Waccamaw Capacity Use Area Groundwater Evaluation Report

Permitting Year 2024

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Technical Report Number: 006-2023
September 2023

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S.C. Department of Health and Environmental Control

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Introduction

The Waccamaw Capacity Use Area (Waccamaw Area), which includes the whole of Georgetown County and Horry County, was the first of six currently designated areas of South Carolina's Coastal Plain to be incorporated into the Capacity Use Program. In the parts of the state designated as a Capacity Use Area, a groundwater withdrawer is defined as, "*a person withdrawing groundwater in excess of three million gallons during any one month from a single well or from multiple wells under common ownership within a one-mile radius from any one existing or proposed well*" (Groundwater Use and Reporting Act, 2000).

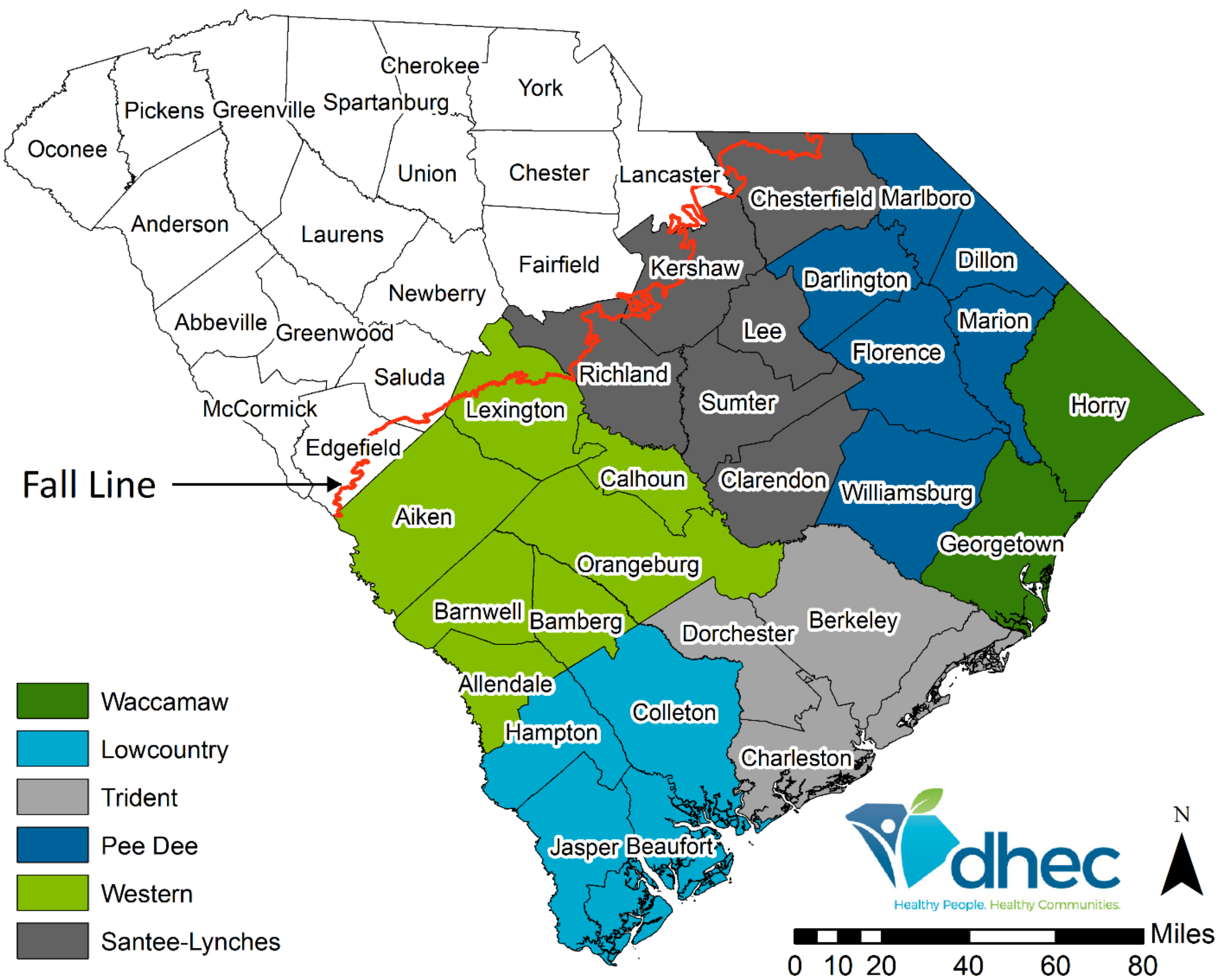


Figure 1. Map of SCDHEC Capacity Use Areas.

Regulatory History

In 1967, the S.C. Water Resources Planning and Coordination Act (Water Resources Act) established the S.C. Water Resources Commission (the Commission), which designated the Waccamaw Area (Horry and Georgetown Counties and Brittons Neck of Marion County) as the first Capacity Use Area in 1979. In 1993, under the Water Resources Act, the responsibilities of the Commission were distributed such that water permitting tasks became the responsibility of the S.C. Department of Health and Environmental

Control (SCDHEC) and water planning tasks became the responsibility of the S.C. Department of Natural Resources (SCDNR), and the Commission was dissolved. In 2000, the South Carolina Code of Laws (Title 49, Section 5) was revised to include what is now the current Groundwater Use and Reporting Act (Groundwater Use and Reporting Act, 2000). Significant changes enacted by the new law were 1) groundwater assessments to determine the necessity of establishing a Capacity Use Area could be initiated by SCDHEC as well as requested by local governments or non-governmental organizations within the state; and 2) a Groundwater Management Plan was now required for each Capacity Use Area. The Capacity Use Areas and associated counties were designated in the following order:

- **Waccamaw Area (1979):** Georgetown and Horry Counties, and Brittons Neck of Marion County
- **Lowcountry Area (1981):** Beaufort, Colleton, and Jasper Counties
- **Trident Area (2002):** Berkeley, Charleston, and Dorchester Counties
- **Pee Dee Area (2004):** Darlington, Dillon, Florence, Marion (including Brittons Neck, leaving only Georgetown and Horry Counties in the Waccamaw Area), Marlboro, and Williamsburg Counties
- **Lowcountry Area (2008):** Addition of Hampton County
- **Western Area (2018):** Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg Counties
- **Santee-Lynches Area (2021):** Chesterfield, Clarendon, Kershaw, Lee, Richland, and Sumter Counties

The initial Waccamaw Groundwater Management Plan (WGMP) (Berezowska & Monroe, 2017) was approved by the SCDHEC Board of Directors in August 2017. The stated goals of the WGMP are to:

1. Ensure sustainable development of the groundwater resource by management of groundwater withdrawals.
2. The protection of groundwater quality from salt-water intrusion.
3. Monitoring of groundwater quality and quantity to evaluate conditions.

The WGMP addressed achieving these goals by evaluating the following aspects of groundwater use in the Waccamaw Area:

- Groundwater sources currently utilized.
- Current water demand by type and amount used.
- Current aquifer storage and recovery, and water reuse.
- Population and growth projections.
- Water demand projections.
- Projected opportunities for aquifer storage and recovery, as well as water reuse.
- Projected groundwater and surface water options.
- Water conservation measures.

Following the guidelines set forth in the WGMP, this document provides an evaluation of current groundwater use and recommendations for its management.

Hydrogeologic Framework

Physiographic Provinces

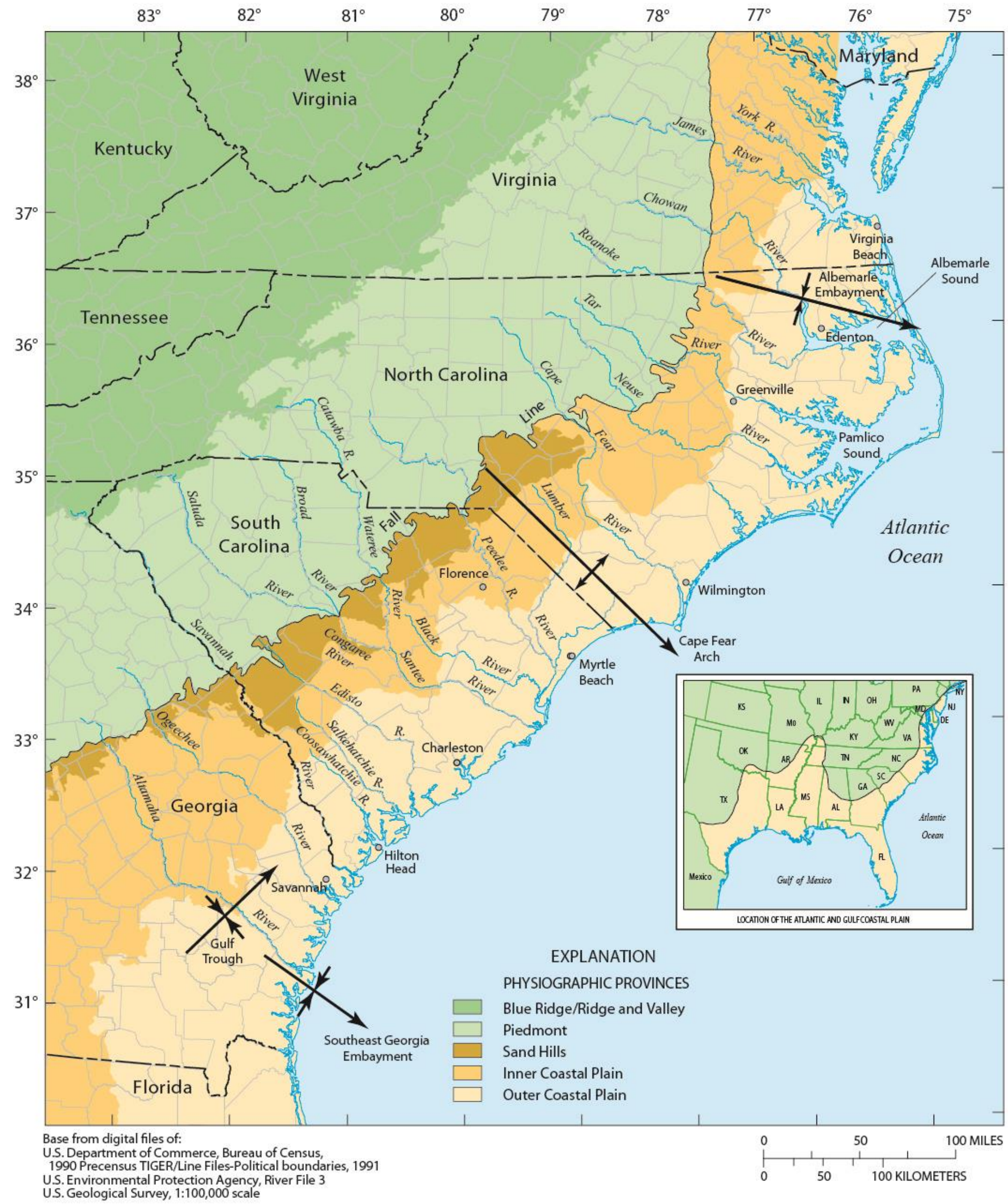


Figure 2. Map of the Atlantic Coastal Plain from North Carolina to Georgia and parts of northern Florida, Virginia, and Maryland. The inset map indicates the extent of the entire Atlantic and Gulf Coastal Plain. U.S. Geological Survey (usgs.gov/media/images/atlantic-coastal-plain-maryland-florida); accessed March 6, 2023.

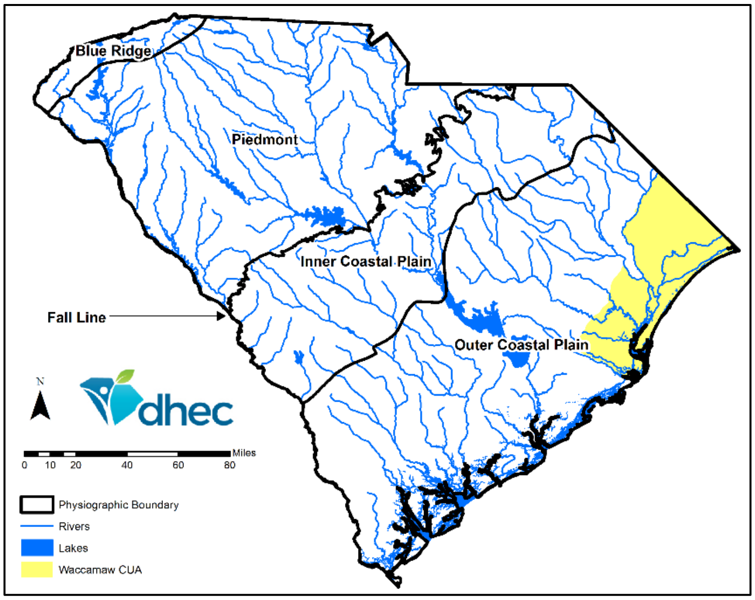


Figure 3. Map of the South Carolina physiographic provinces with the Waccamaw Area highlighted yellow.

