DEPARTMENT OF THE INTERIOR
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THE POTENTIOMETRIC SURFACE AND WATER QUALITY OF THE FLORIDAN AQUIFER IN SOUTHWEST HILLSBOROUGH COUNTY, FLORIDA 1952-74

By
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INTRODUCTION

Large ground-water withdrawals and a 10-year period of below-normal rainfall have caused the potentiometric surface of the Floridan aquifer to decline more than 10 feet (3 metres) in most of a 200-square-mile (520-square-kilometre) area of southwest Hillsborough County (fig. 1). The lowered ground-water levels and the consequent threat of salt-water intrusion concern farmers and residents who depend on ground water for irrigation and domestic purposes. Extensive crop irrigation is continuing; small towns such as Ruskin, Riverview, Sun City Center, and Apollo Beach are rapidly expanding; and new communities are being planned. In addition, there are plans to mine the extensive phosphate deposits a few miles east of this heavily-farmed area. All these activities require large supplies of fresh ground water.

The Hillsborough County Commission cooperated with the U. S. Geological Survey to study changes of water levels and water quality in southwest Hillsborough County. The purpose of this report is to compare the position of the potentiometric surface in 1953 with that in 1973 and to show chloride and sulfate concentrations in ground water in 1974.

For readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English unit	By	To obtain metric unit
inches (in.)	2.540×10^{1}	millimetres (mm)
feet (ft)	3.048×10^{-1}	metres (m)
miles (mi)	1.609	kilometres (km)
square miles (mi^2)	2.590	square kilometres (km^2)
acres	4.047×10^{-3}	square kilometres (km^2)
gallons per minute (gal/min)	6.309×10^{-2}	litres per second (l/s)

PREVIOUS INVESTIGATIONS

Peek (1959a and 1959b) discussed the geology of southwest Hillsborough County, and in his inventory of more than 600 wells reported ground-water level and ground-water quality data collected in the early and middle 1950's. Information from his reports was used in the 20-year comparisons of water levels. Water samples from about 400 wells were analyzed for chloride; complete chemical analyses were determined for water from 29 wells. Menke, Meredith, and Wetterhall (1961 and 1964) described the water resources of Hillsborough County and collected some water-level and water-quality data in the southwestern part of the county. Water-level and water-quality data from these studies and from the current investigation are summarized in the report by Duerr (1975).

HYDROGEOLOGY

The relative positions and ranges in thickness of the geologic formations tapped by water wells in this area are shown in the following table:

Formation	Age	Thickness (ft)	(m)
Undifferentiated, surficial deposits	Holocene and Pleistocene	0-60	(0-18)
Hawthorn Formation	Miocene	10-150	(3-45)
Tampa Limestone	Miocene	50-200	(15-60)
Suwannee Limestone	Oligocene	200-225	(60-70)
Ocala Limestone	Eocene	250±	(75±)
Avon Park Limestone	Eocene	600-700	(180-215)
Lake City Limestone	Eocene	500±	(150±)

Peek (1959a) found that the formations dip to the south and most increase in thickness to the south and southwest. Wells tapping the same formations are several hundred feet deeper in the south than in the north.

The undifferentiated surficial deposits are sand, clay and shell. The Hawthorn Formation is calcareous phosphoritic clay or marl interbedded with thin layers of sand, shells, and sandy limestone. The Tampa, Suwannee, and Ocala Limestones are predominantly limestone; and the Avon Park and Lake City Limestones are limestone and dolomite.

The clay and marl beds of the Hawthorn Formation form the confining bed for the Floridan aquifer. The name "Floridan aquifer" was introduced by Parker and others (1955, p. 189) to include parts or all of the Lake City, Avon Park, Ocala, Suwannee, and Tampa Limestones, and permeable parts of the Hawthorn Formation that are in hydraulic contact with the rest of the aquifer. The Tampa and Suwannee Limestones are the formations most commonly tapped by wells in this area.

Many of the wells inventoried for this study were previously inventoried by Peek (1959a and 1959b). Most wells are irrigation wells tapping the Tampa and Suwannee Limestones and have casings seated in the overlying Hawthorn Formation. Wells tapping the deeper limestone formations are also open to the intervening limestones below the Hawthorn. Avon Park wells, cased through the Hawthorn, are also open to the Tampa, Suwannee, and Ocala. Wells ending in the Hawthorn Formation were not used as control for potentiometric and water-quality maps for the Floridan aquifer because many of these wells tap parts of the Hawthorn Formation that are not in hydraulic contact with the rest of the Floridan aquifer. These wells yield less water and have higher water levels than wells reaching the underlying Floridan aquifer. Many of the Hawthorn wells are a source of water for domestic use and for irrigation of small cultivated tracts.

Generally, wells that tap the Tampa and Suwannee Limestones are 6 to 8 in. (152 to 203 mm) in diameter and yield about 200 to 500 gal/min (13 to 32 l/s). Well depths generally range from 100 ft (30 m) near the Alafia River to 600 ft (180 m) in the southern and eastern parts of the area. Wells that tap the Tampa and Suwannee Limestones supply most of the water for irrigated agricultural land, tropical fish ponds, and residential communities which are distributed over most of southwest Hillsborough County (fig. 2).

A few wells tap the Ocala and Avon Park Limestones. Most of these wells are in the eastern part of the area and are from 500 to 1,000 ft (150 to 300 m) deep. Wells that tap the Tampa, Suwannee, and Ocala Limestones yield about 500 gal/min (32 l/s); wells that also tap the Avon Park Limestone yield about 1,000 gal/min (64 l/s). Few, if any, wells tap the Lake City Limestone.

POTENTIOMETRIC SURFACE

In southwest Hillsborough County, the potentiometric surface fluctuates with the dry (March-May) and wet (June-September) seasons. Water levels are lower during the dry season when lawn and agricultural irrigation is at a maximum and higher during the wet season when irrigation is at a minimum. This seasonal pattern is consistent from year to year in wells open to one or several of the formations (fig. 3). Seasonal fluctuations average about 15 ft (5 m) and are as much as 28 ft (8.5 m) in some wells near Wimauma. The highest and lowest water level recorded each year is shown in figure 4; the gradual decline over the last 20 years is evident.

