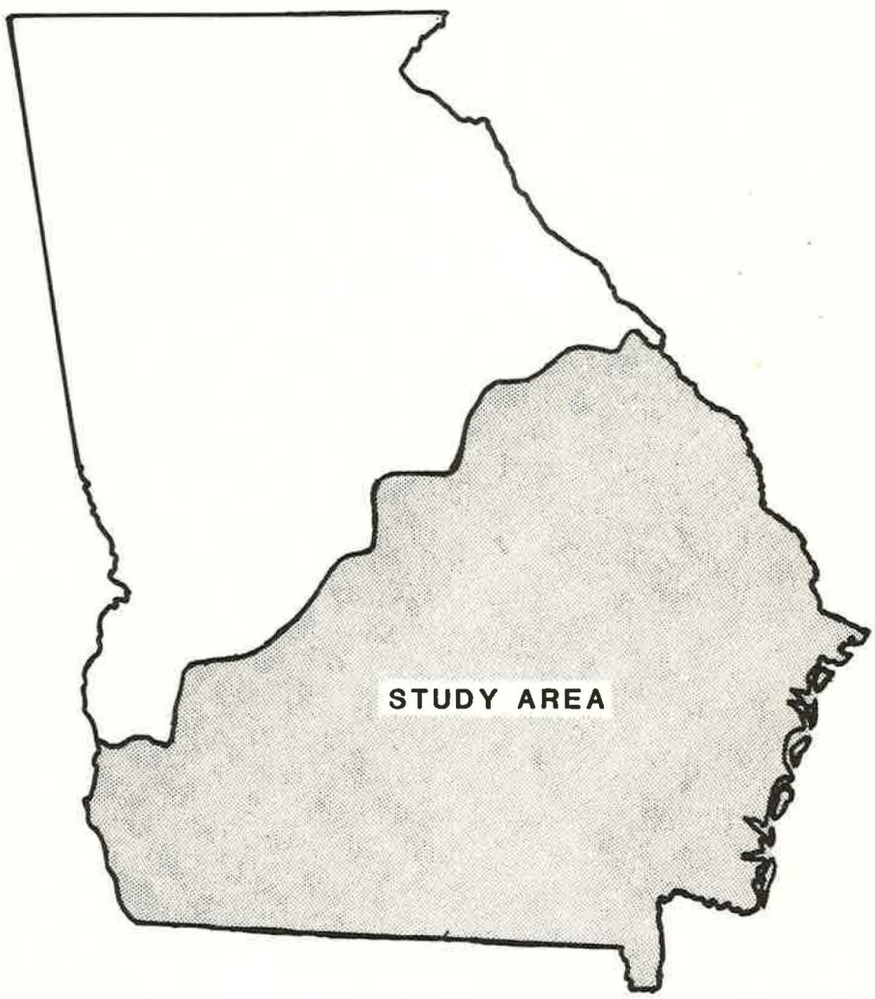
# POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN GEORGIA, 1985 AND WATER-LEVEL TRENDS, 1980-85

by
John S. Clarke




Prepared in cooperation with the Department of the Interior, U.S. Geological Survey

Department of Natural Resources
J. Leonard Ledbetter, Commissioner

Environmental Protection Division
Harold F. Reheis, Assistant Director

Georgia Geologic Survey
William H. McLemore, State Geologist

ATLANTA
1987

HYDROLOGIC ATLAS 16

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

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

HYDROLOGIC ATLAS 16

## INTRODUCTION

The Floridan aquifer system (formerly the principal artesian aquifer) is the main source of ground water in the Coastal Plain of Georgia. About 600 Mgal/d is withdrawn from the upper part of the aquifer system (Upper Floridan aquifer) in Georgia, mostly for industrial use and for irrigation. As a result of this pumping, large cones of depression in the potentiometric surface have formed at Savannah, Brunswick, Jesup, and St Marys, Ga.-Fernandina Beach, Fla. Declining water levels in these and other areas have caused concern over protection of the ground-water resources. To monitor water-level fluctuations and trends in the Floridan and in other aquifers, the U.S. Geological Survey, in cooperation with the Georgia Department of Natural Resources, Environmental Protection Division, Geologic Survey Branch, and other State and local agencies, operates a network of approximately 1,700 water-level monitoring wells, including 149 equipped with continuous water-level recorders.

