Ground-Water Conditions and Studies in the Brunswick–Glynn County Area, Georgia, 2007

Open-File Report 2008–1297

Prepared in cooperation with the City of Brunswick and Glynn County

U.S. Department of the Interior
U.S. Geological Survey

Cover: Real-time water-level and specific-conductance monitoring well located at Georgia-Pacific Cellulose plant in Brunswick, Georgia. Photograph by John S. Clarke, U.S. Geological Survey.

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DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
inch	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
Million gallons (Mgal)	3,785	cubic meter (m^3)

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 the North American Vertical Datum of 1988 (NAVD 88).

Historical data collected and stored as National Geodetic Vertical Datum of 1929 (NGVD 29).

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

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

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).

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Abstract

The Upper Floridan aquifer is contaminated with saltwater in a 2-square-mile area of downtown Brunswick, Georgia. This contamination has limited the development of the ground-water supply in the Glynn County area. Hydrologic, geologic, and water-quality data are needed to effectively manage water resources. Since 1959, the U.S. Geological Survey has conducted a cooperative water-resources program with the City of Brunswick to monitor and assess the effect of ground-water development on saltwater contamination of the Floridan aquifer system. The potential development of alternative sources of water in the Brunswick and surficial aquifer systems also is an important consideration in coastal areas.

During calendar year 2007, the cooperative water-resources monitoring program included continuous water-level recording of 13 wells completed in the Floridan, Brunswick, and surficial aquifer systems; collecting water levels from 22 wells to map the potentiometric surface of the Upper Floridan aquifer during July and August 2007; and collecting and analyzing water samples from 76 wells to map chloride concentrations in the Upper Floridan aquifer during July and August 2007. In addition, work was initiated to refine an existing ground-water flow model for evaluation of water-management scenarios.

Introduction

In the Brunswick, Georgia, area (fig. 1), saltwater has been contaminating the Upper Floridan aquifer for about 50 years, so that as of 2007, within an area of 2 square miles (mi^2) in downtown Brunswick, the aquifer yields water that has a chloride concentration greater than 2,000 milligrams per liter (mg/L), which exceeds the State and Federal secondary drinking-water standard of 250 mg/L (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). Saltwater contamination has constrained further development of the Upper Floridan aquifer in the Brunswick area, prompting interest in the development of alternative sources of water supply, primarily from the shallower surficial and Brunswick aquifer systems. Monitoring ground-water conditions and conducting studies to better define the occurrence of saltwater contamination and assess alternative water sources is important for management of water resources in the Brunswick–Glynn County area.

Brunswick–Glynn County Cooperative Water Program

The Cooperative Water Program (CWP) between the U.S. Geological Survey (USGS), the City of Brunswick, and Glynn County has been in existence since 1959. Current cooperating entities are the City of Brunswick, Glynn County, the Jekyll Island Authority, Sea Island Corporation, Hercules-Pinova, and Georgia-Pacific Cellulose. The CWP was initiated in response to concerns about chloride contamination of the Upper Floridan aquifer, which first became evident during the late 1950s. Since its inception, the CWP has placed emphasis on providing the necessary information about the Floridan aquifer system to manage saltwater intrusion and evaluate water-resources data.

Purpose and Scope

Hydrologic, geologic, and water-quality data are needed to effectively manage water resources effectively in the coastal area of Georgia. During calendar year 2007, the CWP, which includes all of Glynn County (fig. 1), was continued and included continuous water-level monitoring of 13 wells completed in the Floridan, Brunswick, and surficial aquifer systems. Water levels were also collected from 22 wells to map the potentiometric surface of the Upper Floridan aquifer during July and August 2007. In addition, water samples were collected and analyzed from 76 wells in order to assess the configuration of the chloride plume in the Upper Floridan aquifer near the City of Brunswick during July and August 2007. Work was initiated as part of the Coastal Sound Science Initiative (CSSI), described below, to refine an existing ground-water flow model (Payne and others, 2005) for evaluation of water-management scenarios.

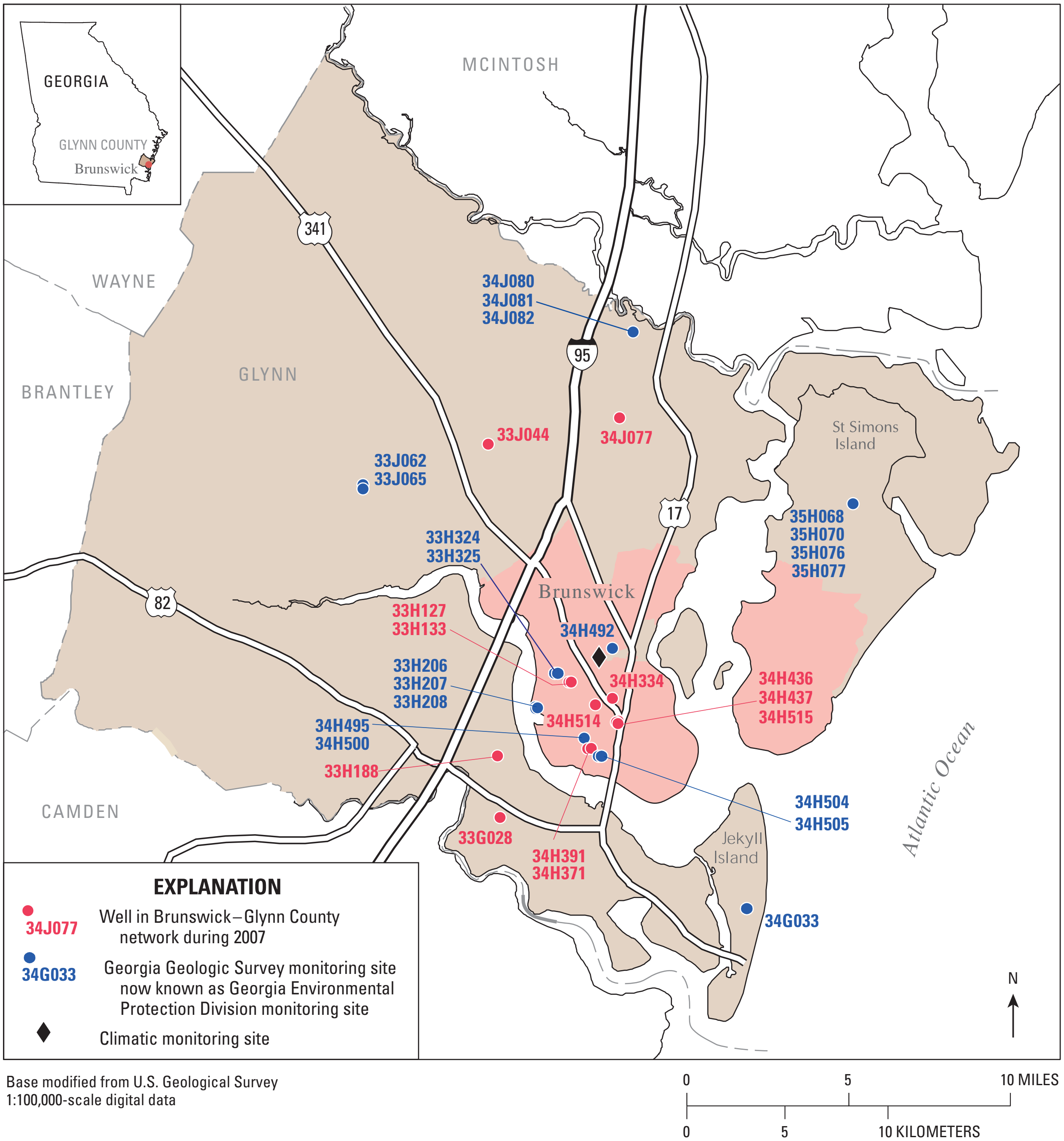


Figure 1. Location of study area and continuous ground-water-level monitoring network for the Brunswick–Glynn County area, Georgia.

Related Studies

The Georgia Environmental Protection Division (GaEPD) CSSI is a program of scientific and feasibility studies to support development of a final strategy to protect the Upper Floridan aquifer from saltwater contamination. In support of the CSSI, the USGS is working on a comprehensive program to evaluate ground-water conditions in the coastal area of Georgia and adjacent parts of South Carolina and Florida. Other participants in the program include other Federal and State agencies, academic institutions, and private consulting firms. Many of the activities of the CSSI directly benefit the City of Brunswick and Glynn County. This includes participation in the development of a refined ground-water flow model for the Brunswick–Glynn County area, and establishment of a real-time ground-water-level and specific conductance monitoring network surrounding the area of chloride contamination.

Acknowledgments

The authors appreciate the technical feedback and guidance provided by the Brunswick–Glynn County Water Resources Management Advisory Committee (WRMAC). Several USGS employees played an important role in the collection, processing, and quality assurance of ground-water data, including Welby L. Stayton, Alan M. Cressler, Michael F. Peck, Michael Hamrick, and Christopher B. Walls. Appreciation is extended to Dorothy F. Payne for consultation and advice during development of a ground-water flow model for the Brunswick–Glynn County area and assistance with water-quality sampling, and to Jaime A. Painter for assistance with Geographic Information System applications. Cartography and layout were by Caryl J. Wipperfurth and Bonnie J. Turcott.

Ground-Water Conditions

Ground-water levels and chloride concentrations in the Brunswick–Glynn County area have been monitored for several decades as part of the CWP. In addition, precipitation and ground-water pumpage are monitored to assess their influence on ground-water conditions. These data are used to guide water-management decisions by State and local authorities.

Ground-Water Levels

During calendar year 2007, ground-water levels in the Brunswick–Glynn County area were continuously monitored in 33 wells, 13 funded by the CWP and 20 funded by GaEPD as part of GaEPD's Statewide network and as part of the CSSI (fig. 1, table 1). Of the 33 continuous water-level recorders, 12 are completed in the Upper Floridan aquifer, 8 in the Lower Floridan aquifer, 8 in the Brunswick aquifer system, and 5 in the surficial aquifer system (table 1).

During 2006–2007, several wells were incorporated into the GaEPD statewide network in Glynn County—test wells completed in the Upper and Lower Floridan, lower Brunswick, and surficial aquifers at a well-cluster site on St. Simons Island (fig. 1, table 1). In addition, real-time water-level monitoring systems were installed in wells completed in the upper and/or lower water-bearing zones of the Upper Floridan aquifer that surround the area of chloride contamination—Southside Baptist Church (34H504 and 34H505), Perry Park (34H514), and Georgia-Pacific Cellulose (33H324 and 33H325). These sites are also being adapted for real-time specific conductance monitoring.

Factors Influencing Ground-Water Levels

Fluctuations and long-term trends in ground-water levels occur as a result of changes in recharge to and discharge from an aquifer. Recharge rates vary in response to precipitation, evapotranspiration, and surface-water infiltration into an aquifer. Discharge occurs as natural flow from an aquifer to streams or springs, as evapotranspiration from shallow water-table aquifers, as leakage to vertically adjacent aquifers, and as withdrawal (pumpage) from wells. Water levels generally are highest in the winter-early spring when precipitation is greatest, evapotranspiration is lowest, and irrigation withdrawals are minimal; water levels are the lowest during summer and fall when evapotranspiration and pumpage are greatest (Payne and others, 2005).

Precipitation

Precipitation in the Brunswick–Glynn County area influences ground-water levels in the shallow surficial aquifer system and, to a lesser degree, in the Brunswick aquifer system. In addition, changes in precipitation affect quantities of ground water withdrawn from deeper aquifers and, therefore, have an indirect effect on ground-water levels in the Upper Floridan aquifer. Rainfall is not evenly distributed throughout the year and maximum rainfall generally occurs during the summer months of June, July, and August (Payne and others, 2005). A real-time climatic site was established as part of the CSSI at the Coastal Georgia Community College campus at Brunswick to monitor precipitation in the Brunswick–Glynn County area (fig. 1). Real-time monitoring data for this site are accessible on the following Web site at *http://www.georgiaweather.net* (accessed on July 30, 2008).

Precipitation data and cumulative departure from normal during 2000–2007 are shown in figure 2. The cumulative departure from normal precipitation for the period of record can be used to evaluate trends in precipitation, which typically relate to recharge of shallow aquifers. Cumulative departure describes the long-term surplus or deficit of precipitation during a designated period and is derived by adding successive values of departures from normal precipitation. In this report, normal precipitation for a given day is defined as the average of total daily precipitation during the period of record (2000–2007). A downward trend in slope indicates a period of below- normal precipitation, whereas an upward trend indicates above-normal precipitation.

Cumulative departure data indicate a period of below-normal precipitation from rainfall during 2000 to May 2002, corresponding to a drought period that began the middle of 1998 (Barber and Stamey, 2000). During 2004 and 2005, precipitation was above normal starting during June 2004, with one short period of below-normal precipitation between October 2004 and February 2005, followed by mostly below-normal rainfall through June 2007 (fig. 2*A*). The maximum amount of rainfall recorded in a 24-hour period was 6.05 inches on October 5, 2005 (fig. 2*B*).

Table 1. Brunswick–Glynn County, Georgia, ground-water-level monitoring network, 2007.

Site name	Aquifer	Subunit
*34H515	Surficial	Deeper (confined) zone
34H437	Upper Brunswick	None
34J077	Upper Brunswick	None
33G028	Brunswick aquifer system	None
33H127	Upper Floridan	Lower water-bearing zone
33H133	Upper Floridan	Upper water-bearing zone
34H334	Upper Floridan	Lower water-bearing zone
34H371	Upper Floridan	Upper water-bearing zone
**34H514	Upper Floridan	Upper water-bearing zone
33H188	Lower Floridan	Fernandina permeable zone
33J044	Lower Floridan	Undifferentiated
34H391	Lower Floridan	Brackish water zone
34H436	Lower Floridan	Brackish water zone
Additional wells (funded by Georgia Environmental Protection Division)		
33H208	Surficial	Deeper (confined) zone
34H492	Surficial	Water-table zone
34J082	Surficial	None
35H076	Surficial	Deeper (confined) zone
33J065	Upper Brunswick	None
34J081	Upper Brunswick	None
33J062	Lower Brunswick	None
34J080	Lower Brunswick	None
35H077	Lower Brunswick	None
33H207	Upper Floridan	Upper water-bearing zone
**33H324	Upper Floridan	Upper water-bearing zone
**33H325	Upper Floridan	Lower water-bearing zone
34G033	Upper Floridan	None
**34H504	Upper Floridan	Upper water-bearing zone
**34H505	Upper Floridan	Lower water-bearing zone
35H070	Upper Floridan	Upper water-bearing zone
33H206	Lower Floridan	Brackish water zone
34H495	Lower Floridan	Fernandina permeable zone
34H500	Lower Floridan	Fresh water-bearing zone
35H068	Lower Floridan	Fresh water-bearing zone

* Replaces 34H438

** Real-time station

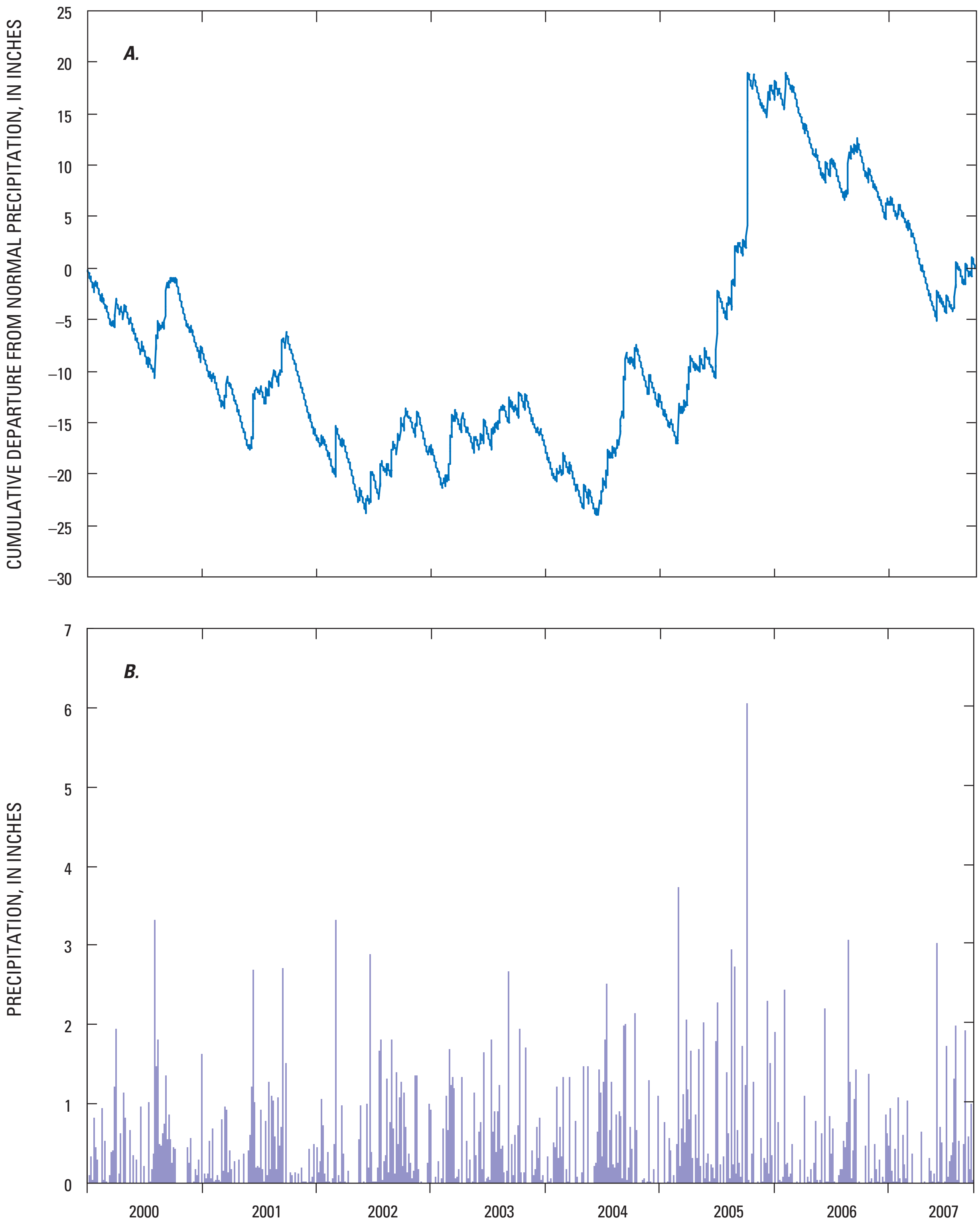


Figure 2. *(A)* Cumulative departure from normal precipitation and *(B)* total daily precipitation at Coastal Georgia Community College, Georgia, January 2000–September 2007 (see figure 1 for location).

Ground-Water Pumpage

Historically, ground-water pumpage peaked in the early 1980s with the majority of ground-water withdrawals used for industrial purposes (fig. 3). In calendar year 1980, Georgia-Pacific Cellulose and Hercules-Pinova withdrew a total of 78.3 million gallons per day (Mgal/d); ground-water withdrawals for public supply averaged 9.8 Mgal/d (L.E. Jones, U.S. Geological Survey, written commun., 2007). At Hercules-Pinova, ground-water pumpage reached a maximum of 24 Mgal/d during 1970, and in 1982 pumpage was reduced to 14 Mgal/d due to water-conservation measures at the facility and the construction of a cooling tower (L.E. Jones, U.S. Geological Survey, written commun., 2007). Georgia-Pacific Cellulose implemented similar water-conservation measures in the early 1990s and reduced ground-water pumpage from 58.8 Mgal/d during 1980 to 33.1 Mgal/d during 2005. Water use for public supply has steadily increased due to the rise in population within Glynn County, which has increased from 21,920 during 1940 to 71,639 during 2005 (Real Estate Center, accessed December 14, 2007, at *http://recenter.tamu.edu/data/pops/pops13.htm*). As a result, the ground-water pumpage for public supply increased from 4.4 Mgal/d during 1940 to 8.9 Mgal/d during 2005 (fig. 3).

The locations of ground-water pumping centers and amounts of water withdrawn from these centers may significantly affect ground-water levels in the Brunswick–Glynn County area. Changes in pumping rates and the addition of new pumping centers may alter the configuration of potentiometric surfaces, reverse ground-water flow directions, and increase seasonal and long-term fluctuations in the aquifers. During 2005, about 50 Mgal/d were withdrawn from the Upper Floridan aquifer in Glynn County, of which 8.9 Mgal/d was for public supply and 41.1 Mgal/d was for industry (J.L. Fanning, U.S. Geological Survey, written commun., 2007). According to Payne and others (2005), pumpage from the Upper Floridan aquifer in Glynn County decreased from 95.4 Mgal/d during 1980 to 61.1 Mgal/d during 2000, reflecting increased water conservation by local industry. During 2001–2005, pumpage from the Upper Floridan aquifer at the Georgia-Pacific Cellulose plant decreased by nearly 4 Mgal/d, while pumpage at the Hercules-Pinova plant remained at about 8 Mgal/d. Public supply for the City of Brunswick, Sea Island, St. Simons Island, and Jekyll Island remained at about 9 Mgal/d (fig. 3). During 1980–2005, water use by local industries (Georgia-Pacific Cellulose and Hercules-Pinova) decreased by nearly half, from 78.3 Mgal/d during 1980 to 41.1 Mgal/d during 2005 (J.L. Fanning, U.S. Geological Survey, written commun., 2006). The reduction in pumpage had a pronounced affect on ground-water levels in the area. During 2007, pumpage estimates indicate further reductions in ground-water withdrawals from the Upper Floridan aquifer at the Georgia-Pacific Cellulose plant of 2.3 Mgal/d and decreased pumpage at the Hercules-Pinova plant by about 1.3 Mgal/d (Vicki Trent, Georgia Environmental Protection Division, written commun., 2008; fig. 3).

