

Potentiometric Surface of the McQueen Branch and Charleston Aquifers in South Carolina, November–December 2022

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The McQueen Branch and Charleston aquifers are two of the deepest Cretaceous-age aquifers in the Coastal Plain of South Carolina and are an important source of water for many public, industrial, and agricultural users. In late 2022, static water-level measurements from 139 wells open to these aquifers were used to produce a potentiometric surface map that illustrates the elevation of water levels in the aquifers, provides an overview of conditions in the aquifers, and indicates the general direction of groundwater flow. Routine monitoring of water levels in these aquifers allows the South Carolina Department of Natural Resources (SCDNR) to identify areas of overpumping, indicated by local cones of depression, and regional changes in aquifer storage related to groundwater development. The boundaries of the McQueen Branch aquifer used for this map are those defined by Gellici and Lautier (2010), who delineated the aquifer using geologic and hydrologic data. The McQueen Branch is a late Cretaceous-age aquifer extending over most of the Coastal Plain. The aquifer, which consists primarily of interbedded quartz sand and clay, outcrops along the Fall Line and reaches its maximum thickness of 350 feet (ft) in Barnwell County. In upland areas, the aquifer is composed of unconsolidated medium to very-coarse grained sand interbedded with clay lenses; downdip, it becomes very-fine grained. The Charleston aquifer occurs only in the lower half of the Coastal Plain and is hydraulically connected to the overlying McQueen Branch aquifer in the middle part of the Coastal Plain, such as in Williamsburg County. Downdip, the two aquifers are separated by clay beds up to 200 ft thick. The Charleston aquifer consists of unconsolidated fine to very-coarse quartz sand, clayey sand, and clay, and reaches a maximum thickness of 300 ft in Jasper County. A more thorough description of the Coastal Plain hydrogeologic framework can be found in Wachob and others (2017). That report also provides a comparison of the McQueen Branch aquifer to the Middendorf aquifer, the equivalent aquifer of the older hydrogeologic framework of Aucott and others (1987), and it includes a listing of numerous earlier Middendorf and Charleston aquifer potentiometric maps.

The map presented here was constructed using static (non-pumping) water levels measured in 139 wells during late 2022. Of those 139 wells, 106 are screened solely in the McQueen Branch aquifer, 27 are screened in the Charleston aquifer, 5 are screened in both the McQueen Branch and Charleston aquifers, and 1 well is screened in both the Charleston aquifer and the underlying Gramling aquifer. Measurements of depth to water in feet were transformed to water level elevation by subtracting the depth to water from elevation at land surface; the resulting information was contoured to represent the aquifers' potentiometric surface in feet above or below the North American Vertical Datum 1988 (NAVD 88).

The 2022 McQueen Branch-Charleston potentiometric surface map shows a generally southeastward groundwater flow affected by potentiometric lows in Charleston, Williamsburg, Georgetown, and Florence Counties. Potentiometric levels range from more than 450 ft near the Fall Line to -154 ft in Georgetown County.

A cone of depression centered at Mount Pleasant continues to affect the Charleston aquifer in Charleston and southern Berkeley Counties. The water-level elevation at the center of the cone is -99 feet. The 20-foot rebound of the potentiometric surface shown on the 2019 map (Czwartacki and Wachob, 2020) was reversed and aquifer levels have returned to near those previously observed in 2016 and 2014. Water levels in wells within the -75-foot contour line have declined between 20 and 38 feet since 2019, and the trend of lower water levels extends eastward to the barrier islands. Compared to 2019, water levels on Sullivan's Island and the southern portion of the Isle of Palms have declined between 4 and 13 feet. The head loss measured in some wells may be exaggerated by water levels being affected by pumping from nearby wells at the time of the measurements; however, the water-level declines seen in most wells in the Charleston area over recent years are occurring and are likely to continue. Water-levels in southern Charleston County near Kiawah Island remain stable with Kiawah Island representing a potentiometric low.

The magnitude and extent of the large cone of depression in the McQueen Branch aquifer in Georgetown County continues to expand and extends to the Town of Andrews in Williamsburg County and also into southern Horry County. Water levels in four wells that define the cone's center have declined between 4 and 9 feet since 2019.

The moderately deep but localized cone of depression around the City of Florence remains relatively unchanged from the 2019 map. There is some uncertainty about the potentiometric levels in Clarendon and Sumter Counties because of a scarcity of water-level measurements available for this map.

