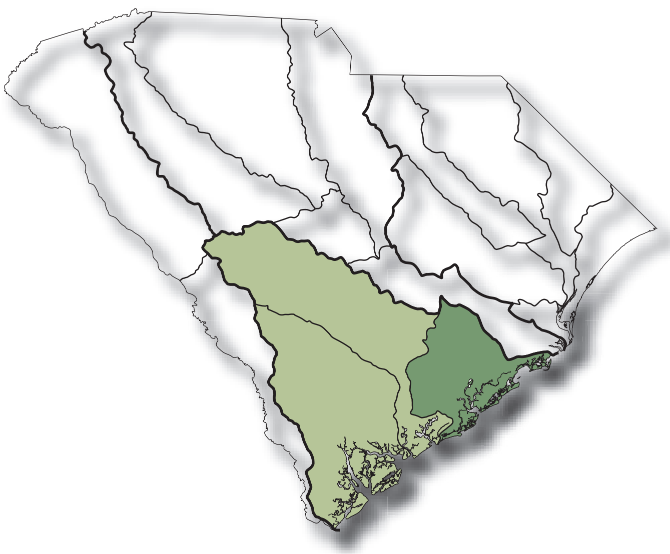
WATERSHED CONDITIONS: ACE BASIN

ASHLEY-COOPER RIVER SUBBASIN



ASHLEY-COOPER RIVER SUBBASIN

The Ashley-Cooper River subbasin is in the central southeastern section of the lower Coastal Plain. The subbasin extends inland approximately 45 miles, encompassing Lake Moultrie and parts of Berkeley, Charleston, and Dorchester Counties (Figure 7-1). The subbasin surface area is approximately 1,710 square miles, 5.5 percent of the State.

DEMOGRAPHICS

The year 2000 population of the subbasin was estimated at 503,400, which was 12.5 percent of South Carolina's total population. By the year 2020, the subbasin population is expected to reach 600,000, an increase of almost 20 percent. Berkeley County is expected to have the most rapid growth (36 percent) during this period, primarily along the corridor between Goose Creek and Moncks Corner. Most of the population in the three counties is classified as urban, and Charleston forms the principal population hub.

The major population centers in 2000 were Charleston (96,650), North Charleston, including Charleston Heights (79,641), Mount Pleasant (47,609), Summerville (27,752), St. Andrews (21,814), and Hanahan (12,937).

The year 2005 per capita income in the subbasin ranged from \$26,207 in Dorchester County, which ranked 17th in the State, to \$34,158 in Charleston County, which ranked second. In 1999, median household income in the subbasin ranged from \$37,810 in Charleston County to \$43,316 in Dorchester County. Median household income in the three counties ranked between tenth and fourth in the State, well above the South Carolina average of \$37,082 (South Carolina Budget and Control Board, 2005).

During 2000, the counties of the subbasin had combined annual average employment of nonagricultural wage and salary workers of about 248,000. Labor distribution in the subbasin counties included management, professional, and technical services, 33 percent; sales and office, 26 percent; service, 16 percent; production, transportation, and materials moving, 13 percent; construction, extraction, and maintenance, 11 percent; and farming, fishing, and forestry, 1 percent. Management, professional, and technical employment was about 10 percent above the State average, and production, transportation, and materials moving employment was about 30 percent below the State average.

Manufacturing output from the three subbasin counties was \$6.6 billion in 1997, with \$3.0 billion produced in Charleston County and \$2.8 billion produced in Berkeley County. Overall, year 2003 crop and livestock production was \$124.5 million, and 2001 timber production was \$48 million (South Carolina Forestry Commission, 2008).

SURFACE WATER

Hydrology

The two major streams draining this subbasin are the Ashley River and the Cooper River. These tidally-influenced rivers, along with several saltwater tidal creeks and rivers, discharge into Charleston Harbor. Numerous tidal streams draining developed and undeveloped areas along the coast discharge into the Atlantic Ocean. All streams in the subbasin are entirely within the lower Coastal Plain. The Charleston metropolitan area makes extensive use of these surface-water resources.

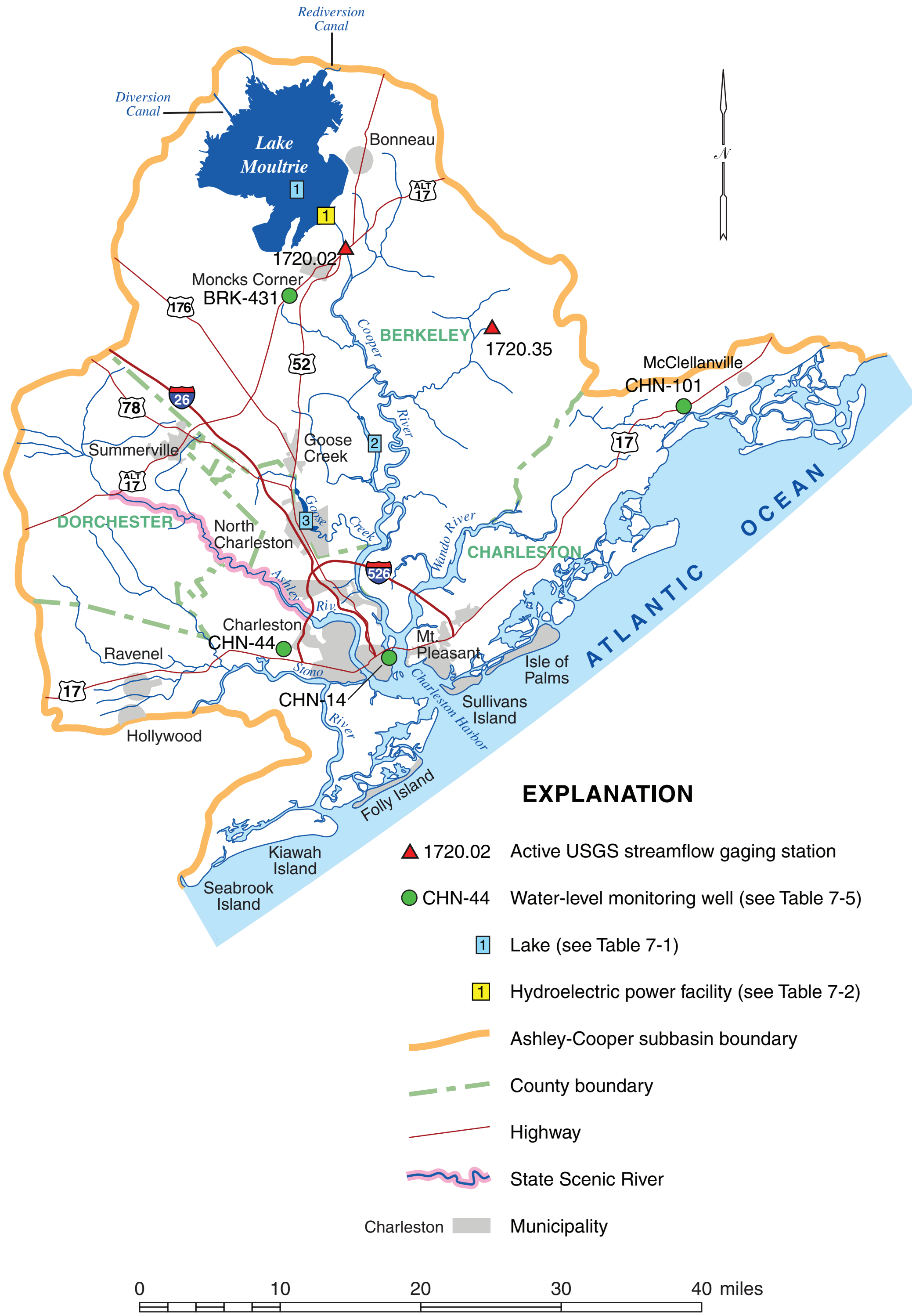


Figure 7-1. Map of the Ashley-Cooper River subbasin.

A 24-mile segment of the Ashley River—from Slands Bridge (U.S. Highway 17-A) near Summerville to the Mark Clark Expressway (I-526) bridge in Charleston—was designated as a State Scenic River in 1998. (See the *River Conservation* section of Chapter 9, *Special Topics*.)

Streamflow data in this subbasin are somewhat limited. Routine streamflow monitoring is done by the U.S. Geological Survey at only two sites (Figure 7-1), because discharge from most coastal streams is influenced by tides. The Lake Moultrie Tailrace Canal at Moncks Corner gage (Station 1720.02) on the West Branch Cooper River reports discharges from Lake Moultrie. Another gage, Turkey Creek above Huger (Station 1720.35), was installed in 2004 on a small creek in the Francis Marion National Forest. Currently, 12 stage-only gaging stations also operate in the subbasin. Discharge values are computed, rather than physically measured, for two other streams using data from stage-only gaging stations. Some of these stations also measure electrical conductivity.

Streamflow in this subbasin provides a limited source of freshwater. The impoundment of freshwater streams in the subbasin and the transfer of water from outside the subbasin provide most available surface-water supplies.

Development

Most surface-water development in this coastal subbasin consists of navigation projects in and around the port of Charleston and flood-control projects in urbanized areas. The subbasin contains only three significant reservoirs (Table 7-1), including one of South Carolina's largest lakes, Moultrie, which was created for hydroelectric-power development in 1941.

Lake Moultrie is formed by the Jefferies (formerly Pinopolis) Dam, which is on the Cooper River north of Moncks Corner, and is managed by the South Carolina Public Service Authority (Santee Cooper). It is the largest lake in the subbasin and the fourth largest lake in the State, having a surface area of 60,400 acres. Its volume of 1,211,000 acre-ft ranks it fifth among the State's lakes by volume. The Jefferies Hydroelectric Station is the only hydroelectric power plant in the ACE basin (Table 7-2).

Table 7-1. Lakes 200 acres or more in the Ashley-Cooper River subbasin (shown on Figure 7-1)

Number on map	Name	Stream	Surface area (acres)	Storage capacity (acre-feet)	Purpose
1	Lake Moultrie	Cooper River	60,400	1,211,000	Power, recreation, and water supply
2	Bushy Park Reservoir (Back River Reservoir)	Back River	850	8,500	Water supply, industry, recreation, and power
3	Goose Creek Reservoir	Goose Creek	600	4,800	Water supply and recreation

Source: U.S. Army Corps of Engineers (1991)

Table 7-2. Hydroelectric power generating facilities in the Ashley-Cooper River subbasin (shown on Figure 7-1)

Number on map	Facility name and operator	Impounded stream	Reservoir	Generating capacity (megawatts)	Water use in year 2006 (million gallons)
1	Jeffries Hydroelectric Santee Cooper	Cooper River	Lake Moultrie	128	983,111

Between 1943 and 1985, most of the natural flow of the Santee River—an average of about 15,000 cfs (cubic feet per second)—was diverted into Lake Moultrie and discharged into the Cooper River, which resulted in severe silting in the Cooper River and Charleston Harbor during that period. To alleviate this problem, in 1985 the U.S. Army Corps of Engineers (COE) constructed another canal to redivert water from Lake Moultrie back into the Santee River. The normal operation of Lake Moultrie releases a daily average of 4,500 cfs into the Cooper River—enough to keep the salinity of the river low—and returns the remainder of its discharge—on average about 10,000 cfs—to the Santee River.

In addition to electric-power production, Lake Moultrie is used for water supply and recreation and is partially within Santee National Wildlife Refuge. Santee Cooper owns and operates a 24-mgd (million gallons per day) water-treatment plant and 26 miles of transmission pipeline. The water is distributed to the Lake Moultrie Water Agency, which is owned by and supplies water to the Moncks Corner Public Works Commission, Summerville Commissioners of Public Works, city of Goose Creek, and Berkeley County Water and Sanitation Authority.

The city of Charleston owns two reservoirs, Bushy Park Reservoir (also known as the Back River Reservoir), and Goose Creek Reservoir, from which it obtains municipal and industrial water supplies. Both streams were tidally influenced until they were impounded for freshwater storage. The Bushy Creek Reservoir receives water primarily from the Cooper River and supplies industrial customers, although it serves as an alternate municipal-supply source. Goose Creek Reservoir is used for recreational purposes and as a backup municipal-supply source. Together, the two reservoirs have a total surface area of 1,450 acres and an approximate volume of 13,000 acre-ft.

The total surface area of all lakes 10 acres or more is 66,281 acres; the total volume is approximately 1,250,000 acre-ft (U.S. Army Corps of Engineers, 1991).

Numerous and extensive navigation projects have been undertaken by the COE in the subbasin. Most of the work has been related to the Charleston Harbor, the Atlantic Intracoastal Waterway, and inlet navigation. The COE completed flood-control projects on Sawmill Branch in 1971 and Eagle Creek in 1986, but has had no similar projects since then. Renourishment at Folly Beach was completed in 2005, and five streambank-erosion control projects were completed in Charleston Harbor, the Cooper River, and the Ashley River between 1987 and 1996. In 2006, the Natural Resources Conservation Service began planning for flood-control projects in the Isaac German area of Mount Pleasant and at Moncks Corner.

Surface-Water Quality

There are five designated classes of water bodies in the Ashley-Cooper River subbasin (DHEC, 2005b). Copahee Sound, Bullyard Sound, Capers Inlet, Mark Bay, Price Inlet, Bulls Bay, and Cape Romain Harbor are all designated as "Outstanding Resource Water" (Class ORW). These are water bodies that constitute an exceptional recreational or ecological resource or are suitable as a drinking-water source with minimal treatment.

Portions of the Wando and Ashley Rivers, Bulls Creek, and the Dick Island Canal are designated "Tidal Saltwater" (Class SA). Class SA comprises tidal saltwater bodies suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora, suitable for primary- and secondary-contact recreation, crabbing, and fishing. Class SA water bodies must maintain daily dissolved-oxygen averages of not less than 5.0 mg/L (milligrams per liter), with a minimum concentration of 4.0 mg/L. These water bodies are not protected for harvesting clams, mussels, or oysters for market purposes or human consumption.

Several water bodies are designated as "Tidal Saltwater" (Class SB), including the Cooper River, Tidal Creek, Grove Creek, the Back River watershed, Flag Creek, Slack Reach, Yellow Horse Creek, the Goose Creek watershed, Filbin Creek, Noisette Creek, Clouter Creek, Shipyard Creek, Newmarket Creek, the Wando River watershed, Turkey Creek, Eagle Creek, Brickyard Creek, Wappoo Creek, and the Charleston Harbor. Class SB water bodies are the same as Class SA water bodies except for the dissolved oxygen standards: Class SB water bodies must maintain dissolved-oxygen averages at or above 4.0 mg/L.

Part of the Wando River, part of the Stono River, Gray Sound, Hamlin Sound, Dewees Inlet, Sewee Bay, Five Fathom Creek, and Folly River are designated as "Shellfish Harvesting" (Class SFH) waters. These are tidal saltwater bodies protected for shellfish harvesting and have the most stringent bacterial standards.

All other water bodies in the basin are designated "Freshwater" (Class FW). Class FW are freshwater bodies that are suitable for survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses.

As part of its ongoing Watershed Water Quality Assessment program, DHEC sampled 97 surface-water sites in the Ashley-Cooper subbasin between 1997 and 2001 in order to assess the water's suitability for aquatic life and recreational use (Figure 7-2). Aquatic-life uses were fully supported at 70 sites, or 72 percent of the water bodies sampled in this subbasin; most of the impaired sites exhibited low dissolved-oxygen levels or excessive concentrations of heavy metals. Recreational use was fully supported in 78 percent of the sampled water bodies; water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2005b). Water-quality impairments in the subbasin are summarized in Table 7-3.

