UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

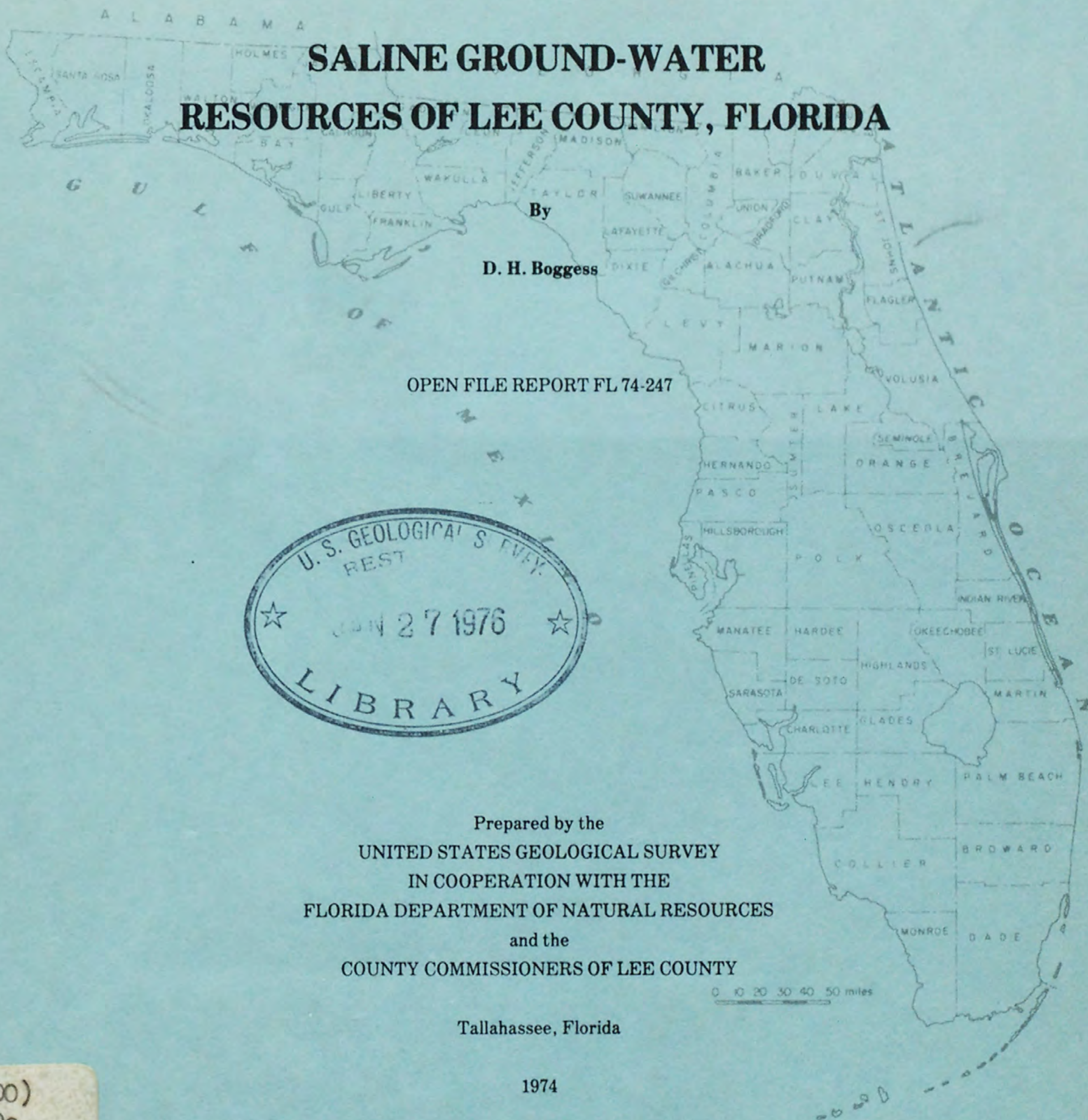
[Reports - Open file series]

SALINE GROUND-WATER RESOURCES OF LEE COUNTY, FLORIDA

By

D. H. Boggess

OPEN FILE REPORT FL 74-247



Prepared by the
UNITED STATES GEOLOGICAL SURVEY
IN COOPERATION WITH THE
FLORIDA DEPARTMENT OF NATURAL RESOURCES
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Tallahassee, Florida

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SALINE GROUND-WATER RESOURCES OF

LEE COUNTY, FLORIDA

By

D. H. Boggess

ABSTRACT

Lee County, an area of 786 square miles (1260 square kilometres) on the southwest coast of Florida, is underlain at depths greater than 400 feet (120 metres) by formations containing saline water. Two saline water-bearing zones occur within the depth interval 400 to 1,200 feet (120 to 370 metres); the upper zone is termed the lower Hawthorn aquifer and the lower zone is termed the Suwannee aquifer. Fresh water infiltrates into the aquifers in the central highlands region of Florida where water levels are as much as 130 feet (40 metres) above sea level. The water subsequently moves southwestward into the report area becoming progressively more saline toward the coast.

Both aquifers are under sufficient artesian pressure to cause wells tapping them to flow at land surface. Water levels range from more than 50 feet (15 metres) above sea level in the northeastern part of the county to about 30 feet (9 metres) or less along the coast. Artesian pressure in the aquifers has been reduced along the Caloosahatchee River by heavy withdrawal and this reduction in pressure is a major factor in deterioration of water quality in the McGregor Isles area, south of Fort Myers.

The average depth of wells tapping the lower Hawthorn aquifer is 572 feet (174 metres); the average depth of wells tapping both the lower Hawthorn and Suwannee aquifers is 858 feet (262 metres). Few wells tap only the Suwannee aquifer. The average length of casing in wells tapping the lower Hawthorn aquifer is 170 feet (52 metres), whereas the average length in wells tapping both aquifers is only 179 feet (55 metres). Flow rates range from 20 to 750 gallons per minute (1 to 47 litres per second) and average 233 gallons per minute (15 litres per second).

The saline water from the lower Hawthorn and Suwannee aquifers is hard and sulfurous. The dissolved solids, as determined from analyses of 31 samples, ranged from 700 to 3,300 mg/l (milligrams per litre) and averaged 1,936 mg/l. The chloride concentrations ranged from 160 to 1,600 mg/l and averaged 869 mg/l. The calcium magnesium hardness ranged from 110 to 1,000 mg/l and averaged 625 mg/l. Sulfate concentrations ranged from 92 to 800 mg/l and averaged 289 mg/l.

Although the mineral content is high, water from the lower Hawthorn and Suwannee aquifers has been used in the past for many purposes, particularly for irrigation. Currently, water from these aquifers may be used to supplement the dwindling supplies of better quality from aquifers at shallow depths.

INTRODUCTION

Saline water as defined by the U. S. Geological Survey, is water that contains more than 1,000 mg/l of dissolved solids (Krieger and others, 1957, p. 4). The deep artesian aquifers underlying Lee Lounty commonly contain water with dissolved-solids concentrations exceeding 1,000 mg/l and thus are termed saline-water aquifers.

For many years, the saline-water aquifers in Lee County have been a major source of water for irrigation of citrus groves, flower farms truck crops, and livestock watering. They also have been a source of supply for domestic use in many areas and formerly were used for the municipal water-supply system for Fort Myers, The rapid urbanization in the county over the last decade has not only greatly altered the land use patterns, but has also required the development of new sources of better quality water. In newly urbanized areas many of the deep artesian wells formerly used for irrigation are no longer in use because the water is too saline for most domestic purposes. In addition, leakage through faulty casings and surface discharge from wells tapping the saline-water aquifers has adversely affected water quality in the shallow aquifers in the county.

Currently (1974) most of the water for domestic use is from shallow fresh-water aquifers less than 300 ft (91 m) deep and from the fresh-water reach of the Caloosahatchee River. The use of water from the shallow aquifers for watering lawns has greatly increased and has generally paralleled the rapid increase in population. The use of water from the shallow aquifers for many other purposes, including irrigation, also has increased steadily.

The shallow aquifers in some parts of the county are inadequate to meet the existing demand, much less the probable future demand. The saline-water aquifers, widespread as they are beneath the county, constitute a valuable alternate source of water for domestic and most other uses. Where the salinity of the water is high, the water can be made useable by desalination. Where it is relatively low, the water can be used for irrigation, possibly even for domestic use with a minimum of treatment. Where it is marginal, the water can be used by blending with water from the shallow aquifers in reservoirs before being transported to points of use.

To make the best of use of the water in these two aquifers, hydrologic and geologic work would be necessary to determine the location of water fresh enough to use without desalination and of water so salty that desalination would be required. Plans for desalination of water in Lee County are in progress and one desalination plant is in operation with a second plant under construction.

Other, recently developed, uses of saline-water aquifers include the disposal of liquid wastes and the storage of fresh water. Whether such uses are applicable in Lee County can be determined on the basis of additional geologic and hydrologic information.

For the convenience of those more familar with the International System (metric) units rather than English units, conversion factors are given in table 1.

Table 1.--English unit-metric unit conversion table.

English	Multiply by	Metric
Inches (in)	2.54	Centimetres (cm)
	25.4	Millimetres (mm)
Feet (ft)	0.3048	Metres (m)
Square miles (mi^2)	2.59	Square kilometres (km^2)
Gallons per minute (gal/min)	.06304	Litres per second (l/s)

PURPOSE AND SCOPE

The purpose of this report is to describe from the available information, the occurrence, and quality of the saline ground-water resources underlying Lee County and the extent to which they are developed, as an aid in the management and use of these water resources, and to indicate where additional information is needed.

Because most of the information on which this report is based was obtained from wells, the report is of limited scope: little is said concerning the hydrologic or water-quality characteristics of the saline-water aquifers where few if any wells have been drilled. For this reason, of course, the report does not contain a quantitative estimate of the total amount of water capable of being developed from the two saline-water aquifers.

PREVIOUS INVESTIGATIONS

Although several publications refer to the saline-water aquifers as a part of broad regional studies, none provides other than general information on those underlying Lee County.

Hendry and Lavender (1957, p. 78-94) provide information on 118 wells in Lee County as part of an inventory of artesian wells in Florida. This inventory was largely directed toward the identification and description of wild flowing, or uncontrolled wells. Lee County had the second highest number of wells in this inventory of 22 counties, and the combined flow rate of 5,665 gal/min or 357 (l/s) (8.2 Mgal/d) was the highest. Apparently most of this water served little or no useful purpose.

Sproul and others (1972) provide the first relatively detailed description of the deep artesian aquifers underlying an area of about 9 mi^2 (23 km^2) near the central part of the county. They also document the effects of upward leakage from deep artesian sources of highly saline water on water quality and temperature of water in the deep artesian aquifers. Most of the geologic and aquifer designations used in the report by Sproul and others (1972) have been adopted in this report.

ACKNOWLEDGMENTS

The author is indebted to many individual well owners and to both public and private organizations for providing information on wells and for permitting the collection of water samples, obtaining geophysical logs, and making hydrologic measurements.

The contributions by local well drillers of drilling logs, well cuttings, and water samples on wells in the county is gratefully acknowledged. Special thanks are given to the Mobil Oil Corporation for releasing geologic data from test holes drilled in the county in 1967.

Geophysical logs and other well data provided by the Florida DNR (Department of Natural Resources) represent a major contribution to an understanding of geology and hydrology of the saline-water aquifers. Most of the logging information was provided by H. J. Woodard, Geologist, DNR and C. R. Sproul, Geologist, formerly with the Bureau of Geology, DNR.

The investigation was made and this report prepared under the general supervision of Mr. Clyde S. Conover, District Chief and Mr. Thomas J. Buchanan, Subdistrict Chief of the Water Resources Division, U. S. Geological Survey.

DESCRIPTION OF THE AREA

Lee County, on the southwest coast of Florida comprises an area of 786 mi^2 ($1,260\ km^2$) (fig. 1). The Caloosahatchee River is the main drainage system in the county and is a major outlet for flood water released from Lake Okeechobee; the river also forms the western part of a cross-state navigable waterway. Land altitudes in the county range from about 25-30 ft (8-9 m) above sea level in the east central and northern parts to only a few feet above along the coastal margins. Because of the low altitude and little relief, the natural drainageways are shallow and relatively short. Major drainage networks consisting of ditches and canals have been constructed at Fort Myers, Cape Coral, and Lehigh Acres.

The climate of Lee County is subtropical; temperature extremes are modified by the tempering influence of the Gulf of Mexico. As reported by the National Oceanic and Atmospheric Administration, U. S. Department of Commerce, the average annual air temperature at Page Field near Fort Myers is about 74°F (23°C); monthly averages range from 83°F (28°C) in August to 64°F (18°C) in January. Rainfall is unevenly distributed throughout the year; more than 60 percent of the average annual 53 inches (1,400 mm) falls in the period from June through September.