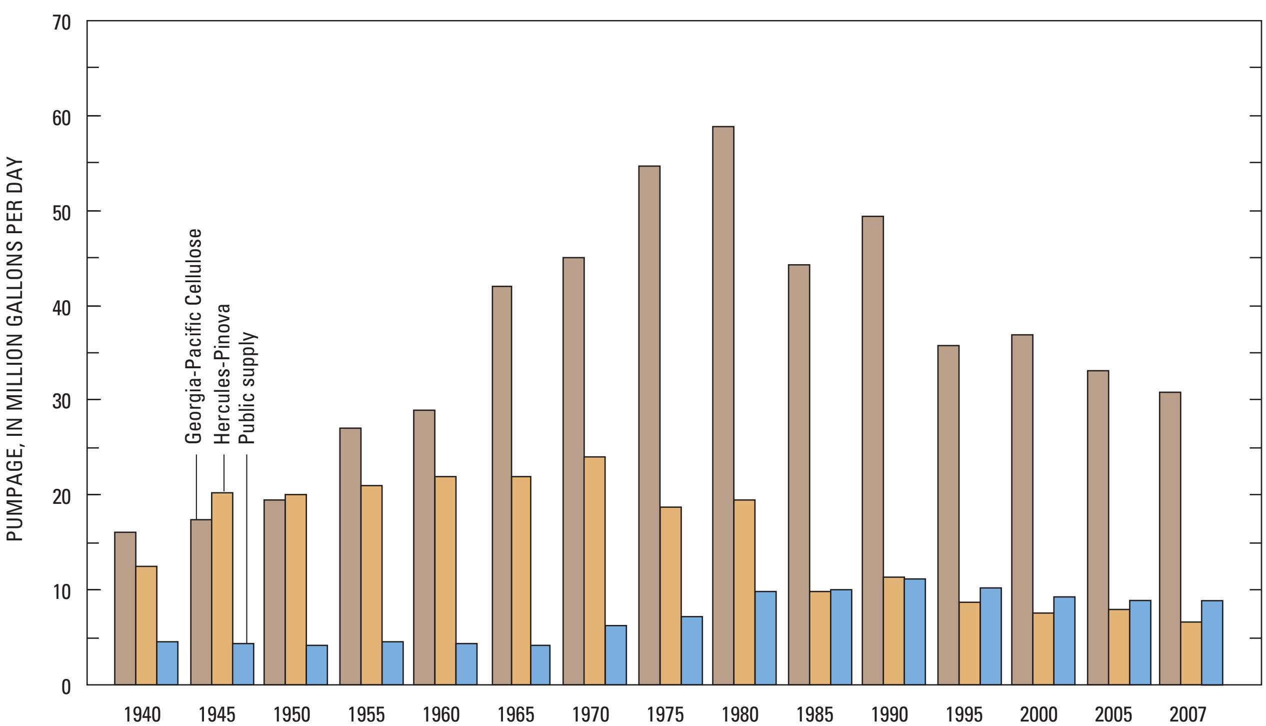
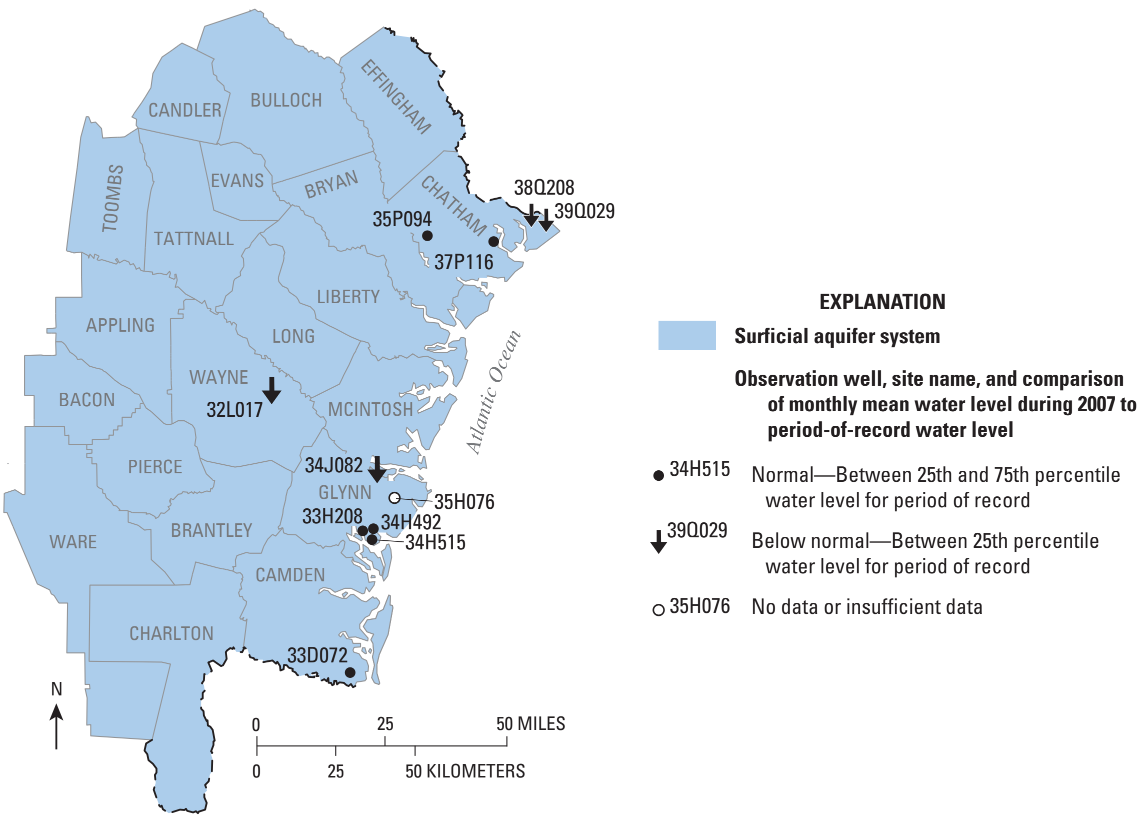


Figure 3. Major ground-water pumpage from the Upper Floridan aquifer in the Brunswick–Glynn County area, Georgia, 1940–2007.

Surficial Aquifer System

During 2007, water levels were monitored in five wells completed in the surficial aquifer system in the Brunswick–Glynn County area (table 1, fig. 4). Hydrographs for these wells are shown in figures 5–8 with well 35H076 excluded because of recent installation during 2007 and insufficient record. Some hydrographs contain provisional data, denoted in red, which has not been approved by the Director of the USGS (fig. 5). Water levels were less than historical daily median values for nearly all of the year in two of these four wells (wells 34H492 and 34J082, figs. 6–7), corresponding to a period of below-normal precipitation from November 2005 through June 2007 (fig. 2). The period of record was too short in wells 34H515 (fig. 8) and 35H076 (fig. 4) for statistical comparisons. Mean water levels were mostly greater than the historical daily median in well 33H208 (fig. 5). The reason for the different pattern at well 33H208 is unknown; however, it could be related to decreased pumpage at Georgia-Pacific Cellulose since 1990 (fig. 3) or local variations in precipitation in the area.



Site name	County	Other identifier[1]
33D072	Camden	Georgia Geologic Survey, St Marys, test well 3
35P094	Chatham	University of Georgia, Bamboo Farm well
37P116	Chatham	Georgia Geologic Survey, Skidaway Institute, test well 4
38Q208	Chatham	Fort Pulaski, Savannah Harbor Expansion, monitoring well 4, COE
39Q029	Chatham	Tybee, Savannah Harbor Expansion, monitoring well 1, COE
33H208	Glynn	Georgia–Pacific Cellulose, south test well 3
34H492	Glynn	Coastal Georgia Community College P-17
34H515	Glynn	Coffin Park test well 4
34J082	Glynn	Coastal Sound Science Initiative, Ebenezer Bend, AR-4
32L017	Wayne	Georgia Geologic Survey, Gardi, test well 3

[1] Georgia Geologic Survey now known as Georgia Environmental Protection Division (GaEPD)

Figure 4. Ground-water levels in the surficial aquifer system in the central and southern coastal areas, Georgia, 2007.

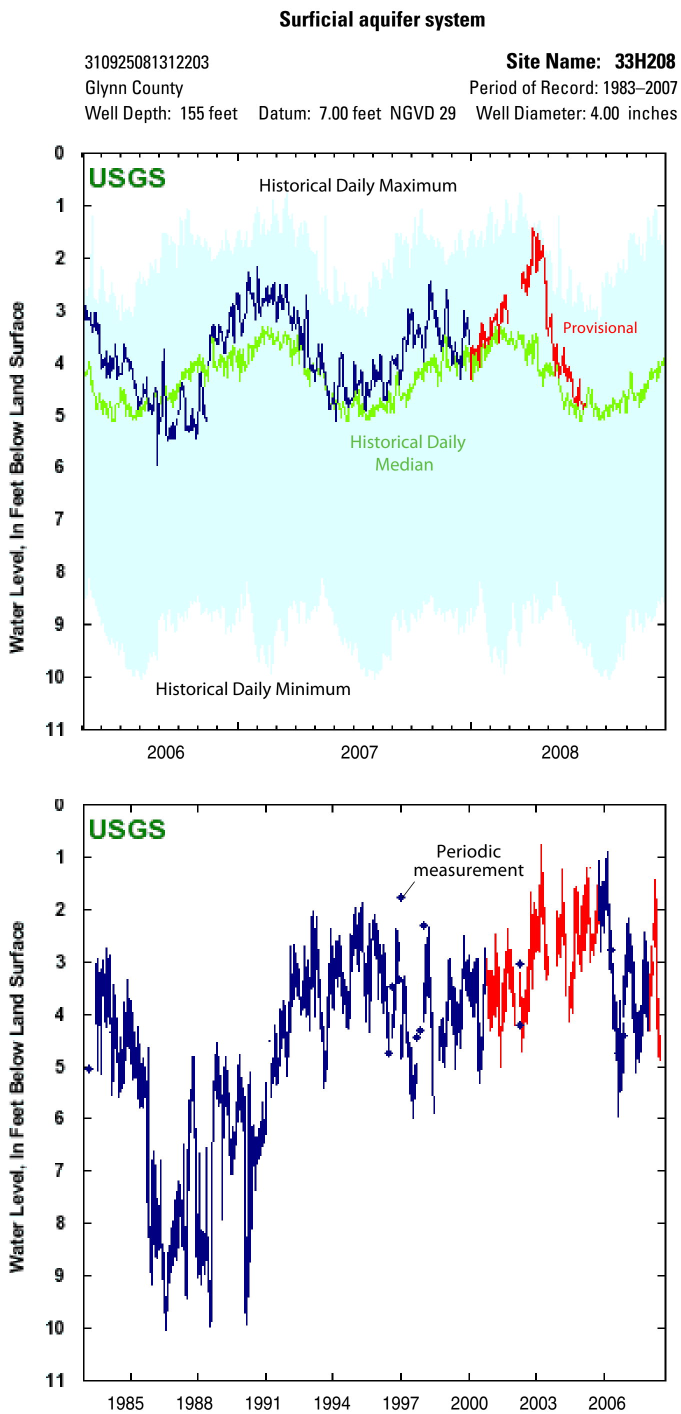


Figure 5. Periodic and daily mean water levels in well 33H208, surficial aquifer system, Glynn County, Georgia, 1983–2007.

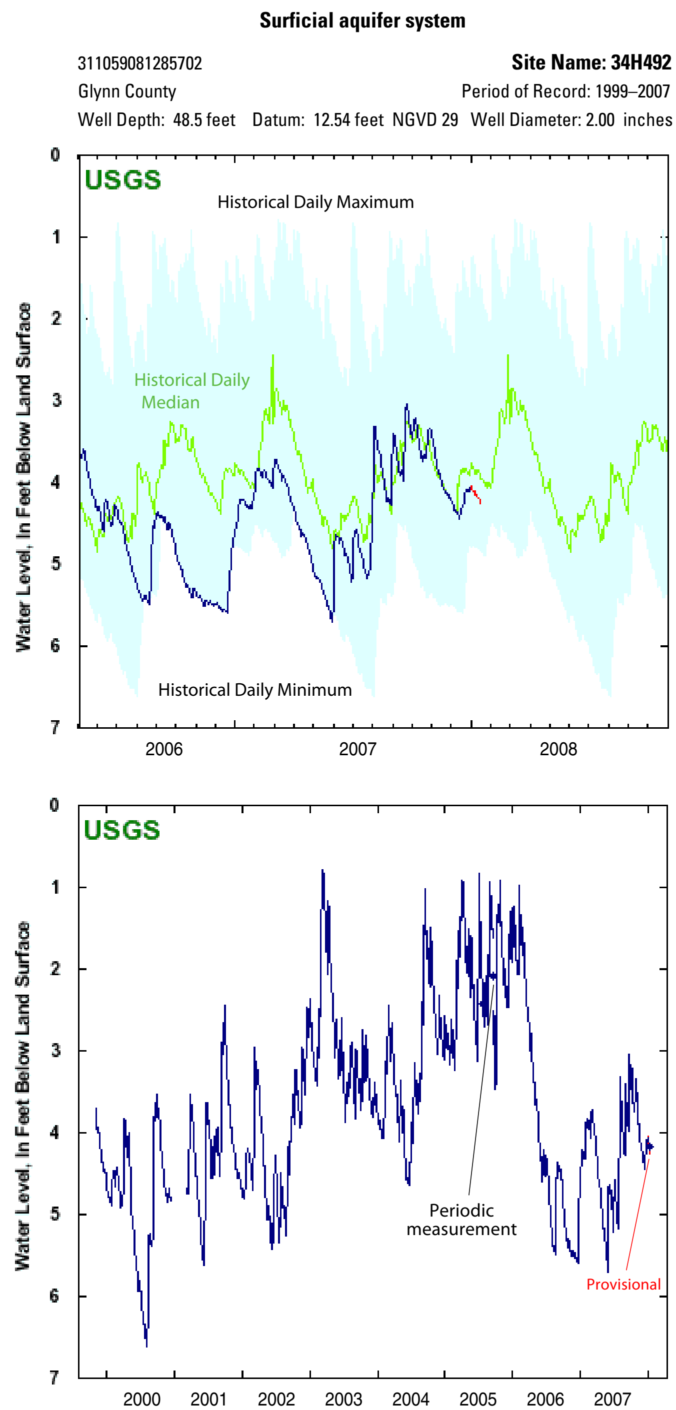


Figure 6. Periodic and daily mean water levels in well 34H492, surficial aquifer system, Glynn County, Georgia, 1999–2007.

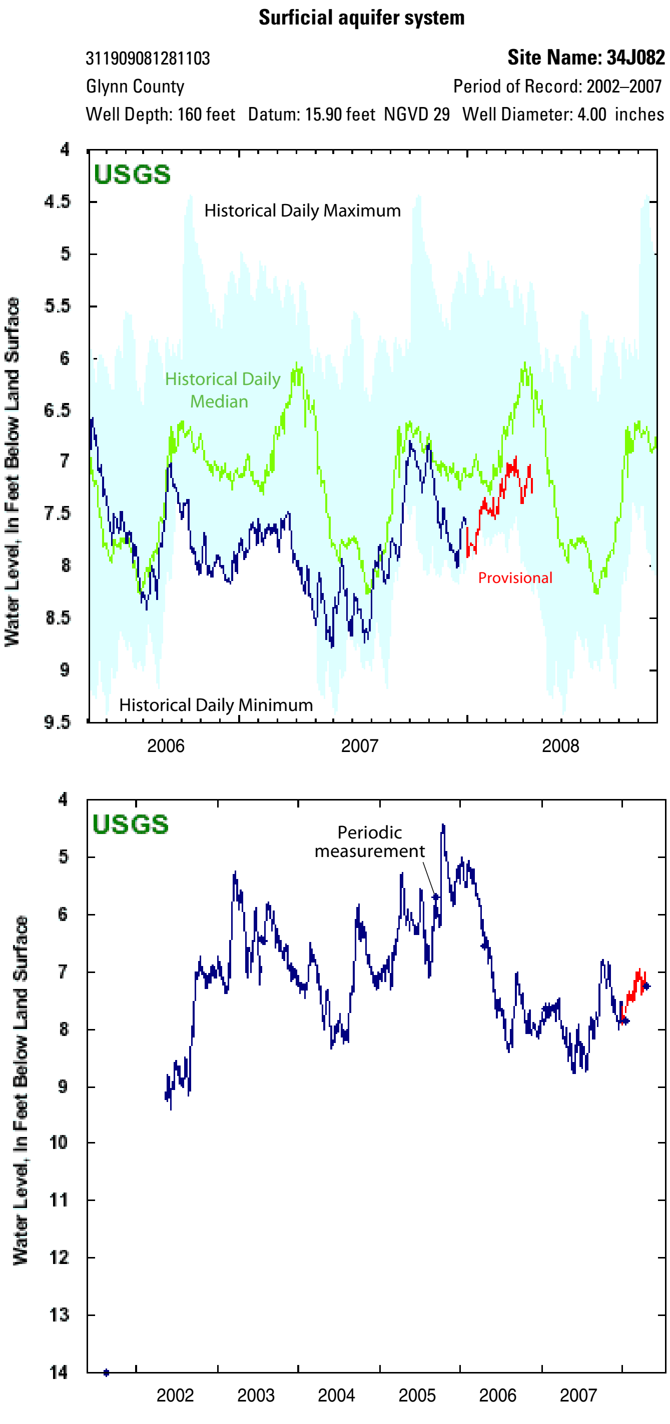


Figure 7. Periodic and daily mean water levels in well 34J082, surficial aquifer system, Glynn County, Georgia, 2002–2007.

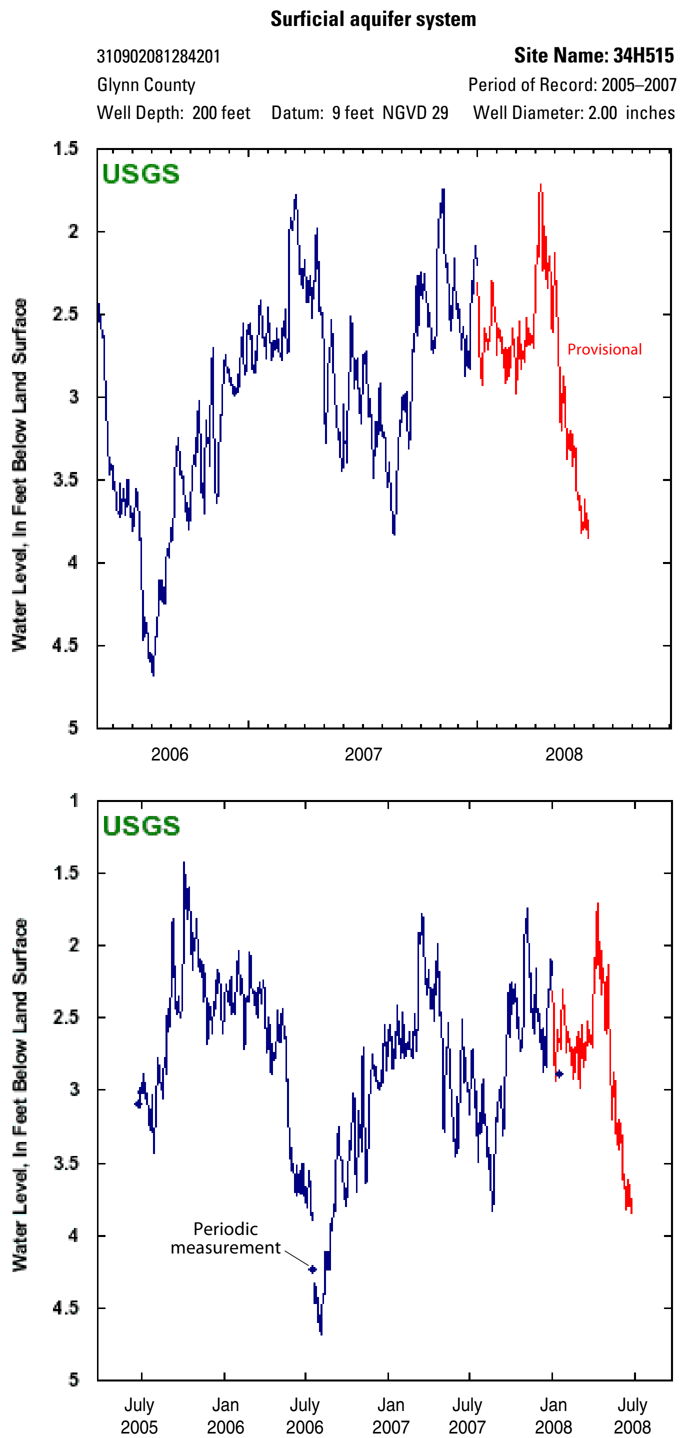
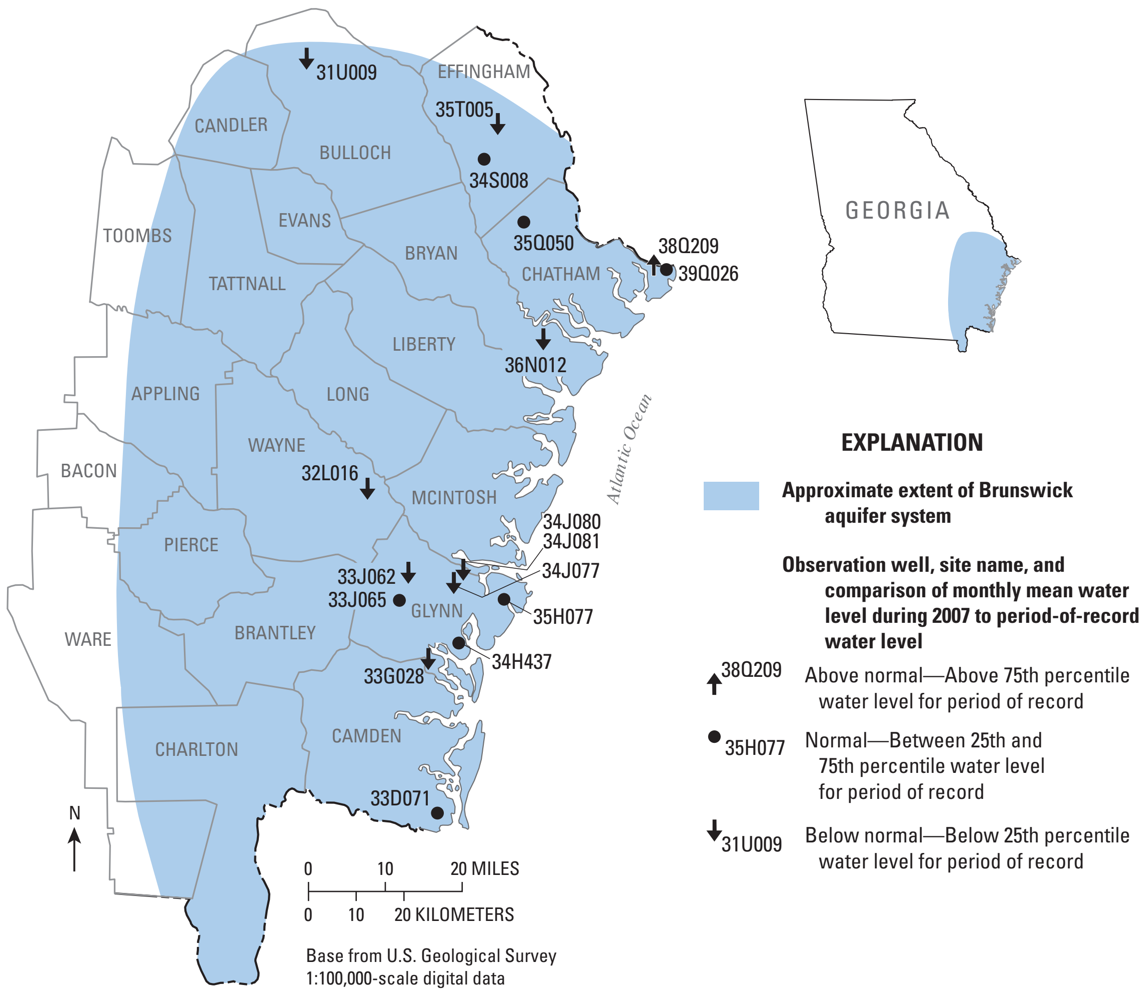


Figure 8. Periodic and daily mean water levels in well 34H515, surficial aquifer system, Glynn County, Georgia, 2005–2007.