The 2022 McQueen Branch-Charleston potentiometric map suggests that, downdip from the recharge areas and outside of the western edge of the aquifer, water levels throughout much of these aquifers have declined 50 to 100 ft below predevelopment levels (Aucott and Speiran, 1985), and in parts of Charleston and Georgetown Counties, more than 200 ft.

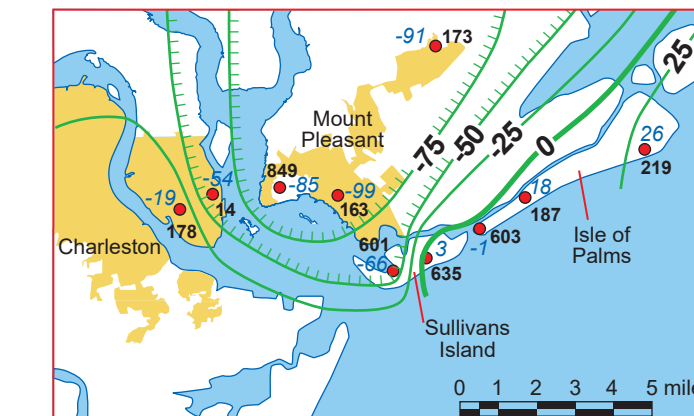
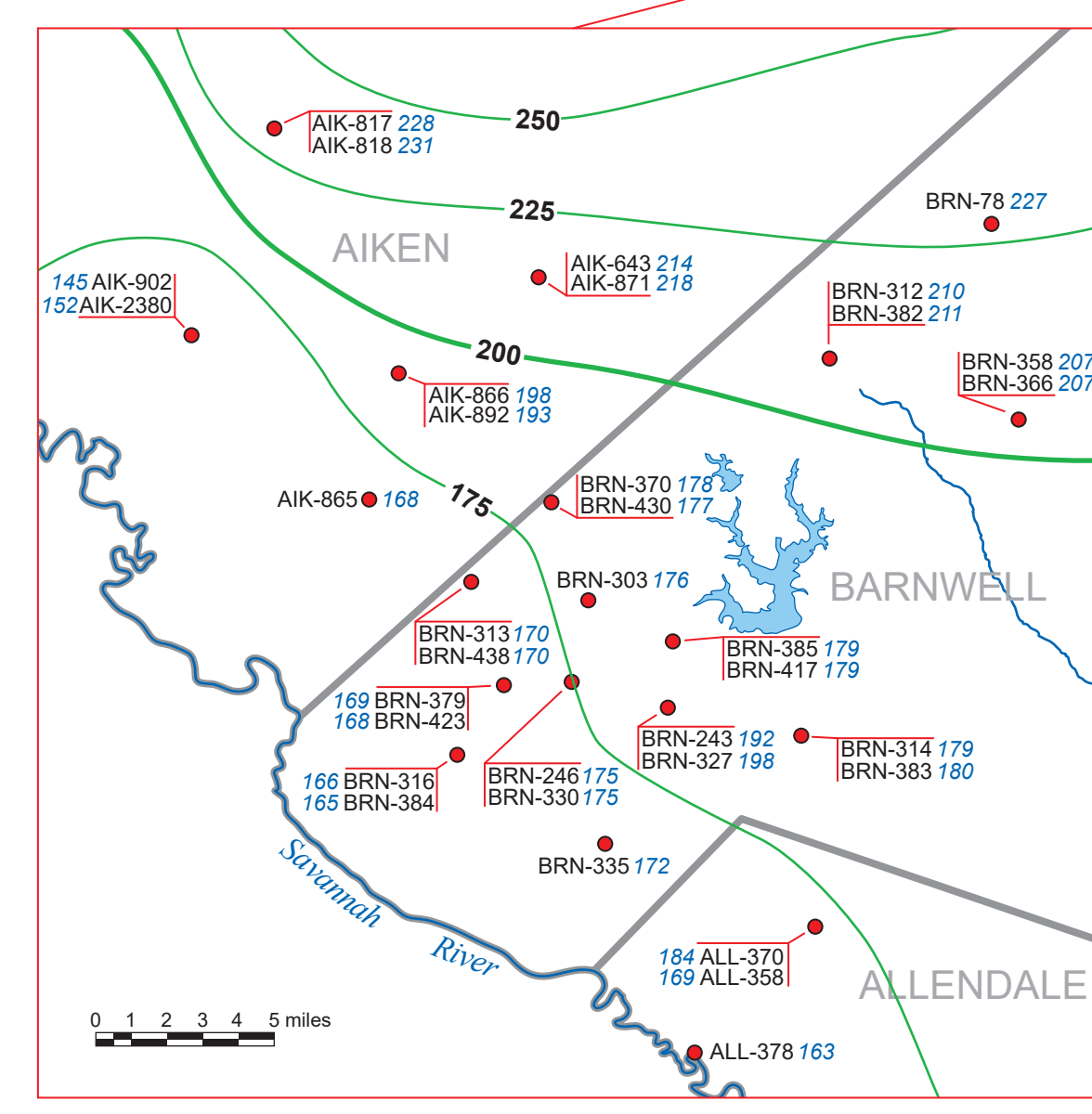
