GROUND-WATER RESOURCES OF HAMPTON COUNTY, SOUTH CAROLINA

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

LAND, WATER AND CONSERVATION DIVISION

WATER RESOURCES REPORT 39

2006

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by

Roy Newcome, Jr.
and
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ABSTRACT

Hampton County, near the southern extremity of South Carolina, is in the fortunate position of having three rivers bounding or crossing the county. It is fortunate, also, in having one of the region's best aquifers within 500 feet of the land surface and additional prolific aquifers in the next 1,500 feet.

The Floridan aquifer, a limestone of mainly Eocene age, supplies numerous farm-irrigation systems, public water supplies, and several industries with water of very good quality. Many wells yield 1,000 gallons per minute or more. Aquifer transmissivity is sufficiently high that wells a few hundred feet deep do not unduly interfere with one another. Shallow wells with little available drawdown are sometimes affected by nearby pumping from irrigation wells.

Wells 800-900 feet deep tap sand aquifers in the Paleocene-age Black Mingo Formation and Cretaceous-age Peedee Formation. With their great available drawdown, these wells commonly exceed 1,000-1,500 gallons per minute in yield; one industrial well produced 3,000 gpm. The water from these wells is considerably softer than that from the limestone wells.

Untapped sand aquifers in the Cretaceous-age Black Creek and Middendorf Formations could be exploited by wells as deep as 2,000 feet. The temperature of ground water from that depth is as high as 100° Fahrenheit, but geophysical logs of wells in counties to the north and south of Hampton County indicate freshwater at that depth.

INTRODUCTION

A description of the ground-water resources of Hampton County, S.C., was included in a multicounty report prepared by Larry Hayes of the U.S. Geological Survey (USGS) and published by the South Carolina Water Resources Commission (SCWRC) in 1979. Since that time a great deal of information has become available concerning ground water in the region. Notable among the information is an SCWRC report by Whiting and Park (1990) on the effects of pumping from the Floridan aquifer in the Estill area and one by Park, Whiting, and Gawne (1991) on the results of a capacity-use investigation for Hampton County.

The purpose of the current study and report is to update the findings and evaluations of Hayes and subsequent hydrologists as they apply to Hampton County.

Location and Geography

Hampton County is a 560-square-mile area near the southern tip of South Carolina (Fig. 1). It is bounded on the north by Allendale County, on the east by Colleton County, on the south by Jasper and Beaufort Counties, and on the west by the Savannah River, the latter serving as the boundary with the State of Georgia. The county is encompassed by latitudes 32° 33′ to 33° 02′ N and longitudes 80° 50′ to 81° 26′ W.

The topographic setting of the county is what would be expected in this South Atlantic coastal zone. Only one county removed from the beachline, Hampton County has low relief and gentle slopes. The elevation ranges from 20 to 150 ft (feet) above sea level. Drainage is provided by the Savannah, Coosawhatchie, and Salkehatchie-Combahee Rivers. Other important streams include Black Creek, Briar Creek, Mill Bay Creek, Whippy Swamp, and Deep Branch. The drainage and topography are well illustrated by the 19 USGS topographic maps whose locations are shown in Figure 2.

Population, Industry, and Agriculture

The population of Hampton County was estimated at 21,329 in the year 2005, ranking it 40th among South Carolina's counties. The county had a population loss of 0.5 percent from 2000 to 2005, while the State's population growth rate was 11.2 percent. About two-thirds of the population is rural, but only a very small portion is employed in farming, fishing, and forestry occupations (1.5 percent). The largest percentage (25) of employees was in production, transportation, and material-moving occupations.

Among Hampton County's major industries is Nevamar, in Hampton, which manufactures industrial and decorative laminates and employs more than 500 people. The Elliot Sawmilling Co., south of Estill, employs 200. Carsonite, near Early Branch, has 132 employees in the manufacture of fiberglass and plastic products. Also near Early Branch, Le Creuset of America has its North American distribution center for its enamel-clad cast-iron cookware. It employs more than 100 people. Several other plants in the county employ less than 50 persons each.

This county is about two-thirds forested and one-third farmland. The largest farm crop is corn, raised for grain. Nearly 20,000 acres are irrigated. Hampton County had 4 of South Carolina's 28 catfish farms in 2002, the most of any county.

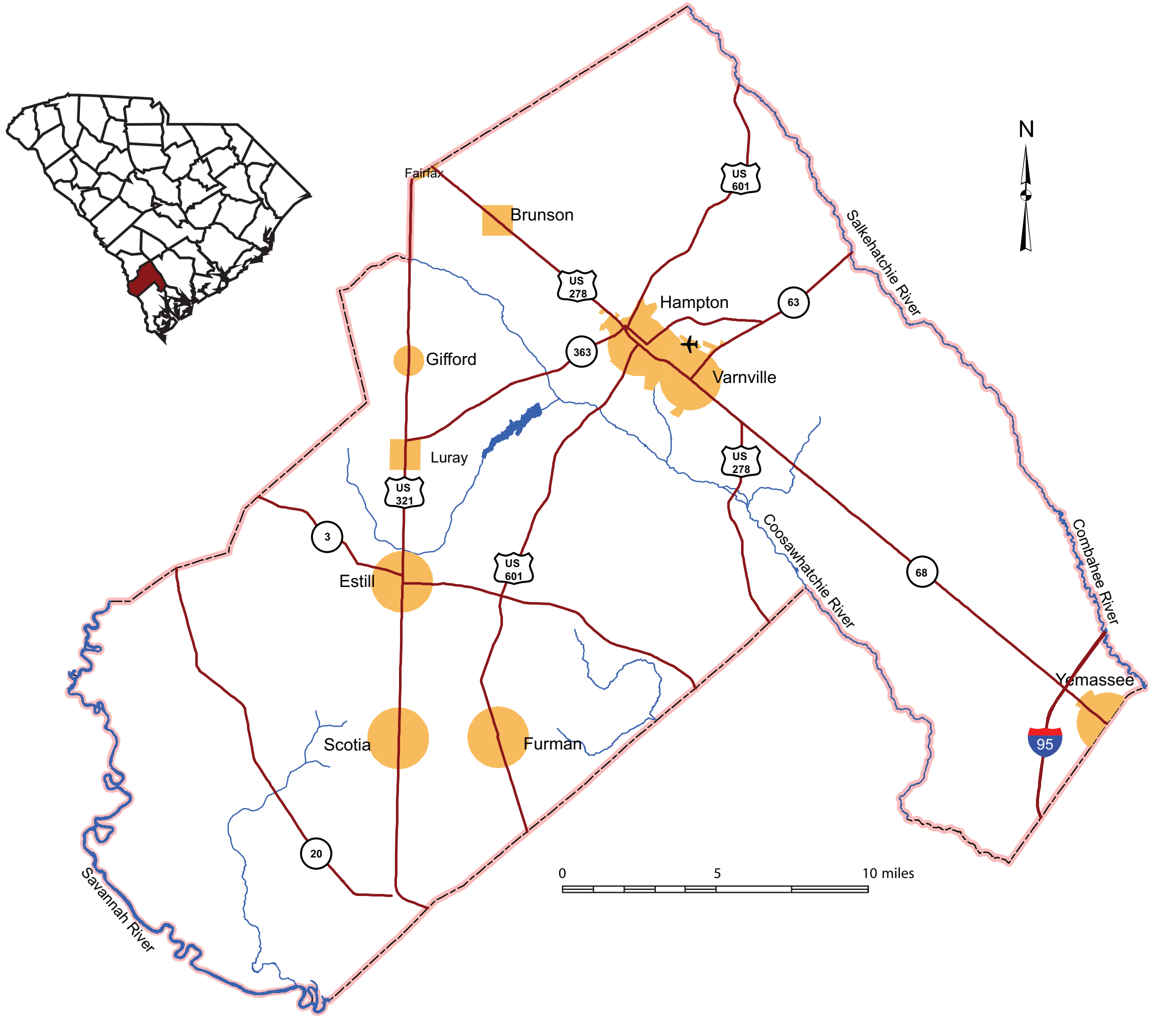


Figure 1. Location of Hampton County, S.C., showing highways and major population centers.

Climate

The Southeast Regional Climate Center, at Columbia, reports temperature and precipitation data for a station at Hampton. For the 53-year period of record (1951-2004), the average air temperature was 65.5° F. This is reflected in the shallow ground-water temperature. On the average, July and August are the hottest months, with highs near 93°, and December and January the coldest, with lows near 35°. Extremes of temperature are about 105° and 0°.

A 54-year record (1951-2005) of precipitation reveals that the annual average rainfall at Hampton is 48.34 inches. June-August is the wettest part of the year and October-December the driest. The growing season is about 200 days, between early April and late October.

Water Supply

Public water supplies in Hampton County are all obtained from wells and have the following pumpages, in millions of gallons per day:

Brunson	0.07	(2 wells)
Estill	0.52	(3 wells)
Furman	0.04	(2 wells)
Gifford	0.03	(2 wells)
Hampton	0.34	(2 wells)
Luray	0.01	(1 wells)
Scotia	0.02	(3 wells)
Varnville	0.25	(2 wells)
Yemassee	0.20	(3 wells)

The 20 wells used for the town supplies range in yield from 30 to 735 gpm (gallons per minute) and in depth from 137 to 1,000 ft (feet). The deepest wells are in Varnville and Luray, the shallowest at Yemassee.

Water supplies for industrial plants in Hampton County are purchased from public suppliers or obtained from their own wells. The largest industry, Nevamar, is on the Town of Hampton water system. The Westinghouse Company has some of the most productive wells in the county to provide water at their Hampton facility.

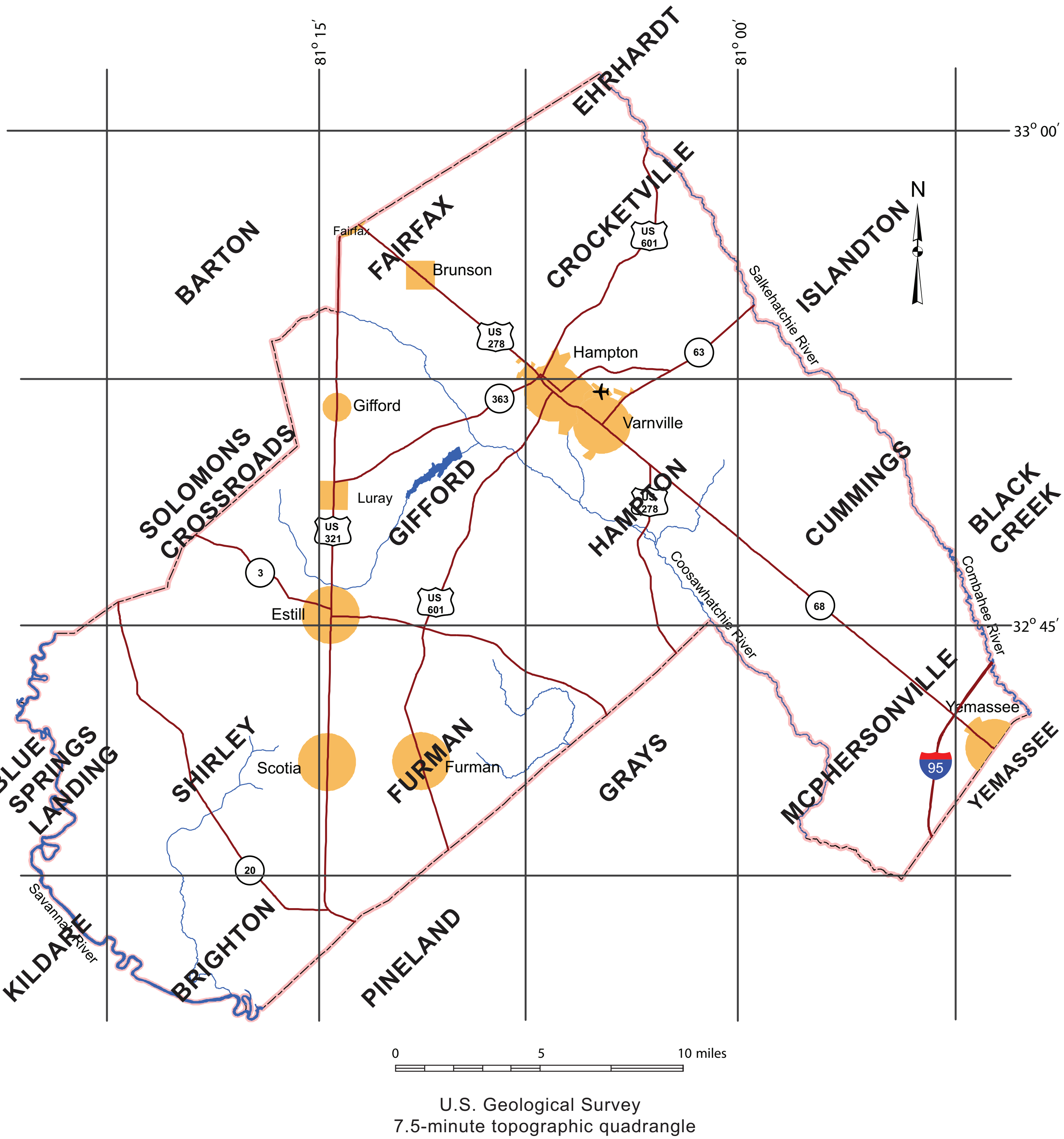


Figure 2. Topographic-map coverage of Hampton County, S.C.

South Carolina Department of Natural Resources (DNR) files contain records of 55 irrigation wells in Hampton County. They range widely in yield, the largest being 2,050 gpm. There doubtlessly are many others that are not recorded.

Approximately 1 million gallons of water is withdrawn daily from wells for rural domestic water supplies.

METHOD OF STUDY

County ground-water studies by the South Carolina Department of Natural Resources are made by analyzing the water-well information in the agency files. These records are supplemented by well-drilling records submitted to the South Carolina Department of Health and Environmental Control (DHEC). The latter records are required by State law to be turned in by well drillers upon completion of wells.

Another very important source of information is the large body of consulting engineers who plan and supervise the installation and testing of public-supply wells. The requirements of DHEC necessitate intensive water-quality tests to insure the safety of South Carolina's public-supply water systems. The records supplied by the engineers routinely contain well construction, drilling and geophysical logs, pumping tests, and water-quality laboratory reports. It should be stated here that the well drillers and engineers who make available this great mass of well information are due much credit for the furtherance of knowledge about South Carolina's ground-water resources.

Three types of technical information are used in evaluating aquifers and wells. These are 1) geophysical logs of wells; 2) pumping tests; and 3) chemical analyses of the water. The three tools are discussed, as they apply to Hampton County, in succeeding pages.

AQUIFERS

Hampton County has freshwater-bearing aquifers to a depth of 2,000 ft—along with Colleton County, just to the east, the deepest in the State. These aquifers occur in the Eocene-age Ocala and Santee Limestone formations in the upper 500 ft, in the Paleocene-age Black Mingo Formation in the next 400 ft, and in the Cretaceous-age Peedee, Black Creek, and Middendorf Formations in the bottom 1,100 ft (from Colquhoun, D.J. and others, 1983). Below this there is about 400 ft of sediment that is thought to contain slightly brackish water. Underlying the Coastal Plain sequence is hard rock of Paleozoic age, the continuation of the basement rocks that are exposed north of the Fall Line in South Carolina's Piedmont physiographic province.

The Ocala and Santee Limestone formations compose the prolific Floridan aquifer, which has several permeable zones. A zone in the upper 50-100 feet corresponds to the Upper Floridan aquifer and is generally the most productive aquifer in the Floridan system. Yields greater than 1,000 gpm have been obtained from this aquifer. Microfossil data from coreholes in adjacent counties (Allendale and Jasper) indicate an upper Eocene age, correlative with the Ocala Limestone. In northern areas of the county, the Upper Floridan is shallow and is probably unconfined and incised by streams. Here, deeper zones are used for water supply.

