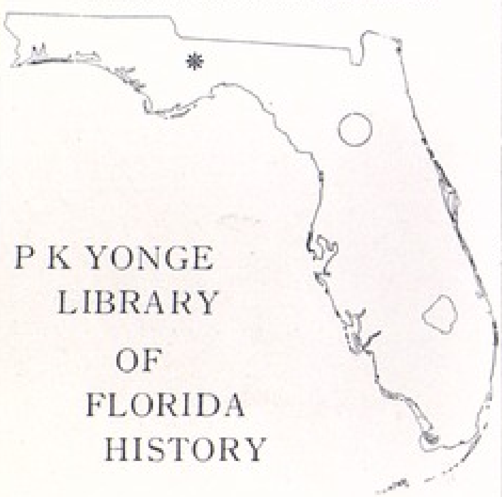
Springs of
Florida



STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Harmon Shields, *Executive Director*

DIVISION OF RESOURCE MANAGEMENT
Charles M. Sanders, *Director*

BUREAU OF GEOLOGY
Charles W. Hendry, Jr., *Chief*

BULLETIN NO. 31
(Revised)

SPRINGS OF FLORIDA

By
Jack C. Rosenau, Glen L. Faulkner,
Charles W. Hendry, Jr., and Robert W. Hull

Prepared by
United States Geological Survey
in cooperation with the

BUREAU OF GEOLOGY
DIVISION OF RESOURCE MANAGEMENT
FLORIDA DEPARTMENT OF NATURAL RESOURCES

and

BUREAU OF WATER RESOURCES MANAGEMENT
FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
Tallahassee, Florida

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An infra-red vertical aerial photograph of the Spring Creek area in Wakulla County. Taken in April, 1972 from an altitude of 3,000 feet, the upwelling spring-flow, known as Spring Creek Rise, is easily located because of water temperature differences. The spring shows as the dark circular area just offshore from the end of State Highway 365.

DEPARTMENT

OF

NATURAL RESOURCES

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Governor

BRUCE A. SMATHERS
Secretary of State

ROBERT L. SHEVIN
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LETTER OF TRANSMITTAL

Bureau of Geology
Tallahassee
August 22, 1978

Governor Reubin O'D. Askew, Chairman
Florida Department of Natural Resources
Tallahassee, Florida 32304

Dear Governor Askew:

The Bureau of Geology, Florida Department of Natural Resources is publishing as Bulletin No. 31 Revised, "Springs of Florida," prepared by J. C. Rosenau, G. L. Faulkner, C. W. Hendry, Jr., and R. W. Hull.

The first comprehensive report on Florida's springs was published in 1947. Since that time much additional data on our springs have been gathered and is incorporated in this publication. This bulletin not only updates these data but also includes data on previously undescribed springs.

This revision represents a major cooperative effort between the U. S. Geological Survey and the Bureau of Geology that has taken several years to complete. It will satisfy a public demand for current information on the nature and occurrence of the springs in Florida.

Respectfully yours,

Charles W. Hendry, Jr., *Chief*
Bureau of Geology

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1977
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Tallahassee
1978

PREFACE

The first comprehensive report of Florida's springs, which contains both a story of the springs and a collection of facts about them, was published thirty years ago (Ferguson and others, 1947). Since then, much additional data on springs have been gathered and the current report, Springs of Florida, makes a wealth of information on springs available to the public. Springs of Florida, prepared by the U.S. Geological Survey in cooperation with the Bureau of Geology, Florida Department of Natural Resources, publishers, and the Bureau of Water Resources Management, Florida Department of Environmental Regulation, is intended to provide sufficient background information for a lucid understanding of the nature and occurrence of the springs in the State.

In accordance with standard practice, referenced reports are cited in the text of this report only by author and date of publication. The report title and publisher are listed in the "References" section of the report.

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SPRINGS OF FLORIDA

By
J. C. Rosenau, G. L. Faulkner,
C. W. Hendry, Jr., and R. W. Hull

SUMMARY AND CONCLUSIONS

Florida has 27 first magnitude springs that discharge water from a thick sequence of limestones known as the Floridan Aquifer. Their total average flow is 9,600 cubic feet per second or slightly more than 6 billion gallons per day. Although an accurate world inventory is not available, it seems that Florida's major springs exceed in number and in quantity of water discharged, those of other states or nations.

Discharge from all of Florida's 300 known springs is estimated at 12,600 cubic feet per second or 8 billion gallons per day. By comparison, all fresh ground water pumped in 1975 in Florida totaled 3.3 billion gallons per day. Records indicate that the major use of the springs is recreational with little significant change in the past 30 years. Nor has their been any significant state-wide change in springflow, although some springs in populous south Florida do show reduced flow.

Few changes since the 1940's appear to have occurred in the quality of the spring water, the springs reflecting the good quality normal to Florida's ground-water aquifers. None were found to be contaminated with pesticides. herbicides, or metals.

The Floridan Aquifer is frequently cavernous and a conductor of immense quantities of water throughout most of the state. The rocks of this artesian aquifer system, or ground-water reservoir, are geologically Tertiary in age. The springs are generally concentrated along the major streams and the west coast of the state. The Suwannee River valley has at least 50 springs that are subject to flooding and even to reversal of flow at high river stages. Nine are discharging more than 100 cubic feet per second (first magnitude flow).

Spring locations are shown by hydrologic subregion and by numbers utilized for spring identification and computer recovery of filed spring data.

The description of over 200 springs include quality of the water data, flow rates, and photographs. Known submarine springs are identified, as are a group of pseudosprings (wells that are commonly and incorrectly identified as springs).

"Springs of Florida" is an inventory of an important natural resource. New information was obtained for the report during extensive field travel; and

data collected through more than 30 years are summarized and included in the spring descriptions. These data are presented for use by scientists, the water manager, and for the casual student of Florida's springs.

INTRODUCTION

Springs are fascinating and of value to man not only because of their beauty and water-supply potential, but also because of their recreational and reputed medicinal value. Ponce de Leon is said to have sought a spring called the "Fountain of Youth" in the territory that came to be called Florida. The large springs encountered by the early Spanish explorers in Florida must have appeared as immense watery cathedrals. And equally amazing must have been the crystal clear rivers that issued from the cavernous depths of the springs that were teaming with colorful fish, sunning turtles, and alligators. To the Indians, the spring sites offered ideal places for villages, providing food, water, and transportation.

Waddells Mill Pond Spring in Jackson County, for example, was reportedly the site of a Chatot Indian village; the once sulfurous water discharging to the Suwannee River at White Springs in Hamilton County has been used as medicinal by white man and Indian; and Little Salt Springs and Warm Mineral Springs of Sarasota County were used by pre-historic man.

Countless writers have described Florida's springs as among her principal natural and scenic resources. Some of the larger springs have been developed as tourist attractions: from glass-bottomed boats the depths of springs can be examined through the clear water, and aquatic life can be observed in its native habitat, apparently unaware of the observer. The uniformly comfortable temperature of the spring water, its clarity, and the underwater cave systems are natural year-round attractions to the swimmer and the scuba diver.

As part of their continuing cooperative program, the Water Resources Division of the U.S. Geological Survey and the Florida Department of Environmental Regulation, previously the Florida Department of Natural Resources, the Water Management Districts, and other state and local agencies collect information on spring flow and water quality. In the section of this report allotted to the descriptions of individual springs, there is given the location, physical description of the spring, and usually a picture of the spring and spring area, spring flow and quality tabulations, and the temperature of the water.

The springs included represent a comprehensive inventory of those made known to the authors through 1977. There are other springs: some too small to be significant, others that are little known or secreted away in the woodlands and the marshlands of the state, and many others that lie undetected in the beds of Florida's rivers, in its estuaries, and offshore.

For those who have only a passing interest in Florida springs and would ask, for example, why Florida has so many springs and where does the water come from that the springs discharge, this report will be helpful. For those who have the responsibility for managing water resources and planning for their conservation for future generations, this report will be invaluable: it provides necessary data for such managing and planning as relates to the utilization and preservation of the springs. Records of spring flow and water quality provide a good measure of long-term hydrologic trends. A spring is generally much more representative of the character of a large part of an aquifer than is a well. For the serious student of springs, the report includes an abundance of data carefully collected, analyzed, and presented; hopefully in a format that will make the information easy to read and use.

Much of the information on springs of Florida are collected as part of the continuing data program just described. The data-collection activity is modified as needed—springs are added to or deleted from the program as necessary, depending on the need for information. The spring data published in 1947 (Ferguson and others) have been substantially updated by this report. A special effort was made to revisit the springs, to check whether the 1947 data are still valid and to visit other signficant springs. Data collected subsequent to the publication of this report are available in the offices of the Florida Department of Environmental Regulation, the respective Water Management Districts, and the Florida District Office of the Water Resources Division, U.S. Geological Survey.

* * * * * *

For use of those readers who may prefer to use metric units rather than U.S. customary units, the conversion factors for the terms used in this report are listed below.

Multiply U. S. customary unit	By	To obtain metric unit
inches (in)	25.4	millimeters (mm)
inches per square mile (in/mi^2)	9.811	millimeters per square kilometer (mm/km^2)
feet (ft)	.3048	meters (m)
miles (mi)	1.609	kilometers (km)
acres	4,047	square meters (m^2)
acre-feet (acre-ft)	1,234	cubic meters (m^3)
square miles (mi^2)	2.59	square kilometers (km^2)
gallons (gal)	3.785	liters (L)
cubic feet (ft^3)	28.32	liters (L)
cubic feet (ft^3)	.02832	cubic meters (m^3)
gallons per minute (gal/min)	.06309	liters per second (L/s)
million gallons per day (Mgal/d)	.04381	cubic meters per second (m^3/s)

A statistical analysis of Florida's springs was not made to determine their past use in contrast to their present use, nor to determine the quantity of water discharged now in comparison to their aggregate discharge 30 years ago. There is, however, an increasing interest by state and local governments in the purchase of springs and contiguous lands for public use. And there is also a demand by private individuals and organizations for homesites at springs, for their recreational development, for overnight or travel parks near springs, and for large-scale housing projects.

An example of the latter is the recent closing off of Peacock Springs in Suwannee County and the development of a 120-acre tract surrounding the springs into 20 homesites (M. Shifflatte, written commun., April 1977). There does not appear to be an overall change in springflow statewide, but in some populated areas of south Florida — areas of heavy ground water pumping — springs have gone dry or have shown marked reduction in flow: Kissengen Spring in Polk County and Health Spring in Pinellas County are examples of springs whose flow has ceased.

SPRING CHARACTERISTICS

A spring is the water discharged as natural leakage or overflow from an aquifer through a natural opening in the ground. The opening may be so small that it yields only enough water to create a wet seep or trickle. On the other hand, the opening — and the associated subterranean cavern that is common to Florida — may be so large that the spring flow is the source of a large river. Some examples are Silver Run from Silver Springs; Blue Run from Rainbow Springs; Weeki Wachee River from Weeki Wachee Springs; and Wakulla River from Wakulla Springs. This type of ground-water discharge is typical of Florida's karst topography — a land of numerous sinkholes, caves, springs, and underground drainage through large cavities in the limestone and dolomite rocks underlying the surface soils.

O. E. Meinzer classified springs by magnitude, from one to eight, on the basis of their volume of flow or discharge. The following tabulation was modified from Meinzer (1927, p. 3):

Magnitude	Average Flow (Discharge)
1	100 ft^3/s (cubic feet per second) or more
2	10 to 100 ft^3/s
3	1 to 10 ft^3/s
4	100 gal/min (gallons per minute) to 1 ft^3/s (448 gal/min)
5	10 to 100 gal/min
6	1 to 10 gal/min
7	1 pint to 1 gal/min
8	Less than 1 pint/min

The United States has about 78 first magnitude springs. Table 1 lists the 9 states that have first magnitude springs, the number's known to exist in each, and the reference from which these data were obtained. The springs discharge from limestone, basalt, or sandstone aquifers. In writing about the springs of Texas, Brune (1975) explains how man's ever-increasing need for water has reduced or stopped the flow of many springs, including two of the four first magnitude springs that Texas had in 1947 (Ferguson, p. 37). According to Brune, the first major effect on the springs of Texas — a decrease in flow — was caused by deforestation of the land by early white settlers. Since then, water use, in all its many forms, has changed — even increased — the flow of Texas springs. The flow of San Felipe Springs, for example, dropped from an average of 149 ft^3/s in 1900 to 22 ft^3/s in 1953, then increased to 82 ft^3/s in 1971. Goodenough Spring is now (1977) inundated to a depth of 150 feet by waters of a nearly completed reservoir that appears to be increasing the flow of some springs, including San Felipe Springs, by increasing recharge and by diverting the flow of Goodenough and other inundated springs to San Felipe Springs. If San Felipe regains first magnitude status, Texas will have three — the others are Comal Springs and San Marcos Springs.

TABLE 1. NUMBER OF FIRST MAGNITUDE SPRINGS IN THE UNITED STATES, BY STATE.

State	Number	Rock type	References[a]
Florida	27	Limestone	—
Idaho	14	Limestone and basalt	3, 5
Oregon	15	Basalt	3
Missouri	8	Limestone	3, 8
California	4	Basalt	3
Hawaii	3	do.	2, 6, 7
Montana	3	Sandstone	3, 4
Texas	2	Limestone	1, 3
Arkansas	1	Basalt	3

a References are listed at back of book.
1 Brune (1975)
2 Hirashima (1967)
3 Meinzer (1927)
4 Moore, L. Grady, U.S. Geological Survey, written commun., January 1977.
5 Ray, Herman A., U.S. Geological Survey, written commun., January 1977.
6 Stearns (1966).
7 Stearns and Macdonald (1946).
8 Vineyard and Feder (1974).

Of the 78 first magnitude springs in the United States, Florida has 27, the most for a single state. Florida seems to have the largest number of springs and also the largest spring in terms of average flow: a submarine spring at Spring Creek in Wakulla County yields about 2,000 cubic feet per second.

Table 2 lists the first magnitude springs in Florida and figure 11 shows their general locations. Although a complete world inventory of springs and springflow is not available, Florida's 27 first magnitude springs appear to exceed in numbers and in quantity of water discharged, those of all countries of the world (table 3).

The classification of Florida's springs by Meinzer's magnitude of discharge system is the simplest way to compare spring impact on the water resources of the State. Florida's 27 first magnitude springs are discharging at an estimated rate of more than 9,600 cubic feet per second or 6.2 billion gallons per day. Some 300 Florida springs are discharging an estimated 12,600 cubic feet per second or over 8 billion gallons per day, which exceeds the total amount of freshwater withdrawn for all uses in Florida in 1975 by a billion gallons per day. S. D. Leach (1977) summarized Florida's 1975 fresh ground-water pumpage for all uses at 3.3 billion, and total fresh surface water at 3.6 billion gallons per day.

About 70 springs are classed as second magnitude, and they discharge about 2,700 cubic feet per second or 21 percent of the total springflow. More than 190 springs are third magnitude or less, and they discharge more than 300 cubic feet per second, or 3 percent of total springflow.

Springs also are categorized according to the type of aquifer from which they derive their water. As such, there are two general types, water-table and artesian springs. Rain that percolates through permeable sediments, such as sand, may ultimately reach a relatively impermeable bed, such as clay. The water then moves down gradient along the top of the impermeable bed to a place of outcrop where the water issues as a spring or seep. This is a water-table or non-artesian type spring. In Florida their flow is normally small and variable. Where water is confined in permeable sediments beneath impervious confining beds, and is under sufficient hydrostatic pressure to rise to the surface through a natural breach in the confining beds, an artesian spring is formed. Most of Florida's large springs are of this type, as are many of the smaller ones. (fig. 1). Florida has numerous artesian submarine springs along its coasts (fig. 17). Where the yield of a submarine spring is great enough, it creates a "slick" or "boil" at the water surface thus identifying the spring location. Submarine springs are known to exist on the Atlantic Coast, offshore at Crescent Beach; and on the Gulf Coast, offshore of Aripeka and from Lee to Wakulla counties.

Springs may be classed in many other ways, including chemical characteristics if, for example, their waters are salty or sulfurous; by temperature — nonthermal or thermal, and thermal springs may be "warm" or "hot"; or by the type of opening through which the water surfaces — seepage, tubular, and fracture.

TABLE 2-- The 27 first-magnitude springs and spring groups of Florida--with period of record, discharge and representative temperatures and dissolved solids--known through December 1976.

Spring and number by county (refer to figs. 11-15, and 17)	Period of record	Average (ft^3/s)	Discharge Range (ft^3/s)	Number of measurements	Average Water temperature C	F	Average Dissolved solids (mg/L)
Alachua County							
9. Hornsby Spring	1972-75	163	76- 250	2	22.5	73	230
Bay County							
1. Gainer Springs	1941-72	159	131- 185	7	22.0	72	60
Citrus County							
2. Chassahowitzka Springs	1930-72	139	32- 197	81	23.5	74	740
4. Crystal River Springs	1964-75	916	(1)	(2)	25.0	75	144
5. Homosassa Springs	1932-74	175	125- 257	90	23.0	73	1,800
Columbia County							
4. Ichetucknee Springs	1917-74	361	241- 578	375	22.5	73	170
Hamilton County							
3. Alapaha Rise	1975-76	608	508- 699	4	19.0	66	130
4. Holton Spring	1976	288	69- 482	3	-	-	-
Hernando County							
19. Weeki Wachee Springs	1917-74	176	101- 275	364	23.5	74	150
Jackson County							
3. Blue Springs	1929-73	190	56- 287	10	21.0	70	116
Jefferson County							
1. Wacissa Springs Group	1971-74	389	280- 605	20	20.5	69	150
Lafayette County							
11. Troy Spring	1942-73	166	148- 205	4	22.0	72	171
Lake County							
1. Alexander Springs	1931-72	120	74- 162	13	23.5	74	512
Leon County							
2. Natural Bridge Spring	1942-73	106	79- 132	5	20.0	68	138
4. St. Marks Spring	1956-73	519	310- 950	130	20.5	69	154
Levy County							
3. Fannin Springs	1930-73	103	64- 139	8	22.0	72	194
5. Manatee Spring	1932-73	181	110- 238	9	22.0	72	215
Madison County							
1. Blue Spring	1932-73	115	75- 145	6	21.0	70	146
Marion County							
5. Rainbow Springs	1898-1974	763	487-1,230	402	23.0	73	93
7. Silver Glen Springs	1931-72	112	90- 129	11	23.0	73	1,200
8. Silver Springs	1906-74	820	539-1,290	155	23.0	73	245
Suwannee County							
8. Falmouth Spring	1908-73	158	(3) 60- 220	8	21.0	70	190
Volusia County							
1. Blue Spring	1932-74	162	63- 214	360	23.0	73	826
Wakulla County							
2. Kini Spring	1972	176	-	1	20.0	68	110
5. River Sink Spring	1942-73	164	102- 215	6	20.0	68	110
6. Wakulla Springs	1907-74	390	25-1,910	276	21.0	70	153
13. Spring Creek Springs (1,4)	1972-74	2,003	(1)	1	19.5	67	2,400

(1) Tidal affected
(2) Continuous record, vane gage
(3) Reverse flow of 365 ft^3/s measured on 02-10-33.
(4) See figure 17.

TABLE 3 MAJOR SPRINGS REPORTED IN OTHER COUNTRIES.

Spring	Country	Average Discharge (ft^3/s)	Rock Type	Reference[a]
Ras-El-Ain	Syria	1,370	Limestone	1, 2
Stella Spring	Italy	1,290	do.	6
Rio Maule Spring	Chile	1,000	Basalt	2
Fontaine de Vaucluse	France	800	Limestone	3, 6
Timaso Spring	Italy	800	do.	5
Komishimigawa	Japan	700	Basalt	5
Ain Zarka	Syria	490	Limestone	5
Sinn River	Syria	430	do.	5
El Gato	Mexico	185	Basalt	4, 7
Lanza	Bolivia	135	do.	5

a References are listed at back of book.
1 Burdon and Safadi (1963).
2 Davis and DeWiest (1966, p. 63, 367-369).
3 Meinzer (1927, p. 91-92, 94).
4 Thomas (1975).
5 Thomas, H. E. (written commun., October 1974).
6 Vineyard and Feder (1974, p. 14).
7 Waring (1965, p. 61).

The natural flow of springs is controlled by hydrologic and geologic factors, such as amount and frequency of rainfall, the porosity and permeability of the aquifer, the hydrostatic head (pressure) within the aquifer, the hydraulic gradient and, in the case of artesian springs, to a lesser degree to influences outside the aquifer, such as atmospheric pressure systems and oceanic tides. The flow of springs is also changed, usually decreased, by man through such means as pumping from wells that tap the aquifer.

Fortunately, Florida has sufficient rainfall distributed through the year to keep its aquifers recharged sufficiently to maintain perennial flow at most artesian springs. Though the State does experience water-supply problems in some areas where ground-water withdrawal is excessive, this condition is the exception, and variations in discharge rates of artesian springs have been remarkably small. The flows of large springs may be substantial even through periods of drought. This is understandable when the large volume of water stored in Florida's artesian aquifer system is compared with the relatively small discharge of its springs. The aggregate discharge from all the artesian springs is not enough to deplete the aquifer between periods of recharge. On the other hand, the variations in flow of water-table springs may be great in response to rainfall variations and may cease flowing in the dry season because of the relatively small size and low storage capacity of many water-table aquifers.

The openings or voids in the rock through which ground water moves may vary in size and relation. They may be as small as the original pore

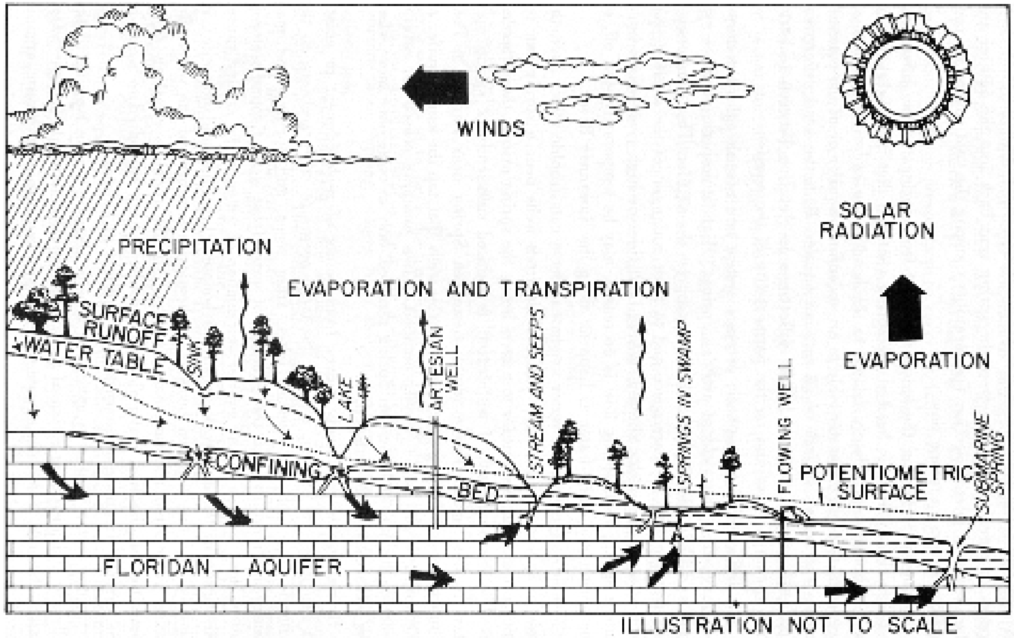

FIGURE 1. — The hydrologic cycle.

spaces between the grains that make up the rock or as large as the sizeable caverns that result from dissolution by circulating water. The size of the pore spaces or caverns extending from the spring vent back into the aquifer and the degree of interconnection (permeability) among the void spaces are controlling factors in spring flow.

Another influence on the amount of flow from springs is the differential between the hydrostatic head at the spring vent and that in the recharge or replenishment area. Closely related to the head is the hydraulic gradient or degree of slope of the water-table in an unconfined aquifer or of the potentiometric (pressure) surface of an artesian aquifer. Both the head differential and gradient are governed by the differences in elevation between recharge and discharge areas and on the permeability of the aquifer.

The influence of atmospheric pressure system ond oceanic tides are minor but may affect the yield of artesian springs. High atmosperic pressure systems and high tides load and thereby compress the aquifer. This compression tends to decrease the pore space and to force water out of the aquifer, thus increasing spring yields slightly. Where high tides or high river stages inundate a spring vent, spring flow is decreased, may be temporarily shut off, or the spring may take water as happens along the Suwannee River.

Man, in supplying his water needs, can have catastrophic effect upon the flow of springs. Large water withdrawals from wells near a spring can reduce pressure in the aquifer to a level below the spring orifice, thus stopping its flow. Subsequently, if withdrawal is reduced sufficiently, a spring may start to flow again. For example, Kissengen Spring near Bartow in Polk County stopped flowing after some nearby wells that tap the same aquifer as the spring began to be heavily pumped. When pumping ceased for several months, the flow of Kissengen Spring resumed, only to cease once more when the wells were again pumped.

Ground water continually moves from points of replenishment to points of discharge. In Florida, natural discharge occurs to other aquifers, to the Atlantic, the Gulf, to streams, lakes, from seeps, and springs, and man causes discharge through the pumping of water from wells. Ground water is not in dead storage in the aquifer; circulation of water in the ground causes dissolution of the host rock, mostly carbonates (limestone and dolomite) in Florida, and this material becomes a chemical constituent of the water. Because water from the carbonate Floridan Aquifer contains relatively large quantities of dissolved material, it is considered hard compared to water in the surface streams and noncarbonate aquifers in Florida.

Ground water issuing as springs is usually clear and clean because of the filtering and absorbing action of the soil and aquifer materials that the water passes through. Some springs, however, may have turbid or brown, organic colored water typical of many surface waters in Florida. Where turbid water or the brown tannic acid water common to swamps recharges an aquifer in proximity to a spring, the water may move quickly through solution channels in the aquifer to discharge at the spring vent little altered in quality. For this reason, it is not uncommon to note "swamp water" discharging from some springs in Florida, especially following heavy rainfall. A few spring waters having relatively high dissolved solids concentrations have a whitish cloudy appearance, possibly the result of precipitation from rapid pressure or temperature changes when discharged. Many Florida springs are bluish, carrying such names as Blue Spring or Blue Hole. The blue color is characteristic of clear water in large quantities, as is true for air in large quantities, and is not due to any particular impurities.

A striking characteristic of spring water is that it seems cold in the summer and warm in the winter. This is not the result of a change in water temperature but the difference between air and water temperatures. The temperature of spring water varies only a few degrees; even among springs the temperature variation is small as the following tabulation illustrates:

	Approximate Range (in °C)	Average Temperature (°C)	(°F)
North Florida	19 to 23	21	70
Central Florida	22 to 26	24	75
South Florida	27 to 31	29	84

Spring water is at or near the temperature of the aquifer, which in the case of shallow aquifers is at or near the average annual air temperature of the particular area. Spring waters from deeper aquifers tend to have higher temperatures.

Water temperatures of a few springs in Florida are appreciably higher than others in the state. The geothermal gradient for ground water, that is, the rate of increase in temperature with depth, is about 1 degree Fahrenheit per 65 feet of depth (Collins, 1925, p. 98) or 1 degree Celsius per 100 feet, although there are exceptions to the rule. The warm springs, such as those in Sarasota County, derive their water from deep formations due to an abnormality of the host rock — such as a fault or fracture which allows this warm deep water to rapidly reach the surface.

Though Florida spring water is normally hard compared to surface or non-carbonate aquifer water, it is not as mineralized as the ground water in older and deeper rocks. Sodium chloride (common salt) is the principal mineral contributing to high mineralization. Highly mineralized water has been obtained from deep wells beneath all of Florida.

GEOLOGY AND HYDROLOGY

That Florida has many springs, some of large size, is the direct result of the particular combination of geologic and hydrologic factors that prevail in the State. Following is a discussion of the geology and hydrology of Florida, to the extent that these relate to the occurrence of these many springs.

Florida is the emergent part of a large platform, called the Floridan Plateau (fig. 2), that projects southward from the continental mass and separates the deep water of the Atlantic Ocean from that of the Gulf of Mexico.

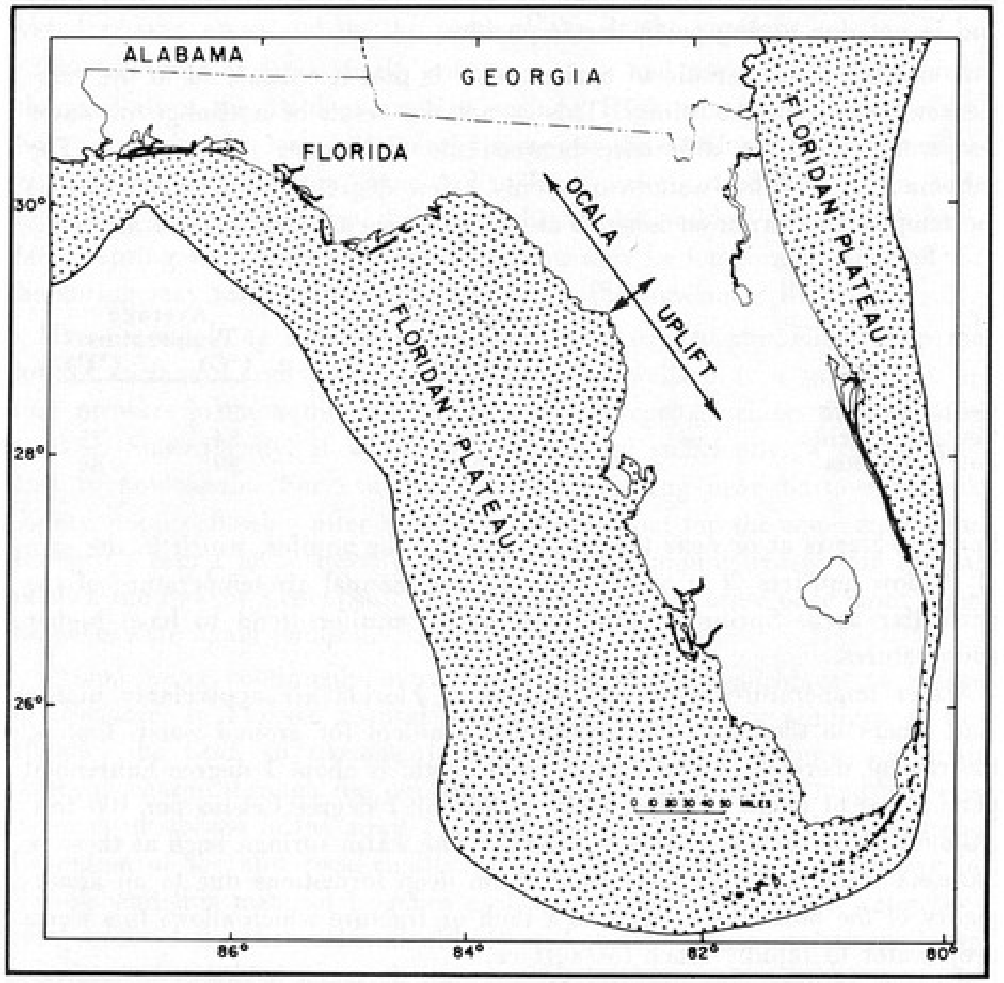

FIGURE 2. — The Floridan Plateau and its emergent part, Florida. The Ocala Uplift, also shown, has an important influence on spring occurrence in the state.

The Floridan Plateau is composed of several thousand feet of nearly flat-lying limestone and dolomite strata that are veneered with sand, clay, limestone, and mixtures of these that are as much as several hundred feet thick. These sediments were deposited mostly in a shallow-marine environment and, for the most part, are not intensely lithified nor have they undergone intensive deformation. The Ocala Uplift, an important surface structural feature affecting the occurrence of many of the springs in Florida is shown in figure 2.

The upper part of the limestone and dolomite rocks of Florida constitutes a part of a very extensive and productive ground-water reservoir identified by V. T. Stringfield (1966) as the Principal Artesian Aquifer of the southeastern United States. Stringfield (1936) originally described this hydrologic system and Parker (1946) redefined and named that part of the system in Florida, the Floridan Aquifer.

The Principal Artesian Aquifer underlies all of Florida and extends beneath parts of Alabama, Georgia, and South Carolina (fig. 3). A substantial part of the sediments veneering the Floridan Aquifer, though porous and permeable in part, is relatively impervious and serves to confine, under pressure, the water in the Floridan Aquifer over much of its areal extent. The Floridan Aquifer supplies all the first magnitude springs in Florida (see table 2) and most of the smaller ones. Permeable parts of the sedimentary veneer are of local extent and in places supply small springs.

GEOLOGY

As a background for a discussion of Florida springs, a description of the nature and attitude of the rocks from which springs flow is important. The number, size, and location of Florida springs is intimately associated with the stratigraphy and structure of the rock formations. For example, more large springs are located near the Ocala Uplift (fig. 2) than elsewhere in Florida.

The Ocala Uplift is the name applied to the structurally high Tertiary strata in the northwest part of peninsular Florida. As the uplift evolved, the clastic-sediment veneer on the uplift was deposited more thinly and was more readily eroded than elsewhere in Florida. These factors left exposed or nearly exposed at the surface the carbonate bedrock that comprises the Principal Artesian or Floridan Aquifer.