The Coastal Plain of South Carolina (CPSC) is part of the larger Atlantic Coastal Plain (ACP). The ACP's northern boundary is in New Jersey and the southern boundary is in Florida. From west to east, the ACP extends from the Fall Line to the coastline with three regions that run roughly parallel to the Atlantic Coastline (Fig. 2).

The CPSC is typically divided into two regions: the Inner Coastal Plain and the Outer Coastal Plain. The Inner Coastal Plain includes the Sandhills Region and is defined by the Fall Line to the northwest and the inland border of the Brandywine terrace to the southeast (Logan & Euler, 1989), and the Outer Coastal Plain is identical to that of the ACP. The Inner Coastal Plain is characterized by rolling hills and deeply incised river valleys, while the Outer Coastal Plain is characterized by a series of coastal terraces dissected by numerous streams (Campbell, et al., 2010). The Waccamaw Area is located entirely within the Outer Coastal Plain (Fig. 3).

The topography of the Waccamaw Area is low relief with elevations ranging from sea level to approximately 115 feet above mean sea level (MSL). Due to the low relief, both Georgetown and Horry County experience frequent inundation from coastal and river flooding (Schwab, et al., 2009). Both groundwater and surface water sources are available and utilized by water withdrawers in the Waccamaw Area.

Aquifers

The hydrogeologic framework of the CPSC consists of wedge-shaped stratigraphy divided into layers of water-bearing, permeable sand or carbonate deposits (aquifers) alternating with layers of fine-grained clays, silts, or low-permeability carbonate deposits (confining units) (Fig. 4). The hydrogeologic units underlying the CPSC were deposited during the late Cretaceous to Tertiary Periods. From oldest to youngest, the Cretaceous units are the Gramling, Charleston, McQueen Branch, and Crouch Branch. The Tertiary units, in the same chronological order, are the Gordon, Floridan (further divided into the Middle Floridan and Upper Floridan), and Surficial (Fig. 4) (Gellici & Lautier, 2010).

The Cretaceous units are present below both Waccamaw Area counties. Of the Tertiary Units, the Gordon aquifer is present below the southernmost portion of Georgetown County, but the Upper and Middle Floridan aquifers are not present below the Waccamaw Area (Czwartacki, Wachob, & Gellici, 2019).

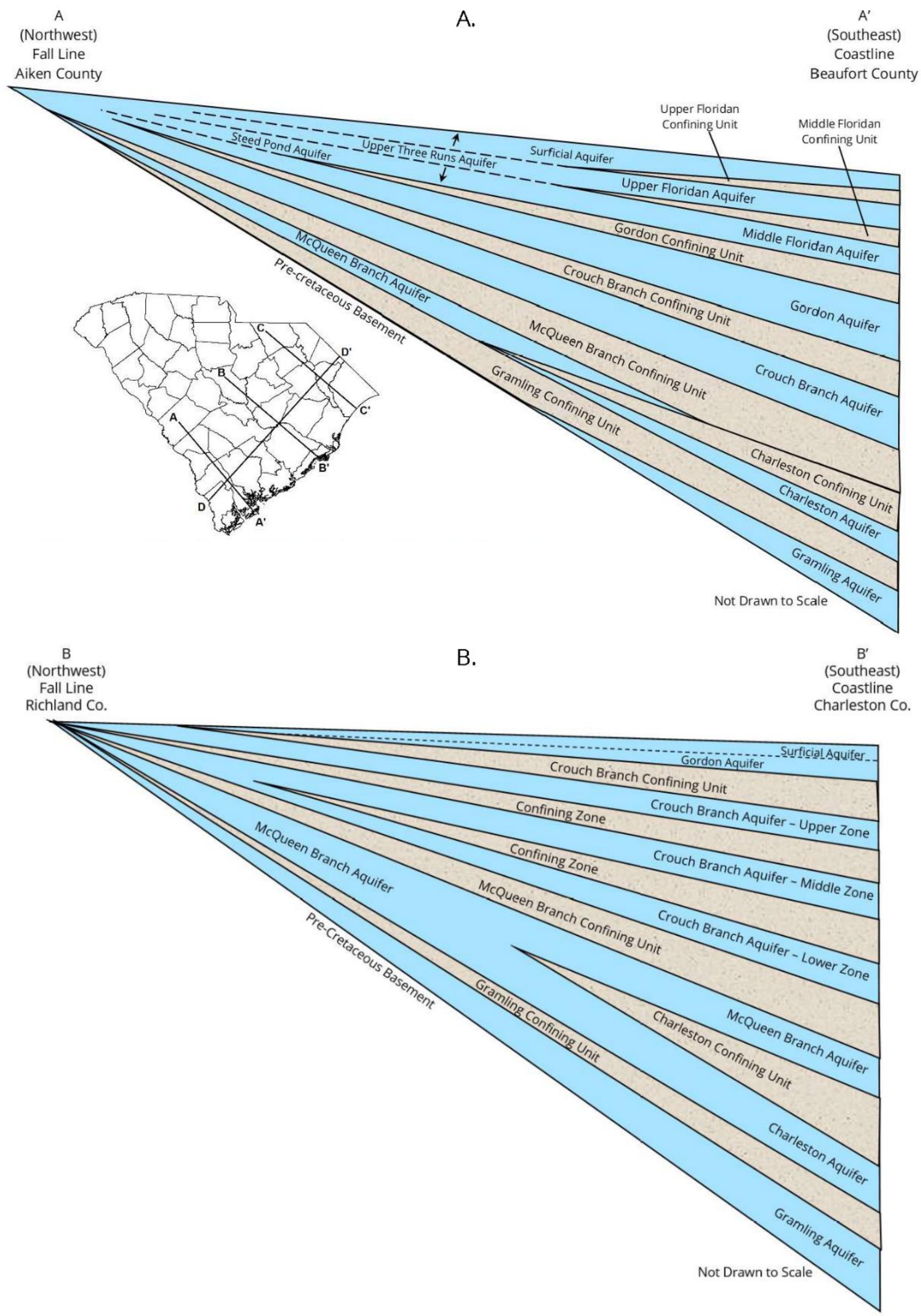
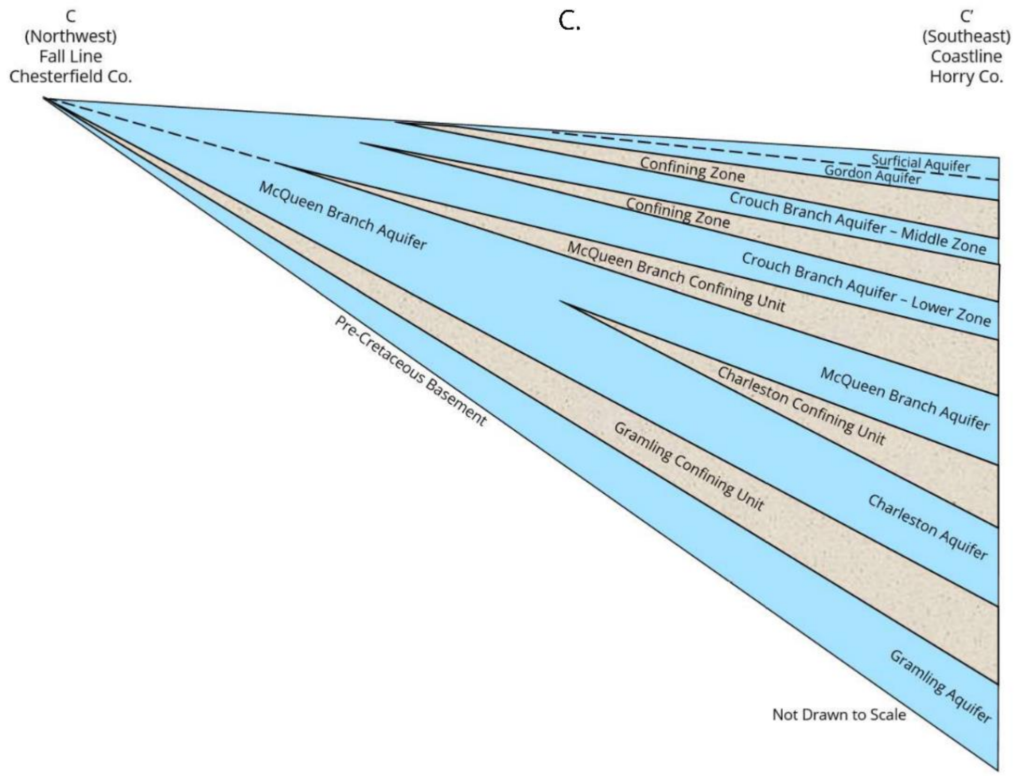


Figure 4. Generalized cross-sections of CPSC stratigraphy. The inset map shows the locations of the four (4) cross-sections. A. The A to A' line; B. The B to B' line; C. The C to C' line; and D. The D to D' line (Campbell & Coes, 2010).



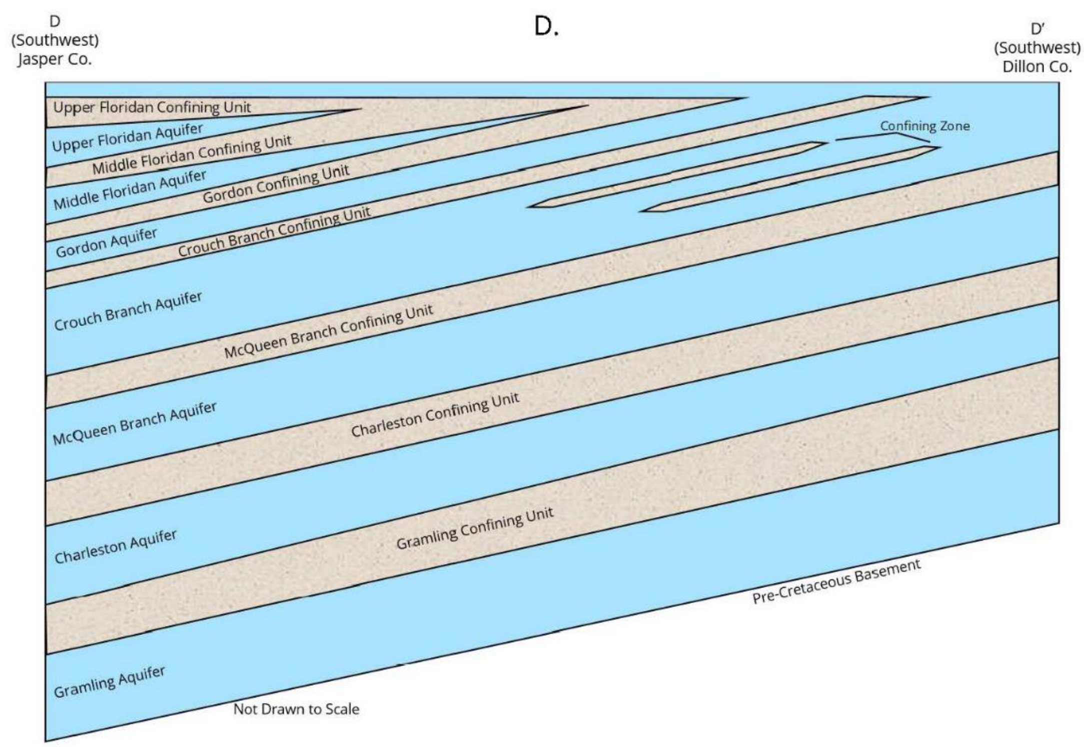


Figure 4, continued.