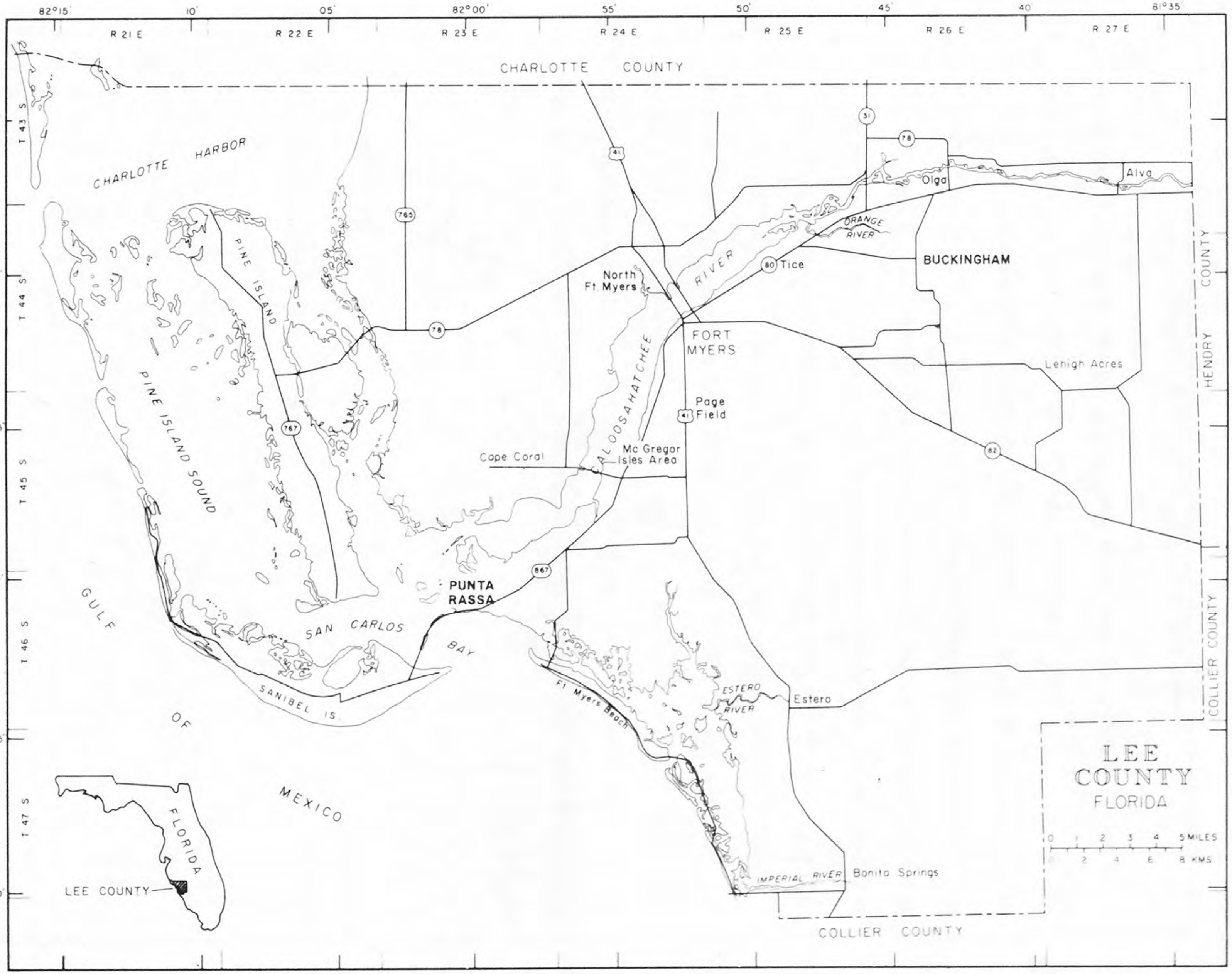

Figure 1.--Lee County showing names referred to in the report.

WELL INVENTORY AND NUMBERING SYSTEMS

The inventory of deep artesian wells, those more than 300 ft (91 m) deep, began in Lee County in 1934 when records for six wells were obtained. Information on about 200 additional wells was obtained between 1943-46 and 1949-51. After 1951, only a few wells were added to the inventory until 1966, when the present investigation of the water resources of the county began. Currently (1974), records for 590 deep artesian wells have been included in the inventory but these are not all the deep wells in the county.

Records for 217 deep artesian wells are included in this report. They were selected because they provide the most detailed information on the saline-water aquifers beneath Lee County. These well records are summarized in table 2 in the appendix. Well locations are shown on figure 2.

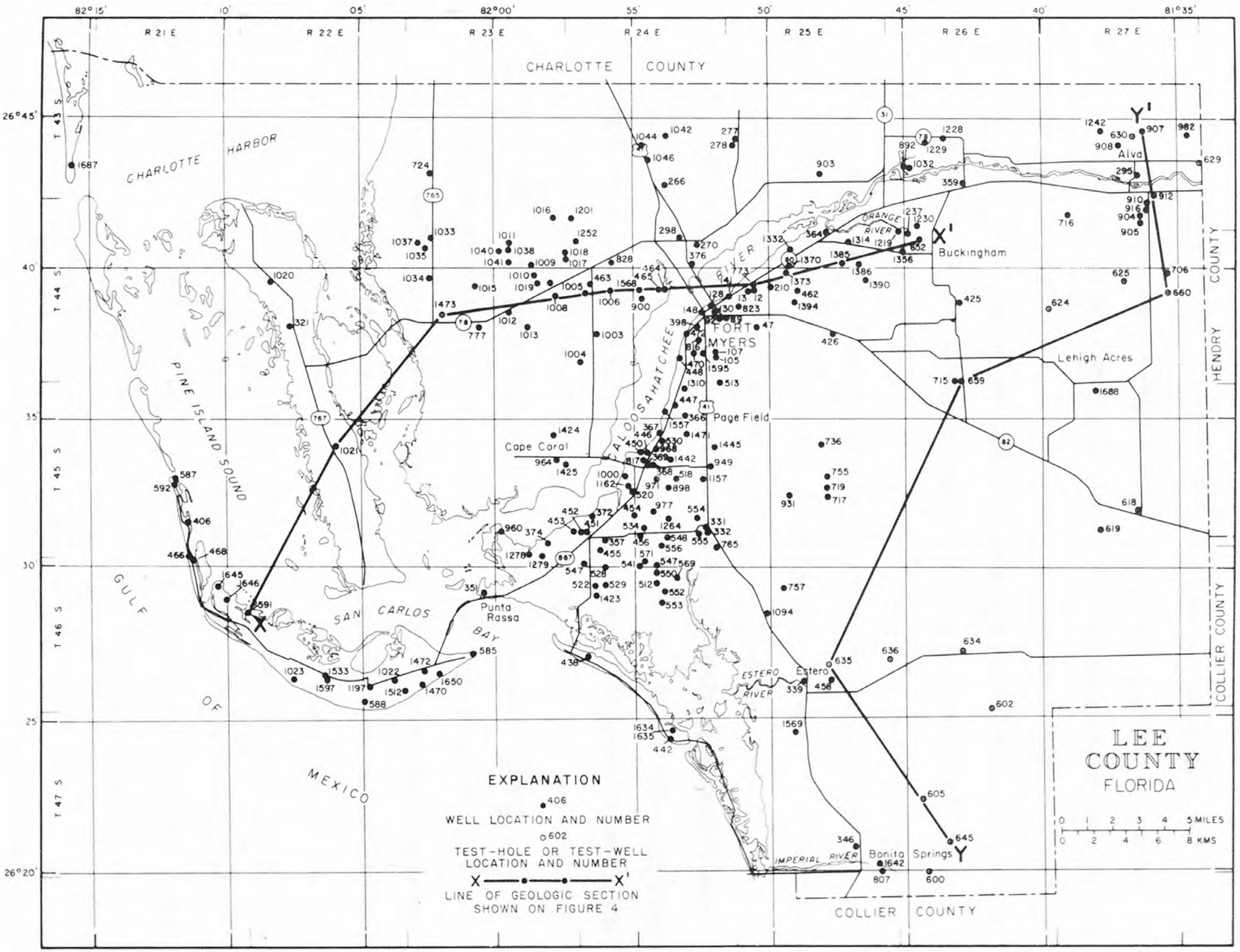

Figure 2.--Location of selected artesian wells, test holes, and geologic sections.

A dual numbering system is used in table 2. The first column of numbers, prefixed by L- (Lee County), indicates the numerical order in which the wells were inventoried. Numbers were assigned in sequence; the first well in table 2 (L-12) was added to the inventory in 1934; the last well (L-1688), was added in 1973. This numbering system is used throughout the report to identify wells and test holes.

The second numbering system permits locating the well to the nearest second of latitude and longtitude. This numbering system is used for the data storage and retrieval system of the U. S. Geological Survey. The first six digits followed by the letter "N" show the latitude. For example, well L-12 in table 2 is at latitude 26°39'17" North. Similarly, the longitude is given by the series of seven digits following the letter N. For well L-12, the longitude is 081°50'32". The last digit following the period refers to the number of wells within the same 1-second rectangle. The approximate location of any well may be determined by use of the assigned latitude and longitude well number and the latitude-longitude scale shown on figure 2.

GEOLOGIC FORMATIONS AND WATER-BEARING ZONES

Of the formations underlying Lee County (fig. 3), the saline water-bearing zones generally between 400 and 1,200 ft (122 and 366 m) beneath the surface are of particular importance in this report. Within this depth range generally are included the lower part of the Hawthorn Formation, and the Tampa and Suwannee Limestones. Detailed studies of the McGregor Isles area (Sproul and others, 1972), about 5 mi (8 km) southwest of Fort Myers, indicate that the most productive water-bearing zones within these formations commonly occur at or near the formation contacts. This concept was derived primarily from current-meter and caliper logs from which the depth and rate of water entry into the well bore were determined. This concept seems valid for other parts of Lee County, although confirmatory data are not available.

Two fresh water-bearing zones occur within the uppermost 150 ft (46 m) of deposits shown on figure 3, and are referred to as the water-table and sandstone aquifers. The formation names and aquifer designations used herein are the same as those used by Sproul and others (1972). A third fresh water-bearing zone, termed the upper Hawthorn aquifer, which occurs within the uppermost 300 ft (91 m) of deposits in the western part of the county, yields little or no water to wells in the eastern part of the county. These three water-bearing zones are collectively referred to herein as the shallow fresh-water aquifers.

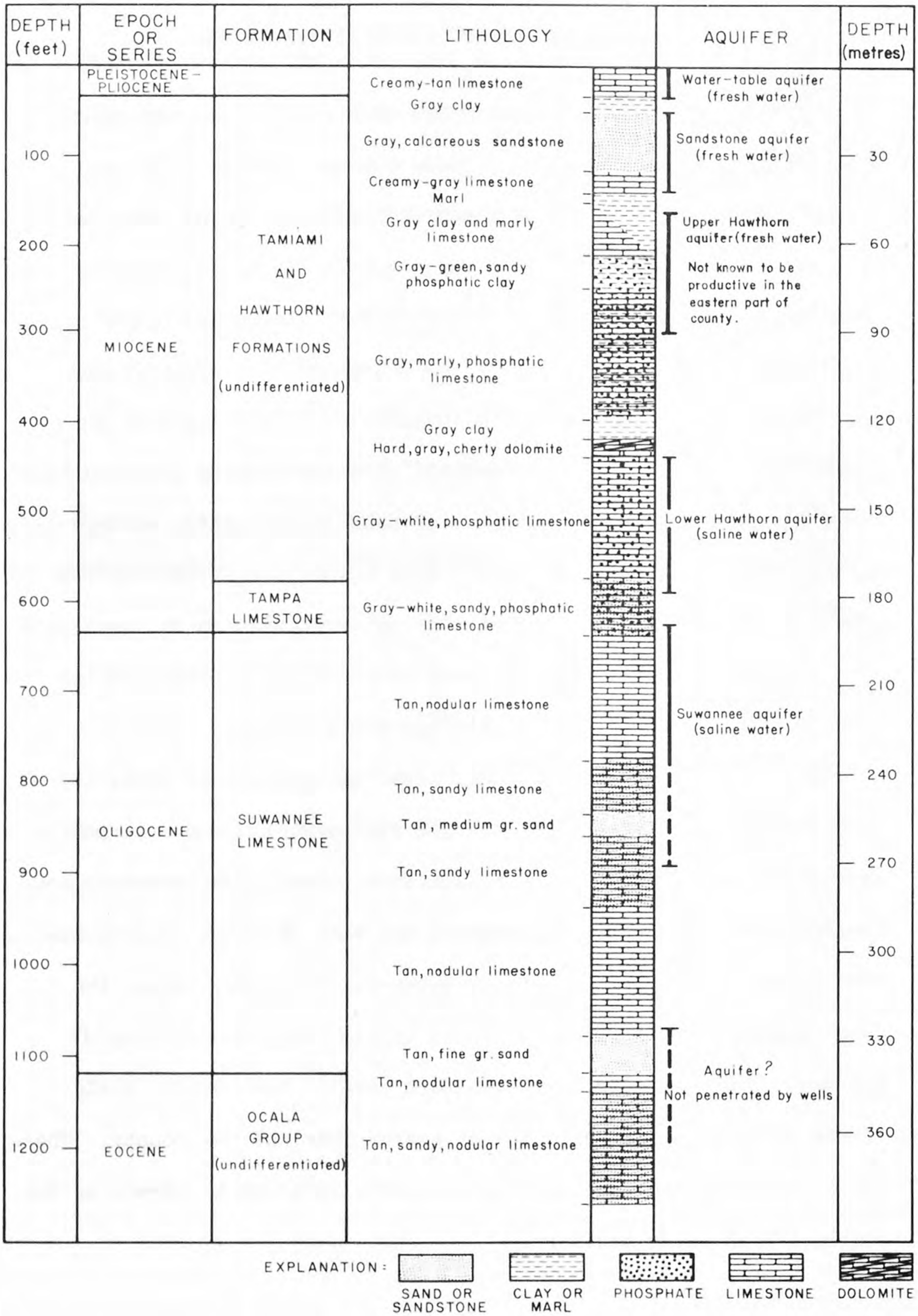

Figure 3.--Log of test hole L-660 showing geologic formations, lithology and aquifer designations.

As shown on the log of test hole L-660 (fig. 3) near the northeast corner of the county, the lower Hawthorn aquifer spans the lower part of the Hawthorn Formation and the upper part of the Tampa Limestone. Similarly, the Suwannee aquifer includes the upper part of the Suwannee Limestone and the lower part of the Tampa Limestone. The existence of a third aquifer, which may occur in the upper limestone of the Ocala Group and the lower part of the Suwannee Limestone, has not been verified because few water wells extend to the required depth. Other aquifers containing highly saline water apparently occur at still greater depths.

The two geologic sections on figure 4 (location on fig. 2) indicate the stratigraphic position and the variations in depth and thickness of the formations underlying the county. The sections are largely based on drill cuttings obtained from wells and test holes, supplemented by geophysical logs. Most of the wells listed in the Y-Y' section are from test holes which were drilled primarily for geologic exploration and thus provided only a small amount of hydrologic information.

Although the aquifer names are not included on the sections of figure 4, these sections and other geologic information were used in the compilation of table 2, which indicates the aquifer(s) tapped by individual wells.

