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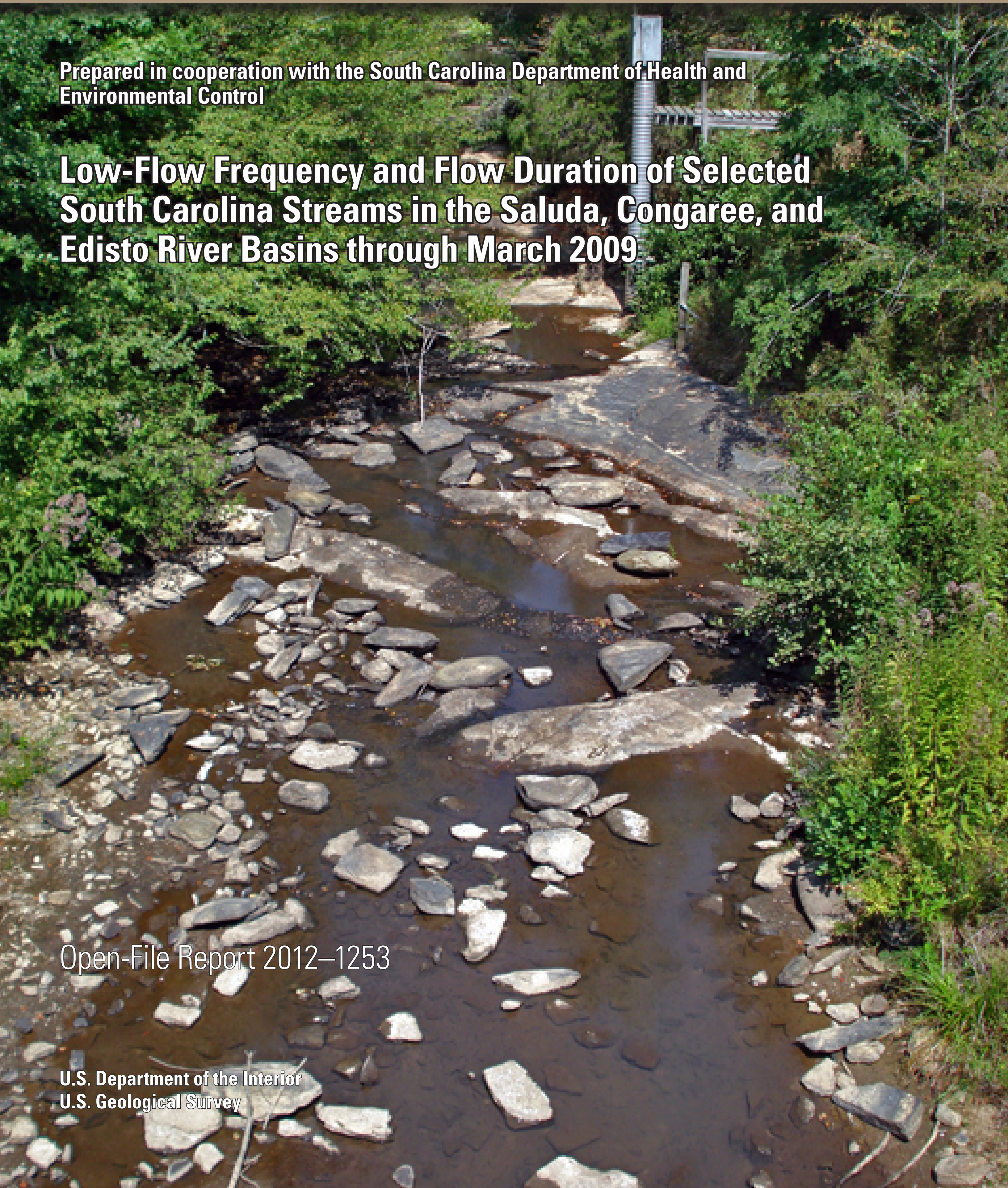
Low-Flow Frequency and Flow Duration of Selected South Carolina Streams in the Saluda, Congaree, and Edisto River Basins through March 2009



Open-File Report 2012–1253

U.S. Department of the Interior
U.S. Geological Survey

Cover photograph. South Rabon Creek near Gray Court, South Carolina.

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By Toby D. Feaster and Wladmir B. Guimaraes

Prepared in cooperation with the South Carolina Department of Health

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27) or 1983 (NAD 83). Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Acronyms and abbreviations

CR	continuous record
CY	climatic year
loratio	ratio of the 10 percentile to the 50 percentile of the average 7-day flows
MOVE.1	Maintenance of Variance Extension, Type 1
PR	partial record
QAQC	quality assurance and quality control
SCDNR	South Carolina Department of Natural Resources
SCDHEC	South Carolina Department of Health and Environmental Control
TMDL	total maximum daily load
USGS	U.S. Geological Survey
WWQMS	Watershed Water Quality Management Strategy
7Q2	annual minimum 7-day average streamflow with a 2-year recurrence interval
7Q10	annual minimum 7-day average streamflow with a 10-year recurrence interval

Low-Flow Frequency and Flow Duration of Selected South Carolina Streams in the Saluda, Congaree and Edisto River Basins through March 2009

By Toby D. Feaster and Wladmir B. Guimaraes

Abstract

Part of the mission of the South Carolina Department of Health and Environmental Control and the South Carolina Department of Natural Resources is to protect and preserve South Carolina's water resources. Doing so requires an ongoing understanding of streamflow characteristics of the rivers and streams in South Carolina. A particular need is information concerning the low-flow characteristics of streams, which is especially important for effectively managing the State's water resources during critical flow periods, such as during periods of severe drought like South Carolina has experienced in the last decade or so.

The U.S. Geological Survey, in cooperation with the South Carolina Department of Health and Environmental Control, initiated a study in 2008 to update low-flow statistics at continuous-record streamgaging stations operated by the U.S. Geological Survey in South Carolina. This report presents the low-flow statistics for 25 selected streamgaging stations in the Saluda, Congaree, and Edisto River basins in South Carolina, and includes flow durations for the 5-, 10-, 25-, 50-, 75-, 90-, and 95-percent exceedances and the annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average flows with recurrence intervals of 2, 5, 10, 20, 30, and 50 years, depending on the length of record available at the streamgaging station. The low-flow statistics were computed from records available through March 31, 2009.

Of the 25 streamgaging stations for which recurrence interval computations were made, 20 were compared to low-flow statistics that were published in previous U.S. Geological Survey reports. A comparison of the low-flow statistics for the annual minimum 7-day average streamflow with a 10-year recurrence interval (7Q10) from this study with the most recently published values indicates that 18 of the 20 streamgaging stations have values lower than the previous published values. The low-flow statistics are influenced by length of record, hydrologic regime under which the record was collected, analytical techniques used, and other changes, such as urbanization, diversions, droughts, and so on, that may have occurred in the basin.

Introduction

Low-flow stream statistics are used by State agencies in South Carolina (SC), such as the South Carolina Department of Health and Environmental Control (SCDHEC) and the South Carolina Department of Natural Resources (SCDNR), for many applications, including determining waste-load allocations for point sources, development of total maximum daily loads (TMDLs) for streams, determining the quantity of water that can be withdrawn safely from a particular stream, and preparing the State Water Plan. In addition, low-flow statistics are useful for improving the general level of understanding of natural and regulated stream systems. The droughts of the past decade in South Carolina (South Carolina Department of Natural Resources, 2012) have heightened awareness of the importance of having up-to-date statistics for making critical water-resources decisions.

Because of the importance of these applications, it is critical to effectively measure and document stream baseflow data for use in updating low-flow statistics on a regular basis, preferably about every 10 years. Low-flow statistics, as defined in this report, are annual minimum daily mean streamflow averaged over designated time periods (Riggs, 1972). The use of "average" with respect to the low-flow statistics in this report refers to the arithmetic mean. Low-flow statistics for streams in South Carolina have not been updated in a systematic way since 1987. In 2008, the U.S. Geological Survey (USGS), in cooperation with the SCDHEC, initiated a study to update low-flow statistics at continuous-record streamgaging stations (hereafter referred to as stations in this report) operated by the USGS in South Carolina. The investigation was originally planned (2008) for a period of 5 years to coincide with the SCDHEC Watershed Water Quality Management Strategy (WWQMS) for monitoring and assessment of eight major river basins in South Carolina (fig. 1), which is completed every 5 years (South Carolina Department of Health and Environmental Control, 2009, table 1). However, the schedule for updating the low-flow statistics was modified (2010) at the request of the SCDHEC. The remaining basins will now be assessed by the USGS on a 2-year schedule, and the results will be published during the second year (table 1). The SCDHEC incudes the Congaree River basin as part of the Saluda River basin and, although the Congaree River basin is not listed in table 1, it was included in the analysis.

Purpose and Scope

The purpose of this report is to present updated low-flow statistics at continuous-record (CR) stations in the Saluda, Congaree, and Edisto River basins of South Carolina. Depending on the length of record available at the CR stations, the report presents estimates of annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average streamflows with recurrence intervals of 2, 5, l0, 20, 30, and 50 years. Low-flow statistics are presented for 25 CR stations. In addition, daily flow durations for the 5-, 10-, 25-, 50-, 75-, 90-, and 95-percent exceedances are presented for these stations (table 2, located at the end of the report).

The scope of this report includes unregulated and regulated streams in the Saluda, Congaree, and Edisto River basins of South Carolina. In order for the low-flow statistics to be updated for CR stations included in the previous study (Zalants, 1991a, b), at least 3 years of additional streamflow data had to be collected after 1987. Of the new CR stations that began collecting data after 1987, only the stations that had at least 5 years of data were included.

Daily mean streamflow data for this study were collected through March 31, 2009, which is the end of the 2008 climatic year. The climatic year (CY) is a continuous 12-month period during which a complete annual cycle occurs and is arbitrarily selected for the presentation or analysis of data relative to hydrologic or meteorological phenomena (Langbein and Iseri, 1960). The CY is usually designated by the calendar year during which most of the 12 months occur. For this investigation, the CY is the 12-month period from April 1 through March 31 and is designated by the year in which it begins. For example, the 2008 CY is the period from April 1, 2008, through March 31, 2009. In South Carolina, minimum streamflows typically occur in the fall months (September, October, and November) and, therefore, use of the CY, as defined, prevents the annual low-flow cycle from being artificially placed in separate years.

Previous Studies

Previous reports by Stallings (1967), Johnson and others (1968), Bloxham and others (1970), Bloxham (1976, 1979, 1981), Barker (1986), Zalants (1991a,b), Feaster and Guimaraes (2009), and Guimaraes and Feaster (2010), described the low-flow frequency and flow-duration streamflows for selected CR stations and partial-record (PR) stations in South Carolina. Stallings (1967) presented low-flow statistics for 61 CR stations and 83 other sites where flow was measured during the 1954 drought. Johnson and others (1968) focused on the low-flow statistics of streams in Pickens County. Low-flow streamflow measurements from 1945 through 1967 were presented for 32 PR stations. The PR stations were correlated with 4 index stations to estimate annual minimum 7-day average streamflow with 2- and 10-year recurrence intervals (7Q2 and 7Q10, respectively). Bloxham and others (1970) presented magnitude and frequency of low-flow streamflows for 9 CR stations in Spartanburg County, and streamflow measurements were presented for 63 sites. At 35 of the 63 sites, correlation methods were used with index stations to estimate the 7Q2 and 7Q10. Bloxham (1976) used 6 index stations from the upper Coastal Plain to estimate the 7Q2 and 7Q10 at 54 PR stations and miscellaneous-measurement sites. Bloxham (1979) used data through the 1976 CY to compute low-flow frequency and flow-duration estimates at 71 CR stations in South Carolina. Bloxham (1981) estimated the 7Q2 and 7Q10 at 113 PR stations in the Piedmont and lower Coastal Plain of South Carolina. Barker (1986) detailed the establishment of 361 PR stations with measurements made from August 1980 through July 1986. Zalants (1991a) provided estimates of the 7Q2 and 7Q10 at 564 PR stations and 27 CR stations on streams in the Blue Ridge, Piedmont, and upper Coastal Plain Physiographic Provinces in South Carolina and parts of North Carolina and Georgia. Zalants (1991b) provided estimates of annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average streamflows with recurrence intervals of 2 to 50 years, depending on the length of record, for 55 CR stations in South Carolina for which at least 5 years of unregulated daily mean streamflow data were available through the 1986 CY. Feaster and Guimaraes (2009), and Guimaraes and Feaster (2010), presented low-flow statistics for 17 and 23 CR stations in the Pee Dee and Broad River basins in South Carolina, respectively. Estimates are presented for the Pee Dee River basin through the 2006 CY and for the Broad River basin through the 2007 CY. In addition, daily flow durations of the 5- to 95-percent exceedances were presented for most of these stations. Much of the general information for this report was taken directly from Feaster and Guimaraes (2009) and Guimaraes and Feaster (2010).

Description of the Study Area

The Saluda River basin of South Carolina includes parts of the Blue Ridge, Piedmont, and upper Coastal Plain Physiographic Provinces (fig. 2). The headwaters of the Saluda River basin begin in the Blue Ridge Physiographic Province and flow toward the City of Greenville. The Saluda River eventually converges with the Reedy River near the City of Greenwood in the headwaters of Lake Greenwood. The Saluda River then flows toward Columbia where it flows into Lake Murray. The Saluda River basin ends in Columbia at its convergence with the Broad River where it forms the Congaree River. The Congaree River then flows south and east where it converges with Wateree River in the headwaters of Lake Marion to form the Santee River.

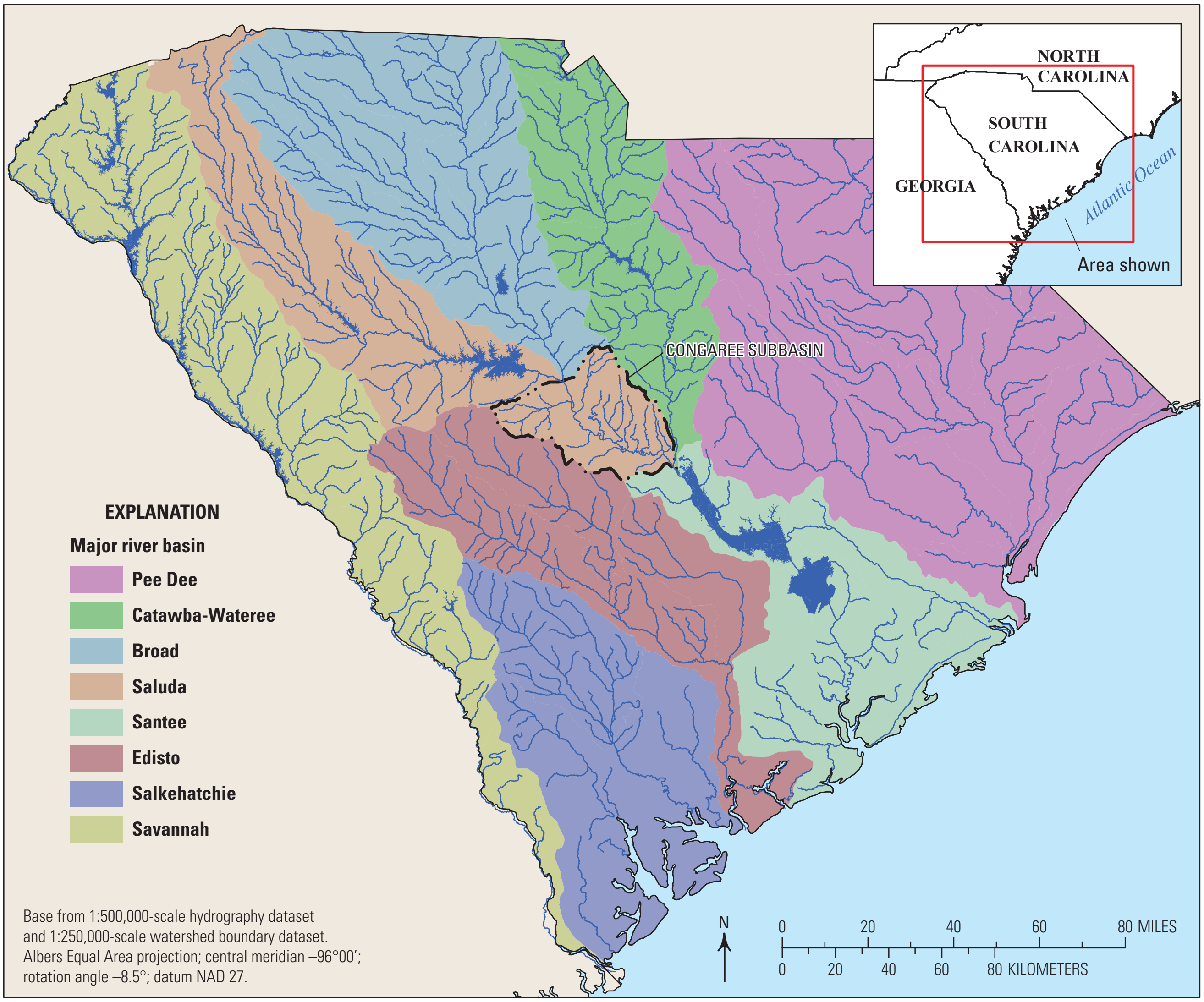

Figure 1. Map showing the eight major river basins in South Carolina as defined by the South Carolina Department of Health and Environmental Control.

