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Concentrations, Loads, and Yields of Nutrients and Suspended Sediment in the South Pacolet, North Pacolet, and Pacolet Rivers, Northern South Carolina and Southwestern North Carolina, October 2005 to September 2009

Scientific Investigations Report 2010–5252

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

Cover photograph: Lake William C. Bowen at the public boat ramp and recreational park off S.C. Highway 9, Spartanburg County, South Carolina.

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KEN SALAZAR, Secretary

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
	Area	
hectare (ha)	2.471	acre
hectare (ha)	0.003861	square mile (mi^2)
	Volume	
liter (L)	0.2642	gallon (gal)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Mass	
kilogram (kg)	2.205	pound avoirdupois (lb)
megagram (Mg)	1.102	ton, short (2,000 lb)
megagram per day (Mg/d)	1.102	ton per day (ton/d)
	Application rate	
kilograms per hectare per year [(kg/ha)/yr]	0.8921	pounds per acre per year [(lb/acre)/yr]

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8$$

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Concentrations, Loads, and Yields of Nutrients and Suspended Sediment in the South Pacolet, North Pacolet, and Pacolet Rivers, Northern South Carolina and Southwestern North Carolina, October 2005 to September 2009

By Celeste A. Journey, Andral W. Caldwell, Toby D. Feaster, Matthew D. Petkewich, and Paul M. Bradley

Abstract

The U.S. Geological Survey, in cooperation with Spartanburg Water, evaluated the concentrations, loads, and yields of suspended sediment, dissolved ammonia, dissolved nitrate plus nitrite, total organic nitrogen, total nitrogen, dissolved orthophosphate, dissolved phosphorus, and total phosphorus at sites in the South Pacolet, North Pacolet, and Pacolet Rivers in northern South Carolina and southwestern North Carolina from October 1, 2005, to September 30, 2009 (water years[1] 2006 to 2009). Nutrient and sediment loads and yields also were computed for the intervening subbasin of the Pacolet River not represented by the South and North Pacolet River Basins.

Except for a few outliers, the majority of the measurements of total nitrogen concentrations were well below the U.S. Environmental Protection Agency recommended guideline of 0.69 milligram per liter for streams and rivers in the nutrient ecoregion IX, which includes the study area within the Pacolet River Basin. Dissolved orthophosphate, dissolved phosphorus, and total phosphorus concentrations were significantly lower at the South Pacolet River site compared to the North Pacolet and Pacolet River sites. About 90 percent of the total phosphorus concentrations at the South Pacolet River site were below the U.S. Environmental Protection Agency recommended guideline of 0.37 milligram per liter, and more than 75 percent of the total phosphorus concentrations at the North Pacolet and Pacolet River sites were above that guideline.

At all sites, minimum annual nutrient loads for the estimation period were observed during water year 2008 when severe drought conditions were present. An estimated mean annual total nitrogen load of 37,770 kilograms per year and yield of 2.63 kilograms per hectare per year were determined for the South Pacolet River site for the estimation period. The North Pacolet River site had a mean annual total nitrogen load of 65,890 kilograms per year and yield of 2.19 kilograms per hectare per year. The Pacolet River had a mean annual total nitrogen load of 99,780 kilograms per year and yield of 1.82 kilograms per hectare per year. Mean annual total phosphorus loads of 2,576; 9,404; and 11,710 kilograms per year and yields of 0.180, 0.313, and 0.213 kilograms per hectare per year were estimated at the South Pacolet, North Pacolet, and Pacolet River sites, respectively. Annually, the intervening subbasin of the Pacolet River contributed negligible amounts of total nitrogen and total phosphorus loads, and large losses of dissolved nitrate plus nitrite and orthophosphate loads were determined for the subbasin. Biological (algal) uptake in the two reservoirs in this intervening area was considered the likely explanation for the loss of these constituents.

Estimated mean annual suspended-sediment loads were 21,190,000; 9,895,000; and 6,547,000 kilograms per year at the South Pacolet, North Pacolet, and Pacolet River sites, respectively. In the intervening Pacolet River subbasin, computed annual suspended-sediment loads were consistently negative, indicating large percentage losses in annual suspended-sediment load. Sedimentation processes in the two reservoirs are the most likely explanations for these apparent losses.

At all sites, the winter season tended to have the highest estimated seasonal dissolved orthophosphate and dissolved nitrate plus nitrite fluxes, and the summer and fall seasons tended to have the lowest fluxes. The reverse pattern, however, was observed in the intervening drainage area in the Pacolet River where the lowest fluxes of dissolved orthophosphate and nitrate plus nitrite occurred during the winter and spring seasons and the highest occurred during the summer and fall seasons.

Synoptic samples were collected during a high-flow event in August 2009 at eight sites that represented shoreline and minor tributary drainages. The South Pacolet River site was identified as contributing greater than 80 percent of the cumulative nutrient and sediment load to the downstream reservoirs for that event. This finding implies that the minor shoreline drainages and tributaries near Lake Bowen and Reservoir #1 were minor contributors to the overall nutrient load into these reservoirs when compared to the South Pacolet River site.

[1] A water year extends from October of one calendar year to September of the following calendar year.

Introduction

The Pacolet River is a tributary of the Broad River and is formed by the confluence of two forks, the North and South Pacolet Rivers, in northwestern South Carolina (fig. 1). The South Pacolet River was impounded in 1960 to form Lake William C. Bowen (Lake Bowen) and again in 1926 to form Municipal Reservoir #1 (Reservoir #1) in Spartanburg County, South Carolina. The North Pacolet River joins the South Pacolet River to form the Pacolet River downstream from the Reservoir #1 dam. The water utility, Spartanburg Water (SW), uses Lake Bowen and Reservoir #1 to supply drinking water for the Spartanburg area.

In 2005, the presence of *trans*-1,10-dimethyl-*trans*-9-decalol (geosmin) and 2-methylisoborneol (MIB) in the raw water from the two reservoirs was identified as the cause of episodic taste-and-odor problems in the finished water (John Westcott, Water Quality Manager, Spartanburg Water, written commun., June 5, 2006; Journey and Abrahamsen, 2008). Taste-and-odor episodes are aesthetic problems only for drinking-water systems; however, these episodes can produce customer complaints.

Cyanobacteria (blue-green algae) and actinomycetes (bacteria) are known to be primary sources of geosmin and MIB. Human activity in the watershed can contribute excessive nutrients (especially phosphorus and nitrogen) to the reservoirs thus enhancing the limnological conditions needed for cyanobacterial blooms, or human activity can introduce high concentrations of actinomycetes by increased sediment-laden stormwater runoff into the reservoirs. Nutrients and sediment in a watershed may come from a variety of sources, including soil erosion, runoff from residential lawns or agricultural fields, irrigation drainage, failing septic or sewer systems, or point sources such as wastewater-treatment plant outfalls or animal feedlots.

The nutrient and sediment budgets in a reservoir or lake respond to nutrient and sediment inputs from the watershed. These inputs are a function of both water quantity (streamflow) and water quality (concentration), commonly called loads. A constituent load in a stream or river is the mass of that constituent transported past a point in a stream during a period of time. Tributaries and shoreline drainage typically are the main pathways by which nutrients and sediments are delivered

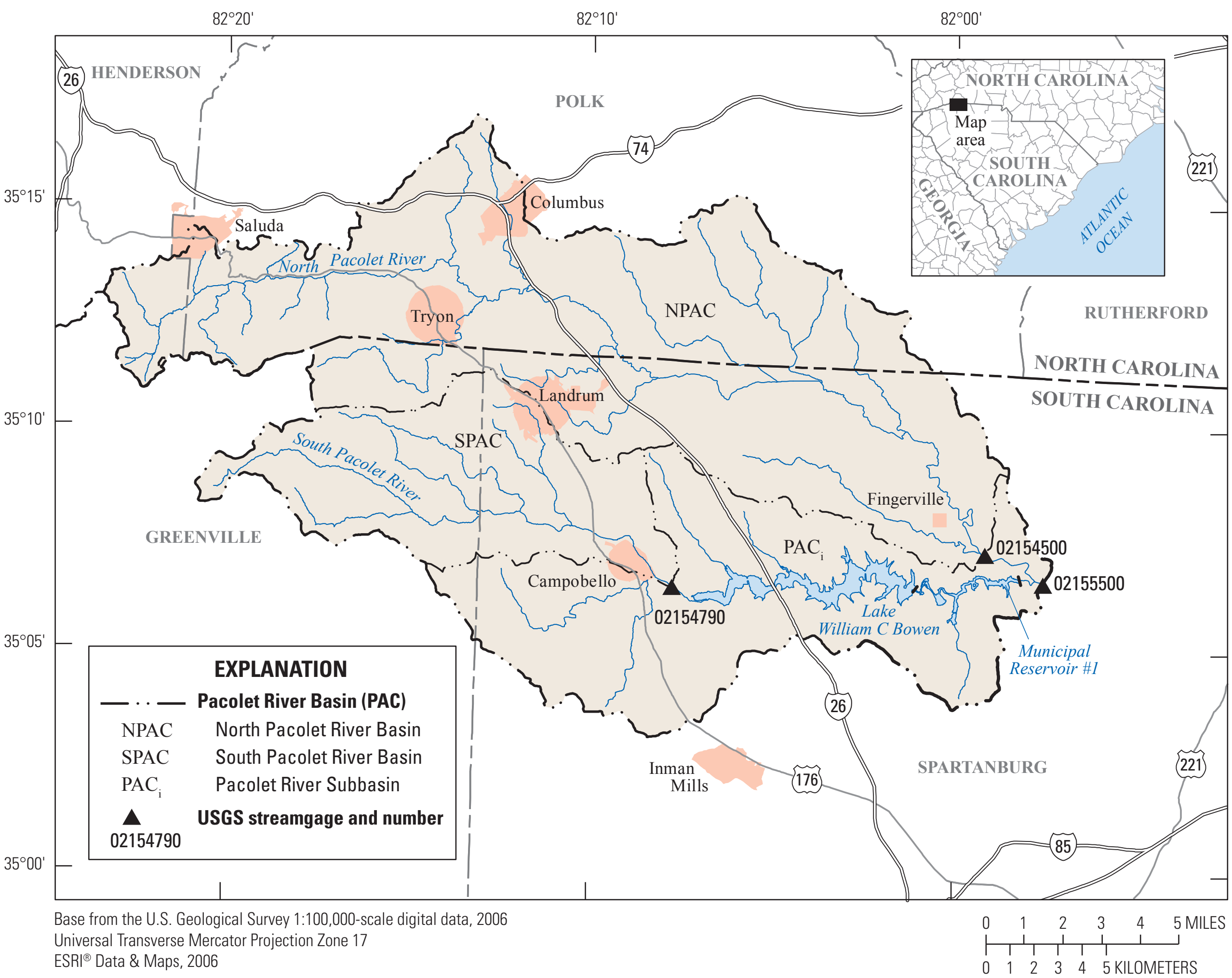


Figure 1. Locations of Lake William C. Bowen, Municipal Reservoir #1, and current U.S. Geological Survey streamgaging stations in the Pacolet River Basin, northern South Carolina and southwestern North Carolina.

to a lake or reservoir. The relation between the annual input of nutrients and the in-lake phosphorus and nitrogen concentrations is central to understanding and managing nutrient-enrichment (eutrophication) conditions.

Since 2005, the U.S. Geological Survey (USGS), in cooperation with Spartanburg Water (SW), has been conducting research in the Pacolet River Basin to provide a better understanding of the environmental factors that favor cyanobacterial dominance and geosmin and MIB release in Lake Bowen and Reservoir #1. One of the objectives of the USGS research is to determine the relative importance of nutrient loadings on cyanobacterial abundance and taste-and-odor occurrence in the reservoirs. Quantification of nutrient contribution from the watershed and immediate shoreline to the reservoirs was needed by SW because this information will enable SW, in collaboration with local and State groups, to focus their management efforts on specific areas near the reservoirs. Throughout the United States, remediation efforts of reservoir conditions where cyanobacteria dominance or taste-and-odor problems existed have been based on a strong scientific understanding of the mechanisms controlling the algal community (Yoo and others, 1995; Downing and others, 2001; Cooke and others, 2005; Taylor and others, 2006; Brookes and others, 2008). Specifically, previous research has shown that defining how nutrient loadings from a watershed influence nutrient concentrations and cyanobacterial dominance in reservoirs has guided the application of effective nutrient management strategies (Yoo and others, 1995; Downing and others, 2001; Cooke and others, 2005; Brookes and others, 2008). Nutrient management strategies that are guided by the understanding of the key limnological processes that link nutrient concentrations and cyanobacteria dominance have been reported to provide protection against conditions under which cyanobacteria dominate (Yoo and others, 1995; Downing and others, 2001; Cooke and others, 2005; Brookes and others, 2008).

This investigation of Lake Bowen and Reservoir #1 conducted by the USGS in cooperation with SW information benefits the Federal interest by improving strategies to identify and protect drinking water sources and by aligning with three of the nine priority water-resource issues listed in the “Strategic Directions for the Water Resources Division, 1998–2008” (U.S. Geological Survey, 1999): effects of urbanization and suburbanization on water resources; drinking water availability and quality; and hydrologic-system management, including optimization of groundwater and surface-water use.

Purpose and Scope

The purpose of this report is to describe the concentrations, loads, and yields of suspended sediment, dissolved ammonia, dissolved nitrate plus nitrite, total organic nitrogen, total nitrogen, dissolved orthophosphate, dissolved phosphorus, and total phosphorus in the South Pacolet River near Campobello, SC, at streamgaging station 02154790 (referred to as SPAC in this report), North Pacolet River near Fingerville, SC, at streamgaging station 02154500 (referred to as NPAC in this report), and Pacolet River near Fingerville, SC, at streamgaging station 02155500 (referred to as PAC in this report) from October 1, 2005, to September 30, 2009 (water years[2] 2006 to 2009) (table 1; fig. 2). The estimated loads for the South Pacolet River represented the major nutrient and sediment contributions to Lake Bowen and Reservoir #1. Loads were computed for the intervening subbasin of the Pacolet River not represented by the SPAC and NPAC contributions but inclusive of Lake Bowen and Reservoir #1 (referred to as PAC_i in this report; table 1). Instantaneous loads and yields were computed from synoptic nutrient and sediment data collected at eight other sites in the PAC_i basin that represented minor tributaries and shoreline drainages to Lake Bowen and Reservoir #1 and are presented in this report (table 1; fig. 2). The information was used to provide a general estimate of the contributions to these reservoirs from minor drainages relative to the South Pacolet River.

Previous Investigations

Lake Bowen was assessed as part of a watershed-wide investigation conducted in the South Pacolet River Basin from February 1973 to February 1974 by the U.S. Environmental Protection Agency (USEPA) National Eutrophication Survey (U.S. Environmental Protection Agency, 1976). The survey ranked Lake Bowen seventh out of 13 lakes in South Carolina in overall poor trophic quality and reported that the reservoir was characterized by phosphorus-limited and nutrient-enriched conditions with macrophytes present in shallow areas.

The estimated total phosphorous and nitrogen loads to Lake Bowen were 2,530 and 80,250 kilograms per year (kg/yr), respectively, in 1974 (table 2). The South Pacolet River delivered 1,780 kg/yr of total phosphorus (about 70 percent of the total load of 2,530 kg/yr) to Lake Bowen (table 2). The combined delivery of the total phosphorus load from minor tributaries and immediate shoreline drainage was an order of magnitude less than the load delivered by the South Pacolet River (395 kg/yr or about 16 percent of the total load; table 2). A municipal sewage-treatment plant (STP) that discharged treated effluent to the South Pacolet River upstream from the reservoirs contributed another 10 percent. The remaining load was attributed to direct precipitation.

In 1974, annual load of total nitrogen to Lake Bowen was 80,250 kg/yr (table 2). The South Pacolet River delivered 60,985 kg/yr (about 76 percent of the total load; table 2). The combined delivery from minor tributaries and immediate shoreline drainage was much less than that of the South Pacolet River (12,120 kg/yr or about 15 percent of the total load; table 2). The municipal STP contributed less than 1 percent, and direct precipitation accounted for about 8 percent of the total nitrogen load to Lake Bowen.

[2] A water year extends from October of one calendar year to September of the following calendar year.

Table 1. Selected streamgaging stations and drainage areas in the Pacolet River Basin in Spartanburg County, South Carolina.

[USGS, U.S. Geological Survey; mi², square mile]

USGS station number	USGS station name	Map site identification (fig. 2)	Drainage area, in hectares (mi²)	Site type
Load estimation tributary sites				
02154790	South Pacolet River near Campobello, SC	SPAC	14,349 (55.4)	Gaged stream from January 1989 to present
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044 (116)	Gaged stream from April 1930 to present
02155500	Pacolet River near Fingerville, SC	PAC	54,908 (212)	Gaged stream from December 1929 to August 2006; October 2007 to present
Intervening subbasin of the Pacolet River from station 02155500 to upstream stations 02154790 and 02154500		PAC_i	10,515 (40.6)	Streamflow computed by subtracting streamflow at 02155500 from streamflows at 02154790 and 02154500
Synoptic tributary sites				
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	S-1	44.0 (0.17)	Storm drain culvert
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	S-2	126.9 (0.49)	Flowing stream
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	S-3	137.3 (0.53)	Flowing stream
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	S-4	1,028 (3.97)	Flowing stream
3507300820702	Alexander Creek at Page Road near Campobello, SC	S-5A	1,049 (4.05)	Flowing stream
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	S-6	585.3 (2.26)	Ponded stream
3506570820116	Unnamed tributary at unnamed road near Fingerville, SC	S-7	15.5 (0.059)	Intermittent stream
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	S-8	5.18 (0.023)	Storm drainage ditch; dry during sampling

Table 2. Summary of nutrient loads to Lake William C. Bowen, Spartanburg County, South Carolina, water year 1974 (U.S. Environmental Protection Agency, 1976).

[ha, hectare; mi², square mile; kg/yr, kilogram per year; (kg/ha)/yr, kilogram per hectare per year; TP, total phosphorus; TN, total nitrogen; NA, not applicable]

Source	Drainage area (ha [mi²])	Total phosphorus load (kg/yr)	Total nitrogen load (kg/yr)	Annual TP export [(kg/ha)/yr]	Annual TN export [(kg/ha)/yr]
South Pacolet River	14,500 [56]	1,780	60,985	0.123	4.21
Minor tributaries and immediate shoreline drainage	6,100 [23.6]	395	12,120	0.065	1.98
Municipal sewage-treatment plant	NA	245	310	NA	NA
Direct precipitation	20,600 [79.5]	110	6,855	0.005	0.33
Total loading to Lake Bowen	NA	2,530	80,250	NA	NA

Figure 2. Locations of water-quality sampling sites in the Pacolet River Basin, September 2007 to August 2009, Spartanburg County, South Carolina.

In 1991, best management practices (BMPs) were implemented by the U.S. Department of Agriculture Natural Resources Conservation Service, in cooperation with the South Carolina Department of Health and Environmental Control (SCDHEC), to reduce nutrient loadings in the Lake Bowen watershed. Public outreach and education efforts were the main forms of BMPs. Improvement in water quality of Lake Bowen was reported by the SCDHEC in 1998, when Lake Bowen was ranked as one of the least eutrophic large lakes in South Carolina. The water quality was characterized by low nutrient concentrations (South Carolina Department of Health and Environmental Control, 2001); however, monitoring data were not adequate to quantify any reduction in nutrient loadings from the watershed. The assessment was based on in-lake nutrient and chlorophyll *a* concentrations. During 2001 to 2008, Lake Bowen and Reservoir #1 continued to be assessed as having good water quality with respect to low nutrient and chlorophyll *a* concentrations relative to established criteria (South Carolina Department of Health and Environmental Control, 2008).

Maluk and others (1998) evaluated trends in nutrient concentrations in waters of the Santee River Basin from 1973 to 1993 as part of the USGS National Water-Quality Assessment Program. A significant upward trend in total phosphorus concentrations and downward trend in nitrate plus nitrite concentrations were identified in the North Pacolet River; however, no information was provided on the South Pacolet or Pacolet Rivers.

More recent trends in total nitrogen and total phosphorus concentrations were described in a recent regional assessment of water-quality conditions in rivers and streams throughout the southeastern United States (Harned and others, 2009; Staub and others, 2010). Data were compiled from the USEPA STORage and RETrieval (STORET) and the USGS National Water Information System (NWIS) databases for surface-water sites throughout Alabama, Florida, Georgia, and North and South Carolina, including the South Pacolet River (NWIS station number 02154790, STORET number 21SC60WQ.B-302), North Pacolet River (NWIS station number 02154500, STORET number 21SC60WQ.B-126), and Pacolet River (NWIS station number 02155500, STORET number 21SC60WQ.B-028). Decreasing trends in total phosphorus concentrations were identified in the South Pacolet River for the period of 1985 to 1995 (–4.5 percent per year; p-value = 0.01) and for the period of 1993 to 2004 (–10.4 percent; p-value = 0.02; Staub and others, 2010). Trends in total nitrogen concentrations were not identified at any of the sites because of insufficient monitoring data.

The USGS developed a model that integrates monitoring data with landscape information known as SPARROW (SPAtially-Referenced Regression On Watershed attributes; Schwarz and others, 2006). This model is watershed based and designed for use in predicting long-term mean water characteristics, including values of concentrations, loads, and yields of selected constituents that are delivered to downstream receiving waters (Preston and others, 2009). Statistical methods are used in the SPARROW model to explain in-stream measurements of water quality (constituent mass or load) in relation to upstream sources and watershed properties (soil characteristics, precipitation amounts, and land cover) that influence the transport of constituents to streams and their delivery to receiving water bodies. The SPARROW modeling approach was applied to nitrogen concentrations in streams in the southeastern United States for 2002 (Hoos and others, 2008; Hoos and McMahon, 2009). Initial mean annual load estimations that were computed by using the USGS load estimation program Fluxmaster for a 29-year period were used as input into the regional SPARROW model. The initial load estimation process included the three surface-water sites discussed in this report: SPAC, NPAC, and PAC (table 3; Schwarz and others, 2006). The long-term (29-year) mean annual total nitrogen loads were 39,777 kg/yr at the SPAC site, 70,643 at the NPAC site, and 130,533 kg/yr at the PAC site (table 3). From the SPARROW model output, the source of the greatest total nitrogen load (64 to 65 percent) for all three watersheds was attributed to atmospheric deposition followed by fertilizer application (15 to 21 percent) and urban runoff (8 percent). Total nitrogen loads from wastewater point sources (0 to 7 percent) and livestock waste (5 to 7 percent) ranked the lowest among the sources. Long-term mean annual total phosphorus loads were 3,048 kg/yr at the SPAC site, 9,171 kg/yr at the NPAC site, and 22,739 kg/yr at the PAC site (table 3). Percentage contributions were similar among the modeled subbasins, so output values from the SPARROW model were averaged for sources of total phosphorus for the entire Pacolet River. Percentage source contributions of total phosphorus were distributed fairly equally among urban runoff (25 percent), fertilizer application (31 percent), and background soil-parent rock (23 percent). Wastewater effluent (15 percent) and manure (5 percent) contributed the least amount of total phosphorus to the Pacolet River. In fact, recent research has identified areas within the Piedmont ecoregion where soil-parent rock is the source of significant phosphorus to streams and groundwater, including portions of the Pacolet River Basin (Terziotti and others, 2010). It is interesting to note that traditional nutrient management strategies that often focus on minimizing fertilizer and wastewater contributions to receiving waters may not address adequately two potentially important contributors of nutrients in the Pacolet River Basin (atmospheric deposition

Table 3. Summary of mean annual total nitrogen and total phosphorus loads estimated by the Fluxmaster load estimation program (number of years = 29) and sources estimated by the SPARROW model for the Pacolet River at streamgaging station 02155500, North Pacolet River at streamgaging station 02154500, and South Pacolet River at streamgaging station 02154790 for 2002 (Hoos and others, 2008; Hoos and McMahon, 2009; Garcia and others, in press).

[kg/yr, kilogram per year; (kg/ha)/yr, kilogram per hectare per year]

Source	Percent contribution of total nitrogen load		
	Pacolet River 02155500	North Pacolet River 02154500	South Pacolet River 02154790
Urban runoff	8	8	8
Wastewater point sources	4	7	0
Livestock/manure	6	5	7
Fertilizer application	17	15	21
Atmospheric deposition	65	65	64
Estimated mean annual total nitrogen load (kg/yr) and yield ([kg/ha]/yr)			
Load	130,533	70,643	39,777
Yield	2.4	2.4	2.8
Source	**Average basinwide percent contribution of total phosphorus load**		
Urban runoff	25		
Wastewater point sources	15		
Livestock/manure	5		
Fertilizer application	31		
Soil-parent rock	23		
Estimated mean annual total phosphorus load (kg/yr) and yield ([kg/ha]/yr)			
Load	22,739	9,171	3,048
Yield	0.41	0.31	0.21

for total nitrogen and soil-parent rock for total phosphorus). Actually, the contribution of phosphorus to streams from weathering and erosion of surficial geologic materials can be used to determine the difference in the effects of natural or background sources of phosphorus and anthropogenic sources of phosphorus, such as municipal wastewater or agricultural practices (Terziotti and others, 2010; Garcia and others, 2010).

Approach and Methods

Hydrologic and chemical data were collected during water years (WY) 2007 to 2009, and used to estimate the nutrient and suspended sediment loads and yields for the SPAC, NPAC, and PAC sites located in Spartanburg County, South Carolina, for WY 2006 to 2009 (table 1; fig. 2). Because the nutrient and suspended sediment loads and yields at the PAC site include the nutrient and suspended-sediment contributions at the SPAC and NPAC sites, nutrient and suspended sediment loads and yields also were computed for the intervening subbasin (PAC_i) of the Pacolet River not represented by the SPAC and NPAC contributions (table 1). Estimated nutrient and suspended sediment loads and yields in the PAC_i subbasin were attributed to outflow from Reservoir #1.

Streamflow Data Collection

The USGS has operated continuous streamflow-gaging stations in cooperation with SW at the SPAC site since January 1989, the NPAC site since April 1930, and the PAC site from December 1929 to August 2006 and from October 2007 to the present (table 1). The three streamgaging stations are equipped with data collection platforms (DCPs) that allow for near real-time access (data transmitted every hour) to the hydrologic data from the USGS South Carolina Water Science Center (SCWSC) Web site (*http://sc.water.usgs.gov*, accessed November 12, 2010). Continuous streamflow data were computed at all streamgaging stations by using standard USGS stage/discharge techniques (Carter and Davidian, 1968; Rantz and others, 1982; Kennedy, 1984). Streamflow data are reviewed, approved, and stored in the USGS Automated Data-Processing System (ADAPS) of the NWIS database according to procedures outlined in the USGS SCWSC Surface Water Quality-Assurance Plan (Cooney, 2001). Quality-assured surface-water data are available for retrieval on the Internet at *http://waterdata.usgs.gov/sc/nwis/sw*, accessed November 12, 2010.

The continuous streamflow-gaging station at the PAC site was discontinued from October 1, 2006, to September 30, 2007 (WY 2007). Therefore, mathematical record-extension techniques were applied to existing streamflow data at the PAC site and the nearby streamgaging station on the North Pacolet River (NPAC site) to estimate streamflow data for WY 2007 at the PAC site (Hirsch, 1982). The selected record-extension technique was the Maintenance of Variance Extension, Type 1 (MOVE.1; Helsel and Hirsch, 1992). The MOVE.1 correlation maintained the mean and variance of the measured data at the short-record gage (PAC) and, therefore, allowed for the generation of a longer-term set of data that possessed the statistical characteristics of the measured data. A MOVE.1 regression was performed on the concurrent daily value streamflow data at the NPAC and PAC sites from October 1, 2004, to September 30, 2006, and from October 1, 2007, to September 30, 2009. The MOVE.1 relation was then used to generate the missing flow data at the PAC site (station 02155500) for October 1, 2006, to September 30, 2007. The MOVE.1 correlation coefficient for the concurrent measured data at the NPAC site (station 02154500) and (PAC site) was 0.97.

The existing streamflow gage on the SPAC site monitored the major inflow to Lake Bowen. Flow measured from the NPAC site minus the flow measured at the PAC site represented the estimated outflow from Reservoir #1.

Water-Quality Data Collection

The number of stream samples collected at the three gaged sites in the Pacolet River Basin from September 2007 to August 2009 ranged from 22 to 25 and were used to quantify the nutrient and sediment load and yields (Appendix 1-A, 1-B, 1-C). Samples were collected over a range of flow conditions and analyzed for nutrient, major ion, and total suspended-solid concentrations by the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado. Equal-width increment (EWI) samples were collected at 10 increments across the stream and composited prior to processing (U.S. Geological Survey, variously dated). Pre-cleaned, acid-rinsed 8-liter (L) plastic churns were used as the compositing devices. For analysis of dissolved constituents, samples were filtered using 0.45-micron glass fiber capsule filters that were conditioned with 1 L of deionized water. A subset of the samples (between 18 and 20) also was analyzed for dissolved organic carbon, iron, manganese, and major anion concentrations by the NWQL. Samples were collected and processed using protocols documented in the USGS National Field Manual to ensure high-quality, representative samples (U.S. Geological Survey, variously dated). Field properties of specific conductance, pH, dissolved oxygen, and water temperature were measured at the time of sampling with a field-calibrated multiparameter sonde. Field property and analytical data were reviewed according to established quality-assurance and quality-control protocols and stored in the USGS NWIS database.

Total organic nitrogen and ammonia (total Kjeldahl nitrogen or TKN) and total phosphorus (TP) concentrations were determined by analyses described by Patton and Truitt (2000 and 1992, respectively). Whole-water samples were analyzed for suspended-sediment concentrations and sand/fine fraction at the USGS Kentucky Sediment Laboratory, in Louisville, Kentucky. Methods for processing suspended-sediment concentrations are described in Knott and others (1993) and Shreve and Downs (2005).

Additionally, a synoptic survey of nutrient and sediment contributions from eight sites (fig. 2; table 1) that represented minor tributary and immediate shoreline drainage to the two reservoirs was conducted during a high-flow event on August 5, 2009. The survey was used to provide a general assessment of nutrient and sediment contributions from these minor tributaries and drainages and compare those contributions to nutrient and sediment contributions from the SPAC site. The samples were analyzed by the NWQL for nutrient and suspended sediment. Samples were collected and processed using protocols documented in the USGS National Field Manual to ensure high-quality, representative samples (U.S. Geological Survey, variously dated). Streamflow and field properties of specific conductance, pH, dissolved oxygen, and water temperature were measured at the time of sampling. Field property and analytical data were reviewed according to established quality-assurance and quality-control protocols and stored in the NWIS database.

Data Analysis

Water-quality and streamflow data collected at the three river sites were analyzed using graphical and statistical techniques. The data-analysis effort focused on describing the basic water chemistry in the selected tributary sites and estimating nutrient and sediment loads and yields from the SPAC site to Lake Bowen and from Reservoir #1 outflow to the Pacolet River (PAC_i). This information could be used to evaluate the influence of nutrient loading on in-lake nutrient concentrations and trophic status.

Nitrogen, phosphorus, and sediment concentrations in streams and rivers are affected by variations in climate, land-use activities, and hydrology. These environmental factors can vary temporally and spatially. Nitrogen occurs in natural waters in several different forms, including dissolved ionic species of ammonia (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-), and within organic compounds (amino acids, amines, proteins, and refractory humic compounds), referred to as total organic nitrogen (TON). Total Kjeldahl nitrogen is the sum of the total organic nitrogen and ammonia species. For this report, the dissolved oxidized ionic species of nitrite and nitrate will be reported together as a sum (NO_2+NO_3). Ammonia, the reduced inorganic species of nitrogen, is the preferred form for algal uptake, followed by nitrite and nitrate (Wetzel, 2001). Total nitrogen (TN) concentrations represent the cumulative concentrations of all particulate and dissolved species of nitrogen. Like nitrogen, phosphorus exists in the aquatic environment in several forms, including organic and inorganic species. The most bioavailable form of phosphorus is the inorganic species, orthophosphate (PO_4^{-3}; Wetzel, 2001). Phosphorus, however, tends to adsorb strongly to particles in the soil, suspended solids in the water, and bed sediments, so the majority of phosphorus in water is particulate (Wetzel, 2001). Total phosphorus is the combination of particulate and dissolved phosphorus in the water.

Suspended-sediment (SSC) and total suspended-solid (TSS) concentrations are obtained from two different laboratory analytical methods used to quantify concentrations of suspended organic and inorganic particles in surface waters (Gray and others, 2000). The SSC analytical method is considered to produce more reliable results; however, the TSS method is the method often adopted for regulatory monitoring. Generally, a bias in relation to SSC and TSS is observed when the fraction of sand-sized material is greater than 25 percent of the sediment dry weight, such that the SSC values tend to exceed their paired TSS values (Gray and others, 2000). Based on past research by Gray and others (2000), this bias indicated TSS was a poor measure of suspended particles in stormwater when the dominant fraction was sand size or coarser. Therefore, load estimation for this investigation was performed on SSC data only.

Nutrient and suspended-sediment concentrations were statistically summarized and compared to recommended guidelines established by the USEPA for nutrients in streams and rivers on the basis of ecoregions (U.S. Environmental Protection Agency, 2000). An ecoregion is defined as a region that has similar biological, chemical, and geographic characteristics within the terrestrial and aquatic compartments of the ecological system (Omernik, 2005). Recommended nutrient guidelines are established for aggregated level III nutrient ecoregions. The majority of the watershed for the Pacolet River lies within the USEPA aggregated nutrient ecoregion IX. The USEPA aggregated nutrient ecoregion IX combines the Piedmont and Southeastern Plains level III ecoregions (U.S. Environmental Protection Agency, 2000; Omernik, 2005). The USEPA guidelines are 0.037 milligram per liter (mg/L) for total phosphorus and 0.69 mg/L for total nitrogen. Although not considered recommended guidelines, the USEPA also provides the 25th percentile of the compiled nutrient data for level III ecoregion 45 (Piedmont ecoregion aggregated within ecoregion IX) that can be considered the lower end of nutrient concentrations for that ecoregion and used for comparison purposes: total Kjeldahl nitrogen concentrations of 0.23 mg/L or less, nitrate plus nitrate concentrations of 0.18 mg/L or less, total nitrogen concentrations of 0.41 mg/L or less, and total phosphorus concentrations of 0.03 mg/L or less (U.S. Environmental Protection Agency, 2000). The USEPA guidelines are considered non-regulatory and were selected for comparison because no numerical nutrient criteria have been established for rivers and streams by the SCDHEC at this time. The guidelines do, however, provide a context to assess nutrient levels in the three rivers of interest.

Descriptive statistics, including mean, maximum, minimum, and median values, were graphically represented in box plots. Median values were used for comparison because they lessen the effects of outliers on the data (Helsel and Hirsch, 1992). Box plots serve as graphical summaries based on percentiles of the data distribution. For example, a 75th percentile represents the concentration whereby 75 percent of all concentrations measured were below that 75th percentile concentration. The 50th percentile or median represents the “middle” concentration, such that 50 percent of the data are above that concentration and 50 percent of the data are below. The “box” displays the median 50 percent of the data (from the 75th to the 25th percentile; Helsel and Hirsch, 1992). The “whiskers” display the data range from the 90th to the 10th percentile, such that 80 percent of the data fall between the range outlined by the upper and lower whiskers. Outliers represent data that fall outside of the range.