Recharge Areas

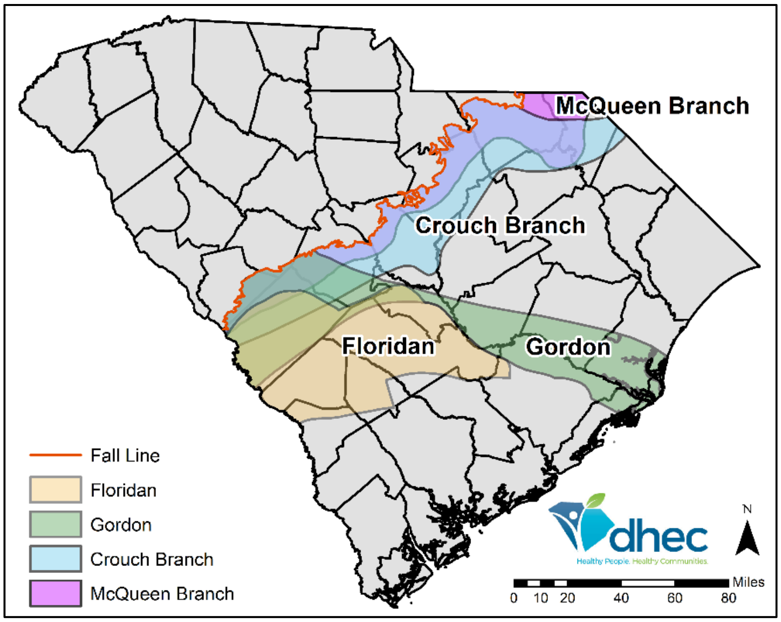


Figure 5. Map indicating the location and extent of the CPSC aquifer recharge areas.

The recharge areas for South Carolina's aquifers are primarily located within the Inner Coastal Plain with the exception of the Gordon aquifer's recharge area, which extends to the coast roughly following the path of the Congaree and Santee Rivers (Fig. 5). The Surficial aquifer receives direct recharge through infiltration of local precipitation and surface water bodies. Groundwater in the deeper aquifers is primarily replenished by precipitation and surface water infiltration in the recharge areas. Water enters the system in the recharge areas, then moves slowly down-dip through the hydrogeologic framework towards the Atlantic Ocean. Consequently, the rate at which groundwater is replenished in the deeper aquifers of the Waccamaw Area is largely controlled by the rate at which groundwater travels from the recharge zones near the Fall Line and the transmissivity of the aquifer. Typical groundwater flow rates for silts to well-sorted sands range from 0.003 to 300 feet per day (Fetter, 2001). This means that once the surface water and precipitation infiltrates into the groundwater system, it may take anywhere from a few years to tens of thousands of years to reach some locations below the Waccamaw Area.

Surface Water

The majority of the Waccamaw Area lies within the Pee Dee River Basin, however, a small portion of southern Georgetown County crosses into the Santee River Basin. Significant rivers that flow through and partially define the boundaries of Georgetown and Horry Counties are the Waccamaw, Little Pee Dee, Great Pee Dee, Black, and Santee Rivers. These rivers, their smaller tributaries, and the Intracoastal Waterway are used as primary water sources or as alternatives to groundwater sources in the Waccamaw Area. There are no major lakes or reservoirs that exist entirely within the Waccamaw Area (Fig. 6).

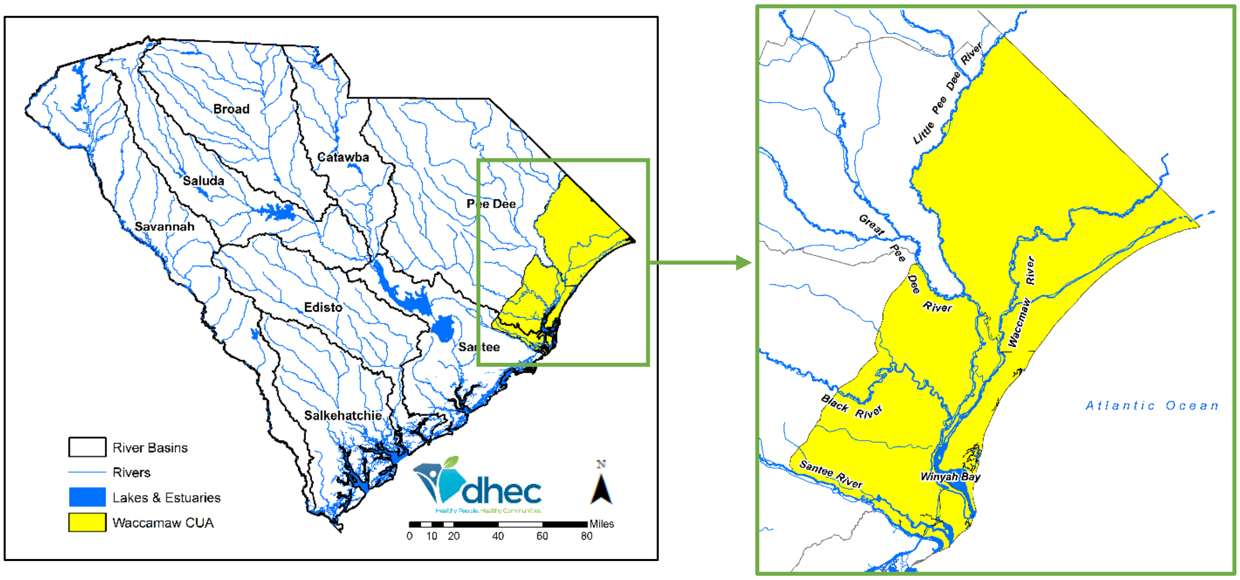


Figure 6. Surface water map of South Carolina with the Waccamaw Area highlighted yellow.

Current Groundwater Demand

In 2022 there were 41 facilities that reported Water Use from 198 wells in the Waccamaw Area counties. Of the permitted wells, 106 are for water supply (54%), followed by golf course irrigation with 71 wells (36%), irrigation with 13 wells (7%), and industry with 8 wells (4%). No wells were permitted for aquaculture, mining, hydropower, nuclear power, thermopower, or other use categories. Most of the permitted wells are in Horry County (77%) and the remaining wells are in Georgetown County (23%) (Table 1, Fig. 7).

Table 1. Waccamaw Area Capacity Use Wells by County and Use Category – 2022.

Use Category	Georgetown	Horry	Total (%)
Golf Course (GC)	2	69	71 (36%)
Industry (IN)	8	0	8 (4%)
Irrigation (IR)	0	13	13 (7%)
Water Supply (WS)	36	70	106 (54%)
Total (%)	46 (23%)	152 (77%)	198 (100%)

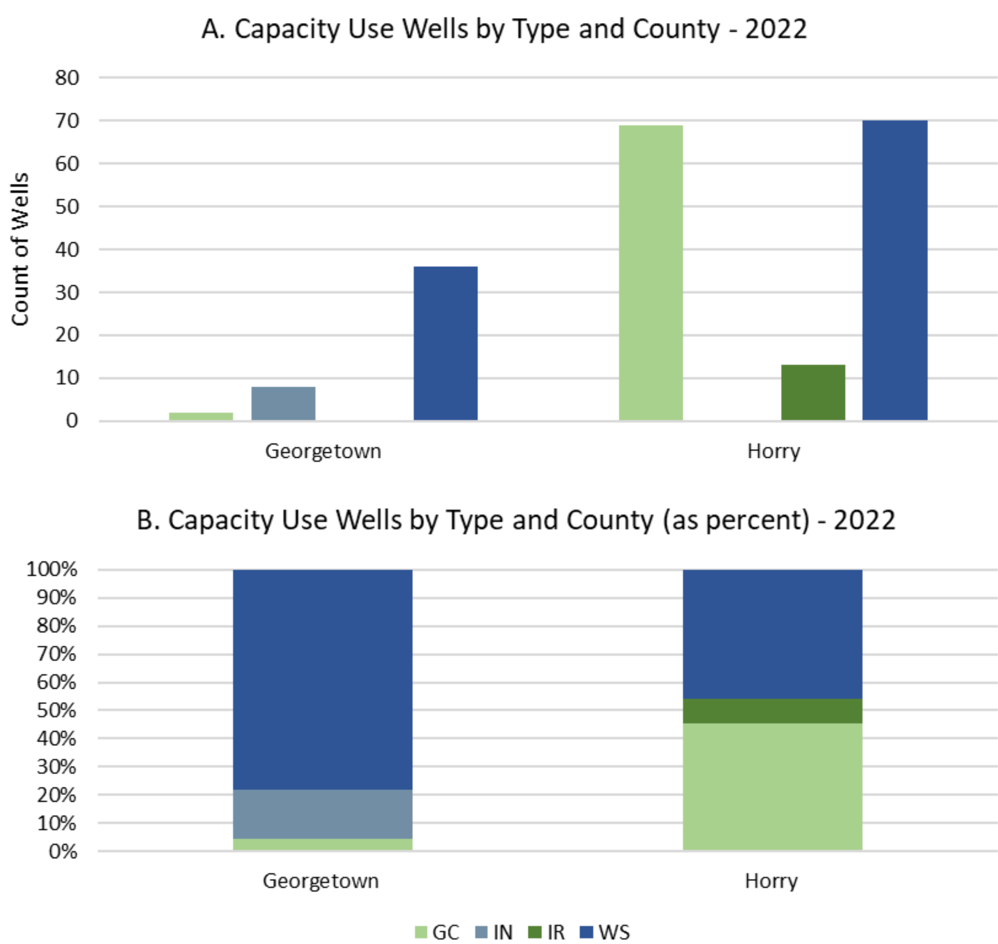


Figure 7. Graphs of Waccamaw Area Permitted Wells by Type and County – 2022. A. Number of each well type by county, and B. Each well type presented as a percent of the total by county.

A total of 3,865.83 million gallons (MG) (or 3.866 billion gallons) was reported for groundwater use in 2022 for the Waccamaw Area. The largest volume of reported groundwater use was for water supply at 81% of the total. Golf course irrigation was the next largest reported water use category at 9%, followed by agricultural irrigation (6%), and industry (3%). Of the two counties, Horry has the largest groundwater demand at 66%, and Georgetown accounts for the remaining 34% (Table 2, Fig. 8).

Table 2. Reported Water Use (MG) by County and Use Category

Use Category	Georgetown	Horry	Total (%)
Golf Course (GC)	34.67	329.41	364.08 (9%)
Industry (IN)	134.20	0	134.20 (3%)
Irrigation (IR)	0	228.38	228.38 (6%)
Water Supply (WS)	1,159.23	1,979.95	3,139.18 (81%)
Total (%)	1,328.09 (34%)	2,537.74 (66%)	3,865.83 (100%)

