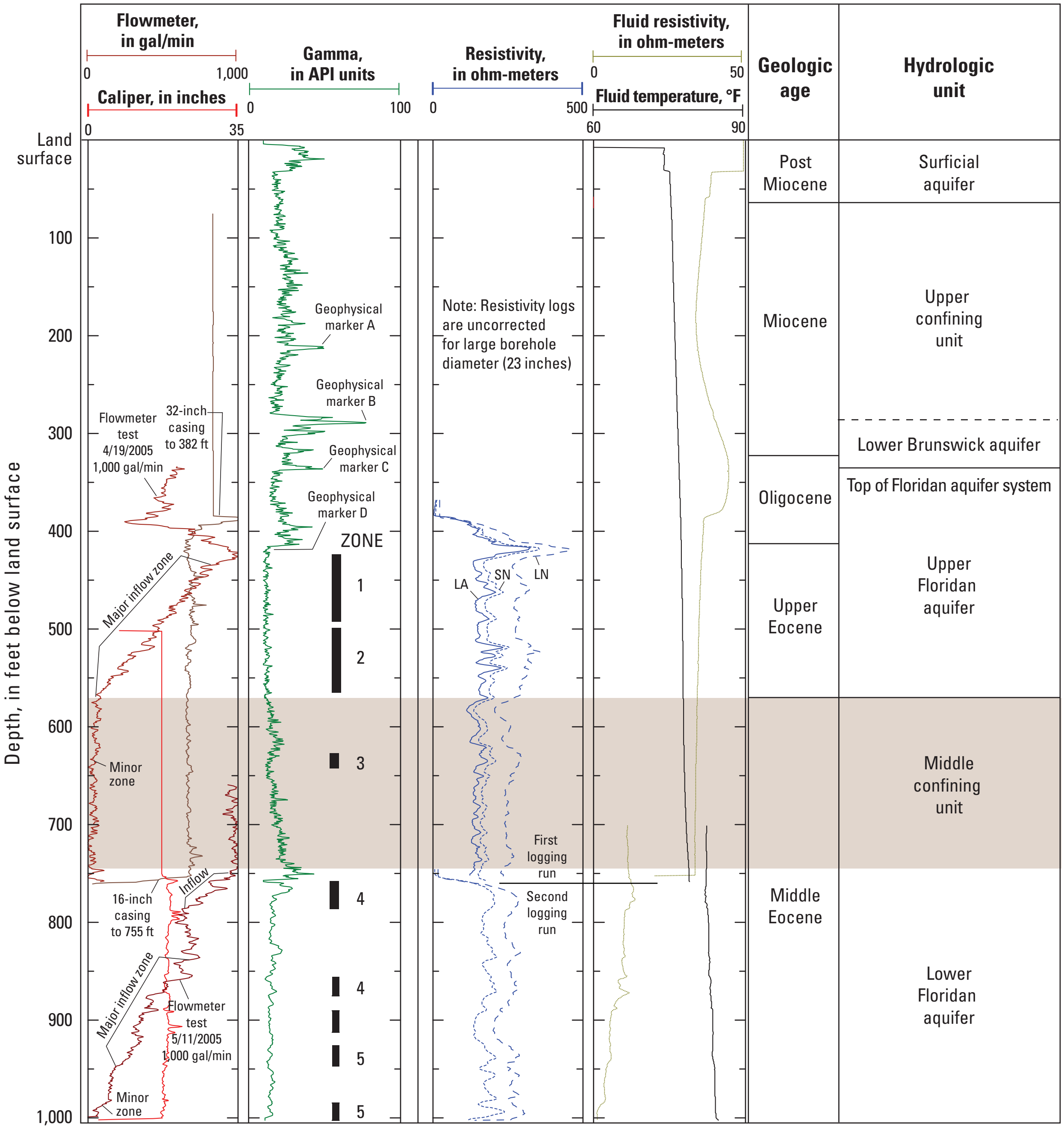



**Figure 8.** *(A)* Borehole geophysical logs from test well 35P109 in the Lower Floridan aquifer at Richmond Hill, Georgia; and *(B)* borehole geophysical logs from test well 35P128 in the Lower Floridan aquifer at Harris Trail, Georgia. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity; LA, lateral resistivity]—Continued

Aquifer tests were completed in both the Upper Floridan aquifer and the Lower Floridan aquifer at the Harris Trail Road site (well 35P128), in accordance with GAEPD permit requirements for determining the hydraulic properties of both aquifers and the middle confining unit. The Upper Floridan aquifer test covered a 24-hr period and the Lower Floridan aquifer test covered a 72-hr period (Gill, 2005). The transmissivity of the Upper Floridan aquifer was determined to be approximately 40,000 $ft^2/d$ with a storage coefficient of $3.4 \times 10^{-4}$. The transmissivity of the Lower Floridan was determined to be approximately 10,000 $ft^2/d$.

Hydraulic properties of the middle confining unit were estimated with groundwater-flow model simulations (Gill, 2005). The groundwater flow model of the Richmond Hill area was developed and calibrated based on the site hydrogeologic data and aquifer-test results. The calibrated model simulated leakage through the middle confining unit at a rate of $3.4 \times 10^{-5}$/d. Given a thickness of 188 ft for the confining unit, the modeled vertical hydraulic conductivity of the middle confining unit was estimated to be $6.4 \times 10^{-3}$ ft/d.

A water sample was collected at the conclusion of well development and test pumping at well 35P128, and water from the Lower Floridan aquifer was determined to be calcium-bicarbonate type with a TDS content of 210 mg/L. Comparisons of these results with the results of water samples collected from nearby Upper and Lower Floridan aquifer wells can be made in the Piper diagrams in figure 9. Generally, constituent concentrations increase with depth, and increasing amounts of chloride and sulfate concentrations typically would be detected in the water samples from deeper intervals. The water sample collected from the Upper Floridan aquifer (well 35P110 at 315–441 ft) was calcium-bicarbonate type and had the lowest ratio of chloride and sulfate to other ions (Falls, Harrelson, and others, 2005). The sample collected from the well 35P128 at 750–1,000 ft in the Lower Floridan aquifer plots to the right of the water sample from the Upper Floridan aquifer but is still calcium-bicarbonate type with a composition similar to that of the Upper Floridan aquifer at well 35P110. Water samples collected from wells 35P109 and 35P125 in the Lower Floridan aquifer (Falls, Harrelson, and others, 2005) were calcium-sulfate type and contained much higher concentrations of TDS because of the much deeper intervals.

## Berwick Plantation Test Site

A deep test well (36Q330) was drilled at Berwick Plantation in Chatham County, GA, during 2002 to evaluate the Lower Floridan aquifer as an alternative source of water supply for that area (fig. 2; Gill, 2002, 2009). Similar to well 35P128 described above, well 36Q330 was completed in several stages to accommodate geophysical and flowmeter logging conducted during well construction.

During the earlier stages of well construction, the test hole was open from 302 to 718 ft exposing upper and middle Eocene carbonate rocks to the open part of the borehole (fig. 10). A flowmeter log identified two major production zones (390–435 ft and 485–525 ft) in rocks of upper Eocene age and a minor production zone (590–610 ft) in rocks of middle Eocene age. These zones are correlated to permeable zones 1, 2, and 3, respectively, in McCollum and Counts (1964). The interval from 544 to 700 ft produced little water, with the exception of the minor production zone (590 to 610 ft, permeable zone 3).

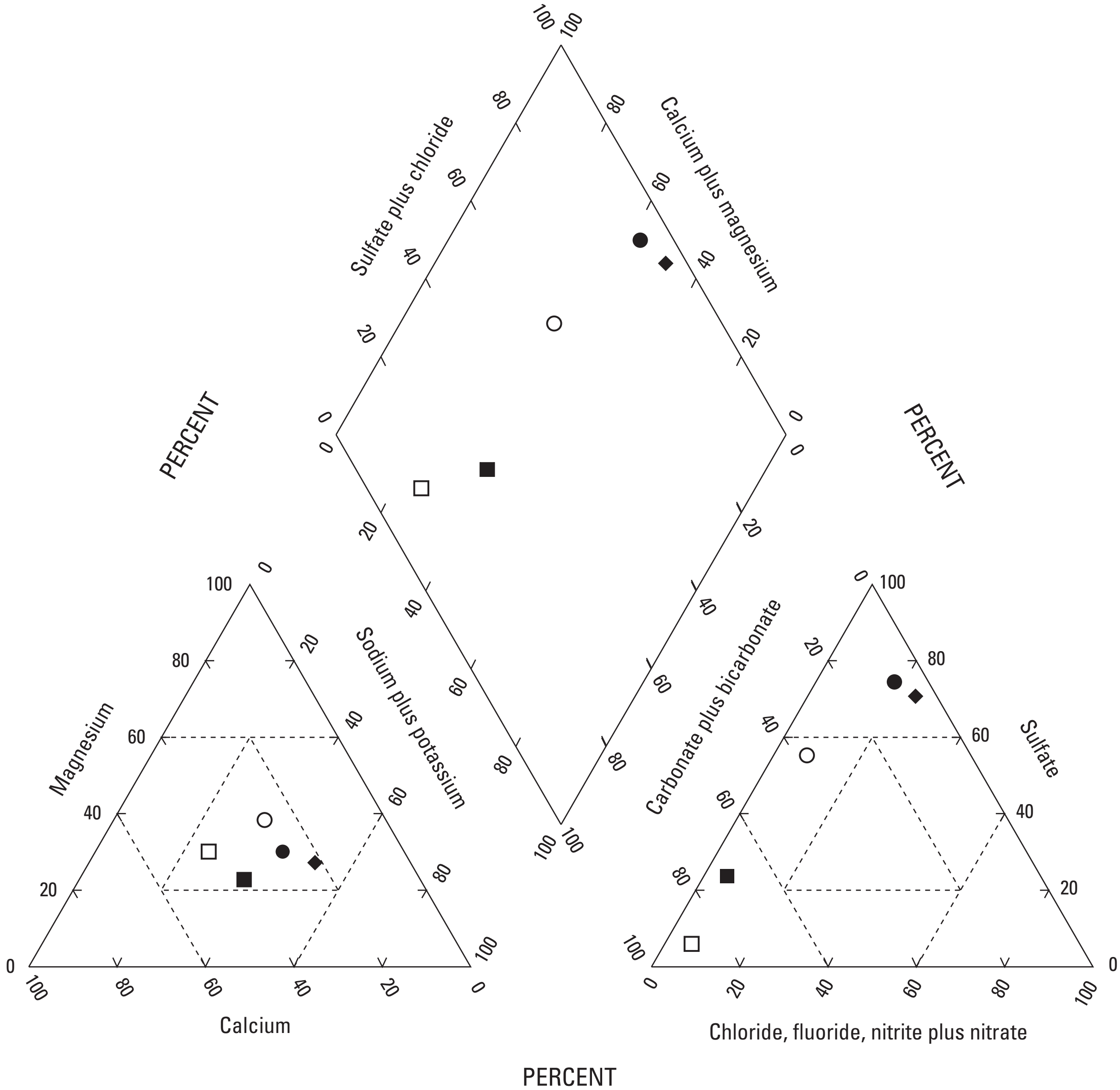
During the latter stages of construction, well 36Q330 was open from 718 to 1,202 ft. Water-producing zones in the deeper interval were determined by using resistivity logs. Although a flowmeter log would have provided more definitive data, the tool could not be lowered into the well because of insufficient clearance past the pump.

Based on results of geophysical logging and flowmeter surveys, the thickest low-permeability zone lies in the 544- to 700-ft interval between zones 2 and 4, identified as the middle confining unit. This unit separates zones 1 and 2 from zones 4 and 5. The well was completed by installing casing to a depth of 718 ft and leaving the 718- to 1,080-ft interval as open hole. (It should be noted that monitoring of the drilling fluids during drilling indicated the presence of poor-quality water zones below 1,080 ft; thus, these deeper zones were sealed off during the final well completion by grouting the lower part of the borehole.)

Following well completion, a 72-hr Lower Floridan aquifer test was conducted in well 36Q330 using a nearby Upper Floridan aquifer well (36Q331) as an observation point. Water-level response in the Upper Floridan aquifer to the pumping from the Lower Floridan aquifer was used to evaluate leakage in the middle confining unit (Faye and Gill, 2005). Transmissivity of the Upper Floridan aquifer was 46,000 $ft^2/d$ and the storage coefficient was $1.0 \times 10^{-4}$; transmissivity of the Lower Floridan aquifer was 8,200 $ft^2/d$.

Hydraulic properties of the middle confining unit were estimated with groundwater-flow model simulations. The flow model was developed and calibrated with hydrogeologic data and aquifer-test results at the test site. The modeling results indicated leakage of $7.2 \times 10^{-5}$/d for the middle confining unit (Faye and Gill, 2005). Given a thickness of 175 ft, the modeled vertical hydraulic conductivity of the middle confining unit was estimated to be $1.3 \times 10^{-2}$ ft/d.

A water sample collected at the end of the 72-hr aquifer test in well 36Q330 was analyzed for major ions, metals, pH, and TDS. The Piper diagrams in figure 11 enable comparison of the water chemistry of the sample from well 36Q330 with the water chemistry of samples collected from wells at Richmond Hill, approximately 10 mi to the south. The results indicate that the water from the Lower Floridan aquifer at this site is calcium-bicarbonate type with a TDS concentration of 299 mg/L. Compared with the water samples from wells at Richmond Hill, this sample had more sulfate and chloride than water from the Upper Floridan aquifer well but had less sulfate and chloride than water from the Lower Floridan aquifer well.




**EXPLANATION**

- □ **Well 35P110**—Open interval 315–441 feet, Upper Floridan, sampled 9/06/2000
- ■ **Well 35P128**—Open interval 750–1,000 feet, Lower Floridan, sampled 6/06/2005
- ○ **Well 35P125**—Open interval 1,010–1,070 feet, Lower Floridan, sampled 8/30/2006
- ● **Well 35P109**—Open interval 1,010–1,275 feet, Lower Floridan, sampled 9/06/2000
- ◆ **Well 35P109**—Open at 1,320 feet, Lower Floridan, sampled 3/12/2000

Note: Wells 35P110, 35P109, and 35P125 are at the same location in Richmond Hill, Chatham County, Georgia. The Harris Trail well (35P128) is located approximately 4,600 feet due north of these wells. Two water samples were taken from well 35P109; one sample was collected at a depth of 1,320 feet during initial construction of the well and another sample collected after sealing the bottom part of the well up to 1,275 feet. On 6/26/2006, well 35P109 was sealed to 1,070 feet and renamed to well 35P125 to obtain that sample.

**Figure 9.** Piper diagram showing major cation and anion compositions in water samples from the Upper and Lower Floridan aquifers at Richmond Hill, Chatham County, Georgia. [Note: Water sample data can be obtained from *http://waterdata.usgs.gov/ga/nwis/qw*.]

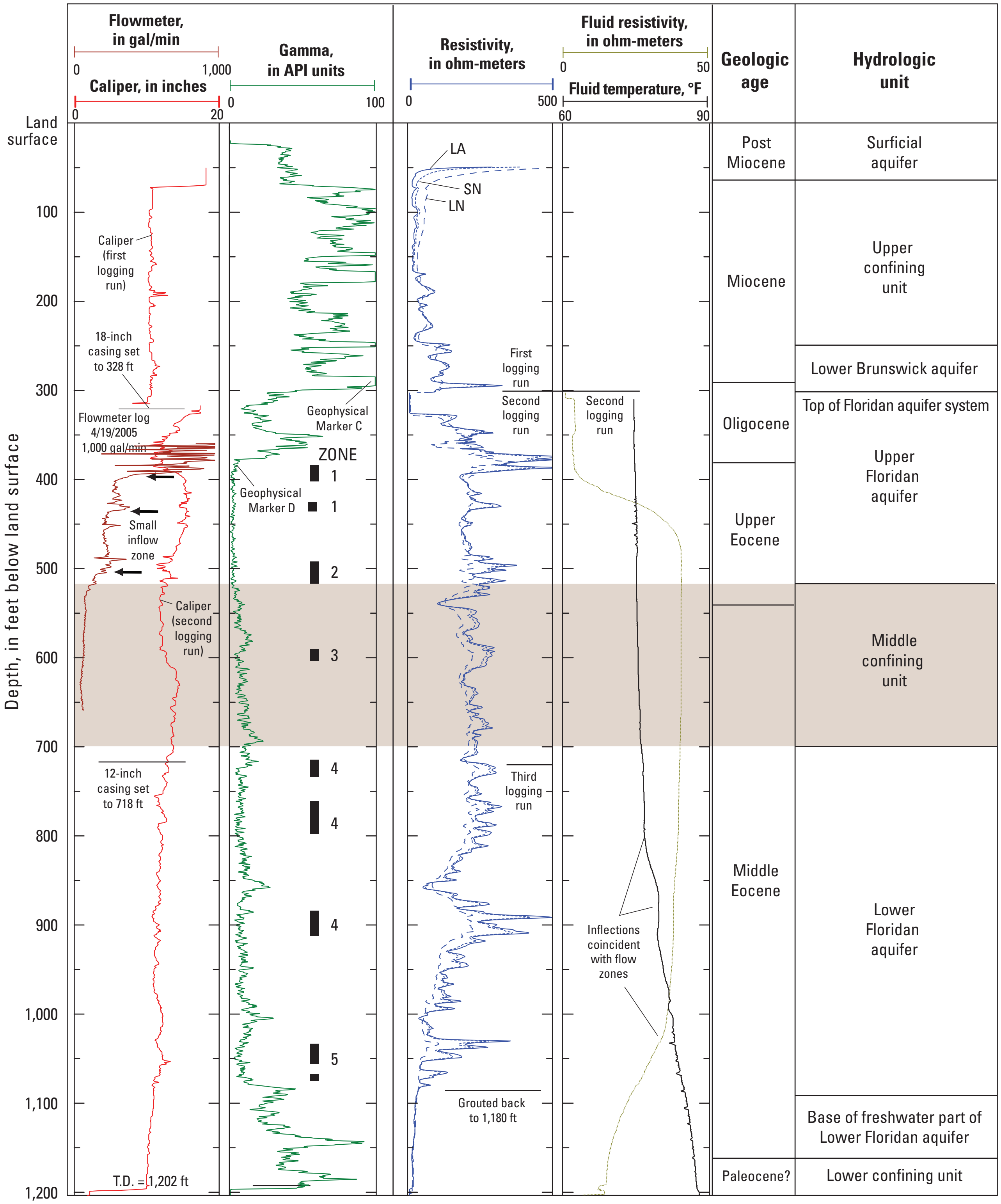



**Figure 10.** Borehole geophysical logs from test well 36Q330 in the Lower Floridan aquifer at Berwick Plantation, Chatham County, Georgia. Black bars denote water-bearing zones. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [gal/min, gallon per minute; API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity, LA, lateral resistivity]

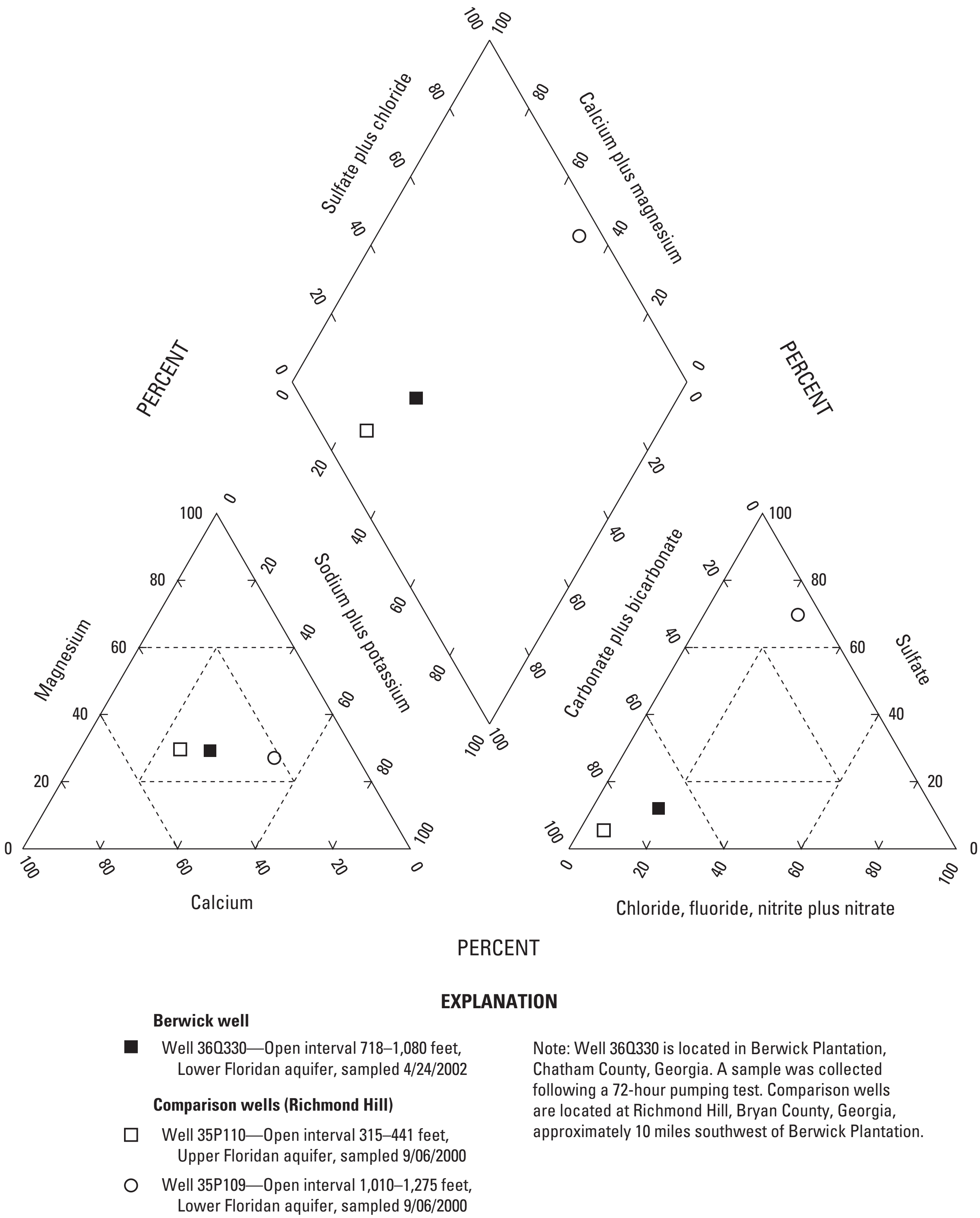



**Figure 11.** Piper diagram showing the major cation and anion composition of water samples from test well 36Q330 in the Lower Floridan aquifer at Berwick Plantation, Chatham County, Georgia, and from wells in the Upper and Lower Floridan aquifers at Richmond Hill, Bryan County, Georgia. [Note: Water sample data can be obtained from *http://waterdata.usgs.gov/ga/nwis/qw.*]

## City of Rincon Test Site

A deep test well (36S048, fig. 2) was drilled at the City of Rincon, Effingham County, GA, between October 2003 and January 2004 to evaluate the Lower Floridan aquifer as an alternative source of water supply (Gill, 2004). During early stages of well construction, the test hole was open from 345 to 568 ft exposing upper and middle Eocene carbonate rocks to the open part of the borehole (fig. 12). A flowmeter log collected in this interval indicated major production zones at 345–372 ft and 390–410 ft in rocks of upper Eocene age, which correlate to zones 1 and 2 in McCollum and Counts (1964). The interval from 410 to 565 ft produced little water, with the exception of a minor production zone at 505–510 ft (permeable zone 3) in rocks of middle Eocene age (just below a zone of increased gamma radiation).

During the latter stages of well construction, test well 36S048 was open to the deeper middle Eocene rocks. A flowmeter-log traverse in this interval identified a single major production zone from 565 to 580 ft and minor production zones at 625–635 ft and 730–740 ft. The two shallower zones correlate to zone 4 in McCollum and Counts (1964), and the deepest zone correlates to zone 5. On the basis of geophysical logging and flowmeter surveys, the thickest zone of low-permeability rocks occurred in the 410–565 ft interval between zones 2 and 4 and was identified as the middle confining unit. The well was completed by installing casing to a depth of 565 ft and leaving the 565–1,000 ft interval as open hole.

Aquifer tests were completed in both the Upper and Lower Floridan aquifers in accordance with GAEPD permit requirements. The first test covered a 24-hr period and was conducted when the test well was at a depth of 568 ft (open from 310 to 565 ft, Upper Floridan aquifer). The second test covered a 72-hr period and was conducted when the test well was completed from 565 to 1,000 ft and open to the Lower Floridan aquifer. The aquifer tests indicated that the transmissivity of the Upper Floridan aquifer was 14,500 $ft^2$/d with a storage coefficient of $3.0 \times 10^{-4}$, and the transmissivity of the Lower Floridan aquifer was 2,470 $ft^2$/d (Clarke and others, 2004; Gill, 2004).

The hydraulic properties of the middle confining unit were determined with flow-model simulations. A groundwater-flow model of the Rincon area was developed and calibrated based on site data and aquifer-test results (Gill, 2004). Results of both aquifer tests were simulated with the calibrated model and indicated a leakage coefficient of $2.2 \times 10^{-3}$ /d for the middle confining unit (Gill, 2004). Given a thickness of 155 ft, the modeled vertical hydraulic conductivity of the middle confining unit was $4.7 \times 10^{-2}$ ft/d.

A water sample collected from the Lower Floridan aquifer at the Rincon test site was compared with water samples collected from Upper Floridan wells at Pineora (34S011), Guyton, and Maldrin in Effingham County (fig. 13). The water sample from the Lower Floridan aquifer is a sodium-bicarbonate type with TDS of approximately 350 mg/L, whereas water from the Upper Floridan aquifer is a calcium-bicarbonate type with a TDS of 140 to 160 mg/L in the three wells used for comparison.

## City of Savannah Well No. 5 Test Site

In 2008, the USGS in cooperation with the City of Savannah collected a flowmeter log from the City's well no. 5 (37Q162, fig. 2; table 1) to estimate the percentage of water being produced from the Lower Floridan aquifer (fig. 14). To conduct this test, a temporary pump was installed and run at a discharge rate of 1,679 gal/min; the drawdown after 3 hrs was only 17 ft. (It should be noted that this pumping rate was about half the typical production rate of this well.) The flowmeter survey indicated water-production zones between 274 and 440 ft. These zones appear to correlate to zones 1 and 2 in McCollum and Counts (1964). Although no flow was detected from the deeper zones (3–5), water-quality changes indicated the presence of three deep, low-yielding zones (less than the 50-gal/min detection limit of the spinner flowmeter used for these tests). Because the Upper Floridan aquifer is extremely productive at this site, the pumping rate used for this test may not have been sufficient to induce flow from deeper zones in the borehole.

Water samples were collected during the flowmeter test at five discrete depths and analyzed for major ions, pH, and specific conductance. The samples from the Upper Floridan aquifer were calcium-bicarbonate-type water (fig. 15). With increasing depth, the samples contained higher proportions of sodium, chloride, and sulfate. In the middle part of the Upper Floridan aquifer (428 ft and 500 ft), the water content had a mixture of dominant ions; in the deeper part of the aquifer (725 ft and 850 ft), the water was a sodium-chloride-sulfate type.

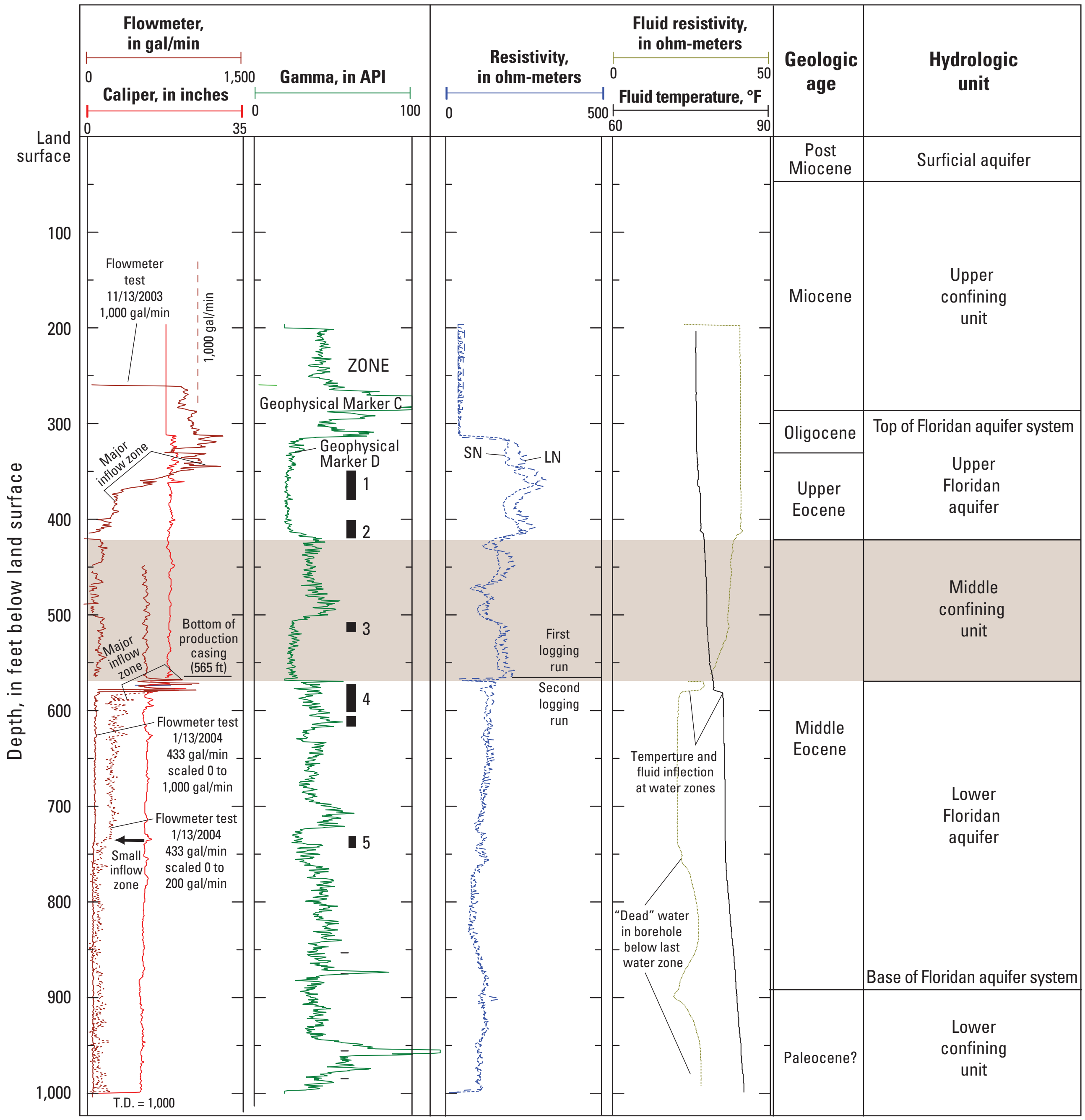
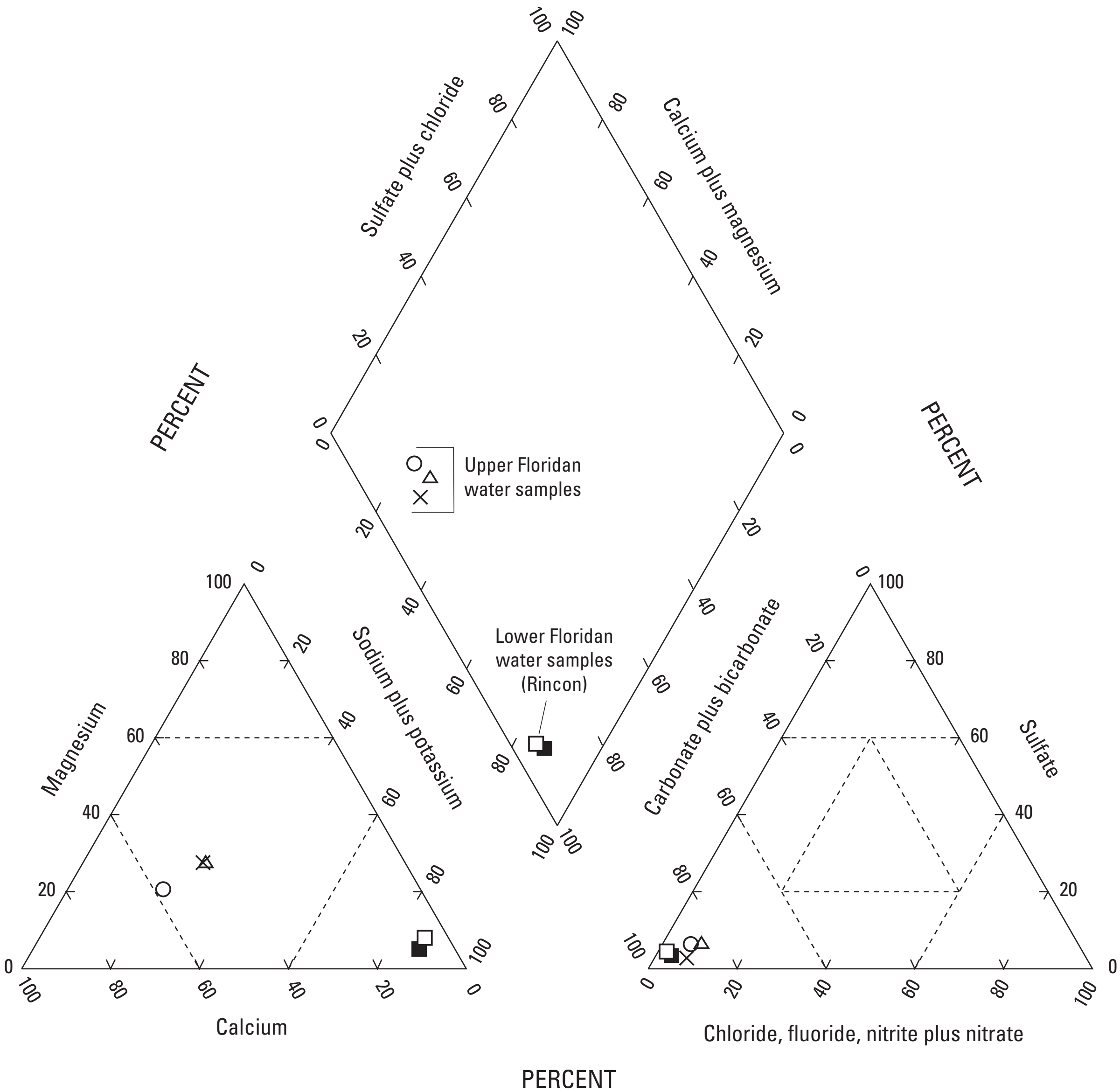



**Figure 12.** Borehole geophysical logs from test well 36S048 in the Lower Floridan at Rincon, Effingham County, Georgia. Black bars denote water-bearing zones. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [gal/min, gallon per minute; API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity]




**EXPLANATION**

**Rincon well**

□ Well 36S048—Open interval 565–1,000 feet, Lower Floridan aquifer, sampled 1/20/2004

■ Well 36S048—Open interval 565–1,000 feet, Lower Floridan aquifer, sampled 1/22/2004

**Comparison wells**

○ Pineora, well 34S011—Open at 360 feet, Upper Floridan aquifer,sampled 12/10/2001

△ Central Railroad, well 34R046—Open interval 350–476 feet, Upper Floridan aquifer, sampled 3/12/1940

× Guyton, well 34S001—Open interval 280–425 feet, Upper Floridan aquifer, sampled 1/29/1941

Note: Water samples were collected from the Rincon Lower Floridan aquifer well on two separate dates during a 72-hour aquifer test. Comparison wells are from the city of Pineora, city of Guyton, and Central Railroad, all located in Effingham County, Georgia.

**Figure 13.** Piper diagram showing major cation and anion composition of water samples from the Lower Floridan aquifer at Rincon and from comparison wells in the Upper Floridan aquifer in Effingham County, Georgia. [Note: Water sample data can be obtained from *http://waterdata.usgs.gov/ga/nwis/qw*.]

