WATER-SUPPLY POTENTIAL OF THE MIDDLE FLORIDAN AQUIFER IN SOUTHERN BEAUFORT COUNTY, SOUTH CAROLINA

Report to the Town of Hilton Head Island
Water Commission

By

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Introduction

This study was undertaken to evaluate the potential of the middle Floridan aquifer as a source of irrigation water on Hilton head island. Specific aspects addressed include the transmissivity and water quality of the middle Floridan aquifer, the magnitude of water-level declines to be expected from different pumping scenarios, and potential effects on rates of saltwater intrusion in the upper Floridan aquifer.

Geology

Hydrogeologic unit

The unit referred to in this report as the "middle Floridan aquifer" consists of one or more permeable units within the "middle zone of low permeability" recognized by Hayes (1979, p. 32). It was first identified by McCollum and Counts (1964), who named it "Zone 4". Of their five zones, Zones 1 and 2 make up the upper Floridan aquifer. Zones 3 and 5, above and below the unit discussed here, do not appear to be significant aquifers on northern Hilton Head Island, but may extend to the southern end of the island. The term "middle Floridan aquifer" is used here to distinguish this unit from the "lower permeable zone" of Hayes, which, if it occurs on Hilton Head Island, lies near the base of the Floridan aquifer several hundred feet below Zone 4. Zones 3-5 and the lower permeable zone were all included in the Lower Hydrogeologic Unit by Spigner and Ransom (1979, p. 47), and in the Lower Floridan Aquifer by Krause and Randolph (1989, p. 23).

The stratigraphic relationships of these units have been interpreted from lithologic samples from wells and from geophysical logs. The middle Floridan aquifer is approximately 30 to 60 ft thick, and lies at depths ranging from 430 to 550 ft below land surface in the vicinity of Hilton Head Island (see map, Fig. 1, and sections, Fig. 2). It is separated from the overlying upper Floridan aquifer by a semiconfining unit 220 to 300 ft thick, and underlain by at least 500 ft of similar semiconfining material.

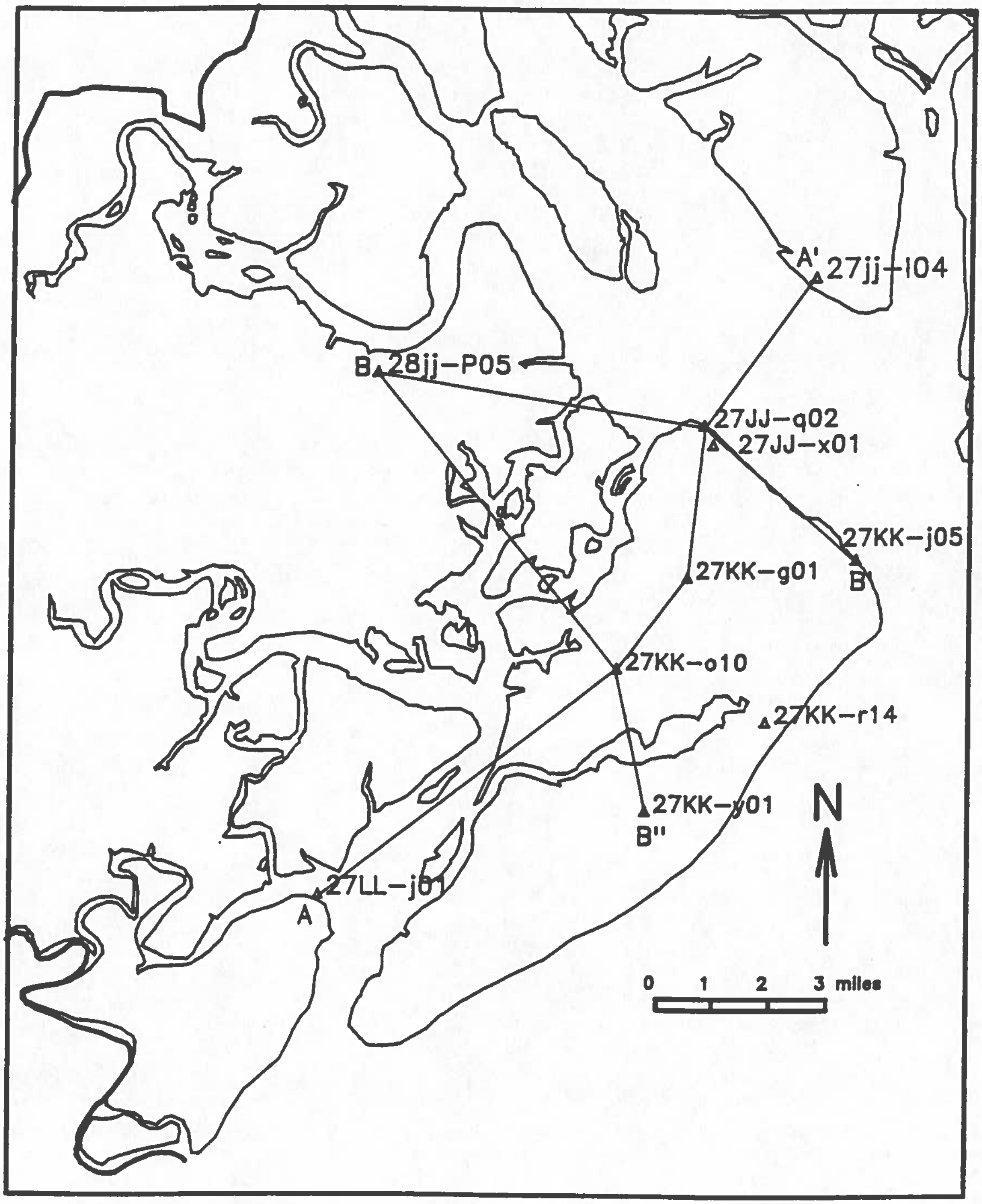

Figure 1. Locations of existing wells in the middle Floridan aquifer.

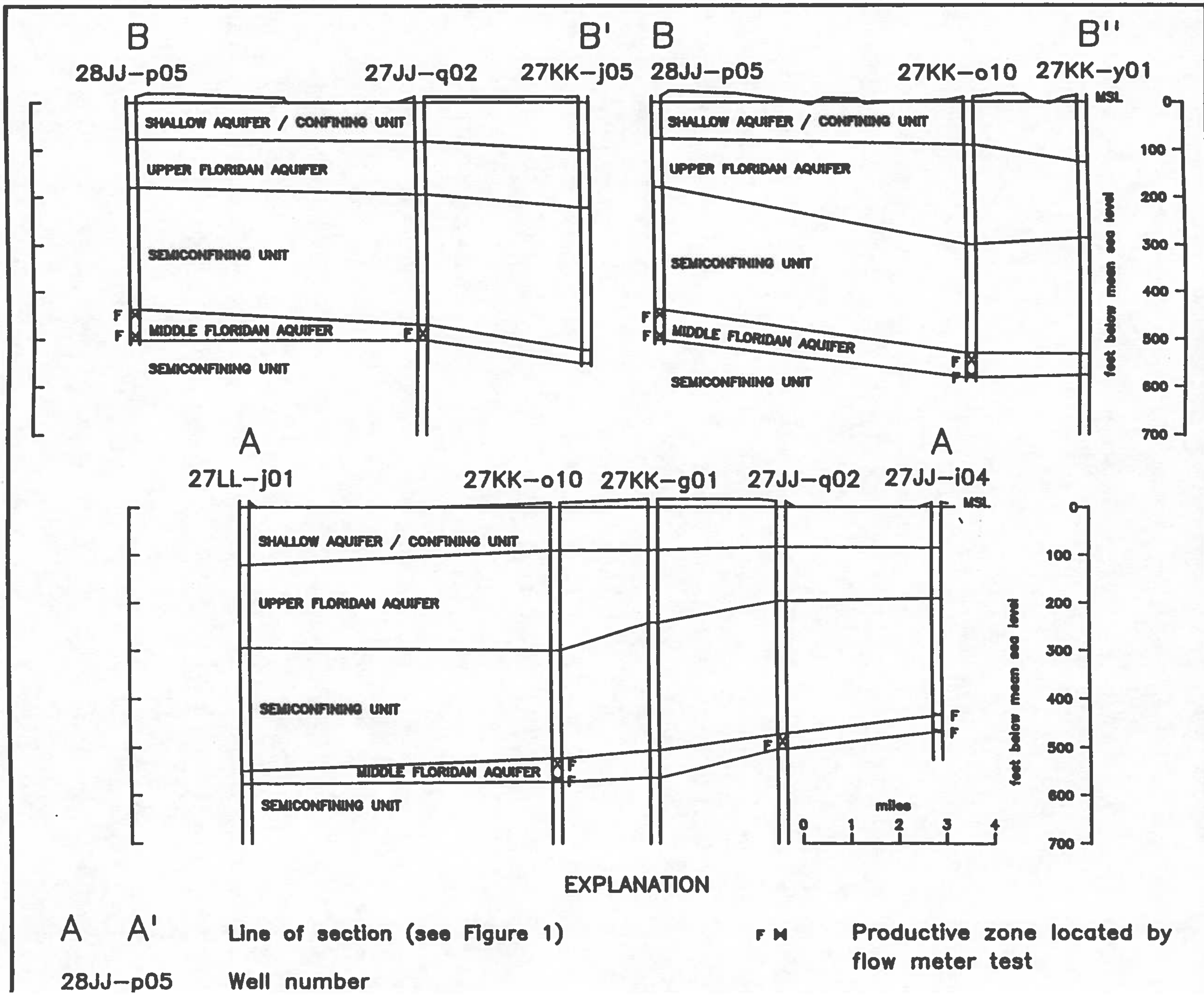

Figure 2. Sections showing hydrologic units within the Floridan aquifer.

Lithology

The lithologies of the middle Floridan aquifer and the semiconfining units above and below it are best displayed in core samples from test well 27JJ-q02 and a sidewall core from Cretaceous test well 27KK-r14. They are also known from cuttings from test wells 27JJ-i04, 28JJ-p05, 27KK-j05, and 27KK-o10.

The semiconfining units consist of fine calcarenites and calcilutites (the limestone textural equivalents of sandstone and shale) containing minor amounts of quartz sand and clay. Identifiable macrofossils are relatively uncommon; the sand-sized calcareous grains are worn and altered shell fragments and microfossils. The sidewall core from 382 ft below land surface in well 27KK-r14 (Appendix) is mainly calcite, with 27.3 percent porosity, 10.4 percent quartz, 9.6 percent dolomite (altered from calcite), and 5.4 percent clay minerals (Atlanta Testing and Engineering, 1992). Measured permeability is 15 millidarcys (a hydraulic conductivity of 0.041 ft/day). Most of the calcarenites and calcilutites are poorly consolidated, interbedded with thin layers of hard limestone.

The middle Floridan aquifer itself consisted originally of whole shells (mainly gastropods, bivalves and bryozoans) and shell fragments in a matrix of lime mud. Much of the lime mud and shell material consisted of aragonite, a mineral that has the same chemical composition as calcite but is more soluble in freshwater. Freshwater moving through the most permeable layers of the unit selectively dissolved the aragonite. Most of the dissolved calcium carbonate was removed; some was reprecipitated as cement in the remaining lime mud matrix. The resulting rock is a hard limestone with a high proportion of interconnected cavities, many of them natural molds of shells. Layers of such rock a few inches thick grade into and are interbedded with thicker intervals of poorly consolidated limestone consisting of well-preserved shell material with much of the lime mud matrix remaining. Permeability of the latter layers is intermediate between that of the most altered layers and that of the semiconfining units. The aquifer is, therefore, not a homogeneous single layer but a vertical sequence of thin layers of varying permeability. Individual permeable layers are probably of limited lateral distribution. Lateral variation in transmissivity (see below) is probably due to differences both in the original thicknesses of shell-rich beds and in the proportion of highly altered, very permeable beds to less altered layers.

Hydraulic Properties

Aquifer tests

Aquifer tests were conducted on six wells in the middle Floridan aquifer (Table 1; Fig. 1). Wells 27JJ-i04, 27JJ-q02, 27KK-j05, 27KK-o10, and 28JJ-p05 were redeveloped by pumping with compressed air prior to the aquifer tests. Well 27JJ-x01 was used as an observation well for the test of well 27JJ-q02; in other tests, no middle Floridan observation well was available. An upper Floridan observation well was monitored during each test. In each test the well was pumped for 24 hours, during which time water levels were monitored manually and instrumentally. Instrumental monitoring was continued through 24 hours of recovery; instrumental data for recovery in wells 27JJ-i04 and 27KK-o10 were lost, but manual measurements were obtained for early recovery in 27KK-i04.

Table 1. Transmissivities from aquifer tests on middle Floridan aquifer

County No.	Well	Discharge gal/min	Transmissivity gal/day/ft	sqft/day	Hydraulic ft/day entire aquifer	Conductivity ft/day productive zones only
985	27KK-g01	600	200,000	26,700	460	---
1809	27JJ-q02	150	58,000	7,800	240	260
1840	27JJ-i04	150	17,000	2,300	60	290
1820	27KK-o10	150	79,000	10,600	180	260
1813	27KK-j05	100	50,000	6,700	240	---
1845	28JJ-p05	150	66,000	8,800	140	220

Flow meter tests

Flow-meter logs made at wells 27JJ-i04, 27KK-o10, 27JJ-q02, and 28JJ-p05 show the amount of water contributed by each layer to the total discharge. In wells 27JJ-i04, 27KK-o10, and 28JJ-p05, two productive zones can be distinguished within the middle Floridan aquifer; in well 27JJ-q02 a single thicker productive zone is shown (Fig. 2).

