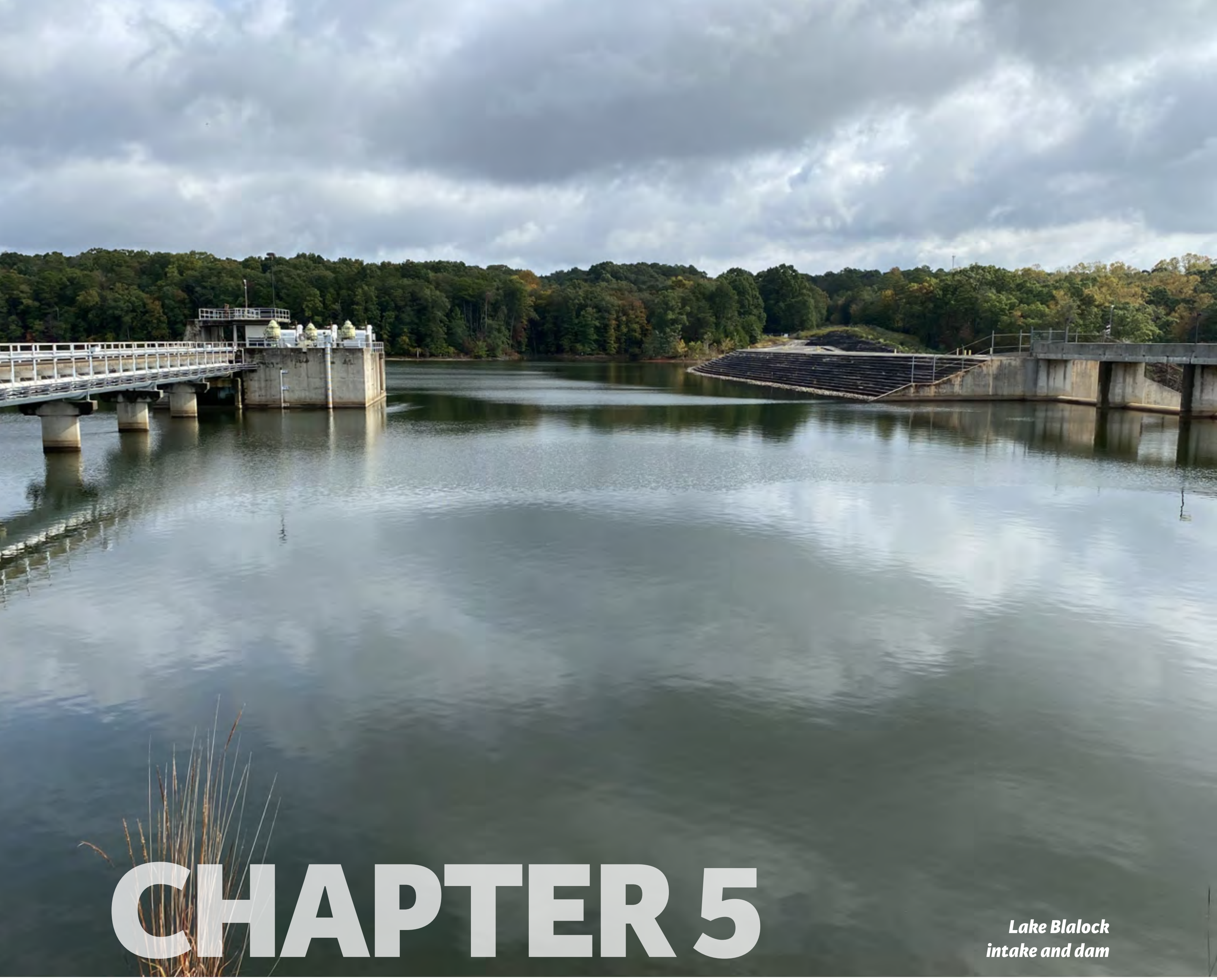


CHAPTER 5

Lake Blalock intake and dam

Water Availability Assessment

This chapter summarizes the results of the technical analyses completed to assess current and future water availability as documented in each River Basin Plan, with the goal of providing an overview of the adequacy of supply and vulnerabilities by basin and by stream reach. The assessment considers a range of future demand scenarios. For surface water supplies, potential impacts on streamflow and aquatic ecosystem health are discussed.

SUMMARY

Analysis throughout the state based on historical average river flows suggests that surface water supplies are generally sufficient through 2070, with isolated risks of shortages. This analysis has limitations and cannot fully assess future water availability. It is imperative that the state routinely reassess through time and adapt the analysis to changing conditions and the best available data. The state continues to grow in population and attract new industry. Increased energy production will be needed to meet the growing demands which will result in higher water use and impact water availability. Continuous planning, adaptive management, adjusted demand projections, and updated water availability assessments will allow for beneficial water use for all users and extend that use as much as possible in severe and extreme drought conditions.

Many of the projected shortages, especially those related to irrigation needs in tributary headwaters, currently can be managed with smaller, site-specific storage already in place but not included in the broader modeling framework. Operational flexibility and supplemental supply can also alleviate risks for most of the state's larger reservoirs with identified risks. Some tributary reaches are overallocated, meaning that more water has been allocated in permits and registrations than might physically be available during drought conditions. Overallocation is most common in headwater reaches but does occur in some larger tributaries.

In addition to the assessment of ability to meet off-stream demands, the River Basin Councils (RBCs) evaluated the impacts of projected future demands on minimum instream flow (MIF) and ecological function. Future withdrawals generally pose a low risk to the ecological function of streams, although there are select areas of moderate or higher risk. Comparison to MIF targets conducted across the state suggest that, in most cases, the frequency of time streamflow drops below seasonal MIF targets will increase slightly under future demand projections, and more markedly if all surface water users were withdrawing at their fully permitted amount.

The groundwater aquifers that underlie the Coastal Plain are generally capable of transmitting large volumes of water and are expected to support projected water demand over the planning horizon with limited exceptions. One notable exception is the groundwater level decline centered around Savannah, Georgia and extending into South Carolina, which has reversed the direction of groundwater flow and introduced saltwater intrusion to coastal communities. Decades of management have led to some rebound in levels, but the condition must be actively managed. Other exceptions occur in the Pee Dee and Edisto basins, where projected increases in pumping in the Crouch and McQueen Branch aquifers could impact water availability and reduce the ability of the aquifers to store and transmit water. These assessments are based on groundwater levels collected over decades and analysis of trends in groundwater level declines. An updated groundwater model was not available at the time most River Basin Plans were developed. Future water planning will utilize the updated groundwater model to assess the ability of aquifers to meet projected demands Continued monitoring of groundwater levels is necessary to track trends, assess impacts from pumping and drought, and support modeling efforts.

Charleston

5.1 Surface Water Availability

Surface water planning scenarios were simulated using previously constructed and recently updated river basin surface water quantity models developed in the Simplified Water Allocation Model (SWAM) software. In total, seven different SWAM models were updated and applied in all river basins except for the Catawba River basin. The Catawba-Wateree Water Management Group (CWWMG) used a different set of models to assess water availability during development of their Integrated Water Resources Plan (IWRP): the CHEOPS (Computer Hydro-Electric Operations and Planning Software) model for the portion of the basin above the outfall of Lake Wateree and the WaterFALL® model for below Lake Wateree. Although surface water availability results from their planning process were not available at the time this State Water Plan was prepared, combined outflows from the CHEOPS and WaterFALL® models were used in the Santee River basin modeling effort.

The SWAM models simulate river basin hydrology, water availability, and water use across a network over an extended timeseries. SWAM provides efficient planning-level analyses of surface water supply systems. A range of water user types can be represented in the model, including municipal water suppliers, agricultural irrigators, power companies, and industrial water users. SWAM's reservoir object can include basic hydrology-dependent calculations including storage as a function of inflow, outflow, and evaporation. It can also include operational rules of varying complexity. Municipal water conservation programs can similarly be simulated with sets of rules of varying complexity.

As outlined in the Planning Framework, surface water supplies were assessed using historical hydrology from U.S. Geological Survey (USGS) stream gages having periods of record ranging from 40 to 90 years, depending on the basin. The four planning scenarios that were evaluated included Current Use, 2070 Moderate Demand, 2070 High Demand, and Permitted and Registered (P&R) Scenarios. In most basins, a fifth scenario, the Unimpaired Flow (UIF) Scenario, was also evaluated. The UIF Scenario removes all surface water withdrawals and discharges and simulates conditions before any surface water development. The results summarized in this chapter focus on the Current Use and 2070 High Demand Scenarios. The High Demand Scenario is defined as "*a future water demand projection based on the assumptions of a hot and dry climate (i.e., increased irrigation) and high population and economic growth.*" The RBCs generally relied on the 2070 High Demand Scenario for developing their water management strategy recommendations, as it covers the desired planning period and is based on conservative (high demand) assumptions. Additional discussion of model results for the other planning scenarios is provided in the River Basin Plans.

5.1.1 Current and Future Surface Water Shortages

Generally, surface water shortages under both the Current Use and 2070 High Demand Scenarios are projected to be small and infrequent across the state. Many of the simulated shortages are for agricultural water users and golf courses withdrawing from small streams or near the headwaters of streams and rivers. At these locations, extended periods of drought can result in low streamflow. Permitted and registered water users at these locations, which are projected to see small and infrequent shortages, may not actually experience shortages, since many of them withdraw water from small impoundments that are not included in the models. These impoundments may provide enough storage to mitigate the modeled shortages.

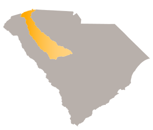
Santee River Dam on Lake Marion

Even with high economic growth rates and conservative assumptions about water demand during dry periods, demands are not projected to outpace surface water supplies through the year 2070, in most cases. When shortages are projected during periods of drought, most can be managed with existing on-site impoundments or achievable demand reductions through conservation programs. **Figures 5-1** and **5-2** summarize the surface water user shortages in each planning basin for the Current Use and 2070 High Demand Scenarios, respectively. The figures show:

- The **number of users with shortages,** calculated by summing the number of users that experience a shortage of any magnitude in the approximately 40 to 90 years of historic hydrology simulated. Small impoundments, which are commonly used as supply sources for agriculture and golf course irrigation, are not included in the models, and therefore, the number of users with projected shortages is likely overstated.
- The **frequency of shortage occurrence** for those users with shortages, calculated as the number of months in which demand was not met divided by the total number of months simulated.

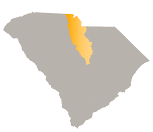
Minor increases in shortages are projected for the 2070 High Demand Scenario compared to the Current Use Scenario in a few of the basins, but projected shortages overall are low. The modeled shortages observed in each basin are as follows:

Upper Savannah River Basin – No shortages are simulated under the Current Use Scenario. Under the 2070 High Demand Scenario, one public water supplier, one industry, and one mining operation are projected to have shortages. The maximum shortages in the 2070 High Demand Scenario over the 82-year simulation period range from 0.3 to 2.5 million gallons per day (MGD).