Potentiometric surface maps (figs. 5-8) of the Floridan aquifer were constructed from water-level measurements in wells open to one or more formations of the Floridan aquifer. Measurements were recorded at the end of the dry and wet seasons to show low and high water-level conditions. The potentiometric surface in May 1973 (fig. 6) was compared to that in May 1953 (fig. 5) as drawn by Peek (1959a). Water-level declines ranged from about 10 to 40 ft (3 to 12 m) with greater declines in the east (fig. 6). A comparison of the potentiometric surface in October 1973 (fig. 8) to that of October 1952 (fig. 7) shows that water-level declines ranged from about 5 to 20 ft (1.5 to 6 m); declines again were greater in the eastern part of the area (fig. 8).

In May 1973 the potentiometric surface was below sea level at the county well fields at Ruskin and Sun City Center and as far east as Wimauma (fig. 6). Extreme dry-weather conditions along with large ground-water withdrawals for domestic and agricultural use contributed to the decline in water levels. In October 1973 after the summer wet season, water levels had risen and remained below sea level only in the coastal areas near Gibsonton (fig. 8).

WATER QUALITY

Water samples from wells that tap the Floridan aquifer were collected at the end of the wet and dry seasons and were analyzed for chloride and sulfate. No significant seasonal differences in water quality were noted. Slight long-term water-quality changes were noted for wells that were sampled both during this investigation and by Peek (1959a and 1959b) in the early and middle 1950's. As in the 1950's, ground water with the poorest quality is in the coastal areas near Tampa Bay.

In southwest Hillsborough County, chloride concentrations in water from the Floridan aquifer normally range from 5 to 50 mg/l. Chloride concentrations in ground water decrease inland from Tampa Bay and are lowest in the extreme eastern parts of the area. Chloride concentrations are higher than 250 mg/l in the Gibsonton area near the mouths of Bullfrog Creek and the Alafia River (fig. 9). Several irrigation wells in this area yield water with chloride concentrations greater than 500 mg/l, and one yields water containing 3,300 mg/l. Generally, chloride concentrations are high in ground water in coastal areas where ground-water withdrawals for irrigation are large.

High chloride concentrations in ground water near the coast indicate sea-water intrusion. According to Peek (1959a), the high chloride concentration in ground water north of Adamsville is caused in part by intrusion of saline water from Tampa Bay and in part by residual sea water that entered the aquifer during Pleistocene time when the coastal areas were submerged. Peek also stated that the high chloride concentration in ground water south of Adamsville was apparently due to residual sea water because the potentiometric surface was sufficiently high (figs. 5 and 7) to prevent intrusion of water from Tampa Bay.

Periodically since Peek's study, however, water levels have fallen below sea level (figs. 3 and 6), and although only slight water-quality changes have been noted to date, the possibility of salt-water intrusion in coastal areas has increased. As stated by Hem (1970, p. 313), "the actual migration of the salt-water front, however, is relatively slow, as it represents actual movement of water in the system under low energy gradients with high resistance. The appearance of salty water in a well may not occur until some years after the head decline has reached serious proportions."

Salt-water intrusion has been observed in well 21 southwest of Ruskin (fig. 9). The 800-ft (240 m) deep irrigation well taps the Avon Park Limestone and has been pumped at a rate of 1,400 gal/min (90 l/s). During 1972-74, the chloride concentration of the well water increased from 260 to 980 mg/l, and the specific conductance increased from 2,200 to 5,000 micromhos. Other nearby wells ranging in depth from 250 to 600 ft (75 to 180 m) tap only the Tampa and Suwannee Limestones. These wells have not experienced water-quality changes, and they yield water with chloride concentrations ranging from 25 to 50 mg/l (fig. 9).

Sulfate concentrations in ground water in southwest Hillsborough County range from 2 to 700 mg/l; sulfate exceeds 250 mg/l everywhere near the coast and exceeds 500 mg/l adjacent to the coast north of the Little Manatee River (fig. 10).

SUMMARY AND CONCLUSIONS

The combination of ground-water withdrawals and extended periods of below-normal rainfall lowered the potentiometric surface of the Floridan aquifer more than 40 ft (12 m) in some places during the last 20 years in southwest Hillsborough County. Fluctuations between wet and dry seasons are as large as 28 ft (8.5 m), and water levels fall below sea level in many areas during the dry season. In coastal areas chloride and sulfate concentrations in ground water are higher than elsewhere, but as of May 1974, only slight changes in water quality have been detected since the middle 1950's.

In the future, continuation of large ground-water withdrawals will probably cause additional lowering of the potentiometric surface of the Floridan aquifer. Consequently, the possibility of salt-water intrusion in coastal areas will increase.

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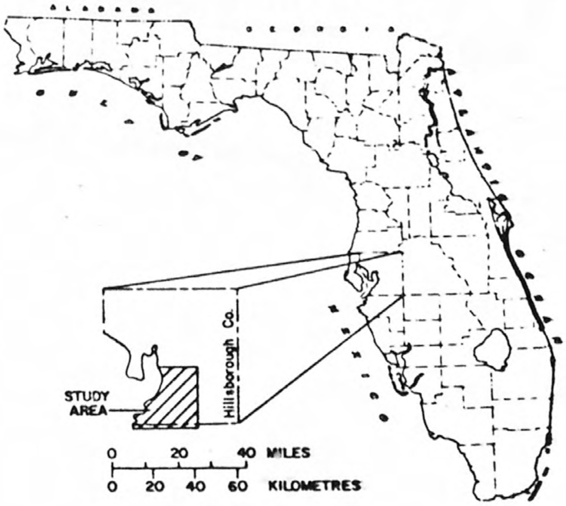


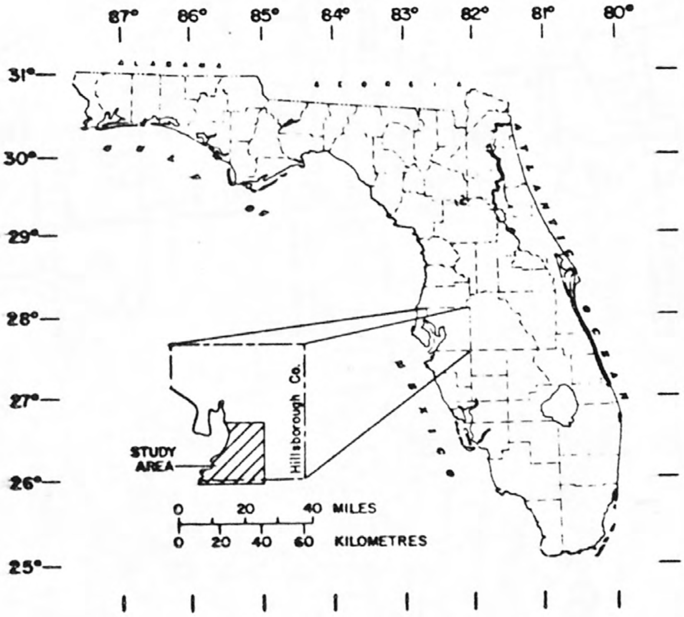


Figure 1. Location map.

