General Description of Aquifers in South Carolina

Crystalline-Rock Aquifer – The crystalline-rock aquifer consists of igneous and metamorphic rock that transmits ground water through fractures and faults. It is exposed or thinly covered in the Piedmont and Blue Ridge physiographic provinces, where it is the principal source of ground water. It also extends beneath the Coastal Plain, where it is rarely used owing to greater permeability and water availability in the overlying sedimentary rock.

The crystalline-rock aquifer is complex both lithologically and structurally. It includes rocks formed deep in the earth's crust through numerous mountain-building events. They are cut by fracture systems formed not only by pressure during mountain building but by later tension during the formation of the Atlantic Ocean and by release of pressure as overlying rocks were eroded. The result is a complex network of fractures, which are sparse in some areas and dense in others, especially along fault zones. The size, number, and extent of fractures diminish with increasing depth, and most crystalline-rock wells are less than 400 feet deep.

More than 70 percent of reported well yields are less than 20 gpm (gallons per minute), and almost half are less than 10 gpm. Contractors rarely guarantee well yield, owing to the chance of drilling a dry hole. Nonetheless, yields greater than 100 gpm have been reported, and the probability of obtaining such yields increases where well-site selection is guided by geologic and geophysical investigation.

Water levels in the aquifer respond to seasonal changes in precipitation and evapotranspiration, with highest levels occurring from February–May and lowest levels occurring most often from September–December. This seasonal pattern is common in wells throughout the State. Aquifers are usually recharged during the cooler, dormant seasons when evapotranspiration rates are low, and are depleted during the warmer, growing seasons when evapotranspiration rates are high.

Cape Fear Aquifer – The Cape Fear aquifer is the lowermost aquifer of the South Carolina Coastal Plain and consists mainly of partially cemented sand and gravel beds separated by thick sections of silt and clay. It is thought to occur mainly in the Lower Coastal Plain and eastern part of the Upper Coastal Plain. Few wells penetrate the aquifer, hence the hydraulic properties and water-level trends of the aquifer are not well known. In general, the aquifer is thought to be much less permeable and productive than the overlying Middendorf and Black Creek aquifers. Yields from the aquifer are generally in the range of several hundred gpm.

Middendorf Aquifer – The Middendorf aquifer overlies the Cape Fear aquifer and consists mainly of sand and clay beds. Sand beds are thicker and contain coarse-grained sand in the Upper Coastal Plain and in the western part of the State, where the aquifer is most productive. Near the coast, the aquifer contains a higher percentage of clay and finer-grained sand and is generally less productive.

The Middendorf aquifer is the State's most widely used artesian aquifer, and wells that tap it can be found in nearly all of South Carolina's Coastal Plain counties. Well depths range from a few tens of feet in its outcrop areas, where locally it is unconfined, to more than 2,700 ft (feet) in Beaufort County. Individual wells can yield 2,000 gpm.

Water levels in the aquifer respond to seasonal changes in precipitation and evapotranspiration, with highest levels occurring from February–May and lowest levels occurring most often from September–December. Droughts and pumping also affect water levels in the aquifer. Water-level declines caused primarily by pumping (i.e., cones of depression) are evident around Florence, Hemingway, Kingstree, Mount Pleasant, and Kiawah Island (link to Hockensmith, 2012, Middendorf report #51).

Black Creek Aquifer – The Black Creek aquifer overlies the Middendorf aquifer in most areas of the State. The aquifer consists of thin- to thick-bedded sand and clay beds with the coarsest sand and least clay content found in the western part of the State.

The Black Creek aquifer is an important source of water supply. Well yields are greatest in the counties of the Upper and Middle Coastal Plain and are least in the coastal counties of Charleston and Beaufort. Individual wells can yield 1,500 gpm. Where the highest possible well yields are desired, the Black Creek aquifer is screened in conjunction with the underlying Middendorf aquifer. These multi-aquifer wells are commonly used by major industrial and public-supply systems in Sumter, Florence, Horry, and Georgetown Counties.

Water levels in the aquifer respond to seasonal changes in precipitation and evapotranspiration, with highest levels occurring from February–May and lowest levels occurring most often from September–December. Droughts and pumping also affect water levels in the aquifer. Water-level declines caused primarily by pumping are evident in the Andrews-Georgetown area and around Marion, Johnsonville, and west of Hemingway (link to Hockensmith, 2012, Black Creek report #52).