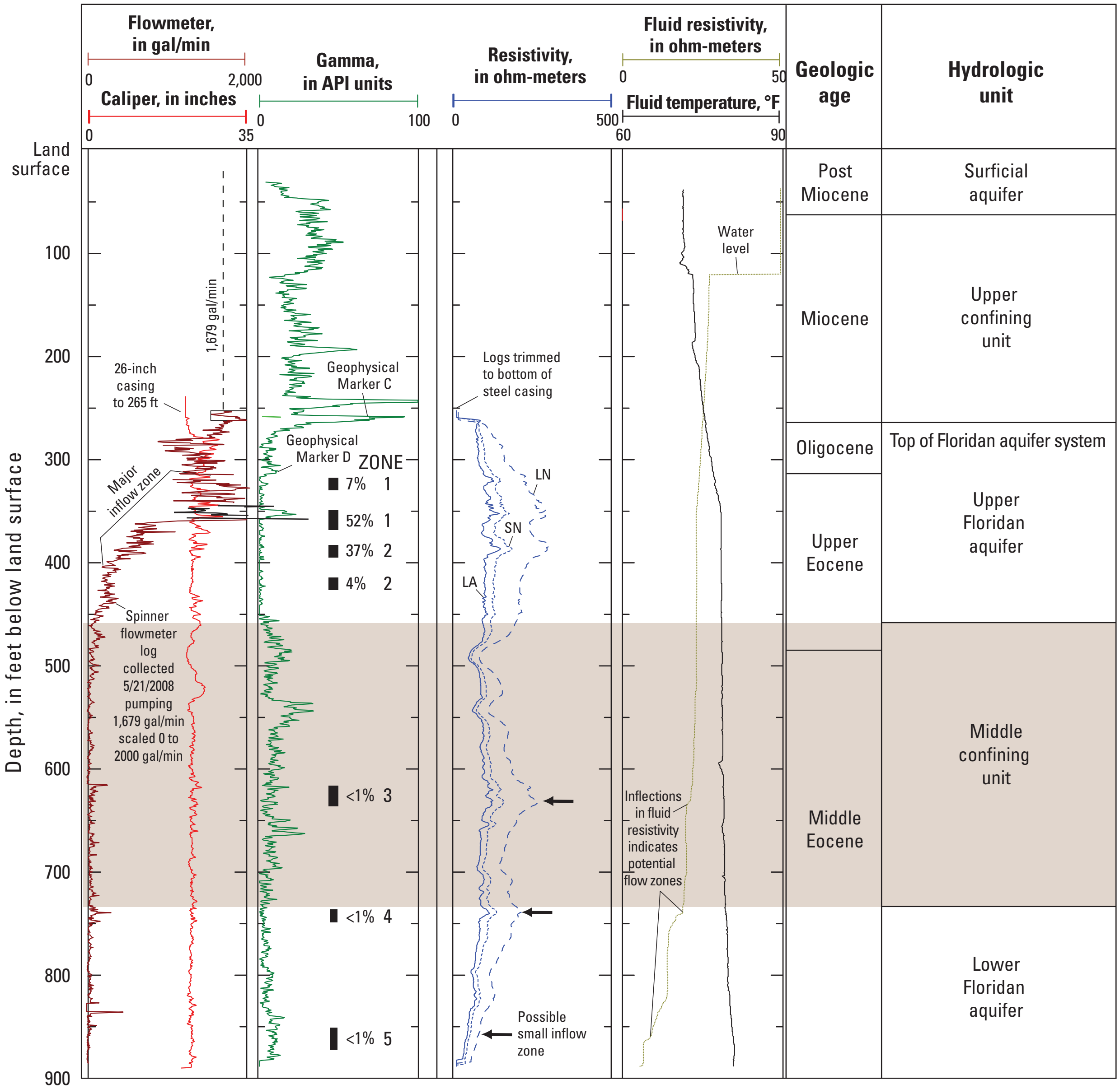
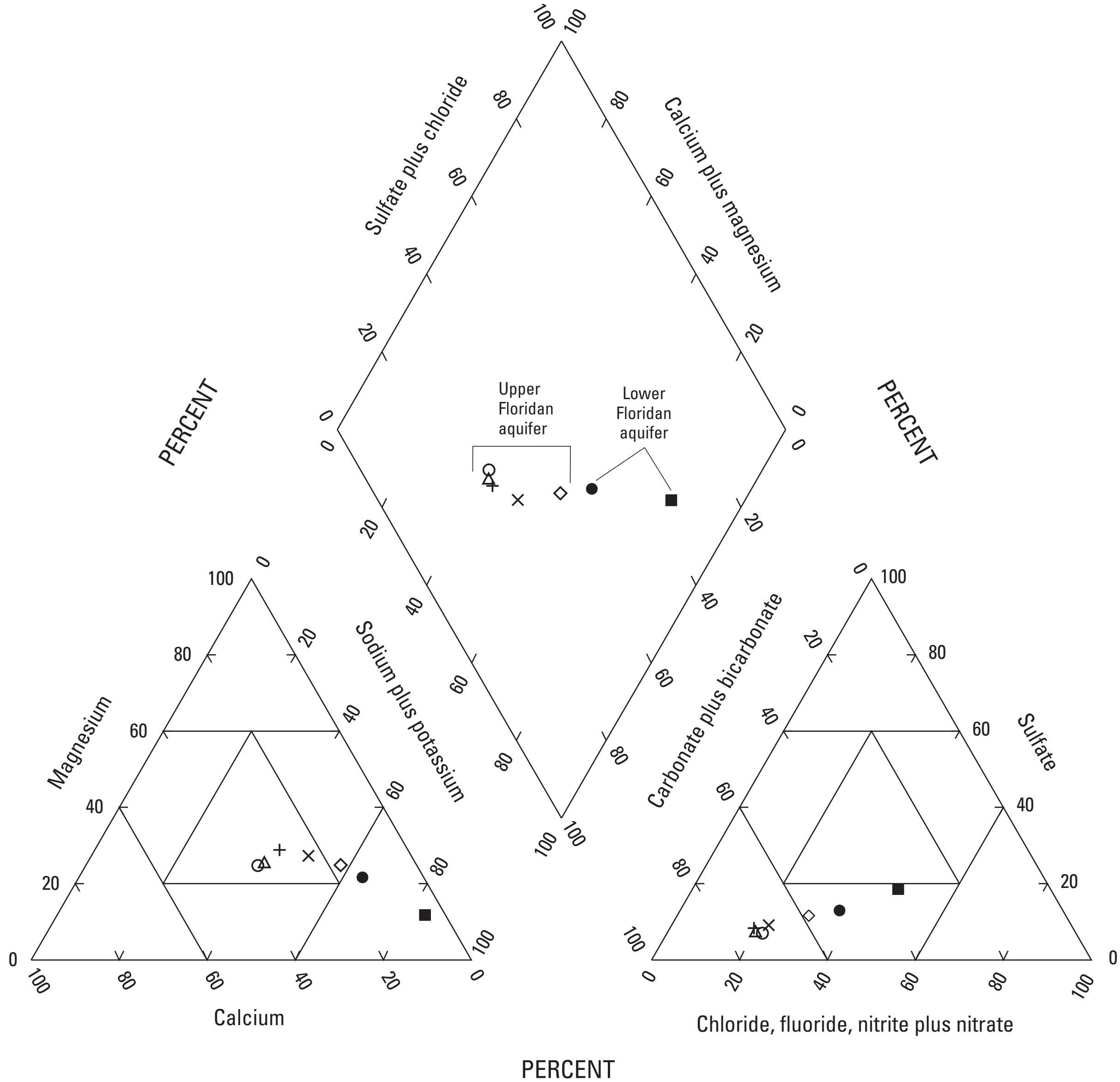



**Figure 14.** Borehole geophysical logs from the City of Savannah well No. 5 (37Q162), Chatham County, Georgia. Black bars denote water-bearing zones with estimated percentages from spinner flowmeter test pumping 1,679 gal/min. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). Zone 3 is correlated from nearby well 37Q022. [gal/min, gallon per minute; API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity, LA, lateral resistivity]




**EXPLANATION**

**Savannah well no. 5 (37Q162)**—Sampled on 5/22/2008 at different depths

| Upper Floridan aquifer | Lower Floridan aquifer |
|---|---|
| ○ 268 feet | ● 725 feet |
| △ 345 feet | ■ 850 feet |
| + 375 feet | |
| × 428 feet | |
| ◇ 500 feet | |

Note: Savannah well no. 5 was sampled at different depths in the open borehole while pumping the well at 1,679 gallons per minute. A wireline sampler was lowered to the specified depth, and the sampler chamber was opened and allowed to fill for 10 minutes. The sampler chamber was then closed and brought to the surface. The water samples were then transferred to sample bottles.

**Figure 15.** Piper diagram showing major cation and anion compositions of grab water samples collected from different depths in the City of Savannah Well no. 5 (37Q162) in the Floridan aquifer in Chatham County, Georgia. [Note: Water sample data can be obtained from *http://waterdata.usgs.gov/ga/nwis/qw*.]

## Pineora Test Site

Several test wells have been drilled at the City of Pineora, Effingham County, GA, to characterize the hydrogeology of the Upper and Lower Floridan aquifers. Well 34S011 (fig. 2) was completed in 2001 in middle Eocene rocks with an open interval between 651 and 870 ft (fig. 16; table 1) as part of the CCSI conducted by the USGS and GAEPD. Flowmeter and aquifer tests were not completed in this well; however, while drilling the middle Eocene interval, water had to be added to maintain the reverse-air rotary discharge indicating a low yield in that part of the formation (Falls, Harrelson, and others, 2005). The rocks composing this interval consist of fine-grained fossiliferous limestone interbedded with glauconitic dolomite typical of the Avon Park Formation (Falls, Harrelson, and others, 2005). Because of the low yield, no water samples were collected from the Lower Floridan aquifer at this test location.

In 2009, a 1,439-ft deep core hole was drilled at Pineora as part of a USGS program to study the geology of the Savannah River Basin (Arthur P. Schultz, U.S. Geological Survey, written commun., 2009). Because the core hole was drilled deeper than the previous test boring (well 34S011, table 1), it provided information on the depths and thicknesses of the permeable zones in the lower part of the middle Eocene (fig. 16). Based on the resistivity logs, permeable zones were identified at 616–621 ft, 674–710 ft, 872–912 ft, and 952–994 ft.

## Hunter Army Airfield Test Site

A 1,168-ft deep test well (36Q392, table 1) was drilled in 2009 at Hunter Army Airfield in Chatham County, GA, to investigate the Lower Floridan aquifer as an alternative to the wells in the Upper Floridan aquifer. Hydrologic testing conducted at this test site included flowmeter surveys, porosity and permeability testing of core samples, packer-slug testing, and aquifer testing of the Upper and Lower Floridan aquifers.

Flowmeter surveys were completed at different stages of well construction to determine the depth and yield of water-bearing zones and to identify confining beds that separate the main production zones (fig. 17). The first flowmeter survey, conducted when the borehole was open to both the upper and middle Eocene carbonate rocks (333–1,168 ft), indicated more than 10 water-bearing zones. The upper 5 zones occurred in upper Eocene rocks and contributed 83.5 percent of the total yield. The lower 5 zones occurred in middle Eocene rocks and supplied the remaining 16.5 percent of the flow (Williams, 2010). The interval from 560 to 703 ft produced little water, with the exception of a minor production zone from 665 to 675 ft (permeable zone 3) in middle Eocene rocks. An upward hydraulic gradient was indicated from an ambient (nonpumping) flowmeter survey of the 333–1,168 ft interval. In that survey, 7.6 gal/min of groundwater was detected entering the borehole between 750 and 1,069 ft, which moved upward and then exited the borehole into lower head zones between 333 and 527 ft. (The ambient flowmeter survey results are not shown in figure 17; see Williams (2010) for further details).

On the basis of geophysical logging and flowmeter surveys, the thickest low-permeability zone occurred in the 560–703 ft interval between zones 2 and 4 and is identified as the middle confining unit, which separates zones 1 and 2 from zones 4 and 5. The well was completed between 703 and 1,112 ft, and intersects zones 4 and 5.

The horizontal hydraulic conductivity of the middle confining unit was determined from four packer slug tests. This unit, which is composed entirely of middle Eocene rocks, is about 160 ft thick with horizontal hydraulic conductivities from the slug tests ranging from 0.16 to 3.1 ft/d (Williams, 2010). Two slug tests conducted in the Lower Floridan aquifer gave the same horizontal hydraulic conductivity value of 1.71 ft/d. Clarke and others (2010) estimated the vertical hydraulic conductivity of the middle confining unit to be between 0.02 and 0.36 ft/d based on a horizontal-to-vertical hydraulic conductivity ratio of 8.5:1 (determined by comparing laboratory analyses for vertical hydraulic conductivity to horizontal hydraulic conductivity determined from the packer tests).

Aquifer tests were completed in the Upper and Lower Floridan aquifers in accordance with GAEPD requirements. The results indicated an Upper Floridan aquifer transmissivity of 40,000 $ft^2/d$ and a Lower Floridan aquifer transmissivity of 10,000 $ft^2/d$ (Williams, 2010). Also, as a result of pumping during the 72-hr aquifer test in the Lower Floridan aquifer, a drawdown response of 0.43 to 0.76 ft was observed in nearby Upper Floridan aquifer wells, which indicated inter-aquifer leakage in response to the pumping.

The hydraulic properties of the middle confining unit were estimated with groundwater-flow model simulations (Clarke and others, 2010). The groundwater-flow model was calibrated to on-site hydrogeologic conditions by incorporating data from the packer and aquifer tests into the regional model by Payne and others, 2005. The calibrated model simulated a leakage response across the confining unit with a modeled vertical hydraulic conductivity of 0.020 ft/d, closely matching the low range of estimated vertical hydraulic conductivity from the packer tests.

A water-quality sample was collected from the Upper Floridan aquifer at a depth of 525 ft on June 22, 2009, and analyzed for major ions (fig. 18). Water from this interval is hard and contains a bicarbonate alkalinity of 150 mg/L, a chloride concentration of 48 mg/L, and a sulfate concentration of 29 mg/L. Concentrations are not dominated by any particular constituent. In the Lower Floridan aquifer, grab water samples were collected from five discrete depths on June 22, 2009, and analyzed for major ions. The samples show a transition with depth, from slightly sodium-dominated mixed-anion water type in the Upper Floridan aquifer at 525 ft to a strong sodium-chloride water type in the Lower Floridan aquifer at 1,075 ft. Water from the Lower Floridan aquifer is hard to very hard and contains a bicarbonate alkalinity of 150–250 mg/L. Data indicate that with the exception of fluoride, constituent concentrations increase with depth. Water from the deepest interval (1,075 ft) had a chloride concentration of 480 mg/L.

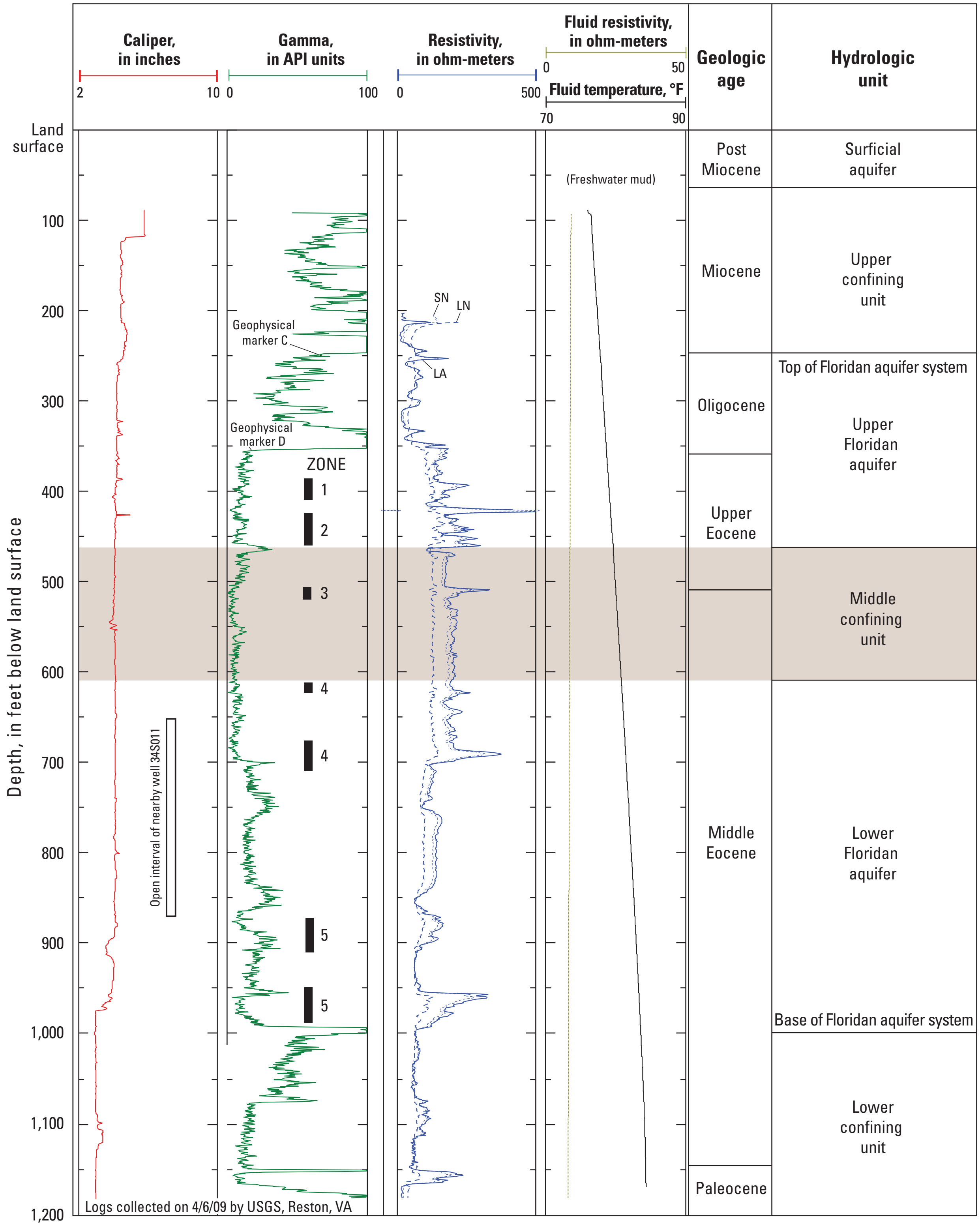



**Figure 16.** Borehole geophysical logs from core hole at Pineora, Effingham County, Georgia. Black bars denote water-bearing zones. Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [API, American Petroleum Institute; °F, degrees Fahrenheit; LN, long normal resistivity; SN, short normal resistivity, LA, lateral resistivity]

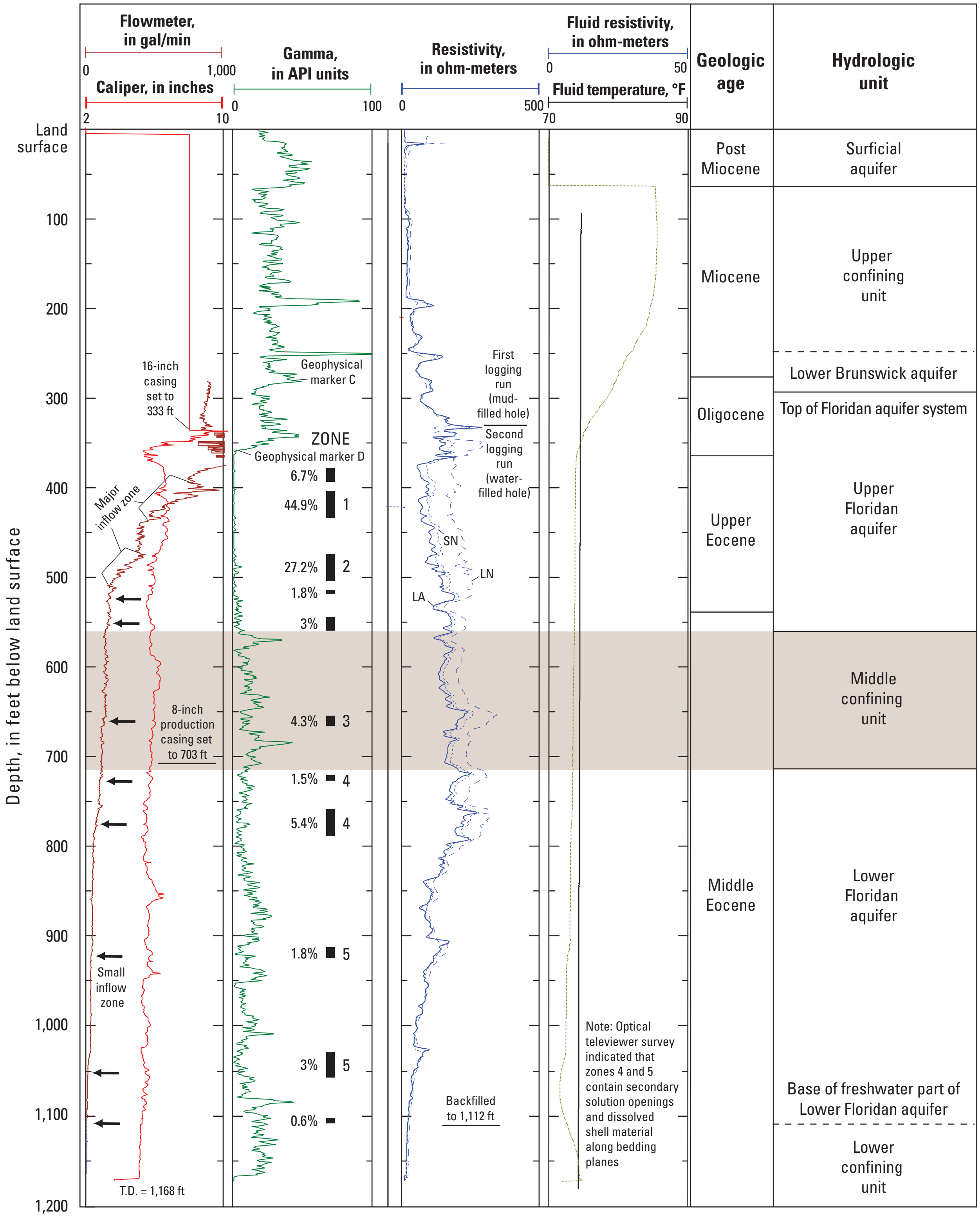



**Figure 17.** Borehole geophysical logs from Hunter Army Airfield well 11 (36Q392), Chatham County, Georgia. Black bars denote water-bearing zones with percentage of flow determined from pumping flowmeter test while pumping 846 gal/min (open from 333 to 1,112 ft). Zones 1 through 5 correlate to water-bearing zones previously defined in the area by McCollum and Counts (1964). [gal/min, gallon per minute; API, American Petroleum Institute; °F, degrees Fahrenheit; ft, feet; T.D., total depth; LN, long normal resistivity; SN, short normal resistivity; LA, lateral resistivity]

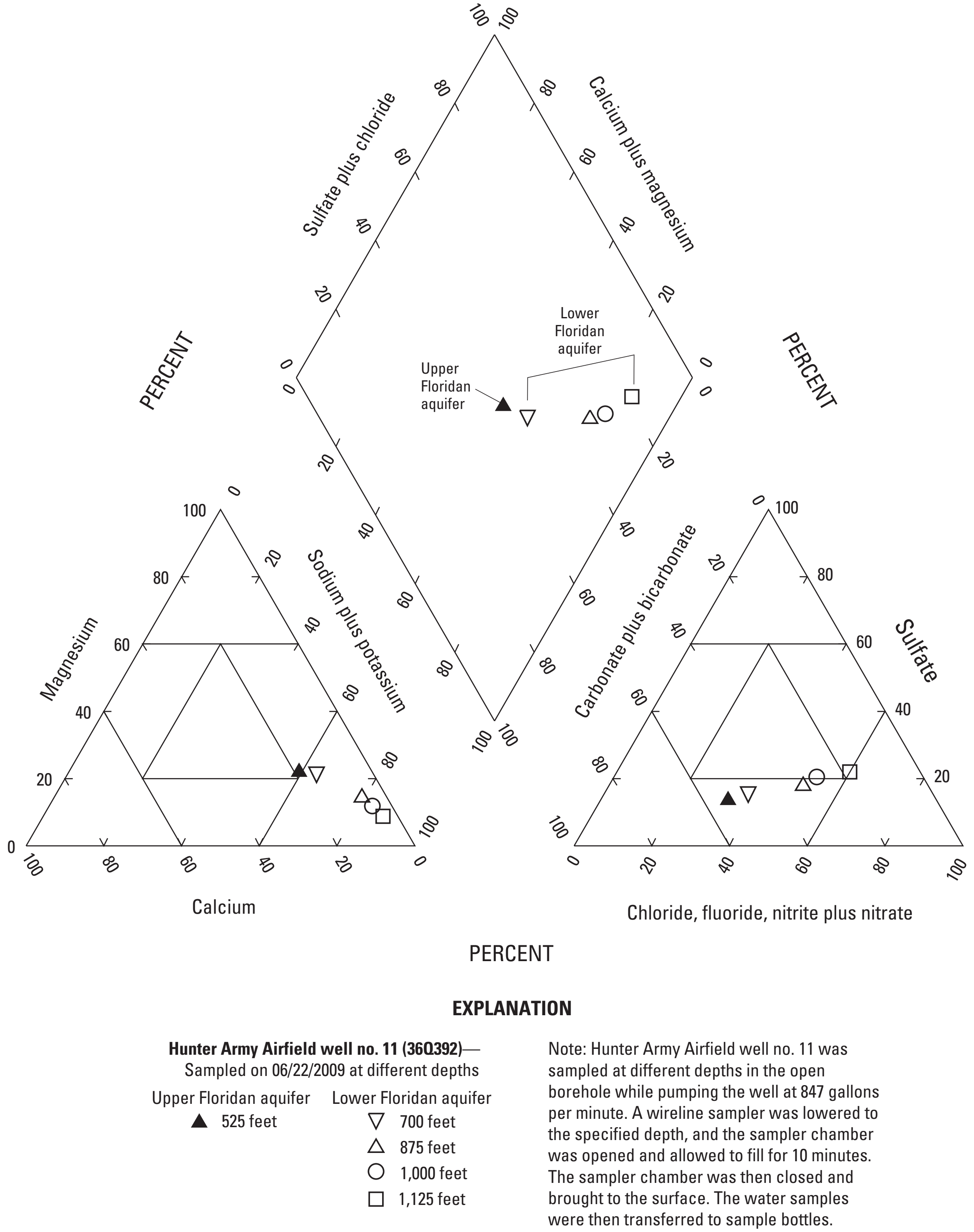



**Figure 18.** Piper diagram showing major cation and anion composition of grab water samples collected from Hunter Army Airfield well no. 11 (36Q392) at different depths in the Floridan aquifer in Chatham County, Georgia. [Note: Water sample data can be obtained from *http://waterdata.usgs.gov/ga/nwis/qw.*]

## Revised Interpretation of the Hydrogeologic Framework

Using the results of field investigations at the aforementioned sites and the borehole geophysical logging and flowmeter surveys from additional wells in the study area, the hydrogeologic framework of the Floridan aquifer system has been revised from the original definition of Miller (1986). The revision of the hydrogeologic framework provides a more consistent correlation of the thickest and most areally extensive zone of low permeability (confining unit) that occurs in the Floridan aquifer system in the northern coastal area. Data from numerous test sites indicate that the thickest and most areally extensive zone of low permeability lies between zone 2 and zone 4 as previously described by McCollum and Counts (1964). Water quality above and below this interval differs; the lower interval has generally higher concentrations of dissolved constituents. In addition, water levels in well clusters completed above and below this interval had varying amounts of head difference. This interval provides hydraulic separation between the Upper and Lower Floridan aquifers and is, herein, designated the middle confining unit.

The revised framework presented below includes (1) an updated map showing the altitude of the top of the Upper Floridan aquifer using the "C" geophysical marker horizon; (2) a map showing the altitude of the top of the uppermost major permeable zone of the Upper Floridan aquifer using the "D" geophysical marker horizon; (3) an updated map showing the altitude of the top of the base of the Upper Floridan aquifer (top of the middle confining unit); (4) an updated map showing the altitude of the top of the Lower Floridan aquifer, which is mapped at the top of the first major water-bearing zone below the middle confining unit; (5) updated maps of the thicknesses of the Upper Floridan aquifer, middle confining unit, and Lower Floridan aquifer; (6) delineation of a local water-bearing zone in Chatham County, GA, within the upper confining unit of the lower Brunswick aquifer (Clarke and others, 1990); and (7) a series of hydrogeologic cross sections showing the permeable zones and confining units (plates 2 and 3). A summary of the hydrogeologic data compiled as part of the new interpretation is provided in Appendix A for reference.

The depths of the mapping horizons with respect to the major and minor hydrogeologic units are shown in figure 19. Because individual permeable zones that compose the Upper and Lower Floridan aquifers essentially lie parallel to textural variations related to depositional facies, these zones were mapped to be generally parallel to stratigraphic boundaries. One of the key stratigraphic horizons used to help guide the correlation of hydrogeologic units was the top of the middle Eocene (Miller, 1986), as shown in figure 20. The configuration of the middle Eocene structural surface generally strikes in an east-west direction and dips gently to the south at an average rate of about 7.5 ft/mi.

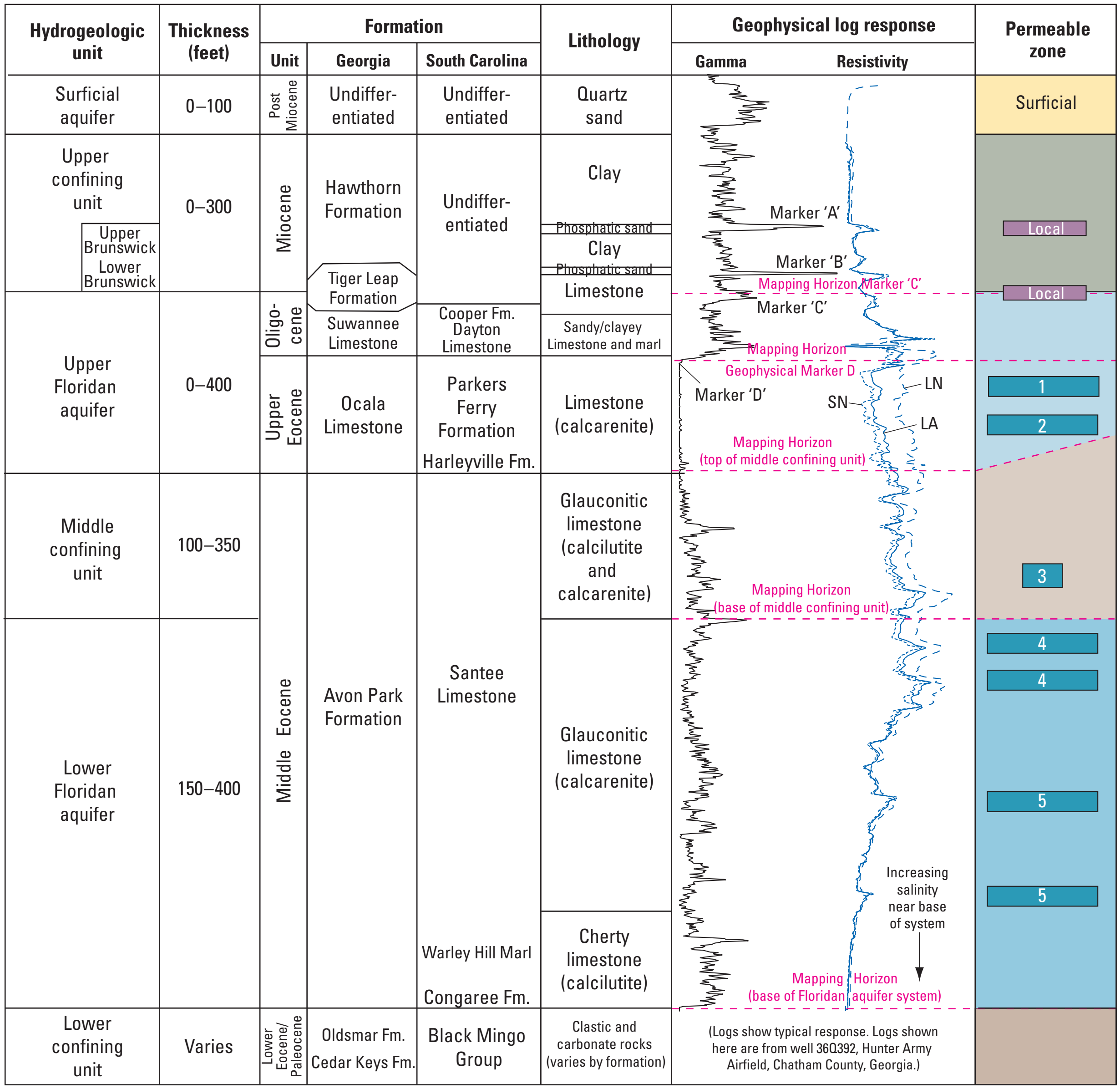
The top of the middle Eocene is a reliable marker horizon and guide for mapping the middle confining unit and permeable zones in the Lower Floridan aquifer in the area of Chatham County and farther south. In these areas, the middle Eocene surface generally coincides with the top of the middle confining unit (and base of the Upper Floridan aquifer). The first major permeable zone (the Lower Floridan aquifer) generally lies between 50 and 150 ft below the top of the middle Eocene horizon.

A series of detailed hydrogeologic cross sections were constructed to determine the stratigraphic position and correlation of individual permeable zones across the area and to determine the location and extent of the confining unit separating the highly-productive upper zones from the less-productive lower zones. The locations of the cross sections are shown in figure 3, and the sections are presented in plates 2 and 3.

Generalized versions of three cross sections are presented in figures 21–23 to illustrate revisions to Miller's (1986) hydrogeologic framework. One of the biggest changes made to the framework deals with the position of the middle confining unit in relation to the Upper and Lower Floridan aquifers. For example, cross section *A–A′* (fig. 21), oriented north-south and parallel to the dip of the major rock units, illustrates the revised position of the middle confining unit separating the Upper and Lower Floridan aquifers. In the revised framework, the middle confining unit is now mapped in the upper 50 to 200 ft of the middle Eocene unit and divides the system into a thinner, high-permeability Upper Floridan aquifer and a thicker low-permeability Lower Floridan aquifer as opposed to the previous framework, which lumped a thicker section of upper and middle Eocene into the Upper Floridan aquifer, such as in parts of Chatham County, GA, and depicted a thinner Lower Floridan aquifer in most of the northern section of the study area. In the revised framework, these rocks are now included in the middle confining unit on the basis of new flowmeter testing (described previously). Because the top of the middle confining unit is now mapped higher in the stratigraphic section, the Lower Floridan is accordingly thickened throughout the northern area. As shown in figures 21–23, a substantial thickness (200–450 ft) of Lower Floridan aquifer is now recognized to lie below the middle confining unit; previously, this aquifer was thought to be thin to absent in this area.

Another major change in the framework is that in the area of Beaufort and parts of Jasper Counties, SC, the Upper Floridan aquifer is now restricted to permeable sections of Oligocene and late Eocene (Ocala) limestone. For example, on cross section *B–B′* (fig. 22) between Skidaway Island, GA, and Hilton Head Island, SC, this new geometry better represents the distribution of permeable zones mapped in that area (Gawne and Park, 1992). In the revised framework, the middle confining unit is interpreted to be much thicker along this trace when compared to Miller's (1986) original framework.

In the Savannah area, the middle confining unit encompasses the lowest part of the upper Eocene and the upper part of the middle Eocene and lies roughly between –400 to –600 ft NGVD 29 (fig. 23). The confining unit thickens eastward because of the inclusion of finer-grained upper Eocene rocks




## EXPLANATION

**Hydraulic unit**

- Surficial aquifer
- Brunswick aquifer
- Upper confining unit
- Upper Floridan aquifer
- Middle confining unit
- Lower Floridan aquifer
- Lower confining unit

5 **Permeable zone**—Number refers to similar water-bearing zones previously defined by McCollum and Counts (1964). Upper two local zones correlate to upper and lower Brunswick aquifers. Local zone shown in Oligocene is a water-bearing zone identified in the Tiger Leap Formation in Chatham County, Georgia.

**Type of Log**

LN = long normal resistivity

SN = short normal resistivity

LA = lateral resistivity

**Figure 19.** Hydrogeologic units and confining beds of the Floridan aquifer system showing representative log response and location of permeable zones and mapping horizons. [Fm., formation]

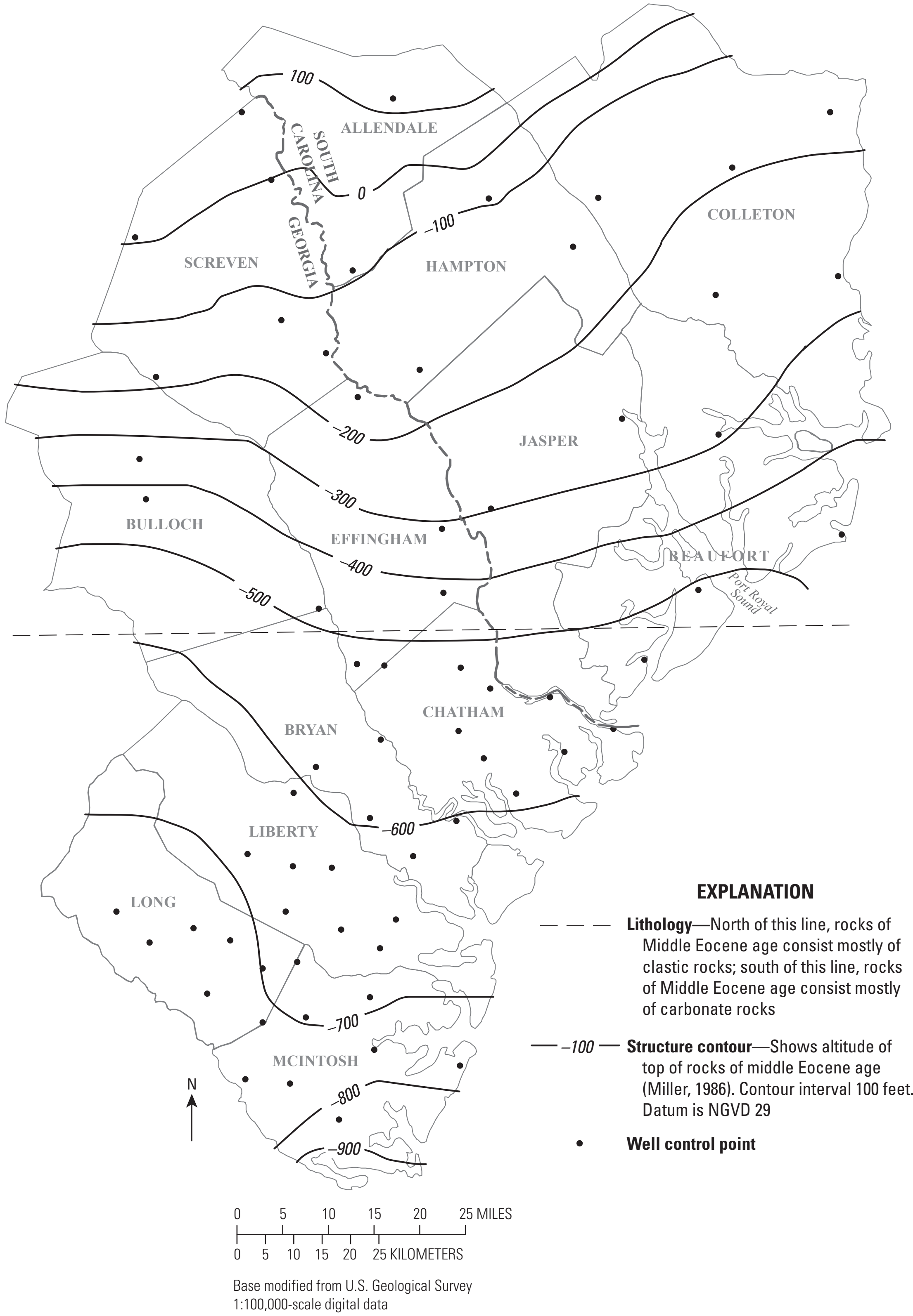



**Figure 20.** Altitude of the top of rocks of Middle Eocene (Miller, 1986) showing lithology of major rock type.

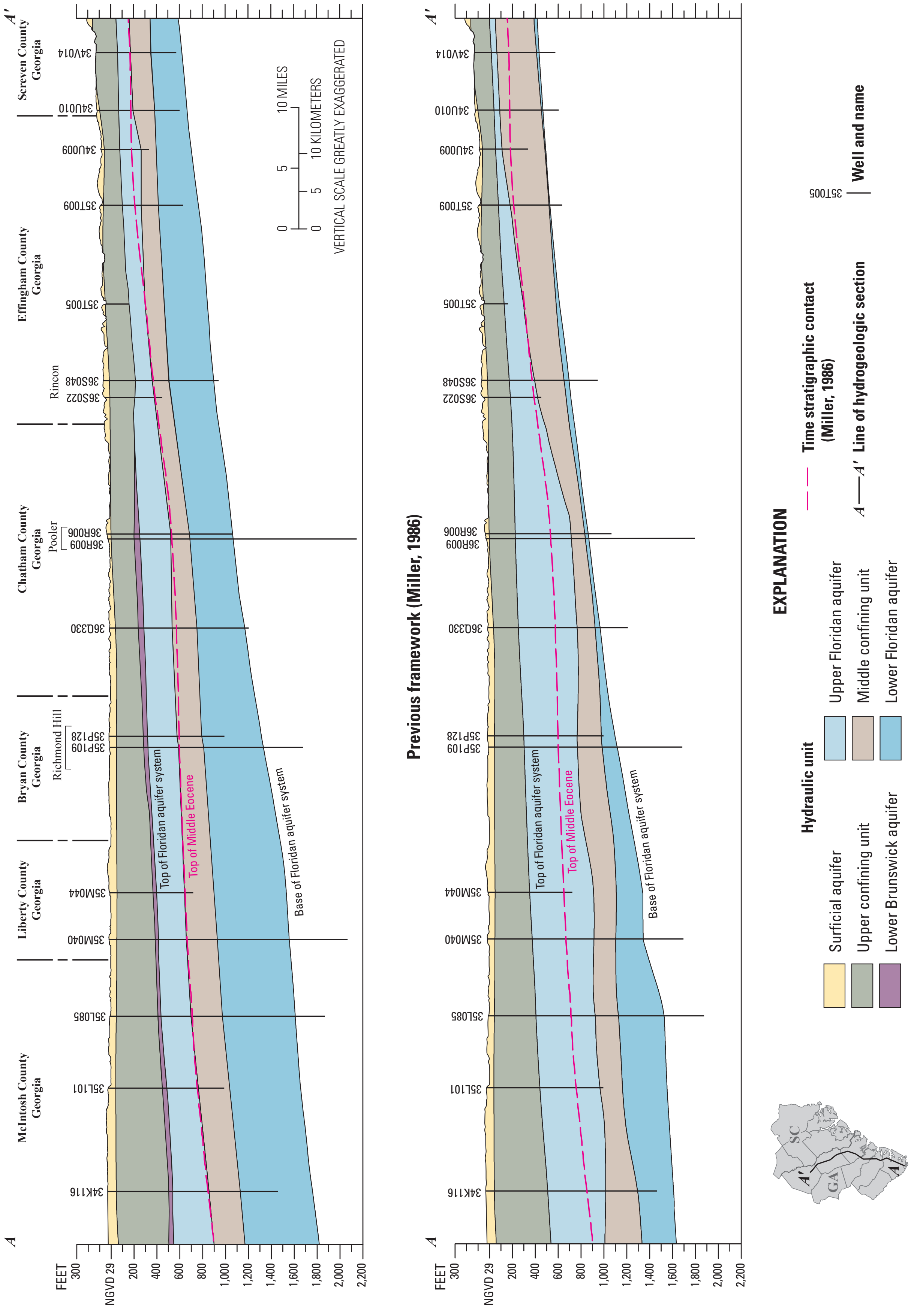



**Figure 21.** Hydrogeologic cross section *A–A′* from well 34K116, McIntosh County, Georgia, to well 34V014, Screven County, Georgia, showing aquifers and confining units of the Floridan aquifer system for the revised framework and the previous framework by Miller (1986).