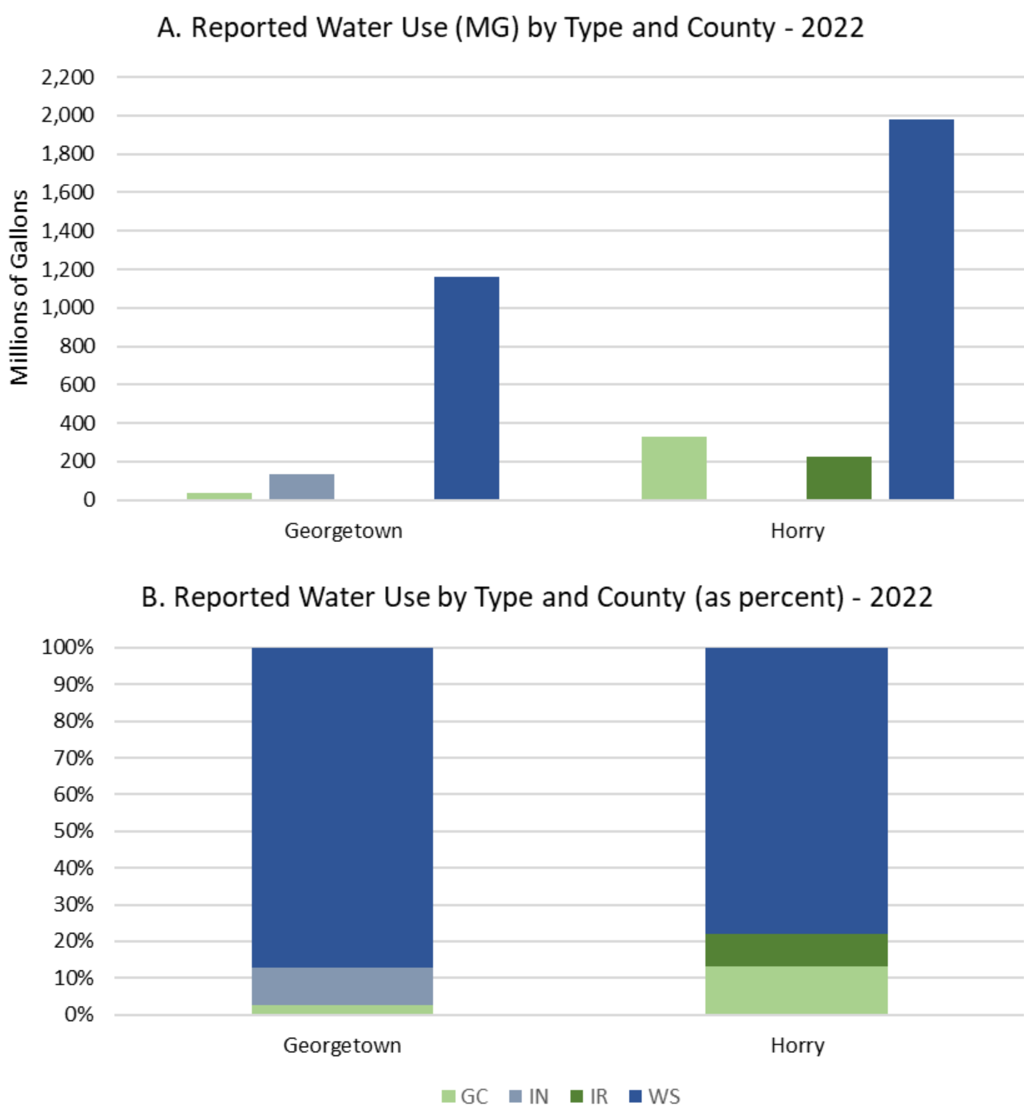


Figure 8. Graphs of Reported Water Use by Type and County - 2022. A. Reported water use for each county in millions of gallons. B. Reported water use as a percent of the total for each county.

Georgetown County Details

Georgetown County has 11 permitted facilities with a total of 46 capacity use wells. Each permitted facility is owned or operated by a groundwater withdrawer and there are groundwater withdrawers that are permitted for more than one facility, some of which have the same name. The total reported groundwater withdrawal for 2022 was 68% of the total permitted annual withdrawal limits for Georgetown County. The largest source of groundwater for the county was the Crouch Branch aquifer which supplied 66% (876.32 MG) of the total reported water use for 2022 (Table 3).

Table 3. Permit Limits and 2022 Reported Water Use – Georgetown County

Facility	Permit No.	Permitted Limit per Year (MGY)	Reported Water Use in 2022 (MGY)	Aquifer(s)
FOUNDERS CLUB	22GC006	24	0	Crouch Branch
Pawley's Plantation	22GC011	50	34.67	Crouch Branch
3V Inc	22IN001	126	98.41	McQueen Branch
Santee Cooper - Winyah Generating Station	22IN002	5	0	Crouch Branch
INTERNATIONAL PAPER - SANTEE WOODYARD	22IN008	60	20.73	Gordon
Interfor U.S. Inc, Georgetown Div.	22IN052	36	15.06	Crouch Branch
GEORGETOWN COUNTY W&S DISTRICT	22WS001	823.3	0 379.25 221.4 42.17 16.45	Surficial Crouch Branch Crouch Branch-McQueen Branch McQueen Branch Charleston
CITY OF GEORGETOWN WTP	22WS002	195.95	166.29	Crouch Branch
Georgetown Rural Community Water District	22WS003	258	167.38	Crouch Branch
Town of Andrews	22WS004	300	113.68	Crouch Branch
Brown's Ferry Water Co.	22WS007	76.7	52.62	Charleston
	TOTALS	**1,954.95**	**1,328.09**	

Horry County Details

Horry County has 30 permitted facilities with a total of 152 capacity use wells. The total reported withdrawals for 2022 were 64% of the total permitted annual withdrawal limits for the Horry County. The largest source of groundwater for Horry County are wells that are screened across the Crouch Branch and McQueen Branch aquifers, which supply 41% (1,044.02 MG) of the county's total reported water use for 2022 (Table 4).

Table 4. Permit Limits and 2022 Reported Water Use – Horry County

Facility	Permit No.	Permitted Limit per Year (MGY)	Reported Water Use in 2022 (MGY)	Aquifer(s)
Azalea Sands Golf Club	26GC001	36	13.64	Crouch Branch
Beachwood Golf Club	26GC003	65	1.13 50.01	Surficial Crouch Branch
Myrtle Beach National GC	26GC009	55	0.15 0.04	Surficial McQueen Branch
Surf Golf & Beach Club	26GC013	75	19.74	Crouch Branch
Aero Club Short Course	26GC020	25	2.6	Crouch Branch-McQueen Branch
Pine Lakes International Country Club	26GC021	72	42.99	McQueen Branch
Eagle Nest Golf Club	26GC025	25	0.52 4.81	Surficial Crouch Branch
Tidewater Golf Club	26GC028	70	1.2 54.5	Surficial Crouch Branch-McQueen Branch
RIVER HILLS GOLF & COUNTRY CLUB	26GC029	30	0	Crouch Branch
City of Myrtle Beach - Whispering Pines Golf Course	26GC036	2.6	0	Surficial
Valley Club at Eastport	26GC041	24.84	1.8 2.7	Surficial Crouch Branch
Legends Golf Resorts	26GC044	99	12.5 22	Surficial Crouch Branch
Harbour View, LLC	26GC051	36	0.54 0	Surficial Crouch Branch
Glen Dornoch LLC	26GC054	70	46.36	Crouch Branch
Tupelo Bay Golf Complex	26GC055	32	4.38	Crouch Branch-McQueen Branch
International Club LLC	26GC056	40	35.78	Crouch Branch-McQueen Branch
WORLD TOUR GOLF LINKS	26GC058	54.5	3.61	Crouch Branch-McQueen Branch
Rose Park, LLC - Crown Park Golf Club	26GC060	20	8.42	Crouch Branch
Coastal Carolina University	26IR019	36	0.24	Crouch Branch
Burroughs and Chapin - Broadway	26IR020	100	92.33	Crouch Branch-McQueen Branch
Squires Tree Farm & Nursery	26IR025	50	38	Surficial
MYRTLE BEACH CITY OF IRRIGATION	26IR026	8.5	0 0.59	McQueen Branch McQueen Branch-Charleston
Myrtle Trace HOA	26IR027	42.4	32	Crouch Branch
GDMB Operations, LLC - Bear Branch	26IR028	26	65.22	McQueen Branch

City of North Myrtle Beach	26WS001	310.67	136.88 0	Crouch Branch-McQueen Branch McQueen Branch
Bucksport Water System, Inc.	26WS002	538.34	241.73 250.05	McQueen Branch McQueen Branch-Charleston
City of Myrtle Beach	26WS003	8.5	1.27 0.74	McQueen Branch McQueen Branch-Charleston
Ocean Lakes Family Campground	26WS005	128	13.2 92.55	Crouch Branch Crouch Branch-McQueen Branch
GRAND STRAND W&S - MYRTLE BEACH SURFACE WATER PLANT	26WS009	1,868.20	81.81 579.45 0 540.33 0 0	Crouch Branch Crouch Branch-McQueen Branch McQueen Branch Crouch Branch-McQueen Branch-Charleston McQueen Branch-Charleston Charleston
Lakewood Camping Resort, Inc.	26WS011	47.04	41.94	Crouch Branch-McQueen Branch
	TOTALS	**3,995.59**	**2,537.75**	

Aquifer Demand Details

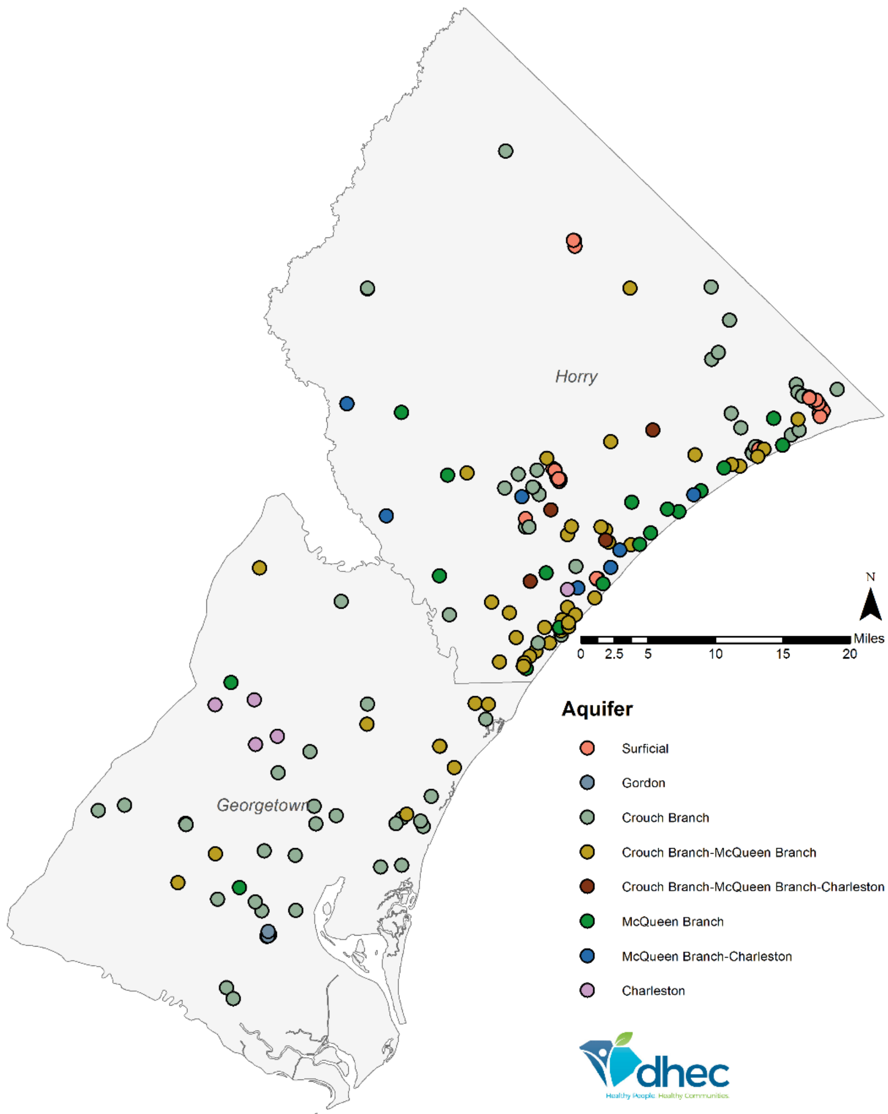


Figure 9. Waccamaw Area map showing the locations of capacity use wells with reported water use for 2022. Different symbol colors represent the aquifer into which each well is screened.

The Waccamaw Area contains wells that are screened in more than one aquifer, or cross-screened wells, which allow water to be withdrawn from each aquifer where a screen is present. Wells that are cross-screened were grandfathered into the groundwater withdrawal permitting program. In accordance with S.C. Regulation 61-71 Well Standards, the Department no longer issues permits for the construction of new wells that are screened across multiple aquifers due to the potential for cross-contamination or water depletion in the aquifer(s) (2016). In terms of number of wells, the Crouch Branch aquifer was the most heavily accessed in the Waccamaw Area in 2022 (64, 32%) followed by the Surficial (47, 24%), wells cross-screened in the Crouch Branch-McQueen Branch (46, 23%), McQueen Branch (20, 10%), wells cross-screened in the McQueen Branch-Charleston (7, 4%), Charleston (6, 3%), wells cross-screened in the Crouch Branch-McQueen Branch-Charleston (4, 2%), and the Gordon aquifer (4, 2%) (Table 5, Fig. 9).
The largest volume of reported groundwater use for 2022 was from wells that are cross-screened in the Crouch Branch-McQueen Branch aquifers (33%), followed by the Crouch Branch (30%), wells cross-

screened in the Crouch Branch-McQueen Branch-Charleston (14%), McQueen Branch (13%), wells cross-screened in the McQueen Branch-Charleston (7%), Charleston (2%), Surficial (<1%), and the Gordon aquifer (1%) (Table 5).