Permeable zones in deeper parts of the aquifer system are difficult to map across the county, commonly occurring at several different stratigraphic horizons. Microfossil data from these zones in adjacent counties indicate a Middle Eocene age, correlative with the Santee Limestone. These zones may be stratigraphically equivalent to the middle Floridan aquifer that was defined in coastal Beaufort County (Gawne and Park, 1992) or to the "lower permeable zone" of Hayes (1979. p. 32 and Fig. 9). It is not known with certainty, however, if they are hydraulically connected across the Coastal Plain from Hampton County to Beaufort County. Limited data indicates that these deeper zones are less productive than the Upper Floridan aquifer.

The Black Mingo Formation is a mixture of limestone, sand, and clay; the limestone usually being sandy or silty. Aquifers in the formation are not as productive as aquifers of the Floridan, nor of the Cretaceous formations. The last-named have a number of sand aquifers of variable thickness and areal extent that can be very productive. Some of the highest-yielding wells in the county are completed in sand aquifers of the Cretaceous Formations. These aquifers are most easily identified on electric logs of wells. The sand beds are separated by clay, also of variable thickness and extent, that forms confining units.

WELLS

Wells in the limestone aquifers are of the "open-hole" type, meaning that they have casing only to prevent the entry of unwanted water and sediment from the surface and shallow depths. They have no well screen. Sand wells, on the other hand, are constructed with screen at the end of the casing opposite the aquifer; the purpose is to prevent the aquifer from collapsing into the well. Screen-opening sizes are selected to pass the finer grains and restrain the larger ones until a gradation of coarseness outside the screen has been attained by pumping, or "development." This provides the most water with the least head loss in passing through the screen and without "pumping sand," which is undesirable and sometimes disastrous.

A considerable number of large-yield wells have been installed in Hampton County. DNR files contain records of nearly 50 Hampton County wells that either currently or did in the past produce at least 500 gpm, 15 of which produce more than 1,000 gpm. The largest yield is 3,000 gpm from an industrial well at Hampton.

Figure 3 is a map showing the locations of the large wells mentioned here. In the DNR filing system each well is identified by two numbers: a grid number based on its geographic location, with the form 33FF-b2 (Fig. 3), and a county number, with the form HAM-265, based on its position in the sequence of well records added in the county.

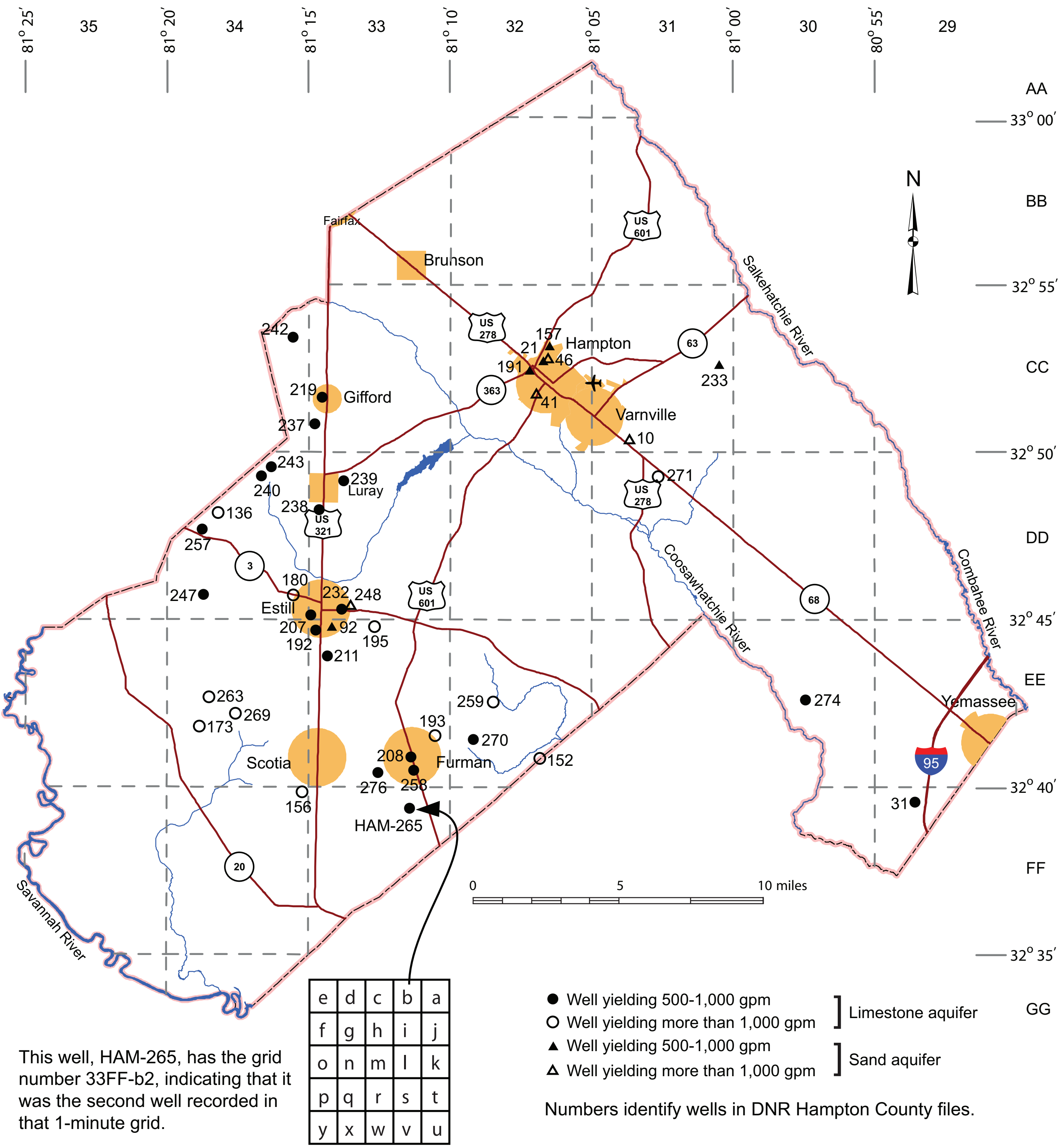


Figure 3. Locations of selected large-yield wells (500 gpm or more) in Hampton County.

GEOPHYSICAL LOGS

The map of Figure 4 shows the locations of several Hampton County geophysical logs that are available in DNR files. Table 1 contains the significant aquifer intervals indicated by the logs and the top and bottom of the limestone section. The information contained in these logs should constitute a helpful guide in the drilling of additional wells. Also of value in choosing where and how deep to drill is the map of Figure 3, which shows where many large-yield wells have been installed.

Two types of geophysical logs were analyzed for this report—electric logs and gamma-ray logs. Electric logs measure the electrical resistance of a formation, which is mainly a function of lithology and water chemistry. Deflections to the right mark an increase in resistance and, in unconsolidated formations, usually indicate permeable freshwater-sand layers that form the sand aquifers in the county (Fig. 5). Deflections to the left mark a decrease in resistance and usually indicate impermeable clay layers that form confining units. Interpretations of electric logs are generally reliable in sand formations but are much less useful in limestone formations. Consequently, the gamma-ray log, where available, was analyzed to locate permeable zones in limestone intervals. Gamma-ray logs measure the frequency of naturally occurring radiation that is emitted from a formation. Typically, permeable limestone layers emit very little radiation and are noted on the logs as deflections to the left. Limestone layers that are less permeable, often due to an increase in clay content, have a higher radiation count and are noted on the logs as deflections to the right. It was also observed in Hampton County that two zones of very high radiation occur—one near the top of the limestone section and the other near the base of the limestone (Fig. 5). These high-radiation zones are probably caused by trace amounts of uranium associated with phosphate minerals.

Geophysical logs in Allendale County, to the north, and Jasper County, to the south, indicate freshwater-bearing sand aquifers to a depth of about 2,000 feet. These appear to be capable of substantial yields to wells, especially when the great amount of available drawdown is considered. The water at this depth probably has a temperature near 100° Fahrenheit.

PUMPING TESTS

The only way to determine how much water an aquifer and/or a well can produce is by means of a pumping test. Several tests are available for Hampton County. They represent the Floridan aquifer system at depths generally less than 300 ft and Black Mingo-Peedee aquifers at depths near 900 ft. Locations of the tests are shown on Figure 6, and the test results are given in Table 2.

The important findings of pumping tests are aquifer transmissivity, well specific capacity, and well efficiency. Transmissivity dictates the rate at which an aquifer can supply water to a well; specific capacity controls the rate at which the well can discharge the water; and the well's efficiency affects how much drawdown is required for that discharge. Well performance is greatly influenced by construction and development conditions. It is critical to well performance to have the well screen (or screens) in sand wells properly selected for the grain size of the aquifer. If a gravel envelope is installed outside the well, it should be sized to pass the appropriate percentage of fine material and allow the coarser aquifer material to move in around the screen. After this, the well must be developed by steady pumping and by "surging." This may take a week or more. Unfortunately, many wells are inefficient, causing more drawdown of the water level in the well than should occur and, obviously, increasing the cost of pumping. See Figure 7 for illustration of the effect of well inefficiency. In the writers' opinion, no well should be less than 75-percent efficient.

By using the transmissivity values obtained from pumping tests, it is possible to construct time-and-distance drawdown graphs (Fig. 8) for selected pumping rates. This facilitates appropriate well spacing to minimize pumping interference.

CHEMICAL ANALYSES

Water from wells completed in the Floridan aquifer limestone is moderately hard (Table 3) but generally of good quality otherwise. The pH is slightly alkaline, and the total dissolved-solids concentration is usually less than 200 mg/L (milligrams per liter). Water from wells in the sand aquifers is more variable in quality, but it generally is good in Hampton County. It is very soft, usually having hardness of less than 20 mg/L. The pH is always well above 7.0 and dissolved-solids concentration below 300 mg/L. Locations of the wells for which the chemical analyses of Table 3 were made are shown on Figure 9.

WATER LEVELS

Ground-water levels are of great interest and importance in Hampton County. As development of water supplies for municipalities, industries, and irrigation proceeds, care must be taken to avoid the concentration of pumping effects to the detriment of healthy economic growth. Although the county has excellent ground-water resources, they are not limitless, and proper monitoring is essential to avoid problems of pumping interference where the water level will be lowered by the impact of more than one well.

Hydrographs of 21 observation wells are included here (Appendix) to illustrate current and historical water-level trends. Figure 10 shows locations of the hydrographs. In late 1998, water levels of wells constructed in the Floridan aquifer were measured and mapped across the State to determine the status of water levels in the aquifer and to examine trends in water-level fluctuations (Hockensmith, 2001). Figure 11 is derived from this map and shows water-level contours for the aquifer in Hampton County. The following are several conclusions drawn from the report.

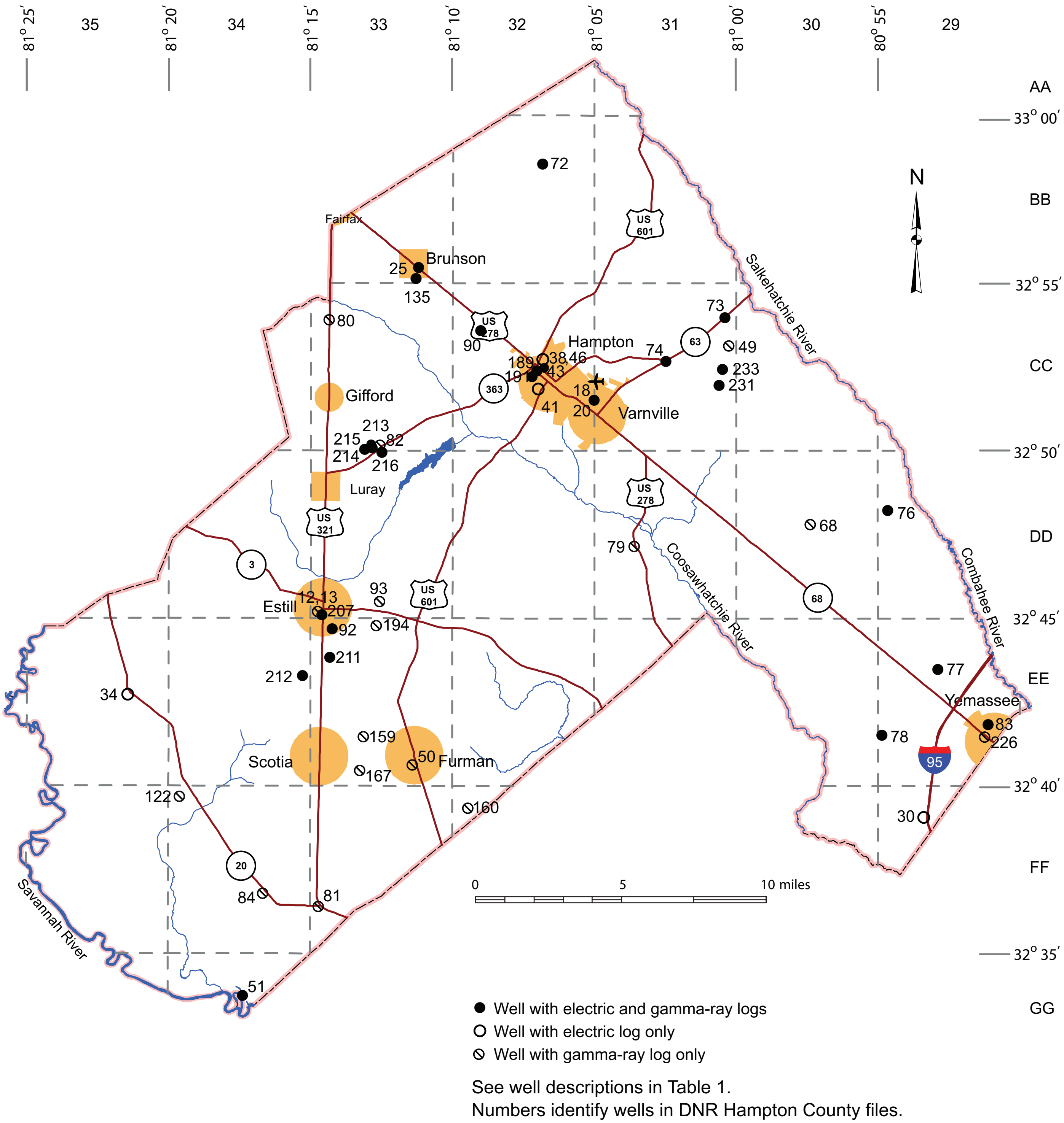


Figure 4. Locations of selected geophysical logs in Hampton County.

