POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER AND TERTIARY SAND AQUIFER IN SOUTH CAROLINA

NOVEMBER 2004

STATE OF SOUTH CAROLINA
DEPARTMENT OF
NATURAL RESOURCES

LAND, WATER AND
CONSERVATION DIVISION

DNR

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Brenda L. Hockensmith

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ABSTRACT

The potentiometric surface of the Floridan aquifer and its updip clastic equivalent, the Tertiary sand aquifer, shows a generally southeastward ground-water flow affected by several potentiometric depressions. These cones of depression have developed because of ground-water pumping at Summerville, North Charleston, Walterboro, and Eutawville. Water levels in Jasper and Beaufort Counties continue to be affected by pumping in the Savannah, Ga. area.

Comparing the 2004 data with historical data shows that water levels near the northwest outcrop areas have declined and near the northeast show inconsistent trends. In areas influenced by pumping, water levels have declined as much as 35 feet between 1998 and 2004.

INTRODUCTION

The Floridan aquifer and its updip clastic equivalent, the Tertiary sand aquifer, is the source of water for many public, industrial, and agricultural supplies in much of the South Carolina Coastal Plain. This important resource is monitored by regularly measuring nonpumping water levels in selected wells. The potentiometric surface of an aquifer is defined by the elevations at which water stands in tightly cased wells completed in the aquifer (Neuendorf and others, 2005). This potentiometric-surface map was prepared by the Land, Water and Conservation Division of the South Carolina Department of Natural Resources (DNR), using data collected during late 2004. Trends in ground-water levels for selected wells are shown by hydrographs.

METHOD OF INVESTIGATION

The boundaries of the Floridan aquifer and the Tertiary sand aquifer used in this investigation are those defined by Aucott and others (1987), who delineated the aquifer on the basis of geologic data (primarily geophysical logs of wells), water levels, water chemistry, and previous investigations. They acknowledged that the complex deposition of sediments in the Coastal Plain makes aquifer delineation uncertain. DNR is currently redefining the hydrogeology of the South Carolina Coastal Plain on the basis of palynological and hydrogeological data from a network of wells and coreholes in the State (Gellici, 2007a and b). This aquifer has been studied extensively by Cooke (1936), Siple (1957), Colquhoun and others (1983), Renken (1984), Aucott and Speiran (1985a, and 1985b), and Aucott (1996). Regional and local studies include Siple (1975), Johnson (1978), Hayes (1979), Crouch and others (1985), Davies and others (1985), Hassen (1985), Park (1985), Crouch and others (1987), Meadows (1987), Hughes and others (1989), Logan and Euler (1989), Gawne (1990), Whiting and Park (1990), Garza and Krause (1992), Gawne (1994), Aadland and others (1995), Ransom and White (2000), and Hockensmith (2001b).

The potentiometric map presented here was constructed by using water levels measured in 244 wells in October and November 2004 (see table). Water-level measurements made during that period are representative of median aquifer conditions, whereas in other periods, such as late winter or early spring and midsummer, measurements represent maximum and minimum levels, respectively. Data were collected by DNR, the U.S. Department of Energy, the South Carolina Department of Health and Environmental Control (DHEC), and the U.S. Geological Survey (USGS) personnel. Wells measured by previous investigators were used, where possible, to compare 2004 data with historical potentiometric maps. Corrections for tidally influenced wells were not made because insufficient data existed. For a few wells in Beaufort County, monthly mean data for October or November were used and are noted as such in the table.

The hydrographs were constructed from measurements by DNR and USGS. Where continuous records were available, daily mean water levels were plotted to minimize tidal influence.

GEOHYDROLOGIC FRAMEWORK

The Coastal Plain formations of South Carolina compose a wedge of sediments that thickens from 0 ft (feet) at the Fall Line to more than 4,000 ft at Hilton Head Island. These sediments consist of sand, clay, and limestone of late Cretaceous and younger ages that were deposited on a pre-Cretaceous basement complex of metamorphic, igneous, and consolidated sedimentary rocks.

The Floridan aquifer generally includes the Cooper Formation, the Ocala Limestone, and the Santee Limestone (Aucott and others, 1987). These units range from Oligocene to middle Eocene in age. The updip limit of this aquifer extends from central Allendale County through northern Colleton County, central Berkeley County south of Lake Moultrie, and eastward through southern Georgetown