Table 1. South Carolina Department of Health and Environmental Control (SCDHEC) schedule for basin data analysis and statistics availability.

SCDHEC basin name (fig. 1)	Data analysis, year[1]	Low-flow information available, year[1]
Pee Dee	2008	2009
Broad	2009	2010
Saluda and Edisto	2010 and 2011	2012
Catawba-Wateree and Santee	2012 and 2013	2014
Savannah and Salkehatchie	2013 and 2014	2015

[1]The year is the Federal fiscal year, which begins in October and ends in September, and is designated by the calendar year in which it ends. For example, year 2009 is the 12-month period from October 1, 2008, through September 30, 2009.

The Edisto River basin includes parts of the upper and lower Coastal Plain Physiographic Provinces of South Carolina. The North and South Fork Edisto Rivers begin in the upper Coastal Plain Physiographic Province and converge near the town of Branchville, South Carolina, to form the Edisto River (fig. 2). The Edisto River then flows south and east through the lower Coastal Plain Physiographic Province and eventually flows to the Atlantic Ocean at Edisto Island, south of Charleston, SC.

Within South Carolina, the Saluda, Congaree, and Edisto River basin encompasse approximately 6,630 square miles (mi^2) and includes all or part of six 8-digit (subbasin) hydrologic units (Eidson and others, 2005; fig. 2; table 3). There are many man-made reservoirs in the study area. For example, there are more than 150 State and Federally-regulated dams and more than 2,500 non-regulated dams (mostly owned by private citizens), in the Saluda River basin upstream from Lake Greenwood. There are two reservoirs in the Saluda River basin that have surface areas that exceed 10,000 acres: Lake Greenwood (11,400 acres) and Lake Murray (51,000 acres) (South Carolina Department of Natural Resources, 2009). The reservoirs within the study area have varying degrees of storage capacity and some are used for hydroelectric power generation (see remarks, table 2).

Low-Flow Statistics

Hydrologic information on the availability of streamflow under low-flow conditions is essential for the effective management of water resources. Low-flow statistics that define the magnitude and frequency of low-flow events typically are provided as a minimum average streamflow over some designated time period at a streamgaging location. For example, one of the most common low-flow statistics is the annual minimum 7-day average streamflow with a 10-year recurrence interval (7Q10). In terms of probability of occurrence, there is a one-tenth or 10-percent probability that the annual minimum 7-day average streamflow in any single year will be equal to or less than the estimated 7Q10 value for a specific location (Riggs, 1985).

Analytical Approach

The analyses of CR stations included in this study were based on four categories of stations: (1) long-term record stations; (2) short-term record stations that have at least 10 years of record; (3) stations that have between 5 and 10 years of record, which were analyzed for a limited set of low-flow statistics by using techniques typically used in analyzing PR stations; and (4) regulated stations.

Typically, low-flow statistics are computed at CR stations if at least 10 years of record are available; however, computing low-flow statistics from long-term records is preferred because the long-term records are considered to be more representative of a broader range of hydrologic conditions. Thus, long-term streamgaging data are better suited for trend assessments and statistical estimates. The USGS uses a value of 30 years of streamflow record to designate long-term streamgages (U.S. Geological Survey, 2009).

For stations with short-term records (those which have at least 10 years of record but less than about 30 years), the low-flow statistics can be improved by using record extension or augmentation methods (Hirsch, 1982) based on correlations with long-term stations. This approach is particularly beneficial if the streamflow data at the short-term record station were collected during an unusually dry, wet, or otherwise unrepresentative period. As a result, the record-extension techniques allow a more representative range of low-flow conditions at the site. For the short-term records included in this study for which no suitable index station was available, the low-flow statistics were computed using the measured data. In situations where long-term record stations (more than 30 years of record) are not candidates for record augmentation, if two long-term record stations are located on the same stream, and one of the stations has many more years of record that includes different hydrologic conditions, it also may be beneficial to extend the long-term record station that has the least years of record. This report presents selected low-flow statistics for three CR stations where record-extension techniques were applied.

A standard PR station is a site where limited streamflow data are collected on a systematic basis over a period of years for use in hydrologic analyses. For low-flow analyses, typically 10 to 20 base-flow measurements are made over a period of about 2 years. Then, mathematical or graphical techniques are used to correlate the base-flow measurements with concurrent daily mean flows at a CR station (index station) (Riggs, 1972; Zalants, 1991a). As noted by Riggs (1972), such a relation can be used to define a limited set of low-flow statistics at the PR station, but should not be used to define an entire frequency curve, because to do so would imply a greater accuracy than is warranted. Consequently, only the annual minimum 7-day average low-flow statistics with 2- and 10-year recurrence intervals (7Q2 and 7Q10, respectively) usually are estimated at PR stations (U.S. Geological Survey, 1979).

This report and study include only CR stations. However, as with standard PR stations, similar techniques can be used to correlate daily mean flows at CR stations that have more than 5 years but less than 10 years of CR streamgaging data. In Feaster and Guimaraes (2009) and Guimaraes and Feasater (2010), such CR stations were referred to as PR stations and represented a third category of stations that were analyzed. Similar to the analyses at standard PR stations, only the 7Q2 and 7Q10 low-flow statistics were estimated at such CR stations. However, no PR stations were analyzed in the Saluda, Congaree, and Edisto River basins because no suitable index stations were found. Index station criteria will be discussed later in the report.

A fourth category of stations included in this study are CR stations on regulated streams. If an assessment of the daily mean flow at a regulated station indicates that the pattern of

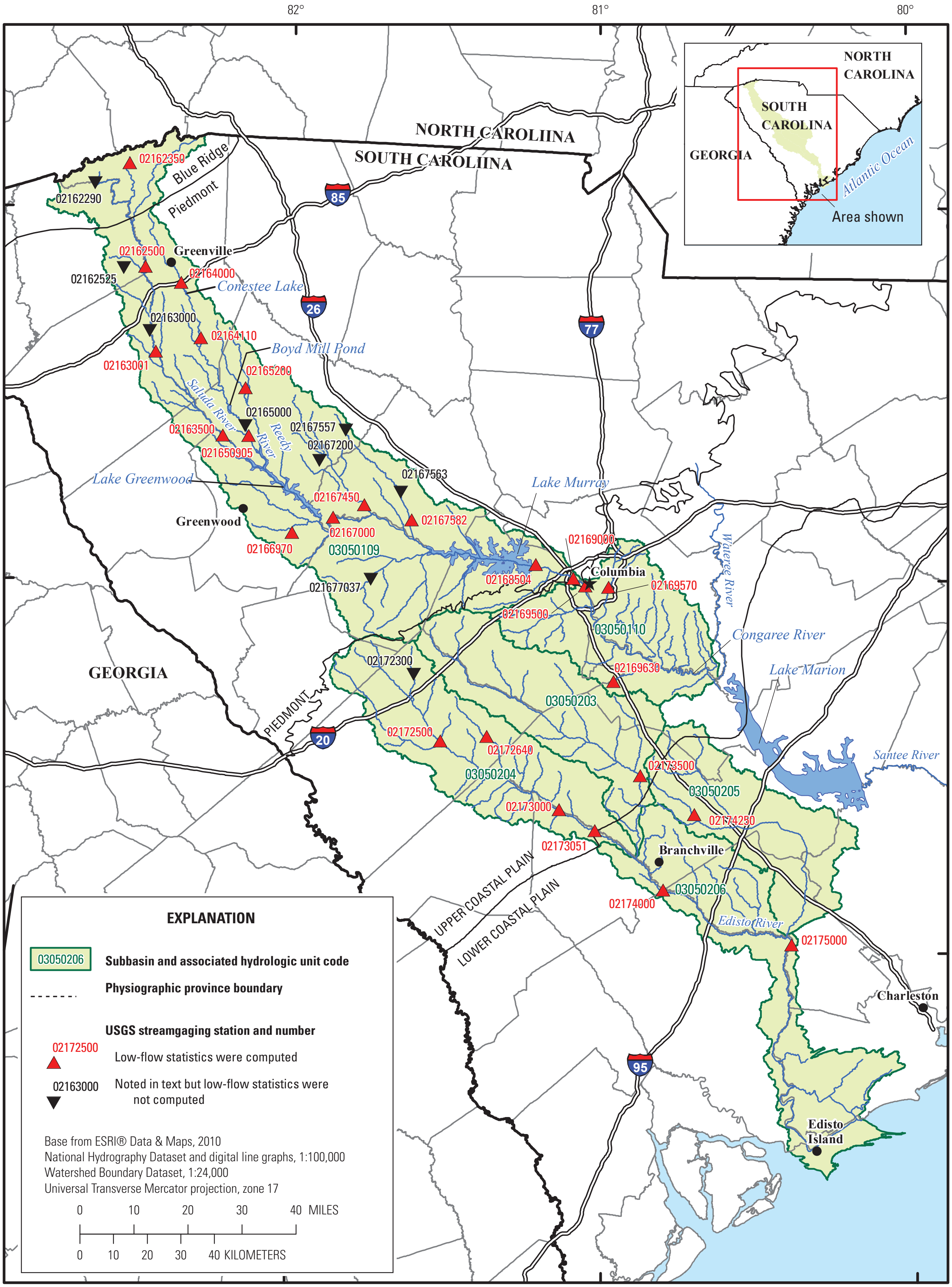

Figure 2. Streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina, as well as the physiographic provinces, and 8-digit hydrologic-unit code boundaries

Table 3. Eight-digit hydrologic unit code subbasins, subbasin name, drainage area in South Carolina, and number of U.S. Geological Survey continuous-record streamgaging stations analyzed per subbasin for the Saluda, Congaree, and Edisto River basins of South Carolina.

[HUC, hydrologic unit code; mi2, square mile; USGS, U.S. Geological Survey; Subbasins in **bold** text are wholly contained within South Carolina]

Eight-digit (subbasin) HUC number (fig. 2)	Subbasin name	Drainage area in South Carolina, in mi^2	USGS continuous-record streamgaging stations analyzed
03050109	Saluda	2,520	14
03050110	Congaree	689	3
03050203	**North Fork Edisto**	**759**	**1**
03050204	**South Fork Edisto**	**1,070**	**4**
03050205	Four Hole Swamp	654	2
0305206	Edisto	940	1
Total		6,630	25

regulation has been relatively consistent, and if the logarithms of the *N*-day flows (where *N* is the number of days used to compute the annual minimum average flow) are consistent with a Pearson Type III distribution, low-flow statistics can be computed for that period using similar techniques for the unregulated stations (Riggs, 1972). The techniques used for estimating low-flow statistics at PR sites usually are applicable only to unregulated streams and, therefore, should not be applied to streams that are highly regulated, such as for power generation. In addition, the low-flow statistics for regulated streams are relevant to similar future regulation patterns and would not be applicable if the future regulation patterns were altered significantly. Information regarding regulation at applicable CR stations is provided in the “Remarks” sections for stations listed in table 2. All stations considered for computations for low-flow statistics are listed in table 4, along with the period of record and drainage area.

Quality Assurance and Quality Control

For this study, a quality assurance and quality control (QAQC) analysis was done using the daily mean flow data and the annual minimum 7-day average streamflow data for CR stations that had a minimum of 10 years of record. The data at each station were reviewed for homogeneity, which suggests relatively stable basin conditions during the period of record. The Kendall’s tau test was used to assess the homogeneity of the record at each station (Helsel and Hirsch, 1992). If a trend was indicated (using a significance level of 0.05), additional assessments were used to determine if the trend may have been caused by a short-term condition. For example, if the station record happened to begin or end under extreme conditions (excessively wet or dry), the test may indicate a trend, but additional analysis that excludes the extreme events may indicate no trend. Trends at unregulated stations may result from changes in climatic cycles, land use, groundwater pumpage, or other practices that may affect groundwater levels. For stations downstream from a major source of regulation, such as a dam, the data were assessed for gross trends, which may indicate a long-term change in the pattern of regulation (William Kirby, U.S. Geological Survey, written commun., June 6, 2005). Additionally, some investigations have shown that substantial urbanization can lead to a reduction in low flows (U.S. Environmental Protection Agency, 2009). Final decisions to include or exclude data from a specific station were made by using hydrologic judgment based on the results of the QAQC analyses and other available information, such as comparisons with other long-term stations.

The QAQC analyses included the use of several computer programs that were developed by using commercial statistical software (SAS Institute, Inc., 1989). The components of the QAQC reviews that were conducted for the CR stations are as follows.

Plot of the ratios of median daily mean flows during the weekend (Saturday and Sunday) and entire week (Sunday through Saturday), and work week (Monday through Friday) and entire week against CY. These plots are useful for regulated streams and can show if the discharge patterns differ from week days to weekends.

The Kendall’s tau test to check for trends in the annual minimum 7-day average streamflow data over time.

Plot of the annual minimum 7-day average streamflow against CY, which is used along with the Kendall’s tau results to assess potential trends.

Plot of the relation of the ratio of the 10th percentile to the 50th percentile of the average 7-day flows (loratio) against CY, which is useful for graphically assessing potential trends.

Plot of the relation of the 50th percentile of the average 7-day flow against CY. This plot is useful for assessing potential changes in the median average 7-day flow over time.

Plot of the relation of the cumulative loratio against CY. A significant change in the slope of this relation indicates a change in flow patterns.

Plot of the relation of the cumulative 50th percentile of the average 7-day flow against CY. A significant change in the slope of this relation indicates changes in the median average 7-day flow patterns.

Results of Quality Assurance and Quality Control Analyses

A trend analysis, as described previously, was made for all stations in the investigation and the analyses indicated a trend in the annual minimum 7-day average streamflow for the

Table 4. Streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina that were considered for computations of low-flow statistics.

[mi², square miles; MOVE.1, Maintenance of Variance Extension, Type 1]

Streamgaging station number (fig. 2)	Station name	Period of record	Number of climatic years of record	Drainage area (mi²)	Remarks
Stations for which low-flow statistics were computed					
02162350	Middle Saluda River near Cleveland	Oct. 1980 – Sept. 2003	22	21.0	
02162500	Saluda River near Greenville	Jan. 1942 – Sept.1978, and Mar. 1990 – Mar. 2009	54	295	
[a]02163001	Saluda River near Williamston	May 1995 to Mar. 2009	13	414	The record was combined with USGS streamgaging station 02163000 to complete the record from Oct. 1929 to Sept. 1971 and May 1995 to Mar. 2009.
02163500	Saluda River near Ware Shoals	Mar. 1939 – Mar. 2009	70	580	
02164000	Reedy River near Greenville	Nov. 1941 – Sept. 1971, and Jun. 1987 – Mar. 2009	50	48.6	
02164110	Reedy River above Fork Shoals	Sept. 1993 – Mar. 2009	15	110	
[b]021650905	Reedy River near Waterloo	Nov. 2004 – Mar. 2009	4	251	The record was combined with USGS streamgaging station 02165000 to complete the record from Apr. 1939 to Sep. 2004 and Nov. 2004 to Mar. 2009. Low-flow statistics were computed from Apr. 1988 to Mar. 2009.
02165200	South Rabon Creek near Gray Court	Jan. 1967 – Sept. 1981, and May 1990 – Mar. 2009	29	29.5	
02166970	Ninety Six Creek near Ninety Six	Oct. 1980 – Sept. 2001	19	17.4	Zero flows
02167000	Saluda River at Chappells	Oct. 1926 – Mar. 2009	81	1,360	Low-flow statistics were computed from Apr. 1983 to Mar. 2009.
02167450	Little River near Silverstreet	Mar. 1990 – Mar. 2009	18	230	

Table 4. Streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina that were considered for computations of low-flow statistics.—Continued

[mi², square miles; MOVE.1, Maintenance of Variance Extension, Type 1]

Streamgaging station number (fig. 2)	Station name	Period of record	Number of climatic years of record	Drainage area (mi²)	Remarks
Stations for which low-flow statistics were computed—Continued					
02167582	Bush River near Prosperity	Feb. 1990 – Mar. 2009	18	115	
02168504	Saluda River below Lake Murray Dam near Columbia	Oct. 1988 – Mar. 2009	19	2,420	
02169000	Saluda River near Columbia	Aug. 1925 – Mar. 2009	82	2,520	Low-flow statistics were computed from Apr. 1989 to Mar. 2009.
02169500	Congaree River at Columbia	Oct. 1939 – Mar. 2009	68	7,850	Low-flow statistics were computed from Apr. 1980 to Mar. 2009.
02169570	Gills Creek at Columbia	Oct. 1966 – Mar. 2009	41	59.6	
02169630	Big Beaver Creek near St. Mathews	July 1966 – Sept. 1993	25	10.0	
02172500	South Fork Edisto River near Montmorenci	Apr. 1940 – Sept. 1966	24	198	Record extended using MOVE.1
02172640	Dean Swamp near Salley	Oct. 1980 – Mar. 1987, and Feb. 1988 – Oct. 2000	16	31.2	
02173000	South Fork Edisto River near Denmark	Aug. 1931 – Sept. 1971, and Oct. 1980 – Oct. 2009	65	720	
02173051	South Fork Edisto River near Bamberg	Apr. 1991 – Mar. 2009	17	807	Record extended using MOVE.1
02173500	North Fork Edisto River at Orangeburg	Oct. 1945 – Sept. 1996	69	683	
02174000	Edisto River near Branchville	Oct. 1945 – Sept. 1996	49	1,720	Record extended using MOVE.1
02174250	Cow Castle Creek near Bowman	Oct. 1970 – Sept. 1981, and Oct. 1995 – Mar. 2009	21	23.4	Zero flows
02175000	Edisto River near Givhans	Jan. 1939 – Mar. 2009	68	2,730	
Stations noted in text but for which low-flow statistics were not computed					
02162290	South Saluda River near Cross Hill	Feb. 2000 – Sept. 2005	5	18	Not analyzed because no suitable index station was found.
02162525	Hamilton Creek near Easely	Jan. 1981 – Sept. 1986	5	1.6	Not analyzed because no suitable index station was found.

