Prepared in cooperation with the
CITY OF TAMPA, FLORIDA

WATER-RESOURCES INVESTIGATIONS
REPORT 83-4085

discharge of the spring into the Hillsborough River for 1961-80 and the monthly mean diversion to Tampa Reservoir are shown in figure 14.

The discharge of Sulphur Springs is related to the elevation of the potentiometric surface of the Floridan aquifer. A linear relation between spring discharges and water levels at well 66, 1.5 miles northwest of the springs (fig. 1), has an average multiple correlation coefficient of 0.90 and an average standard error of estimate of 53 percent. Analyses of spring discharge and stages of Tampa Reservoir do not show any significant relation.

Rosenau and others (1977) stated that water-quality data collected at Sulphur Springs from 1946 to 1972 showed a gradual deterioration in quality. During the 26-year period, specific conductance increased from 260 to 1,240 micromhos per centimeter (μmho/cm); dissolved solids concentrations increased from 480 to 680 milligrams per liter (mg/L); sulfate concentrations increased from 60 to 100 mg/L; and chloride concentrations increased from 160 to 230 mg/L. Menke and others (1961) stated that a hydraulic connection may exist between the spring and other aquifers at depths greater than that penetrated by existing wells in the area. The source of the mineralized water in the spring probably originates in the deep zones of the Floridan aquifer at depths below the bottoms of existing wells in the area.

A pump was installed in Sulphur Springs in May 1964 to provide Tampa with a supplemental water supply of about 20 Mgal/d during periods when the stage of the Hillsborough River is low and water demands are high.

According to Menke and others (1961), concentrations of dissolved materials in Sulphur Springs fluctuate with the stage and discharge of the spring. Specific conductance and chloride and dissolved solids concentrations showed increases during periods when the water level in the pool was lowered. Plots of discharges and concentrations of selected constituents for the period 1946-80 are shown in figure 15. Specific conductance had the largest change with increased discharge of the spring; chloride and sulfate concentrations had the smallest changes with increased discharge. The pool level in Sulphur Springs is controlled by a hand-operated gate on the west side of the pool. If the spring pool is artificially lowered, discharge of the spring is increased for any given potentiometric head, and the quality of the water differs from that during like discharges at high or normal pool levels. The scattering of points showing chloride and sulfate concentrations and specific conductance in figure 15 is due to sampling of the spring when the pool level was artificially lowered below normal operating level. The data illustrate that the chemical quality of water in Sulphur Springs is related to the head of water maintained in the spring pool.

TOURIST CLUB WELL

A plot of chloride concentrations versus specific conductance of water from an unused Floridan aquifer well about 440 feet southeast of Sulphur Springs and 140 feet north of the Hillsborough River is shown in figure 16. The well is 318 feet deep and is cased to 80 feet, or about 60 feet into the upper part of the Floridan aquifer. A linear regression equation of chloride concentrations as a function of specific conductance, determined for the well, is as follows: chloride (mg/L) = −336 + 0.334 × specific conductance (μmho/cm). The correlation coefficient is 0.97.

Specific conductance and chloride concentrations of water in the well have increased steadily since about 1971. During the period 1959-81, chloride concentrations ranged from 200 to 4,800 mg/L (fig. 17). During the same period, specific conductance ranged from 1,000 to 15,500 μmho/cm. The high values of specific conductance and chloride concentrations indicate that mineralized water occurs below 80 feet (bottom of well casing) and, in all probability, at a depth greater than several hundred feet. Menke and others (1961) indicated that highly mineralized water in the area is derived from below the Ocala Limestone and is related to connate water in older rocks that has not been flushed by freshwater.

A plot of the potentiometric head in the Tourist Club well and the discharge of Sulphur Springs for the period 1963-81 is shown in figure 18. The data are included to show the relation between the discharge of the

Curiosity Sink

Curiosity Sink is 2.2 miles north-northwest of Sulphur Springs (fig. 1) and is the terminus of Curiosity Creek. The sink is reported to be about 25 feet deep and 40 feet in diameter. The overall sink area is about 500 feet in length and 100 feet in width. The Curiosity Sink area is internally drained, and under normal conditions, water that discharges into the sink area flows downward to the Floridan aquifer. However, overflow from the sink area occurs on the west side when water levels exceed an elevation of 29 feet above sea level.

The depth of the southern part of the Curiosity Sink area was sounded in 1980, shortly after it was cleaned and deepened by the city of Tampa. Depths averaged 6 to 8 feet below the water surface in the northern part, 4 feet in the central part, and 12 feet in the southern part. A pumping station with an 18-inch discharge pipe was installed in the southern part of the sink area in 1980 to reduce flooding. During high-water levels in the sink, water is pumped into a shallow basin east of the sink and is then discharged into the Hillsborough River by a pipeline. Water levels in the sink area averaged about 19 feet above sea level during nonpumping periods and 17 feet during periods of pumping at an average rate of about 5,000 gal/min. Based on a pumping rate of 5,000 gal/min and a drawdown of 2 feet in the sink, the specific capacity of the sink is about 2,500 gal/min per foot of drawdown.

Blue Sinks

Blue Sinks refers to an area of numerous small sinks 1,000 to 1,800 feet south of Curiosity Sink. A cluster of five of the more prominent sinkholes is shown in figure 1. The area has no surface streams and is drained entirely by sinkholes. A low area on the west side of the sink cluster near the 25-foot land-surface contour appears to be the former streambed of Curiosity Creek (fig. 1).

The site was visited several times by the senior author in 1963-64; at that time, the sinks were 20 to 30 feet deep, and water was observed to be flowing at the bottoms of two of the sinkholes. The sinkholes have since been filled with refuse and in 1981 were less than 6 feet deep and dry.

Orchid Street Sink

Orchid Street Sink (also known as Linebaugh Sink), which is about 6,600 feet north of Sulphur Springs (fig. 1), receives runoff from a residential area. The sink is 60 feet long, 50 feet wide, and bottoms at 24 feet below a general land surface of 26 feet above sea level. When the sink was sounded in March 1981, the water level in a 20-foot circular pool on the south side was 13 feet above sea level. The deepest sounding was 11 feet.