Table 1. Permeable sand and limestone intervals indicated by geophysical logs (E, electric log; G, gamma-ray log)

County well number	HAM-12	HAM-13	HAM-18	HAM-20	HAM-25	HAM-30	HAM-34
S.C. grid number	33DD-y1	33DD-y2	31CC-p1	31CC-p2	33BB-v1	29FF-d1	35EE-l1
Elevation, in ft msl	112	112	107	107	135	45	78
Geophysical logs	G	G	E, G	E, G	E, G	E	E
Top of log (feet)	0	0	0	0	5	20	80
Bottom of log (feet)	848	810	673	912	710	1,390	700
Top of limestone (feet)	120	130	80	80	80	n/a	n/a
Bottom of limestone (feet)	670	660	670	590	545	n/a	n/a
Permeable zones (feet)	120-175	130-210	80-110	80-140	90-145	190-240	110-160
	390-425	290-310	150-175	285-305	215-235	280-295	200-215
	450-460	410-420	240-260	410-435	280-330	300-310	230-260
	670-685	440-450	385-395	460-480	360-410	320-330	280-310
	750-760	660-670		490-500	560-590	375-385	340-360
	780-795	690-710		650-695	625-640	400-425	370-385
		730-740		700-720	650-670	1,110-1,120	395-420
		765-780		790-810		1,185-1,255	575-600
				825-890		1,265-1,280	630-640
						1,305-1,325	685-710

County well number	HAM-38	HAM-41	HAM-43	HAM-46	HAM-49	HAM-50	HAM-51
S.C. grid number	32CC-l4	32CC-s1	32CC-l5	32CC-l1	31CC-j1	33EE-v1	34GG-h1
Elevation, in ft msl	105	100	105	105	70	110	30
Geophysical logs	E	E	E, G	E	G	G	E, G
Top of log (feet)	515	60	0	60	16	5	5
Bottom of log (feet)	1,468	853	242	,030	723	970	130
Top of limestone (feet)	n/a	n/a	60	n/a	56	132	90
Bottom of limestone (feet)	n/a	n/a	n/a	n/a	520	725	n/a
Permeable zones (feet)	575-590	60-90	60-90	60-100	56-100	132-210	90-130
	635-720	140-170	120-160	120-130	145-155	400-460	
	780-850	210-260		240-280	250-270	500-520	
	950-1,075	320-410		350-420	320-340	735-760	
	1,115-1,125	470-500		560-580	525-560	795-815	
	1,135-1,175	660-680		625-710	580-600	865-880	
	1,190-1,220	700-710		770-840	630-650		
	1,255-1,330	780-853		940-1,020			
	1,370-1,445						

n/a, information not available because either no gamma-ray log was available for this well or the well was not deep enough to penetrate the unit

Table 1. Continued

County well number	HAM-68	HAM-72	HAM-73	HAM-74	HAM-76	HAM-77	HAM-78
S.C. grid number	30DD-m1	32BB-i1	31CC-j2	31CC-m1	29DD-f2	29EE-h1	29EE-p1
Elevation, in ft msl	85	116	78	135	67	40	80
Geophysical logs	G	E, G	E, G	E, G	E, G	E, G	E, G
Top of log (feet)	5	10	5	0	0	0	0
Bottom of log (feet)	380	551	200	200	216	135	200
Top of limestone (feet)	90	35	55	110	95	70	120
Bottom of limestone (feet)	n/a	485	n/a	n/a	n/a	n/a	n/a
Permeable zones (feet)	90-110 180-200 280-300	35-65 100-120 270-290 310-340	55-95	110-130 140-175	170-190	70-100	120-160

County well number	HAM-79	HAM-80	HAM-81	HAM-82	HAM-83	HAM-84	HAM-90
S.C. grid number	31DD-n1	33CC-f1	33FF-p2	33CC-w1	29EE-s1	34FF-s1	32CC-g1
Elevation, in ft msl	85	103	75	128	46	70	112
Geophysical logs	G	G	G	G	E, G	G	E, G
Top of log (feet)	5	5	10	5	0	0	0
Bottom of log (feet)	219	48	208	161	156	555	538
Top of limestone (feet)	115	30	115	115	87	92	50
Bottom of limestone (feet)	n/a	n/a	n/a	n/a	n/a	n/a	538
Permeable zones (feet)	115-150	30-48	115-170	115-150	87-125	92-200 340-375	60-85 125-170 290-335 350-400

County well number	HAM-92	HAM-93	HAM-122	HAM-135	HAM-159	HAM-160	HAM-167
S.C. grid number	33EE-e1	33DD-w2	34FF-e2	33BB-v4	33EE-q1	32FF-e1	33EE-x1
Elevation, in ft msl	112	100	73	130	112	105	98
Geophysical logs	E, G	G	G	E, G	G	G	G
Top of log (feet)	5	0	5	10	5	5	5
Bottom of log (feet)	1,015	797	175	808	335	245	53
Top of limestone (feet)	110	110	80	65	140	116	n/a
Bottom of limestone (feet)	670	675	n/a	530	n/a	n/a	n/a
Permeable zones (feet)	110-155 175-185 410-425 670-720 780-795 850-980	110-150 285-310 350-365 410-425 430-450 675-695 780-797	80-170	65-110 265-310 340-390 630-660 710-808	140-200	116-200	

n/a, information not available because either no gamma-ray log was available for this well or the well was not deep enough to penetrate the unit

Table 1. Continued

County well number	HAM-189	HAM-191	HAM-194	HAM-207	HAM-211	HAM-212	HAM-213
S.C. grid number	32CC-l17	32CC-m1	33EE-c3	33DD-y8	33EE-f2	34EE-j1	33CC-w2
Elevation, in ft msl	106	112	106	111	120	130	124
Geophysical logs	E, G	E, G	G	E, G	E, G	E, G	E, G
Top of log (feet)	5	0	0	0	0	120	0
Bottom of log (feet)	896	910	148	196	190	346	90
Top of limestone (feet)	59	70	118	115	125	138	n/a
Bottom of limestone (feet)	588	595	n/a	n/a	n/a	n/a	n/a
Permeable zones (feet)	60-85 115-160 235-265 315-420 470-500 575-590 660-710 770-855	70-100 120-150 235-277 373-430 630-725 790-875	118-148	120-180	125-150 165-190	138-210	35-60

County well number	HAM-214	HAM-215	HAM-216	HAM-226	HAM-231	HAM-233
S.C. grid number	33CC-x2	33CC-w3	33CC-w4	29EE-s6	31CC-k1	31CC-k2
Elevation, in ft msl	117	126	116	46	100	85
Geophysical logs	E, G	E, G	E, G	G	E, G	E, G
Top of log (feet)	0	5	0	0	5	0
Bottom of log (feet)	90	100	86	137	900	903
Top of limestone (feet)	n/a	100	n/a	92	85	85
Bottom of limestone (feet)	n/a	n/a	n/a	n/a	565	550
Permeable zones (feet)	30-55	45-75	30-55	92-137	85-100 130-155 380-410 550-605 810-880	85-110 125-160 350-395 540-600 650-660 770-860

n/a, information not available because either no gamma-ray log was available for this well or the well was not deep enough to penetrate the unit

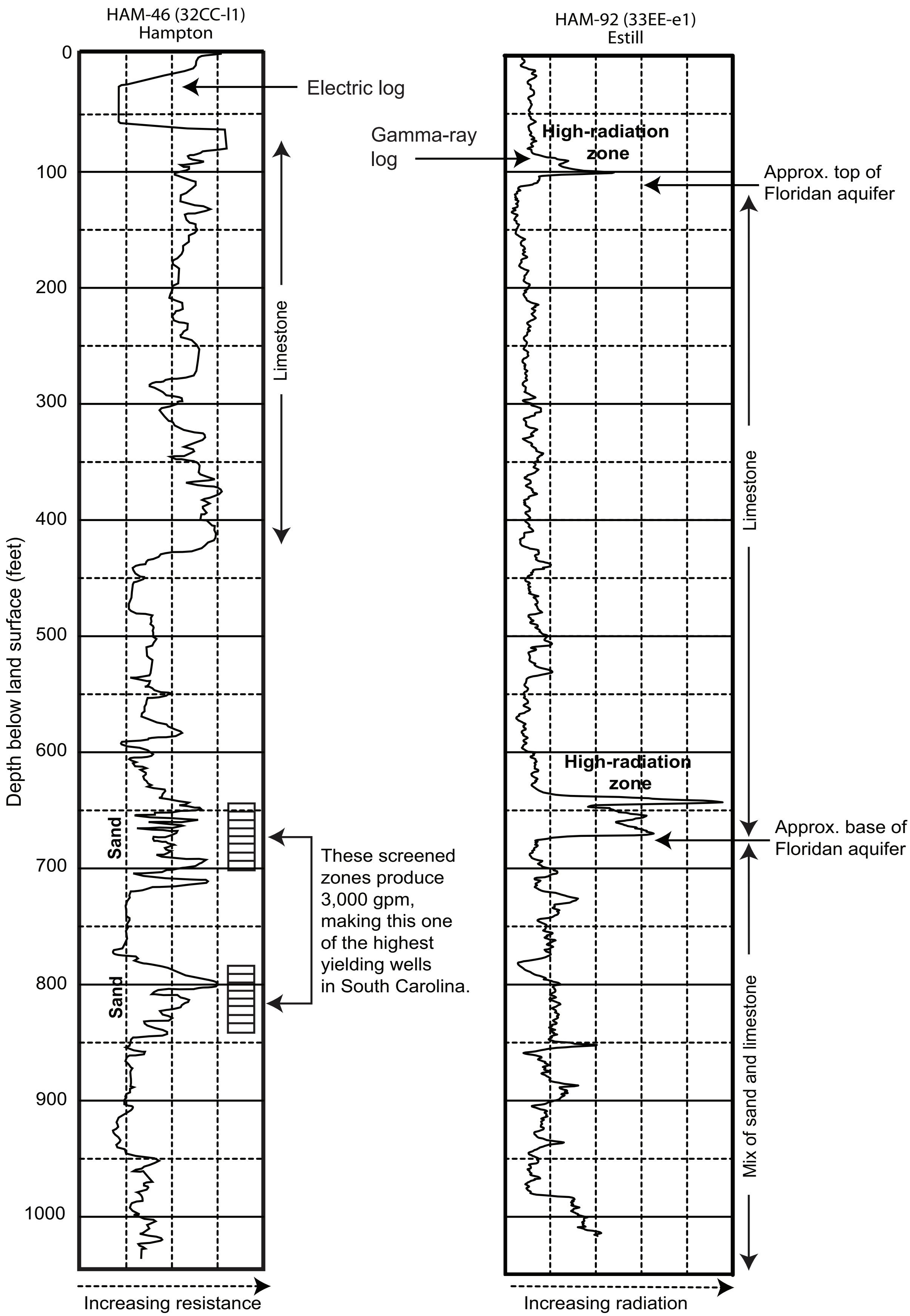


Figure 5. Examples of deep-well electric and gamma-ray logs.

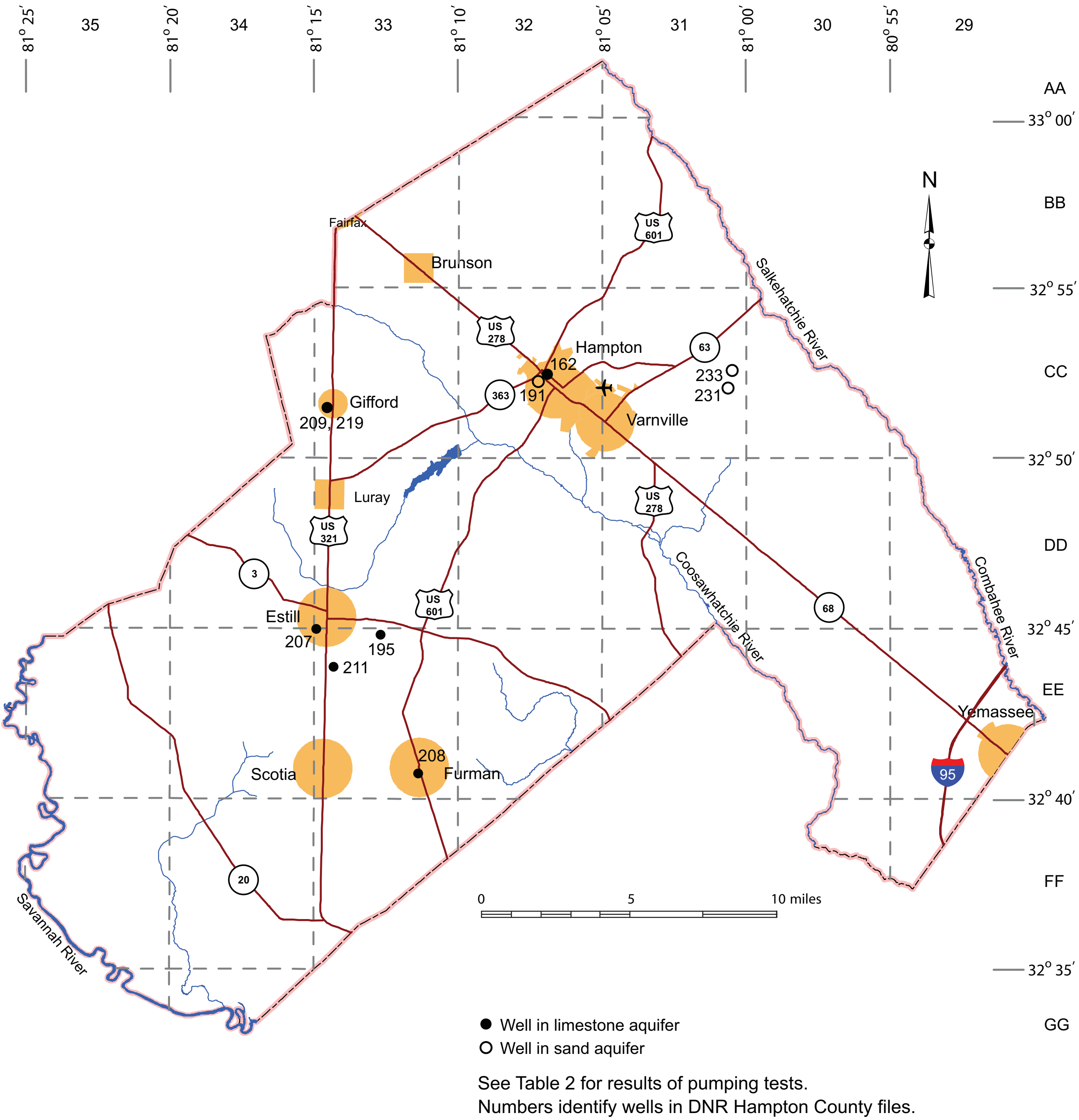


Figure 6. Locations of pumping tests in Hampton County.

Table 2. Results of pumping tests of Hampton County wells

County well no.	S.C. grid no.	Geo. log	Depth (ft)	Aquifer thickness (ft)	Static WL (ft)	Q (gpm)	Trans. (gpd/ft)	Storage coefficient	Specific capacity (gpm/ft)	Well efficiency (percent)
HAM-162	32CC-l15		120	F/	6	100	9,000	0.0001	3.3	75
HAM-191	32CC-m1	E,G	890	PD/	50	709	29,000		8.1	55
HAM-195	33EE-c4	G	251	F/	22	1,500	90,000	0.0002		
HAM-207	33DD-y8	E,G	195	F/	18	603	90,000		22	50
HAM-208	33EE-v3		280	F/	47	471	25,000		12	85
HAM-209	33CC-p2		175	F/		548	43,000			
HAM-211	33EE-f2	E,G	160	F/	30	845	80,000		40	100
HAM-219	33CC-p3		150	F/	33	600	46,000		37	100
HAM-231	31CC-k1	E,G	870	PD/70	38	630	19,000		5.4	55
HAM-233	31CC-k2	E,G	870	PD/90	27	630	18,000		4.6	50

Explanation of table-heading abbreviations:

Geo. log — Geophysical logs available for this well. E, electric log; G, gamma-ray log.
Aquifer thickness — Name of aquifer. F, Floridan; PD, Black Mingo-Peedee system.
Thickness is thickness (in feet) of aquifer when it is apparent on electric log.
Static WL — Non-pumping water level, in feet below land surface.
Q — Pumping rate for test, in gallons per minute.
Trans. — Transmissivity, in gallons per day per foot of aquifer width.
Divide by 7.48 to obtain units in cubic feet per day per foot.
Storage coefficient — Storage coefficient, dimensionless.
Specific capacity — Specific capacity in gallons per minute produced for each foot of water-level drawdown.
Well efficiency — Specific capacity divided by what it should be for the indicated transmissivity.

