cp 2 in press

X

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGIC AND HYDROLOGIC DATA FROM A TEST-MONITOR WELL AT FERNANDINA BEACH, FLORIDA

U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 80-347

Prepared in cooperation with the
OCEAN, HIGHWAY, AND PORT AUTHORITY
NASSAU COUNTY, FLORIDA

80-347 GEOLOGIC AND HYDROLOGIC DATA FROM A TEST-MONITOR WELL AT FERNANDINA BEACH, FLORIDA

80-347

CONVERSION FACTORS

For use of those readers who may prefer to use SI (metric) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI (metric) unit
inch (in)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOLOGIC AND HYDROLOGIC DATA FROM A TEST-MONITOR WELL AT FERNANDINA BEACH, FLORIDA

By David P. Brown

U.S. GEOLOGICAL SURVEY

Open-File Report 80-347

Prepared in cooperation with the

OCEAN, HIGHWAY, AND PORT AUTHORITY

NASSAU COUNTY, FLORIDA

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

For additional information write to:

U.S. Geological Survey
325 John Knox Road
Suite F-240
Tallahassee, Florida 32303

CONTENTS

ILLUSTRATIONS

TABLES

GEOLOGIC AND HYDROLOGIC DATA FROM A TEST-MONITOR WELL AT FERNANDINA BEACH, FLORIDA

By David P. Brown

ABSTRACT

A 2,102-foot observation well was drilled at Fernandina Beach, Florida, to obtain geologic and hydrologic data. Drill cuttings, water samples, and water-level measurements were collected. Geologist's, driller's, and geophysical logs were completed. The well is constructed with 12-inch diameter casing to a depth of 515 feet and 6-inch diameter casing from 515 to 2,000 feet. The remainder is open hole.

The uppermost 500 feet of material penetrated by the well consists of sand, clay, limestone, and dolomite. In the remainder of the hole, the material consists of fragmental and granular limestone and massive to finely crystalline dolomite, which comprise the Floridan aquifer in the area.

After the well was completed, water levels rose from the monitored zone, 2,000 to 2,102 feet, to above land surface. During July and August 1979, water levels ranged from about 8 to 13 feet above land surface.

Chloride concentrations of water sampled through the drill stem from a depth of 632 to 2,039 feet ranged from 25 to 710 milligrams per liter. Chloride increased markedly below 2,039 feet to a maximum of 7,800 milligrams per liter at 2,094 feet. After completion of the well, chloride was 8,100 milligrams per liter.

INTRODUCTION

The primary source of water supplies at Fernandina Beach, Florida, is the Floridan aquifer, a prolific artesian aquifer with several water-producing zones. Since about 1962 withdrawals of water from this aquifer have been approximately 60 Mgal/d at Fernandina Beach. The resulting cone of depression in the potentiometric surface extends over an area of more than 200 mi^2. Artesian pressure in the center of pumpage has declined more than 120 feet below estimated levels in 1880 (Fairchild and Bentley, 1977). Increased salinity has been observed in water from many wells in the area. This increase has been more pronounced in the deeper wells near the center of the cone of depression (Fairchild and Bentley, 1977).

Purpose and Scope

To determine the overall effects of continued withdrawals of ground water in the area, the Geological Survey in cooperation with the Ocean, Highway, and Port Authority of Nassau County, Florida, conducted an investigation of the ground-water resources. The purpose of the investigation was to provide water users with data necessary for the wise use and protection of the resource, and to appraise sources of ground-water supplies that may be utilized in the future.

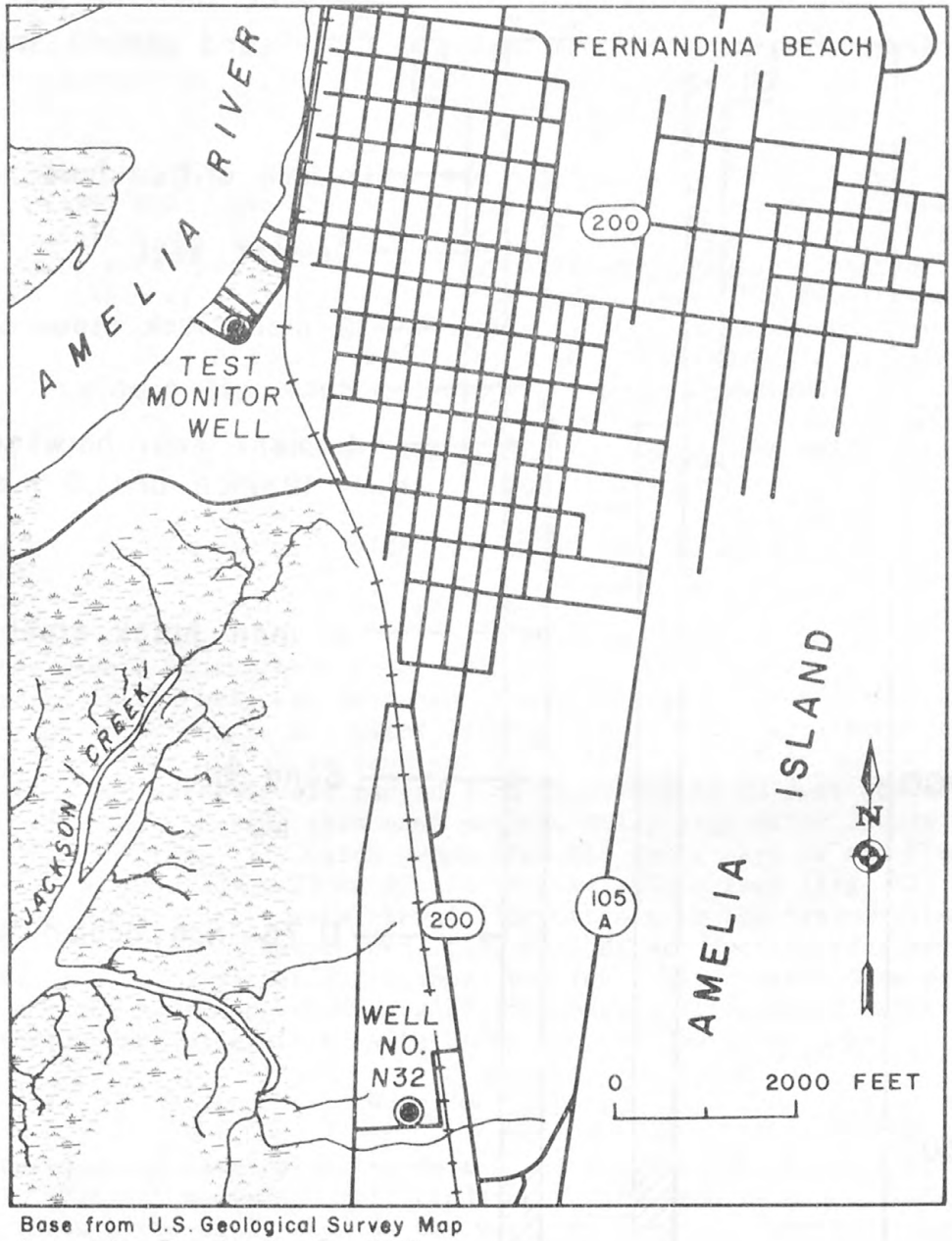
During this investigation, an observation well was drilled at Fernandina Beach to obtain geologic and hydrologic data to aid in the study of the ground-water resources of the area. This well will be used to detect changes in artesian pressure and water quality. It will also aid in determining the depth to the freshwater-saltwater interface and the rate of vertical movement of saline water. This report presents the geologic and hydrologic data collected during construction and after completion of the observation well.

Acknowledgments

The writer wishes to express his appreciation to E. E. Lasserre, Chairman, and members of the Ocean, Highway and Port Authority for their support during this investigation. Particular acknowledgment is given to Richard Hooper and Harry Mills of ITT Rayonier, Inc. and A. D. Harris and Jan Bray of Container Corporation of America for their assistance during the drilling and testing of the monitor well. The writer also wishes to express his appreciation to Layne-Atlantic Company, who drilled the monitor well and provided valuable data during construction and testing of the well.

WELL CONSTRUCTION

The location of the test-monitor well is shown in figure 1. The well was drilled from November 1978 to March 1979. As shown schematically in figure 2, the well was drilled to a total depth of 2,102 feet. It was drilled to a depth of 568 feet by standard mud-rotary method and 12-inch diameter steel casing was installed and grouted from the bottom of the hole to the surface. The remainder of the hole, 568 to 2,102 feet, was drilled by reverse air rotary method. A 6-inch diameter steel casing was installed from a depth of 515 to 2,000 feet below land surface. The casing was cemented in place from a depth of about 1,530 to 2,000 feet. The space between the 6-inch diameter casing and the drilled hole (11.75-inch diameter) was back filled with sand from a depth of 1,530 to about 570 feet below land surface. The annular spacing between the 12-inch and 6-inch diameter casings (515 and 568 feet) was sealed with cement. The interval from 2,000 to 2,102 feet was left open to the formation.