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
AIK-849	36U-o6	333232	812908	258	-2	
ALL-330	34AA-r2	330134	811711	153	6	
ALL-336	33Z-v1	330545	811107	145	-3	
ALL-363	37Z-t4	330649	813023	164	-11	
ALL-364	37Z-t5	330648	813023	161	-9	
ALL-365	37Z-t6	330649	813021	124	-7	
ALL-366	37Z-t7	330648	813023	124	-8	
ALL-371	35AA-q4	330129	812306	188		
ALL-372	35AA-q5	330129	812305	235		
ALL-373	35AA-q6	330129	812304	151	-3	
ALL-375	35AA-q8	330129	812306	127		
BAM-11	33Y-v1	331054	811107	183	1	
BAM-22	32X-g2	331858	810818	166	10	
BAM-26	31Z-t1	330611	810044	130	2	
BAM-31	31X-m9	331749	810213	148	1	
BAM-33	33Y-v2	331056	811106	183	-3	
BAM-37	31Y-s1	331112	810111	130	0	
BAM-74	31Z-u5	330542	810040	118	-5	
BAM-75	31Z-u6	330540	810044	118	-5	
BAM-81	30Y-u1	331034	805500	119	0	
BFT-118	27HH-y1	322519	804501	3	3	
BFT-133	27GG-q1	323120	804302	1	-1	
BFT-145	27GG-f1	323303	804427	-14	-5	
BFT-181	27JJ-j1	321823	804048	6	12	
BFT-198	27HH-t7	322630	804018	5	1	
BFT-301	29II-x8	322043	805358	-11	2	
BFT-315	27JJ-x1	321545	804313	0	1	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
BFT-358	28KK-e1	321455	804943	-7	2	
BFT-374	28KK-f3	321353	804902	-11		
BFT-392	28HH-b4	322940	804643	-4	-1	
BFT-420	27GG-g1	323318	804348	-19	-9	
BFT-429	28JJ-y1	321551	804911	-5	2	
BFT-430	26JJ-n1	321725	803839	2	2	
BFT-436	27LL-f1	320841	804446	-9	4	
BFT-441	27KK-d2	321457	804342	-1	2	
BFT-444	27KK-x1	321035	804337	-6	-10	
BFT-449	24JJ-c1	321936	802740	2	1	
BFT-452	24II-i1	322402	802620	3	0	
BFT-455	24JJ-d1	321944	802806	2	0	
BFT-461	29EE-u1	324049	805030	4	-1	
BFT-470	26II-l1	322213	803615	4	2	
BFT-471	27II-a1	322406	804002	2	1	
BFT-486	29II-u1	322035	805019	-4	3	
BFT-488	25II-a7	322431	803048	2	-2	
BFT-493	28JJ-n3	321709	804853	-3	3	
BFT-497	24II-f3	322345	802948	2	-1	
BFT-500	28JJ-y3	321502	804943	-5	4	
BFT-501	28JJ-n1	321713	804850	-1	2	
BFT-559	27HH-u1	322551	804023	2	1	
BFT-563	25II-m2	322229	803248	3	0	
BFT-564	26II-w2	322006	803724	2	0	DHEC October monthly average
BFT-566	27II-s1	322108	804136	4	0	
BFT-600	25II-q3	322146	803358	6	3	
BFT-652	27KK-h1	321323	804230	-2	4	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
BFT-668	28KK-t2	321113	804525	-7	3	
BFT-676	28KK-i7	321304	804608	-4	4	
BFT-697	27KK-d4	321436	804321	-2	4	
BFT-704	28LL-a1	320913	804553	-10	4	
BFT-709	28LL-m5	320754	804739	-12	3	
BFT-744	28LL-b1	320958	804641	-9	3	
BFT-771	27KK-i2	321306	804155	-9	-4	
BFT-777	27KK-I3	321236	804109	-2	5	
BFT-779	27KK-f13	321333	804414	-3	3	
BFT-782	26HH-d2	322922	803813	6	-8	
BFT-787	27KK-b2	321453	804154	-2	2	
BFT-798	27HH-e4	322930	804418	18	-1	
BFT-805	28KK-v4	321055	804654	-6	4	
BFT-844	29II-v1	322024	805119	-8	1	
BFT-976	26II-u5	322024	803514	3	1	
BFT-982	26II-p1	322152	803935	4	2	
BFT-1212	27GG-e1	323438	804425	-8	-4	
BFT-1239	27LL-e8	320943	804449	-6	5	
BFT-1292	26II-r6	322126	803714	0	-4	
BFT-1306	28HH-k5	322746	804535	6	-3	
BFT-1311	27GG-w3	323010	804215	5	1	
BFT-1326	28JJ-y4	321515	804910	-2		DHEC November monthly average
BFT-1330	28KK-d6	321425	804837	-3	4	
BFT-1417	26II-h11	322318	803657	2	-2	
BFT-1418	29JJ-q2	321657	805307	-11	7	
BFT-1422	29JJ-r3	321651	805259	-9		
BFT-1452	29JJ-m2	321736	805206	0	3	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
BFT-1540	25HH-s3	322559	803158	1	-1	
BFT-1548	25II-o8	322252	803422	3	0	
BFT-1583	26HH-p7	322645	803915	2	-5	
BFT-1592	26II-t3	322134	803542	-1	-4	
BFT-1599	26HH-h3	322833	803757	14	-3	
BFT-1604	24HH-q4	322608	802823	4	3	
BFT-1605	26HH-l4	322707	803646	3	-1	
BFT-1609	25HH-n2	322748	803340	3	1	
BFT-1701	27II-h8	322314	804212	3	2	
BFT-1714	27HH-w3	322541	804226	3	0	
BFT-1717	27HH-q10	322625	804320	3	2	
BFT-1732	27HH-e6	322903	804451	21	-1	
BFT-1733	27GG-y3	323037	804357	5	-3	
BFT-1736	28II-b4	322419	804609	2	4	
BFT-1800	29JJ-v2	321555	805147	-13	3	
BFT-1806	28GG-c1	323446	804700	-9	-5	
BFT-1810	27JJ-q3	321603	804322	0		
BFT-1813	27KK-j5	321358	804038	-2		
BFT-1814	27KK-j6	321358	804038	-1	4	
BFT-1820	28KK-o10	321214	804458	-4	3	
BFT-1822	27KK-o11	321217	804457	-5	2	
BFT-1845	28JJ-p5	321650	804918	-7	1	
BFT-1846	28JJ-p6	321650	804918	12	21	
BFT-1870	29JJ-q3	321453	805028	-8	1	
BFT-1904	28LL-p3	320636	801418	-18		
BFT-1925	27HH-f16	322811	804428	22	-4	
BFT-1970	27II-l27	322230	804136	4	1	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
BFT-2245	29LL-j9	320859	805016	-15		DHEC October monthly average
BFT-2299	28JJ-m9	321737	804702	0		DHEC November monthly average
BFT-2303	28KK-d19	321431	804830	-5		DHEC October monthly average
BFT-2304	28JJ-x6	321524	804806	-3		DHEC November monthly average
BFT-2355	29KK-m5	321035	805553	-21		DHEC November monthly average
BFT-2377	26JJ-b12	321928	803629	3		DHEC October monthly average
BRK-35	16Z-h1	330820	794751	17		
BRK-48	22Y-w2	330902	801738	47	-9	
BRK-141	16W-x1	332048	794852	30	0	
BRK-147	16Z-n2	330753	794839	27		
BRK-165	18X-g1	331825	795809	54	4	
BRK-174	18AA-q1	330152	795802	-3	-1	
BRK-177	19V-p2	332654	800405	50	-5	
BRK-181	19Y-b2	331417	800150	57	1	
BRK-221	20W-d4	332450	800820	80	0	
BRK-450	16X-k1	331713	794530	24	1	
BRK-452	14Y-m2	331220	793735	31	3	
BRK-492	19Y-u1	331007	800048	14	3	
BRK-523	19Z-b7	330927	800130	10		
BRK-535	19Z-p2	330621	800424	-21	5	
BRK-545	18Z-m1	330707	795710	-4		
BRK-546	18Z-m2	330706	795711	-4	2	
BRK-595	16BB-i1	325833	794621	10	3	
BRK-612	21Z-i1	330611	801153	24	-7	
BRK-613	19Z-x7	330528	800311	-10	3	
BRK-644	18W-b2	332416	795604	61		
BRK-647	14X-y52	331542	793926	25	2	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
BRN-62	35Y-i2	331337	812139	158	-2	
BRN-295	33Z-n1	330742	811352	152	-3	
BRN-350	34Y-x2	331045	811854	174	-5	
BRN-351	34Y-x3	331043	811853	174	-5	
BRN-352	34Y-x4	331044	811853	162	-3	
BRN-354	34Y-x6	331044	811854	162	-8	
BRN-359	35X-e3	331916	812427	213	-3	
BRN-360	35X-e4	331915	812427	240	-3	
BRN-367	35X-e7	331915	812428	213	-3	
CHN-44	19DD-o1	324748	800412	-24	-6	
CHN-63	21EE-f3	324302	801420	-8	1	
CHN-101	13AA-n2	330247	793403	11	0	
CHN-169	19CC-y1	325022	800443	-24	-6	
CHN-220	23FF-a1	323933	802026	-23	-3	
CHN-289	17DD-f1	324856	795413	-20	-3	
CHN-297	19BB-w3	325511	800158	-30	-5	
CHN-363	23DD-f1	324836	802404	-10	-9	
CHN-366	23EE-v1	324031	802215	-24	-10	
CHN-387	20FF-d1	323935	800843	-22	-11	
CHN-422	12Y-x1	331004	792815	9	2	
CHN-452	15BB-u1	325529	794051	1	-6	
CHN-457	16CC-p1	325119	794910	-32	-8	
CHN-458	16CC-y11	325045	794933	-21	-12	
CHN-460	18CC-o1	325251	795916	-32	6	
CHN-484	22GG-d1	323455	801822	-23	-11	
CHN-517	14BB-p2	325628	793926	-1	-6	
CHN-693	14BB-b4	325929	793708	7	0	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
CHN-699	15BB-j1	325824	794014	11	-1	
CHN-736	18DD-q4	324637	795815	-18		
CHN-800	18DD-s1	324632	795630	-14		
CHN-803	11Z-b1	330910	792130	-3	0	
CHN-809	18DD-s3	324632	795630	-15		
CHN-813	15CC-b3	325458	794122	-28	-35	
CLA-73	21T-r8	333517	801221	70	-11	
COL-16	26CC-f1	325355	803957	-2	1	DNR November monthly average
COL-51	24GG-k1	323216	802517	-13	-8	
COL-73	28BB-b1	330003	804655	32	-5	
COL-92	26FF-e1	323941	803926	-10	-11	
COL-96	24EE-c1	324408	802707	-17	-12	
COL-97	26AA-k1	330252	803551	30	-7	
COL-149	24FF-w1	323534	802750	-12	-10	
COL-164	29DD-l1	324800	805125	22	0	
COL-170	25FF-q2	323638	803313	-17	-13	
COL-189	24AA-l2	330243	802603	30	-5	
COL-219	31AA-r1	330149	810243	95		
COL-220	31BB-k1	325753	810041	70		
COL-232	30AA-c4	330402	805714	82	-9	
COL-243	26FF-l2	323708	803641	-7	-8	
COL-253	24DD-g1	324809	802812	-5	-9	
COL-255	24BB-q1	325613	802852	-4		
COL-259	26DD-w1	324524	803720	6	-1	
COL-262	26DD-u1	324555	803542	-17		
COL-269	26CC-o2	325149	803911	-16	18	
COL-273	28CC-l2	325238	804643	8	-5	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
COL-274	27CC-l2	325224	804119	-8	-2	
COL-275	27DD-b1	324923	804157	-2		
COL-284	28Z--n1	330743	804842	96	-1	
COL-286	29AA-o1	330240	805436	83	-5	
COL-294	23CC-f1	325302	802417	-6	-8	
COL-295	26DD-m2	324709	803757	-12	-10	
COL-301	22GG-w4	323042	801758	-17		
DOR-49	22BB-l1	325752	801634	-35	-17	
DOR-58	22Z-r1	330638	801657	33	1	
DOR-69	24Y-m1	331246	802706	38	-6	
DOR-78	21AA-f1	330323	801412	-12	-33	
DOR-134	21CC-u1	325056	801203	-17	-28	
DOR-155	24Z-j2	330859	802538	30		
DOR-168	26Y-n2	331227	803826	94	3	
DOR-189	23AA-x2	330052	802314	21	-3	
DOR-240	21AA-r3	330151	801216	-43	-11	
GEO-15	10X-f1	331853	791928	3	-6	
GEO-303	12W-h1	332355	792704	23		
GEO-305	10X-e1	331953	791924	30	1	
GEO-306	13V-q4	332658	793311	25	3	
HAM-50	33EE-v1	324047	811114	93		
HAM-72	32BB-i1	325841	810646	101	8	
HAM-73	31CC-j2	325357	810019	56	1	
HAM-74	31CC-m1	325242	810224	77	-1	
HAM-76	29DD-f1	324821	805435	31	-2	
HAM-77	29EE-h1	324330	805249	9	-2	
HAM-78	29EE-p1	324131	805447	11	-2	