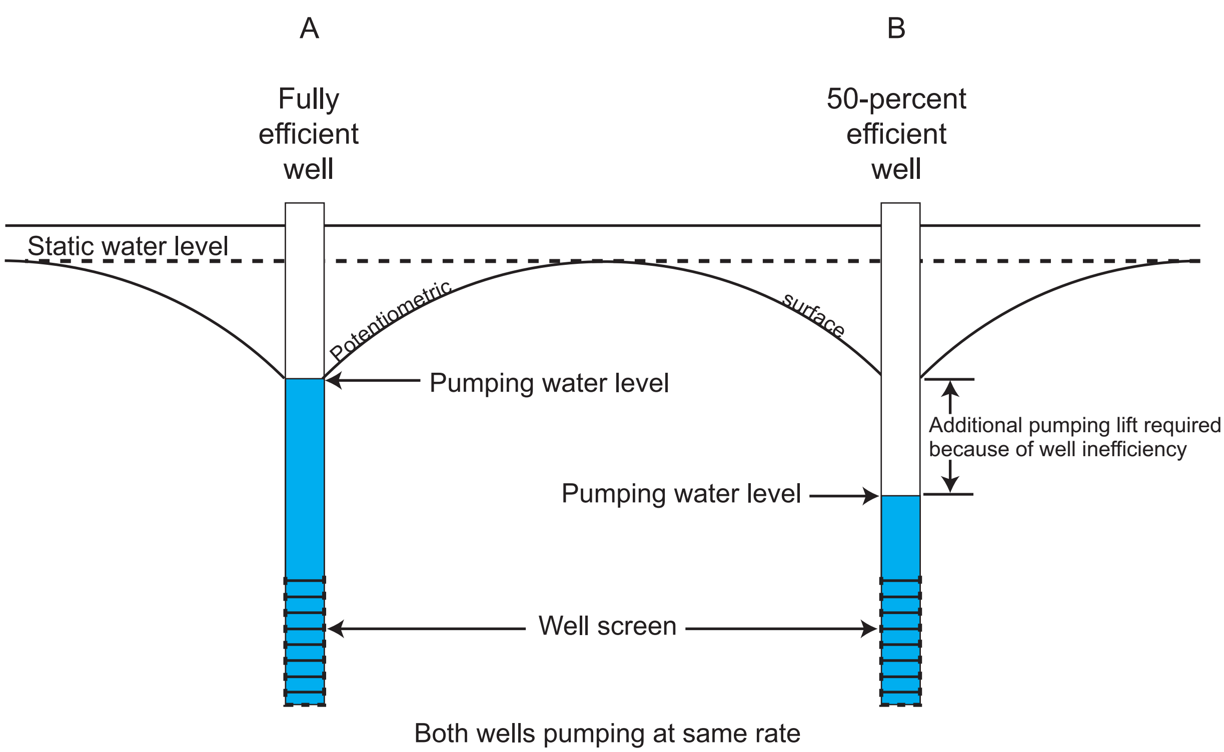
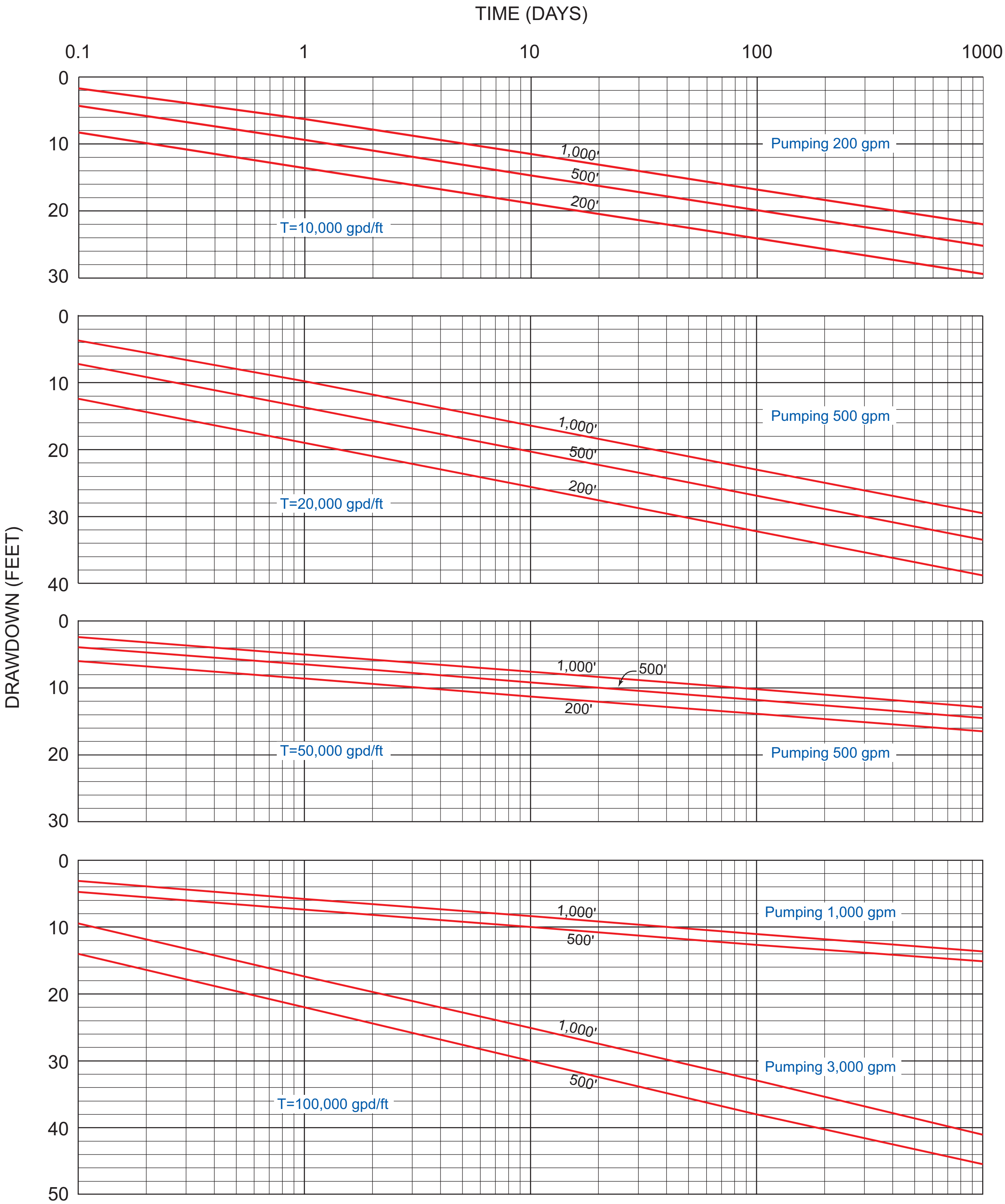


Figure 7. Illustration of the effect of well inefficiency.



ASSUMED CONDITIONS

Pumping rate and transmissivity as indicated. Storage coefficient: 0.0002 (artesian)
For other pumping rates, the drawdown will vary in direct proportion.
For example, doubling the pumping rate will double the drawdown at a given distance and time.
Transmissivity is given here in gallons per day per foot of aquifer width.
To convert to cubic feet per day per foot (ft^2/d), divide by 7.48.

Figure 8. Predicted pumping effects at various times and distances for the aquifers of Hampton County, S.C.

Table 3. Chemical analyses of water from wells in Hampton County, S.C. (constituents and hardness reported in milligrams per liter)

County well no.	S.C. grid no.	Location	Date	Depth (ft)	Silica	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hardness	pH	Analyst
Limestone aquifer																			
HAM-6	30EE-q2	Yemassee, 6 mi E	Jul-56	60	10[1]	0	35	2.9	{ 11 }		144	1	3.0	0.3	0.2	135[1]	100	7.4	U
HAM-14	33DD-y3	Estill	Nov-55	165	23	0.13	25	3.1	33	2.4	157	7.8	3.5	.4	.3	171	76	7.4	U
HAM-35	33DD-x1	Estill	Nov-54	180	29	.13	39	7.5	7.3	3.2	176	4	4.0	.0	.3	186	128	7.4	U
HAM-36	33DD-y5	Estill	Jan-60	152	30	.32	42	5.0	4.7	2.2	155	3.5	3.0	.1	.1	167	126	7.7	U
HAM-48	33DD-x4	Estill	1964	125		.25	49	2.6			138		9			182	134	7.7	U
HAM-73	31CC-j2	Varnville, 5 mi NE	Feb-77	200		.61	48	2.7	5.0	2.4	156				.0		130		U
HAM-77	29EE-h1	Yemassee, 3 mi NW	Feb-77	154		.83	56	8.1	10	4	144				.0		170		U
HAM-80	33CC-f1	Gifford, 2 mi N	Jan-77	60	3	.02	29	1.9	12	2.0	106	7.2	5.4	.2		113	80		U
HAM-190	34EE-t1	Scotia	May-87	168	37	.82	44	1.7	6.0	2.2	160	.0	3.9	.0	.0	175	116	7.5	W
HAM-202	33DD-w4	Estill, 2 mi E	Mar-98	160	26	.03	43	1.4	6.5	1.6	122	5.4	3.6	.1	.1	149	113	8.3	U
HAM-211	33EE-f2	Estill, 1 mi S	Apr-91	160	10[1]	.15	48	1.3	5.4	1.6	120	<5	5.2	<.1	.0	140[1]	125	7.8	C
HAM-229	30EE-l3	Yemassee, 5 mi W	Mar-98	120	55	.05	32	7.8	8.3	3.4	145	.2	3.2	.3	.1	200	111	7.2	U
Sand aquifer																			
HAM-9	29EE-s7	Yemassee	May-54	667	26	0.00	9.1	2.6	76	4.8	247	6.0	3.4	1.2	.6	258	34	7.8	U
HAM-12	33DD-y1	Estill	Nov-55	844	16	.24	4.4	.6	54	3.6	151	7.2	3.0	.6	.2	164	14	8.2	U
HAM-18	31CC-p1	Varnville	Oct-56	870	17	.02	4.5	.7	55	2.2	144	8.7	3.5	.6	.5	158	14	7.5	U
HAM-24	30EE-b1	Lena, 2 mi E	Nov-52	750	15	.09	1.6	.7	{ 108 }		239	7.8	4.8	1.7	.1	275	7	8.8	U
HAM-26	33BB-v2	Brunson	Nov-51	745	15	.11	4.7	1.0	{ 28 }		71	14	2.1	.6	.0	101	16	6.9	U
HAM-27	33BB-v3	Brunson	Aug-52	720	14	.38	4.9	.9	{ 28 }		72	14	2.0	.5	.0	100	16	7.6	U
HAM-34	35EE-l1	Estill, 7 1/2 mi WSW	Feb-77	822	14	.02	3.2	.1	58	2.3	149	7.0	2.9	.5	.0	162	8		U
HAM-41	32CC-s1	Hampton	Dec-64	853	1	.56	4.2	.2	51	4.5	140	11	2.4	.5	.0	144	12	8.1	U
HAM-49	31CC-j1	Varnville, 5 mi NE	Feb-77	723	19	.03	4.3	.1	54	4.3	136	13	2.7	.5	.0	166	11		U
HAM-71	33DD-f1	Luray	May-73	1,000		.3	3.8	1.0			139[1]		9			132	14	8.1	C
HAM-92	33EE-e1	Estill	Jun-80	1,015	9	0	4.6	.3	56	3.9	154	6.3	2.5	.2		159	12	8.7	W
HAM-191	32CC-m1	Hampton	Aug-87	890		.04	51	11	51		132	8.4	4.9	.8		150[1]	17	8.1	C
HAM-231	31CC-k1	Varnville, 5 mi NE	Apr-00	883			28	.4	67	3.2	239	11	10		.1	285	70	8.6	C

[1] Calculated or estimated by authors

Analysts: C, commercial; U, U.S. Geological Survey; W, South Carolina Water Resources Commission

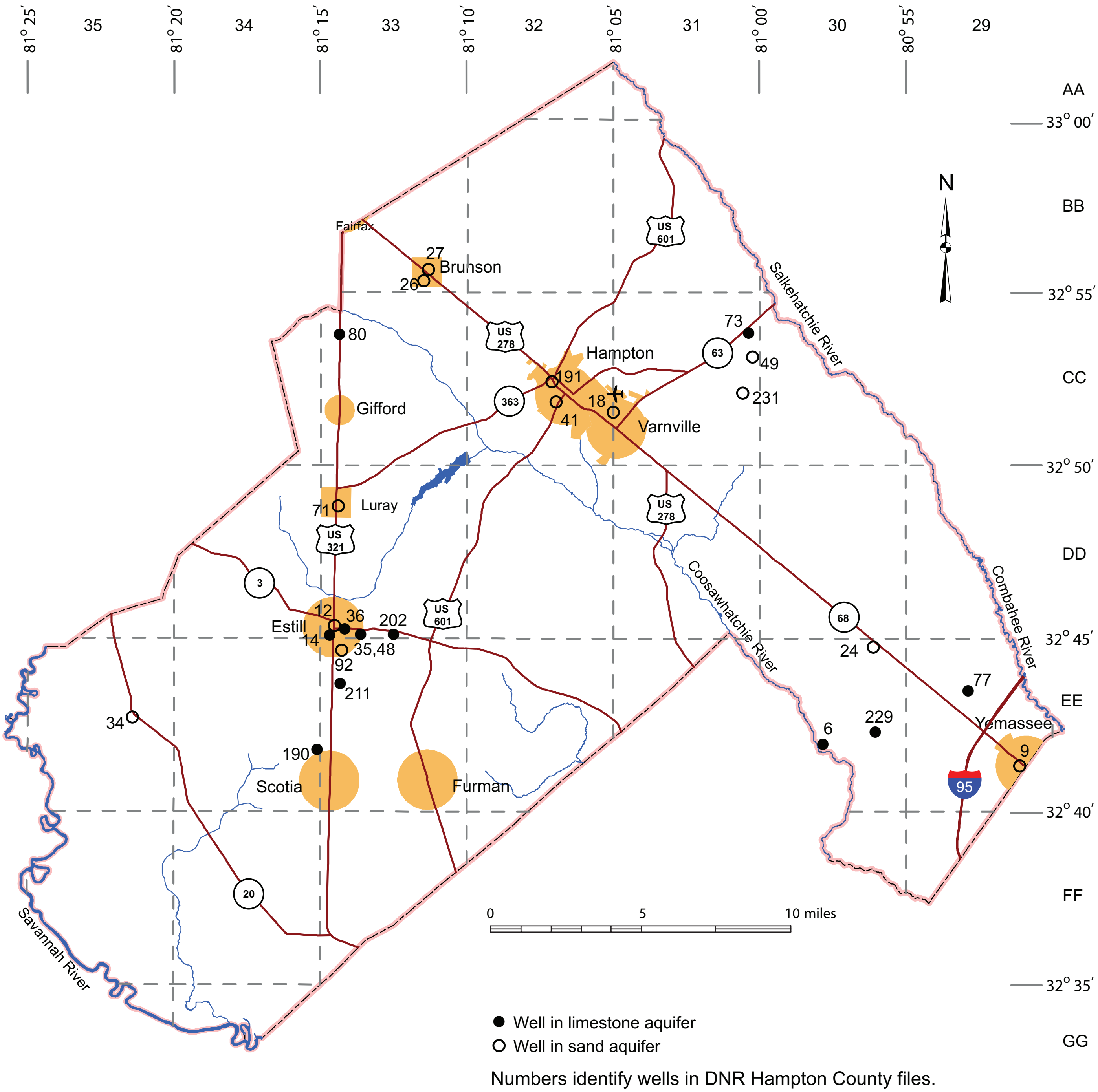


Figure 9. Locations of wells for which chemical analyses appear in Table 3.