To identify differences among the three sites, a nonparametric statistical analysis was performed in two steps (Helsel and Hirsch, 1992). First, a one-way analysis of variance (ANOVA) on ranked data (also called the Kruskal-Wallis test) was applied to the data to determine if a statistical difference existed among at least one of the medians of the groups of data. The Kruskal-Wallis test is a robust test that determines only if a difference existed among the sites but does not identify which sites are different from the others. If the more robust Kruskal-Wallis test indicated a difference existed, then a multiple comparison test called the Tukey studentized range test (also known as the Honestly Significantly Different [HSD] test) was applied to the groups of data only to identify which group or groups were different from the others. Estimated values were given the same rank above censored values and below detected values; censored values were given the same rank below estimated and detected values (Helsel, 2005). A significant difference was determined at an alpha level of 0.05, which means that if the probability value (p-value) of the ANOVA test was less than 0.05, a significant difference existed among the analyzed data group with a 95-percent confidence that the statistical finding was correct.

Spearman Rho correlation analysis also was applied to water-quality data from the SPAC, NPAC, and PAC sites to evaluate the strength of association among nutrient, suspended sediment, and actinomycetes concentrations (SPAC only) and streamflow (Helsel and Hirsch, 1992). An alpha level of 0.05 (95-percent confidence) for significant correlations was selected for the analysis. Spearman correlation measures the observed covariation and the strength of the monotonic relation between two variables, where change is in one direction only (either strictly rising or strictly falling, but not reversing direction). Correlation is quantified with a coefficient. The coefficient for this analysis is called rho. A rho ranges from 0 to 1; the closer the rho is to 1, the stronger the correlation. A probability value (or p-value) is computed during the analysis. A correlation resulting in a p-value below the alpha level of 0.05 (p-value < 0.05) is considered significant in this report. Caution should be expressed in interpreting correlation analysis results because a significant correlation proves only covariation, not cause and effect.

Nutrient and suspended-sediment loads were computed using the computer program S-LOADEST. S-LOADEST is a USGS “plug-in” version of LOAD ESTimator (LOADEST), a FORTRAN program for estimating constituent loads in streams and rivers (Runkel and others, 2004). The plug-in is programmed for TIBCO Spotfire® S+ (version 8.1), a statistical software package (TIBCO, 2008). The TIBCO Spotfire® S+ version of LOADEST allows the user to estimate annual, monthly, and seasonal nutrient and suspended-sediment loads using statistical regression analysis incorporated in the LOADEST software program (Runkel and others, 2004) that is based on the rating curve method (Cohn, 2005). The regression model computes daily loads based on relations between constituent load and one to seven explanatory variables that are functions of streamflow and time. The time component can be represented as an increasing and decreasing trend over time (decimal time term) and as seasonal changes (sine [2π decimal time] plus cosine [2π decimal time] term). Streamflow and constituent load are transformed prior to the regression analysis using the natural logarithm to improve the fit of the regression model. To account for the bias produced in re-transformation, the computed daily loads are adjusted by using the minimum variance unbiased estimate procedure (no censored data; Cohn and others, 1989) or the adjusted maximum likelihood estimator (AMLE) method (Cohn, 2005).

The LOADEST program contains nine pre-defined regression models that can be used to estimate loads that account for the different possible combinations of explanatory variables of streamflow and time (table 4). Some of the pre-defined models are simple and account only for streamflow in the model (models 1 and 2; table 4). These simple models typically work well with suspended-sediment load estimation (Crawford, 1991). Some models account for streamflow and time trends only (models 3 and 5; table 4), which compensate the model for long-term temporal changes in streamflow or concentrations (Helsel and Hirsch, 1992). Some models that account for streamflow and seasonality only (models 4 and 6; table 4) or streamflow, time trends, and

Table 4. Pre-defined regression models in the computer program S-LOADEST for estimating loads in rivers and streams.

[L, natural logarithm (log) of the estimated load; βn, estimated coefficients; Q, log of the stream discharge; T*, centered time in decimal years; sin, sine; cos, cosine; π, pi; T, fraction of the year in decimal years]

Model number	Model description
1	$L = \beta_o + \beta_1 LnQ$
2	$L = \beta_o + \beta_1 LnQ + \beta_2 LnQ^2$
3	$L = \beta_o + \beta_1 LnQ + \beta_2 T^*$
4	$L = \beta_o + \beta_1 LnQ + \beta_2 \sin(2\pi T) + \beta_3 \cos(2\pi T)$
5	$L = \beta_o + \beta_1 LnQ + \beta_2 Q^2 + \beta_3 T^*$
6	$L = \beta_o + \beta_1 LnQ + \beta_2 LnQ^2 + \beta_3 \sin(2\pi T) + \beta_4 \cos(2\pi T)$
7	$L = \beta_o + \beta_1 LnQ + \beta_2 \sin(2\pi T) + \beta_3 \cos(2\pi T) + \beta_4 T^*$
8	$L = \beta_o + \beta_1 LnQ + \beta_2 LnQ^2 + \beta_3 \sin(2\pi T) + \beta_4 \cos(2\pi T) + \beta_5 T^*$
9	$L = \beta_o + \beta_1 LnQ + \beta_2 LnQ^2 + \beta_3 \sin(2\pi T) + \beta_4 \cos(2\pi T) + \beta_5 T^* + \beta_6 T^{*2}$

seasonality (models 7, 8, and 9; table 4) are considered to be more applicable to nutrient load estimation (Cohn and others, 1992; Helsel and Hirsch, 1992). If the “best of the above” model option is selected in S-LOADEST, Akaike Information Criterion (AIC) and Schwarz Posterior Probability Criterion (SPPC) goodness-of-fit measures are provided to aid in model selection (Akaike, 1974; Helsel and Hirsch, 1992), and S-LOADEST selects the model with the lowest AIC (assigned the value 1). Additionally, regression models were examined individually on the basis of validation of the model. Validation checks included examination of model residuals to ensure linear fit, uniform scatter around the fit, normality of distribution, and linearity with all explanatory variables (Helsel and Hirsch, 1992).

Because of the short duration of the data-collection effort in this study, pre-defined models that incorporated time trends were not considered during the model selection process (models 3, 5, 7, 8, and 9). All other pre-defined models were considered (models 1, 2, 4, and 6), and selection was based on the lowest AIC measure for that site and constituent. For the constituent of interest, the formulated regression model was used to estimate loads over a selected time interval (estimation) of October 2005 to September 2009. Mean load estimates, standard errors, and 95-percent confidence intervals were developed on a seasonal and annual basis.

Spatial datasets and Federal Geographic Data Committee (FGDC) compliant metadata for the water-sampling locations were created for the investigation. A unique identifier was used to link the spatial data features to the analytical results for each sampling event. Public-domain datasets that were used as basemaps include digital orthophotographs from 1999 and 2006, high-resolution hydrography from the National Hydrography Dataset, and 1992 and 2001 land-cover data from the National Landcover Database (Homer and others, 2004). In addition, 1:24,000-scale digital raster graphics and digital line graphs for the study area were included as base features available to users for reference. Land-use data were extracted from the 1992 and 2001 National Landcover Databases (NLCD). The NLCD is a 21-class land-cover classification scheme applied consistently across the United States (Price and others, 2007). The 1992 NLCD represents imagery and land-cover data based on Landsat Thematic Mapper satellite data (Landsat 5) from 1992 to 1995. The 2001 NLCD represents imagery and land-cover data based on Landsat 7 data from 1999 to 2003. The spatial resolution of the data is 30 meters (m). A list of the 1992 NLCD land-cover class definitions is available at *http://landcover.usgs.gov/classes.php* (accessed November 12, 2010). The 2001 NLCD definitions are available at *http://www.mrlc.gov/nlcd_definitions.asp* (accessed November 12, 2010). The method used to compare the two datasets to determine land-use change is described in Fry and others (2009).

Quality Assurance

Quality-control and quality-assurance procedures were applied throughout the investigation. Sample collection and processing were conducted according to water-quality sampling and biological assessment protocols documented in the USGS National Field Manual (U.S. Geological Survey, variously dated).

A total of 85 water samples were collected from September 2007 to August 2009. Ten of the 85 samples (about 12 percent) were used for quality assurance for nutrient analysis, and 8 of the 85 samples (about 9 percent) were used for quality assurance for major ion analysis. Field blanks were used to test for bias due to contamination during cleaning, collection, processing, and analysis. Blank water was certified free of inorganic constituents (for major ions, nutrients, and trace elements). Field blanks were below the reporting limits for nitrite, orthophosphate, dissolved phosphorus, total phosphorus, and total nitrogen concentrations. Only one field blank had a detectable level of nitrate plus nitrite, but it was at an estimated concentration of 0.009 mg/L and was one to two orders of magnitude below the concentrations observed in the rivers. From September 2007 to February 2009, field blanks had no detectable level of ammonia. The March and April 2009 field blanks had ammonia concentrations at estimated levels (about 0.015 mg/L) below the minimum reporting limit of 0.02 mg/L. The field blank collected in June 2009 had a dissolved ammonia concentration of 0.025 mg/L. The contamination was attributed to specific lot numbers of the 0.45-micron capsule filter used for filtration. Twenty-five, 59, and 52 percent of the reported dissolved ammonia concentrations in the environmental samples for the SPAC, NPAC, and PAC sites, respectively, were estimated or censored for the entire data-collection period. Because most detectable

USGS field personnel collecting water sample in Lake William C. Bowen using a Van Dorn sampler and churn.

dissolved ammonia concentrations in the river samples were within the range of the field blank detections, all dissolved ammonia concentrations collected during March, April, and June 2009 were not included in the data analysis, and dissolved ammonia was not included as a constituent for load estimation (fig. 3).

Selection of an appropriate method for handling censored data is necessary when laboratories report quantitative, estimated, and censored results. The NWQL used this information-rich type of reporting where (1) results above a "quantitation limit" (equivalent to the NWQL's laboratory reporting limit or LRL) are reported as quantitative, (2) results between the "quantitation limit" and the "detection limit" (equivalent to the NWQL's long-term method detection level, or LT-MDL) are reported as estimated (E) because the values are considered semi-quantitative, and (3) results below the LT-MDL are reported as censored (< LRL; Childress and others, 1999; Appendix 1).

In this report, results are listed in tables as follows: quantitative values as the value with no remark code, estimated values as the reported values with a remark code of E, and censored values as less than the LRL values. For graphical purposes, estimated and censored values were not replaced with other values, but were plotted as the reported estimated and LRL values. The more robust AMLE approach, however, was applied to computing descriptive statistics for constituents with censored values and estimation of loads (Helsel and Hirsch, 1992; Helsel, 2005). For the non-parametric Spearman correlation analysis, censored values were ranked equally below estimated values. All estimated values were ranked equally below measured values (values above the LRL).

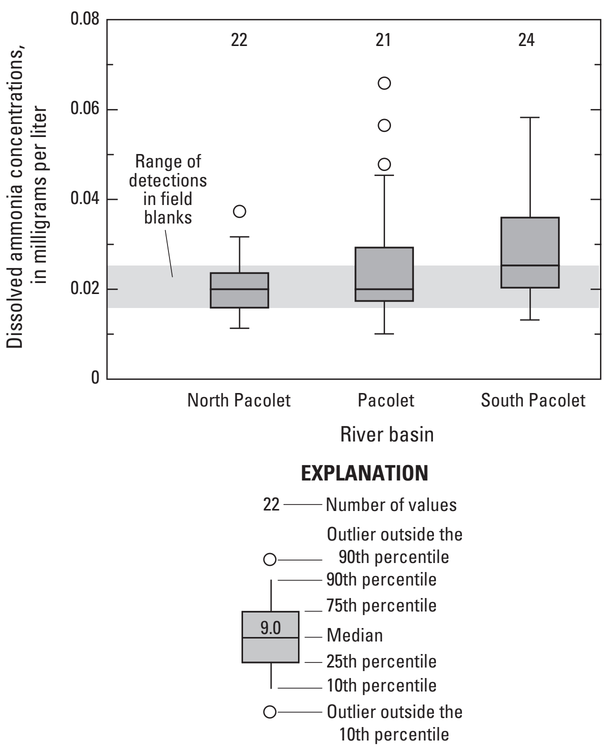


Figure 3. Dissolved ammonia concentrations in all environmental samples for the North Pacolet River at streamgaging station 02154500, Pacolet River at streamgaging station 02155500, and South Pacolet River at streamgaging station 02154790 for September 2007 to August 2009, Spartanburg County, South Carolina, overlain with highlighted range of detectable dissolved ammonia concentrations in field blanks for the March, April, and June 2009 sampling events.

Description of the Study Area

The Pacolet River is a tributary of the Broad River and is formed by the confluence of two forks, the North and South Pacolet Rivers, in Spartanburg County, South Carolina (fig. 1). The headwaters of the South Pacolet River are in northeastern Greenville County, South Carolina, and the river flows toward the east into northern Spartanburg County, where it has been impounded to form Lake Bowen and Reservoir #1. The South Pacolet River drains 14,349 hectares (ha; or 55.4 square miles [mi^2]) of the watershed at the SPAC site. The entire South Pacolet River watershed that encompasses the reservoirs drains 23,673 ha (91.4 mi^2), leaving an intervening drainage area of 9,324 ha (36 mi^2) in the South Pacolet River Basin downstream from the SPAC site. The North Pacolet River at the NPAC site has a drainage area of 30,044 ha (116 mi^2). Outflow from Reservoir #1 dam is located near the confluence of the South and North Pacolet Rivers, which form the Pacolet River. The PAC site is located 322 m or 0.2 mile (mi) downstream from the confluence and has a drainage area of 54,908 ha (212 mi^2), leaving an intervening drainage area of 10,515 ha (40.6 mi^2) not encompassed by the SPAC and NPAC sites (PAC_i), and 90 percent of the PAC_i subbasin is the downstream portion of the South Pacolet River Basin that encompasses the reservoirs. Because of this spatial distribution of streamgaging stations, outflow from Reservoir #1 can be estimated by subtracting the PAC streamflow from the NPAC streamflow.

Environmental factors may influence concentrations and loads of nutrients and suspended sediments in a watershed. These factors include climate (precipitation and streamflow) and land-use activities, especially if changes in the amount of precipitation or sources of nutrients and sediment have occurred during the period of monitoring. Changes in climate related to precipitation amounts and streamflow and changes in land cover in the three river basins and subbasin of interest (SPAC, NPAC, PAC, and PAC_i) during the study period are described in the following sections to determine how these factors may have affected water quality and the load estimation results.

Climate

The climate of the Pacolet River Basin can be classified as temperate (Kronberg and Purvis, 1959; Purvis and others, 1990). Mean annual precipitation computed from 1971 to 2000 for the national weather station at the Greenville-Spartanburg Airport near Greer, SC, was 127.6 centimeters (cm) or 50.24 inches (in.; National Climatic Data Center, 2004). Mean annual temperature for the same period at the same station is 15.6 degrees Celsius (60 degrees Fahrenheit) (National Climatic Data Center, 2004).

Climatic variation from long-term (1971–2000) mean conditions was evident for the period of this investigation. From September 2007 through December 2008, the study area was under severe to extreme drought conditions as reported by the South Carolina Drought Response Committee (South Carolina Department of Natural Resources, 2010) and as indicated by large departures from the long-term mean for annual precipitation at the Greenville-Spartanburg Airport station for the calendar years 2007 and 2008 (table 5; fig. 4). Annual precipitation amounts were 48.7 and 31.0 cm (19.2 and 12.2 in.) below the long-term mean for calendar year 2007 and 2008, respectively, which was in marked contrast to annual precipitation amounts of 32.7 cm (12.9 in.) above the long-term mean conditions for calendar year 2003. Annual precipitation amounts returned to slightly above long-term mean conditions by the end of calendar year 2009. Mean annual precipitation below the long-term mean occurred more frequently over the past decade with only 3 years at or above normal precipitation—2003, 2005, and 2009.

The majority of the data collection for the calibration dataset for load estimation occurred during drought conditions. Those conditions may limit the ability of the developed load model to estimate loads for periods where climatic conditions differed (for example, calendar years 2003 and 2005).

Table 5. Long-term mean annual precipitation for 1971 to 2000 and mean annual precipitation and departures from the long-term mean conditions for 2000 to 2009 calendar years for the Greenville-Spartanburg Airport weather station (National Climatic Data Center, 2004).

[NA, not applicable]

Calendar year	Annual precipitation		Departure from long-term mean	
	Inches	Centimeters	Inches	Centimeters
1971–2000 Mean	**50.24**	**127.6**	**NA**	**NA**
2000	35.04	89.0	–15.20	–38.6
2001	40.38	102.6	–9.86	–25.0
2002	47.85	121.5	–2.39	–6.1
2003	63.11	160.3	12.87	32.7
2004	47.70	121.2	–2.54	–6.4
2005	53.14	135.0	2.90	7.4
2006	41.80	106.2	–8.44	–21.4
2007	31.08	78.9	–19.16	–48.7
2008	38.02	96.6	–12.22	–31.0
2009	52.83	134.2	2.59	6.6

Flow Characteristics

The climatic conditions have a direct affect on streamflow; thereby, periods of high precipitation produce greater annual mean streamflows than periods of low precipitation. Consequently, a similar comparison was made with streamflow as was made with precipitation to determine how climatic conditions during this and past investigaitons may have influenced the comparability of the estimated loads and may limit the applicability of the load models produced by this investigation to periods of differing climatic conditions. Annual mean streamflows for the period of record and the individual water years were examined for the SPAC, NPAC, and PAC sites where nutrient and sediment loads were estimated. Flow duration curves were constructed and used to evaluate how well the sampled streamflows represented the range of possible flow conditions at each site.

As described previously, the periods of record for the SPAC, NPAC, and PAC sites represented 20, 79, and 76 complete water years, respectively (table 1). Additionally, mean annual streamflow and flow duration computations used the existing period of record and required data for the entire water year (October to September). Accordingly, for all three sites, the beginning water years when streamflow monitoring was initiated were not included in the mean annual streamflow and flow duration computations (1989 for SPAC, 1930 for NPAC,

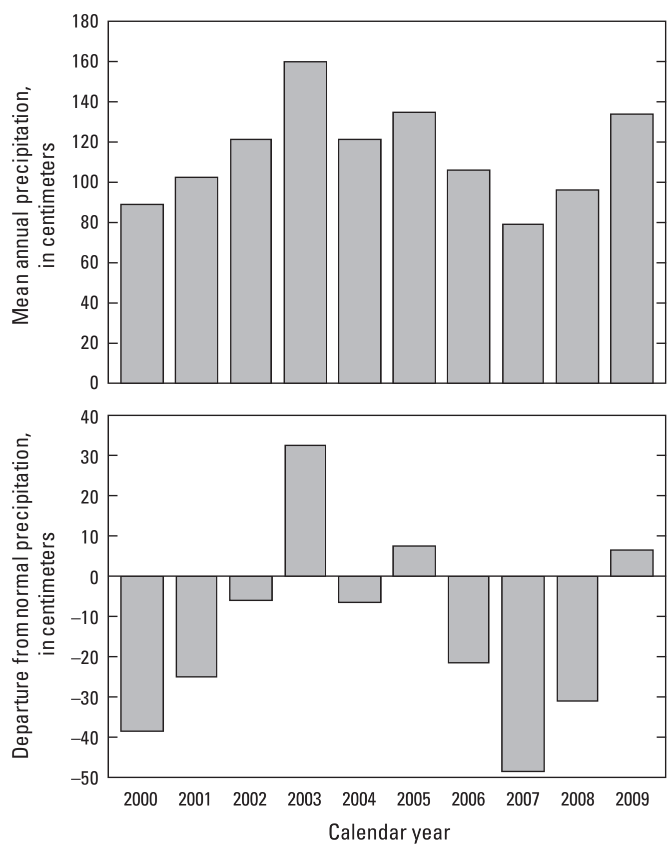


Figure 4. Mean annual precipitation and departures from long-term mean conditions for calendar years 2000 to 2009 for the Greenville-Spartanburg Airport weather station.

and 1929 for PAC) and WYs 1997, 2006, and 2007 were not included in computations for PAC.

Mean annual streamflows for the period of record were 91.3, 200, and 326 cubic feet per second (ft^3/s) for the SPAC, NPAC, and PAC sites, respectively (U.S. Geological Survey 2009) and were considered average streamflow conditions for the three sites. Departures from average streamflow conditions were computed by subtracting the mean annual streamflow from the individual annual mean streamflows for WY 1931 to 2009 at each site (fig. 5; Appendix 2-A). Streamflow exhibited a slower recovery to average streamflow conditions when compared to annual precipitation at all sites from 2006 to 2009 (figs. 4, 5). Precipitation was recovering from its low in 2007 by 2008 and was above the long-term mean conditions by 2009, but streamflow remained below the mean annual streamflow for the entire data-collection period of this study.

Flow duration curves for the SPAC, NPAC, and PAC sites provided the percentage of the time a certain streamflow can be expected to be equaled or exceeded for a site based on the daily mean streamflows for the period of record at that site (fig. 6). The streamflows at the time of sampling at each site were overlain on the curve to determine if a fairly representative range of streamflows were sampled. Only about 20 percent of the samples were collected at median or higher flow conditions (exceedence percentiles equal to or less than 50) at all the sites.

Based on the examination of streamflow characteristics for the SPAC, NPAC, and PAC sites and the streamflow conditions at the time of data collection for this investigation,

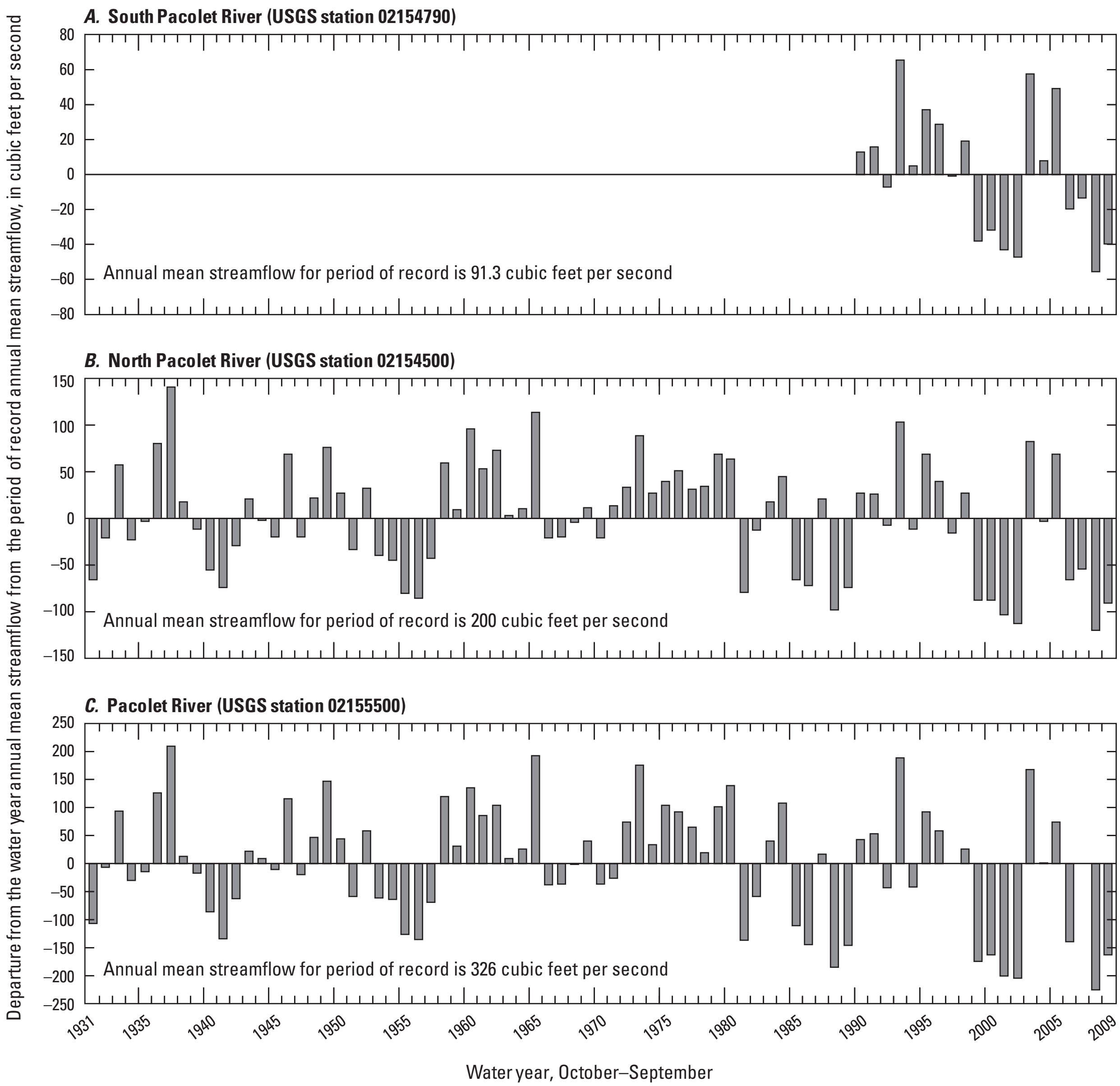


Figure 5. Departure from the period-of-record mean annual streamflow for annual mean streamflows at the *(A)* South Pacolet River at streamgaging station 02154790, *(B)* North Pacolet River at streamgaging station 02154500, and *(C)* Pacolet River at streamgaging station 02155500 for water years 1931 to 2009, Spartanburg County, South Carolina.

estimation of nutrient and sediment loads were limited to recent periods of low to average flow conditions (WY 2006–2009). The long-term mean annual nutrient loads and yields (total nitrogen and total phosphorous; Hoos and others, 2008) were compared to the estimated mean annual nutrient loads for the targeted time period of this investigation (WY 2006–2009) to assess the degree of deviation of the estimated nutrient loads from long-term mean conditions.

To obtain the best loading estimates, water-quality data would have to be collected over several years and target a range of flow conditions because nutrient and sediment concentrations tend to vary from season to season, storm to storm, and year to year. Specifically, large numbers of samples (greater than 50) collected over long time periods (greater than 5 years) that represent a range of climatic conditions (high flow, low flow, average) tend to produce the best loading estimates. The monitoring period for this investigation was limited to monthly samples over a 2-year period, which was dominated by drought conditions. Because of the limitations of the monitoring period (low sample size and drought conditions), the nutrient and sediment data collected in this investigation did not capture the representative range of climatic and flow-induced variability for these constituents. Consequently, the nutrient and sediment load regression equations developed from this limited dataset could not be used to extrapolate estimated nutrient or sediment loading beyond the specifically targeted period of 2006 to 2009. Additionally, caution should be taken in using future monitoring data as input into the developed load regression equations. To develop load regression equations that are more applicable to long-term conditions, additional monitoring data would need to be incorporated with existing data to develop a new load estimation model for the site of interest.

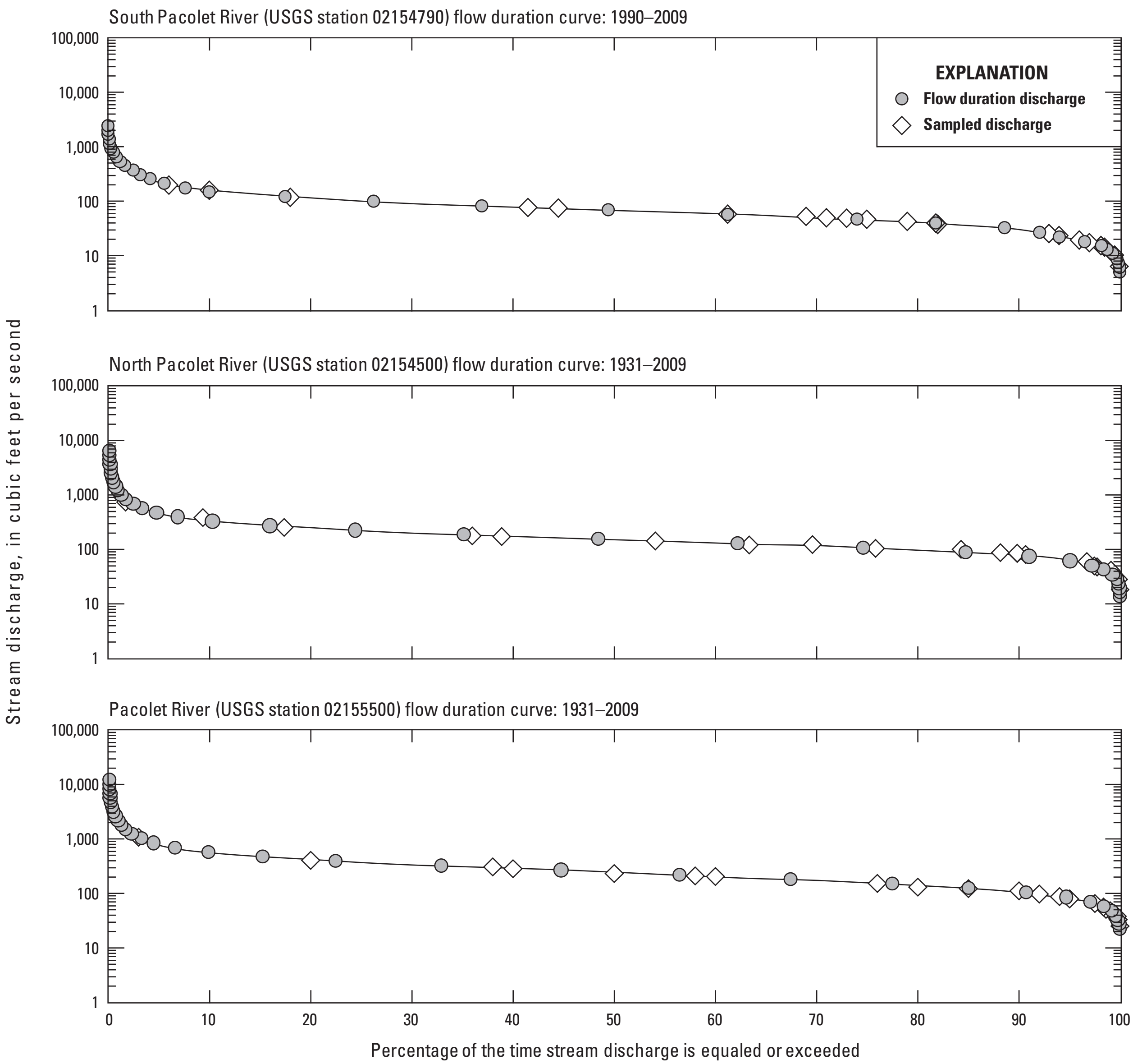


Figure 6. Flow duration curves and sampled discharges for the South Pacolet River at streamgaging station 02154790 for 1990–2009, North Pacolet River at streamgaging station 02154500 for 1931–2009, and Pacolet River at streamgaging station 02155500 for 1931–2009, Spartanburg County, South Carolina. (See fig. 2 for locations.)

Land Use

In general, land use within the Pacolet River Basin in 2001 can be classified as rural (fig. 7; Appendix 2-B). For discussion of variability in land use, the NPAC, SPAC, and intervening PAC_i basins are described and compared. In 2001, the heavily forested headwater areas of the NPAC and SPAC basins gradually changed to a mix of predominantly agricultural pasture and forest downstream in the PAC_i basin (fig. 7). Urban land use was primarily low-intensity residential developments, especially around the reservoirs in the PAC_i basin (fig. 7; Appendix 2-B). The fact that less than 1 percent of urban land use was categorized as high-density residential or commercial-industrial-transportation can be considered a positive characteristic of these basins because these two land-use categories tend to be associated with high impervious areas. Previous research has reported that increased impervious areas in a watershed can modify the stormwater characteristics (quality and quantity) in a detrimental manner with respect to receiving waters (Arnold and Gibbons, 1996; U.S. Environmental Protection Agency, 1997; Bird and others, 2002).

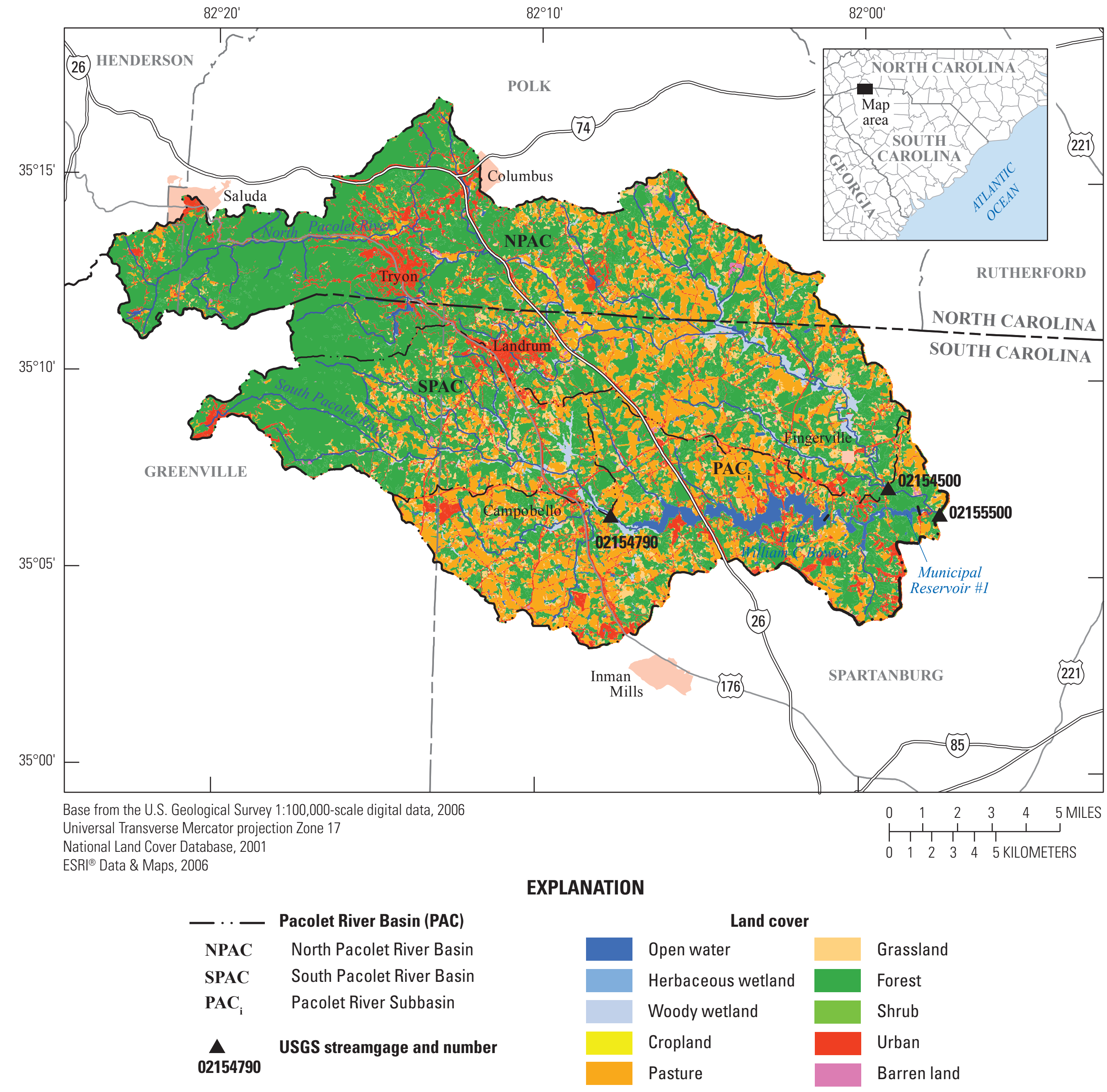


Figure 7. National Land Cover Data (NLCD) land use in selected watersheds in the Pacolet River Basin, in 2001, northwestern South Carolina and southwestern North Carolina.