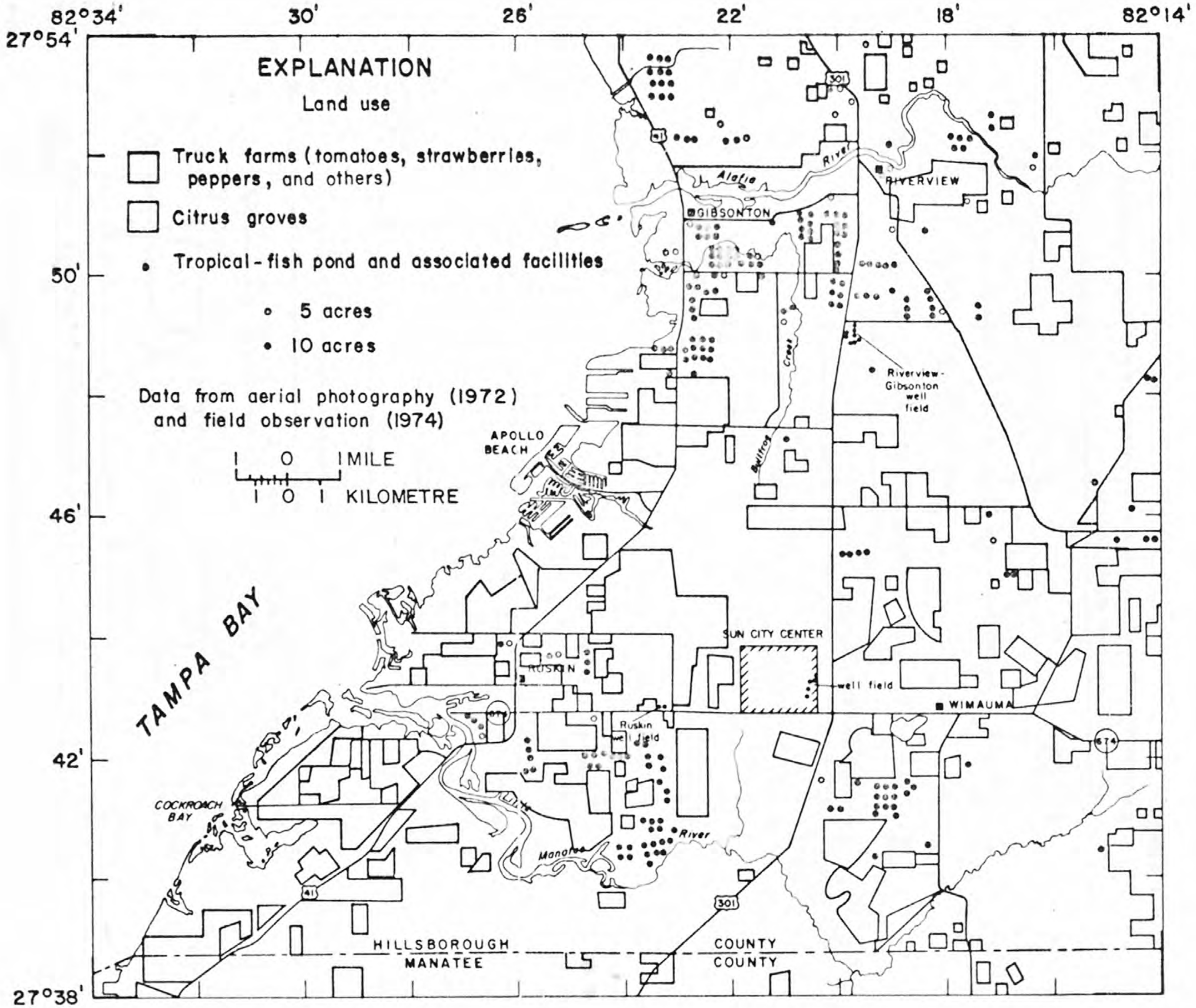


Figure 2. Irrigated agricultural land and fish farms.