Tidal influence

All of these wells are affected by marine tides; water-level changes in the water bodies surrounding Hilton Head Island are transmitted through aquifers as waves of hydrostatic pressure. The tidal efficiency (ratio of water level changes in a well to marine tidal changes) decreases inland, and the tidal lag (time difference between high and low tides and corresponding high and low water levels in a well) increases inland. Tidal efficiencies for middle Floridan wells are lower, and tidal lags longer, than for adjacent upper Floridan wells. If the efficiency and lag of tidal effects in a well relative to tides at a specific tide gage are known, measured water levels can be corrected to remove tidal effects. For the aquifer test at the Waddell Mariculture Center, a temporary tide gage was mounted on a pier on the Colleton River. For the remaining tests, a nearby well in the upper Floridan aquifer was used as a tide gage. For each test, the efficiency and lag of the middle Floridan well with respect to the tide gage was determined by using data from a separate monitoring period before or after the aquifer test; these were applied to tidal measurements taken during the test to calculate tidal corrections for the aquifer test data.

Transmissivity and hydraulic conductivity

Tide-corrected data were analyzed graphically. Transmissivities shown in Table 1 represent averages for drawdown and recovery, where available. The test on well 28JJ-p05 (Waddell Mariculture Center) is poor owing to changes in water level unrelated to the test, perhaps caused by nearby pumping from the upper Floridan aquifer; drawdown data were unusable, and recovery was incomplete. Transmissivity is greatest at Bear Creek Golf Course and least at Parris Island. Part of the wide range observed may be accounted for by variation in the thickness of the middle Floridan aquifer, as interpreted from gamma-ray logs. The remainder is due to local permeability variations as described above. Hydraulic conductivities calculated from the total thickness of the unit are more consistent than transmissivities (Table 1), and those calculated from total thickness of productive zones (as seen in flow meter logs) are even more consistent, averaging 260 ft/day.

Degree of hydraulic isolation

Records from adjacent upper Floridan wells monitored during the aquifer tests do not appear to show drawdown in the upper Floridan aquifer. Drawdown might be obscured owing of the shortness and relatively low discharge of these tests, limitations in the ability to correct for tidal influence, and interference from pumping of other upper Floridan wells. The records confirm, however, that the two aquifers are separated by a unit of low permeability.

Figure 3 shows water levels measured in February 1992, and Figure 4 shows the difference in water levels between the middle Floridan and upper Floridan aquifers. These measurements, with past measurements from wells 27JJ-x01 and 27KK-y01 and from a well pair at Fort Pulaski at the mouth of the Savannah River, show that water levels in the middle Floridan aquifer closely parallel those in the upper Floridan aquifer, and they show similar seasonal changes. Water levels in the middle Floridan average slightly lower than those of the upper Floridan aquifer near Port Royal Sound, about equal (alternately higher and lower) on central Hilton Head Island, and slightly higher at Fort Pulaski. The water levels define a cone of depression centered at Savannah, Ga. Krause and Randolph (1989, p. 23) wrote: "The Lower Floridan is not tapped for water supply in the Savannah area. However, it responds to pumping from the Upper Floridan, as indicated by the similarity between water levels observed in the Upper and Lower Floridan Aquifers.... This suggests that the Lower Floridan is hydraulically connected with the Upper Floridan."

When no water is pumped from the middle Floridan aquifer, its water levels are primarily controlled by those in the upper Floridan aquifer; water moves through the semiconfining unit from the aquifer with the higher water level to that with the lower water level. Under present conditions, vertical flow is downward along the coast of Hilton Head Island facing Port Royal Sound, nearly absent in the middle of the island, and upward southwest of Hilton Head Island. The vertical hydraulic conductivity of the semiconfining unit, although low enough to prevent obvious upper Floridan drawdown in response to short-term pumping of the middle Floridan aquifer, is high enough to permit flow to compensate for a long-term change in relative water levels.

Hydrologic Model for the Upper and Middle Floridan Aquifers, Southern Beaufort County

Model structure

Because of the vertical interaction of the middle Floridan and upper Floridan aquifers, and the lack of natural hydrologic boundaries in the vicinity of Hilton Head Island, it was not possible to construct a local hydrologic model of the middle Floridan aquifer. Instead, the information discussed above was used to formulate a second confining unit and third aquifer layer for the upper Floridan model of Smith (1988), which uses the MODFLOW model code (MacDonald and Harbaugh, 1984). Smith's model includes an area 91 miles northeast-southwest by 80 miles northwest-southeast in South Carolina and Georgia and includes most of the area where water levels are strongly influenced by pumping in the Savannah area (Fig. 5). It is divided into square-mile blocks. For purposes of this study a variable grid was used to divide an 18-mile-square area of Beaufort County south of Broad

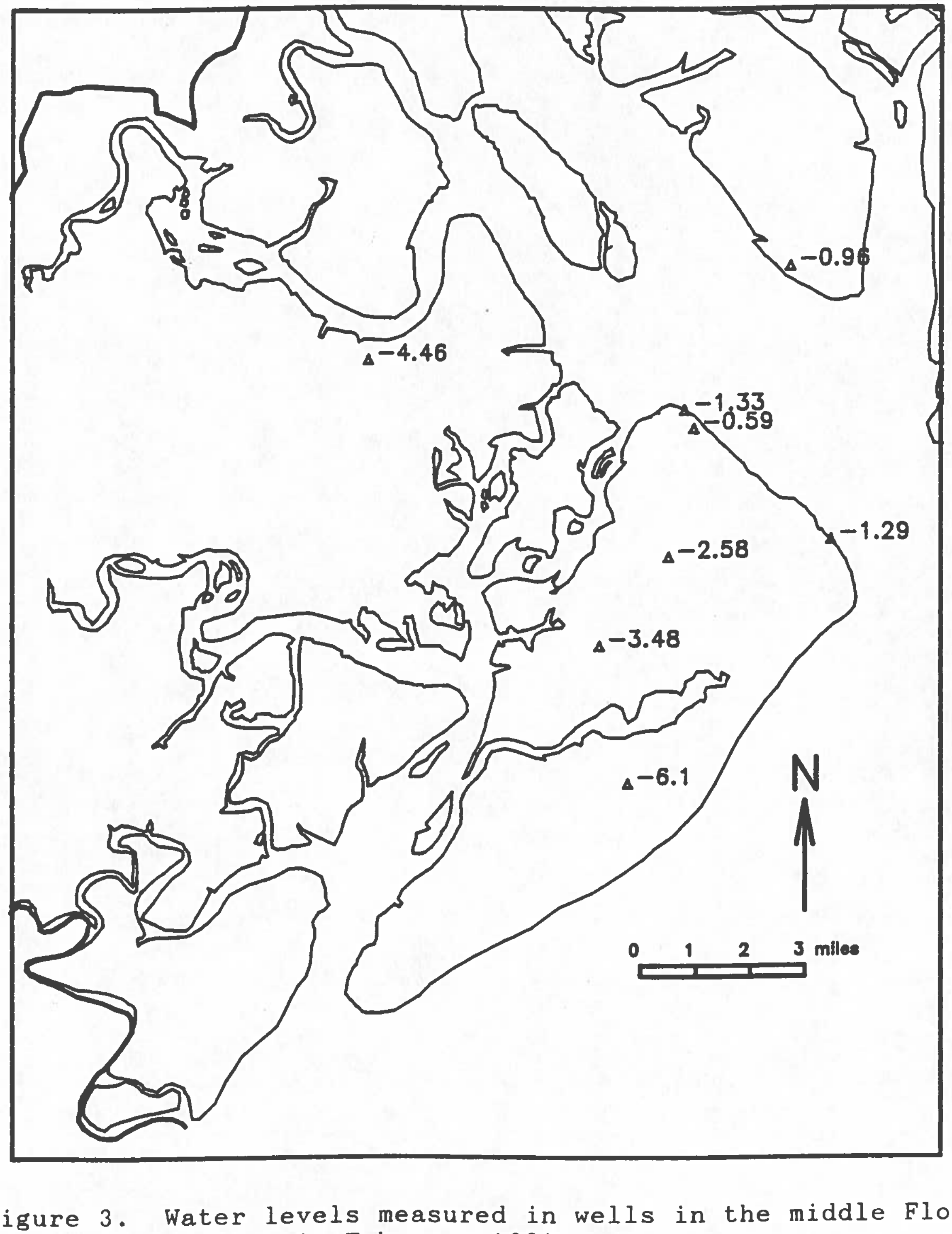

Figure 3. Water levels measured in wells in the middle Floridan aquifer in February 1991.

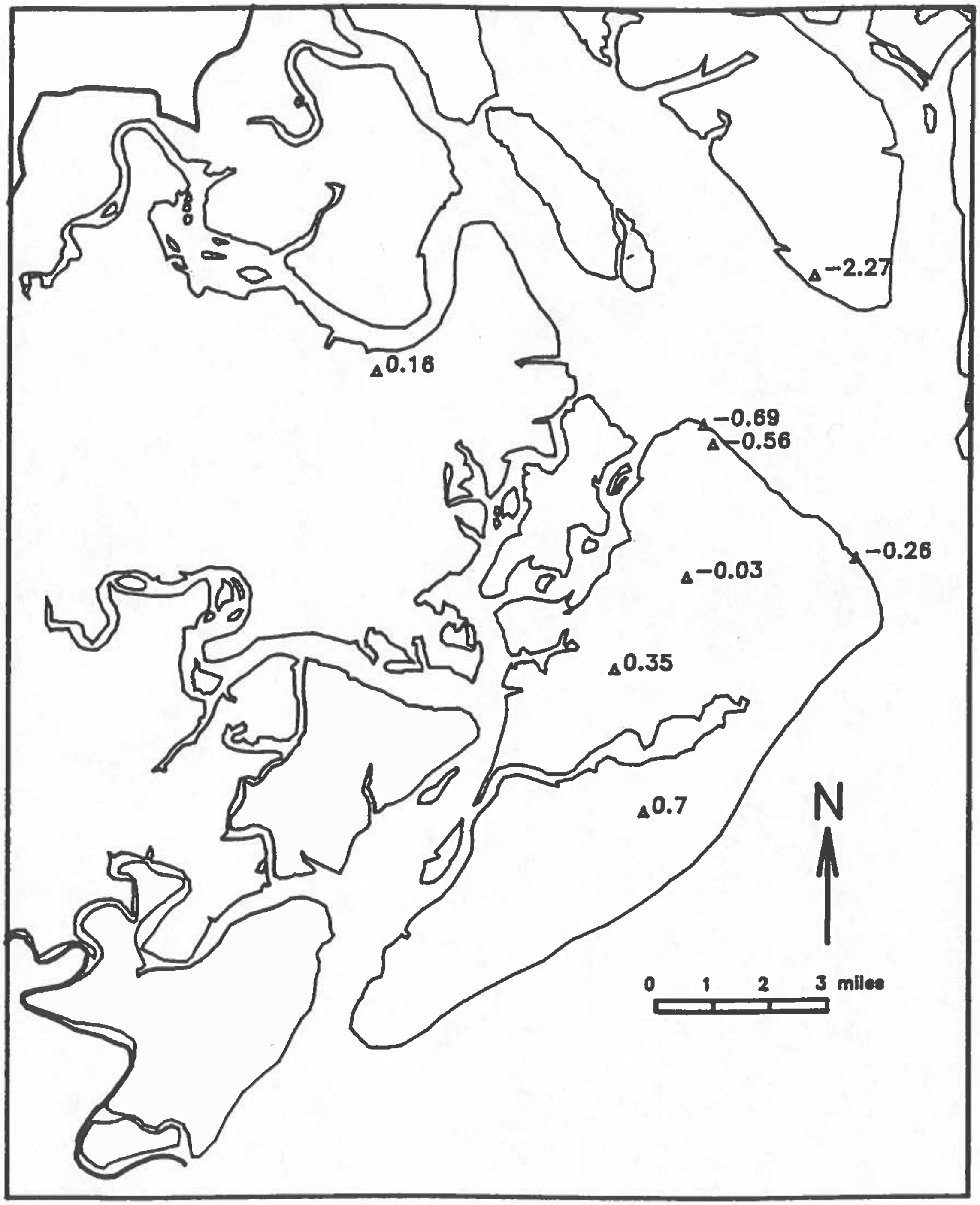

Figure 4. Differences in water levels measured in paired upper and middle Floridan wells, February 1991. A negative difference indicates that the water level in the middle Floridan aquifer was lower than that in the upper Floridan aquifer.