Forested land (cumulative total of mixed, deciduous, and evergreen NLCD coverages) was the predominant basinwide land use in 2001 at 53 percent in the SPAC, 60 percent in the NPAC, and 42 percent in the PAC_i basins (fig. 8). Agricultural land use, represented predominantly by hay and pasture or grasslands, accounted for about 32 percent of the SPAC, 25 percent of the NPAC, and 34 percent of the PAC_i basins. Low-intensity residential, high-intensity residential, and commercial-industrial-transportation land coverages were combined to compute total urban land use. Urban land use was comparatively similar among the basins, with more than 11 percent in SPAC, 12 percent in NPAC, and 14 percent in the PAC_i basins (fig. 8). The minor increase in the urban land use in the PAC_i basin may be attributed to the denser residential development near the shoreline of Lake Bowen.

General change in land use was evaluated by comparing the 1992 and 2001 NLCD land-use coverages (Appendix 2-B). Method differences in the development of the two NLCD coverages may have contributed some differences in land-use categorization and quantification; therefore, guidance by Fry and others (2009) on grouping coverages for comparison was implemented to reduce these method-induced differences. One of the largest reductions in land use from 1992 to 2001 was agricultural row cropping that decreased by 17 percent in the SPAC, 27 percent in the NPAC, and 18 percent in the PAC_i basins. The other large reduction in land use was in forest coverage that decreased by 13 percent in the SPAC and PAC_i basins and by 43 percent in the NPAC basin (Appendix 2-B). Concurrently, large grassy, open areas replaced the row cropping and forested land. The land used for hay and pasture increased by 12 percent in the SPAC, 26 percent in the NPAC, and 13 percent in the PAC_i basins. Natural grasslands increased by 8 percent in the SPAC, 20 percent in the NPAC, and 7.7 percent in the PAC_i basins. Recreational grassy areas increased by more than 9 percent in the SPAC, 26 percent in the NPAC, and 10 percent in the PAC_i basins (Appendix 2-B). Only minor changes (less than 1 percent) in urban land were identified from 1992 to 2001 for the SPAC and PAC_i basins, and these changes may be attributed to method differences in the NLCD coverage development for the two time periods (Appendix 2-B). A reduction in urban land use of about 11.5 percent from 1992 to 2001 was identified for the NPAC basin (Appendix 2-B).

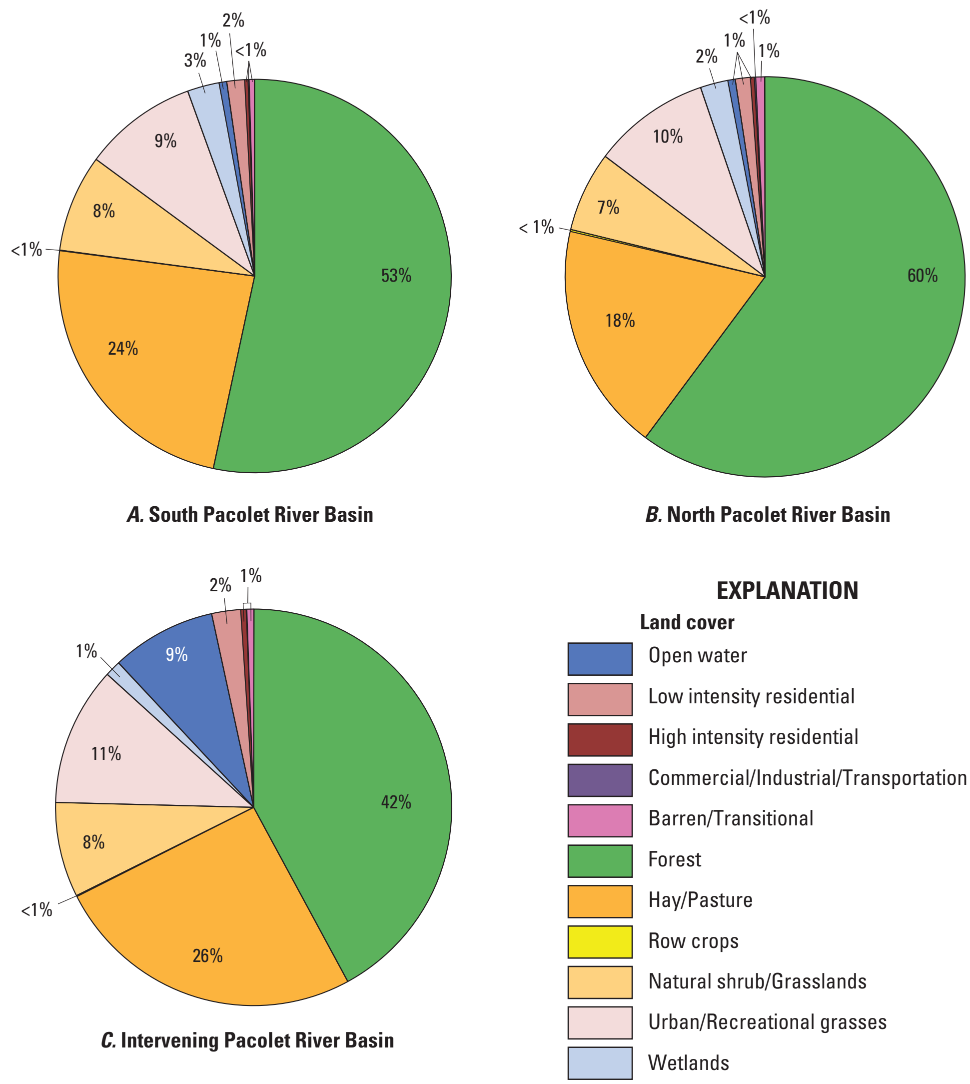


Figure 8. Percentage of land-use coverage in the *(A)* South Pacolet River Basin at the streamgaging station 02154790, *(B)* North Pacolet River Basin at the streamgaging station 02154500, and *(C)* the intervening portion of the Pacolet River Basin at the streamgaging station 02155500 to the above streamgages on the North and South Pacolet Rivers from the 2001 National Land Cover Data (NLCD) geospatial coverage, North and South Carolina. (See fig. 7 for locations; %, percent.)

Land-use coverage within the smaller synoptic drainage basins within the PAC_i basin were more varied than in the three larger basins (fig. 9). The land use in the basins of sites S-5A, S-6, and S-2 in the PAC_i basin were forest, hay-and-pasture, and natural-grassland dominated and most similar to the SPAC basin (fig. 9; Appendix 2-B). The land use in the basins of sites S-3 and S-4 had reduced forest but greater hay and pasture and natural grassland than the SPAC basin (fig. 9; Appendix 2-B). Agricultural land use dominated the basins of site S-1 (hay and pasture) and site S-7 (natural grassland, hay and pasture; fig. 9). Residential development and barren land cover dominated the site S-8 basin relative to agricultural and forested land (fig. 9).

Nutrient and Suspended-Sediment Concentrations, Loads, and Yields

Dissolved ammonia, dissolved nitrate plus nitrite, total organic nitrogen, total nitrogen, dissolved orthophosphate, dissolved phosphorus, total phosphorus, and suspended-sediment concentrations and total nitrogen to total phosphorus ratios were evaluated and compared among sites. Relations of the above constituents with streamflow and season also were evaluated prior to load model selection. Load regression models and variable coefficients are summarized for dissolved nitrate plus nitrite, total organic nitrogen, total nitrogen, dissolved orthophosphate, dissolved phosphorus, total phosphorus, and suspended sediment. The results of seasonal and annual loads and yields for the above constituents for WYs 2006 through 2009 are presented.

Nutrient and Sediment Concentrations

Total organic nitrogen and dissolved nitrate plus nitrite were the two most dominant species of nitrogen in the streamwater at the SPAC, NPAC, and PAC sites for the period of study. Median nitrate plus nitrite concentrations of 0.27 mg/L at the SPAC, 0.30 mg/L at the NPAC, and 0.23 mg/L at the PAC sites were greater than median total organic nitrogen concentrations of 0.10 mg/L at the SPAC, 0.12 mg/L at the NPAC, and 0.18 mg/L at the PAC sites, but maximum

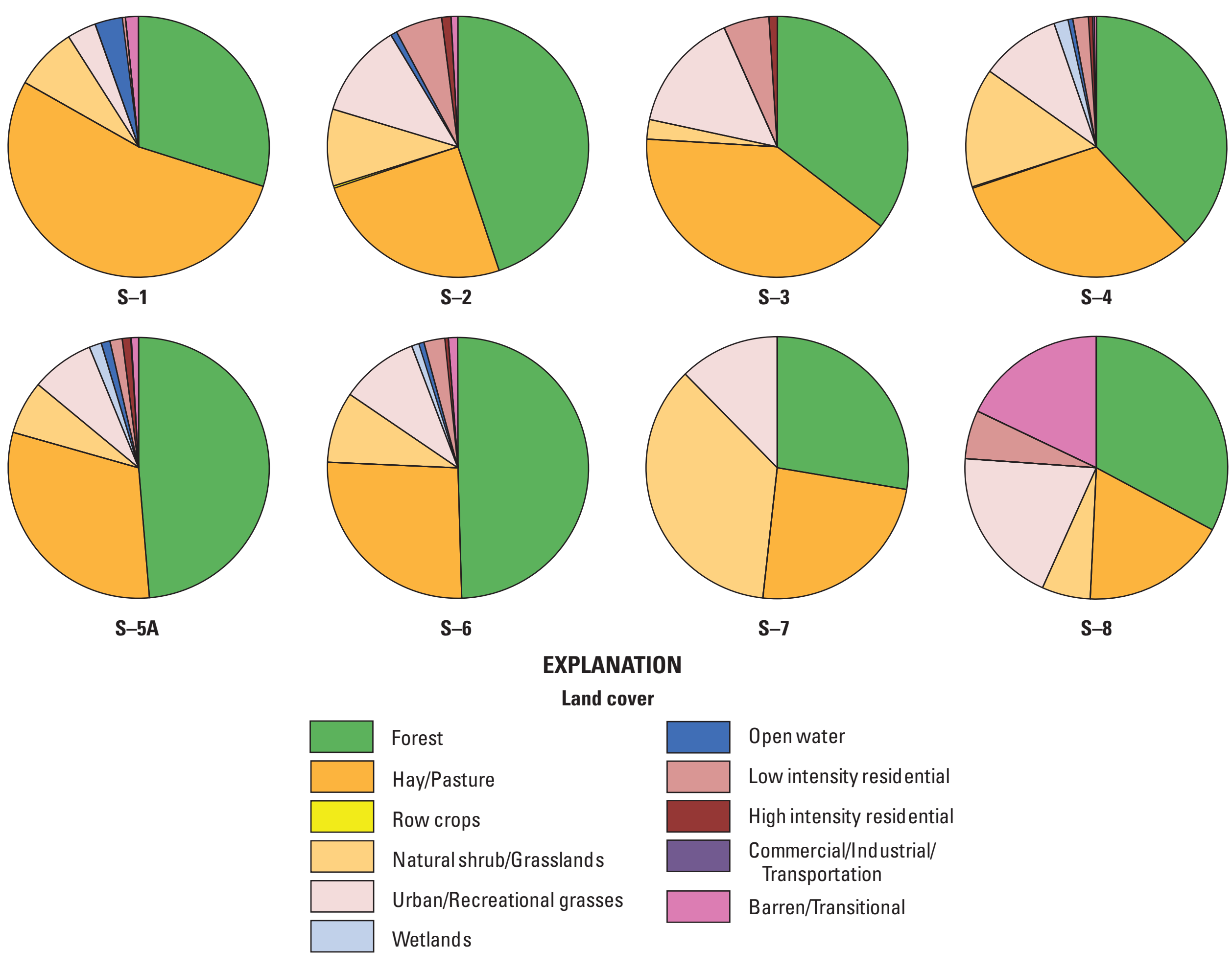
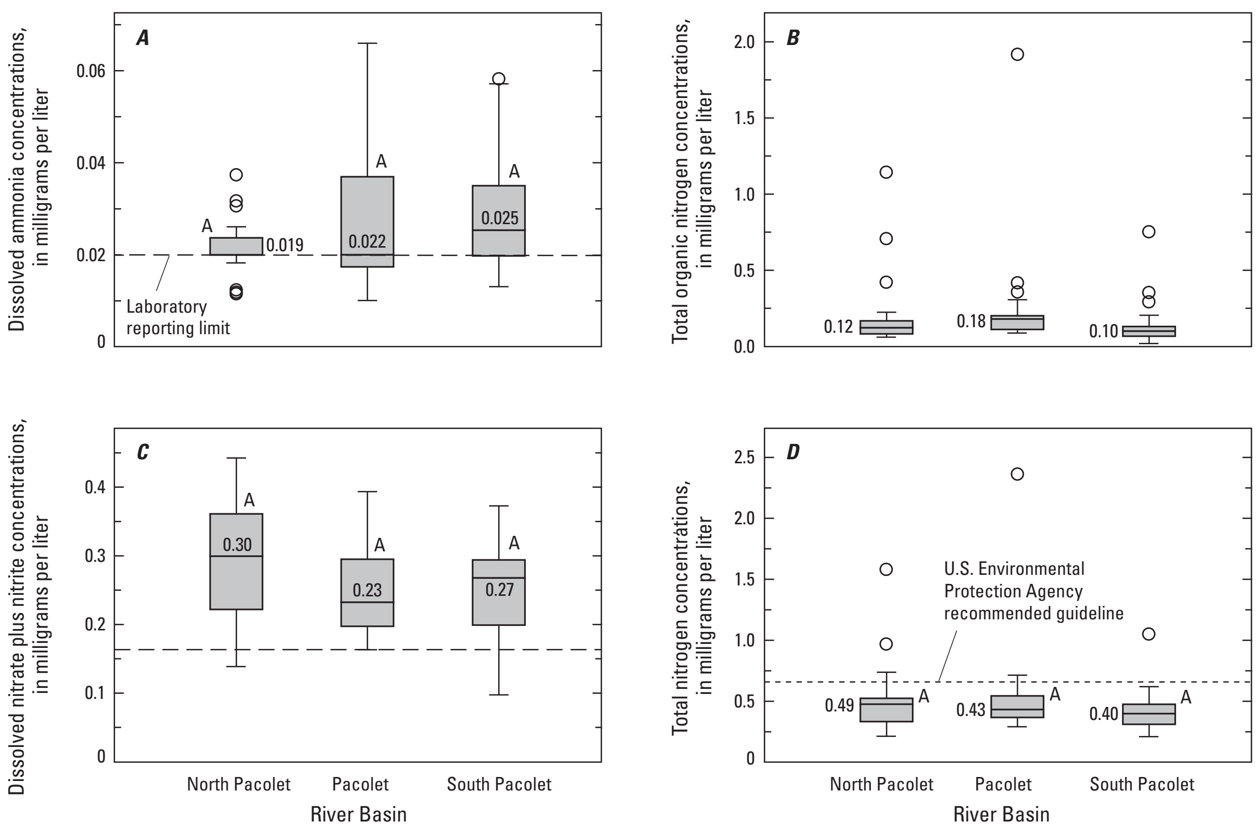


Figure 9. Percentage of land-use coverage at selected synoptic water-quality sites in the South Pacolet River Basin from the 2001 National Land Cover Data (NLCD) geospatial coverage, South Carolina.

concentrations of total organic nitrogen were 2 to 5 times greater than maximum dissolved nitrate plus nitrite concentrations at these sites (table 6; fig. 10). Dissolved nitrate plus nitrite concentrations were statistically similar among the three sites (p-value = 0.12, table 7; fig. 10). Based on maximum dissolved nitrite concentrations of less than 0.005 mg/L, nitrate composed the main fraction of the inorganic nitrogen species (table 6). The Kruskal-Wallis test identified a difference among the sites for total organic nitrogen concentrations (p-value = 0.01), but the Tukey studentized range test was unable to determine which sites were different (fig. 10; table 7). Dissolved ammonia concentrations were an order of magnitude less than total organic nitrogen and dissolved nitrate concentrations, ranging from an estimated 0.013 to 0.058 mg/L at the SPAC site, 0.012 to 0.037 mg/L at the NPAC site, and 0.010 to 0.066 mg/L at the PAC site (fig. 10; table 6). Dissolved ammonia concentrations were similar among sites (p-value = 0. 10, table 7; fig. 10).

Median concentrations of total nitrogen were 0.40 mg/L at the SPAC, 0.49 mg/L at the NPAC, and 0.43 mg/L at the PAC sites (fig. 10; table 6) and were statistically similar among sites (p-value = 0.37, table 7; fig. 10). Except for a few outliers, the majority of the measurements of total nitrogen concentrations were well below the USEPA recommended guideline of 0.69 mg/L for the nutrient ecoregion IX (U.S. Environmental Protection Agency, 2000; fig. 10). In fact, total nitrogen concentrations at the three sites can be considered relatively low compared to other rivers and streams in the Piedmont because their median total nitrogen concentrations were close to 0.41 mg/L, the 25th percentile of the compiled total nitrogen concentration data for ecoregion 45. However, median nitrate plus nitrite concentrations at the three sites were above the 25th percentile of the compiled nitrate plus nitrite concentration data for ecoregion 45 of 0.18 mg/L indicating the three sites had relatively normal to elevated nitrate plus nitrite concentrations compared to other rivers and streams in the ecoregion



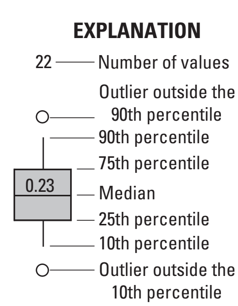


Figure 10. *(A)* Dissolved ammonia, *(B)* total organic nitrogen, *(C)* dissolved nitrate plus nitrite, and *(D)* total nitrogen concentrations for the South Pacolet River at streamgaging station 02154790, North Pacolet River at streamgaging station 02154500, and Pacolet River at streamgaging station 02155500 for September 2007 to August 2009, Spartanburg County, South Carolina. (Boxplots that share the same letter are statistically similar; see fig. 2 for locations.)

Table 6. Summary statistics for selected constituents in water from the North Pacolet River at streamgaging station 02154500, South Pacolet River at streamgaging station 02154790, and Pacolet River at streamgaging station 02155500, Spartanburg County, South Carolina, September 2007 to August 2009.

[<, less than; mg/L, milligram per liter; E, estimated value; *, computed using Adjusted Maximum Likelihood Estimation; NA, not applicable; col/mL, colonies per milliliter]

Constituent	Number of samples (censored)	Censoring level(s)	Units	Minimum	Mean	Median	Maximum
North Pacolet River (02154500)							
Dissolved ammonia	18 (6)	<0.02	mg/L	E0.012	0.020*	0.019*	0.037
Dissolved nitrate plus nitrite	22 (0)	<0.016	mg/L	0.14	0.30	0.30	0.44
Dissolved nitrite	22 (3)	<0.002	mg/L	E0.001	0.002*	0.002*	0.004
Total organic nitrogen	22 (0)	NA	mg/L	0.06	0.20	0.12	1.14
Total nitrogen	22 (0)	<0.06	mg/L	0.21	0.51	0.49	1.58
Dissolved orthophosphate	22 (0)	<0.008	mg/L	E0.006	0.011	0.012	0.019
Dissolved phosphorus	22 (0)	<0.006	mg/L	0.011	0.027	0.025	0.051
Total phosphorus	22 (0)	<0.008	mg/L	0.025	0.082	0.050	0.330
Total nitrogen to total phosphorus ratio	22 (0)	NA	unitless	3.0	8.1	7.9	20
Suspended sediment	23 (0)	<1	mg/L	2	43	10	381
Suspended sediment finer than 63 microns	23 (0)	<1	percent	62	88	90	98
Pacolet River (02155500)							
Dissolved ammonia	17 (2)	<0.02	mg/L	E0.010	0.027*	0.022*	0.066
Dissolved nitrate plus nitrite	21 (0)	<0.016	mg/L	0.16	0.25	0.23	0.39
Dissolved nitrite	21 (2)	<0.002	mg/L	E0.001	0.002*	0.002*	0.004
Total organic nitrogen	21 (0)	NA	mg/L	0.09	0.26	0.18	1.92
Total nitrogen	21 (0)	<0.06	mg/L	0.29	0.54	0.43	2.36
Dissolved orthophosphate	21 (0)	<0.008	mg/L	E0.005	0.009	E0.007	0.017
Dissolved phosphorus	21 (0)	<0.006	mg/L	0.011	0.022	0.021	0.049
Total phosphorus	21 (0)	<0.008	mg/L	0.021	0.081	0.044	0.464
Total nitrogen to total phosphorus ratio	21 (0)	NA	unitless	4.1	8.7	8.0	23
Suspended sediment	21 (0)	<1	mg/L	1	66	12	1,090
Suspended sediment finer than 63 microns	21 (0)	<1	percent	61	87	91	98
South Pacolet River (02154790)							
Dissolved ammonia	20 (1)	<0.02	mg/L	E0.013	0.028*	0.025*	0.058
Dissolved nitrate plus nitrite	24 (0)	<0.016	mg/L	0.10	0.25	0.27	0.37
Dissolved nitrite	24 (3)	<0.002	mg/L	E0.001	0.002*	0.002*	0.003
Total organic nitrogen	24 (0)	NA	mg/L	0.02	0.14	0.10	0.75
Total nitrogen	24 (0)	<0.06	mg/L	0.21	0.42	0.40	1.05
Dissolved orthophosphate	24 (0)	<0.008	mg/L	E0.003	E0.006	E0.005	0.009
Dissolved phosphorus	24 (2)	<0.006	mg/L	E0.003	0.006*	0.005*	0.015
Total phosphorus	24 (0)	<0.008	mg/L	E0.007	0.029	0.016	0.168
Total nitrogen to total phosphorus ratio	24 (0)	NA	unitless	5.7	24	22	61
Suspended sediment	24 (0)	<1	mg/L	2	19	9	162
Suspended sediment finer than 63 microns	24 (0)	<1	percent	29	81	84	98
Actinomycetes	19 (0)	<1	col/mL	8	82	24	700

Table 7. Results of the nonparametric ANOVA (Kruskal-Wallis) and multiple comparison tests (Tukey's studentized range test) to determine differences in selected water-quality constituents among three sites in the Pacolet River Basin (South Pacolet River, North Pacolet River, and Pacolet River), Spartanburg County, South Carolina, water years 2007 to 2009.

[Tukey's test denotes differences among sites such that A > B > C; nd, not able to be determined; α, alpha level]

Constituent	Kruskal-Wallis (Wilcoxon Rank Sum) Test		Tukey's Studentized Range (HSD) Test (α = 0.10)		
	Chi-squared	p-value	South Pacolet	North Pacolet	Pacolet
Total phosphorus	25.031	<0.0001	B	A	A
Dissolved phosphorus	45.438	<0.0001	B	A	A
Dissolved orthophosphate	29.490	<0.0001	C	A	B
Dissolved ammonia	4.516	0.10	A	A	A
Dissolved nitrate plus nitrite	4.261	0.12	A	A	A
Dissolved nitrite	4.261	0.12	A	A	A
Total organic nitrogen	9.219	0.01	nd	nd	nd
Total nitrogen	2.010	0.37	A	A	A
Total nitrogen to total phosphorus ratio	26.759	<0.0001	A	B	B
Suspended sediment	0.470	0.79	A	A	A
Suspended sediment finer than 63 microns	5.089	0.08	A	A	A
Dissolved organic carbon	0.433	0.81	A	A	A
Ultraviolet absorbance at 254 nanometers	6.238	0.04	nd	nd	nd
Specific ultraviolet absorbance at 254 nanometers	11.101	0.004	A	B	B
Hardness	21.281	<0.0001	B	A	A
Dissolved iron	11.286	0.004	A	B	B
Dissolved manganese	13.407	0.001	nd	nd	nd
Specific conductance	30.388	<0.0001	B	A	A
pH	4.028	0.13	A	A	A
Dissolved oxygen	4.518	0.10	A	A	A
Water temperature	0.084	0.96	A	A	A

When compared to nitrogen concentrations, phosphorus species concentrations were more variable among the three sites (figs. 10, 11). Median dissolved phosphorus concentrations of 0.005 mg/L at the SPAC, 0.025 mg/L at the NPAC, and 0.021 mg/L at the PAC sites were about half of the median total phosphorus concentrations of 0.016 mg/L at the SPAC, 0.050 mg/L at the NPAC, and 0.044 mg/L at the PAC sites (table 6; fig. 11). Both dissolved and total phosphorus concentrations, however, were significantly lower at the SPAC site compared to the NPAC and PAC sites (p-values < 0.0001, table 7; fig. 11). More than 50 percent of the dissolved orthophosphate concentrations at the SPAC and PAC sites were below the LRL of 0.008 mg/L, as indicated by estimated median orthophosphate concentrations of 0.005 and 0.007 mg/L, respectively (table 6; fig. 11). The greatest orthophosphate concentrations were at the NPAC site with a median of 0.012 mg/L, followed by the PAC site, then the SPAC site (p-value < 0.0001, table 7).

Total phosphorus concentrations ranged from 0.025 to 0.330 mg/L with a median of 0.050 mg/L at the NPAC site and ranged from 0.021 to 0.464 mg/L with a median of 0.044 mg/L at the PAC sites for the period of study (table 6; fig. 11). All but one sample had total concentrations that were above the USEPA recommended guideline of 0.037 mg/L for the nutrient ecoregion IX (U.S. Environmental Protection Agency, 2000; fig. 11). Total phosphorus concentrations at the SPAC site ranged from an estimated 0.007 to 0.168 mg/L with a median of 0.016 mg/L, and more than 90 percent of the concentrations were below the USEPA guideline (table 6; fig. 11).

Similar total nitrogen concentrations and lower total phosphorus concentrations at the SPAC site also contributed to statistically higher total nitrogen to total phosphorus ratios in the streamwater (median = 22) than at the NPAC and PAC sites (median ratios of 7.9 and 8.0, respectively; tables 6, 7; fig. 11). Lower total nitrogen to total phosphorus ratios in lakes and reservoirs have been linked to cyanobacterial dominance (Downing and others, 2001; Smith and others, 2002).

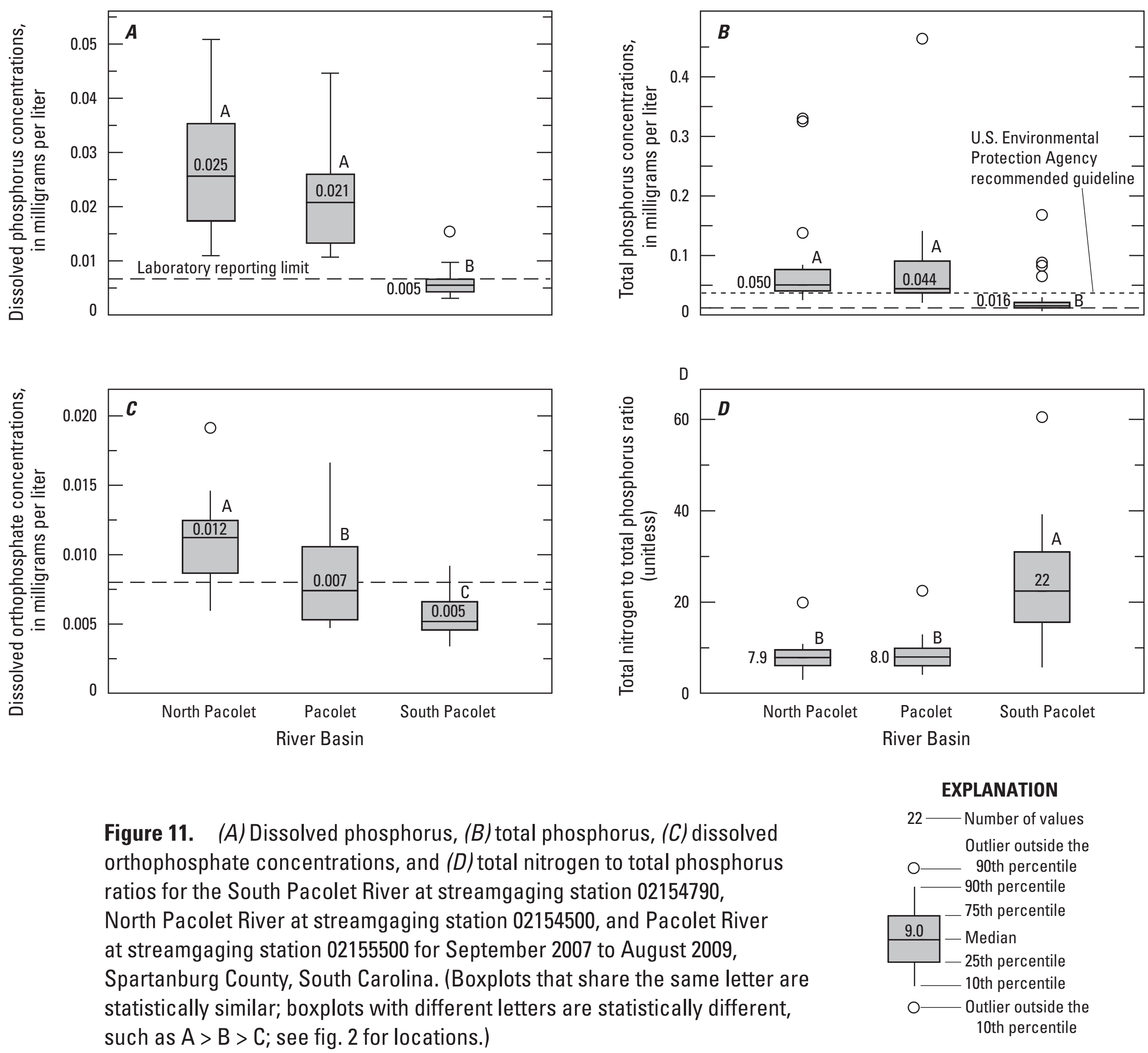


Figure 11. *(A)* Dissolved phosphorus, *(B)* total phosphorus, *(C)* dissolved orthophosphate concentrations, and *(D)* total nitrogen to total phosphorus ratios for the South Pacolet River at streamgaging station 02154790, North Pacolet River at streamgaging station 02154500, and Pacolet River at streamgaging station 02155500 for September 2007 to August 2009, Spartanburg County, South Carolina. (Boxplots that share the same letter are statistically similar; boxplots with different letters are statistically different, such as A > B > C; see fig. 2 for locations.)

Suspended-sediment concentrations were highly variable, ranging from 2 to 162 mg/L at the SPAC site, from 2 to 381 mg/L at the NPAC site, and from 1 to 1,090 mg/L at the PAC site for the period of study (table 6; fig. 12). Median suspended-sediment concentrations of 9 mg/L at the SPAC site, 10 mg/L at the NPAC site, and 12 mg/L at the PAC sites were relatively low. Overall, suspended-sediment concentrations were statistically similar among sites (table 6; p-value = 0.79, table 7; fig. 12).

Percentages of suspended sediment finer than 63 microns (representing silt and clay grain-size fraction of the sediment) also were evaluated and determined to be similar among sites (p-value = 0.08, table 7). Median suspended-sediment concentrations, in percentages finer than 63 microns, were 84 at the SPAC, 90 at the NPAC, and 91 at the PAC sites, (table 6; fig. 12). In fact, the silt and clay fractions were the dominant grain-size fractions at all sites except for one sample (29 percent at SPAC site; fig. 12; table 6).

Actinomycetes concentrations were monitored to determine watershed contributions of this potential geosmin source. Actinomycetes have the ability to adhere to suspended sediment and, thus, be transported to streams and reservoirs. Actinomycetes concentrations were monitored only at the SPAC site because the site is located upstream from the reservoirs. Actinomycetes were found at the SPAC site in concentrations ranging from 8 to 700 colonies per milliliter (col/mL) during the period of study (table 6).

For load estimation, the seasonal and flow-related behaviors of the nutrients of interest were evaluated for the SPAC (fig. 13), NPAC (fig. 14) and PAC (fig. 15) sites. Dissolved nitrate plus nitrite concentrations in streamwater appeared to have some degree of seasonal variability at the SPAC site from September 2007 to August 2009, with lower concentrations in November–December and higher concentrations during the spring and summer (fig. 13*B*); however, seasonal variability was not so apparent in this constituent at the NPAC and PAC

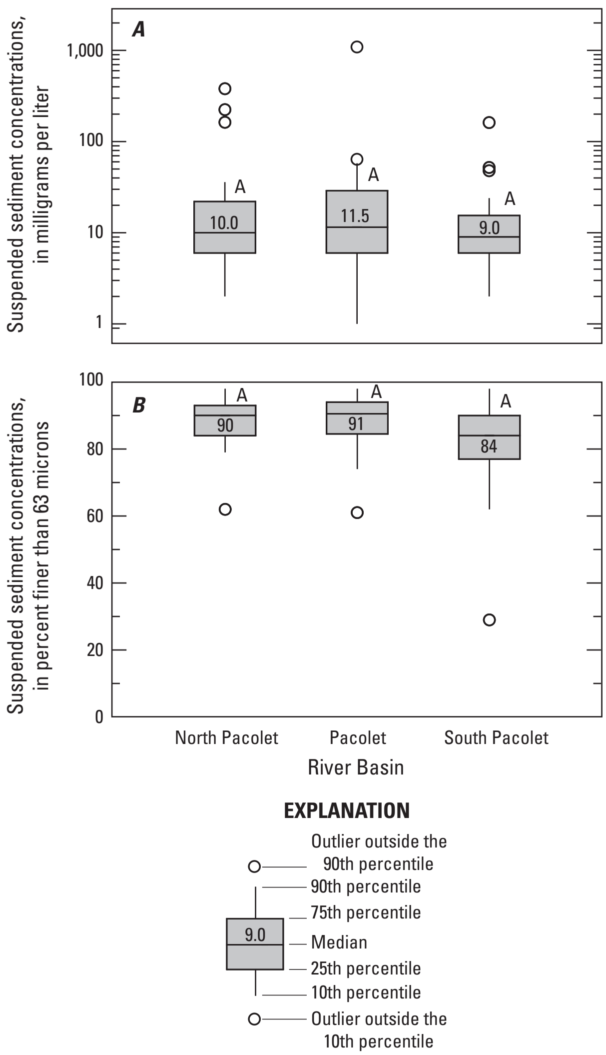


Figure 12. *(A)* Suspended-sediment concentrations and *(B)* suspended sediment finer than 63 microns for the North Pacolet River at streamgaging station 02154500, Pacolet River at streamgaging station 02155500, and South Pacolet River at streamgaging station 02154790 for September 2007 to August 2009, Spartanburg County, South Carolina.

sites (figs. 14*B*, 15*B*). Only the SPAC site had dissolved nitrate plus nitrite concentrations that were significantly correlated to streamflow (Spearman rho correlation coefficient (ρ) = 0.471; p-value = 0.02; Appendix 2-C; fig. 13*A*), Total organic nitrogen concentrations appeared to be more strongly influenced by streamflow than by seasonal variability at all sites, whereby concentrations increased with increased streamflow (figs. 13*A*, 14*A*, 15*A*). Total organic nitrogen was correlated significantly with streamflow at the SPAC site (ρ = 0.466, p-value = 0.02) and the NPAC site (ρ = 0.549, p-value = 0.008; figs. 13*A*, 14*A*; Appendix 2-C). At all sites, total organic nitrogen concentrations remained below dissolved nitrate plus nitrite concentrations, except during periods of high streamflow (figs. 13*B*, 14*B*, 15*B*). Greater contribution of particulate (sediment-bound) forms of total organic nitrogen, such as particulate organic matter, during periods of high streamflow could be the cause of the increase.