This report depicts and describes the potentiometric surface of the Upper Floridan aquifer in Georgia for May 1985. The potentiometric surface, which represents the altitude at which water would have stood in tightly cased wells that tap the aquifer, was constructed from water-level and pressure measurements made in more than 1,000 wells in Georgia and adjacent parts of Alabama, South Carolina, and Florida during May 13-24, 1985. The report also discusses water-level fluctuations and trends in the Upper Floridan aquifer in different parts of the State for 1980-85. The work was done in cooperation with the Georgia Department of Natural Resources, Environmental Protection Division, Geologic Survey Branch; Chatham County; Glynn County; the cities of Brunswick and Valdosta; and the Albany Water, Gas, and Light Commission.

Maps showing the potentiometric surface of the Upper Floridan aquifer in Georgia have been prepared for earlier periods in different parts of the Coastal Plain. Johnston and others (1981) presented a map showing the potentiometric surface of the Floridan aquifer system for the Southeastern States in May 1980. The map was based on water-level and pressure measurements made during May 12-23, 1980. A map showing the estimated potentiometric surface of the aquifer in its area of occurrence prior to development (about 1880) was compiled by Johnston and others (1980). Krause and Randolph (1987) present a map showing the estimated decline in water level from predevelopment conditions (1880) to 1980 in southeast Georgia and adjacent parts of Florida and South Carolina. The U.S. Geological Survey's ground-water data for Georgia report, published annually since 1977, describes water conditions in the State and includes potentiometric maps for the Floridan aquifer system. An extensive listing of these and other reports that present potentiometric maps for the Floridan is included in the report, "Ground-water data for Georgia, 1985" (Clarke and others, 1986).

## UPPER FLORIDAN AQUIFER

The Upper Floridan aquifer is part of a regional water-bearing unit called the Floridan aquifer system, which consists of units of limestone, dolomite, and calcareous sand of primarily Eocene to Miocene age. Near its outcrop area, the Upper Floridan is mainly clastic and consists of sand, gravel, and clay. Downdip, the aquifer is dominantly carbonate and consists of limestone and dolomite. The Upper Floridan aquifer is most productive downdip where it is thickest and dissolution of the limestone has resulted in secondary permeability. In this area, yields of as much as 10,000 gal/min and transmissivities of 1,000,000 ft²/d have been reported.

The Upper Floridan aquifer is at or near land surface along a narrow band that extends from Clay County northeastward to Richmond County. The aquifer dips and thickens to the southeast, where it reaches a maximum thickness of about 500 ft in Glynn County. The Upper Floridan is confined above by the clayey Hawthorn Formation and below by the clayey Lisbon Formation.

## POTENTIOMETRIC SURFACE AND WATER-LEVEL TRENDS

The Coastal Plain of Georgia was divided into four hydrologic areas for discussion of the configuration of the potentiometric surface and water-level fluctuations and trends. They are: the southwest, south-central, northeast, and coastal areas shown in the figure. A discussion of each of the areas follows this section.

The Upper Floridan aquifer is recharged by precipitation along its outcrop belt in the northeast and southwest areas where the overlying confining bed is thin or absent, allowing the infiltration of precipitation. In the south-central area near Valdosta, the aquifer is recharged by streamflow that enters the aquifer from the Withlacoochee River (Krause, 1979). The potentiometric surface generally is highest in recharge areas and lowest in discharge areas. Consequently, ground water flows from areas of recharge to areas of discharge.

The Gulf Trough is a feature that significantly affects the ground-water flow system and, hence, the potentiometric surface (Krause and Hayes, 1981). The Gulf Trough contains fine sediments of low transmissivity and extends in Georgia from Decatur County northeastward to Bullock County. The Gulf Trough adversely affects the ground-water flow system, as evidenced by low well yields, low transmissivity, high dissolved-solids concentrations, and a steepened potentiometric gradient in the Upper Floridan aquifer as described for Colquitt County by Zimmerman (1977). This steepened potentiometric gradient is shown on the map, particularly in the area between the 60-ft and 120-ft contours in the eastern half of the Coastal Plain, and between the 70-ft and 210-ft contours in the south-central part.