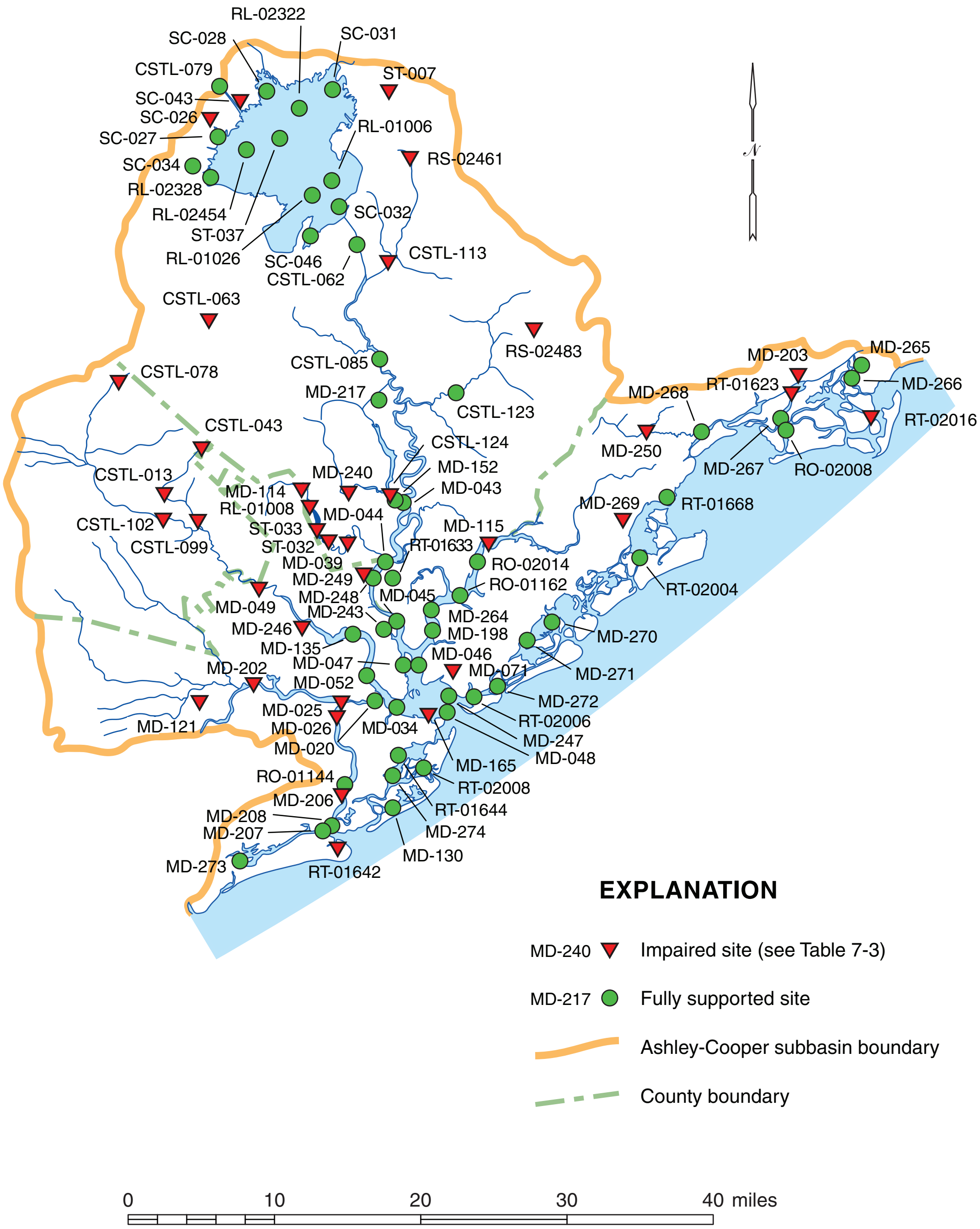


Figure 7-2. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 7-3 (DHEC, 2005b).

Table 7-3. Water-quality impairments in the Ashley-Cooper River subbasin (DHEC, 2005b)

Water-body name	Station number	Use	Status	Water-quality indicator
Lake Moultrie tributary	SC-043	Recreation	Nonsupporting	Fecal coliform
Lake Moultrie tributary	SC-026	Recreation	Nonsupporting	Fecal coliform
Walker Swamp	ST-007	Recreation	Nonsupporting	Fecal coliform
Wadboo Creek	RS-02461	Recreation	Partially supporting	Fecal coliform
	CSTL-113	Recreation	Partially supporting	Fecal coliform
Turkey Creek	RS-02483	Aquatic life	Nonsupporting	Dissolved oxygen, pH
		Recreation	Partially supporting	Fecal coliform
Filbin Creek	MD-249	Aquatic life	Partially supporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Foster Creek	MD-240	Aquatic life	Nonsupporting	Dissolved oxygen
Back River Reservoir	CSTL-124	Aquatic life	Nonsupporting	Dissolved oxygen
Goose Creek	MD-114	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
	MD-039	Recreation	Nonsupporting	Fecal coliform
Goose Creek Reservoir	RL-01008	Aquatic life	Partially supporting	Dissolved oxygen
	ST-033	Aquatic life	Nonsupporting	pH, total phosphorus, Chlorophyll-*a*, copper
	ST-032	Aquatic life	Nonsupporting	pH, total phosphorus, Chlorophyll-*a*
Wando River	MD-115	Aquatic life	Partially supporting	Copper
Wassamassaw Swamp	CSTL-063	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Cypress Swamp	CSTL-078	Aquatic life	Nonsupporting	Zinc
		Recreation	Partially supporting	Fecal coliform
Ashley River	CSTL-102	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Sawmill Branch	CSTL-043	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Dorchester Branch	CSTL-013	Aquatic life	Partially supporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Eagle Creek	CSTL-099	Aquatic life	Nonsupporting	Turbidity
		Recreation	Nonsupporting	Fecal coliform
Ashley River	MD-049	Aquatic life	Nonsupporting	Dissolved oxygen, turbidity, copper, nickel
		Recreation	Nonsupporting	Fecal coliform
Church Creek	MD-246	Recreation	Partially supporting	Fecal coliform
Log Bridge Creek	MD-121	Recreation	Partially supporting	Fecal coliform
Stono River	MD-202	Aquatic life	Nonsupporting	Dissolved oxygen, copper
Elliot Cut	MD-025	Aquatic life	Partially supporting	Dissolved oxygen
Devils Den Creek	RT-02016	Aquatic life	Nonsupporting	Copper
Jeremy Creek	MD-203	Aquatic life	Nonsupporting	Dissolved oxygen, turbidity
		Recreation	Partially supporting	Fecal coliform
Matthews Creek tributary	RT-01623	Aquatic life	Nonsupporting	Turbidity

Table 7-3. Continued

Water-body name	Station number	Use	Status	Water-quality indicator
Awendaw Creek	MD-250	Recreation	Nonsupporting	Fecal coliform
Atlantic Intracoastal Waterway	MD-269	Aquatic life	Nonsupporting	Copper
Shem Creek	MD-071	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Charleston Harbor	MD-165	Aquatic life	Nonsupporting	Dissolved oxygen, copper
Stono River	MD-026	Aquatic life	Nonsupporting	Copper
	MD-206	Aquatic life	Partially supporting	Dissolved oxygen
Stono Inlet tributary	RT-01642	Aquatic life	Nonsupporting	Turbidity

The water quality of Wappoo Creek, Elliott Cut, and Stono River is influenced by water entering from Charleston Harbor on the rising tide. Shipyard Creek has sediment contamination and a shellfish-consumption ban because of point source-contamination (DHEC, 2002).

Water quality conditions can change significantly from year to year and water bodies are reassessed every 2 years for compliance with State water-quality standards. DHEC publishes the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, as in previous years, DHEC issued a fish-consumption advisory for the Diversion Canal, Lake Moultrie, the Rediversion Canal, the Cooper River (from Lake Moultrie to Bushy Park), Wadboo Creek, Durham Creek, and the lower part of the Ashley River. Fish-consumption advisories are issued in areas where fish contaminated with mercury have been found. The contamination is only in the fish and does not make the water unsafe for swimming or boating.

GROUND WATER

Hydrogeology

The Ashley-Cooper River subbasin is entirely in the lower Coastal Plain and is underlain by six aquifers: the Cape Fear, Middendorf, Black Creek, Tertiary sand, Floridan, and shallow aquifers. The thickness of sediments ranges from about 1,700 to 2,800 feet. The principal sources of ground-water supply are the Middendorf aquifer, the Black Mingo Formation of the Tertiary sand aquifer, and the Santee Limestone section of the Floridan aquifer. Selected ground-water data for the subbasin are presented in Table 7-4.

Table 7-4. Selected ground-water data for the Ashley-Cooper River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Moncks Corner	Floridan / Tertiary sand	140–340	55–480
Summerville	Middendorf	1,580–1,800	500
	Floridan / Tertiary sand	250–570	70–510
McClellanville	Floridan / Tertiary sand	100–240	50–200
Seabrook Island	Middendorf	1,840–2,510	1,600
Charleston / Mount Pleasant	Middendorf	1,830–2,030	720–1,400

The Middendorf aquifer has been the principal ground-water source for public supply. Municipal systems in the Mount Pleasant area are the largest users. The town of Summerville used the Middendorf aquifer as its main source until 1994, when it began purchasing surface water from Santee Cooper and the Lake Moultrie Water Agency; the town maintains these wells on standby. Sullivan's Island discontinued well use in 1996. Middendorf wells at Mount Pleasant and Charleston are capable of 700 to 1,400 gpm (gallons per minute) with specific capacities ranging from 5 to 14 gpm/ft (gallons per minute per foot of water-level drawdown). Similarly-constructed wells in the Summerville area produced about 500 gpm with specific capacities less than 5 gpm/ft. Middendorf wells also are used at Kiawah Island for supplemental public supply and for golf-course irrigation.

The Tertiary sand and Floridan aquifers are the most commonly used ground-water sources, particularly in the areas south and west of Charleston. The aquifers are used conjunctively by open-hole wells that tap permeable sections in the Santee Limestone unit of the Floridan aquifer and a Black Mingo Formation sand in the top of the Tertiary sand aquifer: wells are rarely completed in either aquifer alone. The wells mainly are used for domestic and light-commercial purposes, range from 250 to 400 feet in depth, and provide reliable yields up to about 250 gpm. Former industrial wells are known to have produced more than 400 gpm locally. Specific capacities are commonly 4 to 6 gpm/ft but can exceed 10 gpm/ft. Moderately-brackish water occurs in these aquifers at Charleston and in the subbasin area to the north and northwest, and few Tertiary sand and Floridan wells have been used there.

Shallow-aquifer use is scattered throughout the eastern end of the subbasin and generally occurs where the Floridan aquifer and Tertiary sand aquifer are brackish and where public water supply is absent. The largest number of shallow wells is around Johns Island and Wadmalaw Island, where 30- to 50-foot wells yield about 10 gpm. Shallow wells were more widely used on the Sea Islands before public water-supply systems were constructed. The greatest shallow-well yields occur at Mount Pleasant, where former municipal wells produced 30 to 50 gpm. Poor yields are reported west of Charleston where silt and clay predominate: aquifer thinning, commonly between 0 and 30 feet, also reduces potential shallow-well yields in the upper reaches of the subbasin.

Ground-Water Quality

The Cretaceous- and Tertiary-age aquifers are important sources for public-supply, industrial, and irrigation uses in this subbasin. Water in these aquifers becomes increasing mineralized toward the coast and with depth.

The water quality of the Middendorf aquifer is alkaline, very soft, and generally a sodium bicarbonate type that is high in TDS (total dissolved solids) and fluoride. TDS range from 250 to 2,800 mg/L; sodium concentrations range from 20 to 800 mg/L; alkalinity ranges from 500 to 1,300 mg/L; chlorides range from less than 250 to more than 1,400 mg/L; and iron concentrations are variable, ranging from 0.010 to 0.950 mg/L (Park, 1985; Speiran and Aucott, 1994). Fluoride concentrations range from 2.0 to 11.1 mg/L, all above recommended drinking-water limits (Park, 1985). Because of the high concentrations of fluoride, sodium, and chloride, water from the Middendorf aquifer is treated by reverse osmosis for public supplies in Mount Pleasant and for irrigation on Kiawah Island.

Water from the Black Creek aquifer is a sodium bicarbonate type and is soft and alkaline in northern Berkeley and Charleston Counties. Black Creek aquifer water becomes more mineralized to the south in coastal areas, where it becomes a sodium chloride type (Park, 1985). From northwest to southeast in the subbasin, TDS increase from 250 to 2,500 mg/L, sodium increases from 100 to 1,000 mg/L, chloride increases from less than 5 to 1,000 mg/L, and alkalinity increases from 250 to 1,000 mg/L, (Speiran and Aucott, 1994). Fluoride levels in this aquifer range from 1.3 to 6.5 mg/L, with concentrations increasing generally southward.

Water quality in the Tertiary sand is generally good in northern Berkeley County and Charleston County, but it becomes increasingly mineralized to the southeast and with depth. It varies from a sodium bicarbonate type in Berkeley County to a sodium chloride type in south-coastal Charleston County. Chloride and fluoride concentrations range from about 10 mg/L to more than 1,000 mg/L and from 0.1 to 5.0 mg/L, respectively, from northwest to southeast across the subbasin. Hardness ranges from 1 to 250 mg/L and alkalinity ranges from 100 to 700 mg/L. High concentrations of dissolved silica are present in the Tertiary sand aquifer, averaging 30 mg/L and locally exceeding 40 mg/L (Park, 1985).

Water quality in the Floridan aquifer is a calcium bicarbonate type that is moderately-hard to hard with iron concentrations commonly exceeding secondary drinking-water limits. Chloride increases toward the southeast from less than 25 to more than 500 mg/L, locally exceeding 1,000 mg/L (Park, 1985). Silica concentration averages about 20 mg/L but is present at concentrations greater than 40 mg/L.

Water from the Floridan aquifer tends to be less mineralized than that from the Tertiary sand aquifer; however, interaquifer contamination is common in the subbasin as a result of well-construction practices and regional ground-water withdrawals.

Shallow-aquifer water quality varies widely in the subbasin and is generally good for domestic and irrigation use, but is the most vulnerable to contamination. It is usually low in TDS, acidic to slightly alkaline, and can contain high iron concentrations and hardness (Park, 1985). Shallow aquifers in contact with saltwater bodies may become more saline during drought; former Folly Beach wells are reported to have captured seawater shortly after being placed into service.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR and USGS in four wells in the Ashley-Cooper subbasin in order to help assess trends or changes in water levels (Table 7-5). Water levels in other wells are sometimes measured to help develop potentiometric maps of the Middendorf, Black Creek, and Floridan aquifers.

The long-term and ever-increasing use of ground water in this subbasin has led to the development of significant cones of depression in both the Middendorf and Floridan aquifers, the subbasin's two most important aquifers.

The potentiometric surface of the Middendorf aquifer in this subbasin is dominated by a large cone of depression centered at Mount Pleasant, in Charleston County (Figure 7-3). This cone of depression, the center of which is the lowest point on the Middendorf aquifer's potentiometric surface in South Carolina, has continued to expand and deepen in recent years (Hockensmith, 2008a). At Mount

Table 7-5. Water-level monitoring wells in the Ashley-Cooper River subbasin

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
BRK-431	USGS	33 10 22 80 02 18	Middendorf	Moncks Corner	67	1,602–1,607
CHN-14	USGS	32 47 29 79 47 20	Middendorf	Charleston	7	1,805–2,007
CHN-44	DNR	32 47 47 80 04 12	Floridan	Charleston	10	180–425
CHN-101	USGS	33 02 47 79 34 03	Floridan	Awendaw	22	82–91

* *DNR, South Carolina Department of Natural Resources; USGS, United States Geological Survey*

Pleasant, Middendorf water levels are as much as 300 feet lower than predevelopment levels, which ranged from approximately 100 to 150 feet above sea level in this subbasin.

A second, smaller Middendorf cone of depression in southern Charleston County, around Kiawah and Seabrook Islands, has also grown in recent years. Middendorf aquifer water-levels at Seabrook Island have declined as much as 260 feet from predevelopment levels (Hockensmith, 2008a).

The potentiometric map of the Floridan/Tertiary sand aquifer shows a widespread cone of depression encompassing eastern Dorchester County and much of the southern and central parts of Charleston County (Figure 7-4). Within this large depression, smaller, deeper depressions exist around Summerville, North Charleston, and near Mount Pleasant. The depression around Summerville represents a water-level decline of more than 80 feet from predevelopment levels (Hockensmith, 2009).

Primarily in response to increasing Middendorf aquifer use and the consequent water-level decline, in 2002 DHEC declared Charleston, Berkeley, and Dorchester Counties to be the Trident Capacity Use area. In these counties, ground-water withdrawals of 3 million gallons or more in any month are regulated and require a permit from DHEC.

WATER USE

Water use information presented in this chapter is derived from water-use data for the year 2006 that were collected and compiled by DHEC (Butler, 2007) and represents only withdrawals reported to DHEC for that year. Water-use categories and water-withdrawal reporting criteria are described in more detail in the *Water Use* chapter of this publication.

Water use in the Ashley-Cooper subbasin is summarized in Table 7-6 and Figure 7-5. Offstream water use in the Ashley-Cooper subbasin was 222,027 million gallons in 2006, ranking it fifth among the 15 subbasins. Of this amount, 217,183 million gallons were from surface-water sources (98 percent) and 4,844 million gallons were from ground-water sources (2 percent). Thermoelectric water use accounted for 85 percent of this total, followed by water supply (12 percent) and industry (2 percent). Consumptive use in this subbasin is estimated to be 10,761 million gallons, or about 5 percent of the total offstream use.

Three thermoelectric power plants operate in the subbasin. Collectively, they used 188,150 million gallons of water in 2006. Williams Station is owned by SCE&G and operated by the South Carolina Power Generating Company. Located near Charleston, Williams Station is a coal-fired plant with a capacity of 650 MW (megawatts). It can also generate 50 MW of electricity from two natural gas combustion turbines. In 2006, the plant used 172,369 million gallons from the Cooper River. The plant utilizes a once-through cooling system.

Jefferies Generating Station is an oil- and coal-fired plant owned and operated by Santee Cooper. Located in Berkeley County on the Tailrace Canal near Lake Moultrie, it has a capacity of 398 MW and used 13,402 million gallons in 2006. This plant utilizes a once-through cooling system.

Cross Generating Station, also owned and operated by Santee Cooper, is a coal-fired plant located adjacent to the Diversion Canal between Lakes Marion and Moultrie. The plant, which has a capacity of 1,160 MW, used 2,379 million gallons in 2006.