Dissolved phosphorus concentrations had similar seasonal variability as total phosphorus concentrations except during periods of high streamflow at all sites (figs. 13*D*, 14*D*, 15*D*). Total phosphorus and dissolved phosphorus concentrations were correlated positively to streamflow at the SPAC site (ρ = 0.441, p-value = 0.04 and ρ = 0.510, p-value = 0.013, respectively; figs. 13*C*, 14*C*, 15*C*; Appendix 2-C). Conversely, dissolved orthophosphate was correlated negatively to streamflow for both the SPAC (ρ = –0.585, p-value = 0.003) and PAC (ρ = –0.677, p-value < 0.001) sites. Specifically, during periods of high streamflow, total phosphorus concentrations increased, while dissolved orthophosphorate concentrations decreased (figs. 13*C*, 14*C*, 15*C*).

Greater contribution of particulate forms of total phosphorus during high streamflow periods was considered the most likely cause of the increase, and that assumption was further validated by the behavior of suspended sediment at the sites. Suspended-sediment concentrations increased with increasing streamflow at all sites for the period of study (figs. 16–18); however, this relation was significant only at the NPAC site (ρ = 0.435, p-value = 0.03; Appendix 2-C). Only a slight seasonal variability was apparent in suspended-sediment concentrations, with periodic decreases during the winter months.

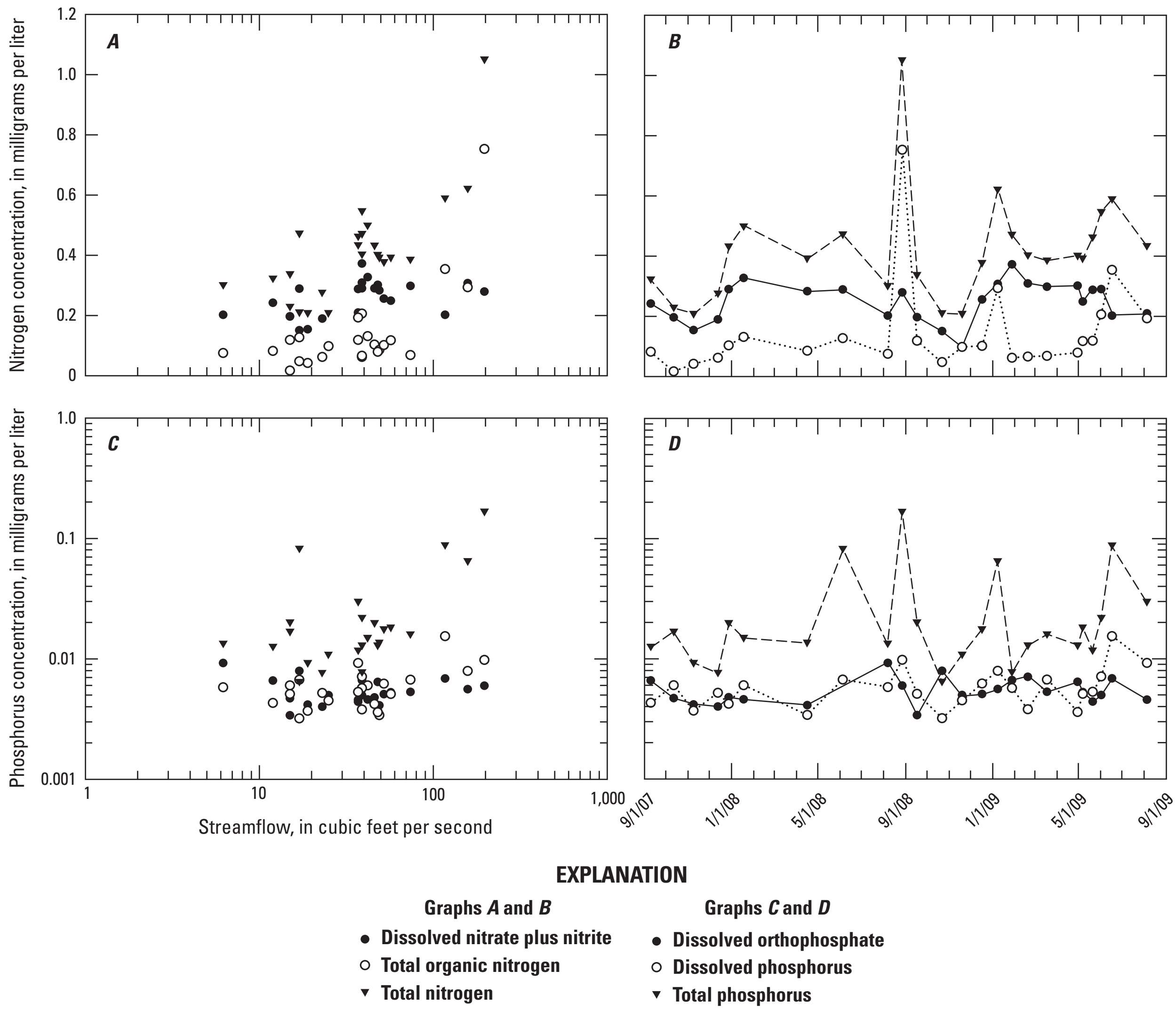


Figure 13. *(A)* Nitrogen species concentrations and streamflow, *(B)* nitrogen species concentrations and time, *(C)* phosphorus species concentrations and streamflow, and *(D)* phosphorus species concentrations and time for the South Pacolet River at streamgaging station 02154790, September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

At the SPAC site, actinomycetes concentrations were correlated significantly to streamflow ($\rho = 0.664$, p-value = 0.002; fig. 16; Appendix 2-C), and these bacteria were compared to suspended-sediment and nutrient concentrations (total phosphorus, total nitrogen, and total organic nitrogen concentrations) to identify any significant correlations. Total phosphorus, dissolved phosphorus, and total organic nitrogen were determined to be correlated strongly (p-value < 0.001) with actinomycetes concentrations, while suspended-sediment, and total nitrogen concentrations also were correlated but not as strongly (p-value = 0.005 and 0.02, respectively; Appendix 2-C). These relations suggested that processes that influenced nutrient concentrations also may have influenced actinomycetes concentrations at the SPAC site, and these more readily measured constituents could serve as a surrogate for actinomycetes (fig. 16).

Annual and Seasonal Nutrient and Sediment Loads and Yields

Annual and seasonal nutrient and sediment loads and yields were estimated for the SPAC, NPAC, and PAC sites for WY 2006–2009 using one of four predefined regression models in the S-LOADEST computer program (models 1, 2, 4, 6; table 4). The selected regression model and variable coefficients are provided for dissolved nitrate plus nitrite, total organic nitrogen, total nitrogen, dissolved phosphorus, dissolved orthophosphate, total phosphorus, and suspended sediment at each of the three sites (table 8). Model 4, which had logarithm of streamflow and seasonal terms as explanatory variables, was the most commonly selected model of the four regression models considered. Annual load output from the S-LOADEST computer program was compiled (Appendix 4-A).

Table 8. Selected load estimation regression models and variable coefficients from the LOADEST computer program for select nutrients and suspended sediment in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and Pacolet River at streamgaging station 02155500 (PAC), Spartanburg County, South Carolina, water years 2006–2009.

[USGS, U.S. Geological Survey; β, model coefficient; StDev, standard deviation; p-value, probability value; LnQ, natural logarithm of discharge; LnQ^2, natural logarithm of discharge squared; π, pi; T, fraction of the year in decimal years; AIC, Akaike Information Criterion; SPCC, Schwarz Posterior Probability Criterion; N/A, not available]

USGS station number	Map identification (fig. 2)	Number of samples (censored)	Load estimation program (LOADEST)			R-squared	Intercept			LnQ			LnQ^2			sine (2π T)			cosine (2π T)		
			Model	AIC Rank (out of 9)	SPPC Rank (out of 9)		β_0	StDev	p-value	β_1	StDev	p-value	β_2	StDev	p-value	β_3	StDev	p-value	β_4	StDev	p-value
Nitrate plus nitrite																					
02154790	SPAC	24 (0)	4	2	1	0.947	3.100	0.050	<0.0001	1.066	0.07	<0.0001	N/A	N/A	N/A	0.252	0.081	0.002	0.002	0.069	0.98
02154500	NPAC	22 (0)	1	1	1	0.905	4.372	0.066	<0.0001	1.091	0.079	<0.0001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
02155500	PAC	21 (0)	1	1	1	0.907	4.498	0.068	<0.0001	0.999	0.074	<0.0001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total organic nitrogen																					
02154790	SPAC	24 (1)	4	1	1	0.904	2.720	0.121	<0.0001	1.772	0.158	<0.0001	N/A	N/A	N/A	–0.281	0.175	0.069	–0.456	0.158	0.001
02154500	NPAC	22 (0)	4	2	1	0.940	3.780	0.090	<0.0001	1.843	0.115	<0.0001	N/A	N/A	N/A	–0.396	0.13	0.003	–0.501	0.122	0.000
02155500	PAC	21 (0)	4	3	2	0.944	4.371	0.089	<0.0001	1.632	0.102	<0.0001	N/A	N/A	N/A	–0.523	0.123	<0.0001	–0.370	0.122	0.003
Total nitrogen																					
02154790	SPAC	24 (1)	6	1	1	0.967	3.518	0.063	<0.0001	1.310	0.0673	<0.0001	0.1121	0.0643	0.059	0.1026	0.0887	0.201	–0.1301	0.0713	0.049
02154500	NPAC	22 (0)	6	1	2	0.959	4.841	0.089	<0.0001	1.377	0.0786	<0.0001	0.1321	0.0854	0.089	–0.0307	0.1155	0.763	–0.2141	0.0871	0.010
02155500	PAC	21 (0)	6	4	5	0.959	5.149	0.103	<0.0001	1.337	0.0761	<0.0001	0.1303	0.0875	0.099	–0.2035	0.1213	0.065	–0.1012	0.1000	0.253
Dissolved phosphorus																					
02154790	SPAC	24 (2)	4	1	1	0.933	–0.677	0.100	<0.0001	1.318	0.104	<0.0001	N/A	N/A	N/A	–0.182	0.118	0.053	–0.253	0.114	0.003
02154500	NPAC	22 (0)	4	1	1	0.903	1.858	0.053	<0.0001	0.724	0.068	<0.0001	N/A	N/A	N/A	0.071	0.076	0.31	–0.349	0.072	<0.0001
02155500	PAC	21 (0)	4	1	1	0.834	1.945	0.079	<0.0001	0.755	0.091	<0.0001	N/A	N/A	N/A	–0.161	0.109	0.115	–0.266	0.109	0.012
Orthophosphate																					
02154790	SPAC	24 (0)	2	3	2	0.935	–0.783	0.056	<0.0001	0.977	0.057	<0.0001	0.122	0.052	0.017	N/A	N/A	N/A	N/A	N/A	N/A
02154500	NPAC	22 (0)	4	5	5	0.904	1.014	0.056	<0.0001	0.813	0.071	<0.0001	N/A	N/A	N/A	0.133	0.081	0.084	–0.103	0.076	0.14
02155500	PAC	21 (0)	2	2	3	0.836	0.926	0.097	<0.0001	0.768	0.081	<0.0001	0.089	0.072	0.19	N/A	N/A	N/A	N/A	N/A	N/A
Total phosphorus																					
02154790	SPAC	24 (0)	4	5	2	0.882	0.612	0.110	<0.0001	1.775	0.154	<0.0001	N/A	N/A	N/A	–0.444	0.179	0.011	–0.561	0.153	0.000
02154500	NPAC	22 (0)	4	1	1	0.938	2.984	0.079	<0.0001	1.602	0.101	<0.0001	N/A	N/A	N/A	–0.512	0.115	<0.0001	–0.502	0.108	<0.0001
02155500	PAC	21 (0)	4	4	2	0.918	3.215	0.097	<0.0001	1.431	0.111	<0.0001	N/A	N/A	N/A	–0.717	0.134	<0.0001	–0.422	0.133	0.002
Suspended sediment																					
02154790	SPAC	24 (0)	6	1	1	0.907	6.561	0.152	<0.0001	1.703	0.162	<0.0001	0.515	0.157	0.001	–0.199	0.22	0.31	–0.438	0.171	0.008
02154500	NPAC	24 (0)	6	2	1	0.818	6.552	0.170	<0.0001	1.913	0.144	<0.0001	0.244	0.065	0.000	–0.576	0.215	0.006	–0.767	0.21	0.000
02155500	PAC	22 (0)	4	5	6	0.805	8.702	0.228	<0.0001	2.020	0.254	<0.0001	N/A	N/A	N/A	–0.894	0.311	0.004	–0.907	0.319	0.004

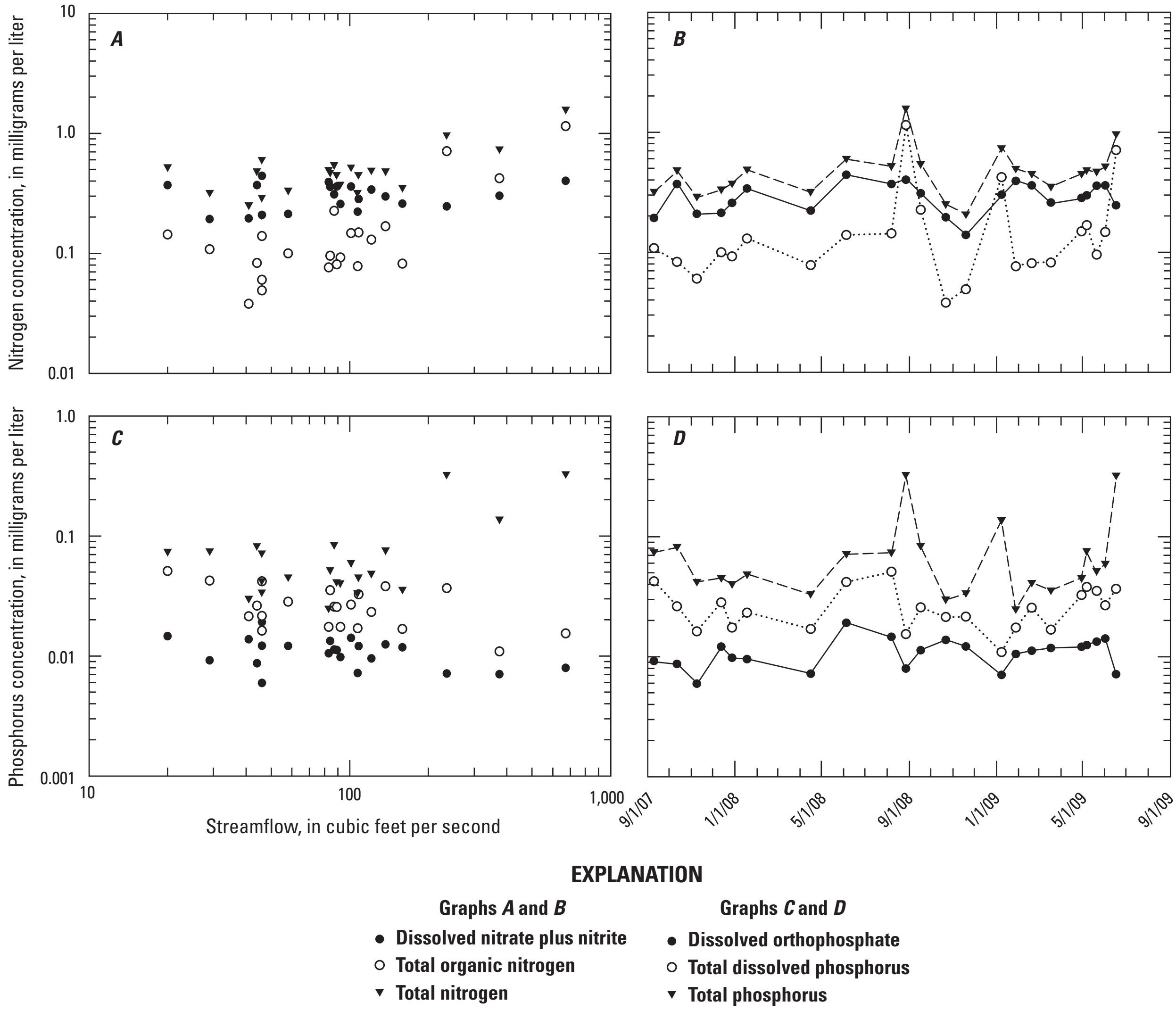


Figure 14. *(A)* Nitrogen species concentrations and streamflow, *(B)* nitrogen species concentrations and time, *(C)* phosphorus species concentrations and streamflow, and *(D)* phosphorus species concentrations and time for the North Pacolet River at streamgaging station 02154500, September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

Four generalizations can be made about the estimated annual nutrient loads that relate to all three sites (SPAC, NPAC, and PAC; table 9):

1. Spatially, annual nutrient loads were highest at the PAC site and lowest at the SPAC site.
2. Temporally, minimum annual nutrient loads for the estimation period (WY 2006–2009) were observed during WY 2008.
3. On average, combined loads of dissolved nitrate plus nitrite and total organic nitrogen accounted for more than 80 percent of the estimated total nitrogen load.
4. Estimated dissolved phosphorus and orthophosphate loads frequently were an order of magnitude less than the estimated total phosphorus loads, suggesting greater contributions from the particulate or sediment-bound forms of phosphorus to the overall annual phosphorus load.

At the SPAC site, estimated annual dissolved nitrate plus nitrite and total organic nitrogen loads had similar distributions. Annual dissolved nitrate plus nitrite loads ranged from 8,736 to 19,970 kg/yr during the estimation period (WY 2006–2009) and had a mean of 14,610 kg/yr (fig. 19; table 9). Annual total organic nitrogen loads ranged from 4,277 to 22,250 kg/yr and had a mean of 14,150 kg/yr (fig. 19; table 9). These similar distribution ranges implied that dissolved nitrate plus nitrite and total organic nitrogen loads contributed relatively equal portions (mean of 44.0 and 36.6 percent, respectively) to the total nitrogen load (table 9). For this investigation, the estimated annual loads for total nitrogen ranged from 14,270 to 65,990 kg/yr and had a mean of 37,770 kg/yr (fig. 19; table 9). Estimated long-term mean annual total nitrogen loads at the SPAC site of 39,777 kg/yr

Table 9. Estimated annual mean nutrient and suspended-sediment loads and yields in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and the intervening basin from the Pacolet River gaging station to the North and South Pacolet River streamgaging stations (PAC_i), Spartanburg County, South Carolina, water years 2006–2009.

USGS station number	USGS station name	Map ID (fig. 2)	Drainage area (hectares)	Water year 2006 constituent loads, in kilograms per year						
				Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophos-phate	Total phosphorus	Suspended sediment
02154790	South Pacolet River near Campobello, SC	SPAC	14,349	16,740	19,790	41,210	490.8	382.1	3,930	22,760,000
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044	37,170	32,970	71,500	2,643	1,166	12,690	12,120,000
02155500	Pacolet River near Fingerville, SC	PAC	54,908	42,040	54,710	105,500	2,945	1,148	15,950	10,020,000
02155500	Intervening subbasin of the Pacolet River	PAC_i	10,515	–11,870	1,954	–7,210	–188.6	–399.8	–667.3	–24,860,000

USGS station number	USGS station name	Map ID (fig. 2)	Drainage area (hectares)	Water year 2007 constituent loads, in kilograms per year						
				Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophos-phate	Total phosphorus	Suspended sediment
02154790	South Pacolet River near Campobello, SC	SPAC	14,349	19,970	22,250	65,990	522.9	517.1	3,726	55,240,000
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044	41,410	35,510	98,140	2,588	1,213	11,820	20,110,000
02155500	Pacolet River near Fingerville, SC	PAC	54,908	46,790	62,030	159,100	2,863	1,275	14,710	7,909,000
02155500	Intervening subbasin of the Pacolet River	PAC_i	10,515	–14,590	4,280	–5,030	–247.7	–455.3	–833.2	–67,440,000

USGS station number	USGS station name	Map ID (fig. 2)	Drainage area (hectares)	Water year 2008 constituent loads, in kilograms per year						
				Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophos-phate	Total phosphorus	Suspended sediment
02154790	South Pacolet River near Campobello, SC	SPAC	14,349	8,736	4,277	14,270	177.6	172.3	795.3	616,200
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044	21,300	10,700	34,180	1,776	772.3	4,512	1,949,000
02155500	Pacolet River near Fingerville, SC	PAC	54,908	22,510	16,440	41,440	1,769	709.1	5,165	2,068,000
02155500	Intervening subbasin of the Pacolet River	PAC_i	10,515	–7,520	1,455	–7,010	–184.6	–235.5	–142.4	–497,600

USGS station number	USGS station name	Map ID (fig. 2)	Drainage area (hectares)	Water year 2009 constituent loads, in kilograms per year						
				Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophos-phate	Total phosphorus	Suspended sediment
02154790	South Pacolet River near Campobello, SC	SPAC	14,349	13,010	10,290	29,620	314.0	278.0	1,852	6,158,000
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044	30,100	22,760	59,740	2,321	1,005	8,594	5,400,000
02155500	Pacolet River near Fingerville, SC	PAC	54,908	36,540	41,120	93,140	2,599	1,032	11,020	6,189,000
02155500	Intervening subbasin of the Pacolet River	PAC_i	10,515	–6,569	8,063	3,780	–35.31	–250.7	578.5	–5,369,000

USGS station number	USGS station name	Map ID (fig. 2)	Drainage area (hectares)	Mean annual constituent loads, in kilograms per year (2006–2009)						
				Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophos-phate	Total phosphorus	Suspended sediment
02154790	South Pacolet River near Campobello, SC	SPAC	14,349	14,610	14,150	37,770	376.3	337.4	2,576	21,190,000
02154500	North Pacolet River near Fingerville, SC	NPAC	30,044	32,500	25,490	65,890	2,332	1,039	9,404	9,895,000
02155500	Pacolet River near Fingerville, SC	PAC	54,908	36,970	43,580	99,780	2,544	1,041	11,710	6,547,000
02155500	Intervening subbasin of the Pacolet River	PAC_i	10,515	–10,140	3,938	–3,868	–164.1	–335.3	–266.1	–24,540,000

Table 9. Estimated annual mean nutrient and suspended-sediment loads and yields in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and the intervening basin from the Pacolet River gaging station to the North and South Pacolet River streamgaging stations (PAC_i), Spartanburg County, South Carolina, water years 2006–2009.—Continued

USGS station number	USGS station name	Water year 2006 constituent yields, in kilograms per hectare per year							Nitrogen speciation, in percent of total nitrogen load	
		Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment	Dissolved nitrate plus nitrite	Total organic nitrogen
02154790	South Pacolet River near Campobello, SC	1.17	1.38	2.87	0.034	0.027	0.274	1,590	40.6	48.0
02154500	North Pacolet River near Fingerville, SC	1.24	1.10	2.38	0.088	0.039	0.422	403	52.0	46.1
02155500	Pacolet River near Fingerville, SC	0.766	1.00	1.92	0.054	0.021	0.290	182	39.8	51.9
02155500	Intervening subbasin of the Pacolet River	–1.13	0.186	–0.686	–0.018	–0.038	–0.063	–2,360		

USGS station number	USGS station name	Water year 2007 constituent yields, in kilograms per hectare per year							Nitrogen speciation, in percent of total nitrogen load	
		Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment	Dissolved nitrate plus nitrite	Total organic nitrogen
02154790	South Pacolet River near Campobello, SC	1.39	1.55	4.60	0.036	0.036	0.260	3,850	30.3	33.7
02154500	North Pacolet River near Fingerville, SC	1.38	1.18	3.27	0.086	0.040	0.393	669	42.2	36.2
02155500	Pacolet River near Fingerville, SC	0.852	1.13	2.90	0.052	0.023	0.268	144	29.4	39.0
02155500	Intervening subbasin of the Pacolet River	–1.39	0.407	–0.478	–0.024	–0.043	–0.079	–6,410		

USGS station number	USGS station name	Water year 2008 constituent yields, in kilograms per hectare per year							Nitrogen speciation, in percent of total nitrogen load	
		Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment	Dissolved nitrate plus nitrite	Total organic nitrogen
02154790	South Pacolet River near Campobello, SC	0.609	0.298	0.994	0.012	0.012	0.055	42.9	61.2	30.0
02154500	North Pacolet River near Fingerville, SC	0.709	0.356	1.14	0.059	0.026	0.150	64.9	62.3	31.3
02155500	Pacolet River near Fingerville, SC	0.410	0.299	0.755	0.032	0.013	0.094	37.7	54.3	39.7
02155500	Intervening subbasin of the Pacolet River	–0.715	0.138	–0.667	–0.018	–0.022	–0.014	–47.3		

USGS station number	USGS station name	Water year 2009 constituent yields, in kilograms per hectare per year							Nitrogen speciation, in percent of total nitrogen load	
		Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment	Dissolved nitrate plus nitrite	Total organic nitrogen
02154790	South Pacolet River near Campobello, SC	0.907	0.717	2.06	0.022	0.019	0.129	429	43.9	34.7
02154500	North Pacolet River near Fingerville, SC	1.00	0.758	1.99	0.077	0.033	0.286	180	50.4	38.1
02155500	Pacolet River near Fingerville, SC	0.665	0.749	1.70	0.047	0.019	0.201	113	39.2	44.1
02155500	Intervening subbasin of the Pacolet River	–0.625	0.767	0.359	–0.003	–0.024	0.055	–511		

USGS station number	USGS station name	Mean annual constituent yields, in kilograms per hectare per year							Nitrogen speciation, in percent of total nitrogen load	
		Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment	Dissolved nitrate plus nitrite	Total organic nitrogen
02154790	South Pacolet River near Campobello, SC	1.02	0.986	2.63	0.026	0.024	0.180	1,480	44.0	36.6
02154500	North Pacolet River near Fingerville, SC	1.08	0.848	2.19	0.078	0.035	0.313	329	51.7	37.9
02155500	Pacolet River near Fingerville, SC	0.673	0.794	1.82	0.046	0.019	0.213	119	40.7	43.7
02155500	Intervening subbasin of the Pacolet River	–0.964	0.375	–0.368	–0.016	–0.032	–0.025	–2,330		

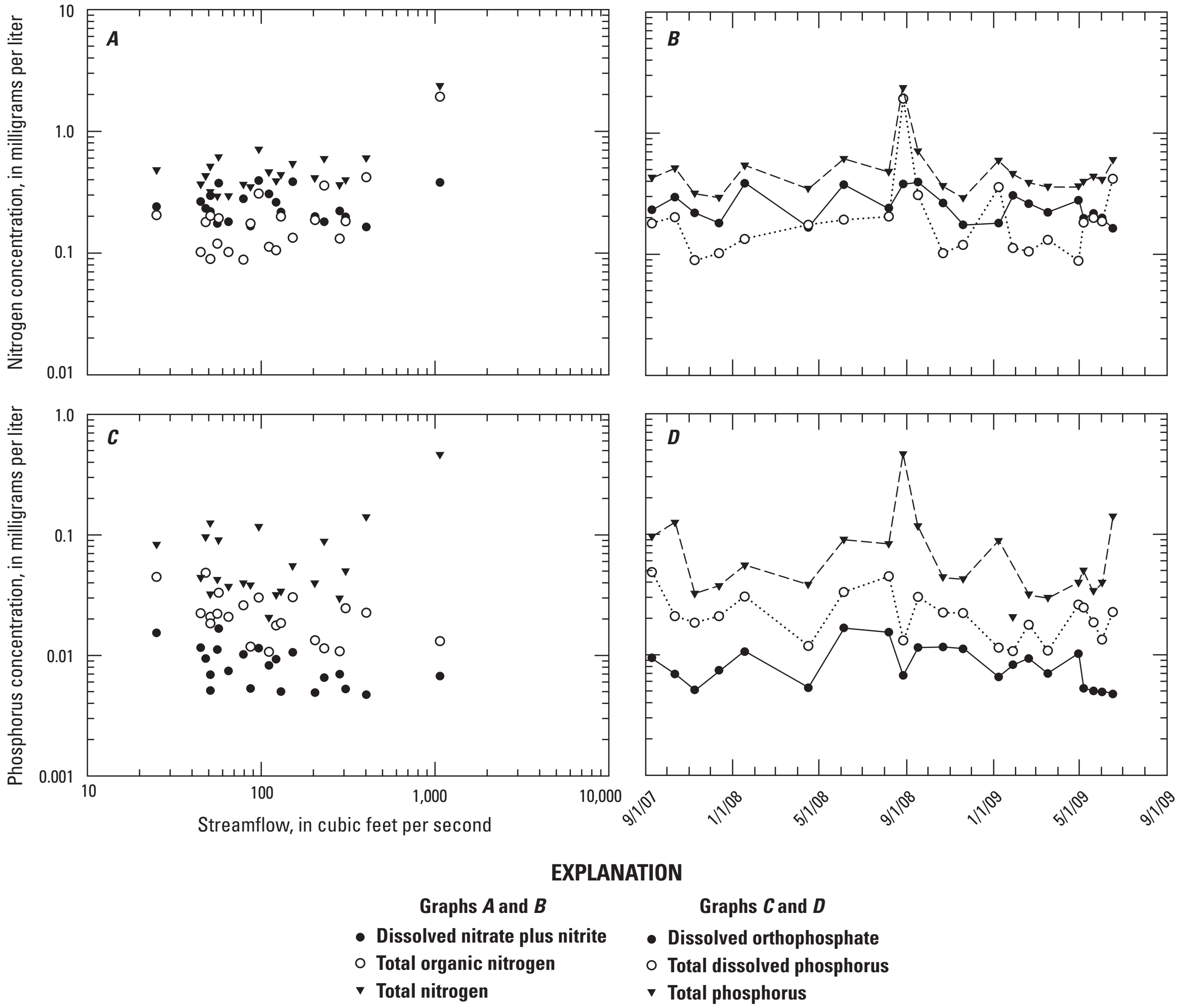


Figure 15. *(A)* Nitrogen species concentrations and streamflow, *(B)* nitrogen species concentrations and time, *(C)* phosphorus species concentrations and streamflow, and *(D)* phosphorus species concentrations and time for the Pacolet River at streamgaging station 02155500, September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

reported by Hoos and others (2008; table 3) and estimated annual total nitrogen load of 60,985 kg/yr reported by the U.S. Environmental Protection Agency (1976) for WY 1974 (table 2) are within the total nitrogen load range estimated in this investigation. Based on a comparison of annual mean streamflow at the NPAC and PAC sites, annual streamflow for WY 1974 probably was above long-term mean conditions at the SPAC site and much greater than the estimation period in this study, so higher loads would be expected (table 6; fig. 5). In this investigation, estimated annual dissolved phosphorus and orthophosphate loads also were similar at the SPAC site. Estimated annual dissolved phosphorus loads ranged from 177.6 to 522.9 kg/yr with a mean of 376.3 kg/yr (table 9; fig. 19). Estimated annual orthophosphate loads ranged from 172.3 to 517.1 kg/yr with a mean of 337.4 kg/yr (table 9; fig. 19). The range in annual loads of dissolved species of phosphorus was much lower than the estimated annual total phosphorus loads that ranged from 795.3 to 3,930 kg/yr (table 9; fig. 19). In this investigation, mean annual total phosphorus load at the SPAC site computed for the estimation period was 2,576 kg/yr (table 9), which was 18 percent lower than the long-term mean annual total phosphorus load of 3,048 kg/yr estimated by Hoos and others (2008). Estimated total phosphorus load at the SPAC site of 1,780 kg/yr for WY 1974 (table 2; U.S. Environmental Protection Agency, 1976) was within the total phosphorus load range, but was below the mean annual total phosphorus load in this study.