The configuration of the potentiometric surface is significantly different upgradient and downgradient from the Gulf Trough. Downgradient from the trough, in the south-central and coastal areas, the transmissivity of the Upper Floridan aquifer is high and the potentiometric surface is relatively flat, except near major pumping centers in the coastal area and near the recharge area at Valdosta. Upgradient from the trough, in the southwest and northeast areas, the transmissivity of the aquifer is lower, the aquifer is less confined, and the configuration of the potentiometric surface is controlled mainly by recharge from precipitation and discharge to streams. Recharge occurs primarily in interstream areas and is indicated on the map by contours that bend downgradient. Discharge to streams is shown by contours that bend upstream, indicating that the potentiometric gradient is toward the stream. Although the potentiometric surface upgradient from the Gulf Trough in the northeast area is largely unaffected by pumpage of more than 275 Mgal/d in the coastal area, Johnston and others (1981) suggest that the radius of influence of the cone of depression at Savannah may have crossed the trough west-northwest of Savannah.

Water-level fluctuations and trends in the Upper Floridan aquifer are shown by hydrographs for wells considered representative of conditions in each hydrologic area. Climatologic conditions are shown by graphs of the cumulative departure of precipitation at National Weather Service stations in each hydrologic area and are based on normals for the period 1980-85. Climatologic data indicate that with the exception of the south-central area, the May 1980 potentiometric surface (Krause and Hayes, 1981) generally is representative of a period of above-normal precipitation, whereas the May 1985 surface is representative of a period of below-normal precipitation. The rainfall deficit in 1985 and the resulting increased pumping from the Upper Floridan aquifer resulted in a lower water level in 1985 than in 1980 over much of the Coastal Plain.

### SOUTHWEST AREA

In the southwest area, comprised largely of the Dougherty Plain, the Upper Floridan aquifer is less than 250 ft thick, is covered over most of the area by 25 to 125 ft of sandy-clay residuum, and locally is hydraulically connected to the streams. In this area, the configuration of the potentiometric surface is largely controlled by recharge from precipitation in interstream areas and by discharge to streams. Southeast of this area, the potentiometric gradient steepens owing to the effects of the Gulf Trough.

During 1980, an annual average of 210 Mgal/d was withdrawn from the Upper Floridan aquifer in the southwest area, primarily for irrigation. This large withdrawal, more than 2,250 Mgal/d during the irrigation season (H. E. Gill, U.S. Geological Survey, written commun., 1981), has not produced a permanent cone of depression because the wells are widely separated, pumping is seasonal, the transmissivity of the aquifer is high, and recharge is plentiful during periods of normal rainfall.

The cumulative departure of precipitation at National Weather Service station, Albany 3SE, indicates that rainfall during 1980-85 generally was below normal. As a result of the deficient rainfall and increased irrigation pumping, the ground-water level in the Upper Floridan aquifer over most of the southwest area declined. Water-level fluctuations in the southwest area during 1980-85 are typified by the hydrographs for well 13L003 in eastern Dougherty County and well 06G006 in southern Early County. At both wells, the seasonal fluctuations in water level are reflected by a high during the rainy season in the winter and early spring, and a low in the autumn and early winter following the irrigation season. The high water level during winter-spring 1985 at well 13L003 was lower than that for 1980, 1983, and 1984, and at well 06G006 was lower than that for any of the other 4 years. This indicates that the winter-spring rainfall was insufficient for the ground-water level to recover from the irrigation season pumping. Record low water levels were measured at both wells in December 1981, as a result of below-normal precipitation and increased irrigation pumping. As a result of this rainfall deficit, the water level at both wells was lower in May 1985 than in May 1980.

### SOUTH-CENTRAL AREA

In the south-central area, the configuration of the potentiometric surface is influenced primarily by recharge at the rate of about 70 Mgal/d from the Withlacoochee River near Valdosta (Krause, 1979). The recharge area is shown on the map as a high in the potentiometric surface near Valdosta. Between the high at Valdosta and the coastal area, the potentiometric gradient is low, primarily because the transmissivity of the aquifer is high and there is little pumping in that area.

Depressions in the potentiometric surface caused by local pumping have formed at Thomasville, Thomas County, and Hazlehurst, Jeff Davis County, where 1980 withdrawals from the Upper Floridan aquifer were 3.6 Mgal/d and 0.4 Mgal/d, respectively (Pierce and others, 1982). In the upgradient part of the south-central area, the potentiometric surface shows a steepened gradient owing to the effects of the Gulf Trough.