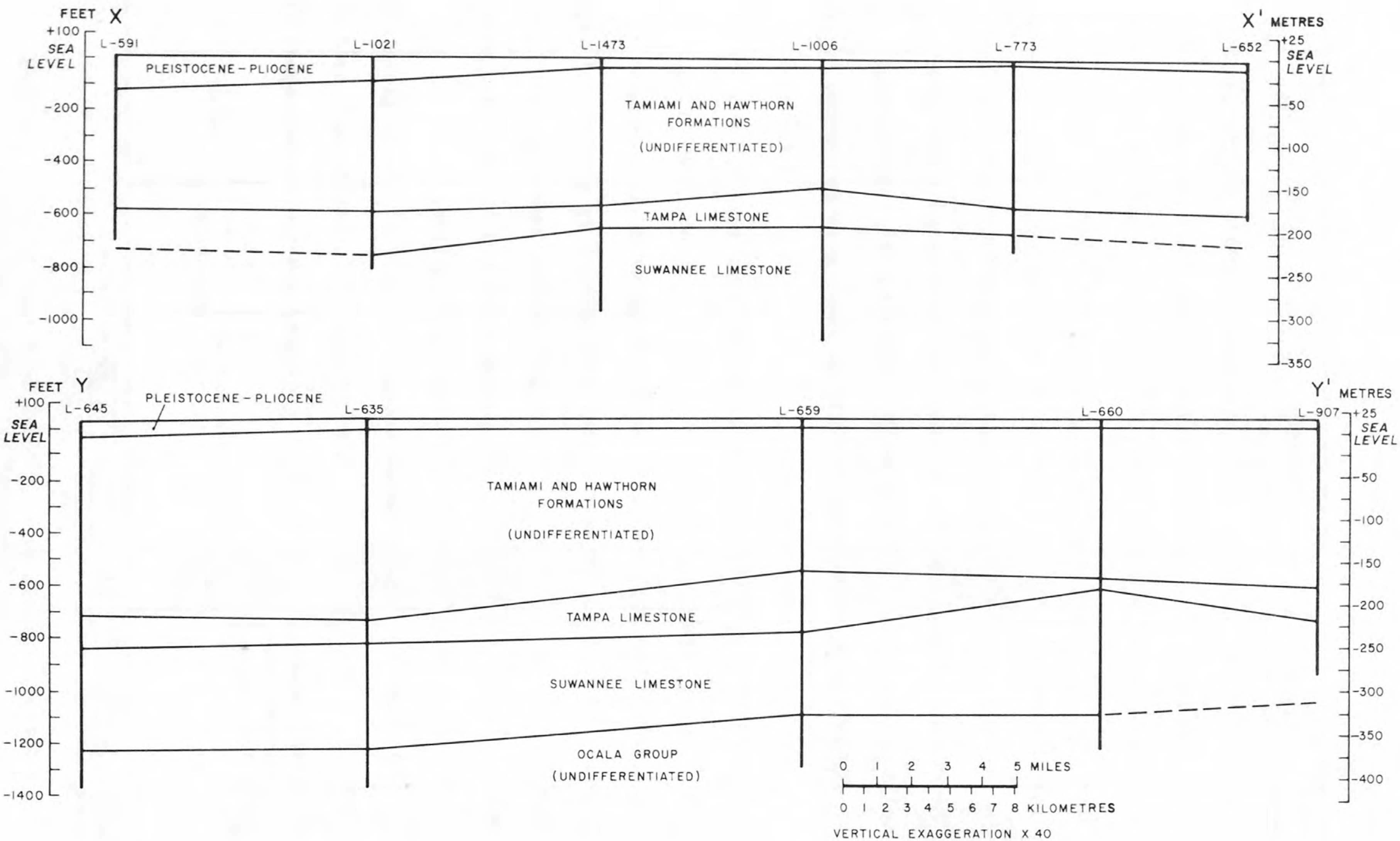

Figure 4.--Cross sections showing the stratigraphic position and the variations in depth and thickness of the geologic formations underlying Lee County.

SALINE GROUND WATER

Artesian Pressures

Saline water in the lower Hawthorn and Suwannee aquifers is under sufficient artesian pressure to cause wells to flow at the land surface throughout Lee County. Although some difference in altitude of the potentiometric surface probably exists between these two aquifers, the altitude is considered herein to be the same in both because little data are available to show otherwise. The potentiometric surface, or height to which water will rise in fully cased wells penetrating these aquifers, is shown on figure 5. Because of the scattered data, measurements made over relatively long periods were necessarily used. Records spanning two periods 1944-50 and 1966-73, were used in the compilation of figure 5.

The contours indicate a general southwest hydraulic gradient. The artesian head was more than 50 ft (15 m) above mean sea level in the northeast and about 30 ft (9 m) or less along the coastal margins. Healy (1962) shows an increase in an artesian head northward from Lee County to a maximum of about 130 ft (40 m) in central Florida. This suggests that recharge to the lower Hawthorn and Suwannee aquifers occurs in areas to the north.

The northeastward shift in the position of the contours of figure 5 along the Caloosahatchee River between the two periods probably was the result of discharge and leakage from the large concentrations of artesian wells along the river, and denotes a general decrease in artesian pressure in these areas.

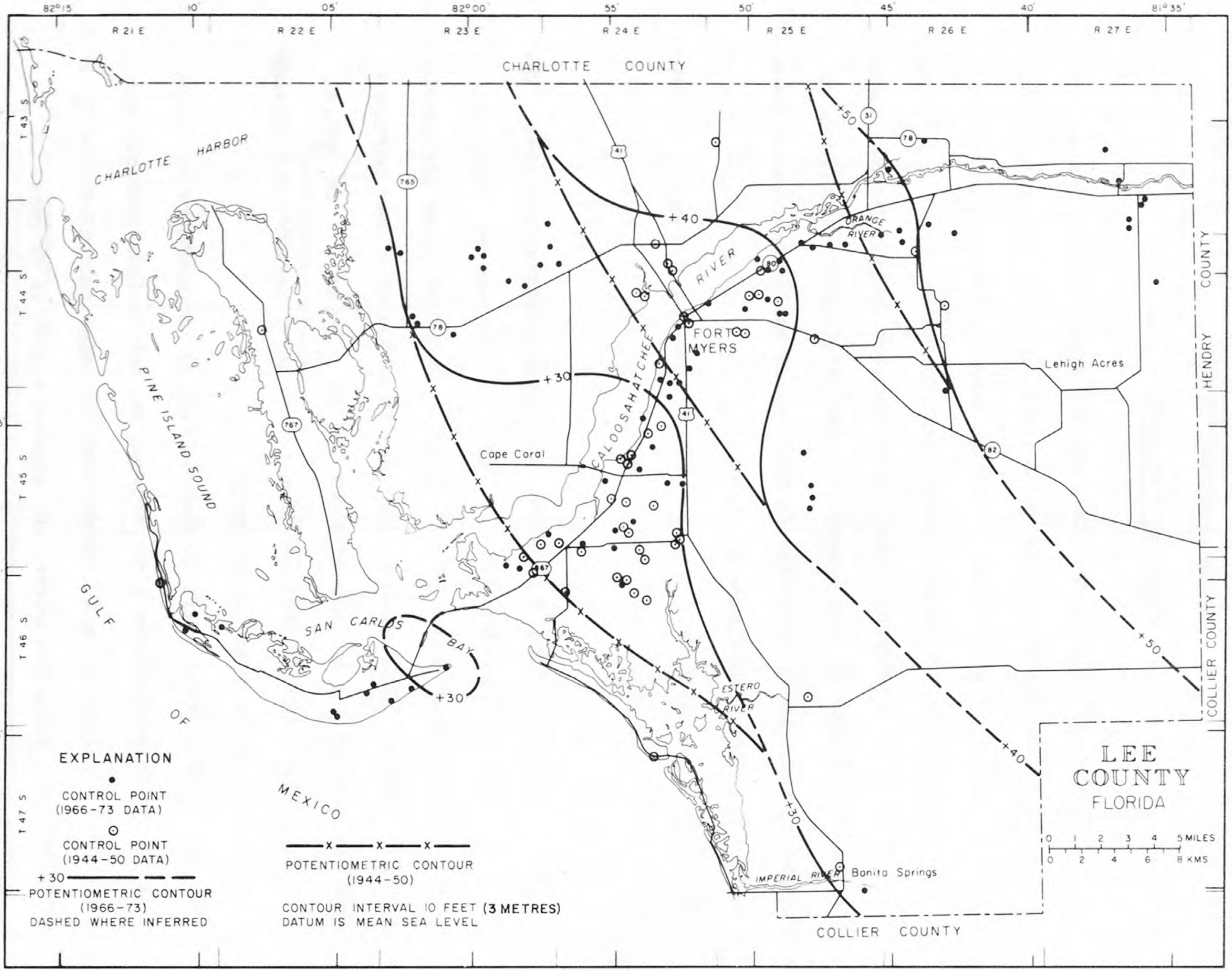

Figure 5.-- Potentiometric surface of the lower Hawthorn and Suwannee aquifers in 1966-73 and 1944-50.

Numerous factors are involved in the accurate determination of artesian pressure by the measurement of shut-in water pressure in artesian wells. Factors that most affect the accuracy of these measurements in Lee County include the length and condition of the well casing and the amount of discharge or leakage from nearby wells. Few wells in the county are fully cased to the saline-water aquifers. Where casings are too short, an interconnection between two or more aquifers exists in the open well bore. Because of differences in head, measurements made on these multiple aquifer wells represent a composite of pressures existing within the bore hole. These measurements nearly always indicate a lower artesian head in the lower Hawthorn or Suwannee aquifers than would have been determined for fully cased wells.

When nearby wells of comparable depth are permitted to discharge,artesian pressure is reduced. Where a large number of wells are discharging, the lowering of artesian pressure within the aquifer will be general. Under these conditions, water-level measurements made on nondischarging wells in the area will reflect the lowered pressure.

During the winter growing season, the use of water from the deeper aquifers for agricultural and lawn irrigation increases. This increase is usually accompanied by a general decrease in artesian pressure so that a seasonal variation in artesian head results. Seasonal changes in artesian pressure in the lower Hawthorn aquifer in the eastern part of Lee County are shown by hydrographs of wells L-652 and L-706 (fig. 6). These wells were selected for continued measurement because the formations between the bottom of the well casing and the top of the aquifer were of relatively low permeability suggesting that little leakage would occur. Well L-706, near the Hendry County boundary, is in an area of few deep artesian wells. Conversely, well L-652, near Orange River is in an area of many deep artesian wells. A comparision of the graphs shows that well L-652 has a wider range in seasonal fluctuations of artesian head than does well L-706. Over the period of record the variation in artesian head in well L-652 was about 6.5 ft (2.0 m) whereas the variation in well L-706 was only about 2.4 ft (0.7 m) The low levels in the spring of 1971 reflect unusually heavy water use during the prolonged dry season.

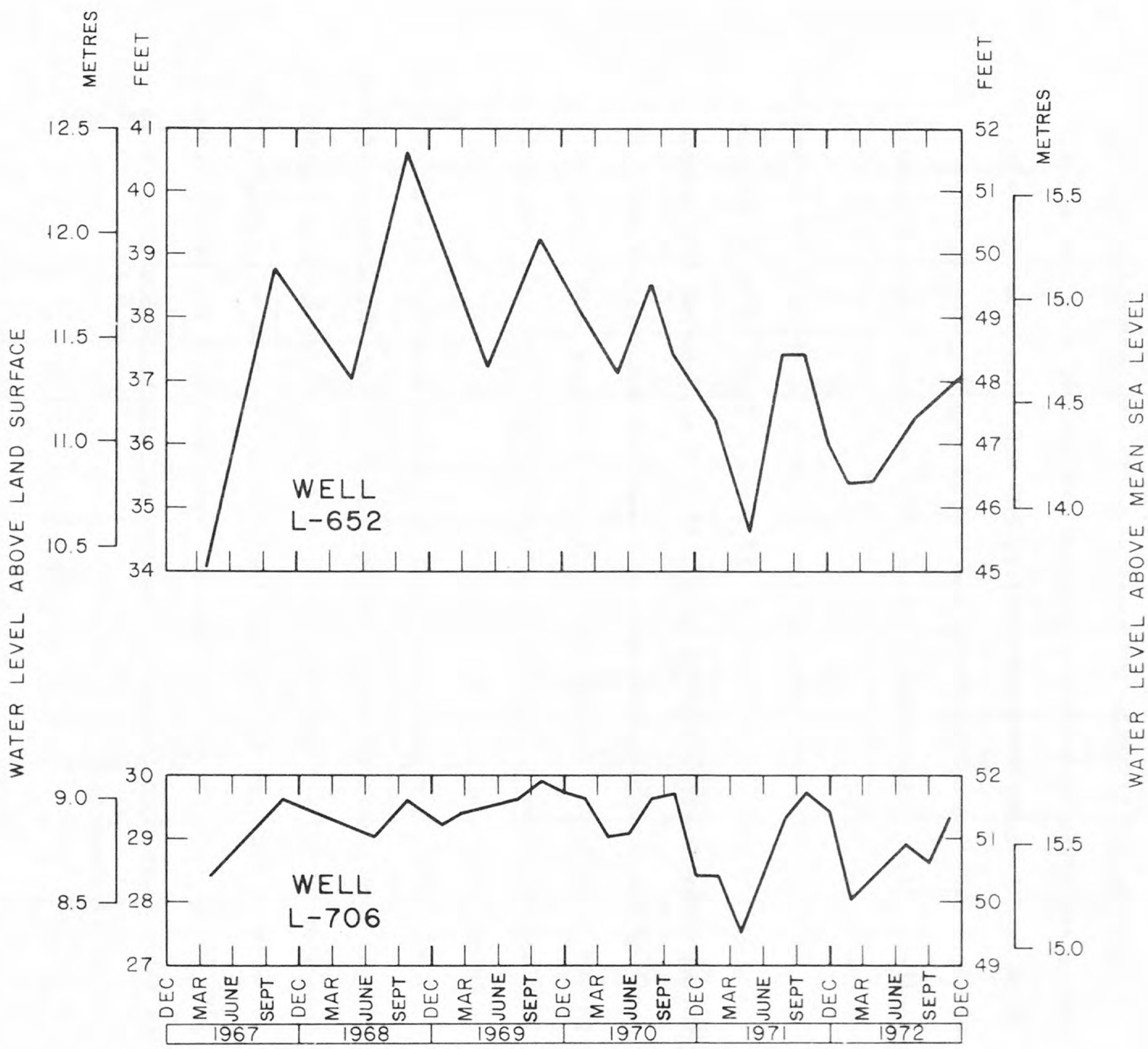

Figure 6.--Variation in artesian head in wells L-652 and L-706, 1967-72

Characteristics of Artesian Wells

Records for 217 selected artesian wells and test holes in Lee County are given in table 2. Included are 105 wells or test holes which tap the lower Hawthron aquifer, 100 which tap both the lower Hawthorn and Suwannee aquifers, and 6 which tap only the Suwannee aquifer. Also included are six test holes which penetrate limestone of the Ocala Group.

Selected data from most of the 217 wells in table 2 are summarized in table 3. As shown in table 3, the average depth of wells drilled to the lower Hawthorn aquifer is 572 ft (174 m), whereas the average depth of those tapping both the lower Hawthorn and Suwannee aquifers is 858 ft (262 m). The average length of casing is about the same (170 and 179 ft or 52 and 55 m) whether the well taps only one aquifer or is open to both.

In contrast, greater lengths of casing are used in wells which seal off the lower Hawthorn aquifer and tap only only the Suwannee aquifer as indicated by the average length of 675 ft (206 m) for 6 wells in table 3.

The casing used in construction of deep artesian wells ranged from 3 to 10 in (8 to 25 cm) in diameter. More than half the wells listed in table 2 are 6 in (15 cm) in diameter and about one-fourth are 4 in (10 cm) in diameter.