Base from U.S. Geological Survey Map
Fernandina Beach, Florida, 1970

Figure 1.--Location of test-monitor well and well number N32, Fernandina Beach, Florida

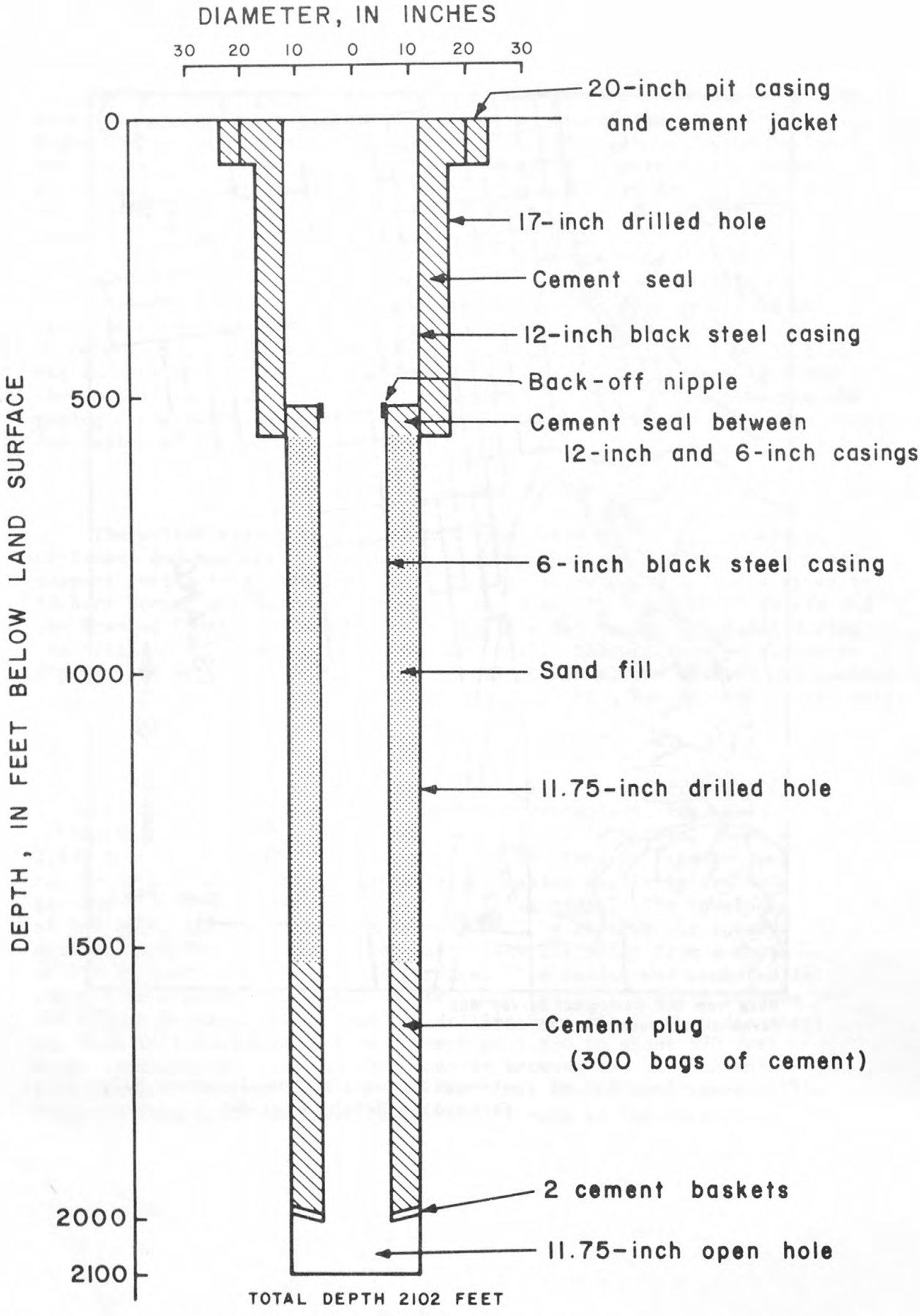


Figure 2.--Schematic diagram of well construction.

GEOLOGIC DATA

Drill cuttings were collected at intervals of about 10 feet and at changes in lithology. The lithologic log (table 1) and the driller's log (table 2) are based on descriptions of the cuttings. The drilling rate at selected intervals during construction of the test hole is listed in table 3.

The uppermost 500 feet of material penetrated by the test well consist of sand, clayey sand, phosphatic sandy clay, sandy limestone, and dolomite. These materials range in age from Miocene (Hawthorn Formation) to Holocene. The remaining materials consist of fragmental and granular limestone and massive to finely crystalline dolomite of Eocene age. The formations, which comprise the Floridan aquifer in the Fernandina Beach area, are, in ascending order, the Oldsmar, Lake City, Avon Park, and Ocala Limestones. The well penetrated about 300 feet into the Oldsmar Limestone.

Geophysical logs were made during construction of the well. Selected logs are included in this report as figures 3 through 11.

HYDROLOGIC DATA

Water Levels

Water levels in the well were generally greater than 20 feet below land surface as the well was deepened from 632 to 2,080 feet (table 4). After the well was completed, water levels rose from the monitored zone, 2,000 to 2,102 feet, to above land surface. From July 18 to August 22, 1979, daily high water levels ranged from about 9.5 to 13 feet above land surface (fig. 12). During this same period, daily high water levels in a nearby well, N32 (fig. 1), which penetrates the upper part of the Floridan aquifer ranged from about 27 to 47 feet below land surface (fig. 12). Figure 13 shows the daily water-level fluctuations in the test-monitor well from July 23-31, 1979. Water-level fluctuations are cyclic tidal induced with a maximum daily variation of about one foot. Water-level data presented in this section have not been adjusted for density differences between freshwater and the mineralized water found in the monitored zone.

Water Quality

Water-quality data collected during the project are shown in tables 5, 6, and 7. Table 5 shows specific conductance and temperature of water sampled through the drill stem as the well was deepened form 1,476 to 2,080 feet. Table 6 shows chloride concentration of water sampled through the drill stem as the well was deepened from 632 to 2,094 feet. Analyses for a wider range of constituents was performed on bottom hole samples collected by means of an electronically controlled downhole sampler at depths of 1,567 and 1,820 feet. The results of these analyses and a similar one of water sampled after completion of the well are shown in table 7.

The specific conductance of the water sampled from a depth of 1,476 to 2,064 feet ranged from 1,000 to 3,600 umhos at 25°C (table 5). At depths of 2,074 and 2,080 feet, specific conductance was 5,200 and 15,000 umhos, respectively. Specific conductance was 22,000 umhos the next day at a depth of 2,080.

Chloride concentrations of water sampled through the drill stem between 632 to 2,039 feet ranged from a low of 25 mg/L at 851 feet to a high of 710 mg/L at 1,226 and 1,460 feet (table 6). Chloride increased markedly below 2,039 feet to a maximum of 7,800 mg/L at a depth of 2,094 feet. After completion of the well, chloride concentration of water collected by the downhole sampler was 8,100 mg/L (table 7).

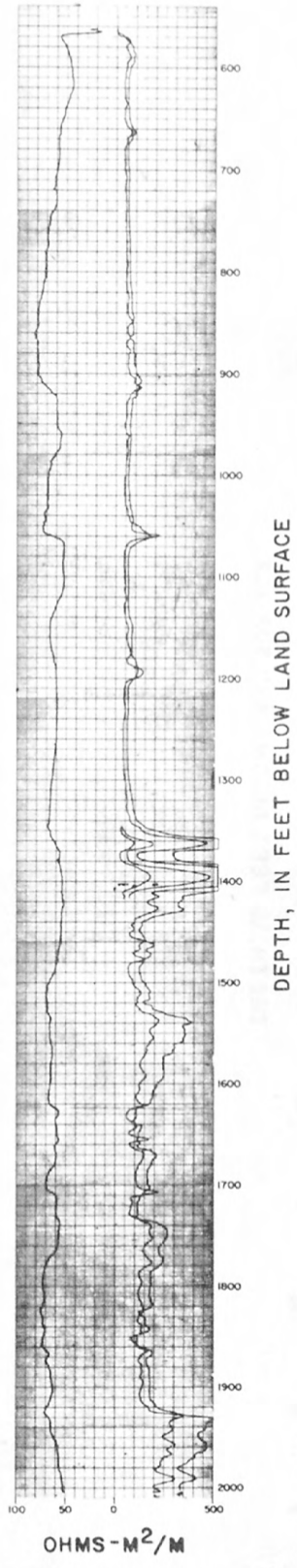


Figure 3.--Electric log, long and short norman and self potential.

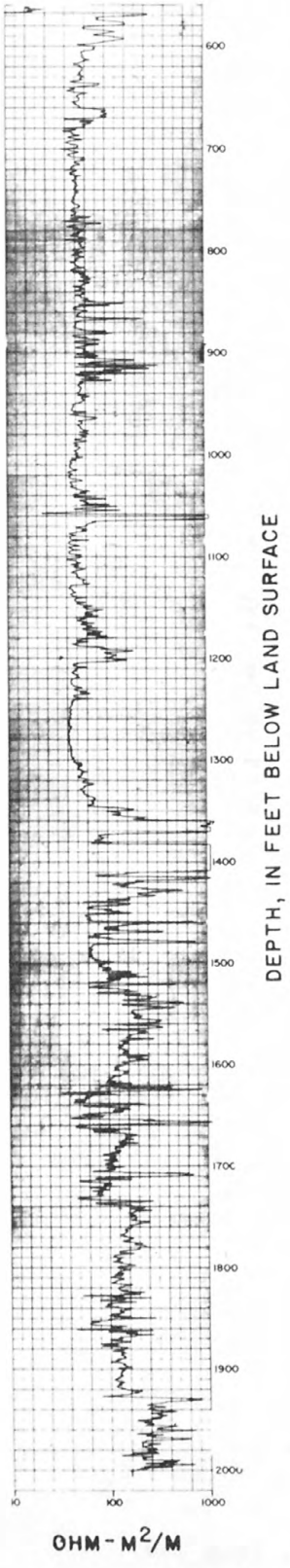


Figure 4.--Electric log (guard).

