

INTRODUCTION

The Sulphur Springs area encompasses about 56 mi<sup>2</sup> in west-central Florida and includes a highly urbanized section of the north-central part of the city of Tampa in western Hillsborough County (fig. 1). The area includes the city of Temple Terrace and the University of South Florida, several industrial and commercial plant sites, and a large commercial recreational site. The Hillsborough River flows through the eastern and southern parts of the area. Most of the western half contains numerous lakes and is partly urbanized. The northern quarter is largely swampy, but much of it is proposed for subdivision development. The southwest quarter includes Temple Terrace and is highly urbanized. The west-central part has numerous sinkholes, an internally drained area, and an area that is subject to flooding. Storm runoff from two residential areas in Tampa is diverted into sinkholes that connect with the Floridan aquifer in the southwestern part of the Hillsborough River near Interstate 275. In use as a supplemental water supply for the city of Tampa and is also a recreational area.

In 1960, the U.S. Geological Survey, in cooperation with the city of Tampa, began a study to determine the hydrogeology of the Sulphur Springs area. The purpose of the study was to provide hydrologic and geologic information that would assist managers in (1) protecting the water resources of the area, and (2) developing plans for control of water use and development where a high water table and other hydrologic conditions are a factor. The information obtained from the study includes the hydrologic impact of using sinkholes as stormwater retention basins, the design and location of sanitary sewage systems, and the location of underground aquifers and the location of underground aquifers.

Information on the hydrology and water quality of the area is included in a report by Menke and others (1961). Map reports of Lake Magdalena (Humm and Reichenbaugh, 1972) and of the Hillsborough River (Humm and Reichenbaugh, 1972) are also available. A hydrogeologic study of the Hillsborough River, written in common, (1982) describes the general hydrology and geology at these lakes. Stewart and Hughes (1974) evaluated the effects on the Floridan aquifer of using ground water to maintain lake levels in the northwestern part of the area. Croft and others (1978) evaluated the water table of the surficial aquifer and the potentiometric surface of the Floridan aquifer in the southeastern part of the study area. The study area is bounded by the Southwest Florida Water Management District. Hydrologic reports that contain data for several hydrologic monitoring stations in the area are published annually by the Geological Survey. During this investigation (1981), field work included an inventory of wells and sinkholes, collection of water samples, and a hydrogeologic analysis from Sulphur Springs and three fields, determination of peak water levels of the 1979 flood in the west-central part of the area, and measurements of water levels in a well used in preparation of water-level and potentiometric surface maps.

The climate of the area is characterized by warm, humid summers and mild, dry winters. An outline of the climate in the summer thunderstorms that frequently occur late in the afternoon during June through September. Based on records for the 49-year period from 1941 to 1989 at the Tampa weather station about 5 miles west of Sulphur Springs, the mean monthly temperature ranged from 65.9°F in January to 82.0°F in August. The mean monthly precipitation ranged from 3.8 inches in January to 8.0 inches in August. The mean annual precipitation was 47.1 inches, of which about 60 percent occurred during June through September.

Land-surface elevations range from less than 5 feet above sea level near the Hillsborough River in the southwestern part of the area below the Tampa Dam to 75 feet above sea level at the top of the Tampa Dam. The 5-, 25-, 35-, 40-, and 75-foot land contours are shown in figure 1. A conspicuous feature is the 5-foot swampy area in the northwestern part of the area. Most of the 25 feet above sea level is an area that is poorly drained and remains wet throughout most years. Land-surface elevations are less than 25 feet above sea level in an area that is poorly drained and remains wet throughout most years. Land-surface elevations are less than 25 feet above sea level in an area that is poorly drained and remains wet throughout most years. Land-surface elevations are less than 25 feet above sea level in an area that is poorly drained and remains wet throughout most years.

The principal stream in the Sulphur Springs area is the Hillsborough River. The average annual discharge of the river at the Tampa Dam (fig. 1) was 560 ft<sup>3</sup>/s in the period 1948 to 1978. The maximum discharge was 6,200 ft<sup>3</sup>/s in September 1933. The river did not have any flow for short periods during several years. Monthly mean discharges of the river at the Tampa Dam are shown in figure 2. The Hillsborough River is the principal source of water for the city of Tampa.