Tertiary Sand Aquifer – The Tertiary sand aquifer is found mainly in the western and central regions of the State where is overlies the Black Creek aquifer. Inland, the aquifer consists mainly of sand and clay; toward the coast, the aquifer consists of a mixture of sand, clay, and limestone.

Well yields are generally greatest in the west-central regions of the state near the Savannah River Site area. Yields up to 600 gpm in the Town of Barnwell have been noted (link to Logan and Euler, 1989, report #155).

Water levels in the aquifer respond to seasonal changes in precipitation and evapotranspiration, with highest levels occurring from February–May and lowest levels occurring most often from August–November. Droughts and pumping also affect water levels in the aquifer but no major cones of depression have formed in the aquifer.

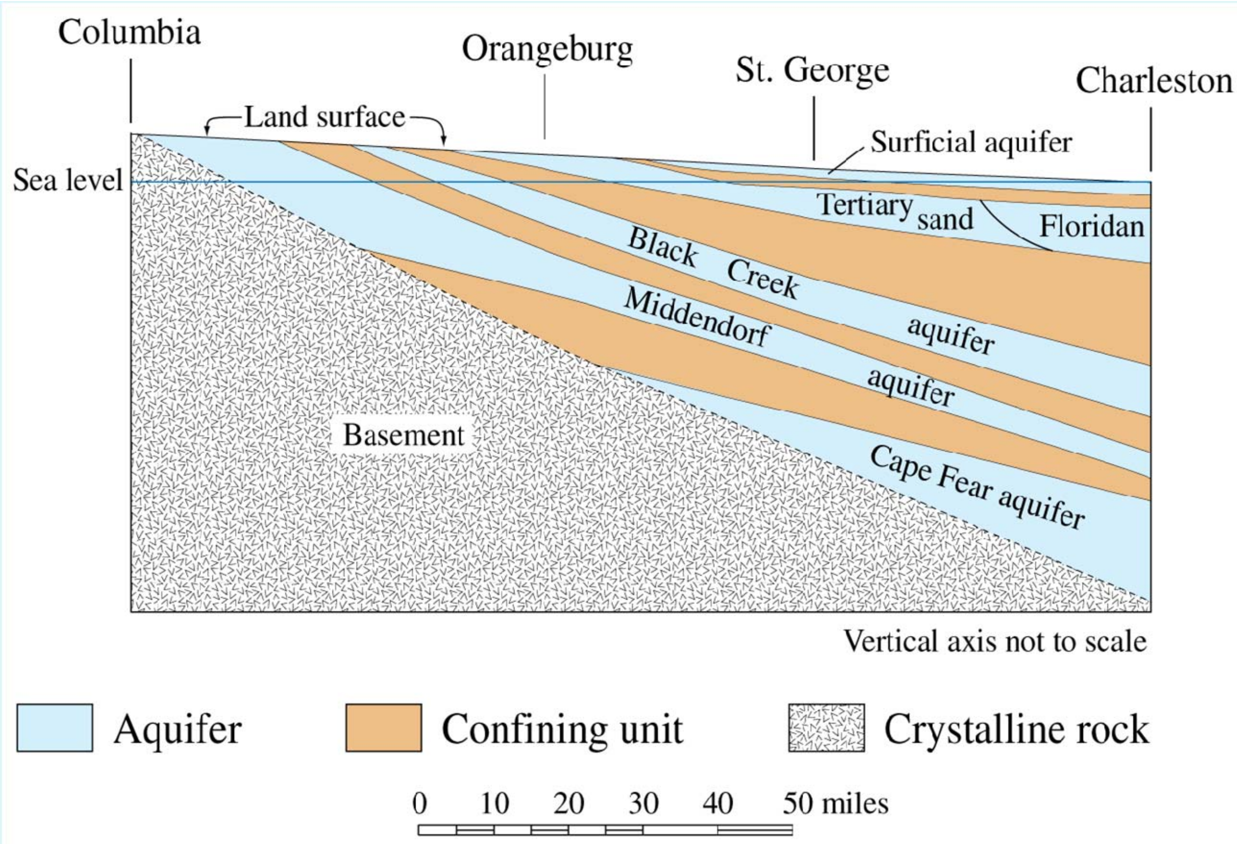
Floridan Aquifer – The Floridan aquifer in South Carolina is the northernmost part of one of the most extensive and prolific groundwater sources in North America. It occurs primarily in the western and central regions of the State, where it overlies or grades into the Tertiary sand aquifer. Inland, the aquifer consists of a mixture of sand, clay, and limestone; toward the coast, the aquifer consists mainly of limestone and marl. Well yields are generally greatest in Beaufort and Jasper Counties, where the aquifer can produce up to 3,000 gpm.