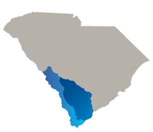


Saluda River Basin – All four shortages under the Current Use Scenario occur for agricultural irrigation users. Under the 2070 High Demand Scenario, one additional agriculture user and one golf course user are also projected to have shortages. The maximum shortages in the 2070 High Demand Scenario over the 94-year simulation period range from 0.03 to 2.5 MGD.

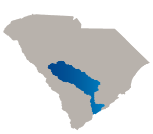
Broad River Basin – No shortages are simulated under the Current Use Scenario. Under the 2070 High Demand Scenario, five water suppliers and three golf courses are projected to have shortages, in addition to a proposed new nuclear power station projected to come online in 2035. In the 2070 High Demand Scenario, the maximum shortages range from 0.03 to 37 MGD over the 90-year simulation period. However, of these projected shortages, all but one (for a public supplier) can likely be alleviated by the operational flexibility of existing or planned reservoirs or the use of existing, supplemental sources.



Catawba River Basin – Water availability in the Catawba Basin is being re-evaluated as part of the Catawba-Wateree IWRP, under the direction of the CWWMG. Revised information on availability and shortage potential were not available during development of the State Water Plan.

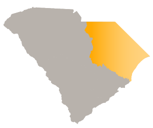


Lower Savannah-Salkehatchie River Basin – All five shortages under the Current Use Scenario occur for agricultural irrigation users in the Salkehatchie basin. Under the 2070 High Demand Scenario, one water supplier in the Lower Savannah basin plus seven existing agricultural water users in the Salkehatchie basin are projected to have shortages. In addition, meeting anticipated new agricultural demands in three Salkehatchie River subbasins could be challenging. The maximum shortages in the 2070 High Demand Scenario for the Salkehatchie basin range from 0.01 to 3.0 MGD over the 70-year simulation period. In the 82-year simulation period of the Lower Savannah basin, the maximum shortage is 3.3 MGD.



Edisto River Basin – All 12 shortages under the Current Use Scenario occur for agricultural irrigation users, many of whom have small, unmodeled impoundments that may reduce the frequency and magnitude of shortages or eliminate them in some instances. Under the 2070 High Demand Scenario, two additional agriculture users and three public water suppliers are also projected to have shortages. In the 2070 High Demand Scenario, the maximum shortages for the public water suppliers range from 0.3 to 5.1 MGD over the 87-year simulation period.

Santee River Basin – Under the Current Use Scenario, two agricultural water users, two golf courses, and two public water suppliers could experience shortages. The golf courses experiencing a shortage have small, unmodeled impoundments that may reduce frequency of shortages or eliminate them in some instances. The two public water suppliers withdraw from Lake Marion and Lake Moultrie. The water levels of both lakes are simulated to drop below the water intake elevation for these users during extended drought conditions, assuming no operational flexibility of reservoir releases is granted by the Federal Energy Regulatory Commission (FERC), and downstream fish passage release requirements are met until reservoir levels drop to approximately 0.5 feet above the bottom of the normal operating range. These are conservative assumptions intended to evaluate a worst case. In the 2070 High Demand Scenario, the maximum shortages range from 0.2 to 70.7 MGD over the 37-year simulation period.



Pee Dee River Basin – Three agriculture, two golf courses, and one mining operation are projected to have shortages under the Current Use Scenario. Under the 2070 High Demand Scenario, one additional mining operation and one additional industrial user are projected to have shortages. In the 2070 High Demand Scenario, the maximum shortages range from 0.1 to 21.0 MGD over the 89-year simulation period.

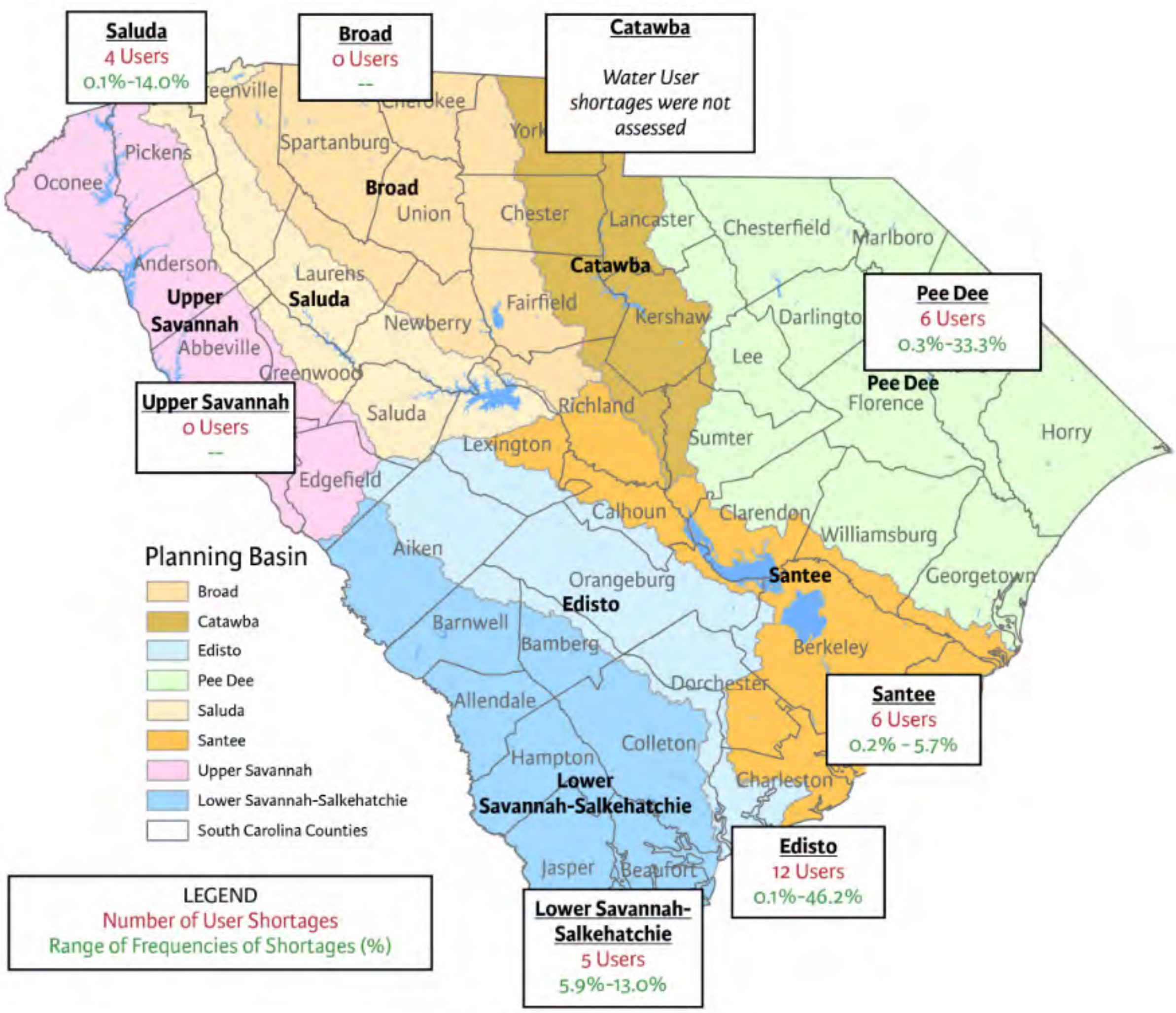


Figure 5-1. Current Use Scenario surface water shortages by planning basin.

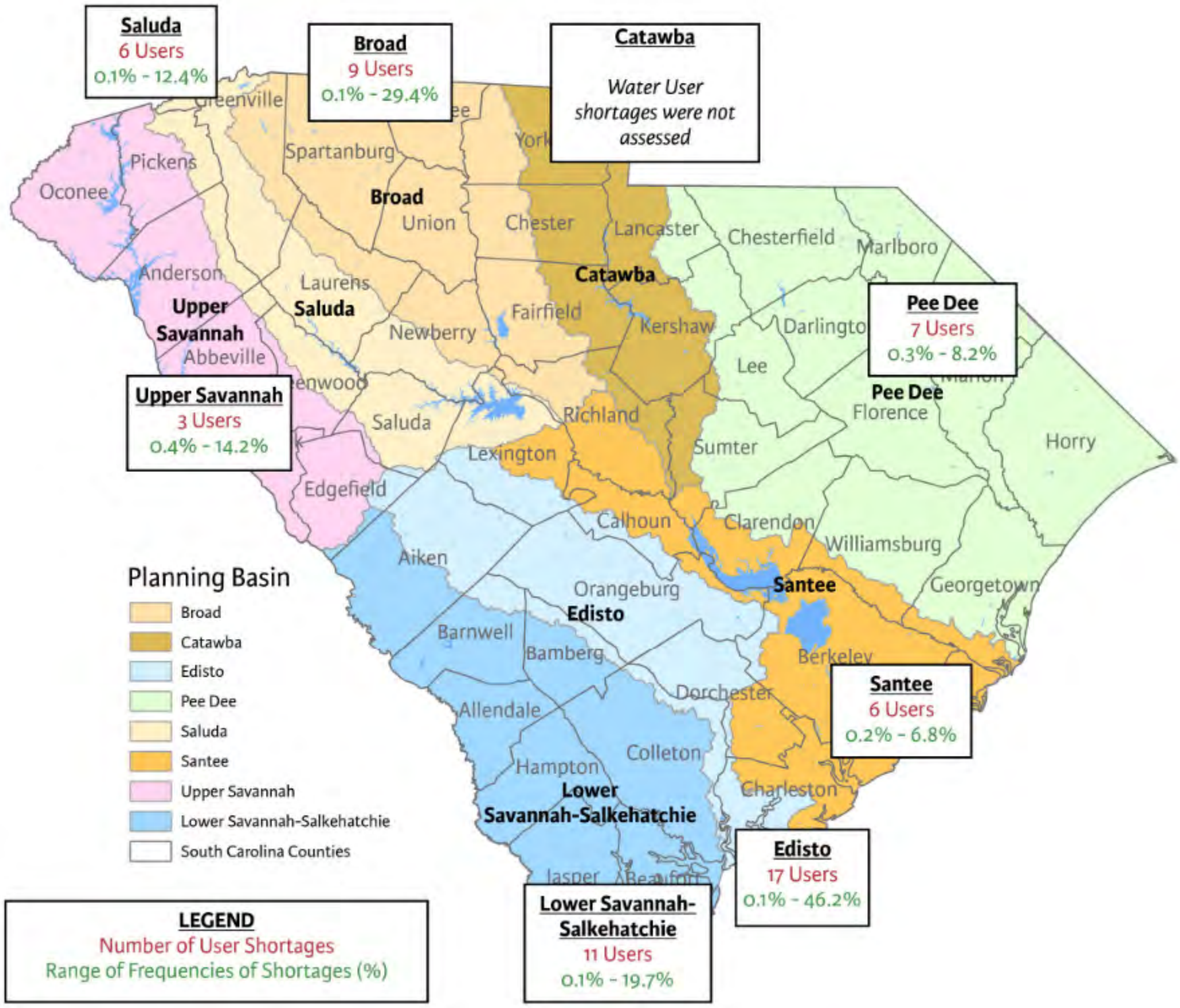


Figure 5-2. 2070 High Demand Scenario surface water shortages by planning basin.