Other streams in the area include Cypress Creek and its principal tributary, Thimble Shoal Run, in the northeastern part of the area. Sweetwater Creek in the northwestern part, and Curiosity Creek in the west-central part. The average daily discharge of Cypress Creek, about 3 miles northeast of Sulphur Springs, was 91.4 ft<sup>3</sup>/s from 1964 to 1980. The maximum discharge was 1,200 ft<sup>3</sup>/s in September 1967. The minimum discharge was 0.05 ft<sup>3</sup>/s in January 1968. The average daily discharge of Sweetwater Creek is a series of intermittent lakes (fig. 1) that include Chapman Lake, Lake Magdalena, Bay Lake, and Lake Ellen. The average daily discharge of Sweetwater Creek at a station about 1.5 miles southeast of Lake Ellen was 7.5 ft<sup>3</sup>/s from 1961 to 1979. Extremes in discharge ranged from 430 ft<sup>3</sup>/s in March 1960 to periods of no flow during some years. Curiosity Creek is an intermittent stream that begins in a swampy area on the east side of Sweetwater Creek near Lake Gato (fig. 1). The creek drains an area of 3.8 mi<sup>2</sup> and flows into a sinkhole near the town of Sulphur Springs about 3 miles south of the lake. During calendar years 1979-80, the maximum flow of Curiosity Creek from 1.7 ft<sup>3</sup>/s in May was 28 ft<sup>3</sup>/s in July, but it extended periods of no flow for most years.

Lakes. All lakes are in the western half of the study area. Lakes Carroll and Magdalena, the largest lakes (fig. 1), are in a highly urbanized area. Lake Carroll has a surface area of about 180 acres and Lake Magdalena about 230 acres. During 1948-60, the maximum daily elevation of Lake Carroll was 80 feet above sea level, and the minimum daily elevation was 41 feet. During the same period, the maximum daily elevation of Lake Magdalena was 110 feet above sea level and the minimum daily elevation was 41 feet. Depths of Lake Carroll and Lake Magdalena are shown in figures 3 and 4. Lakes Charles, Saddleback, Round, and Crawford in the extreme southwest corner (fig. 1) are augmented by water from the power plant pumped from Florida aquifer wells (Stewart and Hughes, 1974). Depths of Saddleback Lake and Lake Charles are shown in figures 5 and 6.

GENERAL GEOLOGY. The Sulphur Springs area is overlain by surficial deposits of sand and clay that range in thickness from less than 10 feet near the Hillsborough River to more than 90 feet at Temple Terrace (fig. 7). The lower part of the surficial deposits consists of fine sand, silty sand, and silty clay. The upper part of the surficial deposits consists of sand, silty sand, and silty clay. The Floridan aquifer underlies most of the area. The confining layer is about 10 feet thick near the northwestern part of the area, about 40 feet thick in the northeastern and southwestern parts, and about 20 feet thick south of the Hillsborough River (fig. 8). Generally, the confining layer is thicker in the eastern half than in the western half. Carr and Ahrens (1959) report the occurrence of patches of the Hawthorn Formation (confining layer) in the southeastern corner of the area, largely at Temple Terrace. Isolated patches of the Hawthorn Formation also occur along the south side of the Hillsborough River south of Temple Terrace. In the Sulphur Springs area, the Tampa Limestone forms the upper part of the Floridan aquifer. The generalized configuration of the top of the Floridan aquifer ranges from 60 feet below sea level in the northern part, about 20 feet below sea level in the western part, and about 10 feet below sea level in the southern part. The Tampa Limestone, Ocala Limestone, Avon Park Limestone, and the Ocala Limestone. Generalized geologic sections of the study area are shown in figures 10 and 11. Section A-A' (fig. 10) extends from the lake area in the west to the lake swampy area in the northeast. The confining layer is thickly uniform along the section and ranges in thickness from about 20 to 30 feet. Section B-B' in the east side of the lake area, and the confining layer is thicker in the eastern part (about 40 feet) than in the western part (about 20 feet).