Florida, though devoid of high altitudes and great relief, does vary in altitude somewhat, from the very low, nearly flat, terraced coastal plains to the high rolling hills of the interior. On the peninsula, the interior ridges reach a maximum of 310 feet above sea level at Sugarloaf Mountain in southern Lake County. The ridges do not extend south of Lake Okeechobee, and so the southern tip of Florida is a low, almost featureless plain. Relief

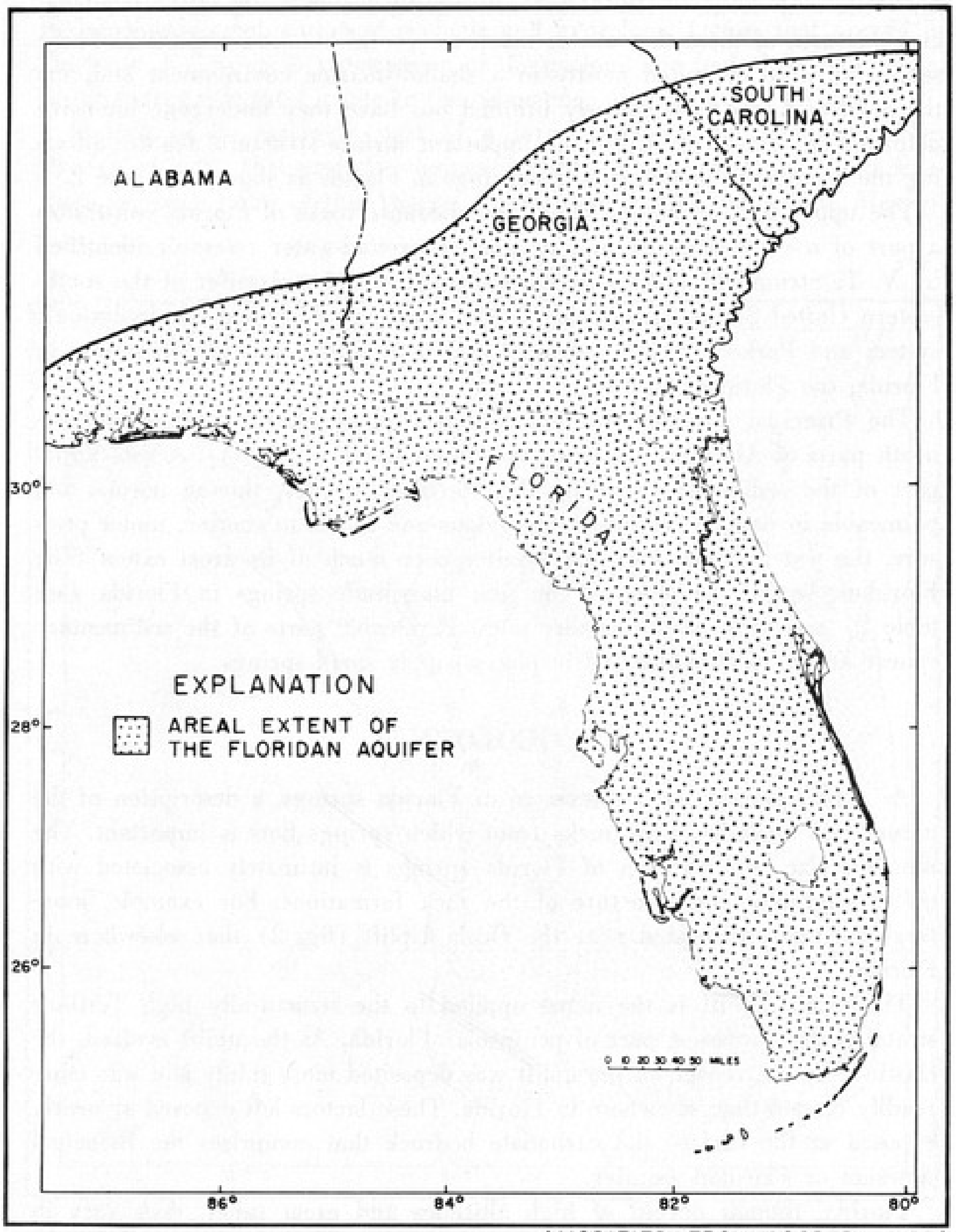

FIGURE 3. — The areal extent of the Principal Artesian Aquifer. That part in Florida is called the Floridan Aquifer.

within the coastal plain usually does not exceed a few feet, whereas in the higher inland areas relief is a few tens of feet, commonly more than 100 feet. In northwest Florida, the highlands are on the average about 30 miles inland from the coast. Surface altitudes range from sea level at the coast to a maximum of 345 feet above sea level in Walton County, near the Florida-Alabama state line.

The high interior ridges of the peninsula are the erosional remnants of deposits laid down during the Pleistocene (ice-age) marine inundations of Florida. The ridges are primarily composed of loose quartz sands with small amounts of clay occurring as a matrix and locally as clay beds. These clastic sediments, where they are sufficiently permeable, constitute water-table or unconfined aquifers. Where the permeablity is low, owing to a high clay content, they serve, along with underlying poorly permeable beds of Miocene and Pliocene age, as confining beds atop the artesian Floridan Aquifer.

Throughout the Tertiary Period, the Floridan Plateau was a shallow marine shelf upon which widespread deposits of chemically precipitated limestone and dolomite, along with the shells and shell fragments derived from the teeming marine life, were laid down. This deposition of very pure calcium and magnesium carbonate continued through early Tertiary time into the late Tertiary. At the beginning of the Miocene Epoch, ever increasing amounts of sand, silt, and clay were transported into Florida by the numerous river systems from the neighboring Appalachian Mountains to the north. These terrestrial clastics were intermixed with the upper Tertiary marine limestone deposits and by late Miocene time the clastics were the dominant type of deposit. Thereafter, in most of Florida, the predominant carbonate deposited was in the form of shells with minor amounts of chemical carbonate precipitate deposited with clay to form marl.

In northwest Florida, from the Chocktawhatchee River westward, sediments are predominantly clastics and both these and the underlying limestone of the Floridan Aquifer slope gently downward and westward into the Mississippi Embayment. Southward from the Ocala Uplift the limestones of the Floridan Aquifer also become progressively lower, so that in the southern part of the State, the aquifer is deeply buried beneath post-Oligocene clastic sediments.

The great depth to the Floridan Aquifer in south Florida and westward of central Walton County effectively eliminates the occurrence of Floridan Aquifer springs in those areas. Water-table springs exist in these places, however, although many of them in south Florida no longer flow owing to the lowered water table resulting from many years of heavy ground-water draft.

In south Florida are some "pseudosprings" or false springs, however. These are old, deep artesian wells, no longer used, whose casings have rusted away, so that today they appear to be, or are labeled as, artesian springs. The locations of Florida's pseudosprings are described in some detail in that section of the report labeled "Pseudosprings."

The Floridan Aquifer consists of limestone and dolomite older than middle Miocene age and younger than early Eocene age. Table 4 is a generalized Tertiary stratigraphic column that shows the vertical position of the Floridan Aquifer in Florida. The Ocala Group[a] (table 4) is the principal water-bearing stratum in much of western peninsular Florida and in much of western peninsular Florida; in the "Big Bend" and southwest peninsular areas, the Suwannee and St. Marks Limestones are the principal aquifers; and in the Jackson-Washington-Holmes County area (Vernon and Puri, 1964) the Marianna Limestone is the principal one. Other formations that are important parts of the Floridan Aquifer are the Lake City and Avon Park Limestones of middle Eocene age in western peninsular Florida; and the Chattahoochee[b], Chipola, and Hawthorn Formations of early and middle Miocene age in north and southwest Florida. For a more detailed discussion of the Floridan Aquifer, see Stringfield (1966, pp. 95-98).

The Hawthorn Formation plays a dual role in that in some areas its lower part is composed of permeable carbonate beds (aquifer) and the upper part is composed of impermeable clastics (confining beds). Where present in the Hawthorn, the clay, marl, and less porous impure limestone of Miocene age and younger serve an important role as the impervious beds that bound the upper surface of the Floridan Aquifer and confine the water in the Floridan Aquifer under pressure.

The quantity of water present in the aquifer depends on the porosity of the rock, that is, on the volume of the spaces or pores or cracks between the solid rock particles. Porosity may be categorized as intergranular porosity (between grains) or as macroporosity, a more gross feature related to solution or fracturing (cavities, cracks, etc.) of the aquifer rock.

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[a] The name used by the Florida Bureau of Geology to include three formations, from older to younger: the Inglis Formation, Williston Formation, and Crystal River Formation. The equivalent terminology used by the U. S. Geological Survey is Ocala Limestone, which is divided into an upper and a lower member. The lower member is approximately equivalent to the Inglis and Williston Formations, whereas the upper member is approximately equivalent to the Crystal River Formation.

[b] The U. S. Geological Survey uses Tampa Limestone instead of Chattahoochee Formation.

After deposition, sediments undergo reduction of initial pore volume through compaction, which may be followed by induration or lithification of the sediments by cementation, further reducing the porosity. Most of the rocks that make up the Floridan Aquifer are poorly indurated so that substantial primary porosity remains. Some limestone strata within the aquifer have, however, undergone chemical and physical changes through partial dolimitization and recrystallization. This alteration generally results in yet a further decrease in intergranular porosity — a condition of secondary porosity.

So that water can move through the rock, pore spaces, cavities and cracks must be connected; the rock must have porosity and permeability. An aquifer

TABLE 4.--General stratigraphic column related to spring discharge from the Floridan Aquifer.

QUATERNARY	HOLOCENE AND PLEISTO-CENE		SAND, CLAY, GRAVEL, PEAT, AND CARBONATE DEPOSITS	
	MIOCENE		UPPER MIOCENE CLAYS AND CLASTICS	
		FLORIDAN AQUIFER	CHIPOLA AND HAWTHORN FORMATIONS	
			CHATTAHOOCHEE AND ST. MARKS FORMATIONS	
	OLIGOCENE		SUWANNEE LIMESTONE AND MARIANNA LIMESTONE	
	EOCENE		LIMESTONES OF OCALA GROUP	CRYSTAL RIVER FORMATION WILLISTON FORMATION INGLIS FORMATION
				AVON PARK LIMESTONE LAKE CITY LIMESTONE OLDSMAR LIMESTONE
	PALEOCENE		CEDAR KEYS LIMESTONE	

that yields large amounts of water to springs (as much as several million gallons per day) is very porous and permeable. Of the two kinds of porosity cited earlier, it is macroporosity (the caverns and cavities) on which the tremendous flow of some of Florida's springs depend. A spring connected to a cavernous limestone may have a large flow depending on the hydraulic gradient.

How these caverns were formed is interesting. Limestone, only slightly soluble in pure water, is easily dissolved in water that contains carbon dioxide, because carbon dioxide and water produce carbonic acid. Carbon dioxide is derived from rain falling through atmosphere and from the soil in which carbon dioxide is produced by plant respiration and organic decomposition. Solution of limestone by natural waters in which carbon dioxide is dissolved is the principal cause of cavities and caverns found in carbonate rocks.

As with porosity, permeability of a rock is classed either as primary or secondary. Primary permeability results from the interconnection of the original pore spaces remaining between the individual grains of the rock after deposition. The primary permeability of limestone depends on the size and shape of the rock grains. As most Florida limestones contain a high percentage of shells and microfossil tests, their primary permeability is high. As with porosity, primary permeability is frequently reduced or destroyed by the processes of dolomitization and recrystallization. Secondary permeability, as in the case of macroporosity, develops from the solution of the rock by water containing carbon dioxide. The extent to which secondary permeability has developed usually determines the usefulness of limestone as an aquifer. Dissolution occurs chiefly along joints, fractures, and bedding planes, as well as along zones which had sufficient primary permeability to permit circulation of water. These openings may range from only a slight increase in the original interstitial openings, through etching of individual mineral grains, to solution cavities several feet or even several tens of feet across.

Because solution activity tends to concentrate in zones of the greatest ground-water circulation, the limestone along fractures, joints, and bedding planes may be very permeable while surrounding rock may be comparatively impermeable. Solution along the contact between beds of differing solubility may result in a zone of cavities and high permeability that is sheet-like in form. In describing this action in Florida, Vernon says, "The heavy rainfall, prolific decaying vegetation in Florida and the low evaporation and agitation in these confined reservoirs cause the artesian waters to be heavily charged with organic acids and acid-forming gases. The solution of limestone aquifers in Florida is therefore active and rapid. In fact, the gentle dip of the beds, the high purity and inherent porosity of the carbonate rocks, the flat sand-covered divides between relatively few surface streams, the dense vegetation and humid climate, the relatively high relief and the active circulation of artesian waters all combine to create in Florida the most favorable conditions for the active solution of carbonate rock by water" (Ferguson and others, 1947, p. 20).

HYDROLOGY

Some of the rain that falls on Florida and upon the immediately adjacent parts of adjoining states (fig. 4) collects in lakes or surface-water courses and flows as rivers and streams to the sea. Some evaporates from free water surfaces and some transpires from plants — all to return to the atmosphere. Another portion of the rainfall infiltrates the ground to replenish the aquifers from which virtually all the State's freshwater supply is obtained. It is this — the infiltrating water — that keeps Florida's springs flowing year after year; to cease or to be reduced only by drought or if large quantities of water are pumped from the aquifer in the vicinity of the spring, or if major construction in the vicinity of the spring disrupts the spring's hydraulic balance.

Water in the ground-water reservoir occurs under either confined or unconfined conditions. When ground water is not confined under pressure, it is said to occur under water-table conditions. The water-table aquifers are recharged locally and the water table fluctuates rapidly in response to rainfall. That is, with rainfall the water table rises. The height at which water stands defines the water table, which is the top of the zone of saturation or the zone in which all pore spaces are filled with water. The shape of the water table is usually a subdued replica of the profile of the land surface. Ground water under the influence of gravity continually moves downgradient, that is, in the direction that is the downward slope of the water table; and from areas of recharge to discharge. In the discharge area, where the water table intersects land surface, ground water will discharge at the surface to form a spring or seep (fig. 1). Likewise, if the water table intersects a stream channel at an altitude equal to or higher than the water level of the stream, ground water will flow or seep into the stream channel and add to the flow of the stream.

Water-table aquifers in Florida are generally made up of Holocene and late Tertiary sands exposed at the surface. Some older strata, including limestone beds of the Floridan Aquifer that are near the surface or not covered by confining beds, also contain water under water-table conditions.

Some ground water moving downgradient in unconfined aquifers enters aquifers that are or become confined further downgradient by layers of im-

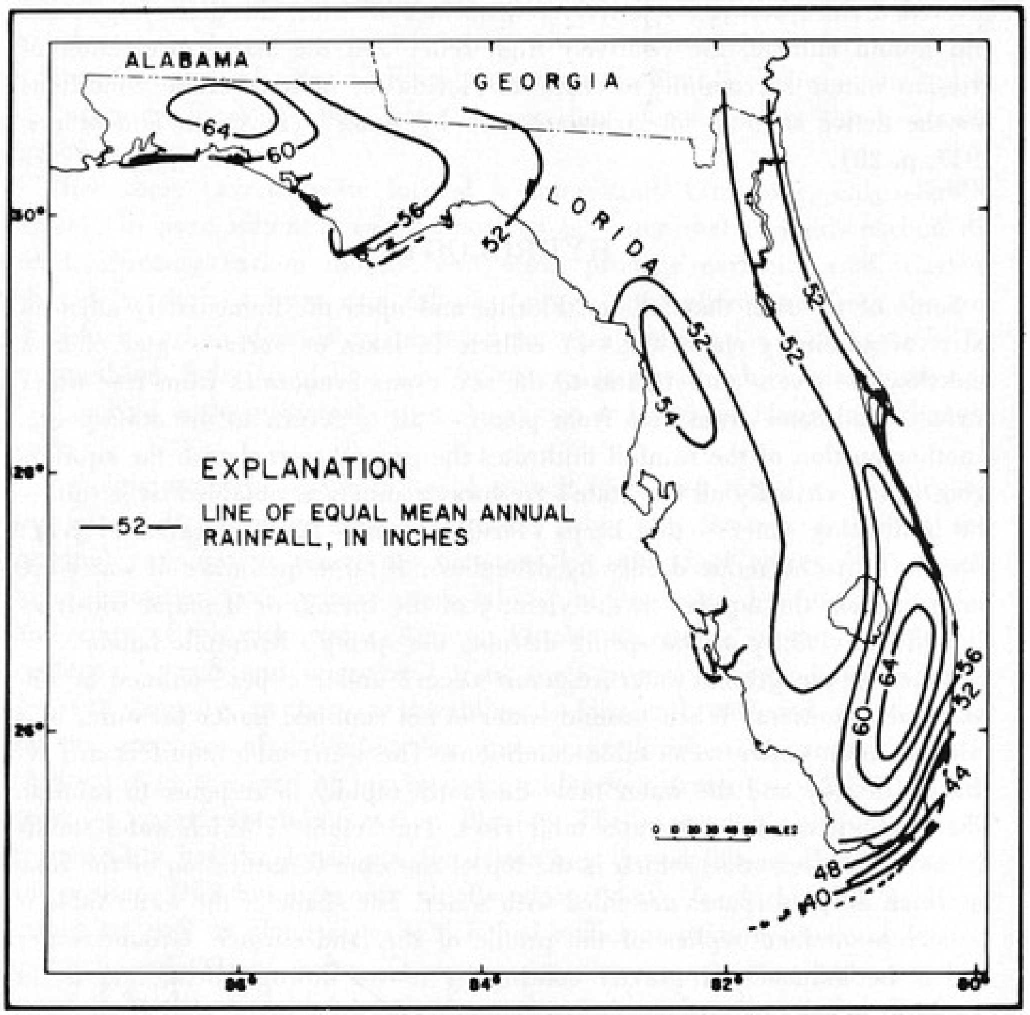


FIGURE 4. — Mean annual rainfall distribution in Florida, 1931-55.

permeable rock. Water confined in such an aquifer is said to be under artesian pressure, and the aquifer is called an artesian or confined aquifer. Florida's rainfall and her water-table aquifers are the major source and avenue for replenishment of the State's artesian water supply.

An artesian aquifer, unlike a water-table aquifer, is completely filled with water, and because it is overlain by a bed of low permeability, the water is contained in the aquifer under pressure, to rise above the top of the aquifer where taped by a well that penetrates the confining bed (see fig. 1). If the pressure is great enough the water will rise in the well to land surface, to spill over the top of the casing and form a "flowing well." At such a location, should a natural passage occur between the aquifer and land surface, a spring would result.

The Floridan Aquifer is principally an artesian aquifer (fig. 5) composed

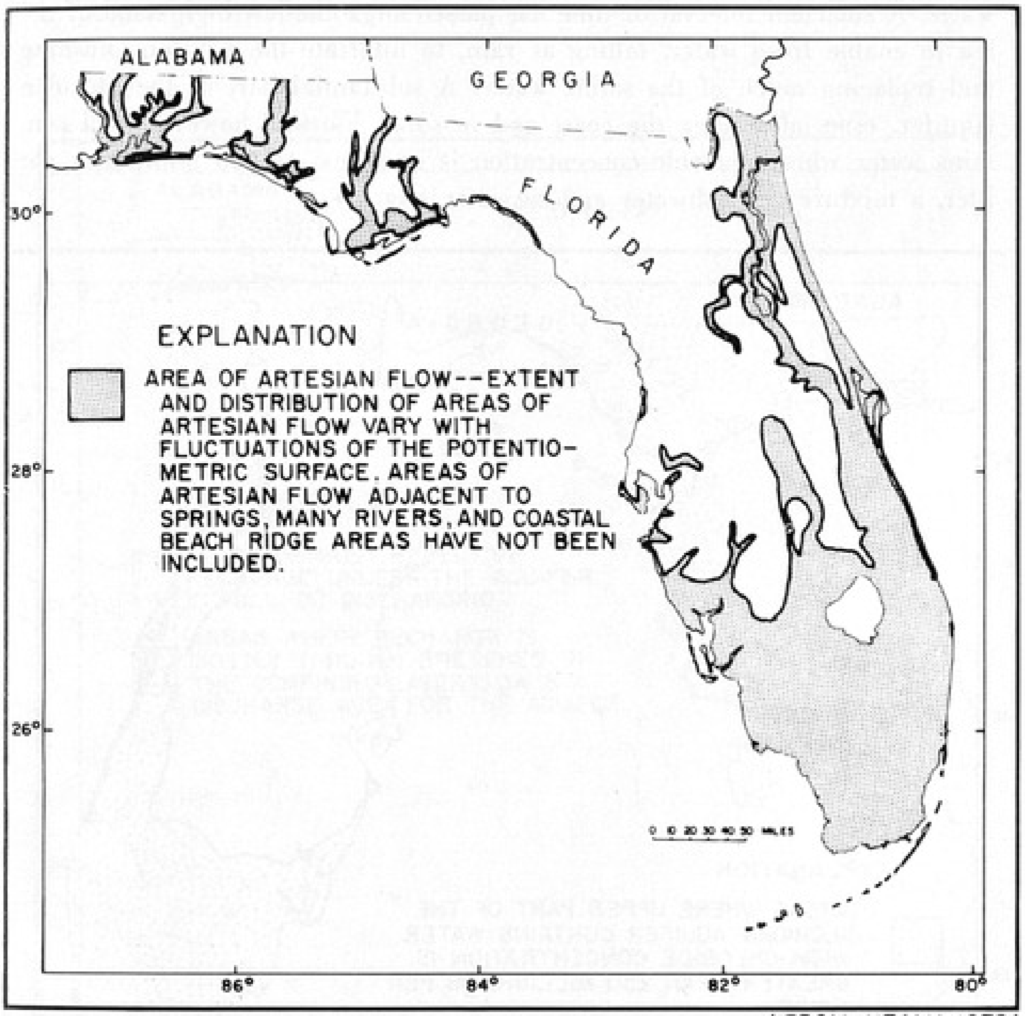
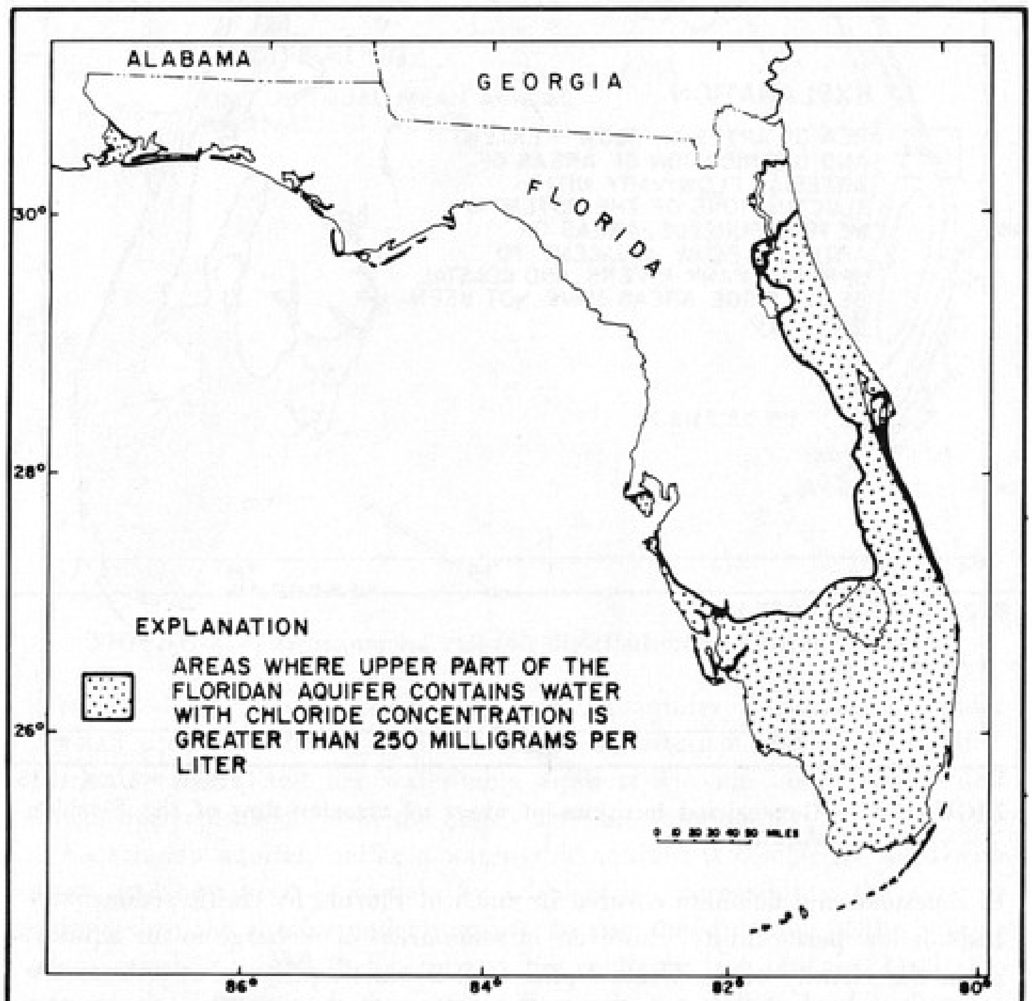


FIGURE 5. — Generalized locations of areas of artesian flow of the Floridan Aquifer.

of limestone and dolomite covered in much of Florida by clastic sedimentary beds of low permeability. However, in some areas of recharge to the aquifer, as in the vicinity of the Ocala Uplift (fig. 2), the aquifer is at or near the surface, and thus is more or less under water-table conditions.

Whereas the porous and permeable sedimentary rocks in the subsurface of Florida have the capacity to store and transmit large volumes of water, only part of these sediments contain water of good quality. In the geologic past, glacial ice has alternately advanced and retreated over the polar regions due to climatic changes. These shifts in the size of the polar ice caps, and consequently the quantity of water in the oceans, have caused substantial fluctuations of sea level; the higher stands inundating most of Florida and replacing most of the fresh and saline water then in the aquifers with seawater. A sufficient interval of time has passed since the last high stand of the sea to enable fresh water, falling as rain, to infiltrate the aquifers, flushing and replacing much of the saline water. A substantial part of the Floridan Aquifer, especially along the coast and in south Florida, however, still contains water whose chloride concentration is in excess of 250 milligrams per liter, a mixture of freshwater and seawater (fig. 6).



(FROM KLEIN, 1975)

FIGURE 6. — Areas of non-potable water in the upper part of the Floridan Aquifer.

The Floridan Aquifer is replenished with water in areas where the aquifer is exposed at the surface or where it is overlain by porous and permeable material. Where relatively impermeable materials mantle the aquifer, recharge may occur through breaches in that mantle, such as sinkholes. Recharge areas are where the aquifer is naturally replenished. Cooper (1953, p. 21) estimated the recharge area of the Floridan Aquifer to be about 13,000 square miles (fig. 7).

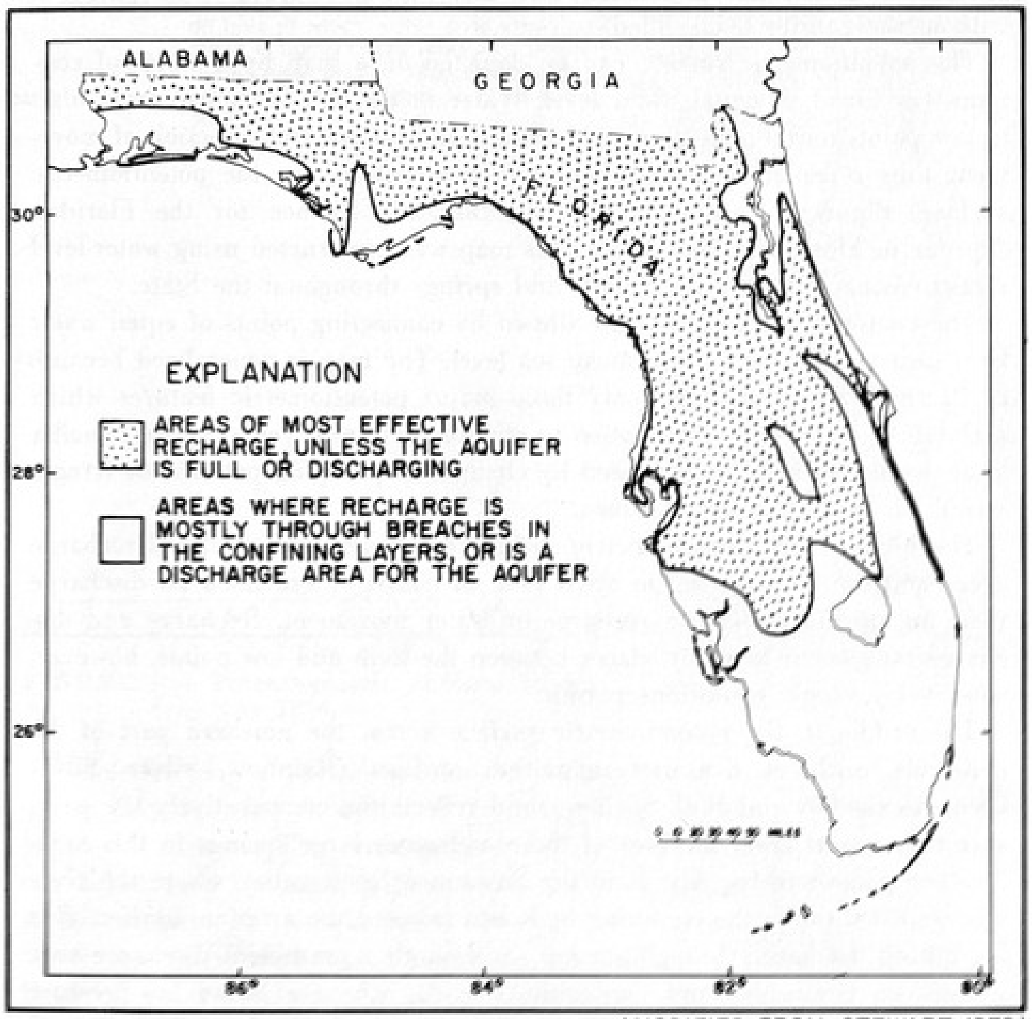


FIGURE 7.—*Areas of recharge to the Floridan Aquifer*

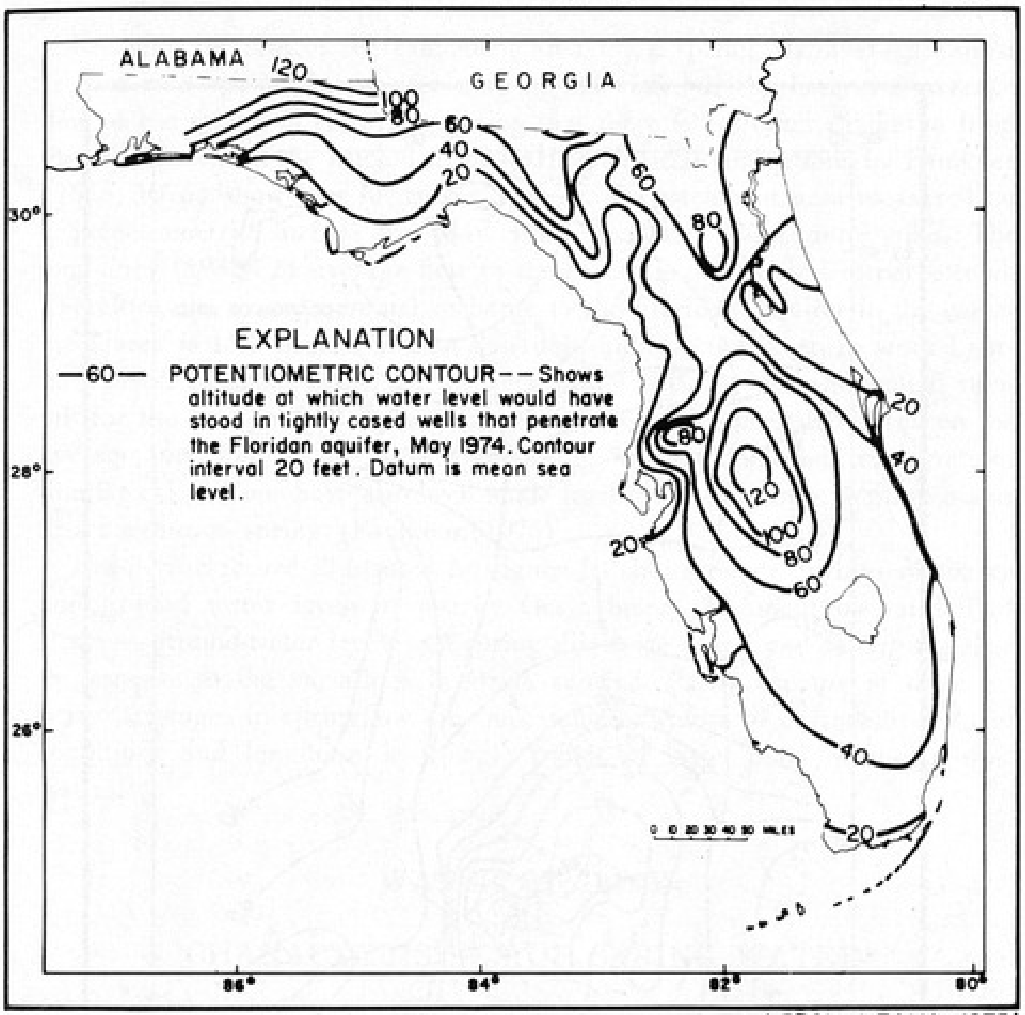
Although the rain that falls on Florida is the source of fresh water, not all that is available gets into the aquifer. Where the aquifer is full, and therefore unable to accept additional water, the rainfall is rejected and leaves the area as surface runoff to lakes and streams. A substantial quantity of water that enters the soil is quickly utilized by the vegetative cover through its root system and is lost by evaporation and transpiration. Where the aquifer is overlain by sediments of low permeability, downward percolation of water is retarded and recharge is limited even though the aquifer may not be full. And when heavy rains occur, the ability of the soil to absorb water may be exceeded and excess water will flow over the surface to lakes and streams without the aquifer being filled.