Brunswick Aquifer System

Water levels in the Brunswick aquifer system are monitored in four wells completed in the upper Brunswick aquifer, three wells completed in the lower Brunswick aquifer, and one well completed in the Brunswick aquifer system (table 1, fig. 9). Hydrographs for these wells are shown in figures 10–17; one well (35H077) has too short a record to allow for statistical comparisons. During 2007, water levels in seven of the eight wells were below the historical daily median for most of the year, with new historic daily minimum values set in several of the wells, 33J065 (fig. 11), 34J077 (fig. 12), 34J081 (fig. 13), 33G028 (fig. 14), and 34J080 (fig. 16). These declines correspond to a period of below-normal precipitation from November 2005 through June 2007 (fig. 2). In well 34J077, (fig. 12) at the Golden Isles development, water levels also show the influence of pumping in that area. Since pumping from the Brunswick aquifer system at the Golden Isle production well began during 1999, the water level has dropped about 15 feet (ft).



Site name	Water-bearing unit[1]	County	Other identifier[2]
36N012	L	Bryan	Genesis Pointe
31U009	UX	Bulloch	Georgia Geologic Survey, Hopeulikit, test well 2
33D071	U	Camden	Georgia Geologic Survey, St Marys, test well 2
35Q050	U	Chatham	Georgia Forestry Commission, test well CB-1
38Q209	B	Chatham	Fort Pulaski, Savannah Harbor Expansion, monitoring well 3, COE
39Q026	UX	Chatham	Tybee Island, test well 3
34S008	LX	Effingham	Pineora test well EB-1
35T005	UX	Effingham	Springfield, Georgia, observation well
33G028	B	Glynn	Georgia Ports Authority, well 3
33J062	L	Glynn	Georgia Forestry Commission, test well GB-1
33J065	U	Glynn	Georgia Forestry Commission, test well GB-4
34H437	U	Glynn	Georgia Geologic Survey, Coffin Park, test well 2
34J077	U	Glynn	Golden Isle, test well 1S
35H077	L	Glynn	Coastal Sound Science Initiative, St. Simons test well 2
34J080	L	Glynn	Coastal Sound Science Initiative, Ebenezer Bend AR-2
34J081	U	Glynn	Coastal Sound Science Initiative, Ebenezer Bend AR-3
32L016	U	Wayne	Georgia Geologic Survey, Gardi, test well 2

[1]B, Brunswick aquifer system; L, lower Brunswick aquifer; U, upper Brunswick aquifer; UX, undifferentiated, low-permeability equivalent to the upper Brunswick aquifer; LX, undifferentiated, low-permeability equivalent to the lower Brunswick aquifer

[2]Georgia Geologic Survey now known as Georgia Environmental Protection Division (GaEPD)

Figure 9. Ground-water levels in the Brunswick aquifer system in the central and southern coastal areas, Georgia, 2007.

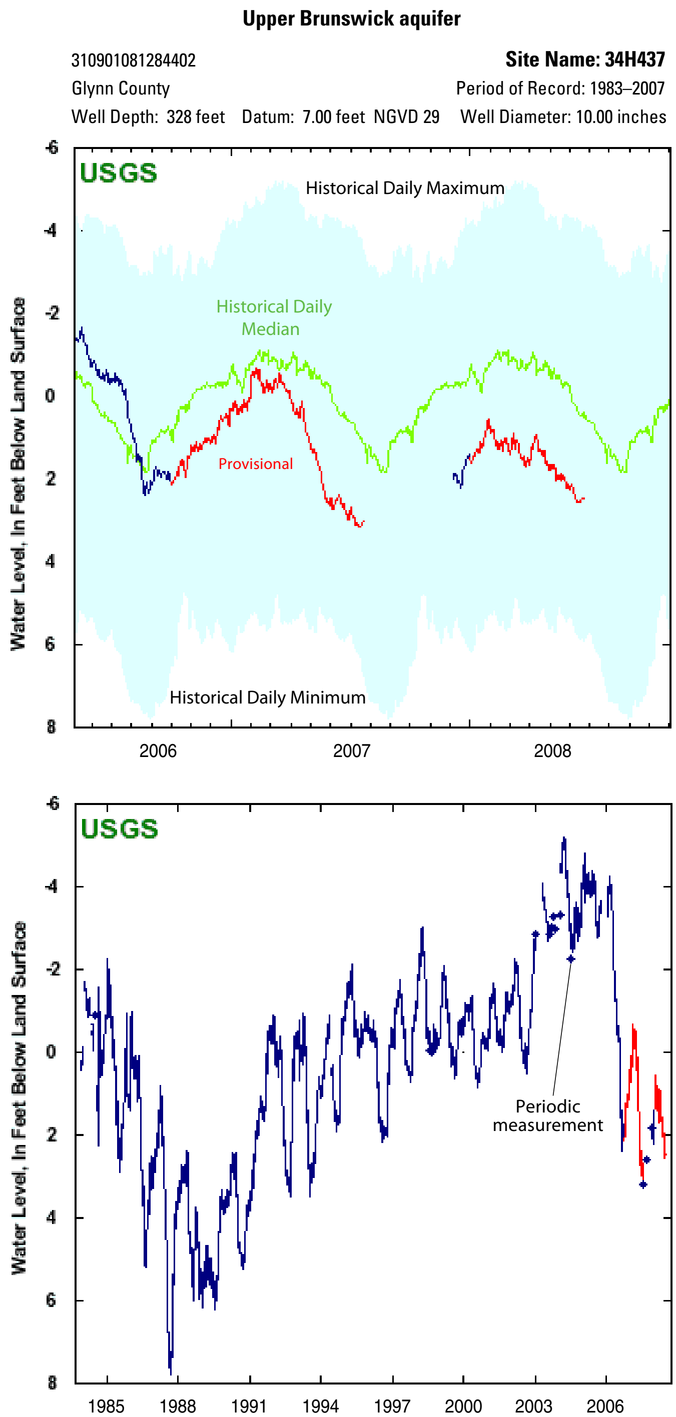


Figure 10. Periodic and daily mean water levels in well 34H437, upper Brunswick aquifer, Glynn County, Georgia, 1983–2007.

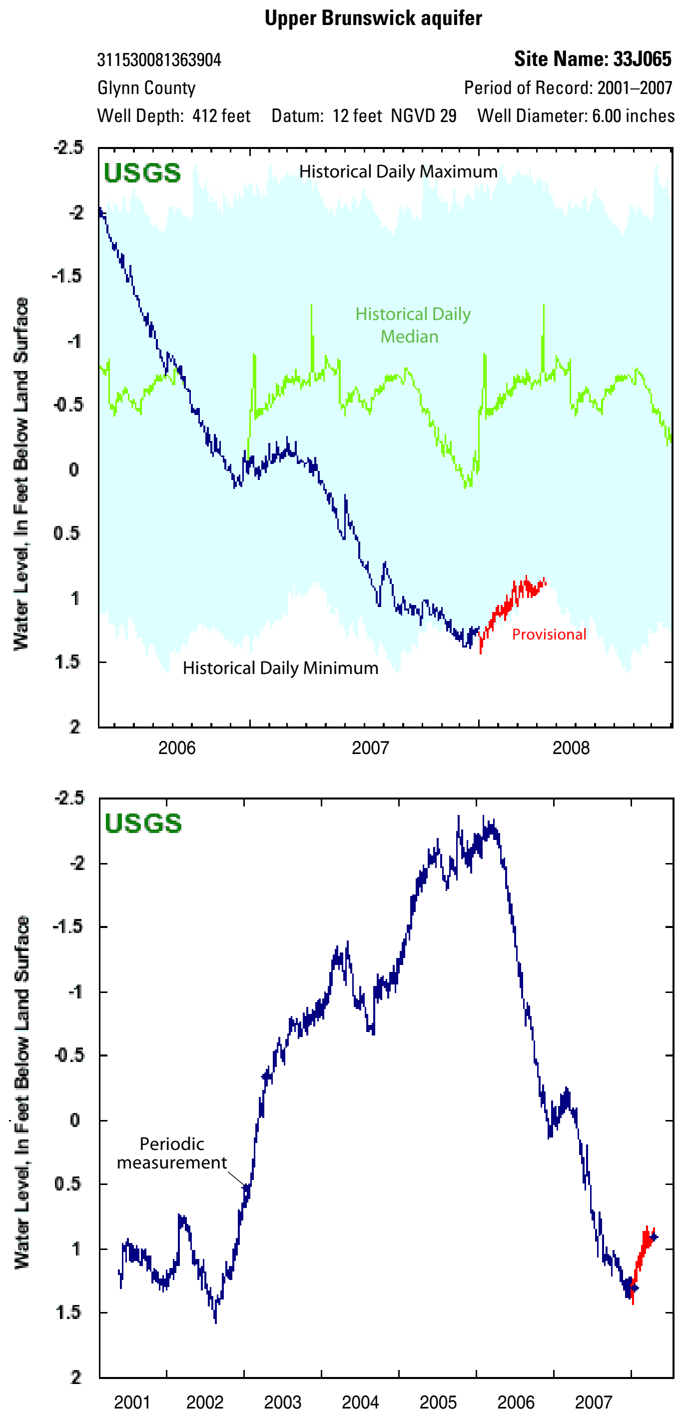


Figure 11. Periodic and daily mean water levels in well 33J065, upper Brunswick aquifer, Glynn County, Georgia, 2001–2007.

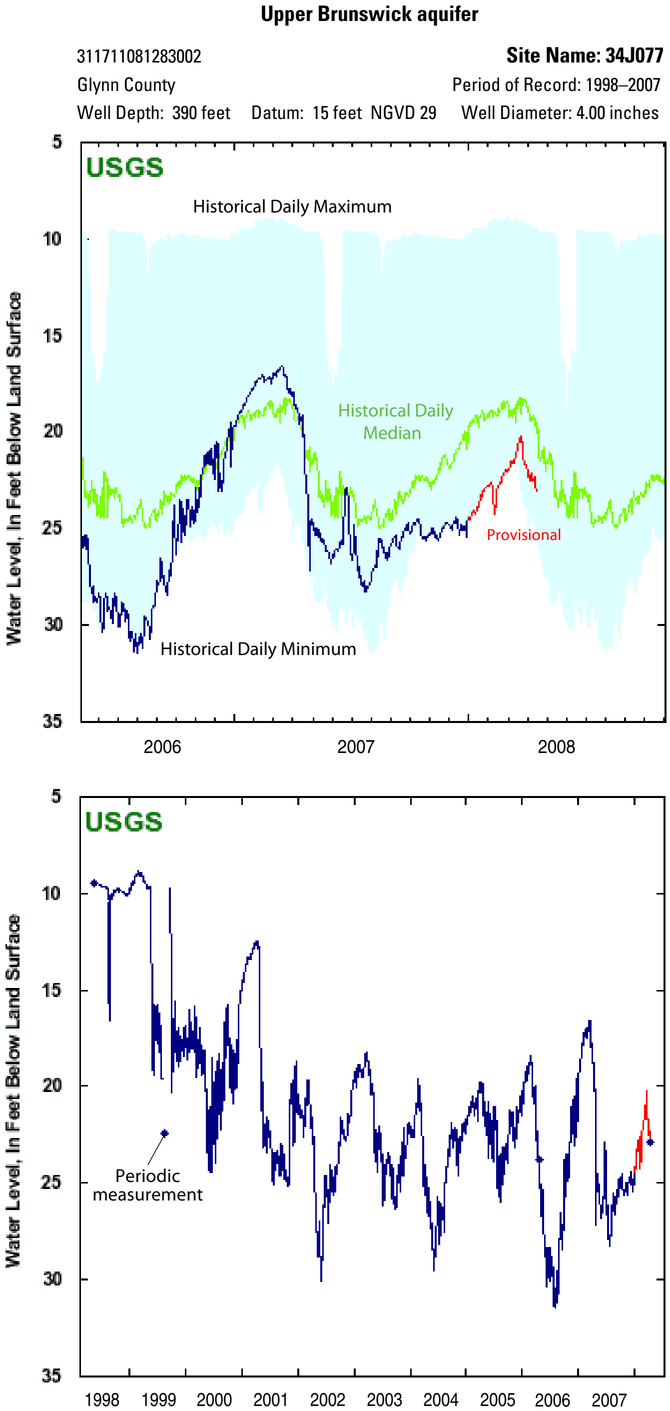


Figure 12. Periodic and daily mean water levels in well 34J077, upper Brunswick aquifer, Glynn County, Georgia, 1998–2007.

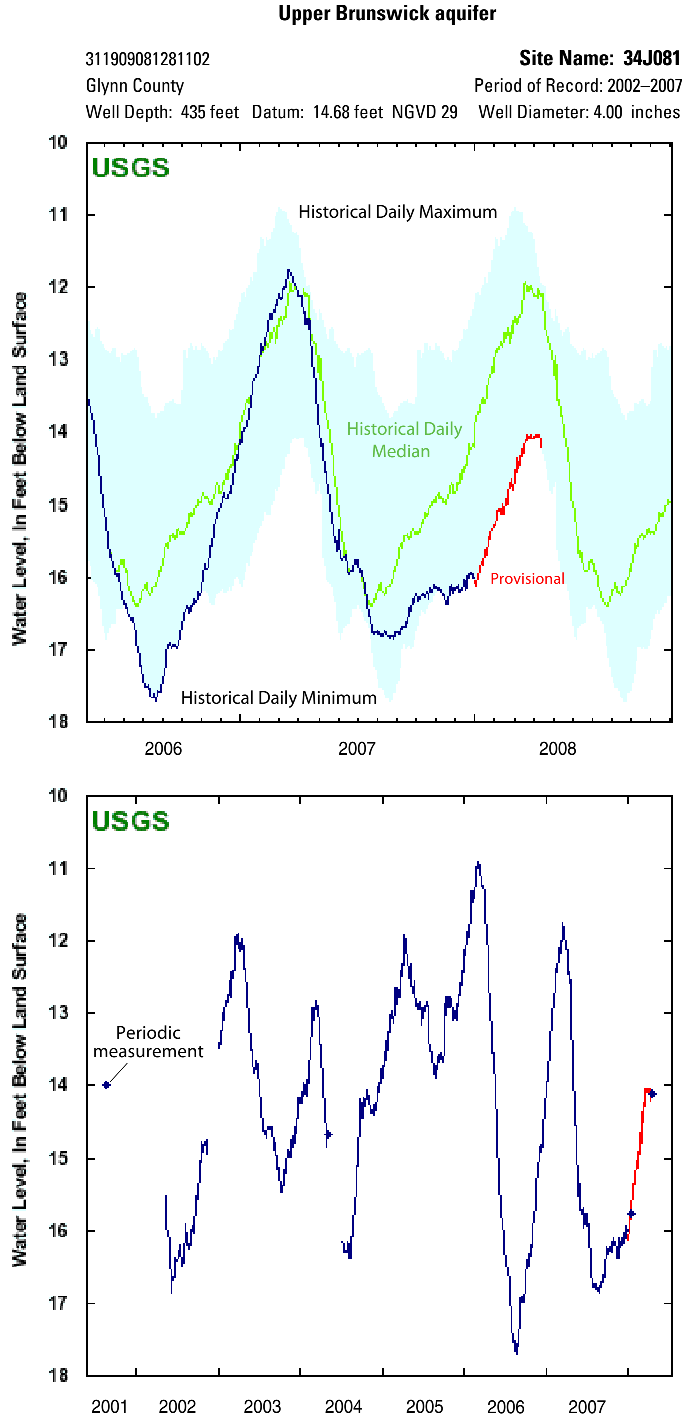


Figure 13. Periodic and daily mean water levels in well 34J081, upper Brunswick aquifer, Glynn County, Georgia, 2002–2007.

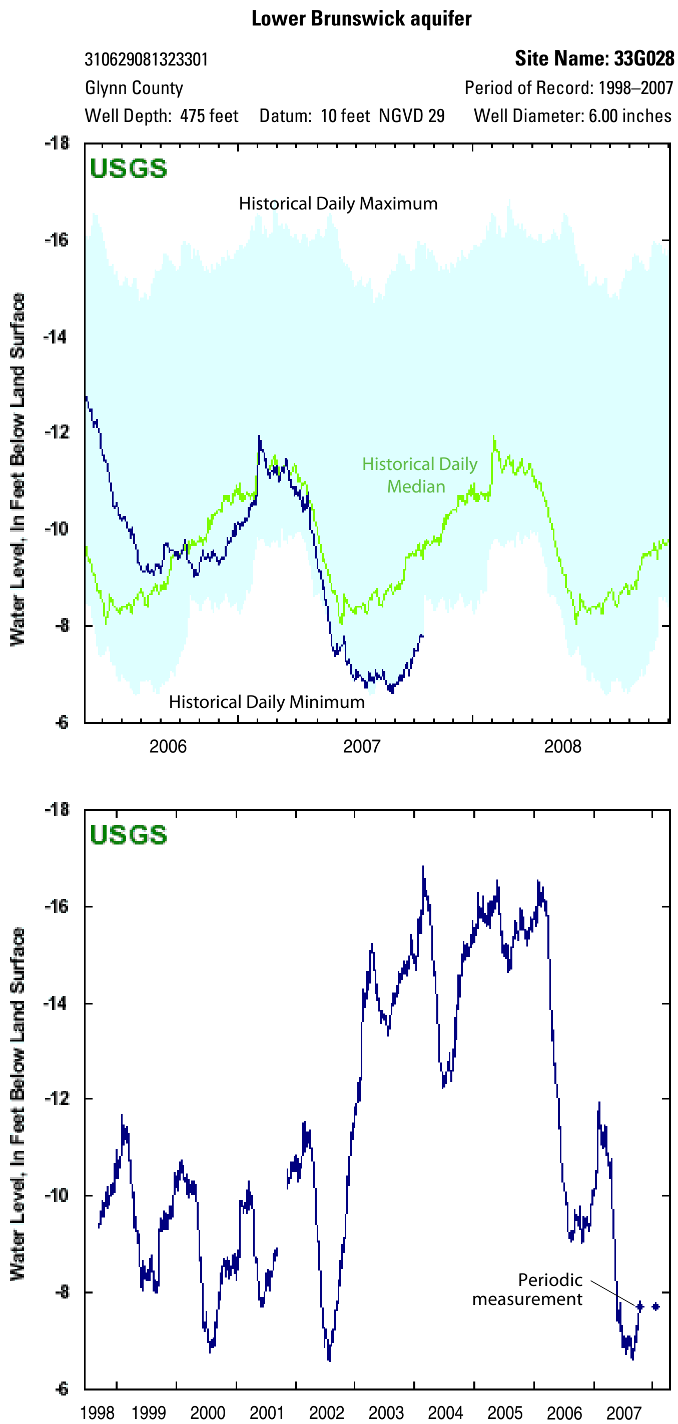


Figure 14. Periodic and daily mean water levels in well 33G028, lower Brunswick aquifer, Glynn County, Georgia, 1998–2007.

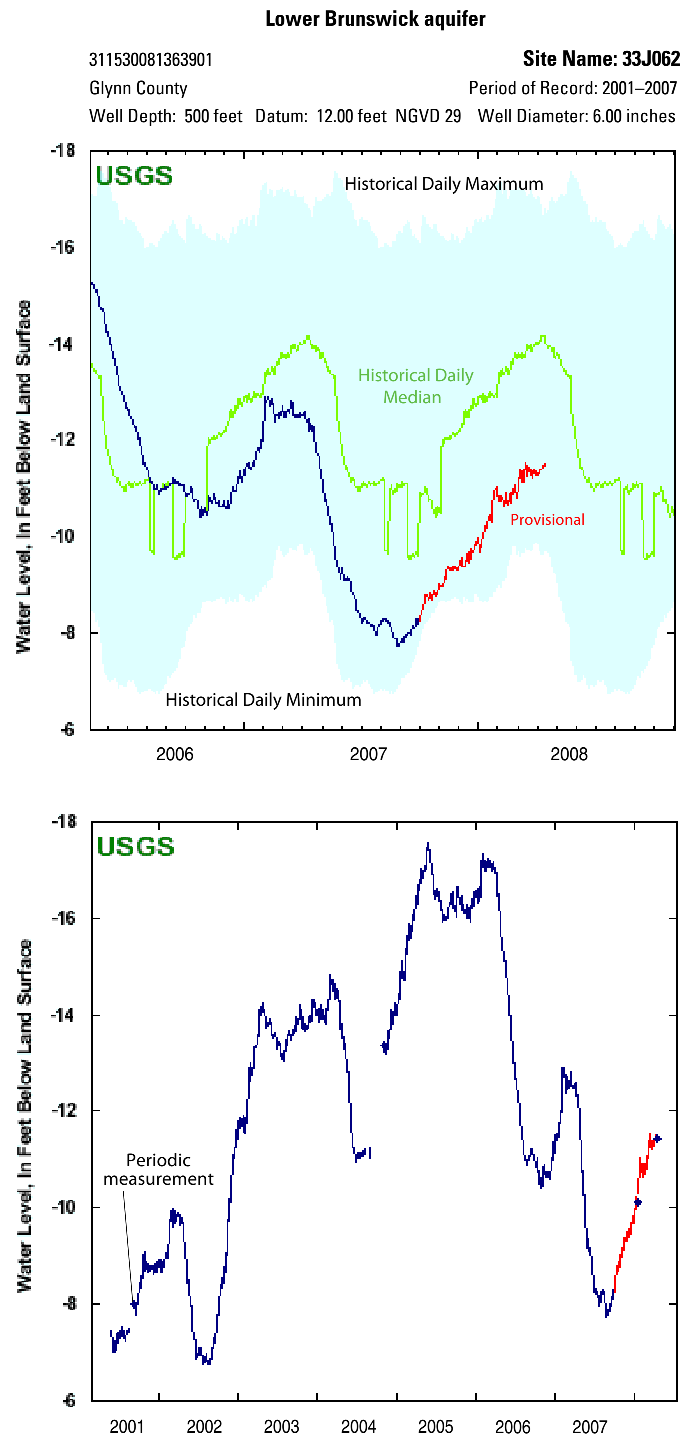


Figure 15. Periodic and daily mean water levels in well 33J062, lower Brunswick aquifer, Glynn County, Georgia, 2001–2007.