Poinsettia Street Sink

Poinsettia Street Sink (Trinity Springs), which is about 1,100 feet north of Orchid Street Sink (fig. 1), receives urban runoff from a residential area. The sink is 75 feet long, 50 feet wide, and bottoms at about 35 feet below a general land surface of 28 feet above sea level. A 30-foot circular pool of water on the west side of the sink was sounded in March 1981 and found to have a maximum depth of 20 feet when the water level in the sink was about 13 feet above sea level.

Tenth Street Sink

Tenth Street Sink is 1,900 feet north-northeast of Sulphur Springs and about 700 feet east of Nebraska Avenue (fig. 1). The sink is 25 feet in diameter and 27 feet deep below a general land surface of about 10 feet above sea level. Land-surface elevation is the lowest observed at a sink in the area. The sink was sounded in March 1981 when its water level was about 5 feet above sea level.

Greco Sink

Greco sink is in the southeastern part of Temple Terrace, about half a mile west of the Hillsborough River (fig. 1). The sink is 110 feet in diameter and bottoms at 32 feet below a general land surface of 45 feet above sea level. The deepest hole sounded was 18 feet below the water level in the sink, or 7 feet above sea level. Quality of a water sample collected at the bottom of the hole suggests a hydraulic connection between the sinkhole and the Floridan aquifer (Stewart and others, 1978).

Hillsborough River Sinks

A profile of the Hillsborough River from Tampa Dam to Fletcher Avenue (Goetz and others, 1978) shows several holes in the bed of the river about 0.7 to 6.9 miles upstream from the dam (fig. 1). The holes range in depth from about 5 to 18 feet below the riverbed and bottom at elevations that range from 6 feet above sea level to 12 feet below sea level. The bottom of a hole 0.7 mile upstream from Tampa Dam is about 6 feet below the riverbed. The deepest hole is 4.4 miles upstream of Tampa Dam or about 0.3 mile east of 56th Street. The hole is 18 feet below the riverbed and bottoms at about 1 foot below sea level.

A deep hole (locally known as Hannah's Swirl) is in a sharp bend of the river about a mile downstream from Tampa Dam and about 0.8 mile southeast of Sulphur Springs (fig. 1). Although the hole may be due to scouring of the river bottom, local residents report the hole to be about 20 feet deeper than the river bed.

A seismic reflection survey of the Hillsborough River in 1981 did not indicate any unreported sinkholes in the river in the Sulphur Springs area (R.M. Wolansky, U.S. Geological Survey, oral commun., 1981).

DYE TESTS

In January and March 1958, the city of Tampa injected fluorescein dye into Curiosity Sink and Blue Sink 5 (fig. 1), about 2 miles north of Sulphur Springs, to determine the rate and direction of ground-water movement. For the January test, 8 pounds of dye were injected into Curiosity Sink, and for the March test, 3.5 pounds of dye were injected into Blue Sink 5. Blue Sink 5 is 1,800 feet south-southeast of Curiosity Sink. During the tests, dye followed a general course toward Sulphur Springs, corresponding to the regional flow patterns shown in figure 13, but its course from Blue Sink 5 to Orchid and Poinsettia Street Sinks was altered somewhat by local structural controls in the aquifer system (Menke and others, 1961). The alteration in course probably was due to an extensive and well-developed cavity system that connects Sulphur Springs with several sinkholes as much as 2 miles north of Sulphur Springs. The time observed for dye to arrive at Sulphur Springs, Poinsettia Street Sink, and Orchid Street Sink after injection and the rates of ground-water movement are given in table 1. During the Curiosity Sink test, ground-water velocities ranged from 5,100 to 7,600 ft/d; for the Blue Sink 5 test, velocities ranged from 4,200 to 9,200 ft/d. Dye was not detected in Tenth Street Sink during the tests.

SULPHUR SPRINGS COLIFORM INDICATOR BACTERIA

The Sulphur Springs swimming pool has been closed temporarily in May or June of most years during the past decade because of high bacteria counts. The pool was closed to swimming on May 19, 1981, when the total coliform bacteria count exceeded the accepted contact level of 1,000 colonies per 100 milliliters (col/100 mL) of water. Usually, the pool is closed shortly after the spring is pumped to augment the city's water supply during the high water-demand period in May and June. The usual pumping rate is estimated to be 20 Mgal/d. Coliform bacteria counts of 1,000 col/100 mL or greater may occur throughout the year. Data collected by the city of Tampa Water Department (Ernie Wilder, Technical Services Supervisor, city of Tampa, written commun., 1981) for the period 1974-81 show that the annual period of heaviest concentration of bacteria in Sulphur Springs is January through August, and the lowest concentration is September through December. The lowest bacteria counts in Sulphur Springs for 1974-81 were observed during November, the driest month, and the highest counts were observed during April and May, moderately wet months. The bacteria count of water in Sulphur Springs probably is related to rainfall and the quality of runoff into sinkholes.

Water from Sulphur Springs and the Orchid Street and Tenth Street Sinks to the north (fig. 1) was sampled twice in May 1981 and once in July 1981. The Sulphur Springs pool is about 30 feet deep, and water samples were collected near the top, middle, and bottom of the pool; Orchid Street Sink is about 11 feet deep, and water samples were collected at middepth in the pool; Tenth Street Sink is 22 feet deep, and samples were collected near the top, middle, and bottom of the pool.

The ratio of fecal coliform to fecal streptococci (FC/FS) for samples from Sulphur Springs, Orchid Street Sink, and Tenth Street Sink are listed below.

Date (1981)	FC/FS at Sulphur Springs	FC/FS at Orchid Street Sink	FC/FS at Tenth Street Sink	Remarks
May 26	17:1-33:1	29:1	0.9:1-1.6:1	After dry period.
May 28	10:1-22:1	2.8:1	3.5:1-5.4:1	After heavy rain.
July 23	1:1	14:1	0.2:1-6:1	After moderate wet period.