The potentiometric surface can be depicted on a map by a series of contours (or lines) of equal water level. Water in the aquifer moves from high to low points on the potentiometric surface and the natural direction of movement thus is generally perpendicular to the contours on the potentiometric surface. Figure 8 represents the potentiometric surface for the Floridan Aquifer in Florida in May 1974. This map was constructed using water-level measurements collected from wells and springs throughout the State.

The contours on the map were drawn by connecting points of equal water level measured in feet above mean sea level. The map is generalized because of its small size and shows only those major potentiometric features which maintain a fairly constant relation to one another from year to year. Smaller local details, such as those caused by changes in pumping patterns or irregularities in rainfall, are not shown.

The highs in the potentiometric surface are generally considered recharge areas and the lows discharge areas and, of course, there must be discharge from an aquifer to have a recharge or water movement. Recharge and discharge may occur at many places between the high and low points, however, wherever geologic conditions permit.

The saddle in the potentiometric surface across the northern part of the peninsula, includes five first magnitude springs (Rainbow, Silver, Silver Glen, Alexander, and Blue Springs) and reflects the comparatively low pressure that results from the flow of these and other large springs in this area. Another potentiometric low is in the Suwannee River valley where the river has eroded through the confining beds and exposed the artesian aquifer, thus permitting discharge through springs. Still another prominent discharge area is between peninsular and panhandle Florida, where a broad low-pressure trough in the potentiometric surface reflects the discharge from Wakulla and several other first magnitude springs. The lows, therefore, may be excellent indicators of the location of numerous or large springs.



(FROM HEALY, 1975)

FIGURE 8. — Potentiometric surface of the Floridan Aquifer in Florida, May 1974.

A detailed map of the potentiometric surface in the vicinity of a particular spring may be used to evaluate the role of the spring in the hydrologic regime of an area. The catchment area or ground-water basin of a spring can be outlined by drawing lines along the drainage divide in the potentiometric surface. This is illustrated in figure 9 where the catchment area for Silver Springs is shown on a potentiometric surface map constructed on the basis of water level measurements from about 130 wells in the Floridan Aquifer. The flow of Silver Springs is derived from recharge by rainfall within the bounds of the catchment area. Silver Springs is the largest fresh-water spring in Florida from the standpoint of long-term average measured discharge. (See table 2.).

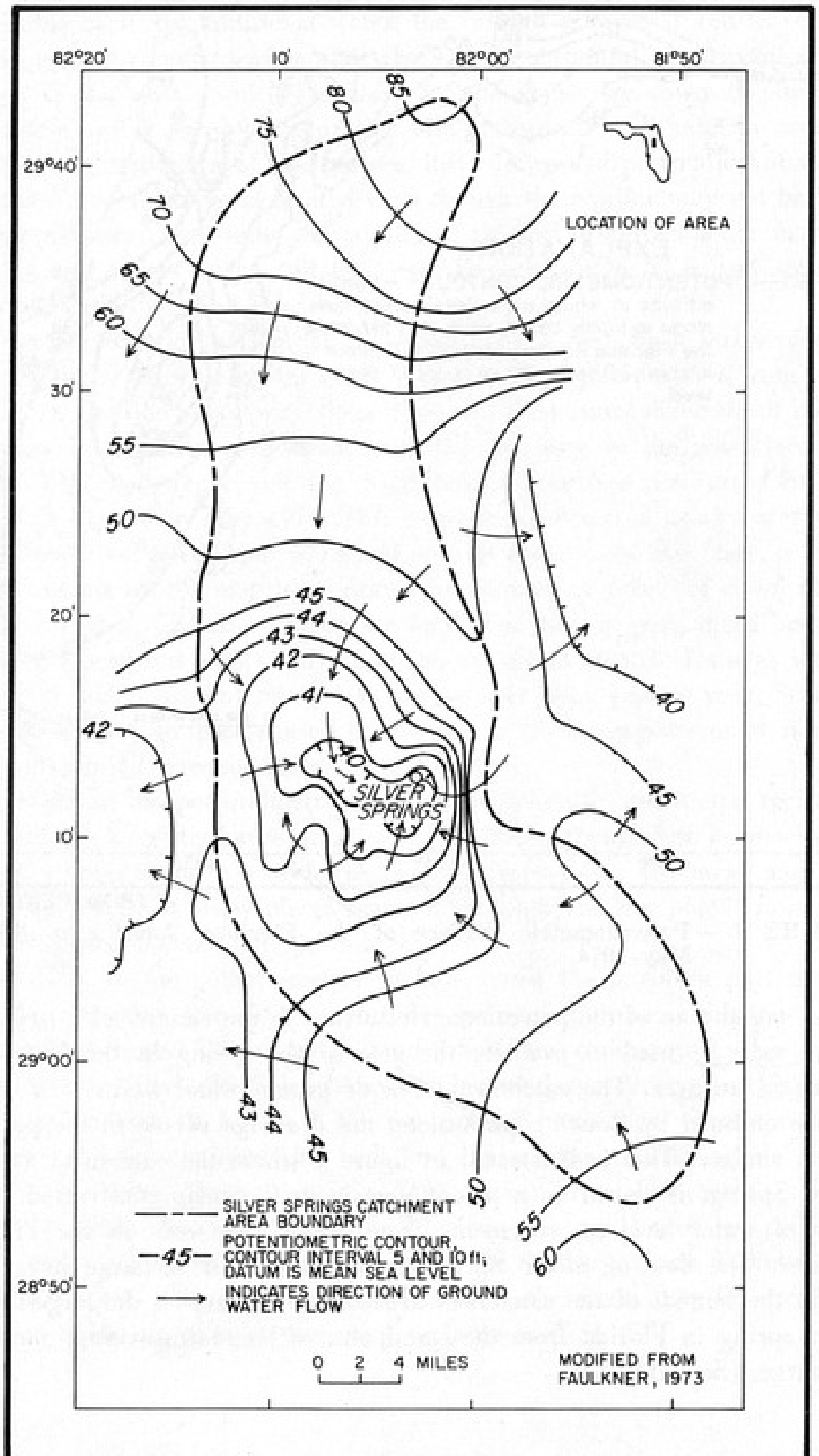


FIGURE 9. — Potentiometric surface of the Floridan Aquifer in the Silver Springs catchment area, May 1968.

Knowing the size of the catchment area for a spring, the average annual rate of recharge to the aquifer may be calculated if the long-term average flow of the spring is known, assuming that there is not other discharge from the aquifer within the catchment area. Hydrologic investigations by Faulkner (1973, 1976) show that for Silver Springs, the catchment area measured on a potentiometric surface for May 1968 is about 730 square miles. The long-term (1932-72) average flow of the spring is 823 cubic feet per second. Therefore, the average annual recharge to the Floridan Aquifer in the catchment area is 15.3 inches. Stream flow data indicate that average annual surface runoff in about 3 inches; the long-term (1931-60) average annual rainfall for the area in 53.2 inches. Therefore, about 35 inches of rainfall on the average, are lost to the area annually by evaporation and transpiration. Similar calculations have also been made for Rainbow Springs, another major first magnitude spring (Faulkner, 1973).

The 3-year record illustrated by figure 10 shows Silver Springs discharge and ground water levels at nearby Ocala being dependent on rainfall at Ocala — ground-water levels and spring discharge rising and falling together in response to the variations in Ocala rainfall. Partly because of these relations, changes in springflow are important indicators of current hydrologic conditions and long-term hydrologic trends of large parts of the aquifer system.

WATER QUALITY

CHARACTERISTICS OF SPRING WATER

The physical and chemical characteristics of the water discharging from Florida's springs are indicative of the quality of the ground waters flowing into the streams of the State. Spring water varies greatly in these characteristics owing to an almost infinite number of hydrologic and geologic environments which place particular contraints upon the hydrologic system. The flow pattern of the water over the land surface, through the rocks and sediments of the aquifer, and the type of rock determines what type and how much mineral or organic matter will be present to become dissolved or suspended, and how much will be lost due to precipitation, drainage, or filtration. Some differences in water — taste, color, and odor — are obvious, but our senses cannot evaluate or detect other, more subtle, differences. We must then rely on mechanical or electrical devices to make available qualitive and quantitative identification. These analyses show a wide range in the chemical constituents and the physical properties or characteristics of spring water.

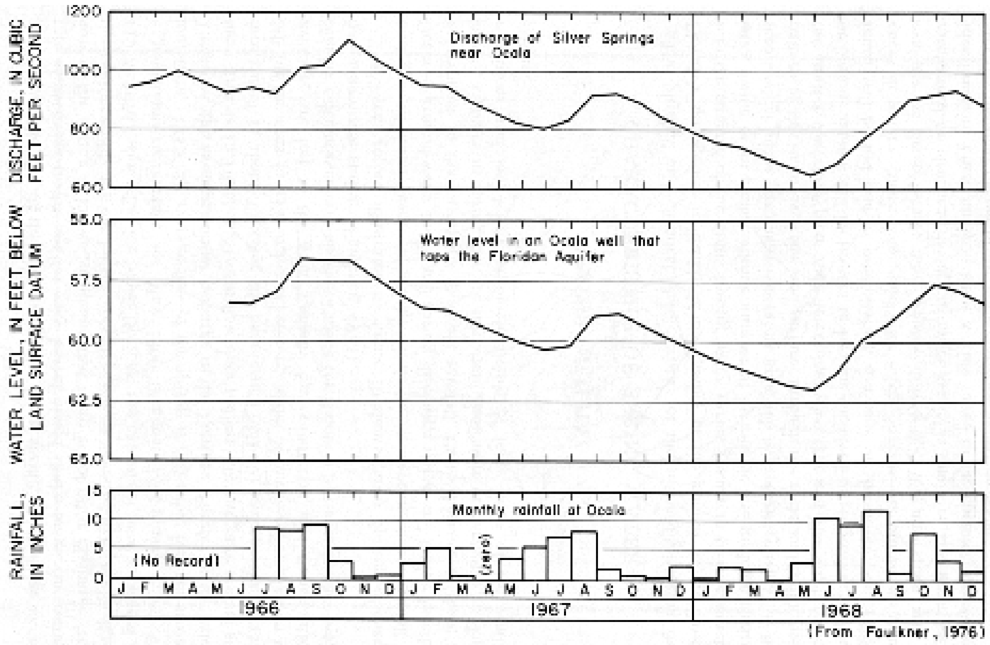


FIGURE 10. — Interrelation of rainfall, water levels in the Floridan Aquifer, and discharge of Silver Springs.

Many obvious examples may be found to give one a feeling for the extent of such variations in chemical characteristics of spring water in Florida. Black Spring in Jackson County is highly colored with organic matter; Green Cove Springs in Clay County emits a sulfur odor; Salt Spring in Marion County is, as its name implies, salty; Copper Spring in Dixie County has deposits of iron around the pool and its run; Indian Springs in Gadsden County yields water whose dissolved solids concentration is as low as any water in the natural environment in Florida.

Samples were collected from most of the springs — from some for the first time and many after a lapse of 20 years or more. Few of Florida's springs show substantial change in the quality of water being discharged as compared to that of 20 or 30 years ago. The water from Florida's springs is usually of good quality — the analyses being typical of water from wells in the vicinity that tap the Floridan Aquifer. Although few springs are discharging water relatively high in some constituents, none sampled carried contaminants such as pesticides, herbicides, or abnormal concentrations of trace elements.

White Springs, formerly known as White Sulphur Springs, yields water that appears to have freshened over the years. Since first sampled in 1923, concentrations of several constituents show declines — for example, sulfate from 19 milligrams per liter in 1923 to zero in 1972. The chemist will add that the data are inadequate to conclude whether the freshening is real or only apparent, but the people of the White Springs area insist that their spring has changed — water has lost that rotten egg odor that once was so noticeable!

DEFINITIONS OF CHEMICAL CONSTITUENTS AND RELATED TERMINOLOGY

The definitions, means of expressing analytical results, and a simplified tabulation of the sources, causes, and the significance of individual parameters are given to provide background material that will be helpful to the reader in understanding the chemical and physical analyses that accompany most of the spring descriptions.

Before the 1968 water year (October 1, 1967 through September 30, 1968), chemical analyses and concentrations of suspended sediment were reported in parts per million and water temperatures were reported in degrees Fahrenheit. In October 1967, the U.S. Geological Survey began reporting data for chemical constitutents and concentrations of suspended sediment in milligrams per liter (mg/L) and water temperatures in degrees Celsius (°C).

Alkalinity. — Caused primarily by bicarbonate and hydroxide. Other weak acid radicals like borate, phosphate, and silicate may contribute to alkalinity. The significance of alkalinity is the ability of such water to neutralize strong acids. High alkalinity itself is not detrimental but usually is associated with high pH, hardness, and dissolved solids which can be detrimental.

Aluminum. — Usually present only in neglible quantities in natural waters except where the waters have been in contact with the more soluble rocks of high aluminum content. Acid waters often contain large amounts of aluminum. High concentrations usually indicate the presence of acid mine drainage or industrial waste. Aluminum may be troublesome in feed waters by forming scale on boiler tubes.

Arsenic. — Found in some ground waters where its source is the natural arsenic-bearing minerals in wastes from industry and mining activity, and residues from some insecticides and herbicides. Florida Department of Environmental Regulation drinking water standards (1975) give a limit of 50 micrograms per liter ($\mu g/L$) for potable waters. A lethal dose of arsenic for animals is believed to be about 20 milligrams per animal pound. Small concentrations in drinking water can accumulate in man and other animals until lethal dosage is reached.

Bicarbonate and Carbonate. — Produced by the reaction of atmospheric carbon dioxide with water and are dissolved from carbonate rocks such as limestone and dolomite. They are significant because they produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to precipitate as scale and release corrosive carbon dioxide gas. They combine with calcium and magnesium to cause carbonate hardness.

Biochemical oxygen demand. — A measure of the quantity of dissolved oxygen necessary for the decomposition of organic material by microorganisms such as bacteria. Biochemical oxygen demand, abbreviated BOD, is significant in that when it is high, severe oxygen depletion may result, with eventual harm to the environment. BOD is reported in milligrams per liter.

Cadmium. — Found in wastes from pigment works, textile printing, lead mines and chemical industries. The results of studies with animals suggest that very small amounts of cadmium can affect the kidneys, heart, and circulatory systems. Cadmium is toxic to fish in varying concentrations. Drinking water standards of the Florida Department of Environmental Regulation (1975) state that cadmium in excess of 10 $\mu g/L$ is cause for rejection of the water supply.

Calcium and Magnesium. — Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in seawater. Calcium and magnesium cause most of the hardness and scale-forming properties of water. Waters low in calcium and magnesium are desired in electroplating, tanning, dyeing, and in textile manufacturing.

Chloride. — Dissolved from rocks and soils; it is also present in sewage and is found in large amounts in ancient brines, seawater, and industrial brines. About 300 mg/L chloride in combination with sodium gives a salty taste to water. Chloride increases the corrosiveness of water. Florida DER drinking water standards (1975) recommend that chloride concentration should not exceed 250 mg/L.

Chromium. — Rarely found in waters from natural sources; water can probably contain only traces of chromium as a cation unless the pH is very low. When chromium is present in water, it is usually the result of pollution by industrial wastes such as metal pickling, plating, manufacturing of paints, dyes, explosives, ceramics, paper, glass, and photography processing. Toxicity to aquatic life varies widely with the species, temperature, pH, and other factors. Florida DER drinking water standards (1975) limit the maximum concentration of hexavalent chromium to 50 μg/L.

Cobalt. — Occurs in nature in the minerals smaltite ($CoAs_2$) and cobaltite (CoAsS). Alluvial deposits and soils derived from shales often contain cobalt in the form of phosphate or sulfate, but other soil types may be markedly deficient in cobalt in any form (Bear, 1955). Biological activity may aid in the solution of small amounts of cobalt. It may also be present in industrial wastes, especially those from manufacture of ceramics, inks, electrical heating units and cobalt pigments. The presence of cobalt usually suggests pollution. Cobalt has a relatively low toxicity to man. Fish and aquatic life tolerance varies widely from less than 3.000 μg/L to more than 10,000 μg/L. Cobalt is essential to these quantities for plant growth.

Color. — The yellow-to-brown color of some water is usually caused by organic matter extracted from leaves, roots, and other organic substances. Objectionable color in water may also result from industrial wastes and sewage. Color in water is objectionable in food and beverage processing and many manufacturing processes; it limits light penetration of water, thus preventing growth of some organisms. Water for domestic and some industrial uses should be free from perceptible color. Color is expressed in units of the platinum-cobalt scale proposed by Hazen (1892). A unit of color is produced by one milligram per liter of platinum in the form of the chloroplatinate ion.

Copper. — A fairly common trace constituent of natural water. Small amounts may be introduced into water by solution of copper and brass water pipes and other copper-bearing equipment in contact with the water or from copper salts added to control algae in open reservoirs. Copper salts, such as sulfate and chloride, are highly soluble in waters with a low pH but in water of normal alkalinity the salts hydrolyze and copper may be precipitated. In the normal pH range of natural water containing carbon dioxide, copper might be precipitated as carbonate. Copper imparts a disagreeable metallic taste to water. As little as 1,500 $\mu g/L$ can usually be detected, and 5,000 $\mu g/L$ can render the water unpalatable. Copper is not considered to be a cumulative systemic poison like lead and mercury; most copper ingested is excreted by the body and very little is retained. The pathological effects of copper are controversial, but it is believed very unlikely that humans could unknowingly ingest toxic quantities from palatable drinking water. Florida DER (1975) recommends that copper should not exceed 1,000 $\mu g/L$ in drinking and culinary water. Copper is essential in trace amounts for plant growth but becomes toxic in large amounts.

Dissolved Oxygen. — Easily dissolves in water from air and from oxygen given off in the process of photosynthesis by aquatic plants. Dissolved oxygen increases the palatability of water. The amount necessary to support fish life varies with species and age, with temperature, and concentration of other constituents in the water. Under average stream conditions, 5 mg/L is usually necessary to maintain a varied fish fauna in good condition. For many industrial uses, zero dissolved oxygen is desirable to inhibit corrosion.

Dissolved solids. — Chiefly the mineral constituents dissolved from weathering or rocks and soils. Waters containing more than 1,000 mg/L of dissolved solids are unsuitable for many purposes. The U.S. Geological Survey classifies the degree of salinity of these more mineralized bodies of water as follows (Swenson and Baldwin, 1965):

Dissolved solids (mg/L)	Degree of Salinity
Less than 1,000	Nonsaline.
1,000 to 3,000	Slightly saline.
3,000 to 10,000	Moderately saline.
10,000 to 35,000	Very saline.

Fluoride. — May be present in water in small to minute quantities as a result of leaching of fluoride bearing rocks and soil. It also may be present in municipal supplies as a result of fluoridation. Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptibility of the individual. (Maier, 1950).

Hardness. — In most waters, hardness is due to the calcium and magnesium content. All of the metallic cations other than the alkali metals also cause hardiness. Water that is high in calcium-magnesium carbonate consumes soap before a lather will form and deposits soap curd on sinks or bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardiness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness up to 60 mg/L are considered soft; 61 to 120 mg/L, moderately hard; 121 to 180 mg/L, hard; more than 180 mg/L, very hard (Durfor and Becker, 1964).

Hydrogen ion concentration. — Commonly is expressed in terms of pH, where $pH = -\log(H^+)$. Hydrogen ions are derived from ionization of weak and strong acids. Acid-generating salts and dissolved gases such as SO_2 and CO_2 increase the number of hydrogen ions. Carbonates, bicarbonates, hydroxides, phosphates, silicates, and borates reduce the number of hydrogen ions. Hydrogen ion concentration in terms of pH ranges between 0 and 14. A pH of 7.0 indicates a solution that has an equal number of hydrogen and hydroxide ions. A pH higher than 7.0 denotes a predominance of hydroxide ions; a pH less than 7.0 denotes a predominance of hydrogen ions. Corrosiveness of water generally increases with decreasing pH, although excessively alkaline waters may also attack metals.

Iron. — Dissolved from many rocks and soils. On exposure to air, normal basic waters that contain more than 1,000 μg/L of iron become turbid with the insoluble reddish ferric compounds produced by oxidation. Surface water, therefore, seldom contains as much as 1.000 μg/L of dissolved iron, although some acid waters carry large quantities of iron in solution. More iron than about 300 μg/L may stain laundry and utensils reddish-brown. Water high in iron is objectionable for food processing, textile processing, beverages, ice manufacture, brewing and other processes. Florida DER (1975) limits, and for esthetic reasons, iron and manganese should not exceed 300 μg/L. Larger quantities cause unpleasant taste and favor growth of iron bacteria.

Lead. — Seldom occurs naturally in surface or ground waters, but industrial mine and smelter effluents may contain relatively large amounts of lead which may contaminate a water source. Atmospheric contamination with lead produced from several types of engine exhausts has considerably increased the availability of this element for solution in rainfall, resulting in lead contamination of water bodies (Hem, 1970). Florida DER (1975) drinking water standards state that lead shall not exceed 50 μg/L in drinking and culinary water. Maximum safe concentrations for animal watering is reported to be 500 ug/L. Toxicity of lead to fish decreases with increasing water hardness.

Manganese. — May be dissolved from some rocks and soils; it is not as common as iron. Large quantities are often associated with high iron content and with acid waters. Manganese has the same objectionable features as iron; it causes dark brown or black stains. Florida DER drinking water standards provide that iron and manganese together should not exceed 300 μg/L.

Micrograms per liter. — A unit expressing the concentration of chemical constitutents in solution as weight (micrograms) of solute per unit volume (liter) of water. Its symbol is μg/L. One thousand micrograms per liter is equivalent to one milligram per liter.

Milligrams per liter. — A unit for expressing the concentration of chemical constitutents in solution. Its symbol is mg/L. Milligrams per liter represents the weight of solute per unit volume of water.

Mineral constitutents (inorganic substances which occur naturally in the earth) in solution. — The analyses listed in this report include only those mineral constituents that have a practical bearing on water use. The analyses generally include silica, iron, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, fluoride, nitrate, pH, and dissolved solids. Aluminum, manganese, color, specific conductance, dissolved oxygen, and other dissolved constitutents and physical properties are reported for certain springs. Organic components (although not mineral) may have an influence over the amount of mineral constituents in solution.

Nickel. — The presence of nickel in water suggests pollution. When present it is chiefly from metal-plating works, or from manufacturing of ceramic colors and inks. Federal drinking water standards do not place a limit on nickel. In the Soviet Union the maximum permissable concentration is 1,000 μg/L. (Kirkor, 1951).

Ammonia Nitrogen. — Includes nitrogen in the form of NH_3 and NH_4+. It is found in many waters but usually only in trace amounts although waters from hot springs may contain high concentrations. Found also in waters carrying sewage and other organic wastes; presence in surface or ground water usually indicates organic pollution. Toxicity to fish is dependent on the pH of the water; 2.5 mg/L ammonia nitrogen can be harmful in the 7.4 to 8.5 pH range (Ellis and others, 1946). Ammonium salts are destructive to concrete made from portland cement.

Organic Nitrogen. — Originates from amino acids, proteins, and polypeptides; derived from living organisms and their life processes and from wastes and sewage. Presence of organic nitrogen sometimes indicates pollution; increases nutrient content of water through decomposition and formation of other nitrogen forms.

Nitrate Nitrogen.—Derived from decaying organic matter, sewage, fertilizers, and nitrates in soil. Nitrate concentrations much greater than the local average may suggest pollution. There is evidence that water with more than about 10 mg/L of nitrate (N) may cause a type of methemoglobinemia in infants which may be fatal and therefore should not be used in baby feeding (Maxcy, 1950). Nitrate encourages growth of algae and other organisms which produce undersirable tastes and odors.

Nitrite Nitrogen. — Unstable in the pressence of oxygen, it is present in only small amounts in most waters. Found in sewage and other organic wastes, nitrite is usually an indication of recent organic pollution. Undesirable in waters for some dyeing and brewing processes.

Total Kjeldahl Nitrogen. — The sum of ammonia nitrogen and organic nitrogen. (See ammonia nitrogen, nitrite, nitrate, and organic nitrogen.)

Nutrients. — Chemicals necessary to the growth and reproduction of rooted or floating flowering plants, ferns, algae, fungi, or bacteria.

Pesticides. — Chemical compounds used to control the growth of undesirable plants and animals. Major categories of pesticides include insecticides, miticides, fungicides, herbicides, and rodenticides. Since the first application of DDT as an insecticide in the early 1930's, there have been almost 60,000 pesticide formulations registered, each containing at least one of the approximately 800 different basic pesticide compounds (Goerlitz and Brown, 1972, p. 24). Unless otherwise noted on the analyses, the pesticides tested for include the insecticides: aldrin, DDD, DDE, DDT, dieldrin, endrin, heptachlor, heptachlor expoxide, lindane, chlordane, toxaphene, ethion, trithion, methyl trithion, parathion, methyl parathion, malathion, and diazinon; and the herbicides: 2, 4-D, silvex, and 2, 4, 5-T.

Picocurie. — One millionth of the amount of radioactivity represented by a microcurie, which is the quantity of radiation represented by one millionth of a gram of radium-226. Its symbol is pCi. A picocurie of radium results in 2.22 disintegrations per minute.

Polychlorinated biphenyls (PCBs). — A class of compounds produced by the chlorination of biphenyls. PCBs are soluble in water, lipids, oils and organic solvents, and resistant to heat and biological degradation. They are relatively nonflammable, have useful heat exchange and dielectric properties and are used in the electrical industry in capacitors and transformers. Can be harmful to fresh water and marine aquatic life and their consumers, and to humans. (EPA 1976, p. 193.)

Radioisotopes. — Isotope forms of an element that exhibit radioactivity. Isotopes are varieties of a chemical element that differ in atomic weight, but are very nearly alike in chemical properties. The difference arises because the atoms of the isotopes forms of an element differ in the number of neutrons in the nucleus. For example: ordinary chlorine, whose atomic weight is 35.453, is a mixture of isotopes having atomic weights 35 and 37. Many of the elements similarly exist as mixtures of isotopes, and a great many new isotopes have been produced in the operation of nuclear devices such as the cyclotron (Rose, 1966). There are 275 isotopes of the 81 stable elements in addition to over 800 radioactive isotopes.

Specific Conductance. — A measure of the ability of a water to conduct an electrical current; it is expressed in micromhos per centimeter at 25°C. Conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids content of the water.

Strontium. — Occurs in water where strontium minerals, such as celestite and strontianite, are present. Is found in seawater and many brines. Naturally occurring strontium is similar chemically to calcium and adds to the hardness of water. Radioactive isotopes of strontium, as from nuclear bomb fallout, can be harmful. These isotopes can be detected by radiometric measurements.

Sulfate. — Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Sulfate is usually present in mine waters and some industrial waters. Sulfate in water containing calcium forms a hard scale in steam boilers; and in large amounts, sulfate in combination with other ions gives a bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. Florida DER drinking water standards state that the sulfate concentration should not exceed 250 mg/L.

Temperature. — Sources of heat are solar energy, heat from earth's core and thermal pollution from waste outfalls. The temperature of water affects

TABLE 5. Conversion of temperature scales Degrees Celcius (°C) to Degrees Fahrenheit (°F).

°C	°F	°C	°F
15.0	59	26.0	79
15.5	60	26.5	80
16.0	61	27.0	81
16.5	62	27.5	81
17.0	63	28.0	82
17.5	63	28.5	83
18.0	64	29.0	84
18.5	65	29.5	85
19.0	66	30.0	86
20.0	68	30.5	87
20.5	69	31.0	88
21.0	70	31.5	89
21.5	71	32.0	90
22.0	72	32.5	90
22.5	72	33.0	91
23.0	73	33.5	92
23.5	74	34.0	93
24.0	75	34.5	94
24.5	76	35.0	95
25.0	77	35.5	96
25.5	78		

* $^{\circ}C = \frac{5(^{\circ}F-32)}{9}$; $^{\circ}F = \frac{(^{\circ}C \times 9)}{5} = 32$

its usefulness for many purposes. Water of uniformly low temperature is desired for most uses. Temperature of water in shallow wells shows some seasonal fluctuations; wells of moderate depths usually yield water which is near the mean annual air temperature of the area. In very deep wells, the water temperature generally increases on the average about one degree Celsius per 100-foot increment of depth (or about one degree Fahrenheit per 65-foot depth). Seasonal fluctuations in temperatures of surface waters are large, depending on the depth of water, but do not reach the extremes of air temperature. See table 5 for conversion of temperature, degrees Celsius to Fahrenheit.

Total Organic Carbon. — A measure of the organically related carbonaceous content of water. It includes all natural and manmade organic compounds that are combustible at a temperature of 950°C.

Turbitity. — Caused by colloidal suspension of sediment, precipitates, and other small particles. Turbitity should be less than 5 Jackson turbidity units (JTU) for domestic use. Turbidity interferes with light penetration, limits growth of organisms, and if high, is lethal to some life forms.

Zinc. — Dissolved from some rocks and soils; it is found in high concentrations in mine waters that have a low pH. Zinc may be derived from zinc plated or galvanized metal products; it is used in many commercial products, and industrial wastes may contain large amounts. Small amounts of zinc are toxic to aquatic plants and animals. Zinc may have such a toxic action on the purifying bacterial flora of streams that serious sewage pollution problems result. Florida DER drinking water standard limit zinc concentrations to 5,000 $\mu g/L$.

DISTRIBUTION OF FLORIDA SPRINGS

The distribution of springs within the state of Florida is not entirely random. The discussions on geology and hydrology show that certain environmental factors affect the potential for spring development. Where the primary physical control is a downcutting river or a local karst topographic feature, the effect may be a regional concentration of springs as in the Suwannee River basin, or an isolated spring as in Sarasota County.

Of the 300 springs listed in this report, most are the result of regional influences, with only a few the result of local influence. The few water-table "seeps" or "filtration" springs, are mainly in northern Florida. Others are unusual in that they are "deep source" springs.

In Florida there are 27 springs of first magnitude. They are listed in table 2 and their locations are shown in figure 11. All are described in detail. Each of these 27 springs, or groups of springs, is discharging water from the Floridan Aquifer at an average rate exceeding 100 cubic feet per second. They have a total average flow of 9,600 cubic feet per second or about 80 percent of the 12,000 cubic feet per second estimated discharge of all of Florida's springs. These first magnitude springs include several that are nationally or even internationally known, such as Rainbow, Weeki Wachee, and Wakulla Springs, which are in Marion, Hernando, and Wakulla counties, respectively. Other first magnitude springs are unknown to even nearby residents; examples are Alapaha Rise and St. Marks Spring, which are in Hamilton and Leon counties, respectively.

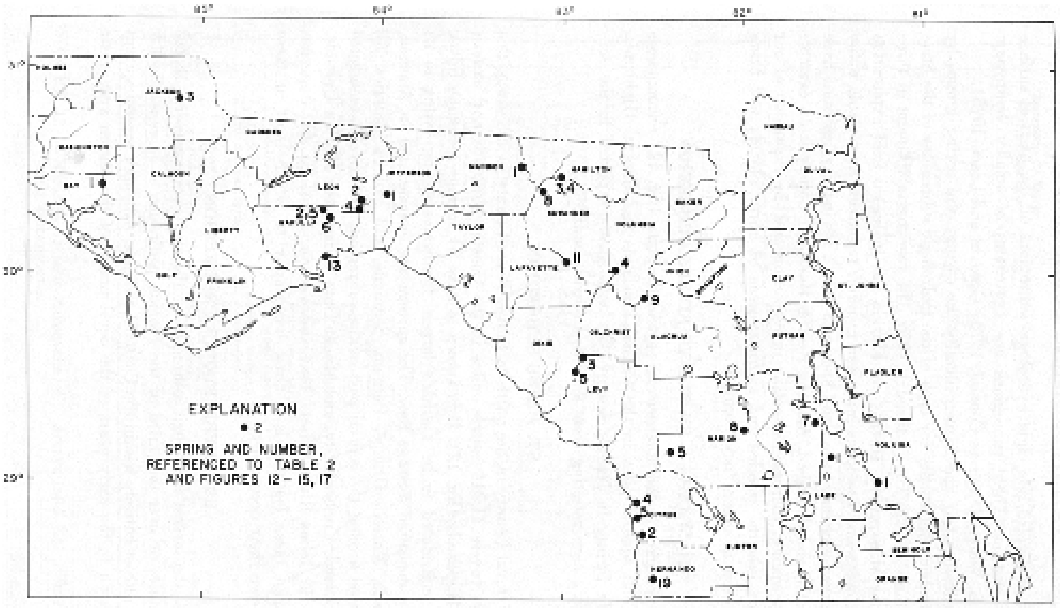


FIGURE 11. — Locations of Florida's 27 first magnitude springs. These are springs or groups of springs that have average flows of 100 cubic feet per second or more.