Table 3.--Summary of selected data from table 2.

(Numbers in parenthesis refer to number of wells in average)

Aquifer	Depth (feet)		Casing length 1/ (feet)		Flow rate (gal/min)		Temperature °C		Chloride concentration 2/ (mg/l)	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
Lower Hawthorn	400-758	572(105)	80-360	170 (46)	40-610	221 (50)	23-32	27.6 (70)	93-1810	875 (82)
Lower Hawthorn-Suwannee	700-1240	858 (99)	84-500	179 (56)	20-750	240 (47)	24.5-31	28.6 (72)	495-2380	884 (83)
Suwannee	740-1161	955 (6)	589-740	675 (6)	125-500	285 (5)	29-35	30.8 (6)	740-1440	847 (6)
All	400-1240	718(210)	80-740	202(108)	20-750	233(102)	23-35	28.2(148)	93-2380	878(171)

Note: 1/ Wells on Sanibel-Captiva Islands excluded because of greater lengths of casing required-average length 453 ft. (17)

2/ Some wells excluded where evidence of unusual conditions was noted. (See L-1442)

The rate of flow generally increases with depth as indicated by the averages in table 3. The higher average rate of flow of 285 gal/min (18 l/s) for the Suwannee aquifer may not be representative because of the small number of wells included in the average. The rate of flow from all wells on which records were available was 233 gal/min (15 l/s) on the average, with a range of 20 to 750 gal/min (1 to 47 l/s).

Factors Affecting Well Yields

The yield by artesian flow of wells in the lower Hawthorn and Suwannee aquifers is controlled by numerous variables including aquifer characteristics, well construction, artesian pressure, and other related factors. With other factors constant, the yield is dependent on the transmissivity of the aquifers penetrated. Where transmissivity is low the yield is small, such as in well L-367 in the McGregor Isles area. This well, now plugged, was 1,106 ft (337 m) deep and cased to a depth of 120 ft (37 m) with 6-in (15-cm) casing. The well penetrated and was open to the upper and lower Hawthorn and the Suwannee aquifers, but yielded only 30 gal/min (2 l/s). Geophysical logs showed that little or no water entered the well from the lower Hawthorn aquifer, nor was there any detectable loss of water into the upper Hawthorn aquifer. Other wells in the area flowed at rates ranging from 200 to 400 gal/min (13 to 26 l/s). Conversely, well L-1473, northwest of Cape Coral, is 968 ft (295 m) deep and contains only 84 ft (26 m) of 4-in (10-cm) casing. This well penetrates the same aquifers as did well L-367, but it flows at a rate of 750 gal/min (47 l/s). These wells obviously represent extreme conditions, but nevertheless the data suggest a wide difference in aquifer characteristics.

The length of well casing affects well yield by free flow in several ways. Where the length of casing is inadequate to prevent movement of water between different water-bearing strata, water from the aquifer with higher artesian pressure will move through the well bore into the aquifer with lower pressure. For example, flow-metre and caliper logs on well L-817, southwest of Fort Myers, indicate an internal flow rate of 100 gal/min (6 l/s) when the well was not permitted to discharge at the surface. This well is 516 ft (157 m) deep and cased to 132 ft (40 m). Two aquifers are inter-connected within the open bore hole and the water moves from the lower Hawthorn aquifer, under higher pressure, into the upper Hawthorn aquifer. This leakage continues, although at a lower rate when the well is permitted to discharge at the surface. Thus, less water is discharged at the surface than would be discharged if the leakage is prevented. The leakage rate in well L-968 near well L-817 and con-structed to a depth of 797 ft (243 m) with 125 ft (38 m) of 4-in (10-cm) casing, apparently is of greater magnitude because none of the water from the lower Hawthorn and Suwannee aquifers reaches the land surface. Sproul and others (1972, p. 10) reported internal leakage rates ranging from about 30 to nearly 100 gal/min (2 to nearly 6 l/s) in wells in the McGregor Isles area.

A second factor contributing to the reduction in well yields resulting from inadequate lengths of casing is related to the caving and blockage in the uncased section of the bore hole. In some parts of the county, clay or marl deposits occur which are referred to by local drillers as "joint clay." If the well casing is not extended through these deposits, large fragments of clay break from the sidewall and block the bore hole, causing a reduction in flow. In other areas sand from formations within the open-bore section, accumulate in the lower part of the well, causing a decrease in depth and possibly a reduction in flow.

The casing diameter affects well yields as a result of pipe friction losses. For new well casing, the friction losses are inversely proportional to the pipe diameter. Incrustation which occurs in most deep wells in Lee County usually causes a reduction in effective pipe diameter and an increase in friction losses.

However, a plot of casing diameter versus flow rate (not included) indicates that the casing diameter, in both new and old wells where some incrustation has occurred, is not a major factor in limiting the flow except for wells less than 4 in (10 cm) in diameter.

Other factors constant, the rate of flow from a given well is proportional to the artesian head at the well site. That is, the higher the artesian pressure, the higher the flow. Conversely, when a general lowering of artesian pressure occurs the flow rates from individual wells in the same aquifer are reduced.

High artesian head in itself does not necessarily imply high flow rates, nor does low head imply low flow rates. For example, the artesian head in 15 of the wells listed in table 2 ranged between 15-16 ft (about 5 m) above land surface, yet the flow rate ranged widely, from 50 to 485 gal/min (from 3 to 31 l/s). Thus, although the artesian head affects the flow rate, it probably is not a major controlling factor. The major factor, of course, is the aquifer transmissivity.

Water Quality

The saline water from the lower Hawthorn and Suwannee aquifers typically is hard and sulfurous. Generally, the water is corrosive in terms of its effect on metal well casing although incrustation of parts of the casing may also occur. An odor of hydrogen sulfide commonly is present in the vicinity of flowing artesian wells tapping the saline-water aquifers.

The chemical characteristics of water from the lower Hawthorn and Suwannee aquifers are indicated by the analyses from 38 wells given in table 4. The analyses are grouped according to the principal aquifer(s) furnishing water to the well and include analyses from 19 wells tapping the lower Hawthorn aquifer, 16 tapping both the lower Hawthorn and Suwannee aquifers, and 3 wells that tap only the Suwannee aquifer. Many of the wells listed in table 4 also are open to the upper Hawthorn aquifer, a fresh-water aquifer. However, because the upper Hawthorn aquifer contributes little water to those wells penetrating the deeper aquifers, the chemical analyses given in table 4 probably are representative of the chemical quality of the water in the deeper aquifers.

Chemical analyses of water from wells L-346, (Bonita Springs) L-351 (Punta Rassa), L-425 (Buckingham), and L-458 (Estero) were made on samples collected both in 1946 and 1973 and are included in table 4 for comparison. The analyses from wells L-346 and L-351 indicate that the water quality in the lower Hawthorn aquifer at these wells changed little between 1946 and 1973. The analyses for wells L-425 and L-458, tapping both the lower Hawthorn and Suwannee aquifers, show some increase in chloride and dissolved-solids concentration, with associated increases in hardness and specific conductance.

Major changes in water quality have occurred in the lower Hawthorn aquifer in some areas. The dissolved-solids concentration in water from the lower Hawthorn aquifer is about 1,800 mg/l on the average, but in the McGregor Isles area water from well L-817 had a dissolved-solids concentration of 10,000 mg/l (table 4). The high value is a result of the effects of the upward intrusion of highly saline water, whose dissolved-solids concentration probably is as great as that of sea water, or about 35,000 mg/l. The analyses for wells L-541 and L-571, in which the dissolved-solids concentration ranged from 4,100 to 5,200 mg/l, suggest that similar upward leakage from deep artesian sources probably has occurred in an area about 4 m (6 km) south of well L-817.

Although, the water from well L-346 at Bonita Springs seems to have changed little in quality between 1946 and 1973, the dissolved-solids concentration of 4,100 mg/l (1973 analysis) is substantially higher than that in water in the lower Hawthorn aquifer in other parts of the county. The chloride in water from L-346 was 1,810 mg/l in 1946 and 1,800 mg/l in 1973. Water from well L-807, about 1.5 m (2 km) southeast of L-346, contained 1,800 mg/l of chloride in 1968 (table 2). A third well (L-1642), between L-346 and L-807, yielded water with a chloride concentration of 2,880 mg/l in 1972 (table 2). High chloride concentrations and the high dissolved-solids concentrations in these wells indicate that the lower Hawthorn aquifer near Bonita Springs contains water more saline than elsewhere in the county, except those areas where intrusion from deep artesian sources has occurred.

A summary of selected constituents from the chemical analyses shown on table 4 is given in table 5 for the lower Hawthorn and Suwannee aquifers. The analyses for wells L-346, L-541, L-571, and L-817 were excluded from the summary because the high concentrations of most chemical constituents would greatly affect the averages. The analyses for L-912, L-1157, and L-1634 were also excluded because these wells tap only the Suwannee aquifer, and the inclusion of these analyses would not provide a valid indication of water quality in the two aquifers throughout the county.

Table 5.--Summary 1/ of chemical analyses included in table 4.

(Chemical constituents in milligrams per litre)

	Recommended limit for drinking water-U. S. Public Health Service	Lower Hawthorn aquifer		Lower Hawthorn-Suwannee aquifers		Summary based on 31 chemical analyses in table 4	
		Range in Concentration	Average Concentration	Range in Concentration	Average Concentration	Range in Concentration	Average Concentration
Silica (SiO_2)		0.8-30	18	4.7-19	14	0.8-30	16
Strontium (Sr)		2.3-30	12.9	0-33	18.8	0-33	16.0
Calcium (Ca)		20-140	80	80-160	108	20-160	94
Magnesium (Mg)		14-140	80	71-140	100	14-140	90
Sodium (Na)		180-800	453	280-800	496	180-800	476
Potassium (K)		14-40	22	16-35	22	14-40	22
Sulfate (SO_4)	250	92-800	243	220-530	332	92-800	289
Chloride (Cl)	250	160-1600	808	520-1500	926	160-1600	869
Fluoride (F)	0.8 2/	1.2-3.8	1.9	1.1-2.1	1.5	1.1-4.6	1.7
Dissolved solids	500	700-3200	1783	1400-3300	2079	700-3300	1936
Hardness (Ca,Mg)		110-900	546	520-1000	699	110-1000	625
Noncarbonate		0-750	408	360-870	561	0-870	486
Spec.conductance		1160-5700	3228	2390-5900	3676	1160-5900	3524
pH		7.5-9.0		7.6-8.2		7.5-9.0	
Temperature °C		24.0-29.5	27.3	28.0-31.0	29.4	24.0-31.0	28.5

1/ Analyses for wells L-346, 541, 571, 817, 912, 1157, and 1634 not included in summary.

2/ Recommended upper limit based on annual average of maximum daily air temperatures at Fort Myers.

The following descriptions of specific chemical constituents or other parameters are based on the chloride analyses included with the record of wells in table 2 and the chemical analyses and summary in tables 4 and 5.

Dissolved Solids

The term "dissolved solids" refers to the total dissolved mineral matter in water and may be reported as "calculated from the sum of the determined constituents in the water," or as the "residue on evaporation." Most of the results given in table 4 were calculated. As shown in table 5, the concentration of dissolved solids ranged from 700 to 3,300 mg/l in water from the saline-water aquifers. The average for 31 analyses was 1,936 mg/l. As previously defined, water containing more than 1,000 mg/l of dissolved solids is termed saline.

The dissolved-solids concentrations were 840, 700 and 907 mg/l in water from wells L-351, L-587, and L-706, respectively, indicating that water much below average in mineral content may be encountered in the lower Hawthorn aquifer in some areas. Based on the range in concentration and averages in table 5, the lower Hawthorn aquifer generally contains water with lower dissolved-solids concentrations than a mixture of water from both the lower Hawthorn and Suwannee aquifers. This difference suggests that water from the Suwannee aquifer is more highly mineralized and may be similar in quality to the water from Suwannee aquifer wells L-912 and L-1634 (analyses in table 4) in which the dissolved-solids concentrations were 2,700 and 3,000 mg/l.

Specific Conductance

The specific conductance of water is a measure of its ability to conduct an electrical current. The specific conductance is related to mineral content of water and increases with increase in dissolved-solids content. Because specific conductance is easily measured with an electrical instrument, this relationship provides a useful means of indicating the approximate dissolved-solids concentration of water where the specific conductance has been determined. However, because the relationship is affected by numerous factors, the relationship for water of a given type should be established by determining both the dissolved solids and the specific conductance. Water samples from the lower Hawthorn and Suwannee aquifers in Lee County for which both the specific conductance and dissolved solids had been determined were used in the preparation of figure 7. The graph should prove useful in indicating the approximate dissolved-solids concentration of water where only the specific conductance has been determined.

As indicated on figure 7 the specific conductance of water from most wells ranged between about 2,000 and 6,000 micromhos. The average specific conductance for water from 31 wells in table 5 was 3,524 micromhos. Thus, the dissolved-solids concentration on the average was about 56 percent of the specific conductance, based on the data in table 5, or about the same percentage as that determined from figure 7.