Table showing water-level elevations during November 2004 in wells completed in the Floridan/Tertiary sand aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 1998 to 2004, in feet	Remarks
HAM-83	29EE-s1	324151	805103	5	-2	
HAM-122	34FF-e2	323940	811901	55	0	
HAM-174	34DD-b1	324922	811702	110	1	
HAM-175	31BB-w1	325529	810253	68	1	
HAM-180	34DD-u1	324543	811534	91	3	
HAM-181	35EE-b1	324403	812139	61	12	
HAM-201	33EE-q2	324156	811300	58	-5	
HAM-228	33BB-s1	325652	811151	118		
JAS-112	32LL-b1	320956	810657	-52		
JAS-298	29HH-n5	322733	805346	-8	-3	
JAS-397	29GG-r4	323134	805205	-3	-3	
JAS-402	32HH-l3	322749	810625	5		
JAS-406	31FF-x1	323535	810329	12	-3	
JAS-420	32JJ-m1	321753	810716	-16	0	
JAS-421	31LL-n1	320752	810324	-57	17	
JAS-425	30FF-o1	323704	805944	6		
ORG-9	23X-e3	331925	802440	89	1	
ORG-40	27W-u1	332058	804046	111	1	
ORG-48	29V-i1	332805	805122	167	11	
ORG-92	23W-j1	332335	802056	35	-3	
ORG-97	32V-r3	332653	810734	199		
ORG-425	22X-h1	331837	801713	52	-23	
ORG-427	26V-o2	332719	803921	128	7	
ORG-430	29U-v2	333030	805154	172		
ORG-431	29U-v3	333030	805154	228		
WIL-187	18U-e1	333452	795920	60	-1	
WIL-205	15W-y1	332141	793954	8	0	

* Latitude and longitude location for wells are generally estimated from topographic maps, unless surveyed or located by global positioning systems.

County (Aucott and others, 1987, as modified from Miller, 1985).

Locally, three subdivisions of the Floridan aquifer are recognized; the upper, middle, and lower Floridan. The upper Floridan corresponds to the highly permeable, bioclastic limestone of the Ocala Limestone. The middle Floridan corresponds to the permeable part of the lower Ocala Limestone and the upper Santee Limestone (Crouch and others, 1987; Gawne, 1994; Gawne and Park, 1992; and Ransom and White, 2000). The lower Floridan corresponds to the lower permeable sections of the Santee Limestone and the upper part of the Black Mingo Formation (Gawne, 1994).

The Tertiary sand aquifer is divided into upper and lower units. The upper unit is the sand facies equivalent of the Floridan aquifer. The updip limit extends from northwestern Allendale County to Orangeburg and curves eastward into southern Georgetown County (extended Floridan aquifer). It is composed of sediments from the Barnwell, McBean, and Congaree Formations and ranges in age from Early to Late Eocene. The lower unit consists of clastic sediments of Early Eocene and Paleocene ages and includes part of the Black Mingo Formation.

The base of the Floridan dips southeastward and is at elevation 300, -600, and -1,400 ft msl (referenced to mean sea level) at Aiken, Walterboro, and Hilton Head Island, respectively. Thickness ranges from 0 ft at the updip limit to more than 1,000 ft at Hilton Head Island.

The upper Floridan is the major aquifer of Beaufort, Jasper, and southern Hampton Counties. The lower Floridan is a source of ground water for Colleton and northern Hampton Counties. The middle Floridan is a source of water supply in north-central Hampton County, and especially for recent developments in Beaufort County. For the preparation of this map, water-level data from upper Floridan wells in Beaufort and Jasper Counties and most of Hampton County were used. Data from middle and/or lower Floridan wells were used within the boundary shown for the Floridan aquifer. Elsewhere, data from wells in the Tertiary sand aquifer were used.

GROUND-WATER FLOW

The potentiometric surface of the Floridan aquifer dips generally coastward and defines a southeastward regional ground-water flow. Water levels in Aiken, Barnwell, and northern Allendale Counties are not contoured because data are sparse and commonly represent unconfined-aquifer conditions that are influenced by surface topography. The highest water level, 258 ft msl, was noted in Aiken County. In areas where the aquifer crops out, it is recharged by rainfall. In the updip sections, where stream valleys incised the aquifer, it is drained by those streams. This is shown by the convex curving of contour lines upstream along the Santee, Savannah, Salkehatchie, and Little Salkehatchie Rivers, and the North and South Forks of the Edisto River. In the downdip sections, the aquifer discharges into overlying aquifers or through pumping wells.

Dimpling this surface are cones of depression caused by concentrated ground-water withdrawal. The potentiometric surface has been affected by pumping in Beaufort, Berkeley, Charleston, Colleton, Dorchester, and Orangeburg Counties. The greatest impact of ground-water withdrawals is in Jasper and Beaufort Counties, where water flows toward Savannah. Potentiometric levels are below -57 ft msl near Savannah and are the lowest measured in 2004.

HISTORICAL TRENDS

Potentiometric levels of the Floridan aquifer have been observed since 1916 (Siple, 1975). Aucott and Speiran estimated predevelopment potentiometric levels (1985b). When they compared their predevelopment potentiometric map with that of November 1982, they noted declines in Barnwell, Beaufort, Berkeley, Charleston, Colleton, Dorchester, Jasper, and Orangeburg Counties (Aucott and Speiran, 1985a). The 2004 data show that the potentiometric surface has continued to decline since 1982 throughout most of the areal extent of the aquifer.

One of the worst multiyear droughts on record, from June 1998 through August 2002, caused significant effects on hydrologic conditions in South Carolina (Kiuchi, 2002). Historical low flows were recorded in 2001 for numerous regulated and unregulated streams (Kiuchi, 2004). Many of the large lakes, originally built for hydroelectric power or flood control, were at their lowest levels near the end of the drought: some were substantially below desired operating levels (Gellici and Badr, 2004). Water levels in selected Floridan and Tertiary sand wells in Allendale, Charleston, Colleton, and Hampton Counties had declines ranging from 5.5 to 9.3 ft (Gellici and Harwell, 2004) as a direct result of this meteorological event or, indirectly, because of increased ground-water pumping.