Extensive cavity systems have been encountered during test drilling and during excavating for commercial and industrial plant sites between Rockwood and Fletcher Avenues, about 5 miles east of Interstate 275. Large quantities of cement have been pumped into an extensive cavity system in the Florida aquifer from Sulphur Springs northeast for about 2 miles or more and a fairly deep below land surface in the Temple Terrace area (Stewart and Hughes, 1974).

HYDRAULIC PROPERTIES OF THE FLORIDAN AQUIFER. The quantity of water that an aquifer will yield to wells depends, in part, upon the hydraulic characteristics of the aquifer and its overlying and underlying confining beds. The principal characteristics are: transmissivity, the ability of the aquifer to transmit water, storage coefficient, the ability of the aquifer to store water, leakage of the confining beds to transmit water vertically from an underlying or overlying aquifer into the pumped aquifer, and hydraulic conductivity, the ability of the aquifer to transmit water through a unit area of the aquifer.

The transmissivity of the Floridan aquifer in the Sulphur Springs area is the most part high, but variable. Stewart and others (1978) reported a transmissivity of 1.3 x 10<sup>-10</sup> ft/s and a storage coefficient of 8 x 10<sup>-10</sup> for the Temple Terrace area. Ryder and others (1980) derived a transmissivity of 5 x 10<sup>-10</sup> ft/s from model calibration of a well field that included the northwestern part of the Sulphur Springs area. The leakage coefficient ranges from 2 x 10<sup>-10</sup> to 8 x 10<sup>-10</sup> ft/d. Hutchison and others (1981) derived a transmissivity of 2 x 10<sup>-10</sup> ft/s from a two-dimensional model that included the part of the area along the Hillsborough River. A hydraulic conductivity of 1.9 x 10<sup>-10</sup> ft/d was obtained for a covered area north of Sulphur Springs using the results of two test wells. It appears that most ground-water flow in this area is in the upper 20 to 30 feet of the Floridan aquifer. Because of the highly variable transmissivity, the estimated transmissivity for the Floridan aquifer is on the order of 2 x 10<sup>-10</sup> ft/s. The storage coefficient is estimated to be 8 x 10<sup>-10</sup>. The transmissivity of the Floridan aquifer in the northeastern part is 7 x 10<sup>-10</sup> ft/s. The storage coefficient is 2 x 10<sup>-10</sup>. In an area 2.12 miles east of the northwestern part of the study area, Stewart (1977) reported a transmissivity of 1.3 x 10<sup>-10</sup> ft/s and a storage coefficient of 2 x 10<sup>-10</sup> from test pumping a large-diameter sinkhole about three-fourths of a mile south of the Hillsborough River. Based on the above studies completed in or near the Sulphur Springs area, transmissivity ranges from 7 x 10<sup>-10</sup> ft/s in the northwestern part to 1.3 x 10<sup>-10</sup> ft/s in the northeastern part and 2 x 10<sup>-10</sup> ft/s in the southern part. The transmissivity is generally highest near the Hillsborough River. Values obtained for transmissivity and storage coefficient and hydraulic conductivity indicate that the Floridan aquifer is highly productive in the study area.

WATER LEVELS. Water levels of the surficial aquifer and the potentiometric surface of the Floridan aquifer for May 1981 are shown by figures 12 and 13. Water levels in the surficial aquifer range from 20 feet above sea level in the southern part to 60 feet above sea level in the Tampa Terrace area (fig. 12). High water levels in the southwestern part of the area are due largely to the low hydraulic conductivity of the greenish-gray clayey sands of the Hawthorn Formation. The material has a low permeability restricts vertical movement of water from the surficial aquifer to the Floridan aquifer. Water levels in the surficial aquifer throughout the study area are 45 to 60 feet above the potentiometric surface. The highest water levels occur in topographically high areas, and the lowest water levels occur in topographically low areas. An area of low water levels, indicated by the 20-foot contour near Interstate 275, extends south of Fowler Avenue to the Hillsborough River and includes several well-developed and prominent sinkholes north of Sulphur Springs.

During May 1981, water levels in the surficial aquifer above Tampa Dam were less than 20 feet above sea level near the Hillsborough River and probably were less than 10 feet above sea level where the aquifer discharges into the river. In the tidal reach below the dam, the stage of the Hillsborough River ranged from less than 2 feet below sea level to less than 2 feet above sea level. Water levels in the surficial aquifer above Tampa Dam were less than 20 feet above sea level near the river and were less than 10 feet above sea level at the river. The stage of the Tampa reservoir is 15 feet above sea level. Thus, the surficial aquifer in the area is a source of ground-water discharge to the river, both upstream and downstream from the Tampa Dam.