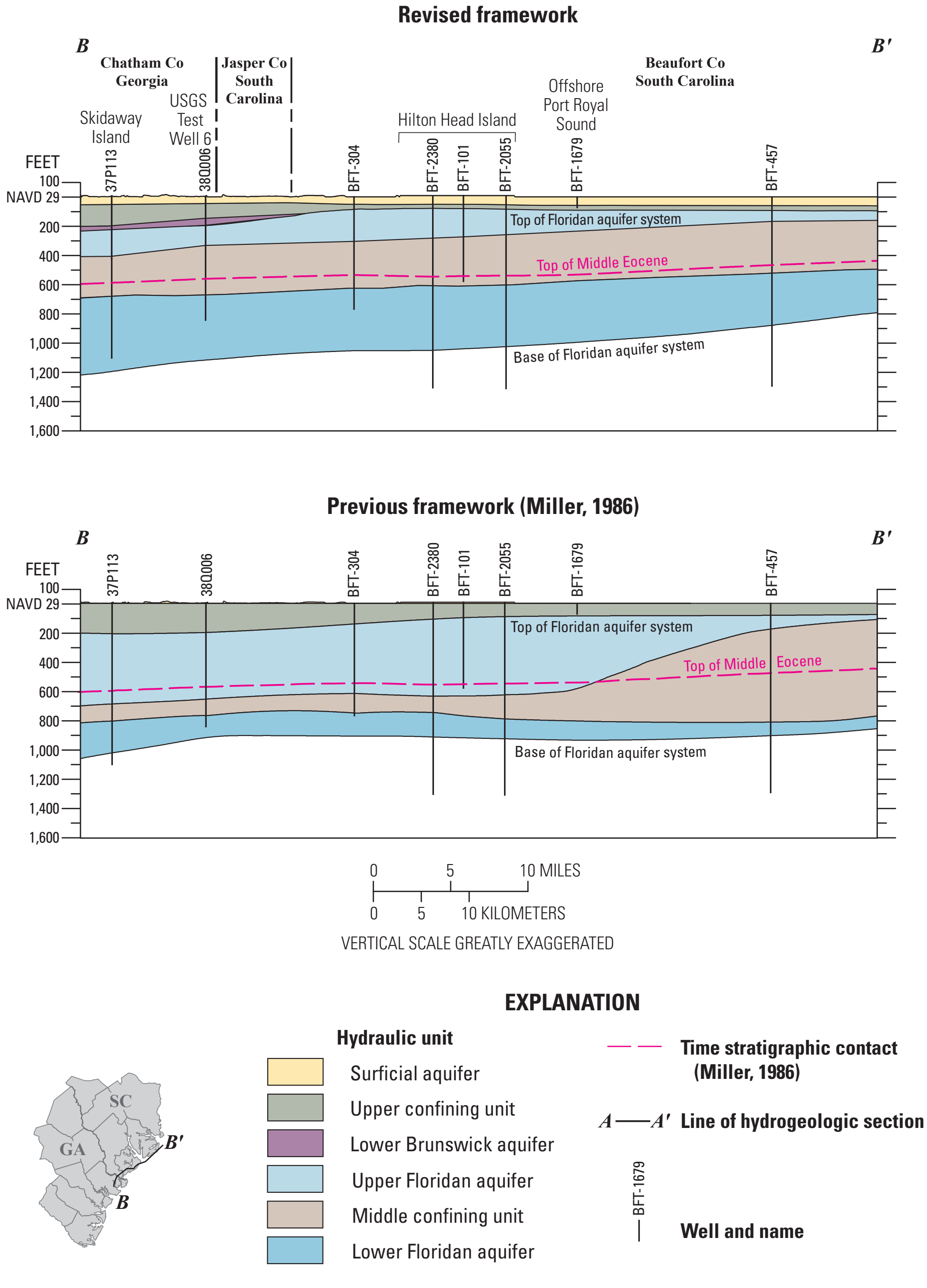



**Figure 22.** Hydrogeologic cross-section *B–B′* from well 37P117, Skidaway Island, Chatham County, Georgia, to well BFT-457, Fripps Island, Beaufort County, South Carolina, showing aquifers and confining units of the Floridan aquifer system for the revised framework and the previous framework by Miller (1986).

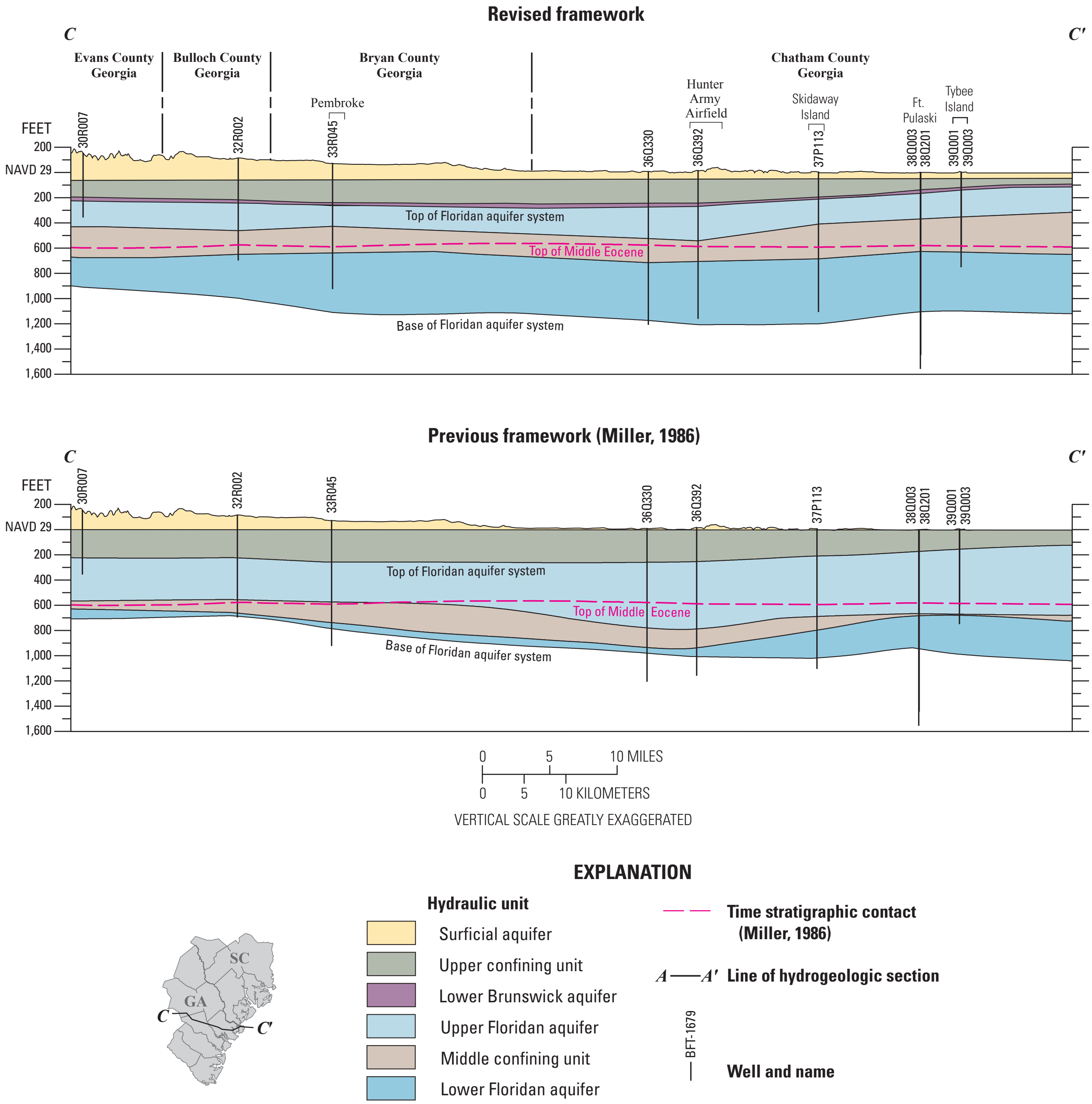



**Figure 23.** Hydrogeologic cross section *C–C′* from well 30R007, Evans County, Georgia, to well 39Q003, Chatham County, Georgia, showing aquifers and confining units of the Floridan aquifer system for the revised framework and the previous framework by Miller (1986).

in the Ridgeland Trough area of cross section *C–C′*. Placement of the middle confining unit at this interval has been well established by flowmeter surveys conducted in or near the City of Savannah, GA. The lower part of the upper Eocene rocks in this area does not supply appreciable amounts of water to wells that intersect these rock units; therefore, the upper Eocene rocks are included as part of the confining unit rather than the Upper Floridan aquifer as described by Miller (1986).

Based on the revised hydrogeologic framework, existing wells were evaluated to determine the aquifer(s) tapped by each well. Descriptions of hydraulic properties in subsequent sections reflect the changes resulting from this evaluation.

## General Configuration and Extent of the Floridan Aquifer System

The Floridan aquifer system in the northern coastal area of Georgia and parts of South Carolina is composed mostly of permeable carbonate rocks of Oligocene and Eocene age that lie between low-permeability carbonate and clastic rocks (and sediments) that compose the *upper confining unit* and low-permeability carbonate and clastic rocks that compose the *lower confining unit*. The Floridan aquifer system consists primarily of interbedded limestone, calcareous sand, and clay in the updip area of South Carolina and massive limestone, dolomitic limestone, and dolomite in the downdip areas of Georgia. These beds are hydraulically connected to varying degrees but are divided into the Upper and Lower Floridan aquifers.

The top of the Floridan aquifer system over most of the study area is marked by Oligocene carbonate rocks (Suwannee Limestone or equivalent) where these rocks are in hydraulic connection with the underlying upper Eocene carbonate rocks (Ocala Limestone). In other areas, the upper Eocene rocks mark the top of the system, such as in South Carolina where Oligocene rocks were never deposited or have been eroded. In the updip areas of South Carolina, the calcareous clastic rocks that make up the top of the aquifer system consist of fossiliferous, argillaceous, glauconitic, and calcareous clay that are part of one or more formations in the Barnwell Group (fig. 3). In the extreme updip part of the aquifer, the lower part of the middle Eocene Santee Limestone forms the top of the system, and the permeable part of the aquifer is the Lower Floridan aquifer.

The base of the Floridan aquifer system in Georgia is marked by relatively low-permeability lower Eocene rocks of the Oldsmar Formation (fig. 3), a chalky, glauconitic, gypsiferous limestone and dolomite. Farther to the north, lower Eocene permeable clastic rocks are hydraulically connected to the Lower Floridan aquifer (Krause and Randolph, 1989), and rocks of Paleocene age in that area generally form the base of the aquifer. In the extreme northern part of the study area in South Carolina, the base of the aquifer system is marked by the lower Eocene Fishburne Formation and clastic rocks of the Black Mingo Group. In the extreme southern part of the study area, Miller (1986) and Krause and Randolph (1989) mapped the base of the system at the top of the lower Eocene Cedar Keys Formation. The Cedar Keys Formation generally forms the base of the system in northeastern Florida and extreme southeastern Georgia. Rocks of the Cedar Keys Formation are dolomitic limestone and dolomite with extensive interbedded anhydrite layers (Miller, 1986).

The thickness of the Floridan aquifer system varies tremendously across the area but generally thickens to the south and reaches a maximum thickness of about 1,200 ft in the southern part of McIntosh County, GA. In the updip part of the aquifer system in South Carolina, the limestone is thin, ranging from 20 to 80 ft in thickness (Krause and Randolph, 1989). In that area, the Upper Floridan aquifer is absent (Hayes, 1979) and the Lower Floridan aquifer is the productive part of the aquifer system. The updip limit of the aquifer system is placed along the southwestern edge of Colleton and northeastern edge of Allendale Counties, SC, where clastic units make up more than 50 percent of the section. As indicated by Krause and Randolph (1989) with model simulations, however, the hydraulic properties of updip-equivalent clastic units are similar to those of the Floridan aquifer system and, therefore, are considered part of an overall hydraulically connected aquifer system.

## Upper Confining Unit and Lower Brunswick Aquifer

The upper confining unit consists mostly of low-permeability clays, silt, and fine sand of the Miocene unit and includes some sediments in the uppermost part of the Oligocene unit, as identified by Weems and Edwards (2001). Overall, Clarke and others (1990) identified two permeable sections within the upper confining unit—the upper and lower Brunswick aquifers. The two aquifers consist of poorly sorted fine-to-coarse phosphatic, slightly dolomitic sand; the upper Brunswick aquifer occurs between geophysical markers A and B, and the lower Brunswick aquifer occurs between markers B and C. Clarke and others (1990) identified the lower Brunswick entirely within Miocene sediments and indicated it was absent in the Savannah and Bulloch County areas because sediments were eroded or never deposited. Studies by Weems and Edwards (2001) indicate that sediments equivalent to the lower Brunswick aquifer are present in that study area and were identified as part of the Oligocene-Miocene Tiger Leap Formation.

The depth, thickness, and water-bearing properties of the lower Brunswick aquifer were evaluated at several test sites in the northern coastal area as part of the GAEPD's Miocene Aquifer Study in coastal Georgia. Golder and Associates, Inc., completed a test well in the lower Brunswick aquifer at Pooler, Chatham County, GA, based on the work of Clarke and others (1990) and Weems and Edwards (2001). The Pooler well was completed between geophysical markers B and C. A 72-hr aquifer test run at 30 gal/min indicated a transmissivity of about 200 $ft^2/d$ (table 3).

**Table 3.** Summary of aquifer-test data from selected test wells in the lower Brunswick aquifer, Chatham County, Georgia.

[USGS, U.S. Geological Survey; land-surface altitude is referenced to National Geodetic Vertical Datum of 1929; ft, foot; gal/min, gallon per minute; (gal/min)/ft, gallon per minute per foot; $ft^2/d$, square foot per day; —, no data; T, transmissivity]

| USGS well name (fig. 24) | Other identifier | Land-surface altitude (ft) | Thickness of lower Brunswick aquifer (ft) | Open interval (ft) | Date(s) tested | Duration (hours) | Pumping rate (gal/min) | Draw-down (ft) | Specific capacity [(gal/min)/ft] | Transmissivity ($ft^2/d$) | Storage (dimensionless) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36Q393 | Cottenvale | 14 | 60 | 252–318 | 11/9/2003 | 24 | 93 | 163.59 | 0.57 | 200 | — | T calculated from drawdown using Cooper-Jacob, 1946, solution. |
| 36Q394 | Enclave | 12 | 65 | 260–320 | 7/23/2003 | 20 | 200 | 136.60 | 1.46 | 500 | — | T calculated from drawdown using Cooper-Jacob, 1946, solution. |
| 36Q395 | Willow Lakes | 8 | 70 | 260–340 | 8/11/2004 | 24 | 164 | 170.00 | 0.96 | 500 | — | T calculated from drawdown using Cooper-Jacob, 1946, solution. |
| 35Q052 | CB-3 | 20 | 50 | 254–304 | 7/29/2002 to 8/1/2002 | 72 | 30 | 57 | 0.53 | 183–242 | $9.34 \times 10^{-5}$ | Multiwell test conducted by Golder and Associates, Inc. (2003); various solutions used. |

The first successful lower Brunswick aquifer production well was completed in Chatham County, GA, in the spring of 2002 by Consolidated Utilities. During that study, a total of three test wells were drilled to determine the best location for a production well in the lower Brunswick aquifer (fig. 24). The well site at Enclave (well 36Q394) showed the best potential, and a 24-hr aquifer test of that well indicated a transmissivity of about 500 $ft^2/d$ at a pumping rate of 200 gal/min (table 3).

Another lower Brunswick production well (36Q393) was drilled in Chatham County, GA, at the Cottenvale site in 2003 (fig. 24; table 3). The Cottenvale test site is located just southeast of Berwick Plantation. The aquifer was not as productive at this site having a transmissivity of only 200 $ft^2/d$ at a pumping rate of less than 100 gal/min.

A third lower Brunswick well (36Q395) was drilled at the Willow Lakes site in 2004 (fig. 24). The transmissivity at this site was reported to be 500 $ft^2/d$ at a pumping rate of 164 gal/min (table 3).

Water levels in a lower Brunswick aquifer well (36Q332) and a nearby Upper Floridan aquifer well (36Q331) have been monitored continuously at the Enclave site since 2004 by Consolidated Utilities. During 2008 (fig. 25), the water level fluctuated a maximum of 9.8 ft in the lower Brunswick aquifer well compared to 7.9 ft in the Upper Floridan aquifer well, and the lower Brunswick aquifer water-level altitude averaged 5.2 ft higher than the Upper Floridan aquifer water-level altitude. This difference in water-level altitudes in the two aquifers at Enclave is similar to the water levels observed in similarly constructed wells in the City of Pooler, Chatham County, GA (Golder and Associates, Inc., 2003).

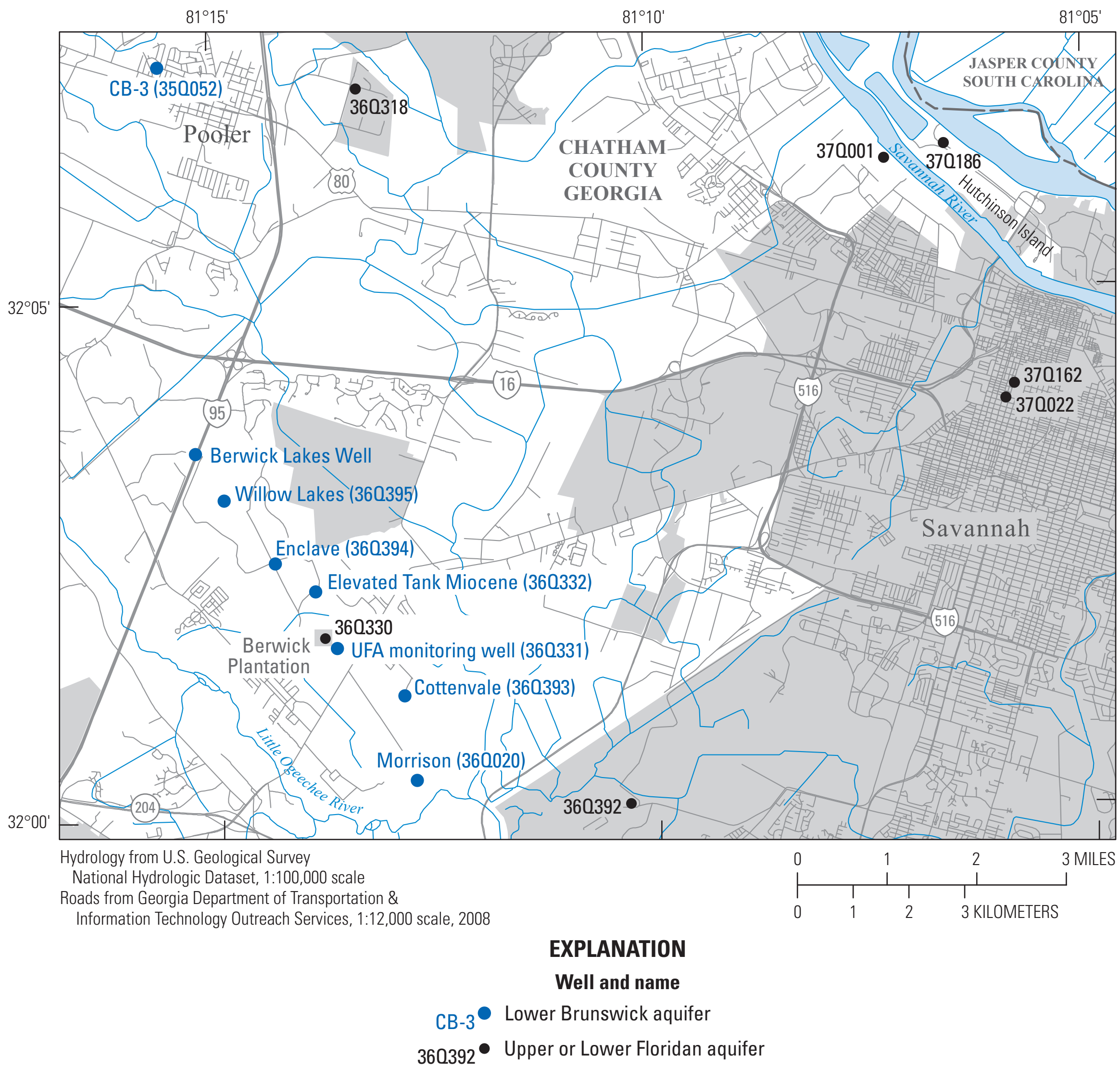



**Figure 24.** Locations of lower Brunswick aquifer and Upper (UFA) or Lower Floridan aquifer wells described in this report, Chatham County, Georgia.

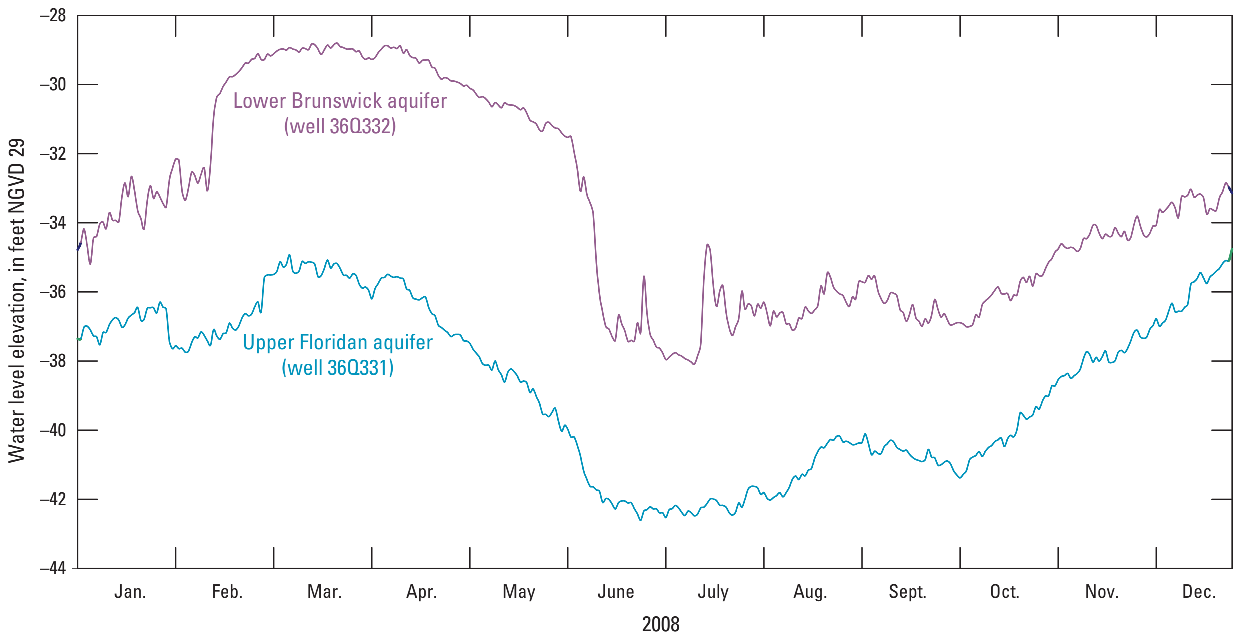



**Figure 25.** Water levels in the lower Brunswick and Upper Floridian aquifers at Berwick Plantation, Chatham County, Georgia (data provided by Consolidated Utilities).

## Upper Floridan Aquifer

The Upper Floridan aquifer is composed of hydraulically connected permeable carbonate rocks in all or part of Oligocene and upper Eocene (fig. 19). This aquifer includes permeable zones 1 and 2, defined by McCollum and Counts (1964), and is the most transmissive part of the Floridan aquifer system. The aquifer lies between low-permeability clay and very fine sand of the upper confining unit and fine-grained carbonate rocks of the middle confining unit. The general configuration of the Upper Floridan aquifer is depicted in maps of the altitude of the top of the Upper Floridan aquifer, using geophysical marker C (fig. 26); the altitude of the top of the upper Eocene rocks (first highly permeable section), using geophysical marker D (fig. 27); and the base of the Upper Floridan aquifer (top of the middle confining unit), using flowmeter and geophysical log data (fig. 28).

The altitude of the top of the Upper Floridan aquifer was contoured by using geophysical marker C identified in 422 geophysical logs distributed throughout the area. The points used in constructing this map include most of the wells used by Clarke and others (1990) and additional points added in the South Carolina area. As described previously, this horizon generally lies at the top of the Oligocene unit (Suwannee Limestone or equivalent). Where the C marker is absent, the top of the Ocala Limestone or geophysical marker D was used.

The surface contours of the Upper Floridan aquifer trend east-west, generally conforming to a regional southward dip. Superimposed on the regional dip are locally pronounced highs and lows on the surface that are probably the result of either subareal erosion when the limestone was at the surface or from subsurface solution of the limestone and formation of karst features, such as sink holes and solution valleys (fig. 26). The altitude of the surface decreases southward at an average rate of about 8 ft/mi.

In the eastern part of the study area, including Chatham County, GA, and Jasper and Beaufort Counties, SC, the top of the Upper Floridan aquifer is markedly influenced by the Beaufort Arch. From Bulloch, Bryan, and Effingham Counties, GA, the contours trend west to east and bend sharply southward around the western flank of the Beaufort Arch (fig. 26). At its shallowest depths, the top of the Upper Floridan aquifer is within 10 to 20 ft of land surface and, in places, is exposed forming windows beneath the Port Royal Sound area of Beaufort County, SC. These windows provide preferential pathways for seawater to enter the aquifer and have been a focus of study by the SCDHEC (Camille Ransom, III, South Carolina Department of Health and Environmental Control, oral commun., 2009).

Although the Suwannee Limestone is not very permeable and is not a primary source of water supply, it is included in the Upper Floridan aquifer because it is, to varying degrees, hydraulically connected to the main part of the Upper Floridan aquifer. In South Carolina, the Suwannee Limestone is the Oligocene-age equivalent of the less permeable Cooper Formation (fig. 3). In some parts of Chatham and Bryan Counties, GA, the Suwannee Limestone separates the main part of the Upper Floridan from the overlying aquifers because it is of lower permeability than the underlying or overlying units.

The main part of the Upper Floridan aquifer is composed of rocks of upper Eocene age, including the Ocala Limestone in Georgia and the Parkers Ferry Formation in South Carolina

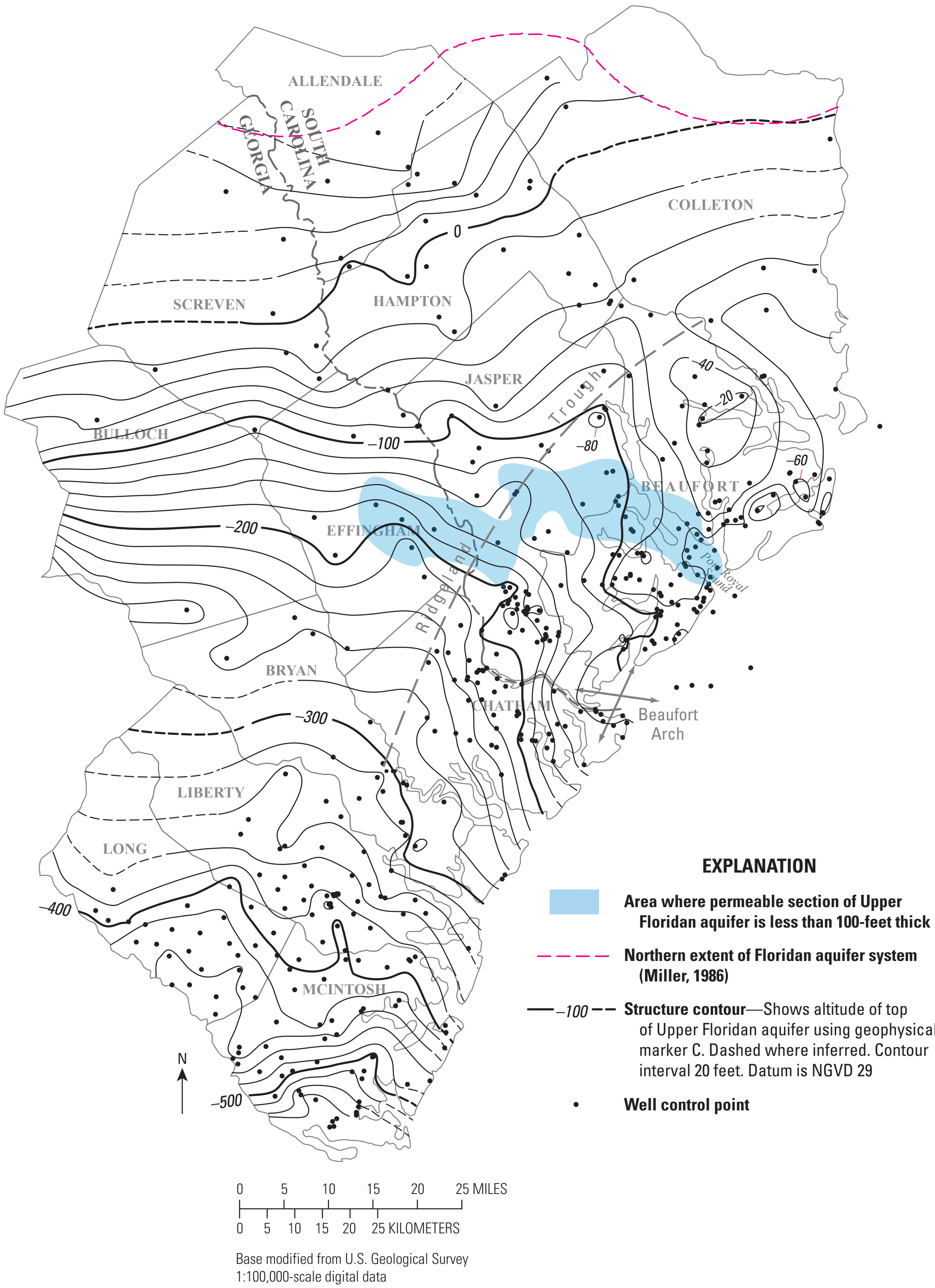



**Figure 26.** Altitude of the top of the Upper Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina, using geophysical marker C.

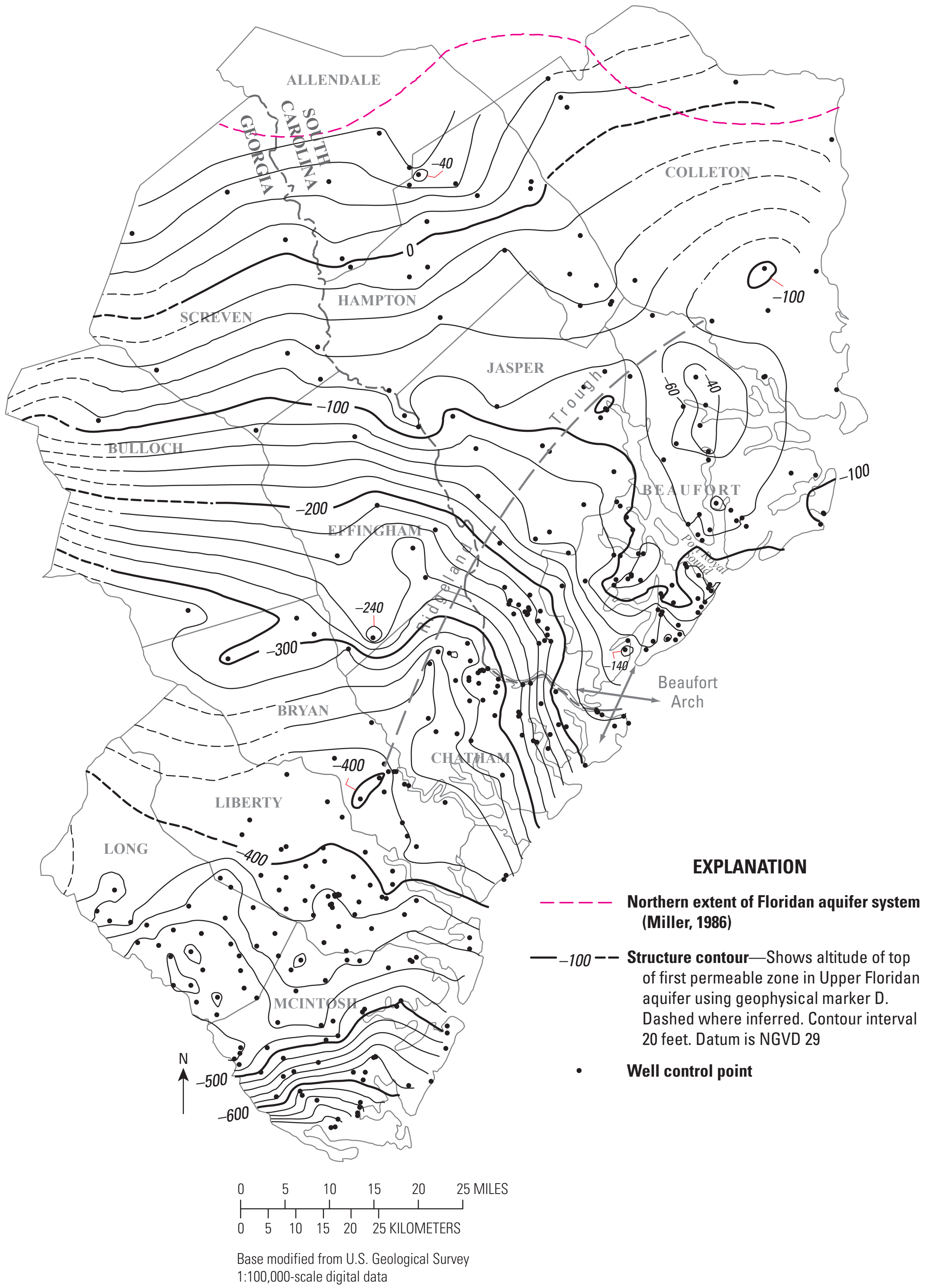



**Figure 27.** Altitude of the top of the upper Eocene rocks (first major permeable zone) in the Upper Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina, using geophysical marker D.

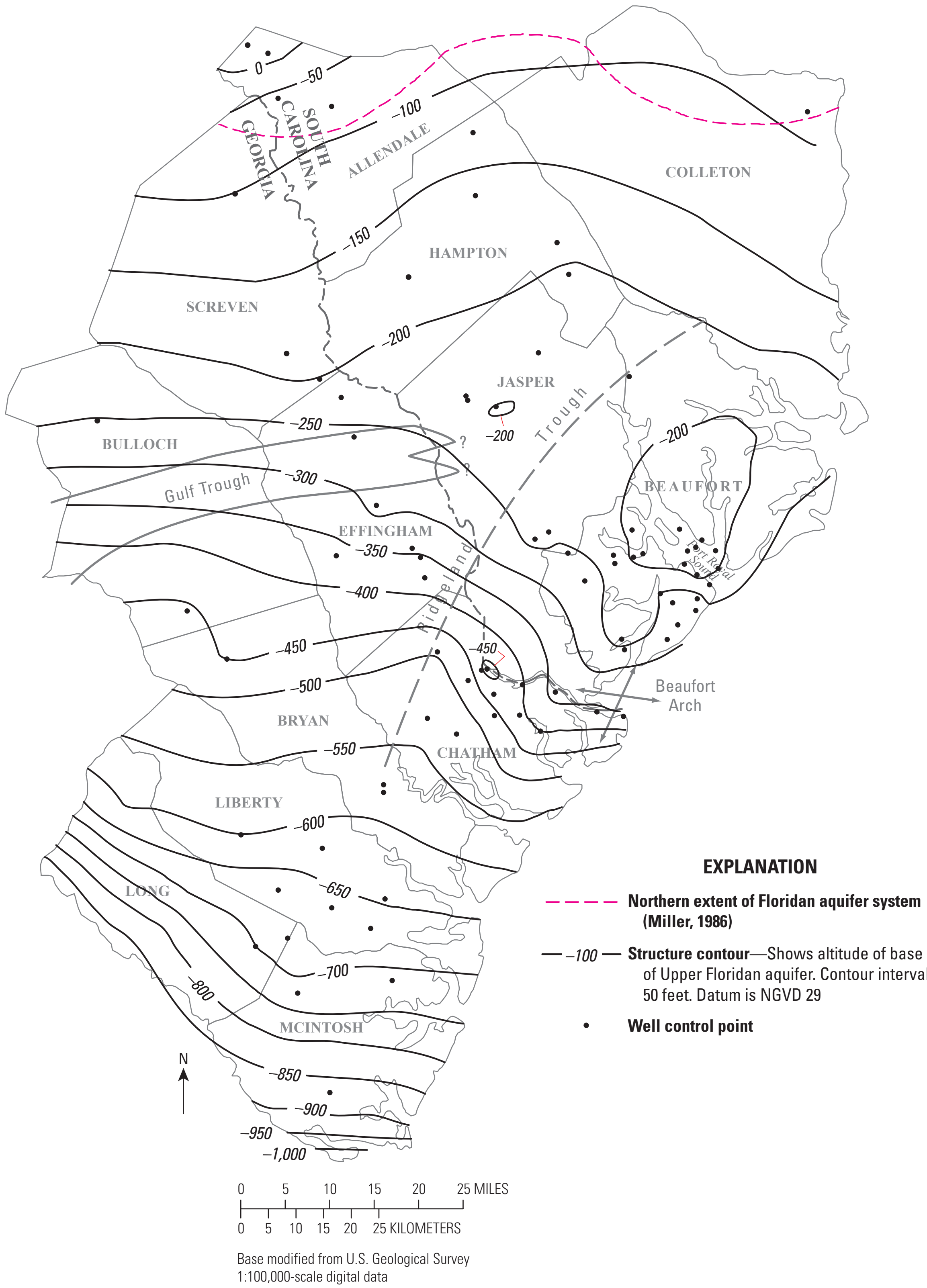



**Figure 28.** Altitude of the base of the Upper Floridan aquifer (top of middle confining unit) in the northern coastal area of Georgia and parts of South Carolina, using flowmeter and geophysical log data.