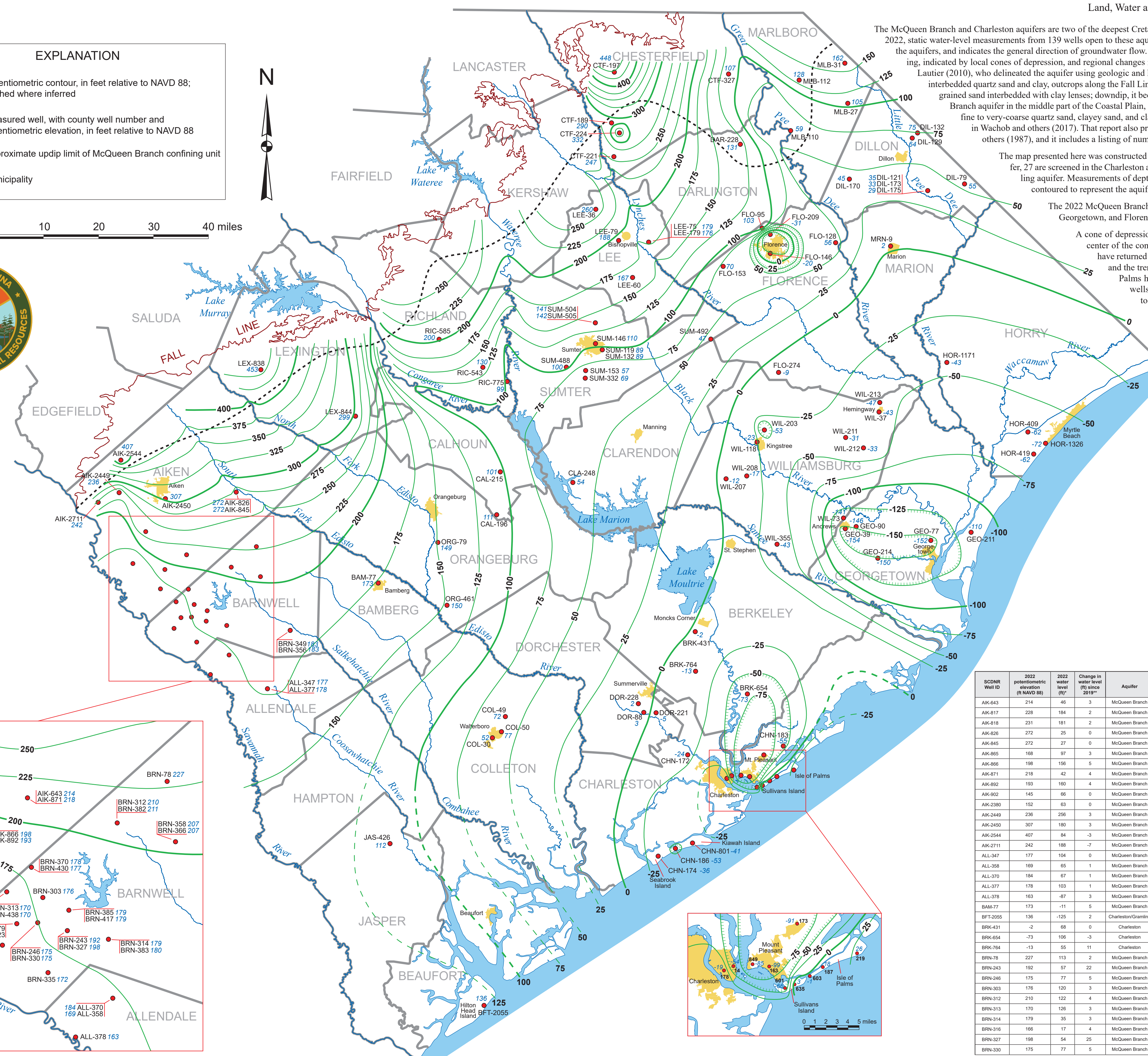
Water levels were collected by staff from SCDNR, the Savannah River National Laboratory, the South Carolina Department of Health and Environmental Control, and the U.S. Geological Survey. The authors are grateful for the assistance of these agencies and the cooperation of well owners to obtain the water-level measurements used to produce this map.