In May 1981, the potentiometric surface of the Floridan aquifer ranged from 10 feet above sea level in the southern part of the area to 45 feet above sea level in the northern part. Figure 13 shows the general direction of ground-water movement by flow lines drawn normal to the contour lines. Ground-water movement is easterly from a potentiometric high in the northwestern part. In the southern part, most ground-water flow lines trend to the northeast toward Sulphur Springs. The potentiometric surface in the study area was about 10 feet above sea level at the Hillsborough River. The head difference between the river and the Floridan aquifer indicates an upward pressure gradient along the part of the channel and represents potential discharge of water from the Floridan aquifer to the river. However, a test hole drilled in the riverbed in 1961, about half a mile southwest of Sulphur Springs, penetrated a green, sandy clay 10 to 15 feet below sea level. This material forms the confining bed that overlies parts of the Floridan aquifer in the southeastern part of the area, and, if unobstructed, would prevent upward movement of Floridan aquifer water. Above the dam, the potentiometric surface of the Floridan aquifer under the reservoir area was 3 to 6 feet lower than the stage of the reservoir. Under this condition and assuming an absence of a confining layer, a potential exists for the reservoir to recharge the Floridan aquifer. Conversely, if the reservoir stage drops below the potentiometric surface, then the aquifer has the potential to discharge to the reservoir. The Floridan aquifer in the study area is recharged by leakage from the surficial aquifer through sinkholes in internally drained areas that are directly and indirectly connected with the surficial aquifer.

Based on the May 1981 potentiometric map, a ground-water gradient of about 15 feet in 1.5 miles (30 to 15-foot contours, fig. 13) exists west of Interstate 275. The gradient decreases to 5 feet in 1.5 miles, or a reduction of about 10 feet per mile. The gradient is greatest in the area between the Tampa Dam and the Hillsborough River. The decrease in gradient is due (1) to an increase in transmissivity of the Floridan aquifer in the southern part of the area, and (2) to a change from an area of lateral or downward ground-water flow in the northern part of the area to one of upward ground-water discharge at Sulphur Springs and the Hillsborough River.

FLOODS. The west-central part of the Sulphur Springs area between Fowler Avenue and Fowler Avenue and west of Fowler Avenue has flooded on numerous occasions during the past 25 years. Prude (1963) delineated the September 1960 flood area along the Hillsborough River. Murphy and others (1982) prepared a report that delineated areas that were flooded during August, October 1978, and the city of Tampa Public Works Department (D.J. Terry, Chief Engineer, written commun., 1981) prepared maps that show areas flooded during floods occurring between September 1951 and September 1979. The 1960 and 1979 flood areas are shown in figure 1. These dates were selected to show flooding that occurred along the Hillsborough River and the Fowler Avenue-Busch Boulevard area west of Fowler Avenue.

WATER USE. In 1981, the city of Tampa pumped an average of 48.5 Mgpd from the Hillsborough River. The monthly mean precipitation ranged from 1.61 inches in October, and 11.5 Mgpd was pumped in November. The city also pumped 1.5 Mgpd from the Hillsborough River and 1.5 Mgpd from the Hillsborough River. The monthly mean precipitation ranged from 1.61 inches in October, and 11.5 Mgpd was pumped in November. The city also pumped 1.5 Mgpd from the Hillsborough River and 1.5 Mgpd from the Hillsborough River.

Table with 2 columns: Quantity pumped (Mgd) and Source. Rows include Public water supply, City of Tampa Water Company, Florida Citrus Water Company, University of South Florida, Irrigation, Air conditioning, Total ground water, Surface water, Public water supply, City of Tampa (Hillsborough River), Total surface water.