Water-supply use in the subbasin was 26,762 million gallons. Surface water accounted for 24,005 million gallons (90 percent) and ground water for 2,757 million gallons (10 percent). Charleston Water System was the largest user, withdrawing 18,347 million gallons from Bushy Park Reservoir. Charleston Water System also draws water from the Edisto River in the Edisto River subbasin. The Lake

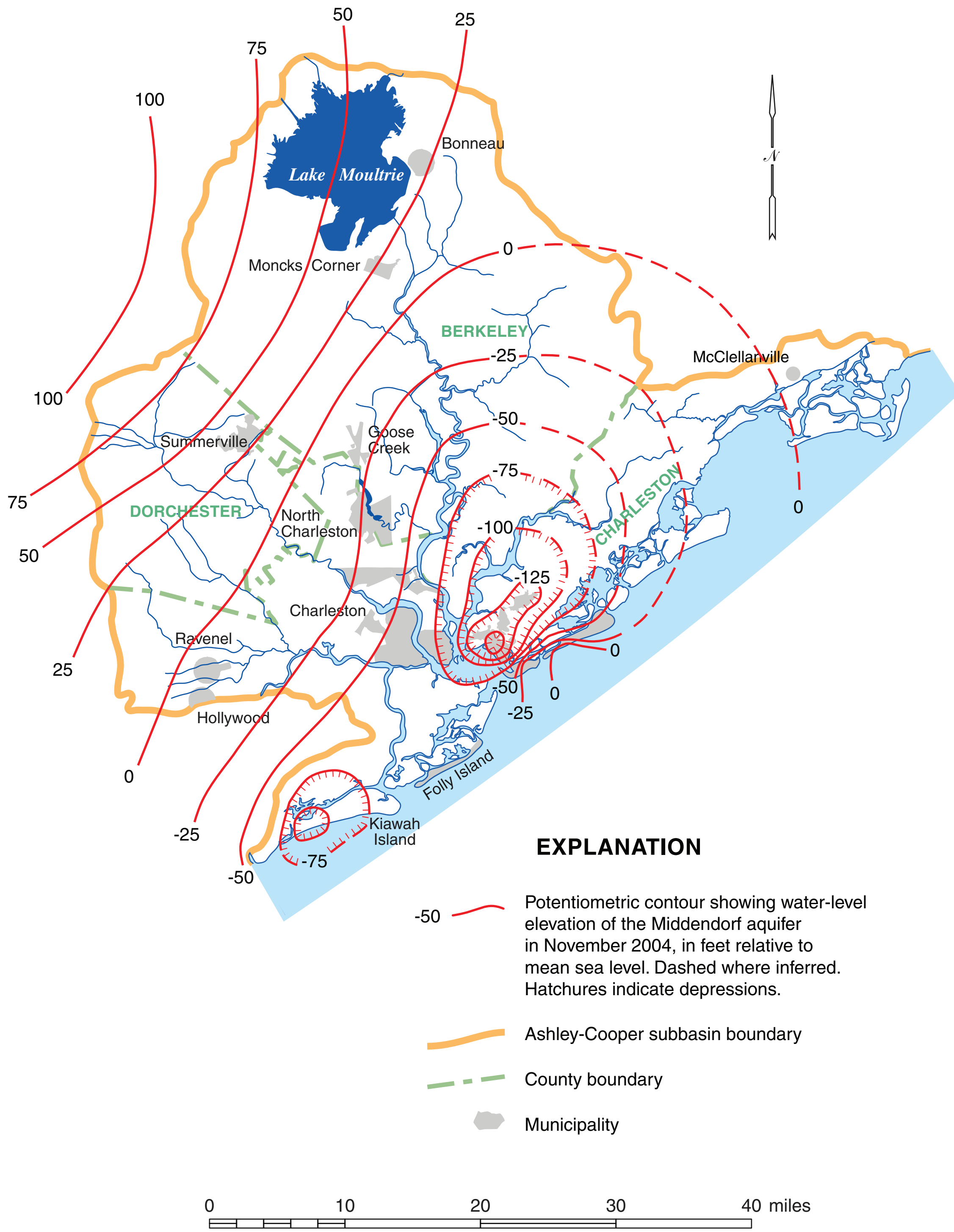


Figure 7-3. Potentiometric contours of the Middendorf aquifer in the Ashley-Cooper River subbasin, November 2004 (from Hockensmith, 2008a).

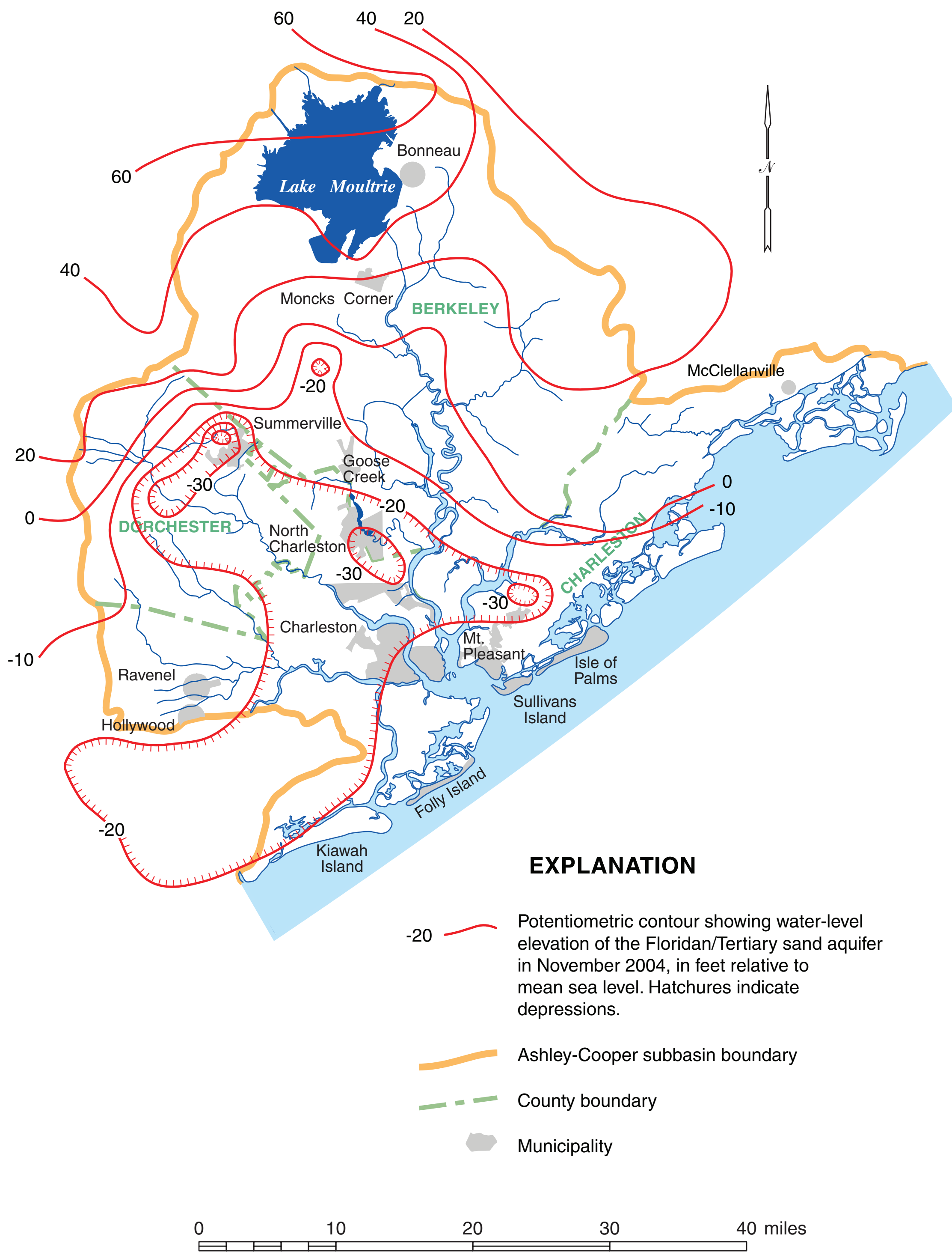


Figure 7-4. Potentiometric contours of the Floridan aquifer in the Ashley-Cooper River subbasin, November 2004 (from Hockensmith, 2009).

Moultrie Water Agency, which serves the Berkeley County Water and Sanitation Authority, the city of Goose Creek, the Moncks Corner Public Water Works Commission, and the Summerville Commissioners of Public Works, had withdrawals of 5,658 million gallons from Lake Moultrie. Thirteen ground-water supply systems have wells in the subbasin. The largest system is Mt. Pleasant in Charleston County, which used 1,783 million gallons in 2006, pumping from the Middendorf aquifer.

Industrial water use was 4,919 million gallons in the subbasin. Of this amount, 3,630 million gallons were from surface-water sources (74 percent) and 1,289 million gallons were from ground-water sources (26 percent). BP Amoco Cooper River chemicals plant near Charleston had the greatest surface-water use, withdrawing 2,619 million gallons from the Cooper River. Nucor Steel in Berkeley County had the greatest ground-water use, withdrawing 1,065 million gallons, mainly from the Middendorf aquifer.

Table 7-6. Reported water use in the Ashley-Cooper River subbasin for the year 2006 (modified from Butler, 2007)

Water-use category	Surface water		Ground water		Total water	
	Million gallons	Percentage of total surface-water use	Million gallons	Percentage of total ground-water use	Million gallons	Percentage of total water use
Aquaculture	68	0.0	4	0.1	72	0.0
Golf course	269	0.1	774	16.0	1,043	0.5
Industry	3,630	1.7	1,289	26.6	4,919	2.2
Irrigation	1,071	0.5	9	0.2	1,080	0.5
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	188,140	86.7	11	0.2	188,150	84.7
Water supply	24,005	11.1	2,757	56.9	26,762	12.1
Total	217,183		4,844		222,027	

Instream water use for hydroelectric power generation totaled 983,111 million gallons in 2006, all by the Jefferies Hydroelectric Station, the only hydroelectric power facility in the subbasin. The plant, owned and operated by Santee Cooper, is located in Berkeley County at Lake Moultrie and has a total capacity of 128 MW (see Table 7-2).

AQUIFER STORAGE AND RECOVERY PROGRAMS

The concept of an aquifer storage and recovery (ASR) program is to treat more surface water than is needed during times of low demand, inject the excess treated water into an aquifer, store it in the ground until the demand for water is high, and then pump the water out of the ground when it can be used to supplement surface-water supplies. ASR wells can provide water for short-term, high-demand periods, which can allow water systems to meet user demands with smaller treatment plants, thereby reducing the overall cost of providing the water. Additionally, the use of an ASR system can reduce water-production costs by allowing treatment plants to operate more efficiently by stabilizing plant production to an optimum flow rate and by treating more surface water in the winter, when the water quality is better than in the summer and is thus less expensive to treat.

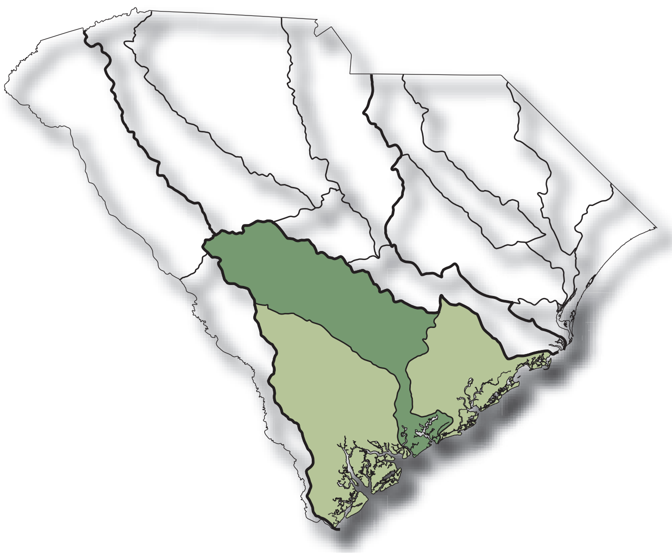
Two of the four active ASR programs in South Carolina are located within the Ashley-Cooper subbasin.

Mount Pleasant Waterworks, in Charleston County, has four ASR wells in operation, all of them completed in aquifers of the Black Mingo Formation. Treated surface water is stored underground during off-peak periods and recovered to supplement drinking-water supplies during periods of peak demand, typically during the spring and summer months. During recovery, the wells each produce between 0.5 and 1.0 million gallons per day.

Kiawah Island Utility, Inc. (KIU), which buys its treated water from Charleston Water System, utilizes two ASR wells to help meet their water demands. Both wells are completed in aquifers of the Black Mingo Formation. The first well was installed in 2002 at their Sora Rail facility near the west end of the island for use during emergencies and peak demand periods (KIU, 2009). Approximately 60 million gallons of treated surface water are stored during non-peak periods for use throughout the peak-demand season. The second well was installed at the east end of Kiawah Island and is used to help satisfy early morning demands. It has a storage-volume target of 60 million gallons (Becky Dennis, KIU, personal communication, 2009). The combined yield of the two wells is about 2.5 million gallons per day.

Figure 7-5. Reported water use in the Ashley-Cooper River subbasin for the year 2006 (modified from Butler, 2007).

EDISTO RIVER SUBBASIN



EDISTO RIVER SUBBASIN

The Edisto River subbasin is in south central South Carolina. From its western extreme in eastern Edgefield County, the subbasin extends southeastward to the coast and follows the course of the Edisto River. The subbasin encompasses parts of 12 South Carolina counties, including most of Colleton and Orangeburg counties and smaller parts of Aiken, Bamberg, Barnwell, Berkeley, Calhoun, Charleston, Dorchester, Edgefield, Lexington, and Saluda Counties (Figure 7-6). The subbasin area is approximately 3,120 square miles, 10.0 percent of the State's area.

DEMOGRAPHICS

The year 2000 population of the subbasin was estimated at 199,000, 5.0 percent of South Carolina's total population. By 2020, the subbasin population is expected to reach 206,000, an increase of 4 percent. The highest rate of population growth is anticipated in Dorchester County, which is projected to have a population increase greater than 30 percent.

The subbasin is primarily rural in character with the city of Orangeburg (population 12,765) being the only sizable urban area. Small towns in the subbasin have experienced negative or little population growth in the past 20 years, including Bamberg (3,733), Denmark (3,328), Johnston (2,336), St. George (2,092), Holly Hill (1,281), and Bowman (1,198).

The year 2005 per capita income for the counties in the subbasin ranged from $20,409 in Barnwell County, which ranked 42nd among the State's 46 counties, to $34,158 in Charleston County, which ranked second. The 1999 median household income ranged from $24,007 in Bamberg County (the lowest in the State) to $44,659 in Lexington County. The median household income was above the State average in five of the 12 subbasin counties (South Carolina Budget and Control Board, 2005).

During 2000, the counties of the subbasin had combined annual average employment of non-agricultural wage and salary workers of about 165,000. Labor distribution in the subbasin counties included management, professional, and technical services, 29 percent; sales and office, 24 percent; production, transportation, and materials moving, 19 percent; service, 15 percent; construction, extraction, and maintenance, 12 percent; and farming, fishing, and forestry, 1 percent.

In the sectors of manufacturing and public utilities, the subbasin counties had an annual product value of about $12 billion in 1997. Agriculture was important in most sections of the subbasin, and total crop and livestock production in the subbasin counties exceeded $500 million in 2003; 2001 timber-product value was about $175 million.

SURFACE WATER

Hydrology

The Edisto River subbasin is drained by four major streams: South Fork Edisto River, North Fork Edisto River, Edisto River, and Four Hole Swamp. The Edisto River is the longest and largest river system completely contained within the borders of South Carolina. The North and South Fork Edisto Rivers originate in and pass through the upper Coastal Plain region before joining to form the Edisto River in the middle Coastal Plain near the

Figure 7-6. Map of the Edisto River subbasin.

town of Branchville. The blackwater Four Hole Swamp, a major tributary originating in Calhoun and Orangeburg Counties, is unique in that it consists of multiple braided channels rather than one well-defined channel. Much of the Edisto River and its tributary streams are associated with extensive swamplands. Near the coast, the Edisto River divides to form the North and South Edisto Rivers, which surround Edisto Island. Near the coast, these tidally-influenced saltwater streams also receive drainage from bordering salt marshes and tidal creeks.

Within this subbasin, the U.S. Geological Survey (USGS) has seven active streamflow gaging stations: one on the Edisto River, one on the North Fork Edisto River, three on the South Fork Edisto River, and one each on McTier Creek and Cow Castle Creek (Figure 7-6). Streamflow statistics for these active stations and three discontinued stations are presented in Table 7-7.

Average annual flow of the South Fork Edisto River is 738 cfs (cubic feet per second) near Denmark, 694 cfs near Cope, and 892 cfs near Bamberg. Ninety percent of the time, streamflow at these sites should be at least 323, 266, and 287 cfs, respectively. For the North Fork Edisto River, average annual flow is 753 cfs at Orangeburg and streamflow should be at least 358 cfs 90 percent of the time. Characteristic of upper Coastal Plain streams, these streamflows are steady, with well-sustained low flows (Figure 7-7).