Table 4. Streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina that were considered for computations of low-flow statistics.—Continued

[mi², square miles; MOVE.1, Maintenance of Variance Extension, Type 1]

Streamgaging station number (fig. 2)	Station name	Period of record	Number of climatic years of record	Drainage area (mi²)	Remarks
Stations noted in text but for which low-flow statistics were not computed—Continued					
02163000	Saluda River near Pelzer	Oct. 1929 – Sept. 1986	55	405	Not analyzed because of its proximity to station 02163001. The average daily mean flows were combined with station 02163001, to become a record from Oct. 1939 to Sept. 1971, and Oct. 1995 to Mar. 2009.
02165000	Reedy River near Ware Shoals	Apr. 1939 – Sept. 2004	63	236	Not analyzed because of its proximity to station 02165905. The average daily mean flows were combined with station 021650905, to become a record from Apr. 1939 to Sept. 2004, and Nov. 2004 to Mar. 2009.
02167200	Watkins Creek near Cross Hill	Feb. 1967 – Feb 1975	8	0.62	Not analyzed because no suitable index station was found.
02167557	Bush River near Joanna	June 1995 – Sept. 2005	9	11.1	Not analyzed because zero flows were observed at station and there-fore, MOVE.1 can not be used to aug-ment record.
02167563	Bush River near Newberry	Mar. 1999 – Sept. 2006	9	62.2	Not analyzed because zero flows were observed at station and there-fore, MOVE.1 can not be used to augment record.
021677037	Little Saluda River at Saluda	May 1992 – Mar. 2009	16	90.0	Not analyzed because station was in backwater from Lake Murray
02172300	Mc Tier Creek near Monetta	Oct. 1995 – Mar. 2009	12	15.6	Not analyzed because no suitable index station was found.

[a] Daily flows from USGS streamgaging station 02163001, Saluda River near Williamston (1995 – 2009) have been combined with daily flows from USGS streamgaging station 02163000, Saluda River near Pelzer (1939 – 1971) to produce a daily flow record that results in a data set from 1939 – 1971 and 1995 – 2009. The proximity of the two streamgaging stations to each other made this possible.

[b] Daily flows from USGS streamgaging station 021650905, Reedy River near Waterloo (2004 – 2009) have been combined with daily flows from USGS streamgaging station 02165000, Reedy River near Ware Shoals (1939 – 2004) to produce a daily flow record that results in a data set from 1939 – 2009, but only the period from 1988 – 2009 was used in the analyses because of changes in regulation patterns.The proximity of the two streamgaging stations to each other made this possible.

period of record at the following stations in South Carolina: 02164000, Reedy River near Greenville; 02165200, South Rabon Creek near Gray Court; 02167582, Bush River near Prosperity; 02169570, Gills Creek at Columbia; 02173051, South Fork Edisto River near Bamberg; 02174250, Cow Castle Creek near Bowman; and, 02175000, Edisto River near Givhans. The annual minimum 7-day average streamflow for the period of record at these stations is plotted in figure 3. The longer period at stations 02164000, 02165200, 02169570, and 02175000 reflect the historic dry years that have occurred in approximately the last decade. Thus, the trends at these stations are likely a result of the hydrologic conditions under which these particular records were collected and are not related to actual changes in the watershed. As noted by Lins and others (2010), sometimes hydrologic records for a time-frame of a few years to a few decades may indicate a trend in the data, but when viewed in the context of longer timeframes spanning decades to centuries, the short–term trends may be recognized as part of a much longer term oscillation. Therefore, low-flow statistics were computed for stations 02164000, 02165200, 02167582, 02169570, 02173051, 02174250, and 02175000 using the complete period of record for each station, respectively. Similar patterns also have been noted in the low-flow assessments for the Pee Dee River and Broad River basins (Feaster and Guimaraes, 2009; Guimaraes and Feaster, 2010).

One other station that was not analyzed, and therefore, not included in this report was station 021677037, Little Saluda River at Saluda, SC. This station (021677037) had a period of record from October 1, 1996, through March 3, 2007, but because the station was influenced by backwater from Lake Murray, the flow values do not fully represent natural flow conditions and, therefore, this station was excluded.

Diversions

Diversions from natural streamflows occur for a variety of reasons. Some diversions are the result of water-supply withdrawals, manufacturing, point-source discharges, and agricultural needs, such as irrigation. Diversions by manufacturers are sometimes confined to short distances along rivers. Water may be taken from the river channel, passed through the manufacturing plant for use in processing, cooling, dilution of wastes, and then returned to the river. Therefore, in many cases, consumptive losses from diversions by manufacturers may be negligible (Ries, 1994). Thus, the effects of diversions to the streamflow regime of a river are variable and depend not only on where the diversions occur but also on the final outcome of the diverted water.

Ries (1994) noted that water diverted from a stream or adjacent aquifer for municipal supplies, which is then returned to the basin as effluent from individual septic systems or from wastewater- treatment plants within the basin, generally causes little loss of water to the basin; however, such diversions may affect the temporal pattern of streamflows. Diversions from one basin to another reduce streamflow in the donor basin and increase streamflow in the receiving basin. Diversions between subbasins of a larger basin can substantially affect streamflows in the subbasins, but if consumptive losses are negligible, streamflows in the larger basin may be nearly unaffected.

The various diversion scenarios described above, indicates that a proper accounting of all diversions in a basin is typically difficult; therefore, most USGS low-flow analyses are made on the flow data as measured at the station without adjustments for diversions. For this study, diversion data, when available, were obtained from the SCDHEC and assessed to determine significance. Diversions upstream from a station were considered significant if the average annual diversion equaled or exceeded 10 percent of the mean annual minimum 1-day streamflow for the period of record. The assumptions for this comparison were that the diversion and streamflow data are of similar quality and were measured with the same frequency and based on concurrent periods of record. If these conditions did not exist, assessments still were made and comments were noted regarding the diversions in table 2, but no adjustments were made to the low-flow estimates.

Frequency Analysis

Low-flow frequency statistics at CR stations are computed by fitting a series of annual minimum *N*-day average streamflows to some known statistical distribution, where *N* can equal any number from 1 to 365. Low-flow frequency statistics for this study were computed by fitting logarithms (base 10) of the annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average streamflows to a Pearson Type III distribution, which also is referred to as a log-Pearson Type III distribution. Fitting the distribution requires calculating the mean, standard deviation, and skew coefficient of the logarithms of the *N*-day streamflows. Estimates of the *N*-day nonexceedance flows for a specified recurrence interval *T* are computed by using the following equation:

$$\log Q_T = \bar{X} + KS \, , \qquad (1)$$

where

Q_T is the *N*-day low flow, in cubic feet per second, and *T* is the recurrence interval, in years;

$\bar{X}$ is the mean of the logarithms of the annual minmum *N*-day average streamflows;

K is a frequency factor that is a function of the recurrence interval and the coefficient of skew; and

S is the standard deviation of the logarithms of the annual minimum *N*-day average streamflows.

Low-flow statistics typically are presented as a set of nonexceedance probabilities or, alternatively, recurrence intervals along with the associated low-flow values. The non-exceedance probability is defined as the probability that a flow at a given station will be equal to or less than the associated low-flow value once in a 1-year period, and is expressed as a decimal fraction less than 1.0 or as a percentage less than 100.

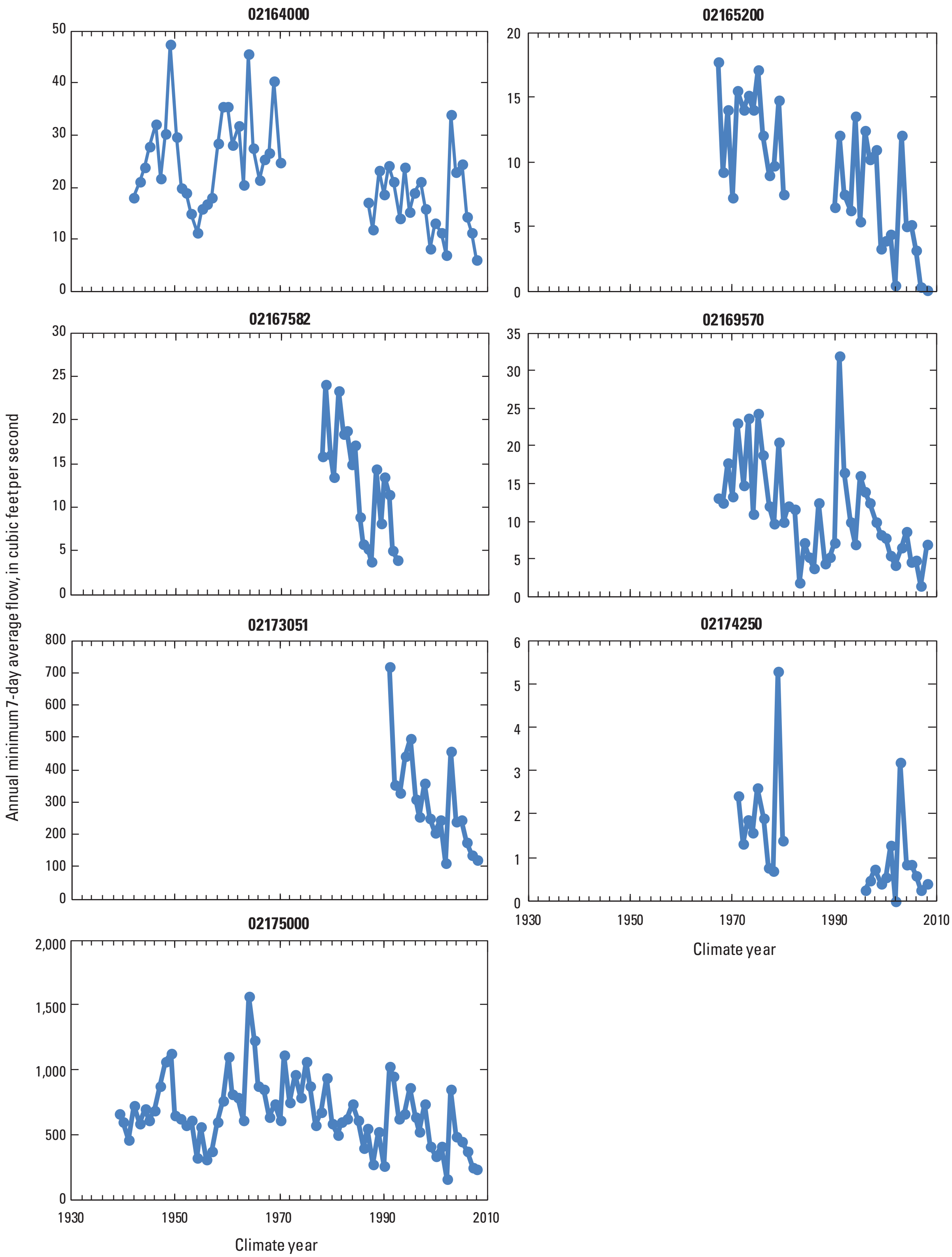

Figure 3. Annual minimum 7-day average streamflow at U.S. Geological Survey streamgaging stations in South Carolina: 02164000, Reedy River near Greenville; 02165200, South Rabon Creek near Gray Court; 02167582, Bush River near Prosperity; 02169570, Gills Creek at Columbia; 02173051, South Fork Edisto River near Bamberg; 02174250, Cow Castle Creek near Bowman; and 02175000, Edisto River near Givhans.

Recurrence interval is defined as the average interval of years (usually referred to as the return period) during which flows at a given station will be equal to or less than the associated low-flow value once. For example, a low-flow value at a given station with a nonexceedance probability of 0.10 indicates that flows at that station have a 10-percent chance of being equal to or less than the low-flow value once in any given year. Recurrence interval and nonexceedance probability are the mathematical inverses of one another; therefore, a flow with a nonexceedance probability of 0.10 has a recurrence interval of 1 divided by 0.10, or 10 years. It should be emphasized that recurrence intervals, regardless of length, always refer to an average period of time (or years) where flows at a given station will be equal to or less than the associated low-flow value once. A 10-year recurrence interval does not mean that the low-flow value will have a nonexceedance every 10 years; it does indicate, however, that the average time between recurrences is equal to 10 years. Consequently, an observed interval between a nonexceedance of the 7Q10 may be as short as 1 year or may be considerably longer than 10 years.

The low-flow frequency curve is generated by application of equation 1 to a set of annual minimum *N*-day average flows for a range of specified return periods. To estimate low-flow statistics for recurrence intervals greater than the period of record, these frequency curves must be extended. For this study, the following criteria were used to limit the extension of the curves based on the period of record at the station: The following criteria were established for extending frequency curves:

1. Curves for stations with 10 or more years of annual low-flow streamflow record, but less than 20 years of record, were extended to a recurrence interval of 20 years;

2. Curves for stations with 20 or more years of record, but less than 30 years of record, were extended to a recurrence interval of 30 years; and

3. Curves for stations with 30 or more years of record were extended to a recurrence interval of 50 years. No data were compiled for recurrence intervals greater than 50 years.

An example of the frequency curve using the log-Pearson Type III curve-fitting procedure is illustrated in figure 4.

Record-Extension Technique

Streamflow statistics are needed to estimate probabilities of occurrences for periods much longer than the actual measured period of record. Consequently, short records that may have been collected during an unusually dry, wet, or otherwise unrepresentative period may not represent the more desirable fuller range of potential hydrologic regimes. Under certain conditions, it is possible to extend or augment a short record by using a correlated station having a longer record. The extended record at the short-term record station will better reflect low-flow conditions over a longer period and provide better estimates of low-flow statistics at that station. The record extension can be accomplished in the following manner.

If a linear relation between the logarithms of the *N*-day flows at a short-term record station is determined to be significantly correlated to a concurrent set of the *N*-day flows at a long-term record station, or index station, a mathematical record-extension method known as the Maintenance of Variance Extension, Type 1 (MOVE.1) method (Hirsch, 1982) can be used to extend the record at the short-term record station. The MOVE.1 relation maintains the mean and the variance of the data at the short-term record and, therefore, allows for the generation of a longer-term set of data that will possess the statistical characteristics of the actual measured data from the short-term record.

The MOVE.1 equation is

$$Y_i = \overline{Y} + \frac{S_y}{S_x}(X_i - \overline{X}) \quad , \qquad (2)$$

where

Y_i is the logarithm of the estimated *N*-day flow for the short-term record station;
$\overline{Y}$ is the mean of the logarithms of *N*-day flows for the concurrent period at the short-term record station;
S_y is the standard deviation of the logarithms of *N*-day flows for the concurrent period at the short-term record station;
S_x is the standard deviation of the logarithms of *N*-day flows for the concurrent period at the long-term record station or index station;
X_i is the logarithm of the flow statistic or observed *N*-day flow at the index station; and
$\overline{X}$ is the mean of the logarithms of the *N*-day flows for the concurrent period at the index station.