References

- 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., 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., Davis, M.E., 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.
- Czwartacki, B., and Wachob, A., 2020, Potentiometric surface of the McQueen Branch, Charleston, and Gramling Aquifers in South Carolina, November–December 2019: South Carolina Department of Natural Resources, Water Resources Report 62, 1 sheet.
- Gellici, J.A., and Lautier, J.C., 2010, Hydrogeologic framework of the Atlantic Coastal Plain, North and South Carolina, in Campbell, B.G., and Coes, A.L., eds., Groundwater availability in the Atlantic Coastal Plain of North and South Carolina: U.S. Geological Survey Professional Paper 1773, p. 49–162.
- Wachob, A., Gellici, J.A., and Czwartacki, B., 2017, Potentiometric surface maps of the South Carolina Coastal Plain Aquifers, November–December 2016: South Carolina Department of Natural Resources, Water Resources Report 60, 35 p., 3 plates.

EXPLANATION

- 175 — Potentiometric contour, in feet relative to NAVD 88; dashed where inferred
- ORG-461 150 — Measured well, with county well number and potentiometric elevation, in feet relative to NAVD 88
- Approximate updip limit of McQueen Branch confining unit
- Walterboro — Municipality



SCDNR Well ID	2022 potentiometric elevation (ft NAVD 88)	2022 water level (ft NAVD 88)	Change in water level (ft) since 2019**	Aquifer
AIK-643	214	46	3	McQueen Branch
AIK-817	228	184	2	McQueen Branch
AIK-818	231	191	2	McQueen Branch
AIK-826	272	25	0	McQueen Branch
AIK-845	272	27	0	McQueen Branch
AIK-866	168	97	3	McQueen Branch
AIK-868	198	158	5	McQueen Branch
AIK-871	218	42	4	McQueen Branch
AIK-882	193	160	4	McQueen Branch
AIK-902	145	66	0	McQueen Branch
AIK-2380	152	63	0	McQueen Branch
AIK-2440	236	256	3	McQueen Branch
AIK-2450	307	180	3	McQueen Branch
AIK-2544	407	84	-3	McQueen Branch
AIK-2711	242	158	-7	McQueen Branch
ALL-347	177	104	0	McQueen Branch
ALL-358	169	65	1	McQueen Branch
ALL-370	184	67	1	McQueen Branch
ALL-377	178	103	1	McQueen Branch
ALL-378	163	-87	3	McQueen Branch
BRK-431	-2	68	0	Charleston
BRK-654	-73	106	-3	Charleston
BRK-764	-13	55	11	Charleston
BRN-78	227	113	2	McQueen Branch
BRN-243	192	57	22	McQueen Branch
BRN-246	175	77	5	McQueen Branch
BRN-303	176	120	3	McQueen Branch
BRN-312	210	122	4	McQueen Branch
BRN-313	170	126	3	McQueen Branch
BRN-314	179	35	3	McQueen Branch
BRN-316	166	17	4	McQueen Branch
BRN-327	198	54	25	McQueen Branch
BRN-330	175	77	5	McQueen Branch

SCDNR Well ID	2022 potentiometric elevation (ft NAVD 88)	2022 water level (ft NAVD 88)	Change in water level (ft) since 2019**	Aquifer
BRN-335	172	33	4	McQueen Branch
BRN-349	183	25	2	McQueen Branch
BRN-355	183	25	2	McQueen Branch
BRN-358	207	61	2	McQueen Branch
BRN-366	207	61	2	McQueen Branch
BRN-370	178	96	2	McQueen Branch
BRN-379	169	95	3	McQueen Branch
BRN-382	211	121	3	McQueen Branch
BRN-383	180	35	3	McQueen Branch
BRN-384	165	18	3	McQueen Branch
BRN-385	179	134	3	McQueen Branch
BRN-417	179	134	3	McQueen Branch
BRN-423	168	96	3	McQueen Branch
BRN-430	177	96	1	McQueen Branch
BRN-438	170	126	2	McQueen Branch
ALL-196	111	40	8	McQueen Branch
CAL-215	101	86	4	McQueen Branch
CHN-14	-54	61	-3	Charleston
CHN-163	-99	125	-20	Charleston
CHN-172	-24	33	-2	Charleston
CHN-173	-91	96	-38	Charleston
CHN-174	-36	44	-3	Charleston
CHN-176	-19	27	2	Charleston
CHN-183	-55	79	-11	Charleston
CHN-186	-53	65	17	Charleston
CHN-187	18	-4	3	Charleston
CHN-219	26	-18	2	Charleston
CHN-401	-66	71	-13	Charleston
CHN-603	-1	15	-4	Charleston
CHN-635	3	7	-6	Charleston
CHN-651	-41	47	4	Charleston
CHN-848	-85	98	-20	Charleston
CLA-248	54	27	n/a	McQueen Branch
COL-30	52	6	0	McQueen Branch
COL-49	72	-8	-3	Charleston