(fig. 19). The top of this permeable section was contoured by using geophysical marker D identified from 353 borehole geophysical logs (fig. 27). The permeability of the rocks beneath marker D is probably one to two orders of magnitude greater than the overlying and underlying carbonate rocks. This zone supplies most of the water to high-capacity municipal and industrial wells in the area.

At the base of the Upper Floridan aquifer, the permeability decreases vertically, either at a sharp contact or gradually over several tens of feet; the boundary between high and low permeability is marked neither by distinctive lithology nor by any other mapping criteria that have been found; thus, the boundary had to be defined hydraulically by means of geophysical logs and flowmeter surveys. In this study, the boundary of decreased permeability was mapped by using both geophysical-log responses in electrical resistivity and(or) where flowmeter logs indicated little or no flow from the lower carbonate units beneath the highly productive zones of the Upper Floridan aquifer (see section, "Hydrogeologic Data from Selected Test Sites").

Using the criteria described above, the altitude of the base of the Upper Floridan aquifer was re-mapped and given a new configuration on top of the middle confining unit (fig. 28). In general, this surface dips gently to the south at a rate of about 8 ft/mi, which is about the same rate as the regional dip of other rock units in this area. The similarity of dip for both the geologic and hydrogeologic units is a result of the reduced permeability that typically lies near the contact of the middle Eocene unit. The zone of reduced permeability is not always at this contact, however. In some areas, such as beneath Hilton Head Island, SC, the zone of reduced permeability is within the shallower upper Eocene Parkers Ferry/Harleyville Formations and ranges from several tens of feet up to 200 ft above the middle Eocene contact.

### Thickness and Extent

Using the updated top and base of the Upper Floridan aquifer (figs. 26, 28), the thickness of the aquifer was mapped (fig. 29). In general, the Upper Floridan aquifer is thickest and most productive to the south because of the thicker section of upper Eocene rocks in Bryan, Liberty, Long, and McIntosh Counties, GA. The aquifer is thinnest and least productive in the extreme northern part of the study area in South Carolina. The Upper Floridan aquifer is reportedly absent (or nonproductive) over much of Colleton County, SC (Hayes, 1979). In the Savannah area, the aquifer thickens to 200–300 ft and is thickest in Long and McIntosh Counties, GA, where it exceeds 400 ft.

As described above, the most permeable part of the Upper Floridan aquifer lies between geophysical marker D and the top of the middle confining unit. The thickness of this permeable section generally follows the same pattern described above except for an area north and west of Hilton Head Island, SC, where the base of the aquifer is higher in the section and, therefore, the aquifer is thinner in these areas. The shaded area in figure 29 shows where the permeable part of the Floridan aquifer is less than 100 ft thick. Groundwater flow rates may by higher in this thinner part of the aquifer than in adjacent thicker parts of the aquifer.

### Permeable Zones

All of the highly permeable zones in the Upper Floridan aquifer occur between geophysical marker D and the top of the middle confining unit. The number, thickness, and vertical separation between these permeable zones vary considerably from well to well and across the study area.

Although McCollum and Counts (1964) initially identified two major permeable zones in this part of the aquifer, newly collected flowmeter data indicate that two distinct zones may not always be present. At the City of Richmond Hill in Bryan County, GA, a flowmeter test of well 35P128 (Harris Trail) in the Lower Floridan aquifer identified a single, continuous, 139-ft thick zone that produced water equally throughout the interval (fig. 8*B*). No distinct separation of zones 1 and 2 was apparent at this well. In another well (36Q392) at Hunter Army Airfield in Chatham County, GA, at least five distinct zones were distinguished in the Upper Floridan aquifer, which indicated a higher degree of zonation in this well; the two principal zones (marked as zones 1 and 2 in fig. 17) were each 30 ft thick and produced more than 70 percent of the total flow. Similar observations were made on other flowmeter tests conducted in the area (McCollum and Counts, 1964).

In as much as some zonation of flow was identified in this aquifer, the vertical separation between the zones is typically only tens of feet apart with fairly permeable strata between the productive zones. Because of this, the Upper Floridan aquifer generally can be thought of as a single productive zone rather than consisting of one or more thin permeable zones.

### Hydraulic Properties

The hydraulic properties of the Upper Floridan aquifer vary by orders of magnitude across the study area. Based on the revised hydrogeologic framework, existing wells were reevaluated to determine which aquifer(s) were tapped by these wells, and the previous available aquifer-test data (Clarke and others, 2004) were placed in context with the new framework.

The revised database indicates that the transmissivity of the Upper Floridan aquifer ranges from 900 $ft^2/d$ in Hampton County, SC, to 250,000 $ft^2/d$ in Long County, GA (fig. 30). The lowest transmissivity values were reported for wells in the northern part of the study area and generally coincide with areas where the aquifer is thinnest and where the aquifer transitions into mostly clastic rocks north of the Gulf Trough (table 4). In that area, the transmissivity is less than 10,000 $ft^2/d$, with the exception of one well (32U018) in Screven County, GA, that had a transmissivity of 13,000 $ft^2/d$. The highest transmissivity was reported in wells in the southern part of the study area where the aquifer is thickest. In Liberty and Long Counties, GA, reported transmissivity ranges from 124,000 to 250,000 $ft^2/d$ (Clarke and others, 2004).

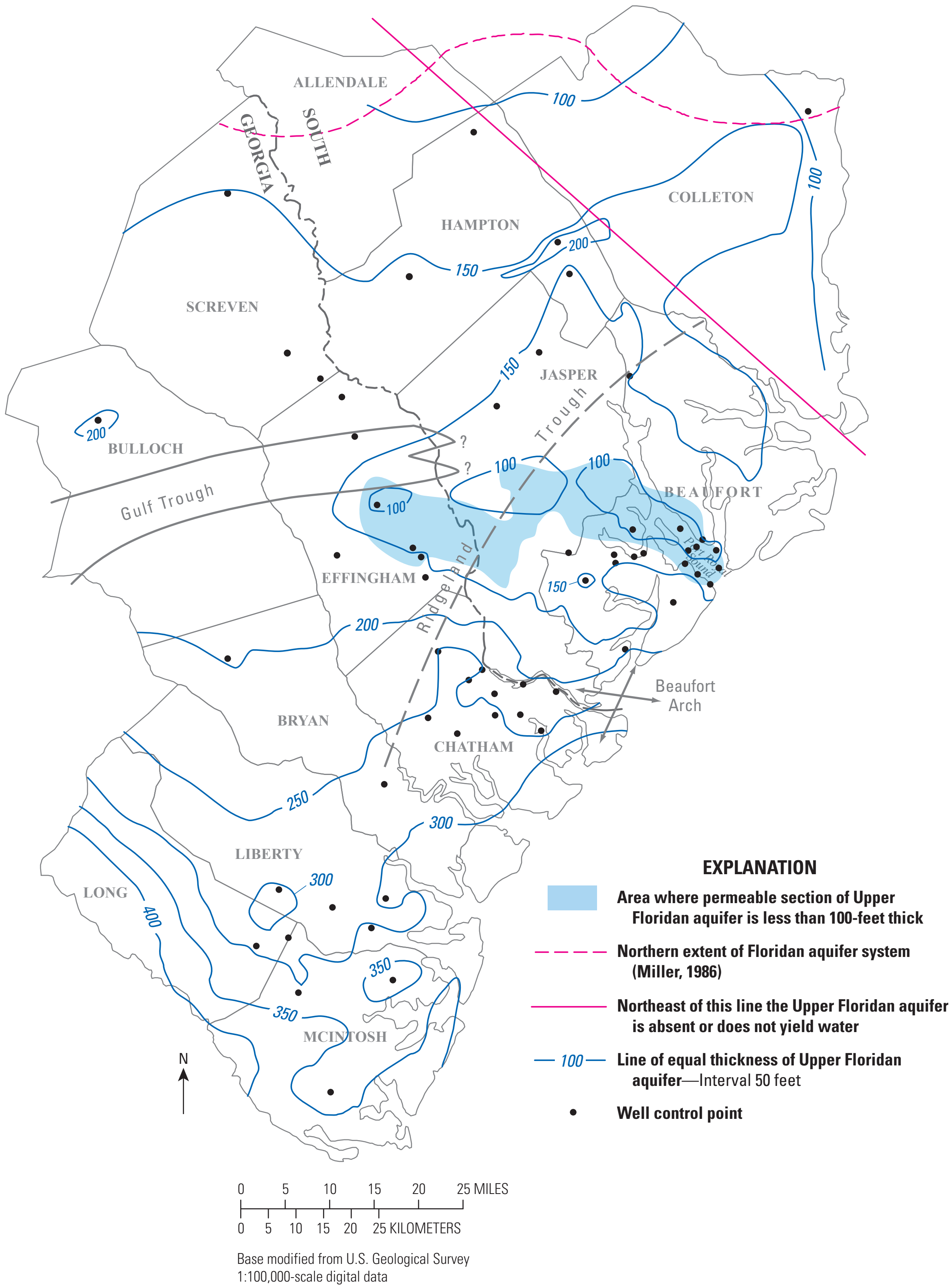



**Figure 29.** Thickness of the Upper Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

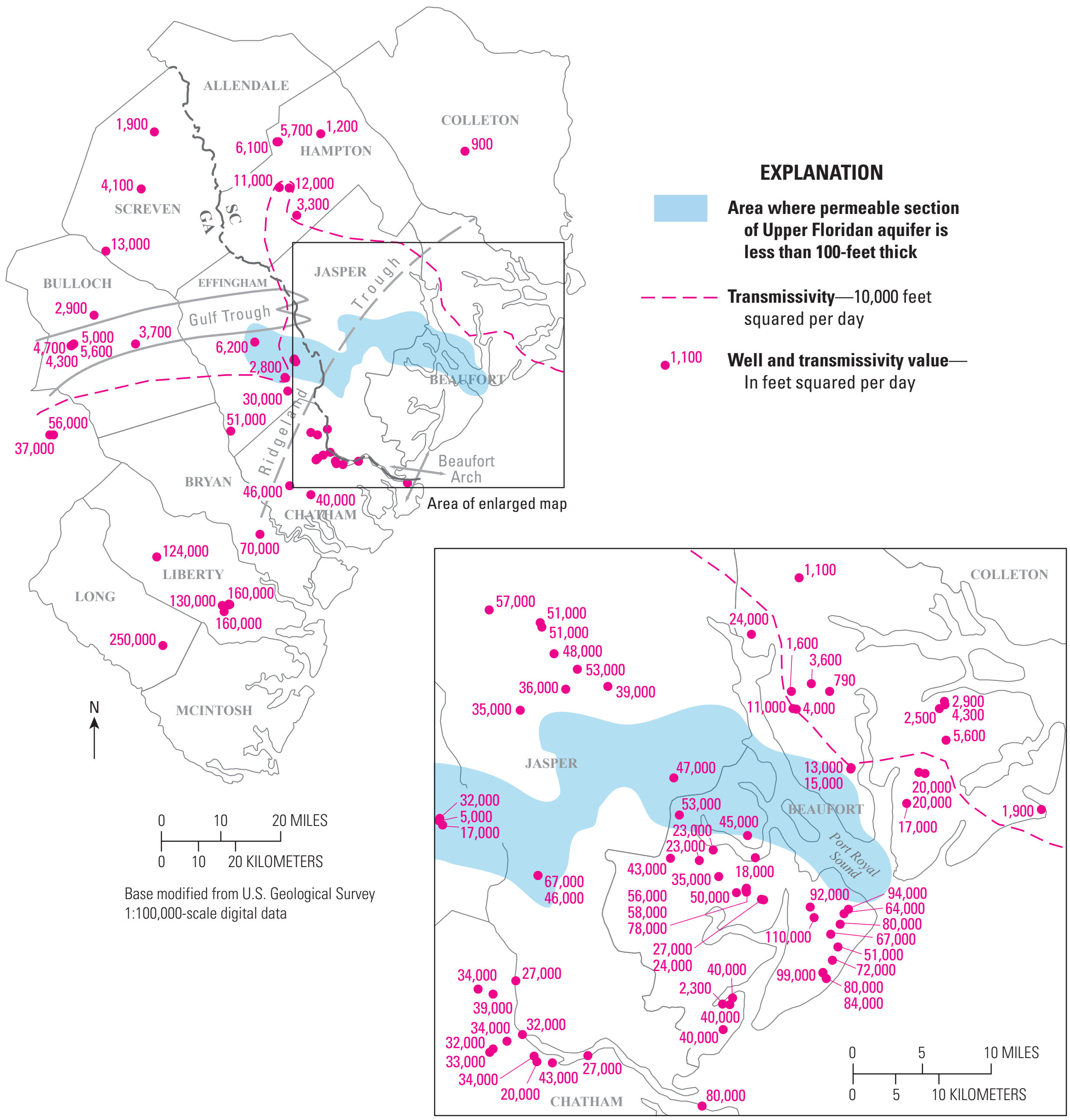



**Figure 30.** Transmissivity of the Upper Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

In Beaufort and Jasper Counties, SC, a pronounced change in transmissivity occurs from north to south of Port Royal Sound. To the north, transmissivity is generally less than 10,000 $ft^2/d$; south of the sound, transmissivity is generally greater than 30,000 $ft^2/d$ and may exceed 100,000 $ft^2/d$ locally. The dramatic increase in transmissivity is not explained by an increase in aquifer thickness; in fact, the aquifer typically is less than 100 ft thick in part of this area (shaded area in fig. 30). This increase indicates that transmissivity probably is controlled by development of secondary permeability along internal lithologic and textural variations.

Storage values for the Upper Floridan aquifer generally range from 0.0001 to 0.0007 (table 4). Of the 39 values reported from multiwell tests, 34 values fall within this range. The lowest values reported were 0.00004 from well BFT-114 in Beaufort County, SC (Newcome, 2000) and 0.00009 from well 36Q331 in Chatham County, GA (Robert E. Faye, U.S. Geological Survey, retired, written commun., 2002). The highest values reported were 0.005 from well 38Q115 in Chatham County, GA (Counts and Donskey, 1963), 0.002 from well BFT-1784 in Beaufort County, SC (Newcome, 2000), and 0.001 from well 37Q185 in Chatham County, GA (Warner and Aulenbach, 1999).

**Table 4.** Summary of hydrologic properties of the Upper and Lower Floridan aquifers in the northern coastal area of Georgia and parts of South Carolina.

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; ft²/d, feet squared per day; d'less, dimensionless; method: NL—nonleaky aquifer analysis, L—leaky aquifer analysis, SC—transmissivity based on specific capacity, SL—straight line analytical solution, V—van der Kamp analysis of oscillating flow (Kruseman and de Ritter, 1994), ?—analytical method not cited; hydrologic unit: UF—Upper Floridan aquifer, LF—Lower Floridan aquifer; —, no data; SCDNR, South Carolina Department of Natural Resources]

| County | USGS well name (plate 1) | Other identifier | Land-surface altitude (feet above NGVD 29) | Open interval (feet) | Transmissivity (ft²/d) | Storage (d'less) | Method | Reference | Hydrologic unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Georgia | | | | | |
| Bryan | 35P110 | Richmond Hill UF TW | 10.47 | 320–440 | 70,000 | — | SL | Harrelson and Falls (2003) | UF |
| Bryan | 35P109 | Richmond Hill LF TW | 13 | 1,010–1275 | 8,300 | — | SL | Harrelson and Falls (2003) | LF |
| Bryan | 35P128 | Harris Trail | 21 | 755–1,000 | 10,000 | — | L | Gill (2005) | LF |
| Bulloch | 31T010 | City of Statesboro # 2 | 227 | 320–555 | 2,900 | — | SC | Kellam and Gorday (1990) | UF |
| Bulloch | 31T024 | Statesboro Gateway 9 (pro) | 197.89 | 398–637 | 4,300 | — | SL | USGS files | UF |
| Bulloch | 31T025 | Statesboro Gateway 1 (observation) | 198.79 | 405–630 | 4,700 | 0.0004 | NL | USGS files | UF |
| Bulloch | 31T027 | Statesboro | 203.93 | 420–580 | 5,600 | 0.0003 | NL | USGS files | UF |
| Bulloch | 31T028 | Statesboro Gateway 6 (observation) | 190.06 | 383–540 | 5,000 | 0.0004 | NL | USGS files | UF |
| Bulloch | 32T013 | City of Brooklet # 1 | 155 | 302–510 | 3,700 | — | SC | Kellam and Gorday (1990) | UF |
| Chatham | 37Q049 | Savannah Electric & Power Company R1 | 19.21 | 250–1,003 | 34,000 | — | NL(?) | Counts and Donsky (1963) | UF |
| Chatham | 36Q392 | HAAF No. 11 | 22 | 703–1,112 | 10,000 | — | NL | Williams, 2010 | LF |
| Chatham | 38Q115 | USNPS Cockspur | 7.5 | — | 80,000 | 0.005 | ? | Counts and Donsky (1963) | UF |
| Chatham | 37Q185 | Hutchison Island TW1 | 6 | 274–344 | 32,000 | 0.001 | NL | Warner and Aulenbach (1999) | UF |
| Chatham | 37Q018 | American Cyanide #1 | 10 | 205–650 | 27,000 | — | NL(?) | Counts and Donsky (1963) | UF |
| Chatham | 37Q016 | Southern Coast Line RR docks | 4.7 | 260–500 | 43,000 | 0.0007 | NL | Warner and Aulenbach (1999) | UF |
| Chatham | 37Q010 | U.S. Postal Service 02 | 42 | 274–695 | 20,000 | 0.0003 | NL | Counts and Donsky (1963) | UF |
| Chatham | 36R010 | Port Wentworth, GA 1 | 16 | 254–650 | 34,000 | — | NL(?) | Counts and Donsky (1963) | UF |
| Chatham | 36Q331 | Berwick Plantation (UF) | 11 | 358–460 | 46,000 | 0.00009 | NL | Robert Faye, USGS retired, written commun., 2002 | UF |
| Chatham | 36Q330 | Berwick Plantation (LF) | 11 | 760–1,085 | 8,200 | — | SL | Robert Faye, USGS retired, written commun., 2002 | LF |
| Chatham | 36Q391 | HAAF No. 9 | 16.3 | 295–425 | 40,000 | 0.00025 | L | Williams, 2010 | UF |
| Chatham | 36Q030 | Hercules, Inc. # 1 | 11 | 251–750 | 33,000 | 0.0004 | NL | Counts and Donsky (1963) | UF |
| Chatham | 36Q008 | Layne-Atlantic | 9.91 | 250–406 | 32,000 | 0.0006 | NL | Warner and Aulenbach (1999) | UF |
| Chatham | 36Q002 | Union Camp 04 | 11 | 237–603 | 34,000 | 0.0003 | NL | Counts and Donsky (1963) | UF |
| Chatham | 37R001 | Savannah Wildlife Refuge | 10 | 280–971 | 39,000 | — | NL | Warner and Aulenbach (1999) | UF |

**Table 4.** Summary of hydrologic properties of the Upper and Lower Floridan aquifers in the northern coastal area of Georgia and parts of South Carolina.—Continued

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; $ft^2/d$, feet squared per day; d'less, dimensionless; method: NL—nonleaky aquifer analysis, L—leaky aquifer analysis, SC—transmissivity based on specific capacity, SL—straight line analytical solution, V—van der Kamp analysis of oscillating flow (Kruseman and de Ritter, 1994), ?—analytical method not cited; hydrologic unit: UF—Upper Floridan aquifer, LF—Lower Floridan aquifer; —, no data; SCDNR, South Carolina Department of Natural Resources]

| County | USGS well name (plate 1) | Other identifier | Land-surface altitude (feet above NGVD 29) | Open interval (feet) | Transmissivity ($ft^2/d$) | Storage (d'less) | Method | Reference | Hydrologic unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Georgia—Continued | | | | | |
| Chatham | 36R037 | Savannah E&P, Port Wentworth | 10 | 270–971 | 27,000 | 0.0002 | NL | Counts and Donsky (1963) | UF |
| Effingham | 36S022 | City of Rincon # 2 | 61 | 281–500 | 2,800 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 36S048 | Rincon Lower Floridan Well | 70 | 565–1004 | 2,470 | — | L | Gill (2004) | LF |
| Effingham | 36S027 | Ft. Howard Paper Company # 3 | 66.99 | 282–500 | 5,000 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 36S025 | Ft. Howard Paper Company # 1 | 67 | 280–500 | 32,000 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 36S004 | Westwood Heights S/D | 61 | 303–565 | 30,000 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 35T003 | City of Springfield 1950 | 40 | 180–400 | 6,200 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 34R043 | Dawes Silicia Company | 32 | 320–689 | 51,000 | — | SC | Kellam and Gorday (1990) | UF |
| Effingham | 36S026 | Ft. Howard Paper Company # 2 | 63.76 | 280–520 | 17,000 | — | SC | Kellam and Gorday (1990) | UF |
| Evans | 30R001 | City of Claxton # 2 | 165 | 401–701 | 37,000 | — | SC | Kellam and Gorday (1990) | UF |
| Evans | 30R002 | City of Claxton | 190 | 452–805 | 56,000 | — | SC | Kellam and Gorday (1990) | UF |
| Liberty | 33N001 | U.S. Army, Ft Stewart 01 | 90 | 451–816 | 124,000 | — | NL | Warren (1944) | UF |
| Liberty | 34M019 | Interstate Paper, 535' | 13.95 | 200–535 | 160,000 | 0.0005 | NL | Dyar and others (1972) | UF |
| Liberty | 34M021 | Interstate Paper Company, 445' | 13.84 | 145–445 | 160,000 | 0.0003 | NL | Dyar and others (1972) | UF |
| Liberty | 34M051 | Interstate Paper Rust 1 | 12 | 427–810 | 160,000 | 0.0004 | NL | Dyar and others (1972) | UF |
| Liberty | 34M052 | Interstate Paper Rust 2 | 13 | 418–810 | 160,000 | 0.0002 | NL | Dyar and others (1972) | UF |
| Liberty | 34M090 | Riceboro, GA, 1985 | 17 | 502–705 | 130,000 | 0.0004 | NL | Krause and Randolph (1989) | UF |
| Long | 33M004 | USGS TW-3 | 61.24 | 538–870 | 250,000 | 0.0007 | NL | Randolph and others (1985) | UF |
| McIntosh | 35L085 | Dan Hawthorne 1 | 10 | 1,144–1,422 | 6,000 | — | NL | Harrelson and Falls (2003) | LF |
| Screven | 32W015 | Sylvania #2 | 223 | 150–301 | 4,100 | — | SL | USGS files | UF |
| Screven | 33X037 | Millhaven Buena Vista | 189 | 370–565 | 3,500 | — | SL | Faye and McFadden (1986) | LF |
| Screven | 33X051 | USGS Millhaven TW-1 | 110 | 50–80 | 1,900 | — | SL | Clarke and others (1996) | UF |
| Screven | 33X052 | USGS Millhaven TW-2 | 110 | 155–205 | 5,600 | — | SL | Clarke and others (1996) | LF |
| Screven | 33X053 | USGS Millhaven TW-3 | 110 | 225–280 | 1,300 | — | SL | Clarke and others (1996) | LF |
| Screven | 32U018 | J.P. King #2 | 157 | 253–670 | 13,000 | — | NL | Harrelson and Falls (2003) | UF |

**Table 4.** Summary of hydrologic properties of the Upper and Lower Floridan aquifers in the northern coastal area of Georgia and parts of South Carolina.—Continued

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; $ft^2/d$, feet squared per day; d'less, dimensionless; method: NL—nonleaky aquifer analysis, L—leaky aquifer analysis, SC—transmissivity based on specific capacity, SL—straight line analytical solution, V—van der Kamp analysis of oscillating flow (Kruseman and de Ritter, 1994), ?—analytical method not cited; hydrologic unit: UF—Upper Floridan aquifer, LF—Lower Floridan aquifer; —, no data; SCDNR, South Carolina Department of Natural Resources]

| County | USGS well name (plate 1) | Other identifier | Land-surface altitude (feet above NGVD 29) | Open interval (feet) | Transmissivity ($ft^2/d$) | Storage (d'less) | Method | Reference | Hydrologic unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | South Carolina | | | | | |
| Allendale | AL-375 | 35AA-q7 | 287 | 453–578 | 970 | 0.0004 | NL | USGS files | LF |
| Allendale | AL-66 | 372-q3 | 215 | 390–720 | 7,100 | — | NL | Faye and McFadden (1986) | LF |
| Allendale | AL-374 | 35AA-q8 | 287 | 450–575 | 1,200 | 0.0003 | NL | USGS files | LF |
| Allendale | AL-310 | 34AA-x4 | 180 | 240–329 | 3,300 | — | SL | Newcome (2000) | LF |
| Allendale | AL-326 | 33BB-p1 | 120 | 257–344 | 500 | — | SL | Newcome (2000) | LF |
| Allendale | AL-27 | 36AA-o1 | 187 | 460–794 | 1,100 | — | SL | Faye and McFadden (1986) | LF |
| Allendale | AL-353 | 33AA-y5 | 200 | 290–340 | 3,900 | — | SL | Newcome (2000) | LF |
| Allendale | AL-320 | 34AA-q3 | 200 | 154–444 | 3,300 | — | SL | Newcome (2000) | LF |
| Allendale | AL-48 | 33Z-y1 | 180 | 180–310 | 4,000 | — | SL | Newcome (2000) | LF |
| Allendale | AL-268 | 34AA-q2 | 179 | 240–328 | 2,900 | — | SL | Aucott and Newcome (1986) | LF |
| Beaufort | BFT-652 | 27KK-h1 | 14.8 | 135–200 | 64,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2185 | 27KK-l12 | 10.8 | 314–600 | 19,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2255 | 27JJ-i10 | 8.8 | 283–603 | 530 | — | SL | SCDNR files | LF |
| Beaufort | BFT-1570 | 25HH-p17 | 20 | 51–59 | 2,900 | — | NL | Newcome (2000) | UF |
| Beaufort | BFT-1869 | 27KK-f23 | 10 | 146–226 | 110,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1868 | 27KK-f22 | 10 | 140–220 | 92,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1809 | 27JJ-q2 | 14 | 227–890 | 6,700 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2248 | 27JJ-i9 | 9.8 | 295–632 | 700 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1840 | 27JJ-i4 | 10 | 250–602 | 1,200 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT- 985 | 27KK-g1 | 17.12 | 542–630 | 27,000 | — | SL | Gawne and Park (1992) | LF |
| Beaufort | BFT- 795 | 27II-l5 | 10 | 45–94 | 15,000 | 0.0003 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1973 | 27II-l30 | 9.17 | 52–88 | 13,000 | 0.0001 | SL | Newcome (2000) | UF |
| Beaufort | BFT- 114 | 27HH-o3 | 35.6 | 83–100 | 3,600 | 0.00004 | NL | Newcome (2000) | UF |
| Beaufort | BFT-2066 | 27HH-n9 | 10 | 120–170 | 790 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1793 | 26II-w16 | 21.8 | 90–120 | 17,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1788 | 26II-s5 | 10 | 55–70 | 20,000 | 0.0003 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1787 | 26II-l3 | 10 | 64–66 | 20,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1560 | 25HH-p6 | 10 | 50–58 | 2,500 | — | NL | Newcome (2000) | UF |
| Beaufort | BFT-1566 | 25HH-p12 | 20 | 59–66 | 4,300 | — | NL | Aucott and Newcome (1986) | UF |
| Beaufort | BFT- 449 | 24JJ-c1 | 6.21 | 96–150 | 1,900 | — | NL | Faye and McFadden (1986) | UF |
| Beaufort | BFT-1784 | 25II-e4 | 10 | 73–78 | 5,600 | 0.002 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1794 | 29LL-s1 | 17.26 | 170–240 | 40,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2243 | 29JJ-d6 | 14.8 | 357–555 | 4,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1766 | 29JJ-e11 | 12 | 130–215 | 53,000 | 0.0003 | NL | Newcome (2000) | UF |

**Table 4.** Summary of hydrologic properties of the Upper and Lower Floridan aquifers in the northern coastal area of Georgia and parts of South Carolina.—Continued

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; $ft^2/d$, feet squared per day; d'less, dimensionless; method: NL—nonleaky aquifer analysis, L—leaky aquifer analysis, SC—transmissivity based on specific capacity, SL—straight line analytical solution, V—van der Kamp analysis of oscillating flow (Kruseman and de Ritter, 1994), ?—analytical method not cited; hydrologic unit: UF—Upper Floridan aquifer, LF—Lower Floridan aquifer; —, no data; SCDNR, South Carolina Department of Natural Resources]

| County | USGS well name (plate 1) | Other identifier | Land-surface altitude (feet above NGVD 29) | Open interval (feet) | Transmis-sivity ($ft^2/d$) | Storage (d'less) | Method | Reference | Hydrologic unit |
|---|---|---|---|---|---|---|---|---|---|
| South Carolina—Continued | | | | | | | | | |
| Beaufort | BFT-2222 | 29JJ-l5 | 15.8 | 353–490 | 8,200 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1452 | 29JJ-m2 | 19.5 | 160–200 | 23,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2202 | 29JJ-o3 | 16.8 | 357–568 | 3,500 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1418 | 29JJ-q2 | 24.8 | 160–200 | 23,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1800 | 29JJ-v2 | 30 | 140–205 | 35,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2264 | 29JJ-v3 | 15 | 356–576 | 18,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1813 | 27KK-j5 | 12 | 276–600 | 6,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT- 309 | 29LL-j4 | 10 | 140–242 | 40,000 | — | SL | SCDNR files | UF |
| Beaufort | BFT-1591 | 27KK-h4 | 20 | 131–200 | 94,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2273 | 29II-y2 | 15 | 314–582 | 5,300 | — | SL | SCDNR files | LF |
| Beaufort | BFT-1438 | 29LL-l2 | 15 | 107–140 | 2,300 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1870 | 29KK-a3 | 23.5 | 43–205 | 50,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2038 | 30JJ-k1 | 19 | 139–220 | 43,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2090 | 30JJ-l1 | 15 | 346–520 | 6,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2089 | 30JJ-m1 | 15 | 321–523 | 4,400 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2256 | 30JJ-n1 | 14.8 | 336–512 | 5,300 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2086 | 30JJ-t2 | 18 | 299–450 | 7,200 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2204 | Island West Golf Club | 18 | 298–450 | 7,229 | — | ? | SCDNR files | LF |
| Beaufort | BFT-2274 | Oldfield #2 | 17 | 295–592 | 3,882 | — | ? | SCDNR files | LF |
| Beaufort | BFT-2291 | Hampton Hall | 14 | 351–560 | 5,355 | — | ? | SCDNR files | LF |
| Beaufort | BFT-2393 | Pinecrest | 29 | 356–552 | 6,962 | — | ? | SCDNR files | LF |
| Beaufort | BFT-2395 | May River Golf Course - East Well | 10 | 342–592 | 4,418 | — | ? | SCDNR files | LF |
| Beaufort | BFT-2406 | Belfair | 25 | 336–557 | 20,082 | — | ? | SCDNR files | LF |
| Beaufort | BFT-310 | 29LL-l1 | 19 | 125–192 | 40,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-115 | 28HH-t2 | 21 | 72–95 | 4,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-758 | 27KK-x8 | 10 | 145–200 | 72,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1589 | 27KK-q5 | 9 | 126–198 | 51,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1820 | 27KK-o10 | 10 | 316–320 | 11,000 | — | SL | Gawne and Park (1992); Newcome (2000) | LF |
| Beaufort | BFT-2241 | 29LL-k6 | 12.8 | 441–638 | 13,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1685 | 27KK-n15 | 13.11 | 118–200 | 67,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2242 | 29II-s5 | 17.8 | 298–600 | 4,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1632 | 27KK-m46 | 15 | 110–200 | 80,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1590 | 27LL-e11 | 10 | 140–198 | 84,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1947 | 27LL-e12 | 10 | 140–200 | 99,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1756 | 28GG-a10 | 15 | 124–224 | 1,100 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-671 | 27LL-d2 | 9.8 | 145–221 | 80,000 | — | SL | Newcome (2000) | UF |

**Table 4.** Summary of hydrologic properties of the Upper and Lower Floridan aquifers in the northern coastal area of Georgia and parts of South Carolina.—Continued

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; $ft^2/d$, feet squared per day; d'less, dimensionless; method: NL—nonleaky aquifer analysis, L—leaky aquifer analysis, SC—transmissivity based on specific capacity, SL—straight line analytical solution, V—van der Kamp analysis of oscillating flow (Kruseman and de Ritter, 1994), ?—analytical method not cited; hydrologic unit: UF—Upper Floridan aquifer, LF—Lower Floridan aquifer; —, no data; SCDNR, South Carolina Department of Natural Resources]

| County | USGS well name (plate 1) | Other identifier | Land-surface altitude (feet above NGVD 29) | Open interval (feet) | Transmissivity ($ft^2/d$) | Storage (d'less) | Method | Reference | Hydrologic unit |
|---|---|---|---|---|---|---|---|---|---|
| South Carolina—Continued | | | | | | | | | |
| Beaufort | BFT-1731 | 28HH-k12 | 30 | 90–112 | 1,600 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1845 | 28JJ-p5 | 12 | 255–600 | 8,800 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT- 358 | 28KK-e1 | 20 | 101–380 | 78,000 | — | SL | SCDNR files | UF |
| Beaufort | BFT-2067 | 28JJ-e8 | 20 | 240–560 | 15,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1630 | 28JJ-f4 | 20 | 100–200 | 45,000 | 0.0004 | NL | Newcome (2000) | UF |
| Beaufort | BFT-2265 | 28JJ-h5 | 16.8 | 397–587 | 11,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-2233 | 28JJ-m7 | 7.8 | 393–587 | 13,000 | — | SL | Newcome (2000) | LF |
| Beaufort | BFT-1389 | 28JJ-n2 | 22 | 125–192 | 18,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-22 | 28HH-t7 | 12.7 | 80–84 | 11,000 | 0.0001 | NL | Newcome (2000) | UF |
| Beaufort | BFT-1330 | 28KK-d6 | 15.02 | 140–174 | 27,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-1790 | 28GG-x1 | 10 | 83–140 | 24,000 | 0.0002 | NL | Newcome (2000) | UF |
| Beaufort | BFT-499 | 28JJ-y2 | 22.09 | 97–209 | 56,000 | 0.0002 | NL | Newcome (2000) | UF |
| Beaufort | BFT-500 | 28JJ-y3 | 21 | 100–340 | 58,000 | — | SL | SCDNR files | UF |
| Beaufort | BFT-1326 | 28JJ-y4 | 10 | 140–200 | 24,000 | — | SL | Newcome (2000) | UF |
| Beaufort | BFT-2229 | 28KK-c1 | 13.8 | 357–568 | 11,000 | — | SL | Newcome (2000) | LF |
| Colleton | COL-275 | 27DD-b1 | 50 | 125–575 | 900 | — | SL | Newcome (2000) | UF |
| Colleton | COL-232 | 30AA-c4 | 110 | 450–510 | 2,000 | — | SL | Newcome (2000) | LF |
| Hampton | HAM-209 | 33CC-p2 | 140 | 175 | 5,700 | — | SL | Newcome (2000) | UF |
| Hampton | HAM-162 | 32CC-l15 | 106.5 | 50–120 | 1,200 | 0.0001 | NL | Newcome (2000) | UF |
| Hampton | HAM-219 | 33CC-p3 | 139 | 102–150 | 6,100 | — | SL | Newcome (2000) | UF |
| Hampton | HAM-211 | 33EE-f2 | 120 | 125–160 | 11,000 | — | SL | Newcome (2000) | UF |
| Hampton | HAM-208 | 33EE-v3 | 113 | 145–280 | 3,300 | — | SL | Newcome (2000) | UF |
| Hampton | HAM-195 | 33EE-c4 | 107 | 131–251 | 12,000 | 0.0002 | NL | Whiting and Park (1990); Newcome (2000) | UF |
| Jasper | JAS-372 | 32HH-s2 | 29 | 142–204 | 35,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-NA | Del Webb/Sun City Argent 2 | 14 | 357–552 | 3,923 | — | ? | SCDNR files | LF |
| Jasper | JAS-449 | Tradition | 11 | 353–559 | 8,515 | — | ? | SCDNR files | LF |
| Jasper | JAS-346 | 30HH-o1 | 40 | 130–220 | 39,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-390 | 31GG-o3 | 62 | 240–500 | 51,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-392 | 32GG-n2 | 21 | 252–555 | 46,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-391 | 32GG-n1 | 65 | 252–545 | 57,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-342 | 31JJ-t1 | 21 | 208–400 | 67,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-386 | 31HH-m3 | 51 | 118–220 | 36,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-375 | 31HH-b3 | 52 | 118–220 | 53,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-384 | 31GG-x5 | 57 | 115–180 | 48,000 | — | SL | Newcome (2000) | UF |
| Jasper | JAS-389 | 31GG-p5 | 59 | 140–300 | 51,000 | 0.0004 | NL | Newcome (2000) | UF |
| Jasper | JAS-104 | 29II-o1 | 21.9 | 145–330 | 47,000 | 0.0004 | SL | Aucott and Newcome (1986) | UF |

## Middle Confining Unit of the Floridan Aquifer System

The middle confining unit of the Floridan aquifer system (middle confining unit) separates the Upper and Lower Floridan aquifers throughout the study area. Over much of its extent the unit consists of a soft micritic limestone and fine-grained dolomitic limestone that grades laterally by facies change from calcareous sand and clay in northeastern Georgia northward into sandy clay in South Carolina (Miller, 1986). The strata that compose the confining unit include the lower part of the upper Eocene unit in Beaufort and Jasper Counties, SC, and the upper to middle parts of the middle Eocene unit elsewhere (see plates 2, 3; fig. 19). Miller (1986) identified these lower permeability rocks as “middle confining unit I,” which was mapped along the Atlantic coast from southeastern South Carolina to the Florida Keys. This unit, as described by Miller (1986), is the leakiest of the seven middle confining units mapped in the Floridan aquifer system. The lithology of middle confining unit I is similar to overlying and underlying units with the exception that it does not appear to have as much secondary permeability. Despite the similarity to overlying and underlying units, minor variations in hydraulic head and water quality occur across this confining unit, which together with the flowmeter data indicate that this unit acts as a confining bed (Miller, 1986).

All of the subregional low-permeability confining units in the Floridan aquifer system can contain local, thin zones of moderate to high permeability (Miller, 1986). In the Savannah area, Chatham County, GA, and extending into parts of Jasper and Beaufort Counties, SC, the confining unit may contain one or more permeable zones, including zone 3 in McCollum and Counts (1964). Between Skidaway Island and Hilton Head Island, cross section *B–B′* (pl. 2) shows the stratigraphic position and areal extent of zone 3 in relation to the Upper and Lower Floridan aquifers and the middle confining unit as it presently is mapped. Because many of the middle Floridan aquifer wells in Beaufort and Jasper Counties, SC, tap both zones 3 and 4 (zone 4 in this report is mapped as part of the Lower Floridan), these wells now are considered to withdraw water primarily from the Lower Floridan aquifer.