For an index station to be considered for this study, it had to have (1) a minimum of 10 years of concurrent record relative to the short-term record station, (2) similar basin geology as the short-term record station, and (3) a basin less than 10 times larger than the size of the smaller basin (Telis, 1991). A minimum correlation coefficient between concurrent flows has not been developed for the MOVE.1 technique; however, similar correlation studies have used values ranging from 0.70 to 0.80 (Hydrology Subcommittee of the Interagency Advisory Committee on Water Data, 1982; Stedinger and Thomas, 1985; Ries, 1994; Nielsen, 1999). In addition, if the record at the short-term record station or available index station included zero flows, record extensions were not applied, because including such values in record-extension techniques has not been adequately tested (Julie Kiang, U.S. Geological Survey Office of Surface Water, written commun., January 26, 2010).

For gaging stations that have relatively long records, such as 30 years or more, record extension may still be beneficial if an index station is available that has additional record

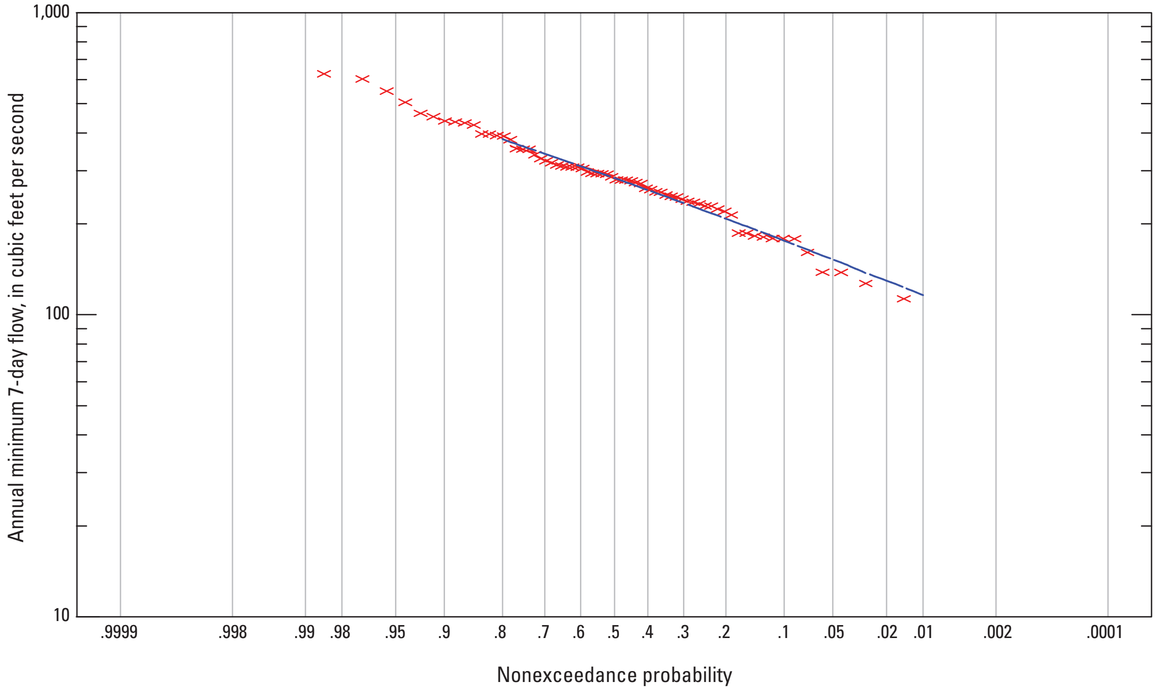

Figure 4. Low-flow frequency curve for the annual minimum 7-day average streamflow for the U.S. Geological Survey streamgaging station 02173000, South Fork Edisto River near Denmark, South Carolina.

collected under hydrologic conditions that are not included in the record being analyzed. Currently, no standard criteria are available for assessing when use of MOVE.1 is warranted with respect to improvement in the low-flow statistics at such stations. Therefore, for this investigation, an arbitrary criterion was set. If the average difference in the 7-day low-flow statistics (computed from the data at index station for the concurrent period of record as compared to those computed using the complete period of record at the index station) was greater than 10 percent, MOVE.1 was used to augment the record at the station of interest. Otherwise, no augmentation was done.

Three CR stations in the Edisto River basin met the criteria listed above and the records were augmented using the MOVE.1 record-extension technique (table 5). Two of these stations were 02172500, South Fork Edisto River near Montmorenci and 02173051, South Fork Edisto River near Bamberg, which used station 02173000, South Fork Edisto River near Denmark as the index station. A plot of the relation for the annual minimum 7-day average streamflow between stations 02172500, South Fork Edisto River near Montmorenci and 02173000, South Fork Edisto River near Denmark is shown in figure 5. Additionally, the record at station 02174000, Edisto River near Branchville, was augmented using station 02175000, Edisto River near Givhans as the index station. The MOVE.1 technique allowed for the inclusion of an additional 41 and 50 years of record for stations 02172500 and 02173051, respectively, and an additional 20 years of record at station 02174000.

Partial-Record Type Analysis

As previously discussed, when limited streamflow data are collected on a systematic basis over a period of years for use in hydrologic analyses, the data-collection site is called a partial-record (PR) station (Zalants, 1991a). With respect to low-flow statistics, once a sufficient number of base-flow measurements have been made over a reasonable period of time, techniques can be used to transfer low-flow statistics from an index station to the PR station (Riggs, 1972). If the relation between the flows at the PR station and the index station is linear, mathematical correlation methods, such as MOVE.1, can be used (Hirsch, 1982). If the relation is nonlinear, then a graphical correlation described by Riggs (1972) can be used.

The MOVE.1 technique can be used to establish a relation between the concurrent daily mean flows. To use daily mean flows that are representative of low-flow conditions, only concurrent flows that are less than or equal to the 90-percent flow duration at the index station were used in the MOVE.1 analysis. That relation is then used to transfer a limited set of low-flow statistics from an appropriate index station to the PR station. Criteria similar to those that were described for extending the record at a short-term record station can be used with the exception of the concurrent-record length. USGS Office of Surface Water Technical Memorandum No. 86.02 (U.S. Geological Survey, 1985), recommended that only the 7Q2 and 7Q10 statistics be estimated for the PR stations. Because of the limited records available at the PR stations, providing a broader set of statistics would suggest an accuracy that is not warranted.

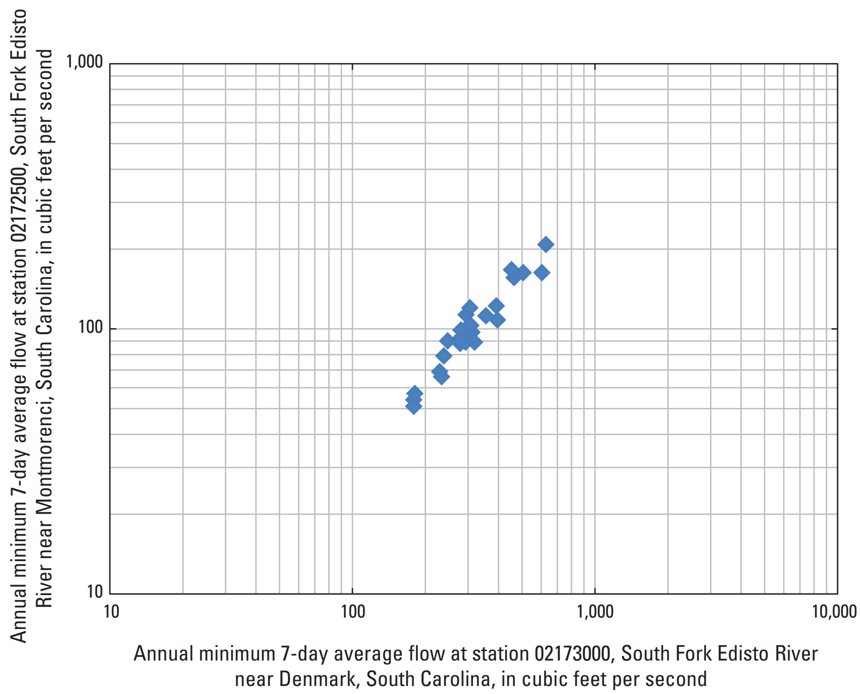

Figure 5. Correlation of annual minimum 7-day average streamflow at U.S. Geological Survey South Carolina streamgaging stations 02172500, South Fork Edisto River near Montmorenci; and 02173000, South Fork Edisto River near Denmark for the concurrent period of record 1940–1965.

The same MOVE.1 equation (eq. 2) as described previously is used to transfer the low-flow characteristic from the index station to the PR station. The difference is that now X_i is the low-flow characteristic computed from the index or long-term record station, and Y_i is the low-flow characteristic estimated at the PR station. Four CR stations in the Saluda or Edisto River basins had greater than 5 years and less than 10 years of record, but no suitable index stations were found for any of the stations. The four CR stations were 02162290, South Saluda River near Cleveland; 02162525, Hamilton Creek near Easley; 02167200, Watkins Creek near Cross Hill; and 02172300, McTier Creek near Monetta. Two additional CR stations on the Bush River (02167557, Bush River near Joanna and 02167563, Bush River near Newberry) had greater than 5 years and less than 10 years of record, and had a suitable index station, but because both stations had minimum daily flows of 0.0 cubic feet per second (ft^3/s), no computations were done.

Flow-Duration Analysis

Flow durations represent the percentage of time that a specified streamflow is equaled or exceeded during a given period (Searcy, 1959). Flow durations are computed by sorting the daily mean flows for the period of record from the largest value to the smallest value and assigning each streamflow value a rank, starting from 1 to the largest value. The frequencies of exceedance are then computed using the Weibull formula for computing plotting position (Helsel and Hirsch, 1992):

$$P = 100 * [M / (n+1)] , \tag{3}$$

where

- P is the probability that a given flow will be equaled or exceeded (percentage of time),
- M is the ranked position (dimensionless), and
- n is the number of events for the period of record (dimensionless).

Flow durations are a summary of the past hydrologic events. Yet, if the streamflow during the period for which the duration curve is based is a sufficiently long period of record, the statistics can be used as an indicator of probable future conditions (Searcy, 1959). To compare flow durations at different stations or in different basins, flow-duration estimates can be normalized by drainage area to represent a streamflow per unit area. Again, it should be noted that the most useful comparisons will be those based on similar lengths of record from similar hydrologic periods.

Flow durations for this report are presented in tabular form for the 5-, 10-, 25-, 50-, 75-, 90-, and 95-percent exceedances (table 2). To be consistent with the low-flow statistics, flow durations were computed based on the CY using daily mean flows through March 2009. For stations where record-extension techniques were used to extend a short-term record based on a relation to a long-term record (table 5), daily mean

Table 5. Streamgaging stations for which record was augmented, index streamgaging stations, additional climatic years of record, and correlation coefficients for gaging stations where record was augmented using MOVE.1 for the Edisto River basin of South Carolina.

[USGS, U.S. Geological Survey; mi^2, square miles]

Streamgaging stations where record was augmented		Index streamgaging station		Number of additional climatic years of record computed	Correlation coefficient						
USGS streamgaging station number and name and drainage area	Period of record	USGS streamgaging station number and name and drainage area	Period of record		1-day	3-day	7-day	14-day	30-day	60-day	90-day
02172500, South Fork Edisto River near Montmorenci, SC (198 mi^2)	Apr. 1940–Sept. 1966	02173000, South Fork Edisto River near Denmark, SC (720 mi^2)	Aug. 1931 – Sept.1971, and Oct. 1980 – Mar. 2009	41	0.93	0.94	0.96	0.96	0.96	0.94	0.95
02173051, South Fork Edisto River near Bamberg, SC (807 mi^2)	Aug. 1991–Mar. 2009	02173000, South Fork Edisto River near Denmark, SC (720 mi^2)	Aug. 1931 – Sept. 1971, and Oct. 1980 – Mar. 2009	50	0.96	0.96	0.97	0.97	0.98	0.98	0.99
02174000, Edisto River near Branchville, SC (1,720 mi^2)	Jan. 1945–Sept. 1996	02175000, Edisto River near Givhans, SC (2,730 mi^2)	Jan. 1939 – Mar. 2009	20	0.96	0.96	0.97	0.97	0.98	0.96	0.96

flows were extended by using MOVE.1. Limited sensitivity tests indicated that this extension technique was appropriate for flows between the 5- and 95-percent duration values (Julie Kiang, U.S. Geological Survey Office of Surface Water, written commun., January 26, 2010). The flow durations were computed by combining the measured data with the synthesized data generated from the record extension.

Analytical Considerations

Streamflow statistics computed at CR stations are based on historical streamflow records but can be useful for making decisions about the future if it can be reasonably assumed that the future streamflow patterns are likely to be relatively similar to historical streamflow patterns. Thus, streamflow statistics computed from records that capture a wide range of hydrologic conditions are more desirable. When a stream is influenced by regulation, techniques for estimating low-flow statistics that are similar to those used for analysis of natural streams can be applied; however, consistency in the regulation patterns also must be considered. If assessments of the historical streamflow records indicate that the regulation patterns have been relatively consistent and if the logarithm of the annual minimum flows for a given averaging period are consistent with a Pearson Type III distribution, low-flow statistics can be computed for the regulated station with the understanding that using those statistics for future planning assumes relatively similar regulation patterns will occur in the future (Riggs, 1972).

In the upper part of the basin, the Saluda River is regulated by a number of dams, many of which are run-of-the-river dams that tend to have little to no water storage capacity, and are sometimes associated with small hydroelectric operations that can have an influence on flow patterns, particularly for the lowest averaging periods, such as annual minimum 1-day and 3-day average flows (table 6; U.S. Army Corp of Engineers, 2007). The influence that the run-of-the-river dam will have on the low-flow statistics tends to decrease the farther downstream a station is located from the dam. On the Reedy River, regulation of low to medium flows occurs at Lake Conestee and Boyds Mill Pond Dam (fig. 2) which include small hydroelectric plants.

In the lower part of the basin, the Saluda River includes two large dams associated with major reservoirs, Lake Greenwood and Lake Murray, both having substantial storage and used for power generation (table 6; Wachob and others, 2009). Flows downstream from the large reservoirs will tend to experience the greatest fluctuation. Therefore, for the stations that are affected by considerable regulation, an additional part of the low-flow analysis involves determining the most recent period of record that can be considered to have relatively stable regulation patterns. Any special considerations for the low-flow analyses included in this report, whether related to regulation or not, are discussed in the following sections.

Stations 02163000, Saluda River near Pelzer, South Carolina, and 02163001, Saluda River near Williamston, South Carolina

Station 02163000 was operated from 1929 to 1971 and has a drainage area of 405 mi^2. Station 02163001 was established in 1995 and is currently (2012) still active and has a drainage area of 414 mi^2. Given that the difference in drainage area between the two stations is only about 2 percent, in addition to comparisons of the daily mean flows for the two stations (fig. 6), the data from the two stations were combined for the low-flow analysis, which provides a longer period of record that encompasses a broader range of hydrologic conditions. Before combining the daily mean flows from the two stations, the flows from station 02163000 were adjusted using the drainage-area ratio method (Ries and Friesz, 2000) to account for the potential increase in flow due to the increase in drainage area at 02163001.

Station 02167000, Saluda River at Chappells, South Carolina

Station 02167000 is located 6.7 miles (mi) downstream from Buzzards Roost Dam, Lake Greenwood, and has daily mean flow records from October 1926 to the current year (2012). The dam was constructed in 1940 for the production of hydroelectric power (Wachob and others, 2009). As part of the 1995 Federal Energy Regulatory Commission (FERC) dam relicensing agreement, minimum flow requirements were set with minimum flow varying by season, inflow, weekday, and weekend (Federal Energy Regulatory Commission, 1995).

An assessment of the annual minimum 7-day average streamflows for the regulated period from CY 1941– 2008 indicated a trend in the data. A plot of the data shows that flow patterns appear to have changed in the early 1980s (fig. 7*A*). An assessment of median weekday and weekend flows also indicates a change in flow patterns in the early 1980s (fig. 7*B*). The plots show that prior to the early 1980s, regulation patterns at 02167000 were such that the ratio of median weekend flows to 7-day weekly flows tended to be lower than the ratio of median weekday flows to 7-day weekly flows, indicating less power generation during the weekend. From the early 1980s forward, the ratios of weekday and weekend flows are more similar, indicating a more consistent pattern of flow releases throughout the week. It was concluded that although a minimum release agreement was put into place in 1995, the regulation patterns appear to be relatively similar back to at least about 1983. Consequently, the low-flow statistics for station 02167000 were computed using the period of record from April 1983 to March 2009 (CY 1983-2008).