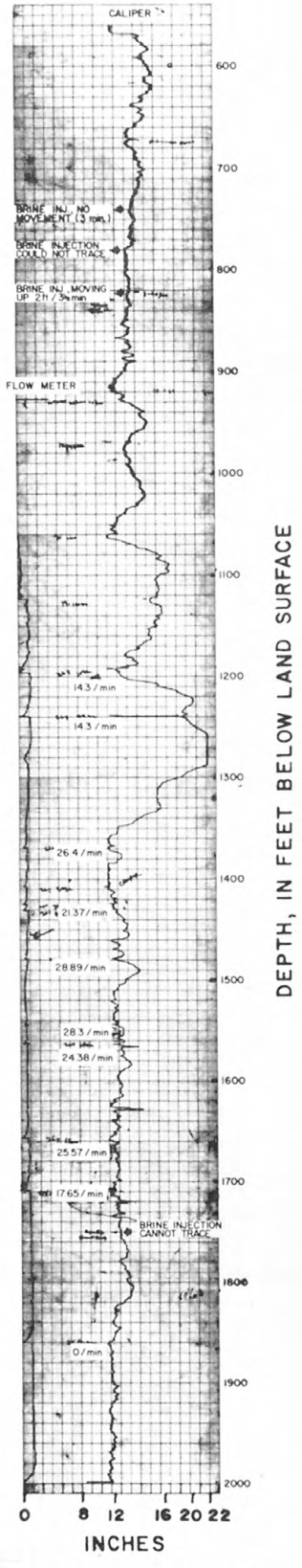


Figure 5.--Caliper log with flow meter and brine injection data.

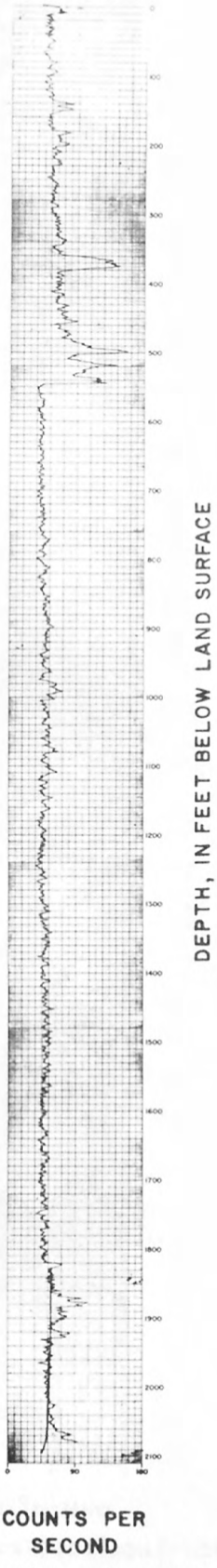


Figure 6.--Natural gamma log.

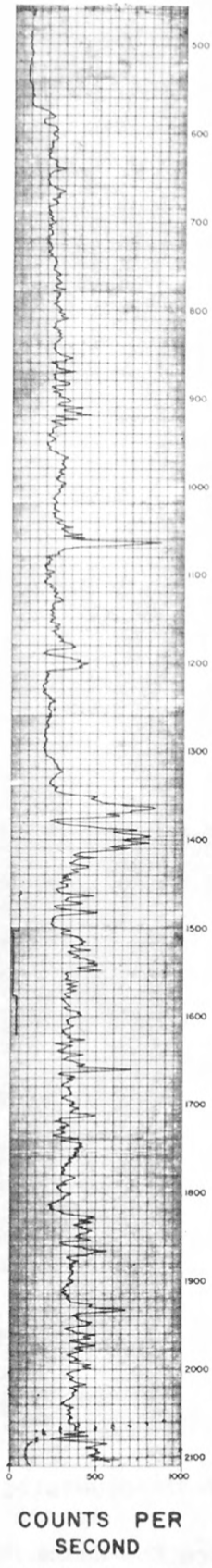


Figure 7.--Neutron porosity log.

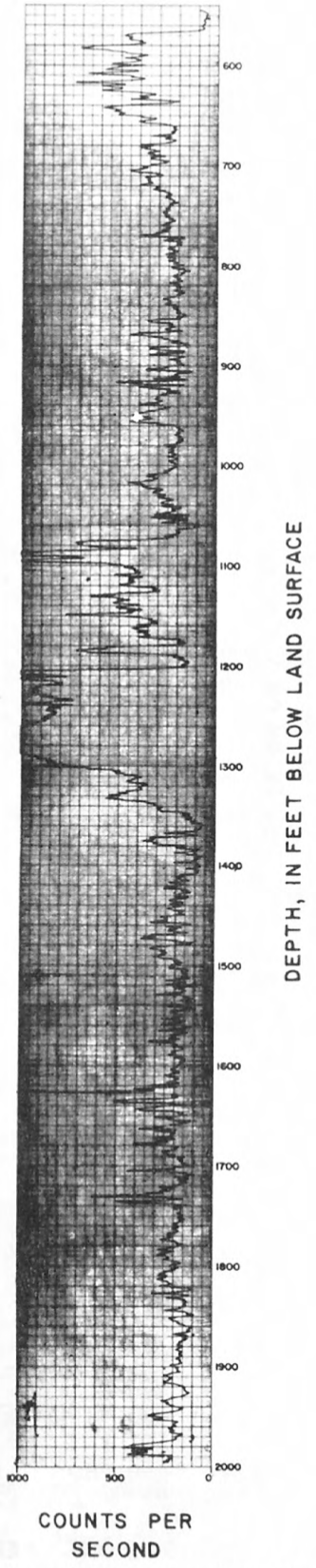


Figure 8.--Gamma density log.

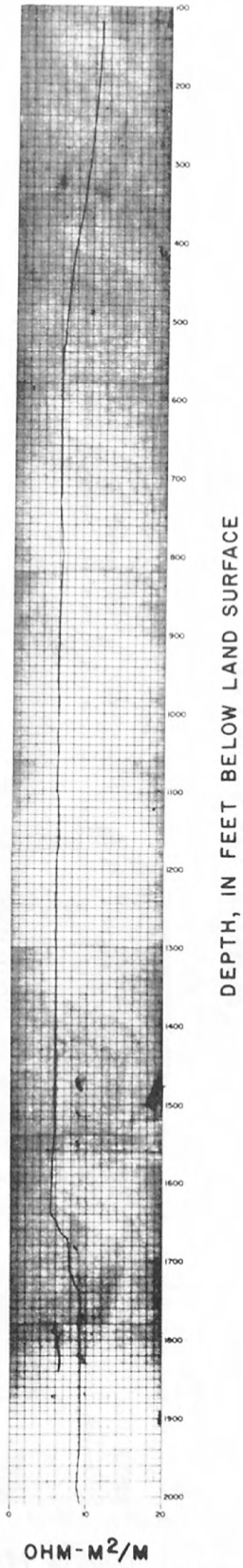


Figure 9.--Fluid resistivity log.

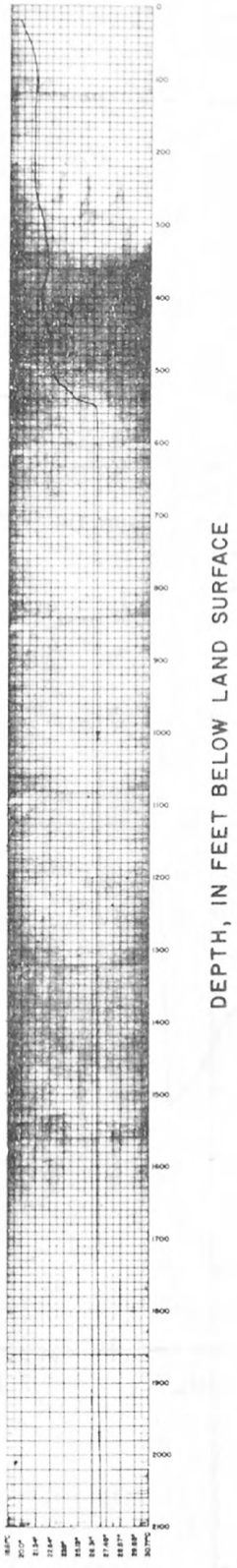


Figure 10.--Temperature log.

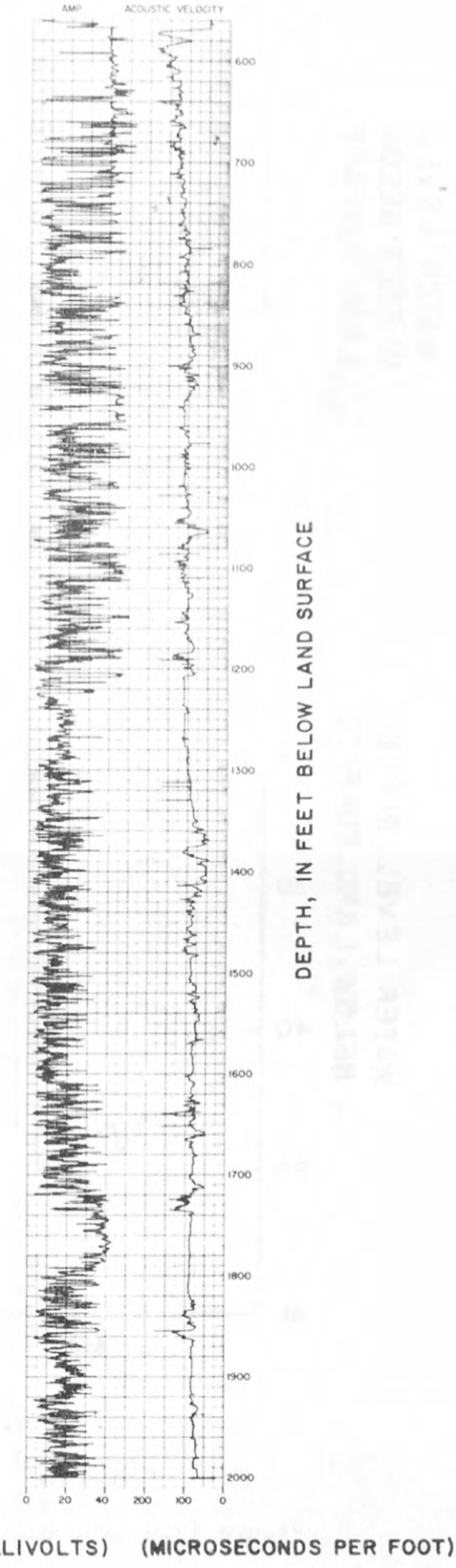


Figure 11.--Acoustic velocity log.