The cumulative departure of precipitation at National Weather Service station, Valdosta 3E, indicates that with the exception of 1984, rainfall in the south-central area was below normal during the period 1980-85. Although rainfall was below normal during 1980-85, there was little water-level decline over most of the south-central area. The lack of decline can be attributed to the high transmissivity of the aquifer and little irrigation pumping in the area. Typical water-level fluctuations and trends in the south-central area are shown by hydrographs for well 19E009 at Valdosta, and well 17K001 at Tifton. From May 1980 to May 1985, the water level at the Tifton well declined about 10 ft, most of which occurred as a result of the 1980-81 drought. Although the difference in water level measured in May 1980 and May 1985 is about 15 ft at the Valdosta well, the 5-year trend is comparatively unchanged. At both wells, seasonal water-level fluctuations are reflected by high water levels during the spring rainy season. The lowest seasonal water level occurs during the fall in the Valdosta area, and during the summer in the Tifton area. A record low water level was measured at the Valdosta well in October 1981 and at the Tifton well in July 1981. The record low water levels in the two wells occurred at different times of the year, because the Valdosta area well is located near a site where stream water recharges the aquifer and thus is influenced more by streamflow, whereas the Tifton well is affected mainly by local pumping.

### NORTHEAST AREA

The configuration of the potentiometric surface in the northeast area is influenced in the upgradient part by recharge from precipitation and by discharge to streams, and in the downgradient part by the Gulf Trough. Areas of recharge generally correspond to interstream areas. Discharge occurs into major gaining streams including the Ocmulgee, Oconee, and Ogeechee Rivers. The effects of the Gulf Trough on the ground-water flow system is reflected by a steepened potentiometric gradient in the southeastern part of the area.

A small depression in the potentiometric surface formed as a result of local pumping at Clinton, Evans County, where 1980 withdrawals were about 0.3 Mgal/d. Vincent (1982) reported that a cone of depression developed at Sandersville, Washington County, during the 1940's as a result of local pumping. However, measurements made during May 1985 indicate that this cone no longer is present because pumping from the aquifer system at Sandersville has been discontinued.

The cumulative departure of precipitation at National Weather Service station, Dublin 3S, indicates that rainfall in the northeast area was above normal in May 1980 and below normal from the end of 1980 through October 1985. Although rainfall was below normal during this period, the water level showed little decline over most of the northeast area. The lack of decline may be attributed to little irrigation pumping in the area. Water-level fluctuations and trends in the northeast area are typified by the hydrographs for well 21T001 in western Laurens County and well 25Q001 in southern Montgomery County. Seasonal variations at each well are reflected by high water levels during the late winter-early spring rainy season, and by lows during the summer and fall. A record low water level was measured at well 25Q001 in October 1981. During the 5-year period, the water level in well 21T001 showed no trend, whereas the water level in well 25Q001 declined about 3 ft as a result of the rainfall deficit.

### COASTAL AREA

In the coastal area of Georgia and adjacent parts of Florida and South Carolina, the potentiometric surface is characterized by a series of coalescing cones of depression caused by large withdrawals from the Upper Floridan aquifer. About 275 Mgal/d is withdrawn from the aquifer in the coastal area of Georgia. Major pumping centers include the Savannah, Jesup, Brunswick, and St Marys, Ga.-Fernandina Beach, Fla., areas. With the exception of the Savannah area, pumping in these areas is mainly for industrial supply. In the Savannah area, pumping is about evenly divided between industrial and public supply. As a result of this pumping, the ground-water level has declined significantly below predevelopment levels. For example, the water level at Savannah has declined more than 150 ft since pumping began in the late 1800's (Krause and others, 1984).

Despite similar rates of withdrawal, the size of the cone of depression at Savannah is significantly larger than in other parts of the coastal area because the transmissivity of the aquifer at Savannah is lower than in the other areas (Krause and Hayes, 1981). For example, Walt and Gregg (1973) reported that the transmissivity at Brunswick was from 107,000 to 134,000 ft²/d, whereas Counts and Donsky (1963) reported that the average transmissivity at Savannah was about 33,000 ft²/d.