Ratios of FC/FS higher than 4:1 are good indicators that pollution is derived from domestic wastes, which are largely composed of man's body wastes, laundry wastes, and food refuse (Geldreich, 1966). Wet and dry conditions at Orchid Street and Tenth Street Sinks were probably the same as that observed at Sulphur Springs.

Ground-water velocities north of Sulphur Springs range from approximately 4,000 to 9,000 ft/d. These high velocities probably are adequate for most bacteria to survive the 28 to 40 hours required to travel approximately 1 to 2 miles from the sinkholes to Sulphur Springs.

A 36-inch sewer line parallels the Hillsborough River from Sulphur Springs westward. Major sewer junctions are about 200 and 500 feet north of Sulphur Springs. The junctions are reported to have been installed at depths of about 2.0 and 2.5 feet above sea level, well below the water table of the surficial aquifer (fig. 12). The top of rock in the area is about 10 feet below sea level (fig. 9), or about 12 feet below the sewer lines. Data were not available to determine if the sewer line leaks. However, it would be expected that the bacteria count in the spring pool would not vary appreciably if the major source of bacteria was the sanitary sewer.

ESTIMATED RUNOFF LOADS

Orchid Street and Poinsettia Street Sinks are used as retention basins for urban runoff from areas around the sinks. Estimated loads of selected constituents that drain into the sinkholes were computed using average base flow and storm-runoff concentrations and runoff volumes based on

A fairly extensive and well-developed cavity system occurs in the Floridan aquifer in the Temple Terrace area and the area north of Sulphur Springs between the Hillsborough River and Fowler Avenue. Ground-water velocities of 1 to 2 miles per day were determined from two dye tests conducted in the Hillsborough River-Fowler Avenue area. Sulphur Springs is a supplemental water-supply source for the city of Tampa and a public recreation area. The spring pool has been temporarily closed to swimming in the spring of most years because coliform bacteria counts exceeded the contact limit of 1,000 col/100 mL. Bacteria counts greater than 1,000 col/100 mL occur most months.

Although the source of the coliform bacteria entering Sulphur Springs was not fully established, indications are that sinkholes north of the spring are the principal sources. The high ratio of fecal coliform and fecal streptococci for Sulphur Springs and two sinkholes north of the spring indicate that the high bacteria count is due to domestic waste. The exceptionally high ground-water velocities obtained for the area probably are adequate for most bacteria to survive the 1- to 2-day underground traveltime needed to reach Sulphur Springs.

REFERENCES

Carr, W.J., and Alverson, D.C., 1959, Stratigraphy of middle Tertiary rocks in part of west-central Florida: U.S. Geological Survey Bulletin 1092, 111 p.

Duerr, A.D., and Trommer, J.T., 1981, Estimated water use in the Southwest Florida Water Management District and adjacent areas, 1980: U.S. Geological Survey Open-File Report 81-1060, 60 p.

Geldreich, E.E., 1966, Sanitary significance of fecal coliforms in the environment: U.S. Department of the Interior, Federal Water Pollution Control Administration, Water Pollution Control Research Series Publication WP-20-3, 122 p.

Goetz, C.L., Reichenbaugh, R.C., and Ogle, J.K., 1978, Water-supply potential of the lower Hillsborough River, Florida, 1976: U.S. Geological Survey Water-Resources Investigations 78-29, 25 p.

Hunn, J.D., and Reichenbaugh, R.C., 1972, A hydrologic description of Lake Magdalene, near Tampa, Florida: Florida Bureau of Geology Map Series 49.

Hutchinson, C.B., Johnson, D.M., and Gerhart, J.M., 1981, Hydrogeology of well-field areas near Tampa, Florida, phase 1—development and documentation of a two-dimensional finite-difference model for simulation of steady-state ground-water flow: U.S. Geological Survey Open-File Report 81-630, 129 p.

Menke, C.G., Meredith, E.W., and Wetterhall, W.S., 1961, Water resources of Hillsborough County, Florida: Florida Geological Survey Report of Investigations 25, 101 p.

Murphy, W.R., Jr., Evans, R.P., and Whalen, J.K., 198_, Flooding in northwestern Hillsborough and southern Pasco Counties, Florida, in 1979: U.S. Geological Survey Open-File Report 82-96 [in press].

National Oceanic and Atmospheric Administration, 1981, Local climatological data, 1980, Tampa, Florida: U.S. Department of Commerce, National Climatic Center, Asheville, N.C.

Pride, R.W., 1962, Floods at Tampa, Florida: U.S. Geological Survey Hydrologic Investigations Atlas HA-66, 2 sheets.

Rosenau, J.C., Faulkner, G.L., Hendry, C.W., Jr., and Hull, R.W., 1977, Springs of Florida (revised): Florida Bureau of Geology Bulletin 31, 461 p.

Ryder, P.D., Johnson, D.M., and Gerhart, J.M., 1980, Model evaluation of the hydrogeology of the Morris Bridge well field and vicinity in west-central Florida: U.S. Geological Survey Water-Resources Investigations 80-29, 92 p.

Sinclair, W.C., 1981, Sinkhole development resulting from ground-water withdrawal in the Tampa area, Florida: U.S. Geological Survey Water-Resources Investigations 81-50, 19 p.

Stewart, J.W., 1968, Hydrologic effects of pumping from the Floridan aquifer in northwest Hillsborough, northeast Pinellas, and southwest Pasco Counties, Florida: U.S. Geological Survey Open-File Report FL-68005, 241 p.

______1977, Hydrologic effects of pumping a deep limestone sink near Tampa, Florida, U.S.A.: International Association of Hydrogeologists, Twelfth International Congress, Karst Hydrogeology, Huntsville, Ala.

Stewart, J.W., Goetz, C.L., and Mills, L.R., 1978, Hydrogeologic factors affecting the availability and quality of ground water in the Temple Terrace area, Hillsborough County, Florida: U.S. Geological Survey Water-Resources Investigations 78-4, 38 p.