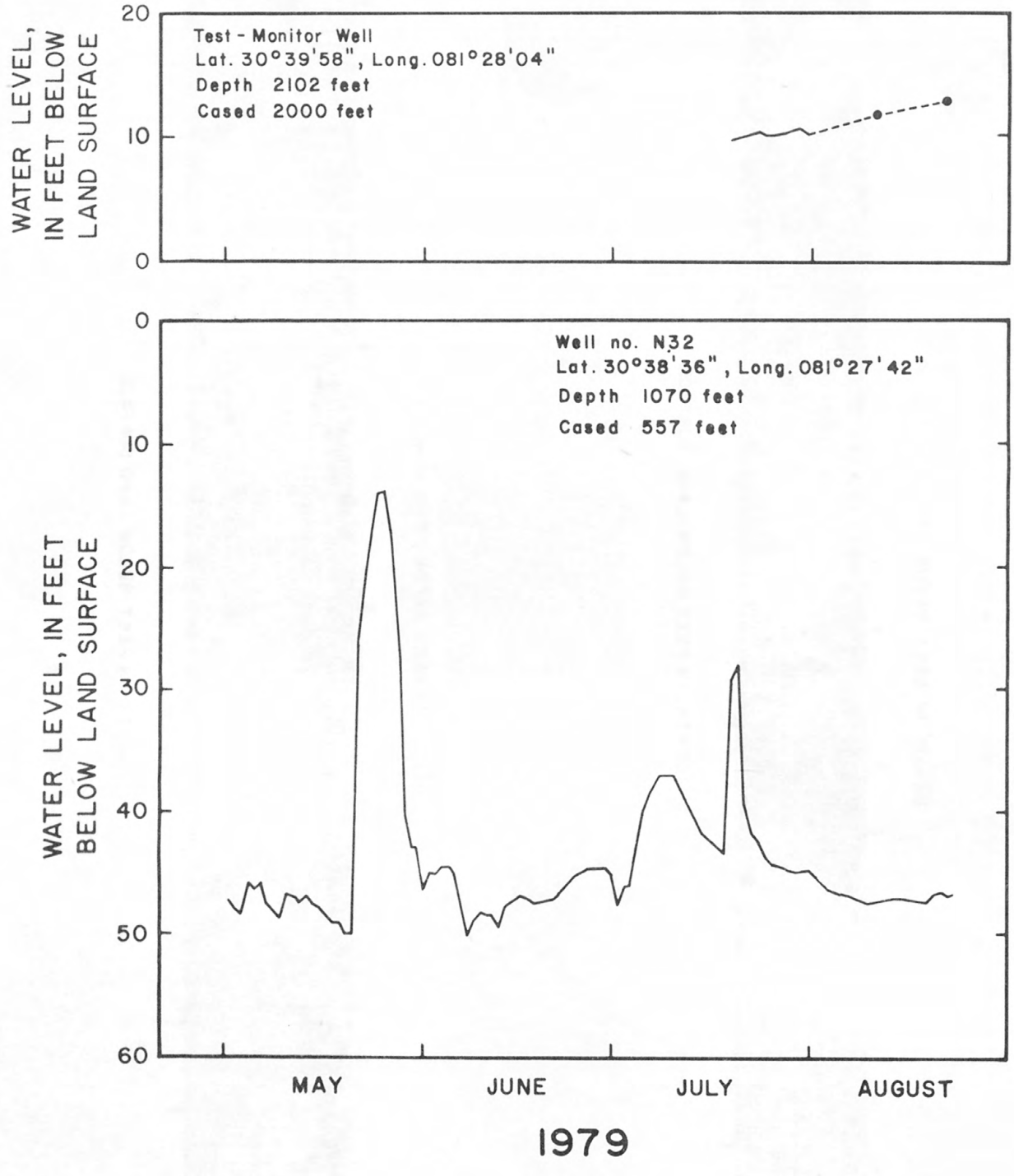


Figure 12.--Hydrographs of test-monitor well and well number N32.

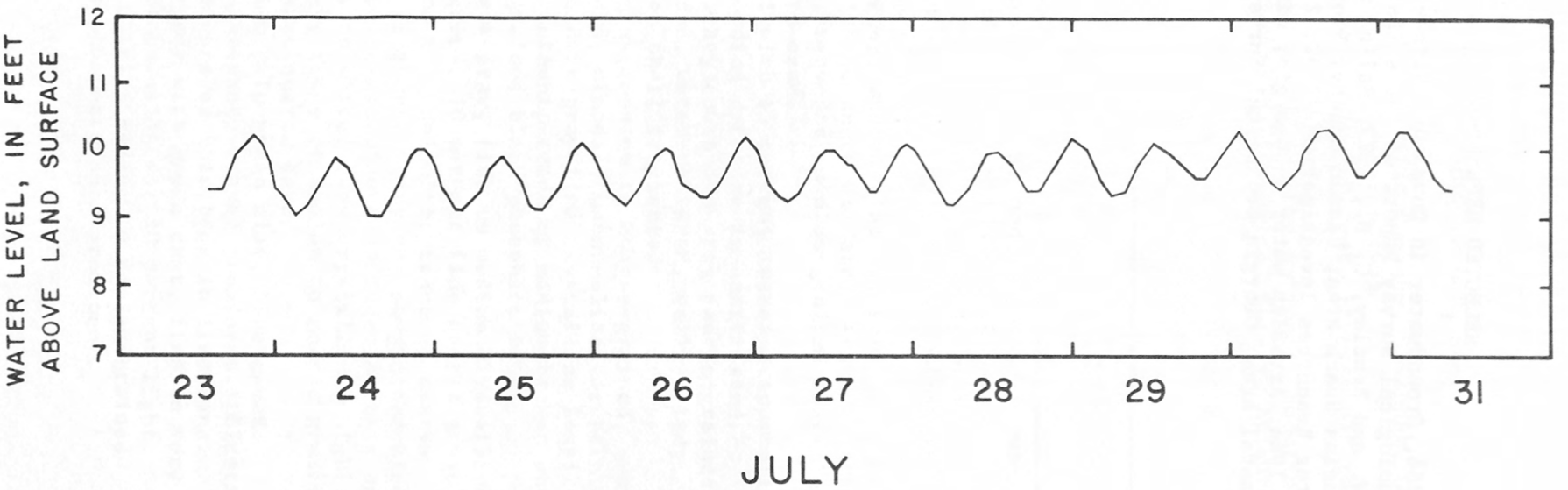


Figure 13.--Hydrograph of test-monitor well, July 23-31, 1979.

SELECTED REFERENCES

Leve, G. W., 1966, Groundwater in Duval and Nassau Counties, Florida: Florida Geological Survey Report of Investigation 43, 91 p.

Fairchild, R. W. and Bentley, C. B., 1977, Saline water intrusion in the Fernandina Beach area, Nassau County, Florida: U.S. Geological Survey Water Resources Investigation 77-32, 27 p.

Warren, M. A., 1944, Artesian water in Georgia, with special reference to the coastal area: Georgia Geological Survey Bulletin 49.

Table 1.-- Lithologic log

Location, lat. 30°39'58", long. 081°28'04", Section 23, T3N, R28E, Nassau County, Florida
Driller, Rudy Polk, Layne-Atlantic Company, Savannah, Georgia
Date Drilled, November 1978 to March 1979
Drilling Method, mud rotary to 568 feet, reverse air rotary 568 to 2,102 feet
Depth, 2,102 feet
Land-surface altitude, about 5' above National Geodetic Vertical Datum of 1929
Logged by, James Miller, U.S. Geological Survey, Atlanta, Georgia

Description	Thickness (feet)	Depth to base (feet)
Sand, quartz, dark-gray, fine-grained, angular to subangular, well-sorted, semiconsolidated; 20 percent dark-gray clay; 15 percent coarse whole to broken white shell fragments; trace of lignite, coarse-grained rounded water-polished quartz sand.	15	15
Sand, quartz, light-gray, medium-grained, subrounded to rounded, water-polished, unconsolidated; trace of coarse white broken shell fragments, medium-grained black to light-gray phosphate sand.	22	37
Sand as 0-15 interval with 15 percent increase in shell fragments, corresponding decrease in quartz sand.	30	67
Sand, quartz, light-gray, coarse to very coarse-grained, rounded to subrounded, water-polished, well-sorted; trace of fine broken shell fragments.	9	76
Sand, quartz, light-gray, medium to coarse-grained, subangular to subrounded, bimodal, unconsolidated; particles of medium to dark-gray fine crystalline fossiliferous dolomite prominent; trace of medium broken shell fragments, medium-grained black phosphate sand.	22	98
Dolomite, light to dark-gray, fine to medium crystalline, pelletal, fossiliferous; 10 percent fine quartz gravel, probably a lag deposit on dolomite; trace of coarse white broken shell fragments, very coarse-grained black phosphate sand. Sparse microfauna includes Archais sp.	10	108
Limestone, light-gray to white, fine crystalline, highly fossiliferous, vuggy; trace of medium to coarse-grained rounded water-polished quartz sand.	10	118
Limestone as above with pale-green clay, fine quartz gravel, fine black phosphate gravel prominent. Clastic material probably occurs as thin beds in limestone.	21	139
Sand, quartz, medium-gray with green cast, fine to very coarse-grained, semiconsolidated; 30 percent light greenish-gray clay matrix; medium to coarse-grained dark-brown to black phosphate sand prominent.	10	149