Station 02169000, Saluda River near Columbia, South Carolina

The daily mean flow record for station 02169000 began in 1925 prior to construction of the Saluda Dam. The Saluda Dam was completed in 1930, and assessment of the flow patterns indicates that regulation patterns have varied throughout the period of record (fig. 8*A*, *B*). On April 22, 1988, a minimum flow release agreement was established between the SCDHEC and the South Carolina Electric and Gas Company (Wade Cantrell, South Carolina Department of Health and Environmental Control, written commun., May 18, 2011). Assessments of the flow data indicate relatively consistent flow patterns since then. Because flow data from most of April 1988 was under old flow conditions, the 1988 CY could not be assessed; therefore, the period of record used to compute low-flow statistics for station 02169000 was April 1989 to March 2009 (CY 1989 – 2008).

Station 02168504, Saluda River below Lake Murray Dam near Columbia, South Carolina

The daily mean flow record for station 02168504 began in October 1988. As noted previously, a minimum flow release was established for the Saluda Dam in April 1988. Consequently, regulation patterns have been relatively consistent during the period of record at station 02168504 and, therefore, the daily mean flow data for CY 1989 – 2008 were included in the low-flow analysis.

Station 02164110, Reedy River above Fork Shoals, South Carolina

Station 02164110 has a drainage area of 104 mi^2 and has daily mean flow record from September 1993 through October 2011. The station is located downstream from Lake Conestee, which has a drainage area of about 66 mi^2 and was created when the current dam was completed in about 1892 (Lake Conestee Nature Park, 2012). Since that time, sediment infilling has substantially reduced the size of the lake. As a result, it is reasonable to assume that the lake has had little, if any, impact on flows at station 02164110 during the period of record. On the other hand, analysis of the flow records from 02164110 in addition to the flow records from station 02164000, Reedy River near Greenville, and 02165000,

Table 6. Streamflow regulation in the Saluda River basin, South Carolina.

[mi², square miles]

Dam or reservoir name	Drainage area, in mi²	Year completed	Stream
Table Rock Reservoir	14.4	1925 (modified in 1980)	South Saluda River
North Saluda Reservoir	26.2	1956 (modified in 1980)	North Saluda River
Saluda Dam	290	1905	Saluda River
Hollidays Bridge	300	1906	Saluda River
Piedmont	375	1874	Saluda River
Upper Pelzer	410	1881	Saluda River
Lower Pelzer	411	1893	Saluda River
Ware Shoals	564	1905	Saluda River
Buzzards Roost (Lake Greenwood)	1,170	1940	Saluda River
Saluda Dam (Lake Murray)	2,420	1930	Saluda River
Lake Conestee	65.5	1812	Reedy River
Boyds Mill Pond	131	1909	Reedy River

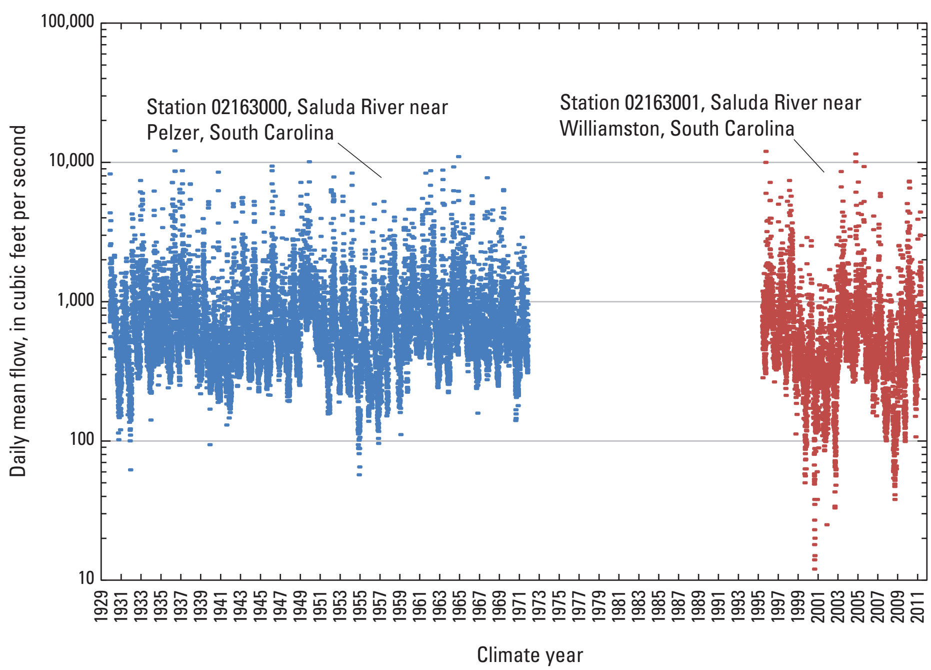

Figure 6. Daily mean flow for stations 02163000, Saluda River near Ware Shoals, South Carolina, and 02163001, Saluda River near Williamston, South Carolina.

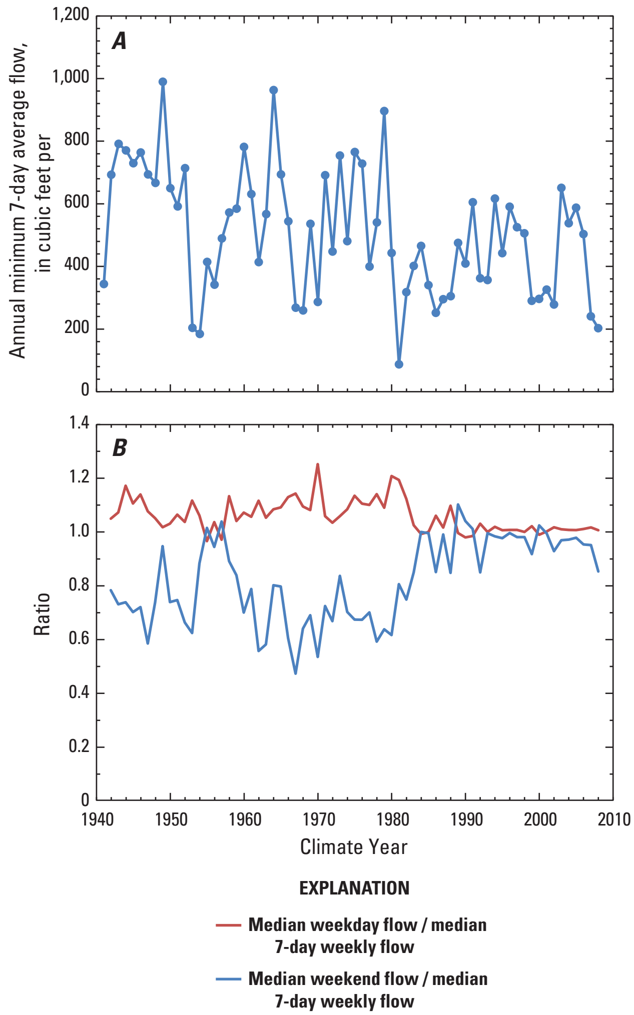

Figure 7. Annual minimum 7-day average streamflow and the ratio of the median weekday to median weekly streamflow and the median weekend to median weekly streamflows at U.S. Geological Survey streamgaging station 02167000, Saluda River at Chappells, South Carolina.

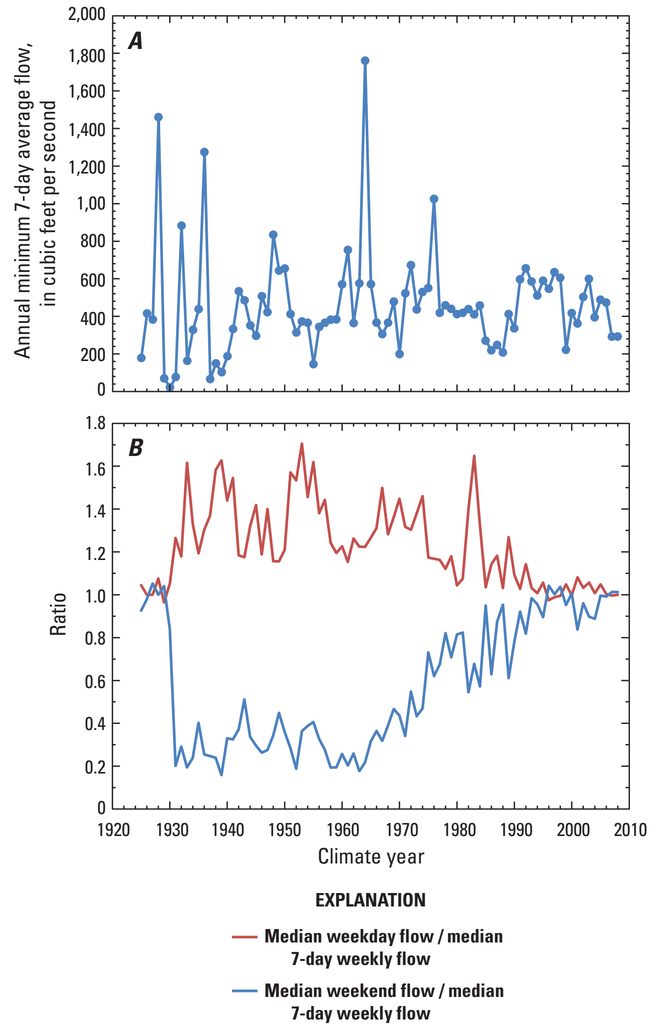

Figure 8. Annual minimum 7-day average streamflow and ratio of the median weekday to median weekly streamflow and the median weekend to median weekly streamflows at U.S. Geological Survey streamgaging station 02169000, Saluda River near Columbia, South Carolina.

Reedy River near Ware Shoals, indicates that the low flows at 02164110 are being influenced by discharge from the Mauldin Road Wastewater Treatment Plant (WWTP).

The Mauldin Road WWTP is located just south of Interstate 85 in Greenville, SC, and station 02164000 (fig. 2). A comparison of flow duration curves for the concurrent period of record (October 1, 1996 to September 30, 2004) at the three Reedy River streamflow stations shows the influence of the discharges from the WWTP, particularly on low flows (fig. 9*A*, *B*). As can been seen, the duration curves for 02164000 and 02165000 tend to be parallel with similar shapes, whereas the duration curve for 02164110 intersects the curve for 02164000 at the lower flows (fig. 9*A*). When plotted on a per square mile basis, the duration curve at 02164110 shows that, except for the highest flows, the rate of flow per square mile is increasingly larger as the percentage exceedence values increase (flows decrease) indicating that the percentage of flow from the Mauldin Road WWTP becomes increasingly larger as the streamflow decreases (fig. 9*B*). The influence of the Mauldin Road WWTP discharge suggests that it is unwise to augment the streamflow record at 02164110 based on correlation with either 02164000 or 02165000. Also, the influence from the WWTP discharge would need to be considered when comparing low-flow statistics from the three stations. For example, the 7Q10 estimates for the three stations are 11, 55, and 50 ft^3/s for stations 02164000, 02164110, and 02165000, respectively (table 2). As discussed in the next section, the 7Q10 for 02165000 was computed using data combined from stations 02165000 and 021650905, Reedy River near Waterloo. Given that the drainage area at 02165000 (021650905) is more than twice the size of the drainage area at 02164110 and that the period of record at 02164110 is much shorter and was collected in a relatively dry period, under natural conditions, the 7Q10 at 02165000 (021650905) should be higher than that of 02164110. Thus, if a 7Q10 estimate were needed between stations 02164110 and 02165000 (021650905) or between stations 02164110 and 02164000, hydrologic judgment would need to be applied with respect to appropriateness of shifting the 7Q10 estimate if based solely on drainage area as is sometimes done (Zalants, 1991a).

Stations 02165000, Reedy River near Ware Shoals, South Carolina, and 021650905, Reedy River near Waterloo, South Carolina

From 1939 to 2004, daily mean flow was collected at station 02165000, located 6.0 mi. downstream from Boyd Mill Pond. In 2004, the gage was moved to a location 1.8 mi downstream and became station 021650905, Reedy River near Waterloo. The drainage area at 02165000 was 236 mi^2 and the drainage area at 021650905 is 251 mi^2, an increase of about 6 percent. Based on a comparison of the daily mean flows (fig. 10) and the similarity in the drainage areas, the records for the two stations were combined for the low-flow analysis. Before combining the daily mean flows from the two stations, the flows from station 02165000 were adjusted by the drainage-area ratio method (Ries and Friesz, 2000) to account for the potential increase in flow due to the increase in drainage area at 021650905. As can be seen in figure 10, the lowest daily mean flows appear to have increased from those previously recorded sometime around the late 1980s. A comparison of the median weekday and weekend flows shows several changes, suggesting variations in the patterns that are likely due to changes in the regulation patterns at Boyd Mill Pond Dam (fig. 11*B*). The weekday and weekend flow patterns as well as the annual minimum 7-day flows appear to have been relatively consistent since the late 1980s (figs. 11*A*, *B*). Consequently, the low-flow statistics were run using data from CY 1988 – 2008.

Station 02169500, Congaree River at Columbia, South Carolina

Daily mean flow data are available at 02169500 from 1939 to the current year (2012). Approximately two-thirds of the drainage basin for 02169500 is from the Broad River. However, because regulation on the Saluda River is much more substantial than that on the Broad River, the ratio of flow from the Saluda River during low-flow periods is likely increased with respect to the total flow in the Congaree River.

Annual median weekday and weekend flows were compared to assess regulation patterns. Similar to patterns for station 02169000, Saluda River near Columbia (fig. 8*B*), several variations can be seen (fig. 12*B*). In addition to the annual minimum 7-day average streamflows, flow patterns appear to have been relatively stable since about 1980 (figs. 12*A, B*). As noted earlier, a minimum flow release agreement was established for the Saluda Dam in 1988. However, due to the flows from the Broad River, the influence on the low flows at station 02169500 is not as apparent as it was for station 02169000 (fig. 8). Consequently, based on the assessment of flows at station 02169500, and in order to use the longest period of record that indicates relatively stable regulation patterns, the low-flows statistics for station 02169500 were computed using data from CY 1980 to 2008.

Considerations for Accuracy of Low-Flow Statistics

With respect to streamflow statistics, the period of collected record can be thought of as a sample, or small portion of the population, which represents all possible measurements. Statistics allow for making inferences about the characteristics of the population based on samples from the population. For example, statistical measures, such as mean, standard deviation, or skew coefficient, can be described in terms of the sample and then used to make inferences about the population from which the sample was obtained. Statistical measures computed from the sample record are estimates of what the measure would be if the entire population were known and used to compute the given measure. Consequently, the accuracy of low-flow statistics at streamgaging stations is related to the length of record (sample from the population) upon which the statistics are based. The longer the period of record at a streamgaging station that covers a broad range of hydrologic conditions, the more accurate or reflective of long-term conditions the low-flow statistics will be.