THE HYDROLOGIC SUBREGIONS

Florida is divided into eight hydrologic subregions on the basis of surface drainage systems. These subregions are aggregates of smaller hydrologic units (U.S. Water Resources Council, 1974; Conover and Leach 1975).

The following text and figures identify the springs and spring groups by name, number, and county for each of the hydrologic subregions of the State and for those springs known through 1976. The recent establishment of three new Water Management Districts in Florida has increased field exploration by hydrologists and geologists interested in water resources. As a result, many springs previously unreported and known to only a few nearby residents have been located and described. Alapaha Rise in Hamilton County is an example of such a spring. Increased scientific investigation and the expansion of our population into the wooded and swampy areas of north Florida will bring identification of other "new" springs.

ALTAMAHA — ST. MARYS RIVERS SUBREGION

This subregion in the northeastern part of the state (fig. 12) encompasses about 1,380 square miles in the Coastal Lowlands and Central Highlands. Su-No-Wa Spring in Nassau County, the only spring reported in the subregion, is a seep resulting from local hydrologic conditions.

ST. JOHNS SUBREGION

From Duval County in the north to Indian River County in the south, this subregion covers 11,310 square miles in the Coastal Lowlands and eastern Central Highlands (fig. 12). It is known to have 51 springs including Silver Springs, considered to be Florida's largest freshwater spring owing to its long-term measured average flow. The springs are concentrated in Alachua, Clay, Lake, Marion, Orange, Putnam, Seminole, and Volusia counties. All are situated around the central part of the subregion. The area is transected by the Deland, Crescent City, and Mount Dora Ridges, the Marion Uplands, and the St. Johns River Offset (Puri and Vernon, 1964, fig. 6). Superimposed upon these features is a karst topography to which most of these springs owe their occurrence.

SOUTHERN FLORIDA SUBREGION

This is the largest hydrologic subregion of the state, encompassing 18,212 square miles or over one third of the Florida peninsula. It is generally flat and lies almost entirely within the Coastal Lowlands. Although several springs were known in the early years of the development of the Miami area, none

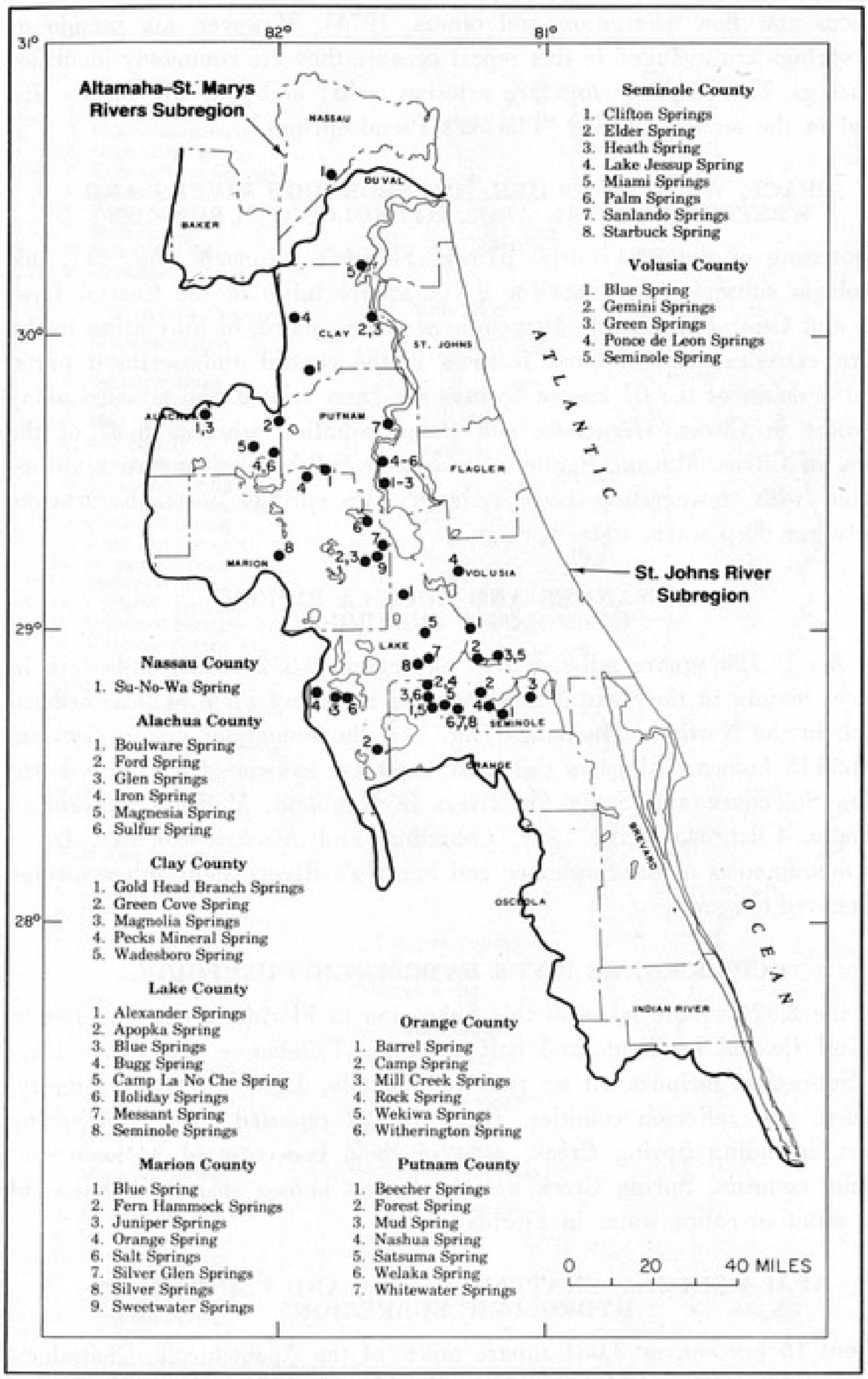


FIGURE 12. — Springs in the Altamaha - St. Marys and St. Johns Hydrologic Subregions.

of them now flow (Ferguson and others, 1974). However, six pseudo or false springs are included in this report because they are commonly identified as springs. The pseudosprings are artesian wells; and they are briefly discussed in the section entitled "Florida's Pseudosprings."

PEACE, WITHLACOOCHEE, HILLSBOROUGH RIVERS AND WESTERN COASTAL AREA HYDROLOGIC SUBREGION

Consisting of the west-central part of Florida's peninsula (fig. 13), this hydrologic subregion accounts for 9,811 square miles in the Coastal Lowlands and Central Higlhands. It is an area of low plains, of hilly areas in the eastern extremes, and of karst features in the central and northern parts. About a dozen of the 61 known springs are karst related and situated along the coast in Citrus, Hernando, and Pasco counties, whereas most of the others, in Citrus, Marion, Sumter, Pasco, and Hillsborough counties are associated with downcutting river systems. Two springs in south Sarasota County are deep warm water springs.

SUWANNEE AND AUCILLA RIVERS HYDROLOGIC SUBREGION

Of the 13,720 square miles of this Subregion, 7,832 square miles are in Florida, mainly in the Coastal Lowlands but including some of the northern section in the Northern Highlands (fig. 14), the remainder are in Georgia. Of the 115 known springs in this area, most are associated with the downcutting Suwannee and Santa Fe Rivers in Hamilton, Madison, Suwannee, Lafayette, Gilchrist, Dixie, Levy, Columbia, and Alachua counties. In or near the channels of the Suwannee and Santa Fe Rivers many other springs are believed to occur.

OCHLOCKONEE RIVER HYDROLOGIC SUBREGION

Of the 2,324 square miles of this Subregion in Florida, about half lies in the Gulf Coastal Lowlands and half is in the Tallahassee Hills (fig. 15.). The Subregion includes all or part of Wakulla, Leon, Franklin, Liberty, Gadsden, and Jefferson counties. There are 27 reported springs or spring groups, including Spring Creek, most of them concentrated in Leon and Wakulla counties, Spring Creek has the largest known spring discharge of fresh water or saline water in Florida.

APALACHICOLA, CHATTAHOOCHEE, AND FLINT RIVER HYDROLOGIC SUBREGION

About 16 percent, or 3,081 square miles, of the Apalachicola, Chattahoochee, and Flint River Subregion is in Florida (fig. 15). About 19 springs have been reported in this Subregion; more than half are associated with

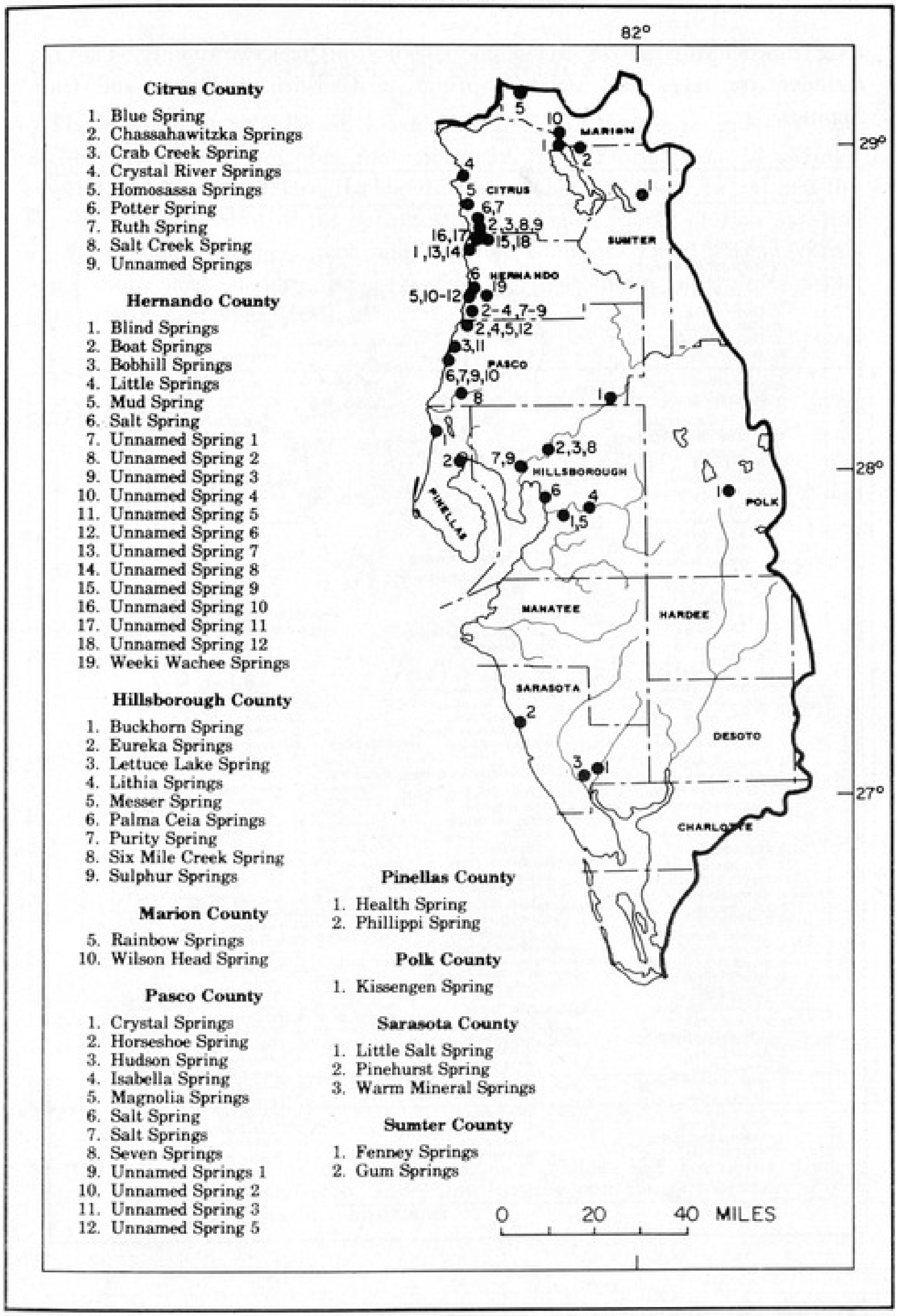
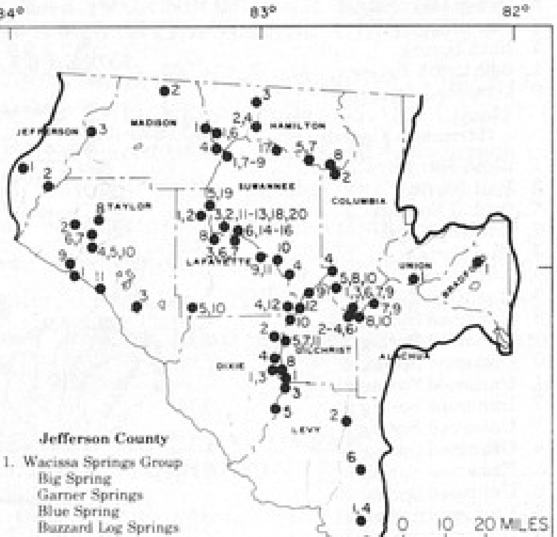


FIGURE 13. — Location of springs in the Peace, Withlacoochee, Hillsborough Rivers and western coastal area Hydrologic Subregions.

river downcutting in the Marianna Uplands in Jackson County. The remainder are seeps and isolated springs in Gadsden, Calhoun, and Gulf counties.



Union County
1. Worthington Spring

Alachua County
7. Darby Spring
8. High Springs
9. Hornsby Spring
10. Poe Springs

Bradford County
1. Heilbronn Spring

Columbia County
1. Allen Spring
2. Bell Springs
3. Columbia Spring
4. Ichetucknee Springs Group
   - Ichetucknee Spring
   - Cedar Head Spring
   - Blue Hole Spring
   - Roaring Springs
   - Singing Springs
   - Boiling Spring
   - Grassy Hole Spring
   - Mill Pond Spring
   - Coffee Spring
5. Jamison Spring
6. July Spring
7. Jonathian Spring
8. Northbank Spring
9. Rum Island Spring
10. Wilson Spring

Dixie County
1. Copper Spring
2. Guaranto Spring
3. Little Copper Spring
4. McCrabb Spring

Gilchrist County
1. Bell Springs
2. Blue Springs
3. Devil's Eye Springs
4. Ginnie Spring
5. Hart Springs
6. Lilly Springs
7. Lumber Camp Springs
8. Otter Springs
9. Pleasant Grove Springs
10. Rock Bluff Springs
11. Sun Springs
12. Townsand Spring

Hamilton County
1. Adams Spring
2. Alapaha Rise
3. Bluff Cemetery Spring
4. Holton Spring
5. Louisa Spring
6. Morgans Spring
7. Wesson's Iron Spring
8. White Springs

Jefferson County
1. Wacissa Springs Group
   - Big Spring
   - Garner Springs
   - Blue Spring
   - Buzzard Log Springs
   - Minnow Spring
   - Cassidy Spring
   - Springs No. 1 and 2
   - Thomas Spring
   - Log Springs
   - Allen Spring
   - Horsehead Spring
2. Walker Spring

Lafayette County
1. Allen Mill Pond Spring
2. Blue Spring
3. Convict Spring
4. Fletcher Spring
5. Iron Spring
6. Mearson Spring
7. Owens Spring
8. Perry Spring
9. Ruth Spring
10. Steinhatchee Spring
11. Troy Spring
12. Turtle Spring

Levy County
1. Big Spring
2. Blue Spring
3. Fannin Springs
4. Little Spring
5. Manatee Spring
6. Wekiva Springs

Madison County
1. Blue Spring
2. Cherry Lake Spring
3. Pettis Spring
4. Suwanacoochee Spring

Suwannee County
1. Anderson Spring
2. Baptizing Spring
3. Bonnet Spring
4. Branford Springs
5. Charles Springs
6. Cow Spring
7. Ellaville Spring
8. Falmouth Spring
9. Lime Spring
10. Little River Springs
11. Luraville Springs
12. Peacock Springs
13. Pump Spring
14. Royal Spring
15. Running Spring
16. Suwannee Blue Spring
17. Suwannee Springs
18. Telford Springs
19. Thomas Spring
20. Walker Spring

Taylor County
1. Big Spring
2. Blue Spring
3. Blue Spring
4. Campground Spring
5. Carlton Spring
6. Ewing Spring
7. Hampton Springs
8. Iron Spring
9. Union Spring
10. Waldo Springs
11. Warrior Spring

FIGURE 14. — Springs in the Suwannee and Aucilla Rivers Hydrologic Subregion.

CHOCTAWHATCHEE, YELLOW, AND ESCAMBIA RIVER HYDROLOGIC SUBREGION

The western panhandle of Florida includes 6,491 square miles of the 14,740 square miles of the Subregion (fig. 15). Florida has 18 springs associated with the Western Highlands, Choctawhatchee River valley, and the Escambia valley. Most of the springs are the result of river erosion and are in Washington, Holmes, Bay, and Walton counties. There probably are many more small springs and seeps than the few known in Walton, Santa Rosa, and Escambia counties.

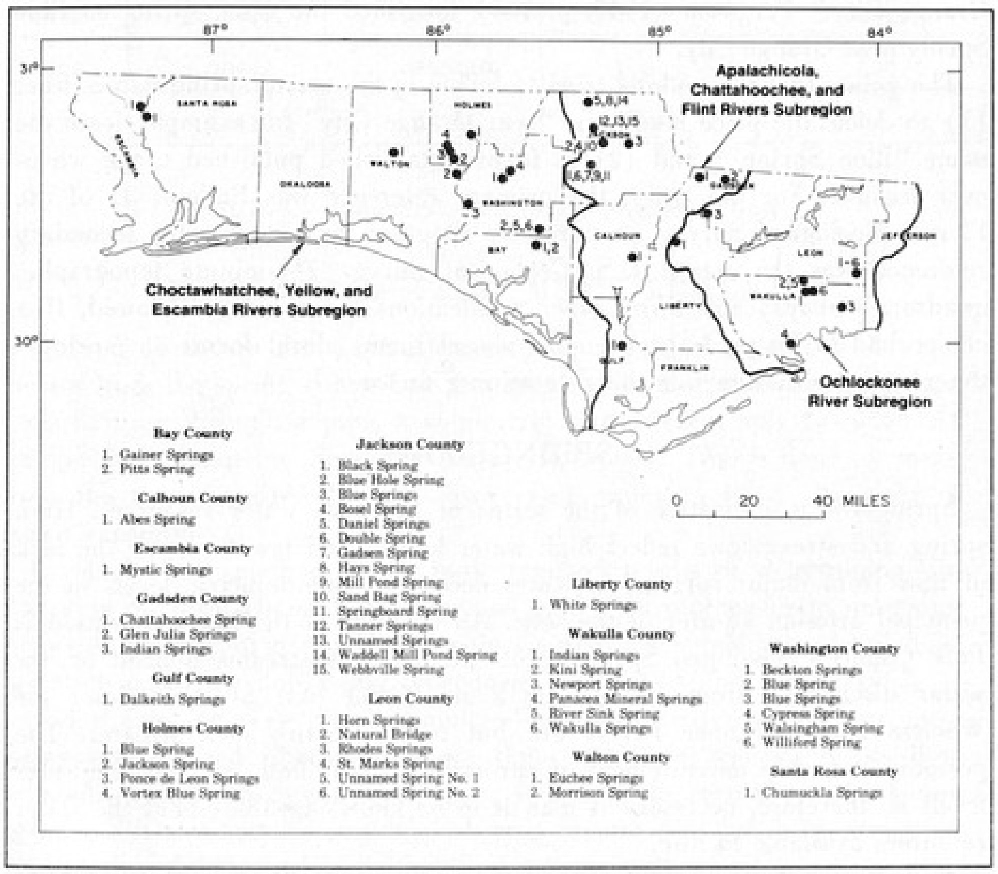


FIGURE 15. — Springs in the Choctawhatchee, Yellow, and Escambia Rivers; Chattahoochee, and Flint Rivers; and the Ochlockonee River Hydrologic Subregions.

SPRING DESCRIPTIONS

SPRING NAMES

There is considerable confusion about the names of many of Florida's springs. Any number of these natural ground-water discharge sites have but a single vent and yet are popularly identified in the plural "Springs". Others have been known by several names; they may have had place names or have been named after individuals such as their owners. Blue Spring in Volusia County is in Blue Springs State Recreation Area; and U.S. Geological Survey records dating back to 1932 have identified it as "Blue Springs near Orange City." Ferguson (1947, p. 163) identified the same spring as Blue Spring near Orange City.

The policy that the authors tried to follow in the use of spring names was: (1) to delete the place modifiers, "near Orange City" for example, from the name "Blue Spring"; and (2) to follow established published usage whenever feasible. For the latter, the primary reference was Bulletin 31 of the Florida Geological Survey, prepared by Ferguson and others; the secondary reference was the recent U.S. Geological Survey 7½-minute topographic quadrangle maps; and third, other publications. Local usage followed. If a choice had to be made between the singular and plural forms of "spring," the physical situation was the determining factor.

SPRINGFLOW

Springflow is indicative of the status of Florida's water resources. High spring and streamflows reflect high water levels; and low flows, or the lack of flow from major springs, indicates declining potentiometric levels in the principal artesian aquifer of the state. An example of the latter condition is Polk County's Kissingen Spring. Most of Florida's streams depend on the water discharged from springs for a significant part of their flow; the Wacissa and Suwannee Rivers are but two of many such streams. The periodic statewide measurement of springflow, streamflow, and ground-water levels is, therefore, necessary if man is to be knowledgeable about the water resources available to him.

Spring and streamflow are normally expressed in cubic feet per second, in million of gallons per day, or in gallons per minute if the volume being measured or reported is small. A rate of flow (discharge) of 1 cubic foot per second represents a volume of 1 cubic foot of water passing a given point during 1 second. Table 6 lists the equivalents useful in converting between the more common hydraulic units.

Springflows are usually measured in the first straight uniform reach of the

Cubic feet per second (ft^3/s)	Acre-feet per day (acre-ft/d)	Million gallons per day (Mgal/d)	Gallons per minute (gal/min)	Inches per square mile per year (in/mi^2)/y
1.0	1.9835	0.646317	448.83	13.574
.50417	1.0	.325851	226.29	6.8438
1.5472	3.0689	1.0	694.44	21.0025
.00223	.00442	.001440	1.0	.03024
.07367	.14612	.04761	33.065	1.0

TABLE 6. — Conversion factors for rates of flow.

METHODS OF FLOW MEASUREMENT

spring run or stream downstream from the spring. If the quantity of water flowing from the spring is small, in the range of 1 cubic foot per second and is discharging through a pipe, a volumetric measurement may be made. An example is Steinhatchee Spring in Lafayette County. This is done by measuring the time required for the discharging water to fill a container of known capacity.

A velocity-area method is the most common means of determining discharge in an open channel. This method uses a current meter to determine the water velocity at a number of points across a channel. For detailed information on all stream-gaging procedures see Corbett and others, 1962.

Under flood or very high streamflow conditions, external pressure on a spring may exceed internal pressure thus causing a reversal of its flow. Falmouth Spring, in Suwannee County, is one of the several springs known to be so affected but the only one where a reverse flow has been measured. In reporting the flow of individual springs, the authors cited such unusual circumstances. Otherwise, the range and average flow were given if all measurements could not be shown.

SPRING-WATER SAMPLING

The methods of collection and analysis of the more recent water samples are described by Brown, Skougstad, and Fishman (1970). The methods that were used before 1970 in collecting samples are described by Rainwater and

Thatcher (1960). All water samples were collected from the springs as close as possible to their orifices, vents, seepage zones, or other points of spring discharge in order to minimize the effects of contact with surface materials or the atmosphere.

Sampling of the water from first magnitude springs was more extensive than from the smaller springs and generally the analyses are more comprehensive. For example, many of the samples were analyzed for trace elements, nutrients, insecticides, herbicides, and polychlorinated biphenyls. A list of those pesticides generally tested for is included in the section on water quality.

SPRING IDENTIFICATION NUMBERS

Spring-discharge and water-quality data collection sites (Table 7) have been identified by either of two systems: a 15-digit identifier or an 8-digit downstream order number. The former system requires explanation because it may also be the geographical location of a station — the numbers consist of the latitude and longitude coordinates to the nearest second, plus "00" or a 2-digit sequential number such as "01." For example, the first part of the number 275134081522001 indicates that the data collection site is in the 1-second quadrangle bounded by latitude 27°51′34″ on the south and the last part indicates that the quadrangle is bounded by longitude 81°52′20″ on the east. The "01" remaining is a sequential number and indicates there may be other data collection sites in that 1-second quadrangle. The geographical significance may become a little more clear by reference to figure 16, for the 15-digit number cited above.

Once the 8- or 15-digit numbers are assigned, they are not subject to change. Even though the latitude and longitude coordinates may change owing to more accurate mapping, or to a change in the location of the data collection site, the station identification number remains as originally selected.

All discharge and water-quality data collected for the springs are available from the U.S. Geological Survey. The identifier numbers just described are important because all the information is filled by these numbers in the Survey's data storage bank. A few springs lack identifying numbers because of poor location information. Others may have two or more numbers; the second assigned without knowledge of the first. Troy Spring in Lafayette is an example of a data point that has two numbers: Springflow data are filed under the number 02320050, but physical details of the spring and its water-quality data are filed under the 15-digit identifier. So, the use of both numbers is necessary to retrieve all the information for that spring.

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS[1] FOR THOSE SPRINGS FOR WHICH DISCHARGE OR WATER-QUALITY HAVE BEEN COLLECTED.

Spring Names	Identification Numbers
Alachua County	
Glen Springs	294027082205000,02240945
Hornsby Spring	295059082353600
Magnesia Spring	293458082090000,02241950
Poe Springs	294933082385800,02322140
Bay County	
Gainer Springs	
Spring No. 1	302540085325000,02359480
Spring No. 2	302536085325400,02359479
Spring No. 3	302538085325500,02359478
Pitts Spring	302556085324700
Bradford County	
Heilbronn Spring	300125082092000,02320951
Citrus County	
Blue Spring	285809082185200,02312980
Chassahowitzka Springs	284254082343500,02310648, 02310650
Homosassa Springs	284758082352000,02310676, 02310678,02310688
Crystal River Springs Group	285417082381300,02310750
Middle Springs	285317082352100,02310735
Ruth Spring	284357082354800,02310660
Clay County	
Green Cove Spring	295936081404000,02245342
Wadesboro Spring	300925081432000,02246204
Columbia County	
Bell Springs	301945082411800
Ichetucknee Springs Group	295709082471000,02322700
Blue Hole Spring	295847082453100
Cedar Head Spring	295900082453200
Grassy Hole Spring	295810082453600
Mill Pond Spring	295804082453700
Roaring Springs	295835082453100
Singing Springs	295833082452900
Jamieson Spring	295532082455600
July Spring	295010082414700
Rum Island Spring	294959082404900
Wilson Spring	295359082453100
Dixie County	
Copper Spring	293650082582600,02323490
Guaranto Spring	294646082562400,02323010

[1]See section entitled "Springs Identification Numbers" for explanation.

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS. (Cont.)

Spring Names	Identification Numbers
Escambia County	
Mystic Spring	305125087174800
Gadsden County	
Chattahoochee Spring	304151084505600
Glen Julia Springs	303905084422700,02358508
Indian Springs	303124084472801
Gilchrist County	
Bell Springs	293550082563000
Blue Springs	294947082405900
Ginnie Spring	295009082420101
Hart Springs	294030082570500,02323150
Lilly Springs	294946082394200
Lumber Camp Springs	294227082560800
Otter Springs	293840082563600,02323200
Rock Bluff Springs	294756082550800,02322997
Sun Springs	294216082560100
Gulf County	
Dalkeith Springs	300020085090000
Hamilton County	
Adams Spring	302554083115400
Alapana Rise	302614083052300
Holton Spring	302615083032700
Morgans Spring	302511083122700
White Springs	301947082454000,02315503
Hernando County	
Boat Spring	282621082392900,02310380
Bobhill Springs	282607028383400,02310405
Little Springs	283049082345100,02310505
Salt Spring	283245082371000,02310562
Weeki Wachee Springs	283100082342500,02310500
Hillsborough County	
Buckhorn Spring	275320082182000,02301700
Eureka Springs	
Spring No. 1	280022082204000
Spring No. 2	280023082203700
Spring No. 3	280023082203300
Spring No. 4	280023082203800
Lettuce Lake Spring	280104082210200
Lithia Springs	275158082135200,02301600
Messer Spring	275340082175000
Palma Ceia Springs	275520082292200
Purity Spring	280118082274000
Six Mile Creek Spring	280104082201800
Sulphur Springs	280115082270500,02306000
Holmes County	
Jackson Spring	304241085554100
Ponce de Leon Springs	304316085555100,02365710
Vortex Blue Spring	304614085565500

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS. (Cont.)

Spring Names	Identification Numbers
Jackson County	
Black Spring	304153085174001
Blue Springs	304725085082600,02358795
Blue Hole Spring	304913085144200
Bosel Spring	304950085140501
Daniel Springs	305655085182800
Double Spring	304213085181001
Gadsen Spring	304213085171801
Hays Spring	305335085133500
Mill Pond Spring	304213085182701
Sand Bag Spring	304718085132000
Springboard Spring	304225085182300
Tanner Springs	304902085193100
Waddels Mill Pond Spring	305236085204000
Webbville Spring	305020085200400
Jefferson County	
Wacissa Springs Group	301804083584700,02326526
Spring No. 2	302022083593001
Blue Spring	301949083591800,02326520
Big Spring	301940083590500,02326523
Lafayette County	
Allen Mill Pond Spring	300945083143301
Blue Spring	300733083133401
Convict Spring	300518083054601
Fletcher Spring	295048082533400
Iron Spring	294940083182800
Mearson Spring	300228083013200
Owens Spring	300244083022901
Perry Spring	300546083111900
Ruth Spring	295944082583801
Steinhatchee Spring	295028083182900,02323885
Troy Spring	300021082595100,02320050
Turtle Spring	295055082532400
Lake County	
Alexander Springs	290450081343000,02236095
Apopka Spring	283400081405100
Blue Springs	284455081494100
Bugg Spring	284507081540600,02237322
Camp La No Che Spring	285702082322400,02235180
Holiday Springs	284354081490500,02237400
Messant Spring	285121081295600,02235255
Seminole Springs	285044081312200,02235250
Leon County	
Horn Spring	301909084074400
Natural Bridge Spring	301706084085000,02326887
Rhodes Springs	
Spring No. 1	301701084092100,023226891
Spring No. 2	301711084093600,02326889
Spring No. 3	301661084085200,02326895
Spring No. 4	301701084092500,02326893
St. Marks Spring	301632084085201,02326900

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS. (Cont.)

Spring Names	Identification Numbers
Levy County	
Blue Spring	292702082415700,02313450
Fannin Springs	293515082560800,02323502
Manatee Spring	292922082583700,02323566
Wekiva Springs	291649082392300,02313600
Madison County	
Blue Spring	302849083144000,02319302
Suwanacoochee Spring	302309083101800,02319498
Marion County	
Fern Hammock Springs	291100081422900,02236132
Juniper Springs	291101081424600,02236130
Orange Spring	293040081564000
Rainbow Springs	290608082261600,02313100
Salt Springs	292100081435800,02236205
Silver Glen Springs	291463081383700,02236160
Silver Springs	291257082031100,02239500
Sweetwater Springs	29130708393600,02236147
Wilson Head Spring	285840082190800
Nassau County	
Su-No-Wa Spring	302615081530000,02231278
Orange County	
Rock Springs	284522081300600,02234610
Wekiwa Springs	284243081273600,02234600
Witherington Spring	284353081292200,02234620
Pasco County	
Crystal Springs	281030082112000,02302000
Horseshoe Spring	282350082412100,02310370
Magnolia Springs	282558082392600,02310410
Salt Springs	281733082430600,02310315
Seven Springs	281251082395700
Pinellas County	
Health Spring	280622082462100,02309494
Polk County	
Kissengen Spring	275032081484100,02294758
Putnam County	
Beecher Springs	292654081384900,02236220
Forest Springs	292725081393500
Mud Spring	292735081394500
Nashua Spring	293033081403400,02244020
Satsuma Spring	293045081403200,02244022
Welaka Spring	292935081402500
Whitewater Springs	293806081385300
Santa Rosa County	
Chumuckla Springs	305000087174800,02375780

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS. (Cont.)