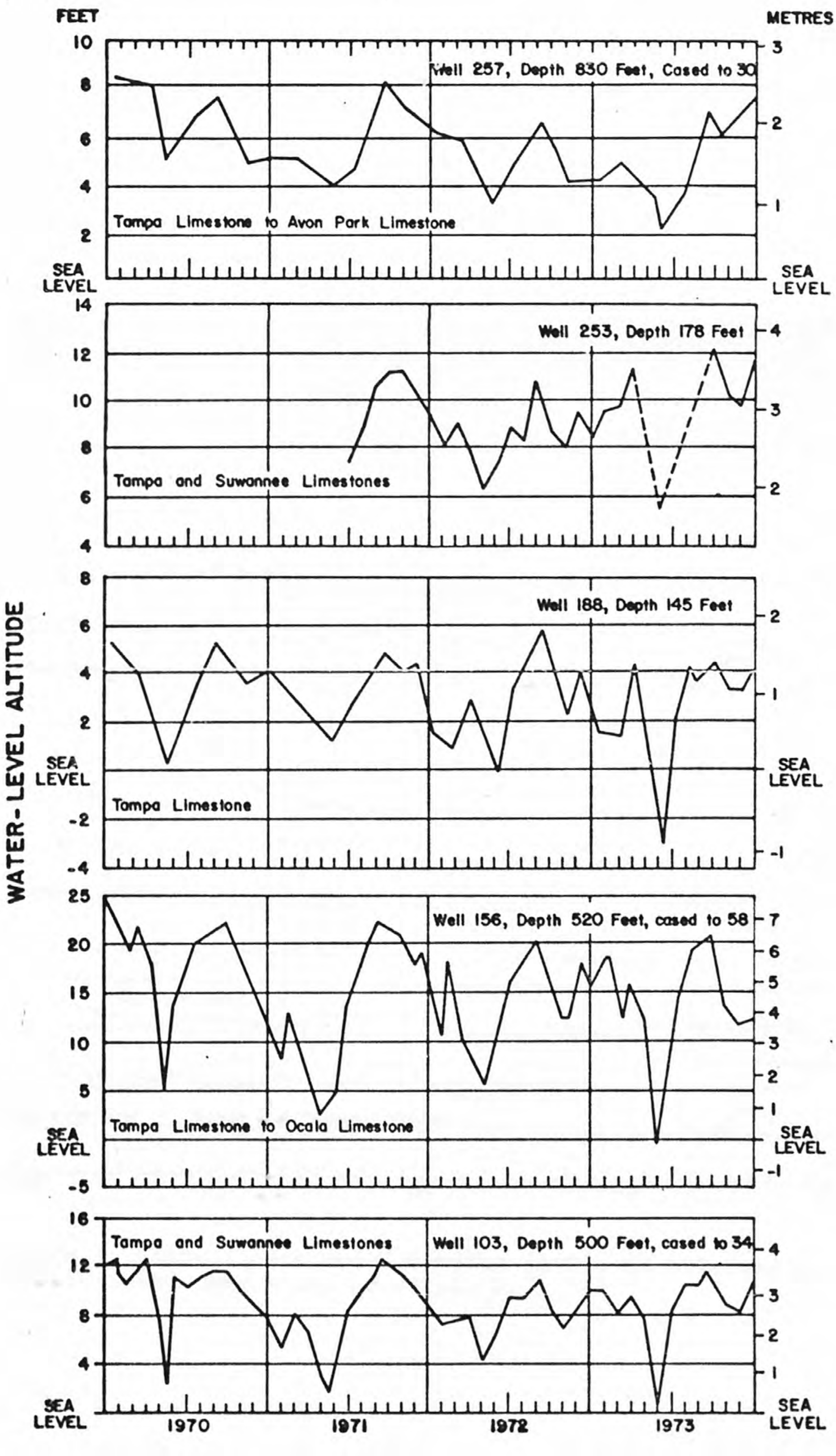


Figure 3. Seasonal water-level fluctuations in selected wells. Well locations are shown on figure 7.

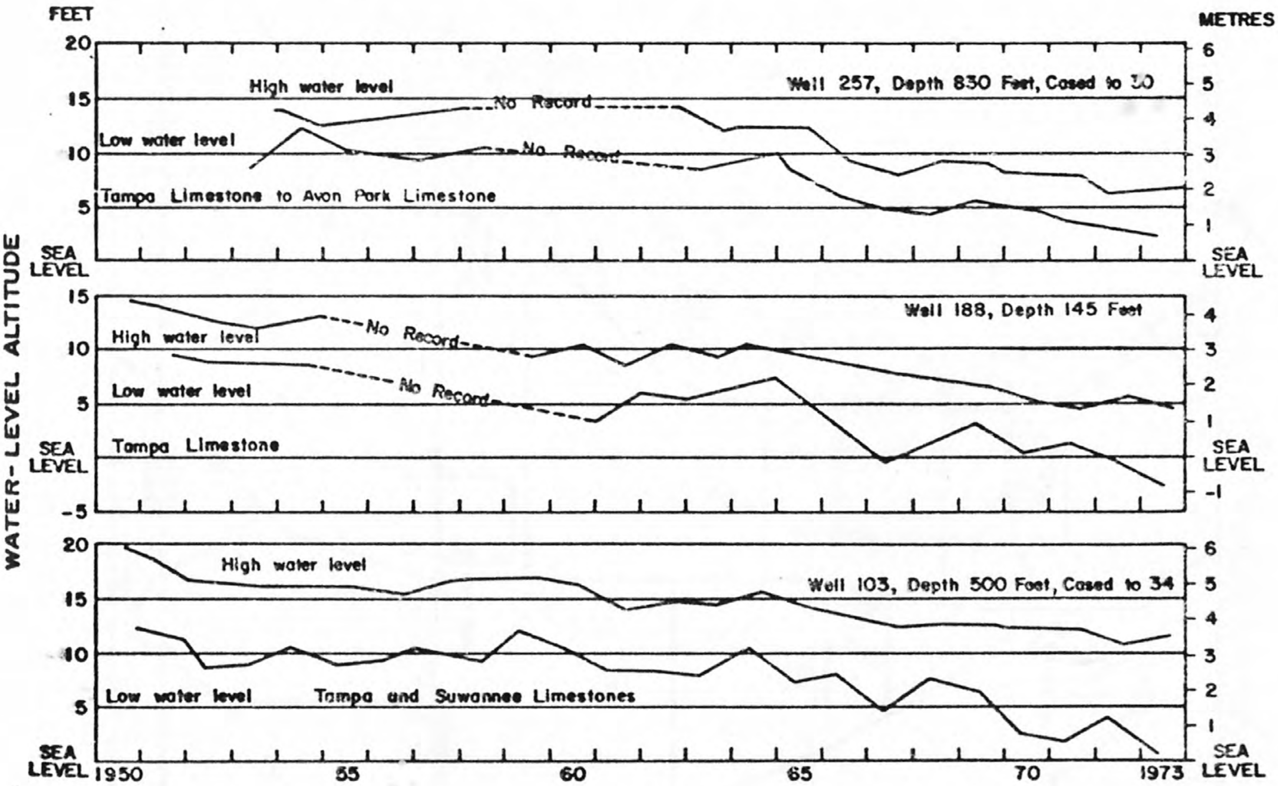
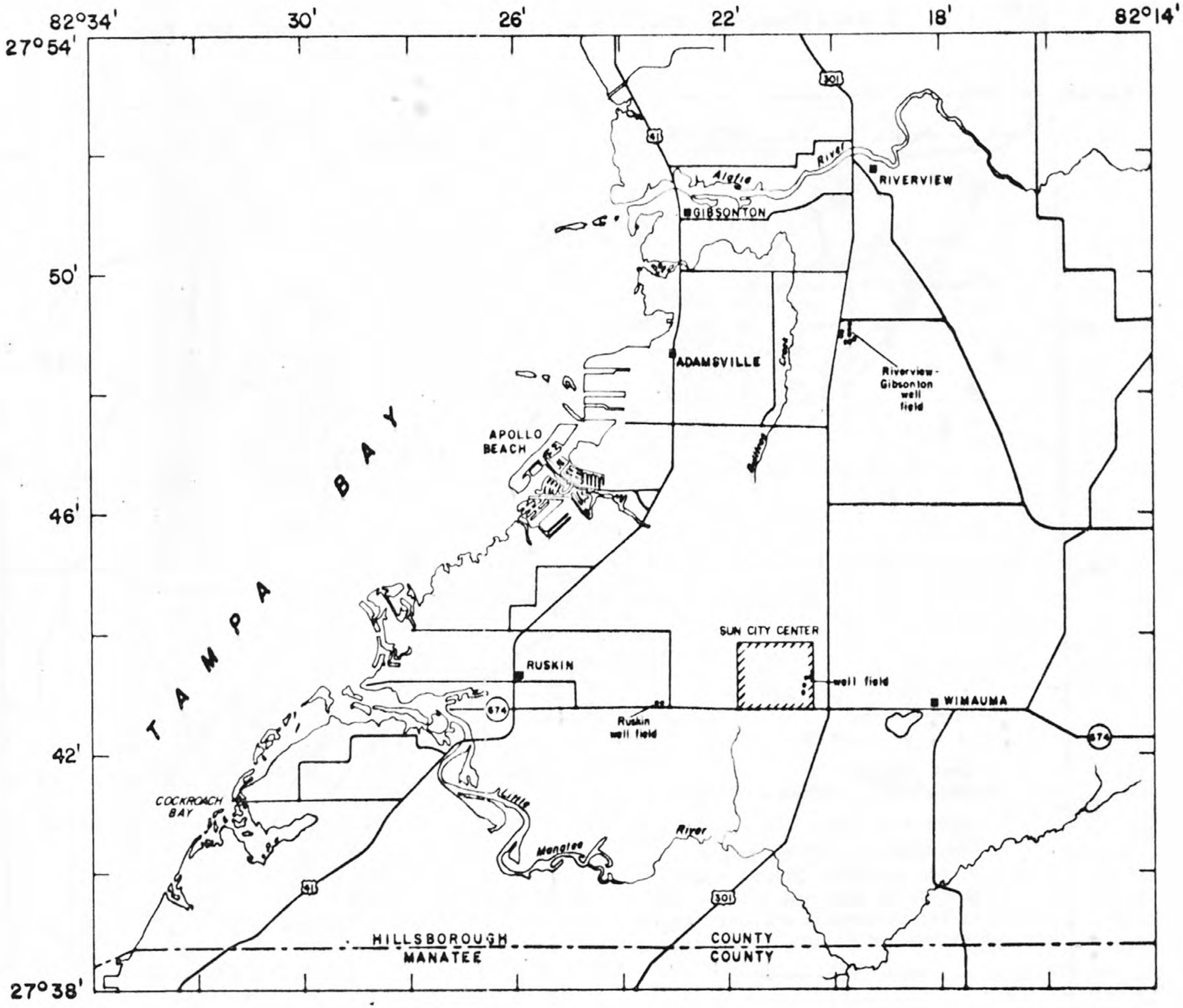