The streamflow statistics for short-term records are much more sensitive to extreme hydrologic events than those for long-term records. As a result, streamflow statistics, whether high or low, from one 10-year period may differ significantly from another 10-year period. Thus, a long-term record is always more desirable when computing streamflow statistics. To test the effect of record length and hydrologic conditions on low-flow statistics, the 7Q10 for station 02175000, Edisto River near Givhans, was computed beginning with the first 10

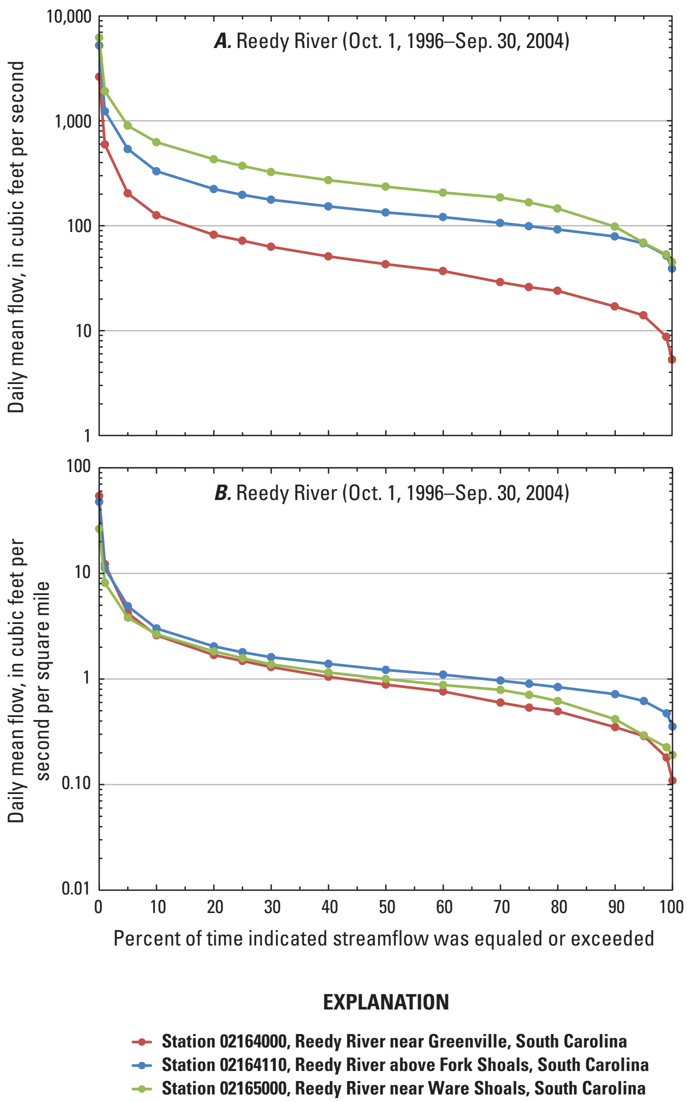

Figure 9. (*A*) Comparison of flow-duration curves for U.S. Geological Survey South Carolina streamgaging stations 02164000, Reedy River near Greenville; 02164110, Reedy River above Fork Shoals; and 02165000, Reedy River near Ware Shoals, and (*B*) flow duration curves normalized by drainage area for the same three stations.

years of record (April 1939–March 1949) and then updated on a 5-year basis through CY 2008. Figure 13 shows the annual minimum 7-day average streamflow by CY for the period of record along with the computed 7Q10 estimates. The figure shows that the 7Q10 for the first 10 years of record was 516 ft^3/s. By CY 1958, the 7Q10 had decreased to 393 ft^3/s due to the addition of records collected during a historic drought period in the 1950s. The 1960s and 1970s tended to be a relatively wet period, and the 7Q10 generally increased during that time. In CY 2002, the lowest annual minimum 7-day average flow of record occurred during the historic drought of 1998-2002. The last few years of the record resulted in two additional dry years (CY 2007 and 2008) and, therefore, the 7Q10 value decreased to 347 ft^3/s in CY 2008. In this analysis, the percent difference between the highest (516 ft^3/s in CY 1948) and lowest (347 ft^3/s in CY 2008) 7Q10 is 39 percent, with percent difference computed as

$$PercentDifference = \frac{|x_1 - x_2|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100 \quad , \qquad (4)$$

where

x_1 is highest 7Q10 estimate from the periods analyzed, and

x_2 is lowest 7Q10 estimate from the periods analyzed.

To show the effect of how the 7Q10 can be influenced under a different set of hydrologic conditions and the significant influence that period of record can have on streamflow statistics, a similar analysis was done using a synthesized record of annual minimum 7-day average flows. The synthesized flows were generated by reversing the annual minimum 7-day average flows from station 02175000. Under these conditions, the streamflow record begins in a significant dry period. As can be seen in figure 14, the 7Q10 computed from the first 10 years of record is 197 ft^3/s, which is 38 percent of the 7Q10 based on the first 10 years of record from the measured data at station 02175000. Because the synthesized record began in a period that was the driest based on the next 60 years of record, the 7Q10 shows a pattern of continuing to increase until the value of 347 ft^3/s was again obtained in CY 2008. The percent difference between the highest and lowest 7Q10 computed in this analysis is 55 percent. This percent difference emphasizes that, although the 7Q10 value at the end of the record was the same for both the measured data and the synthesized data, the intermittent values were sometimes substantially different based on a rearrangement of the hydrologic conditions (starting in an historic dry period as opposed to starting in a relatively normal period). Thus, as the length of record at a streamgaging station increases, the low-flow statistics are moving toward the values that would be expected to be obtained from the population. As the period of record increases, the streamflow statistics tend to be less influenced by extreme conditions, whether wet or dry.

Additional Considerations

As the information in the preceding section indicates, the Saluda, Reedy, and Congaree Rivers are complex with respect to the varying degrees of regulation and other influences that can impact low-flow statistics. Variability in low-flow statistics is related to the length of record available at the CR stations in addition to geologic, topographic, and climatic differences among the various stations being analyzed, even in the same basin (Bloxham, 1979). For the Piedmont region, Bloxham (1979, 1981) reported a decrease in the unit annual minimum 7-day streamflows from the northern part of the region to the southern part with unit values reported from 0.72 to 0.01 $(ft^3/s)/mi^2$ for 7Q2 and from 0.46 to 0 $(ft^3/s)/mi^2$ for 7Q10.

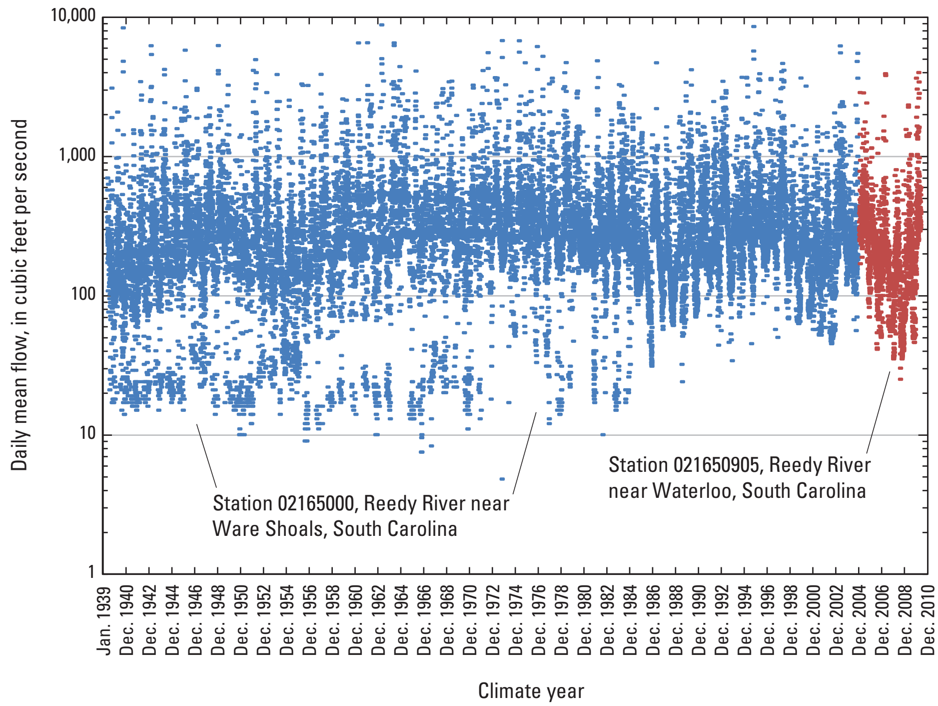

Figure 10. Daily mean flow for U.S. Geological Survey South Carolina streamgaging stations 02165000, Reedy River near Ware Shoals, and 021650905, Reedy River near Waterloo.

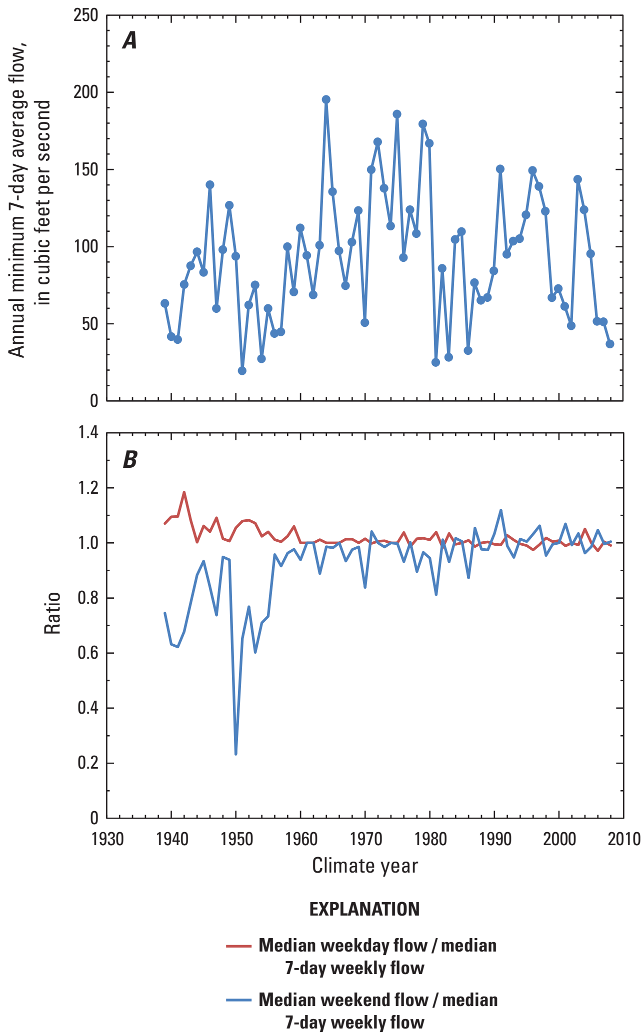

Figure 11. (*A*) Annual minimum 7-day average streamflow and (*B*) ratio of the median weekday to median weekly streamflow and the median weekend to median weekly streamflow for the combined records of U.S. Geological Survey South Carolina streamgaging stations 02165000, Reedy River near Ware Shoals, and 021650905, Reedy River near Waterloo.

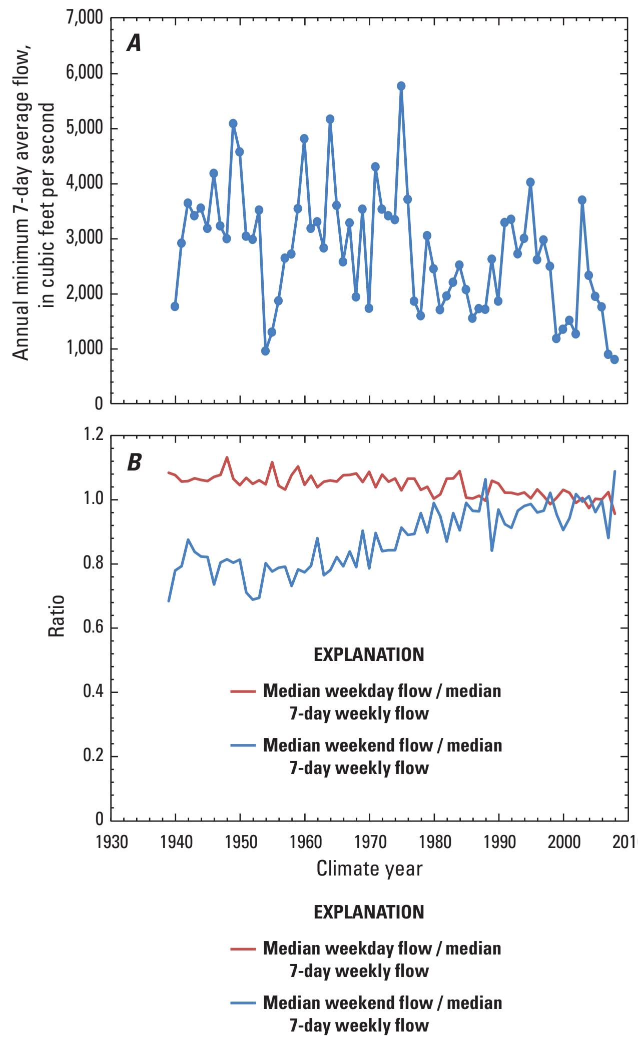

Figure 12. (*A*) Annual minimum 7-day average streamflow and (*B*) ratio of the median weekday to median weekly streamflow and the median weekend to median weekly streamflow for U.S. Geological Survey streamgaging station 02169500, Congaree River at Columbia, South Carolina.

Similar variation can be seen from the low-flow statistics reported in this study for stations along the Saluda and Reedy Rivers (table 7). Thus, along with the anthropogenic influences on the low-flow statistics, other natural influences on variability should be considered as well when comparing values among various sites or when considering the appropriateness of estimating a low-flow statistic at an ungaged location based on the unit flow from a gaged location.

Comparison with Previously Published Low-Flow Statistics

The last systematic update of low-flow statistics in South Carolina included data through March 1987 (the 1986 CY). Since that time, several droughts have occurred, including the severe drought between 1998 and 2002 and a more recent drought from 2006 to 2009 (South Carolina Department of Natural Resources, 2012). Other droughts were reported in 1988, 1990, 1993, and 1995 (Mizzell, 2008). At all stations included in this report that experienced the 1998-2002 and (or) the 2006-2009 droughts, the results were lower annual minimum 7-day average streamflow. That excludes regulated stations where the annual 7-day average is more dependent on flow releases from the dams and stations that were established or discontinued during or before the droughts. Stations 02162350, Middle Saluda River near Cleveland; 02166970, Ninety-Six Creek near Ninety Six; and 02172640, Dean Swamp Creek near Salley were discontinued in 2003, 2001, and 2000, respectively and, therefore, those records do not fully reflect the droughts noted above. Factors other than droughts that likely influenced the differences in the 7Q10 values are record extensions, which were used in this study but were not used in previous studies; whether the 7Q10 analyses were mathematical, as was the case in this study, or graphical; and changes in the basin that, although not necessarily substantial enough to indicate trends in the data, could still have some influence on the low-flow statistics.

Of the 25 stations included in this study, 18 had low-flow statistics that were previously published by Bloxham (1979) or Zalants (1991b). In addition, the records for two stations were combined with the records of stations that were previously published: station 02163001, Saluda River near Williamston was combined with station 02163000, Saluda River near Pelzer; and station 021650905, Reedy River near Waterloo was combined with station 02165000, Reedy River near Ware Shoals. The results of these two stations were compared to the low-flow statistics of the previously published stations (02163000 and 02165000, table 8); therefore, low-flow statistics were compared for 20 stations. The most recently published 7Q10 values for these 20 stations were compared with the current values, and differences, in percent, were computed as follows:

Percent difference = [(current 7Q10 – previous 7Q10) / previous 7Q10] x 100.

As computed, the percent difference indicates the percent of change from the previously published 7Q10 value. The percent differences ranged from -84.0 to 38.9 (table 8). The negative-percent differences for 18 stations indicate that the 7Q10 values decreased, and the positive-percent differences for 2 stations indicate that the 7Q10 values increased. The smallest change in the 7Q10 flow values from the previous investigation was for station 02169630, Big Beaver Creek near St. Matthews, which shows a decrease of -2.0 percent (from 5.0 to 4.9 ft^3/s). It should be noted, however, that the additional data for that station only extended from March 1988 through March 1993. The two stations having an increase in the 7Q10 value were station 02169000, Saluda River near Columbia and station 021650905, Reedy River near Waterloo (compared to station 02165000, Reedy River near Ware Shoals). As previously discussed, an agreement between SCDHEC and the SCE&G set a minimum streamflow for the Lake Murray Dam which is upstream from station 02169000, Saluda River near Columbia. A minimum streamflow release from the dam will be reflected in the 7Q10 as higher minimum streamflow values. Additionally, station 02169000 was evaluated for the period of record from April 1, 1989, through March 31, 2009, because the flow patterns prior to this period were significantly different from the selected period of analysis.

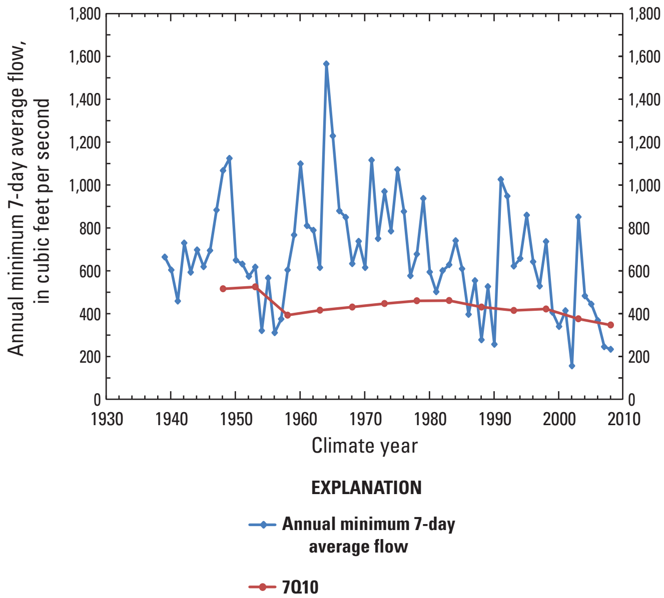

Figure 13. Annual minimum 7-day average streamflow and 7Q10 estimates at U.S. Geological Survey streamgaging station 02175000, Edisto River near Givhans, South Carolina.