Estimated annual nutrient loads at the NPAC site were slightly higher than the estimated nutrient loads at the SPAC site. At the NPAC site, estimated annual dissolved nitrate plus nitrite had a mean of 32,500 kg/yr and ranged from 21,300 to 41,410 kg/yr for the estimation period (fig. 19; table 9). Estimated annual total organic nitrogen loads had a mean of 25,490 kg/yr and ranged from 10,700 to 35,510 kg/yr (fig. 19;

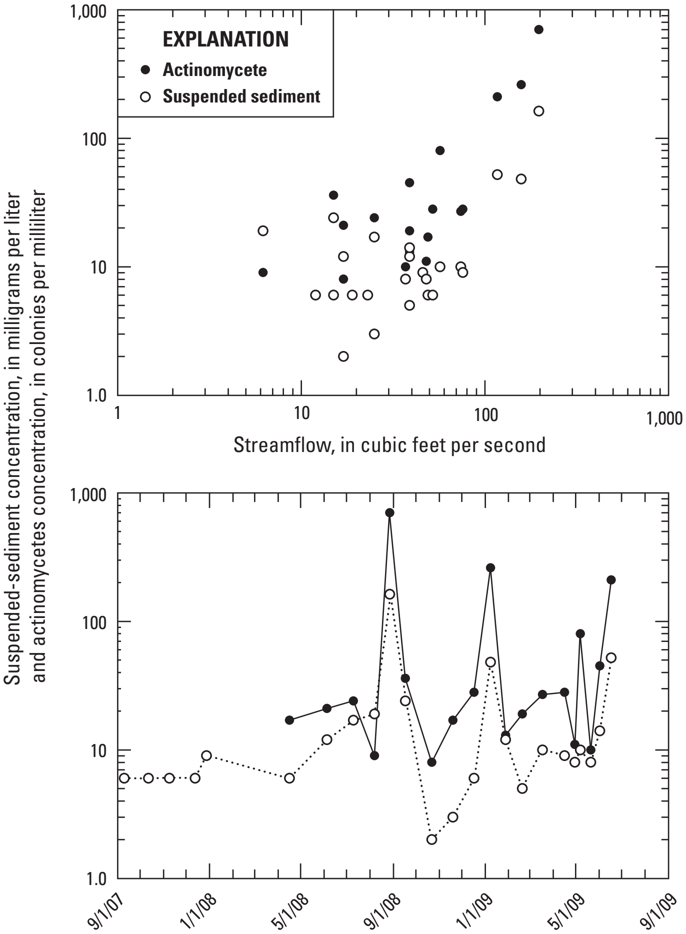


Figure 16. Relations between suspended-sediment and actinomycete concentrations and streamflow, and suspended-sediment concentrations and time for the South Pacolet River at streamgaging station 02154790 for September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

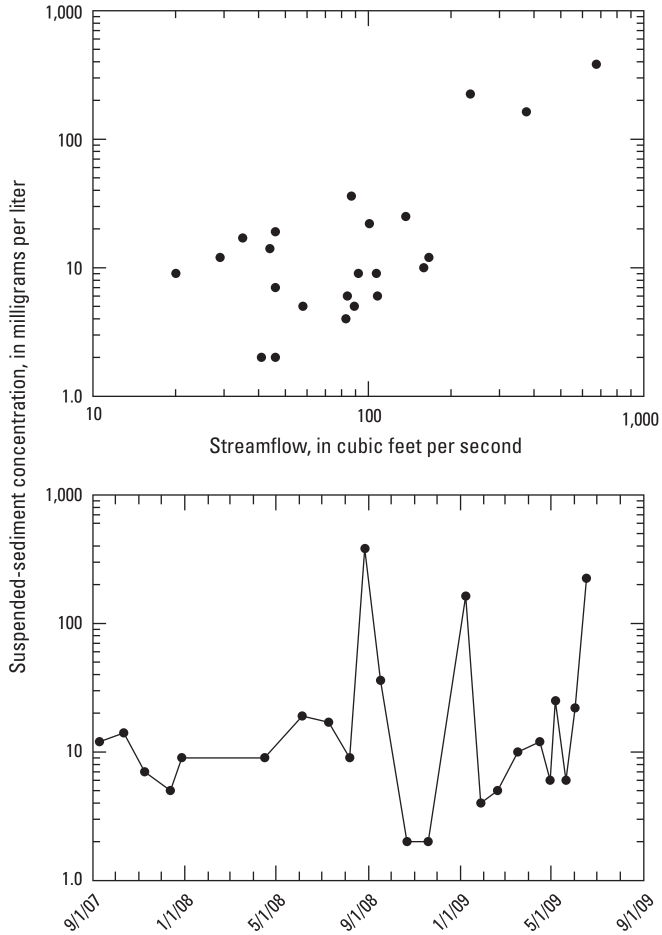


Figure 17. Relations between suspended-sediment concentrations and streamflow, and suspended-sediment concentrations and time for the North Pacolet River at streamgaging station 02154500 for September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

table 9). Dissolved nitrate plus nitrite appeared to contribute a slightly greater portion (mean of 51.7 percent) to the total nitrogen load than the total organic nitrogen (mean of 37.9 percent; table 9). The estimated annual loads for total nitrogen ranged from 34,180 to 98,140 kg/yr and had a mean of 65,890 kg/yr at the NPAC site for the estimation period (fig. 19; table 9). In previous investigations, the estimated long-term mean annual total nitrogen load at the NPAC site of 70,643 kg/yr reported by Hoos and others (2008; table 3) was within the total nitrogen load range and just 7 percent higher than the mean total nitrogen load estimated for this investigation. At the NPAC site, the range in estimated annual dissolved phosphorus loads was from 1,776 to 2,643 kg/yr, which was greater than the range for estimated annual dissolved orthophosphate of 772.3 to 1,213 kg/yr (table 9; fig. 19). Additionally, the estimated mean annual dissolved phosphorus load of 2,332 kg/yr was more than twice the estimated mean annual dissolved orthophosphate load of 1,039 kg/yr (table 9). The range in annual loads of dissolved species of phosphorus was much lower than the estimated annual total phosphorus loads that ranged from 4,512 to 12,690 kg/yr at the NPAC site (table 9; fig. 19). In this investigation, the mean annual total phosphorus load at the NPAC site computed for the estimation period was 9,404 kg/yr (table 9). Estimated long-term mean annual total phosphorus load at the NPAC site of 9,171 kg/yr reported by Hoos and others (2008; table 3) again was within the total phosphorus load range and was similar to the mean annual total phosphorus load estimated in this study.

At the PAC site, estimated annual dissolved nitrate plus nitrite and total organic nitrogen loads were similar. Estimated annual dissolved nitrate plus nitrite loads ranged from 22,510 to 46,790 kg/yr and had a mean of 36,970 kg/yr for the estimation period. Estimated annual total organic nitrogen loads ranged from 16,440 to 62,030 kg/yr and had a mean of 43,580 kg/yr (fig. 19; table 9). At the PAC site, annual dissolved nitrate plus nitrite and total organic nitrogen

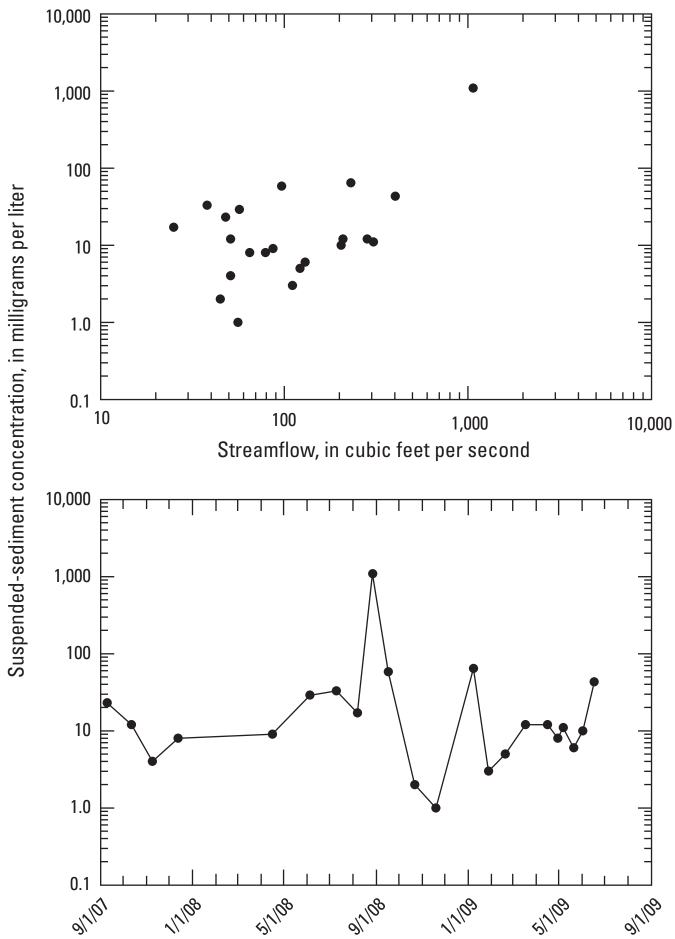


Figure 18. Relations between suspended-sediment concentrations and streamflow, and suspended-sediment concentrations and time for the Pacolet River at streamgaging station 02155500 for September 2007 to August 2009, Spartanburg County, South Carolina. (See fig. 2 for location.)

loads contributed relatively equal portions (mean of 40.7 and 43.7 percent, respectively) to the annual total nitrogen load (table 9). The estimated annual loads for total nitrogen ranged from 41,440 to 159,100 kg/yr and had a mean of 99,780 kg/yr at the PAC site for the estimation period (fig. 19; table 9). In previous investigations, estimated long-term mean annual total nitrogen load at the PAC site of 130,533 kg/yr reported by Hoos and others (2008; table 3) was within the total nitrogen load range and 31 percent higher than the mean annual total nitrogen load in this study. The range in the estimated annual dissolved phosphorus loads at the PAC site was from 1,769 to 2,945 kg/yr and, as was observed at the NPAC site, was greater than the range for estimated annual dissolved orthophosphate, which was 709.1 to 1,275 kg/yr (table 9; fig. 19). The range in annual loads of dissolved species of phosphorus was much lower than the estimated annual total phosphorus loads that ranged from 5,165 to 15,950 kg/yr (table 9; fig. 19). The mean annual total phosphorus load at the PAC site computed for the estimation period was 11,710 kg/yr (table 9). Estimated long-term total phosphorus load at the PAC site of 22,739 kg/yr reported by Hoos and others (2008; table 3) was above the total phosphorus load range and twice the mean annual total phosphorus load in this study.

Estimated annual nutrient loads at the PAC site included the estimated loads at the SPAC and NPAC sites (fig. 1). Nutrient loading from the intervening drainage area (PAC$_i$ subbasin) was computed to provide the contribution from the minor tributaries, shoreline drainages, and releases or outflows from Lake Bowen and Reservoir #1 (fig. 19; table 9). The PAC$_i$ subbasin (10,515 ha) represented about 19 percent of the total drainage area within the PAC basin (54,908 ha). Assuming all influencing factors were constant, expected positive gains in annual nutrient loads in the PAC$_i$ subbasin would be about the same percentage; however, that assumption was not corroborated by the computed annual nutrient loads for the PAC$_i$ subbasin. Except for annual total organic nitrogen loads, annual nutrient loads computed for the PAC$_i$ subbasin were frequently negative, indicating negligible contributions or potential overall loss of constituents within that intervening drainage area (table 9). Notwithstanding, inherent error in the load estimation process produced a relatively high degree of uncertainty (for some models at higher flow conditions, error was greater than 100 percent) in the computed and estimated annual nutrient loads (Appendix 4-A). Therefore, only qualitative assessments can be made.

For the PAC$_i$ subbasin, estimated annual loads of total organic nitrogen ranged from 1,455 to 8,063 kg/yr, total nitrogen ranged from –7,210 to 3,780 kg/yr, dissolved phosphorus ranged from –247.7 to –35.31 kg/yr, and total phosphorus ranged from –833.2 to 578.5 kg/yr (fig. 19; table 9). In general, computed PAC$_i$ loads for the above constituents were less than ± 10 percent of the total estimated annual load at the PAC site, so nutrient contributions by the intervening drainage area probably are negligible (table 10). Computed annual dissolved nitrate plus nitrite loads in the PAC$_i$ subbasin were consistently negative for WY 2006–2009, ranging from –14,590 to –6,569 kg/yr or –18 to –33 percent of the estimated annual load at the PAC site (fig. 19; tables 9, 10). Similar patterns were observed for computed annual dissolved orthophosphate loads in the PAC$_i$ subbasin, ranging from –235.5 and –455.3 kg/yr or –24 to –36 percent of the estimated annual load at the PAC site (fig. 19; tables 9, 10).

Dissolved nitrate plus nitrite and orthophosphate were described earlier as the most bioavailable forms of nutrients for algal uptake. Therefore, algal uptake in Lake Bowen and Reservoir #1 was considered a possible explanation for the potential loss of these constituents in this intervening area. This is a reasonable assumption because the South Pacolet River downstream from the SPAC site encompasses 90 percent of the PAC$_i$ subbasin and includes Lake Bowen and Reservoir #1 (fig. 1). Because the PAC site was located just 322 m (0.2 mi) downstream from the confluence of the NPAC, it also can be assumed that the full estimated nutrient loads from the NPAC site were included in the estimated nutrient loads at the

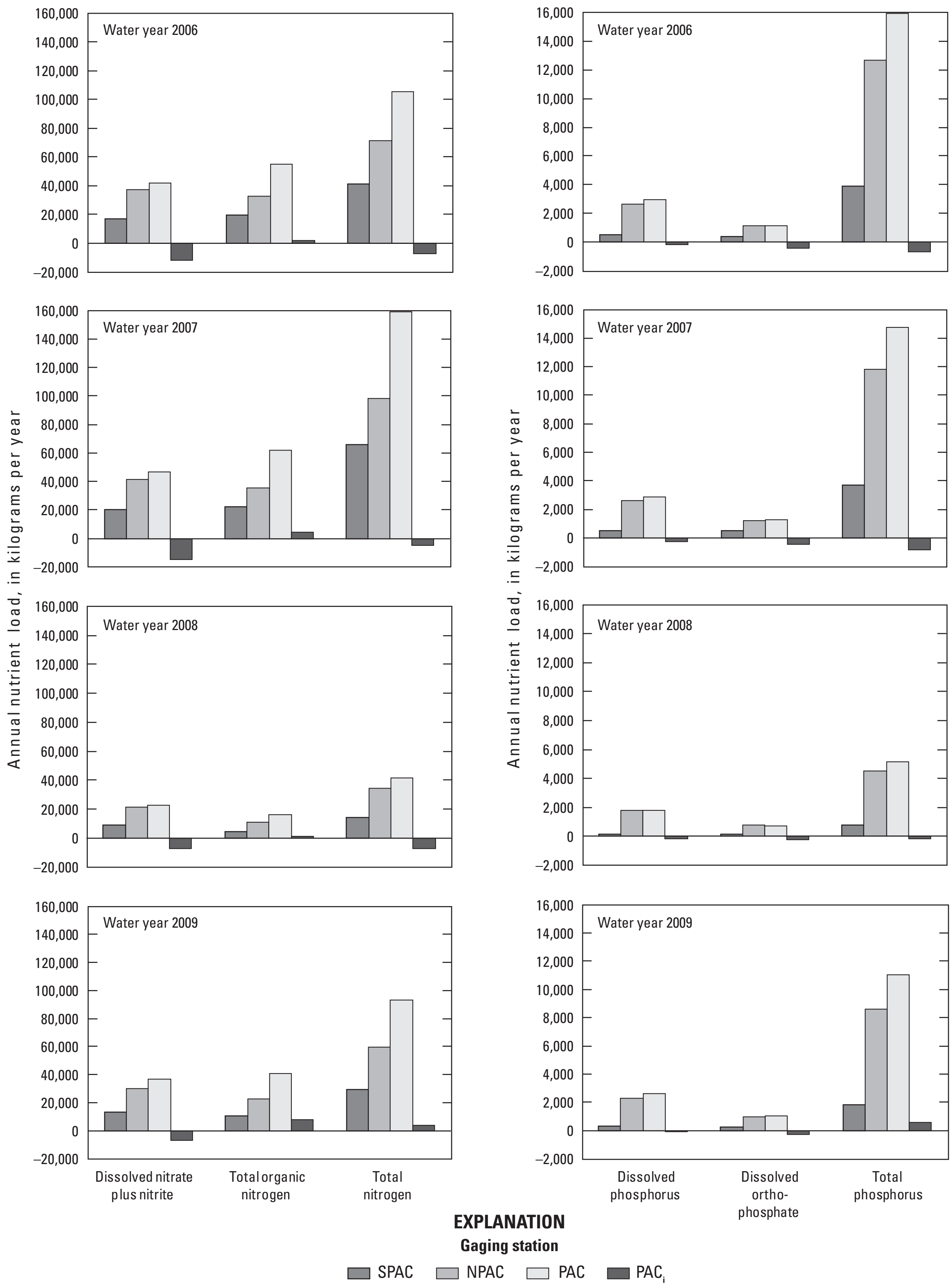


Figure 19. Estimated annual nutrient loads at the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and the intervening basin from the Pacolet River streamgaging station to the North and South Pacolet River streamgaging stations (PAC$_i$), Spartanburg County, South Carolina, water years 2006–2009. (See fig. 2 for locations.)

Table 10. Percentages of the computed annual nutrient loads at the intervening basin from the Pacolet River streamgaging station upstream from the North and South Pacolet River streamgaging stations (PAC_i) as compared to the estimated nutrient loads at the Pacolet River at streamgaging station 02155500 (PAC) and at the South Pacolet River at streamgaging station 02154500, Spartanburg County, South Carolina, water years 2006–2009.

[WY, water year]

Annual load	Computed annual nutrient loads at the PAC_i site (tables 1, 9)						
	Dissolved nitrate plus nitrite	Total organic nitrogen	Total nitrogen	Dissolved phosphorus	Dissolved orthophosphate	Total phosphorus	Suspended sediment
	Percentage of load at the PAC site (tables 1, 11)						
WY 2006	–28	3.6	–6.8	–6.4	–35	–0.4	–248
WY 2007	–31	6.9	–3.2	–8.7	–36	–5.7	–852
WY 2008	–33	8.9	–17	–10	–33	–2.8	–24
WY 2009	–18	20	4.1	–1.4	–24	5.2	–86
Mean annual	–27	9.0	–3.9	–6.4	–32	–2.3	–375
	Percentage of load at the SPAC site (tables 1, 9)						
WY 2006	–71	9.9	–18	–38	–105	–17	–109
WY 2007	–73	20	–7.6	–47	–88	–22	–122
WY 2008	–86	34	49	–104	–137	–18	–81
WY 2009	–50	78	13	–11	–90	–31	–87
Mean annual	–69	28	–10	–44	–99	–10	–116

PAC site (fig. 1). Therefore, the apparent loss of annual nutrient load within the PAC_i subbasin can be attributed totally to the loss of annual nutrient load delivered by the SPAC site, not by the NPAC site.

Based on the above assumptions, the PAC_i subbasin demonstrated dramatic losses in dissolved nitrate plus nitrite and orthophosphate loads when compared to the delivered loads from the SPAC site. Computed annual dissolved nitrate plus nitrite loads in the PAC_i subbasin exhibited a –50 to –86 percent loss in estimated annual dissolved nitrate plus nitrite load from the SPAC site (table 10). With respect to computed annual dissolved orthophosphate loads in the PAC_i subbasin, an almost complete loss in the estimated annual load delivered to Lake Bowen and Reservoir #1 from the SPAC site was indicated. The computed losses in annual dissolved orthophosphate loads in the PAC_i subbasin ranged from –88 to –137 percent relative to the SPAC site (table 10).

A substantial amount of suspended sediment was contributed annually by the basins of the three sites. Estimated annual suspended-sediment loads ranged from 616,200 to 55,240,000 kg/yr at the SPAC site, from 1,949,000 to 20,110,000 kg/yr at the NPAC site, and from 2,068,000 to 10,020,000 kg/yr at the PAC sites (table 9). The SPAC site had the highest mean annual suspended-sediment load of 21,190,000 kg/yr, followed by the NPAC at 9,895,000 kg/yr and the PAC site at 6,547,000 kg/yr (table 9). As was observed for some of the annual nutrient loads in the PAC_i subbasin, computed annual suspended-sediment loads were consistently negative, ranging from –497,600 to –67,440,000 kg/yr (table 9) and from an 81 to 122 percent loss in annual suspended-sediment load delivered by the SPAC site (table 10). Sedimentation processes in Lake Bowen and Reservoir #1 were the most likely explanations for these apparent losses.

Annual nutrient and sediment yields were computed by dividing the estimated annual nutrient or sediment load, in kilograms per day, by the drainage area, in hectares, at a site (table 9). This procedure provided a normalized load per unit area with which to compare nutrient and sediment contributions among sites. The computed nutrient and sediment yields were averaged over the estimation period (WY 2006–2009) to obtain mean annual yields. Four generalizations can be made about the estimated annual nutrient yields that relate to all three sites (SPAC, NPAC, and PAC; table 9):

1. Spatially, annual total phosphorus, dissolved phosphorus, and dissolved orthophosphate yields were highest at the NPAC site and lowest at the SPAC site, indicating a greater contribution of phosphorus from land-use activities in the NPAC basin than in the SPAC basin.

2. Spatially, annual dissolved nitrate plus nitrite, total organic nitrogen, and total nitrogen yields were similar between the SPAC and NPAC sites and slightly lower at the PAC site, indicating similar contributions of nitrogen from land-use activities in the SPAC and NPAC basins.

3. Temporally, minimum annual nutrient yields for the estimation period (WY 2006–2009) were observed during WY 2008.

4. Estimated dissolved phosphorus and orthophosphate yields frequently were an order of magnitude less than the estimated total phosphorus yields, suggesting greater contributions from the particulate or sediment-bound forms of phosphorus.

At the SPAC site, estimated annual dissolved nitrate plus nitrite and total organic nitrogen yields ranged from 0.609 to 1.39 kilograms per hectare per year [(kg/ha)/yr] and 0.298 to 1.55 (kg/ha)/yr, respectively (table 9). The estimated annual yields for total nitrogen ranged from 0.994 to 4.60 (kg/ha/yr with a mean of 2.63 (kg/ha)/yr at the SPAC site for the estimation period (table 9). Estimated long-term total nitrogen yield at the SPAC site of 2.8 (kg/ha)/yr (table 3; Hoos and others, 2008) and 4.2 (kg/ha)/yr for WY 1974 (table 2; U.S. Environmental Protection Agency, 1976) were within the total nitrogen yield range and were above the mean annual total nitrogen yield in this study. Estimated annual dissolved phosphorus and orthophosphate yields were similar at the SPAC site for the estimation period. Estimated annual dissolved phosphorus yields ranged from 0.0124 to 0.0364 (kg/ha)/yr, and estimated annual dissolved orthophosphate yields ranged from 0.0120 to 0.0360 (kg/ha)/yr (table 9). The range in annual loads of dissolved species of phosphorus was much lower than the estimated annual total phosphorus loads that ranged from 0.0554 to 0.274 (kg/ha)/yr (table 9). The mean annual total phosphorus yield at the SPAC site computed for the estimation period was 0.180 (kg/ha)/yr (table 9). Long-term mean annual total phosphorus yield was 0.21 kg/ha-yr (Hoos and others, 2008; table 3), and estimated annual total phosphorus load at the SPAC site for WY 1974 was 0.123 (kg/ha)/yr (table 2; U.S. Environmental Protection Agency, 1976).

At the NPAC site, estimated annual dissolved nitrate plus nitrite and total organic nitrogen yields ranged from 0.709 to 1.38 and 0.356 to 1.18 (kg/ha)/yr, respectively (table 9). The estimated annual yields for total nitrogen ranged from 1.14 to 3.27 (kg/ha)/yr with a mean of 2.19 (kg/ha)/yr in this study (fig. 19; table 9). Estimated long-term mean annual total nitrogen yield at the NPAC site of 2.4 (kg/ha)/yr (table 3; Hoos and others, 2008) was within the total nitrogen yield range and similar to the mean annual total nitrogen yield in this study. The range in estimated annual dissolved phosphorus yields was from 0.0591 to 0.0880 (kg/ha)/yr, which was twice the range for estimated annual dissolved orthophosphate of 0.0257 to 0.0404 (kg/ha)/yr at the NPAC site (table 9). The range in annual yields of dissolved species of phosphorus was much lower than the estimated annual total phosphorus yields that ranged from 0.150 to 0.422 (kg/ha)/yr (table 9). The mean annual total phosphorus yield at the NPAC site computed for the estimation period was 0.313 (kg/ha)/yr (table 9), which was equal to the long-term annual total phosphorus yield of 0.31 (kg/ha)/yr reported by Hoos and others (2008; table 3).

At the PAC site, estimated annual dissolved nitrate plus nitrite and total organic nitrogen yields ranged from 0.410 to 0.852 (kg/ha)/yr and from 0.299 to 1.13 (kg/ha)/yr, respectively (table 9). The estimated annual yields for total nitrogen ranged from 0.755 to 2.90 (kg/ha)/yr with a mean of 1.82 (kg/ha)/yr in this study (table 9). Estimated long-term total nitrogen yield at the PAC site of 2.4 (kg/ha)/yr (table 3; Hoos and others, 2008) was within the annual total nitrogen yield range but greater than the mean annual total nitrogen yield in this study. The range in the estimated annual dissolved phosphorus yields at the PAC site was from 0.0322 to 0.0536 (kg/ha)/yr, which was two times the range for estimated annual dissolved orthophosphate of 0.0129 to 0.0232 (kg/ha)/yr (table 9). The range in annual yields of dissolved species of phosphorus was much lower than the estimated annual total phosphorus yields that ranged from 0.0941 to 0.290 (kg/ha)/yr (table 9). The mean annual total phosphorus yield at the PAC site computed for the estimation period was 0.213 (kg/ha)/yr (table 9), which was about half of the long-term mean annual total phosphorus yield of 0.41 (kg/ha)/yr reported by Hoos and others (2008; table 3).

In the PAC_i subbasin, computed annual yields of total organic nitrogen ranged from 0.138 to 0.767 (kg/ha)/yr; total nitrogen ranged from –0.686 to 0.359 (kg/ha)/yr; dissolved phosphorus ranged from –0.0236 to –0.0034 (kg/ha)/yr; and total phosphorus ranged from –0.0792 to 0.0550 (kg/ha)/yr (table 9). Mean annual yields for total phosphorus of –0.0253 (kg/ha)/yr and total nitrogen of –0.368 (kg/ha)/yr in the PAC_i subbasin indicated negligible contributions or potential losses of these nutrients in this intervening subbasin. In general, computed PAC_i yields probably reflected negligible nutrient contributions by the intervening drainage area (table 9). Computed annual dissolved nitrate plus nitrite yields in the PAC_i subbasin were consistently negative for the estimation period, ranging from –1.39 to –0.625 (kg/ha)/yr (table 9). Similar patterns were observed for computed annual dissolved orthophosphate yields in the PAC_i subbasin, ranging from –0.0433 to –0.0224 (kg/ha)/yr (table 9).

The SPAC, NPAC, and PAC basins contributed substantial amounts of suspended sediment during the period of this investigation. In addition, the SPAC basin contributed more than 4 times the suspended sediment per hectare than the other two basins. Estimated annual suspended-sediment yields ranged from 42.9 to 3,850 (kg/ha)/yr at the SPAC site, from 64.9 to 669 (kg/ha)/yr at the NPAC site, and from 37.7 to 182 (kg/ha)/yr at the PAC sites (table 9). The SPAC site had a mean annual suspended-sediment yield of 1,480 (kg/ha)/yr, followed by the NPAC at 329 (kg/ha)/yr and the PAC site at 119 (kg/ha)/yr, indicating a much greater sediment delivery by land-use activities in the SPAC basin (table 9). As was observed for some of the annual nutrient yields in the PAC_i subbasin, computed annual suspended-sediment yields were consistently negative, ranging from –6,410 to –47.3 (kg/ha)/yr (table 9).

Estimated seasonal loads and fluxes of dissolved nitrate plus nitrite, dissolved phosphorus, dissolved orthophosphate, total organic nitrogen, total nitrogen, total phosphorus, and suspended sediment for the SPAC, NPAC, and PAC sites were compiled and tabulated (Appendix 4-B). Additionally, seasonal loads were computed for the PAC_i subbasin (Appendix 4-B). The estimated total phosphorus, total organic nitrogen, dissolved orthophosphate, and dissolved nitrate plus nitrite seasonal flux (seasonal loads normalized to kilograms per day [kg/d]) were compared among the SPAC, NPAC, and PAC sites (fig. 20) and the PAC_i subbasin (fig. 21).

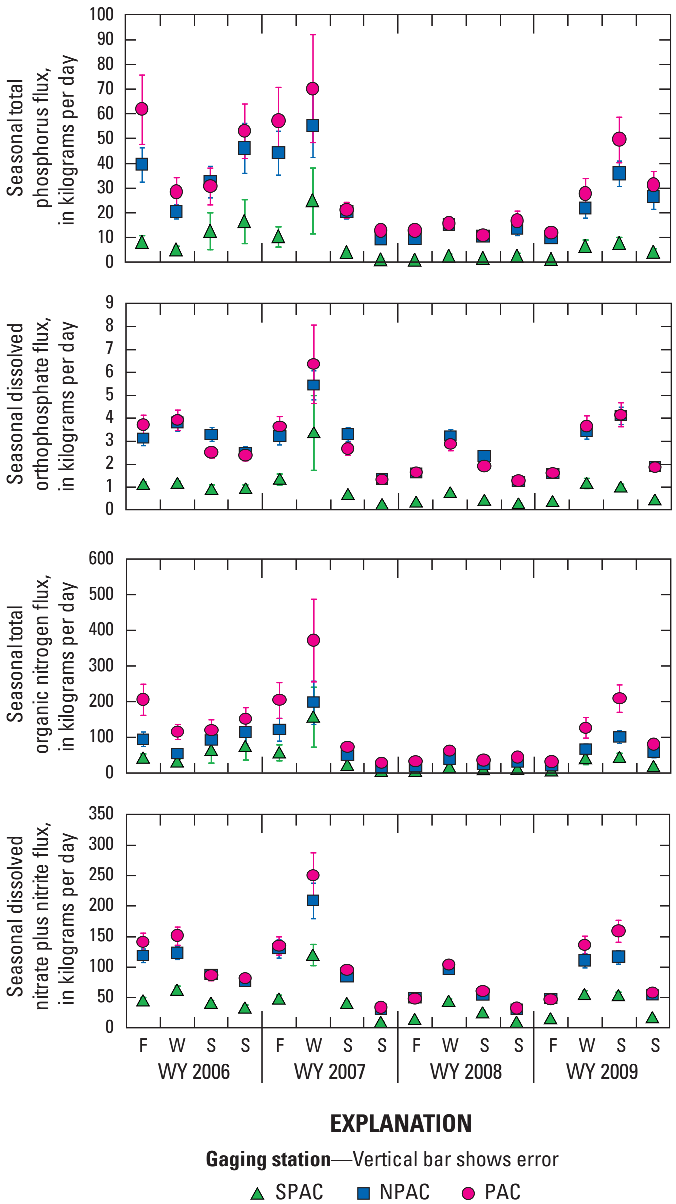


Figure 20. Estimated seasonal nutrient flux and standard error of prediction (SEP) at the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and Pacolet River at streamgaging station 02155500 (PAC), water years 2006–2009, Spartanburg County, South Carolina. (See fig. 2 for locations.)

Estimated seasonal fluxes of total phosphorus, dissolved orthophosphate, and dissolved nitrate plus nitrite at the NPAC site tracked closely with an almost one-to-one correspondence with the same fluxes at the PAC site. For all nutrients, NPAC and PAC sites had higher seasonal fluxes than those at the SPAC site (fig. 20; Appendix 4-B). The total organic nitrogen seasonal flux had a similar temporal pattern as the total phosphorus seasonal flux (fig. 20; Appendix 4-B). At all three sites, a large degree of seasonal variation was observed in the estimated seasonal flux for dissolved orthophosphate and dissolved nitrate plus nitrite as compared to total phosphorus and total organic nitrogen (fig. 20; Appendix 4-B). The winter season tended to have the highest fluxes of these two bioavailable constituents (fig. 20; Appendix 4-B). In contrast, the lowest fluxes were observed during the summer and fall seasons for each water year, when biological uptake would be expected to peak (fig. 20; Appendix 4-B). It should be noted that seasonal explanatory variables were included in the load estimation models at all sites for total phosphorus and total organic nitrogen (tables 8, 4); however, the temporal patterns for these constituents were influenced by streamflow conditions and seasonal processes.

Seasonal fluxes of total phosphorus, total organic nitrogen, dissolved orthophosphate, and dissolved nitrate plus nitrite in the PAC_i subbasin displayed quite different seasonal patterns than observed at the SPAC, NPAC, and PAC sites (fig. 21; Appendix C-2). No strong seasonal pattern was identified for total phosphorus and total organic nitrogen seasonal flux in the PAC_i subbasin. Overall, seasonal patterns for all constituents in the PAC_i subbasin appeared to be opposite to the patterns observed at the SPAC site for the same constituent (figs. 20, 21; Appendix 4-B). In the PAC_i subbasin, the greatest degree of seasonal variation was observed in the estimated seasonal flux for dissolved orthophosphate and dissolved nitrate plus nitrite as compared to total phosphorus and total organic nitrogen (fig. 21; Appendix 4-B). Winter and spring seasons, however, tended to have the lowest fluxes of these two bioavailable constituents (fig. 21; Appendix 4-B). In contrast, the highest fluxes were observed during the summer and fall seasons for each water year, when biological uptake would be expected to peak (fig. 21; Appendix 4-B).

In the PAC_i subbasin for each water year, seasonal total phosphorus flux, as the percentage of the SPAC seasonal flux, tended to be at its lowest in the spring and at its highest in the fall, except for spring 2009 (fig. 21; Appendix 4-B). Additionally, the higher fall flux of total phosphorus generally was positive and indicated an overall gain in total phosphorus in the PAC_i subbasin frequently greater than 50 percent of the SPAC seasonal flux (fig. 21; Appendix 4-B). The lower spring flux was always about –100 percent, indicating a nearly complete loss of total phosphorus of the SPAC seasonal flux (fig. 21; Appendix 4-B). A seasonal pattern similar to total phosphorus also was observed in the dissolved orthophosphate seasonal flux, except that dissolved orthophosphate seasonal flux in the PAC_i subbasin ranged from about –200 percent in the spring to about –50 percent in the fall, suggesting continuous loss of this

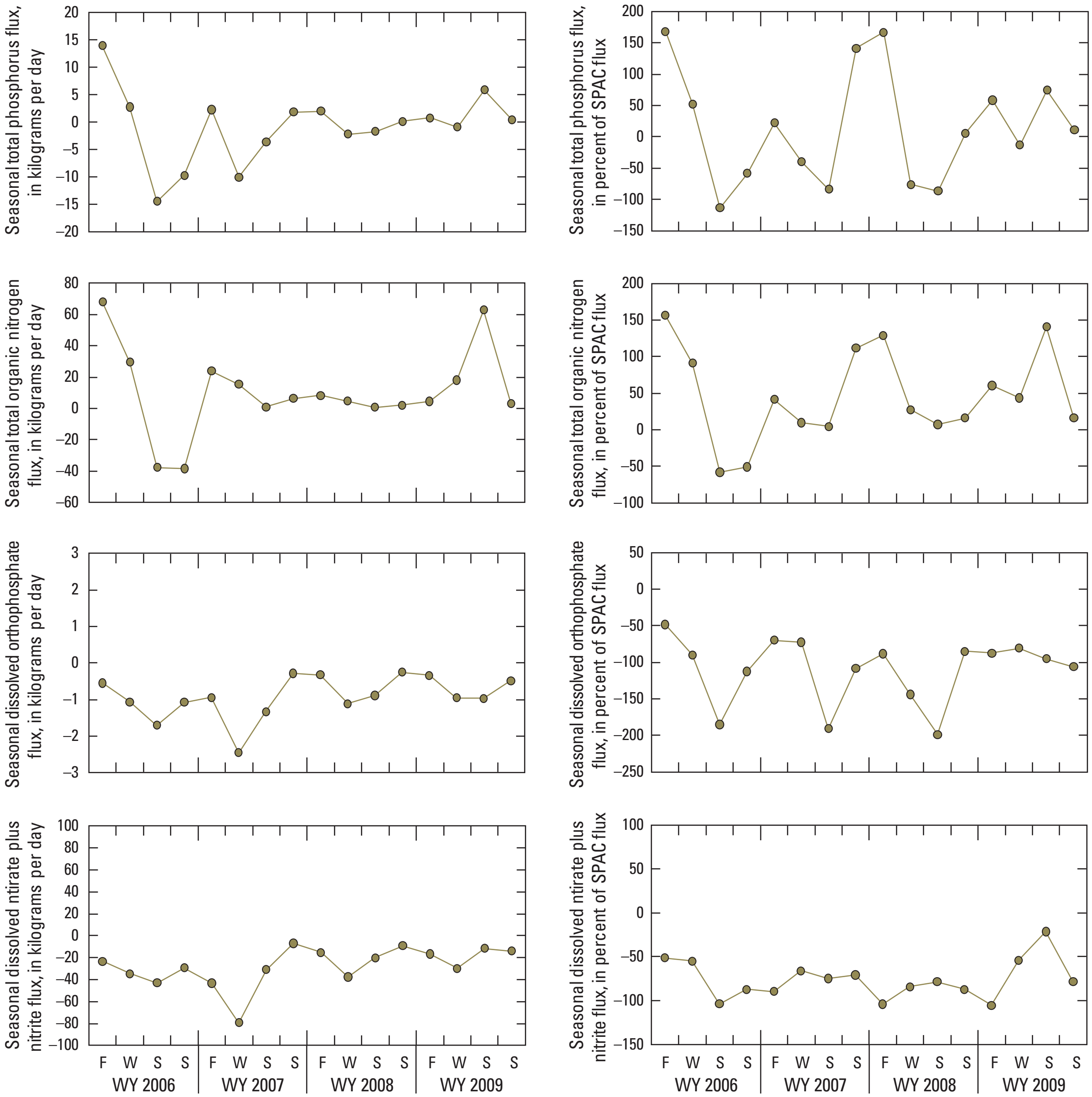


Figure 21. Computed seasonal nutrient flux in the intervening basin (PAC_i) from the Pacolet River at streamgaging station 02155500 upstream to the South and North Pacolet River at streamgaging stations 02154790 (SPAC) and 02154500 (NPAC), respectively, water years 2006–2009, Spartanburg County, South Carolina. (See fig. 2 for locations.)

dissolved orthophosphate year round (fig. 21; Appendix 4-B). Seasonal fluxes of total organic nitrogen tended to exhibit a positive gain throughout all seasons, except for spring and summer of WY 2006, and included peaks in the fall and lows in the spring (fig. 21; Appendix 4-B). In the PAC_i subbasin for each water year, the dissolved nitrate plus nitrite seasonal flux, as the percentage of SPAC seasonal flux, was consistently negative and tended to be at its lowest in the fall (exception in spring 2006), demonstrating an almost complete loss of dissolved nitrate plus nitrite from the seasonal contribution by the SPAC site in the fall (fig. 21; Appendix 4-B). The least amount of loss of dissolved nitrate plus nitrite flux in this subbasin tended to be during the spring and summer seasons (fig. 21; Appendix 4-B).