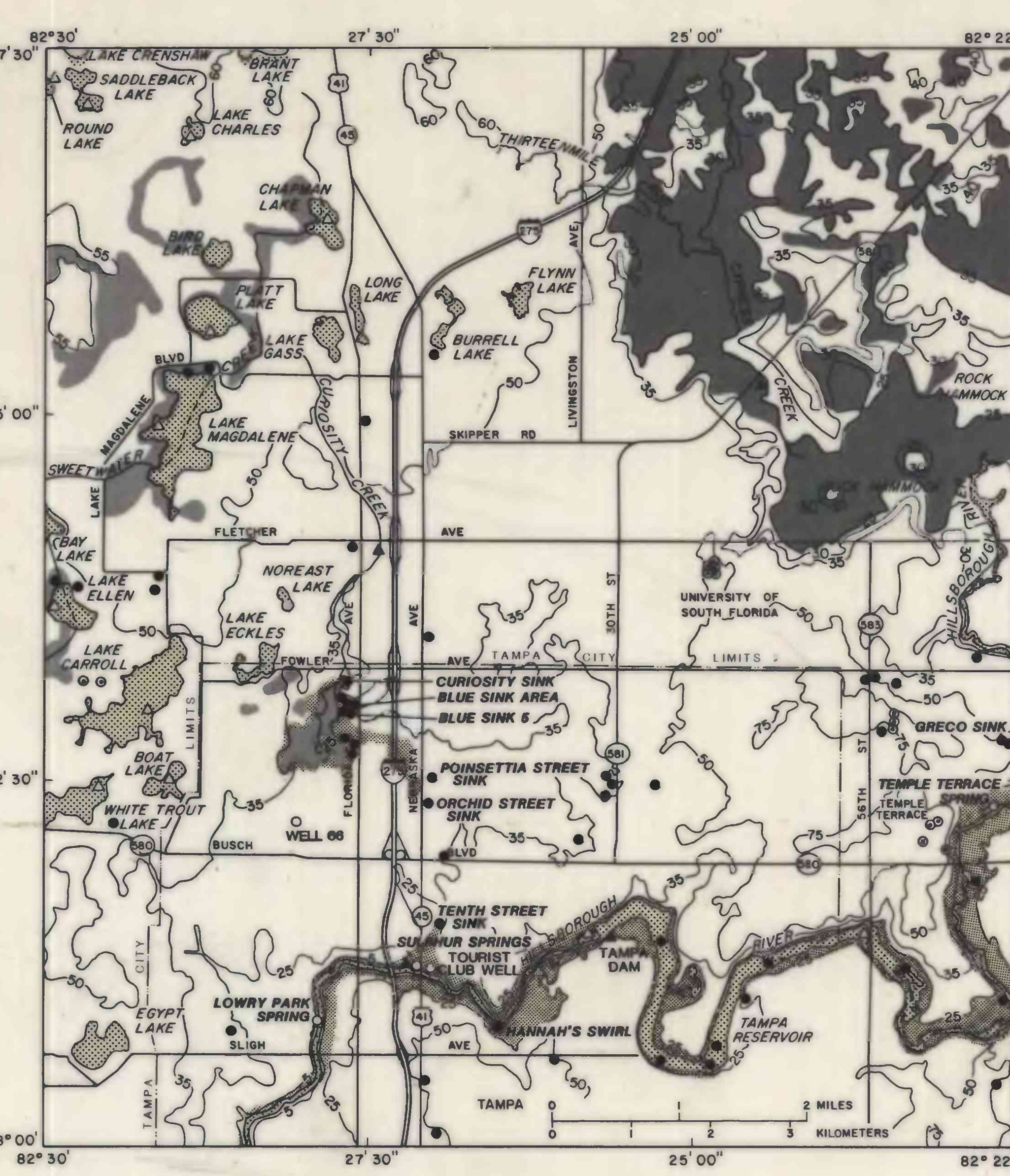
Stewart, J.W., and Hughes, G.H., 1974, Hydrologic consequences of using ground water to maintain lake levels affected by water wells near Tampa, Florida: Florida Bureau of Geology Report of Investigations 74, 41 p.

Yobbi, D.K., and Woodham, W.M., 1981, Ground-water levels in selected well fields and in west-central Florida, May 1981: U.S. Geological Survey Open-File Report 81-1106, 2 sheets.

Yobbi, D.K., Woodham, W.M., and Schiner, G.R., 1981, Potentiometric surface of the Floridan aquifer, Southwest Florida Water Management District, May 1981: U.S. Geological Survey Open-File Report 81-1006, 1 sheet.

ABBREVIATIONS AND CONVERSION FACTORS

Factors for converting inch-pound units to International System (SI) of Units and abbreviations of units



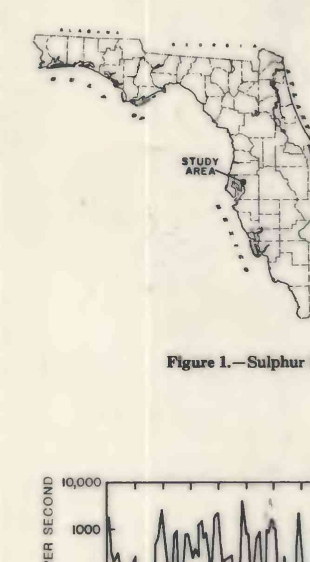


Figure 1.—Sulphur Springs area showing physiographic features and locations of observation and public water-supply wells.

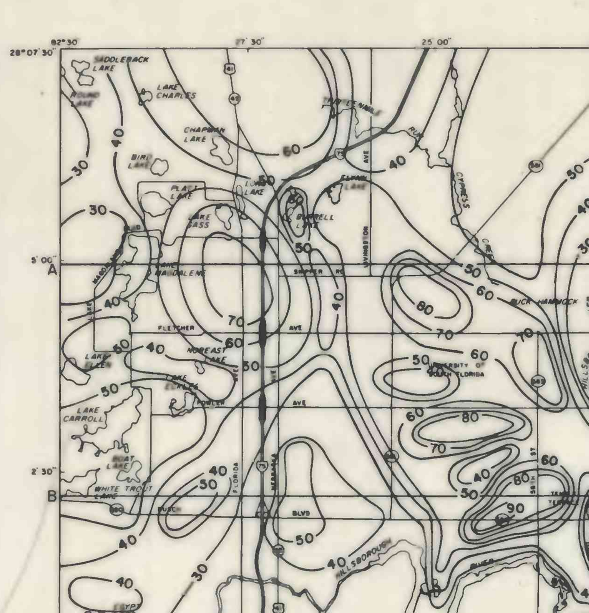


Figure 7.—Thickness of surficial deposits (includes confining layer).