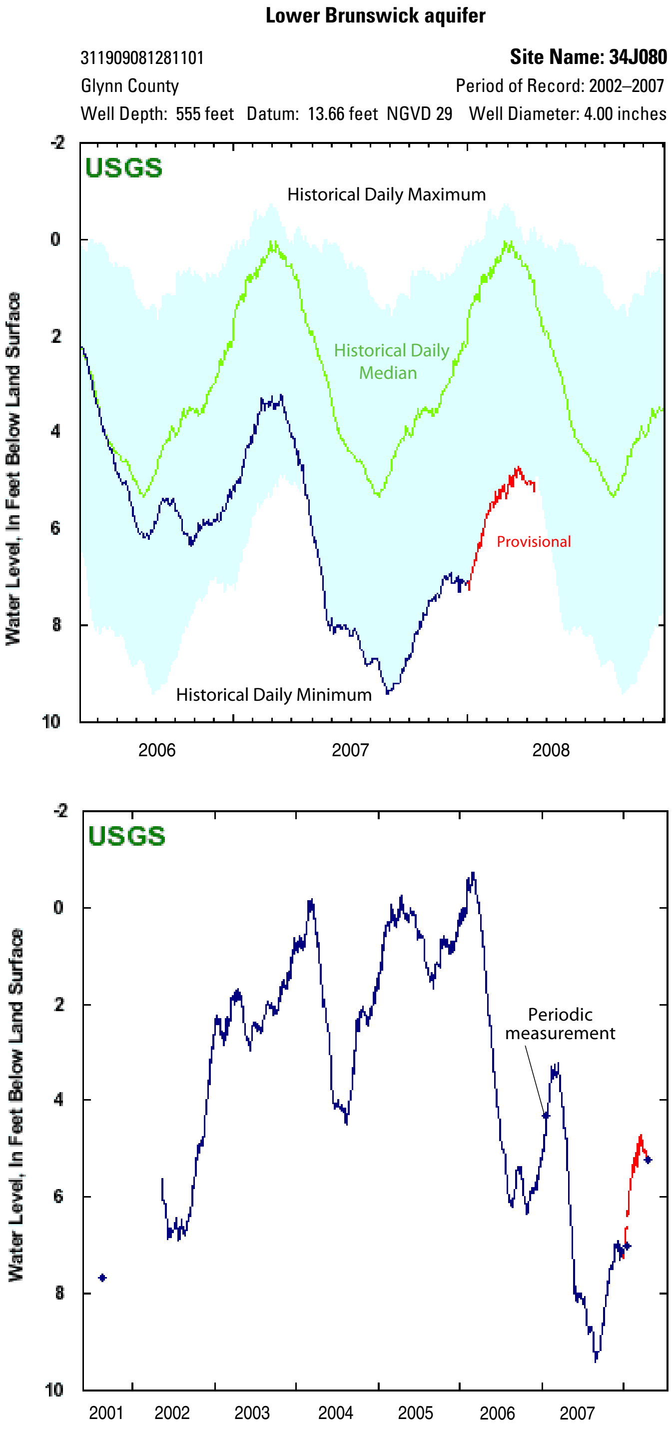


Figure 16. Periodic and daily mean water levels in well 34J080, lower Brunswick aquifer, Glynn County, Georgia, 2002–2007.

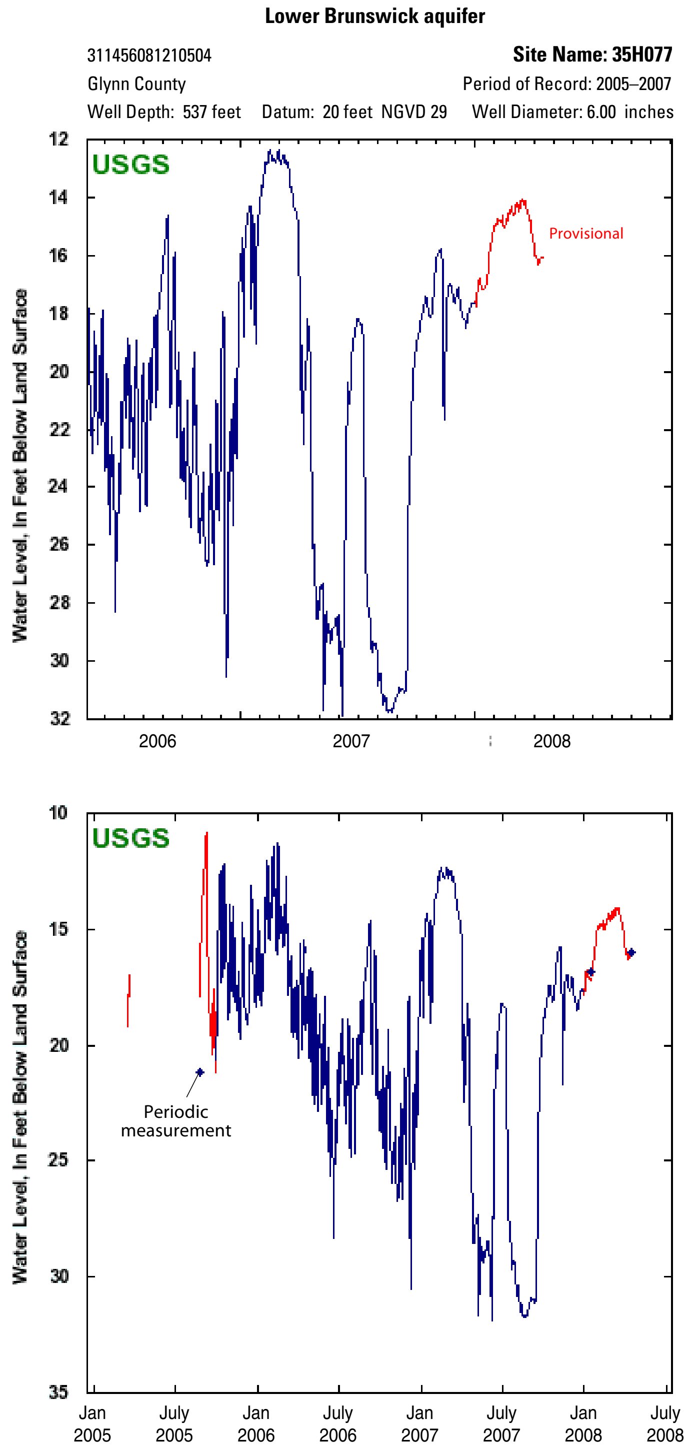


Figure 17. Periodic and daily mean water levels in well 35H077, lower Brunswick aquifer, Glynn County, Georgia, 2005–2007.

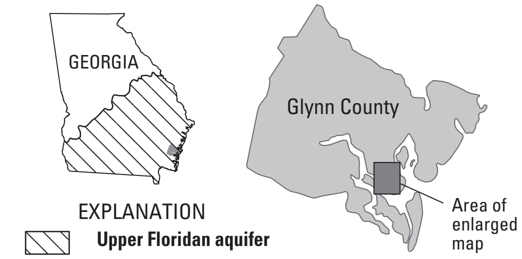
Floridan Aquifer System

Water levels in the Floridan aquifer system in the Brunswick– Glynn County area are continuously monitored in 12 wells completed in the Upper Floridan aquifer and 8 wells completed in the Lower Floridan aquifer (table 1, figs. 18 and 26). Hydrographs for eight of the Upper Floridan wells are shown in figures 19–25, and hydrographs for seven Lower Floridan wells are shown in figures 27–33. The period of record was too short to display hydrographs of the other wells (34H504, 34H505, 35H070, and 35H068; fig. 1 and table 1) with the exception of well 34H514, which is included under the section discussing real-time ground-water monitoring stations.

Although not influenced by direct precipitation, water levels in the Floridan aquifer system declined during 2006–2007, corresponding to increased pumping demand. Despite this decline, water levels in 5 of the 12 wells completed in the Upper Floridan aquifer were at or above historical daily median levels during most of 2007, reflecting the continuing effect of pumping reductions in the coastal area since the 1990s (wells 33H133, 33H207, 34H127, 34H334, and 34H371). The period of record is too short to allow for statistical comparisons for three Upper Floridan aquifer wells (33H324, 33H325, and 34G033).

Water levels in the Lower Floridan aquifer also declined during 2006 –2007 in response to increased pumping. Water levels in five of the wells (33H188, 33H206, 33J044, 34H391, and 34H436) were below historical daily median levels, with levels in three of the wells reaching new historical daily minimum levels (wells 33H188, 34H495, and 34H500). Water levels in wells 33H206 (fig. 28) and 34H436 (fig. 31) were near historical daily median values during most of the year.

In addition to continuous recorders, synoptic water-level measurements were collected in 22 wells completed in the Upper Floridan aquifer during August 2007, and a potentiometric-surface map was prepared based on the data (fig. 18). The map indicates that the principal directions of ground-water flow are from south to north and from east to west, following the gradient created by large industrial withdrawals in the northern and western parts of the Brunswick area (fig. 18).



EXPLANATION

Upper Floridan aquifer

City of Brunswick area

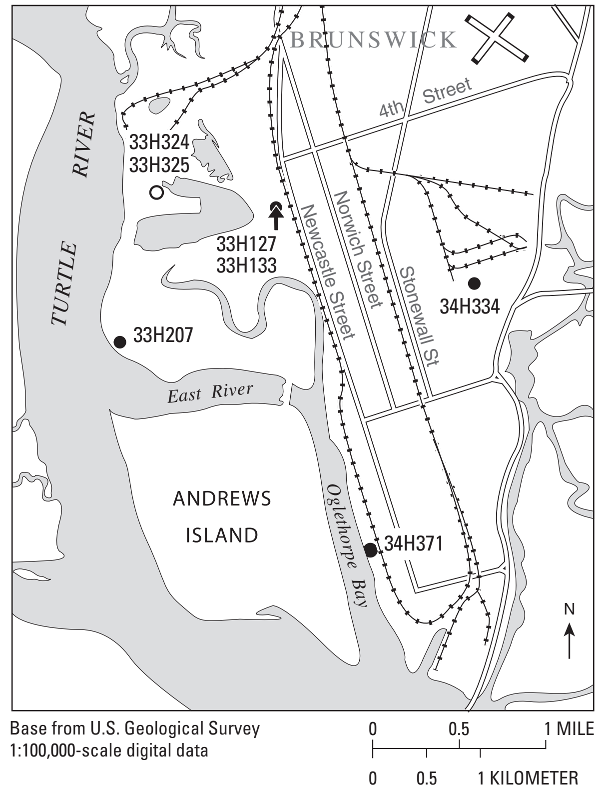
Observation well, site name, and comparison of mean annual water level during 2007 to period-of-record water level

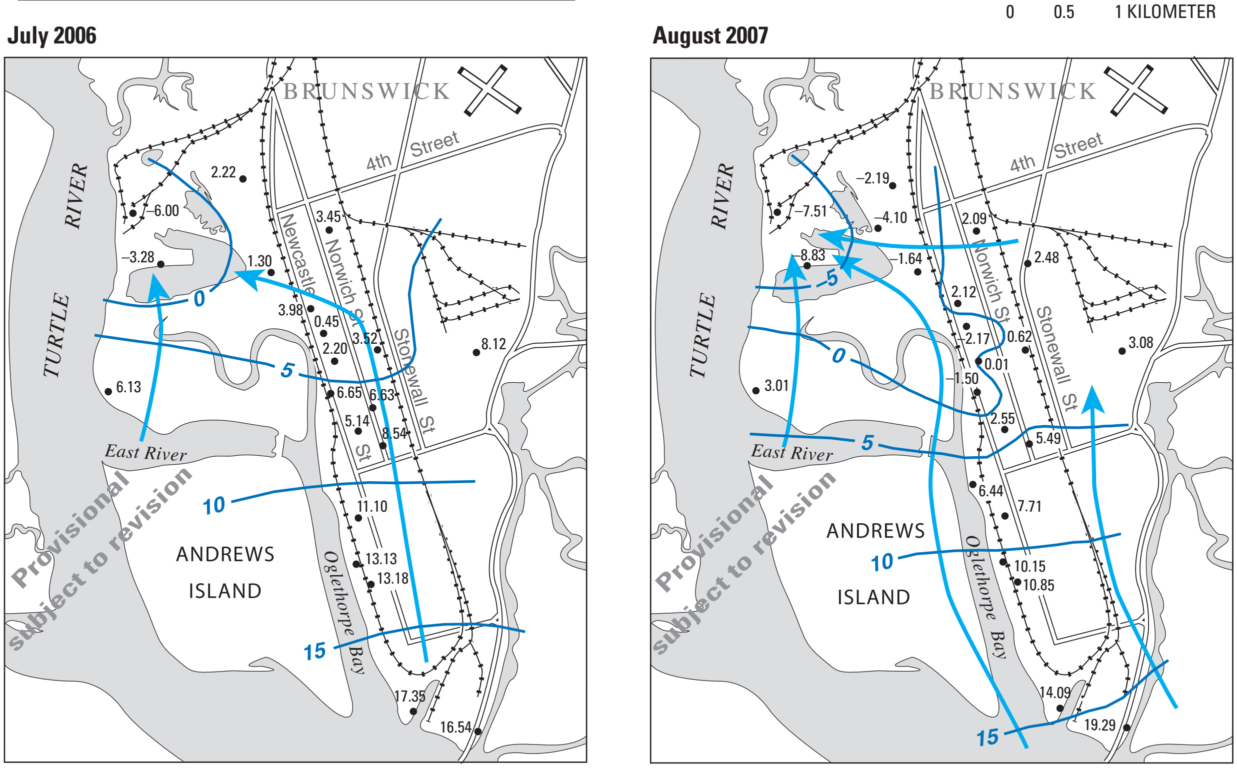
33H127 Above normal—Above 75th percentile water level for period of record

33H207 Normal—Between 25th and 75th percentile water level for period of record

33H325 Insufficient data

Site name	County	Other identifier
33H127	Glynn	U.S. Geological Survey, test well 3
33H133	Glynn	U.S. Geological Survey, test well 6
33H207	Glynn	Georgia-Pacific, south test well 2
33H324	Glynn	Georgia-Pacific, Lower water-bearing zone Coastal Sound Science Initiative
33H325	Glynn	Georgia-Pacific, Upper water-bearing zone Coastal Sound Science Initiative
34H334	Glynn	U.S. Geological Survey, test well 4
34H371	Glynn	U.S. Geological Survey, test well 11





EXPLANATION

15 **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells in the Upper Floridan aquifer. Contour interval 5 feet. Datum is NAVD 88

General direction of ground-water flow

Figure 18. Ground-water level monitoring network and potentiometric surfaces for the Upper Floridan aquifer in the Brunswick–Glynn County area, July 2006 and August 2007.

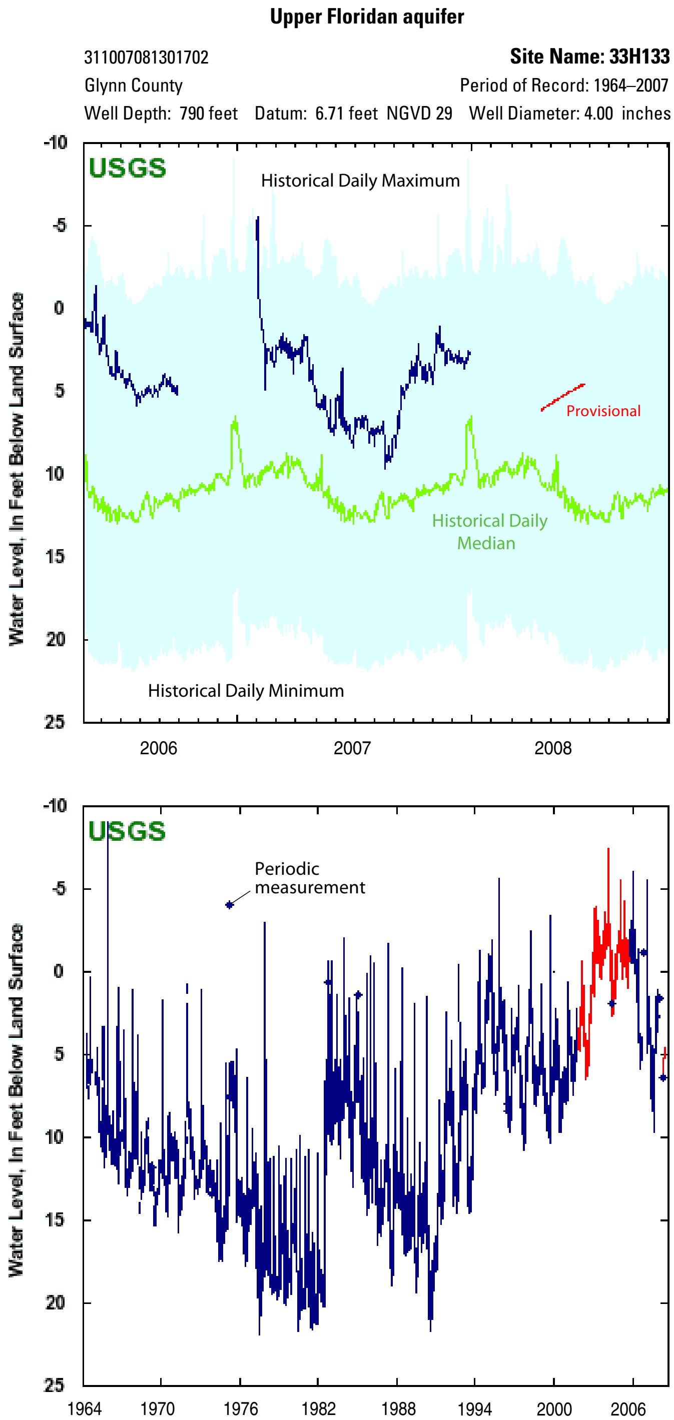


Figure 19. Periodic and daily mean water levels in well 33H133, Upper Floridan aquifer, Glynn County, Georgia, 1964–2007.

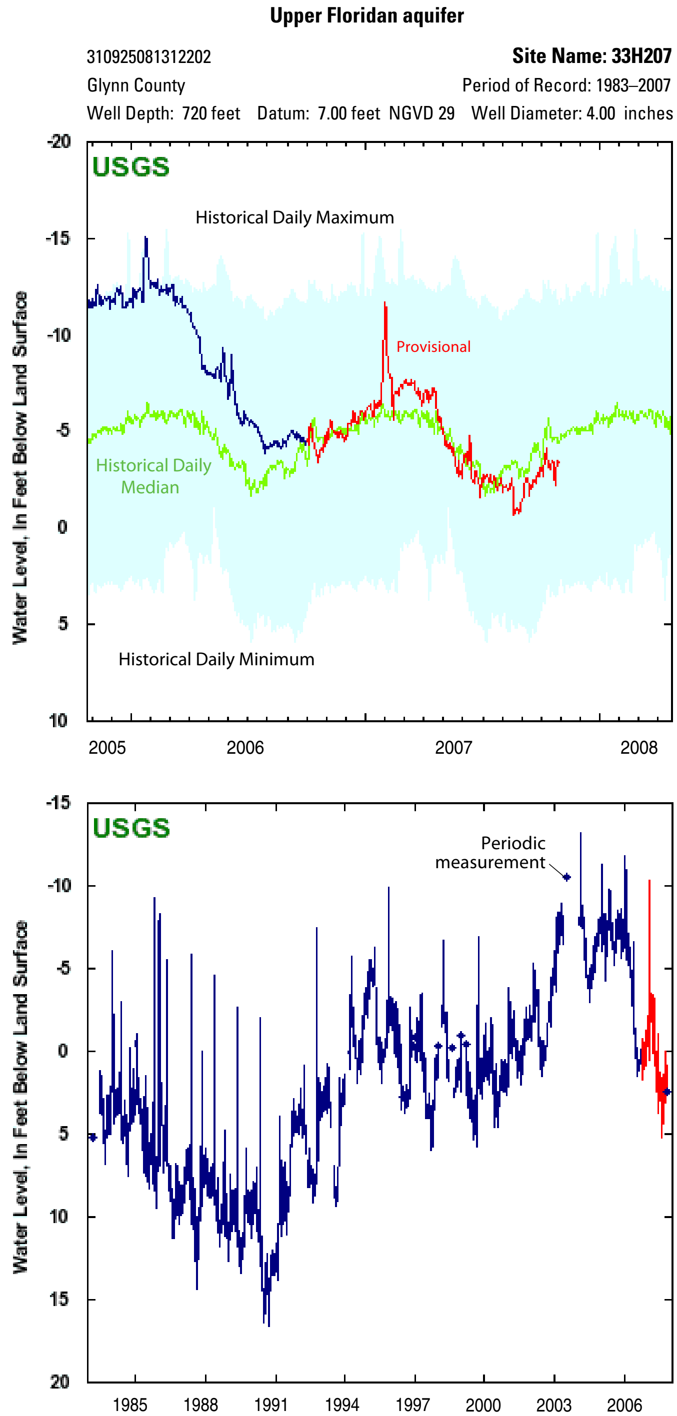


Figure 20. Periodic and daily mean water levels in well 33H207, Upper Floridan aquifer, Glynn County, Georgia, 1983–2007.

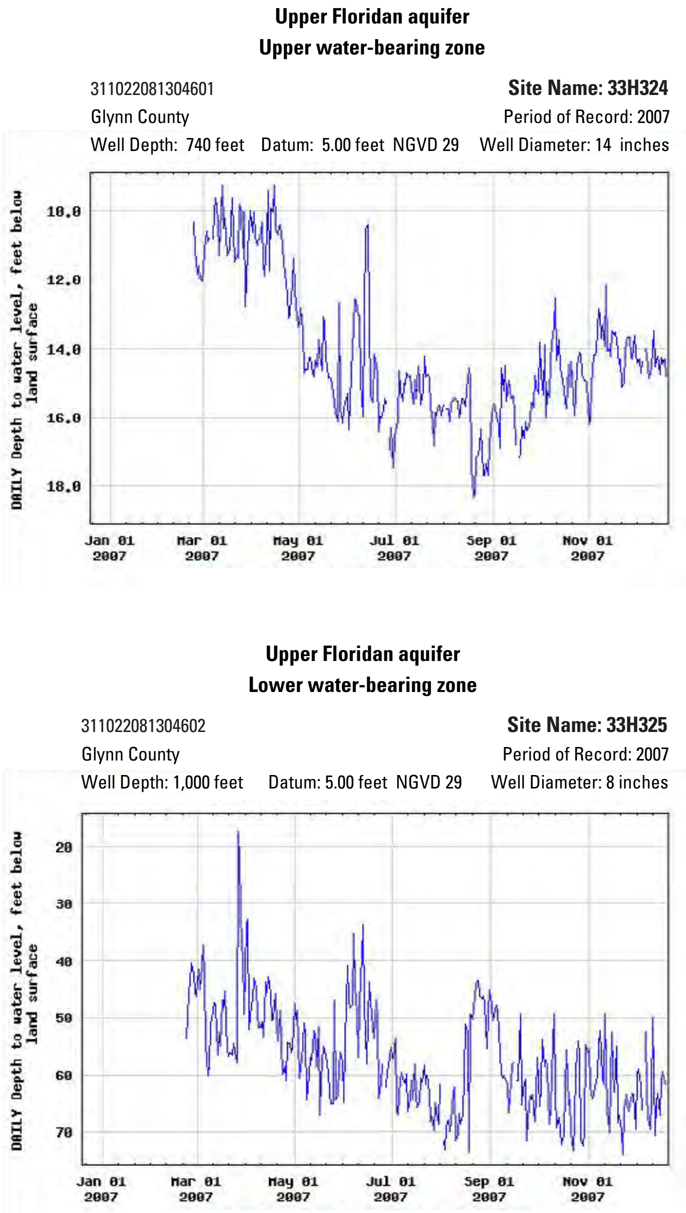


Figure 21. Daily mean water levels in wells 33H324 and 33H325, Upper Floridan aquifer, Glynn County, Georgia, 2007.