A comparison of the 2004 potentiometric surface in the northwestern extent of the aquifer with that of 1998 indicates that water levels generally declined. In AIK-849, the only well measured in Aiken county, water levels declined 2 ft from 1998 to 2004. Wells in Barnwell County all declined during this same interval. Declines ranged from 2 to 5 ft with the average decline being 3.7 ft. In Allendale County, declines ranged from 3 to 11 ft (where 1998 data existed), with the exception of ALL-330, which recovered 6 ft. Water levels in ALL-373 (Fig. 1) generally declined from a high of 160 ft msl (5/11/1998) to 146 ft msl (6/21/2002) largely as a result of the drought, then recovered to 153 ft msl in March 2004 but have been variable since then. Bamberg County water-level changes from 1998 to 2004 varied from 10 to -5 ft, and averaged +0.1 ft. There is no apparent trend in the county with regard to recoveries and declines.

Water-level elevation changes between 1998 and 2004 are inconsistent in the northeastern extent of the aquifer, where data are sparse. The maximum recovery was 3 ft (GEO-306) in Georgetown County, whereas a decline of 6 ft was observed in GEO-303. Water levels differed only

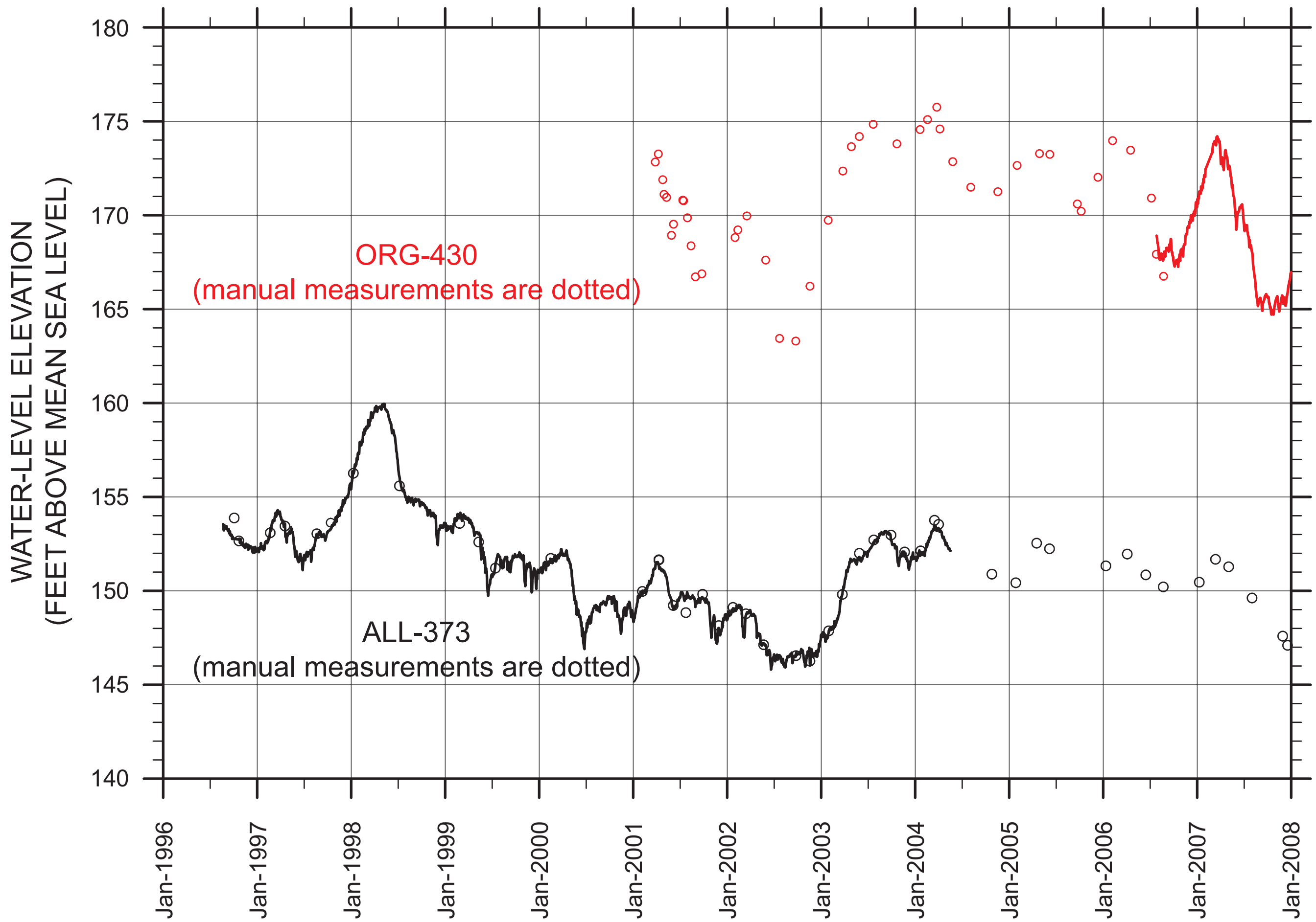

Figure 1. Hydrographs of wells ALL-373 and ORG-430.

slightly (0 to -1 ft) in Williamsburg County. CLA-73, the only well measured in Clarendon County, declined 11 ft in this interval.

Water-level differences in Orangeburg County are also conflicting for the same period. Little change occurred near Holly Hill (ORG-9) where water levels were nearly the same in March 1946 and November 1998 and 2004. Water levels in Eutawville (ORG-92), near Lake Marion, were 80 ft msl in September 1965, 60 ft msl in November 1982, 38 ft msl in November 1998, and 35 ft msl in November 2004, for a total decline of 45 feet. A recovery of nearly 11 ft occurred in ORG-48 from 1998 to 2004; however, water levels near Orangeburg are variable, ranging between 163 to 176 ft msl since 2001 according to the hydrograph for ORG-430 (Fig. 1).

Water levels declined significantly in eastern Dorchester and most of Charleston Counties. Among the greatest changes between 1998 and 2004 occurred along the Interstate 26 corridor between Summerville and Charleston. In the cone of depression near Summerville, water levels declined more than 17 and 11 ft, to -35 and -43 ft msl, respectively, in DOR-49 and DOR-240 during this period. Comparing these values with an estimated predevelopment level of 40 ft msl (Aucott and Speiran, 1985) indicates that historical declines are 75 to 83 ft. To the southeast, another cone of depression defined by a 30-ft contour line exists about North Charleston. The two wells defining this cone differ in water-level changes from 1998 to 2004; CHN-297 shows a 5-ft decline, whereas CHN-460 shows a 6-ft recovery for this period.

Pumping in Dorchester County contributed to the deepening of these cones of depression. Reported pumpage, primarily from the Floridan/Tertiary sand aquifer, increased by 1.6 mgd (million gallons per day) from 2001 to 2004 and averaged 4.2 mgd, in 2004 (Bristol, 2003; and Childress and Bristol, 2005).

The cone of depression defined by the -20-ft contour encompasses most of Charleston County on the 2004 map. The greatest decline noted from 1998 to 2004 occurred in CHN-813, where water levels declined 35 ft. Northeast of this well, water levels are similar to 1998 levels. CHN-44 and CHN-484, in southern Charleston County, show seasonal fluctuations and an overall decline of 6 and 11 feet, respectively, for this period (Figs. 2 and 3). Near Edisto Beach, water-level trends in COL-301 are similar to CHN-484, with a decline of 4 ft between November 2000 and November 2004 (Fig. 3). At COL-301, specific conductance, an indirect measure of dissolved mineral matter in water, shows an increase with declining water level and is an indication that saltwater intrusion is occurring.

Most Berkeley County water levels have recovered since 1998. Recoveries ranged from less than 1 ft to 5 ft. The few wells showing declines are BRK-48, BRK-174, BRK-177, and BRK-612 with declines of 9, 1, 5, and 7 ft, respectively. BRK-48 and BRK-612, with the largest declines, are located in southwestern Berkeley County near I-26. Wells in northern Berkeley County may be influenced by Lake Marion but less so by Lake Moultrie, where stages in each lake averaged 75 ft msl for November 2004.