The P&R Scenario assumes all water users withdraw their maximum permitted and registered volumes simultaneously. Shortages generally increased under this scenario, indicating that some stream reaches, or portions of reaches, are not able to support the fully permitted and registered amounts. This most often occurs on tributary streams but also occurred on the mainstem of the Edisto River. Streams where this occurs (in whole or in part) include the Little River, North Fork Edisto River, and the mainstem of the Edisto River in the Edisto River basin; Naked Creek and Black Creek in the Pee Dee River basin; Pacolet, Middle Tyger, and South Tygser Rivers in the Broad River basin; Reedy River and Rabon Creek in the Saluda River basin; Twelvemile Creek and Golden Creek in the Upper Savannah River basin; and the Little Salkehatchie and Coosawhatchie Rivers in the Salkehatchie River basin. In the Santee River basin, Lake Marion and Lake Moultrie are not able to support the fully permitted and registered withdrawals. **Figure 5-3** shows the locations of the streams that are not able to support the permitted and registered amounts, and the frequencies of the shortages.

The results suggest that while many tributaries cannot support the fully permitted and registered withdrawals, most tributaries and mainstem reaches are not overallocated. It is important to distinguish river reaches that may be "overallocated" from the basins as a whole. Chapter 4 presents comparisons of current and projected demands to the P&R amount, and illustrates that in most basins, P&R amounts far exceed anticipated use. As shown in **Figures 5-1** and **5-2**, in general, water supply is expected to be mostly sufficient to meet statewide demand through 2070.

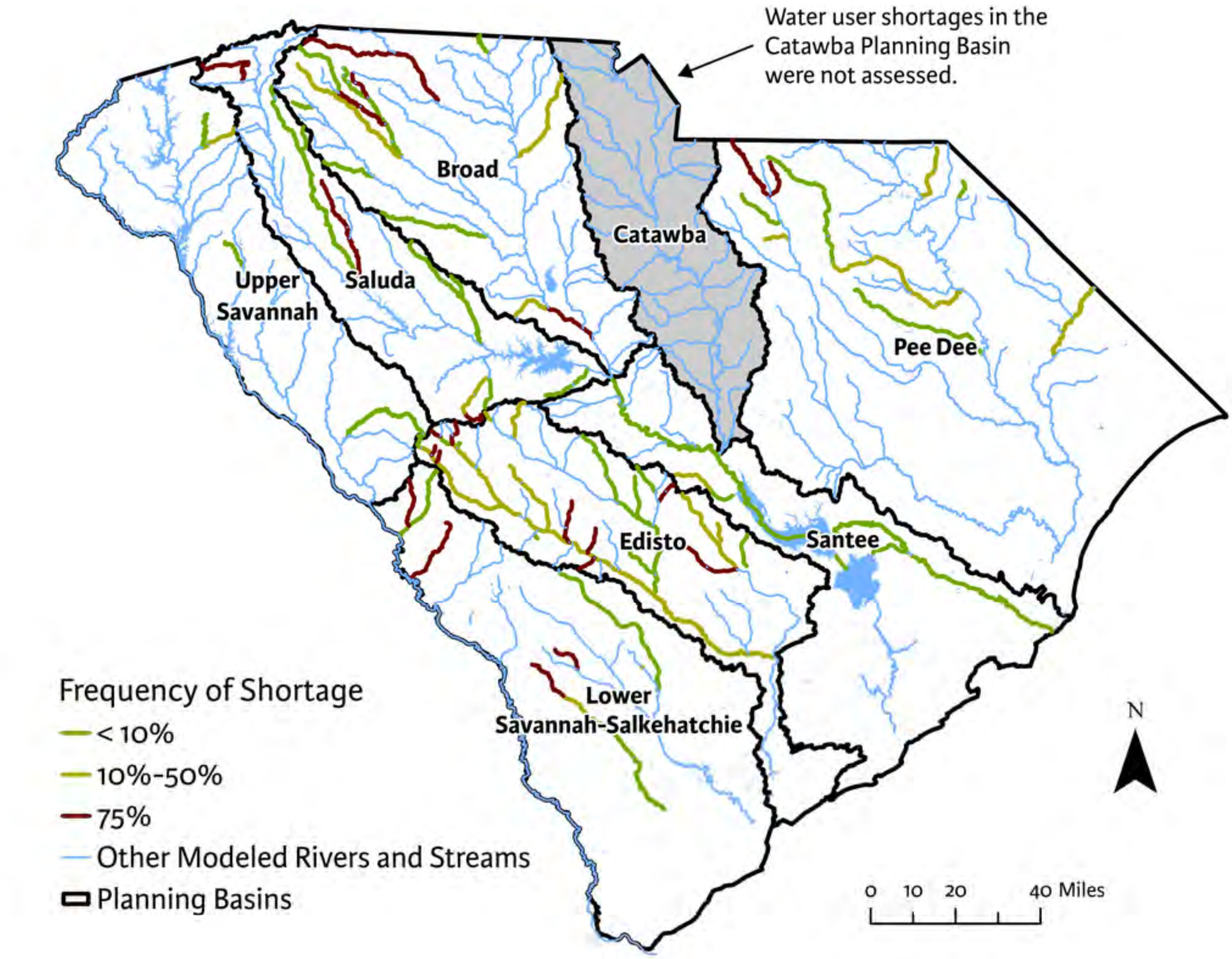


Figure 5-3. Simulated water availability shortages under the P&R Scenario.

5.1.2 Minimum Instream Flow Assessment

As defined in the Surface Water Withdrawal, Permitting, Use, and Reporting regulations (Regulation 61-119), the MIF is the "*flow that provides an adequate supply of water at the surface water withdrawal point to maintain the biological, chemical, and physical integrity of the stream taking into account the needs of downstream users, recreation, and navigation*" (SCDHEC 2012). The South Carolina Surface Water Withdrawal, Permitting, Use, and Reporting Act (Surface Water Act) established the MIF to be 40 percent of the mean annual daily flow for the months of January, February, March, and April; 30 percent of the mean annual daily flow for the months of May, June, and December; and 20 percent of the mean annual daily flow for the months of July through November.

Under the Surface Water Act, surface water withdrawers established after January 1, 2011 must develop a contingency plan for how they will curtail withdrawals and maintain MIFs during low flows. MIF considerations apply only to new surface water users and not existing withdrawers (those established before January 1, 2011), agricultural registrations, or and hydropower stations. Statewide, most permitted surface water users are considered existing. Existing users must only address industry standards for water conservation during periods of low flow.

The River Basin Plans assessed how frequently streamflows fall below MIFs at key river nodes. Modeled flows from daily timestep SWAM simulations were compared to MIFs calculated based on USGS gage records at select locations. The frequency of days below the MIF flow during each month was then calculated for each of the five demand scenarios. **Table 5-1** shows the calculated MIF at two locations (Saluda River near Ware Shoals in the Piedmont region and Salkehatchie River near Miley in the Coastal Plain region), and **Figure 5-4** demonstrates the comparison between MIFs and daily flows at these two locations. MIF comparisons at additional locations are provided in the River Basin Plans. For the Edisto and Pee Dee basins, the MIF comparison was performed as part of the water management strategies assessment but was not assessed for the five planning scenarios.

Table 5-1. Calculated MIF at two select locations.

Gage Name	Gage ID	Period of Record	Mean Annual Daily Flow (cfs)	MIF (cfs)		
				Jan–Apr	May, Jun, and Dec	Jul–Nov
Piedmont Region (Saluda River Basin)						
Saluda River near Ware Shoals[1]	02163500	1939–present	961	384	288	192
Coastal Plain Region (Salkehatchie River Basin)						
Salkehatchie River near Miley[2]	02175500	1951–present	313	125	94	63
Percent of mean annual daily flow for calculating MIF –>				**40%**	**30%**	**20%**

[1] Mean annual daily flow was calculated using streamflow data through the end of water year 2023 (September 30, 2023).
[2] Mean annual daily flow was calculated using streamflow data through the end of water year 2024 (September 30, 2024).

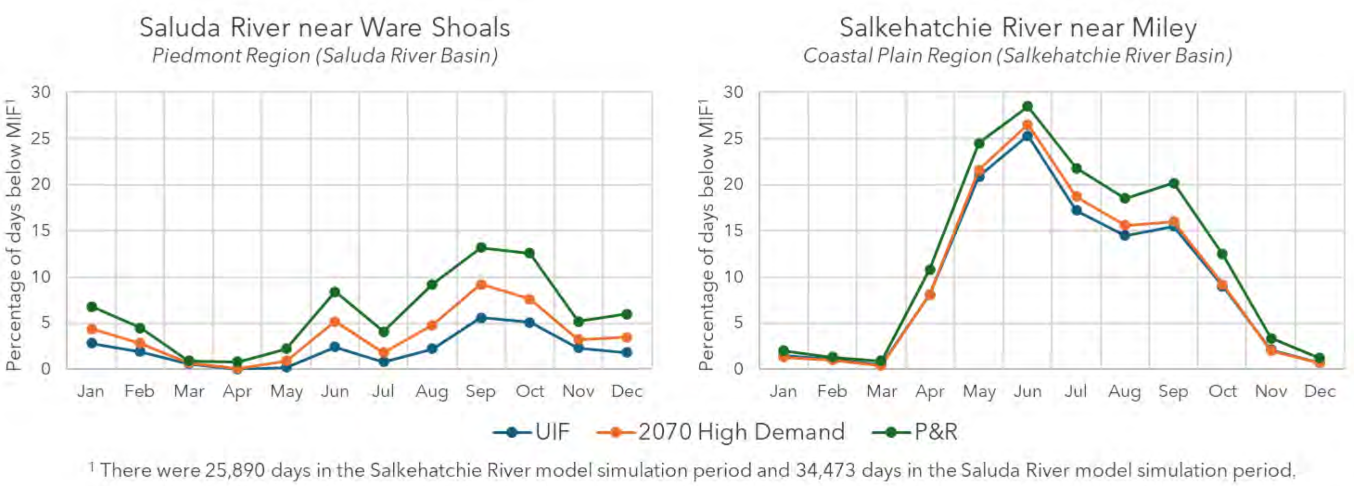


Figure 5-4. Percentage of days below MIF at two select locations.