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Sand and gravel, light to medium-gray mottled; 55 percent quartz sand as above; 45 percent medium-gray rounded fine quartz gravel; medium black to dark-brown phosphate gravel prominent.	12	161
Sand, quartz, medium-gray, medium to very coarse-grained, rounded to subrounded, unconsolidated; fine quartz and phosphate gravel prominent.	10	171
Sand and gravel, medium-gray, unconsolidated; 50 percent fine to medium-grained subrounded to rounded quartz sand; 50 percent fine rounded quartz gravel; white sandy limestone particles, coarse sand to fine gravel-sized dark-gray to black phosphate prominent.	10	181
Sand and gravel as above but semiconsolidated. Sand and gravel are bound by light-gray calcareous clay matrix.	21	202
Gravel, quartz, light-gray, fine-grained, rounded, water-polished, unconsolidated to semiconsolidated; medium-grained quartz sand, fine black phosphate gravel, white argillaceous fine crystalline dolomite matrix prominent.	22	224
Sand, quartz, light-gray, fine to medium-grained, angular to subrounded, semiconsolidated to unconsolidated; 30 percent loose fine quartz gravel as above; trace of fine to medium-grained black phosphate sand.	10	234
Sand and clay, light-gray, semiconsolidated; 60 percent fine to coarse-grained subrounded to rounded quartz sand; 40 percent light-gray silt-sized calcareous clay binder; fine quartz gravel prominent; trace of medium sand to fine gravel-sized black phosphate.	10	244
Sandstone, calcareous, light-gray; as above with calcareous matrix indurated to a fine crystalline limestone.	11	255
Sand, quartz, medium-gray, medium to coarse-grained, rounded to subrounded, unconsolidated; medium to coarse-grained black phosphate sand prominent. A few thin beds of calcareous sand as above.	31	286
Sand, quartz, medium-gray with olive-green cast, medium-grained, subrounded to rounded, water-polished, well-sorted, unconsolidated; dull greenish-gray clay, medium-grained black phosphate sand, hematite-stained quartz sand prominent.	10	296
Clay, dark olive-green, waxy, soft; medium-grained rounded quartz and black phosphate sand prominent. Gypsum bloom prominent on dried clay particles.	10	306

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Sand and clay, dark olive-green, semiconsolidated; 75 percent medium-grained rounded water-polished well-sorted quartz sand; 25 percent dark olive-green clay matrix; medium-grained black phosphate sand prominent.	21	327
Clay, dark olive-green, waxy, blocky, soft; fine to coarse-grained rounded quartz sand, medium-grained black to brown phosphate sand prominent.	31	358
Clay, light-green, light weight, ashy, highly diatomaceous.	10	368
Sand and clay, dark olive-green, semiconsolidated; 40 percent medium to very coarse-grained rounded to subrounded quartz sand; 40 percent light-brown to black medium to very coarse-grained phosphate sand; 20 percent dark olive-green clay matrix.	12	380
Sand, dark-gray, salt-and-pepper, bimodal, unconsolidated; 55 percent coarse-grained rounded water-polished quartz sand; 25 percent coarse-grained black phosphate sand; 10 percent fine-grained angular quartz sand; 10 percent fine-grained light to dark-brown phosphate sand; trace of light greenish-gray sandy dolomite.	10	390
Sand, quartz, medium-gray, salt-and-pepper, medium to coarse-grained, subrounded to rounded, water-polished, unconsolidated; 15 percent medium to coarse-grained dark-brown to black phosphate sand; trace of light-gray sandy phosphatic dolomite.	10	400
Sand as above with 25 percent increase in dolomite, corresponding decrease in quartz sand.	12	412
Sand, quartz, light-gray, medium to coarse-grained, subrounded to rounded, water-polished, unconsolidated; medium to coarse-grained dark-brown to black phosphate sand, light-gray sandy dolomite prominent; 422 to 432 feet, increase in dolomite to 20 percent, corresponding decrease in sand.	32	444
Sand, quartz, light-gray, salt-and-pepper, medium-grained, subrounded to rounded, well-sorted, water-polished, unconsolidated; 10 percent dark-brown to black medium-grained phosphate sand; trace of coarse-grained quartz and phosphate sand, light-gray sandy phosphate dolomite.	10	454
Sand as above but medium to coarse-grained; 15 percent dark olive-green clay, probably interbedded with quartz sand, which correspondingly decreases.	10	464

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Clay, dark olive-green, massive, blocky, semiconsolidated; 15 percent coarse-grained rounded to subrounded quartz sand; trace of coarse-grained black to brown phosphate sand.	11	475
Sand, quartz, coarse to very coarse-grained, rounded to subrounded, unconsolidated; coarse-grained dark-brown to black phosphate sand prominent; trace of fine quartz gravel, pale-green silty clay particles.	20	495
Sand as above with increase in clay to 15 percent, corresponding decrease in quartz sand.	12	507
Sand and clay, dark-gray with olive cast, semiconsolidated; 70 percent medium to very coarse-grained subrounded to rounded water-polished quartz sand; 20 percent dark olive-green silty calcareous clay binder; 10 percent coarse to very coarse-grained dark-brown to black phosphate sand.	10	517
Sand and clay as above with 20 percent increase in clay binder, corresponding decrease in quartz sand.	21	538
Dolomite, sandy, dark olive-green, semiconsolidated to consolidated; 55 percent fine crystalline dark-green dolomite matrix; 35 percent medium to coarse-grained rounded to subrounded water-polished quartz sand; 10 percent medium to coarse-grained brown, black, gray, and white phosphate sand; white gypsum aggregates prominent; trace of white finely pelletal limestone particles.	10	548
Limestone, off-white, highly porous, pelletal, composed of loosely cemented fine limestone pellets, bryozoan fragments, and fine to coarse mollusk fragments. Much dolomite cave in this interval.	10	558
Limestone as above with no dolomite cave. Microfauna from 600 to 610 feet include: *Jugosocythereis bicarinata* (Swain), *Eponides jacksonensis* (Cushman and Applin), *Gyroidina crystalriverensis* Puri, *Cibicides mississippiensis ocalanus* Cushman.	62	620
Limestone, white, highly porous, cuts up fine, composed mostly of bryozoan fragments loosely cemented with fine crystalline limestone; mollusk fragments prominent; trace of algal fragments.	22	642
Limestone as above with *Lepidocyclina* sp. common, *Heterostegina ocalana* Cushman rare.	22	664

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, off-white, porous, coarsely pelletal, consists of coarse limestone pellets, bryozoan fragments, and large foraminifera bound by 10 percent white argillaceous limestone matrix.	31	695
Limestone as above with 30 percent increase in argillaceous limestone matrix, corresponding decrease in pelletal material.	10	705
Limestone as 664 to 695 feet with coarse crystalline "bird's-eyes" of recrystallized calcite, Camerina sp. prominent.	42	747
Limestone, off-white, highly fossiliferous, pelletal; 50 percent large microfossils, chiefly Heterostegina ocalana Cushman, Lepidocyclina sp., and Sphaerogypsina globula (Reuss); 30 percent white argillaceous chalky limestone matrix; 20 percent medium to coarse limestone pellets and bryozoan fragments.	21	768
Dolomite, tan, medium crystalline, euhedral, semiconsolidated; 60 percent fine sand-sized euhedral dolomite crystals, formed as replacement of chalky limestone; 40 percent large microfossils (Heterostegina, Lepidocyclina, Camerina, Asterocyclina) "floating" in dolomite matrix.	10	778
Limestone as 747 to 768 feet with 15 percent increase in limestone pellets, corresponding decrease in chalky matrix; trace of very fine-grained dark-green glauconite 799 to 808 feet.	52	830
Limestone, off-white with yellow cast, pelletal, fossiliferous; 55 percent fine to coarse limestone pellets and small to large microfossils; 45 percent microcystalline to fine crystalline limestone matrix; limonite straining prominent, probably due to oxidation of very fine-grained pyrite and glauconite. Matrix is finely to coarsely recrystallized from 840 to 851 feet.	21	851
Limestone, tan, dolomitized, pelletal; 60 percent fine limestone pellets and small microfossils; 40 percent coarse crystalline euhedral to subhedral tan dolomite matrix.	10	861