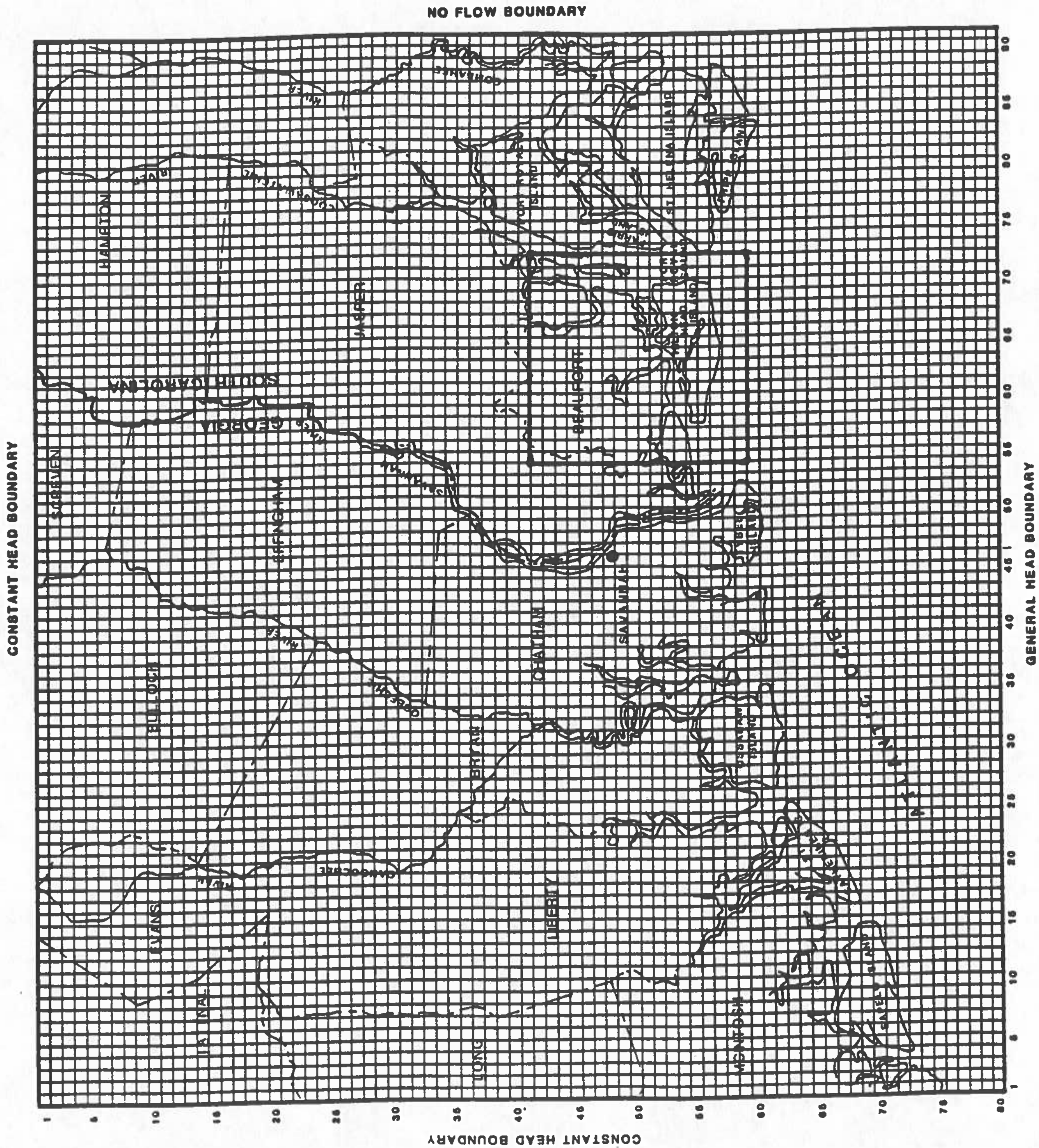

Figure 5. Map of model area with area of detailed model outlined (modified from Smith, 1988, Fig. 10, p. 23).

River into 1/2 mile x 1/2 mile blocks (Fig. 6). It should be emphasized that the model presented here is intended for use only in southern Beaufort County. It extends the "middle Floridan aquifer" beyond the area where it has been recognized in order to avoid artificial boundary effects in the area of interest. Illustrations of model output show only the area of interest; it should be understood that these are extracted from the output of the whole model. This is a steady-state model; it is useful for examining long-term effects of average pumping levels but not for evaluating seasonal or short-term effects unless the assumption can be made that the model reaches hydraulic steady state over the period of interest.

The middle Floridan aquifer is represented in the model by a table of transmissivities, one for each model block, derived by extrapolating the transmissivities shown in Table 1. The semiconfining unit is represented by a table of numbers that represent the inverse of the thickness of the unit, extrapolated between well records, and by a multiplier that includes a uniform vertical hydraulic conductivity for the unit. The product, for any block, is the vertical conductivity divided by the thickness of the unit. The edges of the middle Floridan aquifer, at the outer margins of the model, are no-flow boundaries. Water can enter the layer by downward leakage from the upper Floridan aquifer, and be removed from it either by upward leakage or by pumping. No flow is permitted between the middle Floridan aquifer and any lower unit.

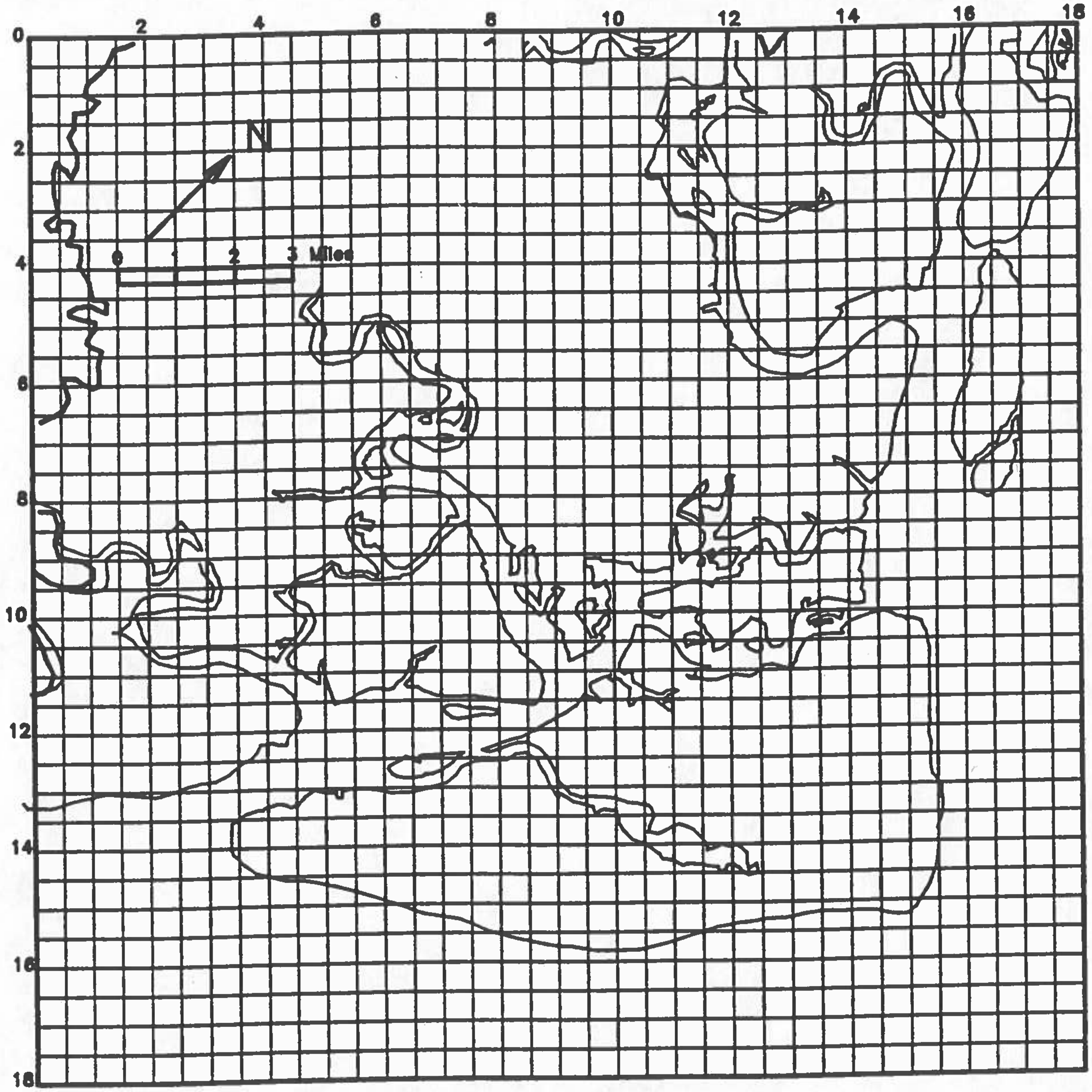

Figure 6. Model grid used for area of southern Beaufort County south of Broad River.

Model calibration

The model was calibrated with water-level and pumping data for 1991, the latest year for which a reasonably complete data set is available. The water levels used for comparison are an average of early March and late July levels. Upper Floridan pumping includes all permitted wells that reported water use in 1991; total reported use on Hilton Head Island was 10.56 mgd (million gallons per day). For each well, the annual total was averaged over the year to calculate a steady-state withdrawal rate. This data set was used with Smith's original model, giving simulated water levels that are consistent with the average measured levels. The three-layer model was then run with the same pumping and adjusted to give both the same upper Floridan water levels as the two-layer model and middle Floridan water levels consistent with the measured levels. Adjustment consisted mainly in altering the vertical hydraulic conductivity of the semiconfining layer. The value that produced the best fit of both upper Floridan and middle Floridan water levels is 0.009 ft/day, approximately one fifth of the laboratory permeability of the sidehole core from well 27KK-r14. It was also necessary to reduce the vertical conductivity of the upper confining unit in the area of heavy pumping near Savannah; part of the water that Smith's model draws from the upper layer is replaced in this model by water from the lower layer.

Model output

The MODFLOW model produces two types of direct output, a table of water levels for each layer and a table of drawdowns for each layer. The program ZONEBUDGET (Harbaugh, 1990) can be used to calculate rates of water flow through any designated part of the model. For this report, the rate of water flow, in millions of gallons per day, from beneath Port Royal Sound to Hilton Head Island was calculated for each layer and set of flow conditions. The flow data were also used to calculate estimates of the velocity of water movement in each aquifer from beneath Port Royal Sound to Hilton Head Island, in feet per year. Flow velocity is found by calculating the total quantity of water moving through a vertical plane in one year, divided by the area of the plane and by the porosity of the aquifer. The velocities shown here assume average thicknesses, along the coast, of 120 ft for the upper Floridan aquifer and average porosities of 30 percent. They represent average water flows and velocities through a 5-mile-long plane the height of the aquifer.

Model scenarios

1) The calibrated model was first used to calculate the effects of reducing pumping in the upper Floridan aquifer on Hilton Head Island to 9.5 mgd, with no pumping from the middle

Floridan aquifer. The water levels generated for this scenario were used as starting water levels for succeeding runs, and the flows were used for comparison with other scenarios.

2) Middle Floridan wells were placed near golf courses now permitted to use water from the upper Floridan aquifer. They were pumped at average rates corresponding to the present permits. This scenario places a high proportion of the withdrawals near Port Royal Sound. Total middle Floridan withdrawals under this scenario are 1.14 mgd.

3) Using the same total middle Floridan pumping as in scenario 2, most of the middle Floridan pumping near Port Royal Sound was moved to sites in central and southern areas of the island.

Modeled results for each scenario

1) Figures 7 and 8 show the predicted water levels in the upper Floridan and middle Floridan aquifers after reduction of upper Floridan withdrawals to 9.5 mgd. The model predicts that 1.20 mgd will flow from Port Royal Sound to Hilton Head Island in the upper Floridan aquifer with a velocity of 61 ft/yr, and 0.27 mgd will flow in the middle Floridan aquifer at 41 ft/yr.

2) Figures 9 and 10 show predicted drawdowns in the upper and middle Floridan aquifers with additional withdrawals of 1.14 mgd from middle Floridan wells in northern and central Hilton Head Island, compared to the levels simulated in scenario 1. Under these conditions an additional 0.05 mgd is drawn under the northeast coast of Hilton Head Island through the upper Floridan aquifer and 0.15 mgd through the middle Floridan aquifer. In each aquifer the velocity of this flow is calculated as 64 ft/yr. Of the remaining 0.94 mgd, part comes from increased leakage of water from the shallow aquifer to the upper Floridan, and the remainder is drawn from under areas north and south of Hilton Head through both aquifers.

3) Figures 11 and 12 show predicted drawdowns, compared to scenario 1, in the upper and middle Floridan aquifers with the same pumping from each aquifer as above but with with the average position of middle Floridan wells shifted southward. Under these conditions the total inflow from Port Royal Sound is 0.07 mgd less than for scenario 2; however, the inflow in the upper Floridan aquifer actually increases slightly. Along the northeast coast, flow velocities are 65 ft/yr in the upper Floridan aquifer and 52 ft/yr in the middle Floridan. The potential effects of middle Floridan withdrawals on the rate of saltwater intrusion in the upper Floridan aquifer are practically the same for the two sets of well positions.