Key observations include:

- Under UIF conditions (i.e., natural flows), flows drop below MIFs at some point in the year at all sites evaluated by RBCs. This demonstrates that low-flow conditions below MIFs at these locations occur naturally.
- At most sites evaluated by RBCs, there is a modest increase in the percentage of days when flows are below MIFs moving from the Current Use to the 2070 Moderate and 2070 High Demand Scenarios. This is because of the higher surface water withdrawals simulated in those scenarios and can be seen at the two example sites shown in **Figure 5-4**. Exceptions to this occur in locations where upstream wastewater returns increase under increasing demand scenarios, thereby increasing streamflows.
- Along many reaches, there is a relatively large increase in the percentage of days when P&R Scenario flows are below MIFs, compared to the other scenarios. This can be seen in the two examples shown in **Figure 5-4**.

Bushy Park Reservoir

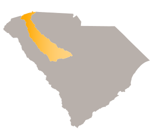
5.1.3 Biological Response Metrics

In a collaboration between Clemson, SCDNR, SCDES, The Nature Conservancy, and RTI International, nearly 1,000 fish and aquatic insect samples were combined with mean daily flow and other stream dynamics to create biological response metrics. Biological response metrics, such as species richness (the number of species found at a given site), were developed by Bower et al. (2022) and combined with hydrologic metrics, such as mean daily flow or timing of lowest observed flow, to identify statistically significant relationships between flow characteristics and ecological suitability for fish and macroinvertebrates. These streamflow characteristics could be calculated from the SWAM model simulations to estimate how future demands may impact the ecology of the basin.

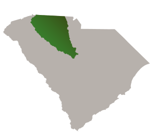
The flow-ecology relationships were developed using data from streams and small rivers that are considered wadeable. Because streams of this size comprise most of the surface water in South Carolina, results are broadly applicable statewide. However, the results should not be extrapolated to large rivers or reservoirs. The assessment also was limited to the hydrologic and biological response metrics selected, and the findings do not rule out potential risks for ecological integrity or tolerance related to other flow metrics or other forms of flow changes. Additionally, the flow metrics used to estimate flow-ecology relationships were based on precipitation, temperature, land cover, etc. within a recent period of record. Future changes in these factors will affect the flow-ecology relationships.

For each of the four future management scenarios, changes in the flow-ecology relationships were quantified and assigned a risk category (high, medium, or low). A summary of the results state-wide is provided below. Additional discussion of these results is provided in Chapter 5 of the River Basin Plans.

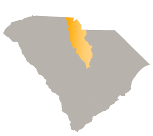
Upper Savannah River Basin – SWAM model–simulated flow metrics for all scenarios result in low risk for ecological integrity. Overall, SWAM estimated no significant change in mean daily flow for all scenarios and at all sites assessed. In the Upper Savannah River basin, the vast majority of water use is from reservoirs or the mainstem, where ecological impacts could not be readily evaluated.



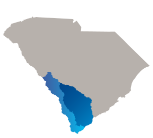
Saluda River Basin – SWAM model–simulated flow metrics for the UIF, Moderate Demand 2070, and High Demand 2070 Scenarios generally result in low risk for ecological integrity and tolerance while the P&R Scenario suggests a moderate to high ecological risk to fish species on the wadeable tributaries of the Saluda River basin. Large changes in mean daily flow for the P&R Scenario and the High Demand 2070 Scenario are predicted to substantially reduce the number of fish species in Rabon Creek.



Broad River Basin – Model–simulated flow metrics for the UIF and Moderate Demand 2070 Scenarios result in low risk for ecological integrity and tolerance. Large changes in mean daily flow for the P&R Scenario and the High Demand 2070 Scenario are predicted to substantially reduce the number of fish species, with five Strategic Nodes predicted to lose more than 20 percent of fish species in the P&R Scenario, and one Strategic Node predicted to lose up to 45 percent of fish species under the High Demand 2070 Scenario. In general, the four future management scenarios examined in this study suggest a moderate to high ecological risk to fish species on the Pacolet and Tyger tributaries of the Broad River basin.



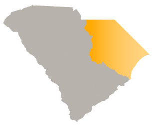
Catawba River Basin - Flow-ecology relationships were thoroughly evaluated during hydro project re-licensing and new flow relationships were established on the mainstem.



Lower Savannah-Salkehatchie River Basin – Biological response metrics were applied at one location, Horse Creek at Clearwater. SWAM model–simulated flow metrics for the UIF, Moderate Demand 2070, and High Demand 2070 Scenarios result in low risk for ecological integrity. However, a large change in mean daily flow for the P&R Scenario is predicted to substantially reduce the number of fish species, resulting in moderate ecological risk.

Edisto River Basin – Modeling generally indicated that flow alterations associated with increasing demand projections would be small, relative to current flow conditions in the primary reaches (North Fork, South Fork, and Four Hole Swamp) and secondary tributaries. Exceptions to this include a medium risk for fish richness on the South Fork Edisto River and a high risk to fish richness in Dean Swamp Creek, both in the P&R Scenario.

Santee River Basin – No biological response metrics were applied because the Santee River Basin is dominated by larger, mostly non-wadeable streams.



Pee Dee River Basin – Generally, changes to mean daily flow, timing of low flow, and frequency of low flow result in low ecological risk at the selected locations under the four management scenarios assessed. The one exception is on Black Creek, where a large change in mean daily flow for the P&R Scenario is predicted to reduce the number of fish species by 35 percent (medium risk category).

5.1.4 Reservoir Safe Yield and Drought Resilience

An important factor in estimating the reliability of current water supply systems against future demand forecasts is the ability of reservoir systems to provide anticipated levels of supply without interruption. The safe yield of a reservoir, or system of reservoirs, is a measure of its long-term reliability. The Planning Framework defines reservoir safe yield as "*the surface water supply for a reservoir or system of reservoirs over the simulated hydrologic period of record.*" Since the surface water supply is the maximum amount of water available for withdrawal 100 percent of the time, the safe yield of a reservoir or system of reservoirs can be thought of as the maximum annual average demand that can be sustained through the period of record without depleting available storage. The Planning Framework stipulates that the drawdown threshold at which safe yield is determined is not necessarily the dead pool level, but the level of the shallowest intake for a water user. Some RBCs also examined safe yield based on dead pool or other elevations that were useful to understand.

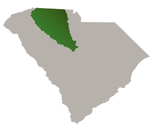
In the Broad, Saluda, Santee, and Upper Savannah River basins, reservoir safe yield was computed for each reservoir or system of reservoirs that provide water to essential water users, including public water supply and power generation. The SWAM model was used to gradually increase hypothetical water demand over the entire period of record until a reservoir, or reservoir system, could no longer satisfy that demand with 100 percent reliability. For any demands upstream of the reservoirs being evaluated, the conservative 2070 High Demand assumptions were applied for the results included in this report. In the Saluda and Upper Savannah Basin, safe yield under the Current Use and P&R Demand scenarios was also evaluated. The analysis was also conducted at a monthly timestep, which does not necessarily account for all operational flexibility of reservoirs. Reservoir operating rules, such as seasonal guide curves, were suspended in some analyses to better balance water supplies across reservoir systems and better quantify physical water availability.

Jefferies Hydroelectric Station

A summary of the results statewide is provided below and in **Table 5-2**. Additional discussion of these results is provided in Chapter 5 of the River Basin Plans.

Upper Savannah River Basin Reservoirs – Because of their pumped storage connection (water is moved into and out of a reservoir for energy production), the safe yield for Bad Creek, Jocassee, and Keowee reservoirs was determined as a system. The Savannah River reservoirs (Lake Hartwell, Lake Russell, and Lake Thurmond) were assessed individually; however, further assessment of the safe yield as a system is warranted. For all reservoirs, the simulated safe yield exceeds the anticipated level of demand in the conservative 2070 High Demand Scenario.

Saluda River Basin Reservoirs – Table Rock and North Saluda Reservoirs (which service Greenville Water), Lake Greenwood (which services Laurens County Water and Sewer Commission [LCWSC] and Greenwood Commission of Public Works [CPW]), and Lake Murray (which services the City of Columbia, West Columbia, Dominion Energy's McMeekin Plant, Newberry County Water & Sewer Authority [NCWSA] and Saluda County Water & Sewer Authority [SCWSA]) were all found to have sufficient supply. For Greenville, the results are conditioned on future supply being available from Lake Keowee. Lake Rabon (which services Laurens CPW) was found to have insufficient supply, though other sources can help make up shortfalls.



Broad River Basin Reservoirs – In most cases, the simulated safe yield exceeds the anticipated level of demand in the conservative 2070 High Demand Scenario, but not in all cases. For example, the water supply reservoirs for the Greer CPW (Lake Robinson and Lake Cunningham) are of sufficient capacity to satisfy the projected 2070 High Demand withdrawals. However, Lakes Whelchel and Gaston Shoals (which supply water to the Cherokee County Board of Public Works, which services Gaffney) were found to not have adequate capacity for the 2070 High Demand Scenario withdrawals. Water supplies for the Spartanburg Water System (Lake Bowen/Reservoir #1 and Lake Blalock) and SJWD (Lake Cooley, North Tyger Reservoir, North Tyger System, Lake Lyman, and Middle Tyger System) were found to be marginally sufficient to meet the projected 2070 High Demand, and further analysis may be prudent.

Santee River Basin Reservoirs – Lakes Marion and Moultrie were analyzed as an interconnected storage system, reflecting their hydraulic and operational dependence. New FERC regulations have stipulated significant downstream flow requirements from both reservoirs. These new regulations impose critical constraints on reservoir operations during the simulated time period. At a monthly timestep, the simulate safe yield of the combined system is 0 MGD, since even without withdrawals, the system cannot satisfy downstream FERC flow requirements all the time. At a daily timestep, the simulated safe yield of the system is approximately 40 MGD, although these results should be used with caution as they are based on exact repetition of daily hydrologic patterns. For these reservoirs, maintaining the FERC required releases during low inflow conditions results in a safe yield that is significantly lower than current and projected demands.

Lake Marion

Table 5-2. Safe yield results for water supply reservoirs under the 2070 High Demand Scenario.