Large ranges and standard errors of predictions (SEP) existed for the seasonal flux of suspended sediment at the SPAC, NPAC, and PAC sites, especially during periods of relatively high streamflow (spring 2006, summer 2006, and winter 2007; fig. 22). No strong seasonal pattern was observed for suspended-sediment flux, and the pattern displayed was reflective of that observed for total phosphorus at these sites (figs. 21, 22). Because of the high SEP, it was difficult to determine if the SPAC site had higher or similar seasonal suspended-sediment flux as compared to the NPAC and PAC sites (fig. 22). Within the PAC_i subbasin, seasonal suspended-sediment flux exhibited some gains during fall 2006, spring to fall 2007, spring 2008, and spring 2009 when compared to loads at the SPAC site. During the remaining seasons, the PAC_i subbasin demonstrated a nearly complete loss of the suspended-sediment flux at the SPAC site. Because the large SEP in suspended-sediment flux estimation for the SPAC site prevented accurate quantification, the seasonal suspended-sediment flux pattern exhibited by the PAC_i subbasin only suggested that Lake Bowen and Reservoir #1 could have served as a major sediment retention structure for the suspended sediment that was delivered by the SPAC site and other nearby tributaries (fig. 22).

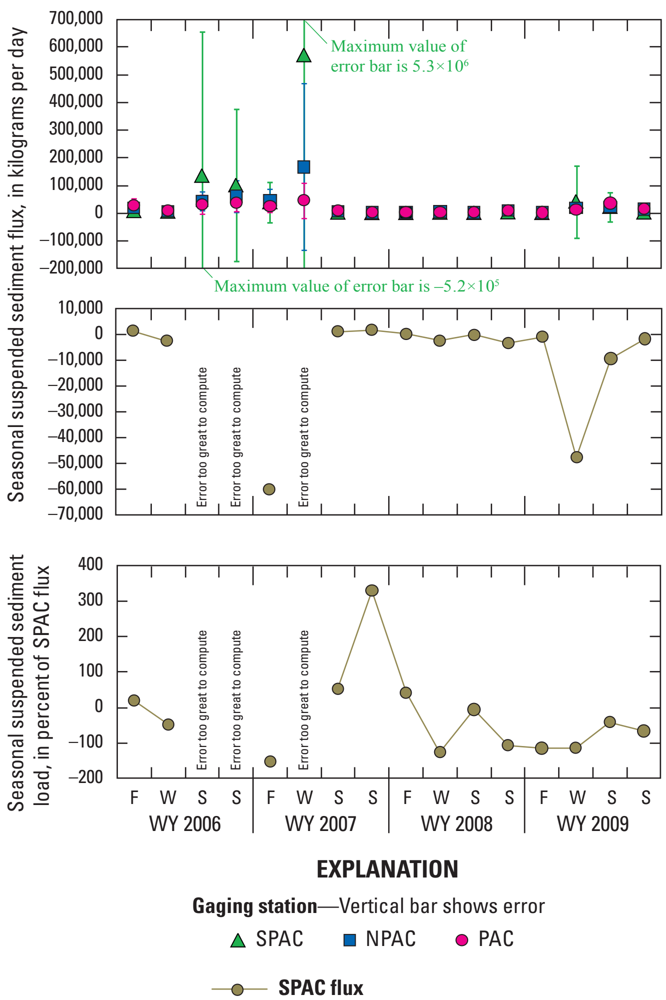


Figure 22. Computed seasonal suspended-sediment flux and standard error of prediction (SEP) at the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and Pacolet River at streamgaging station 02155500 (PAC) and in the intervening basin (PAC_i) from the PAC site upstream to the NPAC and SPAC sites, water years 2006–2009, Spartanburg County, South Carolina. (See fig. 2 for locations.)

Instantaneous Loads and Yields at Synoptic Sites

Eight synoptic tributary sites located within the PAC_i subbasin were sampled during high-flow conditions on November 13 and 14, 2008, and samples were analyzed for suspended sediment (tables 1, 11; fig. 2). The results of this synoptic sampling event were used to compare suspended-sediment contributions among major and minor tributary sites near Lake Bowen and Reservoir #1. The peak streamflow at the SPAC site for this high-flow event was 31 ft^3/s on November 13, 2008. Although this sampling event was indicative of runoff conditions, the peak streamflow during this event was equaled or exceeded about 90 percent of the time during the period of record at the SPAC site (fig. 6). Two of the eight synoptic sites (S-1, S-8) were visited but not sampled because the streams were dry at the time of sampling (table 11). Therefore, the instantaneous load and yield for sites S-1 and S-8 were considered to be zero for this sampling event (table 11). The other synoptic sites had instantaneous suspended-sediment loads that ranged from 10.4 (S-6) to 804 (S-3) kg/d (table 11). Suspended-sediment yields ranged from 17.7 (S-6) to 5,856 (S-3) kg/d (table 11).

The same eight sites were re-visited during a runoff event on August 5, 2009, and samples were collected for suspended sediment and nutrient analysis. Concurrently, a sample was collected at the SPAC site and analyzed for the same constituents as the synoptic sites. The peak streamflow at the SPAC site for this high-flow event was 39.1 ft^3/s, and the SPAC site was sampled near the peak when streamflow was 37 ft^3/s. Although this sampling event was indicative of runoff conditions, the peak streamflow during this event was equaled or exceeded about 80 percent of the time during the period of record at the SPAC site (fig. 6). Instantaneous loads and yields were estimated for suspended sediment, dissolved nitrate plus nitrite, dissolved ammonia, total organic nitrogen, dissolved orthophosphate, and total phosphorus (table 11). Two of the eight synoptic sites (S-1, S-8) were visited but not sampled because the streams were dry at the time of sampling (table 11). Therefore, the instantaneous load and yield for sites S-1 and S-8 for this sampling event were considered to be zero (table 11). For instantaneous nutrient loads, South Pacolet River consistently contributed the largest proportion of nutrients and suspended sediment to Lake Bowen and Reservoir #1 during the synoptic period of August 5, 2009 (fig. 21). During this high-flow event, the SPAC site contributed 93, 84, 92, 93, 86, and 88 percent of the cumulative total phosphorus, dissolved nitrate plus nitrite, total organic nitrogen, dissolved ammonia, suspended sediment, and total nitrogen loads, respectively, computed for the event (fig. 23). Results of the August 2009 synoptic sampling event indicated that the SPAC basin contributed the majority of nutrient load to Lake Bowen when compared to the minor tributary and shoreline drainages. These synoptic sampling events, however, did not capture streamflows that represented median or higher streamflow conditions (greater than 70 ft^3/s; fig. 6), so the computed percentage contributions should be considered qualitative.

Table 11. Computed instantaneous nutrient and sediment loads and yields at eight synoptic sites along Lake William C. Bowen and Municipal Reservoir #1 within the Pacolet River Basin (PAC$_i$) and at the South Pacolet River streamgaging station 02154790 (SPAC), Spartanburg County, South Carolina, November 2008 and August 2009.

[USGS, U.S. Geological Survey; ft³/s, cubic feet per second; nd, not determined; values in bold, estimated from the LOADEST regression model; E, estimated; <, less than]

USGS station number	USGS station name	Map identification (fig. 2)	Date of sample	Drainage area (hectares)	Streamflow (ft³/s)	Instantaneous loads, in kilograms per day							Instantaneous yields, in grams per hectare per day						
						Suspended sediment	Dissolved ammonia	Nitrate plus nitrite	Total organic nitrogen	Dissolved orthophosphate	Total phosphorus	Total nitrogen	Suspended sediment	Dissolved ammonia	Nitrate plus nitrite	Total organic nitrogen	Dissolved orthophosphate	Total phosphorus	Total nitrogen
November 2008 synoptic sampling event																			
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	S-1	11/13/08	44.0	Dry	0	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	nd	nd	nd
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	S-2	11/13/08	126.9	1.73	533	nd	nd	nd	nd	nd	nd	4,203	nd	nd	nd	nd	nd	nd
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	S-3	11/13/08	137.3	1.06	804	nd	nd	nd	nd	nd	nd	5,856	nd	nd	nd	nd	nd	nd
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	S-4	11/13/08	1,028	1.52	26.0	nd	nd	nd	nd	nd	nd	25.3	nd	nd	nd	nd	nd	nd
3507300820702	Alexander Creek at Page Road near Campobello, SC	S-5A	11/13/08	1,049	2.68	190	nd	nd	nd	nd	nd	nd	181	nd	nd	nd	nd	nd	nd
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	S-6	11/14/08	585.3	1.06	10.4	nd	nd	nd	nd	nd	nd	17.7	nd	nd	nd	nd	nd	nd
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	S-7	11/14/08	15.5	0.10	41.1	nd	nd	nd	nd	nd	nd	2,652	nd	nd	nd	nd	nd	nd
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	S-8	11/14/08	5.18	Dry	0	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	nd	nd	nd
02154790	South Pacolet River near Campobello, SC	SPAC	11/14/08	14,403	**28.0**	**1,526**	nd	nd	nd	nd	nd	nd	**106**	nd	nd	nd	nd	nd	nd
August 2009 synoptic sampling event																			
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	S-1	8/5/09	44.0	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	S-2	8/5/09	126.9	0.26	5.09	E0.013	0.166	E0.003	E0.004	E0.003	0.182	40.1	E0.099	1.31	E0.025	E0.035	E0.022	1.43
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	S-3	8/5/09	137.3	0.34	9.15	<0.017	0.812	0.059	E0.005	0.012	0.871	66.7	<0.121	5.91	0.432	E0.040	0.084	6.34
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	S-4	8/5/09	1,028	1.61	15.8	0.249	1.16	0.292	E0.017	E0.024	1.70	15.3	0.243	1.12	0.284	E0.017	E0.023	1.65
3507300820702	Alexander Creek at Page Road near Campobello, SC	S-5A	8/5/09	1,049	2.24	98.7	0.294	1.24	0.948	E0.037	0.130	2.48	94.1	0.280	1.18	0.904	E0.036	0.124	2.36
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	S-6	8/5/09	585.3	0.34	28.3	0.021	0.180	0.119	<0.007	0.016	0.320	48.3	0.036	0.308	0.203	<0.011	0.027	0.547
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	S-7	8/5/09	15.5	0.03	0.881	0.002	0.015	0.018	E0.000	0.013	0.035	56.8	0.149	0.959	1.15	E0.028	0.850	2.26
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	S-8	8/5/09	5.18	Dry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02154790	South Pacolet River near Campobello, SC	SPAC	8/5/09	14,403	37	**1,030**	2.96	19.0	17.5	E0.414	2.72	39.4	71.5	0.205	1.32	1.21	E0.029	0.189	2.73

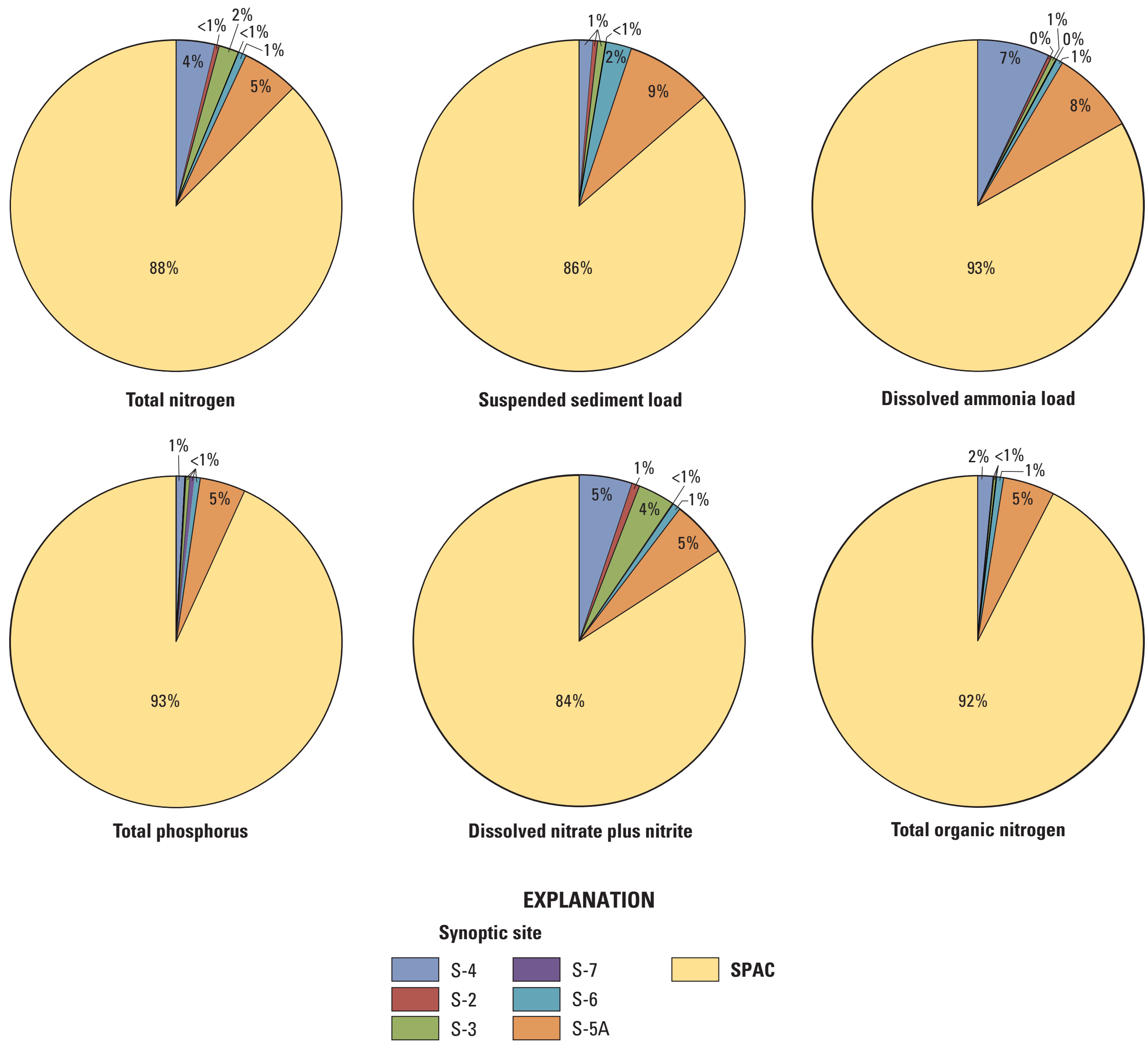


Figure 23. Comparison of instantaneous nutrient and sediment loads at six synoptic sites near Lake William C. Bowen and Municipal Reservoir #1 within the Pacolet River Basin (PAC_i) and at the South Pacolet River at streamgaging station 02154790 (SPAC), Spartanburg, South Carolina, August 5, 2009. (See fig. 2 for locations; %, percent.)

Summary

The U.S. Geological Survey, in cooperation with Spartanburg Water, conducted an investigation of the water-quality conditions in the Pacolet River, which is formed by the confluence of two forks, the North and South Pacolet Rivers, in Spartanburg County, South Carolina. One of the objectives of the investigation was to determine the relative importance of nutrient loadings of major tributaries on cyanobacterial abundance and taste-and-odor occurrence in Lake William C. Bowen and Municipal Reservoir #1, two drinking-water reservoirs in the Pacolet River Basin. Quantification of nutrient contribution from the watershed and immediate shoreline to the reservoirs was needed by Spartanburg Water because this information will augment ongoing collaboration with local and state groups and help focus their management efforts to target areas around the reservoirs.

Monthly stream samples were collected at the South Pacolet, North Pacolet, and Pacolet River sites from September 2007 to August 2009. Samples were analyzed for nutrient and suspended-sediment concentrations. Nutrient and suspended-sediment concentrations were statistically summarized and compared to recommended U.S. Environmental Protection Agency guidelines established for nutrients in streams and rivers. Daily mean streamflow and nutrient and suspended-sediment concentrations collected at the three sites were used to estimate annual and seasonal nutrient and suspended sediment loads and yields from October 1, 2005, to September 30, 2009 (water years 2006–2009) using predefined regression models in the S-LOADEST computer program. Because the nutrient and sediment loads and yields at the Pacolet site include the nutrient and sediment contributions from the South and North Pacolet sites, nutrient and sediment loads and yields were computed for the intervening subbasin of the Pacolet River not represented by the South and North Pacolet River Basins. This intervening basin was of interest because it provided the contribution from the minor tributaries, shoreline drainages, and releases or outflows from the two reservoirs, Lake William C. Bowen and Municipal Reservoir #1. Nutrient and sediment loading at the South Pacolet site represented the major input into these two reservoirs.

The study area was under severe to extreme drought conditions during the data-collection period. Only about 20 percent of the samples were at or above median streamflow conditions. Because of the small sample size and drought conditions, the nutrient and sediment data collected in this investigation did not capture the representative range of climatic and flow-induced variability for these constituents required to produce the best load estimation. Consequently, the nutrient and sediment load regression equations developed from this limited dataset could not be used to extrapolate estimated nutrient or sediment loading beyond the specifically targeted period of water years 2006 to 2009.

Basinwide in 2001, forested land was the primary land cover. Agricultural land use was represented predominantly by hay and pasture or grasslands. Urban land use was similar among the basins, covering 11 to 14 percent of the basins. One of the largest reductions in land use from 1992 to 2001 was agricultural row cropping that decreased from 17 to 27 percent in the studied basins. During the same time period, another large reduction in land use was in forest coverage that decreased by 13 percent in the South Pacolet and intervening Pacolet River Basins and by 43 percent in the North Pacolet River Basin. Concurrently, large grassy, open areas replaced the land once covered by row crops and forests. Agricultural land formerly used for row cropping was replaced with hay and pasture fields. Forests were replaced with natural grasslands and recreational grassy areas.

Prior to load estimation, nutrient and suspended-sediment concentrations were evaluated and compared among sites. Total organic nitrogen and dissolved nitrate plus nitrite were the two most dominant species of nitrogen in the streamwater at the monitored sites for the period of study. Median nitrate plus nitrite concentrations were higher than median total organic nitrogen concentrations. Dissolved nitrate plus nitrite, dissolved ammonia, and total nitrogen concentrations were statistically similar among sites. Median total nitrogen concentrations were 0.40 mg/L at the South Pacolet River site, 0.49 mg/L at the North Pacolet River site, and 0.43 mg/L at the Pacolet River site. Except for a few outliers, the majority of the measurements of total nitrogen concentrations at the three sites were well below the U.S. Environmental Protection Agency recommended guideline of 0.69 mg/L for streams and rivers in the nutrient ecoregion IX. Median total phosphorus concentrations were 0.016 mg/L at the South Pacolet site, 0.050 mg/L at the North Pacolet site, and 0.044 mg/L at the Pacolet site. The South Pacolet site had significantly lower dissolved orthophosphate, dissolved phosphorus, and total phosphorus concentrations than the North Pacolet and Pacolet sites. All but one measurement of total phosphorus concentration at the North Pacolet and Pacolet sites were above the U.S. Environmental Protection Agency recommended guideline of 0.037 mg/L for streams and rivers in the nutrient ecoregion IX. More than 90 percent of the total phosphorus concentrations at the South Pacolet site were below the above recommended guideline.

Suspended-sediment concentrations were highly variable, ranging from 2 to 162 mg/L at the South Pacolet River site, from 2 to 381 mg/L at the North Pacolet River site, and from 1 to 1,090 mg/L at the Pacolet River site for the period of study. Median suspended-sediment concentrations of 9 mg/L at the South Pacolet site, 10 mg/L at the North Pacolet site, and 12 mg/L at the Pacolet River sites were relatively low. Overall, suspended-sediment concentrations were statistically similar among sites. Silt and clay fractions were the dominant grain-size fractions that composed the suspended sediment at all sites.

At all sites, minimum annual nutrient loads for the estimation study period (water years 2006 to 2009) were observed during water year 2008 due to severe drought conditions. Mean annual total nitrogen and phosphorus loads computed for the South and North Pacolet River sites for the 4-year estimation period were similar to long-term (more than 25 years) mean annual loads computed for the same sites. However, mean annual total nitrogen and phosphorus loads for the estimation period were lower than the long-term mean annual loads at the Pacolet site.

At the South Pacolet River site, estimated annual dissolved nitrate plus nitrite loads ranged from 8,736 to 19,970 kg/yr during the estimation period with a mean of 14,610 kg/yr. Annual total organic nitrogen loads ranged from 4,277 to 22,250 kg/yr with a mean of 14,150 kg/yr. For the estimation period of this investigation, the estimated annual loads for total nitrogen ranged from 14,270 to 65,990 kg/yr. The mean annual total nitrogen load of 37,770 kg/yr for this investigation compared well to the long-term mean annual total nitrogen loads at the South Pacolet site of 39,777 kg/yr. Estimated annual dissolved phosphorus loads ranged from 177.6 to 522.9 kg/yr with a mean of 376.3 kg/yr. Estimated annual orthophosphate loads ranged from 172.3 to 517.1 kg/yr, with a mean of 337.4 kg/yr. Estimated annual total phosphorus loads ranged from 795.3 to 3,930 kg/yr for the estimation period. The mean annual total phosphorus load at the South Pacolet for the estimation period of 2,576 kg/yr was 18 percent lower than the long-term mean annual total phosphorus load of 3,048 kg/yr.

At the North Pacolet River site, estimated annual dissolved nitrate plus nitrite had a mean of 32,500 kg/yr and ranged from 21,300 to 41,410 kg/yr for the estimation period. Estimated annual total organic nitrogen loads had a mean of 25,490 kg/yr and ranged from 10,700 to 35,510 kg/yr. The estimated annual loads for total nitrogen ranged from 34,180 to 98,140 kg/yr and had a mean of 65,890 kg/yr at the North Pacolet site for the estimation period, which compared well to the estimated long-term mean annual total nitrogen load of 70,643 kg/yr. The range in annual loads of dissolved species of phosphorus was much lower than the estimated annual total phosphorus loads that ranged from 4,512 to 12,690 kg/yr at the North Pacolet site. The mean annual total phosphorus load at the North Pacolet site of 9,404 kg/yr for the estimation period was similar to the estimated long-term mean annual total phosphorus load of 9,171 kg/yr.

At the Pacolet River site, estimated annual dissolved nitrate plus nitrite loads ranged from 22,510 to 46,790 kg/yr with a mean of 36,970 kg/yr for the estimation period. Estimated annual total organic nitrogen loads ranged from 16,440 to 62,030 kg/yr with a mean of 43,580 kg/yr. The estimated annual loads for total nitrogen ranged from 41,400 to 159,100 kg/yr with a mean of 99,780 kg/yr at the Pacolet site for the estimation period. The estimated long-term mean annual total nitrogen load at the Pacolet site of 130,533 kg/yr was 31 percent higher than the mean annual total nitrogen load in the study. The estimated annual total phosphorus loads ranged from 5,165 to 15,950 kg/yr. The mean annual total phosphorus load at the Pacolet site of 11,710 kg/yr for the estimation period was half of the estimated long-term total phosphorus load at the Pacolet site of 22,739 kg/yr.

Except for annual total organic nitrogen loads, annual nutrient loads computed for the intervening subbasin of the Pacolet River were frequently negative, indicating negligible contributions or potential overall loss of constituent within the intervening drainage area. Notwithstanding, inherent error in the load estimation process produced a relatively high degree of uncertainty (for some models at high-flow conditions, the error was greater than 100 percent) in the computed and estimated annual nutrient loads. Therefore, these assessments should be considered qualitative.

Mean annual nutrient yields for water years 2006 to 2009 were used to determine which basins contributed the greatest amount of nutrients and sediment per hectare of drainage area. The South Pacolet River site contributed the highest annual total nitrogen per hectare of land compared to the North Pacolet and Pacolet sites. Mean annual total nitrogen yields were 2.63 (kg/ha)/yr at the South Pacolet site, 2.19 (kg/ha)/yr at the North Pacolet site, and 1.82 (kg/ha)/yr at the Pacolet site. Conversely, the South Pacolet had the lowest mean annual yields of total phosphorus as compared to the North Pacolet and Pacolet sites. Mean annual total phosphorus yields were 0.180 (kg/ha)/yr at the South Pacolet site, 0.213 (kg/ha)/yr at the Pacolet site, and 0.313 (kg/ha)/yr at the North Pacolet site. The site that represented the intervening subbasin in the study area not included within the South and North Pacolet River Basins contributed negligible amounts of total nitrogen and phosphorus per hectare of land, with minor, negative mean annual yields for total nitrogen and total phosphorus of –0.368 and –0.025 (kg/ha)/yr, respectively.

The South Pacolet River site had the highest mean annual suspended-sediment load of 21,190,000 kg/yr but also the highest standard error of estimation. The North Pacolet site had the second highest mean annual suspended-sediment load of 9,895,000 kg/yr, followed by the Pacolet site at 6,547,000 kg/yr. Computed annual suspended-sediment loads were consistently negative in the intervening drainage basin of the Pacolet River. Sedimentation processes in Lake Bowen and Reservoir #1 were the most likely explanations for these apparent losses.

At the three monitored sites, a large range of seasonal variation was observed in the estimated seasonal flux for dissolved orthophosphate and dissolved nitrate plus nitrite. The winter season tended to have the highest fluxes of these two bioavailable constituents. In contrast, the lowest fluxes were observed during the summer and fall seasons for each water year, when biological uptake would be expected to peak.

Synoptic samples were collected at the sites in the intervening subbasin of the Pacolet River during a high-flow event in August 2009. The South Pacolet River site contributed well over 80 percent of the cumulative total phosphorus, dissolved nitrate plus nitrite, total organic nitrogen, dissolved ammonia, suspended sediment, and total nitrogen loads for that event. This finding suggests that the minor shoreline drainages and tributaries near Lake Bowen and Reservoir #1 were minor contributors to the overall nutrient load into these reservoirs when compared to the South Pacolet site.

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Appendixes 1–4

Appendix 1-A. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, at the South Pacolet River near Campobello, South Carolina (USGS streamgaging station 02154790).

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event								
QWDATA parameter code	Description	Units	09/10/07 12:00	10/12/07 13:30	11/09/07 13:00	12/13/07 13:15	12/28/07 15:00	01/18/08 12:15	04/16/08 13:30	06/05/08 12:00	07/10/08 12:15
P00025	Air Pressure	Millimeters of mercury	747	N/A	745	747	745	743	750	744	745
P00060	Stream discharge, from rating	Cubic feet per second	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14	22
P00061	Stream discharge, instantaneous	Cubic feet per second	12	15	19	23	46	42	49	N/A	E25
P00300	Dissolved oxygen	Milligrams per liter	8.0	8.9	10.0	9.1	10.4	12.1	10.0	7.3	7.3
P00301	Dissolved oxygen	Percent of saturation	90	N/A	87	88	93	99	97	87	87
P00400	pH	Standard Units	7.3	6.9	7.0	6.9	6.0	6.1	6.6	5.6	6.7
P00095	Specific conductance	Microsiemens per centimeter	48	47	48	49	47	47	46	48	50
P00010	Water temperature	Degrees Celsius	21.2	14.4	8.3	13.4	9.3	5.7	13.0	22.6	22.5
P70300	Total dissolved solids	Milligrams per liter	44	44	35	43	47	46	55	45	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	15	14	14	14	12	13	12	14	N/A
P00530	Total suspended solids	Milligrams per liter	<10	11	<10	11	12	<10	<10	12	N/A
P00915	Dissolved calcium	Milligrams per liter	3.31	3.10	3.04	3.17	2.75	2.86	2.83	3.05	N/A
P00925	Dissolved magnesium	Milligrams per liter	1.55	1.48	1.48	1.51	1.34	1.36	1.32	1.43	N/A
P00935	Dissolved potassium	Milligrams per liter	1.08	1.16	1.23	1.14	1.11	1.08	0.85	1.12	N/A
P00930	Dissolved sodium	Milligrams per liter	3.89	3.78	3.70	4.00	3.54	3.68	3.58	3.60	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	2.85	2.78	2.90	2.84	3.02	3.24	2.85	2.87	N/A
P00950	Dissolved fluoride	Milligrams per liter	E0.06	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	15.7	16.5	16.7	15.1	14.6	14.0	14.5	16.2	N/A
P00945	Dissolved sulfate	Milligrams per liter	1.08	1.25	1.27	1.20	2.21	2.72	1.93	1.29	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	<0.020	E0.017	E0.013	0.026	0.040	0.042	0.025	0.057	N/A
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.240	0.200	0.150	0.190	0.290	0.330	0.280	0.289	N/A
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	E0.001	E0.002	E0.001	E0.001	E0.001	E0.002	E0.001	0.003	N/A
P00605	Total organic nitrogen	Milligrams per liter	0.08	E0.02	E0.04	0.06	0.10	0.13	0.08	0.13	N/A
P00671	Orthophosphate	Milligrams per liter as phosphorus	0.007	E0.005	E0.004	E0.004	E0.005	E0.005	E0.004	0.007	N/A
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	E0.004	<0.006	E0.004	E0.005	E0.004	<0.006	E0.003	0.007	N/A
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.013	0.017	0.009	E0.008	0.020	0.015	0.014	0.083	N/A
P62855	Total nitrogen	Milligrams per liter	0.32	0.23	0.21	0.28	0.43	0.50	0.39	0.47	N/A
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	N/A	N/A	17	21	24
P01046	Dissolved iron	Micrograms per liter	501	53	261	513	500	317	319	816	N/A
P01056	Dissolved manganese	Micrograms per liter	67.9	65.5	70.6	71.8	69.9	85.5	84.1	88.0	N/A
P00681	Dissolved organic carbon	Milligrams per liter	1.0	1.1	1.8	1.4	1.4	1.6	1.4	1.7	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.074	0.025	0.058	0.068	0.066	0.071	0.053	0.107	N/A
P61726	Ultraviolet absorbance at 280 nanometers	Units per centimeter	0.062	N/A	0.047	0.056	0.053	0.057	0.043	0.090	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	7.4	3.1	3.2	4.8	4.6	4.5	3.8	6.2	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	95	76	62	88	86	N/A	84	N/A	N/A
P80154	Suspended sediment	Milligrams per liter	6	6	6	6	9	N/A	6	12	17

Appendix 1-A. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, at the South Pacolet River near Campobello, South Carolina (USGS streamgaging station 02154790).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event								
			08/07/08	08/27/08	09/17/08	10/22/08	11/19/08	12/17/08	01/08/09	01/28/09	02/19/09
QWDATA parameter Code	Description	Units	12:50	12:30	12:45	13:10	15:00	09:45	14:30	12:15	13:30
P00025	Air pressure	Millimeters of mercury	741	738	746	749	747	744	733	737	733
P00060	Stream discharge, from rating	Cubic feet per second	6.4	197.0	18.0	20.0	25.0	52.0	143.0	N/A	N/A
P00061	Stream discharge, instantaneous	Cubic feet per second	6.2	N/A	15.0	17.0	N/A	N/A	158.0	39.0	39.0
P00300	Dissolved oxygen	Milligrams per liter	7.2	7.1	8.4	9.3	11.4	9.9	10	10.6	10.8
P00301	Dissolved oxygen	Percent of saturation	90	83	93	89	93	89	91	92	96
P00400	pH	Standard Units	6.5	5.6	6.0	7.2	7.0	6.5	6.6	6.8	6.9
P00095	Specific conductance	Microsiemens per centimeter	54	38	50	52	51	51	43	49	47
P00010	Water temperature	Degrees Celsius	24.7	21.6	19.1	12.4	5.9	9.8	9.6	7.8	8.8
P70300	Total dissolved solids	Milligrams per liter	52	37	62	49	40	40	N/A	38	31
P00900	Hardness	Milligrams per liter as $CaCO_3$	15	9	14	15	14	14	11	12	12
P00530	Total suspended solids	Milligrams per liter	<10	94	<10	<15	<15	<38	27	<15	<15
P00915	Dissolved calcium	Milligrams per liter	3.59	2.12	3.17	3.26	3.09	3.10	2.39	2.68	2.78
P00925	Dissolved magnesium	Milligrams per liter	1.490	0.886	1.440	1.570	1.550	1.420	1.170	1.190	1.330
P00935	Dissolved potassium	Milligrams per liter	1.18	1.94	1.48	1.24	1.39	1.38	1.54	1.05	1.03
P00930	Dissolved sodium	Milligrams per liter	3.79	2.53	3.51	3.80	3.78	3.72	2.87	3.57	3.59
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	22	9	19	21	20	17	12	16	16
P00940	Dissolved chloride	Milligrams per liter	2.8	2.08	2.83	2.91	3.11	3.32	3.29	3.18	3.06
P00950	Dissolved fluoride	Milligrams per liter	<0.12	<0.12	< 0.12	<0.08	E0.06	<0.08	<0.08	E0.09	<0.08
P00955	Dissolved silica	Milligrams per liter as SiO_2	16.5	10.1	15.4	16.6	16.2	15.1	11.3	15.3	14.6
P00945	Dissolved sulfate	Milligrams per liter	1.03	4.25	1.77	1.36	1.41	2.44	3.98	2.18	2.09
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	0.025	E0.019	0.024	E0.013	E0.014	0.021	0.022	0.037	0.029
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.202	0.279	0.197	0.150	0.097	0.256	0.307	0.372	0.309
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	E0.002	E0.002	E0.001	<0.002	<0.002	E0.001	E0.001	E0.002	E0.002
P00605	Total organic nitrogen	Milligrams per liter	0.070	E0.750	0.120	E0.050	E0.100	0.100	0.290	0.060	0.070
P00671	Orthophoshate	Milligrams per liter as phosphorus	0.009	E0.006	E0.003	E0.008	E0.005	E0.005	E0.006	E0.007	E0.007
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	E0.006	0.010	E 0.005	E0.003	E0.004	0.006	0.008	E0.006	E0.004
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.013	0.168	0.020	E0.006	0.011	0.018	0.065	E0.008	0.013
P62855	Total nitrogen	Milligrams per liter	0.30	1.05	0.34	0.21	0.21	0.38	0.62	0.47	0.40
P63688	Actinomycetes	Colonies per milliliter	9	700	36	8	17	28	260	13	19
P01046	Dissolved iron	Micrograms per liter	596	631	610	311	573	488	382	486	572
P01056	Dissolved manganese	Micrograms per liter	120.0	60.1	79.7	93.0	83.9	95.6	65.0	80.7	91.4
P00681	Dissolved organic carbon	Milligrams per liter	1.9	6.2	N/A	1.2	1.8	1.8	3.3	1.3	1.2
P50624	Ultraviolet absorbnace at 254 nanometers	Units per centimeter	0.091	.252	0.110	0.057	0.088	0.086	0.127	0.071	0.075
P61726	Ultraviolet absorbnace at 280 nanometers	Units per centimeter	0.076	0.201	0.090	0.046	0.072	0.070	0.102	0.059	0.062
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	4.8	4.1	N/A	4.7	4.8	4.9	3.9	5.7	6.1
P70331	Suspended sediment	Percent smaller than .0625 millimeter	N/A	79	84	90	83	98	67	29	91
P80154	Suspended sediment	Milligrams per liter	19	162	24	2	3	6	48	12	5