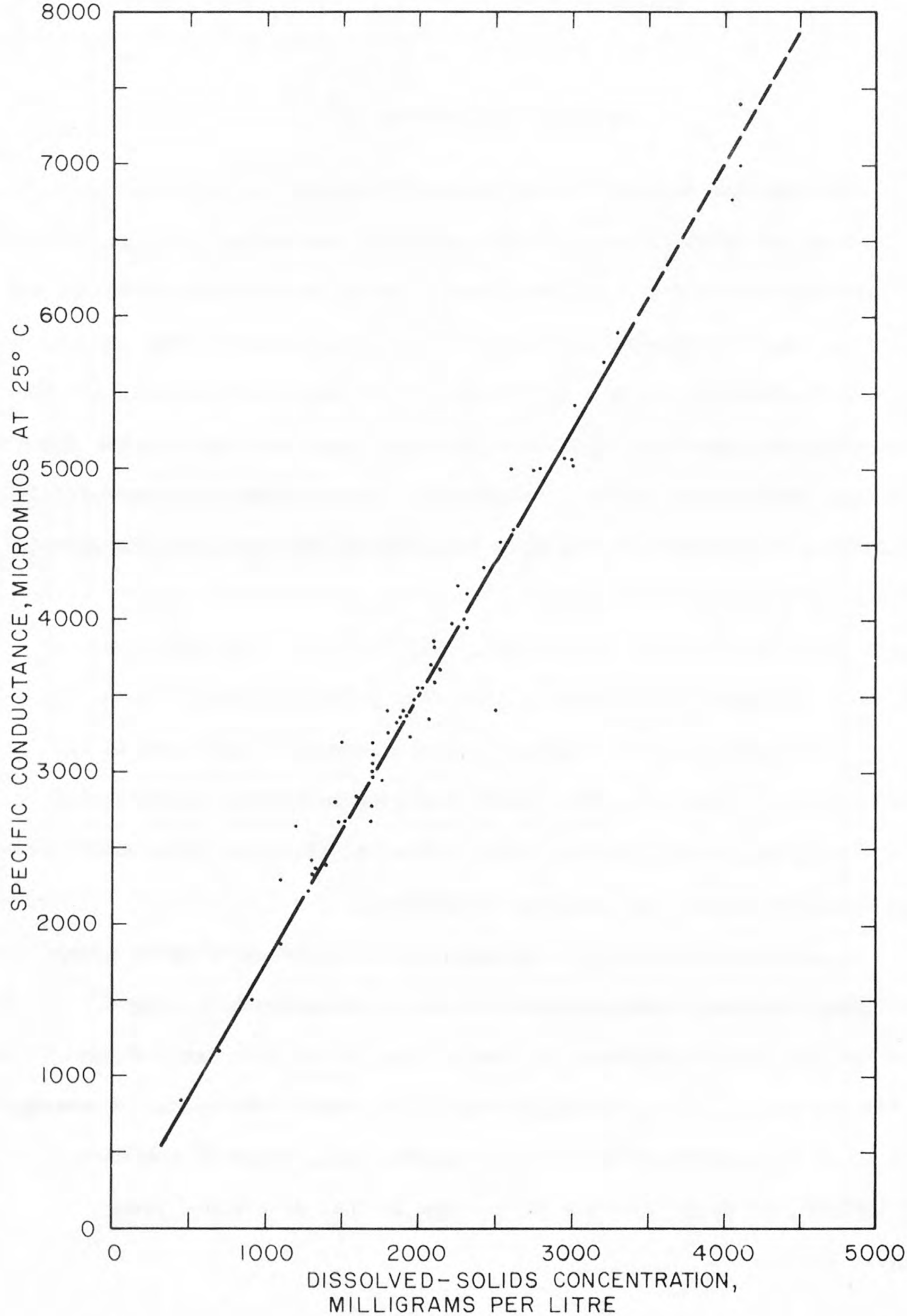

Figure 7.--Relation between specific conductance and dissolved-solids concentration in water from the lower Hawthorn and Suwannee aquifers.

Sodium and Chloride

Sodium is the predominant cation and chloride the predominant anion in water from the lower Hawthorn and Suwannee aquifers. Sodium ranged from 180 to 800 mg/l, and was 476 mg/l on the average (table 5). The range and average in the sodium concentrations was about the same in both aquifers. Chloride ranged from 160 to 1,600 mg/l with 869 mg/l on the average for 31 analyses in table 4. This average compares with the average of 878 mg/l for 171 wells in table 2.

The relation between increase in sodium and chloride concentrations and increase in dissolved solids is shown in figure 8. The figure shows that the chloride concentration increases at a much greater rate than does sodium with the same increase in dissolved solids.

According to McKee and Wolf (1963, p. 258), sodium in drinking water may be harmful to persons suffering from cardiac, renal, and circulatory disease and as much as 200 mg/l may be injurious. The average concentration of sodium in water from the saline-water aquifers in Lee County is 476 mg/l. High concentrations of sodium in irrigation water may be injurious to plants and adversely affect soil conditions.

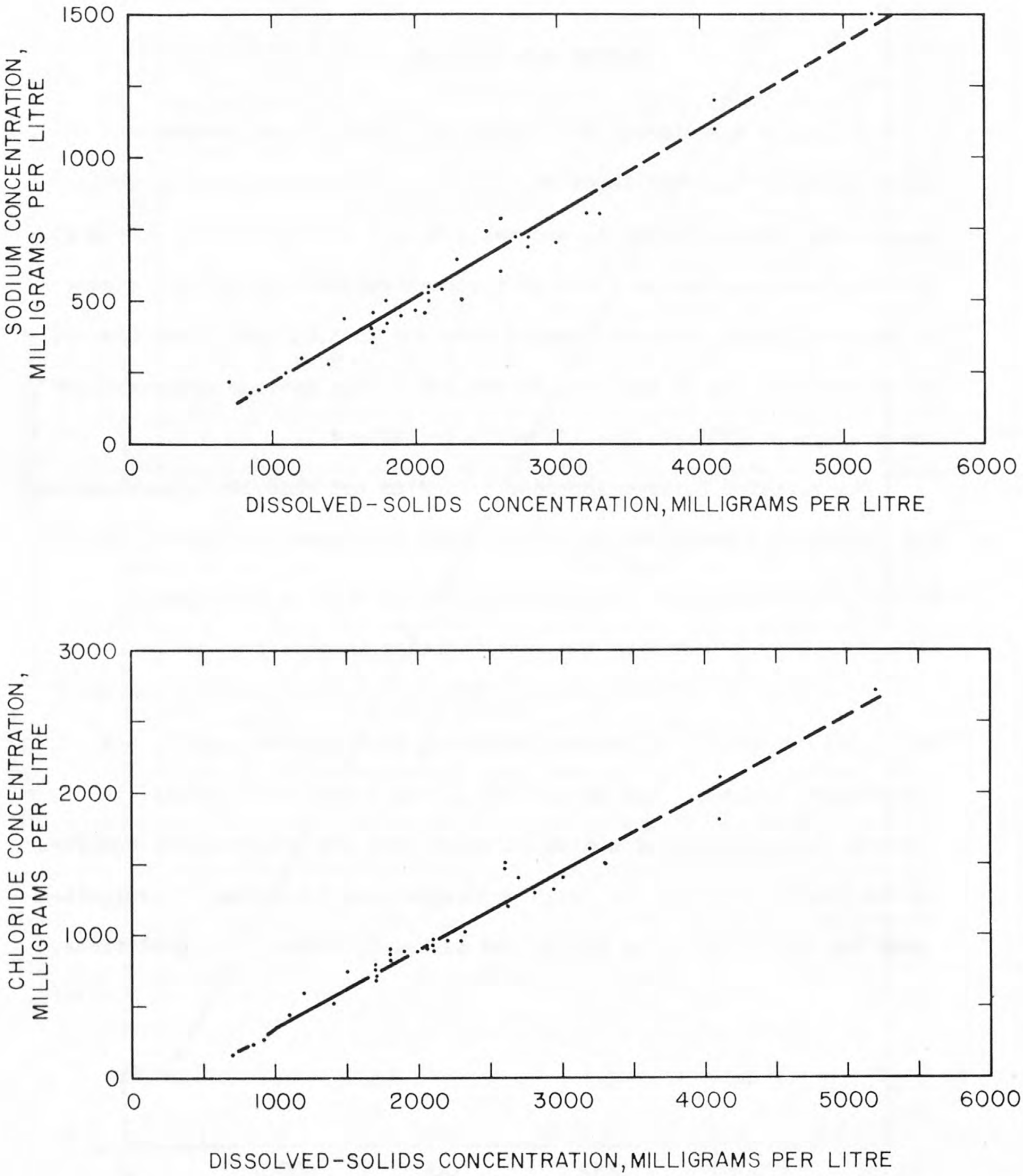

Figure 8.--Relation between sodium and dissolved solids and chloride and dissolved solids in water from the lower Hawthorn and Suwannee aquifers.

Excessive concentrations of chloride in water impart a salty taste, although the taste threshold varies with different individuals. The recommended limit for drinking water is 250 mg/l. McKee and Wolf (1963, p. 159-160) indicate that chloride may be injurious to some people suffering from heart and kidney disease. As indicated by the high average concentration of 869 mg/l of chloride in table 5 and the analyses in table 4, water from the saline-water aquifers in Lee County commonly exceed the recommended limit for drinking water. McKee and Wolf cite numerous examples of the effect of chloride on plant growth.

Sulfate

The sulfate concentration in water from the lower Hawthorn and Suwannee aquifers is highly variable as shown on figure 9. The sulfate concentration commonly exceeds the recommended limit of 250 mg/l for drinking water; only 10 of the wells in table 4 and on figure 9, had sulfate concentrations less than 250 mg/l, 9 of which tapped only the lower Hawthorn aquifer. Where upward intrusion from deep artesian sources has occurred such as in well L-817 in the McGregor Isles area, the high sulfate concentration of 800 mg/l is associated with high chloride concentrations (5,400 mg/l) and high dissolved-solids concentrations of 10,000 mg/l. The analyses for wells L-541 and L-571 show similar effects although of lesser magnitude.

Sulfate concentrations tend to cause a laxative action in those not accustomed to the water (McKee and Wolf, 1963, p. 276). Although the average sulfate concentration of 289 mg/l (table 5) in water from the saline-water aquifers exceeds the recommended limit for drinking water, the adverse effects probably are slight. McKee and Wolf (1963) indicate that sulfate concentrations ranging from 336 to 576 mg/l are within permissible limits for irrigation water.

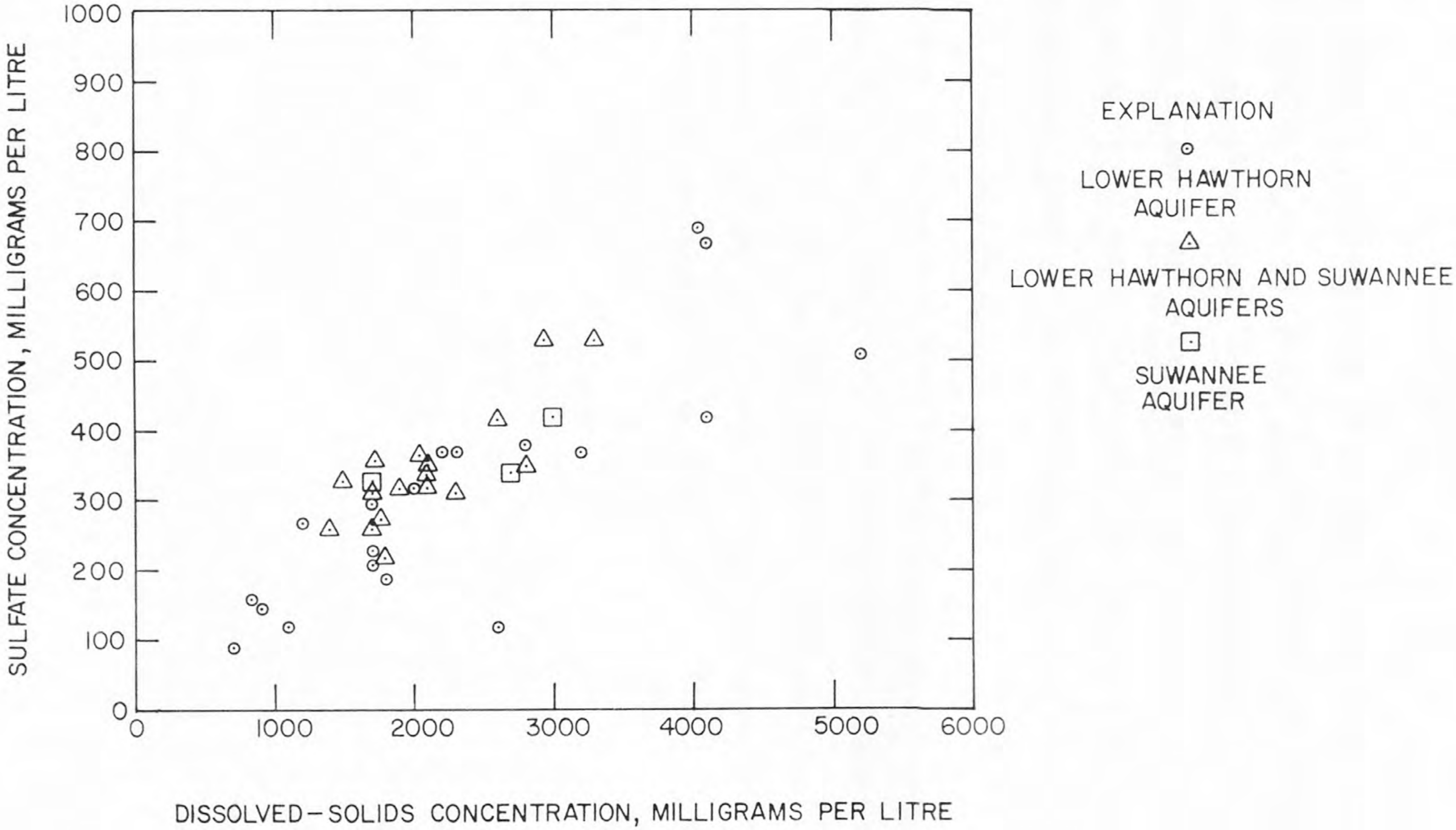

Figure 9.--Relation between sulfate and dissolved solids in water from the lower Hawthorn and Suwannee aquifers.

Fluoride

The analyses in table 4 show the presence of fluoride in concentrations ranging from 1.1 to 4.6 mg/l in all samples for which this constituent was determined. These concentrations exceed the recommended upper limit (U. S. Public Health Service, 1962, p. 8) of 0.8 mg/l of fluoride calculated for drinking water in the Fort Myers area based on the annual average of maximum daily air temperatures.

Hardness

The property of hardness usually is considered in terms of the soap consuming character of the water. The increased use of soap or detergents with increased hardness is largely related to the concentrations of calcium and magnesium ions. According to the classification given by Durfor and Becker (1962, p. 27), water with a hardness range of 61-120 mg/l is moderately hard; 121-180 mg/l is hard; and more than 180 mg/l is very hard.

From table 5, it is evident that water from the lower Hawthorn and Suwannee aquifers is very hard. Its average calcium-magnesium hardness is 625 mg/l. The analysis from well L-587, where the calcium-magnesium hardness was 110 mg/l was the only sample in which the water was not very hard (table 4).

Temperature

The temperature of water in the artesian aquifers underlying Lee County increases with depth. Water from seventy one percent of the wells (table 1) which tap the lower Hawthorn aquifer, ranges in temperature from 27 to 28°C (80-82°F) although a broader range, 23-32°C (73-90°F), is indicated where extreme values are included (table 3). Water from seventy three percent of the wells in table 2 which tap both the lower Hawthorn and Suwannee aquifers ranges in temperature from 27 to 29°C (80-84°F). Of the few wells that tap only the Suwannee aquifer, most yield water ranging in temperature from 29 to 31°C (84-87°F). The increase in temperature of water with depth is also indicated by comparison of the average temperature and average depth columns given in table 3.