Water Systems Served	Reservoir (Total System)	Safe Yield (MGD)	Sufficiency for 2070 High Demand Scenarios
Cherokee County BPW (Gaffney)	Lake Whelchel	6.8	Insufficient to satisfy 2070 High Demand of approx. 25 MGD (annual average)
	Gaston Shoals	6.0	
	TOTAL SYSTEM	12.8	
Greer CPW	Lake Robinson	26.8	Sufficient to satisfy 2070 High Demand of 22 MGD (average annual)
	Lake Cunningham	12.0	
	TOTAL SYSTEM	**<38.8**	
SJWD	Lake Cooley	3.6	Marginally sufficient to meet 2070 High Demand of 25 MGD (daily analysis suggests that safe yield can provide this reliably). Further analysis may be prudent, given the range of values produced.
	North Tyger Res	4.6	
	North Tyger System	10.2	
	Lake Lyman	11.5	
	Middle Tyger System	13.7	
	TOTAL SYSTEM	**<23.9**	
SWS	Lake Bowen/Reservoir #1	32	Marginally sufficient to meet 2070 High Demand of 62 MGD. Further analysis may be prudent.
	Lake Blalock	30	
	TOTAL SYSTEM	**62**	
Greenville Water	Table Rock	19	Sufficient to satisfy 2070 High Demand of 34 MGD (average annual)
	North Saluda	24	
	TOTAL SYSTEM	**43**	
Laurens CPW	**Lake Rabon**	**1.6**	Insufficient to satisfy 2070 High Demand of 2.4 MGD (average annual)
Greenwood CPW and LCWSC	**Lake Greenwood**	**197**	Sufficient to satisfy 2070 High Demand of 20 MGD (average annual)
City of Columbia, West Columbia, Dominion Energy's McMeekin Plant, NCWSA, and SCWSA	**Lake Murray**	**359**	Sufficient to satisfy 2070 High Demand of 311 MGD (average annual)
N/A	Bad Creek Reservoir	No critical water user withdrawals	
N/A	Lake Jocassee		
Greenville Water, Walhalla, Seneca, and Oconee Nuclear Station	Lake Keowee	419	Sufficient to satisfy 2070 High Demand of 146 MGD (average annual)
Clemson Energy, Anderson Regional JWS, South Anderson Water Supply Intake, and Pioneer Water	Lake Hartwell	Safe yield was assessed for each reservoir and the results presented in the River Basin Plan; however, assessment of the safe yield of the entire system is necessary, given the complex and interdependent operations.	Sufficient to satisfy 2070 High Demand of 82 MGD (average annual)
Mohawk and City of Abbeville	Lake Russell		
McCormick	Lake Thurmond		
	TOTAL SYSTEM		

Table 5-2. Safe yield results for water supply reservoirs under the 2070 High Demand Scenario. (continued)

Water Systems Served	Reservoir (Total System)	Safe Yield (MGD)	Sufficiency for 2070 High Demand Scenarios
Santee Cooper Lake Marion Regional Water System	Lake Marion	Safe yield was assessed as a total system	Insufficient to satisfy 2070 High Demand of 73 MGD (annual average) while still maintaining FERC-required reservoir releases
Santee Cooper Lake Moultrie Regional Water System	Lake Moultrie		
	TOTAL SYSTEM	**0-40** depending on time step used	

Several of the RBCs (Saluda, Upper Savannah, and Santee) elected to explore the impact on water availability in the major reservoirs under more severe drought conditions than have been experienced in the hydrologic record. This "synthetic drought" analysis recognizes that historic hydrology may not represent future conditions, and more severe and/or longer droughts could further stress surface water resources. In general, the simulations performed highlight water supply vulnerabilities, especially in the Savannah River basin, if historical observed drought conditions were to occur in the future with greater frequency and/or duration. While modified reservoir storage operations (i.e., relaxing required minimum releases from reservoirs) could mitigate some of the quantified shortages, this would come at a cost of reduced flows downstream of the major reservoirs in these basins. Additional information summarizing the results of the synthetic drought scenarios can be found in the Saluda, Upper Savannah, and Santee River Basin Plans.

5.1.5 Reaches of Interest

The Planning Framework defines a reach of interest as "*a stream reach defined by the RBC that experiences undesired impacts, environmental or otherwise, determined from current or future water demand scenarios or proposed water management strategies. Such reaches may or may not have identified surface water shortages.*"

The Saluda RBC designated the 14-mile stretch of the Saluda River below Saluda Lake as a reach of interest because of its classification as a hydrologically impaired stream segment. Aquatic life and recreational uses in this stretch have been impaired due to the modified peaking operation schedule of the hydropower facility at Saluda Lake Dam. No other reaches of interest were identified in the state. The Saluda RBC intends to work with SCDES and the operator of the hydropower facility to identify solutions to resolve the hydrologic impairment below the Saluda Lake hydro project.

Saluda Lake Hydroelectric Facility

5.2 Groundwater Availability

As described in Chapter 2.3.2, South Carolina's Coastal Plain is underlain by several major aquifers that serve as important sources of water for more than half of the state. Groundwater usage is concentrated in the Coastal Plain, with limited groundwater use in the Upstate. Because the Lower Savannah-Salkehatchie, Edisto, Santee, and Pee Dee basins cover most of the Coastal Plain, groundwater availability assessments were made only for these four basins. This section summarizes conclusions about groundwater availability in each of the Coastal Plain basins, as well as a general summary about groundwater availability in the Upstate.

Unlike watersheds, aquifers are not defined by topography, river basin, or geopolitical boundaries, and the groundwater they hold is a resource shared by neighboring basins. The deepest and oldest aquifers, the Crouch Branch, McQueen Branch/Charleston, and Gramling, span much of the Coastal Plan and are sources of water for all four planning basins. The shallower aquifers, Upper and Middle Floridan and Gordon, while only present in the central to southwest portion of the state, are important resources to the Edisto and Lower Savannah-Salkehatchie basins. Groundwater users in each of these four basins utilize water from 3 to 6 major aquifers.

Conditions in an aquifer are assessed primarily with water level measurements made in wells. The groundwater level—the depth from land surface to the water level in a well—indicates how much pressure the water in the aquifer is under, which is a function of how much water is stored in the aquifer. Water levels measured continuously in monitoring wells provide information on changing water levels over time and thus indicate changes in aquifer storage over time. Water level data from numerous wells open to one aquifer can be used to produce potentiometric maps, which are contour maps of an aquifer's water levels over a wide area. Potentiometric maps provide "snapshots" of aquifer conditions over the full extent of the aquifer at one moment in time. Areas of relatively significant groundwater level declines are indicated on potentiometric maps by locally lower potentiometric elevations, usually centered near the pumping causing the decline. These potentiometric lows, known as cones of depression, appear on potentiometric maps as concentric loops of contour lines.

Current groundwater conditions can be assessed using groundwater-level measurements, but future groundwater conditions and long-term groundwater availability is best predicted using groundwater flow models. Since early in this planning process, the USGS has been working with South Carolina state resource agencies to develop a groundwater flow model for the South Carolina Coastal Plain that will be an update of a previous USGS model published in 2010 (Campbell and Coes 2010). This new Coastal Plain groundwater flow model was intended to serve as the primary assessment tool for evaluating the potential impacts of future groundwater withdrawals on aquifer conditions.

As the first basin to begin planning, the Edisto RBC used an updated USGS Atlantic Coastal Plain Groundwater Model (Campbell and Coes 2010), and the model produced some meaningful results, including the identification of two areas that may experience potential water-level problems in the future. Before groundwater modeling for the Pee Dee basin began, the USGS identified previously unknown problems with the model. Resolution of these problems and subsequent recalibration of the model delayed its completion so much that it was unavailable for use when planning began in the Pee Dee, Lower Savannah-Salkehatchie, and Santee basins. To avoid delaying the release, the Pee Dee, Lower Savannah-Salkehatchie, and Santee River Basin Plans were completed without the use of groundwater modeling.

Because the groundwater model was unavailable to the Pee Dee, Lower Savannah-Salkehatchie, and Santee RBCs, groundwater conditions in these planning basins were evaluated using groundwater-level data, potentiometric aquifer surface contour maps, and current and historical groundwater usage information. The impact of future water demand on aquifer conditions and groundwater availability was estimated based on current groundwater conditions, observed groundwater-level trends, and assumptions about where increased pumping would occur. As such, the groundwater availability assessments for these basins are more generalized than that made for the Edisto basin. Groundwater models for all four Coastal Plain planning basins are expected be available in future planning activities to perform more complete groundwater assessments.

5.2.1 Current and Future Groundwater Shortages

The Planning Framework defines a groundwater shortage as "*a state in which groundwater withdrawals from a specific aquifer violate a groundwater condition applied on that aquifer,*" and a groundwater condition is defined as "*a limitation on the amount of groundwater that can be withdrawn from an aquifer.*" Essentially, a groundwater shortage occurs when pumping results in the groundwater level being lowered to a specific level defined by an RBC.

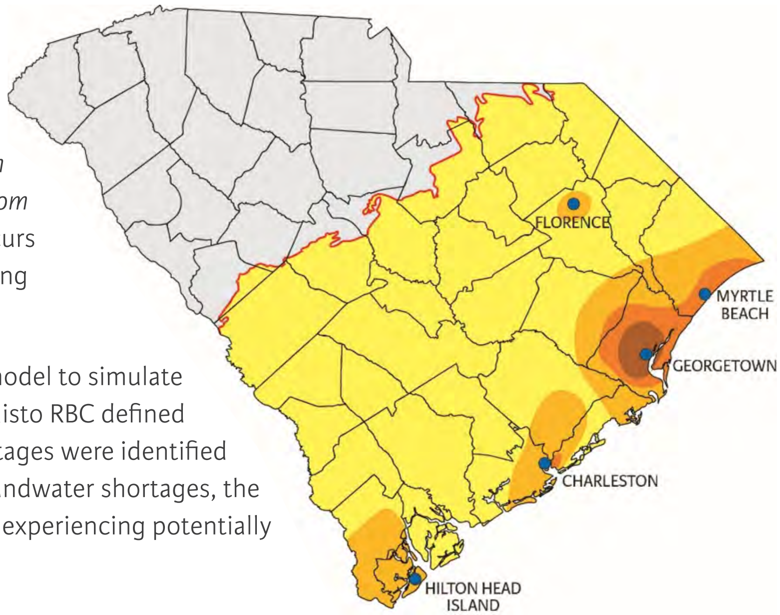


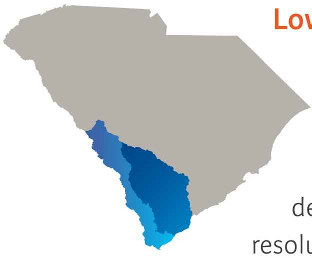
Figure 5-5. Map of South Carolina showing areas of the Coastal Plain that have experienced significant groundwater level declines.