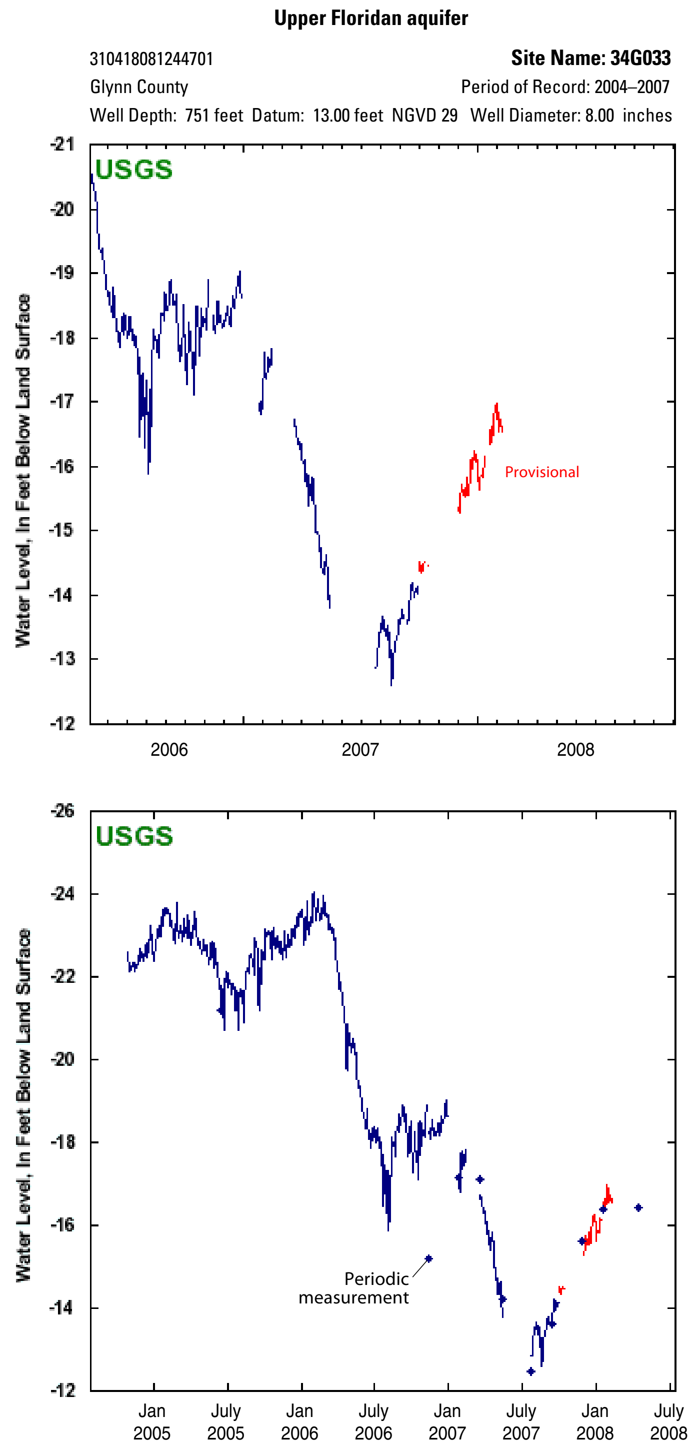


Figure 22. Periodic and daily mean water levels in well 34G033, Upper Floridan aquifer, Glynn County, Georgia, 2004–2007 (see figure 1 for location).

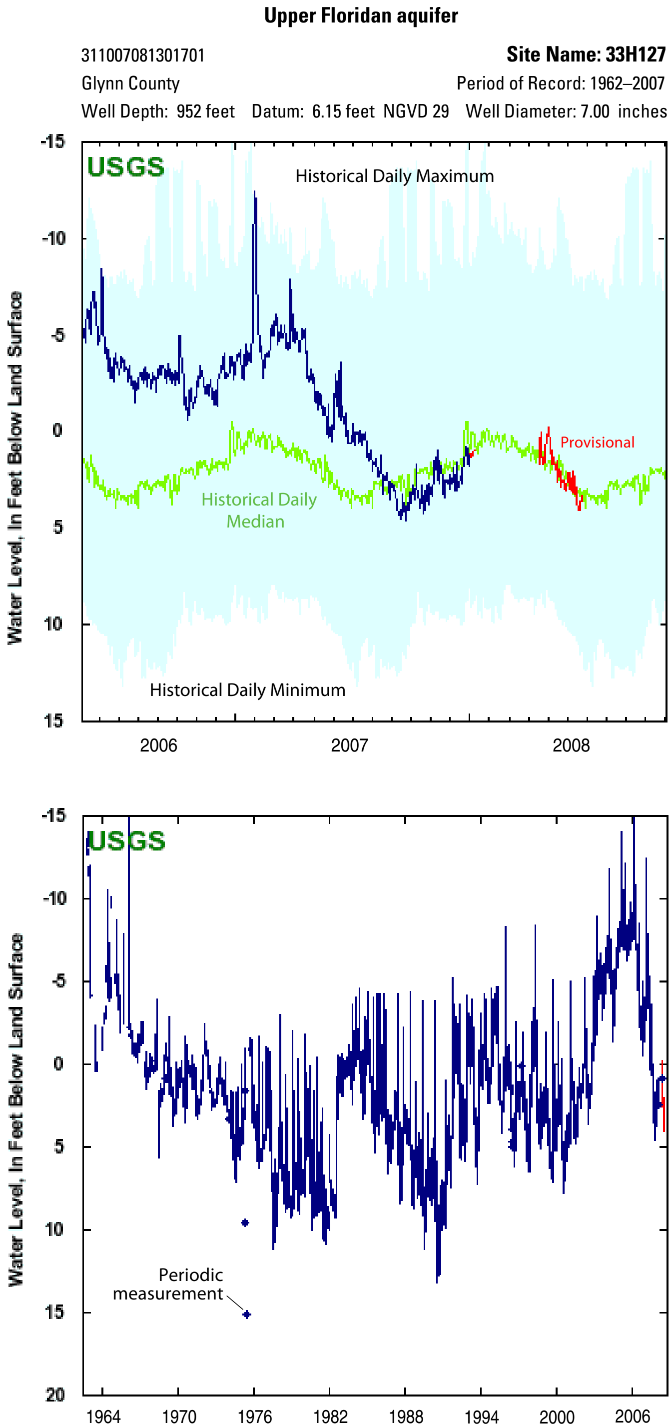


Figure 23. Periodic and daily mean water levels in well 33H127, Upper Floridan aquifer, Glynn County, Georgia, 1962–2007.

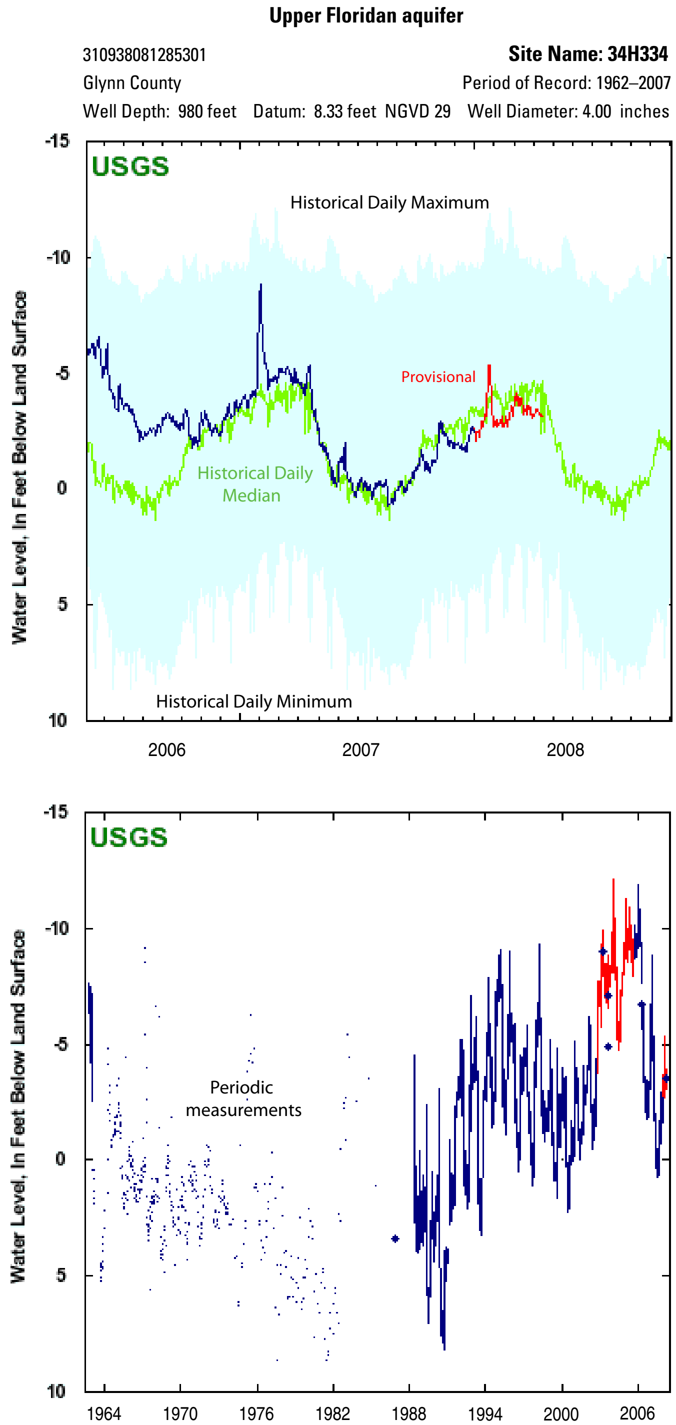


Figure 24. Periodic and daily mean water levels in well 34H334, Upper Floridan aquifer, Glynn County, Georgia, 1962–2007.

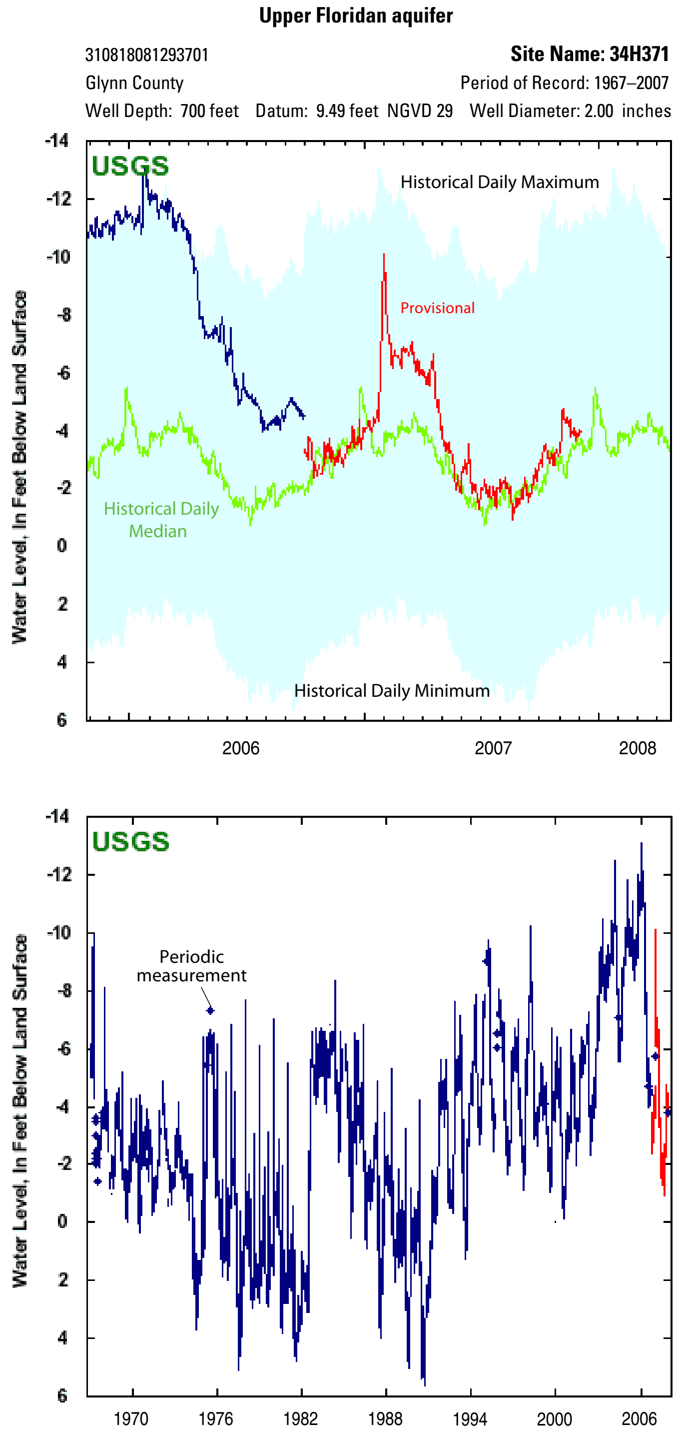
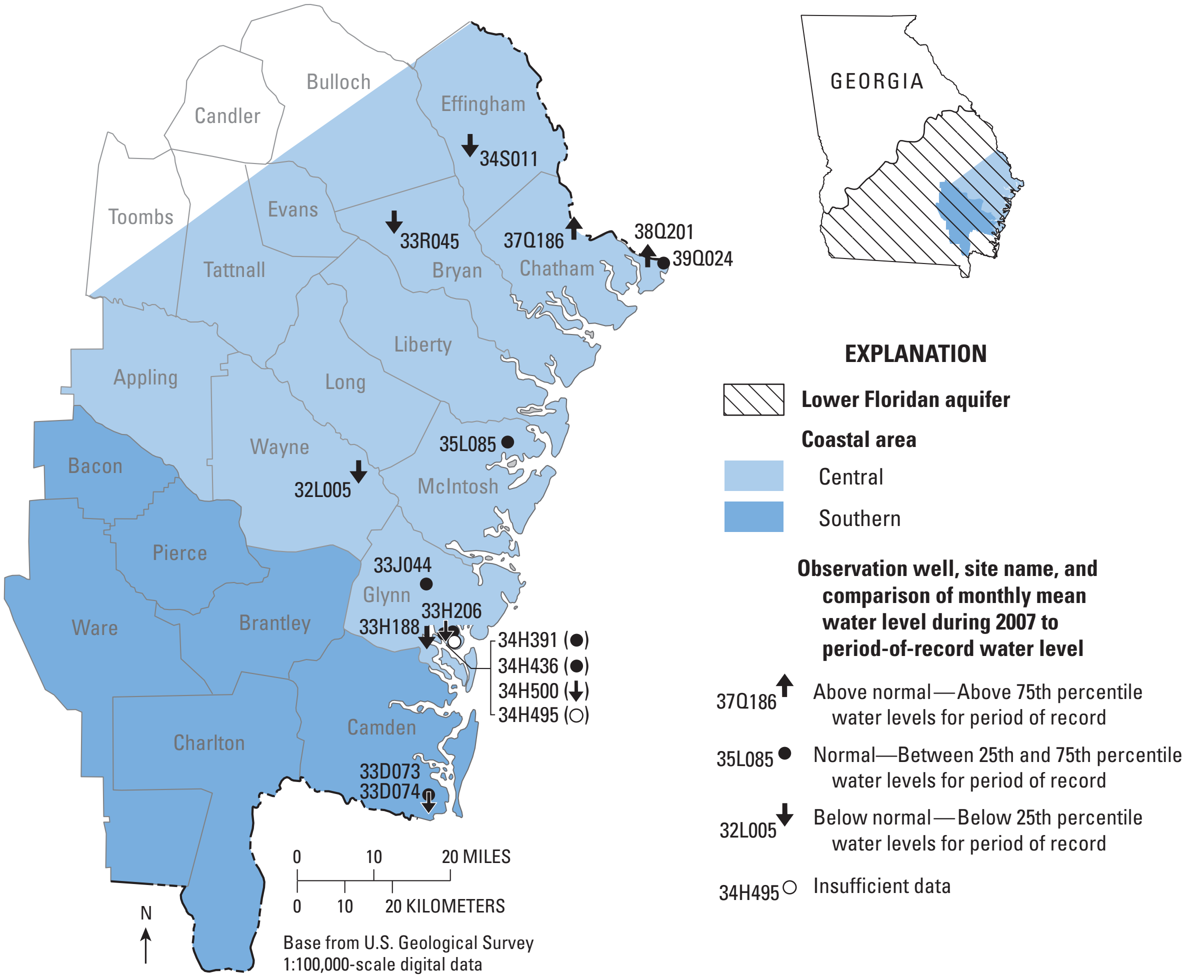


Figure 25. Periodic and daily mean water levels in well 34H371, Upper Floridan aquifer, Glynn County, Georgia, 1967–2007.



Site name	Water-bearing unit[1]	County	Other identifier[2]
33R045	LF	Bryan	Coastal Sound Science Initiative test well
33D073	LF	Camden	St Marys, test well (deep)
33D074	LF	Camden	Coastal Sound Science Initiative, St. Marys test well 2
37Q186	P	Chatham	Hutchinson Island, test well 2
38Q201	P	Chatham	Georgia Geologic Survey, Fort Pulaski, test well
39Q024	LF	Chatham	Georgia Geologic Survey, Tybee Island, test well 1
34S011	LF	Effingham	Coastal Sound Science Initiative, Pineora Ball Park test well
33H188	F	Glynn	U.S. Geological Survey, test well 26
33H206	LF	Glynn	Georgia-Pacific, south, test well 1
33J044	LF	Glynn	U.S. Geological Survey, test well 27
34H391	LF	Glynn	U.S. Geological Survey, test well 16
34H436	LF	Glynn	Georgia Geologic Survey, Coffin Park, test well 1
34H495	F	Glynn	U.S. Geological Survey, test well 29
34H500	LF	Glynn	U.S. Geological Survey, test well 30
35L085	LF	McIntosh	Hawthorne, test well 1
32L005	LF	Wayne	Hopkins No. 2

Figure 26. Ground-water levels in the Lower Floridan aquifer in the central and southern coastal areas, Georgia, 2007.

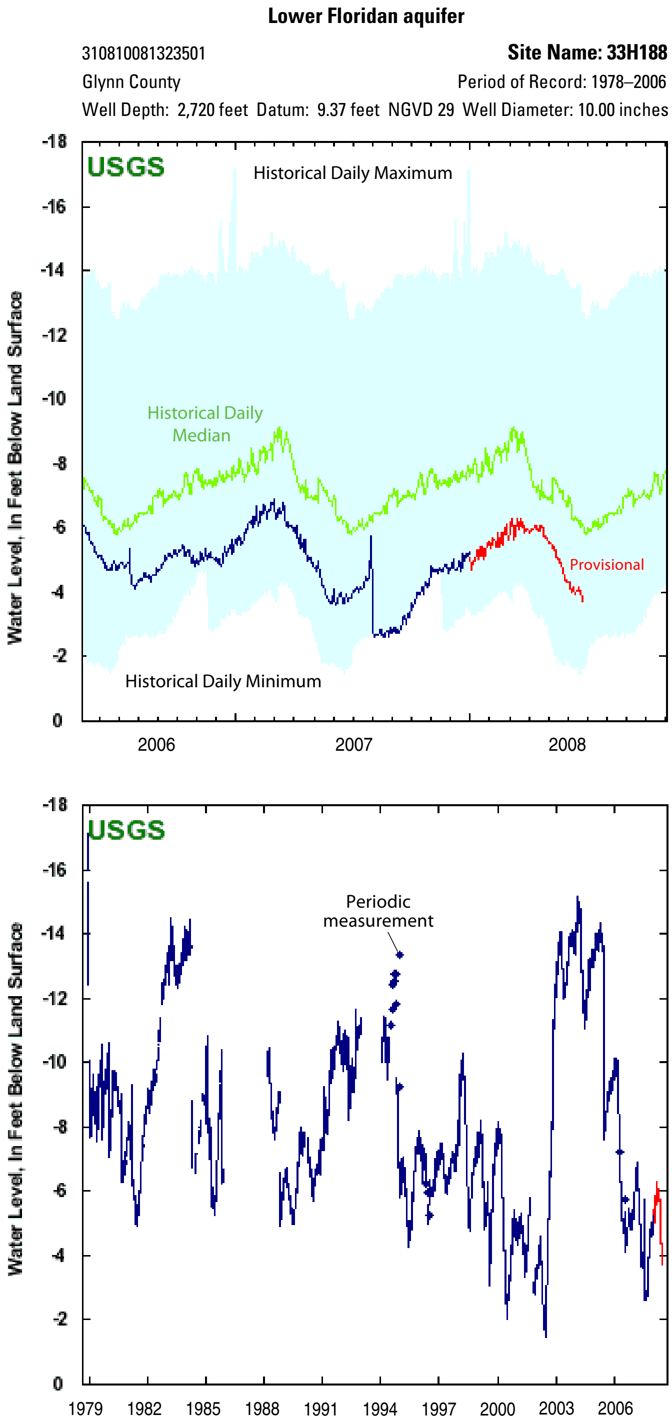


Figure 27. Periodic and daily mean water levels in well 33H188, Lower Floridan aquifer, Glynn County, Georgia, 1978–2007

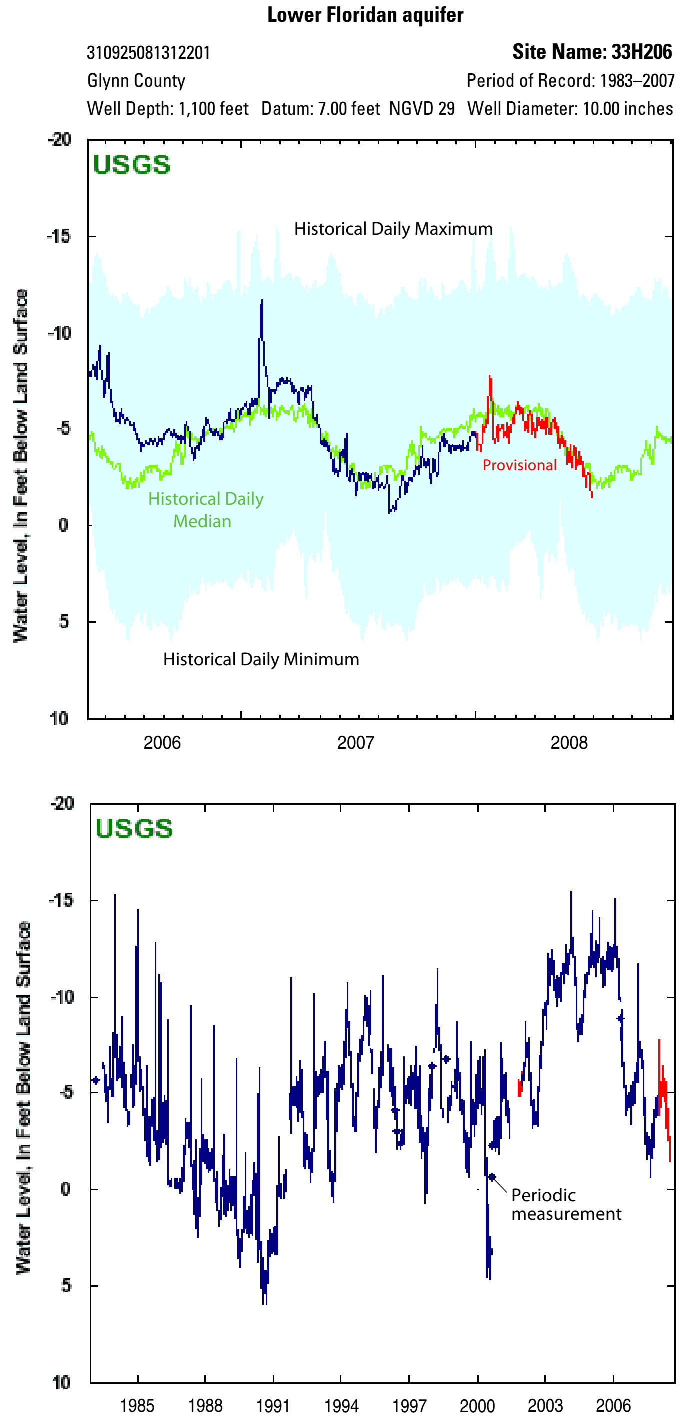


Figure 28. Periodic and daily mean water levels in well 33H206, Lower Floridan aquifer, Glynn County, Georgia, 1983–2007.