The water temperatures given in tables 2 and 3 were determined at the point of discharge and may not necessarily indicate the exact temperature in the aquifer. Observations show that the temperature of water from a deep artesian well generally increases during the initial period of discharge after a period when the well was not permitted to flow. This increase suggests that the column of water within the well adjusts to the temperature of the adjacent formations under non-discharging conditions. When discharge begins, the water in the upper part of the well, which is of lower temperature, emerges first. As the discharge continues, most of the water of lower temperature is displaced and an increase in temperature occurs.

Several minutes to several hours may be required for the temperature to stabilize, depending on well depth, discharge rate, and source of water. The stabilized temperature depends on the proportion of water contributed from each aquifer.

PAST, PRESENT AND FUTURE USE

The saline-water aquifers beneath Lee County have for many decades been a valuable source of water supply for agricultural irrigation. They represent a major alternate source of supply for many other purposes to satisfy the rapidly increasing demands. With increased use and the continued reduction of most existing supplies from fresh shallow aquifers, the saline-water aquifers may assume a role of increasing importance. This trend is evident from recent developments where the saline-water aquifers have been tapped as a source of supply for desalination, for maintaining shallow pond levels, for irrigation of lawns and golf courses, and for health spas.

Possibly thousands of wells have been drilled in the county wherein two or more aquifers were interconnected within the open-borehole because inadequate lengths of casing were used. Frequently this interconnection permitted upward leakage between the saline-water aquifers and the fresh-water aquifers which occur at shallow depth. The combination of upward leakage, heavy withdrawals, and uncontrolled discharge has caused a reduction in artesian pressure within the saline-water aquifers in some areas. In the McGregor Isles area, the lowering of artesian pressure probably is the major factor in permitting the upward intrusion of highly saline water into the lower Hawthorn aquifer from an artesian aquifer at much greater depth.

Large volumes of water from the saline-water aquifers are currently lost for beneficial use. Many wells drilled to the saline-water aquifers and formerly used for agricultural purposes, no longer are used and only a relatively small percentage of these wells has been properly plugged with cement, or are equipped with adequate control devices, or are properly maintained. An unknown number have been destroyed, buried beneath fill areas, roadways, parking lots, bridges, and possibly buildings. Other wells flow wild at the land surface with no visible evidence of well casing or control devices. Most of the wells permit leakage within the open-borehole or through corroded well casing. Leakage from the saline-water aquifers upward into the shallow aquifers, although representing a source of recharge, nevertheless has adversely affected the quality of the water in the shallow aquifers in many parts of the county and has limited the purposes for which the water may be used.

Minimizing the upward leakage and discharge at the surface from wild wells would effectively increase artesian pressure in the saline-water aquifers because it reduces the large volumes of water now wasted. Losses would be further reduced if wells now in use for beneficial purposes were permitted to flow only when the water is needed. Deterioration of the quality of water in shallow aquifers could be effectively reduced if unused deep wells showing high internal leakage rates were properly plugged with cement and if adequate casing lengths were installed in new wells to effectively prevent any interchange of water between different aquifers.

More effective management and better utilization of the saline-water resources of Lee County will require more detailed information than is presently available. As shown on figure 10, little or no geologic, hydrologic, or water quality information is available on the saline-water aquifers in many parts of the county. Nearly everywhere, the aquifer characteristics, transmissivity and storage coefficient are relatively unknown for the lower Hawthorn and Suwannee aquifers. Additional observation wells could be used to monitor changes in artesian pressure and water quality. Additional studies will be of benefit not only for present management needs, but will provide a more realistic basis for meeting future requirements.

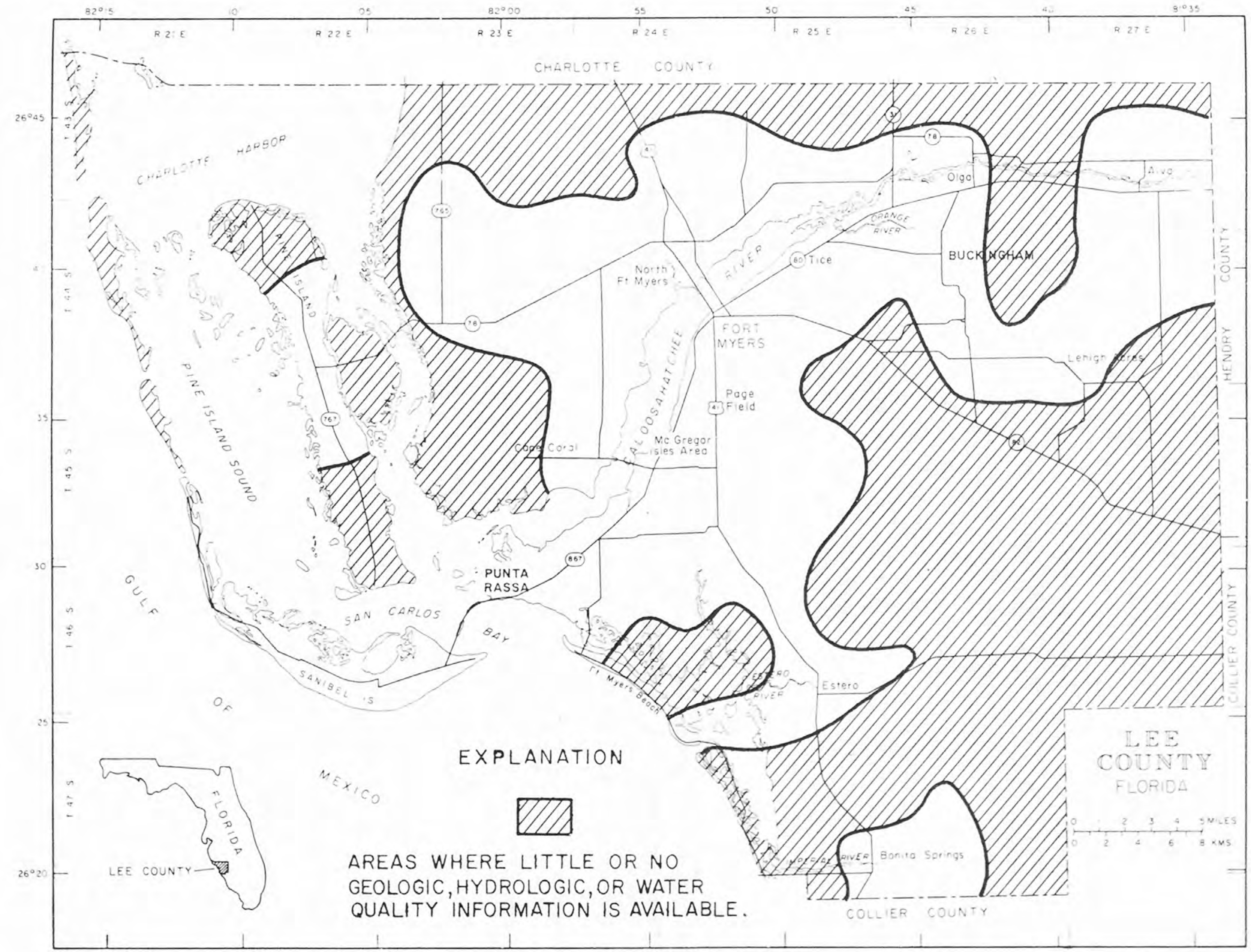

Figure 10.--Lee County showing areas where little or no information is available on the saline-water aquifers.

SUMMARY

Lee County is underlain at depths ranging from about 400 to 1,200 ft (120 to 370 m) by formations which contain saline-ground water. Two water-bearing zones within these formations have been identified, termed the lower Hawthorn and Suwannee aquifers. Both aquifers are of widespread occurrence and underlie all of Lee County.

Historically, water from the lower Hawthorn and Suwannee aquifers has been used in Lee County for many purposes including the municipal water supply for Fort Myers. A large number of wells have been drilled for irrigation of citrus groves, flower farms, truck crops, and for livestock watering. The rapid urbanization of many parts of the county has altered the land-use patterns and the sources from which water is obtained. Currently (1974) most of the water for domestic use is obtained from shallow fresh-water aquifers or from the Caloosahatchee River. Although water from the saline-water aquifers is now used primarily for irrigation, the use is decreasing: many wells formerly used for this purpose are now inactive. One de-salting plant utilizing water from the saline-water aquifers is in use and a second plant is under construction (1974).

The artesian pressure in the lower Hawthorn and Suwannee aquifers is sufficient to cause wells to-flow at the land surface throughout the county. Some reduction in artesian pressure has occurred in the aquifers, particularly in areas adjacent to the Caloosahatchee River where large concentrations of wells have been drilled. The general direction of water movement through the aquifers, as indicated by the slope of the potentiometric surface, is toward the southwest. Recharge to the aquifers occurs in areas north of Lee County, in the central highlands part of the State.

Most deep artesian wells in Lee County tap either the lower Hawthorn aquifer (average well depth 572 ft or 174 m), or both the lower Hawthorn and Suwannee aquifers (average well depth 858 ft or 262 m. The average length of well casing ranges from 170 to 179 ft (52 to 55 m). The casing diameter is 4 to 6 in (10 to 15 cm) in most wells.

The rate of flow from artesian wells was 233 gal/min (15 l/s) on the average, and flow rates ranged from 20 to 750 gal/min (1 to 47 l/s). The flow rates probably are largely controlled by the formation characteristics, although affected by artesian pressure, well construction methods, and other related factors.

Water from the lower Hawthorn and Suwannee aquifers typically is hard and sulfurous with relatively high concentrations of dissolved solids which averaged 1,936 mg/l in 31 analyses. The concentration of the principal cation, sodium, was 476 mg/l on the average, whereas that of the principal anion, chloride, was 869 mg/l on the average. The water from these aquifers usually is high in sulfate, with concentrations of 289 mg/l on the average. The concentrations of dissolved solids, chloride, sulfate, and fluoride frequently exceed the recommended limits for drinking water established by the U. S. Public Health Service.

Although of relatively poor quality, the saline-water aquifers represent a valuable resource which may be used to supplement dwindling supplies from the shallow fresh-water aquifers. Large volumes of water from the saline-water aquifers are wasted; these losses could be reduced and the contaminating effects of upward leakage into the shallow aquifers could be minimized by properly plugging wells that are no longer used or useable and by installing enough casing in new wells to prevent any interchange of water between different aquifers.

Additional studies of aquifer characteristics and the occurrence, quantity, and quality of water from these aquifers in some areas will be required to accomplish more effective management of the saline-water resources.

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APPENDIX

Table 2.--Records of deep artesian wells in Lee County

Abbreviations used in tables: Aquifers -LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-)lsd (feet)	Date of measurement	Flow rate (gal/min)	Temperature (°C)	Chloride (milligrams per litre)	Date of measurement	Aquifer(s)	Remarks
L-12	263917N0815032.1	620	200	6	15	+31.6	2-22-34		32	1350	2-22-34	LH	
L-13	263917N0815039.1	899	200	6	13	+27	6-17-34		29	1150	6-17-34	LH, Su	
L-47	263802N0815026.1	510	154	4	18	+18	11-12-44		28	1250	3-20-46	LH	
L-89	263824N0815131.1	932		6	10	+15.8	3-20-46		29	970	1-24-46	LH, Su	
L-92	263824N0815154.1	1043		8	11	+16	8-22-68		28	960	8-22-68	LH, Su	
L-105	263703N0815209.1	700		4	16				27	660	1-19-44	LH, Su	
L-107	263718N0815206.1	620		6	16	+17.5	10-26-44	360		840	8-23-68	LH	
L-128	263845N0815203.1	493	255	4	5							LH	
L-130	263830N0815157.1	1050		6	12				25	900	1-20-44	LH, Su	
L-141	263859N0815131.1	500		8	6	+30	7-19-69	200	26	1140	7-19-69	LH	
L-148	263829N0815223.1	495		8	9	+33.5	12-23-43		28	895	1-19-44	LH	
L-210	263922N0815001.1	800		4	10	+27	8-12-68			840	8-12-68	LH, Su	
L-266	264257N0815408.1	800		6	18				29	865	11-24-69	LH, Su	
L-270	264053N0815231.1	500		6	12	+29.3	9-26-44					LH	
L-277	264418N0815106.1	1000		8	20			140	30	1020	7-23-68	LH, Su	
L-278	264417N0815108.1	900		6	19	+28.5	4- 9-46		29	870	4- 9-46	LH, Su	
L-295	264359N0813635.1	600		6	16	+33	4-22-69		28	235	4-22-69	LH	
L-298	264056N0815318.1	500		4	12	+22	9-26-44			600	1-17-51	LH	
L-321	263807N0820732.1	400		5	9	+16.2	3-22-46	300	27	920	3-22-46	LH	Chemical analyses in table 4
L-331	263124N0815219.1	900		6	6	+31	9-13-50		28	570	1-16-51	LH, Su	

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-)lsd (feet)	Date of measurement	Flow rate (gpm)	Temperature (°C)	Chloride (milligrams per liter)	Date of measurement	Aquifer(s)	Remarks
L-332	263124N0815218.1	900		6	6							LH, Su	Chemical analysis in table 4
L-339	262606N0814841.1	700		6	10					950	2-25-70	LH	
L-346	262034N0814647.1	450		4	9	+21.7	9-19-44			1810	4-11-46	LH	Chemical analysis in table 4
L-351	262910N0820036.1	685	235	6	3	+13.0	10-31-66		25	202	9-19-46	LH	Chemical analysis in table 4
L-357	263058N0815609.1	760		5	6	+24.9	9-19-44		27	665	1-16-51	LH, Su	
L-359	264302N0814242.1	650+	150	4.5	7	+37.5	8- 8-69		26	900	8- 8-69	LH, Su	Chemical analysis in table 4
L-364	264108N0814747.1	750		4	13	+31.5	9-20-44					LH, Su	
L-366	263416N0815418.1	600		5	5	+27.0	9-25-44			910	9-12-50	LH	
L-367	263406N0815416.1	1106	120	6	7	+29.3	9-25-44	30	28	730	8-26-66	LH, Su	Well plugged
L-368	263325N0815430.1	620	120	6	8	+23.9	9-25-44		28	1320	4- 7-46	LH	
L-369	263324N0815438.1	540		6	8	+25	9-25-44		23	930	4- 7-46	LH	
L-372	263135N0815645.1	900		6	6	+22.5	9-25-44	150	28	1020	1-18-69	LH, Su	
L-374	263048N0815807.1	647		6	5	+28.3	9-25-44			742	2-20-51	LH	
L-376	264008N0815253.1	600		4	6	+34.2	9-27-44			700	7-29-46	LH	
L-398	263802N0815246.1	1100		6	12	+21	8-30-68		27	1240	8-30-68	LH, Su	
L-406	263120N0821134.1	550		6	6				26	880	1-22-46	LH	
L-425	263849N0814301.1	780		6	21	+26.9	3-23-46		29	750	7-10-68	LH, Su	Chemical analysis in table 4
L-426	263751N0814735.1	525		6	21	+26.1	3-20-46	610	28	890	1-24-46	LH	Chemical analysis in table 4
L-438	262655N0815643.1	750		6	5	+ 8	4- 5-46		26	785	4- 5-46	LH, Su	
L-442	262422N0815347.1	700		4	6	+11.7	4- 6-46		27	1110	4- 6-46	LH	

Table 2.--(Continued) Records of deep artesian wells in Lee County.