Figure 4. Annual high and low water levels in selected wells. Well locations are shown on figure 7.

Plain Base map



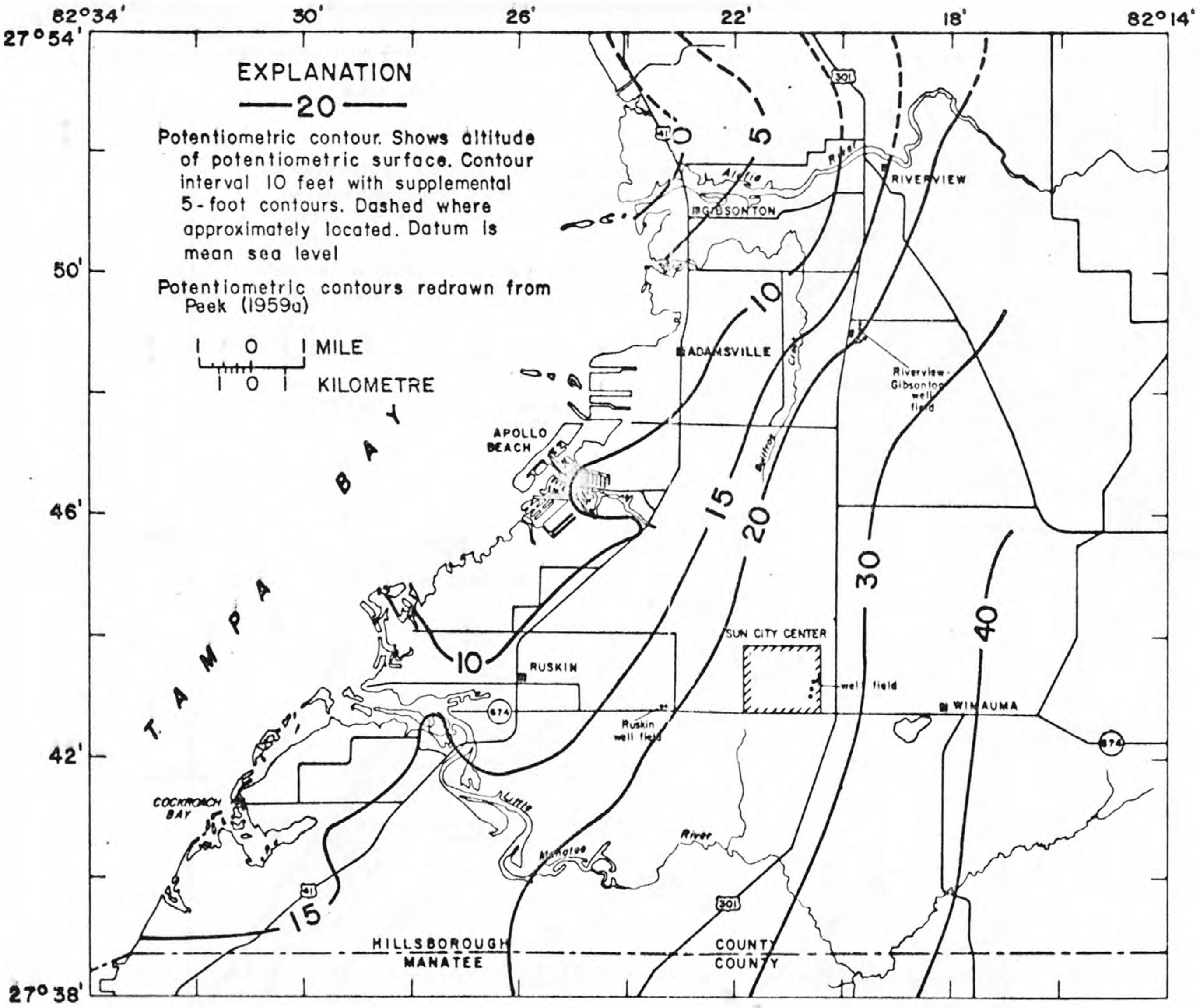


Figure 5. Potentiometric surface of the Floridan aquifer, May 1953.