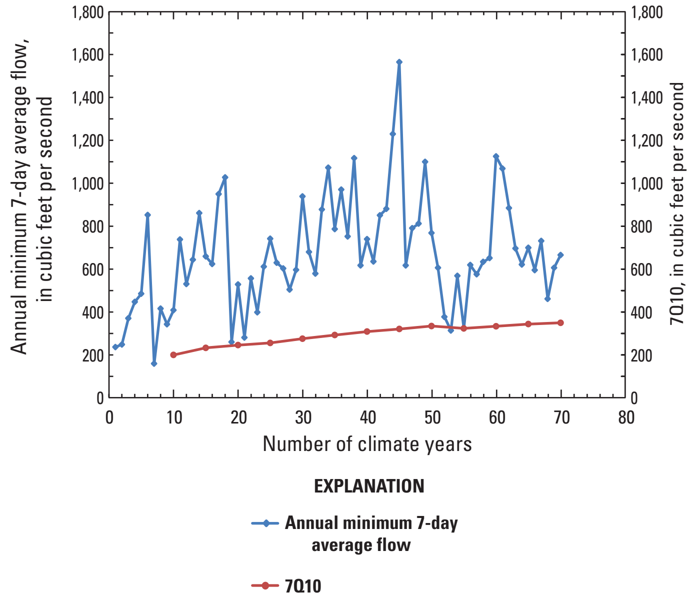

Figure 14. Annual minimum 7-day average streamflow and 7Q10 estimates from a synthesized dataset where the annual minimum 7-day average streamflows from U.S. Geological Survey streamgaging station 02175000, Edisto River near Givhans, South Carolina, were reversed for the period of record.

Table 7. Unit annual minimum 7-day average streamflow with a 2- and 10-year recurrence interval for U.S. Geological Survey streamgaging stations on the Saluda and Reedy Rivers, South Carolina.

[$(ft^3/s)/mi^2$, cubic feet per second per square mile]

Station name and number	Unit 7Q2, in $(ft^3/s)/mi^2$	Unit 7Q10, in $(ft^3/s)/mi^2$
Saluda River		
02162500, Saluda River near Greenville	0.74	0.33
[a]02163001, Sulada River near Williamston	0.66	0.26
02163500, Saluda River near Ware Shoals	0.53	0.22
02168504, Saluda River below Lake Murray Dam near Columbia	0.16	0.10
02169000, Saluda River near Columbia	0.19	0.12
Reedy River		
02164000, Reedy River near Greenville	0.43	0.23
02164110, Reedy River above Fork Shoals	0.66	0.41
[b]021650905, Reedy River near Waterloo	0.35	0.20

[a] Station combined with U.S. Geological Survey station 02163000, Saluda River near Pelzer.

[b] Station combined with U.S. Geological Survey station 02165000, Reedy River near Ware Shoals.

Table 8. Differences between the annual minimum 7-day average streamflow with a 10-year recurrence interval in this report and previously published values for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.

[USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; CY, climatic year; ND, not determined]

USGS streamgaging station number and name	Previous estimate from Bloxham (1979), in ft^3/s	Previous estimate from Zalants (1991b), in ft^3/s	Current (CY 2008) estimate, in ft^3/s	Percent difference from most recent estimate to current estimate
02162350, Middle Saluda River near Cleveland	ND	11	9.3	–15.5
02162500, Saluda River near Greenville	130	160	99	–38.1
[a]02163001, Saluda River near Williamston	168	ND	106	–36.9
02163500, Saluda River near Ware Shoals	190	190	130	–31.6
02164000, Reedy River near Greenville	16	16	11.0	–31.3
[b]021650905, Reedy River near Waterloo	36	36	50	38.9
02165200, South Rabon Creek near Gray Court	6.4	7.8	1.5	–80.8
02166970, Ninety-Six Creek near Ninety Six	ND	0.25	0.04	–84.0
02167000, Saluda River near Chappells	320	ND	258	–19.4
02169000, Saluda River near Columbia	260	ND	304	16.9
02169500, Congaree River at Columbia	1,800	ND	1,210	–32.8
02169570, Gills Creek at Columbia	9.8	5.6	3.9	–30.4
02169630, Big Beaver Creek near St. Mathews	5.0	5.0	4.9	–2.0
02172500, South Fork Edisto River near Montmorenci	65	ND	55	–15.4
02172640, Dean Swamp Creek near Salley	ND	16	14	–12.5
02173000, South Fork Edisto River near Denmark	211	200	175	–12.5

Table 8. Differences between the annual minimum 7-day average streamflow with a 10-year recurrence interval in this report and previously published values for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; CY, climatic year; ND, not determined]

USGS streamgaging station number and name	Previous estimate from Bloxham (1979), in ft^3/s	Previous estimate from Zalants (1991b), in ft^3/s	Current (CY 2008) estimate, in ft^3/s	Percent difference from most recent estimate to current estimate
02173500, North Fork Edisto River near Orangeburg	225	230	209	–9.1
02174000, Edisto River near Branchville	455	480	406	–15.4
02174250, Cow Castle Creek near Bowman	0.74	0.70	0.26	–62.9
02175000, Edisto River near Givhans	442	500	347	–30.6

[a] Compared to station 02163000, Saluda River near Pelzer, because of the proximity of the two stations, the similarity in drainage area, and the different period of record for the two stations, their records were combined.

[b] Compared to station 02165000, Reedy River near Ware Shoals, because of the proximity of the two stations, the similarity in drainage area, and the different period of record for the two stations, their records were combined.

Summary

This report, prepared in cooperation with the South Carolina Department of Health and Environmental Control, provides updated low-flow statistics at continuous-record streamgaging stations operated by the U.S. Geological Survey in the Saluda, Congaree, and Edisto River basins of South Carolina. The continuous-record streamgaging stations included in this study were analyzed based on four categories of stations: (1) long-term record stations, (2) short-term record stations that have at least 10 years of record, (3) stations that have between 5 and 10 years of record and were analyzed for a limited set of low-flow statistics using techniques typically used in analyzing partial-record stations, and (4) regulated stations. The Maintenance of Variance Extension, Type 1, method was used for the record-extension analyses and the partial-record type analyses. Based on the length of record available at the continuous-record streamgaging stations, low-flow frequency statistics were estimated for annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average flows with recurrence intervals of 2, 5, l0, 20, 30, and 50 years. Additionally, daily flow durations for the 5-, 10-, 25-, 50-, 75-, 90-, and 95-percent exceedances were computed for the stations.

Of the 25 streamgaging stations included in this study, 20 had low-flow statistics that were published in previous U.S. Geological Survey reports. Of those 20 stations, only 2 of the stations had an increase in the 7Q10 value. The percent difference of 7Q10 values computed for this report and previously published U.S. Geological Survey reports ranged from –84.0 to 38.9 percent.

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Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Notes: The station low-flow statistics are presented in the following pages in numerical order by station number. See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02162350 Middle Saluda River near Cleveland, SC

LOCATION.—Lat 35°07'12", Long 82°32'16", referenced to North American Datum of 1927, Greenville County, SC, Hydrologic Unit 03050109, at State Road 41 bridge, 3.9 mi north of Cleveland, and 5.0 mi east of Caesers Head.

DRAINAGE AREA.—21.0 mi^2, approximately.

PERIOD OF RECORD.—October 1980 to September 2003.

PERIOD OF ANALYSIS.—April 1981 to March 2003.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	16	16	17	18	20	23	25
5	11	11	11	12	14	16	18
10	8.8	9.0	9.3	10	11	13	15
20	7.4	7.6	7.9	8.5	9.4	11	13
30	6.7	7.0	7.2	7.8	8.7	9.6	10

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
135	104	70	44	27	18	15

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square miie; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.--02162500 Saluda River near Greenville, SC

LOCATION.—Lat 35º50'32", long 82º28'51", referenced to North American Datum of 1927, Pickens County, SC, Hydrologic Unit 03050109, on right bank 700 ft upstream from bridge on State Road 124, 1.6 mi downstream from Saluda Lake Dam, 2.4 mi upstream from Georges Creek, 4.6 mi west of city hall in Greenville, and at mile 132.0.

DRAINAGE AREA.--295 mi^2.

PERIOD OF RECORD.—January 1942 to September 1978, and March 1990 to current year.

PERIOD OF ANALYSIS.—April 1942 to March 1978 and April 1990 to March 2009.

REMARKS.—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Some regulation of low to medium flow by powerplants upstream. Greenville Water diverts water for municipal supply upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	173	195	217	232	255	289	322
5	101	114	135	146	166	189	211
10	72	81	99	109	128	146	164
20	54	59	75	83	101	116	131
30	45	49	64	72	88	102	116
50	37	40	53	60	75	88	100

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
1,410	1,100	753	495	321	223	162

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.--02163001 Saluda River near Williamston, SC

LOCATION.--Lat 34º 36' 35", long 82º 26' 39", referenced to North American Datum of 1927, Greenville County, SC, Hydrologic Unit 03050109, 1,300 ft downstream from Pelzer Mills dam, and 2 mi east of Williamston, SC

DRAINAGE AREA.-– 414 mi^2.

PERIOD OF RECORD.—May 1995 to current year.

PERIOD OF ANALYSIS.—April 1930 to March 1971, and April 1996 to March 2009.

REMARKS.—Daily mean flows are combined with streamgaging station 02163000, Saluda River near Pelzer, SC (October 1929 to September 1971) to extend the period of record. The drainage areas of the two stations are within 2.2 percent of each other. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Some regulation of low to medium flow from upstream Pelzer Mills dam. Greenville Water diverts water for municipal supply upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	212	254	275	285	305	345	377
5	101	138	158	171	196	226	252
10	59	87	106	121	149	175	200
20	35	55	71	87	116	139	163
30	25	41	55	71	101	122	145
50	17	30	42	57	86	106	127

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
1,830	1,360	916	608	408	294	241

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02163500 Saluda River near Ware Shoals, SC

LOCATION.--Lat 34º23'30", long 83º13'25", referenced to North American Datum of 1927, Greenwood County, SC, Hydrologic Unit 03050109, on downstream side of U.S. Highway 25 bridge, 1.4 mi southeast of Ware Shoals, 1.8 mi downstream from Ware Shoals Dam, 5.7 mi upstream from Turkey Creek, and at mile 84.4.

DRAINAGE AREA.–580 mi^2.

PERIOD OF RECORD.–March 1939 to current year.

PERIOD OF ANALYSIS.—April 1939 to March 2009.

REMARKS—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Some regulation of low to medium flow from upstream Ware Shoals Dam. City of Greenville diverts water for municipal water supply upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	203	263	309	338	373	426	470
5	99	150	183	207	238	276	314
10	61	105	130	150	180	211	247
20	38	76	94	112	140	166	199
30	29	63	78	93	121	144	176
50	21	50	63	77	102	123	154

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
2,360	1,750	1,140	724	474	302	238

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02164000 Reedy River near Greenville, SC

LOCATION.-- Lat 34º48'00", long 82º21'55", referenced to North American Datum of 1927, Greenville County, SC, Hydrologic Unit 03050109, on right bank, 375 ft downstream from bridge on Interstate Highway 85, 0.5 mi upstream from Brushy Creek, 2.5 mi upstream from dam at Conestee, 3.9 mi southeast of City Hall in Greenville, and at mile 48.5.

DRAINAGE AREA.—48.6 mi^2.

PERIOD OF RECORD.—November 1941 to September 1971, and June 1987 to current year.

PERIOD OF ANALYSIS.—April 1942 to March 1971, and April 1988 to March 2009.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	19	19	21	24	28	33	39
5	12	13	14	16	19	24	28
10	9.3	10	11	13	16	20	23
20	7.4	8.1	9.2	10	13	17	20
30	6.5	7.2	8.2	9.3	12	16	18
50	5.6	6.3	7.2	8.2	11	15	16

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
214	136	79	50	33	23	18

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02164110 Reedy River above Fork Shoals, SC

LOCATION.—Lat 34º39'10", long 82º17'52", referenced to North American Datum of 1927, Greenville County, SC, Hydrologic Unit 03050109, at Jenkins Bridge Road bridge, 0.1 mi northeast of intersection of Road 418 and Road 146, and 2.4 mi north of Fork Shoals and at mile 36.1.

DRAINAGE AREA.—110 mi^2.

PERIOD OF RECORD.—September 1993 to current year.

PERIOD OF ANALYSIS.—April 1994 to March 2009.

REMARKS.—Based on review of withdrawal data provided by the SCDHEC, there are no significant withdrawals upstream. Based on review of point-source discharge data provided by the SCDHEC, the potential exists for significant discharge upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Diversion into basin by the city of Greenville, SC, from the Saluda River upstream from station 02162500, Saluda River near Greenville, SC

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	69	71	73	77	85	99	113
5	51	52	55	58	66	76	85
10	42	43	45	49	56	65	71
20	36	36	38	42	49	57	60

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
510	306	189	136	98	73	61

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—021650905 Reedy River near Waterloo, SC

LOCATION.— Lat 34º 23' 29", long 82º 08' 22", referenced to North American Datum of 1983, Laurens County, SC, Hydrologic Unit 03050109, at upstream from State Road S-30-36 bridge, 6.0 mi northwest of Waterloo, SC, 7.8 mi downstream from Boyd Mill Pond Dam.

DRAINAGE AREA.—251 mi^2.

PERIOD OF RECORD.—November 2004 to current year.

PERIOD OF ANALYSIS.—April 1988 to March 2009.

REMARKS.--Daily mean flows are combined with streamgaging station 02165000, Reedy River near Ware Shoals, SC (April 1939 to March 2005) to extend the period of record. The drainage areas of the two stations are within 6.0 percent of each other. Based on review of withdrawal data provided by the SCDHEC, there are no significant withdrawals upstream. Based on review of point-source discharge data provided by the SCDHEC, the potential exists for significant discharge upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Some regulation of low to medium flow from upstream dams. Sewage effluent discharged into the Reedy River about 500 ft below station 02164000.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	54	75	88	102	121	151	162
5	38	52	61	72	84	101	109
10	32	42	50	59	67	79	86
20	27	35	42	50	55	63	70
30	25	32	38	44	49	56	61
50	22	29	34	40	43	48	54

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
900	634	375	256	157	90	66

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02165200 South Rabon Creek near Gray Court, SC

LOCATION.-- Lat 34º31'12", long 82º09'06", referenced to North American Datum of 1927, Laurens County, SC, Hydrologic Unit 03050109, at left bank, 125 ft upstream from U.S. Highway 76, 2.5 mi upstream from North Rabon Creek and 7.0 mi southwest of Gray Court.

DRAINAGE AREA.—29.5 mi^2.

PERIOD OF RECORD.—January 1967 to September 1981, and May 1990 to current year.

PERIOD OF ANALYSIS.—April 1968 to March 1981, and April 1991 to March 2009.

REMARKS.--Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	9.0	9.2	9.6	11	12	13	14
5	3.0	3.1	3.4	4.0	5.6	7.1	8.2
10	1.3	1.3	1.5	1.8	3.1	4.3	5.6
20	0.51	0.55	0.63	0.79	1.7	2.6	3.9
30	0.29	0.32	0.36	0.46	1.1	1.9	3.1
50	0.15	0.17	0.20	0.26	0.72	1.3	2.4

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
85	57	37	24	15	8.9	5.6

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02166970 Ninety Six Creek near Ninety Six, SC

LOCATION.--Lat 34º07'57", long 81º59'48", referenced to North American Datum of 1927, Greenwood County, SC, Hydrologic Unit 03050109, 10.1 mi southeast of Greenwood, and at Road 288 bridge 3.3 mi southeast of Ninety Six, SC

DRAINAGE AREA.—17.4 mi^2.

PERIOD OF RECORD.—October 1980 to September 2001.

PERIOD OF ANALYSIS.—April 1981 to March 2001.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	0.27	0.29	0.36	0.37	0.46	0.70	1.1
5	0.10	0.11	0.10	0.13	0.18	0.28	0.42
10	0.06	0.06	0.04	0.07	0.12	0.17	0.25
20	0.0	0.0	0.02	0.04	0.08	0.11	0.16
30	0.0	0.0	0.01	0.03	0.06	0.09	0.12

DURATION OF DAILY FLOW

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
52	21	8.9	3.8	1.2	0.41	0.21

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02167000 Saluda River at Chappells, SC

LOCATION.--Lat 34º10'28", long 81º51'51", referenced to North American Datum of 1927, Saluda County, SC, Hydrologic Unit 03050109, on downstream side of bridge on State Highway 39 at Chappells, 6.7 mi downstream from dam at Lake Greenwood, 9.8 mi upstream from Little River, and at mile 52.3.

DRAINAGE AREA.—1,360 mi^2.

PERIOD OF RECORD.—October 1926 to current year.

PERIOD OF ANALYSIS.—April 1983 to March 2009.