Abbreviations used in tables: Aquifers -LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gal/min)	Temperature (°C)	Chloride (milligrams per litre)	Date of measurement	Aquifer(s)	Remarks
L-446	263347N0815428.1	764	170	6	8	+20.8	4- 7-46	550	28	1170	4- 7-46	LH, Su	
L-447	263527N0815333.1	970	190	6	11	+19.1	4- 7-46	207	29	605	4- 7-46	LH, Su	
L-448	263659N0815317.1	847	390	5	8	+25.6	4- 8-46		29	825	4- 8-46	LH, Su	
L-450	263350N0815440.1	583	142	4	7	+21.3	4- 8-46	154	28	1520	4- 8-46	LH	
L-451	263111N0815652.1	440	142	5	9	+13.8	4- 8-46	235	28	525	4- 8-46	LH	
L-452	263111N0815701.1	700	168	5	9	+13.4	4- 8-46	277	26	545	4- 8-46	LH	
L-453	263111N0815709.1	758	198	5	9	+14.2	4- 8-46	370	27	575	4- 8-46	LH	
L-454	263138N0815458.1	786	160	6	5	+ 9.2	4- 8-46	123	28	495	4- 8-46	LH, Su	
L-455	263037N0815637.1	849	172	6	8	+17.5	4- 8-46	350	28	595	4- 8-46	LH, Su	
L-456	263110N0815447.1	543	146	6	6	+ 6.2	4- 8-46	140	27	93	4- 8-46	LH	
L-458	262612N0814746.1	842	197	8	10	+24.4	4- 8-46	500	31	1310	4- 8-46	LH, Su	Chemical analysis in table 4
L-462	263912N0814857.1	744	124	5	19	+22.1	4-10-46	325	29	830	10- 4-72	LH, Su	
L-463	263922N0815634.1	819	126	4	12	26.6	4-10-46	205	29	830	4-10-46	LH, Su	Well plugged
L-464	263917N0815349.1	634		4	4	+34.5	4-10-46	235	28	515	4-10-46	LH	
L-465	263914N0815403.1	660		4	6	+34	4-10-46	220	28			LH	
L-466	263021N0821124.1	756	432	6	5	+16.5	4-10-46	220	27	890	4-10-46	LH, Su	
L-468	263018N0821114.1	689	438	4.5	5	+15.8	4-10-46		26	690	4-10-46	LH	
L-470	263729N0815231.1	843	427	6	16	+15.1	4-11-46	125	29	675	4-11-46	LH, Su	
L-472	263750N0815243.1	504	140	4	12	+21.4	4-11-46		28	1100	4-11-46	LH	
L-512	262930N0815409.1	760	160	6	3	+27.3	9-13-50	248	29	1060	2-14-69	LH, Su	

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gpm)	Temperature (°C)	Chloride (milligrams per liter)	Date of measurement	Aquifer(s)	Remarks
L-513	263614N0815150.1	915	141	6	16							LH, Su	
L-518	263252N0815325.1	599	172	6	7	+16.5	4-16-69	500	28	690	2-20-51	LH	
L-520	263237N0815457.1	820	160	6	5	+27.5	9-12-50			895	2-19-51	LH, Su	Well plugged
L-522	262922N0815623.1	800		6	5					955	9-12-50	LH, Su	
L-528	263004N0815607.1	800		6	4	+22.2	9-13-50			695	9-13-50	LH, Su	
L-529	262925N0815606.1	520		6	5					760	9-13-50	LH	
L-530	263417N0815356.1	720	147	5	6			150	28	720	9-13-50	LH	Well plugged
L-534	263121N0815427.1	1140	170	6	6	+22.7	9-14-50			565	9-14-50	LH, Su	
L-541	263008N0815442.1	500		6	5	+27	9-15-50	262	28	1180	9-13-50	LH	Chemical analysis in table 4
L-547	263019N0815644.1	820		6	9	+22.3	9-15-50			675	9-15-50	LH, Su	
L-548	263105N0815352.1	900	160	6	6	+23.3	9-14-50			665	9-14-50	LH, Su	
L-549	263006N0815411.1	900		6	5	+17.5	10-23-50	105	29	920	2-13-69	LH, Su	
L-552	262917N0815353.1	780		6	3	+28.5	10-23-50	110	29	975	2-19-51	LH, Su	
L-553	262849N0815357.1	500		6	3	+13.8	10-23-50			510	2-21-51	LH	
L-554	263130N0815239.1	750		6	4	+26.8	10-24-50			795	2-21-51	LH, Su	
L-555	263110N0815248.1	700		4	4	+19.5	10-24-50			167	2-21-51	LH	
L-556	263053N0815405.1	800	170	6	6	+18.5	10-24-50		29	800	1-15-69	LH, Su	
L-569	262940N0815334.1	815	120	8	3	+19.5	2-14-69		29	960	2-14-69	LH, Su	
L-571	263012N0815440.1	600	140	6	5				28	1410	9-21-55	LH	Chemical analysis in table 4
L-585	262710N0820053.1	475	335	6	5	+25.1	1-14-64	50	27	1530	1-14-64	LH	Chemical analysis in table

Table 2.--(Continued) Records of deep artesian wells in Lee County.

Abbreviations used in tables: Aquifers - LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gal/min)	Temperature (°C)	Chloride (milligrams per litre)	Date of measurement	Aquifer(s)	Remarks
L-587	263250N0821149.1	456	437	4	3	+ 5.2	1-14-64		27	160	1- 9-73	LH	Chemical analysis in table 4
L-588	262538N0820456.1	557	403	4	3	+13.1	1-15-64	40	27	1000	6-20-70	LH	Chemical analysis in table 4
L-591	262821N0820813.1	654	405	6	5	+24.2	1-16-64		27	950	12- 8-70	LH	
L-592	263247N0821152.1	724	367	4	4			40	28	1300	1- 9-73	LH, Su	Chemical analysis in table 4
L-600	261952N0814419.1	525			12							LH	Test hole plugged
L-602	262514N0814155.1	475			18							LH	Test hole plugged
L-605	262217N0814421.1	585			16							LH	Test hole plugged
L-618	263148N0813616.1	600			30							LH	Test hole plugged
L-619	263112N0813746.1	540			30							LH	Test hole plugged
L-624	263835N0813944.1	495			18							LH	Test hole plugged
L-625	263928N0813652.1	540			21							LH	Test hole plugged
L-629	264329N0813401.1	515			19							LH	Test hole plugged
L-630	264424N0813627.1	540			19							LH	Test hole plugged
L-634	262709N0814241.1	1425			19			300	31	920	3-28-67	LH, Su, Oc	Test hole plugged
L-635	262643N0814748.1	1405	170	6	15							LH, Su, Oc	Test hole plugged
L-636	262657N0814532.1	1405			19							LH, Su, Oc	Test hole plugged
L-645	262044N0814323.1	1480			15							LH, Su, Oc	Test hole plugged
L-652	264101N0814430.1	598	188	6.5	11	+34.1	4-25-67		28	660	4-25-67	LH	Chemical analysis in table 4
L-659	263613N0814240.1	1340			26							LH, Su, Oc	Test hole plugged
L-660	263905N0813522.1	1260	195	6	24							LH, Su, Oc	Test hole plugged

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gpm)	Temperature (°C)	Chloride (milligrams per liter)	Date of measurement	Aquifer(s)	Remarks
L-706	263943N0813518.1	592	140	6	22	+28.4	5- 9-67	70	28	285	4-29-68	LH	Chemical analysis in table 4
L-715	263612N0814254.1	830	110	6	26	+22.1	6-30-69		31	780	6- 2-69	LH, Su	
L-716	264148N0813854.1	800	86	6	12			500	28	780	5- 9-69	LH, Su	
L-717	263223N0814753.1	804	142	8	21	+24.3	8-13-68	250	24.5	820	6-17-68	LH, Su	
L-719	263244N0814753.1	700+	140	8	22	+24.7	6-17-68		29	720	6-17-68	LH, Su	
L-724	264313N0820220.1	700+		6	8			200	28.5	840	7-18-68	LH	Chemical analysis in table 4
L-736	263407N0814808.1	886	152	6	19	+25.6	11- 7-68	250	31	965	11- 7-68	LH, Su	Chemical analysis in table 4
L-755	263301N0814754.1	748	133	8	21	+24.8	11- 8-68	150	30	905	11- 8-68	LH, Su	
L-757	262919N0814928.1	600	168	3	16				29.5	1000	8-15-68	LH	Chemical analysis in table 4
L-765	263037N0815150.1	700	140	6	8				30.5	885	8-20-68	LH	
L-773	263925N0815034.1	746	132	4.5	12	+21.8	11- 6-72	200	31	1080	3-27-68	LH, Su	Chemical analysis in table 4
L-777	263810N0820032.1	800		4	11	+20.4	12-13-66			840	12-13-66	LH, Su	
L-807	261951N0814558.1	500	80	3	12	+19.4	2-15-68		27	1800	2-15-68	LH	Well plugged
L-816	263740N0815236.1	900		4	17					880	11-20-68	LH, Su	
L-817	263336N0815434.1	516	132	6	8	+15.5	2-15-67	485	29	4000	10-12-66	LH	Chemical analysis in table 4
L-823	263813N0815112.1	468	186	5	14				28	1610	11- 1-67	LH	Chemical analysis in table 4
L-828	264002N0815612.1	597	168	4	12	+22.4	10-24-67		28	920	10-24-67	LH	
L-892	264320N0814503.1	458	160	6	6	+43.4	12- 3-68			815	12- 3-68	LH	Well plugged
L-898	263242N0815350.1	800	151	6	7			350		675	2-12-69	LH, Su	
L-900	263856N0815427.1	640	168	4	10			350	27	560	3-18-69	LH	

Table 2.--(Continued) Records of deep artesian wells in Lee County.

Abbreviations used in tables: Aquifers - LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gal/min)	Temperature (°C)	Chloride (milligrams per litre)	Date of measurement	Aquifer(s)	Remarks
L-903	264256N0814752.1	665	107	6	10				28.5	900	3-31-69	LH	Chemical analysis in table
L-904	264148N0813610.1	772		8	16	+23.9	5-20-69	200	28.5	670	5-20-69	LH, Su	
L-905	264131N0813610.1	440		6	17	+30.5	5-22-69	500	27	1215	5-20-69	LH	
L-907	264434N0813605.1	894	337	6	18			75	31	1370	4-14-69	LH, Su	Chemical analysis in table
L-908	264405N0813705.1	900	84	6	13	+32	9-12-69	200	27	920	9-12-69	LH, Su	
L-910	264214N0813602.1	600		6	13	+22	9- 5-69	68	27.5	380	4-16-69	LH	
L-912	264223N0813553.1	850	650	6	10	+39.3	4-22-69	500	29	1440	4-22-69	Su	Chemical analysis in table
L-916	264207N0813558.1	536	318	4	15			45	28	1080	4-17-69	LH	Chemical analysis in table
L-931	263222N0814922.1	800		7	17			500		820	6-12-69	LH, Su	
L-949	263323N0815217.1	750	189	4	10			65	29	780	7-28-69	LH, Su	
L-960	263110N0815945.1	605	240	10	3			350	27	800	11- 3-69	LH	
L-964	263344N0815752.1	808	362	8	7			400	28	780	12-13-72	LH, Su	Chemical analysis in table
L-968	263351N0815423.1	797	125	4	6	- 4	4- 2-68		29			LH, Su	
L-971	263304N0815409.1	897	172	6	7	+14.5	4-14-67	400	30	710	4-20-67	LH, Su	
L-977	263145N0815428.1	1047	128	6	6			20	29	800	4-17-67	LH, Su	
L-982	264423N0813430.1	567	145	10	19			250	29	440	11-13-69	LH	Chemical analysis in table
L-1000	263309N0815513.1	582	136	6	7			150	28			LH	
L-1003	263748N0815627.1	676	136	6	9							LH, Su	
L-1004	263646N0815700.1	1081	159	8	8			400				LH, Su	
L-1005	263907N0815637.1	642	172	8	12			450				LH	

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measurement	Flow rate (gpm)	Temperature (°C)	Chloride (milligrams per liter)	Date of measurement	Aquifer(s)	Remarks
L-1006	263913N0815544.1	1065	156	6	11							LH, Su	Well plugged
L-1007	263930N0815808.1	510	117	6	13	+23.2	10-18-66	194	28	860	10-18-66	LH	
L-1008	263906N0815750.1	700	156	6	10							LH, Su	
L-1009	264001N0815843.1	706	143	6	13							LH, Su	
L-1010	263949N0815838.1	837	172	6	14	+19	2-26-69	560	28	820	2-26-69	LH, Su	
L-1011	264048N0815934.1	1050	158	6	13	+15	2-26-69	230	27	880	2-26-69	LH, Su	
L-1012	263837N0815933.1	790	163	6	11							LH, Su	
L-1013	263801N0815855.1	804	133	6	10							LH, Su	
L-1015	263916N0820147.1	597	166	6	7					1063	1964	LH	
L-1016	264141N0815804.1	731	132	6	15							LH, Su	
L-1017	264012N0815728.1	619	133	6	13	+20.5	2-15-69	560	28	1000	2-15-69	LH	
L-1018	264024N0815729.1	1001	157	6	13							LH, Su	
L-1019	263939N0815832.1	835	162	6	13			410	29	2380	2-15-69	LH, Su	
L-1020	263939N0820814.1	572	182	6	10					1360	1964	LH	
L-1021	263402N0820601.1	800	265	6	9				28	894	1964	LH, Su	Chemical analysis in table
L-1022	262612N0820359.1	631	440	5	5	+20.5	11-18-70			1000	11- 8-70	LH	
L-1023	262611N0820235.1	490	461	6	7							LH	
L-1032	264321N0814459.1	490	340	4	4	+44.2	2- 2-70	100	27	720	1-20-70	LH	Chemical analysis in table
L-1033	264056N0820224.1	553	132	6	6			200	28	780	12-30-69	LH	
L-1034	263435N0820225.1	468	128	6	5			300	27	1000	12-30-69	LH	

Table 2.--(Continued) Records of deep artesian wells in Lee County.