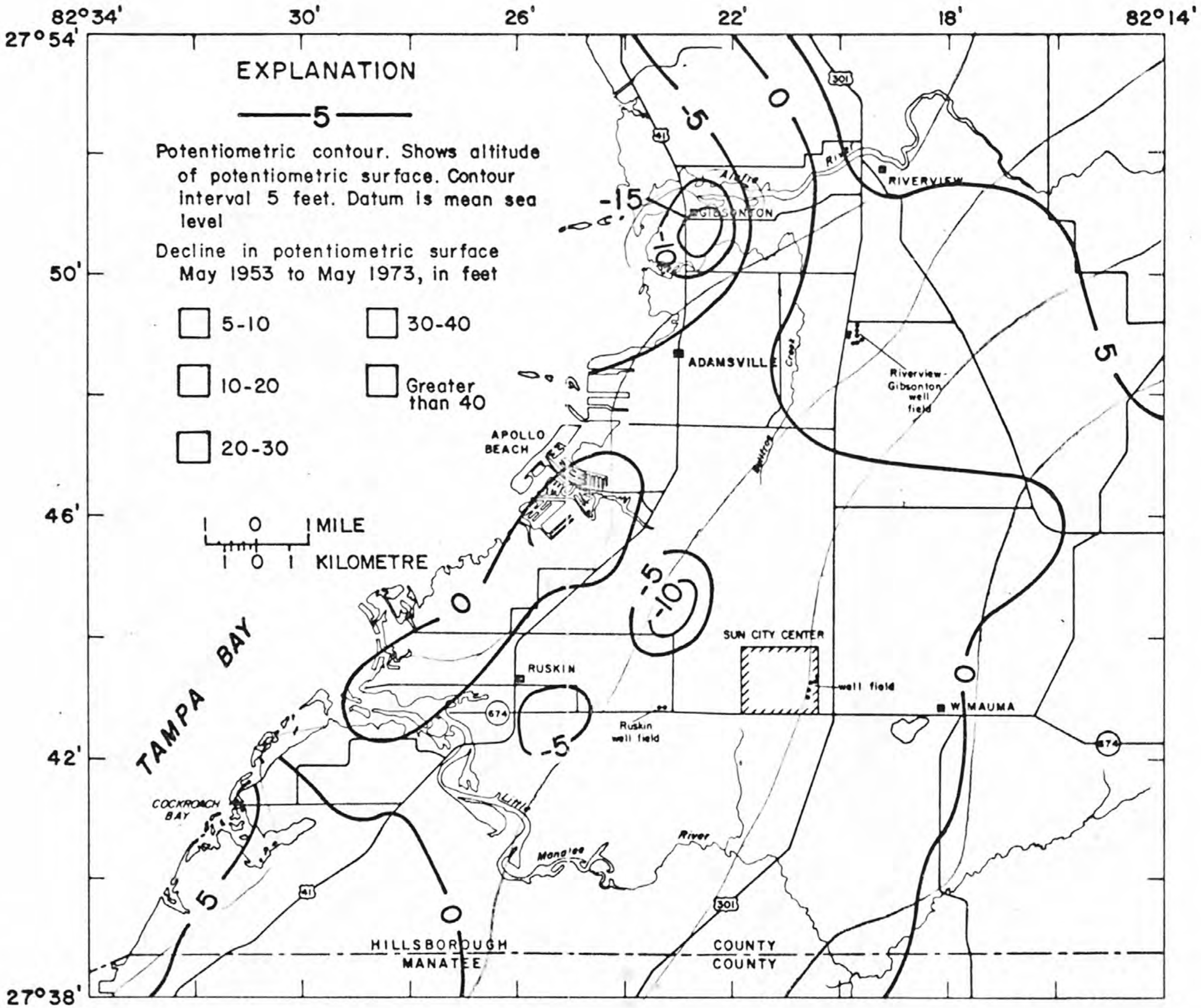


Figure 6. Potentiometric surface of the Floridan aquifer, May 1973, and decline of potentiometric surface May 1953 to May 1973.