Spring Names	Identification Numbers
Sarasota County	
Little Salt Spring	270430082140000,02299480
Pinehurst Spring	271425082303000
Warm Mineral Springs	27033308215400,02299260
Seminole County	
Clifton Springs	284156081141400
Elder Spring	284427081172900
Heath Spring	284442081074200
Lake Jessup Spring	284236081160500,02234351
Miami Springs	284236081263400,02234650
Palm Springs	284127081233400,02234996
Sanlando Springs	284119081234400,02234991
Starbuck Spring	284148081232800,02234997
Sumter County	
Fenney Springs	284742082021900,02312664
Gum Springs	285731082135400
Suwannee County	
Anderson Spring	302112083112300
Baptizing Spring	300801083080400
Betty Spring	295453082502400
Bonnet Spring	300727083081700
Branford Springs	295717082554400,02320502
Charles Springs	301002083135000,02319900
Cow Spring	300617083065200
Ellaville Spring	302303083102100,02319502
Falmouth Spring	302140083080700,02319520
Ichetucknee Springs Group	295709082471000,02322700
Ichetucknee Spring	295902082454300
Boiling Spring	295825082453700
Coffee Spring	295735082462700
Lime Spring	302316083094100
Little River Springs	295947082575901
Luraville Springs	300710083100200
Peacock Springs	300718083075701
Pump Spring	300818083080900
Royal Spring	300501083043000
Running Springs	300615083065901
Suwannee Springs	302339082560400,02315600
Suwannee Blue Spring	300453083040700
Telford Spring	300624083095700,02320003
Thomas Spring	30081308313500
Walker Spring	300759083075000
Taylor County	
Blue Spring	295042083332901
Camp Ground Spring	300403083331400
Carlton Spring	300329083351501
Ewing Spring	300426083395700
Hampton Springs	300450083394500,02325497
Waldo Springs	300257083374700,02324930

TABLE 7. AN INDEX TO SPRING IDENTIFICATION NUMBERS. (Cont.)

Spring Names	Identification Numbers
Union County	
Worthington Spring	295532082253300,02321503
Volusia County	
Blue Spring	285650081202300,02235500
Gemini Springs	285144081183900
Green Springs	285145081145500,02234480
Ponce de Leon Springs	290802081214700,02236110
Seminole Spring	285044081140500
Wakulla County	
Indian Springs	301502084194200
Kini Spring	301643084203400
Newport Springs	301245084104300
Panacea Mineral Springs	
Spring A	300202084232501
Spring B	300202084232502
River Sink Spring	301636084202800,02326997
Wakulla Springs	301407084181000,02327000
Walton County	
Euchee Springs	304340086122300
Morrison Spring	302928085541400,02365580
Washington County	
Beckton Springs	303853085413700,02365990
Blue Spring	302712085315200,02359467
Blue Springs	303048085504700,02366400
Cypress Spring	302929085410400,02365986
Walsingham Spring	302832085314300
Williford Spring	302621085325200,02359474
Florida's Submarine Springs	
Bear Creek Spring	295900084280000
Cedar Island Spring	294859083350500
Cedar Island Springs	
Spring A	282200082420001
Spring B	282200082420002
Choctawhatchee Springs	302405086033600
Crays Rise	295936084243000
Crescent Beach Submarine Spring	294606081123000
Crystal Beach Spring	280500082470700
Everglades Submarine Spring	251842081085400
Freshwater Cave	295930083552400
Mud Hole Submarine Spring	261550082010300
Ocean Hole Spring	300424084074200
Ray Hole Spring	294454084023000
Red Snapper Sink	294426080445200
Spring Creek Rise	300447084195000
Tarpon Springs	280846082453300
The Jewfish Hole	282500082430000
Unnamed Spring No. 4	282025082434500

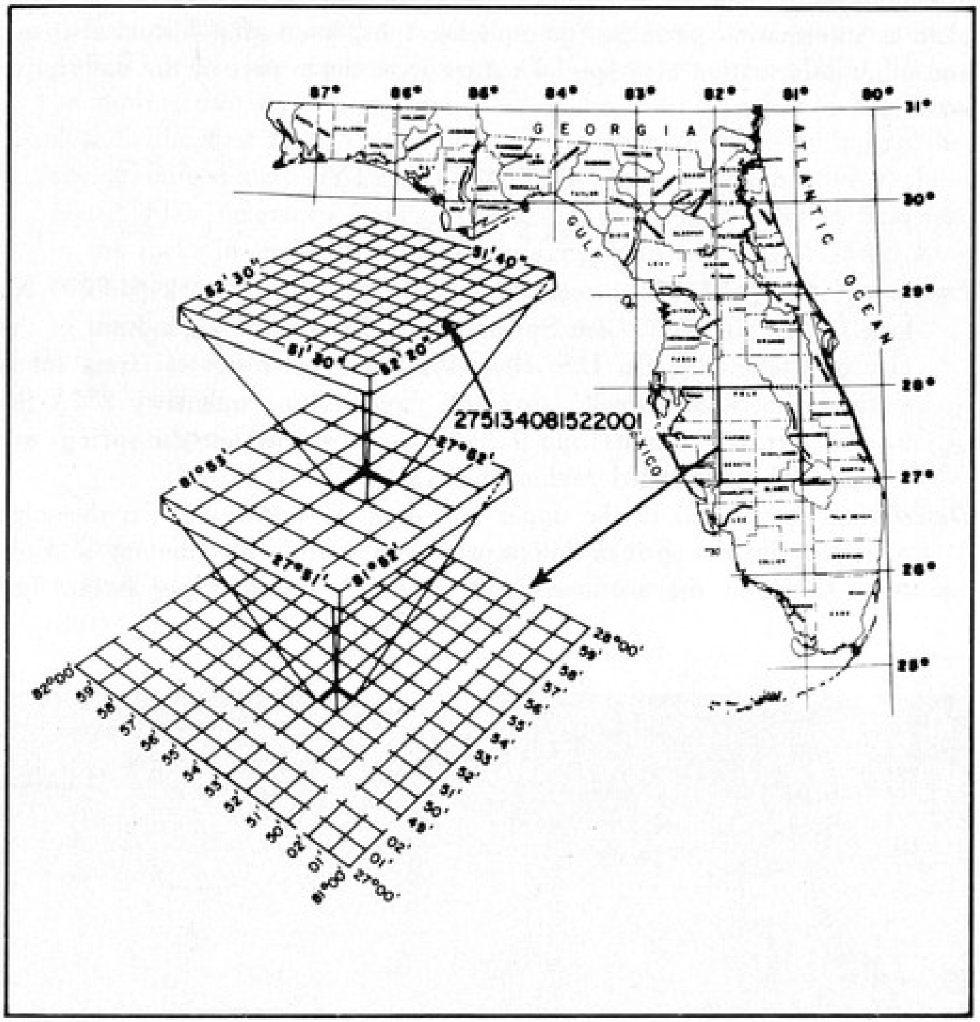


FIGURE 16. — Graphic explanation of the 15-digit identifier — a spring site numbering system.

DESCRIPTIONS OF INDIVIDUAL SPRINGS

This section contains detailed information about Florida's springs. Some of the springs are known to but a few people; others are well known and have been scientifically observed for years. Uniformity of spring descriptions was necessary to obtain the brevity and consistency that would permit inclusion of most spring descriptions in a single book. Therefore, the descriptions were standardized for presentation of spring location, discharge, and quality-of-water data. Physical descriptions and utilization data are as complete as information permits. Some photographs, interesting historical items, and other information of a special nature were made part of the descriptive material.

ALACHUA COUNTY

GLEN SPRINGS
(Text Figure 1)

Location. — SE¼SE¼SW¼ sec. 30, T. 9 S., R. 20 E. (lat. 29°40′27″ N., long. 82°20′50″ W.). Glen Springs is in the northwest quadrant of the city of Gainesville. On U.S. Hwy 441 drive north 1.5 mi from intersection with State Hwy 26, turn left (west) onto State Hwy 232A for 0.5 mi, turn left (south) into the Elks Club parking lot; the springs are in the adjacent wooded ravine (fig. 12).

Description. — Situated in the upper end of a wooded ravine on the edge of a plateau, the springs flow southeastward and are tributary to Hogtown Creek in the northwest end of the Oklawaha River basin. The

TEXT FIGURE 1. Glen Springs viewed downstream from head pool. Flow is controlled to two swimming pools.

elongate, irregularly-shaped head pool is in limestone bedrock. The head pool is about 20 ft long and 10 ft wide and is enclosed by a concrete wall. This concrete enclosure is convex on its upstream end and flat on its downstream end. A control gate in the downstream end regulates flow to the first of two in-line concrete swimming pools built into the ravine immediately downstream from the springs and behind a clubhouse. Flow emanates from several small submerged solution channels in the rocks in the bottom of the pool. From the pool, water flows successively from one swimming pool to the next, thence down the ravine to Hogtown Creek.

Discharge. — December 10, 1941 0.32 ft^3/s
April 16, 1946 0.33
April 24, 1956 0.36
October 17, 1960 0.42
April 17, 1972 0.30

Utilization. — Used as a private recreational facility.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	Apr. 16 1946	Feb. 24 1972	Apr. 17 1972
Nitrite (NO_2 as N)	—	0.00	—
Nitrate (NO_3 as N)	0.41	.00	—
Calcium (Ca)	15	19	—
Magnesium (Mg)	6.7	8.5	—
Sodium (Na)	3.2	3.4	—
Potassium (K)	.6	.4	—
Silica (SiO_2)	10	5.4	—
Bicarbonate (HCO_3)	—	54	—
Carbonate (CO_3)	—	18	—
Sulfate (SO_4)	—	4.0	—
Chloride (Cl)	3.4	7.0	—
Fluoride (F)	.4	.4	—
Nitrate (NO_3)	1.8	—	—
Dissolved oxygen (DO)	—	—	—
Dissolved solids			
Calculated	—	110	—
Residue on evaporation at 180°C	76	95	—
Hardness as $CaCO_3$	65	83	—
Noncarbonate hardness as $CaCO_3$	—	8	
Alkalinity as $CaCO_3$	83	74	

Date of collection	Apr. 16 1946	Feb. 24 1972	Apr. 17 1972
Specific conductance (micromhos/cm at 25°C)	143	170	—
pH (units)	7.0	7.2	—
Color (platinum cobalt units)	0	5	—
Temperature (°C)	—	22.0	—
Biochemical oxygen demand (BOD, 5-Day)	—	—	0.0
Total organic carbon (TOC)	—	—	.0
Organic nitrogen (N)	—	—	.40
Ammonium (NH_4 as N)	—	—	.00
Nitrate (NO_3 as N)	—	—	.87
Orthophosphate (PO_4 as P)	—	—	.38
Total phosphorus (P)	—	—	.42
	(Micrograms per liter)		
Boron (B)	—	—	0
Strontium (Sr)	—	—	—
Arsenic (As)	—	—	0
Cadmium (Cd)	—	—	0
Chromium (Cr^6)	—	—	0
Cobalt (CO)	—	—	0
Copper (Cu)	—	—	0
Iron (Fe)	10	—	—
Lead (Pb)	—	—	0
Zinc (Zn)	—	—	0
Mercury (Hg)	—	—	.0

HORNSBY SPRING

(Text Figure 2)

Location. — NE¼NE¼SE¼ sec. 27, T. 7 S., R. 17 E. (lat. 29°50′59″ N., long. 82°35′36″W.). The spring is about 1.5 mi N. of the town of High Springs. Drive northwest on U.S. Hwy 441 from the junction with State Hwy 236 for about 1.6 mi, turn right (east) onto the road going to Camp Kuluqua, continue 0.9 mi to the camp. The spring is inside the camp grounds about 300 ft NW. of the camp entrance (fig. 14).

Description. — The spring is in a low area surrounded by cypress trees. It forms an elliptical pool about 125 ft wide and 185 ft long oriented westward, and narrowing at its west end to a run in which flow is west-

TEXT FIGURE 2. Head of Hornsby Spring looking westward downstream. Spring run in center background.

northwest 0.8 mi to the Santa Fe River. The pool is partly enclosed on the east and north by a rock and concrete retaining wall 2 to 3 ft high. A diving platform and board extend out from the east edge of the pool. The spring flow is apparently from the east, from a cavern opening or openings under a submerged limestone ledge a short distance out from the diving board. Depth of water over the ledge, as sounded from the diving board on February 25, 1972 was 16 ft. On that date no boil was evident in the pool and the water was tinted brown. It was otherwise clean and clear and its temperature was 22.5°C. (72°F.). The spring is subject to backwater from the Santa Fe River. The buildings at the camp occupy high ground bordering the spring on the east and north.

Discharge. — April 19, 1972 250 ft^3/s
April 25, 1975 76

Utilization. — Used as a swimming and recreational facility by Camp Kulaqua, privately owned and operated by a religious organization.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		February 25, 1972	
Nitrite (NO_2 as N)	0.00	Dissolved solids	
Nitrate (NO_3 as N)	.00	Calculated	230
Calcium (Ca)	5.7	Residue on evaporation	
Magnesium (Mg)	9.6	at 180°	255
Sodium (Na)	8.5	Hardness as $CaCO_3$	180
Potassium (K)	.6	Noncarbonate hardness as	
Silica (SiO_2)	6.3	$CaCO_3$	50
Bicarbonate (HCO_3)	130	Alkalinity as $CaCO_3$	130
Carbonate (CO_3)	16	Specific conductance	
Sulfate (SO_4)	60	(micromhos/cm at	
Chloride (Cl)	12	25°C)	390
Fluoride (F)	.4	pH (units)	8.8
		Temperature (°C)	22.5

MAGNESIA SPRING

(Text Figure 3)

Location. — SE¼NE¼NW¼ sec. 31, T. 10 S., R. 22 E. (lat. 29°34′58″ N., long. 82°09′00″W.). The spring is about 4 mi W. of the town of Hawthorne. Drive west from old U.S. Hwy 301 on State Hwy 20A for 3.8 mi, turn left onto graded road for 0.3 mi to gate, continue 0.1 mi to the spring pool. The spring also may be reached by State Hwy 20A from Grove Park, 1.2 mi NW. of the spring (fig. 12).

Description. — The spring lies at the base of the sandy pine wooded hills on the east side of the Lochloosa Creek valley. The spring discharges to Lochloosa Creek, which flows into Lochloosa Lake, and is in the Oklawaha River subbasin of the St. Johns River basin. The spring forms a 60-by 75-ft oval-shaped pool enclosed by a concrete wall. The spring reportedly has a clay and sand bottom with two holes formerly about 16 and 30 ft deep. About 90 percent of the flow is believed to come from the deeper of the two holes, which is about 20 ft in diameter at its top and is in the north part of the pool. In 1946 the pool reportedly had been sounded with an iron pipe to a depth of 30 ft. The pipe was pushed downward through soft sand in the bottom an additional 30 ft. When interviewed in February 1972, a former owner of the spring reported that the pipe penetrated only a 4- or 5-ft thickness of soft sand before it encountered clay and scattered hard rocks. The former owner also said that in 1950 a large piece of the clay wall of the hole slumped and blocked much of the flow and reduced the depth of the hole. The temperature of the water on April 16, 1946, taken 1 ft below the surface

TEXT FIGURE 3. Magnesia Spring viewed from southeast. Outlet on right to swimming pool not in use. Present outlet at edge of pool in center background.

of the water near the pool outlet was 24°C. (75°F.). Before the middle 1950's, the water was piped to a swimming pool just east of the spring. The water is now allowed to flow from a surface outlet on the north end of the spring pool into an open ditch and thence eastward and southward around the swimming pool to Lochloosa Creek. The swimming pool is now supplied with water from five 4-in. flowing artesian wells ranging in depth from 75 to about 120 ft.

Discharge. —	December 10, 1941	1.82 ft^3/s
	April 16, 1946	0.65
	April 23, 1956	0.016
	October 17, 1960	1.03
	April 21, 1972	0.44

Utilization. — Privately owned, but open to the public for swimming from April to October.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	Apr. 16 1946	Feb. 24 1972
Nitrite (NO_2 as N)	—	0.00
Nitrate (NO_3 as N)	—	.02
Calcium (Ca)	40	34
Magnesium (Mg)	13	12
Sodium (Na)	5.6	5.4
Potassium (K)	.8	.6
Silica (SiO_2)	28	26
Bicarbonate (HCO_3)	180	170
Carbonate (CO_3)	0	0
Sulfate (SO_4)	4.9	5.6
Chloride (Cl)	8.2	8.0
Fluoride (F)	.3	.4
Nitrate (NO_3)	—	.10
Dissolved solids		
Calculated	—	180
Residue on evaporation at 180°C	184	181
Hardness as $CaCO_3$	150	130
Noncarbonate hardness as $CaCO_3$	—	0
Alkalinity as $CaCO_3$	—	140
Specific conductance		
(micromhos/cm at 25°C)	310	300
pH (units)	7.5	8.3
Color (platinum cobalt units)	5	5
Temperature (°C)	—	20.0
Iron (Fe) (μg/L)	20	—

POE SPRINGS

(Text Figure 4)

Location. — SW¼NW¼NE¼ sec. 6, T. 8 S., R. 17 E. (lat. 29°49′33″ N., long. 82°38′58″ W.). Poe Springs is about 3 mi W. of the town of High Springs. Drive southwest on U.S. Hwy 41 and State Hwy 236 from the junction with U.S. Hwy 441 for 0.8 mi, take State Hwy 236 to the right (northwest) about 2.5 mi, turn right (north) onto graded unpaved road bending to the west for 0.6 mi; the springs are directly ahead (fig. 14).

Description. — Poe Springs form a circular pool about 90 ft in diameter on the wooded south bank of the Santa Fe River. The pool is connected to the river by a northward flowing run about 175 ft long and 40 ft wide. On February 25, 1972, a large boil with two or three minor boils near-

TEXT FIGURE 4. Poe Springs viewed from south edge of pool. Spring run in background flows northward to Santa Fe River.

by was observed in the central part of the pool where most of the flow issues from a horizontal cavern. The pool reportedly was about 36 ft deep 50 years earlier, but has apparently filled in considerably with sand and debris. The measured depth of the pool in 1946 was 16.6 ft and in 1972 the depth was estimated to be 16 to 17 ft. Inflow to the pool, in adidtion to that from the vicinity of the boils, comes from small springs and seeps in the swampy area immediately adjacent to the main spring. In the mid-1940's the springs formed the center of a commercial recreation site used primarily for swimming and picnicking. The pool was enclosed on the south and west by a board and sheet metal wall and the site was complete with bathhouses, refreshment stand and picnic facilities. Except for a few weathered pilings which had supported the bathhouses on the west side of the pool, no evidence of the development remains. The spring had reverted to an essentially natural appearance.

Discharge. — February 19, 1917 86.5 ft^3/s
January 31, 1929 75.1

March 14, 1932	31.2
December 13, 1941	84.0
July 22, 1946	75.3
May 2, 1956	39.2
October 17, 1960	91.7
April 18, 1972	93.1

Utilization. — Privately owned and closed to the public; has been used for family recreation, swimming, and snorkeling.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of Collection	Oct. 31 1924	Jul. 22 1946	Feb. 25 1972
Nitrite (NO_2 as N)	—	—	0.00
Nitrate (NO_3 as N)	—	.11	.27
Calcium (Ca)	64	65	65
Magnesium (Mg)	4.7	6.4	5.3
Sodium (Na)	5.7	4.4	4.7
Potassium (K)	5.7	.9	.6
Silica (SiO_2)	8.7	7.8	5.5
Bicarbonate (HCO_3)	200	200	200
Carbonate (CO_3)	—	0	0
Sulfate (SO_4)	10	17	16
Chloride (Cl)	7.0	6.8	7.0
Fluoride (F)	—	.1	.2
Nitrate (NO_3)	—	.50	.27
Dissolved solids			
Calculated	—	—	200
Residue on evaporation at 180°C	204	210	212
Hardness as $CaCO_3$	180	190	180
Noncarbonate hardness as $CaCO_3$	—	—	170
Alkalinity as $CaCO_3$	—	—	170
Specific conductance			
(micromhos/cm at 25°C)	—	368	380
pH (units)	—	7.3	8.2
Color (platinum cobalt units)	—	5	5
Temperature (°C)	—	—	22.0
Iron (Fe) (μg/L)	50	70	—

OTHER SPRINGS

BOULWARE SPRING. — This spring is 2 mi SE. of Gainesville (fig. 12).

DARBY SPRING. — This spring is reported to be about 2 mi N. of the town of High Springs on the left bank of the Santa Fe River at the confluence of the river and the Hornsby Spring run (fig. 14).

FORD SPRING. — This spring is 0.5 mi SE. of Melrose (fig. 12).

HIGH SPRINGS. — These are several small springs near the town of High Springs and reportedly once used as a water supply (fig. 14).

IRON SPRING. — This spring is at Hawthorne (fig. 12).

SULPHUR SPRING. — This spring is at Hawthorne (fig. 12).

BAY COUNTY

GAINER SPRINGS

Formerly called Blue Springs, Gainer Springs consists of three major and at least two minor springs. They are not individually named but have been designated Spring 1A, 1B, 1C, 2, 3, and 4.

Location. — SW¼ sec. 4, T. 1 S., R. 13 W. (about lat. 30°25′35″ N., long. 85°32′53″ W.). Drive 2.3 mi N. from Bennett, at intersection of State Hwy 388 with State Hwy 167, turn west onto winding sand road; about 1 mi to the springs that are along both sides of Econfina Creek (fig. 15).

Description. — The area surrounding the springs is covered with a dense growth of scrub pine and associated vegetation. To the west, on the opposite side of Econfina Creek, the land rises 80 to 90 ft to a woody knoll, and to the east the land slopes gently up 10 to 20 ft above the water surface. Some swamplike growth occurs along the banks of the creek and spring runs, but generally the area is heavily forested.

Gainer Springs No. 1 is north on the sand road from the powerline about 0.3 mi to the head of run trending northeast. (See fig. 17). Lat. 30°25′40″ N., long. 85°32′50″ W.

The spring pool farthest to the northeast is No. 1A .It has a diameter of about 20 ft, and a maximum depth of 6 ft at the vent opening which is about 1 ft wide. The circular pool is surrounded with dense swamp-like vegetation that covers it like a canopy. The run exits to the south-west and reaches a maximum width of about 40 ft just before merging with Econfina Creek.

Spring No. 1B is about 100 ft downstream of Spring No. 1A, in a depression about 12 ft deep in the run of No. 1A. It does not have a pool. Spring No. 1C flows into the run from the southeast about 300 ft farther downstream. The pool has a diameter of about 25 ft and a maximum depth of 13 ft. An 8 ft diameter vent is in the exposed lime-

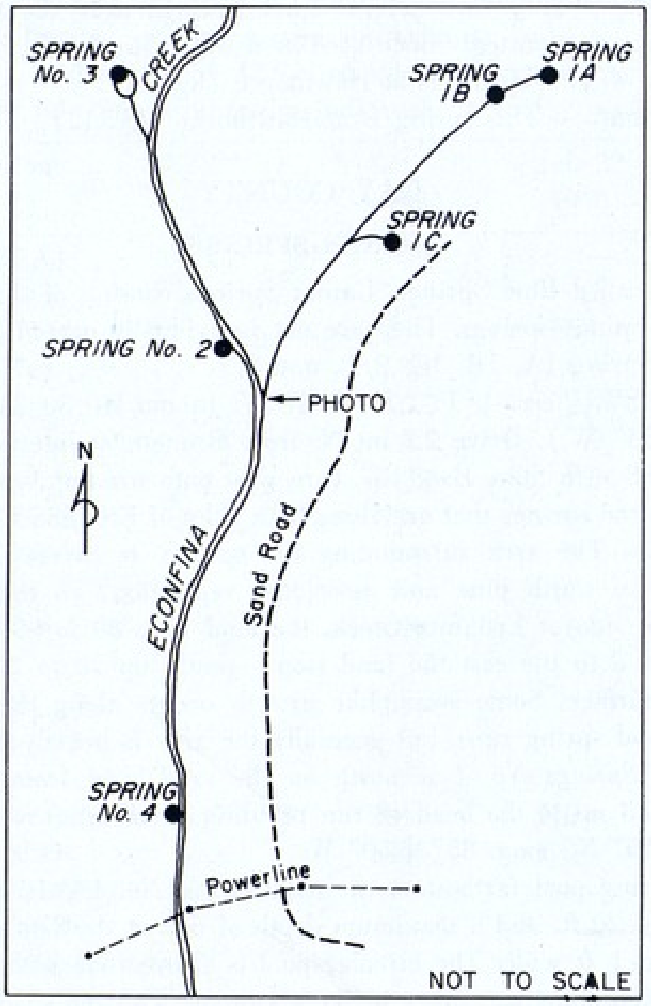


FIGURE 17. — Location map of Gainer Springs.

stone rock in the bottom of the pool. Bottom sediment is in a state of constant agitation due to the flow from the vent.

The combined flow from the three springs enters Econfina Creek about 800 ft downstream from No. 1A. During its course, the run varies in

TEXT FIGURE 5. Westerly view of Econfina Creek below confluence of run from Gainer Spring No. 1. Clear water from Springs Nos. 2 and 3 show white in photograph on the west side of the creek and Springs Nos. 1A, B, and C on the east side. The tannin-colored water in mid-channel is normal to Econfina Creek and in sharp contrast to the clear spring water feeding the creek in this area.

depth from 1 to 3 ft, and occasionally becomes blocked with fallen trees or choked with aquatic grasses.

Gainer Spring No. 2 is located on the west side of Econfina Creek about 100 ft upstream of the confluence of the run from Spring No. 1 and Econfina Creek. Lat. 30°25′36″ N., long. 85°32′54″ W.

This spring discharges from a vertical limestone bank about 25 ft in height and 70 ft in length. The run is about 10 ft wide.

Gainer Spring No. 3 is about 0.1 mi upstream from Spring No. 2. The run for No. 3 enters Econfina Creek from the west. Lat. 30°25′38″ N., long. 85°32′55″ W.

TEXT FIGURE 6. Gainer Spring No. 1C showing the edge of the limestone vent and light spring boil in a swampy wooded area.

The 500-ft diameter circular pool is surrounded by dense swampy growth. The northwest bank of the pool is a rocky limestone bluff, the base of which contains several vents and seeps. A small grass covered island is in the center of the pool. The 300-ft long run exits to the southeast; its width averages 40 ft.

Gainer Spring No. 4 is located about 0.1 mi S. of Spring No. 2 on the west side of Econfina Creek, about 200 ft N. of where the powerline crosses Econfina Creek. Lat. 30°25′30″ N., long. 85°32′54″ W.

This spring could not be reached but appeared as an upwelling of water from the limestone of the west bank of Econfina Creek. A sample of the water was not obtained for chemical analyses nor was a discharge measurement made.

Discharge. — Measurements made between 1941 and 1972 are tabulated by spring and by "total flow." Total flow represents Econfina Creek discharge below points of all known spring entry to the creek less streamflow above the springs. The 60-ft^3/s discrepancy between the total flow of 174 ft^3/s measured on September 11, 1962 and the aggregate 113

TEXT FIGURE 7. View from the run toward the head of Gainer Spring No. 3 and higher ground on the west side of Econfina Creek.

ft^3/s of the individual spring measurements made the same date, suggests that considerable spring discharge occurs in the runs below Springs 1 and 3. The May 16, 1972 data tend to support this as 130 ft^3/s is low as a total flow, although well above the 113-ft^3/s addition of September 1962. The "total flow" measurements were made just below the confluence of the spring runs, near where the photograph of Econfiina Creek was taken. (See fig. 17).

Water temperature of the springs ranged from 20.5 to 23.0°C. (68.9 to 73.4°F.) averaging 21.7°C. (71.1°F.).

	Spring No. 1 Discharge (ft^3/s)	Spring No. 2 Discharge (ft^3/s)	Spring No. 3 Discharge (ft^3/s)	Total Flow (ft^3/s)
November 14, 1941	20.2	—	44.5	—
April 11, 1962	—	—	—	150
September 11, 1962	20.7	53.4	39.1	174

Date of collection	July 25 1946	June 2 1970	Oct. 5 1971	Oct. 11 1972	Jan. 7 1975
Biochemical oxygen demand (BOD, 5-day)	—	0.2	2.5	—	—
Nitrite (NO_2 as N)	—	—	—	.00	—
Nitrate (NO_3 as N)	—	—	—	.26	—
Calcium (Ca)	49	46	48	55	47
Magnesium (Mg)	13	11	13	29	13
Sodium (Na)	29	36	40	180	60
Potassium (K)	1.5	1.6	1.8	6.3	2.5
Silica (SiO_2)	8.6	8.4	8.2	8.0	8.8
Bicarbonate (HCO_3)	180	170	180	170	160
Sulfate (SO_4)	13	13	16	56	21
Chloride (Cl)	53	70	79	320	110
Fluoride (F)	.1	.2	.3	.2	.2
Nitrate (NO_3)	.30	.70	—	1.2	—
Dissolved oxygen (DO)	—	—	6.1	—	5.4
Dissolved solids					
Calculated	261	272	294	740	343
Residue on evaporation at 180°C	—	289	320	771	364
Hardness as $CaCO_3$	180	160	170	260	170
Noncarbonate hardness as $CaCO_3$	—	19	30	120	38
Alkalinity as $CaCO_3$	—	140	140	140	130
Specific conductance (micromhos/cm at 25°C)	470	500	530	1,370	564
pH (units)	7.5	8.2	7.6	8.2	—
Color (platinum colbalt units)	8	10	10	10	10
Temperature (°C)	23.9	26.0	24.5	23.5	22.2
Strontium (Sr) (μg/L)	—	200	200	800	310
Turbidity (JTU)	—	3	2	—	—

CRYSTAL RIVER SPRINGS GROUP

(Text Figure 12)

Location. — Sections 20, 21, and 28, T. 18 S., R. 17 E. (vicinity of lat. 28°53′ N., long. 82°35′ W.). These springs are in and around Kings Bay, at the town of Crystal River, and are the headwaters of Crystal River which discharges to the Gulf of Mexico about 7 mi W. Crystal River is about 60 mi N. of Tampa and 30 mi SW of Ocala (fig. 13).

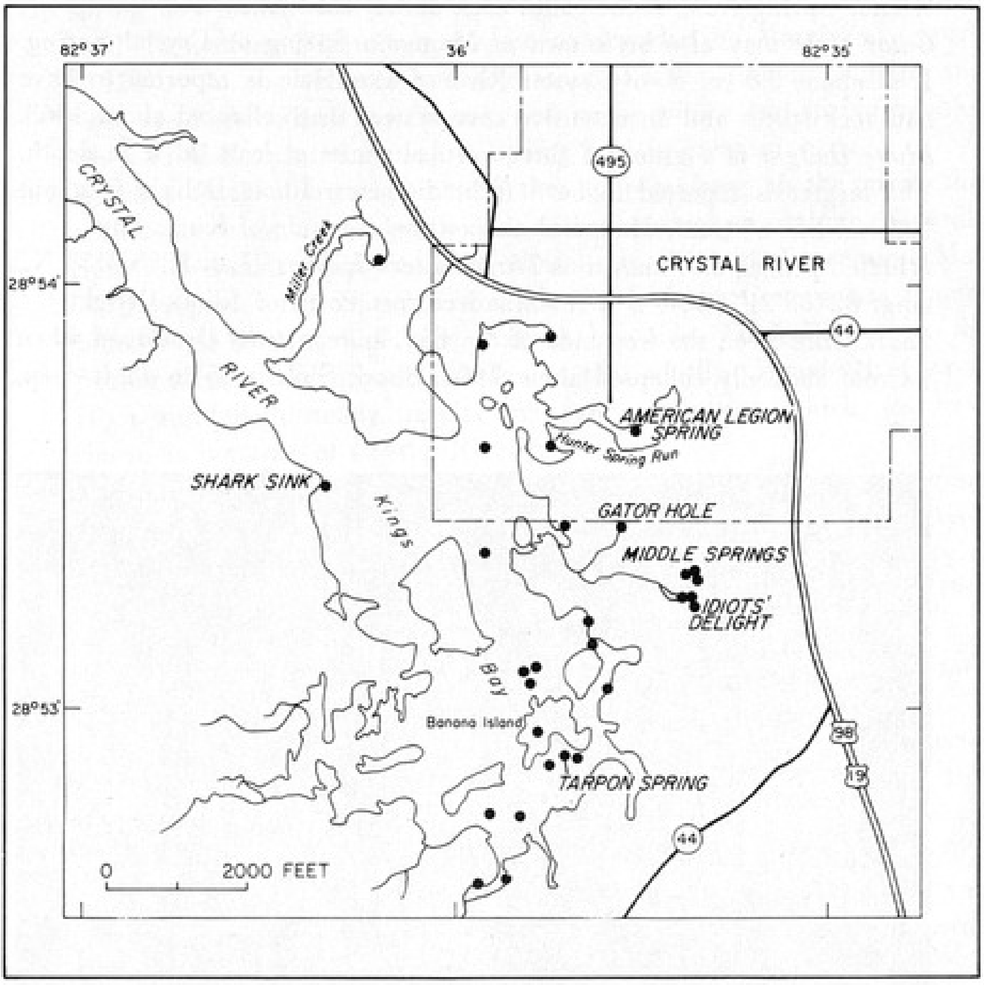


FIGURE 18. — Locations of 30 known springs and sinks in the Crystal River Springs Group.

Description. — A brief description of some of the 30 known springs making up the group follows:

Tarpon Spring, also known as Crystal Spring or Big Hole, is subaqueous and is located on the south side of Banana Island. It is reported to be one of the finest freshwater dive sites in the State owing to its excellent visibility, size, convenience of access, and potential for underwater photography. Tarpon Spring is about 65 ft deep and 200 ft in diameter. On calm days, or at low tide, it has a slight boil or "slick." An adjacent spring (to the east) is reported to have a more vigorous flow.