Water levels in the aquifer respond to seasonal changes in precipitation and evapotranspiration with highest levels occurring from January–March. Wells inland of coastal areas have their lowest levels in September–November, whereas wells in coastal counties generally have their lowest levels in the summer months, typically from June–August. This is possibly due to the reliance on the aquifer for crop and landscape irrigation during the summer months. Droughts and pumping also affect water levels in the aquifer. Water-level declines caused primarily by pumping are evident in Summerville, North Charleston, Walterboro, and Eutawville. Water levels in Jasper and Beaufort Counties continue to be affected by pumping in the Savannah, Ga. area (link to Hockensmith, 2009, Floridan report #48).

Shallow Aquifer System – “Shallow aquifer system” is a term of convenience applied to the complex of materials between land surface and the major aquifers of the Blue Ridge, Piedmont, and Coastal Plain. The shallow aquifer system in the Blue Ridge and Piedmont consists of porous materials overlying the fractured crystalline-rock aquifer system. Saprolite, the residual material from the weathering of bedrock, forms the most geographically extensive shallow unit above the Fall Line. Saprolite typically is 35 to 100 ft thick, but is thin to absent in some mountainous areas and well over 100 ft in some lower areas. It is usually rich in clay, except where the parent rock is mainly quartz. It is a source of water to bored wells—augered or dug wells that must be constructed with large diameters owing to low permeability and the consequent need to store large volumes of water. Such wells may yield groundwater from the clay-rich saprolite, from relict bedrock fractures and intrusive rock, and from the transition zone, a zone of fractured but relatively unweathered rock debris just above the unaltered parent rock. Sustained yields typically are no more than a few gallons per minute; however, the saprolite is the main source of groundwater storage in the region and the main source of groundwater in the underlying crystalline-rock aquifer system. Where the saprolite is thick, water levels usually respond slowly to precipitation because the low permeability of clay inhibits recharge. Water levels also respond slowly to drought because clay will store large volumes of water and release it slowly.

Shallow aquifers above the Fall Line also include modern and relict alluvial (river) deposits. These alluvial aquifers commonly are unconfined, widely dispersed, and small in areal extent. Because of the energy of their source streams, Blue Ridge and Piedmont alluvial aquifers tend to be coarser but less isotropic than their Coastal Plain counterparts. Consequently, well yields can vary widely, even within distances of a few hundred feet.

In the Coastal Plain, the shallow aquifer system consists mainly of coastal terrace deposits, and modern and relict alluvial deposits. This aquifer system is equivalent to the surficial aquifer of Aucott and others (1987) for the Coastal Plain. Where present, the aquifer is generally less than 40 ft thick and consists primarily of sand, shell, and clay (Aucott and others, 1987). The aquifer is generally the water-table aquifer and is present throughout most of the lower Coastal Plain and more sporadically in the middle Coastal Plain.



Generalized cross section from Columbia to Charleston illustrating the hydrogeologic framework of the South Carolina Coastal Plain.

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In 1995, Aadland and others (link to report #5) presented a detailed hydrogeologic characterization of the Coastal Plain sequence at the Savannah River Site (SRS) and surrounding area that resulted in a revised hydrogeologic framework and a new hydrostratigraphic nomenclature for west-central South Carolina (Aadland and others, 1995). Aquifers and confining units were named after local geographic features near type-well localities and the previous aquifer names, which were based on geologic formations, were abandoned at SRS. This revised framework and new nomenclature were extended across the rest of the Coastal Plain in the report Groundwater Availability in the Atlantic Coastal Plain of North and South Carolina (Campbell and Coes, 2010; link to this report) in a chapter entitled Hydrogeologic Framework of the Atlantic Coastal Plain, North and South Carolina (Gellici and Lautier, 2010). A comparison chart between the two nomenclatures is provided in the figure below.