Table 7-7. Selected streamflow characteristics at USGS gaging stations in the Edisto River subbasin

Gaging station name, location, station number	Period of record	Drainage area (mi^2)	Average flow (cfs)	Average flow (cfsm)	90% exceeds flow (cfs)	Minimum daily flow (cfs), year	Maximum daily flow (cfs), year	Maximum peak flow (cfs), year
McTier Creek near Monetta 1723	1995-97 and 2001-07*	15.3	17.5	1.14	5.2	1.4 2002	248 1996	536 1996
South Fork Edisto River near Montmorenci 1725	1940 to 1996	198	244	1.23	110	40 1954	4,260 1964	5,010 1964
South Fork Edisto River near Denmark 1730	1931-71 and 1980-2007*	720	738	1.03	323	110 2002	12,700 1936	13,500 1936
Sout Fork Edisto River near Cope 1730.3	1991 to 2007*	757	694	0.92	266	87 2002	6,510 1998	7,610 1998
South Fork Edisto River near Bamberg 1730.51	1991 to 2007*	807	892	1.11	287	110 2002	8,080 1998	8,640 1998
Bull Swamp Creek below Swansea 1733.51	2001 to 2003	34.4	8.9	0.26	3.5	3.1 2002	80 2001	93 2002
North Fork Edisto River at Orangeburg 1735	1938 to 2007*	683	753	1.10	358	113 2002	8,850 1945	9,500 1945
Edisto River near Branchville 1740	1945 to 1996	1,720	1,991	1.16	820	325 1990	14,400 1964	14,600 1964
Cow Castle Creek near Bowman 1742.5	1971-81 and 1995-2007*	23.4	19.5	0.83	1.5	0.0 2002	1,030 2003	2,340 1979
Edisto River near Ghivans 1750	1939 to 2007*	2,730	2,522	0.92	684	150 2002	24,100 1973	24,500 1973

mi^2, square miles; cfs, cubic feet per second; cfsm, cubic feet per second per square mile of drainage area
90% exceeds flow: the discharge that has been exceeded 90 percent of the time during the period of record for that gaging station
** 2007 is the most recent year for which published data were available when this table was prepared*

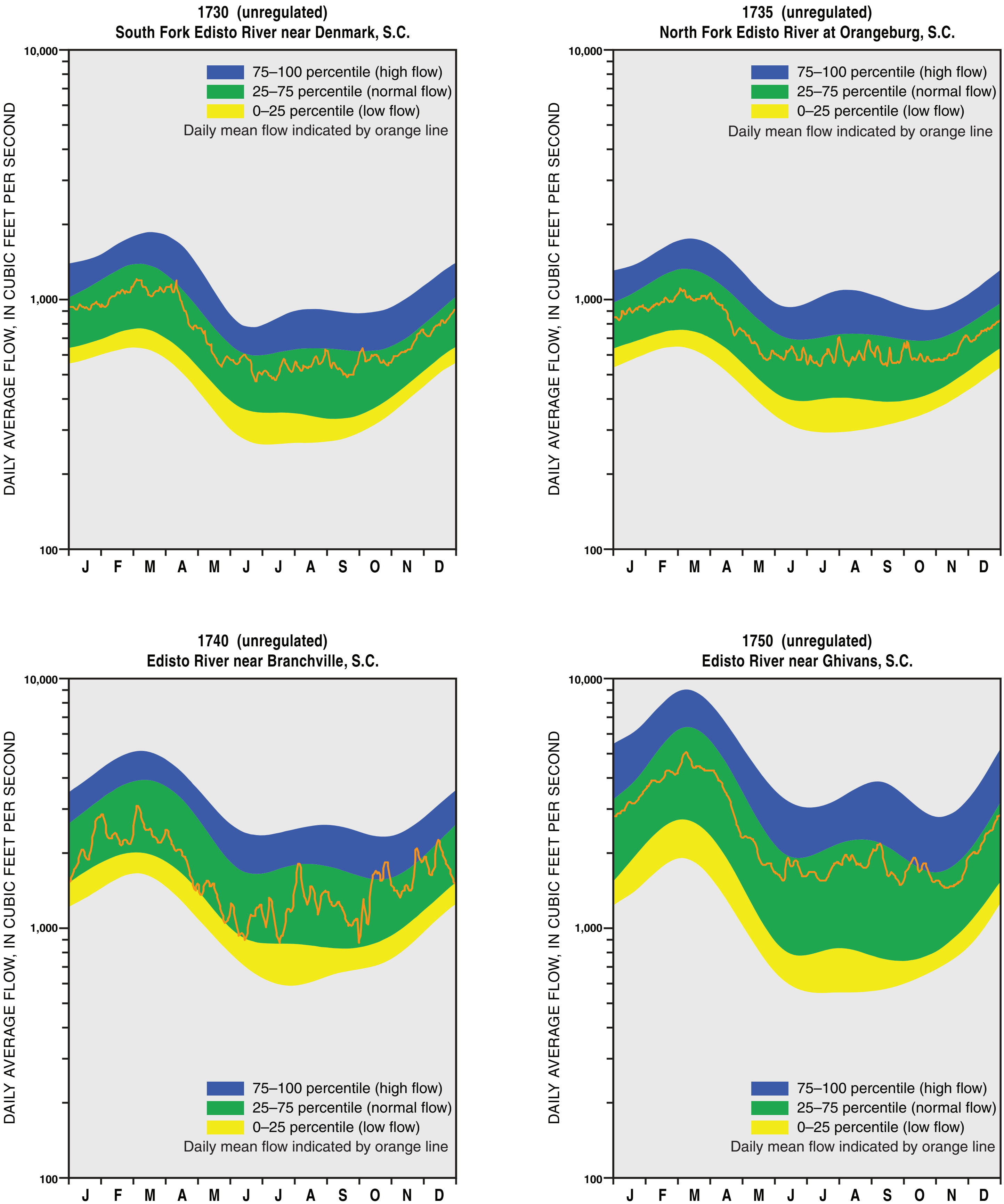


Figure 7-7. Duration hydrographs for selected gaging stations in the Edisto River subbasin.

By contrast, Cow Castle Creek near Bowman, a small tributary of Four Hole Swamp, exhibits more variable flows typical of middle and lower Coastal Plain streams, where flow is more dependent on rainfall and direct runoff. Average annual flow of this stream is 19.5 cfs and should be at least 1.5 cfs 90 percent of the time.

Streamflow on the Edisto River is substantial and fairly consistent (Figure 7-7). These well-sustained flows are caused primarily by discharge from ground-water reserves in the upper Coastal Plain region, in which more than half the drainage area is located. Average annual flow of the Edisto River at the discontinued gage near Branchville is 1,991 cfs and at the gage near Givhans is 2,522 cfs. Streamflow at these sites can be expected to be at least 820 and 684 cfs, respectively, 90 percent of the time. Although large withdrawals by the city of Charleston upstream of the Givhans gage may lower the 90-percent exceedance flow value at this site, those withdrawals alone do not account for the lower exceedance values at the downstream gage.

The highest flow of record for the Edisto River at the Branchville gage is 14,400 cfs, measured in September 1964, and the highest flow of record at the Givhans gage is 24,100 cfs, measured in June 1973. A flow of 25,700 cfs at the location of the Branchville gage has been estimated for a flood event that occurred in September 1928.

The multiyear drought of 1998–2002 broke record low flows previously measured during the drought of the 1950's. A new lowest flow of record for most of the gages was measured in August of 2002.

The Edisto River and tributary streams in the upper Coastal Plain exhibit well-sustained year-round flows and provide a reliable water-supply source. Tributary streams in the middle and lower Coastal Plain region, however, have more variable flows and provide limited surface-water availability during periods of low rainfall.

Development

Surface-water development in the Edisto River subbasin is very limited, consisting of primarily a few navigation and flood-control projects in the southern reach. The Edisto River is completely undammed and unleveed, and no large impoundments occur in the subbasin. Lakes having surface areas of 10 acres or more have an aggregate area of 6,000 acres and a total volume of 29,000 acre-ft (U.S. Army Corps of Engineers, 1991).

The U.S. Army Corps of Engineers (COE) has been involved in four navigation projects and three flood-control projects in the subbasin, none of which are active. The NRCS (Natural Resources Conservation Service), in conjunction with the Horse Range Watershed and Orangeburg Soil and Water Conservation District, completed a flood-control project on Horse Range Swamp in 1975; the project improved 20 miles of channel. The NRCS also has an active flood-control project near Holly Hill in Orangeburg County.

Surface-Water Quality

Most of the water bodies in the Edisto River subbasin are designated "Freshwater" (Class FW). Class FW waters are freshwater bodies suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2004b).

A few water bodies are designated as "Outstanding Resource Water" (Class ORW). These constitute an exceptional recreational and ecological resource or are suitable as a drinking-water source with minimal treatment. Parts of Church Creek and the North Edisto River, and all of Townsend Creek, Frampton Inlet, Dawho River, and Bohicket Creek are classified as ORW.

The South Edisto River and Church Creek from Raven Point Creek to Hoopstick Island are designated as "Shellfish Harvesting" (Class SFH). These tidal saltwater bodies are protected for shellfish harvesting and have the most stringent bacterial standards.

As part of its ongoing Watershed Water Quality Assessment program, DHEC sampled 80 surface-water sites in the Edisto River subbasin between 1997 and 2001 in order to assess the water's suitability for aquatic life and recreational use (Figure 7-8). Aquatic-life uses were fully supported at 58 sites, or 72 percent of the water bodies sampled; most of the impaired sites exhibited low dissolved-oxygen levels. Recreational use was fully supported in 76 percent of the sampled water bodies; water bodies that did not fully support recreational use exhibited high levels of fecal coliform bacteria (DHEC, 2004b). Water-quality impairments in the subbasin are summarized in Table 7-8.

Water-quality conditions can change significantly from year to year, and water bodies are reassessed every 2 years for compliance with State water-quality standards. DHEC publishes the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, as in previous years, DHEC issued a fish-consumption advisory for the South Fork Edisto River from Aiken State Park to the Edisto River, the North Fork Edisto River in Orangeburg County, all of Four Hole Swamp, the Edisto River above Willtown Bluff (near Edisto Island), and Penny Creek in Charleston County. Fish-consumption advisories are issued in areas where fish contaminated with mercury have been found. The contamination is only in the fish and does not make the water unsafe for swimming or boating.

Figure 7-8. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 7-8 (DHEC, 2004b).

Table 7-8. Water-quality impairments in the Edisto River subbasin (DHEC, 2004b)

Water-body name	Station number	Use	Status	Water-quality indicator
Chinquapin Creek	E-091	Recreation	Nonsupporting	Fecal coliform
Horsepen Creek	RS-01004	Recreation	Nonsupporting	Fecal coliform
Bull Swamp Creek	E-034	Aquatic life	Nonsupporting	Dissolved oxygen
North Fork Edisto River	E-099	Recreation	Partially supporting	Fecal coliform
	E-007	Aquatic life	Nonsupporting	pH
	E-007A	Recreation	Partially supporting	Fecal coliform
	E-007C	Aquatic life	Nonsupporting	pH
Shaw Creek	E-094	Aquatic life	Nonsupporting	pH
Windy Hill Creek	E-029	Aquatic life	Partially supporting	Macroinvertebrates
Goodland Creek	E-036	Recreation	Nonsupporting	Fecal coliform
Roberts Swamp	E-039	Aquatic life	Partially supporting	Macroinvertebrates
Cattle Creek	E-108	Recreation	Partially supporting	Fecal coliform
Indian Field Swamp	E-032	Aquatic life	Partially supporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Polk Swamp	E-016	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
	E-109	Aquatic life	Nonsupporting	Dissolved oxygen, macroinvertebrates
		Recreation	Partially supporting	Fecal coliform
South Edisto River	RO-01123	Aquatic life	Nonsupporting	Turbidity
Younges Island Creek	MD-261	Aquatic life	Nonsupporting	Turbidity
Dawho River	RT-01665	Aquatic life	Nonsupporting	Dissolved oxygen, turbidity
	MD-120	Aquatic life	Nonsupporting	Dissolved oxygen, turbidity
Church Creek	MD-195	Aquatic life	Nonsupporting	Dissolved oxygen
Bohicket Creek	MD-209	Aquatic life	Nonsupporting	Dissolved oxygen
Gramling Creek	E-022	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Little Bull Swamp	E-076	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
	E-589	Aquatic life	Partially supporting	Macroinvertebrates
Four Hole Swamp	E-059	Recreation	Partially supporting	Fecal coliform
	E-111	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Goodbys Swamp	RS-01036	Recreation	Nonsupporting	Fecal coliform
Cow Castle Creek	E-050	Recreation	Partially supporting	Fecal coliform
Four Hole Swamp	E-112	Aquatic life	Nonsupporting	Dissolved oxygen
Providence Swamp	E-051	Aquatic life	Partially supporting	Dissolved oxygen
Horse Range Swamp	E-052	Recreation	Partially supporting	Fecal coliform
Four Hole Swamp	E-100	Aquatic life	Partially supporting	Chromium
		Recreation	Partially supporting	Fecal coliform

GROUND WATER

Hydrogeology

The Edisto River subbasin lies completely within the Coastal Plain. The basement (Piedmont) rocks occur at a depth of about 100 feet below land surface at the northwest border of the subbasin, which approximates the Fall Line. Piedmont rocks crop out in riverbeds in the extreme upper reaches of the subbasin, and in a few erosional windows. Near the coast, the sedimentary column is about 3,000 feet thick. Selected ground-water data for the subbasin are presented in Table 7-9.

Ground-water availability in Lexington County is variable. At sites along the Fall Line, water usually must be obtained from the underlying crystalline-rock aquifers where yields are generally low—usually less than 15 gpm (gallons per minute)—and dry holes are common. The southern part of Lexington County is underlain by the Middendorf, Black Creek, and Tertiary sand aquifers. Their combined thickness is 550 feet at Swansea.

The northeastern half of Aiken County is in the subbasin, and the city of Aiken is on the divide between the ACE and Savannah River basins. Near Aiken, where land-surface elevations are about 500 feet above mean sea level, the Coastal Plain sediments are 500 feet thick. Major wells are usually completed in the Middendorf aquifer at depths below 400 feet. Elsewhere in Aiken County, wells are in the Middendorf, Black Creek, or Tertiary sand aquifers and are 70 to 700 feet deep, and yields are 80 to 700 gpm.

The Cretaceous and Tertiary sediments in much of Orangeburg County provide large quantities of good-quality water. Most wells in the upper Coastal Plain of Orangeburg County are developed in the Orangeburg Group, part of the Tertiary sand aquifer, whereas wells in the lower Coastal Plain are developed primarily in the Floridan, Black Creek, and Middendorf aquifers.

Table 7-9. Selected ground-water data for the Edisto River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Pelion-Gaston-Swansea	Middendorf / Black Creek	225–430	70–1,000
Aiken	Middendorf / Black Creek	70–485	120–1,500
Orangeburg	Middendorf / Black Creek / Tertiary sand	105–970	200–1,500
Bowman	Middendorf / Black Creek	350–950	200–1,100
Cope	Middendorf / Black Creek	200–965	300–2,300
Norway	Black Creek / Black Creek	230–350	125–710
North	Middendorf / Black Creek / Tertiary sand	125–480	100–760
Edisto Island	Floridan / Tertiary sand	400–550	200–500

The middle and lower Coastal Plain area of Orangeburg County is underlain by the Cape Fear, Middendorf, Black Creek, Tertiary sand, and Floridan aquifers. The top of the Middendorf aquifer occurs at a depth of 650 feet at Orangeburg and dips southeast to about 1,100 feet at the county boundary. Large-diameter wells screened in this aquifer yield more than 2,000 gpm at Cope. The transmissivity of the aquifer at Orangeburg, Cope, and Eutawville is 20,000 to 27,000 ft^2/day. Hydrologic data for the Black Creek aquifer in the Orangeburg area indicate transmissivities similar to those for the Middendorf. A well at Holly Hill in southern Orangeburg County yielded 1,067 gpm from the Black Creek aquifer.

Wells in the Tertiary sand aquifer yield up to 1,000 gpm. Several wells near the towns of Eutawville and North are screened in both the Tertiary sand and Black Creek aquifers. North and west of the city of Orangeburg, wells in the Tertiary sand aquifer are 200 to 300 feet deep and yield 50 to 400 gpm.

The Floridan aquifer is formed by the Santee Limestone in the middle Coastal Plain and the Santee Limestone and overlying Cooper Formation in the lower Coastal Plain. The Floridan is very transmissive in the Eutawville area in Orangeburg County: transmissivity values of 24,000 and 33,000 ft^2/day have been calculated from tests, and yields as high as 600 gpm have been reported. Transmissivities less than 2,000 ft^2/day are more typical of the lower Coastal Plain section. Shallow aquifers in the Duplin Formation and Pleistocene deposits overlie the Floridan aquifer.

The shallow, Floridan, and Tertiary sand aquifers are the principal sources of ground-water supply where the subbasin includes parts of Dorchester, Colleton, and

Charleston Counties. The underlying Cretaceous aquifers are unused there owing to their great depths and to brackish-water occurrence near the coast.