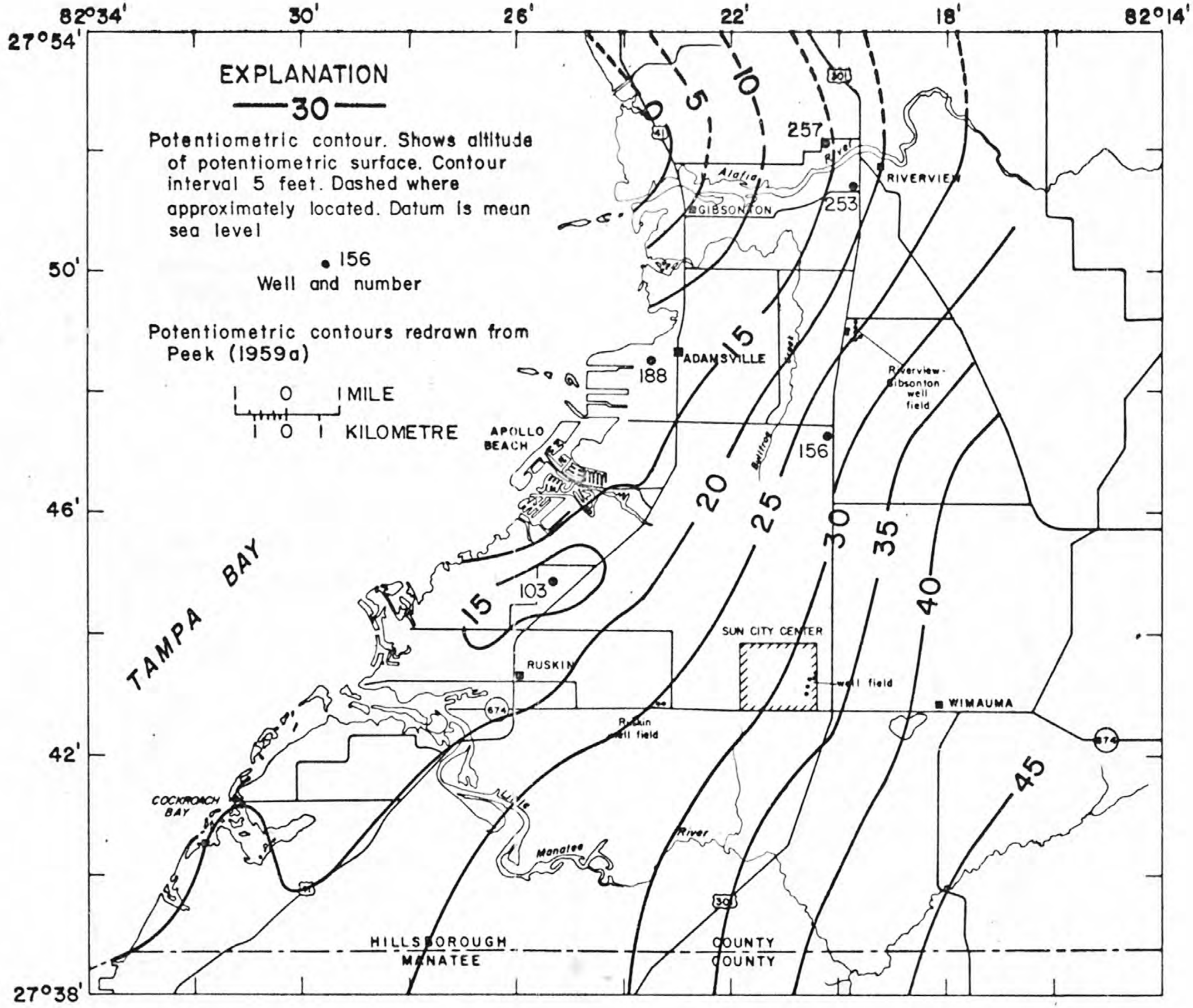


Figure 7. Potentiometric surface of the Floridan aquifer, October 1952.

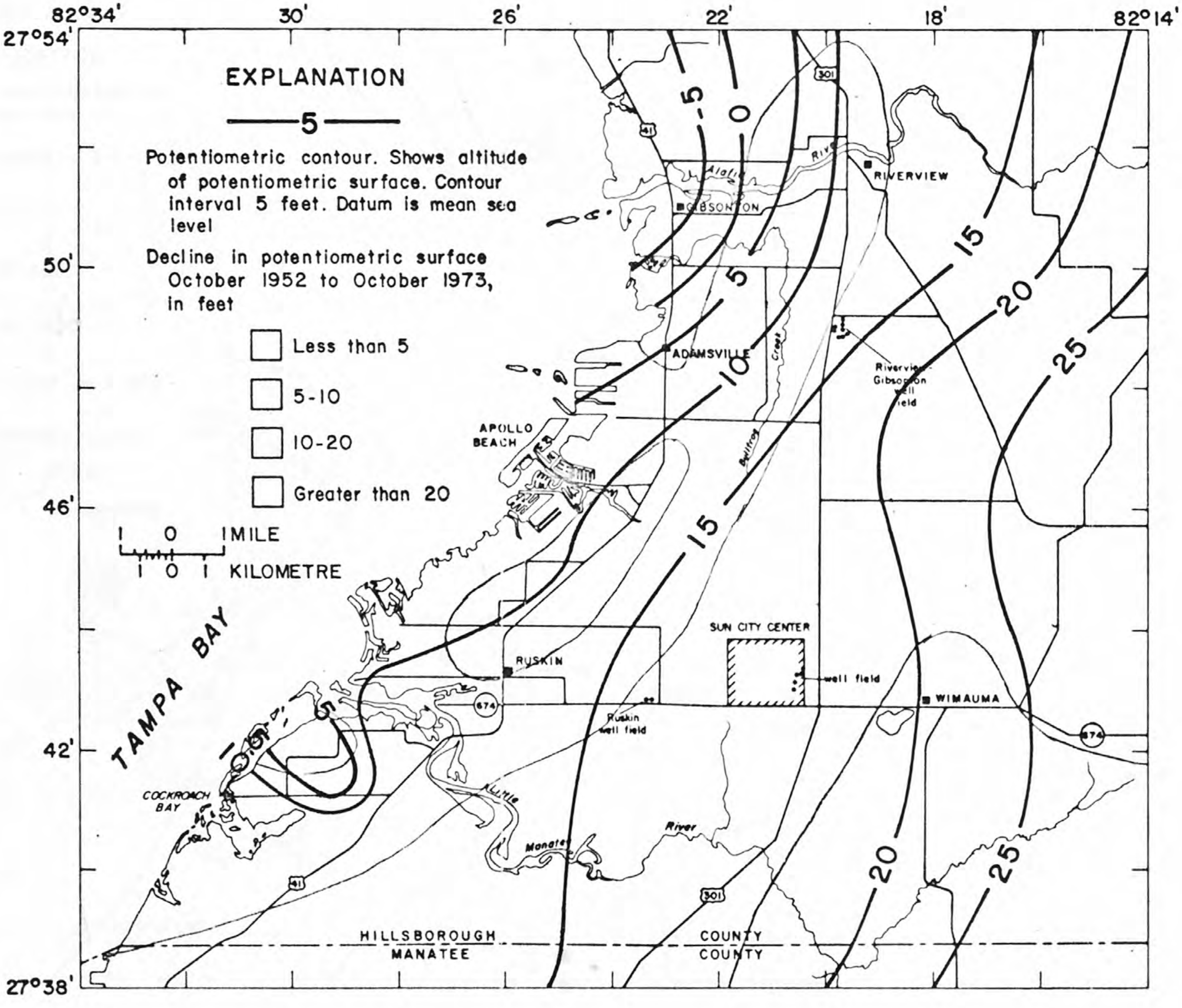


Figure 8. Potentiometric surface of the Floridan aquifer, October 1973, and decline of potentiometric surface October 1952 to October 1973.