Because only the Edisto RBC used a groundwater model to simulate future groundwater levels, and because only the Edisto RBC defined any groundwater conditions, no groundwater shortages were identified in any other basin. Despite not having defined groundwater shortages, the other Coastal Plain basins all have aquifers that are experiencing potentially problematic groundwater levels.

Groundwater level declines in an aquifer are a normal result of groundwater pumping, and water level declines have been observed in all the Coastal Plain aquifers. Fortunately, because of the depth of the aquifers, the vast amount of water stored in them, and the aquifers' ability to recharge, only a few areas have experienced problems related to lowered groundwater levels, and even in those places, groundwater is still available for use.

Figure 5-5 illustrates where significant, localized groundwater level declines from predevelopment water levels have occurred in the South Carolina Coastal Plain aquifer system. Although these cones of depression occur in different aquifers and have developed at different times, they all occur where groundwater use is concentrated near city centers. During the river basin planning process, these areas were given special attention for evaluation and to highlight water management strategies to mitigate further declines.

Lake Marion



Lower Savannah-Salkehatchie River Basin

In the Lower Savannah-Salkehatchie Basin, groundwater supplies approximately half the basin's needs. Groundwater is plentiful in the basin, as it is only basin where all the South Carolina Coastal Plain aquifers are present. Groundwater use is greatest for public water supply and agricultural irrigation. For most of the basin, the groundwater evaluation indicated demand has not adversely affected groundwater levels. Additionally, despite lacking good spatial resolution of monitoring wells in certain areas of the basin, the available data suggest that projected future use would not cause shortages. Although not declared a groundwater area of concern by the RBC, the most pressing issue in the basin is the ongoing saltwater intrusion of the Upper Floridan aquifer at Hilton Head caused by the large cone of depression centered at Savannah, Georgia. Because the focus of water planning in this initial phase was on water quantity and potential shortages over the planning horizon, the RBC acknowledged and discussed the topic, but no further assessment was conducted.

Specific observations and conclusions from the groundwater assessment are presented below.

- In the upper part of the basin, the Crouch Branch and McQueen Branch aquifers have experienced minimal declines from predevelopment levels despite decades of groundwater pumping. This demonstrates a pattern of consistent and sufficient recharge to both aquifers. It is likely that no groundwater supply shortages will occur in the upper basin under projected use scenarios.

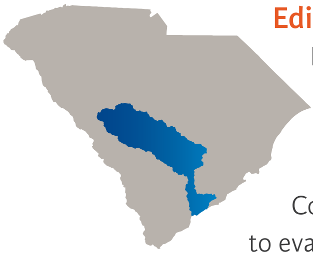
- Agricultural irrigation is common throughout the basin but is most concentrated in Allendale, Bamberg, and Barnwell Counties in the middle of the basin. Irrigation in this area is projected to continue or increase over the planning horizon. There are too few monitoring wells in the Crouch Branch and McQueen Branch aquifers to adequately evaluate groundwater trends in this area. Additional monitoring wells are needed to understand how future pumping may impact aquifer levels in the area.

- The cone of depression in the Upper Floridan aquifer is well documented and is managed through regulatory measures in both Georgia and South Carolina. Large withdrawals from the aquifer to support the development of Savannah, Georgia and Hilton Head Island caused a large cone of depression at Savannah (approximately 150 feet below predevelopment level). As a result of the cone of depression, water levels declined by about 10 feet across Hilton Head, which allowed saltwater to move into in the freshwater portions of the aquifer. Regulatory action by both states have enabled water levels to have rebound and stabilize, but due to the prevailing groundwater gradient towards the cone, the salt plumes continue to move across Hilton Head Island.

- Water demand for public supply is expected to increase in Beaufort and Jasper Counties over the next several decades. Withdrawal limits enforced on the Upper Floridan aquifer in South Carolina have allowed water levels in that aquifer to stabilize and should be continued; additional demand must therefore be met with more surface water use, expanded aquifer storage and recovery (ASR) programs, and the increased use of groundwater from deeper aquifers. These strategies and others are discussed in Chapter 6.

Coosawhatchie at Hwy 601

Edisto River Basin



In the Edisto River basin, groundwater supplies approximately half of the basin's overall water demand. Groundwater is largely for agricultural irrigation in wells completed the Middle Floridan, Gordan, Crouch Branch and McQueen Branch aquifers. Groundwater withdrawals representing current and future demands were incorporated into the updated USGS Atlantic Coastal Plain Groundwater Model (Campbell and Coes 2010), and simulations were performed to evaluate changes in water levels and discharge to streams and to support development of water budgets. Historical, reported pumping rates were assigned to the wells for the years 1983 to 2020. The groundwater demand projections were applied to the model for the period 2021 through 2070. Since the location of potential future wells that may account for the projected increase in demands over the 50-year planning horizon are unknown, all future demands were assigned to existing wells. The model was run for four planning scenarios: Current Use, Moderate Demand, High Demand, and P&R. More details regarding the application of the groundwater model in the basin can be found in Chapter 4 of the Edisto River Basin Plan.

Despite limitations and uncertainties related to groundwater modeling, the results suggest the following:

- Future drawdown potential is a significant concern in upper portions of the Edisto basin in the Crouch Branch and McQueen Branch aquifers. Efforts to quantify these impacts are discussed in the Edisto River Basin Plan. In all scenarios, groundwater levels were simulated to drop below the top of the Crouch Branch aquifer in the southern half of Calhoun County (**Figure 5-6**), and below the top of the McQueen Branch aquifer in a more limited area of Lexington County.

- The modeled water budgets show a relatively minor reduction in discharge to streams resulting from increased pumping from the deeper aquifers, suggesting that groundwater withdrawals from the deeper Crouch Branch and McQueen Branch aquifers in the central part of the basin do not significantly impact stream baseflow. This is to be expected, given the confined nature of the deeper aquifers. Pumping in the upper part of the basin, where the aquifers are thinner, closer to the surface, and less confined, would be expected to have more impact on stream baseflow.

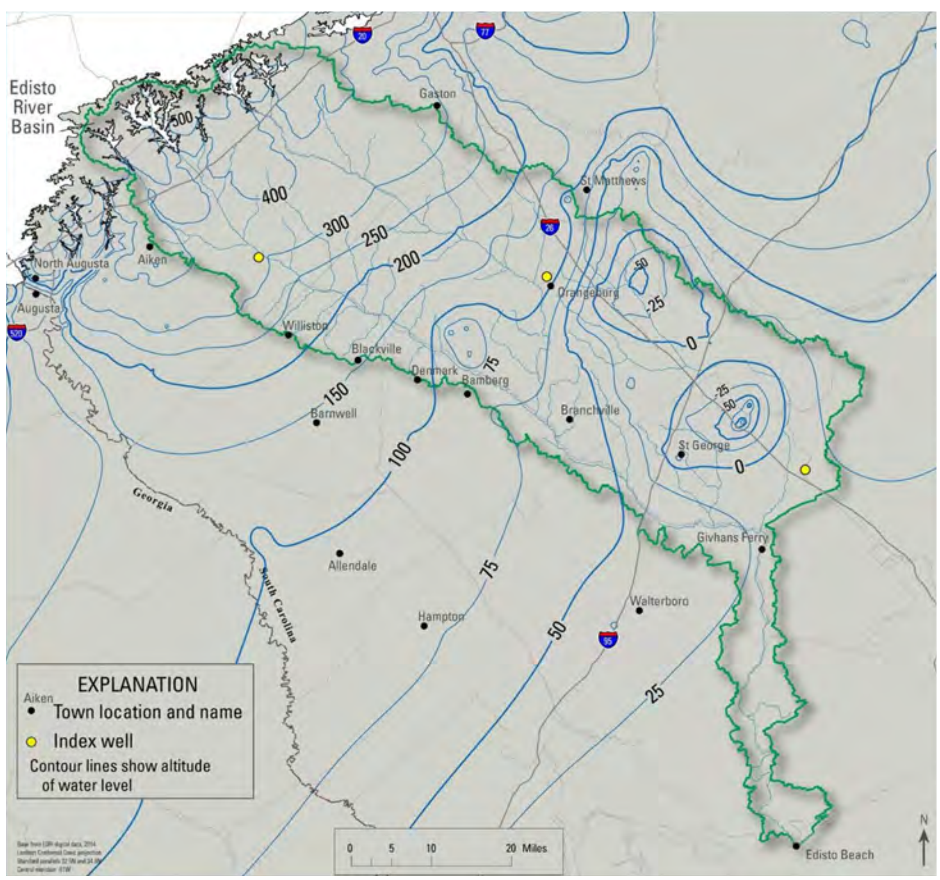
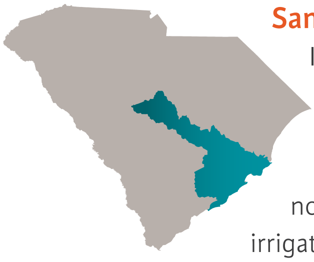


Figure 5-6. Potentiometric map showing simulated Crouch Branch aquifer water levels for the High Demand Scenario in the year 2070. *The cones of depression seen in the central basin prompted the Edisto RBC to classify this area as a groundwater area of concern.*



Santee River Basin

In the Santee Basin, groundwater demand occurs basin-wide, but the demand is overall lower compared to other basins in the Coastal Plain. This, in part, is due to the smaller size of the basin and the presence of significant surface water reservoirs in the basin. The groundwater evaluation showed that for a majority of the basin historical groundwater use has generally not adversely affected groundwater levels. Groundwater use is greatest for agricultural irrigation, public water supply, and industry. In the upper basin (Lexington, Richland, Calhoun, Clarendon, and Orangeburg Counties), most production wells are completed in the Crouch Branch or McQueen Branch aquifers, while in the lower basin (Berkeley, Dorchester, and Charleston Counties), the Gordon, Crouch Branch, and Charleston aquifers are primarily used. Use of the very deep Gramling aquifer, which exists only in the lower part of the basin, is very limited. Although not defined as a groundwater area of concern by the Santee RBC, a notable potentiometric feature is the cone of depression in the Charleston aquifer centered over coastal Charleston County. The cone of depression has been well documented since 2004, when groundwater levels in the Charleston aquifer were more than 200 feet below predevelopment levels.