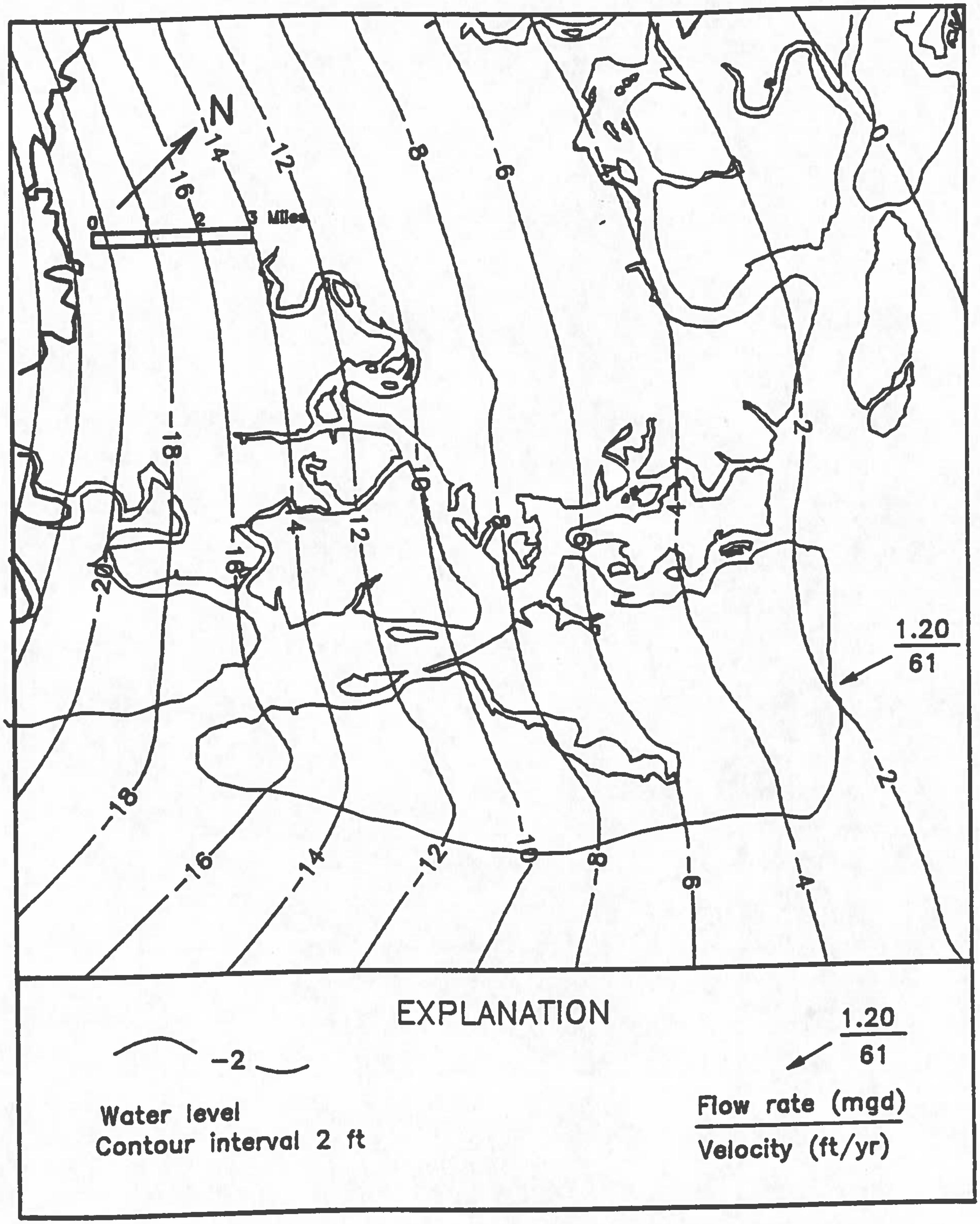

Figure 7. Model-generated water levels in the upper Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer.

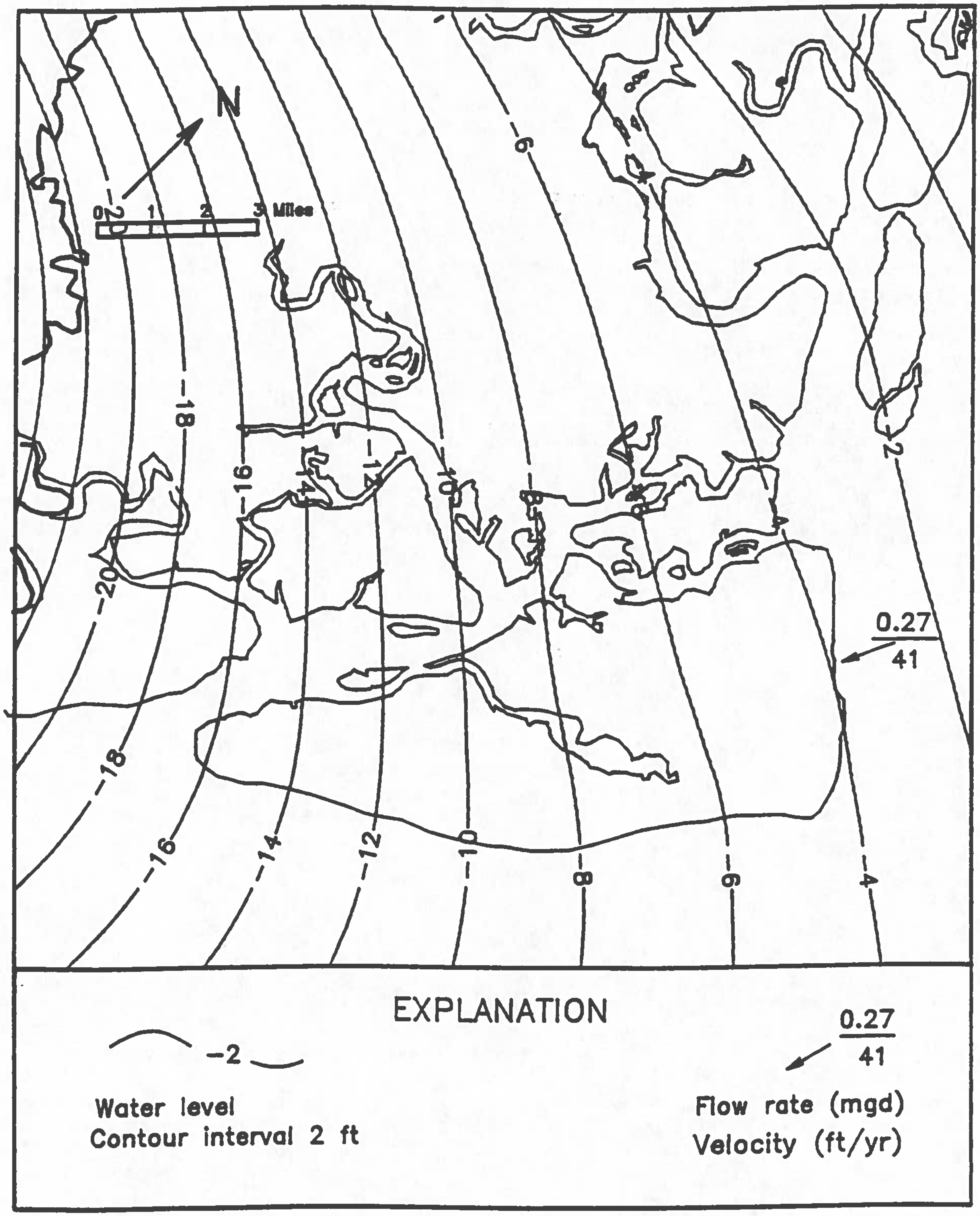

Figure 8. Model-generated water levels in the middle Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer.

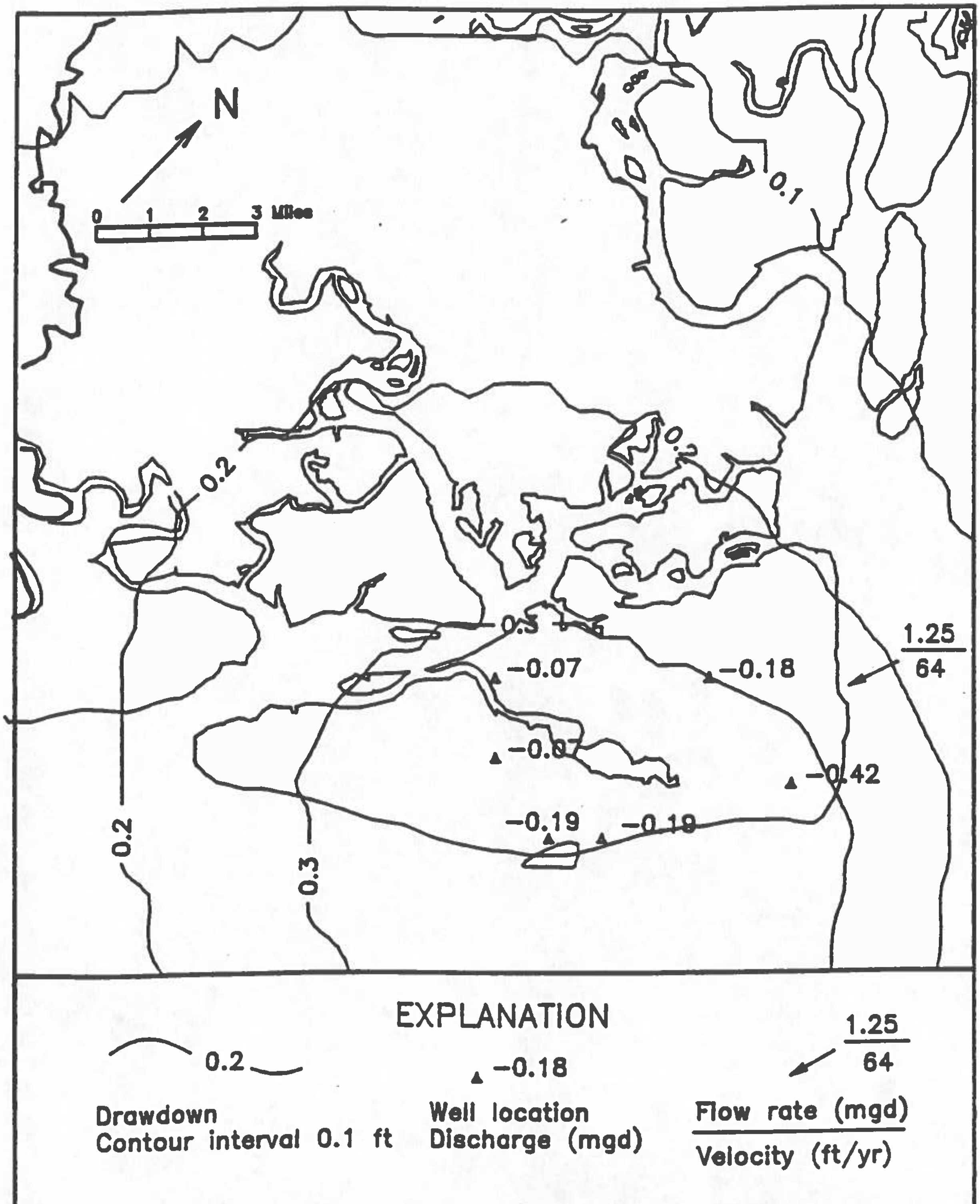

Figure 9. Model-generated drawdown in the upper Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer and 1.1 mgd from the middle Floridan aquifer, distributed as shown.

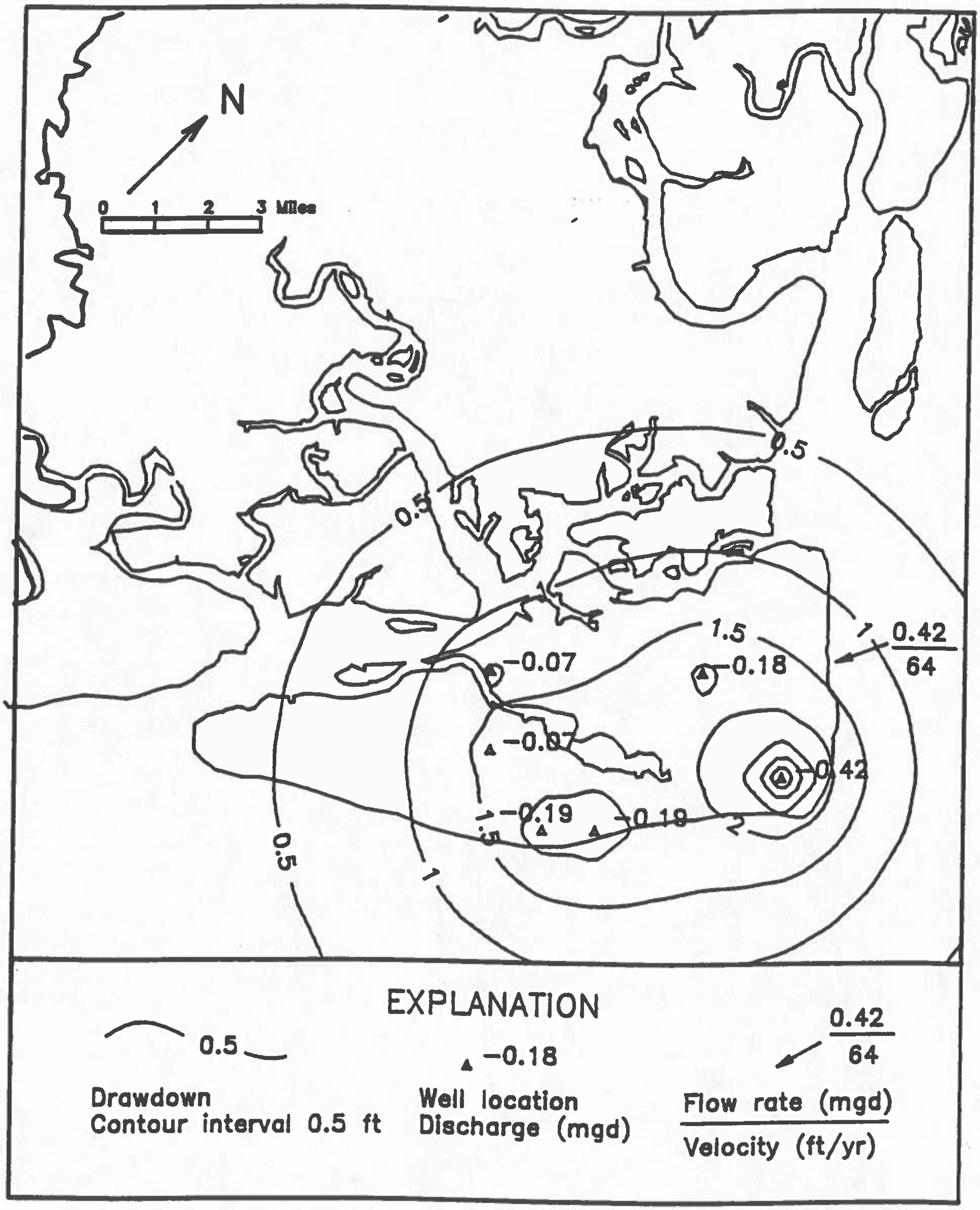

Figure 10. Model-generated drawdown in the middle Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer and 1.1 mgd from the middle Floridan aquifer, distributed as shown.