Table 5. Number of Wells and 2022 Reported Water Use by Aquifer – Waccamaw Area

Aquifer	Number of Wells (%)	2022 Water Use MG (%)
Surficial	47 (24%)	55.83 (<1%)
Gordon	4 (2%)	20.73 (1%)
Crouch Branch	64 (32%)	1,171.25 (30%)
Crouch Branch-McQueen Branch	46 (23%)	1,265.42 (33%)
McQueen Branch	20 (10%)	491.83 (13%)
Crouch Branch-McQueen Branch-Charleston	4 (2%)	540.33 (14%)
McQueen Branch-Charleston	7 (4%)	251.37 (7%)
Charleston	6 (3%)	69.07 (2%)
TOTAL	**198 (100%)**	**3,865.83 (100%)**

Historic Reported Water Use: 2001 – 2022

Water use in the Waccamaw Area decreased from 2001 to 2003, followed by an increase from 2003 to 2007, and has remained relatively constant since 2007 (Fig. 10). Increases in groundwater withdrawals correlate with periods of drought in the Waccamaw Area which, according to the National Integrated Drought Information System (NIDIS), occurred in 2002, 2007, 2011, 2012, early 2018, and 2021 (Appendix A, Fig. A1) (2023). Overall, groundwater withdrawals for golf course irrigation and industrial use have been decreasing since 2011 whereas groundwater withdrawals for irrigation and water supply have remained constant or increased slightly over the same period. One facility reported water use for the "other" use category until the facility closed in 2017.

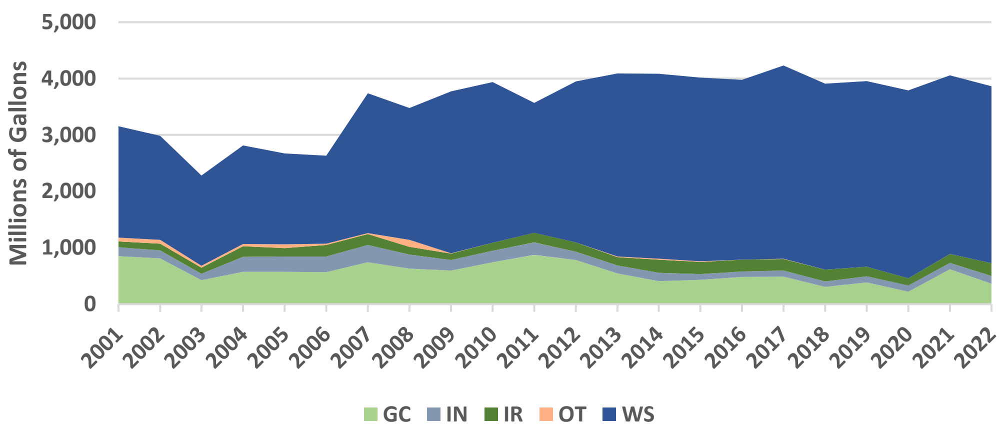


Figure 10. Waccamaw Area reported water use by category from 2001 to 2022.

Comparing historic (2001 to 2022) reported groundwater use across the Waccamaw Area counties shows that Horry County consistently reported larger groundwater use volumes than Georgetown County (Fig. 11). The decrease in reported water use for Horry County in 2003 corresponds with the end of a dry period, resulting in a reduction in water demand. Horry County's water use increased in 2007 and has remained relatively constant since. The trends among use types (Fig. 10) and distribution among the Waccamaw Area counties (Fig. 11) were also observed in the most recent reported water use data (2022).

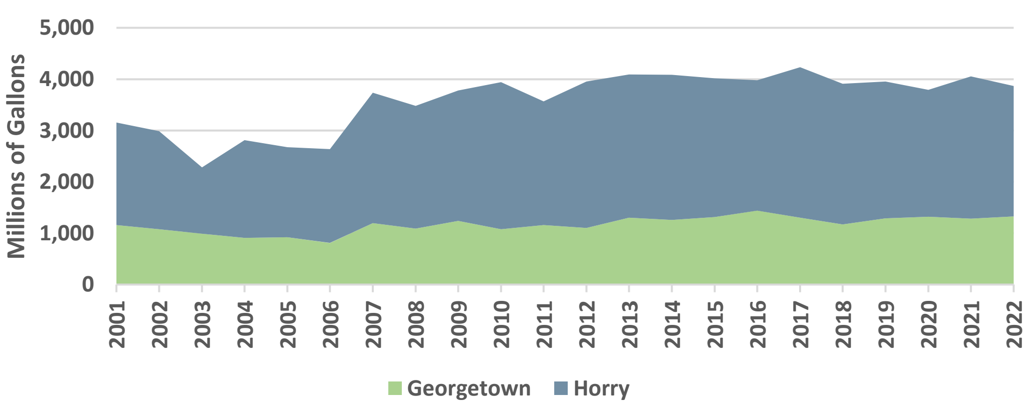


Figure 11. Waccamaw Area reported water use by county from 2001 to 2022.

The total population in the Waccamaw Area has increased by approximately 158,000 people since 2001, primarily the result of population growth in Horry County. Georgetown County has also experienced growth in population, but to a lesser degree (Fig. 12). Reported groundwater use in the Waccamaw Area reflects the increase in population growth (Fig. 11).

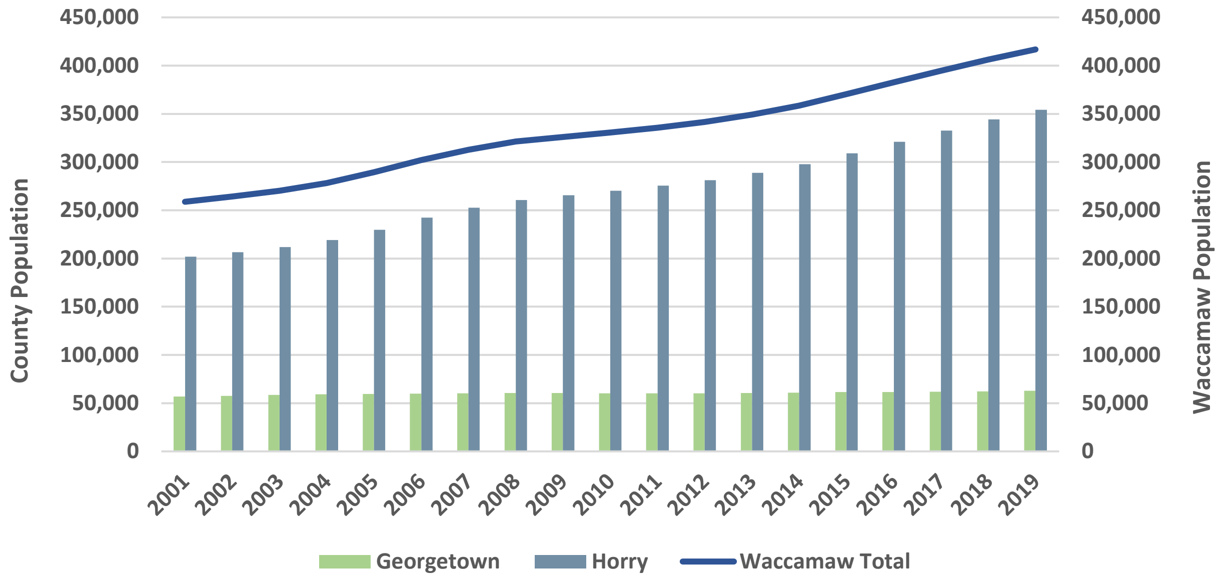


Figure 12. Population estimates and census data for the Waccamaw Area (blue line) and each county (vertical bars) from 2001 to 2019. www.census.gov; accessed May 5, 2023.

Groundwater Impacts

To assess the ongoing conditions of the aquifers in South Carolina, water levels are measured manually or by using automatic data recorders (pressure transducers) in wells screened in each of the CPSC aquifers. The groundwater monitoring network used for these measurements is maintained by SCDNR. These water level measurements are used to understand the impact of groundwater withdrawals over time, as well as provide an aerial snapshot of groundwater conditions at a specific time. The full extent of the SCDNR Groundwater Monitoring Network may be seen in the map in Appendix B.

Groundwater Trends

There are currently 11 public monitoring wells located in Waccamaw Area counties, 7 of which are discussed in this report (Table 6). The length of time for which there are groundwater level measurements ranges from 4.2 years to 22.8 years. All the wells are maintained by SCDNR as part of their groundwater monitoring network.

Table 6. List of monitoring wells in Waccamaw Area counties with aquifer and length of well record.

Well ID	Agency	County	Aquifer	Record Length (years)
GEO-0381	SCDNR	Georgetown	Surficial	9
GEO-0382	SCDNR	Georgetown	Crouch Branch	9
GEO-0387	SCDNR	Georgetown	Gordon	7.7
GEO-0390	SCDNR	Georgetown	Crouch Branch	4.2
HOR-0290	SCDNR	Horry	Crouch Branch	15.1
HOR-0309	SCDNR	Horry	Crouch Branch	22.8
HOR-1326	SCDNR	Horry	McQueen Branch	7.6

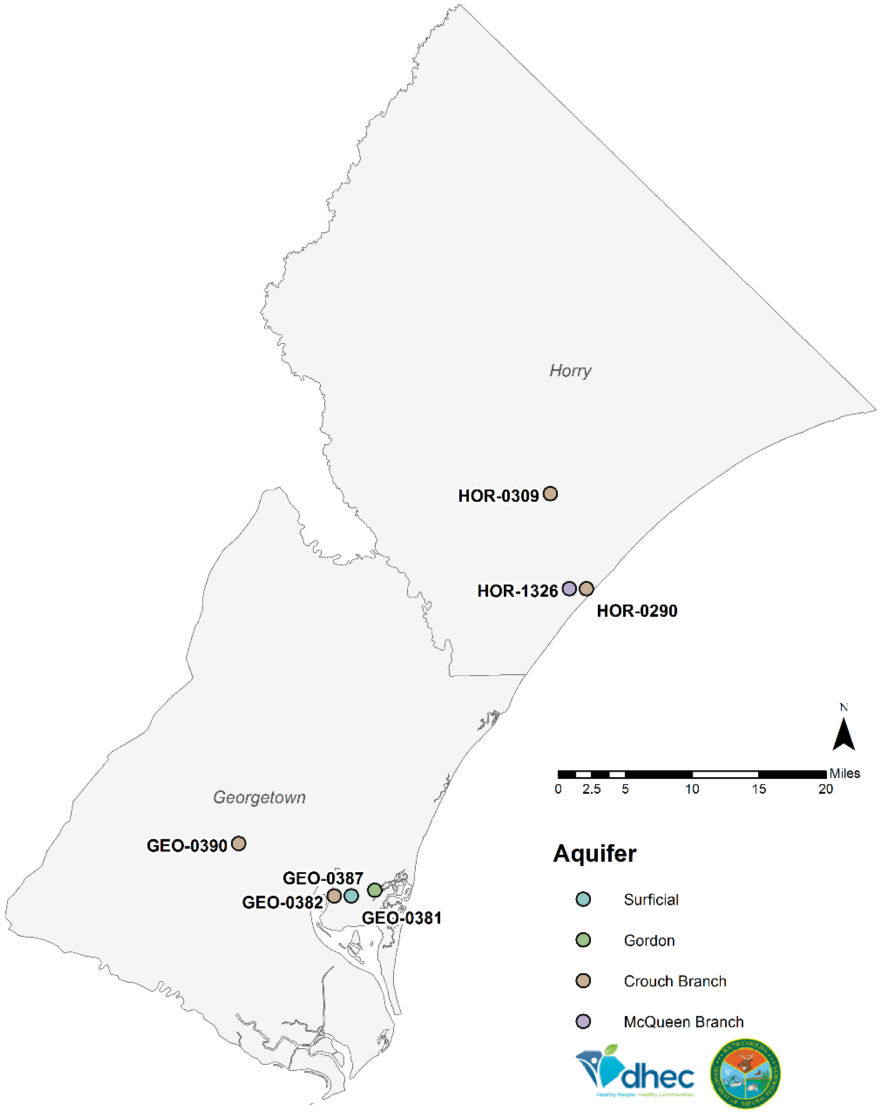


Figure 13. Map of SCDNR monitoring wells discussed in this report in the Waccamaw Area. Different symbol colors represent the aquifer into which each well is screened. The water levels for each are presented below. https://hydrology.SCDNR.sc.gov/well-database.html; accessed March 31, 2023.