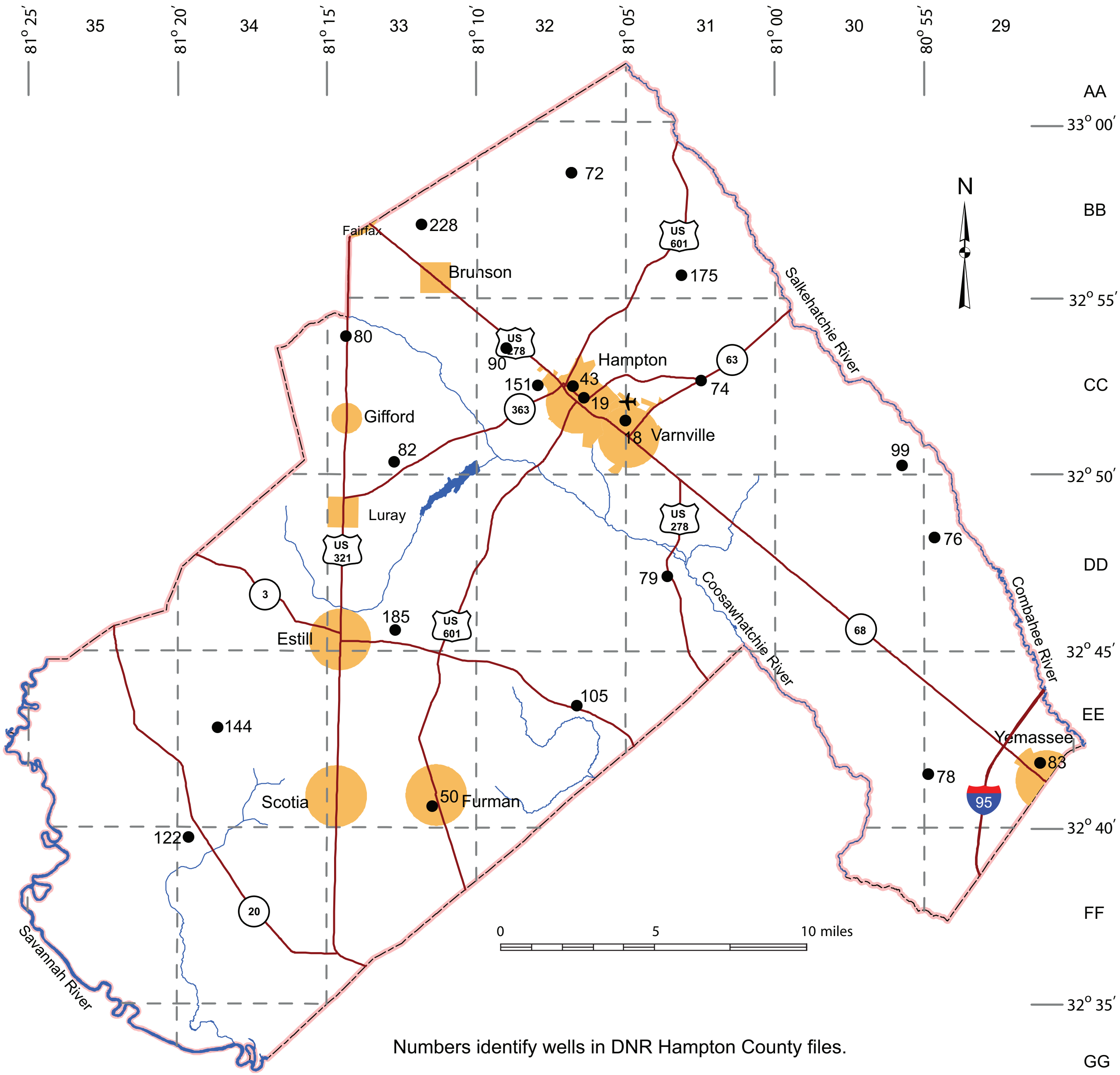


Figure 10. Locations of wells for which the hydrographs in the Appendix are shown.

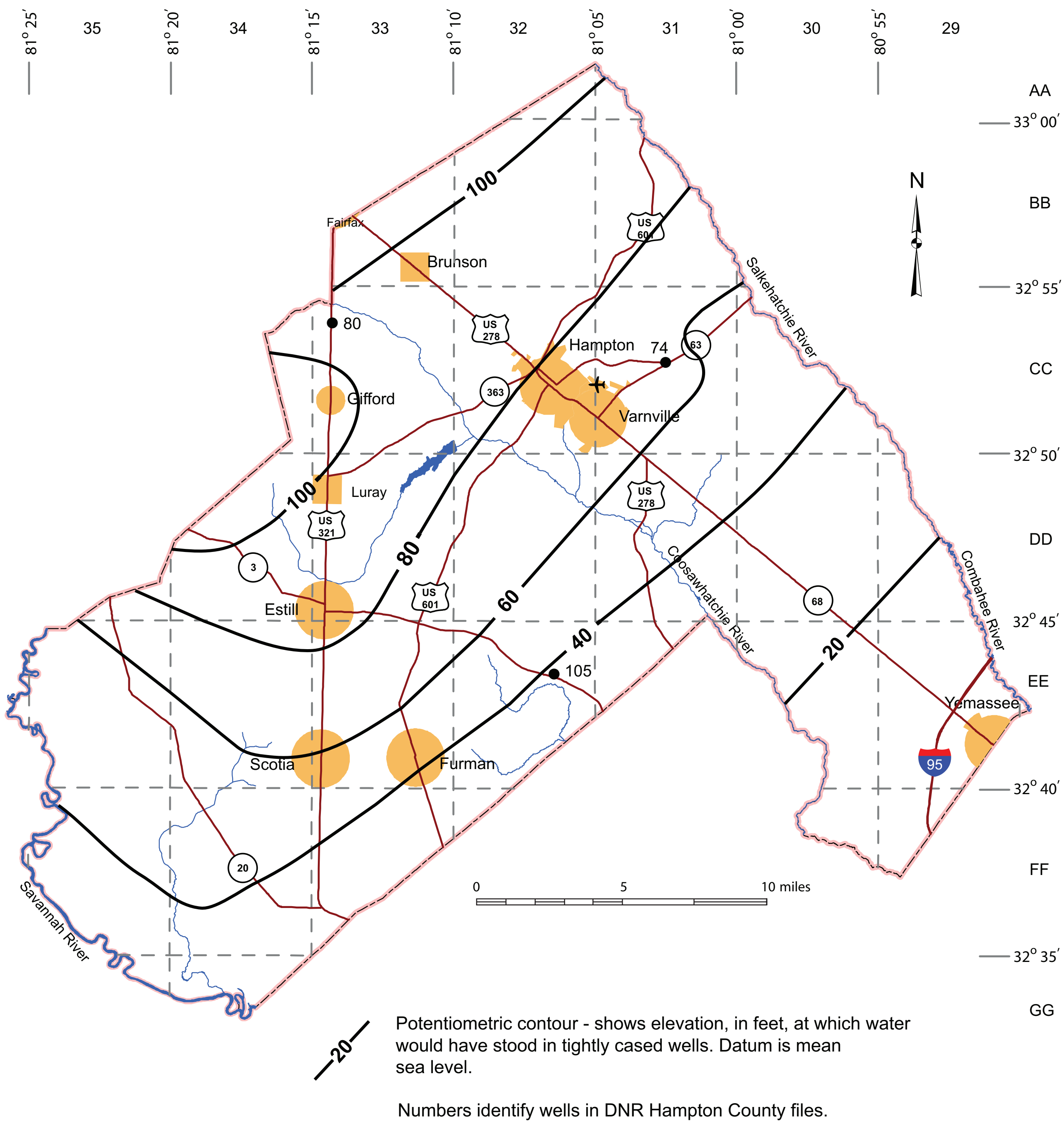


Figure 11. Potentiometric surface of the Floridan aquifer, 1998 (modified from Hockensmith, 2001).

"Hampton County showed water-level declines throughout the county. Water levels were higher than 100 ft msl prior to development (Aucott and Speiran, 1985), but they had declined to about 80 ft msl by 1998. Well HAM-74 showed a decline of 8 feet from 1976 to 1998. A well (HAM-80) in the northwestern part of the county showed winter water-level elevations above 97 ft msl between 1981 and 1990 (Gawne, 1990), but by 1998 levels had declined to 92 ft msl. Another well (HAM-105), located in central Hampton County, showed winter water levels generally above 46 ft msl until 1988, but they had declined to 43 and 38 ft msl in 1990 and 1998, respectively."

It would be reasonable to conclude that a significant cause of water-level declines in Hampton County is pumping outside the county. The existence of a cone of water-level depression centered in the Savannah, Ga., area is well documented. Historical water-level declines in the area were well described by Hayes (1979, p 42 and Figs. 14 and 19).

A planned observation-well run in the near future will result in a map illustrating the current water-level situation. Consideration of these graphs and maps should help the county to plan effectively for the use of its ground water.

RECOMMENDATIONS

Water-level problems have, in the past, demanded attention in parts of Hampton County. Basically, they arose as a result of heavy pumping from rather shallow aquifers causing spreading cones of influence that lowered water levels in the vicinity. An open-file report by Whiting and Park (1990) addressed this problem and made recommendations that are worth repeating here. The following is taken from that report.

"Little can be done to limit future water-level declines, short of prohibiting new uses of ground water. The demand for ground water will increase with population growth, influx of commerce and industry, and the need for agricultural irrigation. Water levels inevitably will decline in response to the greater demand. There are, however, means of reducing the probability of debilitating well interference caused by high-capacity wells.

1. Use of aquifers other than the Upper Floridan. Most domestic wells are completed in the Upper Floridan. Underlying aquifers, between 700 and 1,000 feet, could yield substantial quantities of water. Wells completed in the deeper aquifers are more expensive to construct and operate. Water quality is generally good but might not be suitable for every purpose.
2. Construct wells to produce the minimum quantity of water necessary to serve the intended purpose. As noted previously, a 500-gpm well causes one-third of the drawdown of a 1,500-gpm well during a given period of discharge. The lower capacity well must be pumped longer to achieve the same purpose, and drawdown will continue while it pumps, but the maximum drawdown will be substantially less. As an example, an Upper Floridan well near Estill will cause about 8 feet of drawdown at a distance of 5,000 feet if pumped at 1,500 gpm for 30 days (64.8 million gallons). The same well will cause about 3.2 feet of drawdown after pumping 500 gpm for 90 days (64.8 million gallons).
3. Distribute withdrawals among several widely spaced lower-capacity wells. Drawdown then is distributed over a broader area, and the drawdown near the well field is generally less. The drawdown caused by two 250-gpm wells spaced 2,500 feet apart and pumping 90 days would be about 4.7 to 5.2 feet of drawdown at 1,000 feet. The benefit from distributing withdrawals among multiple wells is decreased, but is increased where aquifer transmissivities are low. The circumstances allow smaller diameter wells to be used; that is, the cost of two 8-inch wells is about the same as a single 12-inch well.
4. Schedule withdrawals to minimize the additive effects of drawdown. The drawdown experienced at any given location is the sum of the drawdowns caused by some combination of pumping wells. Thus, well interference can be minimized by staggering withdrawals from high-capacity wells and minimizing the amount of water pumped at any given time. For example, this might be accomplished in the Estill area by scheduling withdrawals at the Rouse Farm, the Clemson ponds, and the Propst pond so that they never occur at the same time; or by deactivating the Propst well while the Clemson and Rouse wells are pumping, and the reverse.
5. Schedule withdrawals to coincide with periods of low demand by domestic users. Withdrawals would have to be limited to late evening and early morning hours and would be curtailed substantially by this practice.
6. Pump intakes should be set well below static water level to minimize future well-interference problems. Considering the probability of continued regional decline, increased local withdrawals and seasonal fluctuations, pump intakes should be set at a minimum of 35 to 45 feet below static water level."

To the above, the present writers would like to append an appeal for additional technical information on the large wells that are installed in Hampton County. Much needed are pumping tests, chemical analyses, and geophysical logs. A deep test well should be drilled to bedrock to further our knowledge of water quality and quantity for the deeper aquifers in the county. Additional monitoring wells should be installed, especially in the Floridan aquifer, to measure seasonal and long-term ground-water trends.

SELECTED REFERENCES

Aucott, W.R., and Speiran, G.K., 1985, Potentiometric surfaces of the Coastal Plain aquifers of South Carolina prior to development: U.S. Geological Survey Water-Resources Investigations Report 84-4208, 5 sheets.

Aucott, W.R., Davis, M.E., and Speiran, G.K., 1987, Geohydrologic framework of the Coastal Plain aquifers of South Carolina: U.S. Geological Survey Water-Resources Investigations Report 85-4271, 7 sheets.

Colquhoun, D.J., and others, 1983, Surface and subsurface stratigraphy, structure and aquifers of the South Carolina Coastal Plain: University of South Carolina, Department of Geology, 78 p.

Gawne, C.E., 1990, Water-level declines in Hampton County, South Carolina: South Carolina Water Resources Commission Technical Memorandum, 16 p.

——— 1994, Water-level measurements and potentiometric maps for 1991-1993 Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina – with selected hydrographs for 1975-1993: South Carolina Water Resources Commission Open-File Report 43, 20 p. and 11 plates.

Gawne, C.E., and Park, A.D., 1992, Water-supply potential of the middle Floridan aquifer in southern Beaufort County, South Carolina: South Carolina Department of Natural Resources Open-File Report 9, 34 p.

Hayes, L.R., 1979, The ground-water resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina: South Carolina Water Resources Commission Report No. 9, 91 p.

Hockensmith, B.L., 2001, Potentiometric map of the Floridan aquifer and Tertiary sand aquifer in South Carolina, 1998: South Carolina Department of Natural Resources Water Resources Report 23, 1 sheet.

Newcome, Roy, Jr., 1989, Ground-water resources of South Carolina's Coastal Plain: 1988 – an overview: South Carolina Water Resources Commission Report 167, 127 p.

Park, A.D., Whiting, N.M., and Gawne, C.E., 1991, Report of a capacity-use investigation for Hampton County, South Carolina: South Carolina Water Resources Commission Open-File Report 40, 54 p.

Ransom, Camille, III, and White, J.L., 2000, Potentiometric surface of the Floridan aquifer system in southern South Carolina, September 1998: South Carolina Department of Health and Environmental Control Publication 02B-99, 1 plate.