The revised middle confining unit was mapped using flowmeter-log and geophysical-log data from 76 wells. The thickness of the middle confining unit is shown in figure 31 and the altitude of the top of the Lower Floridan aquifer is shown in figure 32.

Because the middle confining unit is delineated based on permeability characteristics (Miller, 1986), neither the top nor the base of this unit necessarily conforms to formation or time-stratigraphic boundaries. The top of the middle confining unit dips gently to the south at a rate of about 8.5 ft/mi and generally conforms to the regional southward dip of upper and middle Eocene rocks with the exception of Jasper and Beaufort Counties, SC (fig. 28); in that area, the middle confining unit thickens because of decreased permeability of the adjacent upper Eocene unit. Over much of Beaufort County and in parts of Jasper County, the altitude of the top of the middle confining unit is between –200 ft and –250 ft.

The base of the middle confining unit was mapped at the top of the first permeable zone of the Lower Floridan aquifer (fig. 32) Over a large part of the study area, the first permeable zone occurs at a depth of 150–200 ft below the top of the middle Eocene unit, except in several scattered wells where the permeable zone is found at shallower depths near the top of the middle Eocene unit. Because of the fairly consistent location of the first permeable zone relative to the top of the middle Eocene, this characteristic can be used for mapping the base of this unit.

### Thickness and Extent

The middle confining unit is present throughout the study area and ranges from less than 100 ft to greater than 350 ft in thickness (fig. 31). In most of the area, the unit has a fairly uniform thickness ranging from about 150 to 200 ft. It is less than 100 ft thick in the updip clastic part of the aquifer system in Colleton County, SC, and in the southwestern part of the area in Long County, GA. The unit has a maximum thickness of about 350 ft in the vicinity of Hilton Head Island, SC. Here, the confining unit includes fine-grained, low-permeability rocks of the upper Eocene unit.

The updip limit of the middle confining unit was defined by Miller (1986) along a line from the western border of Long and Liberty Counties, GA, extending northward through Effingham County, GA, and Hampton and Allendale Counties, SC. In that area, Miller (1986) mapped the Upper and Lower Floridan aquifers as a single aquifer unit. This line is shown in figure 31 for clarity; however, in this report the middle confining unit is extended throughout the study area. The updip limit mapped by Miller (1986) may still have some importance, however, because it marks the area where the confining unit may be more permeable and leaky.

### Hydraulic Properties

The thickness and hydraulic conductivity of the middle confining unit controls the rate of inter-aquifer leakage between the Upper and Lower Floridan aquifers. Although the middle confining unit is present throughout the area, hydraulic properties of this unit have only been determined at four sites in the study area, including the test wells at Harris Road in Richmond Hill (35P128), Berwick Plantation (36Q330), the City of Rincon (36S048), and Hunter Army Airfield (36Q392). At these sites, GAEPD required that the hydraulic properties of the confining unit be determined to assess the effect of pumping from the Lower Floridan aquifer on the Upper Floridan aquifer. As described above, aquifer testing and subsequent modeling of the leakage at these sites indicate a vertical hydraulic conductivity of the confining bed of 0.0064 ft/d for well 35P128, 0.013 ft/d for well 36Q330, 0.047 ft/d for well 36S048, and 0.020 ft/d for well 36Q392 (Gill, 2002; 2004; 2005; Clarke and others, 2010). The only location where on-site physical tests of the confining bed were

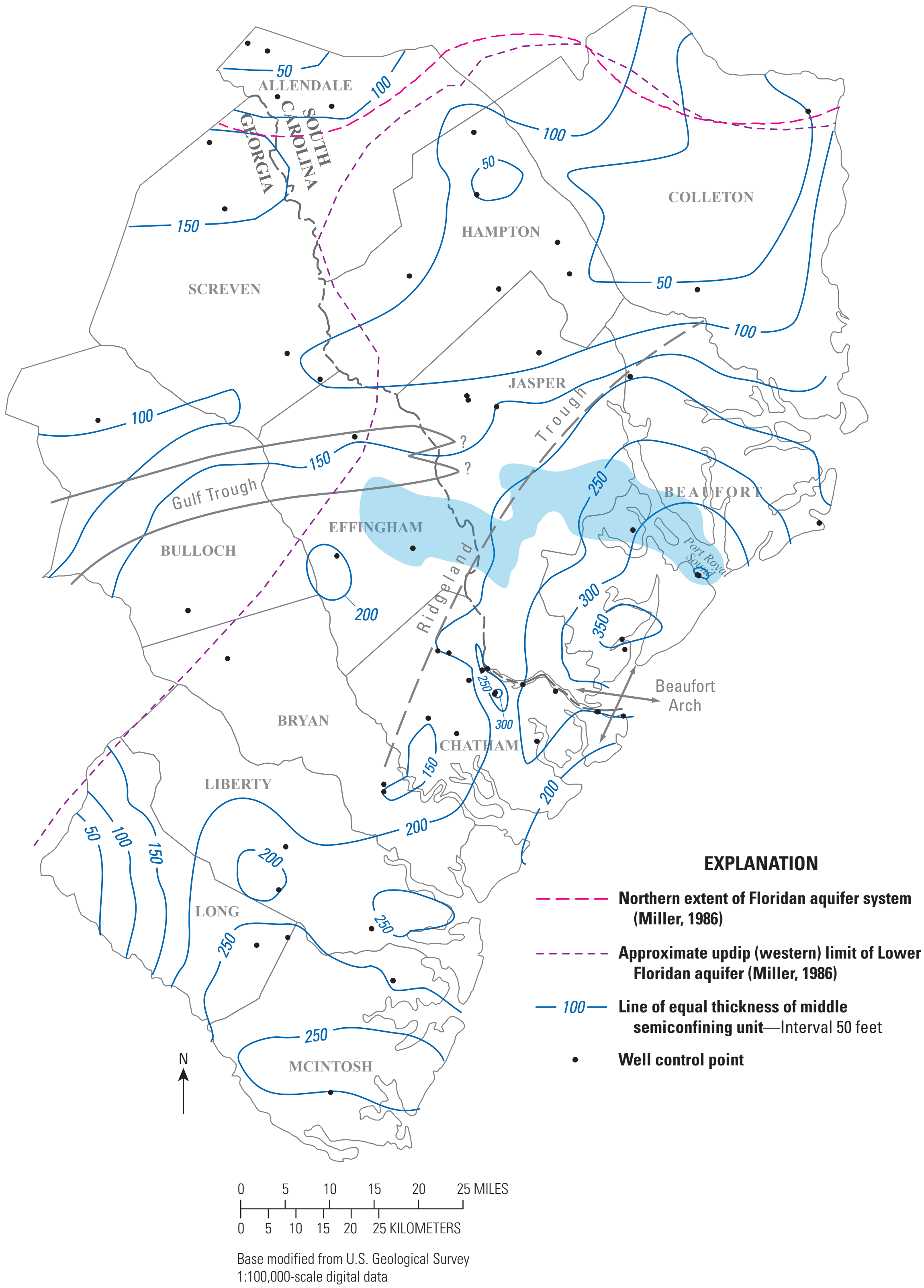



**Figure 31.** Thickness of the middle confining unit in the northern coastal area of Georgia and parts of South Carolina.

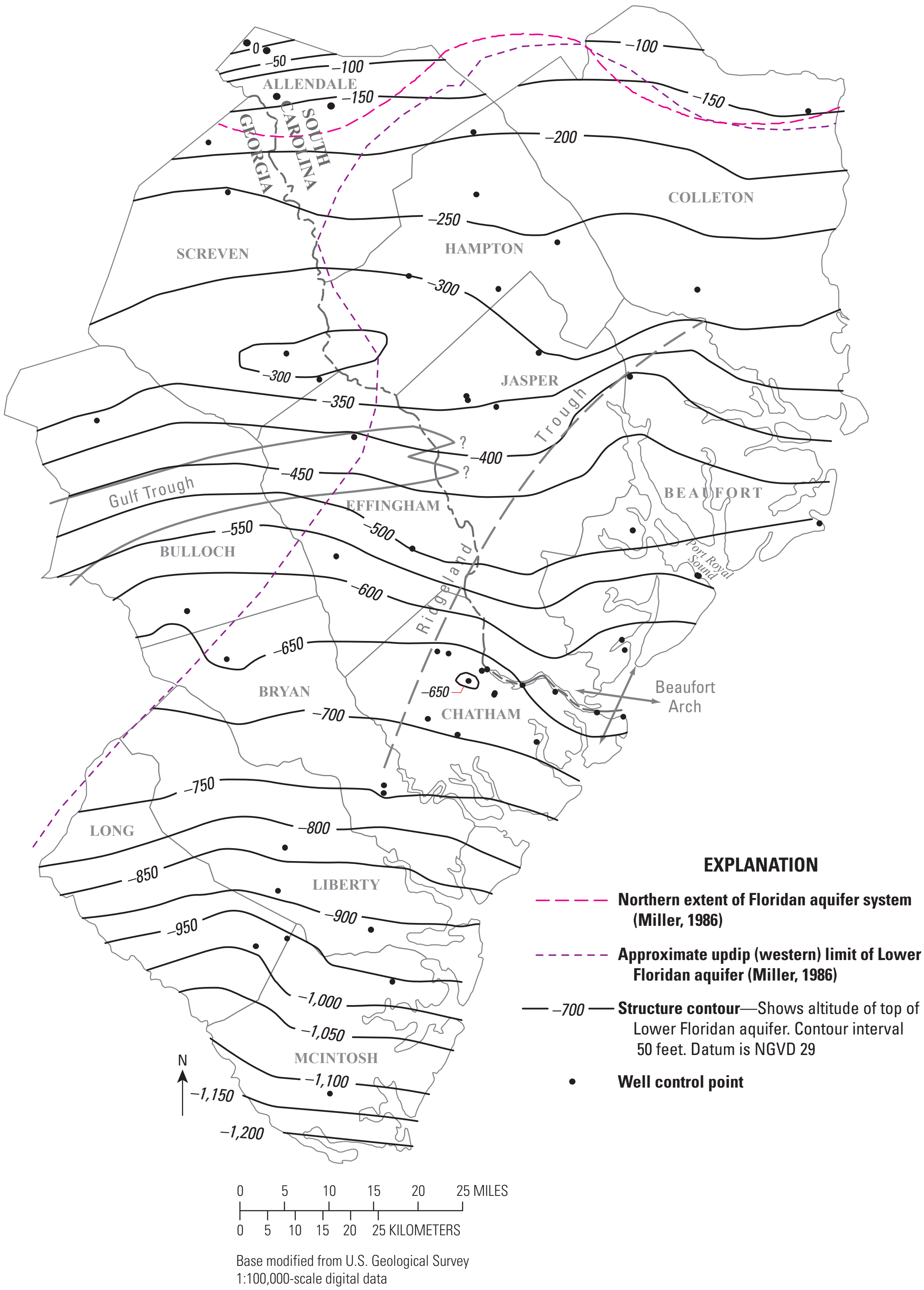



**Figure 32.** Altitude of the top of the Lower Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

conducted was at Hunter Army Airfield (36Q392). Packer tests at four separate intervals gave horizontal hydraulic conductivities ranging from 0.16 to 3.09 ft/d. From this, the vertical hydraulic conductivity was estimated to range from 0.02 to 0.36 ft/d based on a horizontal-to-vertical hydraulic conductivity ratio of 8.5:1, which is in fairly good agreement with the on-site testing and modeling results (Clarke and others, 2010).

## Lower Floridan Aquifer

The Lower Floridan aquifer includes all permeable strata that lie below the middle confining unit and above the base of the aquifer system. The strata that compose the Lower Floridan aquifer include limestone, dolomitic limestone, and dolomite that lie within the middle to lower part of the middle Eocene unit (fig. 19). This aquifer includes permeable zones 4 and 5 in the Savannah and Hilton Head Island areas (McCollum and Counts, 1964) and is correlated with the updip clastic Gordon aquifer (fig. 3). The general configuration of this aquifer is depicted in maps illustrating the altitudes of the top of the Lower Floridan aquifer (fig. 32) and the base of the Lower Floridan aquifer (fig. 33).

Similar to the middle confining unit, the top of the Lower Floridan aquifer was delineated by means of flowmeter and (or) geophysical logs to identify the presence of the first permeable zone below the middle confining unit. Although the depth to the first permeable zone varies, as previously mentioned, it commonly occurs within 150 to 200 ft below the top of the middle Eocene unit (fig. 19).

The strike and dip of the Lower Floridan aquifer generally is consistent with the regional dip of the middle Eocene unit. In the northernmost part of the study area (Screven County, GA, and Allendale, Hampton, and Colleton Counties, SC), the top of the clastic Gordon aquifer (Falls and others, 1997) was used as a mapping horizon to extend the Lower Floridian aquifer into that area. Merging the top of the Lower Floridan aquifer with the updip equivalent Gordon aquifer ties these aquifers into a regional framework.

The base of the Lower Floridan aquifer is generally marked by low-permeability lower Eocene to upper Paleocene rocks (fig. 19). Because the permeability of these rocks is much lower than the permeability of the overlying carbonate rocks, a zone of less active groundwater movement is commonly accompanied by an increase in salinity. In some instances, this higher-salinity water is present near the base of the overlying Lower Floridan aquifer. Because the permeability contrast occurs at the upper Paleocene–lower Eocene stratigraphic horizon over most of the area, the configuration of the base of the Lower Floridan aquifer was contoured by using the altitudes for the these same time-stratigraphic horizons and any other data that would indicate hydraulically interconnected strata at this depth interval. The resulting surface (fig. 33) provides an updated configuration of the base of the aquifer system to that originally mapped by Miller (1986).

### Thickness and Extent

Miller (1986) originally defined the updip limit of the Lower Floridan aquifer on the basis of the presence or absence of the middle confining unit as he defined it. In the revised framework, the Lower Floridan aquifer has been extended into Bulloch and Screven Counties, GA, and into the updip clastic areas in South Carolina. The revised definition of the Lower Floridan aquifer changes the extent of the aquifer and increases the thickness of the aquifer in places where the lower Eocene sediments currently are included.

Based on this new definition, the Lower Floridan aquifer generally thickens from north to south, from approximately 150 ft in northern Allendale County, SC, to 400 ft in northern Chatham County, GA, and to as much as 600 ft in Liberty and Long Counties, GA (fig. 34). This southward increase in the aquifer thickness is mainly the result of thickening of the middle Eocene rocks that compose most of this part of the aquifer.

### Permeable Zones

The Lower Floridan aquifer consists of several permeable zones, each of which is separated by low-permeable limestone, dolomitic limestone, and dolomite. The low-permeability units act as confining units similar to the middle confining unit. This aquifer includes permeable zones 4 and 5 in the Savannah and Hilton Head areas as previously defined by McCollum and Counts (1964).

Based on new flowmeter log data, the number, thickness, and vertical separation between permeable zones vary considerably from well to well and across the study area. In the north-to-south cross section *A–A′* from McIntosh County to Screven County, GA (plate 2) several water-bearing zones are mapped in the Lower Floridan aquifer; these zones thicken and become increasingly separated in the downdip direction. In this cross section, zone 4, which lies just beneath the middle confining unit, is depicted as a continuous permeable zone across the study area; however, from available flowmeter data, this zone appears to be composed of one or more individual zones. For example, at well 36Q392 at Hunter Army Airfield, zone 4 consisted of two distinct permeable zones (fig. 17). In the Harris Trail well (35P128) at Richmond Hill, this same zone is composed of a thick, single, vertically continuous zone (fig. 8*B*). Although it is not possible to display this level of detail in the cross sections, it is important to note that while these zones can be characterized locally by one or more discrete zones, on a larger scale the zones may act as a single, extensive, thin aquifer zone.

In the northern part of the study area, individual zones that compose the Lower Floridan aquifer appear to become increasingly discontinuous as depicted on cross section *G–G′* from Tybee Island in Chatham County, GA, to Colleton County, SC, and on cross section *F–F′* from Hilton Head Island in Beaufort County, SC, to Hampton County, SC (plate 3). The discontinuous nature of these zones may be the result of more frequent erosional unconformities that occur in the updip part of the study area.

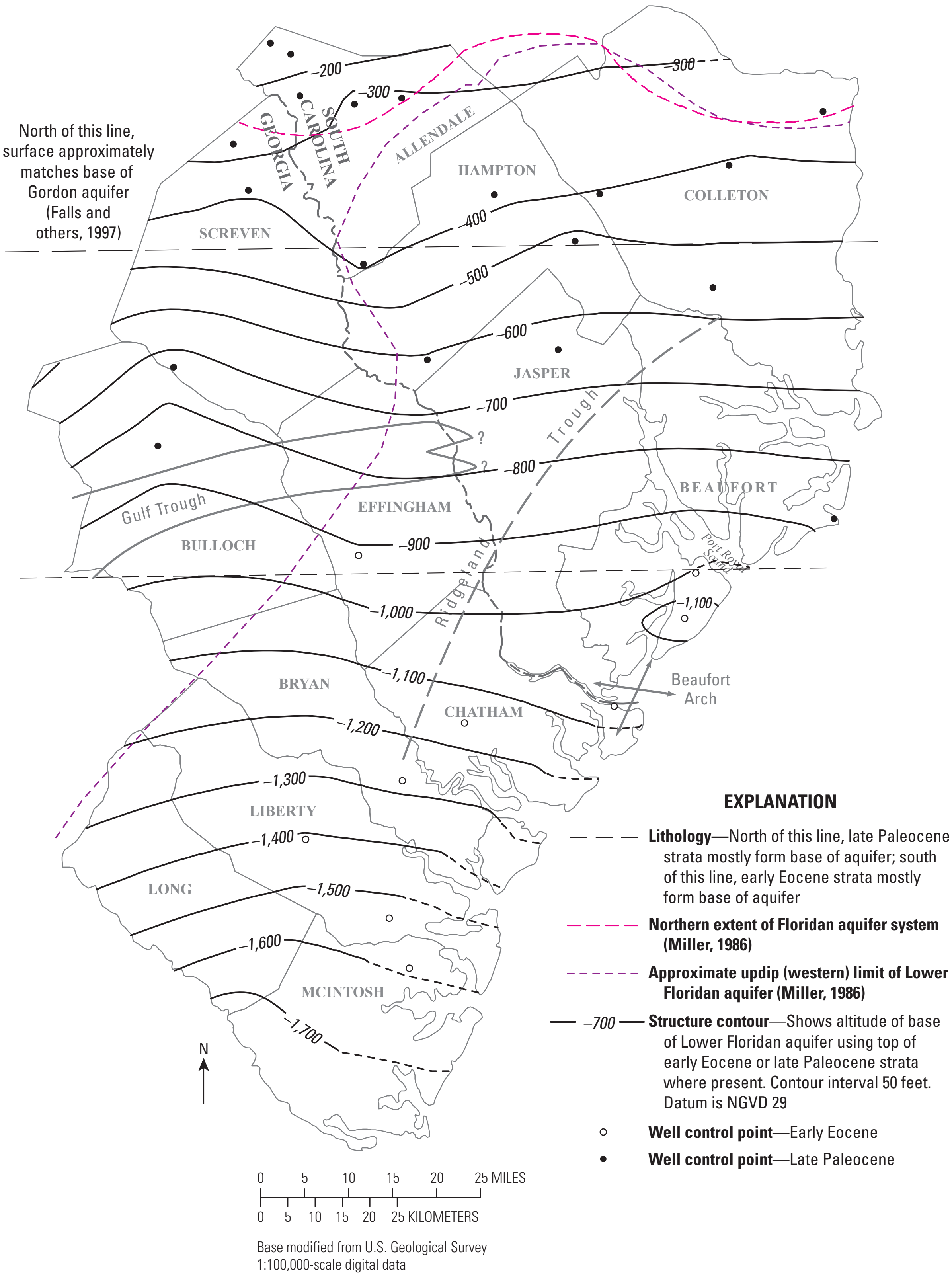



**Figure 33.** Altitude of the base of the Lower Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

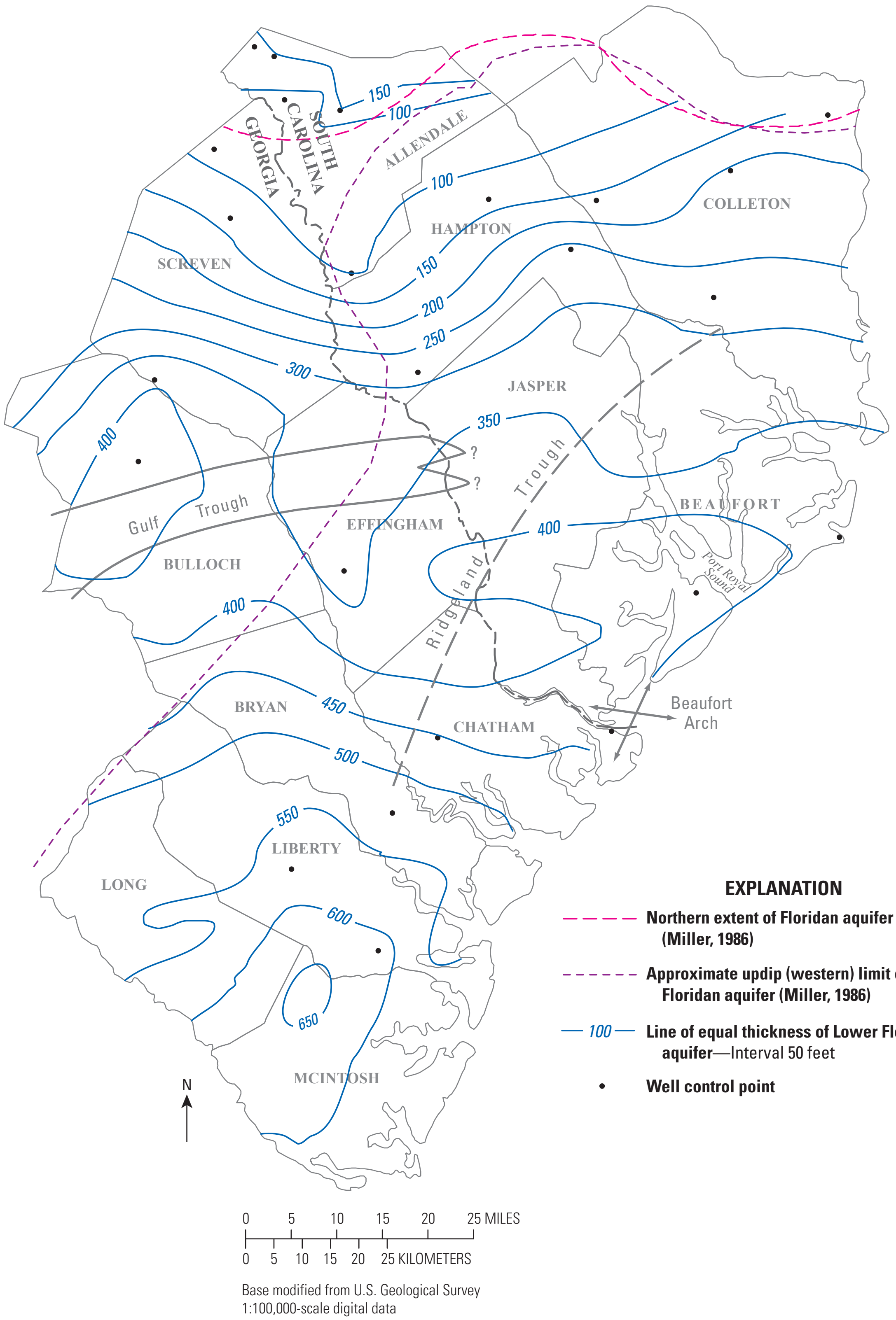



**Figure 34.** Thickness of the Lower Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

## Hydraulic Properties

Because fewer wells tap the Lower Floridan aquifer in the study area, less information describing the hydraulic properties of this aquifer is generally available. Nevertheless, some aquifer tests have been completed, and the properties of this aquifer are fairly well known. Clarke and others (2004) compiled transmissivity values of the Floridan aquifer system based on Miller's (1986) framework. These data were evaluated to determine appropriate hydrogeologic units based on the new framework and were combined with new data from the aforementioned selected test sites. The revised database indicates that the transmissivity of the Lower Floridan aquifer ranges from 500 $ft^2/d$ in Allendale County, SC, to 27,000 $ft^2/d$ in Beaufort County, SC (fig. 35; table 4). Of the 50 reported Lower Floridan transmissivity values, 41 are between 1,000 and 13,000 $ft^2/d$. The lowest transmissivity values reported are from wells in the northern part of the study area (part of the Gordon aquifer) and northeast of Port Royal Sound, SC. In these areas, the Lower Floridan aquifer consists of both carbonate and clastic materials and is less transmissive than the carbonate aquifers to the south. Two of the highest transmissivity values reported are from wells tested on Hilton Head Island, SC. Well BFT-985 had a reported transmissivity of 27,000 $ft^2/d$ (Gawne and Park, 1992) and well BFT-2185 had a reported transmissivity of 19,000 $ft^2$/day (Newcome, 2000). These transmissivity values are as much as three times greater than transmissivity values reported for the Lower Floridan aquifer in that same area. Storage values for the Lower Floridan are reported only for two wells—AL-374 and AL-375 in Allendale County, SC. The storage values reported for these wells are 0.0003 and 0.0004, respectively (table 4).

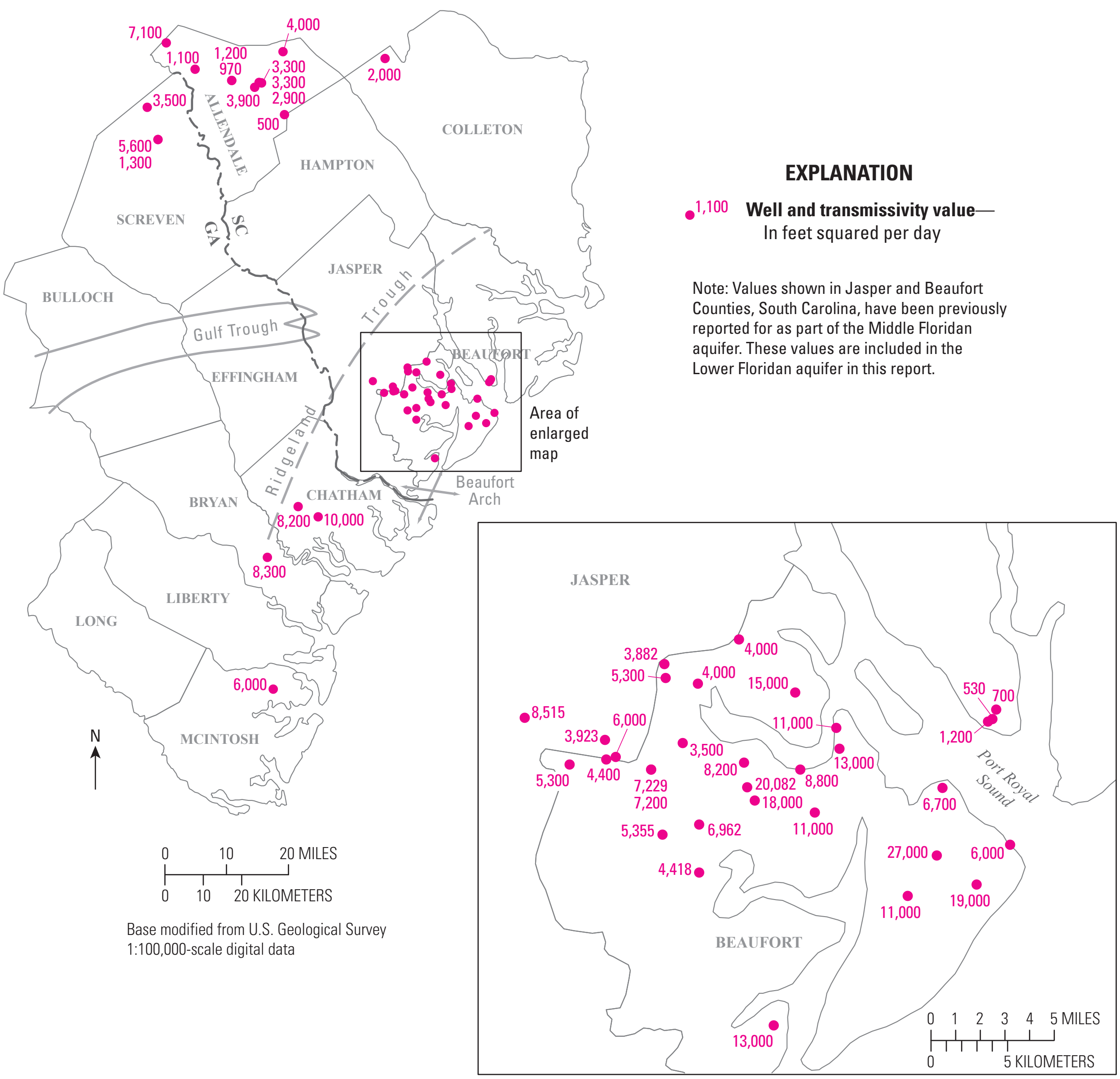



**Figure 35.** Transmissivity of the Lower Floridan aquifer in the northern coastal area of Georgia and parts of South Carolina.

## Aquifer Interconnection

The Upper and Lower Floridan aquifers are separated by a middle confining unit that varies in thickness and permeability across the study area. In most places, head separation between the two aquifers ranges from a few inches to a foot or more, and hydrographs from wells in these units respond similarly, which indicates some degree of interconnection between the aquifers throughout the area. Several vertically clustered well-point sites with wells set at different levels in the Floridan aquifer system have some variation in the degree of hydraulic separation with depth. Because the density of saline water is higher than freshwater, water-level data in some of the wells had to be corrected for equivalent freshwater head. These density corrections were made by using the method described by Post and others (2007), and the data used for these calculations are included in table 5.

One of the earliest well-cluster sites established in the Savannah area was completed in 1954 in eastern Chatham County, GA, using USGS test well 1 (38Q003, fig. 5) and isolating piezometers within the borehole with neat cement plugs. The water levels measured at this site between 1972 and 1986 are shown in figure 36. The graphs show the measured water levels uncorrected for salinity (fig. 36*A*) and the same period of record corrected to an equivalent freshwater head taking into account the salinity differences in the aquifers (fig. 36*B*). In general, the corrected water levels indicate nearly identical water levels in the Upper Floridan aquifer (open from 110 to 348 ft), middle confining unit (open from 606 to 657 ft), and Lower Floridan aquifer (open from 870 to 900 ft, table 5). Head separation between the three zones on any given date ranged from only a few inches to no more than half a foot; heads generally were higher in the deeper intervals than in the shallower intervals, indicating an upward gradient. Unfortunately, during this period of monitoring only the Upper Floridan aquifer piezometer was equipped with a continuous recorder, which makes any detailed correlation of heads over time among the three zones impossible. Water levels measured in a deep well (38Q195) open to the Paleocene strata that lie beneath the Floridan aquifer system also are shown (fig. 36). Computed freshwater heads for the Paleocene strata generally were lower than the heads in the overlying aquifers except for several measurements made during 1984–85.

At a similarly constructed well cluster (38Q199 and 38Q200) closer to the City of Savannah, Chatham County, GA, water levels in well 38Q200 (open from 145 to 200 ft) in the Upper Floridan aquifer were consistently higher than the corresponding water level in well 38Q199 (open from 580 to 626 ft) in the middle confining unit during the period 1972–81, as shown in figure 37. Vertical head differences during the period ranged from –5.79 ft (indicating a downward flow gradient between the Upper and Lower Floridan aquifers) to +2.94 ft (indicating an upward flow gradient). The average gradient was –0.55 ft, which indicated an overall downward flow gradient at the site. Because the chloride concentrations were low (average of 41 mg/L) at this well cluster, a correction for the equivalent freshwater head was not needed. The mostly downward hydraulic gradient may be the result of groundwater withdrawal from the Lower Floridan aquifer in some multiaquifer production wells in the Savannah area.

At Tybee Island, Chatham County, GA, a well cluster (39Q003, 39Q017, and 39Q018) was used for long-term water-level monitoring. After taking into account the effects of salinity (fig. 38*A*, *B*), the differences in equivalent freshwater heads among the Upper Floridan aquifer well (well 39Q003, open from 129 to 600 ft), a deeper well in the upper part of the Lower Floridan aquifer (well 39Q018, open from 630 to 670 ft), and the deepest well in the Lower Floridan aquifer (well 39Q017, open from 710 to 745 ft) ranged from –2.3 ft (downward head gradient) to +2.37 ft (upward head gradient) from 1972 to 1981. This indicates apparent head reversals between the Upper and Lower Floridan aquifers over time, although head gradients generally were downward during this period.

Since 1996, a new set of wells has been used to monitor water levels and water quality at Tybee Island, Georgia (fig. 39). The Upper Floridan aquifer well (39Q025) has an open interval of 125–145 ft, and the Lower Floridan aquifer well (39Q024) has an open interval of 840–888 ft. Both of these wells are instrumented with continuous data recorders. As was the case for the first Tybee Island monitoring site described above, corrected water levels showed a general downward gradient between the Upper and Lower Floridan aquifers during the period of record. At certain times of the year, typically in the summer time when pumping is at its maximum, the water levels in the Upper Floridan aquifer decline below the water levels in the Lower Floridan aquifer. It is during these times when there is potential for upward flow from deeper, more saline parts of the aquifer into the shallower parts of the aquifer. The periods of head reversal range from a few weeks to more than a month at a time.

At the City of Richmond Hill in Bryan County, GA, a cluster of wells has been used to monitor water levels in the Upper and Lower Floridan aquifers since 2003 (fig. 40). The Upper Floridan aquifer well (35P110, open from 314 to 441 ft) and Lower Floridan aquifer well (35P109, open from 1,010 to 1,275 ft) are instrumented with continuous data recorders. Both the uncorrected and density-adjusted water-level measurements indicate a general upward gradient between the Upper and Lower Floridan aquifers. After taking into account the effects of salinity, the differences in equivalent freshwater heads between the Upper and Lower Floridan aquifers ranged from +0.72 ft to +1.28 ft (upward head gradients) during 2003–2005. In July 2006, the lower part of well 35P109 was plugged to a depth of 1,095 ft and renamed to well 35P125. Despite this modification, the water levels and hydraulic gradient remained about the same as with the previous well construction.

**Table 5.** Depth and density values used for computing equivalent freshwater heads in hydrographs presented in this report, Savannah area, Georgia.

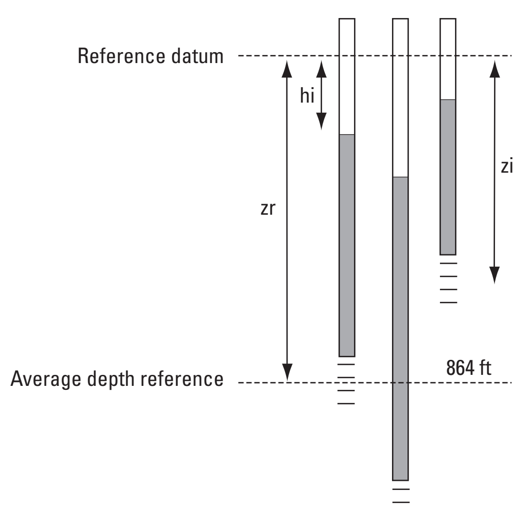
[Hydrologic unit: UF—Upper Floridan aquifer, MCU—middle confining unit, LF—Lower Floridan aquifer, PAL—Paleocene aquifer; ft, feet; kg/m$^3$, kilogram per cubic meter; mg/L, milligram per liter; —, no data]

| Well | Hydrologic unit | Open interval (ft) | Depth to mid-point of screen or open interval, zi (ft) | Density of saltwater, pi (kg/m$^3$) | Average chloride concentration (mg/L) | Total dissolved solids (mg/L) | Average adjustment[c] (ft) |
|---|---|---|---|---|---|---|---|
| **Values used in figure 36 (Ft. Pulaski)** | | | | | | | |
| 38Q002 | UF | 110–348 | 229 | 998.25 | 11 | 20[a] | –1.5 |
| 38Q004 | MCU | 606–657 | 631.5 | 998.44 | 147 | 270[a] | –1.3 |
| 38Q196 | LF | 870–900 | 885 | 1,005.61 | 5,279 | 9,724[a] | 4.6 |
| 38Q195 | PAL | 1,231–1,263 | 1,247 | 1,015.40 | 12,294 | 22,646[a] | 12.6 |
| Average depth reference = 864 ft | | | | | | | |
| Period when equivalent freshwater head was calculated: 1/1/1972–1/1/1987 | | | | | | | |
| **Values used in figure 38 (Tybee Island)** | | | | | | | |
| 39Q003 | UF | 129–600 | 364.5 | 998.24 | 2 | 3[a] | –1.1 |
| 39Q018 | LF | 630–670 | 650 | 999.05 | 583 | 1,075[a] | –0.6 |
| 39Q017 | LF | 710–745 | 727.5 | 999.35 | 728 | 1,465[a] | –0.4 |
| Average depth reference = 650 ft | | | | | | | |
| Period when equivalent freshwater head was calculated: 1/1/1972–1/1/1987 | | | | | | | |
| **Values used in figure 39 (Tybee Island)** | | | | | | | |
| 39Q025 | UF | 124–145 | 134.5 | 998.25 | 13 | 24[a] | –1.1 |
| 39Q024 | LF | 840–888 | 864 | 1,002.51 | 3,057 | 5,632[a] | 1.5 |
| Average depth reference = 650 ft | | | | | | | |
| Period when equivalent freshwater head was calculated: 7/6/1996–9/1/2009 | | | | | | | |
| **Values used in figure 40 (Richmond Hill)** | | | | | | | |
| 35P110 | UF | 314–441 | 377.5 | 998.42 | 156 | 288[a] | –1.3 |
| 35P109 | LF | 1,010–1,275 | 1,142.5 | 999.89 | — | 1,700[b] | –0.4 |
| 35P125 | LF | 1,010–1,095 | 1,052.5 | 999.53 | — | 410[b] | –1.2 |
| Average depth reference = 650 ft | | | | | | | |
| Period when equivalent freshwater head was calculated: 1/1/2003–9/1/2009 | | | | | | | |

[a]Estimated total dissolved solids (TDS) given a seawater ratio of 19,000 mg/L of chloride to 35,000 mg/L of TDS. The TDS value is calculated by multiplying chloride concentration by a factor of 1.842105.

[b]Reported TDS values of 1,700 mg/L (Falls and others, 2005) and 410 mg/L (USGS) were used for wells 35P109 and 35P125, respectively.

[b]Average vertical adjustment made to point head measurements based on given parameters.