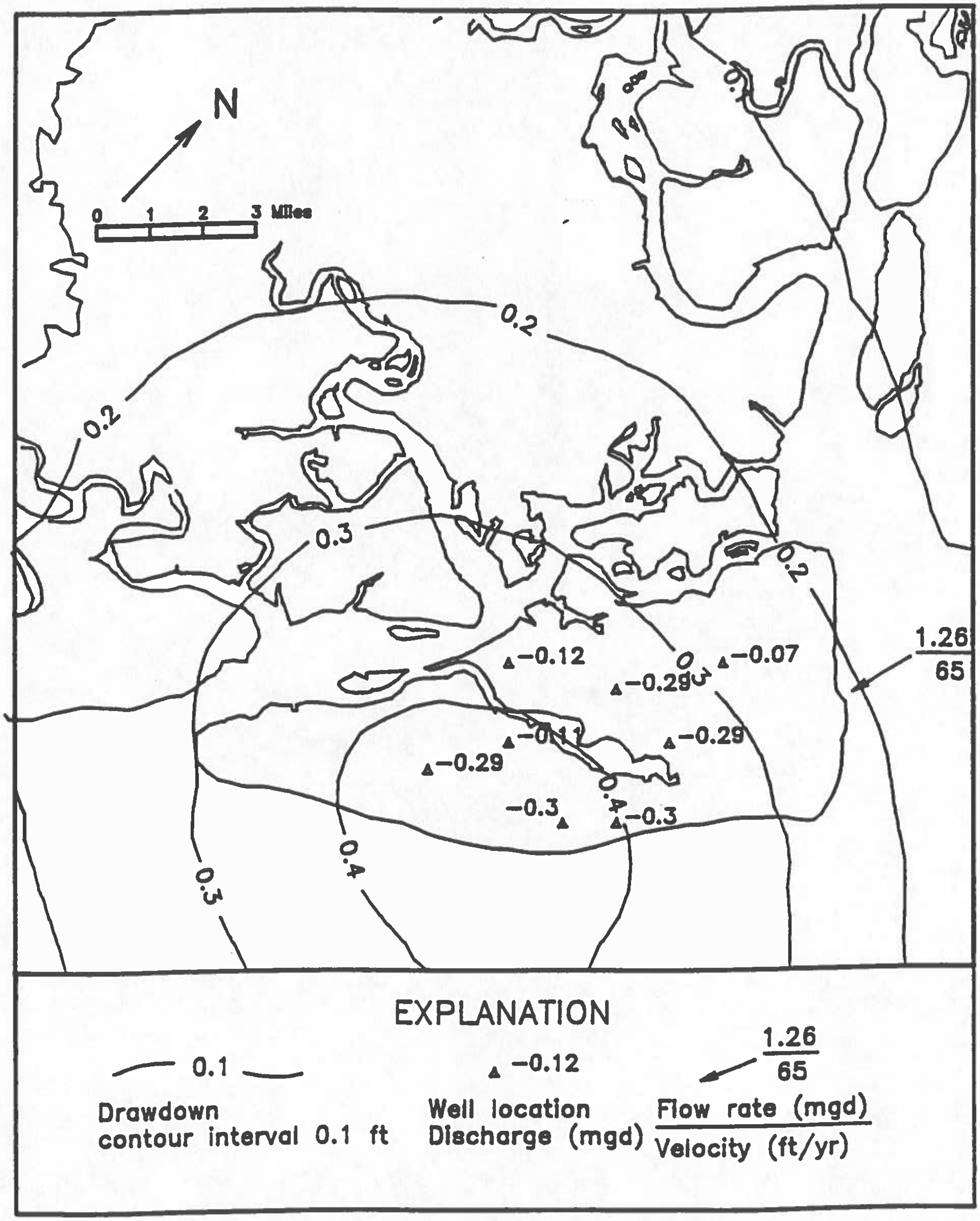

Figure 11. Model-generated drawdown in the upper Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer and 1.1 mgd from the middle Floridan aquifer, distributed as shown.

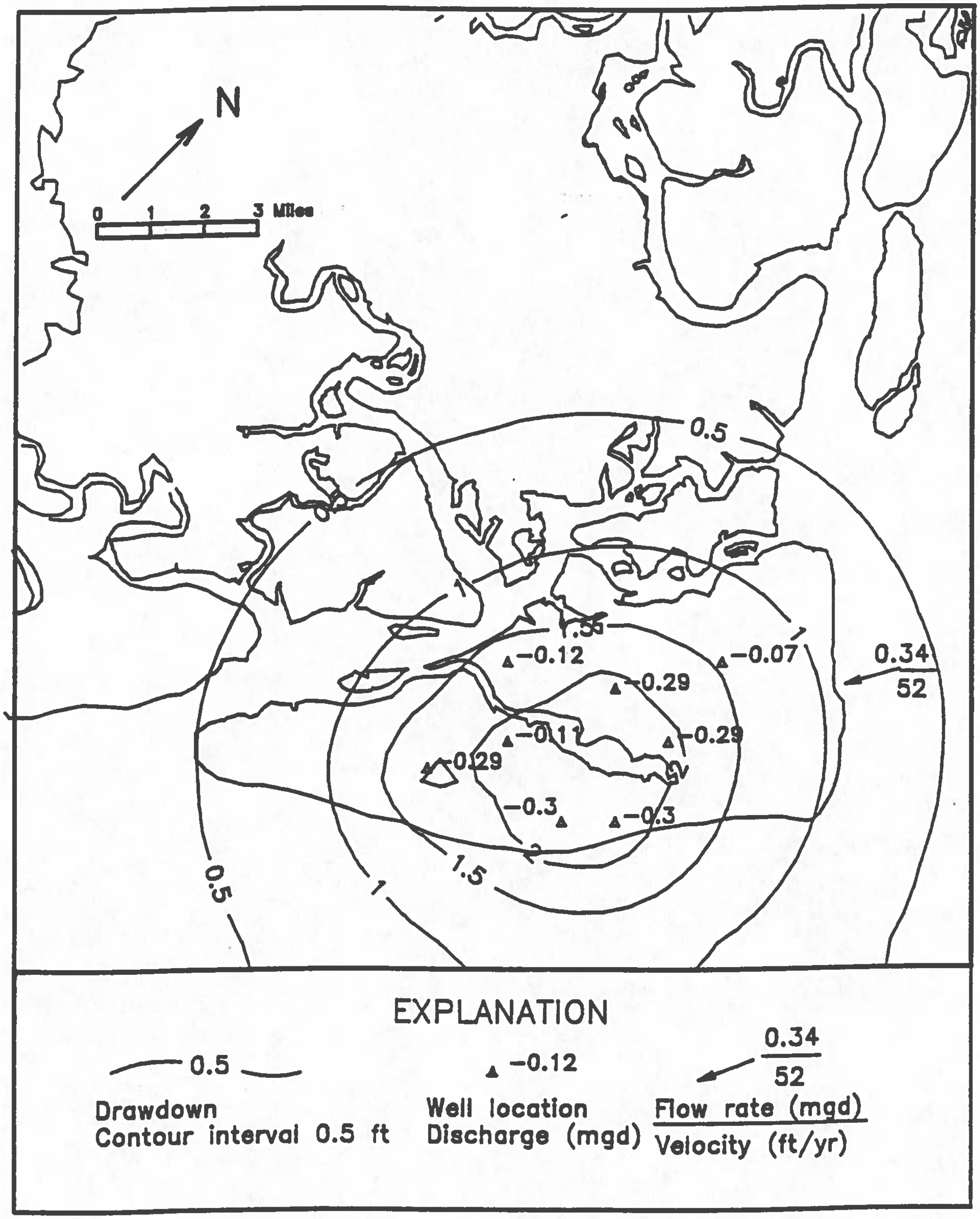

Figure 12. Model-generated drawdown in the middle Floridan aquifer for water use of 9.5 mgd from the upper Floridan aquifer and 1.1 mgd from the middle Floridan aquifer, distributed as shown.

Summary of results of modeling

Withdrawal of 9.5 mgd from the upper Floridan aquifer, with no pumping from the middle Floridan aquifer, is predicted to cause inflow from under Port Royal Sound of 1.20 mgd, at a velocity of 61 ft/year, in the upper Floridan aquifer. Withdrawal of an additional 1.1 mgd from the middle Floridan aquifer, the amount that golf courses are currently permitted to use for irrigation, will increase these flow rates by 4 to 5 percent. This prediction assumes that the full 1.1 mgd is used and is distributed equally through the year. In practice, the full amount would probably not be used in most years. Rates of inflow would be greater in the irrigation season and less in the non-irrigation season.

By comparison, the actual water use in 1991 is calculated to have caused inflow of 1.32 mgd, at an average velocity of 68 ft/yr, 10 percent higher than for the 9.5-mgd withdrawal rate used here. If the golf courses had used all of the irrigation water permitted, the average rate of inflow from beneath Port Royal Sound would have been 1.48 mgd, 23 percent higher than for the 9.5-mgd withdrawal rate, at a velocity of 76 ft/yr.

Water Chemistry

Sampling and analysis

Water chemistry was monitored continuously during aquifer testing, and a water sample was collected near the end of each pumping test. Temperature, specific conductance, and pH were measured in a closed, flow-through cell connected in parallel with the pump discharge. Changes in water quality -- typically marked by increasing specific conductance -- were recorded periodically, and samples were collected after specific conductance, temperature, and pH stabilized.

Samples were collected according to U.S. Geological Survey (USGS) procedures and, with the exception of the well at Bear Creek Golf Course (27KK-g01), were analyzed by the USGS laboratory at Ocala, Fla. Samples included both filtered and unfiltered water for determination of total and dissolved species, and zinc acetate treated water for measurement of sulfide concentrations. The analytical results are summarized in Table 2; copies of provisional analyses are included in the appendix.

Table 2. Selected water-chemistry data for wells open to the middle Floridan aquifer

Well number	27JJ-i04	27KK-j05	27JJ-q02	27KK-o10	28JJ-p05
Location	Parris Island	Fort Walker	Dolphin Head	Indigo Run	Waddell Center
Sample date	07/29/92	08/05/92	07/13/92	07/16/92	07/22/92
Alkalinity	218	194	164	150	154
TDS*	8,940	6,064	4,082	962	232
Sp. Cond.	13200	9,600	6,810	1,710	378
pH	7.1	7.5	7.5	7.8	8.1
Temp (°C)	22.1	24.0	22.8	23.6	23.4
Temp (°F)	71.8	75.2	73.0	74.5	74.1
Hardness	1,571		816	250	66
SAR**	24.1			6.3	2.9
Bicarbonate	265	236	200	182	187
Chloride	4,250	2,825	2,025	390	8
Fluoride	0.7	1.2	0.8	0.9	1.4
Nitrate	0.4	0.1	< 0.1	< 0.1	0.3
Sulfate	440	640	330	110	26
Sulfide	< 1	< 1	< 1	< 1	< 1
Calcium	250		96	31	13
Magnesium	230		140	42	8
Iron	0.01	0.02	0.02	0.01	< 0.005
Manganese	0.01		< 0.005	< 0.005	< 0.005
Potassium	88	70		0.2	5.2
Sodium	2,200	1,600		230	55
Silica	28	36	34	32	35

Concentrations of dissolved species in milligrams per liter; pH and temperature as measured in field.
**TDS: total dissolved solids
* SAR: sodium-adsorption ratio.

Water chemistry

Water chemistry ranged from a fresh, sodium bicarbonate type to a brackish, sodium chloride type. Chloride and dissolved-solids concentrations ranged from 8 mg/L and 232 mg/L, respectively, at the Waddell Mariculture Center (28JJ-p05) to 4,250 mg/L and 8,940 mg/L, respectively, at Parris Island (27JJ-i04).

Figure 13 shows the distribution of chloride and total dissolved-solids concentrations. Their concentrations generally increase toward the northeast, and the poorest water quality occurs at Parris Island. Chloride and total dissolved solids probably exceed the EPA secondary water-quality standards (250 and 500 mg/L, respectively) everywhere beneath Hilton Head Island, but freshwater apparently occurs at, and west of, the Waddell Mariculture Center.