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone and dolomite, light-brown to white; 60 percent white fine pelletal limestone, partially recrystallized, with large foraminifera and bryozoan fragments prominent, trace of very fine-grained glauconite; interbedded with 40 percent coarse crystalline light-brown euhedral dolomite, slightly friable.	10	871
Limestone, off-white, pelletal; 75 percent coarse pellets of white chalky limestone; 25 percent white chalky limestone matrix.	12	883
Dolomite, tan, coarse crystalline (fine sand-sized crystals), euhedral, friable; 15 percent interbedded white chalky fine pelletal fossiliferous limestone.	10	893
Limestone, light-gray with brown cast, pelletal; 55 percent fine to coarse pelletal chalky fossiliferous (medium-sized foraminifera) limestone; 45 percent light-brown fine crystalline dolomite matrix. Microfauna include Discorinopsis gunteri Cole, Valvulina martii Cushman and Bermudez.	31	924
Limestone, tan, pelletal, fine to coarse crystalline, porous; 75 percent fine broken bryozoan and other fossil fragments, well-sorted, recrystallized (fine crystalline) in large part; 25 percent tan coarse crystalline limestone matrix.	41	965
Limestone, off-white, coarsely pelletal, fossiliferous; 65 percent coarse limestone pellets and larger foraminifera; 35 percent off-white chalky limestone matrix, recrystallized to very fine crystalline in part; microfauna includes Fabularia vaughani Cole and Ponton.	32	997
Limestone as 924 to 965 feet.	31	1028
Limestone, off-white, fine to coarsely pelletal; 55 percent white fine to coarse limestone pellets and larger foraminifera; 45 percent coarse crystalline light-tan limestone matrix.	31	1059
Dolomite, light-brown, fine to medium crystalline, massive, trace of dark-brown to black organic material (algal mats) as spots. Much cave in this interval.	12	1071

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, off-white, fine pelletal; 80 percent fine white chalky limestone pellets; 20 percent coarse to very coarse crystalline tan calcite, representing recrystallization of limestone; large microfossils, broken bryozoan and echinoid remains prominent; Dictyoconus sp. common.	20	1091
Limestone, tan, fine to medium crystalline, euhedral to subhedral, recrystallized; 25 percent white chalky limestone matrix; much cave.	11	1102
Limestone as above with 40 percent increase in chalky limestone, corresponding decrease in crystalline limestone; much cave.	31	1133
Limestone, white, consists of fine limestone pellets in chalky matrix, both recrystallized (fine crystalline) in large part; bryozoan fragments prominent.	10	1143
Limestone, off-white, coarsely pelletal; 60 percent coarse off-white limestone pellets and large microfossils (Dictyoconus sp., Camerina sp.); 40 percent off-white chalky limestone matrix, finely to coarsely recrystallized in large part; much cave.	10	1153
Limestone as above except pellets and matrix totally recrystallized (fine crystalline); Dictyoconus sp. comprises 25 percent of rock.	31	1184
Limestone, off-white, microcrystalline, chalky, massive; 25 percent coarse limestone pellets and large microfossils, "floating" in microcrystalline limestone matrix; blebs and patches of tan recrystallized limestone prominent; lower 10 feet of interval very highly recrystallized.	31	1215
Limestone, off-white, pelletal, highly fossiliferous; 75 percent large microfossils (Dictyoconus sp., Camerina sp., Lepidocyclina (Polylepidina) antillea Cushman) and coarse limestone pellets, finely recrystallized; 25 percent white microcrystalline to fine crystalline chalky limestone matrix; large microfossils less prominent from 1226 to 1236 feet.	31	1246
Limestone, tan, finely pelletal; 55 percent fine to medium-sized tan coarsely recrystallized limestone pellets and medium-sized microfossils; 45 percent white chalky microcrystalline limestone matrix.	12	1258
Limestone as above with 25 percent increase in pellets and microfossils, corresponding decrease in chalky matrix; pellets and microfossils are coarse; recrystallization of matrix to very coarse tan calcite prominent from 1278 to 1332 feet.	84	1342

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Dolomite, tan with minor black mottling; coarse crystalline, euhedral to subhedral; 25 percent blebs and patches of white fine crystalline limestone "floating" in dolomite; thin interbeds of limestone as 1258 to 1342 feet common; black dolomite very prominent from 1363 to 1373 feet.	31	1373
Limestone, white, fine pelletal, recrystallized (fine crystalline), bryozoan and Lepidocyclina fragments prominent.	11	1384
Dolomite as 1342 to 1373 feet except mostly fine crystalline, mostly light-brown.	10	1394
Limestone as 1373 to 1384 feet.	10	1404
Dolomite as 1384 to 1394 feet.	12	1416
Limestone, light-gray to off-white interbedded, coarsely pelletal, highly fossiliferous (large microfossils), recrystallized; 20 percent hard microcrystalline limestone matrix. Microfauna include Gyroidina nassauensis Cole.	10	1426
Limestone, tan, fine to medium crystalline (recrystallized); 30 percent white chalky limestone pellets and large microfossils; bryozoan fragments prominent; trace of very fine-grained pyrite.	20	1446
Limestone, white, fine crystalline (recrystallized), sacchroidal texture, finely pelletal; trace of fine-grained pyrite.	10	1456
Limestone, tan with gray mottling, microcrystalline, chalky to dense; white macro- and micro-fossil material "floats" in microcrystalline limestone matrix; very fine-grained disseminated pyrite prominent; trace of slickensided limestone particles.	10	1466
Limestone, light-gray, coarsely pelletal, finely recrystallized, large microfossils prominent; interbedded with microcrystalline medium-gray dense limestone with pyrite aggregates prominent.	21	1487
Limestone as 1446 to 1456 feet with pyrite prominent, commonly recrystallized to coarse crystalline clear to off-white calcite; dark-gray medium crystalline dolomite (interbedded ?) very prominent from 1497 to 1509 feet and 1519 to 1529 feet.	42	1529

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, light-gray, coarsely pelletal; 80 percent coarse off-white to light-gray fine crystalline limestone pellets; 20 percent microcrystalline light-gray limestone matrix; coarse-grained euhedral pyrite prominent.	9	1538
Limestone as 1456 to 1466 feet.	10	1548
Limestone, light-gray, pelletal; 50 percent coarse white limestone pellets and large microfossils; 30 percent white chalky limestone matrix; 20 percent light to medium-gray coarse crystalline euhedral dolomite, as aggregates and as isolated crystals; trace of very fine-grained light-green glauconite.	10	1558
Dolomite, medium-gray, coarse crystalline, euhedral, poorly consolidated, friable; white chalky limestone blebs and patches prominent.	11	1569
Limestone, white, chalky, fine to medium pelletal; 55 percent chalky limestone pellets and medium-sized microfossils; 45 percent white chalky limestone matrix; Amphistegina sp., Bairdia sp. common.	10	1579
Dolomite as 1558 to 1569 feet.	10	1589
Limestone as 1569 to 1579 feet with 15 percent increase in limestone pellets and microfossils, corresponding decrease in chalky limestone matrix.	11	1600
Limestone, white, chalky, pelletal; 40 percent white chalky limestone matrix; 30 percent fine white chalky limestone pellets; 30 percent clear to light-gray coarse crystalline euhedral dolomite, as isolated crystals and as aggregates.	20	1620
Limestone as above with 15 percent increase in dolomite, corresponding decrease in limestone matrix.	11	1631
Dolomite, medium-gray, coarse to very coarse crystalline, euhedral, friable in part, rarely vuggy.	10	1641
Limestone as 1600 to 1620 feet.	10	1651
Limestone as 1620 to 1631 feet; dolomite off-white to tan.	53	1704
Dolomite, tan, medium to coarse crystalline, euhedral, slightly friable; blebs and patches of white chalky pelletal limestone prominent; trace of white gypsum; highly friable in lower 30 feet of interval.	42	1746
Limestone as 1600 to 1620 feet with dolomite light-tan to clear.	10	1756

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, off-white, fine pelletal; 60 percent fine white chalky limestone pellets; 40 percent white chalky limestone matrix; light-tan fine crystalline dolomite prominent; trace of small to medium microfossils.	42	1798
Limestone as above with decrease in dolomite to trace; very fine-grained pyrite and glauconite prominent.	10	1808
Limestone, light-gray, pelletal; 60 percent fine to coarse white chalky limestone pellets; 40 percent off-white chalky limestone matrix, recrystallized in part; medium-sized microfossils, pale to dark-green fine-grained disseminated glauconite prominent; much tan dolomite in lower 20 feet of interval.	31	1839
Limestone as above with light-tan chert very prominent.	12	1851
Limestone as 1808 to 1839 feet.	10	1861
Limestone, tan, pelletal; 45 percent medium to coarse off-white chalky limestone pellets; 40 percent off-white soft chalky limestone matrix; 15 percent light-brown chert; medium to coarse crystalline tan dolomite prominent; trace of very fine-grained dark-green glauconite.	10	1871
Limestone as 1808 to 1839 feet.	31	1902
Limestone, light-gray, finely pelletal, chalky; 10 percent light-gray chert; very fine-grained light-green glauconite prominent.	12	1914
Limestone as above with decrease in chert to trace, corresponding increase in fine pelletal limestone; add trace of coarse-grained light-green glauconite, coarse pyrite aggregates.	10	1924
Limestone, medium-gray, chalky to pelletal interbedded; 65 percent light-gray pelletal limestone as above; 35 percent highly glauconitic chalk, glauconite fine to medium-grained, dark-green.	10	1934
Limestone, light-gray, fine to coarsely pelletal; 60 percent coarse to fine white chalky limestone pellets; 40 percent microcrystalline to fine crystalline white to light-tan limestone matrix; very fine-grained light-green glauconite prominent.	21	1955

Table 1. -- Lithologic log -- Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone as above with 25 percent increase in chalky limestone matrix, corresponding decrease in pelletal limestone.	10	1965
Limestone, light-gray, finely pelletal; 60 percent fine white chalky limestone pellets; 40 percent white soft chalky limestone matrix; trace of tan coarse crystalline euhedral dolomite, very fine-grained dark-green glauconite.	21	1986
Limestone as above but coarsely pelletal, partly recrystallized, matrix not soft; very fossiliferous from 1996 to 2008 feet, contains Lockhartia praealta Levin; glauconite and dolomite absent.	42	2028
Limestone, light-gray, finely to coarsely pelletal; 50 percent white chalky fine to coarse limestone pellets; 50 percent white chalky limestone matrix; trace of medium-sized microfossils.	11	2039
Limestone as above with all pelletal material fine, matrix soft, tan dolomite prominent from 2059 to 2071 feet.	32	2071
Dolomite, tan, medium to coarse crystalline, euhedral, friable in part; blebs of white chalky limestone prominent; trace of vugs.	10	2081 (T.D.)