REMARKS.—Based on review of discharge and withdrawal data provided by the SCDHEC, the potential exists for significant discharge and withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Flow regulated since 1940 by Lake Greenwood, which has a usable capacity of approximately 7,640,000,000 ft^3.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	257	347	402	437	496	583	647
5	176	256	301	326	359	399	427
10	144	218	258	277	299	321	338
20	122	191	225	240	256	265	276
30	111	177	209	222	234	238	246

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
4,430	3,350	1,840	1,040	593	372	301

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02167450 Little River near Silverstreet, SC

LOCATION.--Lat 34º12'34", long 81º45'48", referenced to North American Datum of 1927, Newberry County, SC, Hydrologic Unit 03050109, near center span on downstream side of bridge on U.S. Highway 34, 3.4 mi downstream from Mud Lick Creek, 2.8 mi upstream from mouth, 2.9 mi west of Silverstreet, SC

DRAINAGE AREA.—230 mi^2.

PERIOD OF RECORD.—March 1990 to current year.

PERIOD OF ANALYSIS.—April 1991 to March 2009.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	16	16	17	20	25	33	38
5	4.5	4.9	5.9	7.6	11	16	19
10	2.0	2.2	2.9	4.1	6.6	10	12
20	0.89	1.1	1.5	2.4	4.0	6.9	8.1

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
524	297	153	82	45	21	13

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02167582 Bush River near Prosperity, SC

LOCATION.--Lat 34º10'07", long 81º36'38", referenced to North American Datum of 1927, Newberry County, SC, Hydrologic Unit 03050109, on downstream side of bridge on County Road 244, 5.2 mi southwest of Prosperity, and 7.2 mi south of the center of Newberry, SC

DRAINAGE AREA.—115 mi^2.

PERIOD OF RECORD.—February 1990 to current year.

PERIOD OF ANALYSIS.—April 1990 to March 2009.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	10	11	12	13	16	21	24
5	5.9	6.4	6.9	7.6	9.5	12	13
10	4.3	4.6	5.0	5.5	6.9	8.3	9.3
20	3.2	3.5	3.8	4.1	5.2	6.0	6.8

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
362	181	83	42	23	13	8.6

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02168504 Saluda River below Lake Murray Dam near Columbia, SC

LOCATION.--Lat 34º03'03", long 81º12'35", referenced to North American Datum of 1927, Lexington County, SC, Hydrologic Unit 03050109, on left bank, approximately 1,000 ft downstream from Lake Murray Dam on the Saluda River, and at mile 9.7.

DRAINAGE AREA.—2,420 mi^2.

PERIOD OF RECORD.—October 1988 to current year.

PERIOD OF ANALYSIS.—April 1989 to March 2009.

REMARKS.—Based on review of discharge and withdrawal data provided by the SCDHEC, the potential exists for significant discharge and withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Flow regulated since 1929 by Lake Murray, usable capacity 70,300,000,000 ft^3, and since 1940 by Lake Greenwood, which has a usable capacity of 7,640,000,000 ft^3. A minimum flow release agreement was established between South Carolina Department of Health and Environmental Control and the South Carolina Electric and Gas Company in April 1988 (Wade Cantrell, South Carolina Department of Health and Environmental Control, written commun., May 18, 2011)..

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	248	318	382	440	571	704	889
5	192	236	285	334	400	465	550
10	168	199	240	288	340	376	423
20	151	171	205	254	301	317	339

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
8,430	5,290	2,710	1,290	544	424	322

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02169000 Saluda River near Columbia, SC

LOCATION.--Lat 34º00'50", long 81º05'17", referenced to North American Datum of 1927, Richland County, SC, Hydrologic Unit 03050109, on left bank 0.4 mi upstream from site of Old Saluda Mill, 1.6 mi upstream from confluence with the Broad River and 3.3 mi west of the State Capitol in Columbia, and at mile 1.67.

DRAINAGE AREA.—2,520 mi^2.

PERIOD OF RECORD.—August 1925 to current.

PERIOD OF ANALYSIS.—April 1989 to March 2009.

REMARKS.—Based on review of discharge and withdrawal data provided by the SCDHEC, the potential exists for significant discharge and withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. Flow regulated since 1929 by Lake Murray, usable capacity 70,300,000,000 ft^3, and since 1940 by Lake Greenwood, which has a usable capacity of 7,640,000,000 ft^3. A minimum flow release agreement was established between South Carolina Department of Health and Environmental Control and the South Carolina Electric and Gas Company in April 1988 (Wade Cantrell, South Carolina Department of Health and Environmental Control, written commun., May 18, 2011).

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	351	406	477	535	662	807	987
5	266	313	361	410	484	562	647
10	229	268	304	355	419	470	516
20	202	234	260	314	376	407	427

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
8,540	5,550	2,930	1,420	637	495	422

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02169500 Congaree River at Columbia, SC

LOCATION.--Lat 33º59'35", long 81º03'00", referenced to North American Datum of 1927, Lexington County, SC, Hydrologic Unit 03050110, on right bank at Columbia, 1,000 ft downstream from Gervais Street Bridge, 1.4 mi downstream from confluence of the Broad and Saluda Rivers, and at mile 174.8.

DRAINAGE AREA.—7,850 mi^2.

PERIOD OF RECORD.—October 1939 to current year.

PERIOD OF ANALYSIS.—April 1980 to March 2009.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream. Consequently, no adjustment was made to the data used in the frequency analysis. Flow regulated since 1929 by Lake Murray, usable capacity 70,300,000,000 ft^3, and since 1940 by Lake Greenwood, which has a usable capacity of 7,640,000,000 ft^3. Low to medium flow also regulated by powerplants on Broad River. Municipal supply for the City of Columbia diverted above station from Broad River.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	1,310	1,730	2,120	2,420	2,760	3,250	3,630
5	917	1,220	1,490	1,690	1,890	2,180	2,410
10	756	1,000	1,210	1,360	1,520	1,700	1,890
20	643	836	1,010	1,130	1,250	1,360	1,510
30	587	756	914	1,010	1,120	1,200	1,330

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
22,400	14,800	8,710	5,480	3,420	2,050	1,590

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02169570 Gills Creek at Columbia, SC

LOCATION.--Lat 33º59'22", long 80º58'28", referenced to North American Datum of 1927, Richland County, SC, Hydrologic Unit 03050110, on left bank, downstream side of bridge on U.S. Highways 378 and 76 (Devine Street) at Columbia, 0.75 mi downstream from Lake Katherine, and at mile 7.7.

DRAINAGE AREA.—59.6 mi².

PERIOD OF RECORD.—October 1966 to current year.

PERIOD OF ANALYSIS.—April 1967 to March 2009.

REMARKS.---Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. Natural flow subject to temporary influence from private lakes upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	8.4	9.0	10	12	17	23	29
5	4.5	4.9	5.5	6.8	9.2	13	17
10	3.1	3.4	3.9	4.9	6.4	9.6	13
20	2.2	2.5	2.8	3.7	4.7	7.3	9.6
30	1.8	2.0	2.3	3.1	3.9	6.3	8.2
50	1.4	1.6	1.9	2.6	3.2	5.3	7.0

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time						
5	10	25	50	75	90	95
217	147	83	45	25	13	9.4

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02169630 Big Beaver Creek near St. Matthews, SC

LOCATION.--Lat 33º44'12", long 80º57'30", referenced to North American Datum of 1927, Lexington County, SC, Hydrologic Unit 03050110, on downstream side of bridge on U.S. Highway 21, 0.1 mi below Rock Branch and 11.6 mi northwest of St. Matthews, Calhoun County, SC

DRAINAGE AREA.—10.0 mi^2.

PERIOD OF RECORD.—July 1966 to September 1993.

PERIOD OF ANALYSIS.—April 1967 to March 1993.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	6.5	6.7	7.0	7.3	8.0	8.8	9.3
5	5.1	5.3	5.5	5.8	6.3	7.0	7.4
10	4.5	4.7	4.9	5.1	5.6	6.2	6.6
20	4.1	4.2	4.4	4.6	5.1	5.6	6.0
30	3.9	4.0	4.2	4.4	4.8	5.3	5.7

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
27	22	16	12	8.9	7.1	6.4

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02172500 South Fork Edisto River near Montmorenci, SC

LOCATION.--Lat 33º34'35", long 81º30'50", referenced to North American Datum of 1927, Aiken County, SC, Hydrologic Unit 03050204, near the center span on downstream side of bridge on State Highway 302, 0.4 mi upstream from Cedar Creek, 1.0 mi upstream from Shaw Creek, 7.6 mi northeast of Montmorenci, SC, and at mile 167.3.

DRAINAGE AREA.—198 mi^2.

PERIOD OF RECORD.—April 1940 to September 1966.

PERIOD OF ANALYSIS.—April 1940 to March 1966. Period of record was extended to include climatic years 1932 to 1939, 1966 to 1970, and 1981 to 2008 by using streamgaging station 02173000, South Fork Edisto River near Denmark, SC, as an index station. The MOVE.1 technique was used to augment the record.

REMARKS.—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, with respect to adjusting the low-flow statistics, adequate data are not available to quantify this diversion.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	83	85	91	97	111	125	135
5	59	61	65	70	81	92	100
10	49	51	55	58	68	77	84
20	42	44	47	50	58	66	72

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
453	369	261	186	133	99	79

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02172640 Dean Swamp near Salley, SC

LOCATION.--Lat 33º35'21", long 81º21'57", referenced to North American Datum of 1927, Aiken County, SC, Hydrologic Unit 03050204, on dirt road, Richburg Villa, South of County Road 27, 1.2 mi south of intersection of County Roads 14 and 270.

DRAINAGE AREA.—31.2 mi^2.

PERIOD OF RECORD.—October 1980 to March 1987, then February 1988 to October 2000.

PERIOD OF ANALYSIS.—April 1981 to March 1987, then April 1988 to March 2000.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	**3**	**7**	**14**	**30**	**60**	**90**
2	17	18	18	19	20	22	22
5	15	15	15	16	18	19	19
10	13	14	14	14	16	17	17
20	12	13	13	13	15	16	16

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	**10**	**25**	**50**	**75**	**90**	**95**
36	32	27	24	20	18	16

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02173000 South Fork Edisto River near Denmark, SC

LOCATION.--Lat 33º23'35", long 81º08'00", referenced to North American Datum of 1927, Bamberg County, SC, Hydrologic Unit 03050204, on left bank on downstream side of bridge on U.S. Highway 321, 360 ft downstream from Seaboard Coast Line Railroad Bridge, 1.8 mi downstream from Little River, 4.8 mi north of Denmark, and at mile 136.6.

DRAINAGE AREA.—720 mi^2.

PERIOD OF RECORD.—August 1931 to September 1971, then October 1980 to current year.

PERIOD OF ANALYSIS.—April 1932 to March 1971, then April 1981 to March 2009.

REMARKS.—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	267	271	284	305	343	390	420
5	194	198	207	223	252	286	308
10	164	168	175	188	212	240	257
20	142	145	152	163	182	206	220
30	131	135	140	150	167	189	202
50	121	124	129	138	153	172	183

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
1,640	1,290	872	616	442	317	256

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02173051 South Fork Edisto River near Bamberg, SC

LOCATION.--Lat 33º20'13", long 81º01'08", referenced to North American Datum of 1927, Bamberg County, SC, Hydrologic Unit 03050204, on downstream side of upstream bridge, on U.S. Highway 301/601, 3.0 mi north of Bamberg, and at mile 127.2.

DRAINAGE AREA.—807 mi^2.

PERIOD OF RECORD.—April 1991 to current year.

PERIOD OF ANALYSIS.—April 1932 to March 2009. Period of record was extended to include climatic years 1932 to 1970 and 1981 to 1990 by using streamgaging station 02173000, South Fork Edisto River near Denmark, SC, as an index station. The MOVE.1 technique was used to augment the record.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	277	281	299	331	388	461	510
5	195	199	211	232	271	316	349
10	163	165	175	191	221	256	279
20	139	142	150	163	185	212	231
30	128	131	137	148	168	191	208
50	117	119	125	135	151	171	184

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
2,550	1,940	1,220	796	521	349	271

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02173500 North Fork Edisto River at Orangeburg, SC

LOCATION.--Lat 33º29'00", long 80º52'25", referenced to North American Datum of 1927, Orangeburg County, SC, Hydrologic Unit 03050203, on left bank, under bridge on U.S. Highway 301 at Orangeburg, 0.5 mi upstream from Seaboard Coast Line Railroad bridge, 1.5 mi downstream from Caw Caw Swamp and at mile 22.1.

DRAINAGE AREA.—683 mi^2.

PERIOD OF RECORD.—December 1938 to current year.

PERIOD OF ANALYSIS.—April 1939 to March 2009.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream. Consequently, no adjustments were made to the data used in the frequency analysis. City of Orangeburg diverts municipal water supply upstream, but this diversion was determined to not be significant.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	331	336	347	365	396	441	473
5	239	242	252	265	292	324	346
10	198	201	209	221	244	271	288
20	167	170	178	188	209	232	245
30	153	155	162	171	191	212	223
50	137	140	147	155	173	193	202

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
1,550	1,240	883	646	467	350	284

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi^2, square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02174000 Edisto River near Branchville, SC

LOCATION.--Lat 33º10'35", long 80º48'05", referenced to North American Datum of 1927, Bamberg County, SC, Hydrologic Unit 03050205, 400 ft downstream from bridge on U.S. Highway 21 and 5.2 mi south of Branchville.

DRAINAGE AREA.—1,720 mi^2.

PERIOD OF RECORD.—October 1945 to September 1996.

PERIOD OF ANALYSIS.—April 1940 to March 2009. Period of record was augmented to include climatic years 1940 to 1944, and 1997 to 2009 by using streamgaging station 02175000, Edisto River near Givhans, SC, as an index station. The MOVE.1 technique was used to augment the record.

REMARKS.—Based on review of withdrawal and discharge data provided by the SCDHEC, there are no significant diversions upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	699	706	725	758	817	910	961
5	481	488	505	537	592	662	707
10	384	390	406	437	490	556	596
20	313	319	334	363	415	479	515
30	277	283	298	326	377	441	475
50	244	249	263	290	340	403	435

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
5,100	3,850	2,490	1,580	1,060	761	607

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02174250 Cow Castle near Creek near Bowman, SC

LOCATION.--Lat 33º22'43", long 80º42'00", referenced to North American Datum of 1927, Bamberg County, SC, Hydrologic Unit 03050206, 400 ft downstream from bridge on U.S. Highway 21 and 5.2 mi south of Branchville.

DRAINAGE AREA.—23.4 mi^2.

PERIOD OF RECORD.—October 1970 to September 1981, and October 1995 to current year.

PERIOD OF ANALYSIS.—April 1971 to March 1981, and April 1996 to March 2009.

REMARKS.—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	0.77	0.83	0.94	1.1	1.5	2.0	2.6
5	0.33	0.37	0.43	0.53	0.79	0.98	1.2
10	0.19	0.22	0.26	0.33	0.52	0.68	0.84
20	0.08	0.10	0.11	0.15	0.26	0.50	0.61
30	0.0	0.0	0.0	0.0	0.0	0.43	0.51

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
69	43	18	6.9	2.7	1.4	0.87

Table 2. Low-flow statistics for continuous-record streamgaging stations in the Saluda, Congaree, and Edisto River basins of South Carolina.—Continued

[lat, latitude; long, longitude; ft, feet; mi, mile; mi², square mile; SCDHEC, South Carolina Department of Health and Environmental Control; USGS, U.S. Geological Survey]

Note: See figure 2 for location of the streamgaging stations.

STATION NAME AND NUMBER.—02175000 Edisto River near Givhans, SC

LOCATION.--Lat 33º01'40", long 80º23'30", referenced to North American Datum of 1927, Dorchester County, SC, Hydrologic Unit 03050205, on downstream side of bridge on State Highway 61, 2.3 mi downstream from Four Hole Swamp, 2.8 mi west of Givhans, and at mile 59.9.

DRAINAGE AREA.—2,730 mi^2.

PERIOD OF RECORD.—January 1939 to current year.

PERIOD OF ANALYSIS.—April 1940 to March 2009.

REMARKS.—Based on review of discharge data provided by the SCDHEC, there are no significant point-source discharges upstream. Based on review of withdrawal data provided by the SCDHEC, the potential exists for significant withdrawal upstream. However, adequate data are not available to quantify this diversion. No adjustment was made to the data used in the frequency analysis. City of Charleston diverts municipal water supply upstream.

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Recurrence intervals (years)	Lowest average flow for indicated number of consecutive days (cubic feet per second)						
	1	3	7	14	30	60	90
2	625	634	649	677	738	859	968
5	422	428	439	459	504	566	626
10	332	337	347	364	403	450	491
20	268	272	281	296	331	370	399
30	236	239	248	262	296	332	355
50	206	209	217	230	262	295	314

DURATION OF DAILY FLOWS

Flow equaled or exceeded for indicated percentage of time (cubic feet per second)						
5	10	25	50	75	90	95
7,330	5,240	3,050	1,700	1,000	670	524

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