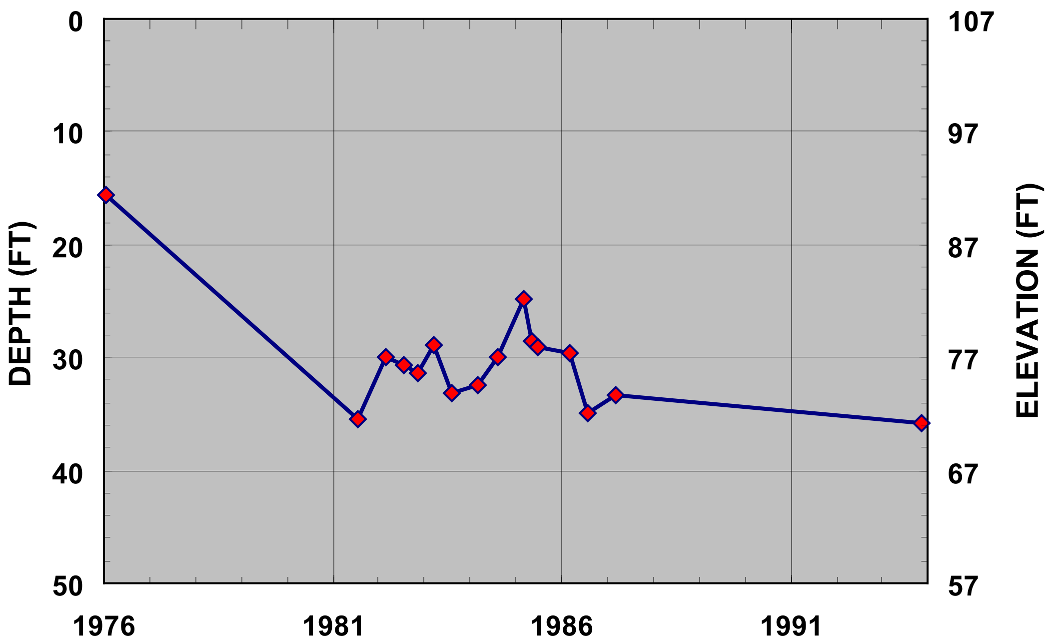
Waters, Karen E., 2003, Ground-water levels in South Carolina – a compilation of historical water-level data: South Carolina Department of Natural Resources Water Resources Report 26, 300 p.

Whiting, N.M., and Park, A.D., 1990, Preliminary investigation of water-level declines in wells near Estill, Hampton County, South Carolina, spring 1990: South Carolina Water Resources Commission Open-File Report 37, 18 p.

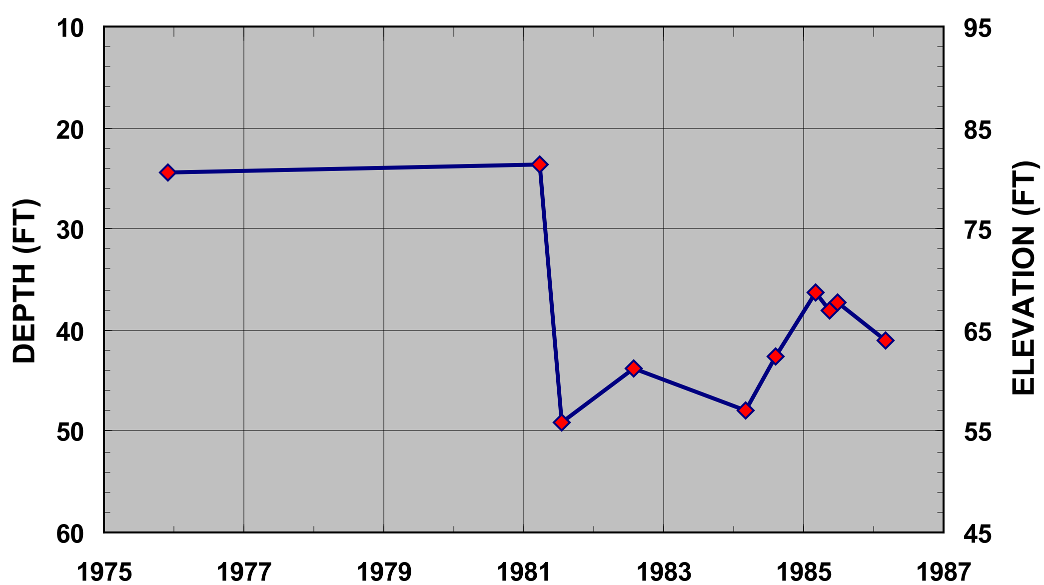
APPENDIX

The following hydrographs, with the exceptions of HAM-50, HAM-83, and HAM-228, are taken from Waters (2003). They are referred to as historical data, meaning that they represent wells no longer measured. Wells HAM-50 and HAM-83 continue to be monitored. HAM-50 is maintained by the South Carolina Department of Natural Resources and is measured every other month. HAM-83 is maintained by the U.S. Geological Survey and is equipped with an automated data recorder. Data from this well can be accessed at the following link http://sc.water.usgs.gov/water-data.html. HAM-228 was maintained by the South Carolina Department of Natural Resources, but this well has recently (August 2006) been discontinued. Aquifer designations are from Aucott and others (1987).

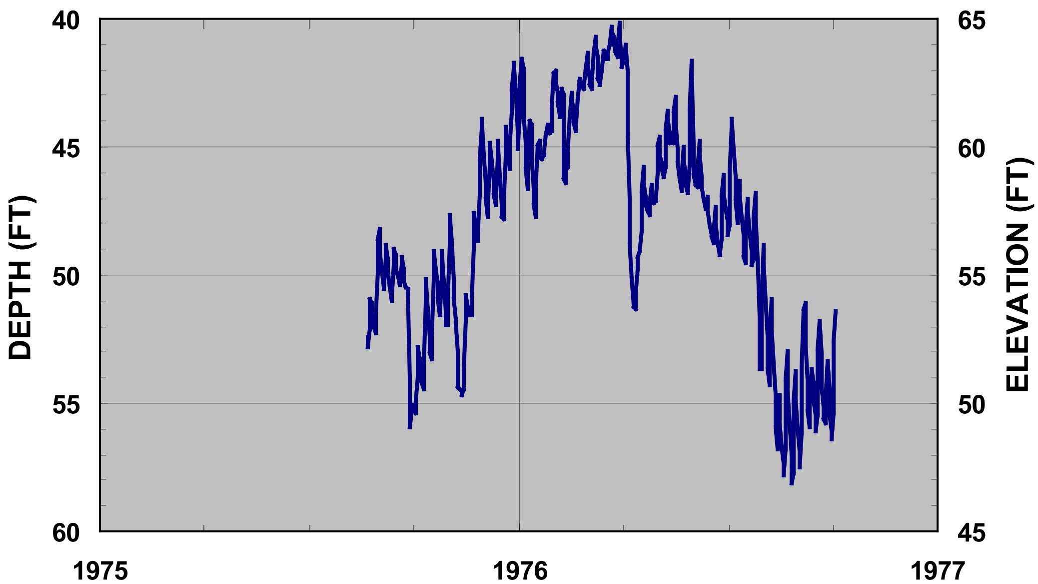
WELL NUMBER: HAM-18 GRID NUMBER: 31CC-p1
LATITUDE: 32°51’30” LONGITUDE: 81°04’57”
LOCATION: Near the intersection of S.C. 68 and 63 in Varnville.
AQUIFER: Black Creek.
CHARACTERISTICS: 4-inch diameter public supply well. Depth: 900 ft. Open interval unknown.
DATUM: Land surface datum is 107 ft above National Geodetic Vertical Datum of 1929.



WELL NUMBER: HAM-19 GRID NUMBER: 32CC-l11
LATITUDE: 32°51’53” LONGITUDE: 81°06’36”
LOCATION: Behind the Town Hall in Hampton.
AQUIFER: Black Creek.
CHARACTERISTICS: 6-inch diameter public supply well. Depth: 850 ft. Open interval: 825-850 ft.
DATUM: Land surface datum is 105 ft above National Geodetic Vertical Datum of 1929.

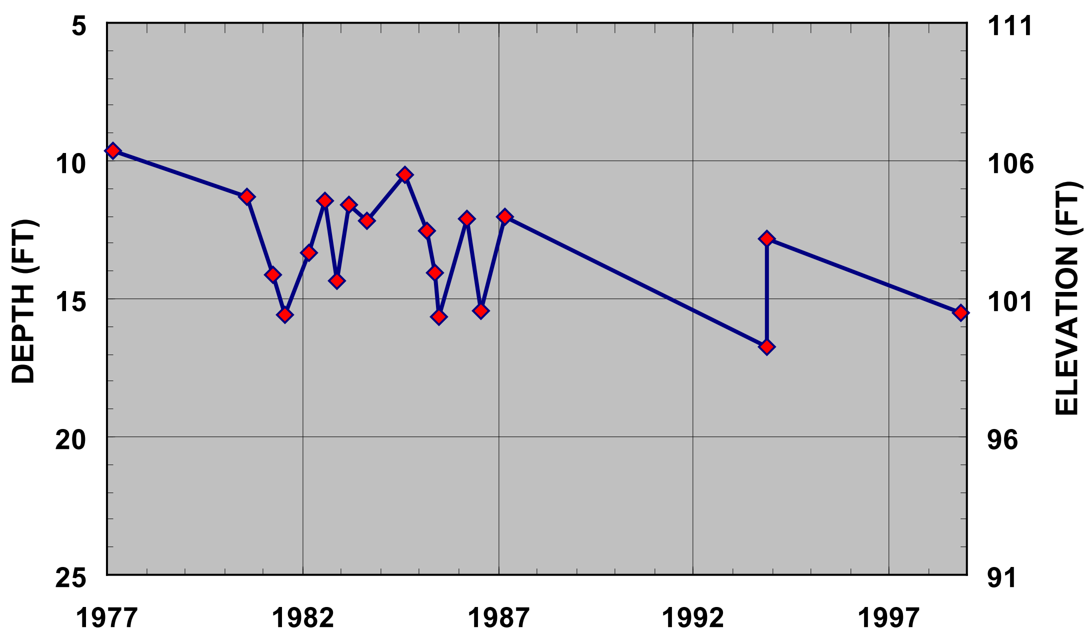


WELL NUMBER: HAM-43 GRID NUMBER: 32CC-l5
LATITUDE: 32°52’51” LONGITUDE: 81°06’26”
LOCATION: U.S. 601, in Hampton.
AQUIFER: Floridan.
CHARACTERISTICS: 12-inch diameter observation well. Depth: 600 ft. Open interval: 177-243 ft.
DATUM: Land surface datum is 105 ft above National Geodetic Vertical Datum of 1929.

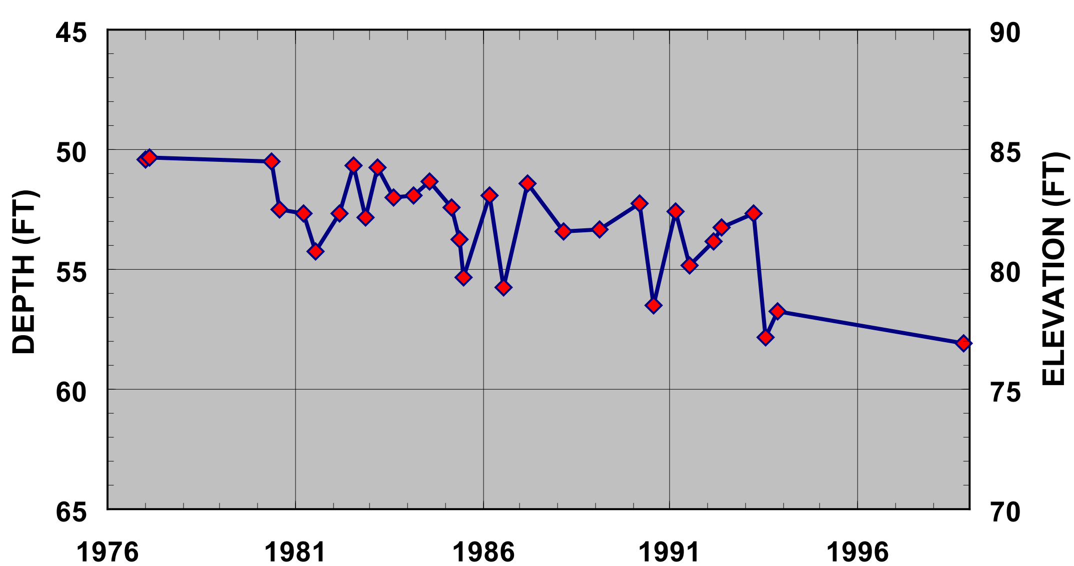


WELL NUMBER: HAM-50 GRID NUMBER: 33EE-v1
LATITUDE: 32°40’47” LONGITUDE: 80°11’13”
LOCATION: U.S. 601, in Furman.
AQUIFER: Black Creek.
CHARACTERISTICS: 8-inch diameter unused public supply well. Depth: 986 ft. Open interval unknown.
DATUM: Land surface datum is 115 ft above National Geodetic Vertical Datum of 1929.

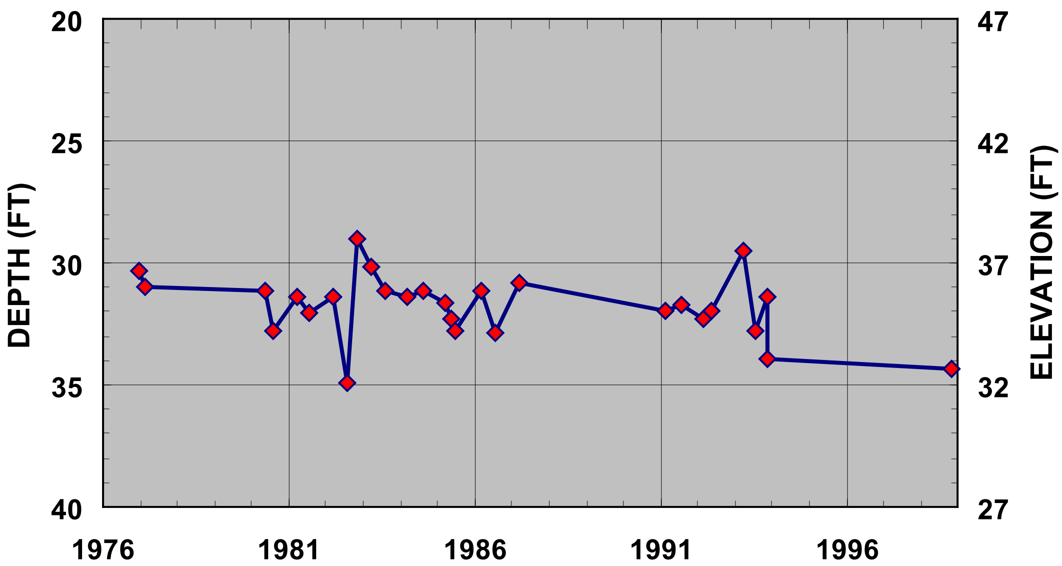
WELL NUMBER: HAM-72 GRID NUMBER: 32BB-i1
LATITUDE: 32°58’41” LONGITUDE: 81°06’46”
LOCATION: 10 mi north of Hampton at the intersection of County Roads 248 and 13.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 551 ft. Open interval: 162-551.
DATUM: Land surface datum is 116 ft above National Geodetic Vertical Datum of 1929.



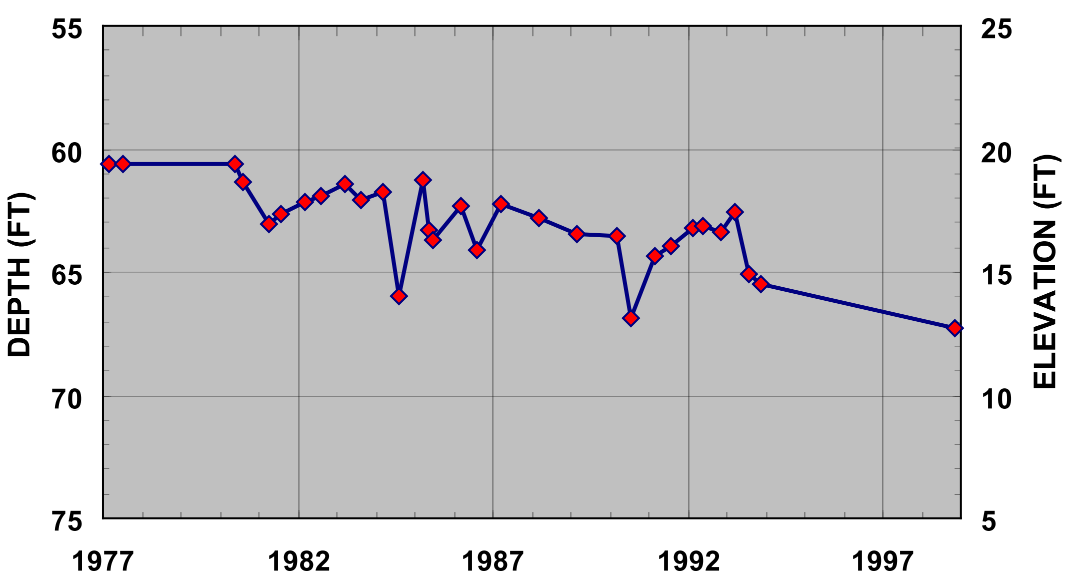
WELL NUMBER: HAM-74 GRID NUMBER: 31CC-m1
LATITUDE: 32°52’42” LONGITUDE: 81°02’24”
LOCATION: 3 mi northeast of Varnville on S.C. 63 and 170 ft NE of the intersection of S.C. 63 and 363.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 200 ft. Open interval: 110-200 ft.
DATUM: Land surface datum is 135 ft above National Geodetic Vertical Datum of 1929.