Because the Upper Floridan aquifer in the coastal area is deeply buried and far from the outcrop area, the ground-water level is not directly influenced by current (1985) precipitation. The water level is, however, affected by increased withdrawals during hot, dry periods. Hot, dry periods are reflected by records of the cumulative departure of precipitation at National Weather Service station, Savannah WSO AP. Rainfall in the coastal area was slightly above normal in May 1980, below normal from June 1980 through February 1983, above normal from February 1983 through March 1985, and below normal from March through December 1985.

In most of the coastal area, the water level in the Upper Floridan aquifer showed little change during 1980-85, and rose in several areas. In 1982, the water level in the Brunswick area rose as much as 15 ft as a result of a reduction in pumping by a major water user.

### SAVANNAH AREA

The cone of depression at Savannah covers an area that includes Chatham County and parts of Bryan, Liberty, and Effingham Counties, Ga., and adjacent parts of South Carolina. During 1984, about 70 Mgal/d was withdrawn from the Upper Floridan aquifer in the Savannah area, primarily for industrial and municipal use. In this area, smaller cones of depression occur at Richboro as a result of industrial pumping, and at Savannah Beach as a result of pumping for public supply.

Water-level fluctuations and trends during 1980-85 near the center of pumping in the Savannah area are typified by well 36Q008. As a result of increased pumping due to the 1980-81 drought, a record low water level was measured at the well in August 1980. A decrease in pumping during 1981-83 allowed the water level to recover from the record low of 1980. The water level showed a downward trend during 1983-85, but for the 5-year period, only a slight downward trend is evident.

### JESUP AREA

The southeast-trending cone of depression in the Jesup area covers part of Wayne and Long Counties along the Altamaha River. Ground-water withdrawal in the Jesup area averages 70 Mgal/d.

The ground-water level in the Jesup area showed little change during 1980-85. Although a record low water level was measured in June 1981, the hydrograph for well 30L003 shows a negligible trend from May 1980 to May 1985. In 1982, the water level rose in response to a general reduction in regional pumping owing to cessation of the 1980-81 drought. The spikes in the hydrograph represent reductions in industrial pumping near Jesup.

### BRUNSWICK AREA

The cone of depression at Brunswick covers an area that lies completely within Glynn County. During 1984, an estimated 80 Mgal/d was withdrawn from the Upper Floridan aquifer in the Brunswick area, primarily for industrial use.

The water level in the Upper Floridan in most of the Brunswick area rose during 1980-85. A typical water-level trend near the center of pumping at Brunswick is shown by the hydrograph for well 33H133. During 1980-85, the water level in the well recovered about 6 ft largely as a result of an estimated 10-Mgal/d reduction in pumpage by a major industrial water user. This pumpage reduction is reflected by a 10-ft water-level recovery during 1982. The spikes on the hydrograph are caused by temporary shutdowns in industrial pumping.

### ST MARYS-FERNANDINA BEACH AREA

Ground-water withdrawals of about 31 Mgal/d at St Marys, Ga., and about 44 Mgal/d at Fernandina Beach, Fla., have resulted in the formation of a northwest-trending cone of depression in the Upper Floridan aquifer.

During 1980-85, the ground-water level in the St Marys-Fernandina Beach area showed a slight decline. Water-level trends in the area are typified by the hydrograph for well 33Z027 at Kings Bay Navy Base. In February 1981, the water level in the well reached a record low as a result of increased regional pumping. Decreased regional pumping as a result of the cessation of the 1980-81 drought allowed the water level to recover from the record low of 1981. During 1983, the water level showed little change and during 1984-85 it showed a decline in response to increased pumping at a nearby supply well. A record low water level was measured in June 1985.

## SELECTED REFERENCES

Clarke, J. S., and Pierce, R. R., 1985, Georgia water facts--ground-water resources, in U.S. Geological Survey, National Water Summary 1984: U.S. Geological Survey Water-Supply Paper 2275, p. 179-184.

Clarke, J. S., Joiner, C. N., Longsworth, S. A., McFadden, K. W., and Peck, M. F., 1986, Ground-water data for Georgia, 1985: U.S. Geological Survey Open-File Report 86-304, 159 p.

Counts, H. B., and Donsky, Ellis, 1963, Salt-water encroachment, geology, and ground-water resources of Savannah area, Georgia and South Carolina: U.S. Geological Survey Water-Supply Paper 1611, 100 p.