SPRINGS. One large spring, Sulphur Springs, and two small springs, Lowry Park Spring and Temple Terrace Spring, are in the Hillsborough River (fig. 1). Sulphur Springs is about a quarter of a mile east of Interstate 275, its discharge ranged from 22 to 29 Mgpd during 1980. Lowry Park Spring discharges less than 10 gal/min to an area of sea level of the river about 0.5 mile east of Sulphur Springs. The discharge of Sulphur Springs, on the north side of the Hillsborough River in Temple Terrace, discharges about 75 gal/min. This spring was the original water supply for the city of Tampa. Curiosity Creek is an intermittent stream that begins in a swampy area on the east side of Sweetwater Creek near Lake Gato (fig. 1). The creek drains an area of 3.8 mi<sup>2</sup> and flows into a sinkhole near the town of Sulphur Springs about 3 miles south of the lake. During calendar years 1979-80, the maximum flow of Curiosity Creek from 1.7 ft<sup>3</sup>/s in May was 28 ft<sup>3</sup>/s in July, but it extended periods of no flow for most years.

TOURIST CLUB WELL. A plot of chloride concentrations versus specific conductance of water from an unlined Florida aquifer well about 400 feet southeast of Sulphur Springs and 160 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 line representing a constant of chloride concentrations as a function of specific conductance, determined from the well, is as follows: chloride (mg/L) = -0.28 + 0.234 x specific conductance (micromhos/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 15,000 micromhos/cm. The high values of specific conductance and chloride concentrations indicate that mineralized water occurs below 80 feet of 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 calcium brines in other rocks that has not been flushed by fresh water. A plot of the potentiometric head in the Tourist Club well and the discharge of Sulphur Springs for the period 1965-81 is shown in figure 18. The data are included to show the relation between the discharge of the spring to corresponding changes in the potentiometric head in the well. Data for the Tourist Club well were used because minimum pool levels were not available for Sulphur Springs. For spring discharges of less than 40 ft<sup>3</sup>/s, the potentiometric head in the well ranged from 7.8 to 10.7 feet above sea level for discharges greater than 40 ft<sup>3</sup>/s, the potentiometric head ranged from 7.8 to 10.7 feet above sea level. The potentiometric head in the well was 10.7 feet above sea level in the spring during the period 1965-81. Large increases in spring discharge were less than about 45 ft<sup>3</sup>/s. Large increases in spring discharge were less than about 45 ft<sup>3</sup>/s. Large increases in spring discharge were less than about 45 ft<sup>3</sup>/s.

SINKHOLES. Sinkholes are common surface features in the basin area of Sulphur Springs. The Floridan aquifer in the area consists of limestone and dolomite, rocks that are susceptible to slow dissolution by acidic water that moves through pore spaces, fractures, and other openings in the rocks. The enlarged openings develop a network of conduits or cavities through which the highly mineralized water flows. The potentiometric head in the rock (Stewart, 1981). As the limestone and dolomite continue to dissolve, the overlying material tends to subside and eventually collapse into the rock openings. A decline in water levels in the area removed part of the support of the overlying material causing it to lose competence and collapse. This results in the development of a depression or opening in the surface. Water may gravitate into the depression. These openings or depressions, commonly referred to as sinkholes, are areas by which surface water may newly enter the Floridan aquifer.

Numerous sinkholes have developed in the Sulphur Springs area. Most are located between Fowler Avenue and the Hillsborough River (fig. 1) in the southwestern part of the area. The sinkholes generally have less than 10 feet in diameter and range in depth from about 10 to 15 feet. The most active area of sinkhole development is a 1-mile-wide strip along both sides of Interstate 275 that extends from the Hillsborough River northward about 4 miles. Sinkholes are common surface features in the basin area of Sulphur Springs. The Floridan aquifer in the area consists of limestone and dolomite, rocks that are susceptible to slow dissolution by acidic water that moves through pore spaces, fractures, and other openings in the rocks. The enlarged openings develop a network of conduits or cavities through which the highly mineralized water flows. The potentiometric head in the rock (Stewart, 1981). As the limestone and dolomite continue to dissolve, the overlying material tends to subside and eventually collapse into the rock openings. A decline in water levels in the area removed part of the support of the overlying material causing it to lose competence and collapse. This results in the development of a depression or opening in the surface. Water may gravitate into the depression. These openings or depressions, commonly referred to as sinkholes, are areas by which surface water may newly enter the Floridan aquifer.