Colleton County water levels east and southeast of Walterboro are below sea level and make the aquifer susceptible to saltwater intrusion. All but three wells in Colleton County declined between 1998 and 2004. The average decline was 7 ft and ranged from 1 to 13 ft. The potentiometric surface is dominated by a lobate curve of the -10-ft contour southeast of Walterboro. A cone of depression formerly was documented about Walterboro in July 1986 (Crouch and others, 1987), March 1991, July 1991, February 1992, November 1992, and November 1993 (Gawne, 1994) and November 1998 (Hockensmith, 2001). Prior to development the water levels were above 50 ft msl at Walterboro, but by 1982 they had declined to 25 ft msl. In 1998 the water levels were lower than -30 ft msl (COL-269), representing a total decline of 80 feet. Water levels ranged between -2 and -15 ft msl near the city. COL-269 recovered 18 ft, whereas COL-274 declined 2 ft, from 1998 to 2004. The hydrograph for COL-16 (Fig. 2) shows a variable but overall declining trend with a low of -16 ft msl occurring in late July 2002 and recovering 18 ft to 2 ft msl in August 2003.

Hampton County showed water-level recoveries in the northwest and declines in the southeast in 2004 from 1998 levels. Recoveries were greatest near the Allendale County line. HAM-72 and HAM-181 recovered 8 and 12 ft, respectively, and recoveries in other wells ranged from 1 to 3 ft. Near Furman, HAM-201 declined 5 feet to 58 ft msl, the greatest decline for the county. Predevelopment levels in this area were estimated at about 75 ft msl (Aucott and Speiran, 1985), indicating a decline of about 17 ft. In eastern Hampton County, declines averaged 2 ft. HAM-76, with a water level of 31 ft msl, indicates a decline of more than 20 feet from predevelopment levels. Water levels in HAM-83 averaged about 10 ft msl prior to 1998 but declined, with some variability, to less than 1 ft in August 2002, then recovered to 9 ft msl in March 2003 and have been more variable since then than prior to 1998 (Fig. 2).

Beaufort and Jasper Counties show the influence of ground-water pumping in the greater Savannah area, with contour lines perpendicular to the coast and declining to the southwest. Reported pumpage near Savannah ranged from 54.0 to 57.5 mgd (million gallons per day) in Chatham County from 1998 through 2004 (Bruce Crawford, DHEC, written communication, 2008). Estimates of predevelopment water levels (circa 1880) are 30 ft msl near Savannah and 10 ft msl on Hilton Head Island, the water discharging near Port Royal Sound (Counts and Donsky, 1963).

North of the Broad River, water levels remain above sea level, except for the Gardens Corner area, the northwest edge of Port Royal Island, and a small area on St. Helena Island. A cone of depression centered at Gardens Corner is -9 ft msl at its center (BFT-420) and has declined 9 ft between 1998 and 2004. Other wells within the 0-ft contour declined 3 to 5 ft during the same interval.

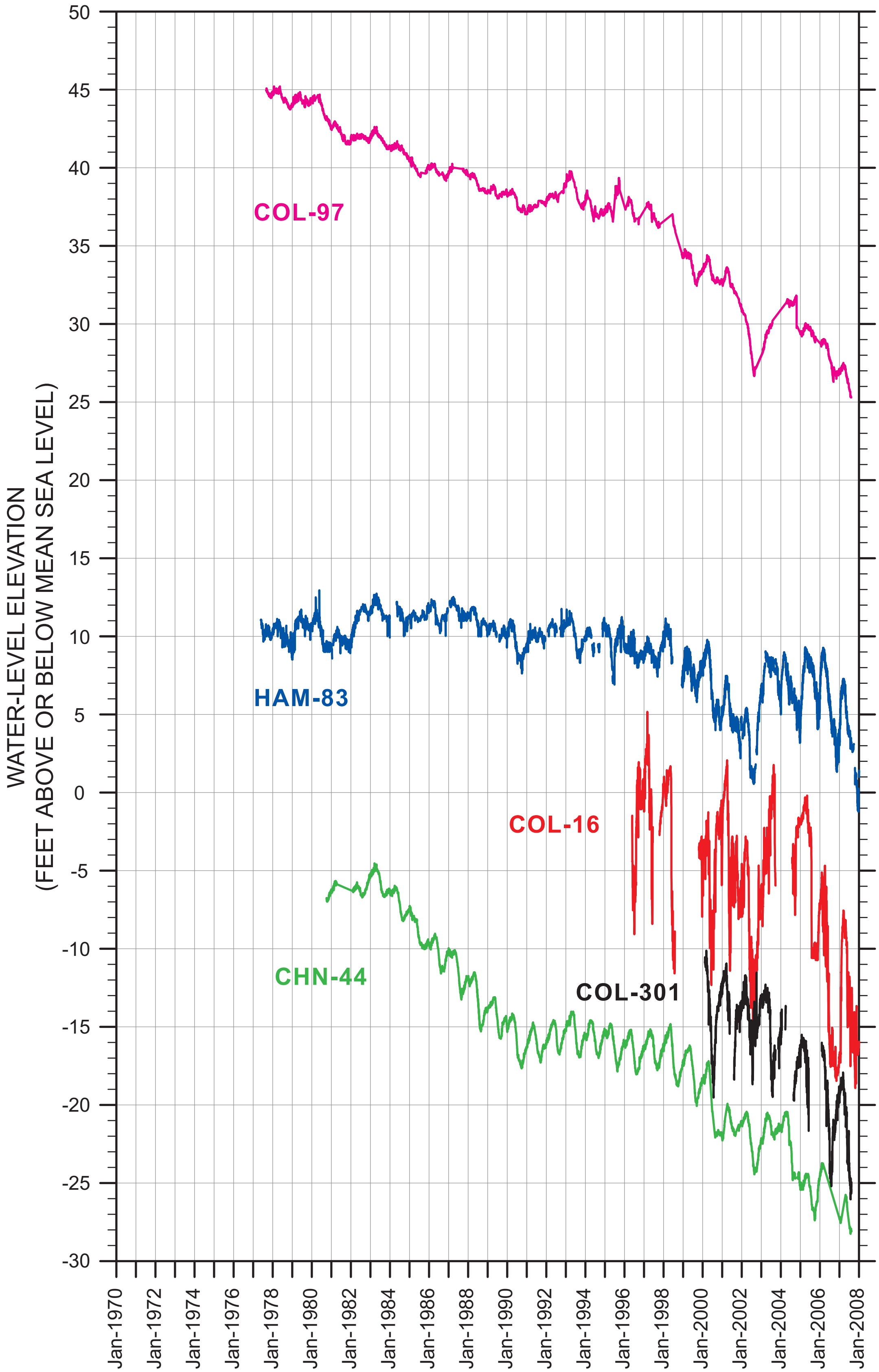

Figure 2. Hydrographs of wells COL-16, COL-97, COL-301, CHN-44 and HAM-83.