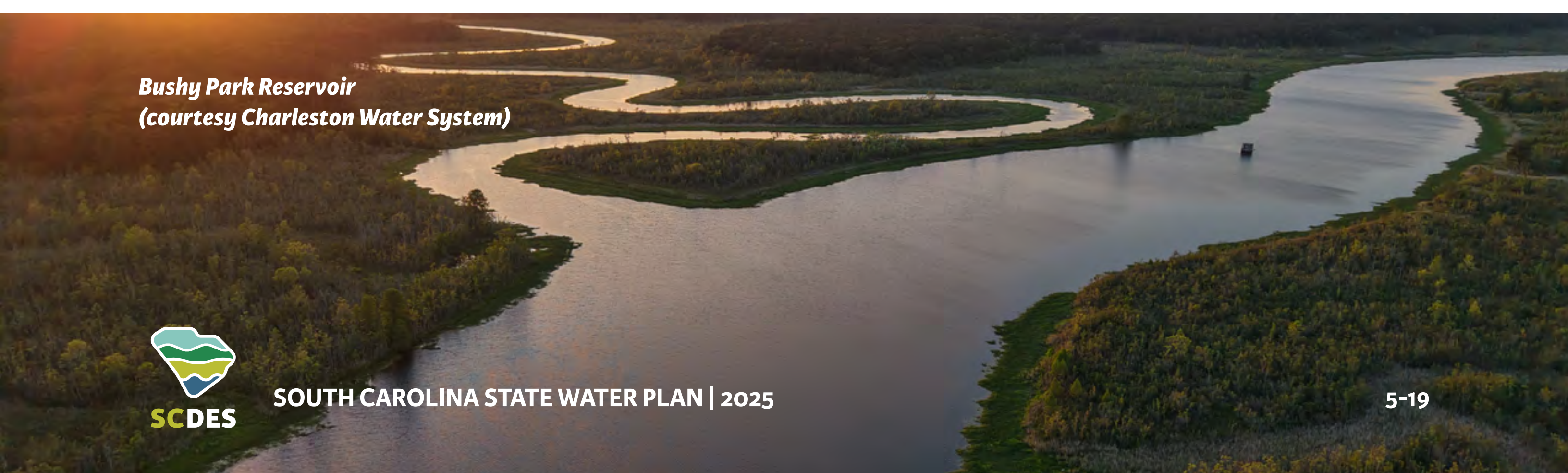
Specific observations and conclusions from the groundwater assessment are presented below.

- Although the Crouch Branch and McQueen Branch aquifers have experienced declines up to 100 feet from predevelopment levels in the upper part of the basin because of consistent and continued use for agriculture and water supply, recharge to both aquifers is generally adequate, and it is likely that no groundwater supply shortages will occur under projected use scenarios in the upper basin.

- Agricultural irrigation is the largest groundwater use in the basin and is concentrated in the upper to middle basin in Calhoun, Clarendon, Orangeburg, Richland, and Sumter Counties, and irrigation in this area is projected to continue or increase over the planning horizon. There are few monitoring wells in the Crouch Branch and McQueen Branch aquifers to adequately evaluate groundwater trends in this area. Although available data do not indicate significant declines, this basin shares its western boundary with the Edisto basin, where modeling suggests future pumping could bring water levels down to the tops of the aquifers. Modeling and additional monitoring wells are needed to better understand how future pumping may impact aquifer levels in the area.

- As a result of increased surface water use and regulatory measures over the past two decades, the cone of depression in the Charleston aquifer has rebounded about 50 feet and stabilized between 100–150 feet below predevelopment levels (**Figure 5-7**). However, **Figure 5-8** shows a long, steady decline in groundwater levels with periods of stabilization in Berkeley County, several miles inland from the cone center. Water demand projections suggest increased groundwater demand for public supply and industrial sector, and increased withdrawals from the Charleston aquifer could cause the cone to worsen and cause further declines region wide.

- Public water supply demand is expected to increase in Berkeley, Charleston, Dorchester, Lexington, and Richland Counties over the next several decades. While most large public suppliers already use both groundwater and surface water, additional supply-side and demand-side groundwater management strategies, such as aquifer storage and recovery or the use of underutilized or deeper aquifers, should be explored to meet the growing demand.



Bushy Park Reservoir (courtesy Charleston Water System)

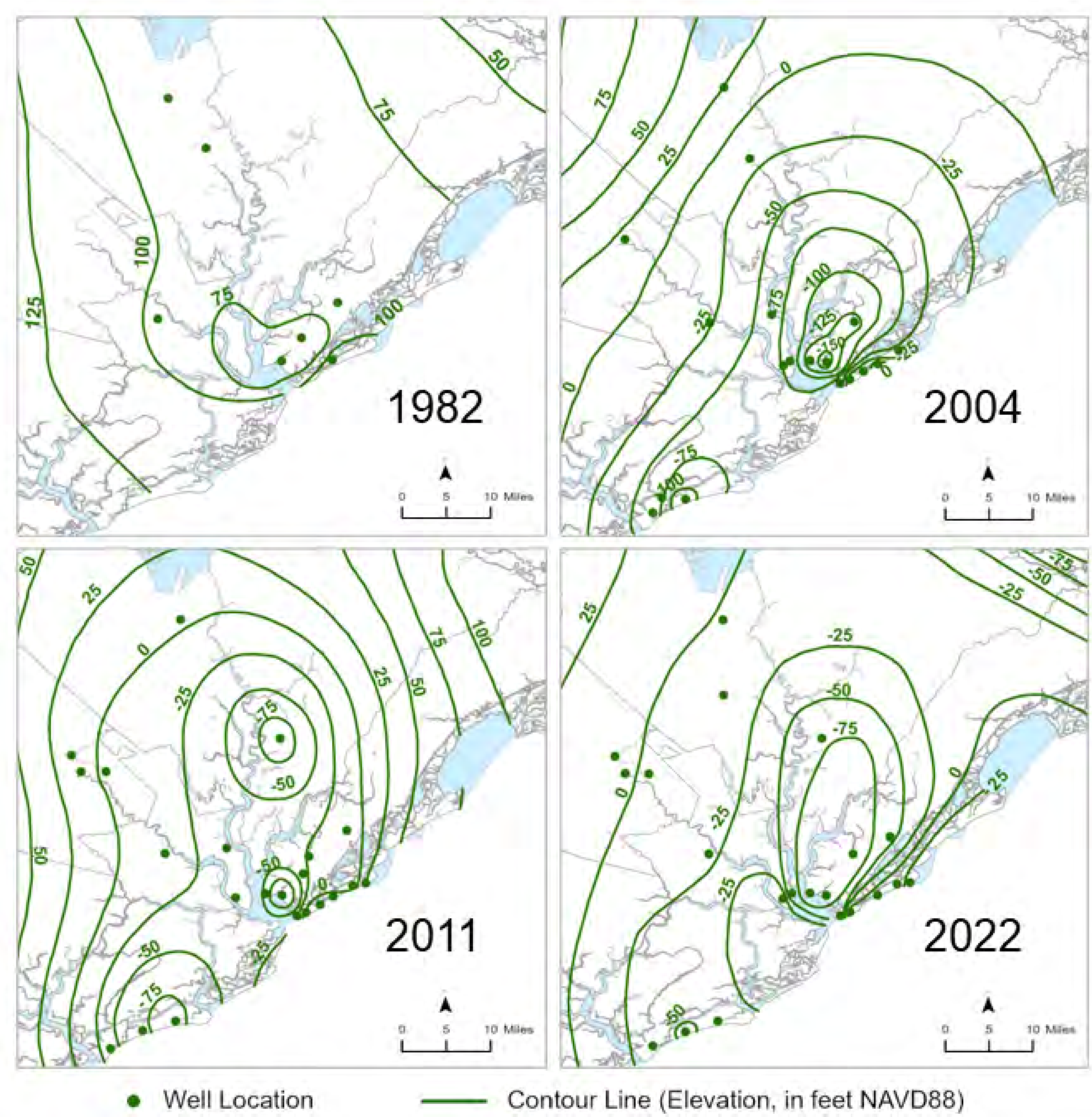


Figure 5-7. Potentiometric water level maps of the Charleston aquifer for the years 1982, 2004, 2011, and 2022.
(Sources: Aucott and Speiran 1984; SCDNR 2008; SCDNR 2013; SCDNR 2023a)

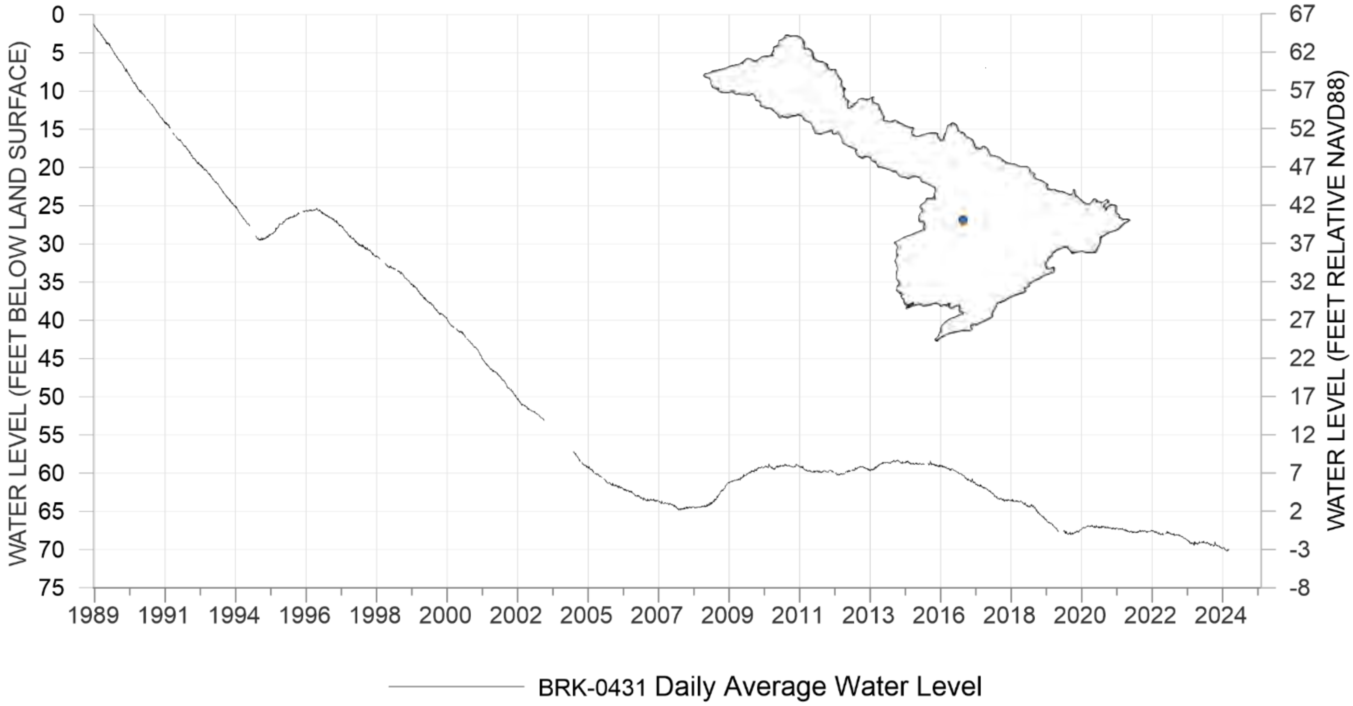
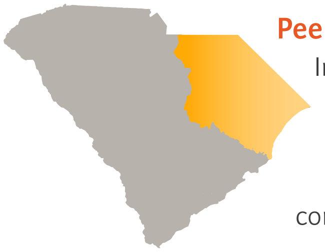


Figure 5-8. Groundwater levels in the Charleston aquifer well BRK-0431/USGS 331022080021801 in Berkeley County.