Hayes, L. R., Maslia, M. L., and Meeks, W. C., 1983, Hydrology and model evaluation of the principal artesian aquifer, Dougherty Plain, southwest Georgia: Georgia Geologic Survey Bulletin 97, 93 p.

Krause, R. E., 1979, Geohydrology of Brooks, Lowndes, and western Echols Counties, Georgia: U.S. Geological Survey Water-Resources Investigations 78-117, 48 p.

Krause, R. E., and Hayes, L. R., 1981, Potentiometric surface of the principal artesian aquifer in Georgia, May 1980: Georgia Geologic Survey Hydrologic Atlas 6, scale 1:1,000,000.

Krause, R. E., Matthews, S. E., and Gill, H. E., 1984, Evaluation of the ground-water resources of coastal Georgia--Preliminary report on the data available as of July 1983: Georgia Geologic Survey Information Circular 62, 55 p.

Krause, R. E., and Randolph, R. B., 1987, Hydrology of the Floridan aquifer system in southeast Georgia and adjacent parts of Florida and South Carolina: U.S. Geological Survey Professional Paper 1403-D (in press).

Johnston, R. H., Healy, H. G., and Hayes, L. R., 1981, Potentiometric surface of the Tertiary limestone aquifer system, Southeastern United States, May 1980: U.S. Geological Survey Open-File Report 81-486, 1 plate, scale 1:1,000,000.

Johnston, R. H., Krause, R. E., Meyer, F. W., Ryder, P. D., Tibbals, C. H., and Hunn, J. D., 1980, Estimated potentiometric surface for the Tertiary limestone aquifer system, Southeastern United States, prior to development: U.S. Geological Survey Open-File Report 80-406, 1 plate, scale 1:1,000,000.

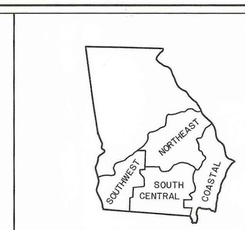
Miller, J. A., 1982, Geology and configuration of the top of the Tertiary limestone aquifer system, Southeastern United States: U.S. Geological Survey Open-File Report 81-1178, 1 sheet, scale 1:1,000,000.

Pierce, R. R., Barber, N. L., and Stiles, H. R., 1982, Water use in Georgia by county for 1980: Georgia Geologic Survey Information Circular 59, 180 p.

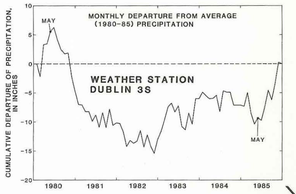
Vincent, H. R., 1982, Geohydrology of the Jacksonian aquifer in central and east-central Georgia: Georgia Geologic Survey Hydrologic Atlas 8, 3 sheets.

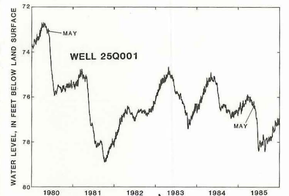
Walt, R. L., and Gregg, D. O., 1973, Hydrology and chloride contamination of the principal artesian aquifer in Glynn County, Georgia: Georgia Geologic Survey Hydrologic Report 1, 93 p.

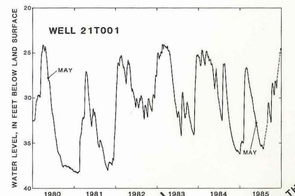
Zimmerman, E. A., 1977, Ground-water resources of Colquitt County, Georgia: U.S. Geological Survey Open-File Report 77-56, 41 p.