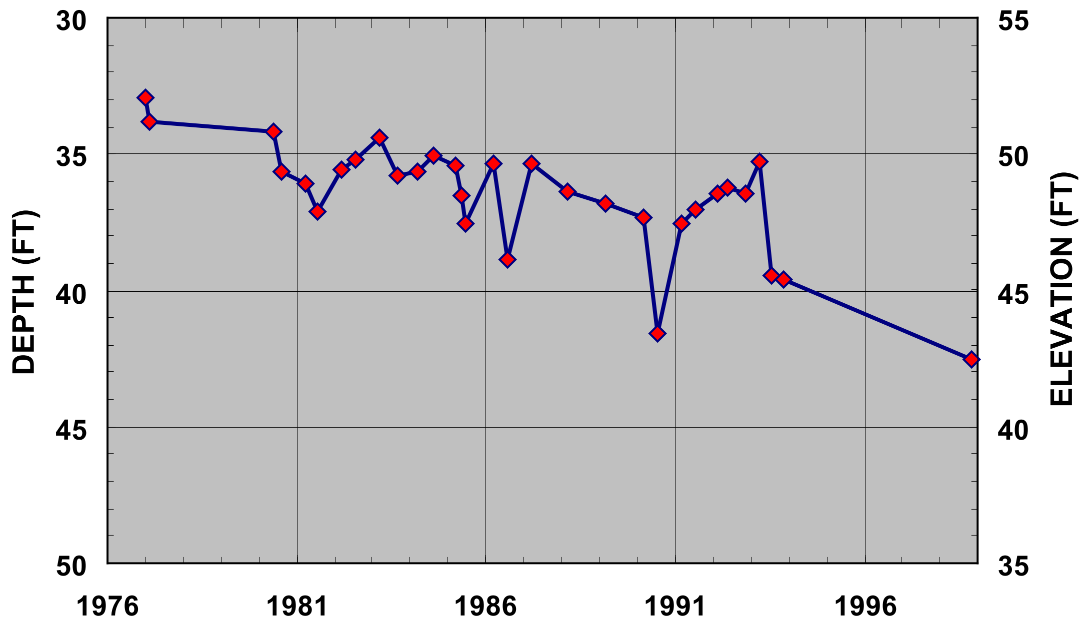
WELL NUMBER: HAM-76 GRID NUMBER: 29DD-f2
LATITUDE: 32°48’21” LONGITUDE: 80°54’35”
LOCATION: Approximately 3.5 mi east of Cummings and near the intersection of County Rds 42 and 13.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 216 ft. Open interval: 94-216 ft.
DATUM: Land surface datum is 67 ft above National Geodetic Vertical Datum of 1929.



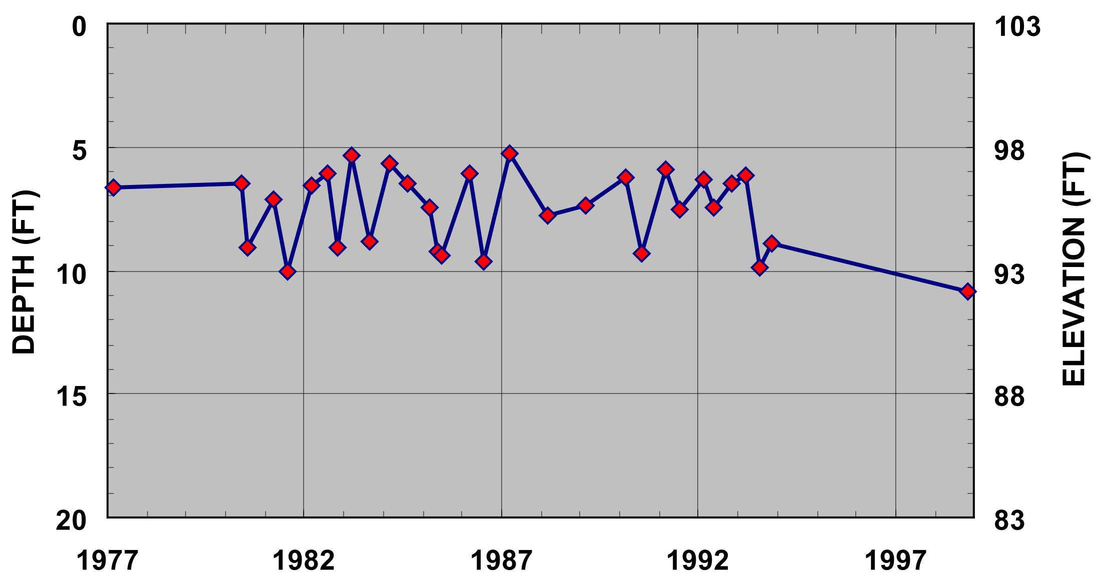
WELL NUMBER: HAM-78 GRID NUMBER: 29EE-p1
LATITUDE: 32°41’31” LONGITUDE: 80°54’47”
LOCATION: Approximately 4 mi NW of Yemassee on County Rd 17, and 0.25 mi N of McPhersonville.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 158 ft. Open interval: 120-158 ft.
DATUM: Land surface datum is 80 ft above National Geodetic Vertical Datum of 1929.



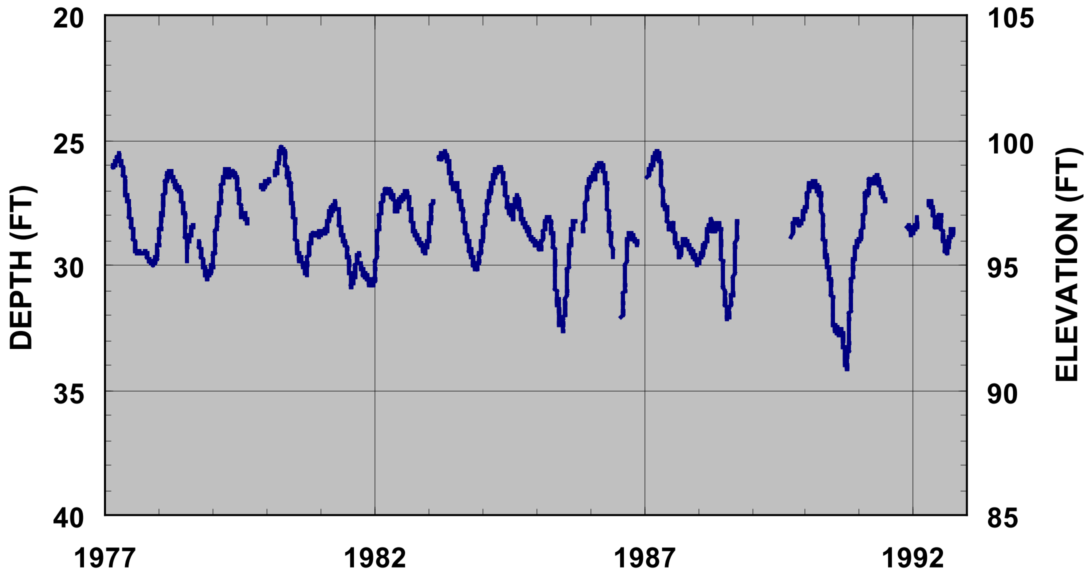
WELL NUMBER: HAM-79 GRID NUMBER: 31DD-n1
LATITUDE: 32°47'07" LONGITUDE: 81°03'29"
LOCATION: 4.5 mi S of Varnville at the intersection of U.S. 278 and County Road 51.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 220 ft. Open interval: 124-220 ft.
DATUM: Land surface datum is 85 ft above National Geodetic Vertical Datum of 1929.



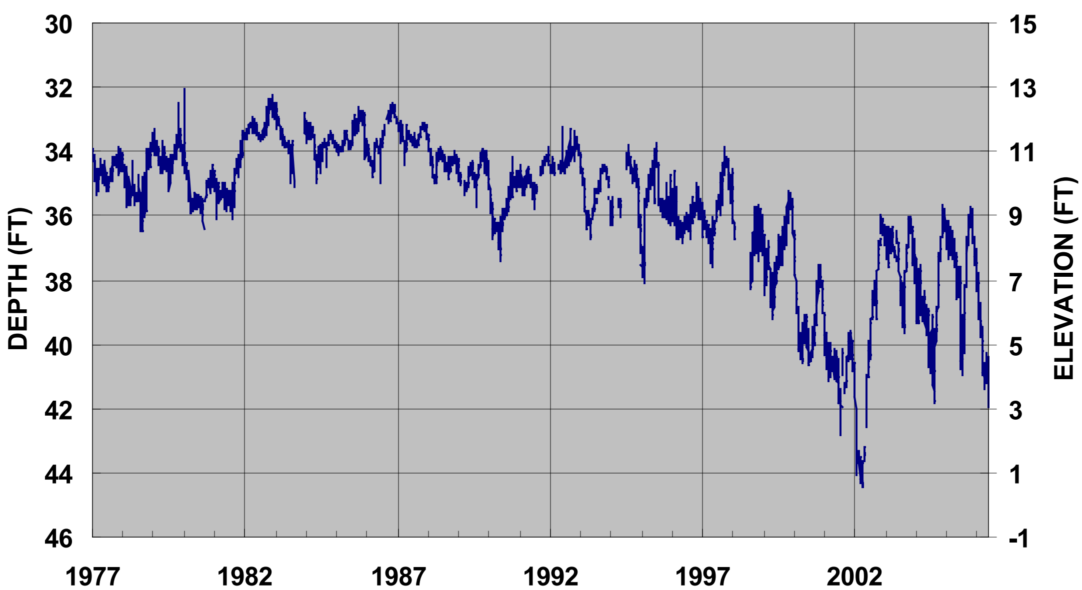
WELL NUMBER: HAM-80 GRID NUMBER: 33CC-f1
LATITUDE: 32°53'52" LONGITUDE: 81°14'18"
LOCATION: 2 mi N of Gifford at the intersection of U.S. 321 and County Roads 21 and 12.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 60 ft. Open interval: 24-60 ft.
DATUM: Land surface datum is 103 ft above National Geodetic Vertical Datum of 1929.



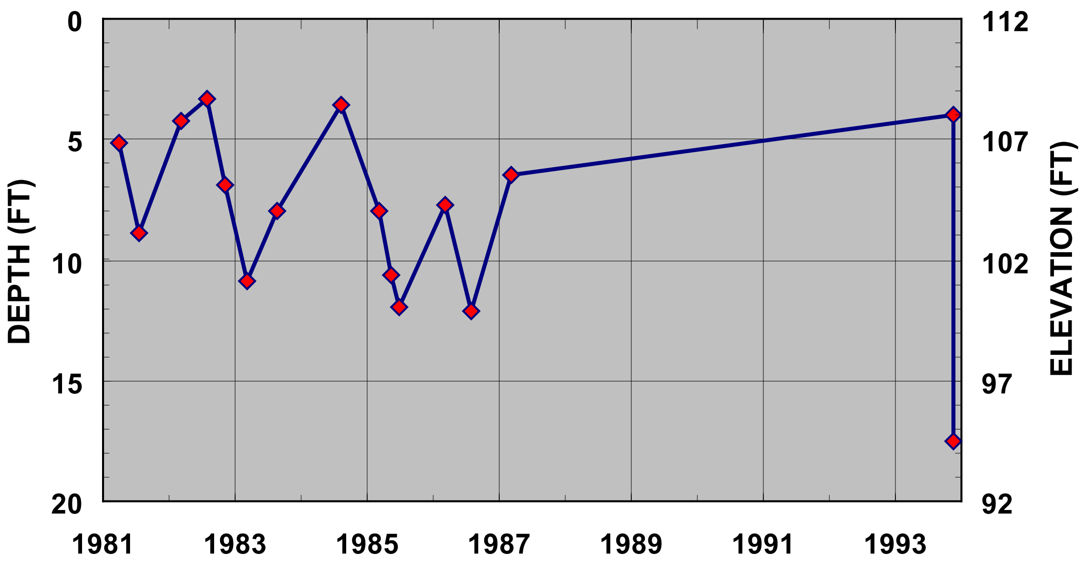
WELL NUMBER: HAM-82 GRID NUMBER: 33CC-w1
LATITUDE: 32°50'05" LONGITUDE: 81°12'28"
LOCATION: Intersection of S.C. 363 and County Rd 41, 5.7 mi W of Hampton, at landfill.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 200 ft. Open interval: 98-200 ft.
DATUM: Land surface datum is 125 ft above National Geodetic Vertical Datum of 1929.



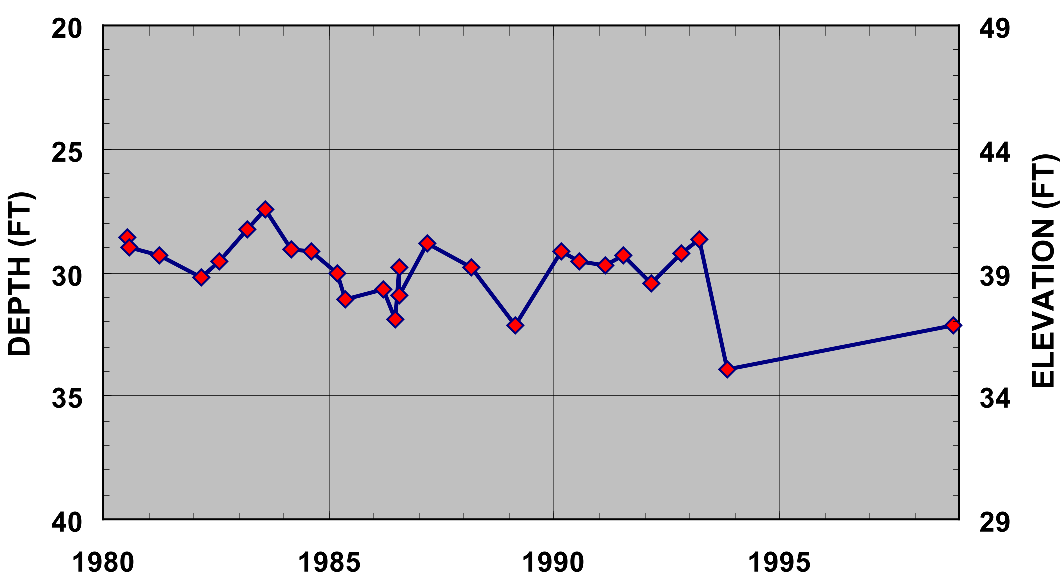
WELL NUMBER: HAM-83 GRID NUMBER: 29EE-s1
LATITUDE: 32°41'52" LONGITUDE: 80°51'04"
LOCATION: NW of Ebenezer Methodist Church, near intersection of Cnty Rds 44 and 10, in Yemassee.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter observation well. Depth: 190 ft. Open interval: 85-190 ft.
DATUM: Land surface datum is 45 ft above National Geodetic Vertical Datum of 1929.