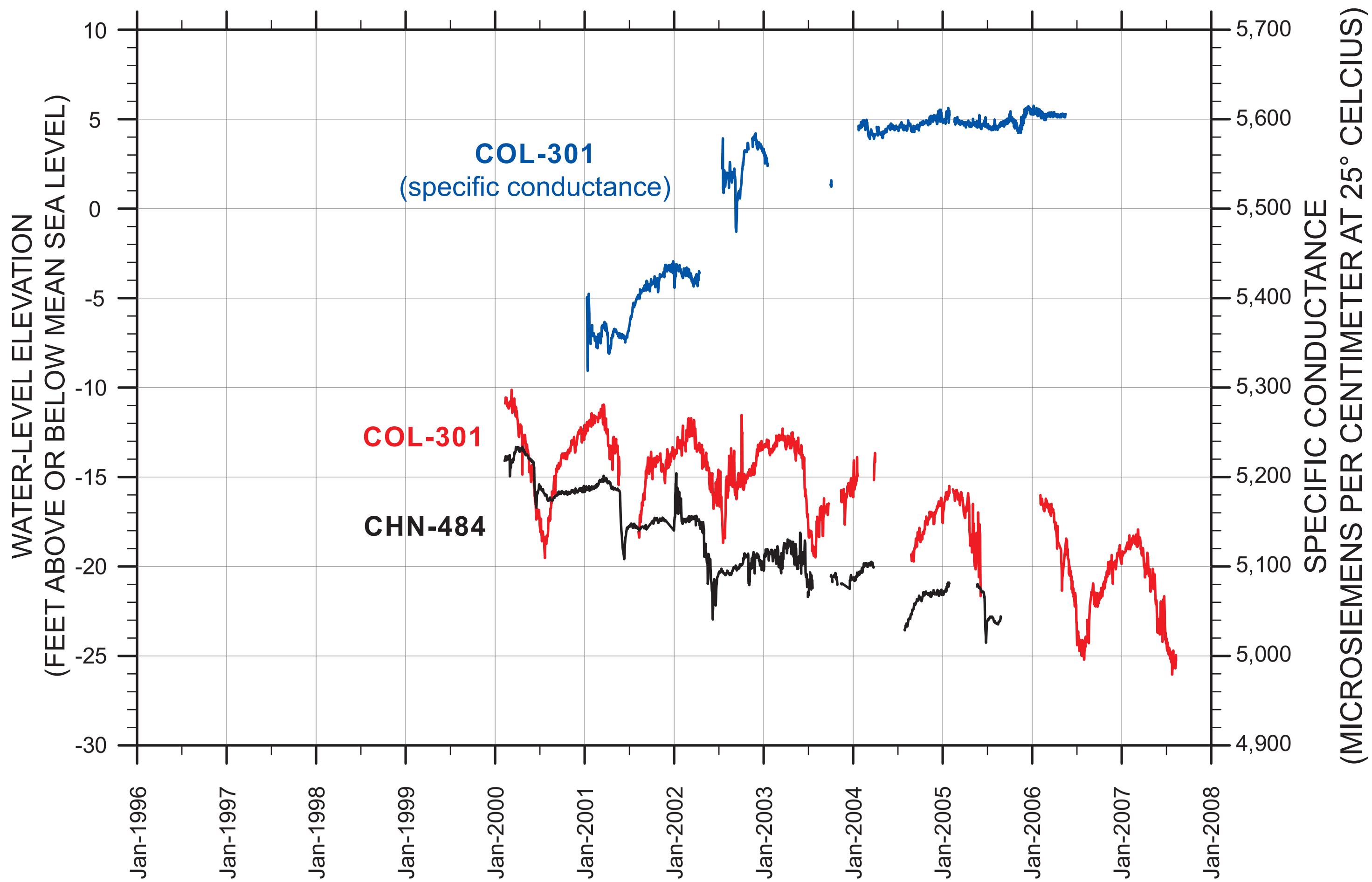

Figure 3. Hydrographs of wells COL-301 and CHN-484 and specific conductance trends in well COL-301.

The highest water level in Beaufort County, at 22 ft msl, was in BFT-1925 on northern Port Royal Island. Water levels in this recharge mound are 1 to 4 ft lower than in 1998. A second recharge mound exists about BFT-1599, with a water level of 14 ft msl on Ladies Island. Hassen (1985) mapped a recharge mound greater than 15 ft msl (with 2-ft contour interval) in March 1984 on the island and Ransom and White (2000) noted a mound greater than 10 ft msl (5-ft contour interval) in September 1998.

On St. Helena Island, water levels range from -1 to 6 ft msl at BFT-1592 and BFT-600, respectively. A small cone of depression is indicated by the 0 contour about BFT-1592, where the water level was 4 ft lower than in 1998 and is probably caused by irrigation pumping.

South of the Broad River in Beaufort County, water levels are at or below sea level, and the direction of ground-water movement is generally southwest toward Savannah, Ga. BFT-429 shows seasonal variations superimposed on declining trends until 1990 when the downward trend in water levels ceased (Fig. 4). Another period of decline occurred between 1998 and 2001 as a result of the drought.

On Hilton Head Island, water levels appear to be 1 to 5 ft higher in 2004 than in 1998. Although tidal corrections could not be applied to the 2004 data, the trend is consistent throughout the island, including wells located in the island interior where tidal influence is small. Two wells, BFT-771 and BFT-444, with declines of 4 and 10 feet, respectively, oppose this trend and are probably influenced by nearby wells.

Total reported ground-water use in Beaufort County was 18.6 mgd in 2004. The majority (12.4 mgd) came from the upper Floridan aquifer, mostly for public supply. The second greatest pumpage is from the middle Floridan (3.8 mgd) largely for golf-course irrigation. Less than 0.2 mgd is pumped from the lower Floridan in Beaufort. The remaining ground-water pumpage is from surficial (0.2 mgd) and Cretaceous-age aquifers (2.1 mgd) (Robert Devlin, DHEC, written communication, 2008).

The lowest point on the potentiometric surface, at -57 ft msl, is in Jasper County. Predevelopment levels were estimated to be above 25 ft msl throughout the county, and ground-water flow was toward the southeast. The direction of ground-water flow has changed and now is to the southwest. The 1998 map shows water levels in the southwestern part of the county at below -70 ft msl, for a decline of more than 95 ft with documented declines ranging from 7 to 11 ft between 1982 and 1998 (JAS-109, -111, -134, and -298). Data from 2004 indicate that some recovery has occurred since 1998 so that water levels are estimated to be more than 80 ft lower than predevelopment levels. JAS-421 showed a recovery of 17 ft between 1998 and 2004, and both this well and JAS-112 indicate water levels above -60 ft msl.

In northern Jasper County the data from JAS-298 and JAS-397 show that water levels declined 3 ft between 1998 and 2004, although these wells may be tidally influenced. Water levels in JAS-425 ranged from 12 to -1 ft msl between 2000 and 2004 (Fig. 4).

Reported ground-water use in Jasper County in 2004 was 1.1 and 0.9 mgd from the upper and middle Floridan, respectively. Upper Floridan pumpage was 0.7 mgd for irrigation and 0.4 mgd for water supply. Middle Floridan pumpage was 0.1 mgd for irrigation and 0.8 mgd for water supply (Robert Devlin, DHEC, written communication, 2008).

There is a need for additional observation wells in several areas of the Coastal Plain. This map was constructed with 120 fewer wells, or a 33-percent decrease from the 364 wells available in 1998. In constructing this map, several cones of depression are defined by only one or two wells (Eutawville, Summerville, and North Charleston). The declines noted along the coast are a concern and should be monitored because the aquifers are susceptible to saltwater intrusion caused by increased development and the proximity of the saltwater interface. The influence of Georgia's ground-water pumpage on the aquifer also should be closely observed. In light of pressures to provide sufficient water for all users, obtaining data in these areas should have high priority. Efforts should be intensified among ground-water users and governmental agencies to maintain existing observation wells and seek additional wells.

SUMMARY AND CONCLUSIONS

The potentiometric map for the Floridan aquifer and its updip equivalent, constructed by using water-level data from 244 wells measured during late 2004, shows that the generally southeastward ground-water flow is affected by several potentiometric lows. These potentiometric lows developed because of ground-water pumping around North Charleston, Summerville, Walterboro, Gardens Corner, and Eutawville. In Jasper and Beaufort Counties, the ground-water flow reversed from its predevelopment direction and now flows southwestward toward Savannah, Ga.

Historical data show that water levels declined near the northwestern aquifer outcrop area, but fluctuations have occurred in areas influenced by pumping. The greatest fluctuations occurred in southern Jasper County, where water levels have declined more than 80 ft from the estimated predevelopment level but have recovered from 1998 levels.