Surficial Aquifer

Despite providing water to approximately 24% (47) of the wells in the Waccamaw Area, the Surficial aquifer only accounted for 1% of total reported groundwater withdrawals from capacity use wells in 2022. Of the three monitoring wells in the Surficial aquifer in the Waccamaw Area, GEO-0381 (Fig. 14, A) has the longest record with 9 years of water level data. Water levels at this location have remained stable overall, but the data indicates that levels decline in the spring and summer months and rebound in the fall and winter. These declines and rebounds are due to the local recharge the Surficial aquifer receives through infiltration of precipitation and surface water bodies which causes the water level profile to reflect the local climate.

Gordon Aquifer

The Gordon aquifer, which is only present below the southernmost portion of Georgetown County, is utilized the least in the Waccamaw Area, providing <1% of all reported water use in 2022. Monitoring well GEO-0387 (Fig. 14, C) is the only SCDNR monitoring well in the Waccamaw Area in the Gordon aquifer. Water levels at this location have remained stable overall, but the data indicates that levels decline in the spring and summer months and rebound in the fall and winter. These declines and rebounds are present because the recharge area for the Gordon aquifer extends through the southernmost part of Georgetown County, allowing the Gordon aquifer to receive direct recharge through infiltration of local precipitation and surface water bodies in this area, and therefore, the water level profile reflects the local climate.

Crouch Branch Aquifer

The Crouch Branch aquifer is the most utilized aquifer in Georgetown County, providing approximately 66% of all reported withdrawals for 2022 in the county. Wells screened in the Crouch Branch aquifer accounted for approximately 30% of all reported withdrawals in the entire Waccamaw Area in 2022, and wells cross-screened in the Crouch Branch-McQueen Branch and Crouch Branch-McQueen Branch-Charleston aquifers accounted for approximately 47% of all reported withdrawals. The majority of the monitoring wells in the Waccamaw Area are screened in the Crouch Branch aquifer including GEO-0382, GEO-0390, HOR-0290, and HOR-0309 (Fig. 14, B, D, and E-F, respectively). The Georgetown County monitoring wells indicate continued declines in groundwater levels at a rate of approximately 2 feet per year. The Horry County monitoring wells indicate that water levels in the Crouch Branch aquifer steadily declined from the mid-2000s through the late-2010s but have remained relatively stable (HOR-0290) or have increased slightly since approximately 2017 (HOR-0390), likely due to an increased reliance on surface water sources in the area; however, the water levels at the Horry County monitoring wells remain well below MSL (-75 feet MSL, HOR-0290; -100 feet MSL, HOR-0390).

McQueen Branch Aquifer

Wells screened in the McQueen Branch aquifer accounted for 13% of all reported withdrawals and wells cross-screened in the Crouch Branch-McQueen Branch, Crouch Branch-McQueen Branch-Charleston, and McQueen Branch-Charleston aquifers accounted for approximately 54% of all reported withdrawals in the Waccamaw Area in 2022. Monitoring well HOR-1326 (Fig. 14, G) is the only SCDNR monitoring well screened in the McQueen Branch aquifer in the Waccamaw Area. Water levels at this location show recurring spring and summer drawdown to approximately 75 feet below MSL and have consistently rebounded to approximately 63 feet below MSL during the fall and winter months since 2016. Overall, water levels observed at this location have remained relatively stable from 2016 through 2023.

Charleston Aquifer

Wells screened in the Charleston aquifer accounted for 2% of all reported withdrawals and wells cross-screened in the Crouch Branch-McQueen Branch-Charleston and McQueen Branch-Charleston aquifers accounted for approximately 21% of all reported withdrawals in 2022; however, there are currently no SCDNR monitoring wells screened in the Charleston aquifer in the Waccamaw Area.

Gramling Aquifer

Although present below the Waccamaw Area counties, there are currently no capacity use wells or SCDNR monitoring wells screened in the Gramling aquifer in the Waccamaw Area.

Figure 14. Water level plots from SCDNR monitoring wells in the Waccamaw Area. Water levels are in feet relative to MSL. The blue lines represent automatic data recordings and red dots represent manual water level measurements. The green background indicates wet periods, and the brown background indicates dry periods. http://hydrology.dnr.sc.gov/groundwater-data/ and https://www.drought.gov/states/south-carolina; accessed March 31, 2023.

Potentiometric Maps

Water level measurements also indicate the surface of the water table or the potentiometric surface at the well location (Fig. 15). The water table is the free surface of the groundwater in the Surficial aquifer that receives recharge directly from precipitation. The potentiometric surface is the water level measured in a confined aquifer and represents the pressure of the overlying water and sediment at that location (the pressure surface). Concurrent water level measurements at several locations within a single aquifer can be combined to create a water table (Surficial aquifer) or potentiometric (confined aquifer) map. Just as contour maps are made of the land surface by connecting points of equal elevation, water table and potentiometric maps are created by connecting points of equal water elevation or pressure.

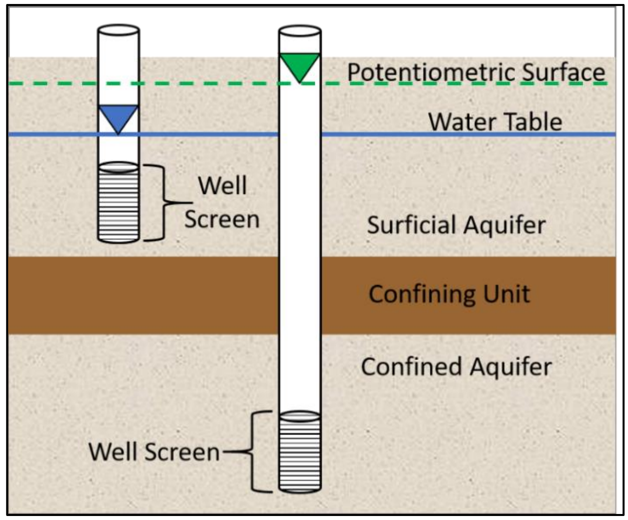


Figure 15. Illustration of a water table and potentiometric surface. Water levels in the wells are indicated by the blue (water table) and green (potentiometric surface) triangles.

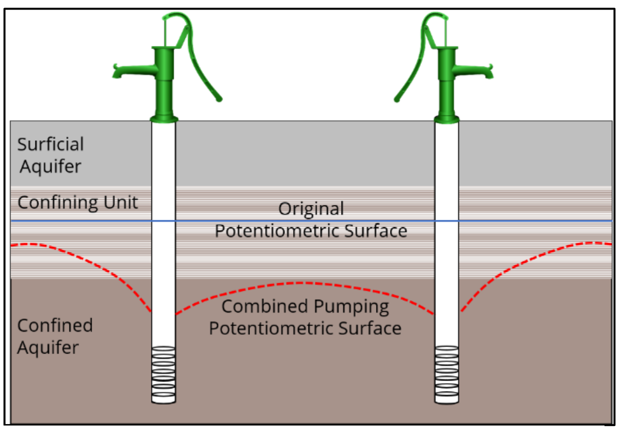


Figure 16. Illustration of the effect of combined pumping on a potentiometric surface.

These maps are used to evaluate groundwater conditions within an aquifer because groundwater withdrawal results in changes to these contour lines. Changes to the contour lines are especially important to note in confined aquifers in areas that take much longer to recharge. Groundwater withdrawal creates a greater impact in confined aquifers when large capacity wells are pumped in close proximity. The combined effect can create pumping cones (or cones of depression) that alter the potentiometric surface for miles from the pumping center (Figs. 16 and 17).

The contours of a potentiometric surface or water table map also point to changes in the direction of groundwater flow because groundwater flows perpendicular to (at right angles to) the contour lines from high to low water elevation (or pressure). Pumping cones change inland flow paths which can introduce contaminants to wells from any nearby source(s), cause other wells to experience reduced flow, and reduce the discharge to local streams and rivers. Coastal pumping cones reverse the normal offshore direction of net groundwater flow (Fig. 17). This reversal of groundwater flow at the coast can cause saltwater to infiltrate coastal wells.

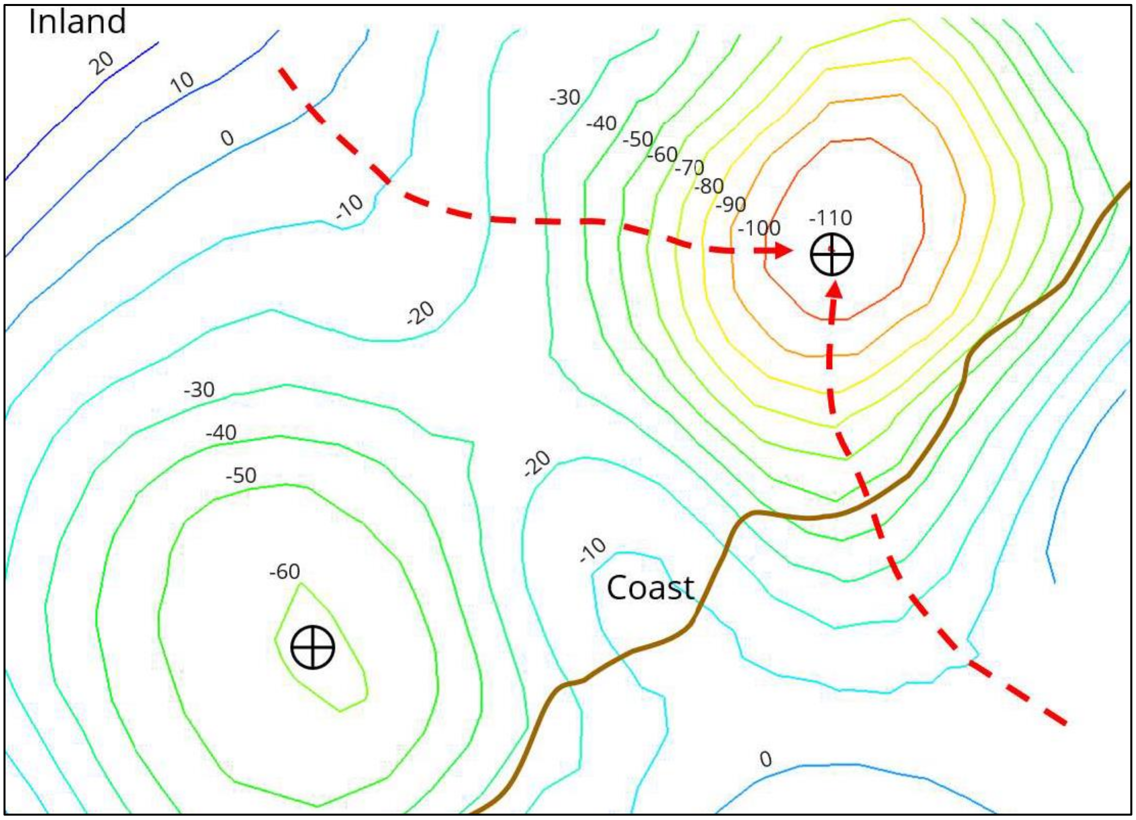


Figure 17. Illustration of a potentiometric map where contour lines show water level elevations from measurements in a confined, coastal aquifer. The numbers in this illustration are elevations in feet relative to MSL (the zero-contour line). Negative values are feet below MSL, and the dashed red arrows indicate the direction of groundwater flow.

Pre-development potentiometric maps were digitized by SCDNR from the maps in a 1985 USGS report (Aucott & Speiran, 1985), and are considered to be the potentiometric surfaces of the aquifers in the year 1900. In 1987, SCDNR began publishing potentiometric maps from water level measurements in the aquifers of the CPSC. In addition to the SCDNR monitoring wells presented previously, other wells belonging to a variety of water suppliers, irrigators, and industry are also used. The following figures are a combination of these potentiometric maps with water use data reported to SCDHEC. Groundwater withdrawal density maps were created using the annual reported groundwater withdrawal amounts from wells in the Waccamaw Area. Clusters with darker shading represent higher concentrations of groundwater withdrawals and areas with lighter or no shading represent lesser amounts of groundwater withdrawals. Each density map was overlain with the corresponding potentiometric map for each year of withdrawal to show how the pressure surface has changed over time.