Spring A is at the head of Salt Creek. It has a 4-ft wide pool and discharges from a small vent in limestone. Flow on September 18, 1961 was estimated at 0.1 ft³/s. The water had a brown flaky material in suspension.

Spring B is about 50 ft downstream of the head of the creek. On September 18, 1961 the spring had a pronounced boil. The creek bottom was obscured by a brown flaky material in suspension.

Spring C is about 125 ft SW. of the head of the creek. It is the southernmost visible boil in Salt Creek.

UNNAMED SPRINGS. — NE¼SW¼ sec. 26, T. 20 S., R. 17 E., about 400 ft E. of Chassahowitzka Springs. Wetterhall describes this site as virtually an entire creek bottom of solution-riddled limestone and spring complex that begins at the mouth of the run and extends upstream more than 100 ft, then another 100 ft with a thin sand cover and small boils. Spring discharge was about 20 ft³/s on September 18, 1961.

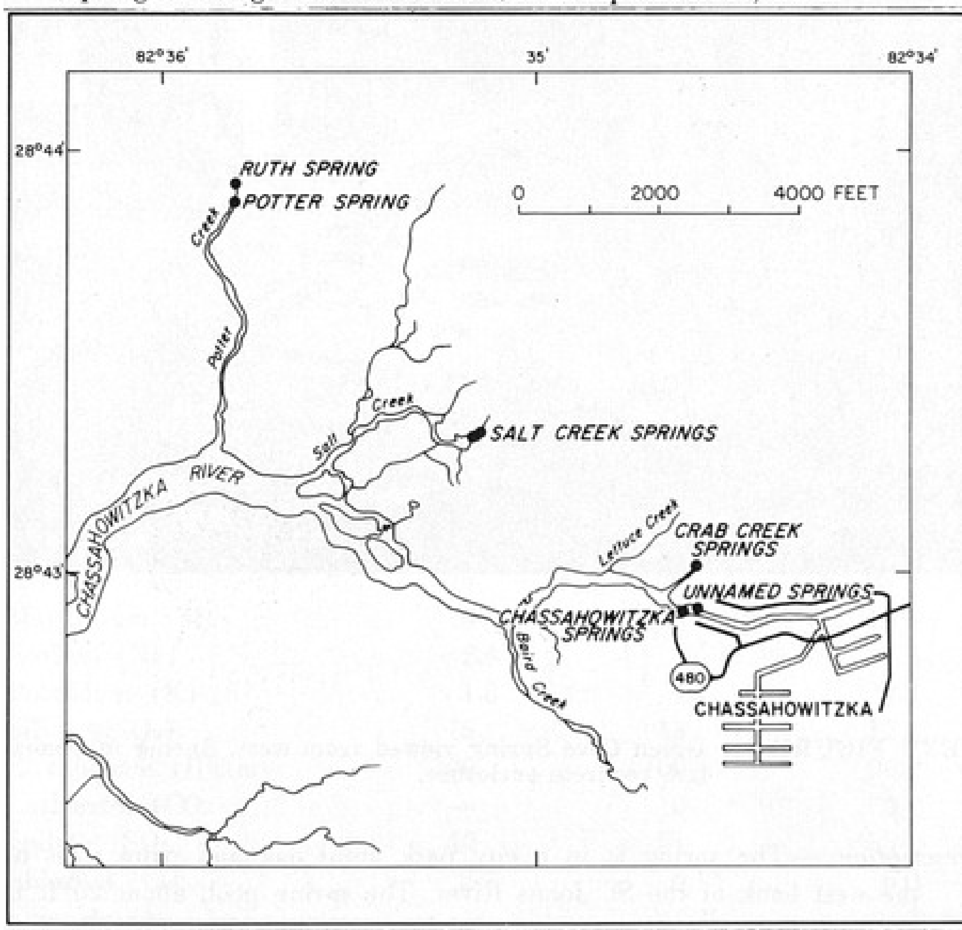


FIGURE 21. — Map showing the springs tributary to the Chassahowitzka River. Sections are 1 mi square, in T. 20 S., R. 17E.

to its confluence with a southward flowing spring run that conveys the combined flow of Cedar Head Spring and Blue Hole Spring.

CEDAR HEAD (OR ALLIGATOR HOLE) SPRING. — About 1,000 ft SE. of Ichetucknee Spring and several hundred feet east of the river. Cedar Head Spring is in the SW¼NW¼NW¼ sec. 7, T. 6 S., R. 16 E. (lat. 29°59′00″ N., long. 82°45′32″ W.) in Columbia County. It forms a pool about 30 ft wide and 60 ft long and is deepest near the south bank at the main vent. Flow from this spring exits to the south, through a run 10 to 15 ft wide, 1 to 3 ft deep, and about 1,100 ft long. It flows into Blue Hole Spring pool.

BLUE HOLE (OR JUG) SPRING. — The pool of Blue Hole Spring is about 85 ft wide and 125 ft long. The spring is in the SW¼SW¼NW¼ sec. 7, T. 6 S., R. 16 E. (lat. 29°58′47″ N., long. 82°45′31″ W.) in Columbia County. The spring is deepest, about 37 ft, at its north-central end near the vent. A wooden boardwalk lines the northwest bank of the pool. Grass and reeds abound on the south perimeter and on both sides of the short run that conveys the combined flow of Cedar Head Spring and Blue Hole Spring to the Ichetucknee River. Briel (1976) further discusses Blue Hole Spring.

TEXT FIGURE 17. Blue Hole Spring looking southeast over spring vent.

Date of collection	May 17 1946	April 2 1975
Biochemical oxygen demand (BOD, 5-day)	—	2.0
Dissolved oxygen (DO)	—	4.5
Total organic carbon (TOC)	—	.0
Total inorganic carbon (TIC)	—	33
Total carbon (TC)	—	33
Organic nitrogen (N)	—	.04
Ammonimum (NH_4 as N)	—	.01
Nitrite (NO_2 as N	—	.01
Nitrate (NO_3 as N)	—	.36
Orthophosphate (PO_4 as P)	—	.05
Total phosphorus (P)	—	.05
Suspended solids	—	0
	(micrograms per liter)	
Strontium (Sr)	—	170
Arsenic (As)	—	1
Cadmium (Cd)	—	0
Copper (Cu)	—	3
Lead (Pb)	—	7
Zinc (Zn)	—	0
Manganese (Mn)	—	20
Nickel (Ni)	—	0
Aluminum (Al)	—	320
Mercury (Hg)	—	.0
Iron (Fe)	30	340

OTHER SPRINGS

ALLEN SPRING. — This spring is located on the right bank of the Santa Fe River (fig. 14) about 1.7 mi downstream from U.S. Hwy 27 or about 0.2 mi upstream from Poe Springs and on opposite side of the river. This spring issues from small limestone caverns and is estimated to be of third magnitude (Briel, 1976).

COLUMBIA SPRING. — Located on the right bank of the Santa Fe River, this spring is about 0.3 mi downstream from the U.S. Hwy 441 (fig. 14). Columbia Spring discharge has been considered by some hydrologists as mostly a return to the surface of underground caverns that are part of the Santa Fe River. A study by Briel (1976) of the uranium isotope ratios in ground and surface waters in the Santa Fe River basin suggests, however, that the spring water includes an appreciable groundwater component derived directly from the Floridan Aquifer. Flow of the spring is estimated to be of second magnitude.

JAMISON SPRING.—SE¼NW¼NE¼ sec. 36, T. 6 S., R. 15 E. (lat. 29°55′32″ N., long. 82°45′56″ W.). Jamison Spring is on the east side of the Santa Fe River to the west of Fort White (fig. 14). Discharge was through numerous vents at 3 ft^3/s from the Ocala Limestone when a water sample was taken on April 28, 1977. The temperature was 21.0°C (70°F), pH was 7.5, and conductance 350 umhos/cm.

JONATHAN SPRING. — This spring is located on the right bank of the Santa Fe River (fig. 14) about 0.5 mi upstream and on the opposite side of the river from Ginnie Spring. The spring is estimated to be of second magnitude (Briel, 1976).

JULY SPRING. — Located on the right bank of the Santa Fe River, about 0.2 mi upstream and across the river from Ginnie Spring (fig. 14), July Spring is of second magnitude (Briel, 1976). Hurst (1975) reports that there are connecting passages between July Spring and Devil's Eye Spring on the other side of the river in Gilchrist County. Snorkeling.

NORTHBANK SPRING. — Located on the right bank of the Santa Fe River, about 1 mi downstream from State Hwy 47 (fig. 14). Discharge is from numerous small vents, their combined flow is estimated to be of third magnitude (Briel, 1976).

RUM ISLAND SPRING. — Located on the right bank of the Santa Fe River (fig. 14), about 0.1 mi below Rum Island and about 0.1 mi upstream of Blue Springs, which is on the left bank of the river in Gilchrist County. The quantity of water discharging from this spring is unknown.

WILSON SPRING. — Located in the SW¼SW¼SW¼ sec. 6, T. 7 S., R. 16 E. (lat. 29°53′59″ N., long. 82°45′31″ W.). Wilson Spring is on the north bank of the Santa Fe River and about 2.5 mi downstream from (northwest) State Hwy 47 bridge over the Santa Fe River (fig. 14). On September 16, 1976 the water temperature measured 22.5°C (71.5°F), pH was 7.6, and specific conductance 440 umhos/cm. Spring discharge was 13 gal/min.

DIXIE COUNTY

COPPER SPRING
(Text Figure 18)

Location. — SE¼SE¼NW¼ sec. 13, T. 10 S., R. 13 E. (lat. 29°36′50″ N., long. 82°58′26″ W.). The spring is about 1 mi NE. of Oldtown on the west side of the Suwannee River (fig. 14). From the junction of U.S.

GLEN JULIA SPRINGS
(Text Figure 21)

Location. — SW¼SW¼SE¼ sec. 14, T. 3 N., R. 5 W. (lat. 30°39′05″ N., long. 84°42′27″ W.). Glen Julia Springs is 1 mi SW. of Mount Pleasant (fig. 15). Drive 0.7 mi SW. on State Hwy 379 from U.S. 90, turn right onto Glen Julia Road for about 0.2 mi to Glen Julia County Park entrance, and 0.3 mi farther to the picnic parking area. The spring pool is several hundred feet down a ravine-trail from the picnic area.

TEXT FIGURE 21. A view of the dam and imponded Glen Julia Springs— an area of hillside seeps.

Description. — Restrained by an earthen dam at its northern end, the pool of Glen Julia Springs is about 200 ft long and 100 ft wide. Source of the water is multiple seeps discharging from clay banks of the pool and adjoining ravine. Flow from the pool is through a verticle overflow culvert, 1.3 ft in diameter, that discharges into a 10-inch concrete pipe and

Date of collection		November 1, 1972	
Sulfate (SO_4)	20	Color (platinum cobalt units)	0
Chloride (Cl)	6.0	Temperature (°C)	22.0
Fluoride (F)	.1	Strontium (Sr) ($\mu g/L$)	60
Nitrate (NO_3)	.00		
Dissolved oxygen (DO)	5.0		
Dissolved solids			
Calculated	194		
Residue on evaporation at 180° C	198		

BLUE SPRINGS

(Text Figure 24)

Location. — NW¼SW¼SE¼ sec. 35, T. 7 S., R. 16 E. (lat. 29°49′47″ N., long. 82°40′59″ W.). Blue Springs is about 4.5 mi WNW. of High Springs (fig. 14). Drive west on State Hwy 36 from the junction with U.S. Hwy 41 at the west edge of High Springs for 4.6 mi, turn right

TEXT FIGURE 24. View of Blue Springs from southeast; flight altitude about 500 feet.

PLEASANT GROVE SPRINGS. — This spring consists of a group of small vents on the left bank of the Santa Fe River just upstream of that river's confluence with the Suwannee River. Combined discharge is estimated to be less than 10 ft^3/s. (third magnitude).

TOWNSEND SPRING. — Located on the east bank of the Suwannee River, this spring is reported to be about 6 mi N. of Bell (fig. 14).

GULF COUNTY

DALKEITH SPRINGS

Location. — SW¼NW¼ sec. 33, T. 5 S., R. 9 W. (lat. 30°00′20″ N., long. 85°09′00″ W.). Dalkeith Springs is in the immediate vicinity of the village of Dalkeith, about 7 mi S. of Wewahitchka on State Hwy 381 (fig. 15).

Description. — The springs are small seeps scattered through the low area south of State Hwy 381A and east of State Hwy 381; they comprise the headwaters of an unnamed creek that flows northeast to Lockey Lake and the Chipola River. The area is lightly wooded and the boundary between farmland and swamp bordering the Chipola-Apalachicola River complex.

Discharge. — March 15, 1972 8 gal/min (estimated)

Utilization. — None. Mrs. Settlemire, a nearby resident, reported that she moved into the area in 1942 and that she and others used the springs until 1957. The water made poor quality coffee and tea and was not suitable for laundry of fine clothing.

HAMILTON COUNTY

ADAMS SPRING

(Text Figure 30)

Location. — SW¼NW¼NW¼ sec. 2, T. 1 S., R. 11 E. (lat. 30°25′54″ N., long. 83°11′54″ W.). Adams Spring is about 3.4 mi NW. of Ellaville and about 1 mi E. of the Withlacoochee River (fig. 14). From the junction of State Hwy 6 and State Hwy 141, drive southwest on State Hwy 141 for 4.4 mi, turn west onto Corinth Church Road and drive for less than 2 mi to the end, turn south down dirt road a few tenths of a mile, turn west at old wood frame house and house trailer, continue down righthand road 0.7 mi to the spring.

Description. — The spring pool, kidney shaped, is 500 to 600 ft long and 200 to 250 ft wide. More than half the pool was covered with green algae at the time of visit. The banks are steep and land surface is about 15 to 20 ft above the water level. The entire area is heavily forested; trees grow around the perimeter and in the pool. There was no flow on

Limestone is exposed in the steep walls of the spring and its run. The water is a dark tannin color. Some trees have fallen into the spring pool and run. Discharge is to the south through a run about 300 ft long and as much as 60 ft wide. The bed of the run is hard and irregular — 2 to 10 ft deep near the Suwannee River where the spring's discharge was measured. About 250 ft N. of Alapaha Rise water flows through a sink measuring about 150 by 400 ft, elongated north-south. Depth to water from land surface was about 40 ft in both the sink and the spring in November 1975.

Discharge. — 1976 measurements made by the Suwannee River Water Management District (oral commun., Richard Musgrove, Aug. 10, 1976).

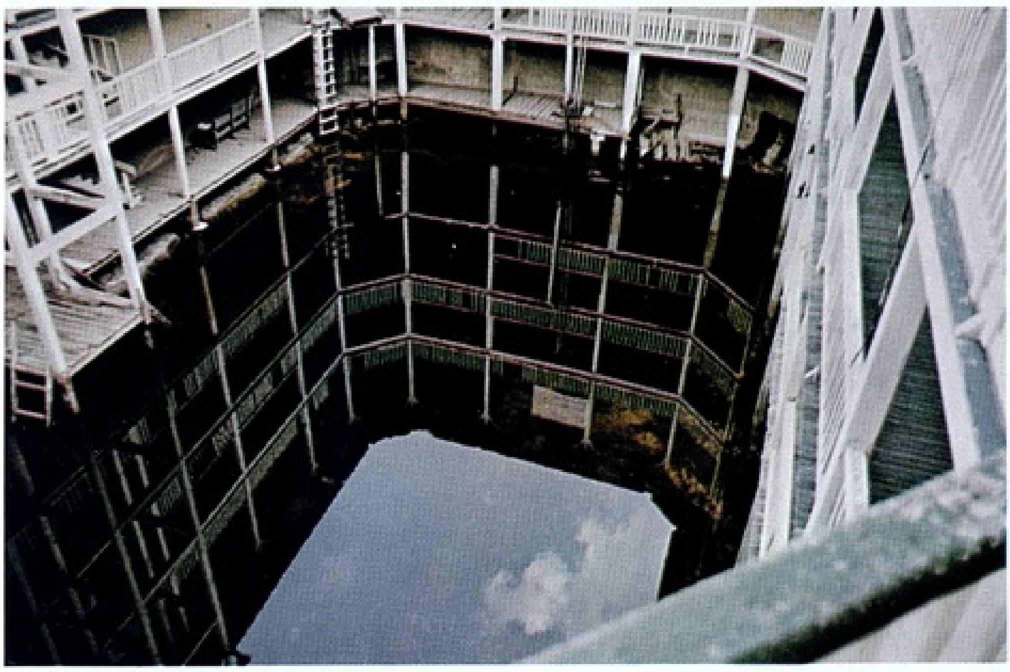
November 25, 1975	508 ft^3/s
April 2, 1976	699
April 27, 1976	594
May 21, 1976	632

Utilization. — None.

TEXT FIGURE 31. View of Alapaha Rise and its run.

WHITE SPRINGS
(Text Figures 32, 33, 34)

Location. — SW¼SW¼NW¼ sec. 7, T. 2 S., R. 16 E. (lat. 30°19′47″ N., long. 82°45′40″ W.). From its intersection with State Hwy 136, drive 0.1 mi W. on U.S. Hwy 41 to the spring. White Springs is on the north bank of the Suwannee River, at the southwest edge of the town of White Springs (fig. 14). White Springs is also known as White Sulphur Springs.



TEXT FIGURE 32. White Springs from inside the four-story Spring House which was demolished late in 1973.

Description. — The spring is enclosed by the concrete foundation of a former bathhouse that was known as the Spring House. The foundation is about 90 by 50 ft and the spring discharges to the Suwannee River through a wooden gate weir in the foundation wall on the south end of the pool. Records indicate that spring flow is from a limestone cavern 39 ft or more deep at the north end of the spring pool. Three ledges have been reported at depths of 4.5, 18, and 39 ft.

Utilization. — The spring is privately owned. This is a traveler's trailer-tenter camp site that is advertised to have some 250 spaces and all recreational and camping facilities.

Water Quality.— Analyses by U.S. Gelogical Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	October 13 1964	August 6 1965	December 15 1972
Calcium (Ca)	37	40	—
Magnesium (Mg)	2.8	2.4	—
Sodium (Na)	3.2	2.9	—
Potassium (K)	.4	0	—
Silica (SiO_2)	6.8	6.4	—
Bicarbonate (HCO_3)	120	120	—
Sulfate (SO_4)	4.8	5.2	—
Chloride (Cl)	5.0	4.0	7.5
Fluoride (F)	0	.1	—
Nitrate (NO_3)	.1	.2	—
Dissolved solids			
Calculated	221	217	—
Hardness as $CaCO_3$	100	110	3
Noncarbonate hardness			
as $CaCO_3$	2	10	—
Alkalinity as $CaCO_3$	100	100	—
Specific conductance			
(micromhos/cm at 25°C)	210	215	246
Color (platinum cobalt units)	0	30	—
Temperature (°C)	—	—	24.0
Iron (Fe) (μg/L)	160	0	—

LITTLE SPRINGS

Location. — NE¼NW¼SW¼ sec. 2, T. 23 S., R. 17 E. (lat. 28°30′49″ N., long. 82°34′51″ W.). Little Springs, also known as Twin Dees, or Twin D's, is about 12 mi SW. of Brooksville, near Weeki Wachee Springs (fig. 13). Drive about 0.5 mi W. on the road from the south parking lot at Weeki Wachee Springs, walk 50 ft E. from the sharp bend in the road; the springs are about 1,000 ft NW. of U.S. Hwy 19 and 300 ft N. of a lake at the head of a swamp and stream.

Description. — There are two pools about 25 ft in diameter and about 40 ft deep near the limestone vent at the pool center. There is a small dam

Date of collection	Apr. 25 1962	July 24 1964	Aug. 6 1965	Dec. 15 1972
Alkalinity as $CaCO_3$	160	130	130	—
Specific conductance				
(micromhos/cm at 25°C)	268	265	260	286
pH (units)	7.8	8.0	7.7	—
Color (platinum cobalt units)	2	3	0	—
Temperature (°C)	—	—	24.5	23.5

SALT SPRING
(Text Figure 37)

Location. — NW¼NE¼NE¼ sec. 29, T. 22 S., R. 17 E. (lat. 28°32′46″ N., long. 82°37′09″ W.). Salt Spring is about 1.5 mi E. of Bayport; about 1,000 ft W. of the junction of State Hwy 50 and State Hwy 595, and 100 ft S. of State Hwy 50 (fig. 13).

TEXT FIGURE 37. Southerly view of Salt Spring. View is downstream from the spring; the vent is in line with rope hanging from trees. A boil was visible when this picture was taken in April 1976.

from a small bridge across the main run near Hammock Creek. The estimated flow of the three small springs was 5 ft^3/s on February 19, 1962. About a fourth of the spring flow was entering the westernmost run and the remainder was flowing toward the larger spring, the flow of which was not determined. The water does not taste salty. The spring does not appear to be used.

UNNAMED SPRING NO. 2.—NW¼SE¼ sec. 30, T. 23 S., R. 16 E. (lat. 28°27′ N., long. 82°38′ W.). Spring No. 2 is about 1.4 mi N. of the Pasco County line and 0.7 mi W. of U.S. Hwy 19, about 10 ft from the west end of a grassy swamp, about 600 ft E. of a jeep trail, and about 0.1 mi N. of a spring run at the crossing of the jeep trail. The spring is seen as a sand boil in the grass that mats the low swampy area. The water flows in an indistinct path across the grassy area to a stream at the southeast side. This stream joins several other spring runs to form Indian Creek. The estimated flow of the run at an alligator pen about 1,000 ft downstream from the springs was 1 ft^3/s on July 13, 1960; temperature 24.0°C. (75°F.); specific conductance 176 μmhos/cm; and chloride 5.0 mg/L and hardness 90 mg/L. Several houses and a hotel in the northern part of Aripeka use water from Indian Creek for domestic purposes.

UNNAMED SPRING NO. 3. — SE¼NW¼ sec. 32, T. 22 S., R. 17 E. (lat. 28°31′ N., long. 82°37′ W.). This spring is about 1,000 ft from the north line and 2,100 ft from the west line of sec. 32, at the head of a small run about 100 ft S. of the Fish Hospital, a hole in a sharp bend of the Weeki Wachee River 1,000 ft upstream from State Hwy 595 bridge. The spring is an almost perfectly cylindrical pipe about 3 ft in diameter and 40 ft deep. Water from the vigorous boil flows north through a channel about 3 ft wide and half a foot deep. The channel empties into the Weeki Watchee River at a large hole 150 ft in diameter and 118 ft deep known as the Fish Hospital. The flow was about 1.5 ft^3/s on May 22, 1962. The spring is not used.

UNNAMED SPRING NO. 4. — NW¼NW¼ sec. 5, T. 23 S., R. 17 E. (lat. 28°31′ N., long. 82°37′ W.). Spring No. 4 is in a 25-ft diameter bay in Jenkins Creek about 200 ft downstream from the head of the creek; about 0.4 mi SE of the State Hwy 595 bridge over the Weeki Wachee River. The spring is about 6 ft in diameter and 18 ft deep. Logs and other trash obscure the view of the spring opening. Water from the spring merges with that of Spring No. 5 to form Jenkins Creek. The estimated discharge was 10 ft^3/s on May 22, 1962. The chloride concentration, based on a specific conductance of 5,500 μmhos/cm, was 1,600 mg/L on May 22, 1962.

UNNAMED SPRING NO. 5. — Lat. 28°31′ N., long. 82°37′ W. Located about

Discharge. —	Blue Springs		Spring Creek	
	Discharge[1] ft^3/s	Temperature °C	Discharge[2] ft^3/s	Temperature °C
October 11, 1918	—	—	115	—
August 2, 1927	—	—	185	—
January 24, 1929	134	—	100	—
September 24, 1930	—	—	200	—
December 14, 1932	—	—	152	—
April 11, 1934	—	—	109	—
December 22, 1934	56	—	—	—
October 14, 1941	—	—	86	—
May 20, 1942	265	21	—	—
April 11, 1946	—	—	277	—
November 15, 1946	178	21	—	—
December 16, 1946	166	—	—	—
January 30, 1947	178	—	—	—
March 16, 1947	207	—	—	—
June 5, 1947	236	—	—	—
October 9, 1947	192	—	—	—
December 10, 1958	—	—	247	—
December 6, 1960	—	—	154	—
April 19, 1972	—	20.5	161	25.5
August 6, 1973	287	22.0	244	23.0

[1]Measured a few feet upstream of the fence.
[2]Measured at base of dam below U.S. Highway 90.

Utilization. — Swimming; facilities for showers and dressing; concession stand. Not generally open to the public. Water discharging from the Mill Pond is used to generate electric power by the Florida Public Utilities Co.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	April 2 1924	May 15 1946	April 19 1972
Calcium (Ca)	43	38	37
Magnesium (Mg)	1.0	2.1	2.1
Sodium (Na)	2.3	1.7	1.6
Potassium (K)		.4	.2
Silica (SiO_2)	12	5.6	6.0

Date of collection	April 2 1924	May 15 1946	April 19 1972
Bicarbonate (HCO_3)	130	120	120
Carbonate (CO_3)	—	0	0
Sulfate (SO_4)	2.4	.9	.0
Chloride (Cl)	2.0	2.5	2.5
Fluoride (F)	—	.0	.1
Nitrate (NO_3)	1.6	5.7	6.2
Dissolved oxygen (DO)	—	—	7.8
Dissolved solids			
Calculated	125	115	110
Residue on evaporation at 180°C	—	—	116
Hardness as $CaCO_3$	110	100	100
Noncarbonate hardness as $CaCO_3$	—	—	3
Alkalinity as $CaCO_3$	—	—	98
Specific conductance (micromhos/cm at 25°C)	—	—	220
pH (units)	—	7.5	7.5
Color (platinum cobalt units)	—	—	0
Temperature (°C)	—	—	20.5
Turbidity (JTU)	—	—	0
Biochemical oxygen demand (BOD, 5-day)	—	—	.0
Dissolved oxygen (DO)	—	—	7.8
Total organic carbon (TOC)	—	—	.0
Total inorganic carbon (TIC)	—	—	24
Total carbon (TC)	—	—	24
Organic nitrogen (N)	—	—	.16
Ammonium (NH_4 as N)	—	—	0.01
Nitrite (NO_2 as N)	—	—	.00
Nitrate (NO_3 as N)	—	—	1.4
Orthophosphate (PO_4 as P)	—	—	.02
Total phosphorus (P)	—	—	.02
	(micrograms per liter)		
Boron (B)	—	—	0
Strontium (Sr)	—	—	40
Arsenic (As)	—	—	10
Chromium (Cr^6)	—	—	1.0
Cobalt (Co)	—	—	0

Date of collection	April 2 1924	May 15 1946	April 19 1972
Copper (Cu)	—	—	10
Lead (Pb)	—	—	2
Polychlorinated biphenyls (PCB)	—	—	* .0
Insecticides and herbicides	—	—	* .00

*Collected April 26, 1972

BLUE HOLE SPRING

Location. — SW¼SW¼NW¼ sec. 21, T. 5 N., R. 10 W. (lat. 30°49′13″ N., long. 85°14′42″ W.). Blue Hole Spring is about 2 mi N. of Marianna (fig. 15). Drive 1.3 mi N. on State Hwy 167 from its intersection with U.S. Hwy 90 in Marianna, 2.2 mi NW. on paved road, 0.4 mi N. or dirt road, then right on dirt road 0.1 mi; the spring is about 150 ft S.

Description. — Situated in the northwest part of Florida Caverns State Park, Blue Hole Spring is in a forested area west of the Chipola River. The spring pool is oval; its diameter is 100 ft, depth 4 to 26 ft. A small pool is connected to the northwest of the large pool which has a sandy beach along the southwest shore and a diving platform on the east bank. Below the water surface the sides drop off sharply to a sandy bottom; visibility is poor in the murky brown water and vegetation is prevalent in the run and along the pool perimeter. The spring discharges to the south, its run decreasing in width to about 40 ft; depths are from 1 to 4 ft. The run discharges 1.6 mi downstream into the Chipola River.

Discharge. — August 8, 1973 56.8 ft^3/s

Utilization. — Swimming; has shower and dressing facilities. Picnic tables and a refreshment stand adjoin the spring.

Water Qulaity. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	August 8, 1973		
Nitrite (NO_2 as N)	.00	Dissolved solids	
Nitrate (NO_3 as N)	.12	Calculated	130
Calcium (Ca)	43	Residue on evaporation	
Magnesium (Mg)	2.6	at 180°C	134
Sodium (Na)	2.5	Hardness as $CaCO_3$	120
Potassium (K)	.5	Noncarbonate hardness	
Silica (SiO_2)	7.0	as $CaCO_3$	0
Bicarbonate (HCO_3)	130	Alkalinity as $CaCO_3$	130

GADSEN SPRING
(Text Figure 50A)

Location. — NW¼NW¼SE¼ sec. 36, T. 4 N., R. 11 W. (lat. 30°42′13″ N., long. 85°17′18″ W.). Gadsen Spring is about 6 mi SW. of Marianna, 0.5 mi NE. of Black Spring and 0.75 mi E. of Double Spring (fig. 15). Drive south on State Hwy 167 for 1.1 mi from its intersection with State Hwy 276A, then left 1.5 mi on a dirt road, left again for 0.2 mi to the east run of Black Spring. By boat, go west into Black Spring and out its north run to Spring Lake; go east (right)to Gadsen Spring run. It is 0.2 mi up the run to the spring.

TEXT FIGURE 50A. Looking north toward Gadsen Spring from its run about 90 feet downstream. Note the aquatic vegetation in the run, and the dense vegetation surrounding the spring.

Description. — The spring pool is oblong, 75 ft east to west and 50 ft north to south. Below the water surface the sides of the cavity slope steeply to depths greater than 50 ft. The water is blue-green and visibility is limited, vegetation covers the shallow areas of the pool perimeter. The run exits the pool to the south and flows through a narrow, shallow (2 to 4 ft deep) bed for about 25 ft; then widens to about 100 ft forming another pool about 150 ft long that is covered with aquatic vegetation. Continuing downstream, the run again narrows for about 800 ft, flowing through densely wooded swampland until it enters Spring Lake.

Discharge. — July 18, 1973 18.0 ft^3/s

Utilization. — Fishing.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		July 19, 1973	
Carbon dioxide (CO_2)	29	Dissolved solids	
Nitrite (NO_2 as N)	.01	Calculated	130
Nitrate (NO_3 as N)	.15	Residue on evaporation	
Calcium (Ca)	39	at 180°C	140
Magnesium (Mg)	5.7	Hardness as $CaCO_3$	120
Sodium (Na)	1.7	Noncarbonate hardness	
Potassium (K)	.3	as $CaCO_3$	2
Silica (SiO_2)	6.5	Alkalinity as $CaCO_3$	120
Bicarbonate (HCO_3)	140		
Carbonate (CO_3)	0	Specific conductance	
Sulfate (SO_4)	.8	(micromhos/cm	
Chloride (Cl)	2.0	at 25°C)	220
Fluoride (F)	.2	pH (units)	7.2
Nitrate (NO_3)	.70	Color (platinum cobalt	
		units)	5
		Temperature (°C)	20.0
		Strontium (Sr) ($\mu g/L$)	90

HAYS SPRING

Location. — W. ½ of sec. 27, T. 6 N., R. 10 W. (about lat. 30°53′35″ N., long. 85°13′35″ W.). Hays Spring is about 4 mi W. of Greenwood and 7 mi N. of Marianna (fig. 15). Drive 3 mi W. on State Hwy 162 from Greenwood; turn right (north) onto State Hwy 167 for 1.4 mi; turn left (west) onto a dirt road; it is about 0.9 mi to the spring run.

Description. — Hays Spring is in a northeasterly trending narrow pond about 0.7 mi long situated in a swampy area surrounded by hilly farmland and woods. The spring is the main source of water for Hays Spring Run which is tributary to the Chipola River above Florida Caverns State Park. Hays Spring was not visited nor was a water sample collected.

of the river is flat and swampy and surface elevations are little more than 3 ft above river level. The area immediately adjoining the river and springs is densely forested with cypress, oak, some pine, and generally moderate undergrowth. To the north, less than a mile from the head of the river, the land becomes hilly, rising in most parts more than 100 ft above the lowland. The river is generally clear and cool — averaging 21°C. (70°F.). The Wacissa River is in the Aucilla Game Management Area. Aquatic growths have become a problem for anyone navigating the river. According to R. Lazor of the Florida State Bureau of Aquatic Plant Research and Control (oral commun., February 27, 1975), water hyacinth and elodea were introduced to the Wacissa River in the mid-1960's and a herbicide program is being utilized to control their spread. Aquatic plants in the river were identified by J. Krumrich of the Florida State Game and Fresh Water Fish Commission (oral commun., February 25, 1975). The surface mats consist of water penny, water hyacinth, yellow water lily, and poison hemlock; the submerged plants are eel grass, Brazilian elodea, southern naiad, and underwater arrowhead. A brief description of the 12 known springs making up the group follows; spring locations are shown on figure 23.

HORSEHEAD SPRING is about 0.4 mi upstream and northwest of the park. Owing to the heavy aquatic growth and fallen trees in the run the spring could not be reached. Streamflow in the run contains an appreciable quantity of tannin.