Point head measurements were converted to equivalent freshwater head (hf) using the following formula:

hf = zr + pi/pf(hi–zi) – pa/pf(zr–zi) (Post and others, 2007)

where:

hf = equivalent freshwater head
hi = depth to water level measured from reference datum
zr = depth to average depth reference
zi = depth to mid-point of screen or open interval
pi = density of saltwater (varies by well)
pf = density of freshwater (1000 kg/m$^3$)
pa = average densisty of saltwater between the points

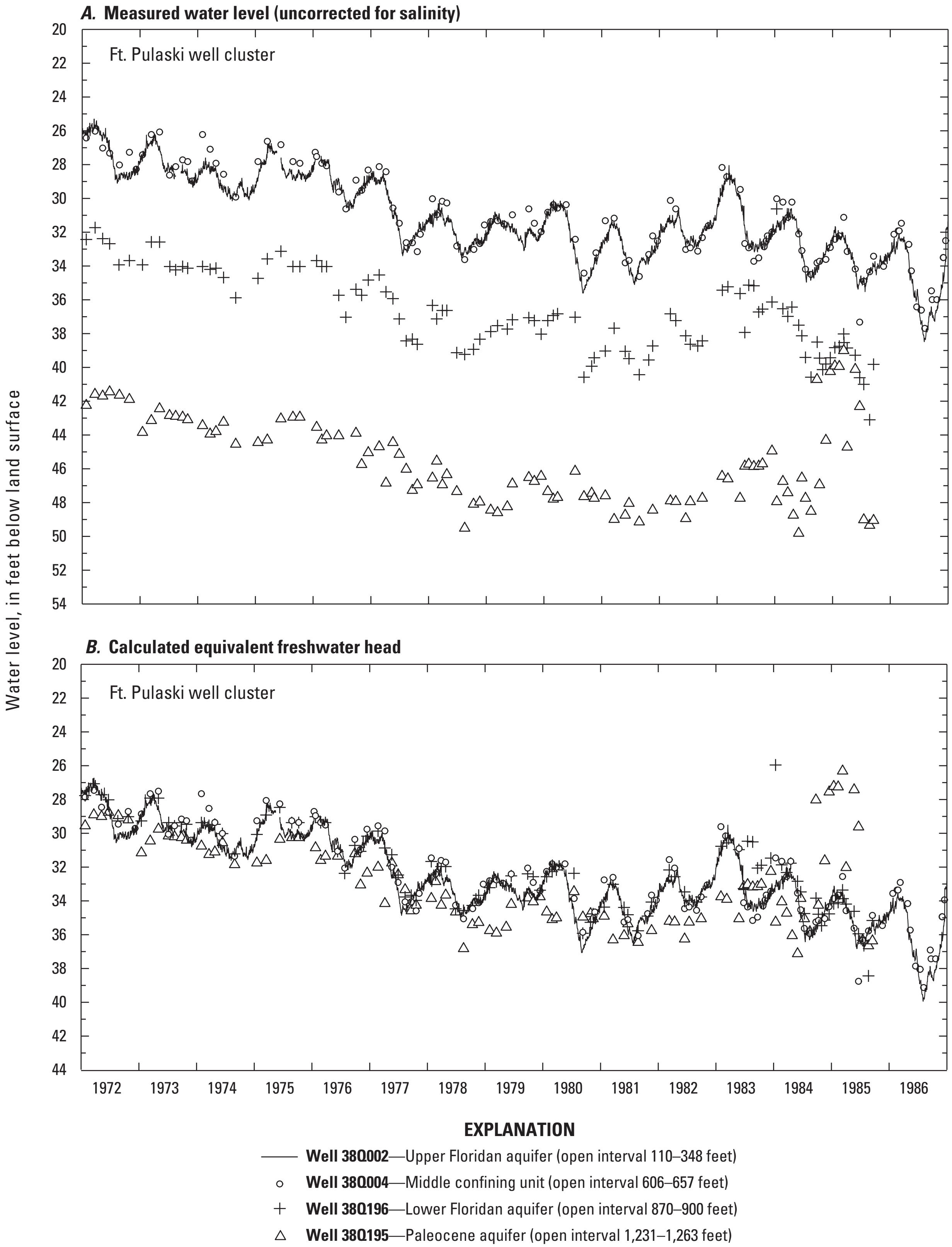



**Figure 36.** *(A)* Measured water levels and *(B)* calculated equivalent freshwater head in well 38Q002 in the Upper Floridan aquifer, well 38Q004 in the middle confining unit, and wells 38Q195 and 38Q196 in the Lower Floridan aquifer from 1972 to 1986 at Fort Pulaski, Chatham County, Georgia. [Land surface altitude is 8 feet above NGVD 29]

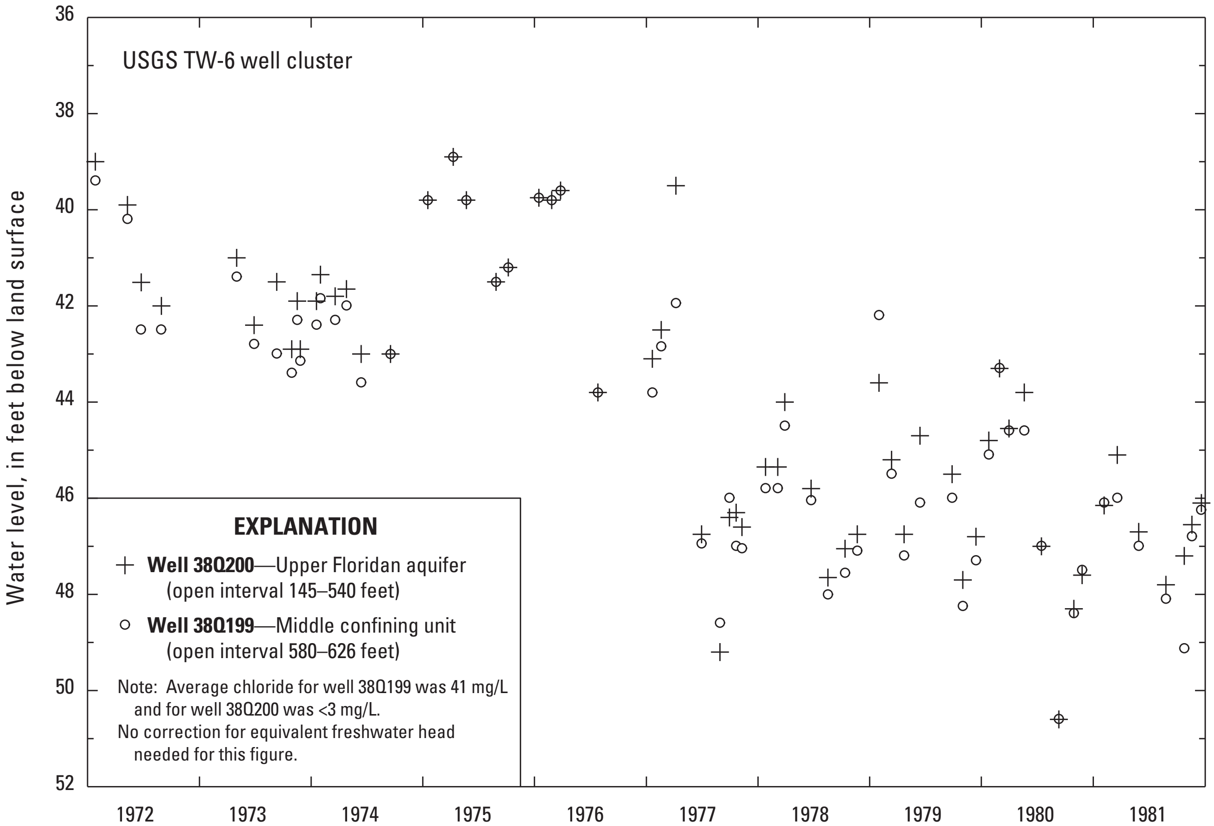



**Figure 37.** Water levels in well 38Q200 in the Upper Floridan aquifer and well 38Q199 in the middle confining unit from 1972 to 1981 in Savannah, Chatham County, Georgia. [Land surface altitude is 7.45 feet above NGVD 29; mg/L, milligrams per liter]

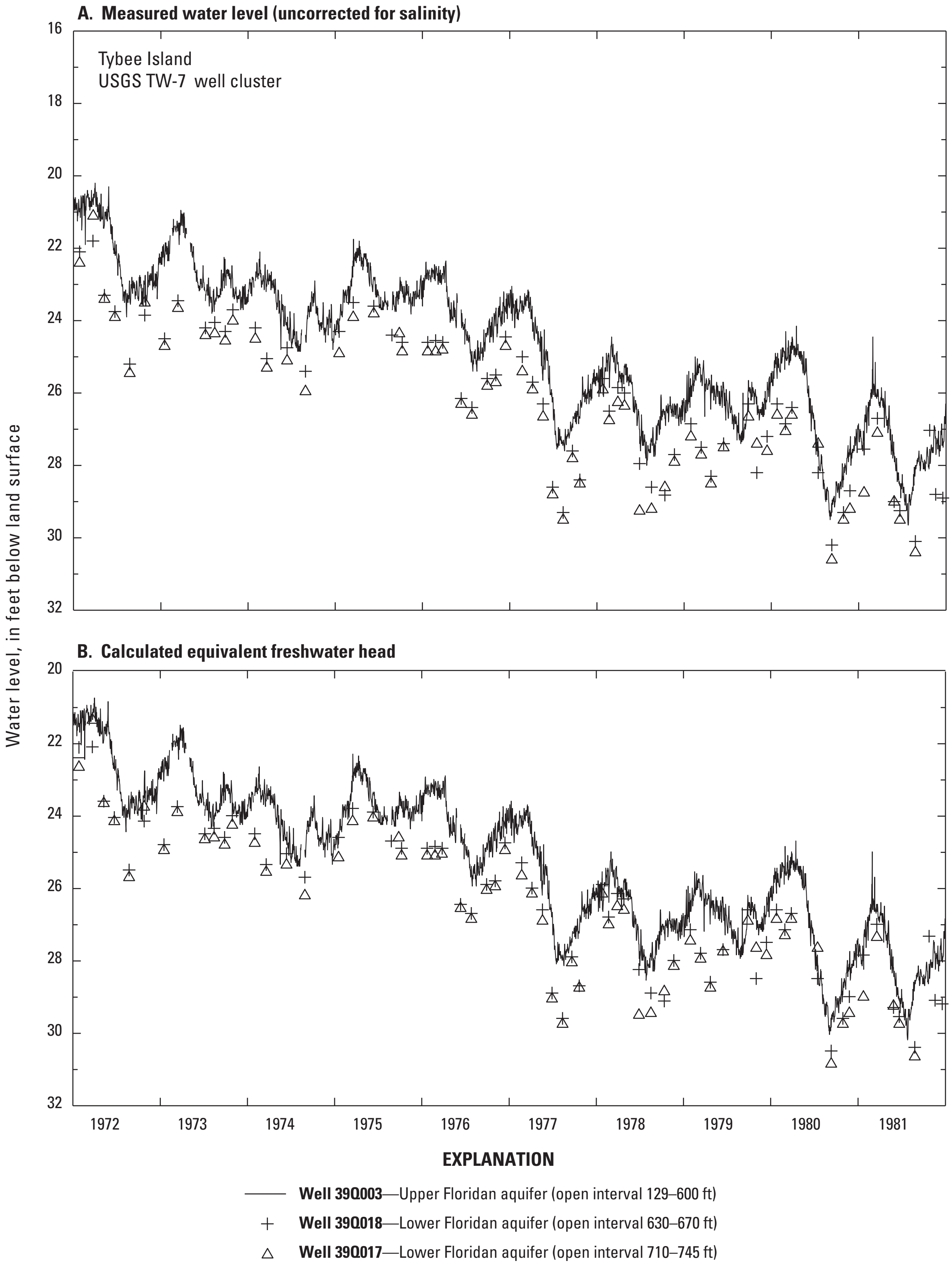



**Figure 38.** Water levels in well 39Q003 in the Upper Floridan aquifer, and in wells 39Q017 and 39Q018 in the Lower Floridan aquifer from 1972 to 1981 on Tybee Island, Chatham County, Georgia. [Land surface altitude is 7 feet above NGVD 29]

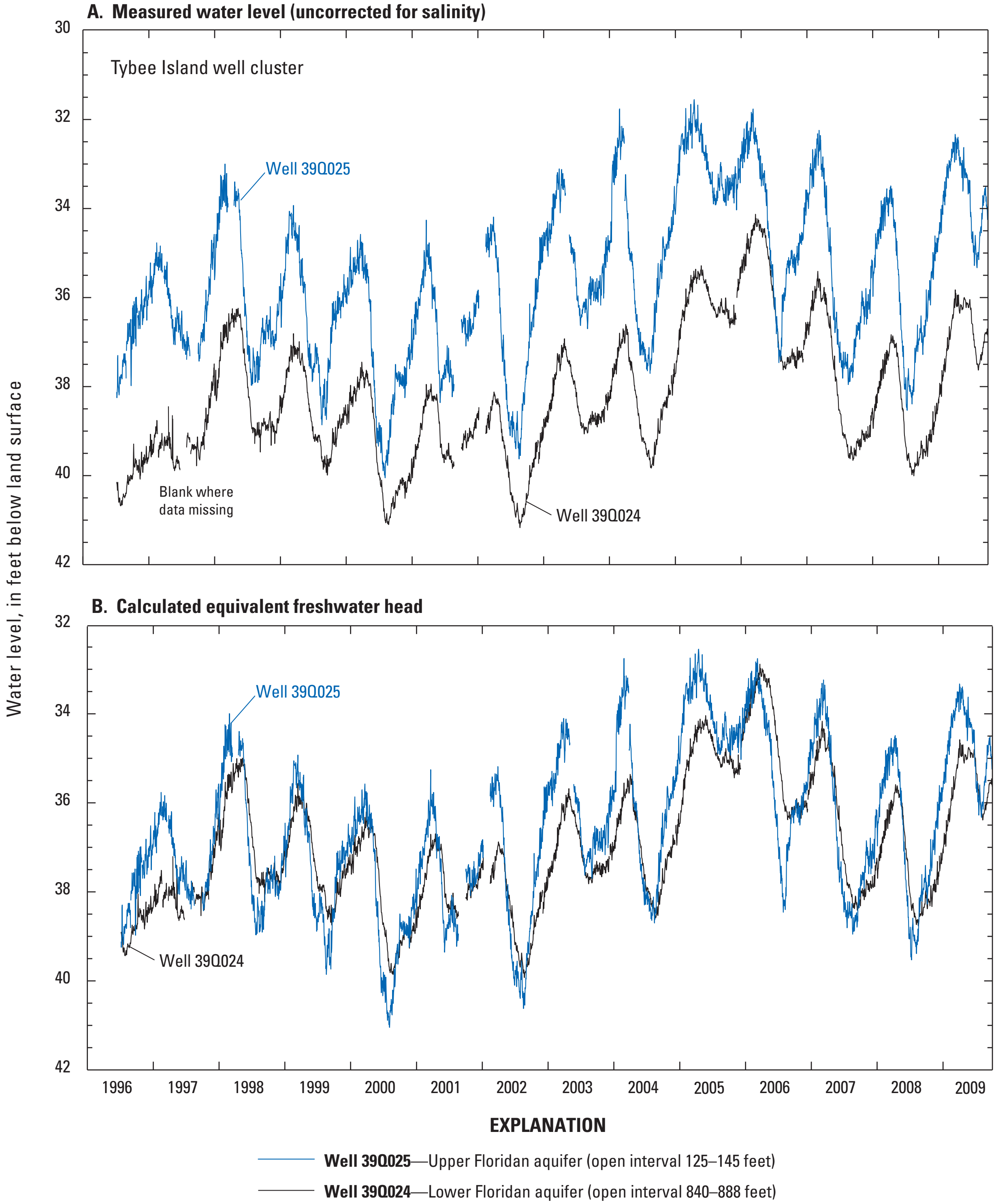



**Figure 39.** *(A)* Daily mean water levels and *(B)* calculated equivalent freshwater head in well 39Q025 in the Upper Floridan aquifer and well 39Q024 in the Lower Floridan aquifer from 1996 to 2009, Tybee Island, Chatham County, Georgia. [Land surface altitude is 10 feet above NGVD 29]

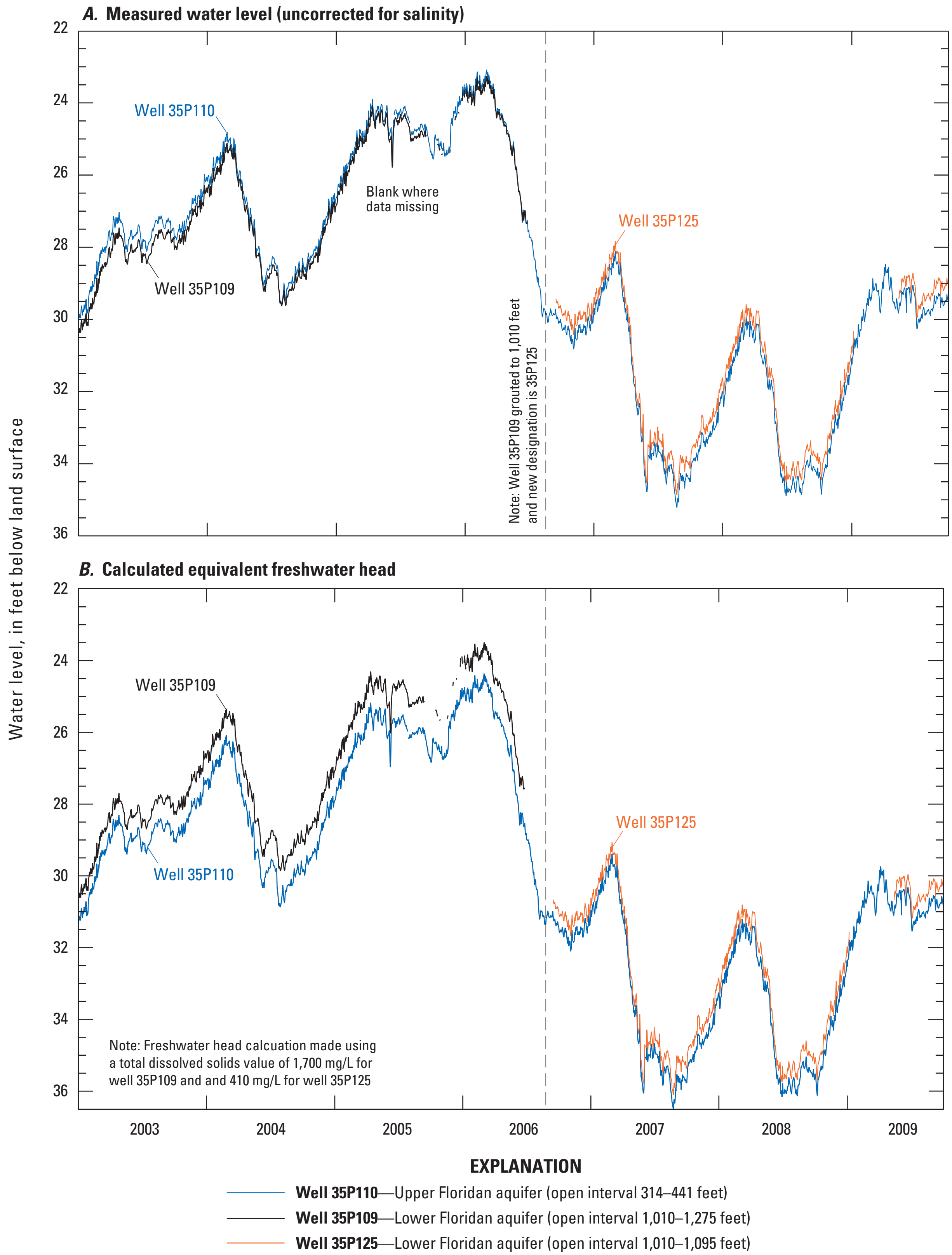



**Figure 40.** *(A)* Daily mean water levels and *(B)* calculated equivalent freshwater head in well 35P110 in the Upper Floridan aquifer and in wells 35P109 and 35P125 in the Lower Floridan aquifer from 2003 to 2009, Richmond Hill, Bryan County, Georgia. [Land surface altitude is 10 feet above NGVD 29; mg/L, milligrams per liter]

## Regional Correlation

The revised framework for the Floridan aquifer system in the northern coastal areas of Georgia and parts of South Carolina, as presented in this report, generally conforms to the regional framework initially established by Miller (1986). Revised mapping horizons generally blend into Miller's (1986) mapped horizons along the outer boundary of the northern coastal area with minor adjustments.

The top of the Upper Floridan aquifer generally conforms to Miller's (1986) definition, both inside and outside of the northern coastal study area. Along the northern boundary of the area, contours of the top of the aquifer blend into published maps showing the configuration of the top of the Upper Three Runs aquifer (Falls and others, 1997). Along the western and southern boundaries, contours generally match those for geophysical marker C from Clarke and others (1990), which are close to those shown by Miller (1986).

The revised base of the Floridan aquifer system is moved downward in some parts of the study area to include all permeable strata above the top of the early Eocene unit in Georgia and above the top of the Paleocene unit in South Carolina. Miller (1986) used mostly well cuttings to determine the basal rocks of the system. Newly collected log data in the area indicate the presence of water-bearing zones deeper than originally mapped. Although these deeper zones are now incorporated into the framework, it is uncertain as to how hydraulically connected these strata are to the main body of the aquifer system. In some areas, the bottom part of the middle Eocene consists of dense non-productive rocks; however these rocks are included in the aquifer system to be consistent with regional mapping.

In the northern part of the study area (Screven County, GA, and Allendale, Colleton, and Hampton Counties, SC), the Upper and Lower Floridan aquifers correlate to the updip clastic-equivalent Upper Three Runs aquifer and the Gordon aquifer, respectively (Falls and others, 1997). Accordingly, the middle confining unit of the Floridan aquifer system correlates to the Gordon aquifer confining unit in those updip areas.

The middle confining unit, as mapped in this report, generally correlates to Miller's (1986) "middle confining unit I," although it is probable that as the middle Eocene rocks thicken to the south, several intermediate confining units separate one or more permeable zones in that part of the aquifer. Such a correlation is difficult to make at this time because of the scarcity of flowmeter data from this part of the aquifer.

To the extent possible, the revised boundaries of the Floridan aquifer system have been mapped taking into account previous interpretations and regional correlations. Because the revised framework does not match the previous framework along all edges, additional work is needed on the regional correlation.

# Summary

An updated framework for the Floridan aquifer system in the northern coastal region of Georgia and parts of South Carolina was developed by incorporating new borehole geophysical and flowmeter log data into a subregional framework that describes the major and minor units of the aquifer system. The revised boundaries of the Floridan aquifer system have been mapped by taking into account results from local studies along with the regional correlations.

The updated framework generally conforms to the original framework established by Miller (1986); the greatest changes affect the internal boundaries of the Upper and Lower Floridan aquifers and the individual permeable zones that compose these aquifers. One of the biggest changes in the framework is the position of the middle confining unit that separates the Upper and Lower Floridan aquifers. This part of the system was not well defined in the original framework because the wells used in the previous study were widely spaced and did not provide enough flowmeter information to hydraulically map the upper and lower contacts of the unit.

The Upper Floridan aquifer composes all of the hydraulically connected permeable carbonate rocks in all or part of the Oligocene and rocks of upper Eocene age. It includes permeable zones 1 and 2 from McCollum and Counts (1964), and it is the most transmissive part of the Floridan aquifer system. This aquifer lies between low-permeability sands and clays of the upper confining unit and fine-grained carbonate rocks of the middle confining unit. The Upper Floridan aquifer is thickest and most productive in the southern part of the area because of the thicker section of upper Eocene rocks in Bryan, Liberty, Long, and McIntosh Counties, GA. It is thinnest and least productive in the extreme updip part of the study area in South Carolina. All of the permeable zones in the Upper Floridan aquifer occur between geophysical marker D and the top of the middle confining unit. The number, thickness, and vertical separation between these permeable zones vary considerably from well to well and across the study area. In as much as there is some zonation of flow identified in the aquifer, the vertical separation between the zones is typically only tens of feet apart with fairly permeable strata between the productive zones. Because of this, the Upper Floridan aquifer generally is characterized as a single hydraulic unit without a substantial degree of internal hydraulic zonation. The transmissivity of the Upper Floridan aquifer ranges from 900 $ft^2/d$ in Hampton County, SC, to 250,000 $ft^2/d$ in Long County, GA.

The middle confining unit separates the Floridan aquifer system into the Upper and Lower Floridan aquifers. Because it is delineated based on permeability characteristics, neither the top nor the bottom of this unit necessarily conforms to formation or time-stratigraphic boundaries and must be delineated by means of flowmeter and (or) borehole geophysical logs. Stratigraphically, the middle confining unit lies in rocks of the lower part of the upper Eocene in Beaufort and Jasper Counties, SC, and in rocks of the upper to middle parts of the middle Eocene elsewhere. This unit correlates to Miller's (1986) "middle confining unit I," which was mapped along the Atlantic coast as an extensive band of low-permeability rocks extending from southeastern South Carolina to the Florida Keys. It is the leakiest of all of the middle confining units mapped in the Floridan aquifer system, and the lithology is not much different from that of the permeable zones above or below it. The middle confining unit ranges from less than 100 ft to greater than 350 ft in thickness and typically ranges from about 150 to 200 ft in thickness over much of the area. The hydraulic properties of the middle confining unit are known only from a few tests. Aquifer tests and subsequent modeling results indicate that the vertical hydraulic conductivity of this unit ranges from 0.0064 to 0.047 ft/d.

The middle confining unit contains locally thin zones of moderate to high permeability. In the Savannah area in Chatham County, GA, and extending into parts of Jasper and Beaufort Counties, SC, the middle confining unit contains one or more of these permeable zones. McCollum and Counts (1964) identified the middle confining unit as zone 3, and it has been correlated to similar depth zones in Beaufort County, SC.

The Lower Floridan aquifer includes all permeable strata that lie below the middle confining unit and above the base of the aquifer system. The strata that compose the Lower Floridan aquifer generally are confined to rocks of middle Eocene age. This aquifer includes permeable zones 4 and 5 from McCollum and Counts (1964). Beneath Hilton Head Island, SC, zone 4 previously was named the *middle Floridan aquifer* and is designated here as part of the Lower Floridan. Similar to the mapping of the middle confining unit, the top of the Lower Floridan was based on identifying the permeable zones below the confining unit by using flowmeter and geophysical logs. Although the depth to the first permeable zone beneath the middle confining unit varies across the area, it typically lies between 150 and 200 ft below the top of the middle Eocene time-stratigraphic horizon. The Lower Floridan aquifer thickens from north to south, from approximately 150 ft in Allendale County, SC, to 400 ft in the northern part of Chatham County, GA, and as much as 600 ft in Liberty and Long Counties, GA. This aquifer contains several permeable zones, each of which is separated by less permeable limestone, dolomitic limestone, and dolomite. The number, thickness, and vertical separation between permeable zones vary considerably from well to well and across the study area. Individual zones that compose the Lower Floridan aquifer become increasingly more discontinuous in the northern part of the study area. The transmissivity of the aquifer ranges from 500 $ft^2/d$ in Allendale County, SC, to 27,000 $ft^2/d$ in Beaufort County, SC, and most of the transmissivity values range between 1,000 and 13,000 $ft^2/d$.

The Upper and Lower Floridan aquifers are interconnected to varying degrees, depending on the thickness and permeability of the middle confining unit that separates the aquifers. In most places, the hydraulic head differences between the two aquifers range from a few inches to a few feet or more. Monitoring at several sites with wells set at different depths in the aquifer indicates variation in the degree of hydraulic separation with depth. In general, the head separation between the Upper and Lower Floridan aquifers increases with depth, which indicates the deeper zones are more hydraulically separated than the shallower parts of the Lower Floridan aquifer.

The revised framework for the Floridan aquifer system in the northern coastal areas of Georgia and parts of South Carolina generally is correlated to the regional framework already established by the USGS. The revised framework differs mainly in the internal consistency of the aquifer and in better defining the middle confining unit that separates the Upper and Lower Floridan aquifers. Within the study area, the top of the aquifer is marked by the Suwannee Limestone of Oligocene age where it is present and by the Ocala Limestone where the Suwannee has been eroded or never deposited. In Chatham and Bryan Counties, SC, the Suwannee is composed of lower permeability rocks and generally separates the Upper Floridan aquifer from the lower Brunswick aquifer.

The base of the Floridan aquifer system is moved downward in some parts of the study area to include all permeable strata above the top of the lower Eocene Oldsmar Formation or where absent above the top of the Paleocene Cedar Keys Formation. In all parts of the study area, these rocks are of much lower permeability than the overlying carbonate rocks and mark the lower extent of the aquifer. The Upper and Lower Floridan aquifers are correlated with the updip clastic-equivalent Upper Three Runs aquifer and the Gordon aquifer, respectively. Accordingly, the middle confining unit of the Floridan aquifer system generally correlates to the Gordon aquifer confining unit in the updip areas.

The lower Brunswick aquifer, previously not identified as a productive aquifer in the northern part of the study area, is present in a test well drilled in Pooler, Chatham County, GA and in several other sites in that same county. The lower Brunswick aquifer provides an alternative water source to the Floridan aquifer system.

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# Appendix A.  Summary of Hydrogeologic Data for Selected Wells Used in This Study