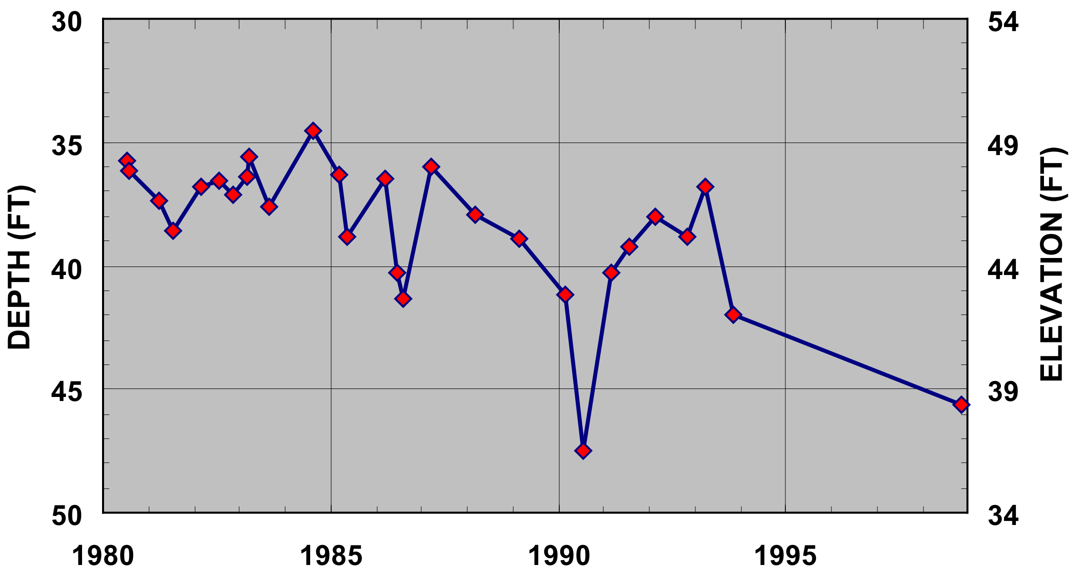
WELL NUMBER: HAM-90 GRID NUMBER: 32CC-g1
LATITUDE: 32°53'43" LONGITUDE: 81°08'56"
LOCATION: Bowers Street off U.S. 278, near Hampton.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 538 ft. Open interval: 224-538.
DATUM: Land surface datum is 112 ft above National Geodetic Vertical Datum of 1929.



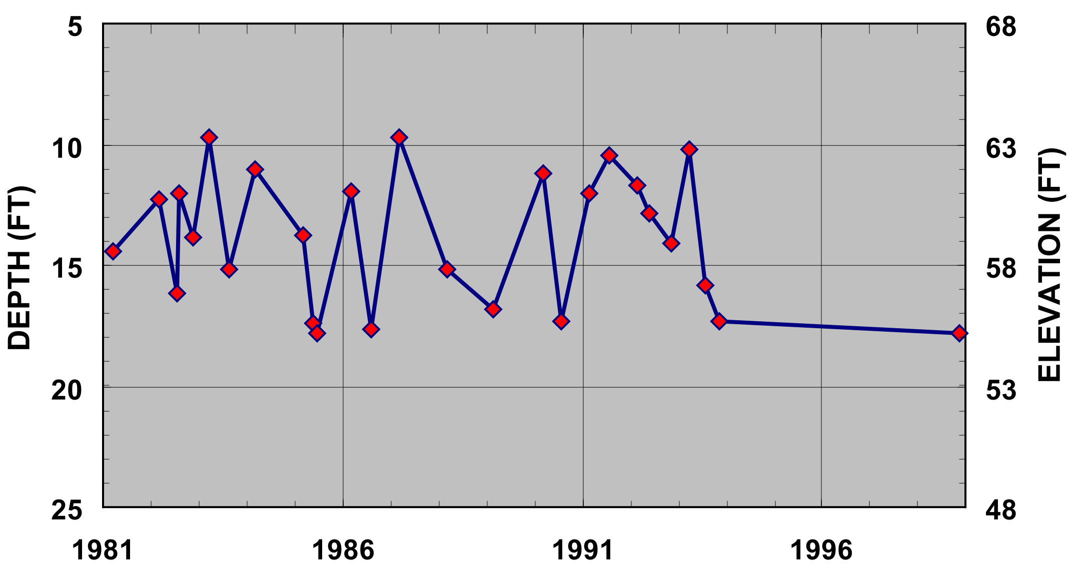
WELL NUMBER: HAM-99 GRID NUMBER: 30CC-u1
LATITUDE: 32°50'14" LONGITUDE: 80°55'35"
LOCATION: Approximately 12 mi north of Yemassee.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 150 ft. Open interval unknown.
DATUM: Land surface datum is 69 ft above National Geodetic Vertical Datum of 1929.



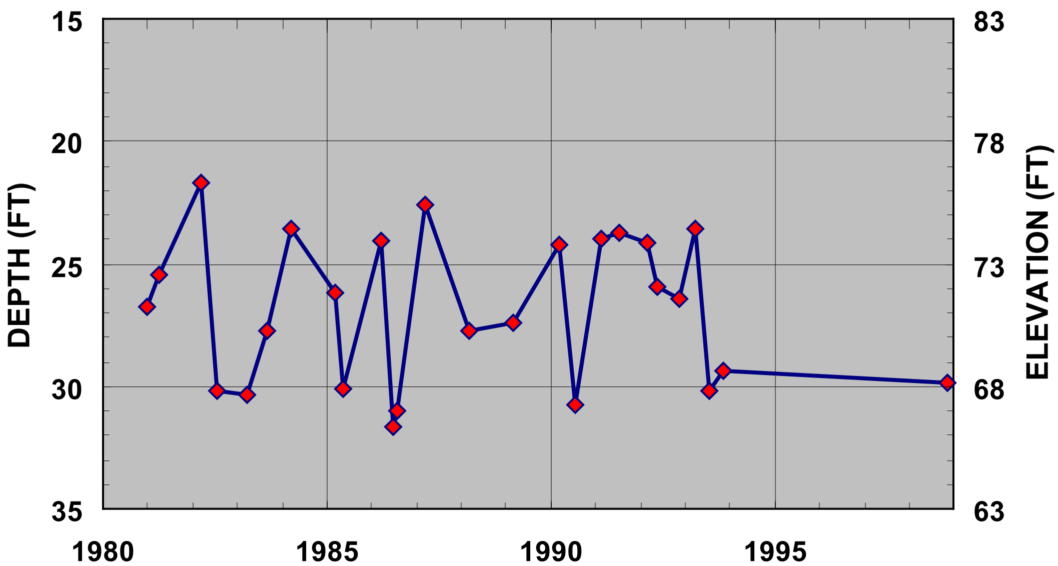
WELL NUMBER: HAM-105 GRID NUMBER: 32EE-i1
LATITUDE: 32°43’20” LONGITUDE: 81°06’27”
LOCATION: 10 mi south of Hampton on S.C. 3 and 0.6 mi northwest of County Road 345.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 270 ft. Open interval: 250-270 ft.
DATUM: Land surface datum is 84 ft above National Geodetic Vertical Datum of 1929.



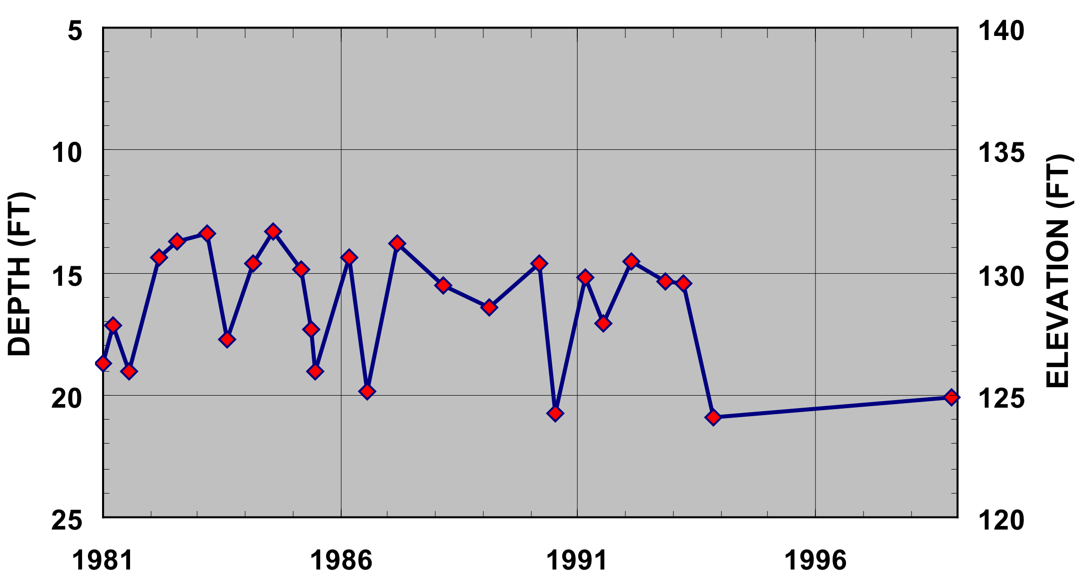
WELL NUMBER: HAM-122 GRID NUMBER: 34FF-e2
LATITUDE: 32°39’40” LONGITUDE: 81°19’30”
LOCATION: Approximately 5 mi southwest of Scotia, on County Road 20.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 160 ft. Open interval unknown.
DATUM: Land surface datum is 73 ft above National Geodetic Vertical Datum of 1929.



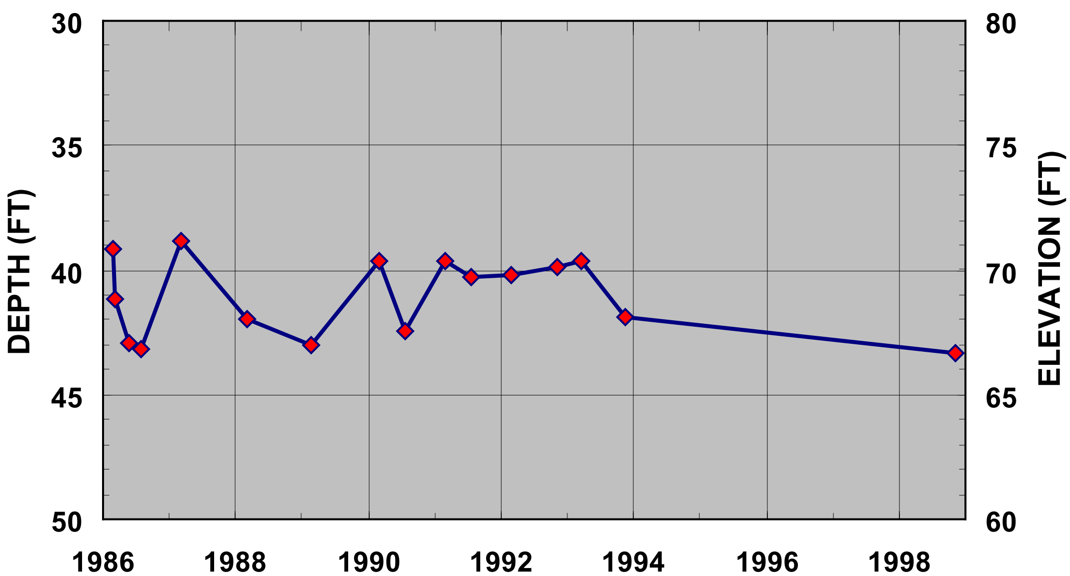
WELL NUMBER: HAM-144 GRID NUMBER: 34EE-n4
LATITUDE: 32°42’48” LONGITUDE: 81°18’56”
LOCATION: Approximately 5 mi south of Estill, near the intersection of County Roads 194 and 62.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 150 ft. Open interval: 100-150 ft.
DATUM: Land surface datum is 98 ft above National Geodetic Vertical Datum of 1929.



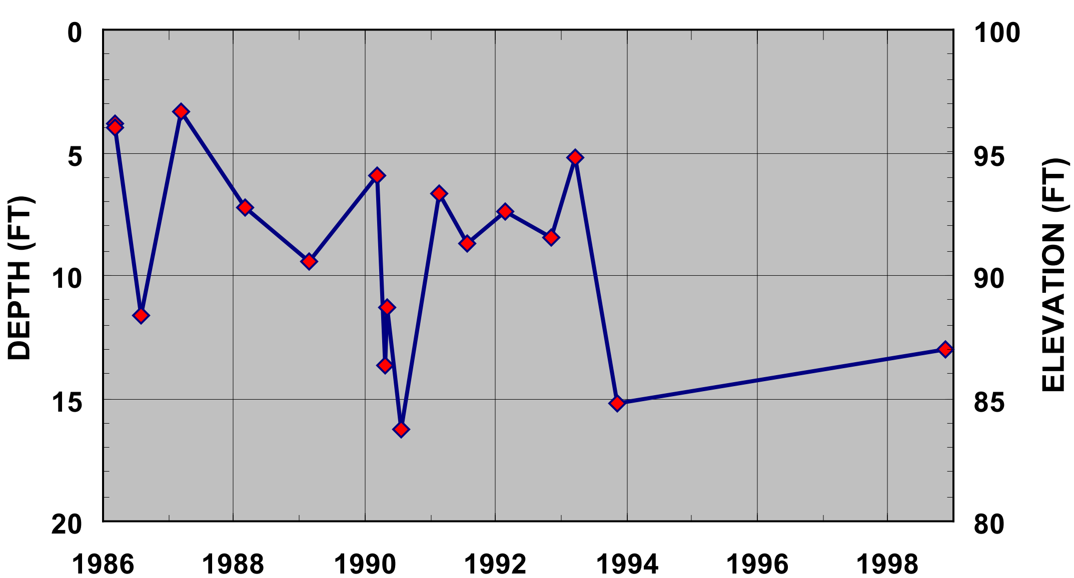
WELL NUMBER: HAM-151 GRID NUMBER: 32CC-n1
LATITUDE: 32°52’20” LONGITUDE: 81°08’01”
LOCATION: Near the intersection of S.C. 363 and U.S. 278 in Hampton.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 145 ft. Open interval: 62-145 ft.
DATUM: Land surface datum is 110 ft above National Geodetic Vertical Datum of 1929.



WELL NUMBER: HAM-175 GRID NUMBER: 31BB-w1
LATITUDE: 32°55’29” LONGITUDE: 81°02’53”
LOCATION: 7 mi NE of Hampton, 1.75 mi SW of County Road 13 on County Road 54.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 100 ft. Open interval: 74-100 ft.
DATUM: Land surface datum is 110 ft above National Geodetic Vertical Datum of 1929.



WELL NUMBER: HAM-185 GRID NUMBER: 33DD-w3
LATITUDE: 32°45’26” LONGITUDE: 81°12’23”
LOCATION: 2 mi east of Estill and 0.45 mi north on County Road 225.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 143 ft. Open interval: 103-143 ft.
DATUM: Land surface datum is 100 ft above National Geodetic Vertical Datum of 1929.



WELL NUMBER: HAM-228 GRID NUMBER: 33BB-s1
LATITUDE: 32°56'52" LONGITUDE: 80°11'50"
LOCATION: McMillan Road, near Brunson.
AQUIFER: Floridan.
CHARACTERISTICS: 4-inch diameter domestic well. Depth: 85 ft. Open interval unknown.
DATUM: Land surface datum is 128 ft above National Geodetic Vertical Datum of 1929.