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Curiosity Sink. Curiosity Sink is 2.2 miles north-northeast of Sulphur Springs (fig. 1) and is the terminus of Curiosity Creek. The sink is reported to be 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 is an internally drained, and under normal conditions, water that discharges into the sink area flows to the sink and is collected in a reservoir. However, overflow from the sink occurs on the west side when water levels exceed an elevation of 29 feet above sea level. The sink is about 2,500 gal/min per foot of drawdown.

Blue Sink refers to an area of numerous small sinks 1,000 to 1,400 feet north of Curiosity Sink. A cluster of five of the more prominent sinks is shown in figure 1. The area has no surface strata and is drained entirely by sinkholes. A line 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).

Orchid Street Sink. Orchid Street Sink (Orchid Sink), which is about 6,000 feet north of Sulphur Springs (fig. 1), receives runoff from a residential area. The sink is 60 feet deep, 50 feet wide, and bottom at about 25 feet below a general land surface of 28 feet above sea level. A 20-foot circular pool of water on the west side of the sink was recorded in March 1981. The sink has a maximum depth of 20 feet when the water level in the sink was about 15 feet above sea level.

Poinsettia Street Sink (Trinity Springs), which is about 1,000 feet north of Orchid Street Sink (fig. 1), receives runoff from a residential area. The sink is 75 feet long, 50 feet wide, and bottom at about 25 feet below a general land surface of 28 feet above sea level. A 20-foot circular pool of water on the west side of the sink was recorded in March 1981. The sink has a maximum depth of 20 feet when the water level in the sink was about 15 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 Fowler 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 elevations in the sink are 10 feet above sea level. The sink was sealed in March 1981 when its water level was about 5 feet above sea level.

Green Sink. Green 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 long and bottom at 32 feet below a general land surface of 45 feet above sea level. The sink is 110 feet long and bottom at 32 feet below a general land surface of 45 feet above sea level. The sink is 110 feet long and bottom at 32 feet below a general land surface of 45 feet above sea level. The sink is 110 feet long and bottom at 32 feet below a general land surface of 45 feet above sea level.

Hillsborough River Sinks. A profile of the Hillsborough River from Tampa Dam to Fletcher Avenue (fig. 2) shows several holes in the bed of the river about 0.1 to 0.3 miles upstream from the dam (fig. 1). The holes range in depth 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 0.3 mile east of the dam. The hole is 4.4 miles upstream from Tampa Dam and about 0.3 mile east of the dam. The hole is 4.4 miles upstream from Tampa Dam and about 0.3 mile east of the dam.

FLUORIDE TESTS. In January and March 1982, the city of Tampa injected fluoride dye into Curiosity Sink and Blue Sink (fig. 1), and into north of Sulphur Springs. To determine the rate and direction of ground-water movement, the dye was injected into Curiosity Sink, and for March test, 3.5 pounds of dye were injected into Blue Sink. The dye followed a general course toward Sulphur Springs. During the test, dye followed a general course toward Sulphur Springs. During the test, dye followed a general course toward Sulphur Springs.

SULPHUR SPRINGS CULMINATION 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 10, 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 bacteria count in the pool after the spring is pumped to augment the city's water supply during the high water-demand period of the year. Data collected at the city of Tampa Water Department Basin Water Treatment Service Station, city of Tampa, written commun., 1981) for the period 1974-81 show that the annual period of highest 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 related to rainfall and 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 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 27 feet deep, and samples were collected near the top, middle, and bottom of the pool. The ratio of fecal coliform to total streptococci (FC/TS) for samples from Sulphur Springs, Orchid Street Sink, and Tenth Street Sink are listed below.

Table with 4 columns: Date, Sulphur Springs, Orchid Street Sink, Tenth Street Sink. Rows include FC/TS (1981), FC/TS (1982), and FC/TS (1983).

Ratio of FC/TS higher than 4:1 are good indicators that pollution is derived from domestic wastes, which are largely composed of man's body wastes, animal wastes, and food refuse (Gardner, 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 6,000 ft/d. These high velocities probably are adequate for most bacteria to survive the 28 to 40 hours required to travel approximately 1 to 1.5 miles from the sinkholes to Sulphur Springs.