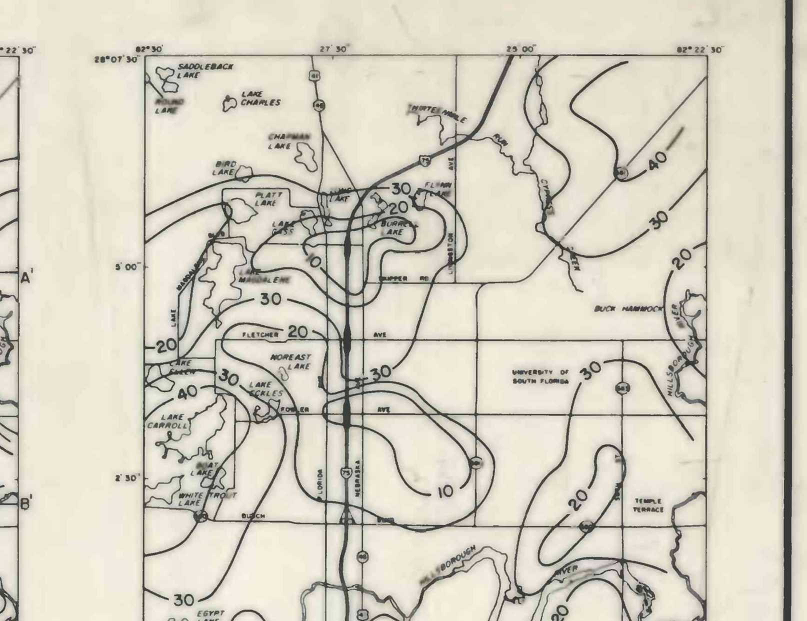


Figure 8.—Generalized thickness of the clay, sandy clay, and clayey sand confining layer.

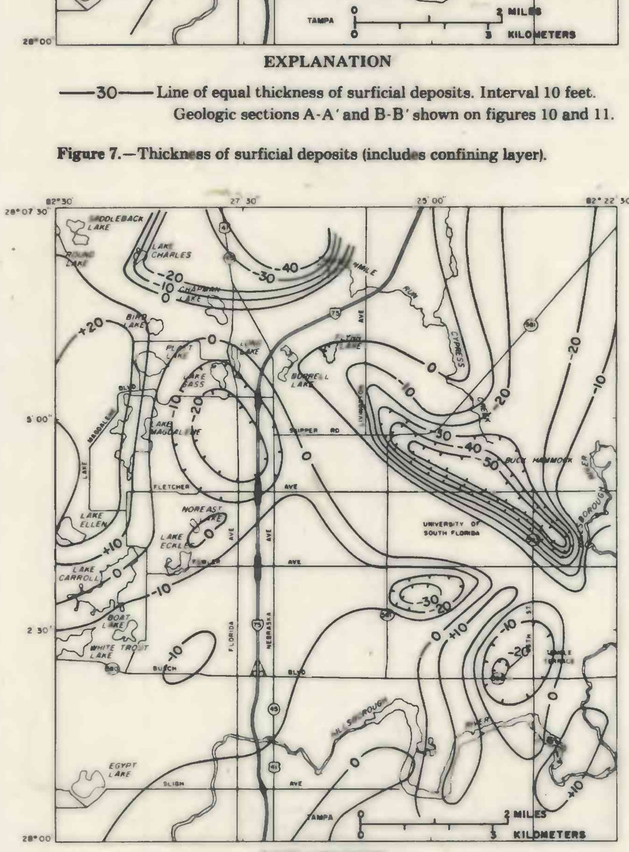


Figure 9.—Generalized configuration of the top of the Floridan aquifer.

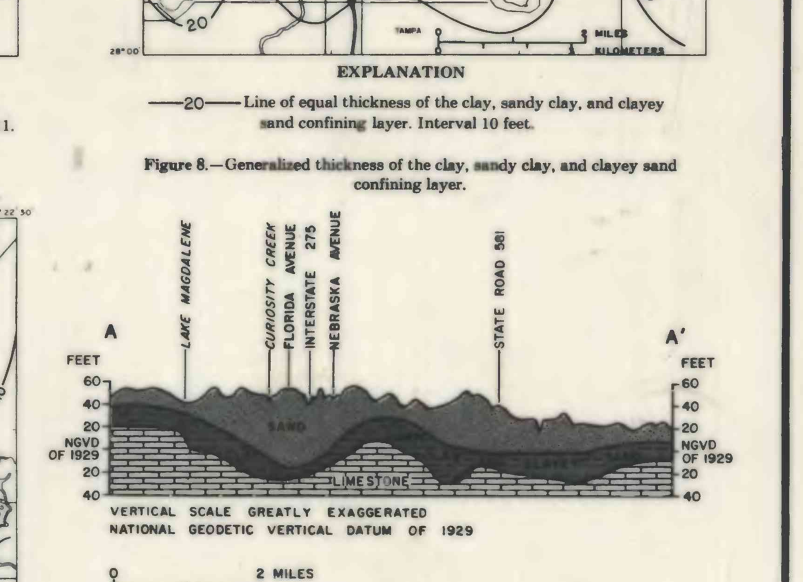


Figure 10.—Generalized geologic section of the northern part of the study area (location of section is shown in figure 7).