Charleston



Pee Dee River Basin

In the Pee Dee Basin, groundwater supplies approximately half the basin's needs, primarily from the Crouch Branch and McQueen Branch aquifers. The two largest groundwater uses are water supply and agricultural irrigation. Notable potentiometric features in this basin are the cone of depression in the McQueen Branch aquifer around the City of Florence and the cone of the depression in the Crouch Branch aquifer in Georgetown County.

Specific observations and conclusions from the groundwater assessment are presented below.

- Water level trends in wells near the recharge areas of the Crouch Branch and McQueen Branch aquifers have generally remained stable over time despite groundwater pumping, indicating consistent and sufficient recharge to both aquifers. It is likely that no groundwater supply shortages will occur in these areas under projected use scenarios.
- Farther away from the recharge zone, moving toward the coast, groundwater levels are declining in both the Crouch Branch and McQueen Branch aquifers at a rate of approximately 1 foot per year. Declines in the Crouch Branch aquifer near Georgetown have been observed at about 2 feet per year.
- The continued growth and expansion of cones of depression in the potentiometric surfaces of the Crouch Branch and McQueen Branch aquifers in Georgetown County has been monitored for years. After the most recent (2022) potentiometric map was created for the Crouch Branch aquifer (**Figure 5-9**), monitoring wells in the area have indicated a rebound in water levels beginning in July 2023 (**Figure 5-10**), which seems to coincide with a water supply well in Georgetown reducing its groundwater use in 2023 and discontinuing it completely in 2024. While the magnitude and duration of this recovery remains to be seen, these preliminary findings suggest the current level of pumping from this aquifer is as much as the aquifer can sustain.
- The deliberate use of both surface and groundwater (termed conjunctive use and further discussed in Chapter 6) in Florence County has resulted in stabilization of groundwater levels in that area. While conjunctive use has been very beneficial for slowing and reversing declining groundwater levels in Florence County, groundwater levels should continue to be monitored to evaluate potential groundwater supply risks that may occur if future uses increase.

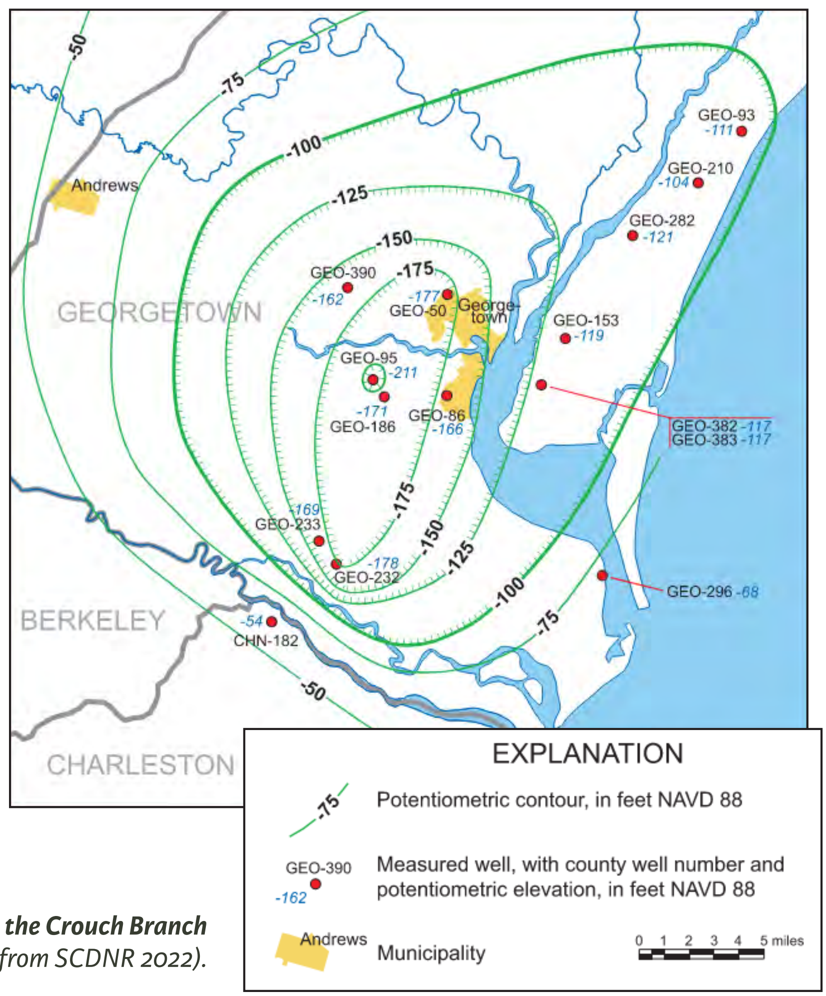


Figure 5-9. 2020 cone of depression in the Crouch Branch aquifer near Georgetown. *(Modified from SCDNR 2022).*

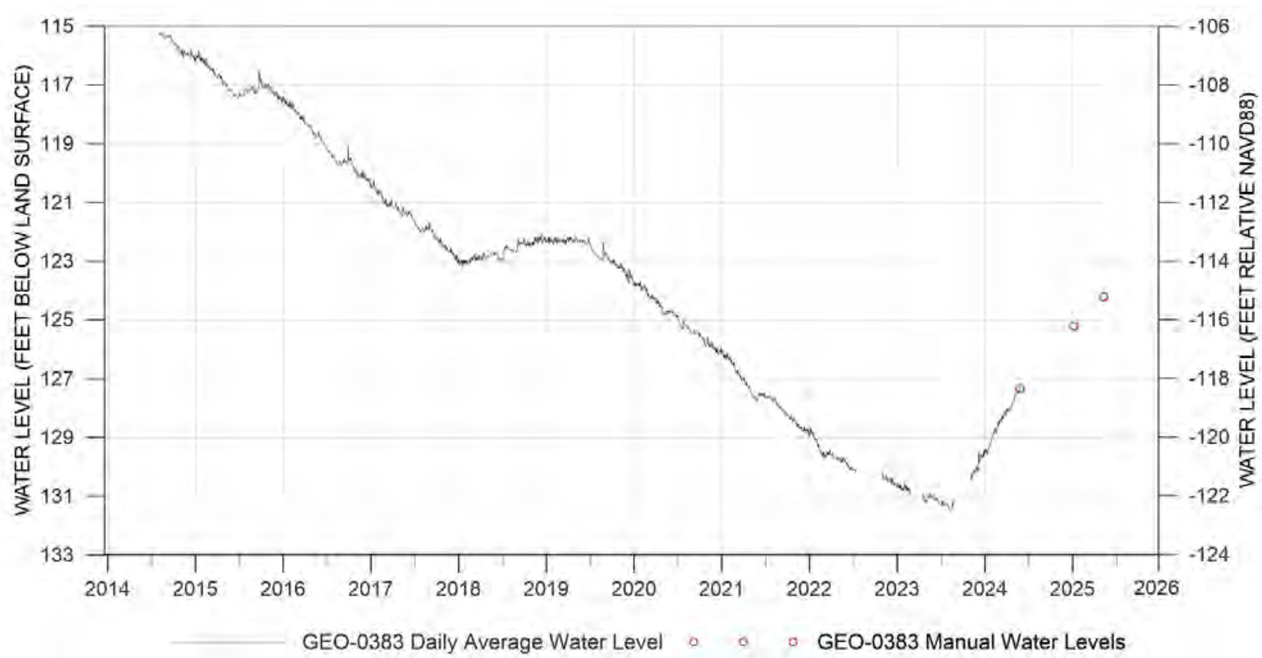
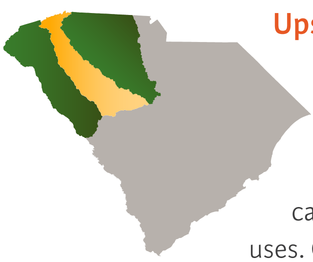


Figure 5-10. Hydrograph showing groundwater levels in the monitoring well GEO-0383, illustrating rebound of water levels in the Crouch Branch aquifer since 2023.



Upstate River Basins (Upper Savannah, Saluda, and Broad River Basins)

The Upper Savannah, Saluda, and Broad River basins are almost entirely within the Piedmont physiographic province, where groundwater occurs in bedrock fractures and in the overlying saprolite. Within the Upstate basins, well yields from fractured rock are reliable but typically low, particularly when compared to Coastal Plain aquifers. Still, Piedmont wells are generally capable of supporting most domestic, private water needs and small irrigation and agricultural uses. Groundwater is the water source for many rural homes in the Piedmont (SCDNR 2023b), especially in areas without access to public water supply systems.

Because of the generally low well yields, groundwater use is mostly limited to domestic wells and small irrigation wells, although some industries and public suppliers rely on wells. Because users of private wells are not required to register or report their withdrawals, the actual number of groundwater users and the volume of groundwater use in the Piedmont is not accurately known.

Potentiometric maps have not been drawn for areas northwest of the Fall Line, including the Upper Savannah, Saluda, and Broad River basins. Unlike in the Coastal Plain region, where water levels in the confined aquifers generally slope toward the coast, groundwater levels in the Upstate generally follow topographic patterns. No modeling or other analysis was performed to assess groundwater availability. No areas are known to experience groundwater-level declines due to over-pumping, but during certain drought conditions, some private wells may be vulnerable to lack of water.

5.2.2 Groundwater Areas of Concern

The Planning Framework defines a groundwater area of concern as "*an area in the Coastal Plain, designated by a River Basin Council, where groundwater withdrawals from a specified aquifer are causing or are expected to cause unacceptable impacts to the resource or to the public health and well-being*" (SCDNR 2019a).

The Pee Dee RBC identified areas around Florence County and along the coast in Georgetown and Horry counties as preliminary groundwater areas of concern due to observed cones of depression. The Pee Dee RBC may later classify these areas as groundwater areas of concern if future groundwater modeling indicates a continued worsening of conditions in these areas.

The Edisto RBC designated groundwater areas of concern in three areas where modeling predicted future declines below the top of an aquifer. The Crouch Branch aquifer in Calhoun County, the McQueen Branch aquifer in Lexington County, and a small area in Aiken County near Shaw Creek are designated as groundwater areas of concern, based on the modeling results.