Appendix 1-A. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, at the South Pacolet River near Campobello, South Carolina (USGS streamgaging station 02154790).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event								
			03/18/09	03/18/09	04/16/09	04/30/09	05/07/09	05/21/09	06/02/09	06/17/09	08/05/09
QWDATA parameter code	Description	Units	13:30	13:45	13:15	12:30	13:00	12:00	12:00	13:30	09:00
P00025	Air pressure	Millimeters of mercury	N/A	747	747	763	739	749	745	N/A	740
P00060	Stream discharge, from rating	Cubic feet per second	N/A	68	N/A	48	57	37	39	117	N/A
P00061	Stream discharge, instantaneous	Cubic feet per second	N/A	74	76	48	57	37	39	117	37
P00300	Dissolved oxygen	Milligrams per liter	N/A	9.6	9.1	8.9	8.2	8.7	8.0	7.4	7.5
P00301	Dissolved oxygen	Percent of saturation	N/A	93	92	92	92	91	89	N/A	87
P00400	pH	Standard units	N/A	6.7	6.3	6.1	6.2	6.2	6.1	5.9	6.2
P00095	Specific conductance	Microsiemens per centimeter	N/A	46	46	48	47	48	49	45	48
P00010	Water temperature	Degrees Celsius	N/A	13.2	14.8	17.0	19.0	16.5	19.6	20.8	21.0
P70300	Total dissolved solids	Milligrams per liter	N/A	38	N/A	42	N/A	N/A	N/A	N/A	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	N/A	13	N/A	13	N/A	N/A	N/A	N/A	N/A
P00530	Total suspended solids	Milligrams per liter	N/A	<15	N/A	<15	<15	<15	<15	38	N/A
P00915	Dissolved calcium	Milligrams per liter	N/A	2.96	N/A	2.95	N/A	N/A	N/A	N/A	N/A
P00925	Dissolved magnesium	Milligrams per liter	N/A	1.36	N/A	1.34	N/A	N/A	N/A	N/A	N/A
P00935	Dissolved potassium	Milligrams per liter	N/A	1.13	N/A	0.94	N/A	N/A	N/A	N/A	N/A
P00930	Dissolved sodium	Milligrams per liter	N/A	3.40	N/A	3.25	N/A	N/A	N/A	N/A	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	16	N/A	17	N/A	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	N/A	3.00	N/A	2.87	N/A	N/A	N/A	N/A	N/A
P00950	Dissolved fluoride	Milligrams per liter	N/A	<0.08	N/A	<0.08	N/A	N/A	N/A	N/A	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	N/A	13.0	N/A	12.7	N/A	N/A	N/A	N/A	N/A
P00945	Dissolved sulfate	Milligrams per liter	N/A	2.85	N/A	1.69	N/A	N/A	N/A	N/A	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	N/A	0.021	N/A	0.022	0.027	0.058	0.052	0.035	0.033
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	N/A	0.298	N/A	0.301	0.249	0.287	0.290	0.201	0.209
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	N/A	E0.001	N/A	<0.002	E0.002	0.002	0.002	0.003	0.002
P00605	Total organic nitrogen	Milligrams per liter	N/A	0.07	N/A	0.08	0.12	0.12	0.21	0.35	0.19
P00671	Orthophosphate	Milligrams per liter as phosphorus	N/A	E0.005	N/A	E0.006	E0.005	E0.004	E0.005	E0.007	E0.005
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	N/A	0.007	N/A	E0.004	E0.005	E0.005	0.007	0.015	0.009
P00665	Total phosphorus	Milligrams per liter as phosphorus	N/A	0.016	N/A	0.013	0.018	0.012	0.022	0.088	0.030
P62855	Total nitrogen	Milligrams per liter	N/A	0.39	N/A	0.40	0.39	0.46	0.55	0.59	0.43
P63688	Actinomycetes	Colonies per milliliter	N/A	27	28	11	80	10	45	E210	N/A
P01046	Dissolved iron	Micrograms per liter	N/A	527	N/A	582	N/A	N/A	N/A	N/A	N/A
P01056	Dissolved manganese	Micrograms per liter	N/A	67.8	N/A	84.8	N/A	N/A	N/A	N/A	N/A
P00681	Dissolved organic carbon	Milligrams per liter	N/A	1.5	N/A	1.5	N/A	N/A	N/A	N/A	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	N/A	0.075	N/A	0.083	N/A	N/A	N/A	N/A	N/A
P61726	Ultraviolet absorbance at 254 nanometers	Units per centimeter	N/A	0.060	N/A	0.069	N/A	N/A	N/A	N/A	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	N/A	4.9	N/A	5.5	N/A	N/A	N/A	N/A	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	69	69	78	90	77	93	93	79	N/A
P80154	Suspended sediment	Milligrams per liter	10	10	9	8	10	8	14	52	N/A

Appendix 1-B. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, for the North Pacolet River at Fingerville, South Carolina (USGS streamgaging station 02154500).

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event								
			09/10/07	10/12/07	11/09/07	12/13/07	12/28/07	01/18/08	04/16/08	06/05/08	07/10/08
QWDATA parameter code	Description	Units	11:15	12:00	10:25	11:30	13:15	14:30	11:30	10:30	10:30
P00025	Air pressure	Millimeters of mercury	747	742	745	747	745	743	750	744	745
P00060	Stream discharge, from rating	Cubic feet per second	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P00061	Stream discharge, instantaneous	Cubic feet per second	29	44	46	58	92	121	107	46	35
P00300	Dissolved oxygen	Milligrams per liter	8.4	9.7	11.4	10.2	10.8	12.8	11.0	8.0	8.3
P00301	Dissolved oxygen	Percent of saturation	99	98	97	99	96	105	106	98	101
P00400	pH	Standard units	7.4	7.1	6.9	6.6	5.9	6.5	6.4	6.0	6.6
P00095	Specific conductance	Microsiemens per centimeter	76	80	77	80	54	70	60	80	69
P00010	Water temperature	Degrees Celsius	22.5	14.6	7.4	13.0	9.1	5.8	12.9	24.3	24.1
P70300	Total dissolved solids	Milligrams per liter	51	61	62	57	39	52	49	60	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	19	18	18	18	16	16	16	18	N/A
P00530	Total suspended solids	Milligrams per liter	<10	<10	<100	<10	<10	<10	<10	19	N/A
P00915	Dissolved calcium	Milligrams per liter	4.73	4.27	4.30	4.43	3.76	3.87	3.89	4.39	N/A
P00925	Dissolved magnesium	Milligrams per liter	1.81	1.73	1.71	1.69	1.51	1.56	1.60	1.64	N/A
P00935	Dissolved potassium	Milligrams per liter	1.50	1.63	1.53	1.51	1.30	1.24	1.13	1.57	N/A
P00930	Dissolved sodium	Milligrams per liter	6.94	8.35	7.70	8.49	4.08	7.10	4.91	7.47	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	5.70	7.51	7.40	7.80	3.17	8.34	3.99	7.85	N/A
P00950	Dissolved fluoride	Milligrams per liter	E0.07	<0.12	<0.12	<0.12	<0.12	<0.10	<0.12	<0.12	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	13.1	14.4	15.5	15.0	14.0	13.7	13.2	14.9	N/A
P00945	Dissolved sulfate	Milligrams per liter	2.98	4.74	4.42	3.94	2.64	3.43	2.97	3.32	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	<0.020	0.032	0.024	0.023	0.026	0.024	<0.020	0.023	N/A
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.193	0.369	0.208	0.212	0.258	0.339	0.222	0.442	N/A
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	<0.002	0.003	E0.002	0.002	E0.001	E0.002	E0.001	0.004	N/A
P00605	Total organic nitrogen	Milligrams per liter	N/A	0.08	0.06	0.10	0.09	0.13	N/A	0.14	N/A
P00671	Orthophosphate	Milligrams per liter as phosphorus	0.009	0.009	E0.006	0.012	0.010	0.010	0.007	0.019	N/A
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	0.043	0.026	0.016	0.028	0.017	0.023	0.017	0.042	N/A
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.075	0.083	0.042	0.045	0.041	0.049	0.034	0.072	N/A
P62855	Total nitrogen	Milligrams per liter	0.32	0.48	0.29	0.34	0.38	0.49	0.32	0.60	N/A
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13	8
P01046	Dissolved iron	Micrograms per liter	205	95	173	454	320	323	376	542	N/A
P01056	Dissolved manganese	Micrograms per liter	67.8	57.8	78.2	57.5	43.8	48.6	34.2	48.8	N/A
P00681	Dissolved organic carbon	Milligrams per liter	1.2	1.4	1.7	1.7	1.2	1.4	2.2	1.6	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.045	0.043	0.048	0.067	0.045	0.048	0.059	0.081	N/A
P61726	Ultraviolet absorbance at 280 nanometers	Units per centimeter	0.036	0.033	0.039	0.056	0.035	0.038	0.048	0.067	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	3.8	3.1	2.9	3.9	3.8	3.3	2.6	4.9	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	98	98	93	90	83	N/A	94	N/A	N/A
P80154	Suspended sediment	Milligrams per liter	12	14	7	5	9	N/A	9	19	17

Appendix 1-B. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, for the North Pacolet River at Fingerville, South Carolina (USGS streamgaging station 02154500).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event								
			08/07/08	08/07/08	08/27/08	09/17/08	10/22/08	11/19/08	01/08/09	01/28/09	02/19/09
QWDATA parameter code	Description	Units	10:54	11:15	11:15	11:00	12:20	12:45	12:30	15:45	12:30
P00025	Air pressure	Millimeters of mercury	N/A	741	738	746	749	747	733	737	733
P00060	Stream discharge, from rating	Cubic feet per second	N/A	N/A	N/A	87	41	46	379	N/A	N/A
P00061	Stream discharge, instantaneous	Cubic feet per second	2.6	20.0	673.0	N/A	41.0	N/A	375.0	83.0	89.0
P00300	Dissolved oxygen	Milligrams per liter	N/A	8.3	7.3	9.0	10.9	13.0	10.7	11.1	11.7
P00301	Dissolved oxygen	Percent of saturation	N/A	106	87	101	103	104	98	97	105
P00400	pH	Standard units	N/A	6.2	5.6	6.2	7.4	7.2	6.8	7.0	7.1
P00095	Specific conductance	Microsiemens per centimeter	N/A	94	41	62	65	68	44	62	58
P00010	Water temperature	Degrees Celsius	N/A	26.3	22.1	19.7	12.2	5.0	9.4	7.9	8.8
P70300	Total dissolved solids	Milligrams per liter	N/A	76	31	54	52	49	38	41	43
P00900	Hardness	Milligrams per liter as $CaCO_3$	N/A	20	9	16	19	18	12	17	16
P00530	Total suspended solids	Milligrams per liter	N/A	<10	276	72	<15	<15	66	<15	<15
P00915	Dissolved calcium	Milligrams per liter	N/A	4.69	2.25	3.97	4.53	4.36	2.84	4.19	3.89
P00925	Dissolved magnesium	Milligrams per liter	N/A	1.890	0.843	1.550	1.840	1.790	1.200	1.590	1.510
P00935	Dissolved potassium	Milligrams per liter	N/A	1.86	2.13	1.88	1.51	1.56	1.62	1.26	1.22
P00930	Dissolved sodium	Milligrams per liter	N/A	9.11	2.82	6.20	4.90	5.53	2.83	4.71	4.90
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	26	11	21	25	25	14	21	20
P00940	Dissolved chloride	Milligrams per liter	N/A	9.45	2.35	6.06	3.91	5.16	2.69	4.29	4.23
P00950	Dissolved fluoride	Milligrams per liter	N/A	E0.07	<0.12	<0.12	E0.05	E0.05	<0.08	E0.06	<0.08
P00955	Dissolved silica	Milligrams per liter as SiO_2	N/A	12.3	8.1	13.8	15.0	15.2	11.2	15.4	13.9
P00945	Dissolved sulfate	Milligrams per liter	N/A	3.89	3.39	2.84	2.50	2.50	3.78	3.06	2.79
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	N/A	E0.012	0.037	E0.012	<0.020	<0.020	E0.018	0.031	E0.012
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	N/A	0.370	0.401	0.309	0.195	0.139	0.301	0.392	0.359
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	N/A	0.003	0.004	0.002	E0.001	<0.002	E0.001	0.002	E0.002
P00605	Total organic nitrogen	Milligrams per liter	N/A	E0.14	1.10	E0.22	N/A	N/A	E0.42	0.08	E0.08
P00671	Orthophoshate	Milligrams per liter as phosphorus	N/A	0.015	0.008	0.011	0.014	0.012	E0.007	0.011	0.011
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	N/A	0.051	0.015	0.026	0.021	0.021	0.011	0.017	0.026
P00665	Total phosphorus	Milligrams per liter as phosphorus	N/A	0.074	0.330	0.084	0.030	0.034	0.138	0.025	0.042
P62855	Total nitrogen	Milligrams per liter	N/A	0.53	1.58	0.55	0.25	0.21	0.74	0.50	0.45
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	180	N/A	N/A	N/A	N/A	N/A
P01046	Dissolved iron	Micrograms per liter	N/A	242	565	492	312	416	484	377	371
P01056	Dissolved manganese	Micrograms per liter	N/A	75.2	129.0	27.2	48.0	62.9	31.9	61.8	46.2
P00681	Dissolved organic carbon	Milligrams per liter	N/A	2.0	8.7	2.4	1.3	1.4	2.8	1.1	1.1
P50624	Ultraviolet absorbnace at 254 nanometers	Units per centimeter	N/A	0.063	0.294	0.103	0.052	0.061	0.132	0.054	0.059
P61726	Ultraviolet absorbnace at 280 nanometers	Units per centimeter	N/A	0.051	0.240	0.084	0.042	0.049	0.107	0.044	0.048
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	N/A	3.1	3.4	4.4	4.0	4.3	4.7	5.0	5.5
P70331	Suspended sediment	Percent smaller than .0625 millimeter	N/A	N/A	84	90	86	93	62	79	84
P80154	Suspended sediment	Milligrams per liter	9	9	381	36	2	2	163	4	5

Appendix 1-B. Summary of selected water-quality data collected from September 2007 to August 2009, Spartanburg County, South Carolina, for the North Pacolet River at Fingerville, South Carolina (USGS streamgaging station 02154500).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event						
			03/18/09	04/16/09	04/30/09	05/07/09	05/21/09	06/02/09	06/17/09
QWDATA parameter code	Description	Units	12:15	11:30	11:30	12:00	10:30	10:00	15:00
P00025	Air pressure	Millimeters of mercury	747	747	763	N/A	749	745	N/A
P00060	Stream discharge, from rating	Cubic feet per second	159	N/A	108	137	87	110	235
P00061	Stream discharge, instantaneous	Cubic feet per second	N/A	166	108	137	84	101	235
P00300	Dissolved oxygen	Milligrams per liter	10.3	10.1	9.9	9.2	9.6	8.7	7.9
P00301	Dissolved oxygen	Percent of saturation	101	102	105	N/A	102	100	N/A
P00400	pH	Standard units	7.2	6.7	6.9	7.0	6.6	6.7	6.3
P00095	Specific conductance	Microsiemens per centimeter	55	54	61	60	61	58	47
P00010	Water temperature	Degrees Celsius	13.6	14.9	18.2	20.0	17.4	21.2	22.1
P70300	Total dissolved solids	Milligrams per liter	30	N/A	46	N/A	N/A	N/A	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	16	N/A	17	N/A	N/A	N/A	N/A
P00530	Total suspended solids	Milligrams per liter	<15	N/A	<15	20	<15	<30	164
P00915	Dissolved calcium	Milligrams per liter	4.04	N/A	4.07	N/A	N/A	N/A	N/A
P00925	Dissolved magnesium	Milligrams per liter	1.56	N/A	1.6	N/A	N/A	N/A	N/A
P00935	Dissolved potassium	Milligrams per liter	1.32	N/A	1.15	N/A	N/A	N/A	N/A
P00930	Dissolved sodium	Milligrams per liter	3.93	N/A	4.15	N/A	N/A	N/A	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	18	N/A	21	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	3.60	N/A	3.74	N/A	N/A	N/A	N/A
P00950	Dissolved fluoride	Milligrams per liter	<0.08	N/A	E0.06	N/A	N/A	N/A	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	13.1	N/A	12.6	N/A	N/A	N/A	N/A
P00945	Dissolved sulfate	Milligrams per liter	3.15	N/A	2.73	N/A	N/A	N/A	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	E0.011	N/A	<0.020	<0.020	<0.020	E0.016	E0.016
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.259	N/A	0.283	0.297	0.357	0.361	0.245
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	E0.001	N/A	<0.002	E0.002	E0.002	E0.002	0.004
P00605	Total organic nitrogen	Milligrams per liter	E0.08	N/A	N/A	N/A	N/A	E0.15	E0.71
P00671	Orthophosphate	Milligrams per liter as phosphorus	0.012	N/A	0.012	0.012	0.013	0.014	E0.007
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	0.017	N/A	0.033	0.038	0.035	0.027	0.037
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.036	N/A	0.045	0.076	0.052	0.060	0.325
P62855	Total nitrogen	Milligrams per liter	0.35	N/A	0.45	0.48	0.47	0.52	0.97
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P01046	Dissolved iron	Micrograms per liter	463	N/A	403	N/A	N/A	N/A	N/A
P01056	Dissolved manganese	Micrograms per liter	28.0	N/A	28.3	N/A	N/A	N/A	N/A
P00681	Dissolved organic carbon	Milligrams per liter	1.4	N/A	1.4	N/A	N/A	N/A	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.064	N/A	0.070	N/A	N/A	N/A	N/A
P61726	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.052	N/A	0.057	N/A	N/A	N/A	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	4.4	N/A	5.0	N/A	N/A	N/A	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	83	89	93	90	96	92	93
P80154	Suspended sediment	Milligrams per liter	10	12	6	25	6	22	224

Appendix 1-C. Summary of selected water-quality data collected from September 2007 to June 2009, Spartanburg County, South Carolina, for the Pacolet River near Fingerville, South Carolina (USGS streamgaging station 02155500).

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event									
			09/10/07	10/12/07	11/09/07	11/09/07	12/13/07	01/18/08	04/16/08	04/16/08	06/05/08	07/10/08
QWDATA parameter code	Description	Units	09:00	08:30	08:30	09:30	09:15	09:30	08:30	09:20	08:15	08:30
P00025	Air pressure	Millimeters of mercury	747	742	N/A	745	747	N/A	750	N/A	744	745
P00060	Stream discharge, from rating	Cubic feet per second	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	33	46
P00061	Stream discharge, instantaneous	Cubic feet per second	48	51	N/A	51	65	152	87	N/A	N/A	38
P00300	Dissolved oxygen	Milligrams per liter	7.1	8.9	N/A	11.1	9.5	12.0	10.0	N/A	6.8	7.0
P00301	Dissolved oxygen	Percent of saturation	82	90	N/A	94	90	N/A	95	N/A	82	85
P00400	pH	Standard Units	7.3	7.4	N/A	7.1	6.2	5.9	6.2	N/A	5.9	5.7
P00095	Specific conductance	Microsiemens per centimeter	76	79	N/A	76	71	67	58	N/A	77	69
P00010	Water temperature	Degrees Celsius	22.7	14.4	N/A	7.2	12.1	4.4	12.4	N/A	23.6	24.1
P70300	Total dissolved solids	Milligrams per liter	52	58	N/A	43	N/A	47	40	N/A	57	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	19	18	N/A	18	18	16	16	N/A	18	N/A
P00530	Total suspended solids	Milligrams per liter	18	<100	N/A	<10	<10	<10	14	N/A	31	N/A
P00915	Dissolved calcium	Milligrams per liter	4.82	4.46	N/A	4.47	4.51	3.79	3.75	N/A	4.53	N/A
P00925	Dissolved magnesium	Milligrams per liter	1.79	1.74	N/A	1.70	1.67	1.47	1.58	N/A	1.62	N/A
P00935	Dissolved potassium	Milligrams per liter	1.53	1.64	N/A	1.42	1.43	1.22	1.23	N/A	1.56	N/A
P00930	Dissolved sodium	Milligrams per liter	6.67	7.62	N/A	7.00	6.42	6.43	4.43	N/A	6.39	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	5.48	6.98	N/A	6.73	N/A	6.35	3.83	N/A	6.66	N/A
P00950	Dissolved fluoride	Milligrams per liter	E0.08	E 0.08	N/A	<0.12	N/A	<0.12	<0.12	N/A	<0.12	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	12.0	13.6	N/A	15.1	N/A	13.8	12.4	N/A	14.0	N/A
P00945	Dissolved sulfate	Milligrams per liter	3.75	4.91	N/A	4.57	N/A	3.70	2.88	N/A	3.93	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	E0.019	E0.017	N/A	E0.011	E0.013	0.025	E0.010	N/A	0.048	N/A
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.232	0.295	N/A	0.219	0.180	0.385	0.166	N/A	0.374	N/A
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	E0.001	0.002	N/A	E0.001	E0.001	E0.002	E0.001	N/A	0.004	N/A
P00605	Total organic nitrogen	Milligrams per liter	E0.18	E0.20	N/A	E0.09	E0.10	0.13	E0.17	N/A	0.19	N/A
P00671	Orthophosphate	Milligrams per liter as phosphorus	0.009	0.007	N/A	E0.005	0.007	0.011	E0.005	N/A	0.017	N/A
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	0.049	0.021	N/A	0.018	0.021	0.030	0.012	N/A	0.033	N/A
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.096	0.125	N/A	0.032	0.037	0.055	0.038	N/A	0.091	N/A
P62855	Total nitrogen	Milligrams per liter	0.43	0.51	N/A	0.32	0.29	0.54	0.35	N/A	0.61	N/A
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	26
P01046	Dissolved iron	Micrograms per liter	150	109	N/A	148	316	295	305	N/A	482	N/A
P01056	Dissolved manganese	Micrograms per liter	124.0	44.2	N/A	85.2	50.2	43.1	33.8	N/A	140.0	N/A
P00681	Dissolved organic carbon	Milligrams per liter	1.4	1.5	N/A	N/A	N/A	1.4	1.7	N/A	1.8	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.046	0.041	N/A	0.044	0.055	0.064	0.053	N/A	0.077	N/A
P61726	Ultraviolet absorbance at 280 nanometers	Units per centimeter	0.036	0.031	N/A	0.036	0.045	0.052	0.042	N/A	0.064	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	3.4	2.7	N/A	N/A	N/A	4.6	3.1	N/A	4.4	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	88	84	74	74	95	N/A	92	92	88	N/A
P80154	Suspended sediment	Milligrams per liter	23	12	4	4	8	N/A	9	9	29	33

Appendix 1-C. Summary of selected water-quality data collected from September 2007 to June 2009, Spartanburg County, South Carolina, for the Pacolet River near Fingerville, South Carolina (USGS streamgaging station 02155500).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event									
			08/07/08	08/07/08	08/27/08	08/27/08	09/17/08	10/22/08	11/19/08	11/19/08	01/08/09	01/28/09
QWDATA parameter code	Description	Units	08:00	08:45	08:45	09:00	09:00	08:45	10:00	10:45	09:30	09:00
P00025	Air pressure	Millimeters of mercury	N/A	741	N/A	738	746	749	N/A	747	733	737
P00060	Stream discharge, from rating	Cubic feet per second	N/A	28	N/A	1060	97	45	N/A	N/A	245	N/A
P00061	Stream discharge, instantaneous	Cubic feet per second	N/A	25	N/A	1070	N/A	N/A	N/A	E56	231	111
P00300	Dissolved oxygen	Milligrams per liter	N/A	6.6	N/A	7.3	8.3	9.6	N/A	12.5	11.0	11.2
P00301	Dissolved oxygen	Percent of saturation	N/A	83	N/A	86	93	90	N/A	98	100	95
P00400	pH	Standard units	N/A	5.8	N/A	5.3	5.5	7.1	N/A	6.9	6.8	6.9
P00095	Specific conductance	Microsiemens per centimeter	N/A	84	N/A	40	70	67	N/A	71	46	64
P00010	Water temperature	Degrees Celsius	N/A	25.8	N/A	21.9	19.7	11.8	N/A	4.0	9.5	6.8
P70300	Total dissolved solids	Milligrams per liter	N/A	66	N/A	39	57	56	N/A	49	47	39
P00900	Hardness	Milligrams per liter as $CaCO_3$	N/A	20	N/A	8	17	19	N/A	18	13	13
P00530	Total suspended solids	Milligrams per liter	N/A	22	N/A	508	47	<15	N/A	<15	43	<15
P00915	Dissolved calcium	Milligrams per liter	N/A	4.95	N/A	1.94	4.12	4.61	N/A	4.35	3.06	3.20
P00925	Dissolved magnesium	Milligrams per liter	N/A	1.820	N/A	0.736	1.590	1.850	N/A	1.780	1.270	1.260
P00935	Dissolved potassium	Milligrams per liter	N/A	1.72	N/A	2.02	1.95	1.53	N/A	1.58	1.56	1.12
P00930	Dissolved sodium	Milligrams per liter	N/A	6.97	N/A	2.88	6.26	5.01	N/A	5.60	3.14	4.31
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	N/A	25	N/A	10	20	25	N/A	25	16	19
P00940	Dissolved chloride	Milligrams per liter	N/A	6.85	N/A	2.41	6.58	4.15	N/A	5.33	2.86	4.66
P00950	Dissolved fluoride	Milligrams per liter	N/A	<0.12	N/A	<0.12	<0.12	E0.06	N/A	E0.05	<0.08	E0.04
P00955	Dissolved silica	Milligrams per liter as SiO_2	N/A	11.6	N/A	7.7	13.4	14.6	N/A	14.8	11.0	14.6
P00945	Dissolved sulfate	Milligrams per liter	N/A	4.73	N/A	3.44	3.08	2.81	N/A	2.83	2.77	2.65
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	N/A	0.037	N/A	0.066	E0.013	<0.020	N/A	<0.020	0.057	0.045
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	N/A	0.240	N/A	0.379	0.393	0.265	N/A	0.174	0.180	0.305
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	N/A	0.002	N/A	0.004	0.002	E0.001	N/A	<0.002	E0.002	E0.002
P00605	Total organic nitrogen	Milligrams per liter	N/A	0.20	N/A	1.90	E0.31	N/A	N/A	N/A	0.36	0.11
P00671	Orthophoshate	Milligrams per liter as phosphorus	N/A	0.015	N/A	0.007	0.011	0.012	N/A	0.011	E0.007	0.008
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	N/A	0.045	N/A	0.013	0.030	0.022	N/A	0.022	0.011	0.011
P00665	Total phosphorus	Milligrams per liter as phosphorus	N/A	0.083	N/A	0.460	0.117	0.044	N/A	0.043	0.088	0.021
P62855	Total nitrogen	Milligrams per liter	N/A	0.48	N/A	2.36	0.71	0.37	N/A	0.29	0.59	0.46
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	130	N/A	N/A	N/A	N/A	N/A
P01046	Dissolved iron	Micrograms per liter	N/A	362	N/A	525	516	218	N/A	345	245	298
P01056	Dissolved manganese	Micrograms per liter	N/A	234.0	N/A	204.0	35.3	70.1	N/A	50.6	16.7	48.1
P00681	Dissolved organic carbon	Milligrams per liter	N/A	2.5	N/A	N/A	2.7	1.4	N/A	1.4	2.5	1.4
P50624	Ultraviolet absorbnace at 254 nanometers	Units per centimeter	N/A	0.071	N/A	0.289	0.120	0.054	N/A	0.058	0.090	0.054
P61726	Ultraviolet absorbnace at 280	Units per centimeter	N/A	0.058	N/A	0.238	0.097	0.043	N/A	0.046	0.071	0.044
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	N/A	2.8	N/A	N/A	4.5	3.8	N/A	4.0	3.6	4.0
P70331	Suspended sediment	Percent smaller than .0625 millimeter	N/A	N/A	61	61	94	94	91	91	85	92
P80154	Suspended sediment	Milligrams per liter	17	17	1090	1090	58	2	1	1	64	3

Appendix 1-C. Summary of selected water-quality data collected from September 2007 to June 2009, Spartanburg County, South Carolina, for the Pacolet River near Fingerville, South Carolina (USGS streamgaging station 02155500).—Continued

[$CaCO_3$, calcium carbonate; SiO_2, silica; E, estimated; <, less than; N/A, not available; DOC, dissolved organic carbon]

Constituent			Date and time of sampling event							
			02/19/09	03/18/09	04/16/09	04/30/09	05/07/09	05/21/09	06/02/09	06/17/09
QWDATA parameter code	Description	Units	09:45	08:30	09:45	08:30	09:30	08:45	08:45	08:30
P00025	Air pressure	Millimeters of mercury	733	747	747	763	N/A	749	745	N/A
P00060	Stream discharge, from rating	Cubic feet per second	N/A	161	N/A	48	291	113	187	389
P00061	Stream discharge, instantaneous	Cubic feet per second	122	283	209	79	306	130	204	403
P00300	Dissolved oxygen	Milligrams per liter	10.6	10.2	9.4	8.4	8.1	8.3	7.4	7.2
P00301	Dissolved oxygen	Percent of saturation	93	97	94	89	N/A	90	87	N/A
P00400	pH	Standard units	6.8	6.8	6.7	6.2	6.0	6.5	6.2	6.1
P00095	Specific conductance	Microsiemens per centimeter	56	51	52	63	53	57	54	48
P00010	Water temperature	Degrees Celsius	8.0	11.9	14.6	18.0	19.9	18.6	22.2	23.7
P70300	Total dissolved solids	Milligrams per liter	36	45	N/A	44	N/A	N/A	N/A	N/A
P00900	Hardness	Milligrams per liter as $CaCO_3$	15	14	N/A	17	N/A	N/A	N/A	N/A
P00530	Total suspended solids	Milligrams per liter	<15	<15	N/A	<15	<15	<15	<15	74
P00915	Dissolved calcium	Milligrams per liter	3.66	3.52	N/A	4.07	N/A	N/A	N/A	N/A
P00925	Dissolved magnesium	Milligrams per liter	1.45	1.37	N/A	1.60	N/A	N/A	N/A	N/A
P00935	Dissolved potassium	Milligrams per liter	1.21	1.32	N/A	1.17	N/A	N/A	N/A	N/A
P00930	Dissolved sodium	Milligrams per liter	4.12	3.53	N/A	4.09	N/A	N/A	N/A	N/A
P29801	Alkalinity	Milligrams per liter as $CaCO_3$	20	18	N/A	21	N/A	N/A	N/A	N/A
P00940	Dissolved chloride	Milligrams per liter	3.41	3.40	N/A	3.84	N/A	N/A	N/A	N/A
P00950	Dissolved fluoride	Milligrams per liter	E0.06	E0.07	N/A	E0.05	N/A	N/A	N/A	N/A
P00955	Dissolved silica	Milligrams per liter as SiO_2	13.3	12.2	N/A	12.3	N/A	N/A	N/A	N/A
P00945	Dissolved sulfate	Milligrams per liter	2.57	2.94	N/A	2.87	N/A	N/A	N/A	N/A
P00608	Dissolved ammonia	Milligrams per liter as nitrogen	0.025	E0.010	N/A	<0.020	E0.019	0.024	0.029	0.023
P00631	Dissolved nitrate plus nitrite	Milligrams per liter as nitrogen	0.261	0.222	N/A	0.278	0.197	0.217	0.199	0.163
P00613	Dissolved nitrite	Milligrams per liter as nitrogen	E0.002	E0.001	N/A	<0.002	E0.002	E0.001	E0.001	E0.002
P00605	Total organic nitrogen	Milligrams per liter	0.11	E0.13	N/A	N/A	E0.18	0.20	0.19	0.42
P00671	Orthophosphate	Milligrams per liter as phosphorus	0.009	E0.007	N/A	0.010	E0.005	E0.005	E0.005	E0.005
P00666	Dissolved phosphorus	Milligrams per liter as phosphorus	0.018	0.011	N/A	0.026	0.025	0.018	0.013	0.023
P00665	Total phosphorus	Milligrams per liter as phosphorus	0.032	0.030	N/A	0.040	0.050	0.034	0.040	0.141
P62855	Total nitrogen	Milligrams per liter	0.39	0.36	N/A	0.37	0.40	0.44	0.41	0.60
P63688	Actinomycetes	Colonies per milliliter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P01046	Dissolved iron	Micrograms per liter	285	418	N/A	341	N/A	N/A	N/A	N/A
P01056	Dissolved manganese	Micrograms per liter	34.7	17.1	N/A	44.4	N/A	N/A	N/A	N/A
P00681	Dissolved organic carbon	Milligrams per liter	1.5	1.8	N/A	1.3	N/A	N/A	N/A	N/A
P50624	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.051	0.054	N/A	0.059	N/A	N/A	N/A	N/A
P61726	Ultraviolet absorbance at 254 nanometers	Units per centimeter	0.040	0.043	N/A	0.048	N/A	N/A	N/A	N/A
P63162	Specific ultraviolet absorbance at 254 nanometers	Liter per milligram of DOC	3.4	3.0	N/A	4.6	N/A	N/A	N/A	N/A
P70331	Suspended sediment	Percent smaller than .0625 millimeter	91	88	74	76	90	98	98	94
P80154	Suspended sediment	Milligrams per liter	5	12	12	8	11	6	10	43

Appendix 2-A. Annual mean streamflow for water years 1931 to 2009 and departure of the water-year annual mean streamflow from the period-of-record mean annual streamflow for the South Pacolet River at U.S. Geological Survey (USGS) streamgaging station 02154790, North Pacolet River at USGS streamgaging station 02154500, and Pacolet River at USGS streamgaging station 02155500 (U.S. Geological Survey, 2009).