Table 2. -- Driller's log (Driller-Rudy Polk, Field Superintendent-R.E. Duckworth, Layne-Atlantic Company, Savannah, Georgia)

Depth (feet)	Description	Depth (feet)	Description
0-15	Top soil.	275-286	Sand, limestone, phosphate little clay, (soft drilling)
15-37	sand, (little clay).	286-296	Sand with little phosphate, clay, shell and limestone.
37-67	Sand, shell and clay.	296-306	Greenish clay with little sand and shell, soft.
67-76	Sand, little shell and clay.	306-317	Clay with little more sand and phosphate.
76-98	Sand, shell, clay and limestone.	317-327	Clay with little more sand and phosphate.
98-108	Sand, shell, limestone and little phosphate, (started losing mud).	327-337	Clay with little sand.
108-118	Limestone, shell, phosphate, little sand, (losing mud).	337-348	Clay with little sand.
118-129	Limestone, shell, phosphate, little sand, (losing mud).	348-358	Clay, medium drill.
129-139	Limestone, shell, phosphate and clay, (losing mud).	358-368	Clay, medium drill.
139-149	Clay, phosphate and sand.	368-380	Clay and phosphate, medium drill.
149-161	Clay, phosphate, sand, shell and limestone.	380-390	Medium sand with clay, lime, phosphate and shell.
161-171	Clay, sand, phosphate, shell and limestone.	390-400	Medium sand with clay, lime, phosphate and shell.
171-181	Medium coarse sand with little limestone and phosphate.	400-412	Medium sand with clay, lime, phosphate and shell.
181-192	Medium coarse sand, clay, limestone, phosphate, shell.	412-422	Medium sand with phosphate, shell and little clay.
192-202	Medium coarse sand, clay, limestone, phosphate, shell.	422-432	Medium sand, limestone with little shell, clay, phosphate.
202-212	Medium coarse sand, clay, limestone, phosphate, shell.	432-444	Medium sand, limestone with little shell, clay, phosphate.
212-224	Medium coarse sand, clay, limestone, phosphate, shell, (using some mud).	444-454	Sand, phosphate, limestone.
224-234	Medium coarse sand, limestone, phosphate, shell, (using some mud).	454-464	Clay, sand, with little limestone.
234-244	Clay, limestone sand shell and phosphate.	464-475	Clay with sand and phosphate.
244-255	Limestone, sand, phosphate and shell, (using mud).	475-485	Sand with clay, shell, phosphate.
255-265	Limestone, sand, phosphate and shell, (using mud).	485-495	Clay with sand, shell and phosphate.
265-275	Limestone, phosphate, shell and clay.	495-507	Clay with sand, shell and phosphate.
		507-517	Clay with sand, shell, phosphate and lime.
		517-527	Had more clay than above with sand, shell, phosphate.
		527-538	Clay, sand, shell, phosphate and lime, medium to hard drill.

Table 2. -- Driller's log -- Continued

Depth (feet)	Description
538-548	Clay, limestone, sand, shell and phosphate, medium to soft.
548-558	Limestone with little clay shell, sand, phosphate.
558-570	Limestone. Set casing at 568 feet.
570-585	Limestone. Set casing at 568 feet.
585-600	Limestone. Set casing at 568 feet
610-620	Grayish limestone.
620-632	Whitish limestone.
632-642	Grayish limestone
642-652	Brown limestone. little gray.
652-664	Light brown limestone.
664-674	Mostly light brown.
674-684	Mostly grayish.
684-695	Mostly grayish.
695-705	Mostly grayish.
705-715	Mostly grayish.
715-727	Brown.
727-737	Grayish.
737-747	Grayish.
747-758	Brownish.
758-768	Limestone.
768-778	Limestone.
778-789	Limestone.
789-799	Limestone.
799-809	Limestone.
809-820	Limestone.
820-830	Brownish.
830-840	Brownish.
840-851	Brownish.
851-861	Brown lime, (little gray).
861-871	Limestone, had some dark brown, (dark brown was hard).
871-883	Limestone, had some dark brown, (dark brown was hard).
883-893	Mostly brown limestone.
893-903	Brown, dark brown with little gray.
903-914	Brown, dark brown with little gray.
914-924	Brown and gray limestone.
924-934	Brown and gray limestone.
934-945	Brown and gray limestone.
945-955	Light brown limestone, soft.
955-965	Light brown limestone, hard streaks.
965-977	Gray, light brown and dark.
977-987	Mostly brown.
987-997	Mostly brown.
997-1008	Mostly brown.
1008-1018	Light brown limestone, soft.
1018-1028	Light brown limestone, soft.
1028-1039	Light brown limestone with little gray.
1039-1049	Light brown limestone, hard streaks.
1049-1059	Light brown limestone, hard streaks.
1059-1071	Dark limestone, 1060' to 1065' was very hard.
1071-1081	Light brown limestone, medium drill.
1081-1091	Light brown limestone, medium drill.
1091-1102	Mostly light brown with little mix, hard streaks.
1102-1112	Mostly light brown with little mix, hard streaks.
1112-1122	Mostly light brown with little mix, hard streaks.
1122-1133	Mostly light brown with little mix, hard streaks.
1133-1143	White limestone with little gray, soft with hard streaks.
1143-1153	White and brown limestone with hard streaks.
1153-1164	Brown and gray limestone with hard streaks.
1164-1174	Brownish limestone with hard streaks.

Table 2. -- Driller's log -- Continued

Depth (feet)	Description
1174-1184	Brownish limestone with hard streaks.
1184-1195	Grayish limestone with hard streaks.
1195-1205	Grayish limestone with hard streaks.
1205-1215	Grayish limestone, soft.
1215-1226	Light brown limestone with little gray, had more fossils in formation
1226-1236	Light brown and gray limestone, soft.
1236-1246	Light brown and gray limestone, soft.
1246-1258	Light brown and gray limestone, soft.
1258-1268	Light brown and gray limestone, sample was little coarser than above, fossils.
1268-1278	Same as last sample.
1278-1290	Same as last sample.
1290-1300	Same as last sample.
1300-1310	Brown limestone with little gray, soft.
1310-1322	Brown limestone with little gray, soft.
1322-1332	Light brown limestone with little gray, soft.
1332-1342	Light brown limestone with little gray, soft.
1342-1353	Light brown limestone with little gray, soft, (last 5 feet was hard).
1353-1363	Light brown and dark, hard
1363-1373	Light brown and dark, hard.
1373-1384	Gray and brown limestone, soft with hard streaks.
1384-1394	Light brown and dark brown, hard, (dark is Dolomite).
1394-1404	Light brown and dark brown, hard, (dark is Dolomite).
1404-1416	Light brown and dark with some black rock, hard.
1416-1426	Gray and brown limestone, hard with soft streaks.
1426-1436	Light brown with little gray, medium drill.
1436-1446	Gray and brown, medium.
1446-1456	Gray with little brown, medium.
1456-1466	Limestone, medium.
1466-1477	Gray with little brown, medium with soft streaks.
1477-1487	Gray with little brown, medium with soft streaks.
1487-1497	Gray limestone, medium with soft streaks.
1497-1509	Gray limestone, medium with soft streaks.
1509-1519	Gray limestone, medium with soft streaks.
1519-1529	Gray and brown limestone with some sandstone.
1529-1538	Gray limestone with little brown, medium drill.
1538-1548	Light gray with little more brown than other sample.
1548-1558	Gray, white and little brown, medium to soft.
1558-1569	Sandstone with hard streaks of limestone.
1569-1579	Gray and white limestone with little brown, soft to medium.
1579-1589	Sandstone with streaks of limestone, soft to medium.
1589-1600	Whitish limestone with little brown, medium drill.
1600-1610	Whitish limestone with little brown, soft to medium.

Table 2. -- Driller's log -- Continued

Depth (feet)	Description
1610-1620	Whitish limestone with little brown, soft to medium.
1620-1631	Brown sandstone with brown and white limestone, hard to medium.
1631-1641	Brown sandstone with little white limestone, hard to medium.
1641-1651	Light brown and whitish limestone, hard to medium.
1651-1663	Brown sandstone with little limestone, hard to medium.
1663-1673	Brownish limestone with hard streaks.
1673-1683	Brownish limestone with hard streaks.
1683-1694	Brown limestone, medium.
1694-1704	Light and dark brown limestone, shell, medium, (sanded limestone).
1704-1714	Light and dark brown limestone, shell, medium with hard streaks.
1714-1726	Light and dark brown limestone, shell, medium with hard streaks.
1726-1736	Light and dark brown limestone, shell, medium with hard streaks.
1736-1746	Light and dark brown limestone, shell, medium.
1746-1756	Light brown limestone with, little dark brown, medium.
1756-1766	Light brown limestone, fossils, soft to medium.
1766-1776	Light brown limestone, fossils, soft to medium.
1776-1788	Light brown limestone, fossils, soft to medium.
1788-1798	Light brown limestone, fossils, soft to medium.
1798-1808	Light brown with greenish streaks.
1808-1819	Light brown with greenish streaks.
1819-1829	Light brown and dark brown with greenish streaks.
1829-1839	Light brown and dark brown with sandstone, white, greenish clay, medium to hard.
1839-1851	Light brown and dark brown with sandstone, white, greenish clay, hard, flint like rock called chert, medium to hard.
1851-1861	Light brown and dark brown with greenish clay, hard.
1861-1871	Light and dark brown limestone, flint, clay, and sandstone, hark.
1871-1882	Light and dark brown limestone, flint, clay, and sandstone, hard.
1882-1892	Light and dark brown limestone, flint, clay, and sandstone, hard.
1892-1902	Light and dark brown limestone, flint, clay, and sandstone, hard.
1902-1914	Grayish limestone with blueish gray clay and flint rock, medium to hard.
1914-1924	Grayish limestone with little clay, fossils and flint rock, medium to hard.
1924-1934	Light and dark brown limestone with greenish streaks, fossils, hard.
1934-1945	Grayish limestone with greenish streaks. Little flint rock and clay, hard.
1945-1955	Brown and grayish limestone with greenish streaks, fossils, medium to hard.