At Edisto Island, open-hole wells tapping both the base of the Floridan and the upper 20 to 50 feet of the Tertiary sand aquifer are the predominant water source: well depths are between about 200 and 550 feet. Yields are everywhere adequate for domestic and light-commercial use, and public-supply wells at Edisto Beach produce about 500 gpm. Shallow wells also are common around Edisto Island, where Pleistocene deposits are as thick as 60 feet.

The ground-water supply potential of the Edisto River subbasin is at or near the greatest in South Carolina. Multiple, highly-transmissive aquifers in a complex of sediments that contain freshwater to depths as great as 2,000 feet ensure reliable water supplies for towns, industries, and farms.

Ground-Water Quality

The Middendorf and Black Creek aquifers encompass a wide range of water quality. The water in both aquifers tends to be soft, alkaline, and a sodium bicarbonate type grading to a sodium chloride type with depth and proximity to the coast. Both aquifers become more mineralized from the upper reaches to the coast. In the Middendorf aquifer, total dissolved solids (TDS) are 25 to more than 1,000 mg/L (milligrams per liter), sodium ranges from 2.5 to 800 mg/L, chloride ranges from 5 to more than 100 mg/L, alkalinity ranges from 2.5 to more than 1,300 mg/L, fluoride ranges from 2.0 to 11 mg/L, and pH values are between 6.5 and 8.5. A zone of iron concentrations greater than 1.0 mg/L has been noted in these aquifers in Bamberg County. Iron concentrations diminish northwest and southeast of this zone to less than 0.1 mg/L (Lee, 1988).

In the Black Creek aquifer, TDS range between 25 and 2,500 mg/L, sodium ranges between 2.5 and 1,000 mg/L, and chloride ranges between 2.5 and 1,000 mg/L. Alkalinity is as great as 1,000 mg/L at the coast. The pH increases from about 4.5 to more than 9.3 along the subbasin (Park, 1985; Speiran and Aucott, 1994).

At the northwest end of the subbasin, water of the Tertiary sand aquifer is acidic, low in dissolved solids, and usually high in iron. Sodium chloride type water predominates, and hydrogen sulfide occurs locally. Downdip, TDS increase and pH increases to about 7.0 as aquifer sediments become more calcareous (Logan and Euler, 1989; Siple, 1975). Naturally-occurring sodium and chloride are usually the dominant ions. Radioactive ground water has been found in the Leesville area of Lexington County, where gross alpha-particle activity was measured as high as 39 pCi/L (picoCuries per liter). Radium-226 levels in water from wells at North, in Orangeburg County, ranged from 4.6 to 7.1 pCi/L (Scott and Barker, 1962; Siple, 1975).

Along the Colleton County and Dorchester County reach, the Tertiary sand aquifer contains a more mineralized sodium bicarbonate water, which in turn becomes a sodium chloride type across Charleston and northeastern Colleton Counties. Fluoride concentrations increase from about 1.0 mg/L to 5.0 mg/L along the lower third of the subbasin. Brackish water is present at the coast, and chloride concentrations increase along the Colleton and Charleston Counties reach. A chloride concentration of 8,000 mg/L has been reported in a Tertiary sand well at Botany Bay Island north of Edisto Beach.

The Tertiary sand aquifer grades and interfingers southeastward into the Santee Limestone section of the Floridan aquifer. Water in the Floridan aquifer generally is typical of carbonate aquifers. It is a calcium bicarbonate type, has pH between 7.5 and 8, has TDS generally less than 200 mg/L, and is moderately hard to hard. Down the length of the subbasin, TDS concentrations range from 50 to 1,850 mg/L, and high iron concentrations and hydrogen sulfide are common. Chloride concentrations inland of Charleston County are less than 40 mg/L, but are as great as 1,000 mg/L at Edisto Beach.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR and DHEC in 15 wells in the Edisto River subbasin in order to help assess trends or changes in water levels (Table 7-10). Water levels in other wells are sometimes measured to help develop potentiometric maps of the Middendorf, Black Creek, and Floridan aquifers.

No site-specific water-level problems occur in the Middendorf aquifer in this subbasin. Water-level elevations range from more than 300 feet above sea level in the northwest corner of the subbasin to 50 feet below sea level at the southeast edge of the subbasin (Hockensmith, 2008a). In the upper part of this subbasin, near the Middendorf recharge area, water levels are not significantly lower than estimated predevelopment levels. In the lower half of the subbasin, water levels have been lowered because of the large cone of depression surrounding the Charleston area (see Figure 7-3). In Charleston County, near Edisto Island, Middendorf water levels may be as much as 200 feet lower than predevelopment levels (Hockensmith, 2008a).

The potentiometric surface of the Floridan/Tertiary sand aquifer slopes fairly uniformly down toward the southeast, from a high elevation of about 160 feet in central Orangeburg County to about 20 feet below sea level at Edisto Island. A small but deep cone of depression exists around Holly Hill, and the much larger depression that encompasses much of southern Charleston County (see Figure 7-4) impacts water levels near the coast in this subbasin. Water levels in Orangeburg and Bamberg Counties are generally stable and not much lower than estimated predevelopment levels, but

Table 7-10. Water-level monitoring wells in the Edisto River subbasin

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
AIK-826	DNR	33 32 35 81 29 08	Middendorf	DNR cluster site C-3, Aiken State Park	295	485–495
AIK-845	DNR	33 32 35 81 29 08	Middendorf	DNR cluster site C-3, Aiken State Park	297	341–351
AIK-846	DNR	33 32 34 81 29 08	Black Creek	DNR cluster site C-3, Aiken State Park	298	240–250
AIK-847	DNR	33 32 33 81 29 07	Black Creek	DNR cluster site C-3, Aiken State Park	299	178–188
AIK-848	DNR	33 32 33 81 29 07	Black Creek	DNR cluster site C-3, Aiken State Park	300	116–126
AIK-849	DNR	33 32 32 81 29 06	Shallow	DNR cluster site C-3, Aiken State Park	302	82–92
CHN-484	DNR	32 34 55 80 18 22	Floridan	Blue House Plantation, Edisto Island	14	280–548
COL-97	DNR	33 02 51 80 35 51	Floridan	near Canadys	84	134–342
COL-301	DNR	32 30 42 80 17 58	Floridan	Edisto Beach State Park	10	516–545
LEX-844	DNR	33 44 45 81 06 27	Middendorf	Swansea Primary School	360	392–502
ORG-202	DHEC	33 26 53 81 07 30	Tertiary sand	Norway	237	undetermined
ORG-385	DHEC	33 22 09 81 01 50	Black Creek	near Cope	175	475–535
ORG-393	DNR	33 30 29 80 51 54	Black Creek	Clark Middle School, Orangeburg	256	423–463
ORG-430	DNR	33 30 29 80 51 54	Tertiary sand	Clark Middle School, Orangeburg	256	205–265
ORG-431	DNR	33 30 29 80 51 54	Floridan	Clark Middle School, Orangeburg	256	83–88

* *DHEC, South Carolina Department of Health and Environmental Control;*
DNR, South Carolina Department of Natural Resources

water levels in the lower part of the subbasin have declined 10 to 20 feet since 1985 and as much as 40 feet from predevelopment levels. Near Edisto Beach, the increasing specific conductivity measured in wells having declining water levels suggests that saltwater intrusion is occurring (Hockensmith, 2009).

WATER USE

Water use information presented in this chapter is derived from water-use data for the year 2006 that were collected and compiled by DHEC (Butler, 2007) and represents only withdrawals reported to DHEC for that year. Water-use categories and water-withdrawal reporting criteria are described in more detail in the *Water Use* chapter of this publication.

Water use in the Edisto River subbasin for the year 2006 is summarized in Table 7-11 and Figure 7-9. Total offstream water use in the subbasin was 46,958 million gallons in 2006, ranking it ninth among the 15 subbasins. Of this amount, 30,702 million gallons came from surface-water sources (65 percent) and 16,256 million gallons came from ground-water sources (35 percent). Water-supply use accounted for 39 percent of this total, followed by industry (23 percent), thermoelectric power (17 percent), and irrigation (16 percent). Consumptive use in this subbasin is estimated to be 15,299 million gallons, or about 32 percent of the total offstream use.

Surface-water sources provided most of the water for water-supply use in the subbasin (16,534 million gallons, or 89 percent). Ground-water sources supplied 2,007 million gallons (11 percent). Charleston Water System, which serves the city of Charleston and some surrounding areas, was the largest user, withdrawing 11,900 million gallons from the Edisto River in 2006. Orangeburg Department of Public Utilities used 3,485 million gallons from the North Fork Edisto River and the city of Aiken used 743 million gallons from Shaw Creek.

Twenty-nine water supply systems use ground water in the subbasin. The city of Aiken, which has most of their public-supply wells in the Lower Savannah River subbasin, has one well in the Edisto subbasin, which produced 461 million gallons from the Middendorf aquifer in 2006. The town of Edisto Beach used 191 million gallons from a 50-foot thick sandy-limestone formation at the base of the Floridan aquifer system, which is about 550 feet deep. Gilbert-Summit Rural Water District pumped 164 million gallons from shallow sand beds (less than 150 feet deep)—probably part of the outcropping Middendorf and/or Black Creek aquifers—and from the deeper crystalline-rock aquifer.

Table 7-11. Reported water use in the Edisto River subbasin for the year 2006 (modified from Butler, 2007)

Water-use category	Surface water		Ground water		Total water	
	Million gallons	Percentage of total surface-water use	Million gallons	Percentage of total ground-water use	Million gallons	Percentage of total water use
Aquaculture	0	0.0	0	0.0	0	0.0
Golf course	106	0.3	29	0.2	135	0.3
Industry	9,335	30.4	1,502	9.2	10,837	23.1
Irrigation	2,410	7.8	4,938	30.4	7,348	15.7
Mining	3	0.0	1,891	11.6	1,894	4.3
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	2,313	7.5	5,888	36.2	8,201	17.5
Water supply	16,534	53.9	2,007	12.4	18,542	39.5
Total	30,702		16,256		46,958	

Industrial water use totaled 10,837 million gallons in 2006. Of this amount, 9,335 million gallons (86 percent) came from surface-water sources and 1,502 million gallons (14 percent) came from ground-water sources. MeadWestvaco Corporation in North Charleston was the largest surface-water user, withdrawing 9,168 million gallons. The cement manufacturer Holcim, in Orangeburg County, was the largest ground-water user, pumping 623 million gallons, mostly to dewater their limestone quarries.

Two thermoelectric power plants operate in the subbasin, both owned and operated by SCE&G. Cope Station is a coal-fired plant located in Orangeburg County along the South Fork Edisto River. It has a capacity of 430 MW (megawatts). In 2006, the Cope plant used 5,887 million gallons of water from the Black Creek and Middendorf aquifers, making it the single largest ground-water withdrawer in the State in 2006. Canadys Station is a coal-fired plant located in Colleton County along the Edisto River. It has a capacity of 470 MW. In 2006, it used 2,313 million gallons of water from the Edisto River and a small amount of ground water (0.7 million gallons).

Irrigation water use was 7,348 million gallons in the subbasin, the second highest total in this category behind the Combahee-Coosawhatchie subbasin. Of this amount, 4,938 million gallons came from ground-water sources (67 percent) and 2,410 million gallons came from surface-water sources (33 percent). Super Sod Patten Seed Co. in Orangeburg County had the highest use, pumping 1,995 million gallons, most from the Black Creek aquifer. Millwood Farms in Orangeburg County had the greatest surface-water use, withdrawing 708 million gallons.

Mining water use was 1,894 million gallons in the subbasin, the highest in the State. Nearly this entire amount—1,891 million gallons—came from ground-water sources. All of the ground water was used by Martin Marietta Aggregates at their Orangeburg County quarry, mainly for dewatering operations.

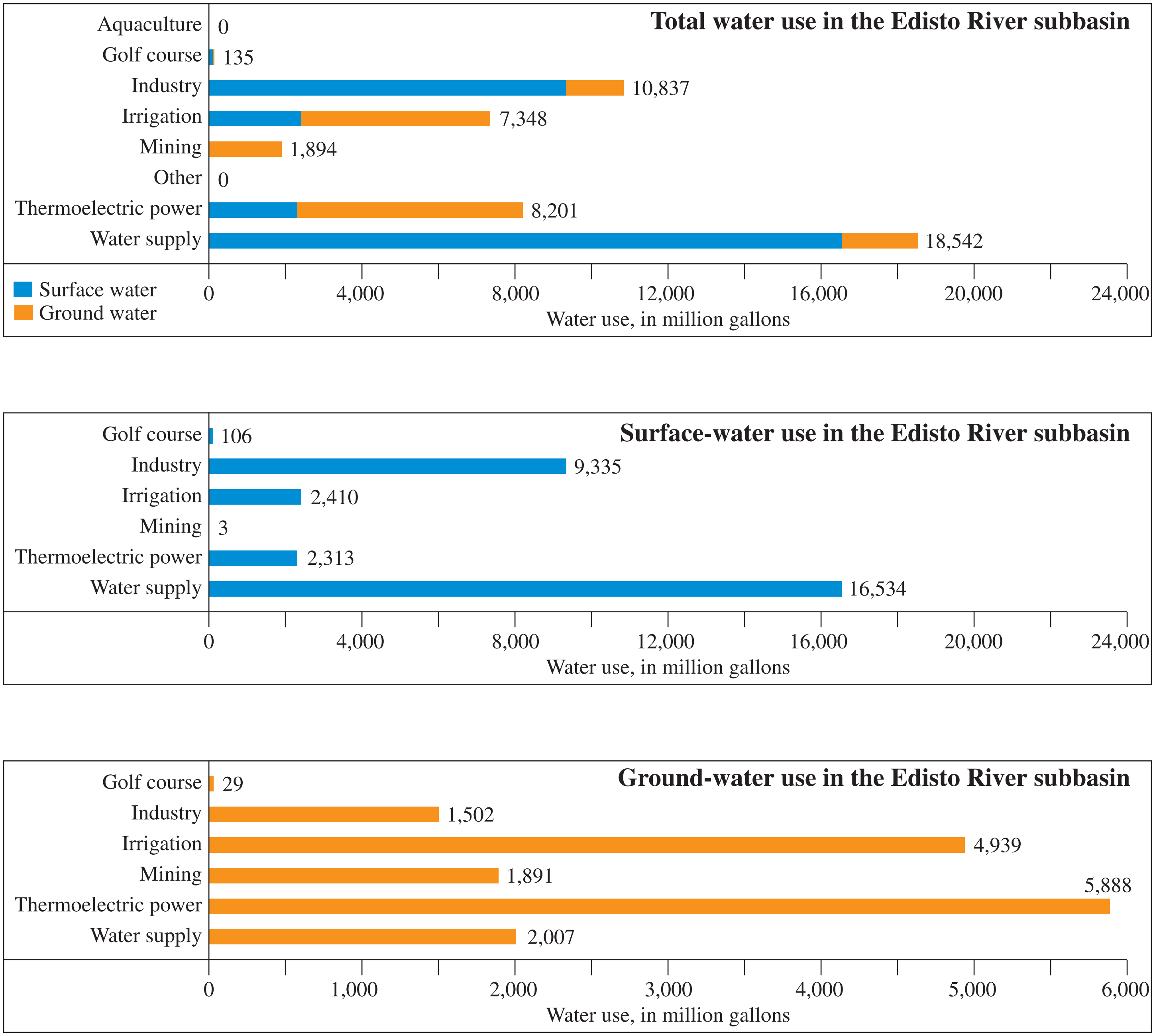
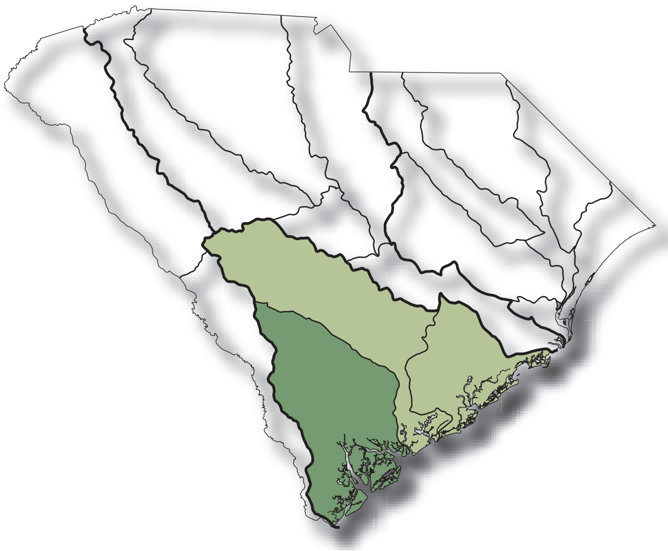


Figure 7-9. Reported water use in the Edisto River subbasin for the year 2006 (modified from Butler, 2007).

COMBAHEE-COOSAWHATCHIE RIVER SUBBASIN



COMBAHEE-COOSAWHATCHIE RIVER SUBBASIN

The Combahee-Coosawhatchie River subbasin is in the southern Coastal Plain region of the State. The subbasin extends 95 miles inland from the Atlantic Ocean and includes all of Beaufort County and parts of Aiken, Allendale, Bamberg, Barnwell, Colleton, Hampton, and Jasper Counties (Figure 7-10). The subbasin area is approximately 3,270 square miles, 10.5 percent of State.