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | Bryan | 33R045 | 320754081364301 | 32.1319 | –81.6118 | 75 | Pembroke Lower Floridan Test Well |
| GA | Bryan | 34P014 | 315800081243801 | 31.9669 | –81.4104 | 18 | USA Fort Stewart Firing Range |
| GA | Bryan | 34R049 | 321008081263801 | 32.1691 | –81.4437 | 80 | GA DOT I-16 Mile Post 144 |
| GA | Bryan | 34R050 | 321142081284101 | 32.1952 | –81.4779 | 80 | GA DOT I-16 Mile Post 141 |
| GA | Bryan | 35N025 | 315011081162701 | 31.8366 | –81.2740 | 18 | — |
| GA | Bryan | 35N035 | 315132081165501 | 31.8591 | –81.2818 | 21 | — |
| GA | Bryan | 35N064 | 314910081152501 | 31.8197 | –81.2568 | 10 | Humble/Darieng 01 |
| GA | Bryan | 35N065 | 315133081164401 | 31.8594 | –81.2787 | 19 | Humble/Blige 01 |
| GA | Bryan | 35P010 | 315634081182801 | 31.9430 | –81.3076 | 11 | I.P.C., Ford Clinic |
| GA | Bryan | 35P020 | 315630081173201 | 31.9419 | –81.2921 | 6 | Interedec, Ford, Y B |
| GA | Bryan | 35P025 | 315508081160901 | 31.9191 | –81.2690 | 7 | Interedec, Ford, S C |
| GA | Bryan | 35P040 | 315558081193201 | 31.9330 | –81.3254 | 11 | Fort, Leon Skate Rink |
| GA | Bryan | 35P057 | 315356081214301 | 31.8991 | –81.3618 | 20.38 | — |
| GA | Bryan | 35P063 | 315718081185501 | 31.9552 | –81.3151 | 15 | DNR Fish Hatchery Well |
| GA | Bryan | 35P106 | 315634081174701 | 31.9430 | –81.2962 | 11 | Interedec, Ford, S F |
| GA | Bryan | 35P107 | 315519081163601 | 31.9222 | –81.2765 | 10 | Interedec, Ford 5/84 |
| GA | Bryan | 35P109 | 315434081185901 | 31.9097 | –81.3162 | 13 | Richmond Hill |
| GA | Bryan | 35Q001 | 320122081201601 | 32.0230 | –81.3376 | 17 | USA Fort Stewart at River |
| GA | Bryan | 36P006 | 315326081115701 | 31.8908 | –81.1990 | 15 | GA DNR Richmond Hill |
| GA | Bulloch | 31T015 | 322813081471001 | 32.4750 | –81.7806 | 200 | Statesboro #6 |
| GA | Bulloch | 31U008 | 323123081511601 | 32.5232 | –81.8543 | 205 | USGS Hopeulikit No. 1 Test Well |
| GA | Bulloch | 32R002 | 321240081411501 | 32.2113 | –81.6873 | 120 | USGS Bulloch South Test Well |
| GA | Candler | 28S003 | 321956082091001 | 32.3324 | –82.1526 | 263 | Morris, M L |
| GA | Candler | 29S003 | 322008082000601 | 32.3357 | –82.0015 | 235 | Irvin Banner Jr |
| GA | Candler | 29T002 | 322436082024201 | 32.4102 | –82.0448 | 200 | Perry Roundtree No.1 |
| GA | Candler | 29T003 | 322711082070201 | 32.4532 | –82.1171 | 270 | J.A. Durdon |
| GA | Candler | 29T009 | 322958082023801 | 32.4966 | –82.0393 | 262 | Donaldson, B |
| GA | Candler | 29T013 | 322339082012901 | 32.3943 | –82.0246 | 170 | Carl Daughtry |
| GA | Candler | 29T014 | 322906082021801 | 32.4852 | –82.0382 | 240 | E.R. Donaldson |
| GA | Candler | 29T015 | 322742082052901 | 32.4618 | –82.0912 | 230 | — |
| GA | Candler | 29T016 | 322839082023901 | 32.4777 | –82.0440 | 283 | — |
| GA | Candler | 29U001 | 323028082071501 | 32.5079 | –82.1207 | 288 | Rushton, L |
| GA | Candler | 30T007 | 322650081593201 | 32.4474 | –81.9921 | 260 | 1 J.O. Rocker |
| GA | Candler | 30T008 | 322807081595201 | 32.4688 | –81.9976 | 250 | Emerson Jones No. 1 |
| GA | Candler | 30T009 | 322320081585701 | 32.3891 | –81.9823 | 220 | GA Forestry Commission |
| GA | Chatham | 35P128 | 315521081185601 | 31.9225 | –81.3156 | 21 | Harristrail Lower Floridan Well |
| GA | Chatham | 35T009 | 322919081212401 | 32.4886 | –81.3567 | 80 | Seismic Line 1 Hole 3 |
| GA | Chatham | 36P036 | 315922081084501 | 31.9897 | –81.1457 | 18 | Savannah, GA 36 |
| GA | Chatham | 36Q001 | 320609081073301 | 32.1027 | –81.1257 | 11 | Union Camp 03 |
| GA | Chatham | 36Q002 | 320558081074701 | 32.0997 | –81.1296 | 11 | 36Q002 |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 33R045 | –251 | –296 | –450 | –632 | — |
| 34P014 | –321 | –385 | — | — | — |
| 34R049 | –265 | –292 | — | — | — |
| 34R050 | –250 | –297 | — | — | — |
| 35N025 | –323 | –392 | — | — | — |
| 35N035 | –316 | –384 | — | — | — |
| 35N064 | –273 | –362 | — | — | — |
| 35N065 | –305 | –365 | — | — | — |
| 35P010 | –320 | –401 | — | — | — |
| 35P020 | –296 | –371 | — | — | — |
| 35P025 | –289 | –361 | — | — | — |
| 35P040 | –329 | –406 | — | — | — |
| 35P057 | –323.62 | –403.62 | — | — | — |
| 35P063 | –303 | –385 | — | — | — |
| 35P106 | –299 | –371 | — | — | — |
| 35P107 | –298 | –364 | — | — | — |
| 35P109 | –318 | –388 | –587 | –737 | –1,284 |
| 35Q001 | –292 | –368 | — | — | — |
| 36P006 | –295 | –374 | — | — | — |
| 31T015 | — | — | — | — | –870 |
| 31U008 | –47 | –82 | –255 | –360 | — |
| 32R002 | –291 | –330 | –460 | –645 | — |
| 28S003 | –177 | — | — | — | — |
| 29S003 | –339 | — | — | — | — |
| 29T002 | –127 | — | — | — | — |
| 29T003 | –26 | –119 | — | — | — |
| 29T009 | –113 | — | — | — | — |
| 29T013 | –150 | –285 | — | — | — |
| 29T014 | –138 | — | — | — | — |
| 29T015 | –97 | — | — | — | — |
| 29T016 | –106 | –147 | — | — | — |
| 29U001 | –41 | — | — | — | — |
| 30T007 | –85 | –170 | — | — | — |
| 30T008 | –77 | — | — | — | — |
| 30T009 | –193 | — | — | — | — |
| 35P128 | — | — | –579 | –749 | — |
| 35T009 | –91 | –135 | –264 | –412 | — |
| 36P036 | –243 | –314 | — | — | — |
| 36Q001 | –204 | –310 | — | — | — |
| 36Q002 | –217 | –320 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | Chatham | 36Q008 | 320530081085001 | 32.0919 | –81.1471 | 9.91 | Layne-Atlantic Co. |
| GA | Chatham | 36Q017 | 320314081085001 | 32.0541 | –81.1471 | 12 | Howard Johnsons Mtl |
| GA | Chatham | 36Q020 | 320021081124801 | 32.0060 | –81.2132 | 13 | H.J. Morrison |
| GA | Chatham | 36Q032 | 320515081085101 | 32.0880 | –81.1479 | 10 | Hercules #3 |
| GA | Chatham | 36Q038 | 320456081074401 | 32.0824 | –81.1284 | 15 | Meddin Package Co 2 |
| GA | Chatham | 36Q040 | 320709081083701 | 32.1194 | –81.1434 | 19.8 | GA Port Auth (8/1942) |
| GA | Chatham | 36Q318 | 320701081131901 | 32.1171 | –81.2218 | 20 | Pooler |
| GA | Chatham | 36Q328 | 320515081102201 | 32.0877 | –81.1726 | 24 | Garden City No. 5, 1986 |
| GA | Chatham | 36Q330 | 320139081134002 | 32.0275 | –81.2278 | 11 | Berwick Plantation |
| GA | Chatham | 36Q392 | 320005081102101 | 32.0014 | –81.1725 | 20 | HAAF No. 11 |
| GA | Chatham | 36R001 | 320854081085401 | 32.1485 | –81.1482 | 11 | CHA-449 |
| GA | Chatham | 36R004 | 321034081092801 | 32.1763 | –81.1576 | 12.74 | Union Carbide Co |
| GA | Chatham | 36R006 | 320759081110301 | 32.1333 | –81.1840 | 40 | Port Wentworth (CHA-452) |
| GA | Chatham | 36R041 | 320809081122101 | 32.1360 | –81.2057 | 19 | Pooler VPI |
| GA | Chatham | 36S048 | 321812081145902 | 32.3047 | –81.2494 | 70 | Rincon Lower Floridan Well |
| GA | Chatham | 37N004 | 314609081050701 | 31.7694 | –81.0851 | 6 | GA DNR Ossabaw Willow Pond Rd |
| GA | Chatham | 37N009 | 314544081052501 | 31.7624 | –81.0901 | 11 | GA DNR Ossabaw USCG |
| GA | Chatham | 37P002 | 315947081025101 | 31.9966 | –81.0473 | 11 | Funk, A J 2 |
| GA | Chatham | 37P003 | 315851081061801 | 31.9810 | –81.1048 | 23 | Featherston, W H |
| GA | Chatham | 37P005 | 315838081054301 | 31.9774 | –81.0951 | 20 | Forest City Gun Club |
| GA | Chatham | 37P010 | 315557081051301 | 31.9327 | –81.0868 | 8.08 | Harmon, Jack |
| GA | Chatham | 37P113 | 315906081011201 | 31.9852 | –81.0198 | 10 | Skidaway Test Well |
| GA | Chatham | 37P117 | 315914081013401 | 31.9874 | –81.0259 | 11 | Roebling Quarters |
| GA | Chatham | 37P118 | 315920081025001 | 31.9891 | –81.0471 | 12 | GGS Bull 82 CH-1 |
| GA | Chatham | 37Q001 | 320614081071801 | 32.1041 | –81.1215 | 7 | Hutchinson Island (CHA-46) |
| GA | Chatham | 37Q003 | 320611081070901 | 32.1033 | –81.1190 | 11 | Union Camp Paper Corp 02 |
| GA | Chatham | 37Q006 | 320604081070601 | 32.1013 | –81.1171 | 12.1 | — |
| GA | Chatham | 37Q010 | 320440081053501 | 32.0780 | –81.0929 | 42 | CHA-471 |
| GA | Chatham | 37Q016 | 320433081042701 | 32.0760 | –81.0740 | 4.7 | East Coast Terminal Well |
| GA | Chatham | 37Q017 | 320443081023701 | 32.0788 | –81.0434 | 5.6 | Standard Oil |
| GA | Chatham | 37Q019 | 320451081014301 | 32.0831 | –81.0178 | 15 | #2 American Cyanamid |
| GA | Chatham | 37Q022 | 320402081054801 | 32.0674 | –81.0965 | 40.6 | Sav No. 2 (Cha-481) |
| GA | Chatham | 37Q034 | 320028081054201 | 32.0080 | –81.0948 | 27.31 | Benedictine School |
| GA | Chatham | 37Q042 | 320152081030101 | 32.0313 | –81.0501 | 12.7 | Thunderbolt, GA 02 |
| GA | Chatham | 37Q071 | 320147081030101 | 32.0302 | –81.0501 | 6 | Thunderbolt |
| GA | Chatham | 37Q072 | 320248081003601 | 32.0469 | –81.0098 | 12 | Grays Subdivision |
| GA | Chatham | 37Q083 | 320517081052601 | 32.0883 | –81.0904 | 5 | Carribbean Lumber (83) |
| GA | Chatham | 37Q162 | 320356081055401 | 32.0652 | –81.0982 | 41 | Savannah No. 5 |
| GA | Chatham | 37Q175 | 320317081071601 | 32.0549 | –81.1209 | 15 | Sav Elec & Pwr Co Op 2 |
| GA | Chatham | 37Q182 | 320138081031401 | 32.0274 | –81.0537 | 22 | Thunderbolt, GA 7/80 |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 36Q008 | –217.09 | –307.09 | — | — | — |
| 36Q017 | –247 | –326 | — | — | — |
| 36Q020 | –264 | –335 | — | — | — |
| 36Q032 | –222 | –305 | –472 | — | — |
| 36Q038 | –215 | –309 | — | — | — |
| 36Q040 | –218.2 | –323.2 | — | — | — |
| 36Q318 | –276 | –368 | — | — | — |
| 36Q328 | –237 | –330 | — | — | — |
| 36Q330 | –284 | –368 | –534 | –689 | –1,149 |
| 36Q392 | –274 | –360 | –536 | –699 | — |
| 36R001 | — | –328 | — | — | — |
| 36R004 | –233.26 | — | — | — | — |
| 36R006 | –230 | –316 | — | –680 | — |
| 36R041 | –249 | –352 | –499 | –699 | — |
| 36S048 | –237 | –279 | –342 | –495 | — |
| 37N004 | –265 | –372 | — | — | — |
| 37N009 | –270 | –374 | — | — | — |
| 37P002 | –198 | –287 | — | — | — |
| 37P003 | –235 | — | — | — | — |
| 37P005 | –238 | — | — | — | — |
| 37P010 | –240.92 | –336.92 | — | — | — |
| 37P113 | –177 | –259 | –400 | –680 | — |
| 37P117 | –175 | –257 | — | — | — |
| 37P118 | –193 | — | — | — | — |
| 37Q001 | — | –309 | –433 | –683 | — |
| 37Q003 | –211 | –299 | — | — | — |
| 37Q006 | –217.9 | — | — | — | — |
| 37Q010 | — | –316 | — | — | — |
| 37Q016 | –215.3 | — | — | — | — |
| 37Q017 | –202.4 | –280.4 | –404 | — | — |
| 37Q019 | — | –256.12 | — | — | — |
| 37Q022 | –215.4 | –308.4 | –419.4 | –699.4 | — |
| 37Q034 | –220.69 | — | — | — | — |
| 37Q042 | –210.3 | –278.3 | — | — | — |
| 37Q071 | — | — | –408 | — | — |
| 37Q072 | — | –229 | — | — | — |
| 37Q083 | –208 | –304 | — | — | — |
| 37Q162 | — | — | –399 | –699 | — |
| 37Q175 | –215 | –319 | — | — | — |
| 37Q182 | –211 | –287 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | Chatham | 37Q183 | 320202081031101 | 32.0341 | –81.0529 | 21 | Thunderbolt, GA 8/84 |
| GA | Chatham | 37Q184 | 320146081055701 | 32.0297 | –81.0990 | 23 | Candler Hospital |
| GA | Chatham | 37Q185 | 320622081063701 | 32.1063 | –81.1101 | 6 | Hutchinson Island TW 1 |
| GA | Chatham | 37Q186 | 320622081063702 | 32.1063 | –81.1101 | 6 | Hutchinson Island Test Well |
| GA | Chatham | 38P002 | 315947080593701 | 31.9964 | –80.9936 | 11 | #2 Wilmington Park |
| GA | Chatham | 38P013 | 315639080553901 | 31.9444 | –80.9273 | 8 | Petit Chou TW 01 |
| GA | Chatham | 38P015 | 315826080595401 | 31.9741 | –80.9982 | 5 | S GA Mineral Program CH-13 GGS 1445 |
| GA | Chatham | 38P016 | 315707080591001 | 31.9522 | –80.9859 | 8 | GGS Bull 82, D-1 |
| GA | Chatham | 38P018 | 315911080591401 | 31.9866 | –80.9871 | 15 | GGS Bull 82 CH-2, GGS 1340 |
| GA | Chatham | 38Q002 | 320202080541201 | 32.0341 | –80.9032 | 8 | U.S. National Park Service, Test Well 6 |
| GA | Chatham | 38Q003 | 320151080540401 | 32.0310 | –80.9009 | 7.7 | USGS Test Well 1 Cockspur Is. (CHA-357) |
| GA | Chatham | 38Q006 | 320358080585201 | 32.0663 | –80.9809 | 7.45 | USGS Test Well 6 (CHA-484) |
| GA | Chatham | 38Q012 | 320029080574201 | 32.0083 | –80.9615 | 10 | — |
| GA | Chatham | 38Q116 | 320135080533301 | 32.0266 | –80.8923 | 5 | USNPS Fort Pulaski |
| GA | Chatham | 38Q190 | 320043080583701 | 32.0122 | –80.9768 | 5.8 | Savannah, GA 20 |
| GA | Chatham | 38Q201 | 320150080540601 | 32.0308 | –80.9015 | 7 | Fort Pulaski Test Well |
| GA | Chatham | 38Q202 | 320054080531701 | 32.0152 | –80.8879 | 5 | S GA Minerals Program CH-4A GGS 1358 |
| GA | Chatham | 38Q203 | 320151080555101 | 32.0310 | –80.9307 | 5 | S GA Mineral Program CH-12 GGS 1411 |
| GA | Chatham | 39P002 | 315916080510501 | 31.9880 | –80.8512 | 7 | S GA Mineral Program CH-10 GGS 1394 |
| GA | Chatham | 39Q003 | 320122080510204 | 32.0230 | –80.8504 | 7 | USGS Test Well 7 (Cha-487) |
| GA | Chatham | 39Q006 | 320041080503201 | 32.0116 | –80.8421 | 10 | Savannah Beach 01 (39) |
| GA | Chatham | 39Q022 | 320024080520601 | 32.0069 | –80.8682 | 5 | S GA Mineral Program CH-11 GGS 1393 |
| GA | Chatham | GA-CH8 | 320151080540401 | 32.0308 | –80.9011 | 8 | GA-CH8 |
| GA | Effingham | 34R036 | 320836081224401 | 32.1435 | –81.3787 | 32 | Central Of Georgia Rr |
| GA | Effingham | 34S007 | 322129081261101 | 32.3582 | –81.4362 | 77 | S GA Minerals Program EF-1 GGS 2174 |
| GA | Effingham | 34S011 | 321742081234904 | 32.2952 | –81.3968 | 80 | Pineora Core Hole |
| GA | Effingham | 34U009 | 323307081224701 | 32.5521 | –81.3799 | 95 | Clyo/Kildare |
| GA | Effingham | 35R026 | 320940081195201 | 32.1613 | –81.3307 | 59 | J. Carlson (Lakeside Prk) |
| GA | Effingham | 35S003 | 322102081160301 | 32.3507 | –81.2673 | 20 | Boy Scout Camp |
| GA | Effingham | 35T005 | 322234081190003 | 32.3761 | –81.3167 | 40 | Springfield |
| GA | Effingham | 35U005 | 323115081153701 | 32.5210 | –81.2601 | 91 | S GA Mineral Program EF-6 GGS 2179 |
| GA | Effingham | 36S004 | 321523081133601 | 32.2566 | –81.2265 | 61 | Westwood Heights |
| GA | Effingham | 36S022 | 321722081135601 | 32.2896 | –81.2337 | 61 | Rincon Well #2 |
| GA | Effingham | 36S027 | 322001081122101 | 32.3338 | –81.2057 | 66.99 | Fort Howard Paper Co 03 |
| GA | Evans | 30R002 | 320945081544701 | 32.1627 | –81.9129 | 190 | Claxton, GA |
| GA | Evans | 30R004 | 321313081523501 | 32.2205 | –81.8762 | 151 | — |
| GA | Evans | 30R005 | 321032081535001 | 32.1764 | –81.8968 | 105 | — |
| GA | Liberty | 32N007 | 314631081380401 | 31.7755 | –81.6343 | 94 | Liberty Co Road & Revenue |
| GA | Liberty | 33M007 | 314322081303301 | 31.7230 | –81.5090 | 16 | Humble/Union Bag 009 |
| GA | Liberty | 33N044 | 314909081305901 | 31.8197 | –81.5162 | 10.55 | Kelly, J |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 37Q183 | –212 | –287 | — | — | — |
| 37Q184 | –211 | –303 | –477 | — | — |
| 37Q185 | –219 | –318 | — | — | — |
| 37Q186 | –218 | –316 | –464 | –674 | — |
| 38P002 | –165 | –236 | — | — | — |
| 38P013 | –134 | –197 | — | — | — |
| 38P015 | –173 | –245 | — | — | — |
| 38P016 | –156 | — | — | — | — |
| 38P018 | –164 | — | — | — | — |
| 38Q002 | –105 | –176 | — | — | — |
| 38Q003 | –107.3 | –177.3 | –362.3 | — | — |
| 38Q006 | –129.55 | –187.55 | –332.55 | –602.55 | — |
| 38Q012 | –135 | –192 | — | — | — |
| 38Q116 | –104 | –171 | — | — | — |
| 38Q190 | –142.2 | –207.2 | — | — | — |
| 38Q201 | –109 | –177 | — | –593 | — |
| 38Q202 | –118 | — | — | — | — |
| 38Q203 | –126 | — | — | — | — |
| 39P002 | –129 | — | — | — | — |
| 39Q003 | –112 | –179 | –348 | –633 | — |
| 39Q006 | –126 | –194 | — | — | — |
| 39Q022 | –122 | –191 | — | — | — |
| GA-CH8 | — | — | — | — | –1,058 |
| 34R036 | –259 | –323 | — | — | — |
| 34S007 | –185 | — | — | — | — |
| 34S011 | –192 | –235 | –370 | –580 | –910 |
| 34U009 | — | — | –220 | — | — |
| 35R026 | — | –240 | — | — | — |
| 35S003 | –195 | — | — | — | — |
| 35T005 | –189 | –221 | –286 | — | — |
| 35U005 | –63 | –68 | — | — | — |
| 36S004 | –229 | –261 | –375 | — | — |
| 36S022 | — | — | –360 | — | — |
| 36S027 | –168.01 | –237.01 | — | — | — |
| 30R002 | –273 | –318 | — | — | — |
| 30R004 | –289 | –359 | — | — | — |
| 30R005 | –263 | — | — | — | — |
| 32N007 | — | –458 | — | — | — |
| 33M007 | –374 | –416 | — | — | — |
| 33N044 | –344.45 | –384.45 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | Liberty | 33N076 | 315043081353001 | 31.8453 | –81.5917 | 54 | LIB-7 |
| GA | Liberty | 33N076 | 315043081353001 | 31.8455 | –81.5915 | 54 | Mingledorff, F |
| GA | Liberty | 33N092 | 315206081343401 | 31.8685 | –81.5759 | 29 | Humble/Quaterman 01 |
| GA | Liberty | 33N093 | 314536081365301 | 31.7602 | –81.6146 | 68 | Humble/Union Bag 024 |
| GA | Liberty | 33N094 | 314928081302701 | 31.8244 | –81.5075 | 21 | #39 Union-Camp |
| GA | Liberty | 33N094 | 314928081302701 | 31.8247 | –81.5073 | 21 | Union Camp #39 |
| GA | Liberty | 33N095 | 314625081302901 | 31.7738 | –81.5079 | 17 | Humble/Union Bag 040 |
| GA | Liberty | 33N096 | 314643081332301 | 31.7788 | –81.5562 | 16 | Humble/Union Bag 041 |
| GA | Liberty | 33N097 | 314512081312101 | 31.7535 | –81.5223 | 17 | Union Camp #44 |
| GA | Liberty | 33P019 | 315728081301101 | 31.9411 | –81.5028 | 26 | Fort Stewart |
| GA | Liberty | 34M019 | 314431081254201 | 31.7422 | –81.4282 | 13.95 | Interstate Paper Co (535') |
| GA | Liberty | 34M020 | 314438081245701 | 31.7441 | –81.4157 | 9.78 | Interstate Paper Co (453') |
| GA | Liberty | 34M021 | 314442081243401 | 31.7452 | –81.4093 | 13.84 | Interstate Paper Co (445') |
| GA | Liberty | 34M050 | 314340081252901 | 31.7280 | –81.4246 | 19 | Kearsey, E E |
| GA | Liberty | 34M051 | 314438081242501 | 31.7441 | –81.4068 | 12 | Interstate Paper Co, Rust 1 |
| GA | Liberty | 34M052 | 314435081243901 | 31.7433 | –81.4107 | 13 | Interstate Paper Co, Rust 2 |
| GA | Liberty | 34M053 | 314428081245301 | 31.7413 | –81.4146 | 12 | Interstate Paper Co, Rust 3 |
| GA | Liberty | 34M057 | 314439081242501 | 31.7444 | –81.4068 | 10 | Interstate Paper Crp |
| GA | Liberty | 34M075 | 313901081234101 | 31.6524 | –81.3954 | 10 | Texaco Station I95 & US17 |
| GA | Liberty | 34M083 | 314324081251301 | 31.7233 | –81.4203 | 17 | LIB-3 |
| GA | Liberty | 34M083 | 314324081251301 | 31.7235 | –81.4201 | 17 | Humble/James, Wm 01 |
| GA | Liberty | 34M083 | 314324081251301 | 31.7288 | –81.4218 | 19 | USGS TW #2 Liberty Co |
| GA | Liberty | 34M084 | 314240081272601 | 31.7113 | –81.4571 | 19 | Humble/Minson, R 01 |
| GA | Liberty | 34M085 | 314241081224101 | 31.7116 | –81.3779 | 19 | Humble/Union Bag 010 |
| GA | Liberty | 34M086 | 314132081243301 | 31.6924 | –81.4090 | 15 | Humble/Lambert 01 |
| GA | Liberty | 34M087 | 314000081261701 | 31.6669 | –81.4379 | 22 | Humble/Union Bag 058 |
| GA | Liberty | 34M088 | 314408081282201 | 31.7358 | –81.4726 | 14 | Humble/Barton 01 |
| GA | Liberty | 34N088 | 314754081260201 | 31.7994 | –81.4337 | 11.5 | Midway, GA |
| GA | Liberty | 34N089 | 315214081235301 | 31.8708 | –81.3979 | 17 | U.S. Geological Survey, Test Well 1 |
| GA | Liberty | 34N094 | 314624081224401 | 31.7735 | –81.3787 | 17 | Humble/Union Bag 012 |
| GA | Liberty | 34N095 | 314731081281301 | 31.7922 | –81.4701 | 15 | Humble/Union Bag 043 |
| GA | Liberty | 34N096 | 314528081272701 | 31.7580 | –81.4573 | 15 | Humble/Union Bag 011 |
| GA | Liberty | 34N097 | 314915081260701 | 31.8210 | –81.4351 | 17 | Humble/Union Bag 038 |
| GA | Liberty | 34N097 | 314915081260701 | 31.8208 | –81.4353 | 17 | LIB-5 |
| GA | Liberty | 34P024 | 315346081253101 | 31.8963 | –81.4251 | 18 | Gill, J F |
| GA | Liberty | 35M027 | 314352081153301 | 31.7313 | –81.2590 | 4 | — |
| GA | Liberty | 35M040 | 314114081204601 | 31.6874 | –81.3459 | 26 | Jelks-Rodgers No. 1 |
| GA | Liberty | 35M041 | 314419081192801 | 31.7388 | –81.3243 | 26 | Tippens, Sam J |
| GA | Liberty | 35M043 | 314352081221001 | 31.7313 | –81.3693 | 7 | Humble/Union Bag 103 |
| GA | Liberty | 35M044 | 314412081190101 | 31.7367 | –81.3169 | 16 | LIB-2 |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 33N076 | — | — | –601 | — | — |
| 33N076 | –344 | –382 | — | — | — |
| 33N092 | –346 | –390 | — | — | — |
| 33N093 | –415 | –457 | — | — | — |
| 33N094 | — | — | — | — | –1,414 |
| 33N094 | –336 | –379 | — | –829 | –1,414 |
| 33N095 | –376 | –417 | — | — | — |
| 33N096 | –371 | –411 | — | — | — |
| 33N097 | –369 | –415 | –683 | –885 | — |
| 33P019 | –348 | –399 | — | — | — |
| 34M019 | –388.05 | –432.05 | — | — | — |
| 34M020 | –385.22 | –425.22 | — | — | — |
| 34M021 | –371.16 | –416.16 | — | — | — |
| 34M050 | –416 | –452 | — | — | — |
| 34M051 | –367 | –411 | — | — | — |
| 34M052 | –381 | –423 | — | — | — |
| 34M053 | –382 | –422 | — | — | — |
| 34M057 | –370 | –410 | — | — | — |
| 34M075 | –404 | –435 | — | — | — |
| 34M083 | — | — | –668 | — | — |
| 34M083 | –399 | –438 | — | — | — |
| 34M083 | –401 | –442 | — | — | — |
| 34M084 | –381 | –418 | — | — | — |
| 34M085 | –384 | –416 | — | — | — |
| 34M086 | –400 | –438 | — | — | — |
| 34M087 | –385 | –434 | — | — | — |
| 34M088 | –375 | –414 | — | — | — |
| 34N088 | — | –408.5 | — | — | — |
| 34N089 | –335 | –395 | — | — | — |
| 34N094 | –363 | –411 | — | — | — |
| 34N095 | –364 | –410 | — | — | — |
| 34N096 | –376 | –410 | — | — | — |
| 34N097 | –356 | –401 | — | — | — |
| 34N097 | — | — | –625 | — | — |
| 34P024 | –330 | –392 | — | — | — |
| 35M027 | –350 | –428 | — | — | — |
| 35M040 | –387 | –434 | –674 | –916 | –1,549 |
| 35M041 | –344 | –402 | — | — | — |
| 35M043 | –363 | –405 | — | — | — |
| 35M044 | –337 | –402 | –646 | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | Liberty | 35M045 | 314233081165501 | 31.7094 | –81.2818 | 9 | Humble/Stevens 01 |
| GA | Liberty | 35N061 | 314530081181601 | 31.7586 | –81.3043 | 22 | Humble/Union Bag 104 |
| GA | Liberty | 35N062 | 314649081181201 | 31.7805 | –81.3032 | 30 | Humble/Union Bag 013 |
| GA | Liberty | 35N063 | 314531081205001 | 31.7588 | –81.3471 | 28 | Humble/Union Bag 105 |
| GA | Liberty | 35N068 | 314844081211901 | 31.8124 | –81.3551 | 10 | Ashburn, T N (Swim Pond) |
| GA | Liberty | 36M004 | 314008081093301 | 31.6691 | –81.1590 | 13 | Noble Fd-St Cath Power House |
| GA | Liberty | 36M013 | 314236081142301 | 31.7102 | –81.2395 | 15 | Yellow Bluff Fishing Camp |
| GA | Liberty | 36M020 | 313905081093401 | 31.6516 | –81.1593 | 11 | Noble Fd-St Cath Greenseed Pond |
| GA | Long | 31M003 | 314005081452301 | 31.6683 | –81.7562 | 38 | Humble/Altam. Land Co 03 |
| GA | Long | 31M004 | 314203081464201 | 31.7010 | –81.7782 | 41 | 31M004 |
| GA | Long | 31M007 | 314331081522301 | 31.7255 | –81.8729 | 52 | 31M007 |
| GA | Long | 31M008 | 314021081474701 | 31.6727 | –81.7962 | 34 | Humble/Sav Rv Lum Corp 01 |
| GA | Long | 31M025 | 314223081483401 | 31.7066 | –81.8093 | 41 | Humble/Altam. Land Co 05 |
| GA | Long | 31M029 | 314233081505801 | 31.7094 | –81.8493 | 38 | Humble/Sav Rv Lum Corp 02 |
| GA | Long | 31N005 | 314532081502001 | 31.7591 | –81.8387 | 44 | Humble/J.E. Parker No 2 |
| GA | Long | 32L001 | 313426081410901 | 31.5741 | –81.6857 | 28 | Humble/Sav Rv Lum Corp 03 |
| GA | Long | 32L002 | 313607081414401 | 31.6022 | –81.6954 | 21 | Humble/Sav Rv Lum Corp 04 |
| GA | Long | 32L003 | 313308081384701 | 31.5524 | –81.6462 | 23 | Humble/Sav Rv Lum Corp 05 |
| GA | Long | 32L018 | 313606081434301 | 31.6019 | –81.7284 | 42 | Humble/Sav Rv Lum Corp 06 |
| GA | Long | 32L019 | 313454081384201 | 31.5819 | –81.6448 | 23 | Humble/Union Bag 030 |
| GA | Long | 32M003 | 313857081440001 | 31.6494 | –81.7332 | 31 | Humble/Altam. Land Co 01 |
| GA | Long | 32M005 | 314235081373901 | 31.7099 | –81.6273 | 69 | 32M005 |
| GA | Long | 32M006 | 314349081414601 | 31.7305 | –81.6959 | 64 | Humble/Union Bag 025 |
| GA | Long | 32M010 | 314109081402301 | 31.6860 | –81.6729 | 82 | Humble/Union Bag 026 |
| GA | Long | 32M011 | 314133081433901 | 31.6927 | –81.7273 | 68 | Humble/Union Bag 027 |
| GA | Long | 32M012 | 313921081414101 | 31.6560 | –81.6946 | 31 | Humble/Union Bag 028 |
| GA | Long | 32M013 | 313734081402101 | 31.6263 | –81.6723 | 27 | 32M013 |
| GA | Long | 33L001 | 313442081341101 | 31.5786 | –81.5695 | 22 | 33L001 |
| GA | Long | 33L002 | 313724081355601 | 31.6236 | –81.5987 | 57 | Humble/Union Bag 021 |
| GA | Long | 33L003 | 313541081353501 | 31.5949 | –81.5929 | 23 | Humble/Union Bag 059 |
| GA | Long | 33M001 | 314100081315601 | 31.6835 | –81.5321 | 22 | Humble/Union Bag 005 |
| GA | Long | 33M002 | 314335081342401 | 31.7266 | –81.5732 | 21 | Humble/Union Bag 006 |
| GA | Long | 33M004 | 313845081361701 | 31.6486 | –81.6009 | 61.24 | USGS TW #3 Long Co |
| GA | Long | 33M005 | 313849081313401 | 31.6472 | –81.5259 | 18 | Humble/Union Bag 014 |
| GA | Long | 33M006 | 314003081370301 | 31.6677 | –81.6173 | 62 | Humble/Union Bag 022 |
| GA | Long | 33M010 | 313949081340501 | 31.6638 | –81.5679 | 19 | Union Bag #60 |
| GA | McIntosh | 33K009 | 312814081361901 | 31.4708 | –81.6051 | 24 | — |
| GA | McIntosh | 33K012 | 312955081361001 | 31.4988 | –81.6026 | 20 | — |
| GA | McIntosh | 33K016 | 312659081312001 | 31.4499 | –81.5212 | 12 | Terrell, Mrs Phillip |
| GA | McIntosh | 33K020 | 312850081365301 | 31.4808 | –81.6146 | 13 | Humble/Fort Barrington |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 35M045 | –364 | –435 | — | — | — |
| 35N061 | — | –393 | — | — | — |
| 35N062 | –319 | –390 | — | — | — |
| 35N063 | –356 | –407 | — | — | — |
| 35N068 | –342 | –397 | — | — | — |
| 36M004 | — | –427 | — | — | — |
| 36M013 | –356 | — | — | — | — |
| 36M020 | –340 | –439 | — | — | — |
| 31M003 | –427 | –461 | — | — | — |
| 31M004 | –423 | –453 | — | — | — |
| 31M007 | –395 | –413 | — | — | — |
| 31M008 | –436 | –466 | — | — | — |
| 31M025 | –399 | –413 | — | — | — |
| 31M029 | –392 | –412 | — | — | — |
| 31N005 | –362 | –391 | — | — | — |
| 32L001 | — | –470 | — | — | — |
| 32L002 | –461 | –489 | — | — | — |
| 32L003 | –457 | –479 | — | — | — |
| 32L018 | –455 | –483 | — | — | — |
| 32L019 | –459 | –483 | — | — | — |
| 32M003 | –450 | –486 | — | — | — |
| 32M005 | –424 | –451 | — | — | — |
| 32M006 | –411 | –441 | — | — | — |
| 32M010 | –440 | –479 | — | — | — |
| 32M011 | –432 | –467 | — | — | — |
| 32M012 | –421 | –449 | — | — | — |
| 32M013 | –429 | –463 | — | — | — |
| 33L001 | –436 | –472 | — | — | — |
| 33L002 | –443 | –474 | — | — | — |
| 33L003 | –432 | –467 | — | — | — |
| 33M001 | –388 | –428 | — | — | — |
| 33M002 | –388 | –424 | — | — | — |
| 33M004 | –424.76 | –463.76 | — | — | — |
| 33M005 | –402 | –435 | — | — | — |
| 33M006 | –435 | –468 | — | — | — |
| 33M010 | –411 | –434 | –701 | –991 | — |
| 33K009 | –442 | –465 | — | — | — |
| 33K012 | –429 | –455 | — | — | — |
| 33K016 | –492 | –552 | — | — | — |
| 33K020 | –446 | –457 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | McIntosh | 33K021 | 312728081335201 | 31.4580 | –81.5643 | 13 | Humble/Union Bag 034 |
| GA | McIntosh | 33K022 | 312849081311801 | 31.4803 | –81.5217 | 12 | #54 Union-Camp |
| GA | McIntosh | 33K023 | 312953081330301 | 31.5031 | –81.2039 | 19 | #33 Union-Camp |
| GA | McIntosh | 33K024 | 312920081361401 | 31.4889 | –81.6039 | 41 | #32 Union-Camp |
| GA | McIntosh | 33K025 | 312729081300401 | 31.4583 | –81.5009 | 12 | Humble/Union Bag 035 |
| GA | McIntosh | 33K026 | 312501081320901 | 31.4172 | –81.5357 | 17 | Humble/Sav Rv Lum Corp 07 |
| GA | McIntosh | 33L010 | 313219081314901 | 31.5388 | –81.5301 | 19 | Union Camp Paper Corp |
| GA | McIntosh | 33L072 | 313723081300901 | 31.6233 | –81.5023 | 15 | Humble/Union Bag 002 |
| GA | McIntosh | 33M018 | 314032081302402 | 31.6756 | –81.5067 | 22 | Union Bag No. 45 |
| GA | McIntosh | 34J027 | 312158081253001 | 31.3663 | –81.4248 | 21 | Darien, GA (1968) |
| GA | McIntosh | 34J046 | 312227081253901 | 31.3744 | –81.4273 | 22 | Pack, John |
| GA | McIntosh | 34J047 | 312156081255901 | 31.3658 | –81.4329 | 4 | — |
| GA | McIntosh | 34K008 | 312515081291101 | 31.4191 | –81.4862 | 14 | — |
| GA | McIntosh | 34K079 | 312244081250601 | 31.3791 | –81.4182 | 22 | Fisher, W |
| GA | McIntosh | 34K080 | 312430081273501 | 31.4099 | –81.4582 | 28 | Pearling Ind Shoe Factory |
| GA | McIntosh | 34K082 | 312531081292001 | 31.4255 | –81.4901 | 10 | — |
| GA | McIntosh | 34K085 | 312817081271501 | 31.4716 | –81.4540 | 19.58 | GA DOT I-95 Weigh Station |
| GA | McIntosh | 34K086 | 312417081223101 | 31.4049 | –81.3751 | 8 | — |
| GA | McIntosh | 34K087 | 312350081223501 | 31.3974 | –81.3762 | 6 | Newburn, Joe |
| GA | McIntosh | 34K091 | 312319081225101 | 31.3888 | –81.3807 | 7 | — |
| GA | McIntosh | 34K092 | 312303081225101 | 31.3844 | –81.3807 | 7 | — |
| GA | McIntosh | 34K100 | 312718081231601 | 31.4552 | –81.3876 | 15 | Humble/Union Bag 037 |
| GA | McIntosh | 34K116 | 312521081255302 | 31.4225 | –81.4314 | 31 | Union Bag #53 |
| GA | McIntosh | 34L027 | 313208081253101 | 31.5383 | –81.4240 | 6.87 | Ware, G |
| GA | McIntosh | 34L048 | 313054081245501 | 31.5152 | –81.4151 | 22 | Williams, W E & F B |
| GA | McIntosh | 34L059 | 313522081293701 | 31.5897 | –81.4934 | 15 | Warsaw Lumber Co |
| GA | McIntosh | 34L061 | 313155081264801 | 31.5322 | –81.4465 | 20 | — |
| GA | McIntosh | 34L066 | 313620081261201 | 31.6058 | –81.4365 | 17 | Humble/Union Bag 048 |
| GA | McIntosh | 34L071 | 313031081261801 | 31.5088 | –81.4382 | 15 | Eulonia, GA, 4/84 |
| GA | McIntosh | 34L080 | 313506081292002 | 31.5850 | –81.4889 | 16 | Union Bag #49 |
| GA | McIntosh | 34M001 | 313814081234201 | 31.6374 | –81.3948 | 14 | Stebbins, C H |
| GA | McIntosh | 34M070 | 313820081290301 | 31.6391 | –81.4840 | 12 | King, Charles |
| GA | McIntosh | 35K062 | 312553081165601 | 31.4316 | –81.2820 | 6 | Sapelo Research Fd-Longtabby |
| GA | McIntosh | 35K065 | 312717081215201 | 31.4549 | –81.3643 | 4 | Sapelo Research Fd-Mainland Dk |
| GA | McIntosh | 35K068 | 312632081220901 | 31.4424 | –81.3690 | 9 | Pease Island Development |
| GA | McIntosh | 35K069 | 312840081205301 | 31.4780 | –81.3479 | 11 | Gore, S |
| GA | McIntosh | 35K071 | 312845081204001 | 31.4794 | –81.3443 | 11 | Bolton, George |
| GA | McIntosh | 35L067 | 313325081214901 | 31.5572 | –81.3634 | 8 | Holt, V |
| GA | McIntosh | 35L071 | 313722081185801 | 31.6230 | –81.3159 | 14 | Proudfoot, H S |
| GA | McIntosh | 35L072 | 313309081220401 | 31.5527 | –81.3676 | 14 | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 33K021 | –468 | –502 | — | — | — |
| 33K022 | –471 | –516 | — | — | — |
| 33K023 | –449 | –486 | — | — | — |
| 33K024 | –434 | –461 | — | — | — |
| 33K025 | –496 | –552 | — | — | — |
| 33K026 | –506 | –576 | — | — | — |
| 33L010 | –421 | –452 | — | — | — |
| 33L072 | –401 | –421 | — | — | — |
| 33M018 | — | — | –668 | –973 | — |
| 34J027 | –593 | –700 | — | — | — |
| 34J046 | –572 | — | — | — | — |
| 34J047 | –586 | –702 | — | — | — |
| 34K008 | –564 | –634 | — | — | — |
| 34K079 | –567 | –679 | — | — | — |
| 34K080 | –574 | –655 | — | — | — |
| 34K082 | –550 | –625 | — | — | — |
| 34K085 | –482.42 | –540.42 | — | — | — |
| 34K086 | –535 | –634 | — | — | — |
| 34K087 | –551 | –652 | — | — | — |
| 34K091 | –555 | –653 | — | — | — |
| 34K092 | –555 | –648 | — | — | — |
| 34K100 | –525 | –588 | — | — | — |
| 34K116 | — | — | –869 | –1,118 | — |
| 34L027 | –428.13 | –477.13 | — | — | — |
| 34L048 | –432 | –480 | — | — | — |
| 34L059 | –415 | –443 | — | — | — |
| 34L061 | –418 | –459 | — | — | — |
| 34L066 | –405 | –439 | — | — | — |
| 34L071 | –453 | –496 | — | — | — |
| 34L080 | — | — | –714 | — | — |
| 34M001 | –401 | –440 | — | — | — |
| 34M070 | –389 | –415 | — | — | — |
| 35K062 | –466 | –571 | — | — | — |
| 35K065 | –509 | –589 | — | — | — |
| 35K068 | –510 | –592 | — | — | — |
| 35K069 | –502 | –587 | — | — | — |
| 35K071 | –501 | –585 | — | — | — |
| 35L067 | –432 | –494 | — | — | — |
| 35L071 | –386 | –454 | — | — | — |
| 35L072 | –439 | –494 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| GA | McIntosh | 35L080 | 313336081180601 | 31.5602 | –81.3015 | 18 | Julienton, Thorpe, H |
| GA | McIntosh | 35L081 | 313410081173701 | 31.5697 | –81.2934 | 15 | Julienton, Middle Rd |
| GA | McIntosh | 35L085 | 313608081182701 | 31.6021 | –81.3075 | 10 | Shellman Bluff Lower Floridan Test Well |
| GA | McIntosh | 35M013 | 313823081154201 | 31.6399 | –81.2615 | 16.3 | U.S. Fish and Wildlife Service |
| GA | McIntosh | 35M014 | 313759081163001 | 31.6333 | –81.2701 | 20 | USF&WL Harris Neck Airfield 8" |
| GA | McIntosh | 35M015 | 313806081162501 | 31.6352 | –81.2734 | 14 | USF&WL Harris Neck Airfield 3" |
| GA | McIntosh | 35M046 | 313810081221501 | 31.6363 | –81.3707 | 17 | Humble/Union Bag 007 |
| GA | McIntosh | 36K001 | 312611081142101 | 31.4366 | –81.2390 | 12 | — |
| GA | McIntosh | 36K004 | 312925081123001 | 31.4899 | –81.2090 | 12 | USF&WL Blackbeard Isl 04 |
| GA | McIntosh | 36L008 | 313135081122201 | 31.5266 | –81.2059 | 8 | USF&WL Blackbeard Isl 01 |
| GA | McIntosh | 36L009 | 313053081122301 | 31.5149 | –81.2062 | 10 | USF&WL Blackbeard Isl 02 |
| GA | Screven | 31W027 | 324932081465401 | 32.8256 | –81.7817 | 255 | Screven #4 |
| GA | Screven | 32U017 | 323614081442701 | 32.6033 | –81.7394 | 155 | King Finishing Mfg 01 |
| GA | Screven | 32U017 | 323614081442701 | 32.6039 | –81.7469 | 160 | King Finishing Dover |
| GA | Screven | 33U024 | 323009081325401 | 32.5027 | –81.5482 | 75 | Screven Oil Test 1933-34 |
| GA | Screven | 33V052 | 324125081302901 | 32.6903 | –81.5081 | 200 | Screven #8 |
| GA | Screven | 33X037 | 325726081372201 | 32.9657 | –81.6226 | 189 | Millhaven Buena Vista |
| GA | Screven | 33X048 | 325325081354301 | 32.8904 | –81.5951 | 110 | Millhaven Core Hole |
| GA | Screven | 33X056 | 325443081311501 | 32.9119 | –81.5208 | 90 | Screven #7 |
| GA | Screven | 34U010 | 323458081251801 | 32.5828 | –81.4217 | 110 | Seismic Line 1 Hole 2 |
| GA | Screven | 34V013 | 323810081253001 | 32.6361 | –81.4250 | 52 | Screven #1 |
| GA | Screven | 34V014 | 323736081290401 | 32.6267 | –81.4844 | 130 | Seismic Line 1 Hole 1 |
| GA | Screven | 34W004 | 324841081290401 | 32.8108 | –81.4842 | 59 | GA DOT Roadside Park |
| SC | Allendale | AL-27 | 330307081291000 | 33.0397 | –81.4883 | 186 | — |
| SC | Allendale | AL-35 | 325412081234609 | 32.9035 | –81.3959 | 155 | — |
| SC | Allendale | AL-37 | 324552081212900 | 32.7646 | –81.3579 | 72.8 | — |
| SC | Allendale | AL-44 | 325850081174509 | 32.9807 | –81.2957 | 160 | — |
| SC | Allendale | AL-47 | 324559081221301 | 32.7664 | –81.3703 | 60 | Grotan Plantation |
| SC | Allendale | AL-306 | 325523081142100 | 32.9232 | –81.2390 | 110 | — |
| SC | Allendale | AL-324 | 330737081324500 | 33.1271 | –81.5457 | 203 | — |
| SC | Allendale | AL-347 | 330130081230301 | 33.0250 | –81.3842 | 289.6 | — |
| SC | Allendale | C7 | — | 33.1133 | –81.5061 | 252 | — |
| SC | Beaufort | BFT-2 | 322054080402509 | 32.3485 | –80.6734 | 10 | — |
| SC | Beaufort | BFT-7 | 321956080425609 | 32.3324 | –80.7154 | 0 | — |
| SC | Beaufort | BFT-29 | 322610080402000 | 32.4355 | –80.6726 | 20 | — |
| SC | Beaufort | BFT-59 | 323140080404500 | 32.5252 | –80.6748 | 5 | — |
| SC | Beaufort | BFT-67 | 323555080024500 | 32.5988 | –80.0456 | 0 | Hilton Head Os |
| SC | Beaufort | BFT-101 | 321005080442701 | 32.1683 | –80.7407 | 13.8 | USGS TW 2 |
| SC | Beaufort | BFT-115 | 322615080453609 | 32.4377 | –80.7598 | 8 | — |
| SC | Beaufort | BFT-121 | 322745080435800 | 32.4635 | –80.7346 | 31.25 | Military Reservation near Beaufort |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| 35L080 | –434 | –502 | — | — | — |
| 35L081 | –433 | –501 | — | — | — |
| 35L085 | — | — | –712 | –955 | — |
| 35M013 | –388.7 | –453.7 | — | — | — |
| 35M014 | –391 | –452 | — | — | — |
| 35M015 | –383 | –441 | — | — | — |
| 35M046 | –383 | –433 | — | — | — |
| 36K001 | –468 | –568 | — | — | — |
| 36K004 | –434 | –531 | — | — | — |
| 36L008 | –385 | –487 | — | — | — |
| 36L009 | –400 | –499 | — | — | — |
| 31W027 | — | 75 | — | — | — |
| 32U017 | –22 | –45 | — | — | –746 |
| 32U017 | — | — | — | — | –746 |
| 33U024 | –118 | –126 | — | — | — |
| 33V052 | 7 | — | — | — | — |
| 33X037 | — | — | — | –179 | –276 |
| 33X048 | 60 | 50 | –95 | –255 | –390 |
| 33X056 | 61 | 38 | — | — | — |
| 34U010 | –22 | –72 | –202 | –301 | — |
| 34V013 | –8 | –56 | — | — | — |
| 34V014 | –22 | –72 | –180 | –295 | — |
| 34W004 | 32 | 7 | — | — | — |
| AL-27 | — | 77 | –63 | –138 | –228 |
| AL-35 | 72 | 48 | — | — | — |
| AL-37 | –7.2 | –14.2 | — | — | — |
| AL-44 | 93 | 76 | — | — | — |
| AL-47 | 25 | 15 | — | — | –396 |
| AL-306 | 80 | 80 | — | — | — |
| AL-324 | — | 168 | 28 | –2 | –127 |
| AL-347 | — | 105 | –80 | –160 | –310 |
| C7 | — | 152 | 22 | 2 | –148 |
| BFT-2 | –50 | — | — | — | — |
| BFT-7 | –72 | –80 | — | — | — |
| BFT-29 | –76 | –84 | — | — | — |
| BFT-59 | –25 | –30 | — | — | — |
| BFT-67 | –130.8 | — | — | — | — |
| BFT-101 | –99.2 | –127.2 | –276 | — | — |
| BFT-115 | –79 | –79 | — | — | — |
| BFT-121 | –48.75 | –53.75 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Beaufort | BFT-130 | 322340080353509 | 32.3946 | –80.5929 | 10 | — |
| SC | Beaufort | BFT-133 | 323152080433500 | 32.5238 | –80.7184 | 12.12 | — |
| SC | Beaufort | BFT-154 | 322218080511109 | 32.3719 | –80.8529 | 8 | — |
| SC | Beaufort | BFT-161 | 322032080270909 | 32.3424 | –80.4523 | 7 | — |
| SC | Beaufort | BFT-192 | 322022080364009 | 32.3396 | –80.6109 | 10 | — |
| SC | Beaufort | BFT-209 | 320820080471109 | 32.1391 | –80.7862 | 8 | Sea Pines Golf |
| SC | Beaufort | BFT-210 | 320835080472201 | 32.1433 | –80.7893 | 5.93 | — |
| SC | Beaufort | BFT-304 | 320846080502201 | 32.1389 | –80.8394 | 13 | Test Well #3 |
| SC | Beaufort | BFT-308 | 321445080512909 | 32.2460 | –80.8579 | 25 | — |
| SC | Beaufort | BFT-315 | 321558080431301 | 32.2492 | –80.7013 | 17 | USGS Test Well 8, Hilton Head Island |
| SC | Beaufort | BFT-316 | 321412080514809 | 32.2369 | –80.8632 | 23 | — |
| SC | Beaufort | BFT-317 | 321359080445908 | 32.2333 | –80.7495 | 9 | — |
| SC | Beaufort | BFT-318 | 321701080505409 | 32.2838 | –80.8482 | 15 | — |
| SC | Beaufort | BFT-320 | 322245080504709 | 32.3794 | –80.8462 | 5 | — |
| SC | Beaufort | BFT-321 | 321218080411800 | 32.2052 | –80.6882 | 7 | Foley Field |
| SC | Beaufort | BFT-341 | 321652080480300 | 32.2813 | –80.8007 | 15.13 | — |
| SC | Beaufort | BFT-406 | 321350080403200 | 32.2274 | –80.6804 | 11.03 | Golf Course |
| SC | Beaufort | BFT-407 | 321307080402500 | 32.2230 | –80.6743 | 10.03 | — |
| SC | Beaufort | BFT-419 | 323415080413409 | 32.5710 | –80.6926 | 10 | — |
| SC | Beaufort | BFT-431 | 322042080270100 | 32.3433 | –80.4537 | 5 | — |
| SC | Beaufort | BFT-436 | 320842080444808 | 32.1452 | –80.7465 | 11 | — |
| SC | Beaufort | BFT-437 | 320911080441809 | 32.1533 | –80.7382 | 10 | — |
| SC | Beaufort | BFT-446 | 322439080302400 | 32.3955 | –80.5026 | 8 | — |
| SC | Beaufort | BFT-449 | 321930080273400 | 32.3252 | –80.4593 | 6.21 | — |
| SC | Beaufort | BFT-450 | 324024080462609 | 32.6735 | –80.7737 | 15 | — |
| SC | Beaufort | BFT-452 | 322353080261509 | 32.3982 | –80.4373 | 6 | — |
| SC | Beaufort | BFT-454 | 321446080444000 | 32.2461 | –80.7347 | 7 | BEA-2 |
| SC | Beaufort | BFT-454 | 321446080444000 | 32.2488 | –80.7312 | 6.71 | BFT 454 |
| SC | Beaufort | BFT-457 | 321939080274200 | 32.3275 | –80.4617 | 7 | Fripps Island |
| SC | Beaufort | BFT-457 | 321939080274200 | 32.3277 | –80.4615 | 7 | Fripp |
| SC | Beaufort | BFT-458 | 324052080485300 | 32.6891 | –80.8307 | 8 | — |
| SC | Beaufort | BFT-459 | 321851080415100 | 32.3144 | –80.6973 | 3 | — |
| SC | Beaufort | BFT-480 | 321412080525609 | 32.2369 | –80.8821 | 20 | — |
| SC | Beaufort | BFT-482 | 322101080344709 | 32.3505 | –80.5796 | 10 | — |
| SC | Beaufort | BFT-485 | 321918080491409 | 32.3219 | –80.8204 | 20 | — |
| SC | Beaufort | BFT-486 | 322045080500509 | 32.3460 | –80.8345 | 15 | — |
| SC | Beaufort | BFT-489 | 322434080304909 | 32.4096 | –80.5134 | 10 | — |
| SC | Beaufort | BFT-490 | 322432080305209 | 32.4091 | –80.5143 | 10 | — |
| SC | Beaufort | BFT-491 | 322152080504909 | 32.3646 | –80.8468 | 7 | — |
| SC | Beaufort | BFT-494 | 321118080420509 | 32.1885 | –80.7012 | 6 | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| BFT-130 | –48 | — | — | — | — |
| BFT-133 | –49.88 | –62.88 | — | — | — |
| BFT-154 | –114 | –114 | — | — | — |
| BFT-161 | –111 | –130 | — | — | — |
| BFT-192 | –68 | –82 | — | — | — |
| BFT-209 | –102 | — | — | — | — |
| BFT-210 | –99.07 | –124.07 | — | — | — |
| BFT-304 | –167 | — | –218 | — | — |
| BFT-308 | –73 | –95 | — | — | — |
| BFT-315 | –81 | –130 | –194 | — | — |
| BFT-316 | –67 | –77 | — | — | — |
| BFT-317 | –78 | –91 | — | — | — |
| BFT-318 | –83 | –92 | — | — | — |
| BFT-320 | –113 | — | — | — | — |
| BFT-321 | –98 | –126 | — | — | — |
| BFT-341 | –54.87 | — | — | — | — |
| BFT-406 | –98.97 | –128.97 | — | — | — |
| BFT-407 | –99.97 | –129.97 | — | — | — |
| BFT-419 | –24 | –24 | — | — | — |
| BFT-431 | –115 | –125 | — | — | — |
| BFT-436 | –131 | –149 | — | — | — |
| BFT-437 | –134 | –152 | — | — | — |
| BFT-446 | –52 | — | — | — | — |
| BFT-449 | –91.79 | –91.79 | — | — | — |
| BFT-450 | –50 | –65 | — | — | — |
| BFT-452 | –94 | — | — | — | — |
| BFT-454 | — | — | — | — | –1,007 |
| BFT-454 | –60 | — | — | — | –1,007 |
| BFT-457 | — | — | — | –537 | –883 |
| BFT-457 | –87 | — | — | — | –883 |
| BFT-458 | –62 | — | — | — | — |
| BFT-459 | –92 | –97 | — | — | — |
| BFT-480 | –104 | — | — | — | — |
| BFT-482 | –130 | — | — | — | — |
| BFT-485 | –102 | — | — | — | — |
| BFT-486 | –95 | –95 | — | — | — |
| BFT-489 | –76 | –86 | — | — | — |
| BFT-490 | –68 | — | — | — | — |
| BFT-491 | –108 | –113 | — | — | — |
| BFT-494 | –92 | –104 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Beaufort | BFT-498 | 322659080402108 | 32.4499 | –80.6723 | 14 | — |
| SC | Beaufort | BFT-499 | 321508080494200 | 32.2524 | –80.8282 | 22.09 | — |
| SC | Beaufort | BFT-500 | 321502080494309 | 32.2508 | –80.8284 | 21 | — |
| SC | Beaufort | BFT-501 | 321711080484908 | 32.2866 | –80.8134 | 19 | — |
| SC | Beaufort | BFT-528 | 321932080361008 | 32.3258 | –80.6026 | 8 | — |
| SC | Beaufort | BFT-556 | 322931080411300 | 32.4921 | –80.6868 | 5 | — |
| SC | Beaufort | BFT-558 | 321138080464509 | 32.1941 | –80.7790 | 9 | — |
| SC | Beaufort | BFT-559 | 322547080402900 | 32.4299 | –80.6746 | 7 | — |
| SC | Beaufort | BFT-562 | 322419080275800 | 32.4055 | –80.4659 | 4 | — |
| SC | Beaufort | BFT-563 | 322228080325000 | 32.3746 | –80.5471 | 17.38 | — |
| SC | Beaufort | BFT-564 | 322005080371900 | 32.3349 | –80.6218 | 17 | — |
| SC | Beaufort | BFT-565 | 321918080402500 | 32.3219 | –80.6734 | 15.77 | — |
| SC | Beaufort | BFT-566 | 322050080413600 | 32.3474 | –80.6932 | 13.06 | — |
| SC | Beaufort | BFT-752 | 320748080481309 | 32.1302 | –80.8034 | 9.9 | — |
| SC | Beaufort | BFT-777 | 321235080411209 | 32.2099 | –80.6865 | 10 | — |
| SC | Beaufort | BFT-780 | 321150080414009 | 32.1974 | –80.6943 | 5 | — |
| SC | Beaufort | BFT-786 | 321459080420101 | 32.2483 | –80.6984 | 12.14 | TH #7 |
| SC | Beaufort | BFT-789 | 321138080460800 | 32.1838 | –80.7715 | 10.33 | — |
| SC | Beaufort | BFT-791 | 321943080384000 | 32.3288 | –80.6443 | 10 | — |
| SC | Beaufort | BFT-799 | 321109080462409 | 32.1860 | –80.7732 | 13 | — |
| SC | Beaufort | BFT-805 | 321055080465201 | 32.1822 | –80.7809 | 13 | — |
| SC | Beaufort | BFT-813 | 322931080411308 | 32.4921 | –80.6868 | 4 | — |
| SC | Beaufort | BFT-824 | 321126080461309 | 32.1908 | –80.7701 | 15 | — |
| SC | Beaufort | BFT-832 | 321134080422408 | 32.1930 | –80.7065 | 9 | — |
| SC | Beaufort | BFT-845 | 322203080390808 | 32.3677 | –80.6521 | 9 | — |
| SC | Beaufort | BFT-920 | 323210080360709 | 32.5363 | –80.6018 | 9 | — |
| SC | Beaufort | BFT-921 | 323005080404509 | 32.5016 | –80.6790 | 6 | — |
| SC | Beaufort | BFT-922 | 321334080470209 | 32.2263 | –80.7837 | 7 | — |
| SC | Beaufort | BFT-933 | 323415080490209 | 32.5710 | –80.8171 | 19 | — |
| SC | Beaufort | BFT-967 | 322110080375809 | 32.3530 | –80.6326 | 10 | — |
| SC | Beaufort | BFT-974 | 321201080441409 | 32.2005 | –80.7371 | 20 | — |
| SC | Beaufort | BFT-982 | 322155080393608 | 32.3655 | –80.6598 | 10 | — |
| SC | Beaufort | BFT-1199 | 322006080381909 | 32.3352 | –80.6384 | 10 | — |
| SC | Beaufort | BFT-1480 | 321444080500909 | 32.2458 | –80.8357 | 20 | — |
| SC | Beaufort | BFT-1558 | 321256080461008 | 32.2158 | –80.7693 | 10 | — |
| SC | Beaufort | BFT-1596 | 321433080484100 | 32.2427 | –80.8112 | 10 | — |
| SC | Beaufort | BFT-1610 | 322208080290608 | 32.3691 | –80.4848 | 8 | — |
| SC | Beaufort | BFT-1668 | 321413080574709 | 32.2371 | –80.9629 | 30 | — |
| SC | Beaufort | BFT-1672 | 321530080393400 | 32.2585 | –80.6593 | 8 | BFT-1672 |
| SC | Beaufort | BFT-1673 | 321719080430000 | 32.2888 | –80.7165 | 8 | BFT-1673 |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| BFT-498 | –34 | –36 | — | — | — |
| BFT-499 | –65.91 | –77.91 | — | — | — |
| BFT-500 | –61 | –81 | — | — | — |
| BFT-501 | –71 | –91 | — | — | — |
| BFT-528 | –81 | –81 | — | — | — |
| BFT-556 | –31 | –31 | — | — | — |
| BFT-558 | –96 | –130 | — | — | — |
| BFT-559 | –34 | — | — | — | — |
| BFT-562 | –71 | –86 | — | — | — |
| BFT-563 | –107.62 | — | — | — | — |
| BFT-564 | –78 | –78 | — | — | — |
| BFT-565 | –63.23 | –71.23 | — | — | — |
| BFT-566 | –61.94 | –79.94 | — | — | — |
| BFT-752 | –100.1 | –145.1 | — | — | — |
| BFT-777 | –102 | — | — | — | — |
| BFT-780 | –85 | –102 | — | — | — |
| BFT-786 | –57.86 | –134.86 | — | — | — |
| BFT-789 | –79.67 | — | — | — | — |
| BFT-791 | –82 | — | — | — | — |
| BFT-799 | –99 | –143 | — | — | — |
| BFT-805 | –108 | — | — | — | — |
| BFT-813 | –24 | –29 | — | — | — |
| BFT-824 | –93 | –141 | — | — | — |
| BFT-832 | –104 | — | — | — | — |
| BFT-845 | –51 | — | — | — | — |
| BFT-920 | –16 | — | — | — | — |
| BFT-921 | –19 | — | — | — | — |
| BFT-922 | –74 | — | — | — | — |
| BFT-933 | –52 | — | — | — | — |
| BFT-967 | –58 | –64 | — | — | — |
| BFT-974 | –84 | — | — | — | — |
| BFT-982 | –46 | –50 | — | — | — |
| BFT-1199 | –74 | — | — | — | — |
| BFT-1480 | –55 | –63 | — | — | — |
| BFT-1558 | –60 | –83 | — | — | — |
| BFT-1596 | –70 | –75 | — | — | — |
| BFT-1610 | –48 | — | — | — | — |
| BFT-1668 | –150 | –190 | — | — | — |
| BFT-1672 | –98 | — | –200 | — | — |
| BFT-1673 | –84 | — | –180 | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Beaufort | BFT-1674 | 321636080424600 | 32.2769 | –80.7126 | 8 | BFT-1674 |
| SC | Beaufort | BFT-1675 | 321115080401600 | 32.1877 | –80.6709 | 8 | BFT-1675 |
| SC | Beaufort | BFT-1676 | 321440080402500 | 32.2446 | –80.6734 | 8 | BFT-1676 |
| SC | Beaufort | BFT-1677 | 321738080420300 | 32.2941 | –80.7007 | 8 | BFT-1677 |
| SC | Beaufort | BFT-1678 | 321926080435700 | 32.3241 | –80.7323 | 8 | BFT-1678 |
| SC | Beaufort | BFT-1679 | 321242080374000 | 32.2119 | –80.6276 | 8 | BFT-1679 |
| SC | Beaufort | BFT-1680 | 321716080394900 | 32.2880 | –80.6634 | 8 | BFT-1680 |
| SC | Beaufort | BFT-1809 | 321603080432201 | 32.2677 | –80.7226 | 14 | BFT-1809 |
| SC | Beaufort | BFT-1813 | 321358080403801 | 32.2330 | –80.6771 | 12 | BFT-1813 |
| SC | Beaufort | BFT-1820 | 321217080445701 | 32.2049 | –80.7490 | 10 | Indigo Run |
| SC | Beaufort | BFT-1840 | 321820080412301 | 32.3058 | –80.6896 | 10 | Parris Island |
| SC | Beaufort | BFT-1845 | 321650080491801 | 32.2808 | –80.8215 | 12 | Spring Island |
| SC | Beaufort | BFT-1871 | 321454080502709 | 32.5747 | –80.8205 | 5 | Bray’s Island |
| SC | Beaufort | BFT-2055 | 321128080421500 | 32.1913 | –80.7040 | 12 | Test Hole (BFT-2055) |
| SC | Beaufort | BFT-2067 | 321932080492500 | 32.3258 | –80.8234 | 20 | Spring Island |
| SC | Beaufort | BFT-2090 | 321727080565800 | 32.2910 | –80.9493 | 15 | Del Web |
| SC | Beaufort | BFT-2185 | 321237080420409 | 32.2105 | –80.7009 | 10 | PSD #1 Office |
| SC | Beaufort | BFT-2222 | 321708080513809 | 32.2858 | –80.8604 | 13 | Belfair Plat |
| SC | Beaufort | BFT-2241 | 320752080504209 | 32.1313 | –80.8448 | 12.8 | Haig Pt. |
| SC | Beaufort | BFT-2245 | 320846080501709 | 32.1463 | –80.8379 | 9 | — |
| SC | Beaufort | BFT-2249 | 320402080444109 | 32.0674 | –80.7446 | 0 | 7 Mile |
| SC | Beaufort | BFT-2251 | 320407080404209 | 32.0688 | –80.6782 | 0 | 10 Mile |
| SC | Beaufort | BFT-2291 | 321441080550501 | 32.2447 | –80.9181 | 17 | Hampton Hall |
| SC | Beaufort | BFT-2295 | 320414080425501 | 32.0706 | –80.7153 | 0 | 8 Mile |
| SC | Beaufort | BFT-2349 | 321709080481709 | 32.2860 | –80.8046 | 23 | Colleton River |
| SC | Beaufort | BFT-2380 | 320848080454301 | 32.1467 | –80.7619 | 10 | South Island Psd 1 |
| SC | Beaufort | BFT-2406 | 321616080513101 | 32.2711 | –80.8586 | 25 | Belfair |
| SC | Beaufort | BFT-2409 | 321313080462001 | 32.2203 | –80.7722 | 10 | PSD #1 Jenkins Island |
| SC | Beaufort | JAS-134 | 320844081004000 | 32.1458 | –81.0109 | 18.2 | Hud 22 |
| SC | Colleton | COL-50 | 325447080383601 | 32.9131 | –80.6461 | 70 | #1 Alico Land Development |
| SC | Colleton | COL-51 | 323234080251308 | 32.5430 | –80.4201 | 10 | — |
| SC | Colleton | COL-53 | 325902080272100 | 32.9961 | –80.4578 | 50 | COL-2 |
| SC | Colleton | COL-56 | 325720080540509 | 32.8719 | –80.9022 | 65 | Martin |
| SC | Colleton | COL-60 | 324246080410809 | 32.7131 | –80.6850 | 14 | COL-4 |
| SC | Colleton | COL-63 | 322850080201000 | 32.4807 | –80.3359 | 10 | — |
| SC | Colleton | COL-92 | 323941080392700 | 32.6616 | –80.6573 | 12 | — |
| SC | Colleton | COL-93 | 324350080482009 | 32.7307 | –80.8054 | 42 | — |
| SC | Colleton | COL-94 | 323405080332900 | 32.5682 | –80.5579 | 10 | — |
| SC | Colleton | COL-95 | 324437080330909 | 32.7438 | –80.5523 | 5 | — |
| SC | Colleton | COL-96 | 324411080270900 | 32.7364 | –80.4525 | 3 | Edisto Boat Ramp |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| BFT-1674 | –98 | — | — | — | — |
| BFT-1675 | –91 | — | — | — | — |
| BFT-1676 | –90 | — | — | — | — |
| BFT-1677 | –90 | — | –176 | — | — |
| BFT-1678 | –70 | — | –158 | — | — |
| BFT-1679 | –103 | — | — | — | — |
| BFT-1680 | –100 | — | –190 | — | — |
| BFT-1809 | –79 | –108 | –192 | — | — |
| BFT-1813 | –100 | –105 | –211 | — | — |
| BFT-1820 | –75 | –92 | –260 | — | — |
| BFT-1840 | –85 | –94 | –190 | — | — |
| BFT-1845 | — | — | –188 | — | — |
| BFT-1871 | –85 | –90 | –215 | –411 | — |
| BFT-2055 | — | — | –255 | — | — |
| BFT-2067 | –94 | –102 | –190 | –470 | — |
| BFT-2090 | –140 | –145 | –265 | — | — |
| BFT-2185 | –78 | –102 | –255 | — | — |
| BFT-2222 | –111 | –124 | –228 | — | — |
| BFT-2241 | –94.2 | –134.2 | –283 | –608 | — |
| BFT-2245 | –95 | –146 | — | — | — |
| BFT-2249 | –74 | — | — | — | — |
| BFT-2251 | –135 | — | — | — | — |
| BFT-2291 | –115 | –123 | –270 | — | — |
| BFT-2295 | –80 | — | — | — | — |
| BFT-2349 | –57 | –64 | –175 | — | — |
| BFT-2380 | –78 | –175 | –268 | — | — |
| BFT-2406 | — | — | –235 | — | — |
| BFT-2409 | –75 | –130 | –250 | — | — |
| JAS-134 | –195.8 | –239.8 | — | — | — |
| COL-50 | — | — | — | — | –416 |
| COL-51 | –90 | –100 | — | — | — |
| COL-53 | — | — | –90 | –140 | –326 |
| COL-56 | — | — | — | — | –405 |
| COL-60 | — | — | — | –235 | –551 |
| COL-63 | –70 | –70 | — | — | — |
| COL-92 | –78 | –95 | — | — | — |
| COL-93 | –43 | –50 | — | — | — |
| COL-94 | –70 | –70 | — | — | — |
| COL-95 | –65 | –107 | — | — | — |
| COL-96 | –62 | –80 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Colleton | COL-97 | 330256080354500 | 33.0477 | –80.5976 | 84 | — |
| SC | Colleton | COL-98 | 330150080562709 | 33.0307 | –80.9407 | 80 | — |
| SC | Colleton | COL-99 | 323404080333901 | 32.5678 | –80.5608 | 12 | — |
| SC | Colleton | COL-101 | 324030080325609 | 32.6752 | –80.5487 | 21 | — |
| SC | Colleton | COL-240 | 330345080574809 | 33.0627 | –80.9632 | 100 | — |
| SC | Colleton | COL-241 | 330054080554400 | 33.0152 | –80.9287 | 80 | — |
| SC | Colleton | COL-244 | 325700080245109 | 32.9502 | –80.4140 | 25 | — |
| SC | Dorchester | SC-DOR2 | | 32.8875 | –80.3569 | 20 | SC-Dor2 |
| SC | Dorchester | SC-DOR5 | | 32.9472 | –80.2764 | 19 | SC-Dor5 |
| SC | Hampton | HAM-32 | 324136080511301 | 32.6933 | –80.8536 | 48 | — |
| SC | Hampton | HAM-34 | 324235081212600 | 32.6069 | –81.2489 | 80 | J.M. Bostick |
| SC | Hampton | HAM-38 | 325231081063400 | 32.8753 | –81.1094 | 105 | Westinghouse |
| SC | Hampton | HAM-43 | 325231081062600 | 32.8754 | –81.1070 | 96 | — |
| SC | Hampton | HAM-49 | 325346081000600 | 32.8963 | –81.0015 | 60 | — |
| SC | Hampton | HAM-50 | 324042081111001 | 32.6783 | –81.1861 | 112 | — |
| SC | Hampton | HAM-51 | 323342081171700 | 32.5618 | –81.2879 | 30 | — |
| SC | Hampton | HAM-68 | 324744080571101 | 32.7956 | –80.9531 | 81 | HAM-68 |
| SC | Hampton | HAM-69 | 324438080555300 | 32.7441 | –80.9312 | 73 | — |
| SC | Hampton | HAM-69 | 324438080555301 | 32.7439 | –80.9314 | 73 | HAM-69 |
| SC | Hampton | HAM-72 | 325839081064301 | 32.9775 | –81.1119 | 110 | HAM-72 |
| SC | Hampton | HAM-73 | 325355081000800 | 32.8849 | –81.0029 | 75 | — |
| SC | Hampton | HAM-76 | 324821080543500 | 32.8060 | –80.9096 | 70 | — |
| SC | Hampton | HAM-77 | 324327080524800 | 32.7243 | –80.8798 | 45 | — |
| SC | Hampton | HAM-78 | 324131080544700 | 32.6921 | –80.9129 | 80 | — |
| SC | Hampton | HAM-79 | 324707081032701 | 32.7853 | –81.0575 | 84 | — |
| SC | Hampton | HAM-80 | 325341081141600 | 32.8954 | –81.2390 | 104 | — |
| SC | Hampton | HAM-82 | 325005081122800 | 32.8349 | –81.2076 | 125 | Hampton County Landfill |
| SC | Hampton | HAM-83 | 324143080505900 | 32.6980 | –80.8509 | 45 | — |
| SC | Hampton | HAM-90 | 325343081085901 | 32.8953 | –81.1497 | 111 | — |
| SC | Hampton | HAM-92 | 324452081141100 | 32.7464 | –81.2444 | 110 | HAM-92 |
| SC | Hampton | HAM-93 | 324541081123001 | 32.7614 | –81.2083 | 100.8 | — |
| SC | Hampton | HAM-160 | 323917081092401 | 32.6547 | –81.1567 | 105 | — |
| SC | Hampton | HAM-30 | 324323081041301 | 32.7231 | –81.0704 | 81 | Buckfield Plantation |
| SC | Jasper | JAS-1 | 321002081070300 | 32.1674 | –81.1173 | 10.1 | U.S. Fish & Wild Life |
| SC | Jasper | JAS-3 | 320947081035209 | 32.1633 | –81.0643 | 13 | — |
| SC | Jasper | JAS-74 | 323125080521009 | 32.5238 | –80.8693 | 14 | — |
| SC | Jasper | JAS-80 | 320921080581400 | 32.1560 | –80.9704 | 5.81 | Red Bluff Plat |
| SC | Jasper | JAS-88 | 323008081135809 | 32.5024 | –81.2326 | 20 | — |
| SC | Jasper | JAS-89 | 323009081134609 | 32.5027 | –81.2293 | 18 | — |
| SC | Jasper | JAS-90 | 323031080524709 | 32.5088 | –80.8796 | 12 | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| COL-97 | 14 | 9 | — | — | — |
| COL-98 | — | 10 | — | — | — |
| COL-99 | –65 | –73 | — | — | — |
| COL-101 | –86 | –86 | — | — | — |
| COL-240 | 46 | 40 | — | — | — |
| COL-241 | 15 | 6 | — | — | — |
| COL-244 | –5 | –10 | — | — | — |
| SC-DOR2 | — | — | — | — | –418 |
| SC-DOR5 | — | — | — | — | –385 |
| HAM-32 | –44 | –44 | — | — | — |
| HAM-34 | — | — | — | — | –610 |
| HAM-38 | — | — | –175 | –225 | –371 |
| HAM-43 | 36 | 36 | — | — | — |
| HAM-49 | 5 | 5 | — | — | — |
| HAM-50 | –18 | –58 | — | — | — |
| HAM-51 | –60 | –77 | — | — | — |
| HAM-68 | — | — | –175 | –255 | –527 |
| HAM-69 | –25 | –29 | — | — | — |
| HAM-69 | — | — | –206.5 | –266.5 | — |
| HAM-72 | — | — | –124 | –199 | — |
| HAM-73 | 19 | 13 | — | — | — |
| HAM-76 | –27 | –27 | — | — | — |
| HAM-77 | –24 | –24 | — | — | — |
| HAM-78 | –41 | –41 | — | — | — |
| HAM-79 | –33 | –40 | — | — | — |
| HAM-80 | 74 | 64 | — | — | — |
| HAM-82 | 7 | 5 | — | — | — |
| HAM-83 | –45 | –45 | — | — | — |
| HAM-90 | 61 | 61 | — | — | — |
| HAM-92 | 5 | –5 | –180 | –300 | — |
| HAM-93 | –9.2 | –9.2 | — | — | — |
| HAM-160 | –12 | — | — | — | — |
| HAM-30 | — | — | — | –268 | — |
| JAS-1 | –194.9 | — | — | — | — |
| JAS-3 | –197 | — | — | — | — |
| JAS-74 | –96 | –96 | — | — | — |
| JAS-80 | –158.19 | — | — | — | — |
| JAS-88 | –80 | –80 | — | — | — |
| JAS-89 | –84 | — | — | — | — |
| JAS-90 | –82 | –82 | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Jasper | JAS-91 | 322515080512509 | 32.4210 | –80.8568 | 5 | — |
| SC | Jasper | JAS-93 | 321834081045509 | 32.3096 | –81.0818 | 20 | Philips |
| SC | Jasper | JAS-103 | 322205080550009 | 32.3683 | –80.9165 | 21 | — |
| SC | Jasper | JAS-109 | 322314081025109 | 32.3874 | –81.0473 | 20 | — |
| SC | Jasper | JAS-117 | 320939080581109 | 32.1610 | –80.9696 | 5 | Red Bluff Plt |
| SC | Jasper | JAS-119 | 320744081052509 | 32.1291 | –81.0901 | 5 | Fife Plt |
| SC | Jasper | JAS-122 | 321417081042809 | 32.2383 | –81.0743 | 17 | Hud 1 |
| SC | Jasper | JAS-123 | 320929080594009 | 32.1583 | –80.9943 | 22 | Hud 1A |
| SC | Jasper | JAS-124 | 321348081041209 | 32.2302 | –81.0698 | 18 | Hud 2 |
| SC | Jasper | JAS-125 | 321410081034200 | 32.2363 | –81.0615 | 12 | Hud 3 |
| SC | Jasper | JAS-126 | 321235081040209 | 32.2099 | –81.0671 | 8 | Hud 5 |
| SC | Jasper | JAS-127 | 321230081025409 | 32.2085 | –81.0482 | 11 | Hud 6 |
| SC | Jasper | JAS-128 | 321139081032909 | 32.1944 | –81.0579 | 7 | Hud 7 |
| SC | Jasper | JAS-129 | 321149081021109 | 32.1971 | –81.0362 | 12 | Hud 11 |
| SC | Jasper | JAS-130 | 321214081014600 | 32.2041 | –81.0293 | 10 | Hud 12 |
| SC | Jasper | JAS-131 | 321138081014900 | 32.1941 | –81.0301 | 13.5 | Hud 14 |
| SC | Jasper | JAS-132 | 321146081020409 | 32.1963 | –81.0343 | 12 | Hud 16 |
| SC | Jasper | JAS-133 | 320854080591409 | 32.1485 | –80.9871 | 14 | Hud 20 |
| SC | Jasper | JAS-135 | 320857081000100 | 32.1494 | –81.0001 | 22 | Hud 25 |
| SC | Jasper | JAS-136 | 320907080594600 | 32.1521 | –80.9959 | 20 | Hud 26 |
| SC | Jasper | JAS-137 | 320919080593809 | 32.1555 | –80.9937 | 22 | — |
| SC | Jasper | JAS-138 | 321054081003800 | 32.1819 | –81.0104 | 10.9 | Hud 28 |
| SC | Jasper | JAS-139 | 321005080593500 | 32.1683 | –80.9929 | 18.6 | Hud 29 |
| SC | Jasper | JAS-140 | 321223081043209 | 32.2066 | –81.0754 | 10 | Hud 4 |
| SC | Jasper | JAS-141 | 321133081015509 | 32.1927 | –81.0318 | 12 | Hud |
| SC | Jasper | JAS-142 | 322750081065109 | 32.4641 | –81.1140 | 47 | Tilman |
| SC | Jasper | JAS-143 | 322753081072009 | 32.4649 | –81.1221 | 25 | Tilman |
| SC | Jasper | JAS-145 | 323105081095909 | 32.5182 | –81.1662 | 38 | — |
| SC | Jasper | JAS-152 | 322725080585009 | 32.4571 | –80.9804 | 48 | — |
| SC | Jasper | JAS-153 | 322508080520509 | 32.4191 | –80.8679 | 14 | Bolin Hall |
| SC | Jasper | JAS-154 | 323117080515901 | 32.5214 | –80.8692 | 10 | David Malphus |
| SC | Jasper | JAS-155 | 321201081025709 | 32.2005 | –81.0490 | 10 | JAS 155 |
| SC | Jasper | JAS-159 | 321345081015100 | 32.2294 | –81.0307 | 19.2 | JAS 159 |
| SC | Jasper | JAS-160 | 321255081034909 | 32.2155 | –81.0634 | 11 | Hud |
| SC | Jasper | JAS-161 | 321311081030609 | 32.2199 | –81.0515 | 11 | JAS161 |
| SC | Jasper | JAS-162 | 321151081002009 | 32.1977 | –81.0054 | 10 | Hud 7 |
| SC | Jasper | JAS-163 | 321159081013909 | 32.1999 | –81.0273 | 10 | JAS163 |
| SC | Jasper | JAS-164 | 321328081013109 | 32.2246 | –81.0251 | 7 | JAS164 |
| SC | Jasper | JAS-165 | 320959081022009 | 32.1666 | –81.0387 | 10 | Hardeville |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| JAS-91 | –117 | –117 | — | — | — |
| JAS-93 | –154 | –185 | — | — | — |
| JAS-103 | –117 | –127 | — | — | — |
| JAS-109 | –150 | — | — | — | — |
| JAS-117 | –163 | — | — | — | — |
| JAS-119 | –203 | — | — | — | — |
| JAS-122 | –201 | –239 | — | — | — |
| JAS-123 | –171 | –214 | — | — | — |
| JAS-124 | –206 | — | — | — | — |
| JAS-125 | –216 | — | — | — | — |
| JAS-126 | –193 | –239 | — | — | — |
| JAS-127 | –191 | –236 | — | — | — |
| JAS-128 | –211 | –253 | — | — | — |
| JAS-129 | –190 | –237 | — | — | — |
| JAS-130 | –172 | –232 | — | — | — |
| JAS-131 | –171.5 | –236.5 | — | — | — |
| JAS-132 | –186 | — | — | — | — |
| JAS-133 | –176 | –221 | — | — | — |
| JAS-135 | –176 | –226 | — | — | — |
| JAS-136 | –176 | — | — | — | — |
| JAS-137 | –173 | — | — | — | — |
| JAS-138 | –171.1 | –214.1 | — | — | — |
| JAS-139 | –171.4 | –216.4 | — | — | — |
| JAS-140 | –196 | — | — | — | — |
| JAS-141 | –180 | –230 | — | — | — |
| JAS-142 | –113 | — | — | — | — |
| JAS-143 | — | –132 | — | — | — |
| JAS-145 | –102 | –107 | — | — | — |
| JAS-152 | –112 | –112 | — | — | — |
| JAS-153 | –116 | — | — | — | — |
| JAS-154 | –101 | –101 | — | — | — |
| JAS-155 | –198 | — | — | — | — |
| JAS-159 | –186.8 | — | — | — | — |
| JAS-160 | –204 | –229 | — | — | — |
| JAS-161 | –192 | — | — | — | — |
| JAS-162 | –185 | –212 | — | — | — |
| JAS-163 | –185 | –237 | — | — | — |
| JAS-164 | –173 | –217 | — | — | — |
| JAS-165 | –200 | — | — | — | — |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| State | County | USGS well name (plate 1) | USGS site number | Latitude | Longitude | Land-surface altitude | Other identifier |
|---|---|---|---|---|---|---|---|
| SC | Jasper | JAS-166 | 323336080543809 | 32.5602 | –80.9104 | 14 | — |
| SC | Jasper | JAS-169 | 322312081071609 | 32.3844 | –81.1208 | 20 | McLaurie |
| SC | Jasper | JAS-170 | 322630081073909 | 32.4419 | –81.1273 | 20 | — |
| SC | Jasper | JAS-171 | 322331081023609 | 32.3921 | –81.0432 | 19 | — |
| SC | Jasper | JAS-202 | 323504080520709 | 32.5846 | –80.8684 | 0 | — |
| SC | Jasper | JAS-346 | 322759080593609 | 32.4666 | –80.9932 | 40 | — |
| SC | Jasper | JAS-385 | 323155081044700 | 32.5321 | –81.0796 | 60 | Calfpen Bay |
| SC | Jasper | JAS-391 | 323259081081709 | 32.5499 | –81.1379 | 65 | Low Co Ag |
| SC | Jasper | JAS-392 | 321618081051000 | 32.5431 | –81.1356 | 60 | Low Co Ag |
| SC | Jasper | JAS-426 | 323704080594508 | 32.6180 | –80.9957 | 59 | Gillsonville/C-15 Core Hole Site |
| SC | Jasper | JAS-443 | 321934080590201 | 32.3261 | –80.9838 | 20 | Hampton Pt. |
| SC | Jasper | JAS-449 | 321856081004401 | 32.3155 | –81.0121 | 16 | Tradition |