SCDNR Well ID	2022 potentiometric elevation (ft NAVD 88)	2022 water level (ft NAVD 88)	Change in water level (ft) since 2019**	Aquifer
COL-50	77	16	1	Charleston
CTF-189	290	13	0	McQueen Branch
CTF-179	448	121	-3	McQueen Branch
CTF-221	247	145	2	McQueen Branch
CTF-224	332	157	4	McQueen Branch
CTF-327	107	85	0	McQueen Branch
DAR-228	131	37	1	McQueen Branch
DEL-79	55	32	-1	McQueen Branch
DEL-121	35	57	-4	McQueen Branch
DEL-129	64	86	7	McQueen Branch
DEL-132	75	67	3	McQueen Branch
DEL-170	45	68	-2	McQueen Branch
DEL-173	33	49	-3	McQueen Branch
DEL-175	29	53	-4	McQueen Branch
DOR-88	3	25	-3	Charleston
DOR-221	-5	27	-2	Charleston
DOR-228	2	49	-3	Charleston
FLO-85	103	35	-1	McQueen Branch
FLO-128	56	38	-11	McQueen Branch
FLO-146	-20	131	9	McQueen Branch
FLO-153	70	75	-6	McQueen Branch
FLO-209	-31	159	-2	McQueen Branch
FLO-274	-9	88	-7	McQueen Branch
GEO-39	-146	185	-8	McQueen Branch
GEO-77	-152	170	-8	McQueen Branch
GEO-214	-150	155	-8	McQueen Branch
GEO-211	-110	132	2	McQueen Branch
GEO-214	-150	155	-8	McQueen Branch
HOR-419	-62	76	1	McQueen Branch
HOR-419	-62	85	3	McQueen Branch
HOR-1171	-43	80	-3	McQueen Branch
HOR-1326	-72	89	-2	McQueen Branch
JAS-426	112	-55	-3	Charleston
LEE-36	260	94	16	McQueen Branch
LEE-60	167	10	-3	Charleston

SCDNR Well ID	2022 potentiometric elevation (ft NAVD 88)	2022 water level (ft NAVD 88)	Change in water level (ft) since 2019**	Aquifer
LEE-75	179	16	1	McQueen Branch
LEE-79	188	41	-3	McQueen Branch
LEE-179	178	20	-3	McQueen Branch
LEX-484	453	79	2	McQueen Branch
LEX-484	299	71	2	McQueen Branch
MLB-27	105	74	0	McQueen Branch
MLB-31	162	24	0	McQueen Branch
MLB-110	99	32	-1	McQueen Branch
MLB-112	128	5	0	McQueen Branch
MRN-9	2	63	2	McQueen Branch
ORG-79	149	34	4	McQueen Branch
ORG-461	150	-30	3	McQueen Branch
RIC-543	193	48	-1	McQueen Branch
RIC-545	200	122	-1	McQueen Branch
RIC-775	99	52	-3	McQueen Branch
SUM-119	89	56	11	McQueen Branch
SUM-132	89	55	12	McQueen Branch
SUM-146	110	61	6	McQueen Branch
SUM-153	57	118	-6	McQueen Branch
SUM-332	69	118	-21	McQueen Branch
SUM-488	100	79	-2	McQueen Branch
SUM-492	47	74	0	McQueen Branch
SUM-504	141	25	1	McQueen Branch
SUM-505	142	24	1	McQueen Branch
WIL-37	-43	93	1	Charleston
WIL-73	-141	158	n/a	McQueen Branch
WIL-118	-23	79	2	MB / Charleston
WIL-203	-53	130	1	MB / Charleston
WIL-207	-12	85	-6	MB / Charleston
WIL-211	-31	95	-6	MB / Charleston
WIL-212	-33	70	-3	Charleston
WIL-212	-37	100	-2	Charleston
WIL-355	-43	99	-3	McQueen Branch

* Depth to water from land surface. Negative value indicates flowing well.
** Change in water level from measurement made for 2019 potentiometric map. Positive number indicates higher water level in 2022.