ESTIMATED RUNOFF LOADS. Orchard Street and Poinsettia Street Sinks are used as retention basins for storm 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 data collected at nine urban watersheds in the Tampa Bay area (R.F. Giovanelli and M.A. Lopes, written commun., 1981).

Orchid Street Sink receives drainage from a 77-acre residential area about 3.65 miles east of Sulphur Springs. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level.

Poinsettia Street Sink receives drainage from a 66-acre residential area in the southern part of the area. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level.

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 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 is a public recreation area. The spring pool has been temporarily closed to swimming in the spring of most years because of high bacteria counts. However, overflow from the sink occurs on the west side when water levels exceed an elevation of 29 feet above sea level. 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 source. The high ratio of fecal coliform and coliform streptococci for Sulphur Springs and two sinkholes north of the spring indicates 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 travel time needed to reach Sulphur Springs.

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

DYE TESTS. In January and March 1982, the city of Tampa injected fluoride dye into Curiosity Sink and Blue Sink (fig. 1), and into north of Sulphur Springs.

SULPHUR SPRINGS CULMINATION 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.

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 1981.

Ratio of FC/TS higher than 4:1 are good indicators that pollution is derived from domestic wastes, which are largely composed of man's body wastes, animal wastes, and food refuse (Gardner, 1966).

Ground-water velocities north of Sulphur Springs range from approximately 4,000 to 6,000 ft/d. These high velocities probably are adequate for most bacteria to survive the 28 to 40 hours required to travel approximately 1 to 1.5 miles from the sinkholes to Sulphur Springs.

ESTIMATED RUNOFF LOADS. Orchard Street and Poinsettia Street Sinks are used as retention basins for storm runoff from areas around the sinks.

Orchid Street Sink receives drainage from a 77-acre residential area about 3.65 miles east of Sulphur Springs. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level.

Poinsettia Street Sink receives drainage from a 66-acre residential area in the southern part of the area. The sinkhole is 110 feet in diameter and bottom at 32 feet below sea level.

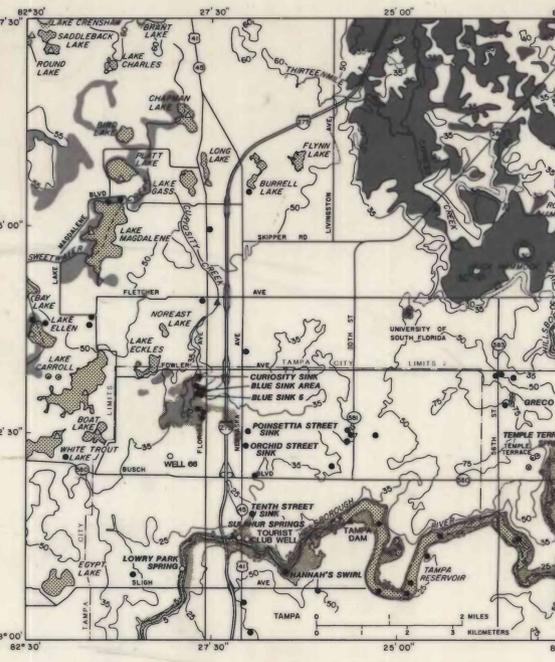


Figure 1—Sulphur Springs area showing physiographic features and locations of observation and public water supply wells.

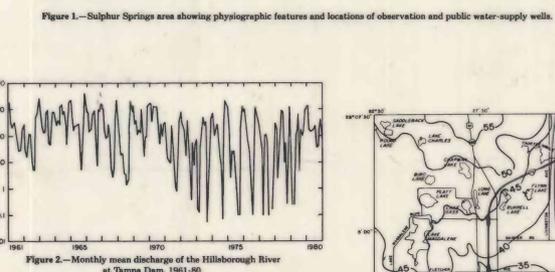


Figure 2—Monthly mean discharge of the Hillsborough River at Tampa Dam, 1961-80.



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

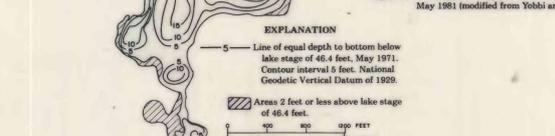


Figure 4—Depth of Lake Magdalena, May 1971 (from Humm and Reichenbaugh, 1972).