Table 2. -- Driller's log -- Continued

Depth (feet)	Description
1955-1965	Brown and grayish limestone with greenish streaks, fossils, medium to hard.
1965-1976	Brown and grayish limestone with greenish streaks, fossils, medium to hard.
1976-1986	Light brown with little gray, white clay and fossils, medium to hard.
1986-1996	Light brown with little gray, white clay and fossils, medium to hard.
1996-2008	Mostly brown and fossils with little gray and white clay.
2008-2018	Light brown with little clay, fossils, medium.
2018-2028	Light brown with little clay, fossils, medium.
2028-2039	Light brown with little clay, fossils, medium.
2039-2049	Light brown with little clay, fossils, medium.
2049-2059	Light brown with little clay, fossils, medium.
2059-2071	Light brown with some gray and little clay and fossils, (chloride up 3400).
2071-2081	Dark brown (hard) with white and sanded limestone, (chloride up 5200).
2081-2091	Light and dark brown limestone, little clay and fossils, hard.
2091-2102	Light and dark brown limestone, clay with fossils, medium to hard.

Table 3. -- Drilling rate at selected intervals during construction of well.

Depth (ft)	Interval (ft)	Rate (ft/min)	Depth (ft)	Interval (ft)	Rate (ft/min)
642	10.0	0.20	1223	11.0	0.50
652	10.0	.12	1226	3.0	.75
664	12.0	.27	1231	5.0	.70
674	10.0	.11	1248	5.0	.80
684	10.0	.40	1263	5.0	.80
696	11.5	.46	1290	11.0	.90
705	10.0	.50	1330	10.0	.53
715	10.0	.50	1340	10.0	.45
727	12.0	.80	1351	11.0	.22
737	10.0	.90	1356	5.0	.30
799	10.0	.40	1361	5.0	.05
893	10.0	.40	1371	10.0	.12
903	10.0	.50	1382	11.0	.41
915	12.0	.48	1391	9.0	.08
925	10.0	.43	1400	9.0	.05
935	10.0	.31	1414	14.0	.11
946	12.0	.44	1424	10.0	.20
957	10.0	.77	1434	10.0	.18
967	10.0	.41	1444	11.0	.44
977	12.0	.30	1462	18.0	.19
988	10.0	.29	1472	10.0	.18
998	10.0	.29	1476	4.0	.10
1008	10.0	.33	1486	10.0	.19
1018	10.0	.67	1496	10.0	.71
1028	10.0	.67	1517	10.0	.31
1039	11.0	.34	1527	10.0	.22
1049	10.0	.37	1536	9.0	.36
1059	10.0	.31	1545	5.0	.20
1063	4.0	.10	1567	15.0	.31
1071	8.0	.20	1572	5.0	.16
1086	5.0	.60	1600	10.0	.23
1091	8.0	.80	1610	10.0	.25
1102	11.0	.80	1624	14.0	.14
1118	7.0	.60	1632	8.0	.13
1124	5.0	.60	1642	10.0	.31
1133	9.0	.80	1652	10.0	.29
1175	5.0	.46	1663	11.0	.12
1180	5.0	.30	1673	10.0	.28
1195	15.0	.42	1683	10.0	.18
1208	7.0	.30	1695	12.0	.43

Table 3. -- Drilling rate at selected intervals during construction of well -- Continued

Depth (ft)	Interval (ft)	Rate (ft/min)	Depth (ft)	Interval (ft)	Rate (ft/min)
1717	5.0	0.33	1887	5.0	0.16
1726	8.0	.30	1891	4.0	.26
1733	7.0	.40	1897	6.0	.30
1757	14.0	.31	1920	6.0	.30
1767	10.0	.32	1925	5.0	.25
1777	10.0	.53	1930	5.0	.16
1788	11.0	.37	1935	5.0	.14
1798	10.0	.50	1945	8.0	.25
1808	10.0	.30	1977	17.0	.29
1820	12.0	.67	1991	14.0	.23
1830	10.0	.17	2013	5.0	.33
1840	10.0	.07	2018	5.0	.46
1851	11.0	.15	2025	7.0	.70
1866	4.0	.10	2040	12.0	.57
1871	5.0	.15	2050	10.0	.47
1882	8.0	.16	2060	10.0	.40

Table 4. -- Water level in well during drilling.

Date	Depth interval (ft)	Water level (ft below landsurface)
12/15/78	568-632	68
12/18/78	568-695	70
1/22/79	568-1746	36
1/24/79	568-1856	20
2/02/79	568-1914	23
2/05/79	568-1945	22
2/13/79	568-2080	34

Water levels affected by nearby pumping wells

Table 5. -- Specific conductance and temperature of water samples obtained through the drill stem as the well was deepened from 1,476 to 2,080 feet.

Date	Depth (ft)	Specific Conductance (umhos at 25°C)	Temperature (°C)	Date	Depth (ft)	Specific Conductance (umhos at 25°C)	Temperature (°C)
1/16/79	1476	1600	25.0	2/1/79	1887	1600	-
	1517	2100	25.5		1891	1500	27.0
	1536	1900	26.5	2/2/79	1914	1440	27.0
1/17/79	1545	1500	25.5		1935	1500	27.0
	1577	1000	26.5		1944	1650	27.0
	1600	1000	27.0		1945	1500	27.0
1/18/79	1632	1220	26.5	2/5/79	1960	1580	26.0
	1642	1420	27.5		1976	1420	26.5
	1652	1380	28.0		1991	1490	26.0
	1663	2090	28.0	2/12/79	2013	1430	26.5
	1673	1850	28.0		2018	1230	27.0
	1683	1850	28.0		2025	1160	26.7
	1694	1880	28.0		2040	1380	29.0
1/19/79	1712	2200	26.0		2054	1140	27.7
	1726	1750	28.0		2060	1060	28.0
	1733	1850	27.0		2064	1080	27.5
1/22/79	1744	1700	26.0		2074	5200	27.5
	1757	1580	26.0		2080	15,000	27.5
	1767	3600	26.5	2/13/79	2080	22,000	-
	1777	1680	27.0				
	1788	1800	26.5				
	1798	1760	26.5				
	1808	1700	26.5				
1/23/79	1820	1690	24.5				
	1830	1540	26.5				
	1840	1560	28.5				
	1861	1280	28.5				
2/1/79	1866	1500	27.0				
	1882	1500	27.0				

Table 6. -- Chloride concentrations of water samples obtained through the drill stem as the well was deepened from 632 to 2,094 feet.

Depth (ft)	Chloride (mg/L)	Depth (ft)	Chloride (mg/L)
632	31	1,460	710
664	31	1,446	640
695	35	1,477	470
727	30	1,509	470
758	30	1,538	160
789	31	1,569	150
820	28	1,600	61
851	25	1,631	110
883	30	1,663	440
914	30	1,694	390
945	32	1,726	420
977	29	1,756	320
1,006	30	1,788	350
1,039	30	1,819	360
1,071	34	1,851	210
1,102	47	1,882	260
1,133	120	1,914	270
1,164	190	1,945	270
1,195	620	1,976	240
1,226	710	2,008	50
1,258	700	2,039	100
1,290	700	2,071	912
1,322	650	2,084	4,800
1,353	690	2,094	7,800
1,384	560		

Table 7. -- Water quality at selected depths. (All values are in milligrams per liter unless indicated otherwise.)

Constituent	Depth of Sample in feet below land surface		
	1567	1820	2000
Calcium (Ca)	78	73	760
Magnesium (Mg)	77	22	520
Sodium (Na)	40	62	4,200
Potassium (K)	2.7	9.0	94
Strontium (Sr)	.76	.82	18
Bicarbonate (HCO_3)	200	257	164
Sulfate (SO_4)	180	200	1,600
Chloride (Cl)	86	33	8,100
Fluoride (F)	.6	.5	1.0
Total hardness as $CaCO_3$	380	270	4,100
Noncarbonate hardness as $CaCO_3$	-	-	4,000
Alkalinity as $CaCO_3$	164	211	134
pH (units)	7.8	7.2	6.9
Specific conductance (umhos at 25°C)	849	725	25,000
Silica (Si02)	35	13	-
Iron (dissolved) (Fe)	.00	.01	.09
Bromide (Br)	.0	.2	.5
Iodide (I)	.03	.03	.18
Date collected	1/17/79	1/28/79	3/26/79

*U.S. GOVERNMENT PRINTING OFFICE: 1980-648-700/3917. Region 4.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
325 John Knox Rd--Suite F240
Tallahassee, Florida 32303

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR
INT. 413

U.S.MAIL

FIRST CLASS