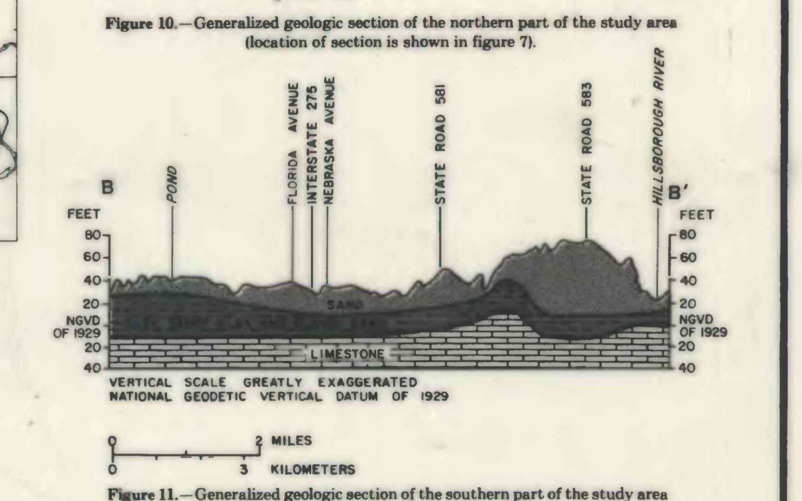


Figure 11.—Generalized geologic section of the southern part of the study area (location of section is shown in figure 7).

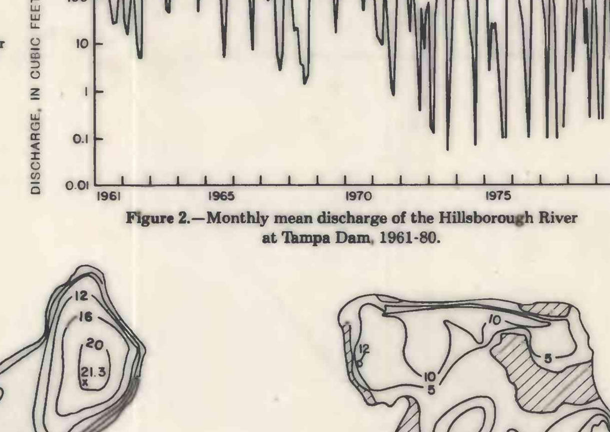


Figure 2.—Monthly mean discharge of the Hillsborough River at Tampa Dam, 1961-80.

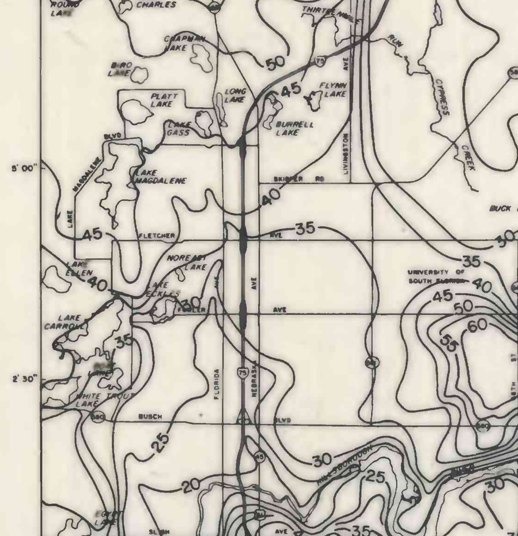


Figure 12.—Generalized configuration of water table in the surficial aquifer, May 1981 (modified from Yobbi and Woodham, 1981).

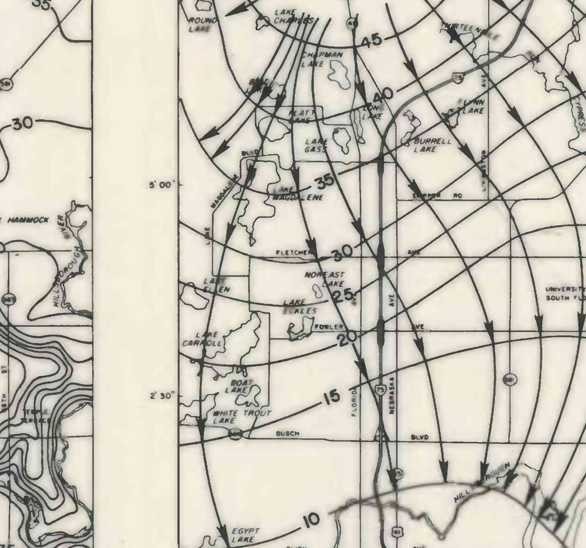


Figure 13.—Potentiometric surface of the Floridan aquifer, May 1981 (modified from Yobbi and others, 1981).

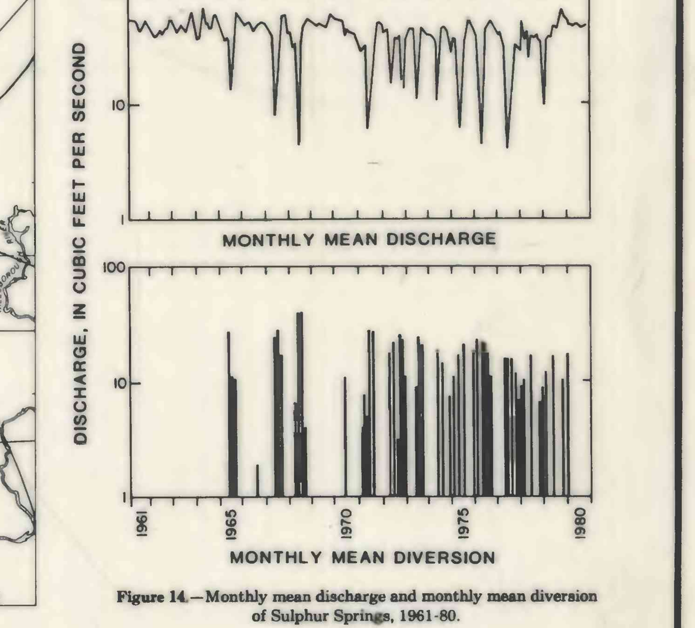


Figure 14.—Monthly mean discharge and monthly mean diversion of Sulphur Springs, 1961-80.