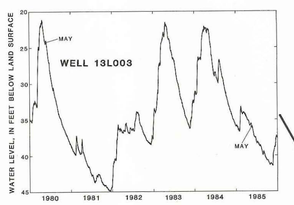


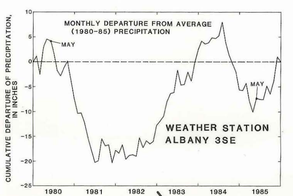

LOCATION OF HYDROLOGIC AREAS

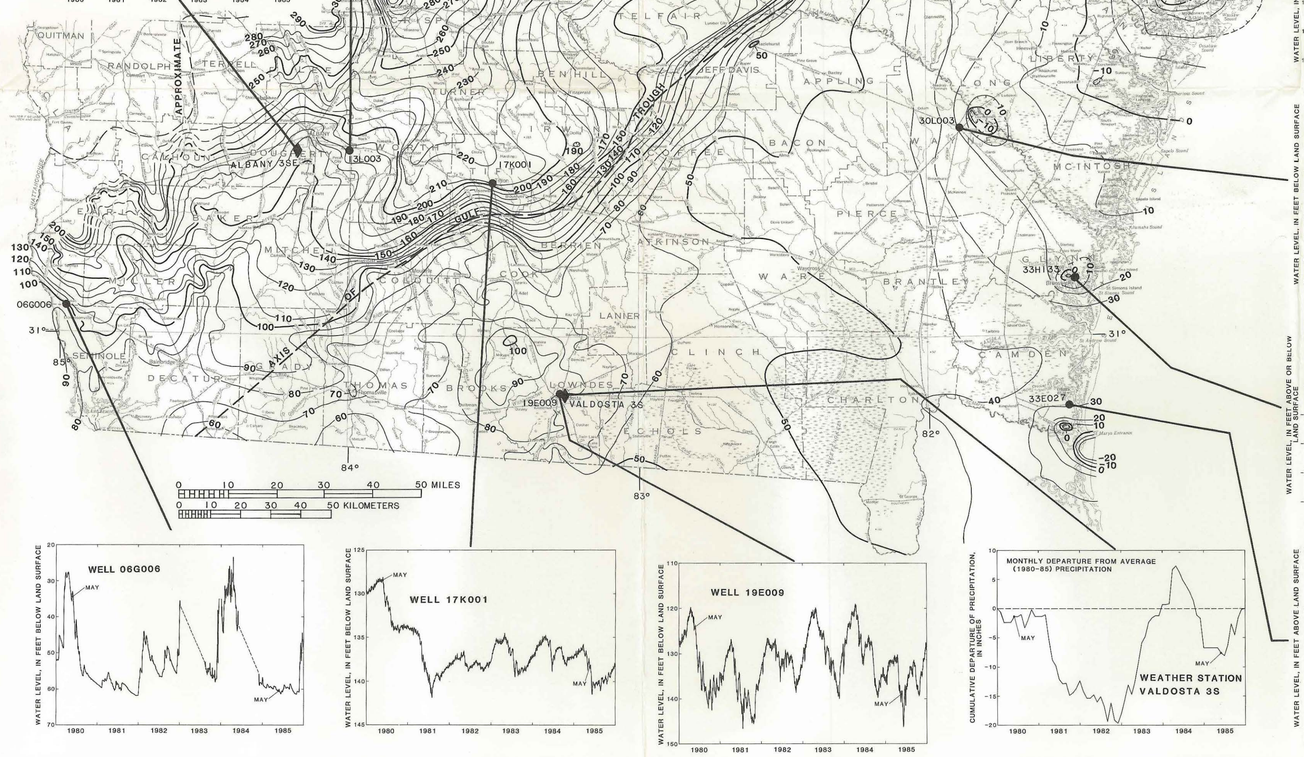


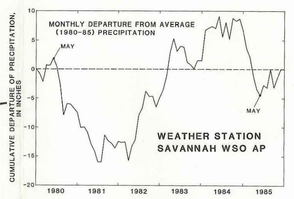



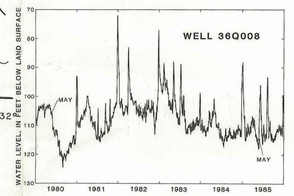



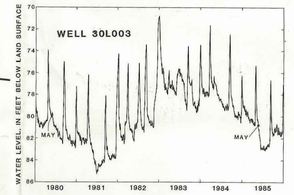



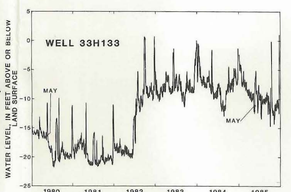



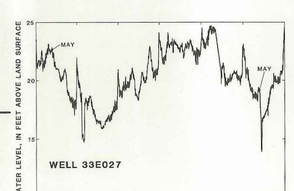
















Base from U.S. Geological Survey
State base map, 1:1,000,000, 1970

Cartography by Willis G. Hester

# POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN GEORGIA, MAY 1985, AND WATER-LEVEL TRENDS, 1980-85

By

John S. Clarke

1987