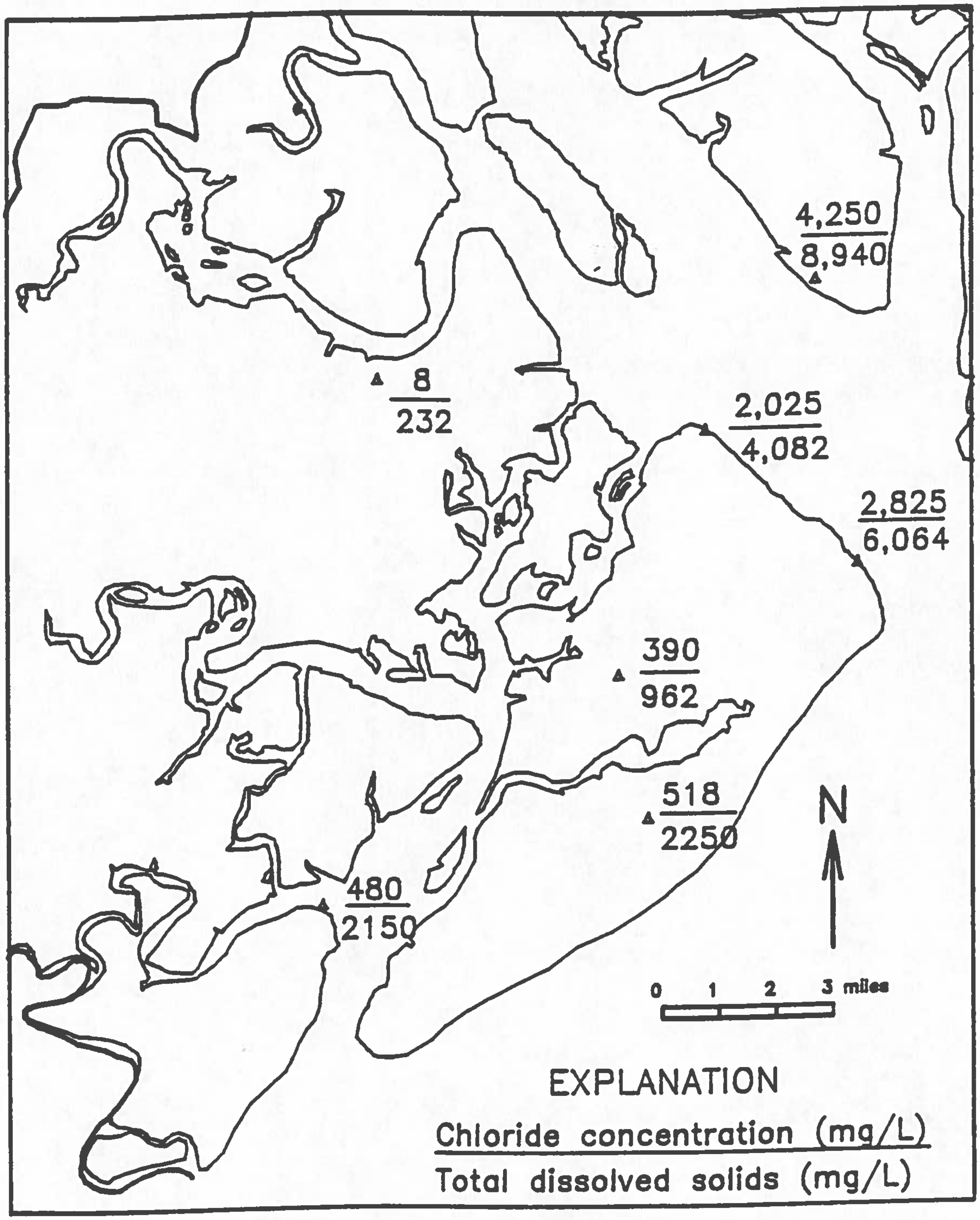

Figure 13. Areal distribution of chloride concentrations and total dissolved solids, in mg/L, in samples from middle Floridan wells.

Summary

The middle Floridan aquifer is a thin limestone sequence whose permeability principally evolved from the dissolution of aragonitic shell material. At Hilton Head Island, the top of the aquifer occurs at about 500 ft below land surface and the aquifer's thickness ranges from 30 to 60 ft. Fine calcarenites and calcilutites containing minor amounts of sand and clay adjoin the more permeable middle Floridan and behave as semiconfining units.

Aquifer tests were made at six locations and usually consisted of both drawdown and recovery measurements in each middle Floridan well. Measurements also were taken in nearby upper Floridan wells. The transmissivity of the middle Floridan ranged from 2,300 to 26,700 ft^2/day; the hydraulic conductivity in productive zones identified by flowmeter logs ranged from 220 to 290 ft/day. No response was apparent in the upper Floridan wells.

The middle Floridan was modeled by formulating a second confining unit and third aquifer for the upper Floridan model of Smith (1988) -- steady-state conditions are simulated. The effects of reducing upper Floridan withdrawals to 9.5 mgd and of adding 1.14 mgd of pumping in the middle Floridan were modeled. Simulations indicate that a 1.14-mgd withdrawal from the middle Floridan would increase inflow in the upper Floridan aquifer by 4 to 5 percent; shifting the withdrawals southward does not reduce this additional inflow. Pumping 1.14 mgd from the middle Floridan could result in an average of about 0.3 ft of drawdown in the upper Floridan.

Water in the middle Floridan aquifer is fresh beneath the mainland, brackish at Hilton Head Island, and moderately saline at Parris Island. Chloride concentrations range from 8 to 4,250 mg/L and total dissolved solids range from 232 to 8,940 mg/L.

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Appendix

Results from analyses by the USGS laboratory,
Ocala, Florida (provisional data)

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*  U.S. GEOLOGICAL SURVEY    *
*   Q. W. SERVICE UNIT       *
*    OCALA, FLORIDA          *
*   SUN, SEP 20 1992         *
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* STATION ID: BFT1840   DATE: 07/29/1992 TIME: 0945 FIELD ID: 27JJL04   OCALA LAB ID NUMBER: 926789
* STATION NAME: BFT 1840   STATE CODE: 45 USER / DISTRICT CODE: 45
* SAMPLE MEDIUM: 6 GEOLOGIC UNIT: ANALYSIS STATUS: H ANALYSIS SOURCE: 1 HYDROLOGIC CONDITION: 9 SAMPLE TYPE: 9
* HYDROLOGIC EVENT: 9 PROJECT ACCOUNT: 454500300   COST $ 148.   FILE DEPOSITION: Q SCHEDULES: 4417 0000 0000 0000 0000
* RETRIEVED ON: 09/20/92   BY: JMBARTON

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Cations	Mg/L	Meq.	Anions	Mg/L	Meq.	Selected Parameters	Value
Acidity as H	0.80	0.794	Bicarbonate as HCO3	265.80	4.356	Sp. Cond. (LAB)	13200.000
Calcium as Ca	250.00	12.475	Chloride as Cl	4250.00	119.892	Sp. Cond. (FLD)	1260.000
Magnesium as Mg	230.00	18.920	Fluoride as F	0.71	0.037	pH (LAB)	7.390
Sodium as Na	2200.00	95.700	Sulfate as SO4	440.00	9.161	pH (FLD)	7.100
Potassium as K	88.00	2.251	Nitrate as NO3	0.35	0.000	Alk. as CaCO3 (LAB)	218.009
Iron as Fe	0.01	0.000				Alk. as CaCO3 (FLD)	210.000
Manganese as Mn	0.01	0.000				ROE at 180 C	8940.000
						ROE (Calc)	7618.190
						Silica as SiO2	28.300
Cation Ionic Total		130.140	Anion Ionic Total		133.447	Percent Ionic Error	-1.255

LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK / VALUE
0001	71825	ACIDITY AS H	EPA 305.1	0.8000
0070	90410	ALK TOT (LAB) CACO3	I-1030-84	218.0000
0002	00410	ALK TOT FIELD CACO3	- -	210.0000
0091	00028	ANALYZING AGENCY	- -	81213.0000
1178	95440	BICARBONATE LAB (EP)	- -	265.8000
0659	00915	CALCIUM DISS (ICP)	I-1472-87	250.0000
4659	00916	CALCIUM TOT. (ICP)	EPA 200.7	240.0000
0292	00940	CHLORIDE DIS (IC)	I-2057-85	4200.0000
0083	00027	COLLECTION AGENCY	- -	84540.0000
0654	99457	DIGESTION HCL WATER	I-3485-85	1.0000
0498	00950	FLUORIDE DIS (ELEC)	EPA 340.2	0.7000
1181	95902	HARDNESS N-CARB LAB	I-1344-85	1353.3009
0499	00900	HARDNESS TOT	I-1340-85	1571.3098
0645	01046	IRON DISS (ICP)	I-1472-87	12.0000
0275	01044	IRON SUSPENDED	I-7000-79	32.0000
4645	01045	IRON TOT. (ICP)	EPA 200.7	44.0000
4030	99899	JULIAN LOGIN DATE	- -	92214.0000
0663	00925	MAGNESIUM DISS (ICP)	I-1472-87	230.0000
4663	00927	MAGNESIUM TOT. (ICP)	EPA 200.7	230.0000
0648	01056	MANGANESE DISS (ICP)	I-1472-87	8.0000
0262	01054	MANGANESE SUSPENDED	I-7000-79	< 1.0000
4648	01055	MANGANESE TOT. (ICP)	EPA 200.7	8.0000
0228	00631	NITR NO2+NO3-N DIS	I-2545-84	0.0900
0160	00613	NITR NO2-N DIS	I-2540-84	< 0.0100
0167	00618	NITR NO3-N DIS	I-1531-78	0.0800
0045	71851	NITR NO3-NO3 DIS	I-1532-77	0.3541
4020	99898	OCALA LAB ID NUMBER	- -	26789.0000
0068	00403	PH (LABORATORY)	I-1586-84	7.3900
0051	00400	PH FIELD	I-1586-85	7.1000
0130	71886	PHOSPHORUS -PO4 TOT	- -	0.6132
0129	00665	PHOSPHORUS TOTAL	I-4600-84	< 0.2000
0054	00935	POTASSIUM DISSOLVED	I-1630-84	88.0000
0321	00937	POTASSIUM TOT USGS	I-3630-84	100.0000
0028	70301	RES DIS CALC SUM	I-1751-85	7618.1896
0027	70300	ROE DISS @ 180 C	I-1750-84	8940.0000
0667	00955	SILICA DISS (ICP)	I-1472-87	28.0000
0058	00933	SODIUM + POTASSIUM	- -	2288.0000
0057	00931	SODIUM ABSORP RATIO	I-1738-85	24.1545
0059	00930	SODIUM DISSOLVED	I-1735-85	2200.0000
0060	00932	SODIUM PERCENT	I-1740-85	73.9877
0320	00929	SODIUM TOT USGS	I-3735-85	2200.0000
0021	00095	SP. CONDUCTANCE FLD	I-1780-85	1260.0000
0069	90095	SP. CONDUCTANCE LAB	I-1780-84	13200.0000
0538	00945	SULFATE DIS (IC)	I-2057-85	440.0000
0089	00745	SULFIDE TOTAL	I-3840-85	< 1.0000
0064	00010	WATER TEMPERATURE	- -	22.1000

** ERROR ** 4659 CALCIUM TOT. (ICP)   240.0000 IS LESS THAN 0659 CALCIUM DISS (ICP)   250.0000

** ERROR ** ROE 180 / ROE (calc)   1.17351 IS GREATER THAN   1.12000
** ERROR ** SPC-LAB / SPC-FLD   10.47619 IS GREATER THAN   1.15000
** Actual value is known to be less than the value shown   ** LABCODE: 0160 NITR NO2-N DIS   VALUE = <   0.0100
** Actual value is known to be less than the value shown   ** LABCODE: 0129 PHOSPHORUS TOTAL   VALUE = <   0.2000
** Actual value is known to be less than the value shown   ** LABCODE: 0089 SULFIDE TOTAL   VALUE = <   1.0000

27JJ-i04
Parris Island

1S RECEIVED AUG 2 0 1992

PROVISIONAL
SUBJECT TO REVISION

****
* U.S. GEOLOGICAL SURVEY *
* Q. W. SERVICE UNIT *
* OCALA, FLORIDA *
* MON, AUG 17 1992 *

PROVISIONAL
SUBJECT TO REVISION

****
* STATION ID: BFT1809 DATE: 07/13/1992 TIME: 1400 FIELD ID: 27JJQ2 OCALA LAB ID NUMBER: 926460 *
* STATION NAME: BFT-1809 STATE CODE: 45 USER / DISTRICT CODE: 45 *
* SAMPLE MEDIUM: 6 GEOLOGIC UNIT: ANALYSIS STATUS: H ANALYSIS SOURCE: 1 HYDROLOGIC CONDITION: 9 SAMPLE TYPE: 9 *
* HYDROLOGIC EVENT: 9 PROJECT ACCOUNT: 454500300 COST $ 148. FILE DEPOSITION: Q SCHEDULES: 4417 0000 0000 0000 0000 *
* RETRIEVED ON: 08/17/92 BY: JMBARTON *
****

Cations	Mg/L	Meq.	Anions	Mg/L	Meq.	Selected Parameters	Value
Acidity as H	0.30	0.298	Bicarbonate as HCO3	200.20	3.281	Sp. Cond. (LAB)	6810.000
Calcium as Ca	96.00	4.790	Chloride as Cl	2025.00	57.125	Sp. Cond. (FLD)	6600.000
Magnesium as Mg	140.00	11.516	Fluoride as F	0.78	0.041	pH (LAB)	7.750
Iron as Fe	0.02	0.000	Sulfate as SO4	333.18	6.937	pH (FLD)	7.500
						Alk. as CaCO3 (LAB)	164.204
						Alk. as CaCO3 (FLD)	146.000
						ROE at 180 C	4082.000
						Silica as SiO2	33.780
			Anion Ionic Total		67.384		

LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK / VALUE	LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK / VALUE
0001	71825	ACIDITY AS H	EPA 305.1	0.3000	0260	00926	MAGNESIUM SUSPENDED	I-7000-79	140.0000
0070	90410	ALK TOT (LAB) CACO3	I-1030-84	164.0000	4663	00927	MAGNESIUM TOT. (ICP)	EPA 200.7	140.0000
0002	00410	ALK TOT FIELD CACO3	- -	146.0000	0648	01056	MANGANESE DISS (ICP)	I-1472-87	< 5.0000
0091	00028	ANALYZING AGENCY	- -	81213.0000	4648	01055	MANGANESE TOT. (ICP)	EPA 200.7	< 5.0000
1178	95440	BICARBONATE LAB (EP)	- -	200.2000	0228	00631	NITR NO2+NO3-N DIS	I-2545-84	< 0.0200
0659	00915	CALCIUM DISS (ICP)	I-1472-87	96.0000	0160	00613	NITR NO2-N DIS	I-2540-84	< 0.0100
0243	81357	CALCIUM SUSPENDED	I-7000-79	< 0.1000	4020	99898	OCALA LAB ID NUMBER	- -	26460.0000
4659	00916	CALCIUM TOT. (ICP)	EPA 200.7	96.0000	0068	00403	PH (LABORATORY)	I-1586-84	7.7500
0292	00940	CHLORIDE DIS (IC)	I-2057-84	2000.0000	0051	00400	PH FIELD	I-1586-85	7.5000
0083	00027	COLLECTION AGENCY		84540.0000	0130	71886	PHOSPHORUS -PO4 TOT	- -	0.0920
0498	00950	FLUORIDE DIS (ELEC)	EPA 340.2	0.8000	0129	00665	PHOSPHORUS TOTAL	I-4600-84	0.0300
1181	95902	HARDNESS N-CARB LAB	I-1344-85	651.9515	0027	70300	ROE DISS @ 180 C	I-1750-84	4080.0000
0499	00900	HARDNESS TOT	I-1340-85	816.1554	0667	00955	SILICA DISS (ICP)	I-1472-87	34.0000
0645	01046	IRON DISS (ICP)	I-1472-87	20.0000	0021	00095	SP. CONDUCTANCE FLD	I-1780-85	6600.0000
0275	01044	IRON SUSPENDED	I-7000-79	16.0000	0069	90095	SP. CONDUCTANCE LAB	I-1780-84	V 6810.0000
4645	01045	IRON TOT. (ICP)	EPA 200.7	36.0000	0538	00945	SULFATE DIS (IC)	I-2057-85	330.0000
4030	99899	JULIAN LOGIN DATE	- -	92204.0000	0089	00745	SULFIDE TOTAL	I-3840-85	< 1.0000
0663	00925	MAGNESIUM DISS (ICP)	I-1472-87	140.0000	0064	00010	WATER TEMPERATURE	- -	22.8000

** Actual value is known to be less than the value shown ** LABCODE: 0648 MANGANESE DISS (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 4648 MANGANESE TOT. (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 0228 NITR NO2+NO3-N DIS VALUE = < 0.0200
** Actual value is known to be less than the value shown ** LABCODE: 0160 NITR NO2-N DIS VALUE = < 0.0100
** Results verfied by laboratory re-run ** LABCODE: 0069 SP. CONDUCTANCE LAB VALUE = V 6810.0000
** Actual value is known to be less than the value shown ** LABCODE: 0089 SULFIDE TOTAL VALUE = < 1.0000

27JJ-qo2
Dolphin Head

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U.S. GEOLOGICAL SURVEY
Q. W. SERVICE UNIT
OCALA, FLORIDA
SUN, AUG 30 1992

STATION ID: BFT1813 DATE: 07/29/1992 TIME: FIELD ID: 27KKJ05 OCALA LAB ID NUMBER: 926895
STATION NAME: BFT-1813 STATE CODE: 45 USER / DISTRICT CODE: 45
SAMPLE MEDIUM: 6 GEOLOGIC UNIT: ANALYSIS STATUS: H ANALYSIS SOURCE: 1 HYDROLOGIC CONDITION: 9 SAMPLE TYPE: 9
HYDROLOGIC EVENT: 9 PROJECT ACCOUNT: 454500300 COST $ 148. FILE DEPOSITION: Q SCHEDULES: 4417 0000 0000 0000 0000
RETRIEVED ON: 08/30/92 BY: JMBARTON

Cations	Mg/L	Meq.	Anions	Mg/L	Meq.	Selected Parameters	Value
Acidity as H	0.50	0.496	Bicarbonate as HCO3	236.40	3.875	Sp. Cond. (LAB)	9600.000
Sodium as Na	1640.00	71.340	Chloride as Cl	2825.00	79.693	Sp. Cond. (FLD)	7440.000
Potassium as K	70.00	1.791	Fluoride as F	1.20	0.063	pH (LAB)	7.890
Iron as Fe	0.02	0.000	Sulfate as SO4	640.00	13.325	pH (FLD)	7.520
			Nitrate as NO3	0.09	0.000	Alk. as CaCO3 (LAB)	193.895
						Alk. as CaCO3 (FLD)	192.000
						ROE at 180 C	6064.000
						Silica as SiO2	35.960
			Anion Ionic Total		96.956		

LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK	VALUE
0001	71825	ACIDITY AS H	EPA 305.1		0.5000
0070	90410	ALK TOT (LAB) CACO3	I-1030-84		194.0000
0002	00410	ALK TOT FIELD CACO3	- -		192.0000
0091	00028	ANALYZING AGENCY	- -		81213.0000
1178	95440	BICARBONATE LAB (EP)	- -		236.4000
0292	00940	CHLORIDE DIS (IC)	I-2057-84		2800.0000
0083	00027	COLLECTION AGENCY	- -		84540.0000
0312	72019	DEPTH BELOW LSD (FT)	- -		21.0000
0498	00950	FLUORIDE DIS (ELEC)	EPA 340.2		1.2000
0645	01046	IRON DISS (ICP)	I-1472-87		16.0000
0275	01044	IRON SUSPENDED	I-7000-79	<	10.0000
4645	01045	IRON TOT. (ICP)	EPA 200.7		18.0000
4030	99899	JULIAN LOGIN DATE	- -		92220.0000
0228	00631	NITR NO2+NO3-N DIS	I-2545-84		0.0300
0160	00613	NITR NO2-N DIS	I-2540-84	<	0.0100
0167	00618	NITR NO3-N DIS	I-1531-78		0.0200
0045	71851	NITR NO3-NO3 DIS	I-1532-77		0.0885
4020	99898	OCALA LAB ID NUMBER	- -		26895.0000
0068	00403	PH (LABORATORY)	I-1586-84		7.8900
0051	00400	PH FIELD	I-1586-85		7.5200
0130	71886	PHOSPHORUS -PO4 TOT	- -		0.1840
0129	00665	PHOSPHORUS TOTAL	I-4600-84		0.0600
0054	00935	POTASSIUM DISSOLVED	I-1630-84		70.0000
0321	00937	POTASSIUM TOT USGS	I-3630-84		66.0000
0027	70300	ROE DISS @ 180 C	I-1750-84		6060.0000
0667	00955	SILICA DISS (ICP)	I-1472-87		36.0000
0058	00933	SODIUM + POTASSIUM	- -		1710.0000
0059	00930	SODIUM DISSOLVED	I-1735-85		1600.0000
0320	00929	SODIUM TOT USGS	I-3735-85		160.0000
0021	00095	SP. CONDUCTANCE FLD	I-1780-85		7440.0000
0069	90095	SP. CONDUCTANCE LAB	I-1780-84	V	9600.0000
0061	00061	STREAMFLOW-INST. CFS	- -		100.0000
0538	00945	SULFATE DIS (IC)	I-2057-85		640.0000
0089	00745	SULFIDE TOTAL	I-3840-85	<	1.0000
0064	00010	WATER TEMPERATURE	- -		24.0000

** ERROR ** 0321 POTASSIUM TOT USGS 66.0000 IS LESS THAN 0054 POTASSIUM DISSOLVED 70.0000
** ERROR ** 0320 SODIUM TOT USGS 160.0000 IS LESS THAN 0059 SODIUM DISSOLVED 1600.0000
** ERROR ** SPC-LAB / SPC-FLD 1.29032 IS GREATER THAN 1.15000
** Actual value is known to be less than the value shown ** LABCODE: 0160 NITR NO2-N DIS VALUE = < 0.0100
** Results verfied by laboratory re-run ** LABCODE: 0069 SP. CONDUCTANCE LAB VALUE = V 9600.0000
** Actual value is known to be less than the value shown ** LABCODE: 0089 SULFIDE TOTAL VALUE = < 1.0000

PROVISIONAL
SUBJECT TO REVISION

27KK-j05
Ft. Walker

RECEIVED SEP 1 7 1992

PROVISIONAL
SUBJECT TO REVISION

****
* U.S. GEOLOGICAL SURVEY *
* Q. W. SERVICE UNIT *
* OCALA, FLORIDA *
* TUE, SEP 08 1992 *

PROVISIONAL
SUBJECT TO REVISION

* STATION ID: BFT1820 DATE: 07/16/1992 TIME: 1300 FIELD ID: 27KK010 OCALA LAB ID NUMBER: 926461
* STATION NAME: BFT-1820 STATE CODE: 45 USER / DISTRICT CODE: 45
* SAMPLE MEDIUM: 6 GEOLOGIC UNIT: ANALYSIS STATUS: H ANALYSIS SOURCE: 1 HYDROLOGIC CONDITION: 9 SAMPLE TYPE: 9
* HYDROLOGIC EVENT: 9 PROJECT ACCOUNT: 454500300 COST $ 148. FILE DEPOSITION: Q SCHEDULES: 4417 0000 0000 0000 0000
* RETRIEVED ON: 09/08/92 BY: JMBARTON

Cations	Mg/L	Meq.	Anions	Mg/L	Meq.	Selected Parameters	Value
Calcium as Ca	31.00	1.547	Bicarbonate as HCO3	182.80	2.996	Sp. Cond. (LAB)	1710.000
Magnesium as Mg	42.00	3.455	Chloride as Cl	390.00	11.002	Sp. Cond. (FLD)	1690.000
Sodium as Na	230.00	10.005	Fluoride as F	0.91	0.048	pH (LAB)	8.170
Potassium as K	0.15	0.004	Sulfate as SO4	110.00	2.290	pH (FLD)	7.800
Iron as Fe	0.01	0.000				Alk. as CaCO3 (LAB)	149.933
						Alk. as CaCO3 (FLD)	130.000
						ROE at 180 C	962.000
						ROE (Calc)	926.501
						Silica as SiO2	32.470
Cation Ionic Total		15.011	Anion Ionic Total		16.336	Percent Ionic Error	-4.228

LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK	VALUE
0001	71825	ACIDITY AS H	EPA 305.1		0.1000
0070	90410	ALK TOT (LAB) CACO3	I-1030-84		150.0000
0002	00410	ALK TOT FIELD CACO3	- -		130.0000
0091	00028	ANALYZING AGENCY	- -		81213.0000
1178	95440	BICARBONATE LAB (EP)	- -		182.8000
0659	00915	CALCIUM DISS (ICP)	I-1472-87		31.0000
4659	00916	CALCIUM TOT. (ICP)	EPA 200.7		29.0000
0292	00940	CHLORIDE DIS (IC)	I-2057-85		390.0000
0083	00027	COLLECTION AGENCY	- -		84540.0000
0654	99457	DIGESTION HCL WATER	I-3485-85		1.0000
0498	00950	FLUORIDE DIS (ELEC)	EPA 340.2		0.9000
1181	95902	HARDNESS N-CARB LAB	I-1344-85		100.4087
0499	00900	HARDNESS TOT	I-1340-85		250.3411
0645	01046	IRON DISS (ICP)	I-1472-87		11.0000
0275	01044	IRON SUSPENDED	I-7000-79	<	10.0000
4645	01045	IRON TOT. (ICP)	EPA 200.7		19.0000
4030	99899	JULIAN LOGIN DATE	- -		92204.0000
0663	00925	MAGNESIUM DISS (ICP)	I-1472-87		42.0000
4663	00927	MAGNESIUM TOT. (ICP)	EPA 200.7		39.0000
0648	01056	MANGANESE DISS (ICP)	I-1472-87	<	5.0000
4648	01055	MANGANESE TOT. (ICP)	EPA 200.7	<	5.0000
0228	00631	NITR NO2+NO3-N DIS	I-2545-84	<	0.0200
0160	00613	NITR NO2-N DIS	I-2540-84	<	0.0100
4020	99898	OCALA LAB ID NUMBER	- -		26461.0000
0068	00403	PH (LABORATORY)	I-1586-84		8.1700
0051	00400	PH FIELD	I-1586-85		7.8000
0130	71886	PHOSPHORUS -PO4 TOT	- -		0.0613
0129	00665	PHOSPHORUS TOTAL	I-4600-84		0.0200
0054	00935	POTASSIUM DISSOLVED	I-1630-84		0.2000
0321	00937	POTASSIUM TOT USGS	I-3630-84		22.0000
0028	70301	RES DIS CALC SUM	I-1751-85		926.5005
0027	70300	ROE DISS @ 180 C	I-1750-84		962.0000
0667	00955	SILICA DISS (ICP)	I-1472-87		32.0000
0058	00933	SODIUM + POTASSIUM	- -		230.1500
0057	00931	SODIUM ABSORP RATIO	I-1738-85		6.3266
0059	00930	SODIUM DISSOLVED	I-1735-85		230.0000
0060	00932	SODIUM PERCENT	I-1740-85		66.6526
0320	00929	SODIUM TOT USGS	I-3735-85		220.0000
0021	00095	SP. CONDUCTANCE FLD	I-1780-85		1690.0000
0069	90095	SP. CONDUCTANCE LAB	I-1780-84		1710.0000
0538	00945	SULFATE DIS (IC)	I-2057-85		110.0000
0089	00745	SULFIDE TOTAL	I-3840-85	<	1.0000
0064	00010	WATER TEMPERATURE	- -		23.6000