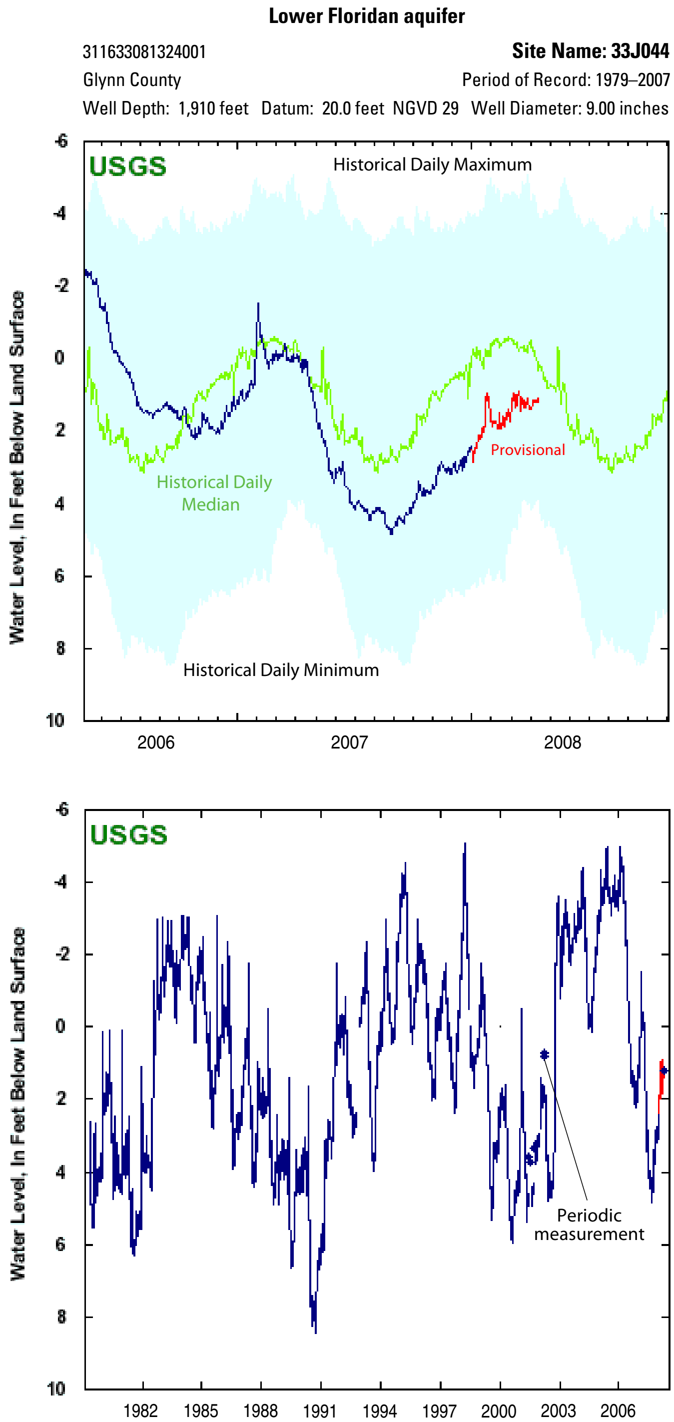


Figure 29. Periodic and daily mean water levels in well 33J044, Lower Floridan aquifer, Glynn County, Georgia, 1979–2007.

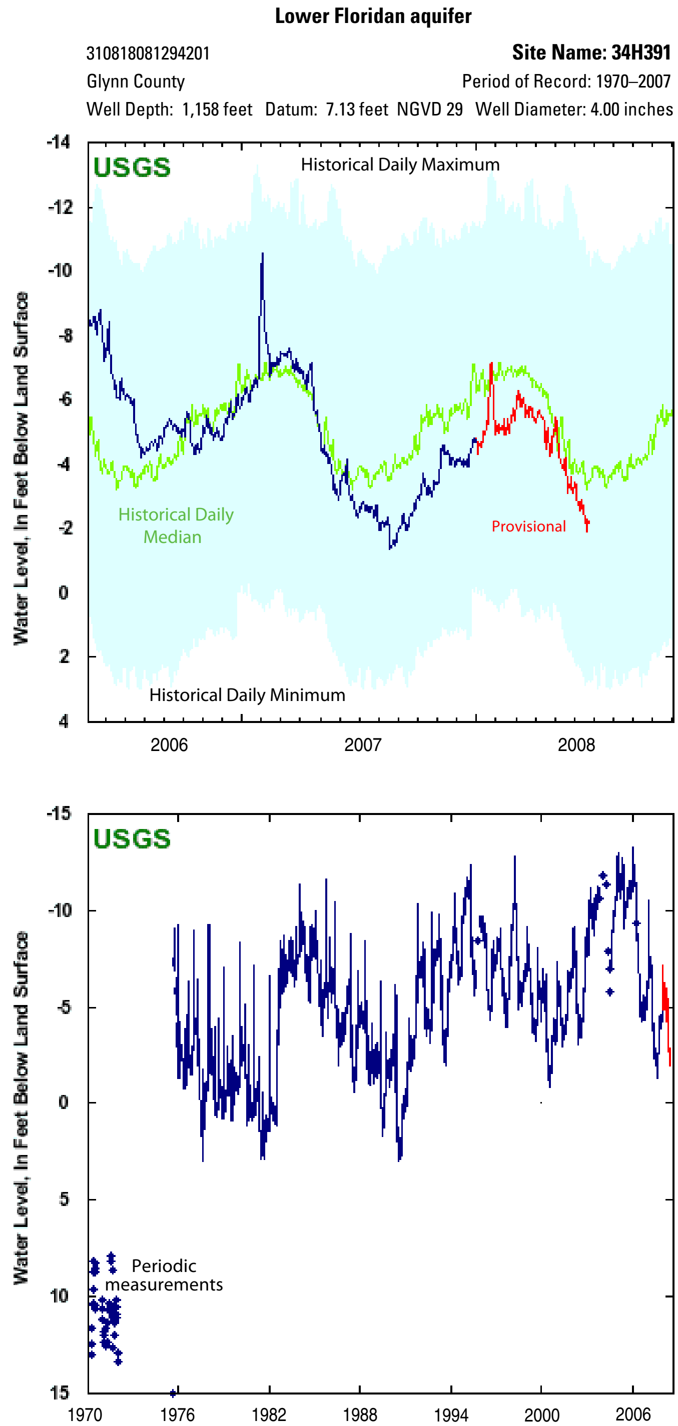


Figure 30. Periodic and daily mean water levels in well 34H391, Lower Floridan aquifer, Glynn County, Georgia, 1970–2007.

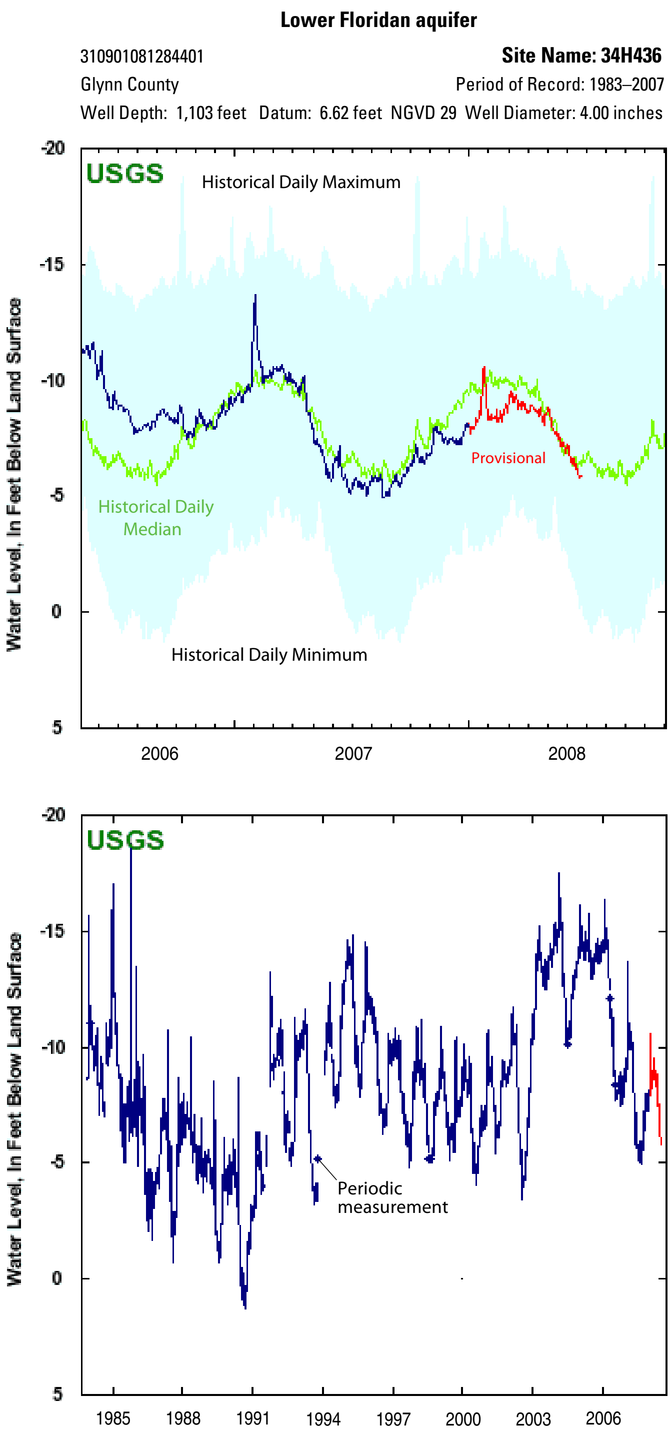


Figure 31. Periodic and daily mean water levels in well 34H436, Lower Floridan aquifer, Glynn County, Georgia, 1983–2007.

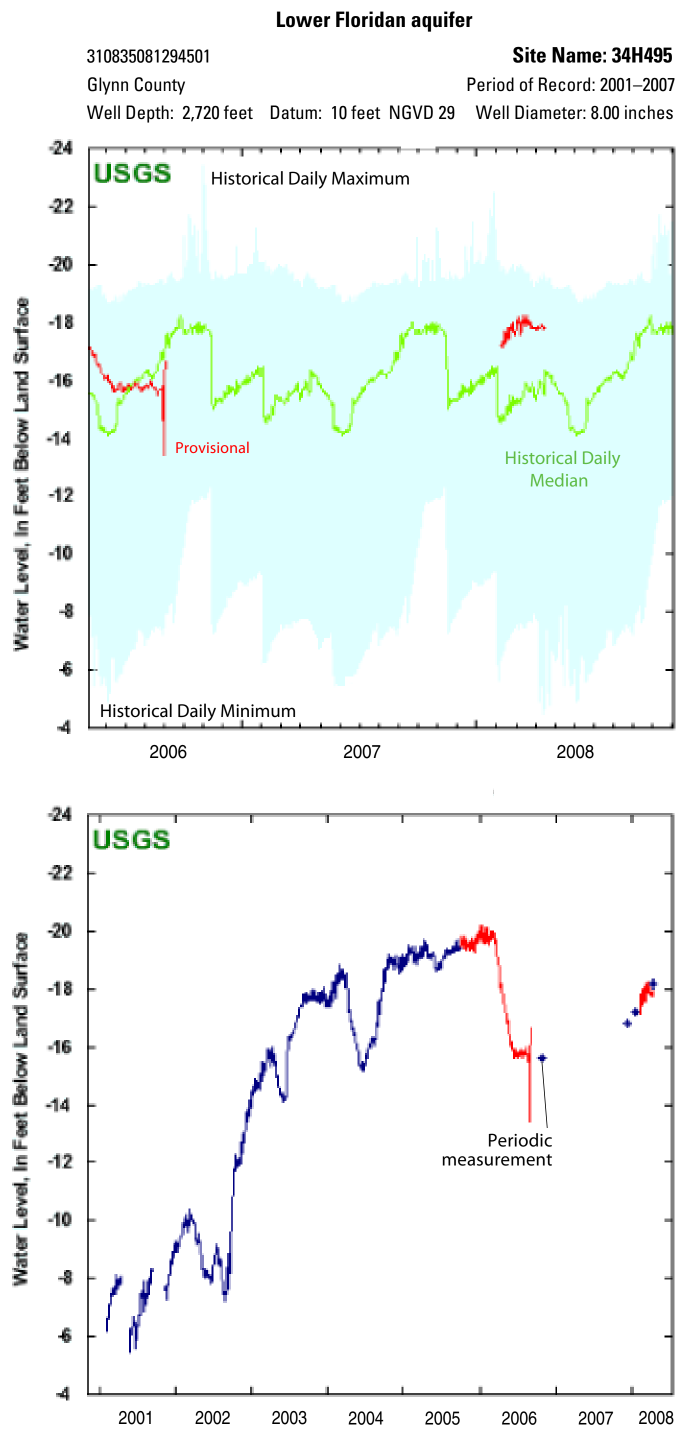


Figure 32. Periodic and daily mean water levels in well 34H495, Lower Floridan aquifer, Glynn County, Georgia, 2001–2007.

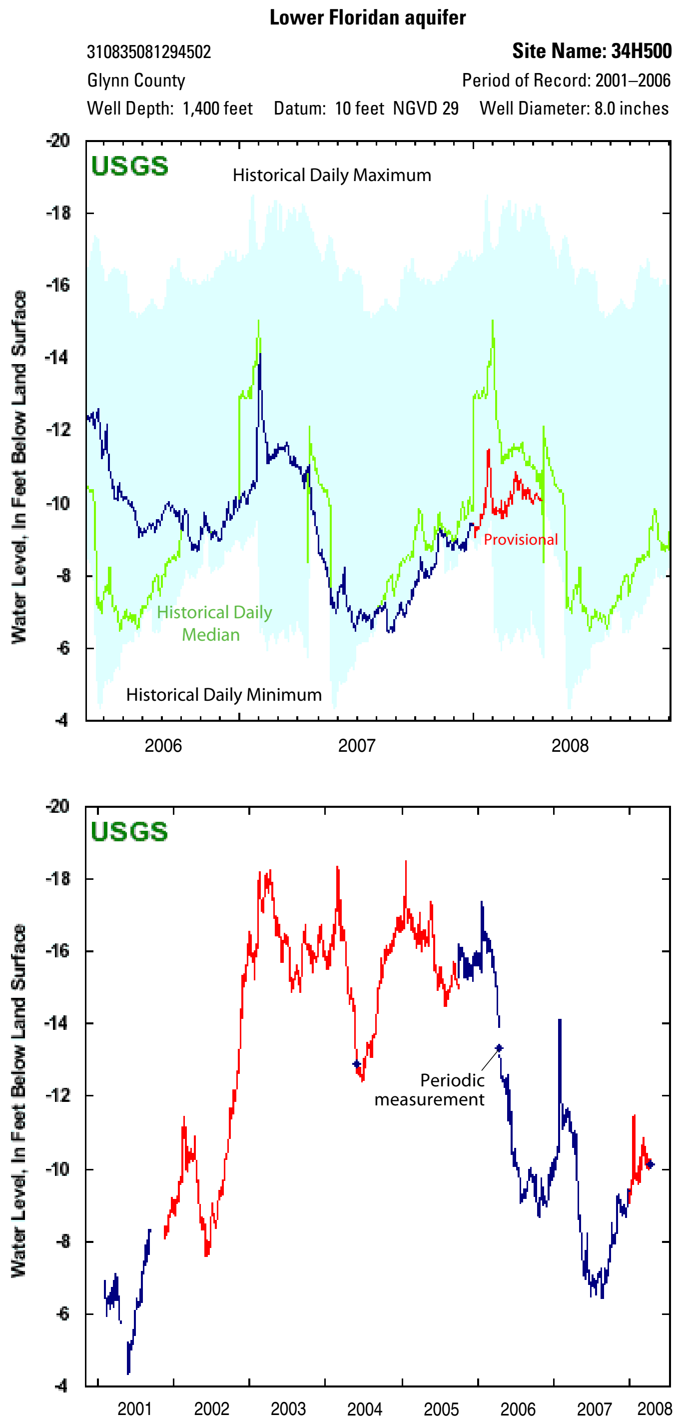


Figure 33. Periodic and daily mean water levels in well 34H500, Lower Floridan aquifer, Glynn County, Georgia, 2001–2007.

Chloride Concentrations

Chloride concentrations have been monitored in the Brunswick area since the late 1950s when saltwater was first detected in wells completed in the Upper Floridan aquifer in the southernmost part of Brunswick (Wait, 1965). Saltwater has migrated upward from deep saline zones through breaches in confining units as a result of reduced pressure in water-bearing zones of the Upper Floridan aquifer. By the 1960s, chloride-contaminated ground water had migrated northward toward two major industrial pumping centers. Currently (2008), the USGS collects and analyzes samples from a network of wells on an annual basis for the CWP (fig. 34; table 2).

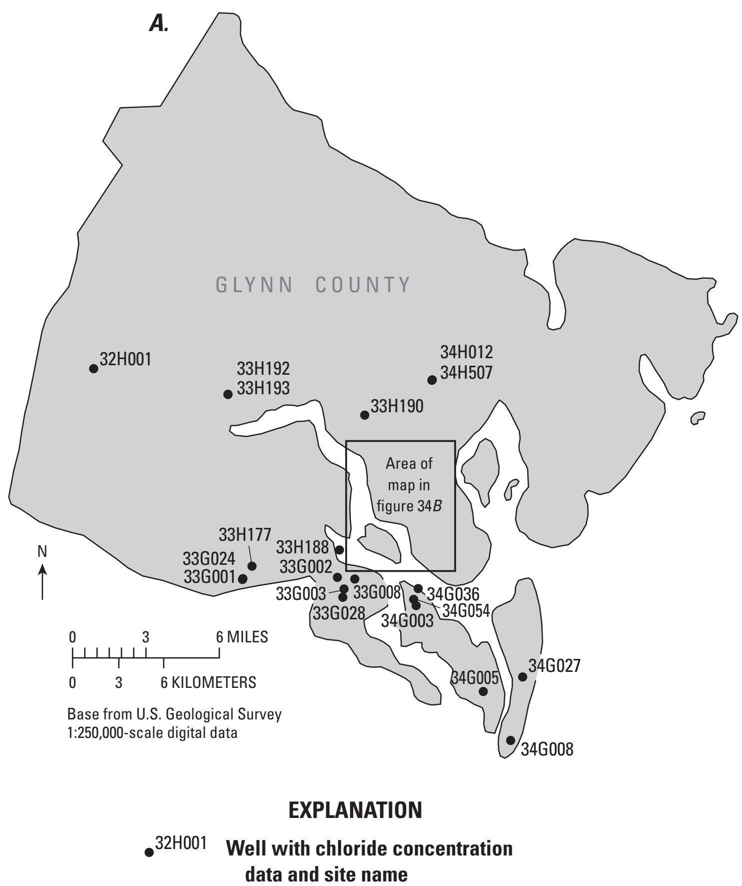
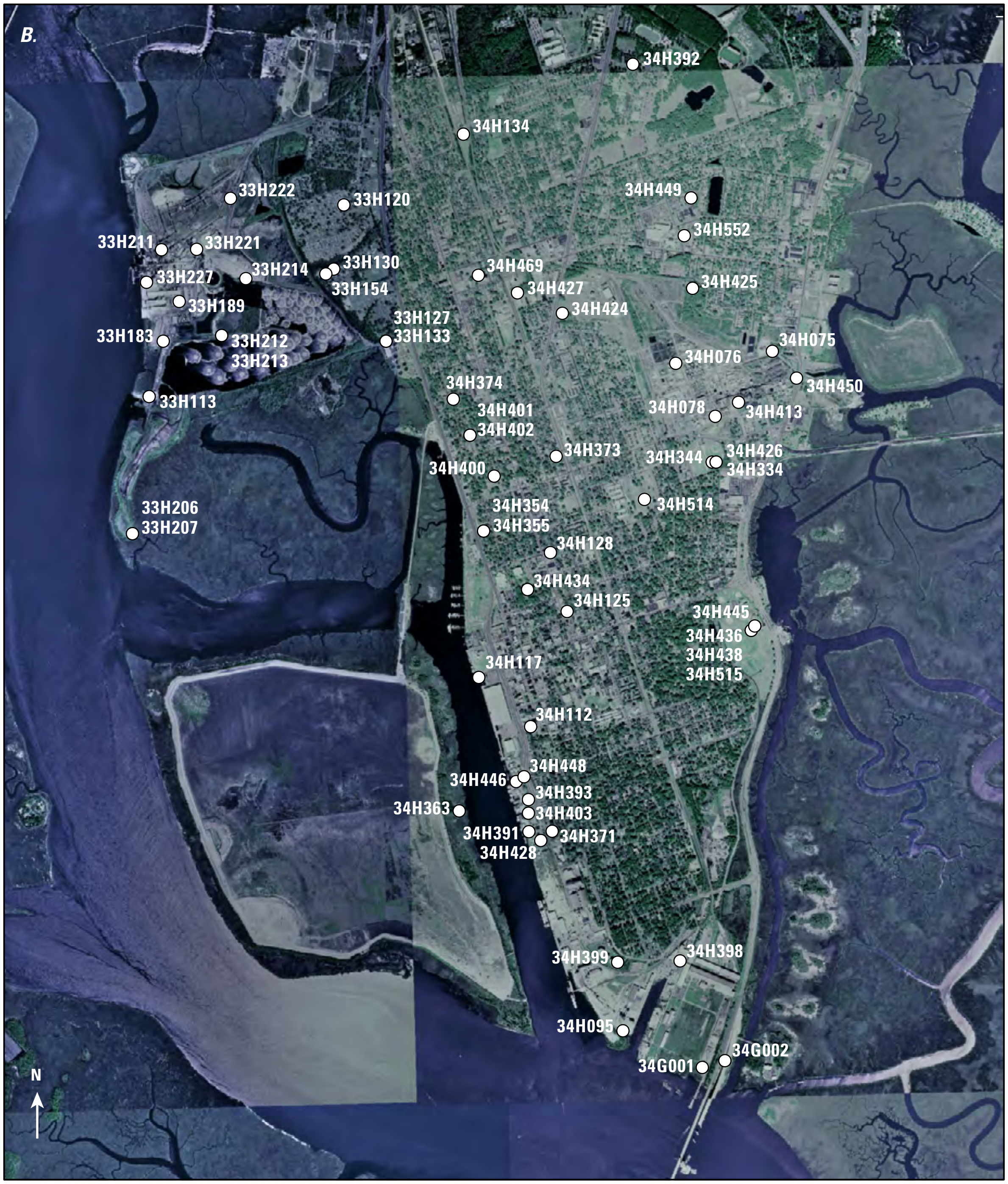


Figure 34. Chloride-monitoring network for the Brunswick–Glynn County area, Georgia: *(A)* location and *(B)* enlarged area.