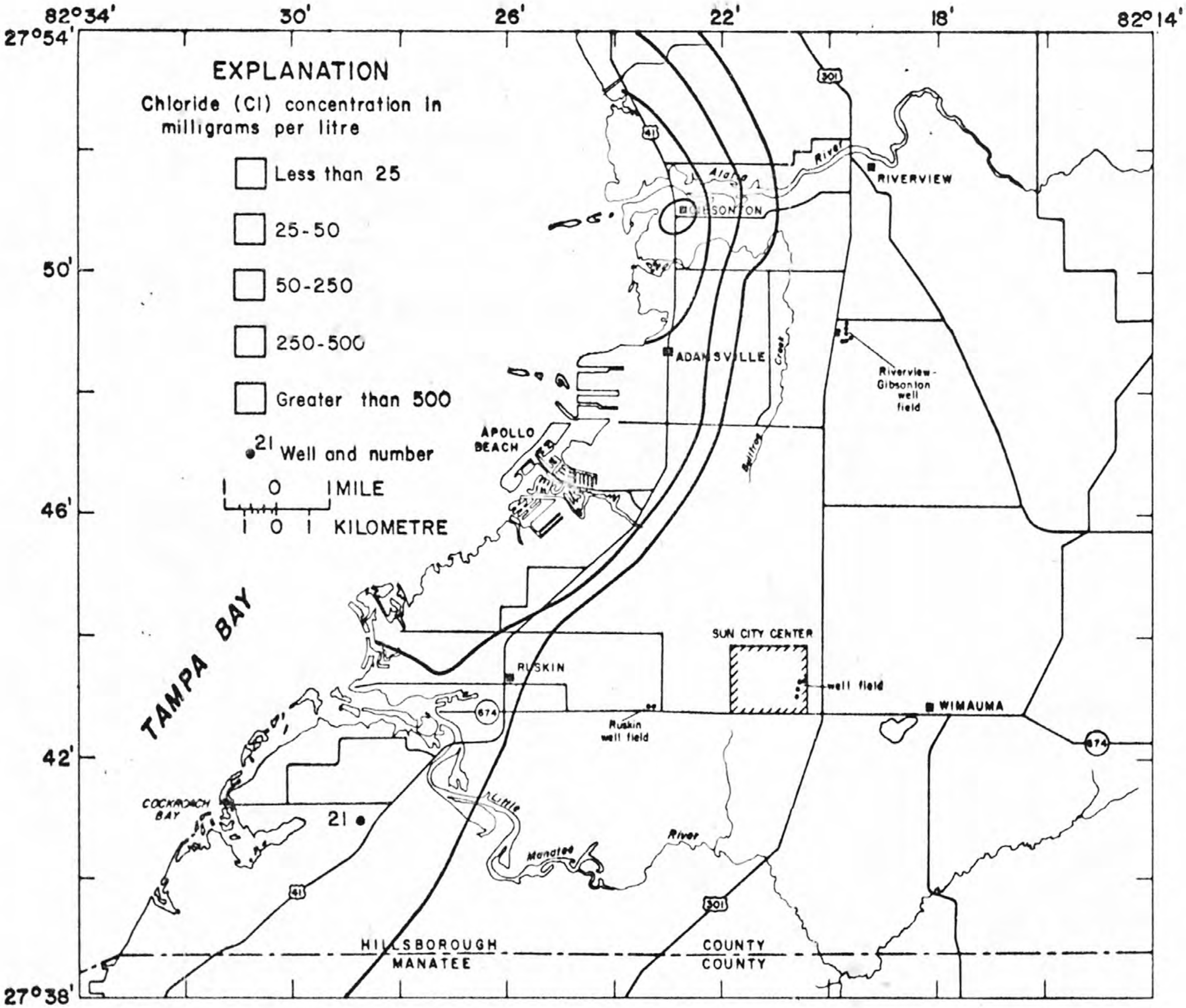


Figure 9. Chloride concentration of water in the Floridan aquifer, May 1974.

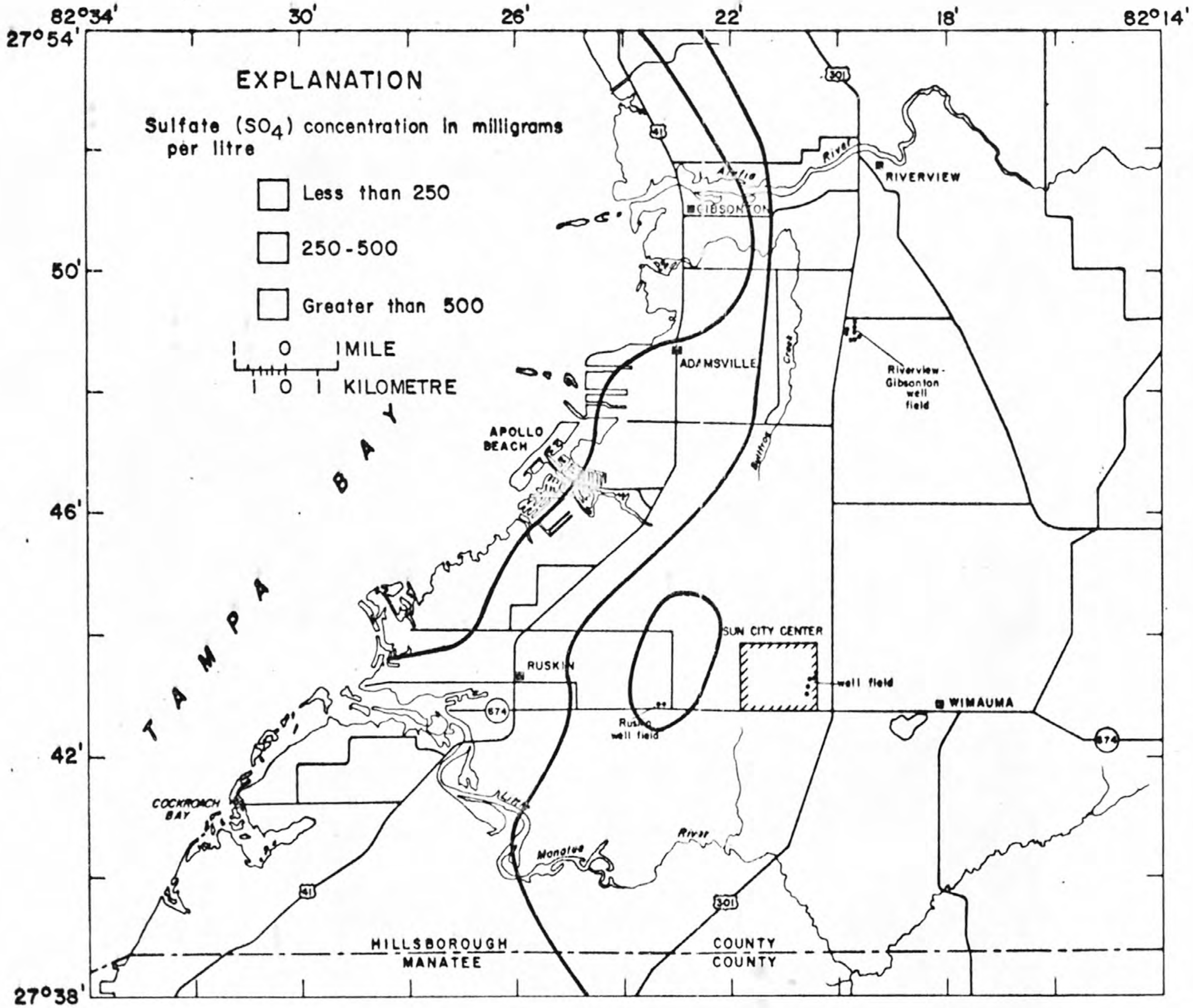


Figure 10. Sulfate concentration of water in the Floridan aquifer, May 1974.