LABORATORY AND FIELD COMMENT(S) FOR LAB ID NUMBER: 926461

PROVISIONAL
SUBJECT TO REVISION

** ERROR ** 4659 CALCIUM TOT. (ICP) 29.0000 IS LESS THAN 0659 CALCIUM DISS (ICP) 31.0000
** ERROR ** 0320 SODIUM TOT USGS 220.0000 IS LESS THAN 0059 SODIUM DISSOLVED 230.0000
** ERROR ** % Ionic Error -4.22831 IS LESS THAN -2.50000
** ERROR ** Cation. / Cond. 0.87782 IS LESS THAN 0.92000
** ERROR ** ROE (calc) / Cond. 0.54181 IS LESS THAN 0.55000
** Actual value is known to be less than the value shown ** LABCODE: 0648 MANGANESE DISS (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 4648 MANGANESE TOT. (ICP) VALUE = < 5.0000

27KK-o10
Indigo Run

28JJ-p05
BFT 1845

PROVISIONAL
SUBJECT TO REVISION

28JJ-p05

PROVISIONAL
SUBJECT TO REVISION

RECEIVED SEP - 8 1992

****
* U.S. GEOLOGICAL SURVEY *
* Q. W. SERVICE UNIT *
* OCALA, FLORIDA *
* SUN, AUG 30 1992 *

* STATION ID: BFT1845 DATE: 07/22/1992 TIME: 1120 FIELD ID: ~~28JJ005~~ OCALA LAB ID NUMBER: 926573 *
* STATION NAME: BFT-1845 STATE CODE: 45 USER / DISTRICT CODE: 45 *
* SAMPLE MEDIUM: 6 GEOLOGIC UNIT: ANALYSIS STATUS: H ANALYSIS SOURCE: 1 HYDROLOGIC CONDITION: 9 SAMPLE TYPE: 9 *
* HYDROLOGIC EVENT: 9 PROJECT ACCOUNT: 454500300 COST $ 148. FILE DEPOSITION: Q SCHEDULES: 4417 0000 0000 0000 0000 *
* RETRIEVED ON: 08/30/92 BY: JMBARTON *

Cations	Mg/L	Meq.	Anions	Mg/L	Meq.	Selected Parameters	Value
Calcium as Ca	13.00	0.649	Bicarbonate as HCO3	187.80	3.078	Sp. Cond. (LAB)	378.000
Magnesium as Mg	8.20	0.675	Chloride as Cl	8.37	0.236	Sp. Cond. (FLD)	370.000
Sodium as Na	55.00	2.392	Fluoride as F	1.40	0.074	pH (LAB)	8.180
Potassium as K	5.20	0.133	Sulfate as SO4	26.21	0.546	pH (FLD)	8.110
			Nitrite as NO2	0.07	0.000	Alk. as CaCO3 (LAB)	154.034
			Nitrate as NO3	0.31	0.000	ROE at 180 C	232.000
						ROE (Calc)	245.626
						Silica as SiO2	35.450
Cation Ionic Total		3.849	Anion Ionic Total		3.934	Percent Ionic Error	-1.090

LAB-CODE	WAT-STORE	PARAMETER NAME	METHOD	REMARK / VALUE
0001	71825	ACIDITY AS H	EPA 305.1	0.1000
0070	90410	ALK TOT (LAB) CACO3	I-1030-84	154.0000
0091	00028	ANALYZING AGENCY	- -	81213.0000
1178	95440	BICARBONATE LAB (EP)	- -	187.8000
0659	00915	CALCIUM DISS (ICP)	I-1472-87	13.0000
4659	00916	CALCIUM TOT. (ICP)	EPA 200.7	12.0000
0292	00940	CHLORIDE DIS (IC)	I-2057-84	8.4000
0083	00027	COLLECTION AGENCY	- -	84540.0000
0654	99457	DIGESTION HCL WATER	I-3485-85	1.0000
0498	00950	FLUORIDE DIS (ELEC)	EPA 340.2	1.4000
0499	00900	HARDNESS TOT	I-1340-85	66.2278
0645	01046	IRON DISS (ICP)	I-1472-87	< 5.0000
0275	01044	IRON SUSPENDED	I-7000-79	< 10.0000
4645	01045	IRON TOT. (ICP)	EPA 200.7	7.0000
4030	99899	JULIAN LOGIN DATE	- -	92207.0000
0663	00925	MAGNESIUM DISS (ICP)	I-1472-87	8.2000
4663	00927	MAGNESIUM TOT. (ICP)	EPA 200.7	8.0000
0648	01056	MANGANESE DISS (ICP)	I-1472-87	< 5.0000
4648	01055	MANGANESE TOT. (ICP)	EPA 200.7	< 5.0000
0228	00631	NITR NO2+NO3-N DIS	I-2545-84	0.0900
0160	00613	NITR NO2-N DIS	I-2540-84	0.0200
0046	71856	NITR NO2-NO2 DIS	I-1541-77	0.0657
0167	00618	NITR NO3-N DIS	I-1531-78	0.0700
0045	71851	NITR NO3-NO3 DIS	I-1532-77	0.3099
4020	99898	OCALA LAB ID NUMBER	- -	26573.0000
0068	00403	PH (LABORATORY)	I-1586-84	8.1800
0051	00400	PH FIELD	I-1586-85	8.1100
0130	71886	PHOSPHORUS -PO4 TOT	- -	0.0920
0129	00665	PHOSPHORUS TOTAL	I-4600-84	0.0300
0054	00935	POTASSIUM DISSOLVED	I-1630-84	5.2000
0321	00937	POTASSIUM TOT USGS	I-3630-84	4.8000
0028	70301	RES DIS CALC SUM	I-1751-85	245.6257
0027	70300	ROE DISS @ 180 C	I-1750-84	232.0000
0667	00955	SILICA DISS (ICP)	I-1472-87	35.0000
0057	00931	SODIUM ABSORP RATIO	I-1738-85	2.9414
0059	00930	SODIUM DISSOLVED	I-1735-85	55.0000
0060	00932	SODIUM PERCENT	I-1740-85	62.1631
0320	00929	SODIUM TOT USGS	I-3735-85	54.0000
0021	00095	SP. CONDUCTANCE FLD	I-1780-85	370.0000
0069	90095	SP. CONDUCTANCE LAB	I-1780-94	378.0000
0538	00945	SULFATE DIS (IC)	I-2057-85	26.0000
0089	00745	SULFIDE TOTAL	I-3840-85	< 1.0000
0064	00010	WATER TEMPERATURE	- -	23.4000

LABORATORY AND FIELD COMMENT(S) FOR LAB ID NUMBER: 926573

PROVISIONAL
SUBJECT TO REVISION

OPOTASSIUM VALUES VERIFIED
** ERROR ** 4659 CALCIUM TOT. (ICP) 12.0000 IS LESS THAN 0659 CALCIUM DISS (ICP) 13.0000
** ERROR ** 0321 POTASSIUM TOT USGS 4.8000 IS LESS THAN 0054 POTASSIUM DISSOLVED 5.2000
** ERROR ** 0320 SODIUM TOT USGS 54.0000 IS LESS THAN 0059 SODIUM DISSOLVED 55.0000
** Actual value is known to be less than the value shown ** LABCODE: 0645 IRON DISS (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 0648 MANGANESE DISS (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 4648 MANGANESE TOT. (ICP) VALUE = < 5.0000
** Actual value is known to be less than the value shown ** LABCODE: 0089 SULFIDE TOTAL VALUE = < 1.0000

28JJ-p05
Waddell Center

Appendix

Laboratory analysis of core from Cretaceous test well.

Western Atlas International
A Litton/Dresser Company

CORE LABORATORIES

Depth: 382 ft

Company : South Carolina Water Res. Comm
Well : Hilton Head Deep Cret. Test
Location : Hilton Head
State : South Carolina
File No. : 57161-11161A
Analyst : Vickery, Cantwell

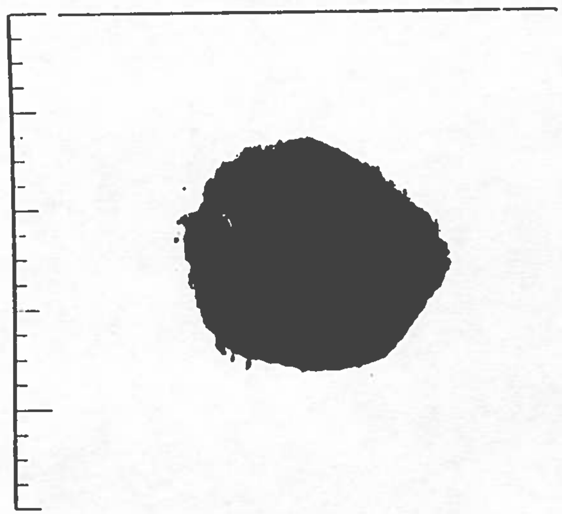
Sidewall Core Analysis

Permeability, mD			
Empirical		Measured	
Sidewall Kair	Laser PSA Kair	Profile Permeameter Kair	Profile Permeameter K∞
15			

Porosity (Fluids) %	Saturation (Bulk Volume) Oil %	Saturation (Bulk Volume) Gas %	Saturation (Bulk Volume) Water %	Critical Water Satn % Vp	Probable Production
27.3	0	7.7	19.6		

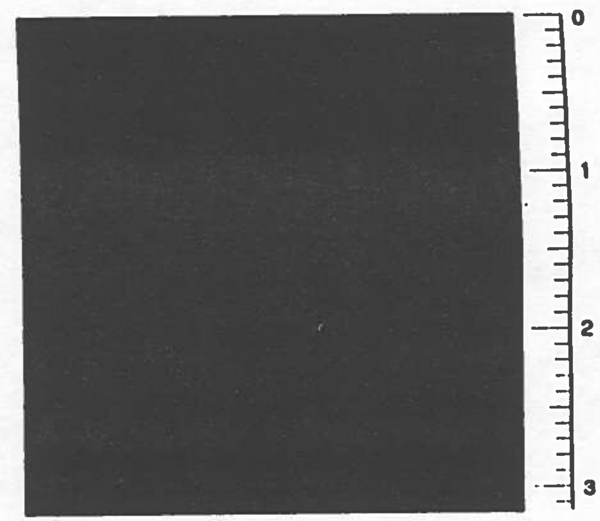
Description:
Sd vf-fgr sslty vcalc no fluor

Visible Light



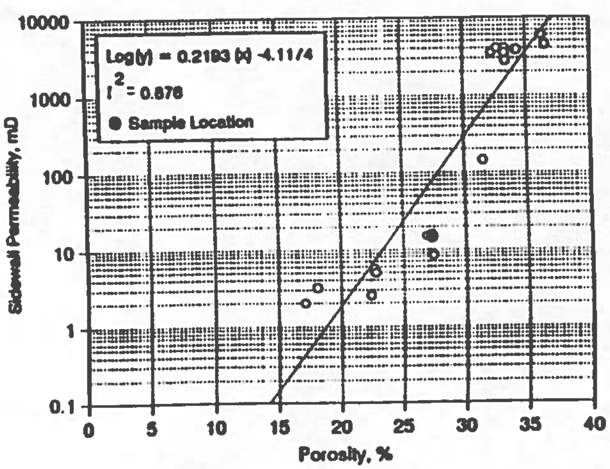
(MAGNIFICATION = 2X)

UV Fluorescence

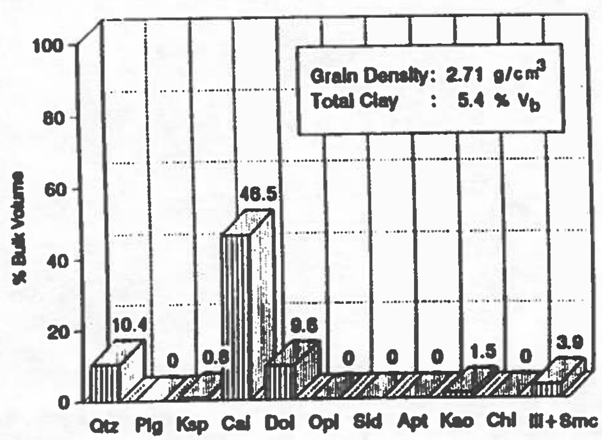


(MAGNIFICATION = 2X)

Permeability vs Porosity



Mineralog™



Laser Particle Size Analysis