DEMOGRAPHICS

The year 2000 population of the subbasin was estimated at 229,300, 5.7 percent of the State's total population. By the year 2020, the subbasin population is expected to reach 273,000, an increase of 19 percent. The highest rate of population growth during this time period is anticipated for Beaufort County, which grew 37 percent between 1990 and 2000.

In general, the subbasin is rural outside of Beaufort County, which is becoming increasingly urbanized. The county includes the affluent retirement and resort community of Hilton Head Island, the State's ninth largest city in 2000. Substantial growth now occurs in the area between Hilton Head Island and Beaufort.

The major centers of 2000 population in the subbasin were Hilton Head Island (33,862), Beaufort (12,950), Laurel Bay (6,625), Barnwell (5,556), Walterboro (5,153), Allendale (4,410), Bamberg (3,733), Denmark (3,328), and Hampton (2,837).

The per capita income of the region in 2005 ranged from $39,308 in Beaufort County, which ranked first among the State's 46 counties, to $18,871 in Allendale County, which ranked last. Of the remaining subbasin counties, only Aiken County had a per capita income as high as the State average ($28,285). Median household incomes for 1999 ranged from the State's highest, $46,992 in Beaufort County, to the State's lowest, $20,898 in Allendale County. Six of the eight counties ranked below the State average ($37,082).

During 2000, the counties of the subbasin had combined annual average employment of nonagricultural wage and salary workers of about 98,000. Labor distribution in the subbasin counties included management, professional, and technical services, 27 percent; sales and office, 25 percent; service, 18 percent; production, transportation, and materials moving, 15 percent; construction, extraction, and maintenance, 14 percent; and farming, fishing, and forestry, 1 percent. Farming, fishing, and forestry employment averaged about four times as great as the State average; management, professional, and technical employment and production-related employment were significantly below State averages.

In the sectors of manufacturing and public utilities, the subbasin counties had a relatively low annual product value of $5.7 billion in 1997, when Aiken County provided nearly 75 percent of manufacturing output. Agricultural production in individual counties was generally less than $15 million, although Aiken County accounted for $59 million. The year 2003 delivered value of timber was about $125 million in the eight subbasin counties; Colleton County, which ranked fourth in the State, delivered $32.4 million (South Carolina Budget and Control Board, 2005).

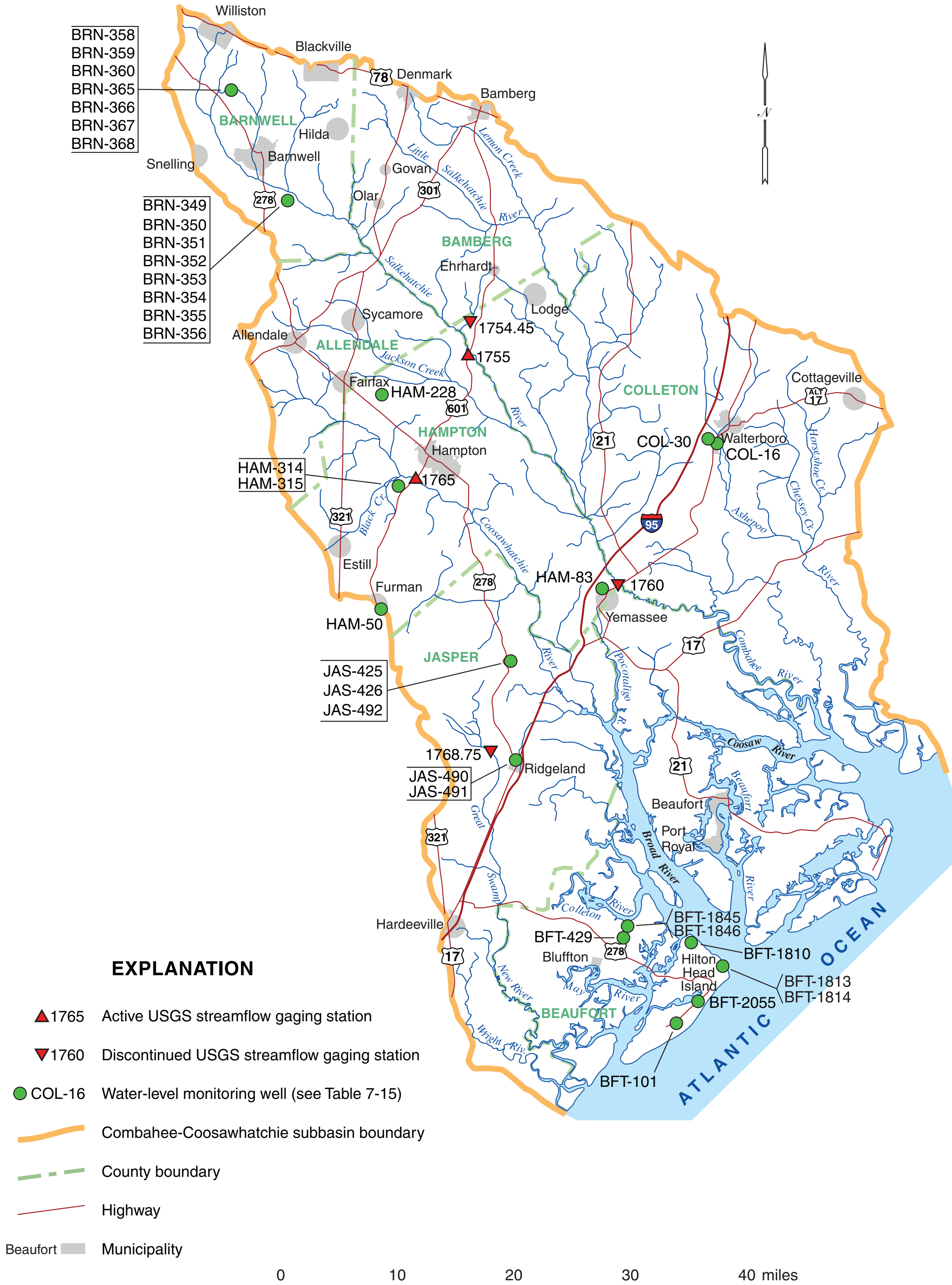


Figure 7-10. Map of the Combahee-Coosawhatchie River subbasin.

SURFACE WATER

Hydrology

The major streams draining this mostly middle and lower Coastal Plain subbasin are the Salkehatchie River, Coosawhatchie River, and Ashepoo River. The Salkehatchie and Little Salkehatchie Rivers join to form the tidally-influenced Combahee River. The Coosawhatchie River discharges into the Broad River, a tidal saltwater river that also receives drainage from surrounding marshlands. The coastal area of this subbasin contains the most extensive estuarine water bodies in the State. These coastal water bodies are dominated by St. Helena Sound and Port Royal Sound and include numerous, often interconnecting, tidal creeks and rivers.

Streamflow has been monitored on the Salkehatchie and Coosawhatchie Rivers since 1951. A gage was also in operation for several years in the 1950's on the Combahee River near Yemassee. Another gage was in operation on Great Swamp from 1977 to 1984. Streamflow statistics of these active and discontinued gaging stations are presented in Table 7-12. Several stage-only gages are in operation on the Broad River.

Table 7-12. Selected streamflow characteristics at USGS gaging stations in the Combahee-Coosawhatchie River subbasin

Gaging station name, location, station number	Period of record	Drainage area (mi^2)	Average flow (cfs)	Average flow (cfsm)	90% exceeds flow (cfs)	Minimum daily flow (cfs), year	Maximum daily flow (cfs), year	Maximum peak flow (cfs), year
Savannah Creek at Ehrhardt 1754.45	2001 to 2003	2.2	4.3	1.96	0.23	0.11 2002	96 2003	– – –
Salkehatchie River near Miley 1755	1951 to 2007*	341	337	0.99	91	2.9 2002	3,390 1992	4,360 1992
Combahee River near Yemassee 1760	1951 to 1957	1,100	483	0.44	60	9.0 1954	5,070 1955	– – –
Coosawhatchie River near Hampton 1765	1951 to 2007*	203	169	0.83	2.2	0.0 many years	6,590 1969	8,910 1992
Great Swamp near Ridgeland 1768.75	1977 to 1984	48.8	31	0.64	0.0	0.0 many years	1,950 1984	– – –

mi^2, square miles; cfs, cubic feet per second; cfsm, cubic feet per second per square mile of drainage area
90% exceeds flow: the discharge that has been exceeded 90 percent of the time during the period of record for that gaging station
** 2007 is the most recent year for which published data were available when this table was prepared*

Average-annual streamflow of the Salkehatchie River near Miley is 337 cfs (cubic feet per second) and can be expected to be at least 91 cfs 90 percent of the time. Streamflow at this site is relatively steady and well-sustained (Figure 7-11), probably due to discharges from ground-water storage and from several headwater streams in the upper Coastal Plain region. Flow at this site rarely exceeds 1,000 cfs; the maximum flood flow of record—4,360 cfs—was recorded in 1992.

Streamflow in the Coosawhatchie River is more variable than in the Salkehatchie River (Figure 7-11). Average annual flow of this river near Hampton is 169 cfs, and the flow can be expected to equal or exceed 2.2 cfs 90 percent of the time. This stream is entirely contained in the middle and lower Coastal Plain and is, therefore, dependent on rainfall and runoff from the area's low-lying and highly-permeable terrain to support streamflow. Flow in the Coosawhatchie River can diminish greatly during summer months, and periods of no flow have been recorded numerous times since 1951. Flow at this site rarely exceeds 1,000 cfs; the maximum flood flow of record—8,910 cfs—was recorded in 1992.

Although the period of record for streamflow data on Great Swamp is short, the data collected indicate characteristics typical of lower Coastal Plain streams, including several periods of no flow during summer months.

The quantity of fresh surface water available in this subbasin is limited. Available streamflow in the upper portion of the Salkehatchie River is reliable, but flow downstream in the middle and lower Coastal Plain region

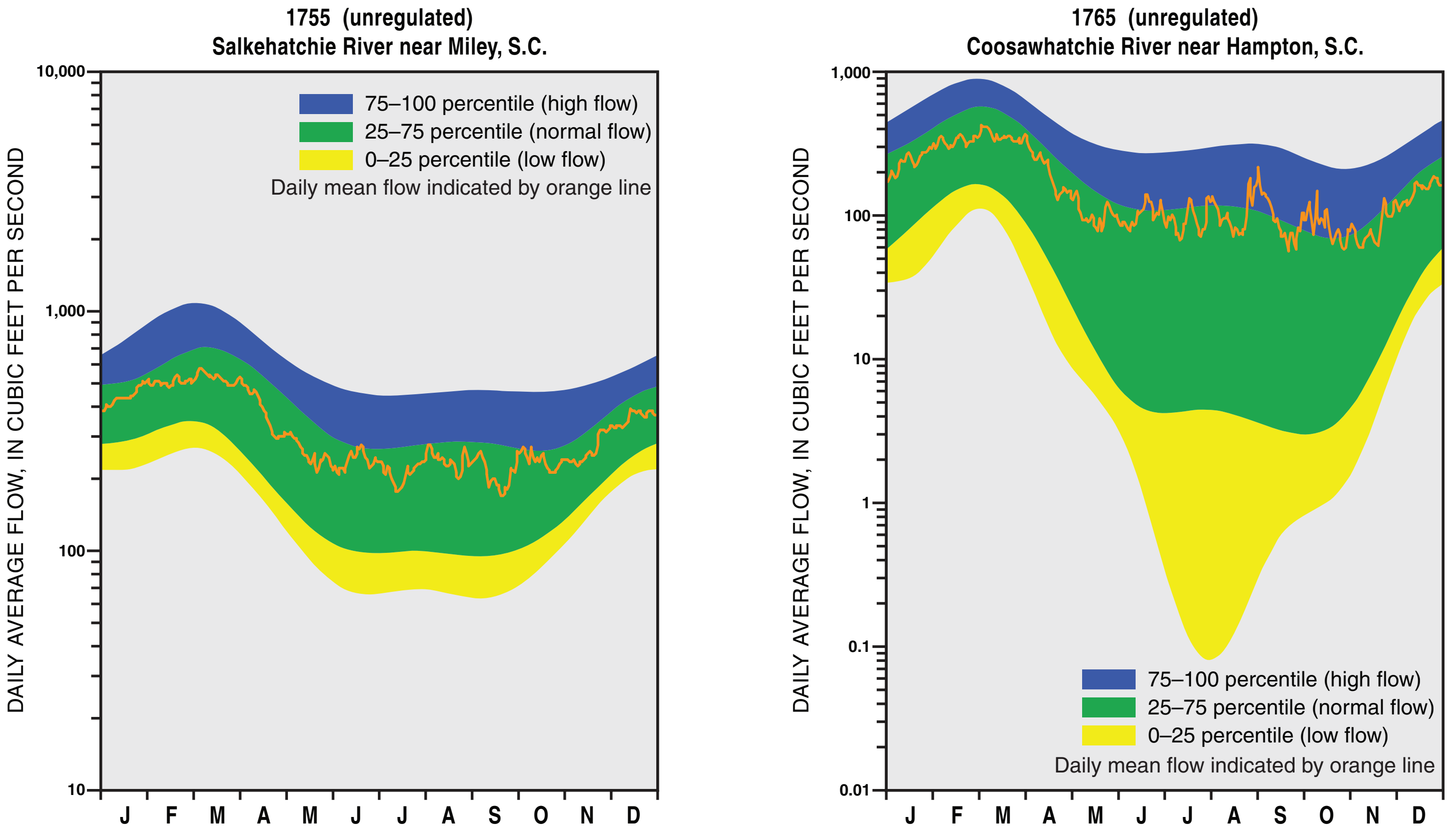


Figure 7-11. Duration hydrographs for selected gaging stations in the Combahee-Coosawhatchie River subbasin.

may be subject to greater variability. Available streamflow in the Coosawhatchie River and Great Swamp is extremely limited and unreliable since flow is often nonexistent during summer and fall months.

Development

Surface-water development in the Combahee-Coosawhatchie River subbasin consists primarily of navigation projects in tidal water bodies and some flood-control projects.

The subbasin contains no large reservoirs, and the largest lake is an unnamed pond near the Ashepoo River with a surface area of 800 acres and a volume of 2,400 acre-ft. Lake Warren on Black Creek near the town of Hampton has a surface area of 600 acres and a volume of 3,600 acre-ft. The total surface area of all lakes larger than 10 acres is about 7,000 acres, and total volume is approximately 29,000 acre-ft (U.S. Army Corps of Engineers, 1991). No hydroelectric-power facilities occur in the subbasin.

The U.S. Army Corps of Engineers (COE) has conducted extensive navigation projects in the subbasin, concentrated primarily near the coast. Channels are maintained through Port Royal Sound, the Beaufort River, and Battery Creek for the port of Port Royal. The COE also maintains a long section of the Atlantic Intracoastal Waterway.

The Willow Swamp watershed of Colleton and Bamberg Counties and upper New River in Jasper County are areas of past Natural Resources Conservation Service flood-control projects. Willow Swamp has had 37 miles of channel improvement and the New River has had 28 miles of channel improvement. Beaufort County has undertaken many smaller-scale flood-control projects.

Surface-Water Quality

Surface-water bodies in the Combahee-Coosawhatchie River subbasin encompass five water-use classifications (DHEC, 2003d). Parts of the Colleton River and the mouth of the May River are designated as “Outstanding Resource Water” (Class ORW), which are saltwater bodies that constitute outstanding recreational or ecological resources.

Portions of the New River and the Beaufort River are designated “Tidal Saltwater” (Class SA). Class SA water bodies are tidal saltwater bodies suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora and for primary- and secondary-contact recreation, crabbing, and fishing. These water bodies are not protected for harvesting clams, mussels, or oysters for market purposes or human consumption. Class SA waters must always have dissolved-oxygen concentrations at or greater than 4.0 mg/L (milligrams per liter) and have daily average dissolved-oxygen levels of at least 5.0 mg/L.

A portion of Bees Creek is classified as "Tidal Saltwater" (Class SB). Class SB water bodies are the same as Class SA water bodies, except that Class SB waters must only maintain dissolved-oxygen concentrations of at least 4.0 mg/L.

A large number of water bodies in the coastal reaches of the subbasin are designated "Shellfish Harvesting" (Class SFH). These tidal saltwater bodies are protected for shellfish harvesting and have the most stringent bacterial standards. Class SFH water bodies include parts of the Combahee River, the lower Ashepoo River, Coosawhatchie River, Pocotaligo River, Chechessee River, Whale Branch, Coosaw River, Beaufort River, Calibogue Sound, Broad Creek, part of Port Royal Sound, the mouth of Skull Creek, and the mouth of May River.

All other water bodies in this subbasin are designated "Freshwater" (Class FW). Class FW water bodies are suitable for survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses.