LOG SPRINGS are about 0.1 mi up Horsehead Run. The springs consist of two vents in a 15- by 40-ft pool. Maximum depths in the limestone are 24 and 28 ft at the entrance to the vents in the southwest and northeast sectors of the pool. Discharge is about 100 ft SW. to Horsehead Run.

THOMAS SPRING is in the river about 300 ft WNW. of the boat ramp at the park. According to Ferguson and others (1947) the spring has a vent 8 ft in diameter and is 28 ft below water surface.

SPRING NO. 1 is about 250 ft SW of the diving board, at the west side of the park, in the Wacissa River. Usually the spring flow from the vent, at a depth of about 25 ft, is strong enough to develop a boil at the water surface.

SPRING NO 2 is about 15 ft S. of shore near the diving board. It discharges from a limestone vent at a depth of about 19 ft.

ALLEN SPRING is about a mile above the confluence of the Wacissa and Little Rivers — in the headwaters of Little River. The spring was not visited owing to the stream-blocking aquatic growth and fallen trees.

CASSIDY SPRING is about 0.5 mi downstream of the park and on the west

TEXT FIGURE 56. View of Allen Mill Pond looking towards the run exiting to the southeast. The spring site is surrounded by gently sloping woodland and thick undergrowth.

drive 4.3 mi NW. of U.S. Hwy 27, turn right and drive 4.4 mi, then right 0.2 mi; the spring is about 900 ft E.

Description. — Allen Mill Pond is in a valley surrounded by dense woodland. The 50-ft wide elongate pond has at least 3 spring vents in its 150-ft length. The pool is 2 to 3 ft deep except at the cavities where it is at least 6 ft deep and near the log dam at the head of the run where it is 4 ft deep. The water is clear and limestone is visible around the vents beneath the three distinct boils; elsewhere, the bottom is sand with a sparse vegetation cover.

The run flows 0.6 mi SE. to the Suwannee River. It increases in width downstream from 20 to 100 ft; its depth ranges from 1 to 2 ft.

Discharge. — November 26, 1973 21.8 ft^3/s

Utilization. — Private camping grounds.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		November 14, 1973	
Dissolved oxygen (DO)	1.5	Temperature (°C)	21.5
Dissolved solids		Strontium (Sr) (μg/L)	0
Calculated	175		
Residue on evaporation at 180°C	187		

STEINHATCHEE SPRING
(Text Figure 63)

Location. — SE¼NW¼SE¼ sec. 27, T. 7 S., R. 10 E. (lat. 29°50′28″ N., long. 83°18′29″ W.). Steinhatchee Spring is about 3 mi NNE. of Clara on the east bank of the Steinhatchee River (fig. 14). From Clara, drive 3.3 mi N. on State Hwy 51, right on a dirt road and go 0.3 mi, turn right again and go less than 0.1 mi; the spring is to the southwest.

Description. — The spring is in a clearing in Steinhatchee River State Park

TEXT FIGURE 63. The south side of Steinhatchee Spring. Spring vent outside the wall is at base of rocks at lower-center of picture.

large-diameter boil at the water's surface over the spring orifice. On April 2, 1946 the water depth over the cavern opening was 25.5 ft. When visited on April 6, 1972, an experienced scuba diver present at the site estimated the depth of water over the cavern opening to be about 25 ft. He described the opening in the rock as elliptical and estimated it to be about 40 ft long and 20 ft wide. The pool discharges directly to a run about 150 ft wide that flows northwest a short distance, then curves north and thence eastward to the St. Johns River. The spring water was clean and clear.

Discharge. —

February 12, 1931	112 ft^3/s
February 7, 1933	124
April 13, 1935	162
October 15, 1935	74.5
December 3, 1935	131
April 2, 1946	101
April 23, 1956	136
November 16, 1960	124
June 8, 1960	124
April 25, 1967	146
June 22, 1967	114
July 2, 1969	109
April 19, 1972	103

Utilization. — The spring area has been developed by the U.S. Forest Service into a multiple-use recreational facility. The area is open to the public offering clean beaches and clear water, with picnic and camp facilities, boat rentals, swimming, scuba, snorkeling, and nature trails.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	April 2 1946	April 14 1972
Calcium (Ca)	41	44
Magnesium (Mg)	18	20
Sodium (Na)	100	130
Potassium (K)	2.3	2.0
Silica (SiO_2)	8.8	8.3
Bicarbonate (HCO_3)	98	140
Carbonate (CO_3)	—	0
Sulfate (SO_4)	56	60
Chloride (Cl)	192	230
Fluoride (F)	.9	.5

Date of collection	April 2 1946	April 14 1972
Dissolved solids		
Calculated	—	570
Residue on evaporation at 180°C	508	602
Hardness as $CaCO_3$	180	190
Noncarbonate hardness as $CaCO_3$	—	73
Alkalinity as $CaCO_3$	—	120
Specific conductance (micromhos/cm at 25°C)	920	1,050
pH (units)	6.9	7.9
Color (platinum cobalt units)	0	5
Temperature (°C)	—	24.0
Biochemical oxygen demand (BOD, 5-day)	—	.1
Total organic carbon (TOC)	—	3.0
Organic nitrogen (N)	—	.01
Ammonium (NH_4 as N)	—	.13
Nitrite (NO_2 as N)	—	.00
Nitrate (NO_3 as N)	—	.03
Orthophosphate (PO_4 as P)	—	.04
Total phosphorus (P)	—	.04
	(micrograms per liter)	
Boron (B)	—	180
Arsenic (As)	—	0
Cadmium (Cd)	—	0
Chromium (Cr^6)	—	0
Cobalt (CO)	—	0
Copper (Cu)	—	0
Zinc (Zn)	—	10
Manganese (Mn)	—	.0
Mercury	—	.0
Iron (Fe)	30	10

APOPKA SPRING

(Text Figure 68)

Location. — NW¼SW¼SE¼ sec. 14, T. 22 S., R. 26 E. (lat. 28°34′00″ N., long. 81°40′51″ W.). This spring is about 3 mi NW. of Oakland. Drive 3.7 mi W. on State Hwy 438 from the pricinpal street intersection in Oakland, turn right (north) onto a sand road through an orange grove

Utilization. — Leased by the Navy from a private owner for use as an underwater research facility. Not open to the public.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	April 19 1946	April 14 1972
Calcium (Ca)	44	44
Magnesium (Mg)	2.9	2.8
Sodium (Na)	4.4	4.8
Potassium (K)	.2	.4
Silica (SiO_2)	9.0	8.6
Bicarbonate (HCO_3)	150	140
Carbonate (CO_3)	—	0
Sulfate (SO_4)	2.0	3.2
Chloride (Cl)	6.6	6.0
Fluoride (F)	.0	.1
Nitrate (NO_3)	.30	—
Dissolved solids		
Calculated	—	140
Residue on evaporation at 180°C	140	151
Hardness as $CaCO_3$	120	120
Noncarbonate hardness as $CaCO_3$	—	4
Alkalinity as $CaCO_3$	120	120
Specific conductance		
(micromhos/cm at 25°C)	259	260
pH (units)	7.4	8.0
Color (platinum cobalt units)	5	5
Temperature (°C)	.3	24.0
Biochemical oxygen demand		
(BOD, 5-day)	—	.1
Organic nitrogen (N)	—	.25
Ammonium (NH_4 as N)	—	.04
Nitrite (NO_2 as N)	—	.01
Nitrate (NO_3 as N)	—	.29
Orthophosphate (PO_4 as P)	—	.02
Total phosphorus (P)	—	.06
	(micrograms per liter)	
Boron (B)	—	0
Strontium (Sr)	—	50
Arsenic (As)	—	0

at Echo Glen at Yalaha," is a small circular pool about 5 ft in diameter and 3 ft deep at the upstream end of a shallow, narrow, wooded ravine. The water in the pool emanates from a nearly horizontal tubular passage with a submerged opening 3 ft wide and 2 ft high. The passage slopes gently downward to the southeast in blue-green clay. Flow from the pool is northward down a gently meandering run 0.25 mi to Lake Harris. The run is 6 to 8 ft wide in most places. Spring sand boils are common at various locations in the sandy bottom of the run all the way to Lake Harris. Depth of the run varies from a few inches to a foot or two. A few hundred feet down the run from the head of the spring, flow can be diverted through a concrete swimming pool on the west side of the run.

Discharge. — April 19, 1946 4.64 ft^3/s
April 30, 1956 3.59
October 31, 1960 4.75
June 23, 1967 3.00
March 15, 1972 3.52

Utilization. — The owner uses the spring water to fill a private swimming pool (located a few hundred feet downstream), for domestic use, and to spray a fern nursery during periods when damage could result from frost.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		March 15, 1972	
Nitrite (NO_2 as N)	.01	Hardness as $CaCO_3$	100
Nitrate (NO_3 as N)	.60	Noncarbonate hardness as $CaCO_3$	5
Calcium (Ca)	33	Alkalinity as $CaCO_3$	100
Magnesium (Mg)	5.4	Specific conductance (micromhos/cm at 25°C)	225
Sodium (Na)	4.3	pH (units)	8.1
Potassium (K)	.6	Color (platinum cobalt units)	5
Silica (SiO_2)	11	Temperature (°C)	24.0
Bicarbonate (HCO_3)	120		
Carbonate (CO_3)	0		
Sulfate (SO_4)	2.8		
Chloride (Cl)	8.0		
Fluoride (F)	.4		
Dissolved solids			
Calculated	130		
Residue on evaporation at 180°C	129		

end of the northwest ravine, 0.25 mi from the juncture of the ravines. Flow from the springs is northeast or southeast down their respective ravines to finally converge into a single east-flowing stream that forms a head water to Seminole Creek. The combined flow of the springs can be measured in a section of the stream about 125 ft below the juncture of the two ravines.

SPRING NO. 1 issues from a hole in sand about 3 ft in diameter near the head of the southwest ravine. The hole was about 2 ft deep on April 7, 1972. A strong boil was evident on that date at the water surface over the hole and bits of limestone were present around the edges of the hole. A few small sand boils were in the shallower sand bottom of the run near the point of principal spring discharge. Flow from the spring is northeast down the ravine in a shallow, sand-bottom run a few feet wide and 2 or 3 in. deep.

SPRING NO. 2 issues from a tubular opening 3 ft in diameter in limestone at the head of a short reentrant in the steep east side of the ravine about 0.1 mi downstream from Spring No. 1. The spring orifice slopes downward to the north at the north end of a north-oriented oval pool. On April 13, 1972 the pool was about 5 ft wide, 10 ft long and 3 ft deep. The top of the tubular opening was barely below the pool surface and near the top of limestone bedrock overlain by about 30 ft of clayey sand that formed a steep slope on the north, east and south sides of the spring pool. Flow from the spring orifice produced a vigorous boil at the pool surface. Flow from the pool is westward down a short, shallow, sand-bottomed run to join the northeastward flow from Spring No. 1. The discharge from Spring No. 2 was appreciably greater than from Spring No. 1.

SPRING NO. 3 is only 60 ft N. of Spring No. 2 and in another short reentrant in the east side of the ravine. A clayey sand ridge about 30 ft high separates the two spring pools. Spring No. 3 forms a semicircular pool about 15 ft in diameter bounded on the southwest, south and east by steep clayey sand slopes. It has a sand bottom and was about 1 ft deep over most of its area on April 13, 1972. Most of the spring discharge appeared to come from two nearly horizontal tubular openings 4 ft apart and each about 1 ft in diameter in limestone at the south edge of the pool. Flow from the orifices was appreciable, causing gentle boils in the surface of the pool. The pool was about 2 ft deep for about 3 ft out from the spring orifices. From the pool, water flows northwestward down a short run, then joins the combined northeastward flow of Springs 1 and 2. When the spring sites were visited, water was about 0.5 ft deep in the short run, the flow of Spring 2 appeared to be con-

RHODES SPRINGS

Location. — The Rhodes Springs group is in the north-central and northwest part of sec. 29, T. 2 S., R. 2 E. The springs are about 13 mi SE. of Tallahassee, and 6 mi E. of Woodville; south of Natural Bridge Road (State Hwy 354) and west of the St. Marks River (fig. 15).

Description. — The area surrounding the springs is covered with a dense growth of scrub pine, and associated tropical vegetation. On the west side is a planted pine forest, to the east is Natural Bridge Monument and wayside park, to the north is a small swamp, and to the south are several miles of mixed forest. In general the area averages about 15 ft above mean sea level reaching a maximum of less than 25 ft in a locale with well developed karst features such as sinkholes and solution tubes. Rhodes Springs is a group of four major springs designated as No. 1, No. 2, No. 3, and No. 4.

SPRING NO. 1 is NW¼SE¼NW¼ sec. 29, T. 2 S., R. 2 E. (lat. 30°17′01″ N., long. 84°09′21″ W.). From Natural Bridge Monument go about 1,000 ft SW. along overgrown lumber road; the spring is about 600 ft SE. in a swampy area. The spring pool diameter is about 50 ft; maximum depth near the center of the pool is about 30 ft. The bottom is fairly uniform in depth and sandy with some submerged tree trunks and logs. The run exits the pool to the northeast over a shallow area 3 ft deep and about 25 ft wide, increasing in width to about 30 ft and flowing 100 ft downstream, there forming a pool 10 ft deep. The run then takes a 90° turn to the right and continues for 50 ft, emptying into a sink with a diameter of about 50 ft and a maximum depth near the center of more than 45 ft.

SPRING NO. 2 is NW¼NW¼NW¼ sec. 29, T. 2 S., R. 2 E. (lat. 30°17′11″ N., long. 84°09′36″ W.). From Natural Bridge Monument go nearly 0.5 mi W. (about 300 ft W. of Old Plank Road) and about 150 ft south of the road. This spring consists of two vents located in separate pools about 100 ft apart; they parallel Old Plank Road. The northernmost spring is about 150 ft S. of the road (south of a small sink about 20 ft off the road). The north spring is about 25 ft in diameter and it discharges south about 100 ft where it merges with the eastward flow from the southern spring. The south spring is similar in appearance to the other, and 50 ft W. of the junction of their two runs. The combined flow goes east about 100 ft into a 20-ft wide sinkhole; much of the 15 ft wide run is lined with the remains of a wood flume.

SPRING NO. 3 was not found in spite of field trips to the area in 1960, 1971, and 1973. According to Ferguson (1947, p. 103-104), "Head of Spring No. 3 is 200 ft SE. of an abandoned but standing brick chimney

TEXT FIGURE 77. Southerly view of spring and run taken from the north bank.

Date of collection		April 19, 1972	
Nitrate (NO_3)	.30	Total phosphorus (P)	.03
Dissolved solids			
Calculated	90	(micrograms per liter)	
Residue on evaporation		Boron (B)	90
at 180°C	92	Strontium (Sr)	100
Hardness as $CaCO_3$	79	Arsenic (As)	0
Noncarbonate hardness		Cadmium (Cd)	0
as $CaCO_3$	2	Chromium (Cr^6)	0
Alkalinity as $CaCO_3$	77	Cobalt (CO)	0
		Copper (Cu)	0
Specific conductance		Lead (Pb)	0
(micromhos/cm		Zinc (Zn)	0
at 25°C)	156	Iron (Fe)	10
pH (units)	7.9	Manganese (Mn)	0
Color (platinum cobalt		Mercury (Hg)	.0
units)	0		
Temperature (°C)	23.5		
Turbidity (JTU)	0		

OTHER SPRINGS

BIG SPRING. — Located about 3 mi S. of Lebanon Station, this spring is in the NW¼SE¼ sec. 1, T. 16 S., R. 16 E. (fig. 14).

LITTLE SPRING. — Located about 6 mi N. of the Withlacoochee River on the W. side of U.S. Hwy's 19-98, this spring is about 0.5 mi SW. of Big Spring. Little Spring is in the NE¼NW¼ sec. 12, T. 16 S., R. 16 E. (fig. 14).

LIBERTY COUNTY

WHITE SPRINGS

(Text Figure 83)

Location. — SW¼SE¼SE¼ sec. 3, T. 1 S., R. 7 W. (lat. 30°25′00″ N., long. 84°55′03″ W.). White Springs is about 4 mi E. of Bristol, on State Hwy 20 and 0.5 mi E. of Telogia Creek Bridge (fig. 15).

Description. — The springs are numerous seeps on the east end of the dammed-up southeast-northeast oriented stream, White Branch, of Telogia Creek. The eastern pool is about 600 ft long and 250 ft wide. At its western end is a 45-ft wide earthen dam and then another pool, 420 ft long and 260 ft wide, with another dam at its western end. The east on State Hwy 6 to the Withlacoochee River and turn south onto a road parallel to and on the west side of the river. Blue Spring is about 0.1 mi S. of State Hwy 6.

Description. — The spring pool is about 25 ft across. A single vent opens from a nearly horizontal cavity about 20 by 35 ft and about 25 ft beneath water surface. There is limestone and sand in the pool and a limestone cliff 25 ft high forms the south bank. The spring discharges northeastward to the Withlacoochee River through a run about 25 ft wide and 100 ft long. At times of high water on the Withlacoochee River, Blue Spring is inundated. The water is clear and blue-green.

Discharge. — Flow is retarded or may even reverse when the Withlacoochee River is high.

March 16, 1932	75 ft^3/s
July 23, 1932	145
April 24, 1956	77.8
November 15, 1960	141
May 28, 1963	113
November 6, 1973	139

Utilization. — Blue Spring is popular for swimming, snorkeling and scuba diving. The spring is still in a natural state. It is of historical importance because it was a source of freshwater for the early inhabitants of the area.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	July 23 1946	November 15 1960	November 6 1973
Carbon dioxide (CO_2)	—	4.6	4.7
Calcium (Ca)	39	41	40
Magnesium (Mg)	8.7	7.2	10
Sodium (Na)	2.4	2.6	2.9
Potassium (K)	.7	.3	.8
Silica (SiO_2)	9.2	9.1	9.4
Bicarbonate (HCO_3)	150	140	150
Carbonate (CO_3)	0	0	0
Sulfate (SO_4)	10	9.6	11
Chloride (Cl)	3.6	4.0	4.0
Fluoride (F)	.1	.4	.1
Nitrate (NO_3)	1.5	.00	—
Dissolved solids			
Calculated	147	145	151

About 1 mi downstream from the pool, a spring known as Garfish Hole boils from a crevice in the limestone run. On January 8, 1947 the hole had a maximum depth of 24 ft.

Near Garfish Hole the shallow valley of Blue Run bends to the south and is joined from the northeast by a broad, heavily-wooded, swampy valley. In much earlier times this valley may have been the course of another important spring run that was tributary to Blue Run. Ferguson and others (1947) mentioned other springs a mile east of Rainbow Springs that formed a second pool whose "outflowing waterway" curves southwest to join Blue Run about a mile below the head of Blue Run. A topographic map published in 1894 by the U.S. Geological Survey shows a pool at about the site indicated in the 1947 report for the second pool. However, no outlet or tributary from that pool to Blue Run was indicated on the map. A larger scale more detailed topographic map published in 1954 by the Geological Survey shows neither the second pool nor a tributary stream to Blue Run, but does show the broad swampy valley leading from the northeast to Blue Run. In extraordinary wet periods when ground-water levels in the area are especially high, appreciable spring flow may emanate from the site of the second pool, and flow down the swampy valley to Blue Run. However, the valley may not contribute important flow to Blue Run during normal or below normal ground-water level conditions.

Water in Rainbow Springs and Blue Run is generally clean and clear. The temperature of the water in the headwater springs ranges consistently between 23.0 and 24.0°C. (73 and 74°F.) throughout the year. The water in the headwater springs is considerably softer than most Floridan aquifer springs. Waters issuing from springs in Blue Run some distance downstream is considerably harder than water in the pool. Aquatic vegetation is abundant on the bottom and edges of the pool and Blue Run. A large variety of fish and other aquatic animal life are abundant in the springs.

Discharge. — The flow of Rainbow Springs was measured once each water year 1899, 1905, 1907, 1917, 1929, and 1930. Periodic measurements were made from October 1930 to November 1964. From December 1964 through September 1974 daily discharge was computed from the relation between artesian pressure at a well in the Floridan aquifer 1 mi SW. of the head of the springs and discharge measured periodically in Blue Run 5 mi below the head of the springs. Studies made by the U.S. Geological Survey (Faulkner, 1973) indicate that the flow of Rainbow Springs is derived from local rainfall that infiltrates the aquifer over a catchment area of about 645 mi^2 distributed mostly north and northeast

SILVER SPRINGS
(Text Figure 93, 94, 95)

Location. — SW¼SW¼NW¼ sec. 6, T. 15 S., R. 23 E. (lat. 29°12′57″ N., long. 82°03′11″ W.). Silver Springs is about 6 mi NE. of Ocala (fig. 12). From the intersection of U.S. Hwys 301-441 in Ocala, drive east then northeast on State Hwy 40 for 6.1 mi to large sign and fountain on the right and the entrance to the spring area. Turn onto the access road and continue 0.3 mi to the parking area near head of springs.

Description. — Silver Springs, at the western edge of the Oklawaha River valley, forms the headwater of the Silver Springs River. The river, sometimes called Silver Springs Run, is a major tributary to the Oklawaha River. From the springs water flows down the eastward winding course of the Silver River through a dense cypress swamp about 5 mi to the Oklawaha River. The Oklawaha flows northward and is tributary to the St. Johns River. Higher, sandy pine terrain lies to the west of the springs.

The largest of the several spring vents or orifices from which the water flows forms a pool about 250 ft in diameter at the head of Silver River.

TEXT FIGURE 93. Aerial view of Silver Springs from the southeast.

time from two different points of inflow in the walls and floor of the cavern. At one point the temperature was reportedly about 22.5 and at the other about 24.5°C. (72 and 75°F.). Presumably the warmer water comes from a deeper source than does the cooler.

The flow of Silver Springs is supplied through a vast system of fractures and solution channels in limestone and dolomite of the Floridan aquifer. Investigations by the U.S. Geological Survey indicate that the flow to the springs in from recharge by local rainfall in a catchment area of 730 mi^2 that lies mostly north, west and south of the springs (Faulkner, 1973).

Discharge. — For October 1932 through September 1974 the average discharge of record is 820 ft^3/s. Daily discharge is computed from the relation between artesian pressure measured continuously at a well in the Floridan Aquifer about 4 mi SE. of the head of the springs and discharge measured periodically in Silver River 2 to 5 mi below the head of the springs. According to Ferguson and others (1947), discharge measurements made just below the pool indicate that about half the total flow of Silver Springs comes from the large spring orifice in the pool. Silver Springs as a group has the largest long-term, measured average flow of any freshwater spring group in Florida and possibly in the United States. However, some spring groups along the Florida coast that have little or no discharge records may discharge greater quantities of water.

Maximum	October 7, 13-17, 20, 1960	1,290 ft^3/s
Minimum	May 7, 1957	539

Utilization. — For many years Silver Springs has been operated as a major tourist attraction. It possibly is most famous for its rides in glass bottomed boats from which the several spring outlets and the associated aquatic life may be viewed through the remarkably clear water. In addition to this, one may take a ride in a jungle-cruise boat several miles down the Silver River and enjoy many other interesting attractions along the shores of the pool area of the springs, including zoos, museums, gift shops and various food service facilities.

Water Quality. — Analyses by U. S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	December 16 1907	October 21 1946	September 16 1972
Nitrite (NO_2 as N)	—	—	0.00
Nitrate (NO_3 as N)	0.04	0.29	2.6
Calcium (Ca)	73	68	68

TEXT FIGURE 99. View of Wekiwa Springs and run.

treme southeast edge of the pool. Except for the rock bottom in the southeast part of the pool, the pool bottom was mostly sand. Parts of the pool bottom were grassy. The temperature of the water was 23.5°C. (74°F.) on March 20, 1972.

Discharge. — A total of 60 discharge measurements were made between 1932 and August 1975. Discharge averaged 74.2 ft^3/s.

Maximum	October 17, 1960	92 ft^3/s
Minimum	April 27, 1956	62

Utilization. — Wekiwa Springs is part of Wekiwa Springs State Park. The area provides camping, picnicking, swimming, fishing, boating, nature trails and abundant wildlife.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	August 8 1924	November 8 1971	April 11 1972
Nitrite (NO_2 as N)	—	0.00	0.00
Nitrate (NO_3 as N)	—	.80	.71
Calcium (Ca)	28	30	—

vertical rock wall below water surface. Discharge is west about 100 ft to where the water passes under a 3-ft natural limestone bridge. The water surfaces and flows 75 ft to a second bridge that is about 10 ft long, under which the water flows and discharges in vigorous boils through three holes into Salt Springs Run. The water is clear. The run is in limestone.

Discharge. — Flow measured in the spring run includes water from other sources. The 1961 flow was measured in the spring run and at the point of spring discharge. At hig htide the flow reverses and salt water enters the spring at about the same rate as discharged.

	Spring Run	Spring Discharge
	ft^3/s	ft^3/s
November 23, 1960	14.0	e 9.0
January 18, 1961	15.4	10.5
December 12, 1972	14.0	e 9.0

e estimated.

Utilization. — None.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	November 23 1960	January 14 1964	December 12 1972
Calcium (Ca)	—	240	—
Magnesium (Mg)	—	520	—
Sodium (Na)	—	4,400	—
Potassium (K)	—	180	—
Silica (SiO_2)	—	5.5	—
Bicarbonate (HCO_3)	134	140	—
Carbonate (CO_3)	0	70	—
Sulfate (SO_4)	—	1,100	—
Chloride (Cl)	7,900	8,000	9,500
Fluoride (F)	—	.1	—
Nitrate (NO_3)	—	.70	—
Dissolved solids			
Calculated	—	14,500	—
Residue on evaporation at 180°C	—	16,200	—
Hardness as $CaCO_3$	2,680	2,700	—

Date of collection	November 23 1960	January 14 1964	December 12 1972
Noncarbonate hardness as $CaCO_3$	2,560	2,600	—
Alkalinity as $CaCO_3$	110	—	150
Specific conductance (micromhos/cm at 25°C)	21,800	21,800	28,600
pH (units)	7.1	7.6	—
Color (platinum cobalt units)	—	55	—
Temperature (°C)	—	21.7	23.5
Iron (Fe) (ug/L)	—	900	—

SEVEN SPRINGS
(Text Figure 104)

Location. — SW¼NW¼NW¼ sec. 24, T. 26 S., R. 16 E (lat. 28°12′51″ N., long. 82°39′57″ W.). Seven Springs is about 4 mi E. of Elfers and 5 mi SE. of New Port Richey (fig. 13). Drive 3.7 mi E. from Elfers on State

TEXT FIGURE 104. Seven Springs discharge pipe vent. Flow is not known to have occurred since 1960.

is 8 to 10 ft. The east part of the spring basin appears to be appreciably shallower than the west part. The water was a pale-green color and too cloudy to see the bottom in the deep area; vegetation covered the bottom of shallow parts of the pool. Numerous small fish were observed.

For a few tens of feet north of the pool edge, the area is grassy and clear of trees, but the upward-sloping land surface farther north is covered with open woods containing palms, pine and hardwood trees. Dense woods border the pool to the south.

From the central south edge of the spring basin water flows south down a run that is about 30 ft wide. The run continues south about 1.25 mi to discharge into the St. Johns River. Between the springs and the river, water is diverted for the National Fish Hatchery operated by the U.S. Department of Interior.

On May 26, 1972, the water had a distinct sulfur odor; temperature at the boils was 23.5°C. (74°F.).

Discharge. — November 23, 1960 12.4 ft^3/s
April 20, 1972 9.02

Utilization. — Owned by the U.S. Department of the Interior, National Fish Hatchery. The spring water is used in the fish hatching pools. Not open to the public.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		May 26, 1972	
Nitrite (NO_2 as N)	.00	Dissolved solids	
Nitrate (NO_3 as N)	.00	Calculated	230
Calcium (Ca)	33	Residue on evaporation at 180°C	242
Magnesium (Mg)	8.3	Hardness as $CaCO_3$	120
Sodium (Na)	41	Noncarbonate hardness as $CaCO_3$	25
Potassium (K)	1.4	Alkalinity as $CaCO_3$	92
Silica (SiO_2)	6.3	Specific conductance (micromhos/cm at 25°C)	446
Bicarbonate (HCO_3)	110	pH (units)	7.9
Carbonate (CO_3)	0	Color (platinum cobalt units)	10
Sulfate (SO_4)	11	Temperature (°C)	23.5
Chloride (Cl)	74	Strontium (Sr) ($\mu g/L$)	280
Fluoride (F)	.2		
Nitrate (NO_3)	.00		

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	June 8, 1972
Carbon Dioxide (CO_2)	1.7
Nitrate (NO_2 as N)	.00
Nitrate (NO_3 as N)	.00
Calcium (Ca^3)	128
Magnesium (Mg)	100
Sodium (Na)	900
Potassium (K)	21
Silica (SiO_2)	6.4
Bicarbonate (HCO_3)	108
Carbonate (CO_3)	0
Sulfate (SO_4)	260
Chloride (Cl)	1,600
Fluoride (F)	0.5
Dissolved solids	
Calculated	3,100
Residue on evaporation at 180°C	—
Hardness as $CaCO_3$	730
Noncarbonate hardness as $CaCO_3$	640
Alkalinity as $CaCO_3$	89
Specific conductance (micromhos/cm at 25°C)	5,400
pH (units)	8.0
Color (platinum cobalt units)	0
Temperature (°C)	25.0

WELAKA SPRING

(Text Figure 111)

Location. — SW¼NE¼SE¼ sec. 33, T. 11 S., R. 26 E. (lat. 29°29′35″ N., long. 81°40′25″ W.). This spring is at the north edge of the town of Welaka (fig. 12). Drive 1.1 mi N. on State Hwy 309 from the junction with State Hwy 308B, turn west on sand trail for 0.1 mi, bear north for 0.1 mi to the spring pool.

Description. — Welaka Spring is in a semitropical wooded setting at the east edge of the St. Johns River lowlands. The spring has a semicircular pool about 100 ft in diameter that opens on the southwest to a run that averages about 300 ft wide and follows a curving course southwest to northwest about 1,000 ft to the St. Johns River. From the edge of the

west and southeast, and by landscaping of the pool perimeter into a circular shape.

Warm Mineral Springs has been the subject of investigation by its owners in cooperation with State of Florida underwater archeologists, U.S. Geological Survey hydrologists, University of Florida geologists, Sarasota County Historical Commission, and the Florida Archeological Society.

Water Quality. — Analyses by U.S. Geological Survey. Water samples collected from discharge point at spring pool. Units are in milligrams per liter unless otherwise indicated.

Date of collection	Feb. 10 1927	Aug. 4 1930	Aug. 11 1943	Apr. 9 1962	Apr. 24 1972
Calcium (Ca)	770	510	640	720	500
Magnesium (Mg)	470	630	540	480	580
Sodium (Na)	—	—	—	4,900	5,200
Potassium (K)	—	—	—	180	150
Silica (SiO_2)	18	—	—	17	16
Bicarbonate (HCO_3)	170	170	160	160	160
Carbonate (CO_3)	—	—	—	0	0
Sulfate (SO_4)	1,700	1,700	1,700	1,600	1,700
Chloride (Cl)	9,400	9,600	9,400	9,200	9,500
Fluoride (F)	—	—	—	2.0	1.9
Nitrate (NO_3)	—	—	—	1.7	—
Dissolved solids					
Calculated	—	—	—	17,200	18.000
Residue on evaporation at 180°C	—	—	—	19,000	—
Hardness as $CaCO_3$	3,800	3,900	3,800	3,800	3,700
Noncarbonate hardness as $CaCO_3$	—	—	—	3,600	3,500
Alkalinity as $CaCO_3$	—	—	—	130	130
Specific conductance (micromhos/cm at 25°)	—	—	—	26,000	27,000
pH (units)	—	—	7.0	7.2	7.3
Color (platinum cobalt units)	—	—	6	5	—
Temperature (°C)	—	—	30.0	28.9	29.5
Dissolved oxygen (DO)	—	—	—	—	1
Total organic carbon (TOC)	—	—	—	—	3.0

Date of collection	Feb. 10 1927	Aug. 4 1930	Aug. 11 1943	Apr. 9 1962	Apr. 24 1972
Ammonium (NH_4 as N)	—	—	—	—	.38
Nitrite (NO_2 as N)	—	—	—	—	.00
Nitrate (NO_3 as N)	—	—	—	.38	—
Orthophosphate (PO_4 as P)	—	—	—	.40	—
Total phosphorus (P)	—	—	—	—	.01
Carbon dioxide (CO_2)	—	—	—	16	—
		(micrograms per liter)			
Strontium (Sr)	—	—	—	—	31,000
Arsenic (As)	—	—	—	—	10
Cadmium (Cd)	—	—	—	—	0
Chromium (Cr^6)	—	—	—	—	6
Cobalt (CO)	—	—	—	—	0
Copper (Cu)	—	—	—	—	20
Lead (Pb)	—	—	—	—	0
Zinc (Zn)	—	—	—	—	20
Iron (Fe)	—	—	—	—	40
Manganese (Mn)	—	—	—	—	20
Mercury (Hg)	—	—	—	—	.0

TEXT FIGURE 118. Elder Spring viewed from south. The spring is inside the enclosure.

vertically into the ground at the point of discharge. The pool contained by the pipe is about 2 ft deep; spring flow is from a white-sand bottom and out through a 2-in. diameter hole near the top of the pipe. Discharge from the pool is northwest to a manmade pond about 50 ft away. It is covered by a metal lid. The spring is pumped intermittently to supply a nearby residence with clear clean water.