Floridan Aquifer System

The Floridan Aquifer System, formerly known as the Tertiary Aquifer System and Black Mingo Aquifer System, contains what are now known as the Upper and Middle Floridan aquifers and the Gordon aquifer (Gellici & Lautier, 2010). The pre-development map was made using historic water level data from wells screened in the Upper and Middle Floridan aquifers and the Gordon aquifer. The most recent measurements were published in 2019 as separate maps of the Upper and Middle Floridan aquifers and the Gordon aquifer. Because the Upper and Middle Floridan aquifers are not present below the Waccamaw Area, only the 2018 Gordon aquifer potentiometric map has been included below.

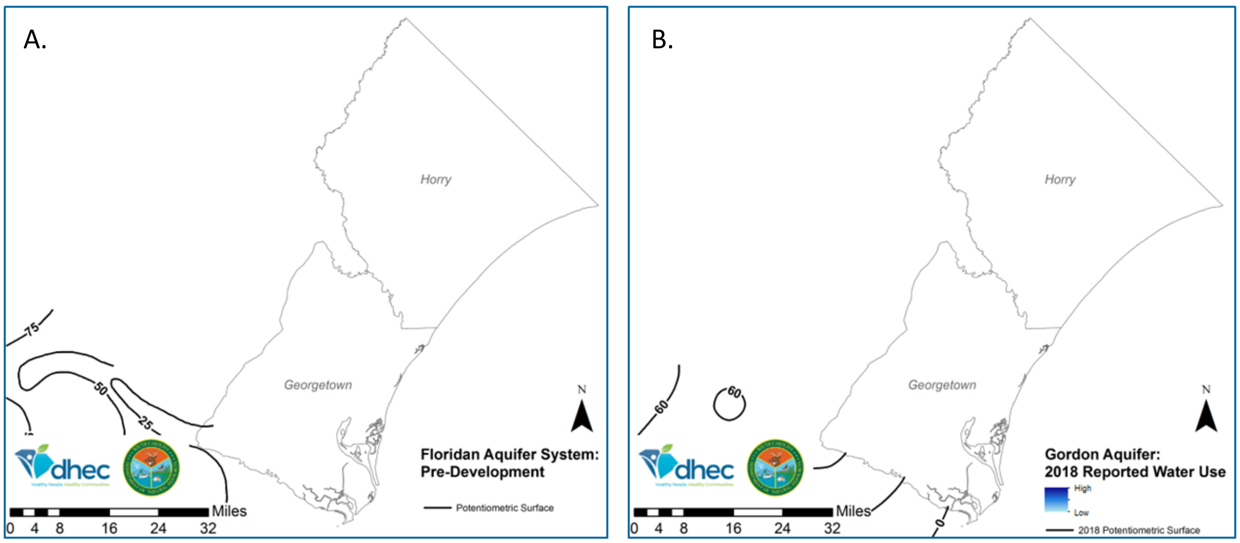


Figure 18. A. Pre-development potentiometric map of the Floridan Aquifer System in the Waccamaw Area (Aucott & Speiran, 1985). B. 2018 potentiometric map of the Gordon aquifer (Wachob, Gellici, & Czwartacki, 2019). Contour lines are in feet relative to MSL.

The pre-development potentiometric surface map (Fig. 18, A) indicates that the water level approached zero (MSL) at the coast and that the flow of groundwater was in a southeasterly direction (Aucott & Speiran, 1985). Due to the local recharge that the Gordon aquifer receives from precipitation and surface water bodies in southern Georgetown County, and the negligible withdrawal amounts reported in the Waccamaw Area, the 2018 potentiometric surface has not been significantly altered since pre-development (Wachob, Gellici, & Czwartacki, 2019). The direction of groundwater flow remains in a southeasterly direction, and the zero-contour line remains near the coast in southern Georgetown County (Fig. 18, B).

Crouch Branch Aquifer

The pre-development potentiometric surface of the Crouch Branch aquifer indicates that groundwater flowed in a southeasterly direction and water levels were approximately 50 feet above MSL below southern Georgetown County and northern Horry County (Fig. 19, A). By 2020 the pressure surface had lowered by 225 feet in southern Georgetown County and had lowered by 50 to 75 feet in northern Horry County. The groundwater flow has remained in a southeasterly direction below most of the Waccamaw Area, but a pumping cone has developed below southern Georgetown County and has reversed the groundwater flow from a southeasterly direction to a westerly direction along Georgetown County's coastline (Fig. 19, B). The substantial decline of groundwater levels in the Crouch Branch aquifer in the Waccamaw Area is likely a result of concentrated, high-capacity public water supply withdrawals in conjunction with increased groundwater flow rates in the area. The impacts of the pumping cone in the Crouch Branch aquifer heavily influence water levels throughout the entire Waccamaw Area and surrounding counties.

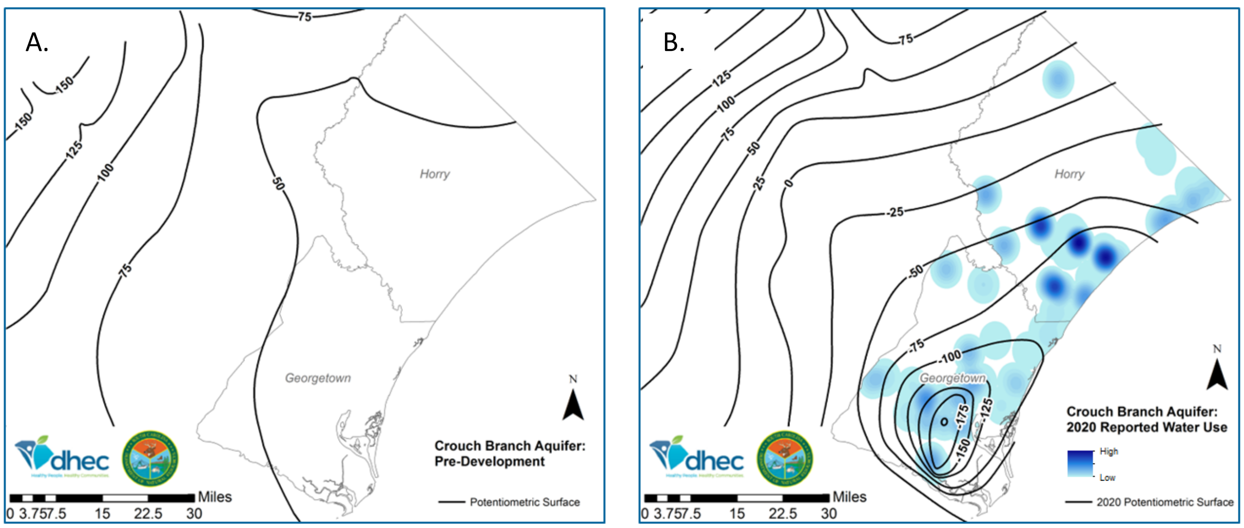


Figure 19. A. Pre-development potentiometric map of the Crouch Branch aquifer in the Waccamaw Area (Aucott & Speiran, 1985). B. 2020 potentiometric map of the Crouch Branch aquifer (Czwartacki & Wachob, 2021). Contour lines are in feet relative to MSL.

Middendorf Aquifer System

The McQueen Branch, Charleston, and Gramling aquifers are collectively known as the Middendorf Aquifer System in South Carolina. They are now referenced individually as the McQueen Branch, Charleston, and Gramling aquifers. The pre-development potentiometric map was created for the Middendorf Aquifer System, and SCDNR continues to publish potentiometric maps by combining data from all three of the Middendorf aquifers; therefore, it is not possible to determine the pressure surface changes unique to each aquifer.

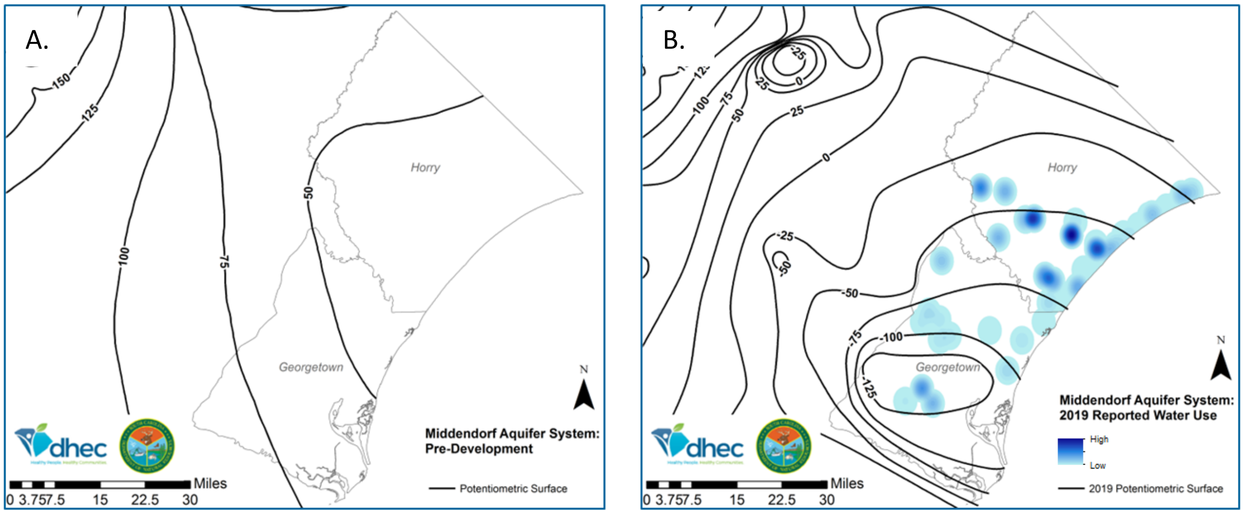


Figure 20. A. Pre-development potentiometric map of the Middendorf Aquifer System in the Waccamaw Area (Aucott & Speiran, 1985). B. 2019 potentiometric map of the Middendorf Aquifer System (Czwartacki & Wachob, 2020). Contour lines are in feet relative to MSL.

The pre-development potentiometric surface of the Middendorf Aquifer System indicates that groundwater flowed in an easterly direction and water levels ranged from 75 feet above MSL below southern Georgetown County and approached MSL in eastern Horry County (Fig. 20, A). By 2020 the pressure surface had lowered by 200 feet in southern Georgetown County and had lowered by 100 feet in southern Horry County. The groundwater flow has shifted to a southerly direction below northern Georgetown and Horry Counties and has shifted to a northerly direction in southern Georgetown County due to the pumping cone that has developed below southern Georgetown County (Fig. 20, B). The substantial decline of groundwater levels in the Middendorf Aquifer System in the Waccamaw Area is likely a result of concentrated, high-capacity public water supply withdrawals from wells cross-screened in the Crouch Branch and McQueen Branch aquifers in conjunction with increased transmissivity of the aquifer in the area. The impacts of the pumping cone in the Middendorf Aquifer System heavily influence water levels throughout the entire Waccamaw Area and surrounding counties.

Groundwater Evaluation

The Waccamaw Area was originally established due to observed declines in water levels of monitoring wells, saltwater intrusion into wells in the North Myrtle Beach area of Horry County, and the occurrence of “dry” wells across the region. Although water levels have declined since 1900 in all the aquifers below the Waccamaw Area counties, the primary area of concern remains the pumping cone that exists in the Crouch Branch aquifer and the Middendorf Aquifer System below the towns of Andrews and Georgetown in southern Georgetown County. Monitoring wells GEO-0382 and GEO-0390 (Fig. 14, B and D) show that water levels in the Crouch Branch aquifer in this area are continuing to decline at a rate of approximately 2 feet per year. This pumping has also altered the potentiometric surface, causing the pressure surface to decline from approximately 25 feet above MSL to 200 feet below MSL since 1900 in the Crouch Branch aquifer (Fig. 19), and the pressure surface of the Middendorf Aquifer System has declined from approximately 75 feet above MSL to 125 feet below MSL since 1900 (Fig. 20).