Base from U.S. Geological Survey
1:100,000 scale digital orthophotos for Glynn County

0 0.25 0.5 MILE
0 0.25 0.5 KILOMETER

EXPLANATION

○ 34G002 **Well with chloride concentration data and site name**

Figure 34. Chloride-monitoring network for the Brunswick–Glynn County area, Georgia: *(A)* location and *(B)* enlarged area.—Continued

Table 2. Chloride and sulfate concentrations in water samples collected from wells in the Brunswick–Glynn County area, Georgia, June 2003–2005, and July 2006 and July and August 2007 (chloride only).

[Well locations shown in figures 34*A* and 34*B*; aquifer or system: S–surficial, BAS–Brunswick aquifer system, LBA–lower Brunswick aquifer, UFA–Upper Floridan aquifer, FAS–Floridan aquifer system, LFA, Lower Floridan aquifer; —, no data]

Well identification	Aquifer or system	June 2003		June 2004		June 2005		July 2006	July and August 2007	
		Chloride	Sulfate	Chloride	Sulfate	Chloride	Sulfate	Chloride	Chloride	Change from July 2006
		Milligrams per liter								
34H428	S	13.9	81.8	12.8	77.8	11.3	82.7	14.0	13.3	–0.7
34H438	S	2,870	285	2,540	304	—	—	—	—	—
34H448	S	20.7	85.5	18.3	87.1	15.3	87.4	19.0	—	—
*34H515	S	—	—	—	—	5,370	665	5,130	5,250	120
33G028	BAS	—	—	14.0	0.5	12.4	2.1	15.2	14.8	–0.4
34H446	LBA	285	189	285	170	297	208	290	—	—
33G002	UFA	—	—	70.5	130	72.8	137	76.8	73.4	–3.4
33G008	UFA	—	—	24.1	97	23.7	98.0	29.8	30.0	0.2
33G024	UFA	18.6	90	16.8	96	14.7	95.2	18.8	17.7	–1.1
34G002	UFA	37.1	100	79.1	124	77.3	128	78.0	72.1	–5.9
34G003	UFA	136	150	150	154	153	176	—	150	—
34G005	UFA	—	—	—	—	22.9	97.9	27.4	26.4	–1.0
34G008	UFA	—	—	—	—	—	—	170	—	—
34G027	UFA	—	—	—	—	—	—	—	27.6	—
34G054	UFA	—	—	—	—	—	—	45.7	44.5	–1.2
32H001	UFA	30.2	83.2	25.3	80.3	24.8	80.3	—	27.9	—
33H113	UFA	—	—	381	197	—	—	—	—	—
33H120	UFA	23.0	89.3	19.3	89.1	17.5	85.3	23.0	22.5	–0.5
33H130	UFA	3,010	851	2,460	730	2,690	780	2,620	2,540	–80
33H133	UFA	2,050	631	1,950	629	2,160	670	2,230	2,180	–50
33H177	UFA	28.7	121	24.2	122	22.4	126	27.0	25.0	–2.0
33H183	UFA	25.4	104	23.7	106	31.1	110	30.0	—	—
33H190	UFA	25.2	84.6	20.8	83.8	19.1	80.8	23.9	22.5	–1.4
33H193	UFA	—	—	—	—	—	—	19.5	18.0	–1.5
33H207	UFA	21.0	85.9	15.5	100	15.9	82.7	17.3	23.2	5.9
33H211	UFA	15.6	83.6	14.2	84.1	16.1	80.4	82.2	21.3	–61
33H213	UFA	58.1	125	48.4	120	35.0	112	45.4	49.1	3.7
33H221	UFA	1,180	411	1,130	430	834	375	800	—	—
33H222	UFA	595	249	303	162	626	277	—	—	—
33H227	UFA	35.8	108	125	125	247	173	300	—	—
34H012	UFA	—	—	26	98	—	—	—	—	—
34H095	UFA	—	—	26	90	27.1	81.2	32.2	30.8	–1.4

Table 2. Chloride and sulfate concentrations in water samples collected from wells in the Brunswick–Glynn County area, Georgia, June 2003–2005, and July 2006 and July and August 2007 (chloride only).—Continued

[Well locations shown in figures 34*A* and 34*B*; aquifer or system: S–surficial, BAS–Brunswick aquifer system, LBA–lower Brunswick aquifer, UFA–Upper Floridan aquifer, FAS–Floridan aquifer system, LFA, Lower Floridan aquifer; —, no data]

Well identification	Aquifer or system	June 2003		June 2004		June 2005		July 2006	July and August 2007	
		Chloride	Sulfate	Chloride	Sulfate	Chloride	Sulfate	Chloride	Chloride	Change from July 2006
		Milligrams per liter								
34H112	UFA	1,660	472	1,580	501	1,620	464	1,590	1,450	–140
34H117	UFA	527	206	497	175	499	222	531	551	20
34H125	UFA	605	280	496	188	479	256	431	360	–71
34H128	UFA	727	341	682	349	706	349	710	—	—
34H334	UFA	1,120	269	1,080	288	1,070	347	1,480	1,090	–390
34H344	UFA	26.9	86.5	25.7	86.1	18.6	84.8	72.2	30.0	–42
34H355	UFA	237	129	313	147	321	168	334	326	–8
34H363	UFA	—	—	—	—	—	—	73.8	80.9	7.1
34H371	UFA	17.0	91.8	14.5	91.8	12.7	90.0	15.0	15.2	0
34H373	UFA	381	217	402	185	387	239	369	353	–16
34H374	UFA	959	339	985	382	1,040	387	1,080	981	–99
34H392	UFA	—	—	—	—	—	—	19.8	18.7	–1.1
34H393	UFA	2,130	585	1,820	536	1,980	518	1,940	1,870	–70
34H400	UFA	425	190	412	170	422	210	438	433	–5
34H401	UFA	2,200	703	1,790	609	2,280	750	1,900	1,800	–100
34H413	UFA	623	254	587	256	471	244	—	—	—
34H424	UFA	—	—	—	—	—	—	2,330	2,180	–150
34H425	UFA	—	—	—	—	—	—	263	269	6
34H427	UFA	1,470	497	1,520	520	1,520	465	1,500	1,390	–110
34H434	UFA	2,040	679	1,740	616	1,840	583	1,820	1,620	–200
34H445	UFA	17.6	87.8	16.4	87.7	15.9	85.9	19.4	18.4	–1.0
34H449	UFA	31.0	94.7	24.9	95.3	24.0	94.7	28.9	27.5	–1.4
34H450	UFA	21.7	85.6	17.9	84.5	15.3	81.9	17.4	16.6	–0.8
34H469	UFA	1,350	174	1,140	450	—	117	1,020	894	–126
34H507	UFA	—	—	—	—	24.9	96.9	30.0	—	—
34H552	UFA	—	—	—	—	—	—	—	31.3	—
33G003	FAS	—	—	68.1	0.9	27.4	99.0	35.6	39.5	3.9
34G001	FAS	—	—	—	—	—	—	74.0	—	—
33H127	FAS	879	346	907	389	906	353	974	863	–111
33H154	FAS	1,970	541	2,060	590	2,210	571	2,310	2,210	–100
33H189	FAS	—	—	—	—	—	—	410	—	—
33H212	FAS	1,210	540	1,130	516	1,160	488	1,180	1,100	–80

Table 2. Chloride and sulfate concentrations in water samples collected from wells in the Brunswick–Glynn County area, Georgia, June 2003–2005, and July 2006 and July and August 2007 (chloride only).—Continued

[Well locations shown in figures 34*A* and 34*B*; aquifer or system: S–surficial, BAS–Brunswick aquifer system, LBA–lower Brunswick aquifer, UFA–Upper Floridan aquifer, FAS–Floridan aquifer system, LFA, Lower Floridan aquifer; —, no data]

Well identification	Aquifer or system	June 2003		June 2004		June 2005		July 2006	July and August 2007	
		Chloride	Sulfate	Chloride	Sulfate	Chloride	Sulfate	Chloride	Chloride	Change from July 2006
		Milligrams per liter								
33H214	FAS	—	—	—	—	—	—	—	124	—
34H075	FAS	29.0	92.1	42.8	93.9	51.3	97.9	170	—	—
34H076	FAS	—	—	—	—	—	—	1,030	974	–56
34H078	FAS	222	125	334	154	—	—	—	—	—
34H134	FAS	46.7	88.0	38.9	86.7	45.3	86.9	52.8	34.8	–18
34H354	FAS	1,360	502	1,360	513	1,330	460	1,440	1,440	0
34H398	FAS	126	169	135	163	140	197	140	137	–3
34H402	FAS	2,740	851	2,020	669	2,210	702	2,280	2,350	70
34H403	FAS	1,310	244	1,240	395	1,420	399	1,380	1,380	0
33G001	LFA	34.9	119	32.7	125	33.2	137	36.2	34.0	–2.2
34G036	LFA	305	89.1	438	199	453	323	476	479	3.0
33H188	LFA	—	—	8,170	2,920	10,285	3,120	9,830	9,910	80
33H192	LFA	—	—	—	—	—	—	784	744	–40
33H206	LFA	357	253	404	197	416	257	411	389	–22
34H391	LFA	3,030	717	2,340	621	2,470	608	2,540	2,740	200
34H399	LFA	6,590	1,290	5,910	1,410	6,440	1,450	6,710	6,940	230
34H426	LFA	—	—	854	315	881	327	790	542	–248
34H436	LFA	22.9	103	20.2	105	18.9	104	22.1	20.8	–1.3

*Replaces 34H438

Upper Floridan Aquifer

The area of chloride contamination in the Upper Floridan aquifer at Brunswick during July and August 2007 was mapped based on samples from 25 wells (fig. 35). During this period, the chloride concentration was greater than the 250-mg/L State and Federal secondary drinking-water standard (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000) in an approximate 2-mi² area, and exceeded 2,250 mg/L in part of the area. Yearly fluctuations of chloride concentration indicate increases as much as 20 mg/L and decreases as much as 390 mg/L from 2006 to 2007 (fig. 36; table 2). The July and August 2007 map (fig. 35) is similar to previously published maps for 2004 and 2005 (Leeth and others, 2007) and shows that areas of highest concentration are near the two industrial pumping centers in the northern part of the city, as well as the original area of contamination in the southern part of the city.

Graphs of chloride concentrations in water samples from wells with open intervals in the upper and lower water-bearing zones of the Upper Floridan aquifer are shown for the southern Brunswick area (wells 34H393 and 34H403, fig. 37) and northern Brunswick area (wells 33H133 and 33H127, fig. 38). Chloride concentration in water from the Lower Floridan aquifer is shown for well 34H391 in the southern Brunswick area (fig. 37). More information about the Brunswick area monitoring can be accessed at *http://ga.water.usgs.gov/projects/brunswick/*.

During July and August 2007, chloride concentrations in the Brunswick area were generally lower than during 2006, with decreases as much as 200 mg/L in the southern part of the area (fig. 36). Chloride concentrations in the southern Brunswick area have continued to decrease since the 1990s (fig. 37). In the northern Brunswick area, chloride concentrations slightly decreased during 2006–2007, following a general increase since the 1960s (fig. 38; table 2).

Outside the plume area, chloride concentrations are less than the 250-mg/L drinking-water standard (fig. 35; table 2). However, local areas have chloride concentrations greater than 50 mg/L, which is considered to be greater than background levels. This includes concentrations in wells 34G002, 34G003, and 34H398 (fig. 35; table 2). The reason for elevated chloride concentrations in these wells remains unclear, but elevated concentrations could be related to failed or improper well-casing seals (Hall and Peck, 2005). During 2006, borehole geophysical and television-camera data were collected from well 34G003 to assess well construction (Cherry, 2007). Results of this effort were inconclusive. No flaws were apparent in the well construction, so the source of the saltwater contamination remains unclear.

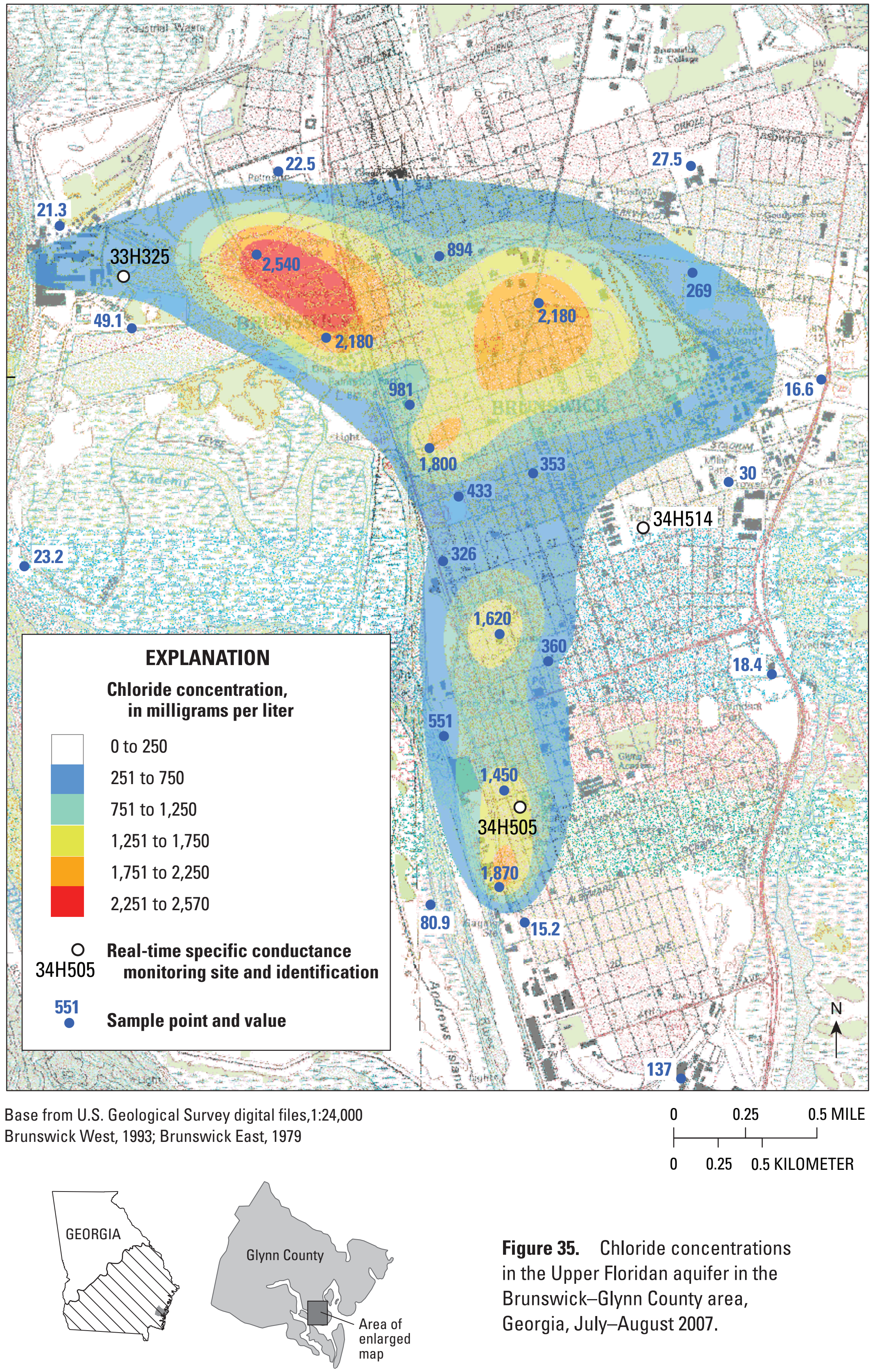
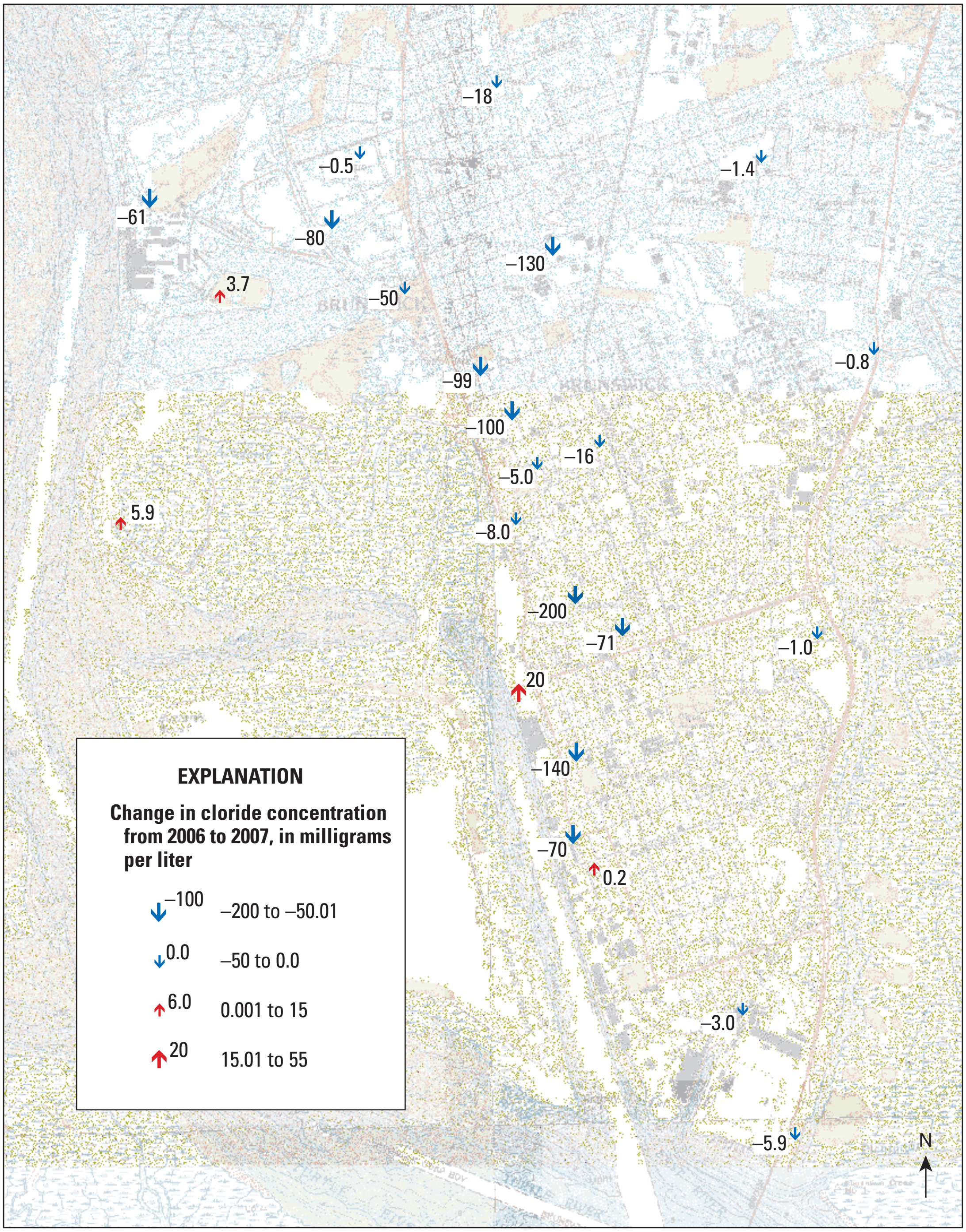


Figure 35. Chloride concentrations in the Upper Floridan aquifer in the Brunswick–Glynn County area, Georgia, July–August 2007.



Base from U.S. Geological Survey digital files,1:24,000
Brunswick West, 1993; Brunswick East, 1979

0 0.25 0.5 MILE
0 0.25 0.5 KILOMETER

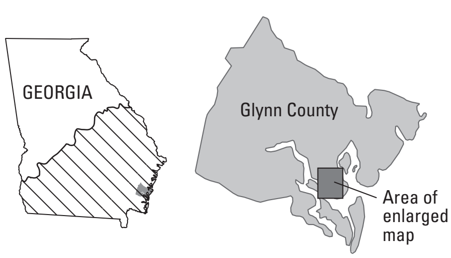


Figure 36. Change in chloride concentration in the Upper Floridan aquifer in the Brunswick–Glynn County area, Georgia, from 2006 to 2007.

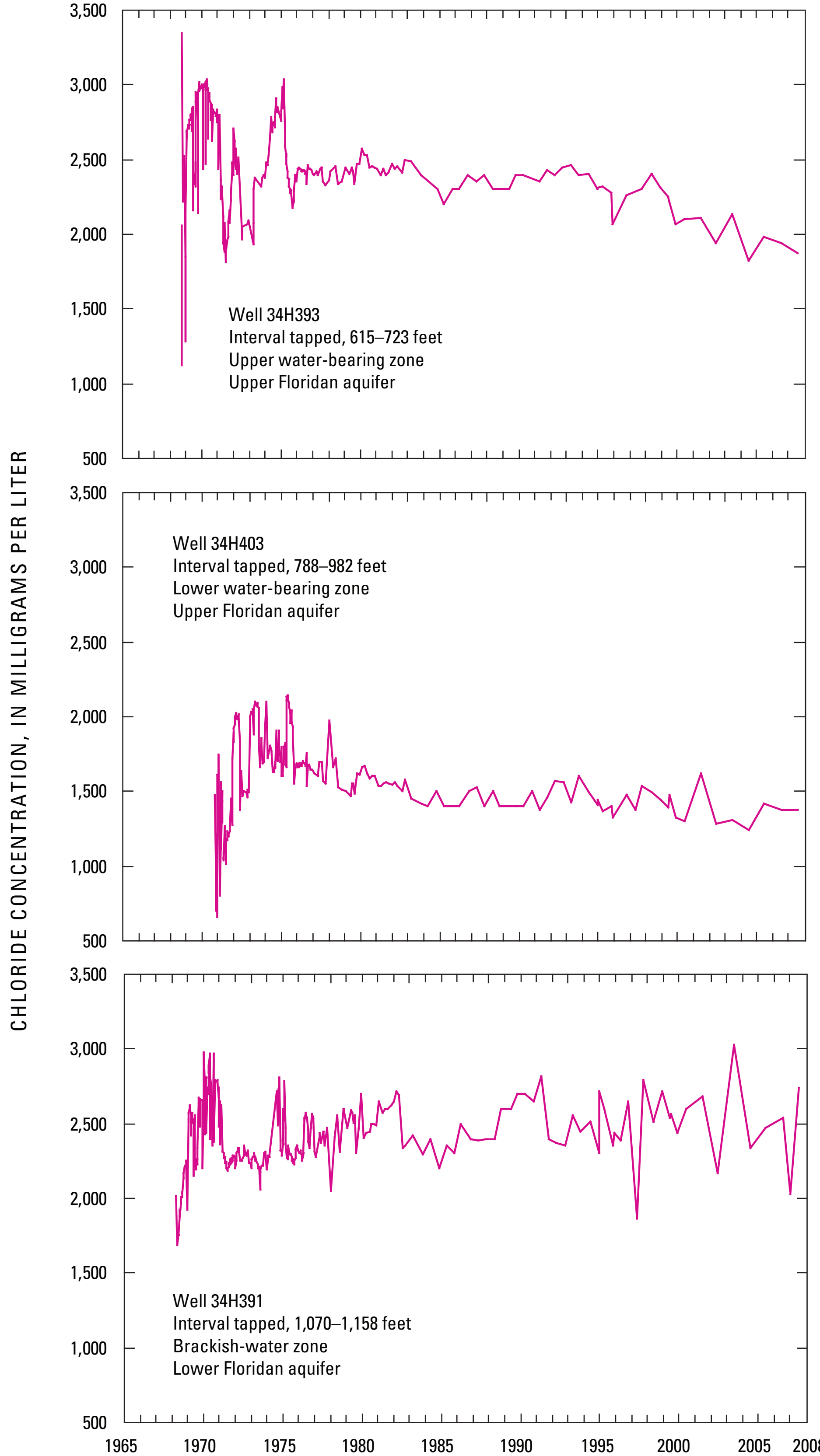


Figure 37. Chloride concentration in water for selected wells in the southern Brunswick area, Georgia, 1968–2007 (see figure 34*B* for well location).