As part of its ongoing Watershed Water Quality Assessment program, DHEC sampled 68 sites in the Combahee-Coosawhatchie subbasin between 1996 and 2000 in order to assess the water's suitability for aquatic life and recreational use (Figure 7-12). Aquatic life was fully supported at 49 sites, or 72 percent of the water bodies sampled; most of the impaired sites exhibited low dissolved-oxygen levels. Recreational use was fully supported in 61 percent of the sampled water bodies; water bodies that did not fully support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2003d). Water-quality impairments in the subbasin are summarized in Table 7-13. Because of high phosphorus levels, Lake Edgar Brown in Barnwell County is one of the most eutrophic small lakes in South Carolina.

Water-quality conditions can change significantly from year to year, and water bodies are reassessed every 2 years for compliance with State water-quality standards. DHEC publishes the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, as in several prior years, DHEC issued fish-consumption advisories for the Coosawhatchie River in Jasper County; the Salkehatchie River from U.S. Highway 301 to the Combahee River; the entire Little Salkehatchie River; the Combahee River from the Salkehatchie River to U.S. Highway 17; the Ashley River from Walterboro to U.S. Highway 17; part of New River (Great Swamp) in Jasper County; and Cuckolds, Chessey, and Horseshoe Creeks in Colleton County. Fish-consumption advisories are issued in areas where fish are contaminated with mercury; the contamination is only in the fish and does not make the water unsafe for swimming or boating.

GROUND WATER

Hydrogeology

The Combahee-Coosawhatchie River subbasin is in the lower Coastal Plain. Ground water in the subbasin is available from six aquifers: the Cape Fear, Middendorf, Black Creek, Tertiary sand, Floridan, and shallow aquifers. Table 7-14 lists the depths and yields of major wells in the subbasin. This subbasin is part of the most intensely studied and monitored region of South Carolina, outside of the Savannah River Site.

The Cape Fear and Middendorf aquifers are not generally used for water supply, primarily because of their depths and the availability of water from shallower aquifers. The top of the Middendorf extends from about 600 feet below land surface at Williston to nearly 3,000 feet on the coast. At Walterboro, in Colleton County, two wells screened between the depths of 1,602 and 1,760 feet flowed at a rate of more than 1,000 gpm (gallons per minute) in the 1970's. A 3,400-foot public-supply well on Hilton Head Island is screened in the Cape Fear and Middendorf aquifers and produces about 2 million gallons per day; water from this well is treated by reverse osmosis and blended with water from the Floridan aquifer.

The Black Creek aquifer has been tapped by a few wells near the upper end of the subbasin where the top of this aquifer is at a depth of approximately 400 feet. It is below 2,000 feet near the coast. In Beaufort County, the Black Creek aquifer consists of about 800 feet of sediment that is mostly clay. In Allendale, Barnwell, Colleton, and Hampton Counties, several large-diameter municipal and irrigation wells withdraw water from this aquifer, with yields in excess of 1,000 gpm.

The Tertiary sand aquifer beneath the subbasin mainly consists of the Black Mingo Formation. The top of the Tertiary sand aquifer ranges in depth from 400 feet in Allendale County to 1,200 feet near Beaufort, where the aquifer is about 250 feet thick. Fine-grained sediments such as clay or clayey limestone comprise much of the aquifer in coastal areas. In Hampton and Colleton Counties, the top of the aquifer ranges from 500 to 1,000 feet in depth and wells usually yield less than 500 gpm.

The Floridan aquifer is the main source of ground water in all but the upper end of the subbasin. Wells 50 to 900 feet deep tap this aquifer and provide most of the ground water used. The thickness of the Floridan aquifer ranges from 500 feet in Hampton and Colleton Counties to 1,000 feet at Hilton Head Island.

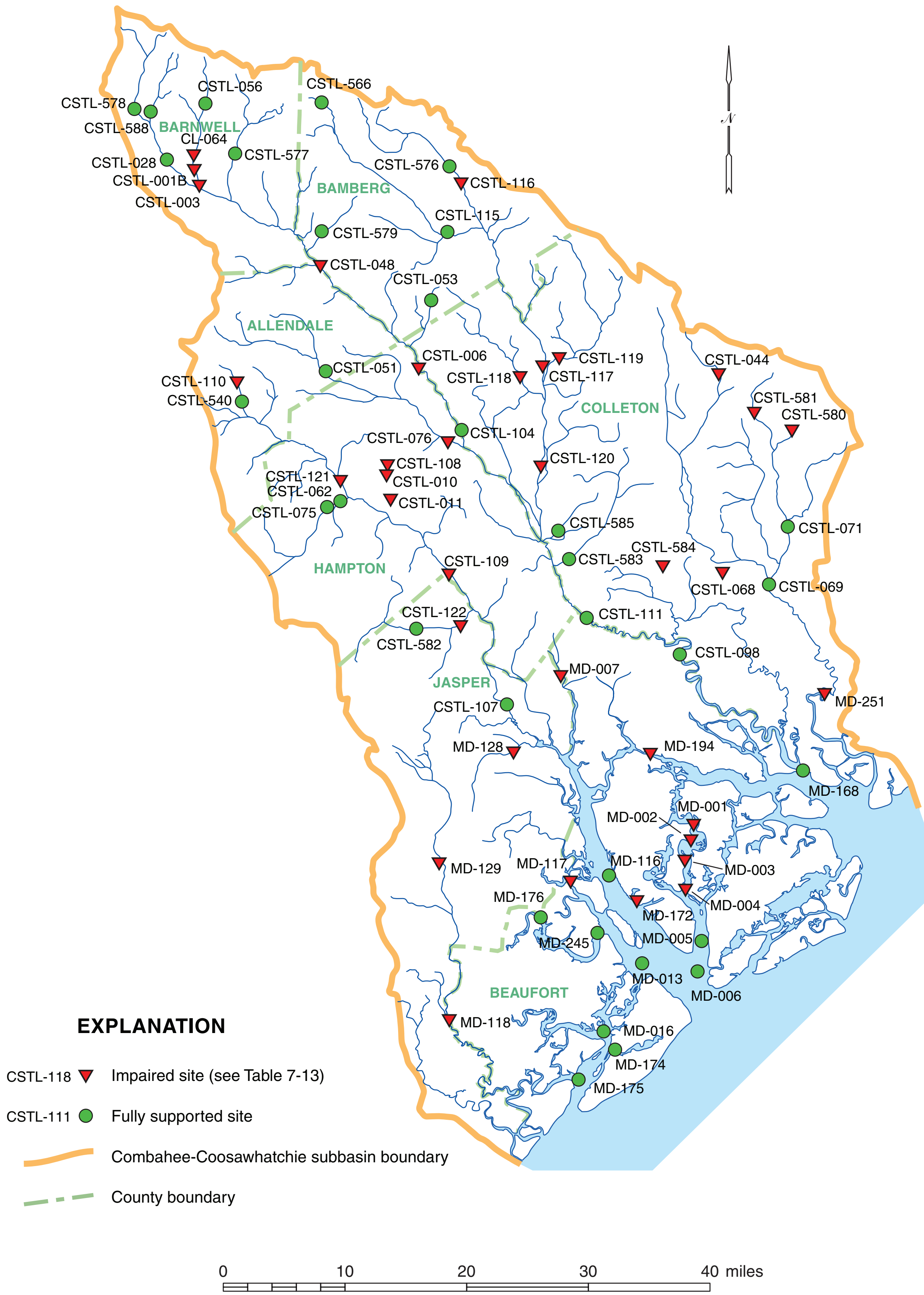


Figure 7-12. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 7-13 (DHEC, 2003d).

Table 7-13. Water-quality impairments in the Combahee-Coosawhatchie River subbasin (DHEC, 2003d)

Water-body name	Station number	Use	Status	Water-quality indicator
Turkey Creek	CSTL-001B	Recreation	Partially supporting	Fecal coliform
Lake Edgar Brown	CL-064	Aquatic life	Nonsupporting	Chlorophyll-*a*
Salkehatchie River	CSTL-003	Recreation	Partially supporting	Fecal coliform
	CSTL-048	Recreation	Partially supporting	Fecal coliform
	CSTL-006	Recreation	Partially supporting	Fecal coliform
Whippy Swamp	CSTL-076	Recreation	Partially supporting	Fecal coliform
Lemon Creek	CSTL-116	Recreation	Partially supporting	Fecal coliform
Little Salkehatchie River	CSTL-117	Recreation	Partially supporting	Fecal coliform
Buckhead Creek	CSTL-119	Recreation	Nonsupporting	Fecal coliform
Willow Swamp	CSTL-118	Recreation	Nonsupporting	Fecal coliform
Little Salkehatchie River	CSTL-120	Recreation	Partially supporting	Fecal coliform
Ireland Creek	CSTL-044	Recreation	Nonsupporting	Fecal coliform
Bluehouse Swamp	CSTL-584	Aquatic life	Nonsupporting	Macroinvertebrates
Fuller Swamp Creek	CSTL-581	Aquatic life	Nonsupporting	Macroinvertebrates
Chessey Creek	CSTL-580	Aquatic life	Nonsupporting	Macroinvertebrates
Ashepoo River	CSTL-068	Recreation	Partially supporting	Fecal coliform
	MD-251	Aquatic life	Nonsupporting	Turbidity
Coosawhatchie River	CSTL-110	Aquatic life	Partially supporting	Dissolved oxygen
	CSTL-121	Aquatic life	Nonsupporting	Dissolved oxygen
Sanders Branch	CSTL-108	Recreation	Nonsupporting	Fecal coliform
	CSTL-010	Recreation	Partially supporting	Fecal coliform
	CSTL-011	Aquatic life	Partially supporting	Macroinvertebrates, dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Coosawhatchie River	CSTL-109	Aquatic life	Nonsupporting	Dissolved oxygen, pH
Bees Creek	MD-128	Aquatic life	Partially supporting	Dissolved oxygen, pH
		Recreation	Partially supporting	Fecal coliform
Cypress Creek	CSTL-122	Recreation	Partially supporting	Fecal coliform
Pocotaligo River	MD-007	Aquatic life	Nonsupporting	Turbidity
		Recreation	Nonsupporting	Fecal coliform
Broad River	MD-172	Aquatic life	Partially supporting	Dissolved oxygen
Chechessee River	MD-117	Aquatic life	Nonsupporting	Dissolved oxygen
Beaufort River	MD-001	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-002	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-003	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-004	Aquatic life	Nonsupporting	Dissolved oxygen
Whale Branch	MD-194	Aquatic life	Nonsupporting	Dissolved oxygen
Great Swamp	MD-129	Recreation	Partially supporting	Fecal coliform
New River	MD-118	Aquatic life	Nonsupporting	pH
		Recreation	Nonsupporting	Fecal coliform

Table 7-14. Selected ground-water data for the Combahee-Coosawhatchie River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Allendale-Fairfax	Floridan (shallow wells), Tertiary sand or Black Creek (deep wells)	350–1,040	400–1,250
Barnwell		270–320	250–500
Blackville		300–470	300–2,000
Bamberg-Denmark		160–1,000	200–2,150
Williston		450–900	1,350
Hampton	Tertiary sand	700–1,000	400–3,000
Estill	Floridan	180–300	500–2,050
	Black Creek	1,015	800
Walterboro	Floridan (lower) / Tertiary sand	492–563	280–300
	Middendorf	1,680–1,760	1,200–1,430
Edisto Beach	Floridan (lower)	514–570	390–450
Hilton Head Island	Floridan (upper)	195–240	920–1,500
	Middendorf / Cape Fear	3,832	1,209

Many large wells in southwestern Beaufort, Hampton, and Jasper Counties produce water from the Ocala Limestone section of the Floridan aquifer. They range in depth from 40 to 500 feet. Beaufort County has, by far, the most wells in the Floridan aquifer. Nearly 70 pumping tests, at discharge rates of 40 to 2,900 gpm, indicated transmissivity as high as 106,000 ft^2/day. More than half of the tests showed transmissivity greater than 10,000 ft^2/day. Six Floridan-aquifer pumping tests from wells in Hampton County indicate transmissivity values from 1,200 to 12,000 ft^2/day and yields from 100 to 1,500 gpm. Jasper County, with 11 pumping tests, had the consistently highest transmissivity values, all between 35,000 and 67,000 ft^2/day, and well yields of 260 to 1,600 gpm.

The shallow aquifer encompasses the Hawthorn and Duplin Formations and various Pleistocene deposits and is developed by 25- to 60-foot wells. Ten pumping tests yielded transmissivity values from 150 to 2,100 ft^2/day. Well yields were 75 gpm or less. This aquifer is a source of domestic water supplies in coastal areas where the underlying Floridan aquifer is brackish.

Ground-Water Quality

Water quality in the Middendorf aquifer varies throughout the subbasin. In the upper reaches, the water quality is good; the water is a dilute sodium chloride type with a TDS (total dissolved solids) concentration near 50 mg/L (milligrams per liter) and pH of about 6.5. Downdip, the ground water becomes increasingly mineralized and alkaline; TDS concentrations exceed 1,000 mg/L and pH values are between 8.0 and 8.5. Chloride concentrations exceed 250 mg/L and a fluoride concentration of 8.5 mg/L was found in a Fripp Island well in Beaufort County (Speiran and Aucott, 1994).

Water quality in the Black Creek aquifer is similar to that of the Middendorf aquifer, and, like the Middendorf, it becomes more mineralized downgradient. Total dissolved solids range from 50 mg/L in the upper part of the subbasin to 200 mg/L in southern Allendale County and greater than 2,500 mg/L near the coast. Sodium and chloride concentrations increase from about 3 to 1,000 mg/L, alkalinity increases from less than 25 to more than 1,000 mg/L, and pH values increase from about 5.5 to more than 7.5 (Speiran and Aucott, 1994; Logan and Euler, 1989). Samples taken during drilling projects showed chloride concentrations of 440 and 1,100 mg/L at Parris Island and Fripp Island, respectively (Siple, 1956; Hayes, 1979).

Dissolved-iron concentrations of 1.0 mg/L are present in Cretaceous aquifers in Bamberg County. Iron concentrations diminish southeast of this zone to less than 0.1 mg/L between Walterboro and the coast (Lee, 1988).

The Tertiary sand aquifer is present in the upper reaches of the subbasin. Water from this aquifer has low TDS (usually less than 50 mg/L), is acidic, and locally is high in iron. Hydrogen sulfide gas is present in some areas. Downdip, the water evolves into a calcium bicarbonate type as sediments become more calcareous and TDS, alkalinity, and pH increase (Logan and Euler, 1989).

The Floridan aquifer is the most widely-used aquifer in the middle and lower reaches of the subbasin. Its water is a calcium bicarbonate type with a pH between 7.5 and 8, TDS concentration less than 200 mg/L, and hardness usually less than 140 mg/L (as $CaCO_3$) (Hayes, 1979). Dissolved solids tend to increase downdip except near Allendale, where TDS decrease because of local recharge (Logan and Euler, 1989).

In the coastal areas, water quality in the Floridan aquifer varies with proximity to saltwater. In Beaufort County, chloride concentrations are 100 to 7,000 mg/L in the lower and middle Floridan permeable zones (Hughes and others, 1989). In the upper permeable zone, chloride concentrations are less than 10 mg/L inland of the Sea Islands and 25 to 100 mg/L beneath most of St. Helena and Hilton Head Islands, but exceed 10,000 mg/L beneath areas of the Port Royal Sound estuary (see the *Special Topics* chapter). Brackish water is present beneath the tidal streams between St. Helena Sound and Port Royal Sound; the islands are underlain by freshwater lenses that have low TDS concentrations, are moderately hard, and commonly contain dissolved iron in concentrations above 0.3 mg/L and hydrogen sulfide.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR, DHEC, and USGS in 35 wells within the Combahee-Coosawhatchie subbasin (Table 7-15). Water levels in other wells in the subbasin are sometimes measured to help develop potentiometric maps of the Middendorf, Black Creek, and Floridan aquifers.

The Floridan aquifer is the source of most ground water in this subbasin, and years of pumping from this aquifer have significantly changed the aquifer's potentiometric surface in the lower part of the subbasin. Whereas predevelopment water levels were estimated to be above sea level throughout the subbasin, water levels are now at or below sea level in most of the coastal areas (Figure 7-13). Although some of this water-level decline stems from pumping in Beaufort, Colleton, and Charleston Counties, much of the decline is due to pumping from the Floridan aquifer at Savannah, Georgia. A large cone of depression has developed around Savannah, where water levels in the aquifer that were originally 10 to 35 feet above sea level in 1880 were as low as 140 feet below sea level in 2004. In 2004, the lowest point on the Floridan potentiometric surface in South Carolina, in southern Jasper County, was 57 feet below sea level, about 80 feet below the predevelopment level (Hockensmith, 2009).

The Floridan water-level decline has changed the original direction of ground-water movement from a southeasterly flow toward Port Royal Sound to a southwesterly flow toward Savannah. Lower water levels in the aquifer along the coast and the change in ground-water flow direction have allowed for the lateral and vertical movement of saltwater into the aquifer beneath Edisto Beach, Hilton Head Island, and in Port Royal Sound in southern Beaufort County. Research by DHEC and the USGS has shown that brackish water is moving from marshlands and tidal streams toward the top of the Floridan aquifer in areas northeast of Savannah. This vertical contamination will affect water quality at Savannah well in advance of the lateral saltwater migration from Port Royal Sound (see the *Special Topics* chapter). Continued pumping of the Floridan aquifer near the Savannah cone of depression may also lead to permanent degradation of the aquifer by causing compaction of overlying confining beds.