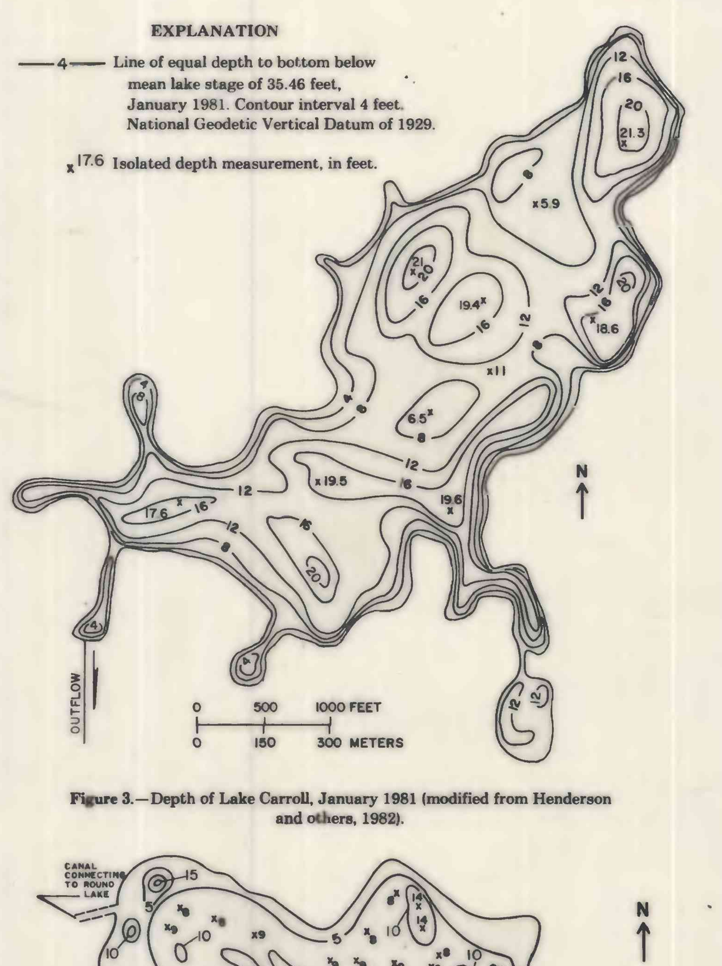


Figure 3.—Depth of Lake Carroll, January 1981 (modified from Henderson and others, 1982).

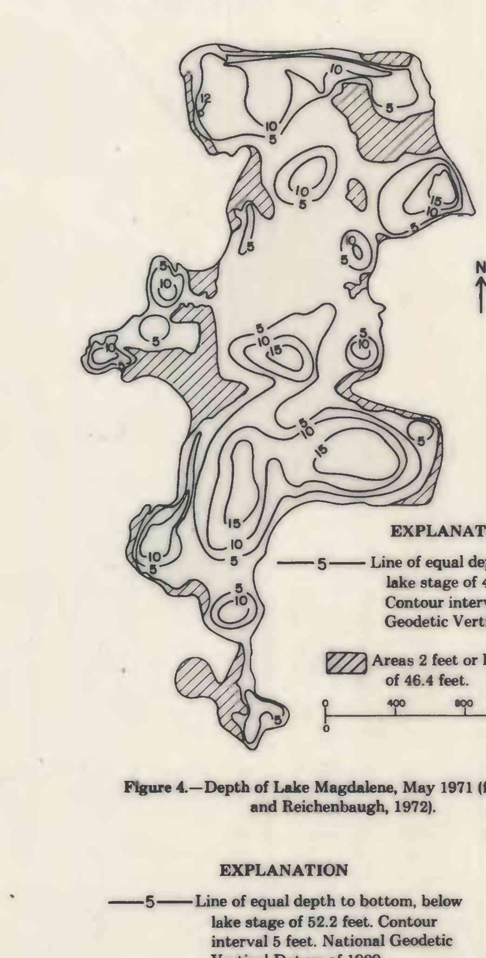


Figure 4.—Depth of Lake Magdalene, May 1971 (from Hunn and Reichenbaugh, 1972).

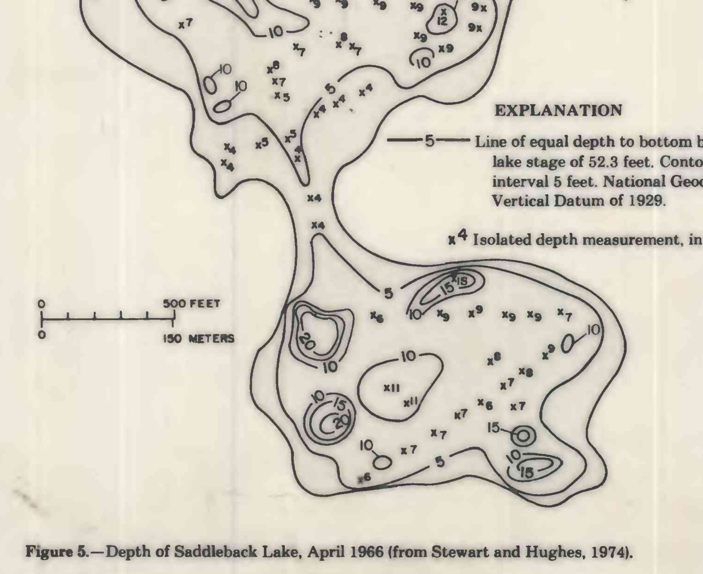


Figure 5.—Depth of Saddleback Lake, April 1966 (from Stewart and Hughes, 1974).

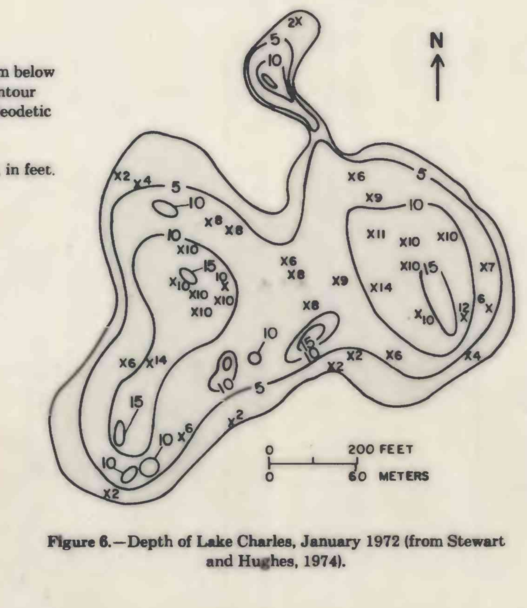


Figure 6.—Depth of Lake Charles, January 1972 (from Stewart and Hughes, 1974).