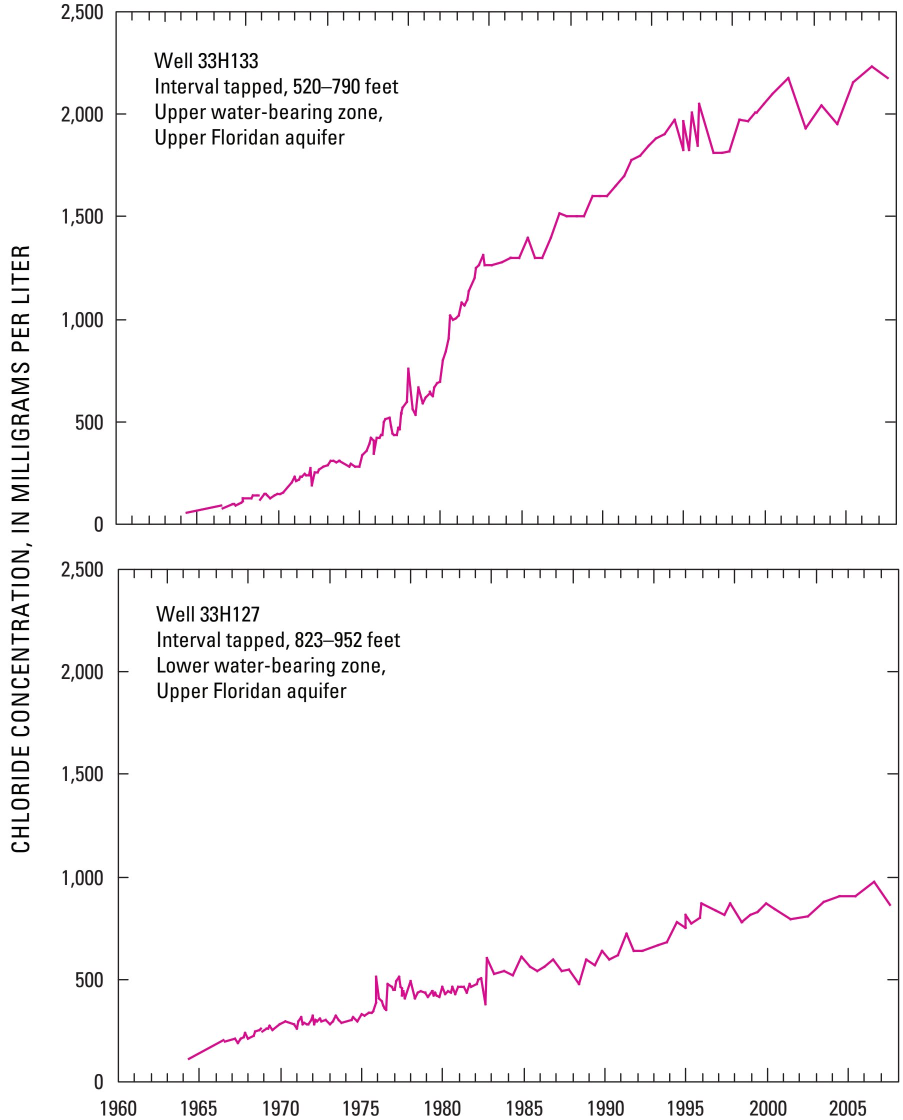


Figure 38. Chloride concentration in water for selected wells in the northern Brunswick area, Georgia, 1968–2007 (see figure 34*B* for well location).

Surficial and Brunswick Aquifer Systems

Historically, water-quality data-collection efforts in the Glynn County area have focused on the Floridan aquifer system. However, Clarke and others (1990) recognized that locally water-quality problems do exist in the surficial and Brunswick aquifer systems. These problems typically can be associated with (1) saltwater encroachment in shallow wells near the coast, tidal rivers, and estuaries; (2) upward leakage of water from underlying aquifers through semiconfining units or fractures as a result of natural or pumping-induced head gradients; or (3) failed well casing. Localized saltwater contamination has been recognized in a number of areas along the coast, including Vernonburg, Ga., in Chatham County (Hall and Peck, 2005) and Sea Island, Ga., in Glynn County (Julie Vann, Georgia Environmental Protection Division, written commun., July 2005).

During 2007, water samples were collected and analyzed for chloride concentration from two wells completed in the surficial aquifer system and two wells completed in the Brunswick aquifer system (table 2). Well 34H515 was drilled during 2005 as a replacement well for well 34H438, which had shown a large increase in chloride concentration (fig. 39). The new well produced similar chloride levels verifying the increase indicated by the earlier well. The reason for the increase is unknown—no known supply wells are completed in the surficial aquifer in the area, nor have there been any changes in land-use practices in the immediate area. The monitoring of chloride concentrations in this well is ongoing.

Real-Time Monitoring of Specific Conductance and Water Levels

To ensure that the area of chloride contamination in the Brunswick area is contained, a network of real-time monitoring wells completed in the upper and lower water-bearing zones of the Upper Floridan aquifer is being established around the plume (fig. 35). This network includes the Perry Park site (well 34H514) funded by the CWP, and the Southside Baptist Church (wells 34H504 and 34H505) and Georgia-Pacific Cellulose (wells 33H324 and 33H325) sites, funded by GaEPD as part of the CSSI. During 2007, each of the five sites was equipped with real-time water-level recorders, and the Perry Park site (well 34H514) was also equipped with real-time specific conductance monitoring. The Southside Baptist Church site (well 34H505) and Georgia-Pacific Cellulose site (33H325) were instrumented for real-time specific conductance monitors during 2008 (fig. 35).

The Perry Park well (34H514) is immediately outside the plume area, with chloride concentrations that fluctuate in response to pumping changes. This unused City of Brunswick production well was incorporated into the CWP monitoring network during 2007 and is equipped with satellite telemetry for real-time monitoring of water levels and specific conductance (fig. 40). The specific conductance at this site has fluctuated from 478 to 1,370 microsiemens per centimeter, but it is unclear how these changes in specific conductance are related to water-level changes. The real-time data are available on the USGS Web site and can be accessed at: *http://waterdata.usgs.gov/ga/nwis/current/?type=gw*.

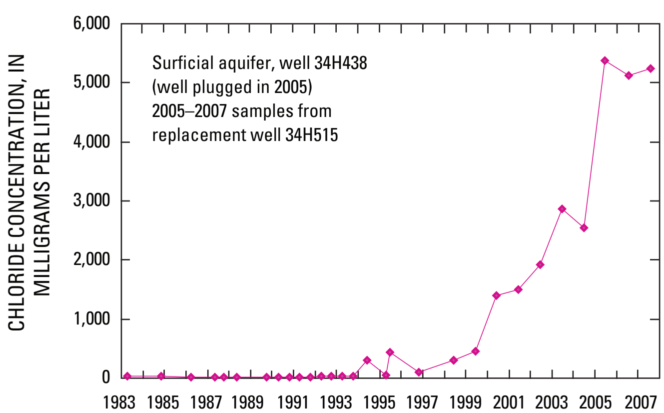


Figure 39. Chloride concentration in wells 34H438 and 34H515, surficial aquifer system, in the Brunswick–Glynn County area, Georgia, 1983–2007 (see figure 34*B* for well location).

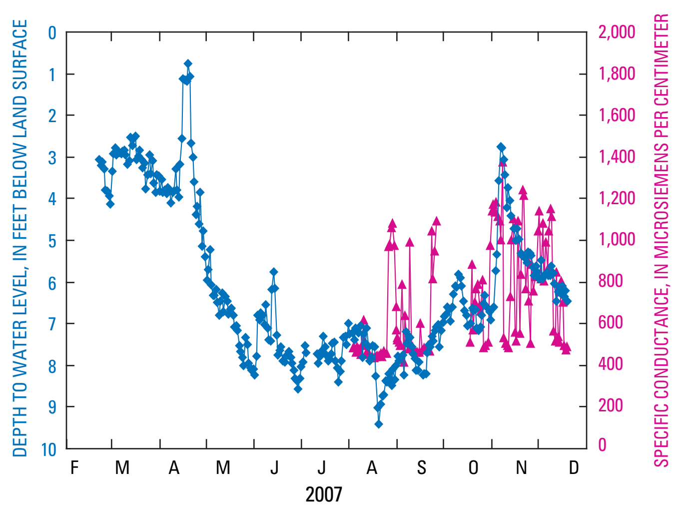


Figure 40. Daily mean ground-water levels and periodic specific conductance in the Upper Floridan aquifer at well 34H514, Perry Park, Brunswick–Glynn County, Georgia, 2007.

Ground-Water Studies

The CWP provides for the ongoing collection of hydrologic data to support a better understanding of the occurrence and controls on saltwater contamination in the and for the evaluation of alternative water sources. In past years, this has included collecting borehole geophysical logs to characterize physical and chemical properties of hydrogeologic units, conducting field inventories of existing wells to obtain ground-water level and water-quality data, and to improve data coverage in the area.

During 2007, the principal focus of ground-water studies for the CWP was the refinement of an existing ground-water flow model to enable better-detailed simulations in the vicinity of the chloride plume. The model has been designed to evaluate changes in hydraulic gradients near the chloride plume resulting from changes in pumpage (Cherry and Payne, 2007). Currently (2008), the lateral extent of chloride contamination is contained because large ground-water withdrawals create a depression in the potentiometric surface of the Upper Floridan aquifer and ground-water flows inward from surrounding areas along a hydraulic gradient. If this gradient were reversed due to large-scale pumping outside of the plume area, chloride contaminated ground water could flow outward in the opposite direction and contaminate freshwater areas.

The model used in this study—described in detail in Payne and others (2005)—uses MODFLOW-2000 (Harbaugh and others, 2000), which is a finite-difference, constant-density flow simulator. The model boundaries extend throughout the coastal Georgia area and into adjacent parts of Florida and South Carolina and encompass an area approximately 42,155 mi^2 (fig. 41). The original MODFLOW model is horizontally discretized using a variably spaced grid, with cell sizes ranging from approximately 4,000 x 5,000 ft at Savannah and Brunswick, Georgia, to 16,500 x 16,500 ft near the lateral boundaries (Payne and others, 2005). Grid density is higher at Savannah and Brunswick to enable simulation of steeper head gradients near areas of concentrated pumping. Each unit is represented with one layer of grid cells in the vertical dimension. To enable an even more refined simulation of hydraulic gradients near the Brunswick chloride plume, the grid size for the refined model is reduced to 500 x 500 ft.

The original model (Payne and others, 2005) is comprised of seven aquifers and confining units. These include, in descending order:

- the confined upper and lower water-bearing zones of the surficial aquifer system, grouped together (unit 1);
- the Brunswick aquifer system confining unit (unit 2);
- the upper and lower Brunswick aquifers, grouped as the Brunswick aquifer system (unit 3);
- the Upper Floridan aquifer confining unit (unit 4);
- the Upper Floridan aquifer (unit 5);
- the Lower Floridan aquifer confining unit (unit 6); and
- the Lower Floridan aquifer (unit 7).

The refined model incorporates additional model layers to provide for local variations in hydraulic properties at Brunswick, Georgia (fig. 42). This includes subdividing the Brunswick aquifer system (unit 3) into separate units for the upper and lower Brunswick aquifers, and subdividing the Upper Floridan aquifer (unit 4) into upper and lower water-bearing zones as defined by Wait and Gregg (1974). Each new layer is separated from adjacent aquifers by a semi-confining unit. These changes were made in order to more accurately simulate the horizontal and vertical hydraulic gradients that have been documented for these units in the Brunswick–Glynn County area.

The original model (Payne and others, 2005) simulated steady-state conditions during predevelopment, 1980, and 2000. The refined model is being updated to include simulated conditions during 2004.

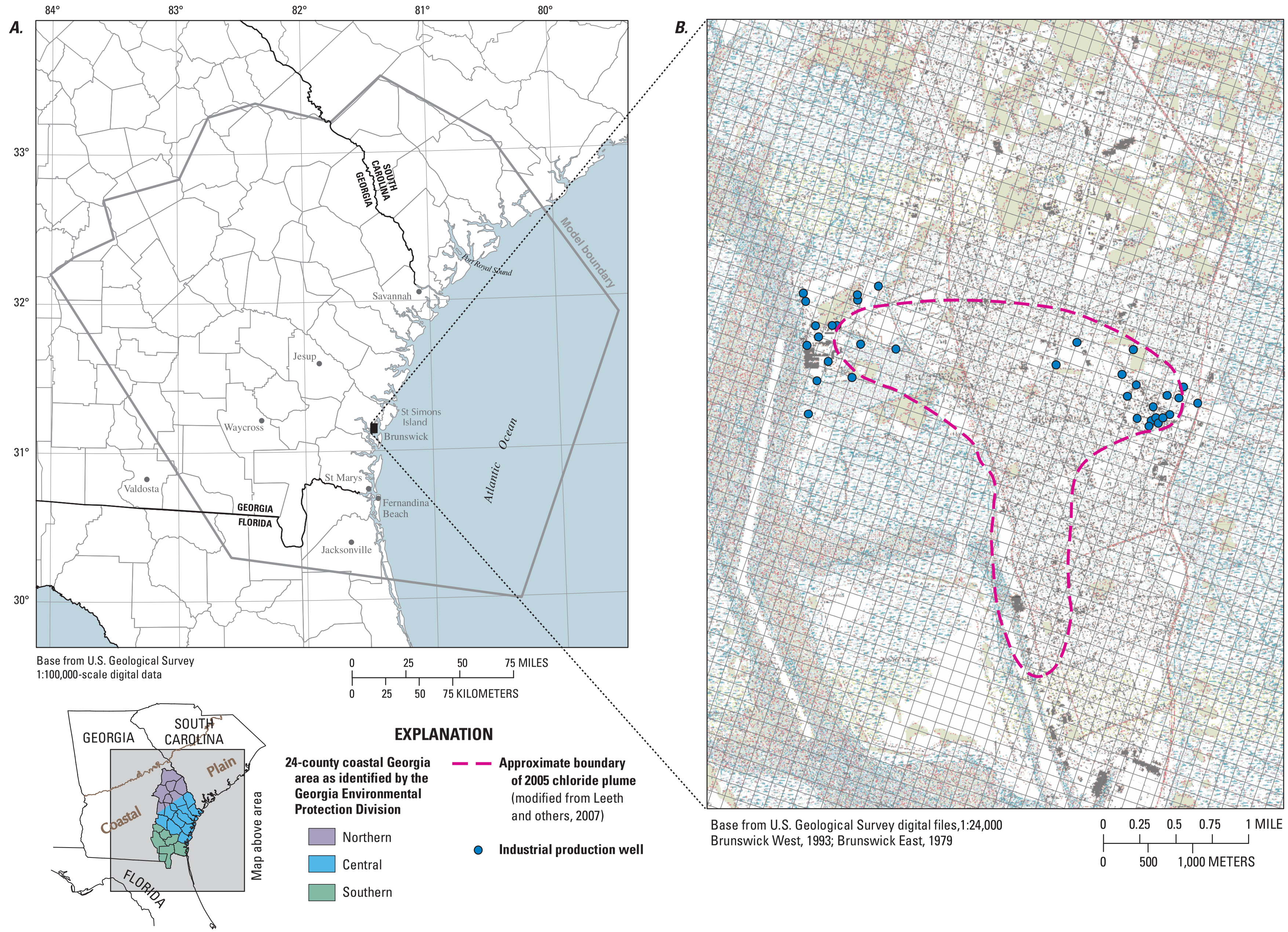
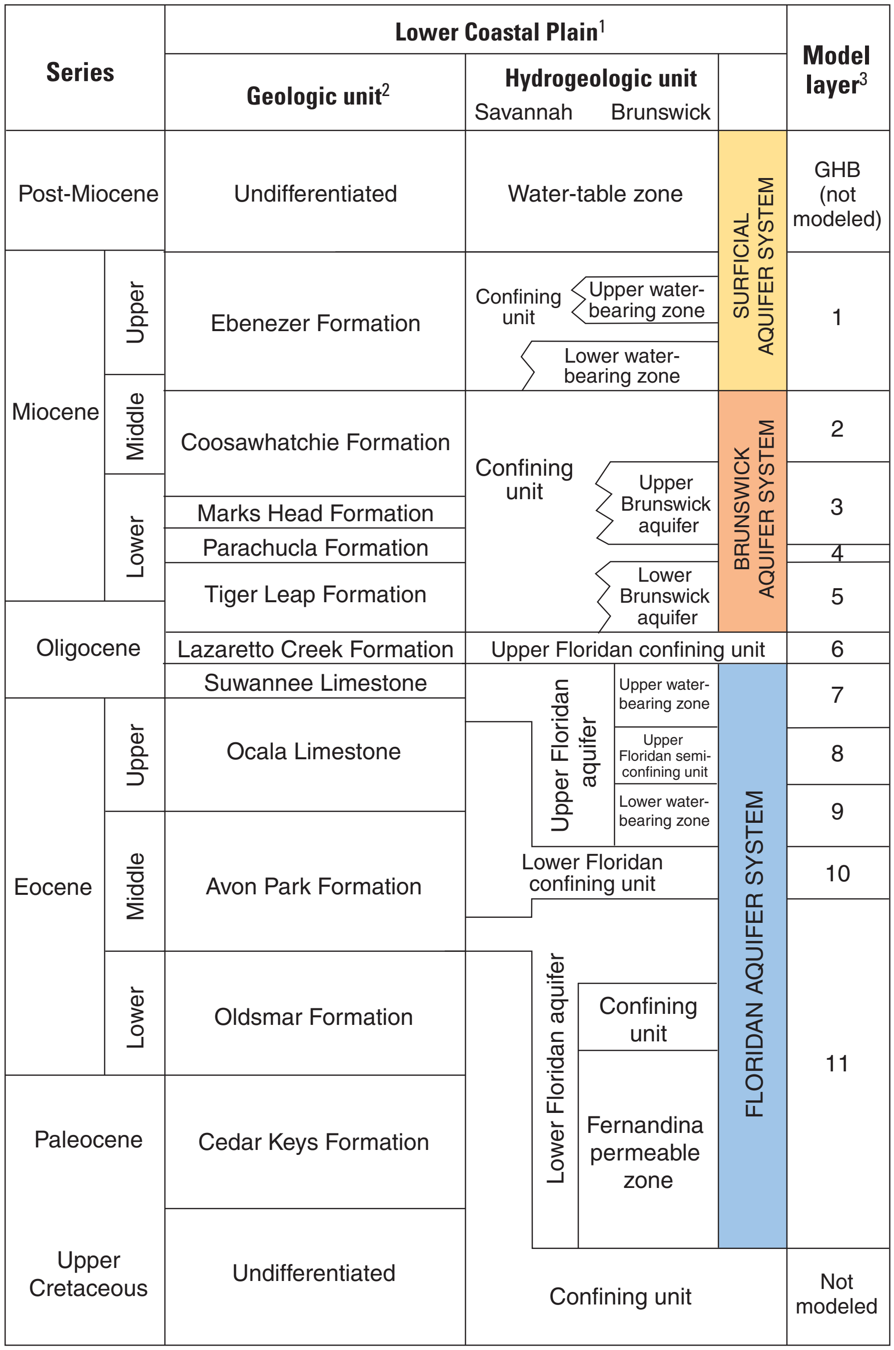


Figure 41. *(A)* Location of 24-county coastal Georgia area and model extent, and *(B)* model grid, major industrial production wells, and extent of chloride plume in the Upper Floridan aquifer, Brunswick–Glynn County area, Georgia, 2005.



[1]Modified from Randolph and others, 1991; Clarke and Krause, 2000
[2]Modified from Randolph and others, 1991; Weems and Edwards, 2001
[3]From Payne and others, 2005

Figure 42. Generalized correlation of geologic and hydrogeologic units and model layers. [GHB, general-head boundary]

Reports and Technical Presentations

The USGS prepared several reports and technical presentations about coastal Georgia during 2007 and has provided technical briefings and progress reports at monthly meetings of the Glynn County Glynn County Water Resources Management Advisory Committee (WRMAC). Recent reports on coastal Georgia include:

- USGS Scientific Investigations Report completed as part of the Georgia cooperative water program titled, “Ground-water conditions and studies in Georgia, 2004–2005” by David C. Leeth, Michael F. Peck, and Jaime A. Painter (*http://pubs.usgs.gov/sir/2007/5017/*), describes the current ground-water monitoring network in Georgia and includes sections outlining the Brunswick–Glynn County CWP.

- USGS Open-File Report titled, “U.S. Geological Survey Georgia Water Science Center and City of Brunswick–Glynn County Cooperative Water Program—Summary of Activities, July 2005 through June 2006,” by Gregory S. Cherry (*http://pubs.usgs.gov/of/2006/1368/*)

- Abstract in the Proceedings of the 2007 Georgia Water Resources at The University of Georgia held in Athens, Ga., titled, “Optimization of ground-water pumping distribution to limit chloride plume expansion in the Upper Floridan aquifer near Brunswick, Georgia,” by Gregory S. Cherry and Dorothy F. Payne (*http://cms.ce.gatech.edu/gwri/uploads/proceedings/2007/7.2.4.pdf*)

- Paper in the Proceedings of the 2007 Georgia Water Resources at The University of Georgia held in Athens, Ga., titled, “The monitoring and modeling approach to support ground-water management in Georgia,” by John S. Clarke (*http://cms.ce.gatech.edu/gwri/uploads/proceedings/2007/2.7.1.pdf*)

- Paper in the Proceedings of the 2007 Georgia Water Resources at The University of Georgia held in Athens, Ga., titled, “Effects of pumpage reductions in the Savannah, Georgia–Hilton Head Island, South Carolina, area on saltwater intrusion near Hilton Head Island,” by Dorothy F. Payne (*http://cms.ce.gatech.edu/gwri/uploads/proceedings/2007/7.3.2.pdf*)

- Paper in the Proceedings of the 2007 Georgia Water Resources at The University of Georgia held in Athens, Ga, titled, “Saltwater contamination in the Upper Floridan aquifer in the Savannah/Vernonburg, Georgia, area, 2004–2006,” by Mark E. Hall and Michael F. Peck (*http://cms.ce.gatech.edu/gwri/uploads/proceedings/2007/8.4.pdf*)

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