The spring is in the center of a circular concrete-wall enclosure 18 in. high and about 12 ft in diameter. This is covered by a peaked metal roof supported on pillars about 7 ft high. Woven-wire fencing extends from the top of the wall to the eaves of the roof to further enclose the spring.

Discharge. — August 15, 1972 8 gal/min (estimated)

Utilization. — Beginning about in 1900, Elder Spring water was bottled and sold for drinking and as a substitute for distilled water in batteries. The water is now used for domestic purposes.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

TEXT FIGURE 121. Looking west at head of Miami Springs. Boil is right of center close to the wood retaining wall.

ground" and go 0.1 mi, turn northeast onto a sand road and continue 0.3 mi to the spring site.

Description. — Miami Springs is at the base of a pine, hardwood, and palm, open-wooded hillside that rises southward from the Wekiva River valley. The spring has a semicircular pool about 30 ft in diameter and 3 ft deep on the average and is partly enclosed by a wood retaining wall about 2 ft high. The pool has a sandy bottom much of which was covered with algae and grass. Discharge is from one submerged tubular vent near the west edge of the pool. The vent is about 5 ft in diameter at its top, sloping down toward the west and narrowing with depth. The maximum depth was 7 ft measured at the vent on March 28, 1972. Flow from the vent caused a strong boil at the surface; the water was clean and clear, and had a hydrogen sulfide odor. From the pool, water flows about 50 ft E., then 250 ft N., in a run about 35 ft wide, thence through a concrete weir 5.5 ft wide and 9 ft long. About 350 ft below the weir, the spring flow is impounded by a small concrete dam to form a 90-ft diameter, sand-bottom swimming pond. Discharge from this pond is through a 4-ft wide weir in the dam to the Wekiva River about 200 yds N.

Discharge. — August 8, 1945 5.79 ft^3/s
October 17, 1960 7.38
March 28, 1972 4.37

Utilization. — Used for fishing and swimming by campers in private campground.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		March 28, 1972	
Nitrite (NO_2 as N)	0.02	Dissolved solids	
Nitrate (NO_3 as N)	.02	Calculated	111
Calcium (Ca)	25	Residue on evaporation	
Magnesium (Mg)	7.4	at 180°C	120
Sodium (Na)	4.1	Hardness as $CaCO_3$	93
Potassium (K)	.6	Noncarbonate hardness	
Silica (SiO_2)	8.9	as $CaCO_3$	6
Bicarbonate (HCO_3)	110	Alkalinity as $CaCO_3$	87
Carbonate (CO_3)	0	Specific conductance	
Sulfate (SO_4)	5.6	(micromhos/cm	
Chloride (Cl)	7.0	at 25°C)	210
Fluoride (F)	.2	pH (units)	7.8
Nitrate (NO_3)	.09	Color (platinum cobalt	
		units)	0
		Temperature (°C)	24.5

PALM SPRINGS

(Text Figure 122)

Location. — SW¼SW¼NW¼ sec. 2, T. 21 S., R. 29 E. (lat. 28°41′27″ N., long. 81°23′34″ W.). Palm Spring is about 3 mi W. of Longwood (fig. 12). Drive west on State Hwy 434 from the junction with State Hwy 427 in Longwood for 3. 6 mi, turn north into "The Springs" residential development and go 0.6 mi to the Springs and Park Information Center, continue 0.15 mi NE. to the tennis court parking area; walk east-northeast around the side of a hill about 750 ft to the spring pool.

Description. — Palm Springs is in a semitropical setting. The spring basin is about 100 ft long and 50 ft wide with its long dimension oriented north-south. It is enclosed by the collapsing remains of a 4-ft-high concrete retaining wall that once formed a swimming pool, curved outward

TEXT FIGURE 126. Spring No. 3 of Gum Springs group viewed from west. Spring orifice is just off end of the dock.

numbers 1, 2 and 3 in downstream order from the north, form individual pools within 800 ft of each other aligned northeast to southwest, and together comprise the headwaters of Gum Slough. Flow from the three pools converge westerly down separate short runs to form the southwest-flowing Gum Slough. The other three springs (4, 5, and 6 in downstream order) are within about 1,000 ft of each other in the channel of Gum Slough, about 0.6 to 0.8 mi downstream from the confluence of springs 1-3.

SPRING NO. 1 is in dense swamp woods. Its pool is about 50 ft in diameter. Spring flow is from under a rock ledge on the north side and near the bottom of a circular vent in the central part of the pool. The edge of the vent is 5 or 6 ft below the pool surface and is about 20 ft in diameter at its top, narrowing downward to a maximum depth of 20.5 ft below the pool surface. The run, which is the uppermost reach of Gum Slough, bends southwest about 500 ft W. of the spring.

SPRING NO. 2 has a circular pool about 40 ft in diameter about 500 ft SW. of Spring No. 1. It is in a more open, grassy, wooded area at a break between swamp forest to the west and slightly higher, flat sparsely

road intersection, turn sharply west and drive 0.3 mi; the spring is about 20 ft W. of the road (see fig. 26).

Description. — Baptizing Spring is overgrown with brush, weeds, and small trees. The water was black and there was no flow in September 1974. The pool is shallow and its limits difficult to define.

Discharge. — None.

Utilization. — None apparent.

BONNET SPRING
(Text Figure 129)

Location. — NW¼SW¼NE¼ sec. 20, T. 4 S., R. 12 E. (lat. 30°07′27″ N., long. 83°08′17″ W.). Bonnet Spring is about 2 mi E. of Luraville (fig. 14). Drive 1.8 mi E. on paved road from State Hwy 51 near Luraville, turn right onto the first dirt road past fence line and go about 0.2 mi to the spring (see fig. 26).

Description. — Bonnet Spring is in the headwaters of Peacock Slough, in a densely forested area. The banks of the pool are moderately steep and there are occasional cypress trees at the edge of the water. The surface

TEXT FIGURE 129. Bonnet Spring viewed from its southwest side. The clear pool area near the north shore is above the vent of the spring. The trail shown on the north bank is the access route from the road.

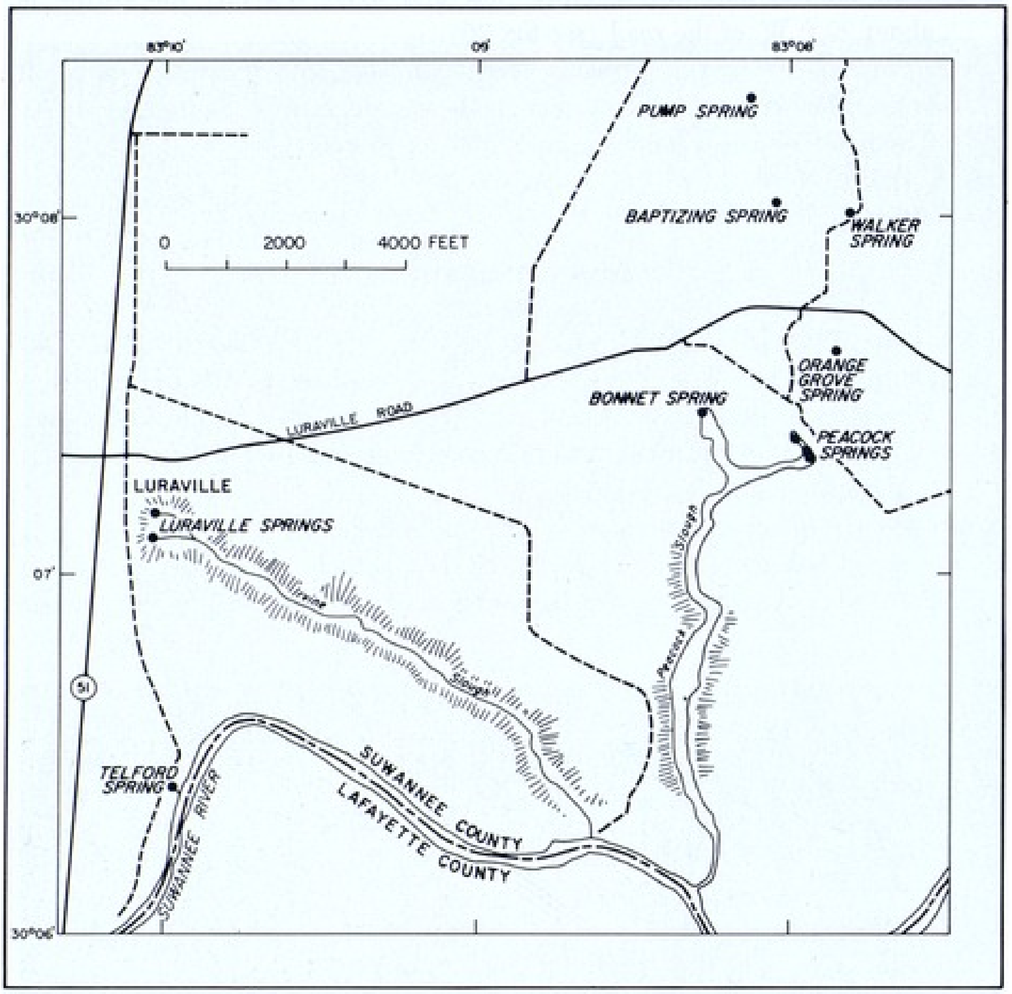


FIGURE 26. — Location map for springs in the vicinity of Luraville, 15 miles southwest of Live Oak. Included are Baptizing, Bonnet, Luraville, Orange Grove, Peacock, Pump, and Walker Springs.

of the pool is patched with lily pads, water hyacinths, and other aquatic plants. The pool has a diameter of about 75 ft, an average depth of 4 ft, and a maximum depth of 20 to 30 ft at the vent opening. The bottom is soft sand with some limestone rock exposed around the vent. The run has an average depth of 2 ft and flows into a swamp several hundred feet downstream.

Discharge. — Little flow was apparent in November 1973, but a reverse flow was visible near its confluence with Peacock Springs run owing to the strong flow from Peacock Springs.

Utilization.—Used for swimming, fishing, and snorkeling. No public facilities.

TEXT FIGURE 131. View of Branford Springs from the top of the south bank of the spring. Two round vents (lower center) are to the left of the small raft. This is in the southeast part of the pool — to the right of the swimmers in the other picture.

Utilization. — The spring is used for swimming and is equipped with a diving board. Adjacent are canoe rental, boat ramp, restrooms, and other recreational facilities.

Water Quality. —Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		November 3, 1972	
Nitrite (NO_2 as N)	0.01	Dissolved solids	
Nitrate (NO_3 as N)	.60	Calculated	210
Calcium (Ca)	71	Residue on evaporation	
Magnesium (Mg)	7.0	at 180°C	241
Sodium (Na)	2.3	Hardness as $CaCO_3$	210
Potassium (K)	.3	Noncarbonate hardness	
Silica (SiO_2)	4.7	as $CaCO_3$	59
Bicarbonate (HCO_3)	180	Alkalinity as $CaCO_3$	150

TEXT FIGURE 133. A northerly view of Charles Springs showing the limestone bridge that spans the springhead. This photograph and the previous one were taken from the same location southeast of the spring.

the road angles to the left, turn left and drive another 0.4 mi; the spring is to the right.

Description. — The banks of this oblong pool are steep. The pool is divided by a small limestone bridge and each section has a boil. It is not known if the springs discharge from one or two vents. The pool has a maximum diameter of about 25 ft and depths from 2 to 10 ft. The depth is greatest at the southwest end near the bridge. Water flows from the pool beneath limestone rock to a run 1 to 3 ft deep and 35 to 40 ft wide but narrowing to 15 ft some 75 ft downstream near the river. Water temperature was 22°C. (71.5°F.) in April 1956 and 21°C. (70.0°F.) in November 1960.

Discharge. —	May 13, 1927	7.4 ft^3/s
	May 15, 1927	17.9
	December 12, 1941	9.41
	May 29, 1942	36.9

TEXT FIGURE 134. A view south-southwest across Cow Spring.

ELLAVILLE SPRING
(Text Figure 135)

Location. — NW¼NW¼SE¼ sec. 24, T. 1 S., R. 11 E. (lat. 30°23′03″ N., long. 83°10′21″ W.). Ellaville Spring is east of U.S. Hwy 90 in Ellaville on the south shore of the Suwannee River (fig. 14). The spring discharges through a large crevice about 50 ft W. of a railroad trestle.

Description. — Ellaville Spring is discharging from the 6-ft-wide mouth of a horizontally oriented 30 ft deep cave located in a high limestone bluff on the south bank of the Suwannee River. The water flows turbulently some 40 to 50 ft to the river through a "V" shaped limestone run that is 8 to 10 ft wide and 10 to 15 ft deep. The area of the cave entrance and run is littered with limestone boulders some more than 10 ft long and two that span the width of the run; one boulder nearly blocks the cave entrance causing the spring flow to boil up into the run. The water is generally clear and the rocks covered with green algae.

Discharge. —	December 9, 1942	41.2 ft^3/s
	November 16, 1960	27.9
	November 8, 1973	82

Utilization. — None.

TEXT FIGURE 142. A view of the northwest corner of the pool at Suwannee Springs. This is the deepest part of the pool. The Suwannee River is just visible in the upper right of the photograph.

clustered in a sandy 30-yard area at the edge of the Suwanne River. Four of the springs are at the edge of the river east and west and outside of a 15-ft high concrete and rock wall that confines the main spring system. The wall encloses a 45-by 85-ft area that has a 35-by 50-ft spring pool and a sloping sand beach. The pool is deepest towards the river and is 3 to 15 ft deep. A boil at the southeast corner marks one source of spring flow to the pool. A second source is the cavity in the northwest part of the pool. The water is clear and has a slight hydrogen sulfide odor.

Discharge. — From 1906 through 1973 the discharge of Suwannee Springs has been measured 52 times. The average flow was 23.4 ft^3/s. When the river is in flood, spring flow cannot be measured and river water may be entering the aquifer through the spring vent.

Lowest measured flow:	April 25, 1956	2.35 ft^3/s
Highest measured flow:	June 4, 1964	71.5

Utilization. — Swimming. No facilities. The bathhouses and cottages that once served Suwannee Sulphur Springs (Matson and Sanford, 1913, p. 412) as a popular health resort have been destroyed. The flood-wall remains, 90 to 100 years old.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection	February 26 1924	May 11 1966	November 19 1973
Carbon dioxide (CO_2)	—	—	9.1
Calcium (Ca)	53	53	48
Magnesium (Mg)	12	7.2	11
Sodium (Na)	5.5	4.0	4.2
Potassium (K)	.6	.4	1.0
Silica (SiO_2)	14	11	12
Bicarbonate (HCO_3)	180	180	180
Carbonate (CO_3)	—	0	0
Sulfate (SO_4)	27	18	17
Chloride (Cl)	7.0	7.0	5.3
Fluoride (F)	—	.2	.1
Dissolved oxygen (DO)	—	—	4.5
Dissolved solids			
Calculated	220	187	187
Residue on evaporation at 180°C	—	—	199
Hardness as $CaCO_3$	180	160	170
Noncarbonate hardness as $CaCO_3$	—	18	18
Alkalinity as $CaCO_3$	—	140	150
Specific conductance (micromhos/cm at 25°C)	—	330	333
pH (units)	—	7.5	7.5
Color (platinum cobalt units)	—	15	10
Temperature (°C)	—	21.5	21.0
Strontium (Sr) ($\mu g/L$)	—	—	0

SUWANNEE BLUE SPRING

Location. — NE¼SW¼NE¼ sec. 1, T. 5 S., R. 12 E. (lat. 30°04′53″ N., long. 83°04′07″ W.). This spring is about 15 mi SSW. of Live Oak on the north bank of the Suwannee River (fig. 14). From Branford, drive 5 mi N. on State Hwy 249, turn west and drive 8.5 mi W. and NW. on State Hwy 349; the spring is at the end of the dirt road that intersects State Hwy 349 from the left.

between the Perry-Foley Airport and the Foley plant of Buckeye Cellulose Corporation (fig. 14). From U.S. Hwy 19, turn east onto State Hwy 30 and go about 900 ft beyond the Atlantic Coast Line railroad tracks to a dirt road that goes about 700 ft S. to the spring; on the north bank of the Fenholloway River.

Description. — Camp Ground Spring is in an open area adjacent to the Fenholloway River. There are scattered oak and pine trees, with cedar and brush along the flood plain of the river. The area is suggestive of its name — the grassy spaciousness and access-trail generate visions of past community gatherings. The spring is presently a circular pool about 50 ft in diameter and without flow. At higher levels it discharges south about 50 ft to the Fenholloway River. A water sample was not taken.

Utilization. — None.

CARLTON SPRING
(Text Figure 146)

Location. — NW¼SW¼SW¼ sec. 12, T. 5 S., R. 7 E. (lat. 30°03′29″ N., long. 83°35′15″ W.). Carlton Spring is about 3.5 mi S. of Perry off the

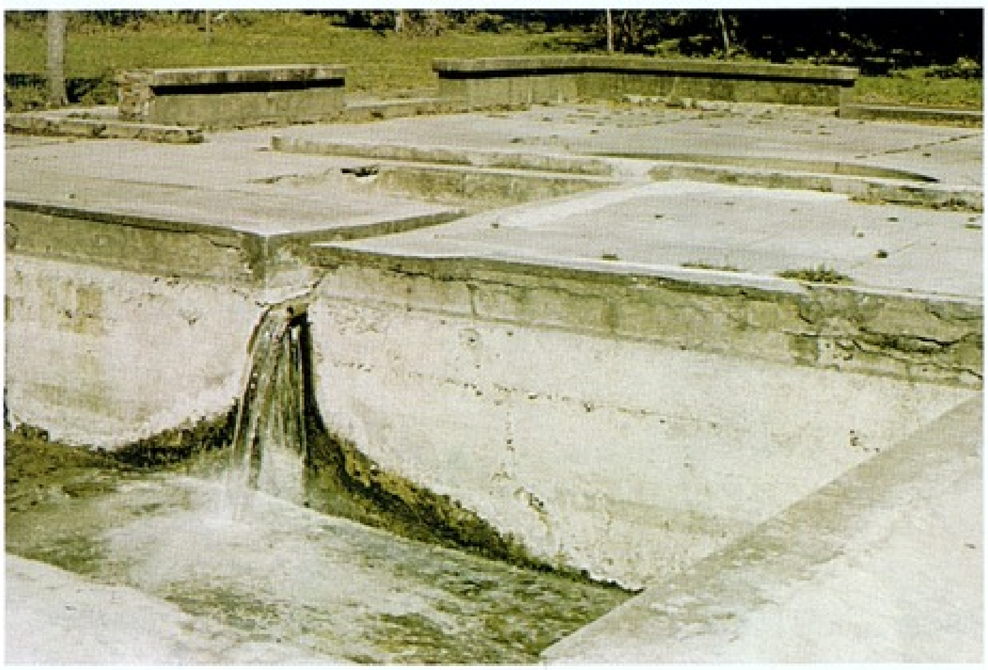
TEXT FIGURE 146. A westerly view of Carlton Spring. The picture was taken from a concrete remnant of an old bridge.

sinkholes are numerous. This spring water is unusual in that it is high in sulfate but low in chloride and sodium — a characteristic first reported by Ferguson (1946, p. 160) and verified by the 1972 sampling. Hydrogen sulfide odor is strong in the area when the pool is allowed to fill.

Discharge. —

1913	.52 ft^3/s	223 gal/min
November 21, 1923	.61	260
January 25, 1929	.16	67
July 23, 1946	.47	202
May 3, 1956	.05	22
December 8, 1960	.18	76
March 23, 1972	.21	90

Utilization. — Hampton Springs was developed into a winter resort in 1910 when the Hampton Springs Hotel was built. The hotel was destroyed by fire in 1954. The springs are now part of the Taylor County Recreation Center with 5 mi of nature trails on 120 acres. The site is used for out-



TEXT FIGURE 148. The foundation of the once popular Hampton Springs Hotel. The spring water rises from below the foundation and is shown here flowing into the hotel swimming pool.

TEXT FIGURE 149. Waldo Springs, looking northward to the spring run.

Description. — Waldo Springs is in low flatlands on the south bank of the Fenholloway River. The spring pool is about 60 ft in diameter. There is a boil over the vent in the southwest part of the pool, and seeps are visible along the south shore. Spring flow has also been reported from the crevices in the limestone floor on the north side of the pool. Maximum depth in the pool is about 9 ft. The spring discharges to the north, about 120 ft to the Fenholloway River, through a run that was 14 ft wide and about 1 ft deep in 1972. A line of debris showed around the spring pool and its run indicates that the site is subject to flooding by the Fenholloway River.

Discharge. —

July 24, 1946	3.3 ft^3/s
May 1, 1956	0
December 8, 1960	7.1
March 27, 1969	6.9
June 26, 1969	4.6
April 17, 1972	4.4

Utilization. — Swimming by local residents.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

TEXT FIGURE 150. Worthington Spring viewed from southwest. Spring is inside a small square concrete and wood enclosure in left-center on edge of abandoned swimming pool.

on the north side of the Santa Fe River (fig. 14). Drive 0.4 mi S. on State Hwy 121 from the junction with State Hwy 18, turn right onto a side road paralleling the highway a short distance, then continuing about 400 ft due W.; the abandoned spring-swimming pool is southwest of the end of the road.

Description. — The spring is in a low wooded area near the north bank of the Santa Fe River. Flow of the spring is small and the spring is subject to flooding by the river. It is enclosed by a 12-ft square concrete wall at the east end of the ruins of a concrete swimming pool 90 ft long by 50 ft wide. At one time the spring was developed as a privately operated recreation area complete with a hotel, swimming pool, bathhouse and recreation hall. Nothing remains but the spring enclosure and remnants of the swimming pool. When the facility was in operation, controlled flow was from the spring directly into the adjacent swimming pool and thence through a controlled outlet to the river nearby. On February 29, 1972, highly colored water from the river was backed up over the spring and into the swimming pool; no flow was evident. On April 24, 1972 the

TEXT FIGURE 151. Looking north, upstream at the head of Blue Spring. Note the boil at the water surface near the center of the picture.

14). Drive north for 0.25 mi on U.S. Hwy 17 from the junction with State Hwy 430A, turn west onto paved road and continue 3.25 mi to Blue Springs State Recreational Area; the springhead is about .25 mi N. of the parking area and is reached by a foot trail along the east bank of the spring run.

Description. — Blue Spring, in a wooded area of palm and hardwoods, has a nearly circular pool about 100 ft in diameter. The pool has a steep bank about 10 ft high except to the south where the spring opens to the spring run. The bottom of the pool, somewhat funnel shaped, tapers downward. Fifteen feet from the north edge of the pool is a limestone ledge at a depth of about 9 ft. From the ledge the bottom slopes precipitously to about 40 ft; the maximum depth sounded on January 3, 1947 was 41.7 ft. On March 2, 1972, there was a prominent boil at the surface. The water typically has a cloudy bluish-green appearance and a hydrogen sulfide odor, although the intensity of the cloudiness reportedly varies. From the pool the spring run goes about 0.2 mi S., then another 0.2 mi SW. to the St. Johns River. The run varies from 70 to 100 ft in

Date of collection	July 8 1946	Nov. 1 1960	Apr. 12 1972	May 2 1972
Specific conductance (micromhos/cm at 25°C)	2,840	1,060	—	1,800
pH (units)	7.6	7.5	—	7.8
Color (platinum cobalt units)	5	0	—	0
Temperature (°C)	23.0	23.0	—	23.0
Total inorganic carbon (TIC)	—	—	—	31
Total carbon (TC)	—	—	—	31
Total phosphorus (P)	—	—	—	.07
		(micrograms per liter)		
Strontium (Sr)	—	—	—	1,100
Arsenic (As)	—	—	—	0
Cadmium (Cd)	—	—	—	2
Cobalt (CO)	—	—	—	0
Copper (Cu)	—	—	—	20
Iron (Fe)	70	—	—	70
Lead (Pb)	—	—	—	1
Zinc (Zn)	—	—	—	20
Manganese (Mn)	—	—	—	0

TEXT FIGURE 153. Green Springs viewed from the east. The spring is behind the rope stretched from pool steps. Shallow swimming and wading area is in the foreground.

is into a shallow run 6 ft wide and 2 or 3 in. deep at the southeast edge of the pool and then southeast about 200 ft to a small creek that flows south 0.25 mi to Lake Monroe.

Discharge. — March 7, 1932 — 1.00 ft^3/s
October 18, 1960 — 1.84
April 14, 1965 — 0.58
January 27, 1966 — 0.72
December 9, 1966 — 0.88
April 21, 1972 — 0.28

Utilization. — Private recreational area. Not open to public.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		April 21, 1972	
Nitrite (NO_2 as N)	0.00	Dissolved solids	
Nitrate (NO_3 as N)	.00	Calculated	930
Calcium (Ca)	63	Residue on evaporation	

Date of collection		April 21, 1972	
Sodium (Na)	330	Hardness as $CaCO_3$	410
Potassium (K)	7.7	Noncarbonate hardness	
Silica (SiO_2)	9.9	as $CaCO_3$	280
Bicarbonate (HCO_3)	160	Alkalinity as $CaCO_3$	140
Carbonate (CO_3)	0	Specific conductance	
Sulfate (SO_4)	98	(micromhos/cm	
Chloride (Cl)	650	at 25°C)	2,460
Fluoride (F)	.3	pH (units)	6.9
Nitrate (NO_3)	.00	Color (platinum cobalt	
		units)	0
		Temperature (°C)	23.5
		Strontium (Sr) (μg/L)	2,100

WAKULLA COUNTY

INDIAN SPRINGS

(Text Figure 156)

Location. — NE¼NE¼SW¼ sec. 3, T. 3 S., R. 1 W. (lat. 30°15′02″ N., long. 84°19′42″ W.). Indian Springs is about 13 mi S. of Tallahassee

TEXT FIGURE 156. Westerly view across the discharge end of the pool at Indian Springs.

Date of collection	March 21 1972	January 21 1973	December 21 1973
Silica (SiO_2)	6.1	7.2	—
Bicarbonate (HCO_3)	90	83	94
Carbonate (CO_3)	0	0	0
Sulfate (SO_4)	12	12	—
Chloride (Cl)	8.0	8.0	7.5
Fluoride (F)	.2	.2	—
Carbon dioxide (CO_2)	—	5.3	3.8
Dissolved solids			
Calculated	110	100	—
Residue on evaporation at 180°C	121	129	—
Hardness as $CaCO_3$	87	79	90
Noncarbonate hardness as $CaCO_3$	13	10	13
Alkalinity as $CaCO_3$	74	68	77
Specific conductance (micromhos/cm at 25°C)	195	195	209
pH (units)	7.4	7.4	7.6
Color (platinum cobalt units)	50	60	—
Temperature (°C)	20.0	20.0	21.0
Turbidity (JTU)	—	2	2
Biochemical oxygen demand (BOD, 5-day)	—	.5	.9
Chemical oxygen demand (COD)	—	—	14
Total organic carbon (TOC)	—	6.0	8.0
Total inorganic carbon (TIC)	—	14	20
Total carbon (TC)	—	20	28
Organic nitrogen (N)	—	.52	.19
Ammonium (NH_4 as N)	—	.03	.02
Nitrite (NO_2 as N)	.00	.00	.00
Nitrate (NO_3 as N)	.04	.03	.03
Orthophosphate (PO_4 as P)	—	.01	.02
Total phosphorus (P)	—	.01	.02
	(micrograms per liter)		
Boron (B) Total	—	20	—
Strontium (Sr)	—	60	—
Arsenic (As)	—	10	6
Cadmium (Cd)	—	0	—
Chromium (Cr^6)	—	0	—

Date of collection	March 21 1972	January 21 1973	December 21 1973
Copper (Cu)	—	0	1
Lead (Pb)	—	0	8
Zinc (Zn)	—	40	0
Iron (Fe)	—	80	0
Manganese (Mn)	—	10	14
Mercury (Hg)	—	0	—

WAKULLA SPRINGS

(Text Figure 161, 162, 162A, 162B)

Location. — SW¼NW¼SE¼ sec. 11, T. 3 S., R. 1 W. (lat. 30°14′05″ N., long. 84°18′10″ W.). Wakulla Springs is about 14 mi S. of Tallahassee (fig. 15). From the intersection of State Hwy 267, drive SE. 1.2 mi on State Hwy 61 to the entrance.

TEXT FIGURE 161. Southeasterly aerial view of Wakulla Springs from an altitude of 4,000 feet on May 14, 1978. The main spring-vent is west of the buildings in the right center of the photograph. Sally Ward Spring is at the head of the small stream and pool near the bottom. State Highways 267 and 61 are along the left and bottom of the photograph, respectively.

Submarine springs, curiosities of nature, are a "neglected phenomenon of coastal hydrology throughout the world — known to exist off the coasts of California, Florida, and New York; the islands of the Bahamas, Cuba, Jamaica, and Barbados; Mexico's Yucatan Peninsula, Chile, Hawaii, Guam, American Samoa, Australia, and Japan; at Bahrain in the Persian Gulf, and in the Mediterranean Sea off Spain, France, Italy, Greece, Syria, Lebanon, Israel, and Libya" (Kohout, 1966).

A summary of available information about Florida's submarine springs follows. Distances are given in statute miles.

BEAR CREEK SPRING

Location. — SW¼SE¼NE¼ sec. 6, T. 6 S., R. 2 W., in Franklin County, (lat. 29°59′ N., long. 84°28′ W.). Bear Creek Springs is about 2.5 mi NW. of Shell Hammock on Bear Creek which is tributary to the Ochlockonee River.

Description. — Bear Creek Spring is in the south part of the St. Marks National Forest in the grass-tidal area in the mouth of the Ochlockonee River. The spring was not located.

Utilization. — Fishing.

CEDAR ISLAND SPRING

(Text Figure 170)

Location. — SE¼NW¼NW¼ sec. 1, T. 8 S., R. 7 E., (lat. 29°48′58″ N., long. 83°35′05″ W.). Cedar Island Spring is a coastal submarine spring 17 mi S. of the Perry-Foley airport, Taylor County. It may be reached from State Hwy 361, 1.5 mi S. of Keaton Beach. From the highway go 0.3 mi W. and then 0.2 mi N. to the spring located at the north end of the community.

Description. — Cedar Island Spring is on the south side of a canal or inlet of the Gulf of Mexico. It is reported to be a deep vent discharging clear, fresh water. When visited on December 3, 1975 the tide was high. There was no boil, nor was the vent visible.

Utilization. — Recreational. Facilities include a diving board, dock, and covered platform and seating area.

CEDAR ISLAND SPRINGS

Spring A location. — NW¼SE¼ sec. 21, T. 24 S., R. 16 E. (lat. 28°22′ N., long. 82°42′ W.). Wetterhall's description of Springs A and B (1965, p. 18-19) follows: These springs are about 1.1 mi N. of Hudson, Pasco County, 1,200 ft N. of Cedar Island Point, and 1,000 ft W. of the shore-

TEXT FIGURE 171. Westerly view of Crays Rise, a coastal submarine spring adjacent to Ochlockonee Bay.

Water Quality. — Analyses by U.S. Geological Survey. Units are in milligrams per liter unless otherwise indicated.

Date of collection		March 21, 1972	
Nitrite (NO_2 as N)	0.00	Dissolved solids	
Nitrate (NO_3 as N)	.18	Calculated	6,600
Calcium (Ca)	120	Residue on evaporation	
Magnesium (Mg)	250	at 180°C	—
Sodium (Na)	2,000	Hardness as $CaCO_3$	1,300
Potassium (K)	72	Noncarbonate hardness	
Silica (SiO_2)	4.5	as $CaCO_3$	1,200
Bicarbonate (HCO_3)	100	Alkalinity as $CaCO_3$	85
Carbonate (CO_3)	0	Specific conductance	
Sulfate (SO_4)	520	(micromhos/cm	
Chloride (Cl)	3,600	at 25°C)	11,200
Fluoride (F)	0.5	pH (units)	7.5
		Color (platinum cobalt	
		units)	65
		Temperature (°C)	21.0

80°35′04″ W.). This apparent spring is a well 1,244 ft deep that flows about 1,000 gal/min into Lake Chekika. The water temperature is 24.5°C. (76°F.) and the chloride concentration 1,300 mg/L.

SHANGRI LA MOTEL HEALTH RESORT

Location. — SE¼NE¼SW¼ sec. 35, T. 47 S., R. 25 E. (lat. 26°20′07″ N., long. 81°46′48″ W.). U.S. Hwy 41, Bonita Springs, Lee County. The source of the water, used primarily for scenic value, is an artesian well reportedly drilled before 1921. The flow of the well varies, but can be as great as 700 gal/min. Water temperature is 25°C. (77°F.) and the chloride concentration is 360 mg/L.

WARM SPRINGS SPA

Location. — SW¼NW¼NW¼ sec. 17, T. 46 S., R. 25 E. (lat. 26°28′31″ N., long. 81°50′14″ W.). Warm Springs Spa is about 10 mi S. of Ft. Myers. The spring is an artesian well 1,015 ft deep with an 8-in diameter casing. The water temperature is 32°C. (89°F.) and the chloride concentration is 1,000 mg/L. The water is used in an outdoor bathing pool.

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