**Appendix A.** Summary of hydrogeologic data for selected wells used in this study.—Continued

[USGS, U.S. Geological Survey; latitude–longitude referenced to North American Datum of 1983; all altitudes referenced to National Geodetic Vertical Datum of 1929; accuracy of land-surface altitude varies based on method of measurement. Values reported to hundredths of a foot represent measurement made by surveying or global positioning techniques; MCU, middle confining unit; —, no data]

| USGS well name | C–Marker (top of Upper Floridan aquifer) | D–Marker (top of permeable zone) | Bottom of Upper Floridan aquifer (top of MCU) | Top of Lower Floridan aquifer (bottom of MCU) | Bottom of Lower Floridan aquifer |
|---|---|---|---|---|---|
| JAS-166 | –93 | –93 | — | — | — |
| JAS-169 | –133 | –158 | — | — | — |
| JAS-170 | –112 | — | — | — | — |
| JAS-171 | –151 | — | — | — | — |
| JAS-202 | –83 | –83 | — | — | — |
| JAS-346 | –108 | –108 | — | — | — |
| JAS-385 | –62 | –80 | –200 | –382 | — |
| JAS-391 | — | — | –230 | –340 | — |
| JAS-392 | — | — | –230 | –340 | — |
| JAS-426 | –80 | –155 | –210 | –301 | –660 |
| JAS-443 | –127 | –134 | –240 | — | — |
| JAS-449 | –129 | –137 | –236 | — | — |

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