The lowering of the pressure surface along the coast in conjunction with a growing population (Fig. 12) and continued concentrated, high-capacity groundwater pumping can reduce the freshwater flow toward coastal discharge areas and cause saltwater to infiltrate the freshwater zones of the aquifer (Fig. 17). Saltwater intrusion decreases freshwater storage in the aquifers, and, in extreme cases, can result in the abandonment of public water supply wells. The cone of depression in southern Georgetown County is also affecting water levels and potentiometric surfaces of the Crouch Branch aquifer and Middendorf Aquifer System in the surrounding counties of Berkeley, Charleston, Florence, Marion, and Williamsburg.

An additional concern in the Waccamaw Area is land subsidence, or the sinking of the land surface caused by the compaction of sediment grains associated with the removal of large quantities of groundwater from the underlying aquifers. As the land sinks and sea level continues to rise, South Carolina will experience increased occurrences of coastal flooding. The U.S. Geological Survey measures land subsidence using InSAR satellite data (Barnard, et al., 2023), but, to further improve data collection efforts regarding land subsidence in South Carolina, the S.C. Office of Resilience (SCOR) has recommended that the State, “Install extensometers along the coast to monitor vertical land movement to develop a better understanding of relative versus absolute sea level rise and improved understanding of the causes of subsidence,” as part of the initial Strategic Statewide Resilience and Risk Reduction Plan (2023).

Recommendations

All aquifers below the Waccamaw Area counties have experienced water level declines and therefore the ongoing pressure on these groundwater sources should be carefully monitored. The primary area of concern remains the pumping cone that exists below the towns of Andrews and Georgetown in southern Georgetown County. Due to continued water level declines in the Crouch Branch and McQueen Branch aquifer, the Department has issued the following recommendations.

Crouch Branch Aquifer and McQueen Branch Aquifer

- No increases in permitted groundwater withdrawal rates should be approved for existing wells screened in the Crouch Branch aquifer or McQueen Branch aquifer in either of the Waccamaw Area counties. This hold should remain in effect until the Waccamaw Area undergoes its next 5-year review in 2029 at which time the hold on withdrawal rate increases should be re-evaluated based on new water level information.
- No new wells with associated groundwater withdrawal rate increases should be permitted for construction and production in the Crouch Branch aquifer or McQueen Branch aquifer in either of the Waccamaw Area counties. This hold should remain in effect until the Waccamaw Area undergoes its next 5-year review in 2029 at which time the hold on new construction should be re-evaluated based on new water level information.
- New Groundwater Withdrawal Permit Applications and renewals with requested withdrawal rate increases which propose to use the Crouch Branch aquifer or McQueen Branch aquifer should be diverted to the Surficial, Charleston, or Gramling aquifers in Georgetown and Horry Counties as appropriate for the proposed use.
- Increase the use of Aquifer Storage and Recovery (ASR) wells and increase the use of Artificial Recharge (AR) to aid in the recovery of the pumping cone below southern Georgetown County.
- Each new and renewal permit for water supply wells should require that a water audit be conducted annually in accordance with the American Water Works Association policy statement for Water Loss Management, Metering, and Accountability (2019).

Waccamaw Capacity Use Area

- Encourage the use of surface water as a source for future water demands to further reduce the groundwater demands in and around the Georgetown County pumping cone to aid in recovery of the cone and to minimize the risk of saltwater intrusion and land subsidence in the region.
- Encourage groundwater withdrawers to discontinue using and properly abandon wells that have been screened across multiple aquifers and ensure that all future wells are screened in the target aquifer only, with appropriate grouting starting at the plug above the screen interval or the first confining bed immediately above the target aquifer to the top of land surface.
- Cooperative work with SCDNR should continue in preparing the potentiometric surface maps, and future maps should be based on data from individual aquifers to the greatest extent possible to better aid in evaluation of how groundwater withdrawals from capacity use wells (which must be screened into single aquifers) are impacting the local groundwater conditions.
- Work toward educating all South Carolinians on best practices for water conservation must continue in cooperation with all stakeholders.
- Work in conjunction with local, state, and federal partners to expand the groundwater monitoring network in all Waccamaw Area aquifers by identifying wells scheduled for abandonment that may be incorporated and of benefit to the well network.

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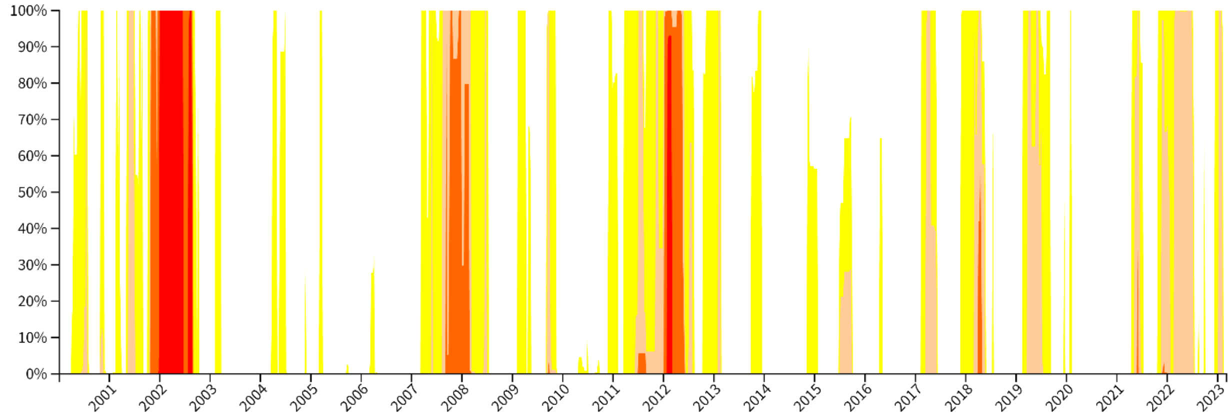
Appendix A: Historic Drought Conditions

A. Georgetown County (SC) Percent Area in U.S. Drought Monitor Categories



B. Horry County (SC) Percent Area in U.S. Drought Monitor Categories

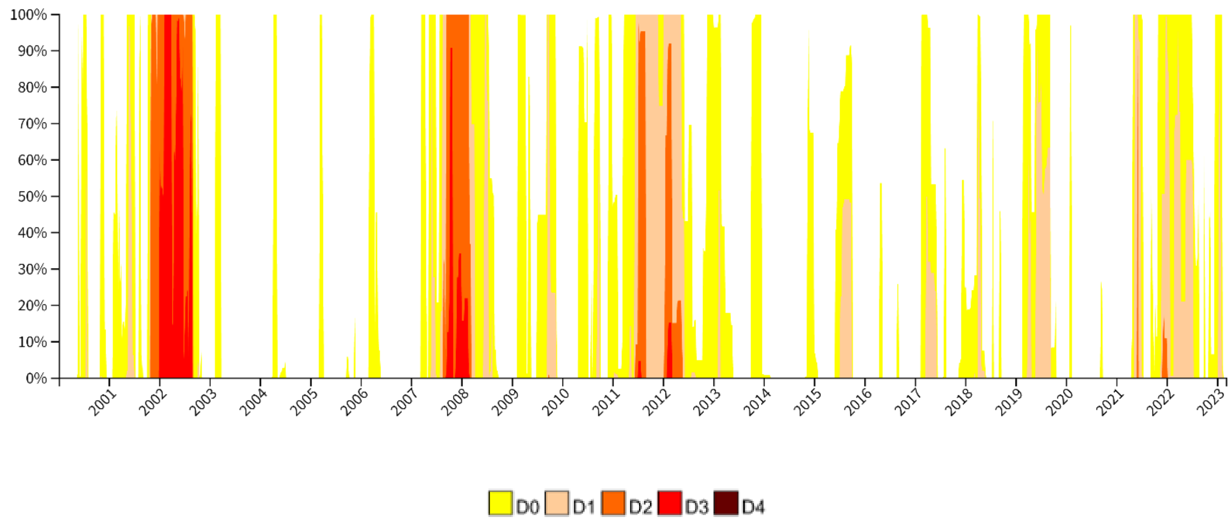


Figure A1, A-B. Severity and percent drought coverage for Waccamaw Area counties. D0 represents abnormally wet periods and D4 represents periods of exceptional drought. https://www.drought.gov/; accessed March 23, 2023.

Appendix B: SCDNR Groundwater Monitoring Network

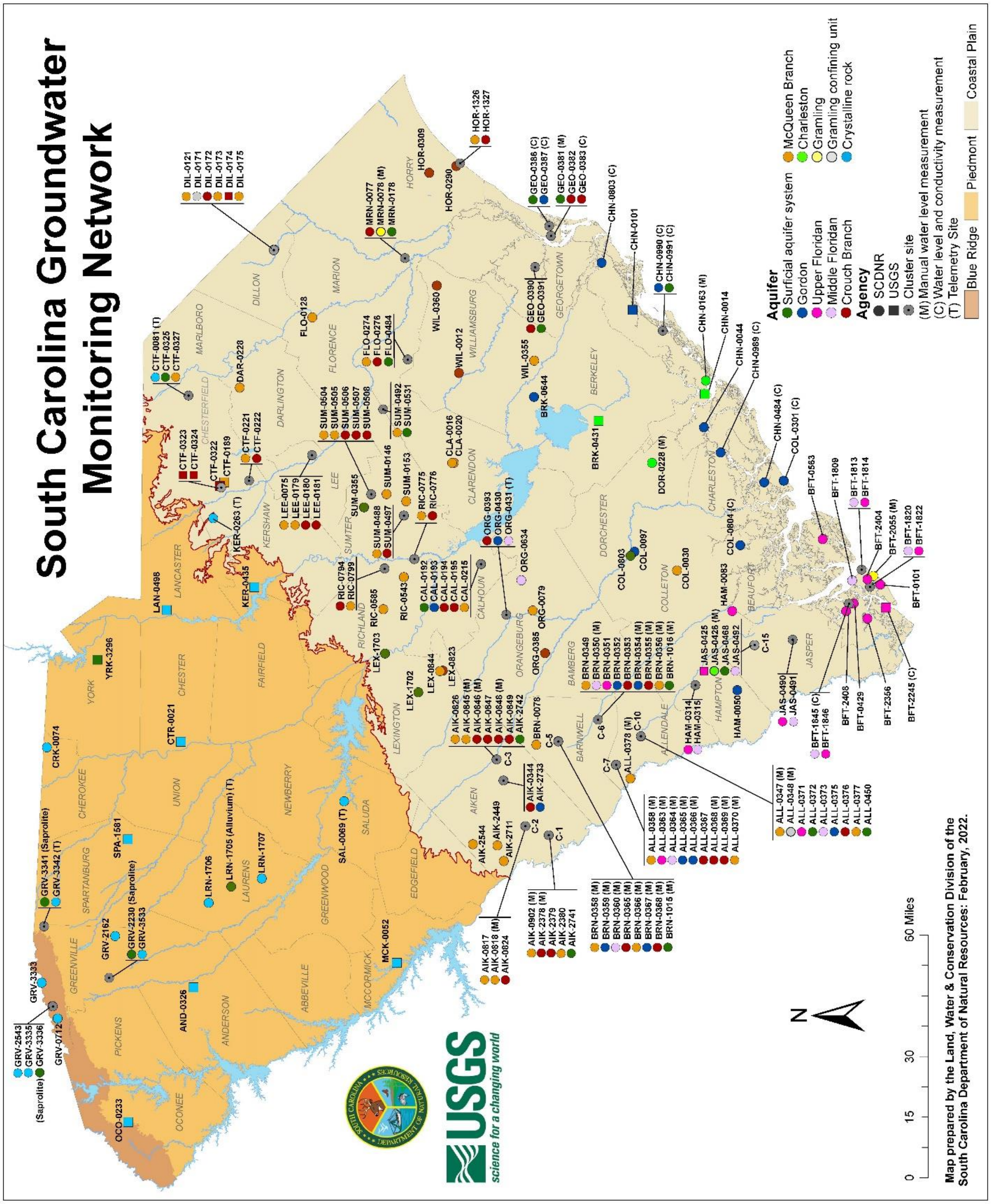


Figure B1. Map of wells included in the SCDNR Groundwater Monitoring Network. https://hydrology.dnr.sc.gov/; accessed June 26, 2023.