Abbreviations used in tables: Aquifers - LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-)lsd (feet)	Date of measurement	Flow rate (gal/min)	Temperature (°C)	Chloride (milligrams per litre)	Date of measurement	Aquifer(s)	Remarks
L-1035	264040N0820245.1	832	122	6	6	+14	2-27-69	150	27	760	12-30-69	LH, Su	
L-1037	264054N0820256.1	977	130	6	4	+17.5	2-27-69	200	28	940	12-31-69	LH, Su	
L-1038	264033N0815935.1	642	157	6	13	+12	2-26-69	230	29	640	8-28-69	LH	
L-1040	264033N0815952.1	770	137	6	13	+16	2-26-69	150	30	980	8-28-69	LH, Su	
L-1041	264004N0815934.1	511	155	4	14	+17	2-26-69	120	28	900	8-29-69	LH	
L-1042	264424N0815347.1	600		6	21			40	28.5	1000	2-24-70	LH	
L-1044	264407N0815441.1	1000		4	20				28.5	950	2-24-70	LH, Su	
L-1046	264338N0815427.1	1240		6	19			350	29	900	2-24-70	LH, Su	Chemical analysis in table 4
L-1094	262831N0815014.1	1015	500	4	8				32	1000	1970	LH, Su	Chemical analysis in table 4
L-1157	263306N0815223.1	919	589	4	12	+22.8	1- 6-71	300	31	920	12-20-70	, Su	Chemical analysis in table 4
L-1197	262605N0820447.1	500	480	4	4					600	1-27-71	LH	
L-1162	263244N0815501.1	600	129	8	6	+18.3	10-25-57	100	27	1350	11-10-70	LH	Well plugged
L-1201	264136N0815718.1	700		6	16	+21	2-12-69	265	28	700	2-12-69	LH, Su	
L-1219	264111N0814510.1	800		4	8			40	27	800	8-22-69	LH, Su	
L-1228	264423N0814341.1				10	+37.5	2-11-69	110	31	1000	8-11-69	LH, Su	
L-1229	264419N0814409.1	1000		6	6				29	1120	10-31-69	LH, Su	
L-1230	264122N0814437.1	500		6	9	+29.5	8-27-69	370	28	725	7-24-72	LH	
L-1237	264109N0814448.1	600		6	8	+19	8-28-69		27	760	8-28-69	LH	
L-1242	264429N0813749.1	1100		5	20				28	900	9-10-69	LH, Su	
L-1252	264053N0815709.1	660		6	14	+20.5	2-12-69	300	27	660	2-12-69	LH, Su	

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-)lsd (feet)	Date of measurement	Flow rate (gpm)	Temperature (°C)	Chloride (milligrams per liter)	Date of measurement	Aquifer(s)	Remarks
L-1264	263132N0815352.1	794		6	6				26	620	1-13-69	LH, Su	
L-1278	263027N0815847.1	783		4	4	+15	1-28-69	60	27	950	1-28-69	LH, Su	
L-1279	263023N0815821.1	580		4	4	+17	1-28-69	120	28	1080	1-28-69	LH	
L-1310	263600N0815305.1	440		6	13	+18.5	9- 9-68	150	28	1000	9- 9-68	LH	
L-1314	264050N0814704.1	900		6	16	+27	8- 6-69		27	660	8- 6-69	LH, Su	
L-1332	264039N0814907.1	520		4	15			75	23	740	7-25-69	LH	
L-1356	264033N0814506.1	660		4	12	+31	8-21-69	160	26	700	8-21-69	LH	
L-1370	264013N0814903.1	649		4	15	+20.5	7-30-69		26	740	7-30-69	LH	
L-1373	263958N0814918.1	1000		5	12	+13	7-31-69		30	1900	7-31-69	LH, Su	
L-1385	264014N0814716.1	600		4	18	+26	8-26-69	400	28	1060	8-26-69	LH	
L-1386	264013N0814636.1	876	147	5	20	+ 7	8-22-69		31	840	8-22-69	LH, Su	
L-1390	263943N0814629.1	540		6	19	+18	8-12-69	200	28	900	8-12-69	LH	
L-1394	263856N0814907.1	1000		6	19	+17	8-19-68	225		960	8-19-68	LH, Su	
L-1423	262911N0815630.1	613	182	6	5			200	29	3300	3-11-71	LH	Well plugged
L-1424	263430N0815802.1	500	126	3	6							LH	
L-1425	263337N0815731.1	500	126		6	+16.6	5-17-66		27			LH	
L-1442	263331N0815346.1	1161	648	4	5	+15.9	5-21-71	200	35	13300	7-20-71	Su	
L-1445	263404N0815201.1	740	685	4	12	+21.3	6- 7-71	125	29	740	6- 2-71	Su	
L-1470	262603N0820253.1	542	420	4	6	+16.7	8- 3-71			1050	8- 3-71	LH	
L-1471	263431N0815307.1	961	735	6	9			300	30	740	8-24-71	Su	

Table 2.--(Continued) Records of deep artesian wells in Lee County.

Abbreviations used in tables: Aquifers - LH (lower Hawthorn), Su (Suwannee), Oc (Ocala).

Well number	Latitude-Longitude number	Depth (feet)	Casing (feet)	Diameter (inches)	Altitude of land surface (feet)	Water level above(+) or below(-) lsd (feet)	Date of measure-ment	Flow rate (gal/min)	Temper-ature (°C)	Chloride (milligrams per litre)	Date of measure-ment	Aquifer(s)	Remarks
L-1472	262632N0820247.1	786	660	4	4			125		5700	10- 6-71	LH	Well plugged
L-1473	263818N0820209.1	968	84	4	7	+27.7	10-27-71	750	28	675	10- 7-71	LH, Su	Chemical analysis in table 4
L-1512	262553N0820328.1	565	465	4	6				27	2300	3- 7-72	LH	
L-1533	262627N0820618.1	895	496	4	5							LH, Su	
L-1557	263513N0815348.1	575		5	5			60	28	550	12-29-71	LH	
L-1568	263910N0815454.1	712	162	6	9				28	550	4- 3-72	LH, Su	Chemical analysis in table 4
L-1569	262427N0814911.1	809	294	4	12							LH, Su	
L-1595	263735N0815226.1	928	322	4	16			40	29	840	6-13-72	LH, Su	
L-1597	262626N0820618.1	575	503	10	5	+17.4	7-14-72	45				LH	
L-1634	262435N0815351.1	950	740	6	5				31	1240	10-18-72	Su	Chemical analysis in table 4
L-1635	262435N0815350.1	620	360	6	5			120		1110	9-29-72	LH	Chemical analysis in table 4
L-1642	261958N0814609.1	600	184	6	11					2880	10-17-72	LH	Well plugged
L-1645	262923N0821018.1	540	442	4	3	+ 7.8	10-26-72		27	300	10-26-72	LH	
L-1646	262653N0821001.1	673	382	4	4	+19.8	10-26-72	40		870	10-31-72	LH	
L-1650	262623N0820214.1	613	462	6	8	+20.9	11-29-72	100	29	1400	11-29-72	LH	
L-1687	264323N0821534.1	900	141	6	4							LH, Su	
L-1688	263554N0813754.1	900		5	26			60	31	900	3-22-73	LH, Su	Chemical analysis in table 4

Table 4.--Chemical analyses of water from the lower Hawthorn and Suwannee aquifers
(Chemical constituents in milligrams per litre)

Well number	Date of collection	Depth (ft.)	Aquifer(s)	Silica (SiO_2)	Iron (Fe)	Strontium (Sr)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids Calc.	Dissolved solids Res	Hardness as $CaCO_3$ Ca, Mg	Hardness as $CaCO_3$ Non-carbonate	Alkalinity as $CaCO_3$	Spec. conductance at 25°C (micromhos)	pH	Color	Temp. °C
L-321	3-14-73	400	LH	.8	.03	3.5	22	85	500	30	57	9.0	190	900	1.3	0	1800		410	350	62	3400	9.0	5	
L-346	4-11-46	450	LH		.02		138	147	1150		218		690	1810				4040	949			6770	7.3	8	27
	3-12-73			23	.06	9.3	120	150	1200	42	216	0	670	1800	1.7	0	4100		930	750	177	7000	7.8	5	27.5
L-351	4- 7-46	685	LH		.02		38	42	175		248	0	150	202		3.7			268			1340	7.7	7	
	3-13-73			26	.04	3.2	40	43	180	17	244	0	160	250	2.9	0	840		280	80	200	1350	7.9	5	26
L-426	3-17-73	525	LH	14	.03	22	120	100	540	22	158	0	370	960	1.5	.4	2200		740	610	130	3750	7.7	5	27.5
L-541	3- 9-73	500	LH	13	.23	26	170	200	1500	46	176	0	510	2700	1.8	0	5200		1300	1200	144	9500	7.9	5	28.5
L-571	2- 6-73	600	LH	13		25	160	180	1100	40	155	0	420	2100	1.8	0	4100		1200	1100	127	7400	7.6	5	28
L-585	2-15-73	475	LH	10		19	70	100	790	28	28	2.0	120	1500	1.2	0	2600		610	580	23	5000	8.7	5	24
L-587	1- 9-73	456	LH	25		3.4	20	14	220	18	290	0	92	160	3.8	0	700	683	110	0	238	1160	8.0	10	26.5
L-588	1- 9-73	557	LH	30		8.2	88	87	640	40	196	0	370	960	2.5	0	2300		590	430	161	4000	8.1	5	27
L-652	6- 2-69	598	LH	13		16	89	88	386	19	168	0	296	720	1.4	0	1700		605	467	138	2800	7.9	3	26
L-706	5- 1-69	592	LH	19		6.1	48	52	196	14	292	0	146	280	2.2	0	907		341	102	239	1500	8.1	3	28
L-724	3-14-73		LH	19		2.3	120	90	380	18	164	0	230	800	1.5	0	1700		670	530	134	3200	7.7	5	28.5
L-817	2- 3-73	516	LH	13		42	250	350	3000	88	178	0	800	5400	1.7	0	10000		2100	1900	146	17000	8.0	5	29.5
L-823	2-20-73	468	LH	15		30	140	120	800	22	156	0	370	1600	1.4	0	3200		880	750	128	5700	7.5	5	29.5
L-905	3- 3-73	665	LH	14		25	100	90	470	17	148	0	320	880	1.4	0	2000		650	530	121	3550	8.0	5	28.5
L-916	3- 7-73	536	LH	23		6.8	60	52	250	16	200	0	120	450	1.6	0	1100		370	210	164	2300	7.7	5	29
L-982	3- 7-73	567	LH	14		20	96	72	300	18	164	0	270	600	1.3	0	1200		560	420	134	2650	7.6	5	29
L-1032	3- 3-73	490	LH	22		9	69	70	460	20	192	0	210	760	1.9	0	1700		470	310	157	3060	8.0	10	
L-1635	2-16-73	620	LH	20		17	120	140	690	28	180	0	380	1300	2.2	0	2800		900	750	148	5000	7.6	5	26

Well number	Date of collection	Depth (ft.)	Aquifer(s)	Silica (SiO_2)	Iron (Fe)	Strontium (Sr)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids Calc.	Dissolved solids Res.	Hardness as $CaCO_3$ Ca, Mg	Hardness as $CaCO_3$ Non-carbonate	Alkalinity as $CaCO_3$	Spec. conductance at 25°C (micromhos)	pH	Color	Temp. °C
L-332	3- 9-73	900	LH,Su	4.7		14	84	84	400	22	184	0	310	700	1.7	0	1700		570	420	151	3000	7.7	5	29.5
L-359	3- 6-73	650+	LH,Su	14		22	110	92	500	21	148	0	350	920	1.5	0	2100		680	560	121	3600	7.9	5	28
L-425	3-23-46	780	LH,Su				87	78	392		182		359	615		.2		1710	538			2770	7.4	4	29
	3- 6-73			14		17	90	85	440	21	168	0	330	750	1.7	0	1500		590	450	138	3200	7.7	5	29
L-458	4- 8-46	842	LH,Su		.02		164	140	715		164		534	1310			2940		984			5070	7.4	5	
	3-12-73			13	.03	26	160	140	800	27	152	0	530	1500		0	3300		1000	870	125	5900	7.6	5	31
L-592	1- 9-73	724	LH,Su	18		25	130	130	720	35	184	0	352	1300	2.1	0	2800		890	740	151	4800	7.8	5	28
L-715	6- 2-69	830	LH,Su	14		14	85	89	397	19	164	0	276	780	1.5	0	1760		594	460	135	2950	7.8	3	31
L-735	5- 7-69	836	LH,Su	5		20	114	101	455	22	160	0	368	900	1.4	0	2060		724	592	131	3350	7.9	3	31
L-773	5- 6-69	746	LH,Su	16		23	134	111	530	21	160	0	308	1120	1.1	0	2320		818	687	131	3950	7.8	3	31
L-907	5-29-69	894	LH,Su	14		33	154	122	600	23	124	0	416	1200	1.1	0	2620		924	823	102	4600	7.8	3	31
L-964	12-13-72	808	LH,Su	16		15	86	90	450	20	181	0	320	780	1.9	0	1900		600	450	148	3350	8.0	0	28
L-1021	12-18-72	800	LH,Su	19		0	80	95	550	27	194	0	320	960		0	2100		590	430	159	3850	8.2	0	28
L-1046	3- 3-73	1240	LH,Su	17		23	98	90	420	17	164	0	220	830	1.5	0	1800		640	500	134	3260	8.0	5	29
L-1094	2- 7-73	1015	LH,Su	14		19	120	110	500	20	168	0	340	940	1.5	0	2100		770	630	138	3810	7.9	5	28.5
L-1473	12- 8-72	968	LH,Su	15		15	86	82	360	19	186	0	260	720	1.5	0	1700		570	420	153	3120	8.1	0	28
L-1568	12- 8-72	712	LH,Su	17		16	86	71	280	16	192	0	260	520	1.5	0	1400		520	360	157	2390	8.2	0	28
L-1633	3-22-73	900	LH,Su	14	.03	19	110	100	540	22	160	0	350	900	1.4	0	2100		710	560	131	3660	7.6	10	31
L-912	3- 7-73	850	Su	2.2		28	120	100	720	24	8	0	340	1400	1.0	0	2700		740	730	7	5000	6.6	5	
L-1157	2-21-73	740	Su	11		18	86	90	400	19	158	0	320	700	1.7	0	1700		610	480	130	2960	7.9	5	
L-1634	2-16-73	950	Su	13		28	160	150	700	26	158	0	420	1400	1.3	0	3000		1000	870	130	5030	7.7	5	31

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