Potentiometric maps are only as good as the data available to construct them. A greater availability of observation wells, timely measurements, and periodic construction of potentiometric maps will provide improved understanding of the aquifer and subsequently allow better management of this resource.

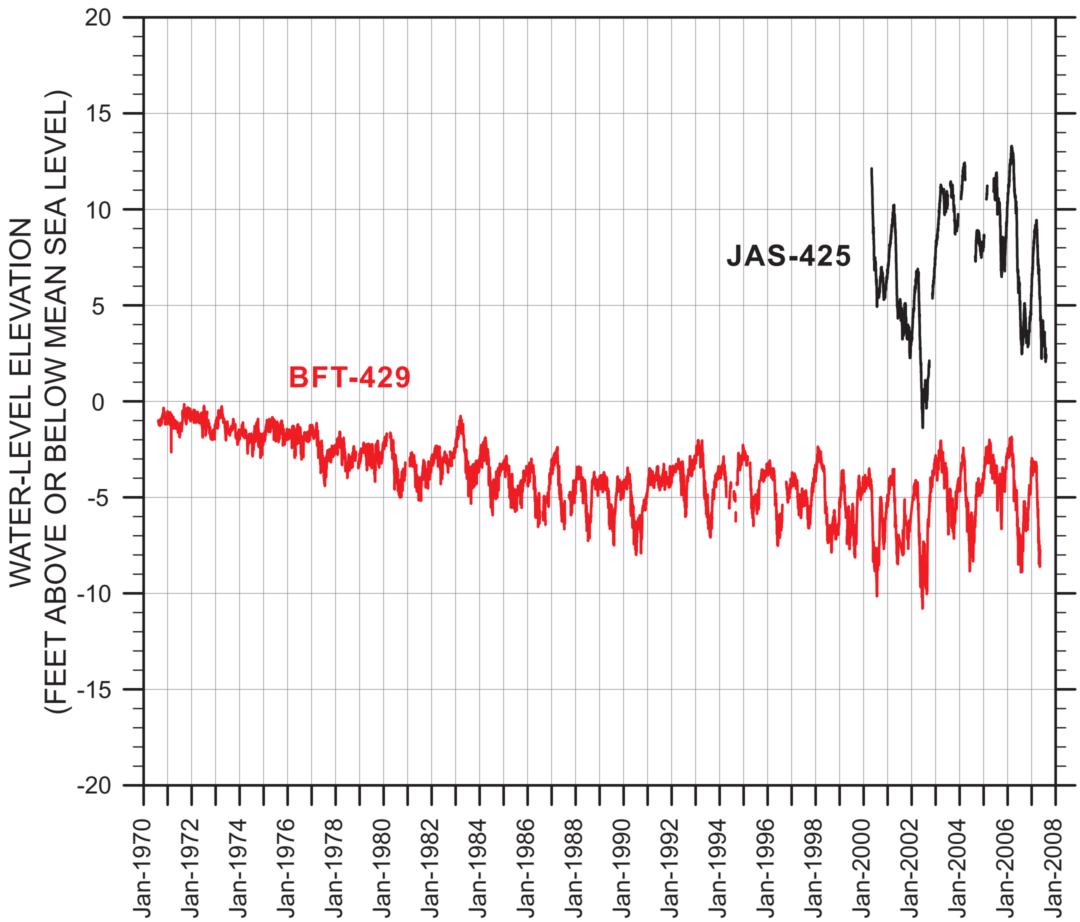

Figure 4. Hydrographs of wells BFT-429 and JAS-425.

REFERENCES

Aadland, R.K., Gellici, J.A., and Thayer, P.A., 1995, Hydrogeologic framework of west-central South Carolina: South Carolina Department of Natural Resources, Water Resources Division Report 5, 200 p, 47 plates.

Aucott, W.R., 1996, Hydrology of the southeastern Coastal Plain aquifer system in South Carolina and parts of Georgia and North Carolina: U.S. Geological Survey Professional Paper 1410-E, 83 p.

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.

Aucott, W.R., and Speiran, G.K., 1984, Water-level measurements for the Coastal Plain aquifers of South Carolina prior to development: U.S. Geological Survey Open-File Report 84-803, 36 p, 1 sheet.

——— 1985a, Potentiometric surfaces of November 1982 and declines in the potentiometric surfaces between the period prior to development and November 1982 for the Coastal Plain aquifers of South Carolina: U.S. Geological Survey Water-Resources Investigations Report 84-4215, 7 sheets.

——— 1985b, 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.

Bristol, P.L., 2003, South Carolina water use report – 2001 summary: South Carolina Department of Health and Environmental Control, Bureau of Water, 26 p.

Childress, J.M., and Bristol, P.L., 2005, South Carolina water use report – 2004 summary: South Carolina Department of Health and Environmental Control, Bureau of Water Technical Document 004-05, 39 p.

Colquhoun, D.J., Woollen, I.D.,VanNiewenhuise, D.S., Padgett, G.G., Oldham, R.W., Boylan, D.C., Bishop, J.W., and Howell, P.D., 1983, Surface and subsurface stratigraphy, structure and aquifers of the South Carolina Coastal Plain: Columbia, S.C., University of South Carolina, Department of Geology, 78 p.

Cooke, C.W., 1936, Geology of the Coastal Plain of South Carolina: U.S. Geological Survey Bulletin 867, 196 p.

Counts, H.B., and Donsky, Ellis, 1963, Saltwater encroachment, geology, and ground-water resources of the Savannah area, Georgia and South Carolina: U.S. Geological Survey Water-Supply Paper 1611, 100 p., 6 plates.

Crouch, M.S., Davies, M.R., Hassen, J.A., and Hughes, W.B., 1985, Water-level conditions in the upper permeable zone of the Floridan aquifer in the South Carolina Low Country, March 1985: South Carolina Water Resources Commission Open-File Report 85-1, 9 p.

Crouch, M.S., Hughes, W.B., Logan, W.R., and Meadows, J.K., 1987, Potentiometric surface of the Floridan Aquifer in South Carolina, July 1986: South Carolina Water Resources Commission Report 157, 1 plate.

Davies, M.R., Hassen, J.A., and Hughes, W.B., 1985, Water-level conditions in the upper permeable zone of the Floridan aquifer in the South Carolina Low Country, June 1985: South Carolina Water Resources Commission Open-File Report 85-3, 9 p.

Garza, Ragina, and Krause, R.E., 1992, Water-supply potential of major streams and the upper Floridan aquifer in the vicinity of Savannah, Georgia: U.S. Geological Survey Open-File Report 92-629, 49 p., 19 plates.

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., 11 plates.

——— 1997, Correction for tidal effects on water-level measurements, Floridan aquifers, southern coast of South Carolina; *in* Contributions to the hydrology of South Carolina: South Carolina Department of Natural Resources, Water Resources Division Report 14, 54 p.

Gawne, C.E., and Park, A.D., 1992, Water-supply potential of the middle Floridan aquifer in southern Beaufort County, South Carolina: Report to the Town of Hilton Head Island Water Commission, 34 p.

Gellici, J.A., 2007a, Hydrostratigraphy of the AIK-2448 and AIK-2449 core holes in the Breezy Hill area of Aiken County, South Carolina: South Carolina Department of Natural Resources Water Resources Report 42, 31 p., 4 plates.

——— 2007b, Hydrostratigraphy of the ORG-393 core hole at Orangeburg, South Carolina: South Carolina Department of Natural Resources Water Resources Report 43, 28 p., 3 plates.

Gellici, J.A., and Badr, A.W., 2004, Lake levels in South Carolina during the June 1998 – August 2002 drought *in* Hydrologic effects of the June 1998 – August 2002 drought in South Carolina; compilation of hydrographs illustrating the effects of the drought on ground-water levels, lake levels, and streamflows in South Carolina: South Carolina Department of Natural Resources, Water Resources Division Report 34, 49 p.