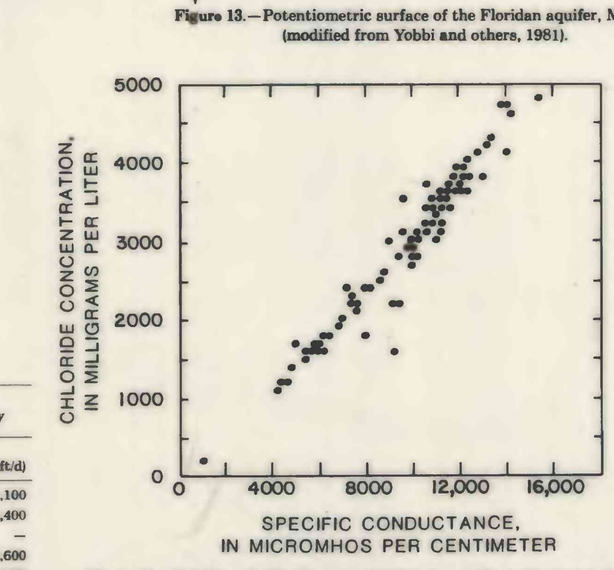


Figure 16.—Relation of chloride concentration to specific conductance of water from the Tourist Club well, 1946-80.

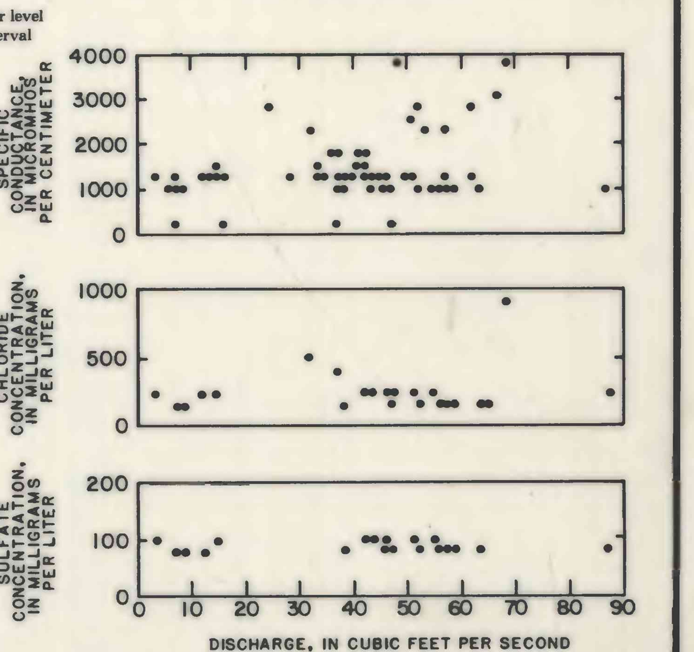


Figure 15.—Relation of specific conductance (top), chloride concentration (middle), and sulfate concentration (bottom) to discharge of Sulphur Springs, 1946-80.

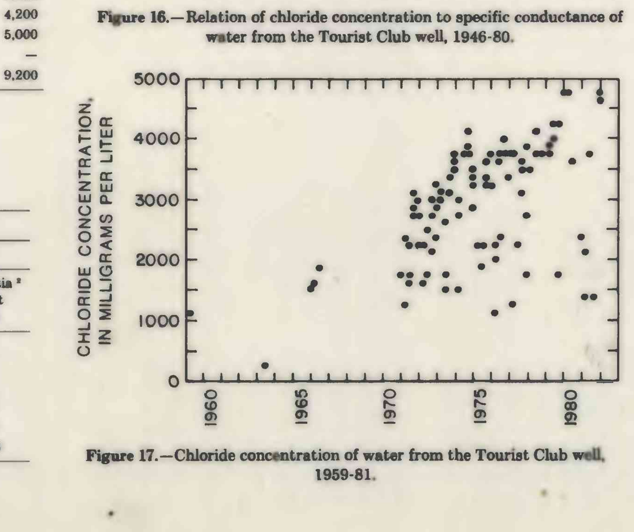


Figure 17.—Chloride concentration of water from the Tourist Club well, 1959-81.

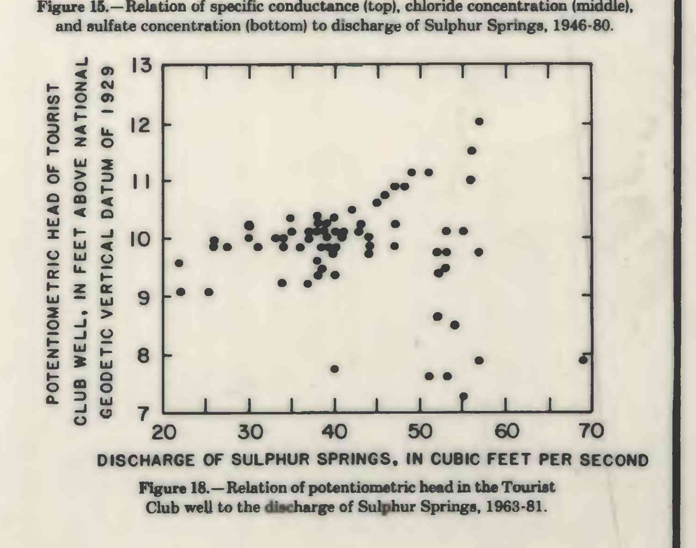


Figure 18.—Relation of potentiometric head in the Tourist Club well to the discharge of Sulphur Springs, 1963-81.

HYDROGEOLOGY OF THE SULPHUR SPRINGS AREA, TAMPA, FLORIDA

By
J.W. Stewart and L.R. Mills

1984