WATER USE

Water-use information presented in this chapter is derived from water-use data for the year 2006 that were collected and compiled by DHEC (Butler, 2007) and represents only withdrawals reported to DHEC for that year. Water-use categories and water-withdrawal reporting criteria are described in more detail in the *Water Use* chapter of this publication.

Water use in the Combahee-Coosawhatchie subbasin is summarized in Table 7-16 and Figure 7-14. Offstream water use in the subbasin was 20,249 million gallons in 2006, ranking it eleventh among the 15 subbasins. Of this amount, 16,684 million gallons were from ground-water sources (82 percent) and 3,564 million gallons were from surface-water sources (18 percent). Irrigation accounted for 45 percent of the total use, followed by water supply (35 percent) and golf course (17 percent). Consumptive use in this subbasin is estimated to be 12,108 million gallons, or about 60 percent of the total offstream use.

Irrigation water use in the subbasin was 9,024 million gallons in 2006, the highest in the State. Of this amount, 7,563 million gallons were from ground-water sources (84 percent) and 1,461 million gallons were from surface-water sources (16 percent). Sixty-two withdrawers reported water use in 2006. Williams Farms, in Colleton County, was the largest ground-water irrigator, withdrawing 1,877 million gallons. Using almost as much was Oswald Farms, in Allendale County, which pumped 1,843 million gallons, mainly from the Black Creek aquifer. Sharp and Sharp Certified Seed, in Allendale County, withdrew 474 million gallons from surface-water sources.

Water-supply use in the subbasin was 7,125 million gallons, all of it supplied by ground water. Several facilities operated by the South Island Public Service District in Beaufort County collectively used about 2,400 million gallons from the Floridan aquifer, and the Hilton Head Public Service District used 1,112 million gallons from the Floridan aquifer. Other ground-water systems of note are Broad Creek Public Service District (568 million gallons from the Floridan aquifer), the city of Walterboro (555 million gallons from the Floridan and Middendorf aquifers), and the city of Barnwell (393 million gallons from the Tertiary sand aquifer).

Golf-course irrigation is a major use of water in the subbasin, ranking second only to the Waccamaw River subbasin in this category. A total of 3,394 million gallons were used at 41 golf courses in 2006. Of this amount, 2,056 million gallons came from surface-water sources (61 percent) and 1,338 million gallons came from ground-water sources (39 percent). Most of the ground water was

Table 7-15. Water-level monitoring wells in the Combahee-Coosawhatchie River subbasin

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
BFT-101	DNR	32 10 05 80 44 26	Floridan	Hilton Head Island	14	129–470
BFT-429	DNR	32 15 50 80 49 11	Floridan	Victoria Bluff Wildlife Mgmt. Area, Bluffton	22	119–300
BFT-1810	USGS	32 16 03 80 43 22	Floridan	Hilton Head Island	14	105–199
BFT-1813	DNR	32 13 58 80 40 38	Floridan	Hilton Head Island	12	280–600
BFT-1814	DNR	32 13 58 80 40 38	Floridan	Hilton Head Island	12	120–210
BFT-1845	DNR	32 16 49 80 49 17	Floridan	Waddell Mariculture Center, Bluffton	12	320–600
BFT-1846	DNR	32 16 50 80 49 18	Floridan	Waddell Mariculture Center, Bluffton	12	85–180
BFT-2055	DNR	32 11 28 80 42 15	Cape Fear	Hilton Head Island	10	2,782–3,688
BRN-349	DNR	33 10 44 81 18 51	Middendorf	DNR cluster site C-6, near Kline	209	1,030–1,040
BRN-350	DNR	33 10 45 81 18 54	Tertiary sand	DNR cluster site C-6, near Kline	207	155–165
BRN-351	DNR	33 10 43 81 18 53	Tertiary sand	DNR cluster site C-6, near Kline	207	80–90
BRN-352	DNR	33 10 44 81 18 53	Tertiary sand	DNR cluster site C-6, near Kline	207	278–288
BRN-353	DNR	33 10 43 81 18 54	Black Creek	DNR cluster site C-6, near Kline	208	573–583
BRN-354	DNR	33 10 44 81 18 54	Gordon	DNR cluster site C-6, near Kline	208	396–406
BRN-355	DNR	33 10 44 81 18 55	Crouch Branch	DNR cluster site C-6, near Kline	208	686–696
BRN-356	DNR	33 10 43 81 18 56	McQueen Branch	DNR cluster site C-6, near Kline	209	914–924
BRN-358	DNR	33 19 14 81 24 28	Middendorf	DNR cluster site C-5, near Barnwell	266	832–842
BRN-359	DNR	33 19 16 81 24 27	Tertiary sand	DNR cluster site C-5, near Barnwell	266	199–209
BRN-360	DNR	33 19 15 81 24 27	Tertiary sand	DNR cluster site C-5, near Barnwell	264	125–134
BRN-365	DNR	33 19 15 81 24 28	Black Creek	DNR cluster site C-5, near Barnwell	264	524–534
BRN-366	DNR	33 19 14 81 24 28	Black Creek	DNR cluster site C-5, near Barnwell	267	700–710
BRN-367	DNR	33 19 15 81 24 28	Tertiary sand	DNR cluster site C-5, near Barnwell	264	270–280
BRN-368	DNR	33 19 14 81 24 28	Black Creek	DNR cluster site C-5, near Barnwell	265	428–438
COL-16	DNR	32 53 55 80 39 57	Floridan	Walterboro	62	68–528
COL-30	DNR	32 53 45 80 40 40	Black Creek	Walterboro	61	undetermined

Table 7-15. Continued

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
HAM-50	DNR	32 40 48 81 11 20	Black Mingo	Furman	110	undetermined
HAM-83	USGS	32 41 52 81 51 04	Floridan	Yemassee	46	86–156
HAM-228	DNR	32 56 52 81 11 50	Floridan	Brunson	128	undetermined
HAM-314	DHEC	32 49 49 81 09 57	Floridan	Lake Warren State Park	112	88–122
HAM-315	DHEC	32 49 49 81 09 57	Floridan	Lake Warren State Park	112	200–568
JAS-425	DNR	32 37 04 80 59 45	Floridan	DNR cluster site C-15, Gillisonville	65	150–255
JAS-426	DNR	32 37 06 80 59 45	Middendorf	DNR cluster site C-15, Gillisonville	63	1,949–1,994
JAS-490	DHEC	32 28 54 80 58 22	Floridan	Ridgeland	40	288–558
JAS-491	DHEC	32 28 54 80 58 22	Floridan	Ridgeland	40	144–220
JAS-492	DNR	32 37 06 80 59 45	Floridan	DNR cluster site C-15, Gillisonville	65	300–600

* *DHEC, South Carolina Department of Health and Environmental Control; DNR, South Carolina Department of Natural Resources; USGS, United States Geological Survey*

pumped from the Floridan aquifer. Some of the larger users are the Colleton River Plantation Nicholas Golf Course in Beaufort County (290 million gallons), Belfair Plantation in Beaufort County (219 million gallons), and Dataw Island Club in Beaufort County (169 million gallons).

AQUIFER STORAGE AND RECOVERY PROGRAMS

The concept of an aquifer storage and recovery (ASR) program is to treat more surface water than is needed during times of low demand, inject the excess treated water into an aquifer, store it in the ground until the demand for water is high, and then pump the water out of the ground when it can be used to supplement surface-water supplies. ASR wells can provide water for short-term, high-demand periods, which can allow water systems to meet user demands with smaller treatment plants, thereby reducing the overall cost of providing the water. Additionally, the use of an ASR system can reduce water-production costs by allowing treatment plants to operate more efficiently by stabilizing plant production to an optimum flow rate and by treating more surface water in the winter, when the water quality is better than in the summer and is thus less expensive to treat.

The Beaufort-Jasper Water and Sewer Authority (BJWSA), which provides water to much of Beaufort and Jasper Counties, has one of the four active ASR programs in South Carolina. BJWSA, which primarily uses surface water from the Savannah River, has three ASR wells as part of its water system, all completed in the Floridan aquifer. Two of the wells are located at their Chelsea Water Treatment Plant; at this site, one well is used for injection and both wells are used for recovery. Combined, the two wells yield 3.0 million gallons per day. A third ASR well, with a capacity to yield 2.5 million gallons per day, is located at their Purrysburg Water Treatment Plant. BJWSA injects treated surface water during the fall and winter, and withdraws water to meet peak demands during the spring and summer months. A total of 300 million gallons of treated water from the Savannah River is injected and stored in the aquifer each year.

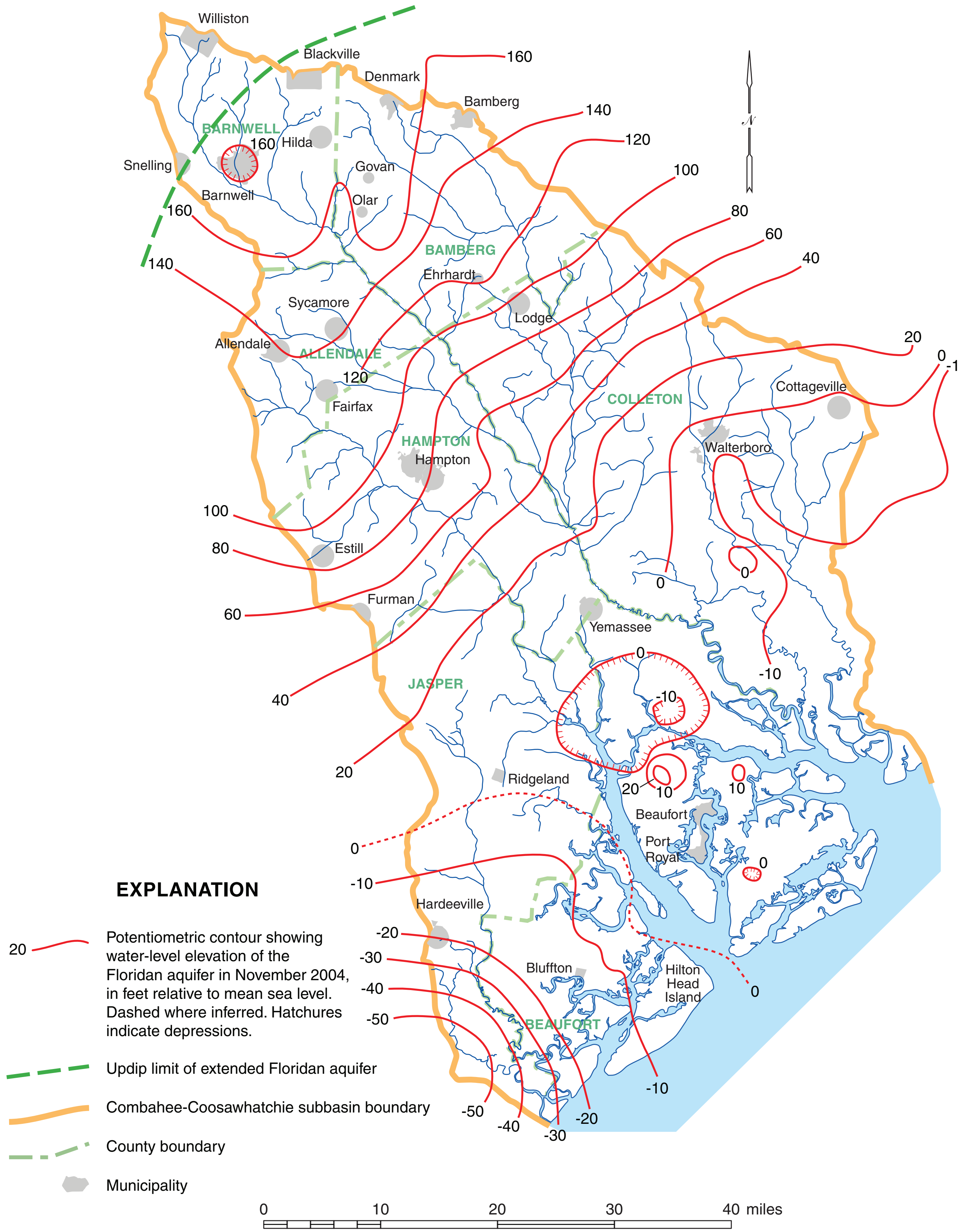


Figure 7-13. Potentiometric contours of the Floridan aquifer in the Combahee-Coosawhatchie River subbasin, November 2004 (from Hockensmith, 2009).

Table 7-16. Reported water use in the Combahee-Coosawhatchie River subbasin for the year 2006 (modified from Butler, 2007)

Water-use category	Surface water		Ground water		Total water	
	Million gallons	**Percentage of total surface-water use**	**Million gallons**	**Percentage of total ground-water use**	**Million gallons**	**Percentage of total water use**
Aquaculture	47	1.3	95	0.6	143	0.7
Golf course	2,056	57.7	1,338	8.0	3,394	16.8
Industry	0	0.0	530	3.2	530	2.6
Irrigation	1,461	41.0	7,563	45.3	9,024	44.6
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	33	0.2	33	0.2
Thermoelectric power	0	0.0	0	0.0	0	0.0
Water supply	0	0.0	7,125	42.7	7,125	35.2
Total	3,564		16,684		20,249	

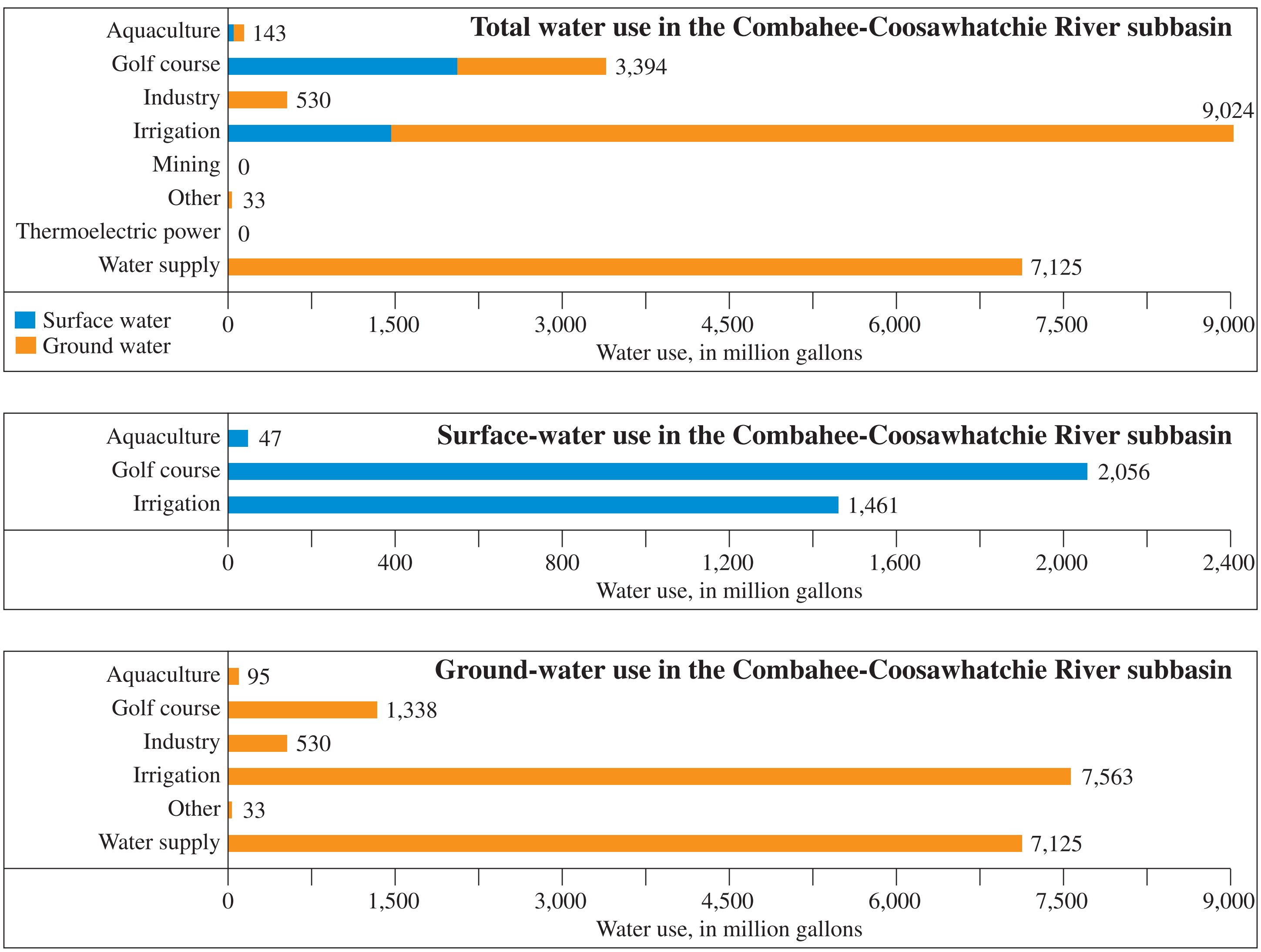


Figure 7-14. Reported water use in the Combahee-Coosawhatchie River subbasin for the year 2006 (modified from Butler, 2007).