Gellici, J.A., and Harwell, S.A., 2004, Ground-water levels in South Carolina during the June 1998 – August 2002 drought *in* Hydrologic effects of the June 1998 – August 2002 drought in South Carolina; compilation of hydrographs illustrating the effects of the drought on ground-water levels, lake levels, and streamflows in South Carolina: South Carolina Department of Natural Resources, Water Resources Division Report 34, 49 p.

Hassen, J.A., 1985, Ground-water conditions in the Ladies and St. Helena Islands area, South Carolina: South Carolina Water Resources Commission Report 147, 56 p.

Hayes, L.R., 1979, The ground-water resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina: South Carolina Water Resources Commission Report 9, 91 p.

Hockensmith, B.L., 2001a, Water-level measurements used in construction of the 1998 potentiometric map for the Floridan aquifer and Tertiary sand aquifer in South Carolina: South Carolina Department of Natural Resources, Land, Water and Conservation Division Open-File Report 6, 23 p.

——— 2001b, 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.

Hughes, W.B., Crouch, M.S., and Park, A.D., 1989, Hydrogeology and saltwater contamination of the Floridan aquifer in Beaufort and Jasper Counties, South Carolina: South Carolina Water Resources Commission Report 158, 52 p.

Johnson, P.W., 1978, Reconnaissance of the ground-water resources of Clarendon and Williamsburg Counties, South Carolina: South Carolina Water Resources Commission Report 13, 43 p.

Kiuchi, Masaaki, 2002, Multiyear-drought impact on hydrologic conditions in South Carolina, water years 1998-2001: South Carolina Department of Natural Resources (pamphlet).

——— 2004, Streamflow conditions in South Carolina during the June 1998 – August 2002 drought *in* Hydrologic effects of the June 1998 – August 2002 drought in South Carolina; compilation of hydrographs illustrating the effects of the drought on ground-water levels, lake levels, and streamflows in South Carolina: South Carolina Department of Natural Resources, Water Resources Division Report 34, 49 p.

Logan, W.R., and Euler, G.M., 1989, Geology and ground-water resources of Allendale, Bamberg, and Barnwell Counties and part of Aiken County, South Carolina: South Carolina Water Resources Commission Report 155, 113 p., 1 sheet.

Meadows, J.K., 1987, Ground-water conditions in the Santee Limestone and Black Mingo Formation near Moncks Corner, Berkeley County, South Carolina: South Carolina Water Resources Commission Report 156, 38 p.

Miller, J.A., 1985, Geohydrologic framework of the Floridan aquifer system in Florida, Georgia, and parts of Alabama and South Carolina: U.S. Geological Survey Professional Paper 1403-B, 91 p., 33 plates.

Neuendorf, K.K.E., Mehl, J.P. Jr., Jackson, J.A., eds., 2005, Glossary of geology (5th ed.): Alexandra, VA., American Geological Institute, 779 p.

Park, A.D., 1985, The ground-water resources of Charleston, Berkeley, and Dorchester Counties, South Carolina: South Carolina Water Resources Commission Report 139, 145 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.

Renken, R.A., 1984, The hydrologic framework for the sand aquifer of the Southeastern United States Coastal Plain: U.S. Geological Survey Water-Resources Investigations Report 84-4243, 30 p., 8 sheets.

Siple, G.E., 1957, Ground water in the South Carolina Coastal Plain: Journal of the American Water Works Association, v. 49, no. 3, p. 283-300.

——— 1975, Ground-water resources of Orangeburg County, South Carolina: South Carolina State Development Board, Division of Geology Bulletin No. 36, 59 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.

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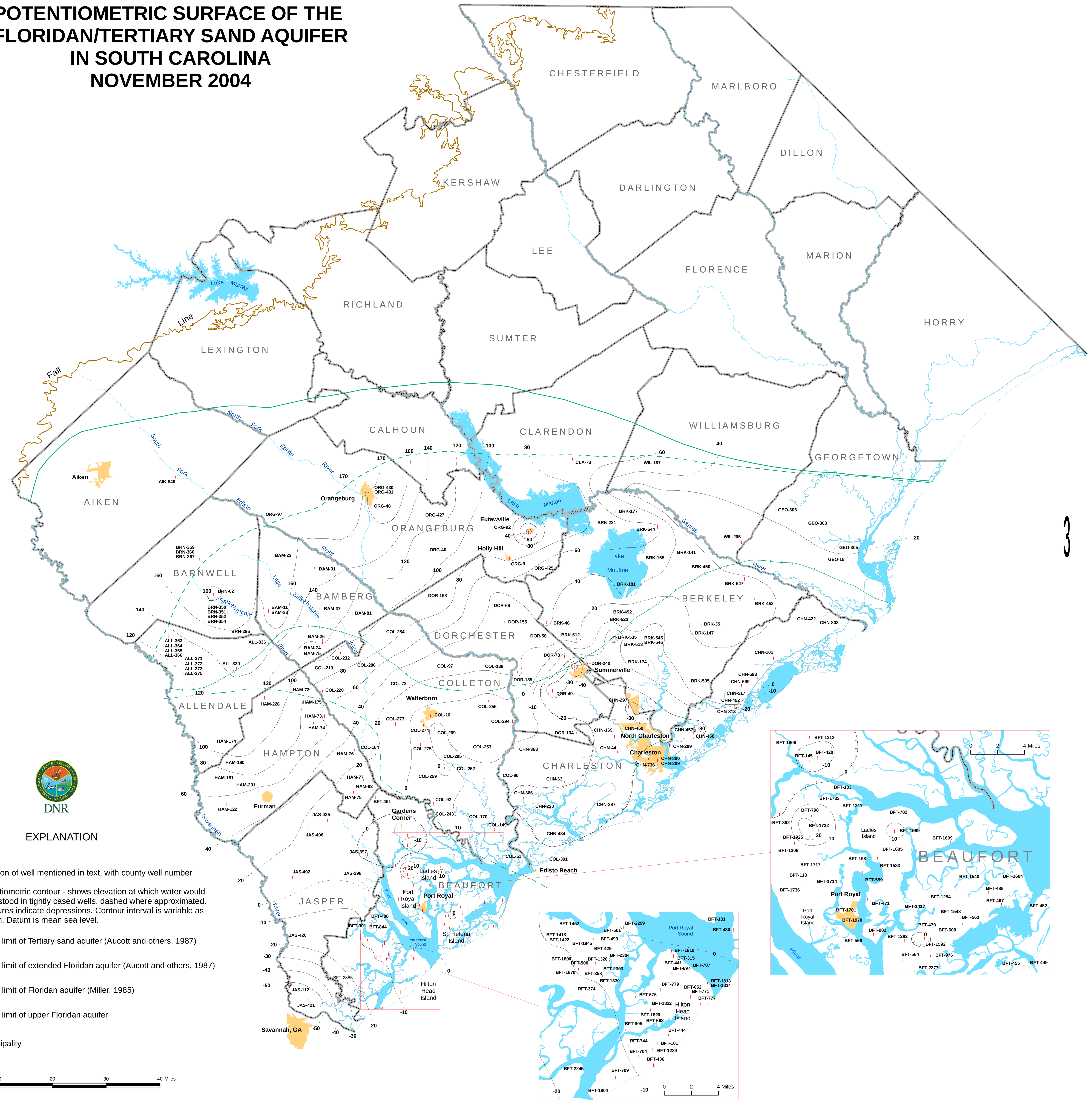
2009

POTENTIOMETRIC SURFACE OF THE FLORIDAN/TERTIARY SAND AQUIFER IN SOUTH CAROLINA NOVEMBER 2004



EXPLANATION

AIK-131 Location of well mentioned in text, with county well number

100 Potentiometric contour - shows elevation at which water would have stood in tightly cased wells, dashed where approximated. Hachures indicate depressions. Contour interval is variable as shown. Datum is mean sea level.

Updip limit of Tertiary sand aquifer (Aucott and others, 1987)

Updip limit of extended Floridan aquifer (Aucott and others, 1987)

Updip limit of Floridan aquifer (Miller, 1985)

Updip limit of upper Floridan aquifer

Municipality