Water year	Annual mean streamflow, in cubic feet per second (Values in parentheses are mean annual streamflow for the period of record at the site, in cubic feet per second)			Departure of water year annual mean streamflow from period-of-record mean annual streamflow, in cubic feet per second		
	South Pacolet River (91.3)	North Pacolet River (200)	Pacolet River (326)	South Pacolet River	North Pacolet River	Pacolet River
1931	ND	133.5	218.8	ND	–66.5	–107.2
1932	ND	178.2	318.5	ND	–21.8	–7.5
1933	ND	257.4	419.2	ND	57.4	93.2
1934	ND	176.3	295.3	ND	–23.7	–30.7
1935	ND	196.5	311.0	ND	–3.5	–15.0
1936	ND	279.9	452.4	ND	79.9	126.4
1937	ND	340.0	535.1	ND	140.0	209.1
1938	ND	216.9	339.0	ND	16.9	13.0
1939	ND	188.3	308.4	ND	–11.7	–17.6
1940	ND	144.0	239.4	ND	–56.0	–86.6
1941	ND	125.5	191.5	ND	–74.5	–134.5
1942	ND	170.7	262.5	ND	–29.3	–63.5
1943	ND	220.1	347.4	ND	20.1	21.4
1944	ND	197.1	334.9	ND	–2.9	8.9
1945	ND	179.8	315.4	ND	–20.2	–10.6
1946	ND	268.0	441.5	ND	68.0	115.5
1947	ND	179.5	305.3	ND	–20.5	–20.7
1948	ND	221.5	372.1	ND	21.5	46.1
1949	ND	275.3	472.8	ND	75.3	146.8
1950	ND	226.3	369.6	ND	26.3	43.6
1951	ND	166.5	266.2	ND	–33.5	–59.8
1952	ND	231.6	384.5	ND	31.6	58.5
1953	ND	159.7	264.5	ND	–40.3	–61.5
1954	ND	154.9	261.4	ND	–45.1	–64.6
1955	ND	118.6	199.3	ND	–81.4	–126.7
1956	ND	113.4	190.1	ND	–86.6	–135.9
1957	ND	156.2	255.7	ND	–43.8	–70.3
1958	ND	258.8	446.0	ND	58.8	120.0
1959	ND	208.4	357.3	ND	8.4	31.3
1960	ND	296.0	461.2	ND	96.0	135.2
1961	ND	253.0	411.7	ND	53.0	85.7
1962	ND	272.4	430.3	ND	72.4	104.3
1963	ND	202.2	334.9	ND	2.2	8.9
1964	ND	209.7	352.1	ND	9.7	26.1
1965	ND	313.4	519.0	ND	113.4	193.0
1966	ND	178.1	287.3	ND	–21.9	–38.7
1967	ND	180.0	289.2	ND	–20.0	–36.8
1968	ND	194.9	324.9	ND	–5.1	–1.1
1969	ND	210.8	366.2	ND	10.8	40.2

Appendix 2-A. Annual mean streamflow for water years 1931 to 2009 and departure of the water-year annual mean streamflow from the period-of-record mean annual streamflow for the South Pacolet River at U.S. Geological Survey (USGS) streamgaging station 02154790, North Pacolet River at USGS streamgaging station 02154500, and Pacolet River at USGS streamgaging station 02155500 (U.S. Geological Survey, 2009).—Continued

Water year	Annual mean streamflow, in cubic feet per second (Values in parentheses are mean annual streamflow for the period of record at the site, in cubic feet per second)			Departure of water year annual mean streamflow from period-of-record mean annual streamflow, in cubic feet per second		
	South Pacolet River (91.3)	North Pacolet River (200)	Pacolet River (326)	South Pacolet River	North Pacolet River	Pacolet River
1970	ND	178.2	288.8	ND	–21.8	–37.2
1971	ND	213.1	298.8	ND	13.1	–27.2
1972	ND	232.8	399.5	ND	32.8	73.5
1973	ND	288.1	501.2	ND	88.1	175.2
1974	ND	226.3	359.6	ND	26.3	33.6
1975	ND	239.1	429.2	ND	39.1	103.2
1976	ND	251.0	418.4	ND	51.0	92.4
1977	ND	231.1	390.7	ND	31.1	64.7
1978	ND	234.3	345.5	ND	34.3	19.5
1979	ND	268.2	427.7	ND	68.2	101.7
1980	ND	262.9	464.9	ND	62.9	138.9
1981	ND	119.8	188.8	ND	–80.2	–137.2
1982	ND	186.9	266.1	ND	–13.1	–59.9
1983	ND	217.3	366.1	ND	17.3	40.1
1984	ND	244.3	434.2	ND	44.3	108.2
1985	ND	133.5	214.7	ND	–66.5	–111.3
1986	ND	127.8	180.8	ND	–72.2	–145.2
1987	ND	219.9	342.2	ND	19.9	16.2
1988	ND	101.4	139.7	ND	–98.6	–186.3
1989	ND	125.4	179.0	ND	–74.6	–147.0
1990	104.2	226.5	368.4	12.9	26.5	42.4
1991	106.8	225.2	379.4	15.5	25.2	53.4
1992	84.0	192.3	282.7	–7.3	–7.7	–43.3
1993	156.6	302.7	514.8	65.3	102.7	188.8
1994	96.2	188.2	283.3	4.9	–11.8	–42.7
1995	128.3	268.5	418.4	37	68.5	92.4
1996	120.0	238.8	383.6	28.7	38.8	57.6
1997	90.1	183.5	ND	–1.2	–16.5	ND
1998	110.5	226.4	352.1	19.2	26.4	26.1
1999	53.2	112.1	150.8	–38.1	–87.9	–175.2
2000	59.2	111.7	161.7	–32.1	–88.3	–164.3
2001	48.2	95.9	124.0	–43.1	–104.1	–202.0
2002	44.0	87.0	120.8	–47.3	–113.0	–205.2
2003	148.7	282.3	493.2	57.4	82.3	167.2
2004	99.0	196.5	326.8	7.7	–3.5	0.8
2005	140.3	268.1	400.3	49	68.1	74.3
2006	71.3	133.6	186.1	–20	–66.4	–139.9
2007	77.6	145.1	ND	–13.7	–54.9	ND
2008	35.4	79.3	99.2	–55.9	–120.7	–226.8
2009	51.5	108.7	161.9	–39.8	–91.3	–164.1

Appendix 2-B. Land use within selected watersheds in the Pacolet River Basin in 1992 and 2001, northwestern South Carolina and southwestern North Carolina.

NWIS station number	Site description	Site type	MAP ID	1992 National Land Cover Data, in hectares											
				Open water	Low intensity residential	High intensity residential	Commercial/ Industrial/ Transportation	Barren/ Transi- tional	Forest	Hay/ Pasture	Row crops	Natural shrub/ Grasslands	Urban/ Recreational grasses	Wetlands	TOTAL
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	Synoptic	S-1	0.18	0	0	0	0	42.75	0.18	0.72	0	0	1.26	45.09
3506060820214	Unnamed Tributary at Fagen Drive near Fingerville, SC	Synoptic	S-2	0	0.81	0	0.09	0	91.8	8.91	23.94	0	0	0.18	125.7
3506060820409	Unnamed Tributary at Millerfarm Road above New Prospect, SC	Synoptic	S-3	0	8.1	0	14.04	0	42.93	32.94	33.84	0	5.04	0.27	137.2
3505560820626	Unnamed Tributary at Dickson Road below Campobello, SC	Synoptic	S-4	3.33	18.27	0	4.86	0.36	572.0	125.6	294.9	0	1.8	6.84	1028
3507300820702	Alexander Creek at Page Road near Campobello, SC	Synoptic	S-5A	4.05	11.34	0	10.98	0.99	678.7	117.7	214.4	0	4.14	5.94	1048
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	Synoptic	S-6	2.61	19.08	0.36	14.4	0.09	369.3	73.08	90.36	0	12.69	2.43	584.4
3506570820116	Unnamed Tributary at unnamed Road near Fingerville, SC	Synoptic	S-7	0	0.18	0	0	0	9.54	0.99	4.41	0	0.09	0.09	15.3
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	Synoptic	S-8	0	1.17	0	0	0	3.24	0.36	1.26	0	0	0	6.03
02154790	South Pacolet River near Campobello, SC	Gaged	SPAC	48.42	218.3	12.06	82.35	139.9	9628	1751	2457	0	33.75	48.69	14419
02155500	Incremental subbasin on the Pacolet River near Fingerville, SC	Gaged	PAC_i	682.3	296.6	16.65	93.60	4.95	5144	1126	1718	0	82.53	114.0	9278
02154500	North Pacolet River near Fingerville, SC to Municipal Reservoir #1 Dam	Gaged	NPAC	100.2	1237	33.21	466.7	30.15	22517	3113	2600	0	214.9	106.3	30418
NA	NA	Watershed	Upper Pacolet	249.2	111.5	10.89	13.50	21.69	2985	1428	1655	0	18.99	63.63	6557

Appendix 2-B. Land use within selected watersheds in the Pacolet River Basin in 1992 and 2001, northwestern South Carolina and southwestern North Carolina.—Continued

NWIS station number	Station name	Site type	MAP ID	2001 National Land Cover Data, in hectares											
				Open water	Low intensity residential	High intensity residential	Commercial/ Industrial/ Transportation	Barren/ Transi-tional	Forest	Hay/ Pasture	Row Crops	Natural shrub/ Grasslands	Urban/ Recreational grasses	Wetlands	TOTAL
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	Synoptic	S-1	1.53	0.18	0	0	0.72	13.50	24.03	0	3.51	1.62	0	45.09
3506060820214	Unnamed Tributary at Fagen Drive near Fingerville, SC	Synoptic	S-2	0.99	7.29	1.44	0	1.08	56.43	31.41	0.36	11.97	14.76	0	125.7
3506060820409	Unnamed Tributary at Millerfarm Road above New Prospect, SC	Synoptic	S-3	0	7.74	1.44	0	0	48.51	55.62	0	3.33	20.52	0	137.2
3505560820626	Unnamed Tributary at Dickson Road below Campobello, SC	Synoptic	S-4	5.94	19.89	5.13	2.34	2.97	390.9	326.6	1.8	152.1	102.15	18.18	1028
3507300820702	Alexander Creek at Page Road near Campobello, SC	Synoptic	S-5A	11.34	16.11	10.89	0.81	9.45	510.3	322.0	0	69.39	81.81	16.11	1048
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	Synoptic	S-6	3.69	15.12	2.61	0	6.66	289.8	152.8	0	51.57	56.7	5.4	584.4
3506570820116	Unnamed Tributary at unnamed Road near Fingerville, SC	Synoptic	S-7	0	0	0	0	0	4.23	3.69	0	5.49	1.89	0	15.3
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	Synoptic	S-8	0	0.36	0	0	1.08	1.98	1.08	0	0.36	1.17	0	6.03
02154790	South Pacolet River near Campobello, SC	Gaged	SPAC	89.01	211.4	39.6	12.42	63.27	7698	3415	7.20	1153	1350	381.2	14419
02155500	Incremental subbasin on the Pacolet River near Fingerville, SC	Gaged	PAC_i	794.2	218.2	42.21	4.59	53.64	3904	2363	7.56	718.6	1051	121.1	9278
02154500	North Pacolet River near Fingerville, SC	Gaged	NPAC	178.8	373.1	92.7	34.2	217.4	18318	5614	50.67	1969	2886	685.1	30418
NA	NA	Watershed	Upper Pacolet	304.2	181.4	15.03	3.6	29.88	2441	2394	14.04	478.1	676.8	19.53	6557

Appendix 2-B. Land use within selected watersheds in the Pacolet River Basin in 1992 and 2001, northwestern South Carolina and southwestern North Carolina.—Continued

NWIS station number	Station name	Site type	MAP ID	Change in land use computed as 2001 – 1992 National Land Cover Data, in percent										
				Open water	Low intensity residential	High intensity residential	Commercial/ Industrial/ Transportation	Barren/ Transi-tional	Forest	Hay/ Pasture	Row Crops	Natural shrub/ Grasslands	Urban/ Recreational grasses	Wetlands
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	Synoptic	S-1	3.0	0.40	0	0	1.6	–64.9	52.9	–1.6	7.8	3.6	–2.8
3506060820214	Unnamed Tributary at Fagen Drive near Fingerville, SC	Synoptic	S-2	0.79	5.2	1.1	–0.07	0.86	–28.1	17.9	–18.8	9.5	11.7	–0.14
3506060820409	Unnamed Tributary at Millerfarm Road above New Prospect, SC	Synoptic	S-3	0	–0.26	1.0	–10.2	0	4.1	16.5	–24.7	2.4	11.3	–0.20
3505560820626	Unnamed Tributary at Dickson Road below Campobello, SC	Synoptic	S-4	0.25	0.16	0.50	–0.25	0.25	–17.6	19.6	–28.5	14.8	9.8	1.1
3507300820702	Alexander Creek at Page Road near Campobello, SC	Synoptic	S-5A	0.70	0.46	1.0	–0.97	0.81	–16.1	19.5	–20.5	6.6	7.4	0.97
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	Synoptic	S-6	0.18	–0.68	0.39	–2.5	1.1	–13.6	13.6	–15.5	8.8	7.5	0.51
3506570820116	Unnamed Tributary at unnamed Road near Fingerville, SC	Synoptic	S-7	0	–1.2	0	0	0	–34.7	17.6	–28.8	35.9	11.8	–0.59
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	Synoptic	S-8	0	–13.4	0	0	17.9	–20.9	11.9	–20.9	6.0	19.4	0
02154790	South Pacolet River near Campobello, SC	Gaged	SPAC	0.28	–0.05	0.19	–0.48	–0.53	–13.4	11.5	–17.0	8.0	9.1	2.3
02155500	Incremental subbasin on the Pacolet River near Fingerville, SC	Gaged	PAC_i	1.2	–0.85	0.28	–0.96	0.52	–13.4	13.3	–18.4	7.7	10.4	0.08
02154500	North Pacolet River near Fingerville, SC	Gaged	NPAC	0.80	–7.90	0.62	–4.2	1.93	–42.6	25.9	–26.5	20.2	26.0	5.8

Appendix 2-C. Spearman rank correlation coefficients and probability values (p value) of streamflow, nutrient, and suspended-sediment concentrations in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and the Pacolet River at streamgaging station 02155500 (PAC), Spartanburg County, South Carolina, September 2007 to August 2009.

[Corr. coef., correlation coefficient; correlations were considered signficant at p-value < 0.05]

Variables		Spearman rank correlation for South Pacolet River at streamgaging station 02154790 (SPAC)								
		Dissolved ammonia	Dissolved nitrate plus nitrite	Total organic nitrogen	Dissolved orthophosphate	Dissolved phosphorus	Total phosphorus	Total nitrogen	Actinomy-cetes	Suspended-sediment concentra-tions
Stream discharge	Corr. coef.	0.152	0.471	0.466	–0.585	0.51	0.441	0.581	0.664	0.317
	P value	0.517	0.0202	0.0218	0.00347	0.0129	0.0351	0.00302	0.00188	0.129
	Number of samples	20	24	24	23	23	23	24	19	24
Dissolved ammonia	Corr. coef.		0.63	0.431	0.0279	0.0368	0.186	0.565	–0.141	0.383
	P value		0.0029	0.0574	0.905	0.877	0.439	0.00944	0.629	0.114
	Number of samples		20	20	19	19	19	20	13	18
Dissolved nitrate plus nitrite	Corr. coef.			0.254	–0.0793	0.13	0.21	0.689	0.0417	0.334
	P value			0.226	0.716	0.548	0.333	0.000147	0.869	0.125
	Number of samples			24	23	23	23	24	17	22
Total organic nitrogen	Corr. coef.				–0.0177	0.571	0.768	0.775	0.758	0.694
	P value				0.933	0.00455	0.0000002	0.0000002	0.000124	0.000267
	Number of samples				23	23	23	24	17	22
Dissolved orthophos-phate	Corr. coef.					0.0331	0.0439	–0.0988	–0.276	0.138
	P value					0.88	0.841	0.649	0.275	0.537
	Number of samples					23	23	23	17	22
Dissolved phosphorus	Corr. coef.						0.601	0.539	0.746	0.621
	P value						0.0025	0.00819	0.000301	0.00204
	Number of samples						23	23	17	22
Total phosphorus	Corr. coef.							0.627	0.861	0.713
	P value							0.00137	0.0000002	0.000119
	Number of samples							23	17	22
Total nitrogen	Corr. coef.								0.57	0.696
	P value								0.0164	0.000245
	Number of samples								17	22
Actinomycetes	Corr. coef.									0.613
	P value									0.00533
	Number of samples									19

Appendix 2-C. Spearman rank correlation coefficients and probability values (p value) of streamflow, nutrient, and suspended-sediment concentrations in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and the Pacolet River at streamgaging station 02155500 (PAC), Spartanburg County, South Carolina, September 2007 to August 2009.—Continued

[Corr. coef., correlation coefficient; correlations were considered signficant at p-value < 0.05]

Variables		Spearman rank correlation for Pacolet River at streamgaging station 02155500 (PAC)							
		Dissolved ammonia	Dissolved nitrate plus nitrite	Total organic nitrogen	Dissolved orthophosphate	Dissolved phosphorus	Total phosphorus	Total nitrogen	Suspended-sediment concentrations
Stream discharge	Corr. coef.	0.347	–0.176	0.357	–0.677	–0.477	0.00455	0.248	0.214
	P value	0.182	0.438	0.11	0.00066	0.0288	0.98	0.274	0.334
	Number of samples	16	21	21	21	21	21	21	22
Dissolved ammonia	Corr. coef.		0.378	0.599	–0.0789	–0.214	0.247	0.728	0.624
	P value		0.143	0.0137	0.763	0.416	0.348	0.000988	0.0123
	Number of samples		16	16	16	16	16	16	15
Dissolved nitrate plus nitrite	Corr. coef.			0.0519	0.588	0.251	0.227	0.521	0.181
	P value			0.819	0.00511	0.269	0.317	0.0156	0.437
	Number of samples			21	21	21	21	21	20
Total organic nitrogen	Corr. coef.				–0.225	0.065	0.706	0.816	0.82
	P value				0.322	0.776	0.000244	0.0000002	0.0000002
	Number of samples				21	21	21	21	20
Dissolved orthophos-phate	Corr. coef.					0.589	0.191	0.0928	–0.094
	P value					0.00499	0.402	0.686	0.686
	Number of samples					21	21	21	20
Dissolved phosphorus	Corr. coef.						0.518	0.216	0.193
	P value						0.0162	0.34	0.41
	Number of samples						21	21	20
Total phosphorus	Corr. coef.							0.705	0.731
	P value							0.000257	0.000113
	Number of samples							21	20
Total nitrogen	Corr. coef.								0.755
	P value								0.0000002
	Number of samples								20

Appendix 2-C. Spearman rank correlation coefficients and probability values (p value) of streamflow, nutrient, and suspended-sediment concentrations in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02154500 (NPAC), and the Pacolet River at streamgaging station 02155500 (PAC), Spartanburg County, South Carolina, September 2007 to August 2009.—Continued

[Corr. coef., correlation coefficient; correlations were considered signficant at p-value < 0.05]

Variables		Spearman rank correlation for North Pacolet River at streamgaging station 02154500 (NPAC)							
		Dissolved ammonia	Dissolved nitrate plus nitrite	Total organic nitrogen	Dissolved orthophosphate	Dissolved phosphorus	Total phosphorus	Total nitrogen	Suspended-sediment concentrations
Stream discharge	Corr. coef.	0.159	0.129	0.549	–0.382	–0.385	0.265	0.434	0.435
	P value	0.524	0.561	0.00823	0.0779	0.0761	0.23	0.0431	0.0336
	Number of samples	18	22	22	22	22	22	22	24
Dissolved ammonia	Corr. coef.		0.569	0.0824	–0.318	–0.328	0.147	0.438	0.235
	P value		0.0137	0.742	0.195	0.181	0.552	0.068	0.356
	Number of samples		18	18	18	18	18	18	17
Dissolved nitrate plus nitrite	Corr. coef.			0.359	0.213	0.12	0.342	0.75	0.354
	P value			0.0996	0.337	0.589	0.118	0.0000002	0.113
	Number of samples			22	22	22	22	22	21
Total organic nitrogen	Corr. coef.				–0.0921	0.29	0.834	0.795	0.818
	P value				0.679	0.186	0.0000002	0.0000002	0.0000002
	Number of samples				22	22	22	22	21
Dissolved orthophosphate	Corr. coef.					0.527	–0.205	–0.0588	–0.306
	P value					0.0119	0.355	0.789	0.175
	Number of samples					22	22	22	21
Dissolved phosphorus	Corr. coef.						0.324	0.158	0.0475
	P value						0.138	0.479	0.832
	Number of samples						22	22	21
Total phosphorus	Corr. coef.							0.727	0.845
	P value							0.0000429	0.0000002
	Number of samples							22	21
Total nitrogen	Corr. coef.								0.74
	P value								0.0000154
	Number of samples								21

Appendix 3. Selected water-quality data for eight synoptic sites near Lake William C. Bowen and Municipal Reservoir #1 within the Pacolet River Basin (PAC_l) and at the South Pacolet River at streamgaging station 02154790 (SPAC), Spartanburg County, South Carolina, November 2008 and August 2009.

[USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; °C, degrees Celsius; nd, not determined; E, estimated; < , less than]

USGS station number	USGS station name	Map site identification (fig. 2)	Date of sample	Drainage area (hectares)	Streamflow (ft^3/s)	Dissolved oxygen (mg/L)	pH (standard units)	Specific conductance (µS/cm)	Water temperature (°C)
November 2008 synoptic sampling event									
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	S-1	11/13/08	44.0	Dry	nd	nd	nd	nd
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	S-2	11/13/08	126.9	1.73	8.4	6.5	53	11.3
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	S-3	11/13/08	137.3	1.06	8.6	6.55	93	11.4
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	S-4	11/13/08	1,028	1.52	8.1	6.64	56	11.3
3507300820702	Alexander Creek at Page Road near Campobello, SC	S-5A	11/13/08	1,049	2.68	8.3	6.75	54	12.0
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	S-6	11/14/08	585.3	1.06	6.9	6.62	52	13.1
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	S-7	11/14/08	15.5	0.10	nd	nd	nd	nd
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	S-8	11/14/08	5.18	Dry	nd	nd	nd	nd
02154790	South Pacolet River near Campobello, SC	SPAC	11/19/08	14,403	25	11.5	6.97	51	5.9
August 2009 synoptic sampling event									
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	S-1	8/5/09	44.0	Dry	nd	nd	nd	nd
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	S-2	8/5/09	126.9	0.26	7.7	5.03	46	19.0
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	S-3	8/5/09	137.3	0.34	7.6	6.19	58	21.9
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	S-4	8/5/09	1,028	1.61	6.1	6.2	53	21.8
3507300820702	Alexander Creek at Page Road near Campobello, SC	S-5A	8/5/09	1,049	2.24	7.0	6.05	48	23.2
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	S-6	8/5/09	585.3	0.34	7.7	6.26	47	21.7
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	S-7	8/5/09	15.5	0.03	5.4	5.31	43	20.2
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	S-8	8/5/09	5.18	Dry	nd	nd	nd	nd
02154790	South Pacolet River near Campobello, SC	SPAC	8/5/09	14,403	37	7.5	6.17	48	21.0

Appendix 3. Selected water-quality data for eight synoptic sites near Lake William C. Bowen and Municipal Reservoir #1 within the Pacolet River Basin (PAC_i) and at the South Pacolet River at streamgaging station 02154790 (SPAC), Spartanburg County, South Carolina, November 2008 and August 2009.—Continued

[USGS, U.S. Geological Survey; ft³/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; °C, degrees Celsius; nd, not determined; E, estimated; < , less than]

USGS station number	USGS station name	Suspended sediment		Dissolved ammonia (mg/L)	Dissolved nitrate plus nitrite (mg/L)	Dis-solved nitrite (mg/L)	Total organic nitrogen (mg/L)	Dissolved orthophos-phate (mg/L)	Total phospho-rus (mg/L)	Total nitrogen (mg/L)	Total nitrogen to total phospho-rus ratio
		Percent finer than 63 microns	Concen-tration (mg/L)								
November 2008 synoptic sampling event											
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	43	126	nd	nd	nd	nd	nd	nd	nd	nd
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	86	310	nd	nd	nd	nd	nd	nd	nd	nd
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	81	7	nd	nd	nd	nd	nd	nd	nd	nd
3507300820702	Alexander Creek at Page Road near Campobello, SC	32	29	nd	nd	nd	nd	nd	nd	nd	nd
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	97	4	nd	nd	nd	nd	nd	nd	nd	nd
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	49	168	nd	nd	nd	nd	nd	nd	nd	nd
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
02154790	South Pacolet River near Campobello, SC	83	3	E0.014	0.097	<0.002	E0.098	E0.005	0.011	0.21	19
August 2009 synoptic sampling event											
3506070820026	Municipal Reservoir #1 at the River Oak Golf Course below Fingerville, SC	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3506060820214	Unnamed tributary at Fagen Drive near Fingerville, SC	55	8	E0.020	0.261	E0.001	E0.005	E0.007	E0.004	0.29	65
3506060820409	Unnamed tributary at Millerfarm Road above New Prospect, SC	55	11	<0.020	0.976	0.004	0.071	E0.007	0.014	1.05	75
3505560820626	Unnamed tributary at Dickson Road below Campobello, SC	96	4	0.063	0.294	E0.002	0.074	E0.004	E0.006	0.43	71
3507300820702	Alexander Creek at Page Road near Campobello, SC	87	18	0.054	0.225	0.003	0.173	E0.007	0.024	0.45	19
3507040820452	Turkey Creek on Foster Road near New Prospect, SC	88	34	0.025	0.217	E0.002	0.143	<0.008	0.019	0.39	20
3506570820116	Unnamed tributary at unnamed Road near Fingerville, SC	93	12	0.031	0.202	E0.002	0.243	E0.006	0.180	0.48	3
3506540820019	Municipal Reservoir #1 at Timberlake Drive near Fingerville, SC	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
02154790	South Pacolet River near Campobello, SC	nd	nd	0.033	0.209	0.002	0.193	E0.005	0.030	0.44	15

Appendix 4-A. S-LOADEST output of estimated annual flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.

[kg/d, kilograms per day; NDAYS, number of days]

Suspended Sediment

Suspended sediment annual flux and loads			SPAC [South Pacolet River (02154790)]					
Time step	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)
WaterYearEnding.2006	2006	365	62,355	38,628,878,354	898.0	391,404	197,799	22,759,740
WaterYearEnding.2007	2007	365	151,335	171,026,401,734,273	5.0264	610,066	13,077,823	55,237,401
WaterYearEnding.2008	2008	366	1,684	217,113	814.6	3,098	591	616,208
WaterYearEnding.2009	2009	365	16,872	1,960,816,821	355.4	100,625	44,510	6,158,357

Suspended Sediment—Continued

Suspended sediment annual flux and loads			NPAC [North Pacolet River (021545000)]					
Time step	Water year	NDAYS	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	33,199	370,119,339	8,520	90,082	21,925	12,117,687
WaterYearEnding.2007	2007	365	55,087	6,288,970,262	3,645	256,476	82,565	20,106,801
WaterYearEnding.2008	2008	366	5,325	2,744,655	2,094	11,264	2,395	1,948,947
WaterYearEnding.2009	2009	365	14,795	31,607,831	6,300	29,709	6,090	5,400,100

Suspended Sediment—Continued

Suspended sediment annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
Time step	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/season	Percent of SPAC load
WaterYearEnding.2006	2006	365	27,452	305,679,895	6,628	76,905	18,990	10,020,091	–24,857,336	–109.2
WaterYearEnding.2007	2007	365	21,668	384,891,109	3,254	75,734	20,618	7,908,967	–67,435,235	–122.1
WaterYearEnding.2008	2008	366	5,649	5,865,067	1,677	14,151	3,315	2,067,570	–497,585	–80.7
WaterYearEnding.2009	2009	365	16,957	63,222,027	6,015	38,258	8,470	6,189,150	–5,369,308	–87.2

Dissolved Orthophosphate

Dissolved orthophosphate annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
Time step	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	1.05	0.0142	0.829	1.30	0.122	382	3.19	0.0413	2.80	3.62	0.208	1,170
WaterYearEnding.2007	2007	365	1.42	0.202	0.732	2.49	0.453	517	3.32	0.0594	2.86	3.84	0.250	1,210
WaterYearEnding.2008	2008	366	0.471	0.000523	0.425	0.520	0.0241	172	2.11	0.0154	1.87	2.37	0.128	772
WaterYearEnding.2009	2009	365	0.762	0.00677	0.609	0.941	0.085	278	2.75	0.0290	2.42	3.11	0.176	1,005

Appendix 4-A. S-LOADEST output of estimated annual flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Dissolved Orthophosphate—Continued

Dissolved orthophosphate annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
Time step	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	3.15	0.0861	2.60	3.77	0.301	1,150	–402	–105
WaterYearEnding.2007	2007	365	3.49	0.266	2.58	4.63	0.525	1,280	–447	–86.5
WaterYearEnding.2008	2008	366	1.94	0.0212	1.66	2.25	0.151	709	–235	–136
WaterYearEnding.2009	2009	365	2.83	0.0664	2.34	3.38	0.266	1,030	–253	–91.0

Dissolved Phosphorus

Dissolved phosphorus annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC vari-ance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	1.34	0.0321	1.02	1.74	0.185	491	7.24	0.18	6.42	8.14	0.440	2,643
WaterYearEnding.2007	2007	365	1.43	0.0618	1.00	2.00	0.256	523	7.09	0.19	6.25	8.01	0.449	2,588
WaterYearEnding.2008	2008	366	0.485	0.00240	0.394	0.592	0.0506	178	4.85	0.07	4.34	5.41	0.273	1,776
WaterYearEnding.2009	2009	365	0.860	0.00887	0.684	1.07	0.0982	314	6.36	0.13	5.65	7.13	0.376	2,321

Dissolved Phosphorus—Continued

Dissolved phosphorus annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i load	
RowNames	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	8.07	0.599	6.63	9.73	0.792	2,945	–189	–38.4
WaterYearEnding.2007	2007	365	7.84	0.644	6.36	9.57	0.821	2,863	–248	–47.4
WaterYearEnding.2008	2008	366	4.83	0.147	4.10	5.66	0.396	1,769	–185	–104
WaterYearEnding.2009	2009	365	7.12	0.391	5.94	8.46	0.644	2,599	–35	–11.2

Total Nitrogen

Total organic nitrogen annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	113	430	77.0	160	21.2	41,206	196	295	163	234	18.1	71,496
WaterYearEnding.2007	2007	365	181	12,098	51.1	466	111	65,993	269	6,139	146	455	79.6	98,142
WaterYearEnding.2008	2008	366	39.0	5.49	34.3	44.0	2.47	14,265	93.4	37.1	81.3	107	6.5	34,185
WaterYearEnding.2009	2009	365	81.1	252	54.0	117	16.2	29,617	164	237	134	197	16.1	59,735

Appendix 4-A. S-LOADEST output of estimated annual flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Nitrogen—Continued

Total organic nitrogen annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	289	908	233	355	31.3	105,468	–7,233	–17.6
WaterYearEnding.2007	2007	365	436	52,336	146	1,019	230	159,053	–5,082	–7.70
WaterYearEnding.2008	2008	366	113	61.1	97.8	130	8.32	41,441	–7,008	–49.1
WaterYearEnding.2009	2009	365	255	1,505	186	342	39.9	93,144	3,792	12.8

Dissolved Nitrate plus Nitrite

Dissolved nitrate plus nitrite annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	45.9	13.6	38.9	53.7	3.776	16740.756	102	66.1	86.4	119	8.37	37,173
WaterYearEnding.2007	2007	365	54.7	33.4	43.9	67.3	5.972	19968.872	113	127	92.3	138	11.7	41,410
WaterYearEnding.2008	2008	366	23.9	2.181	21.0	27.0	1.535	8735.661	58.2	14.7	50.7	66.4	4.01	21,295
WaterYearEnding.2009	2009	365	35.6	6.918	30.6	41.3	2.755	13010.585	82.5	41.3	70.1	96.3	6.69	30,100

Dissolved Nitrate plus Nitrite—Continued

Dissolved nitrate plus nitrite annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Water year	NDAYS	PAC annual flux (kg/d)	PAC vari-ance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	115	96.4	96.7	136	10.1	42,041	–11,873	–70.9
WaterYearEnding.2007	2007	365	128	183	103	158	14.0	46,786	–14,593	–73.1
WaterYearEnding.2008	2008	366	61.5	17.0	53.5	70.4	4.31	22,511	–7,520	–86.1
WaterYearEnding.2009	2009	365	100	74.7	83.7	119	8.96	36,542	–6,569	–50.5

Total Organic Nitrogen

Total organic nitrogen annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	54.2	325	26.0	100	19.3	19,790	90.3	241	61.9	127	16.8	32,969
WaterYearEnding.2007	2007	365	60.9	595	25.4	124	25.7	22,246	97.3	404	61.8	146	21.6	35,507
WaterYearEnding.2008	2008	366	11.7	2.65	8.45	15.8	1.87	4,277	29.2	9.72	22.7	37.1	3.68	10,704
WaterYearEnding.2009	2009	365	28.2	42.3	17.0	44.1	6.98	10,292	62.4	75.3	46.2	82.4	9.25	22,763

Appendix 4-A. S-LOADEST output of estimated annual flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Organic Nitrogen—Continued

Total organic nitrogen annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	150	540	108	203	24.3	54,713	1,954	9.87
WaterYearEnding.2007	2007	365	170	1,377	106	259	39.1	62,032	4,280	19.2
WaterYearEnding.2008	2008	366	44.9	19.0	36.0	55.4	4.97	16,436	1,455	34.0
WaterYearEnding.2009	2009	365	113	241	83.9	148	16.4	41,118	8,063	78.3

Total Phosphorus

Total phosphorus annual flux and loads			SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Water year	NDAYS	SPAC annual flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/yr)	NPAC annual flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/yr)
WaterYearEnding.2006	2006	365	10.8	16.0	4.70	21.3	4.30	3,930	34.8	22.5	25.9	45.6	5.04	12,690
WaterYearEnding.2007	2007	365	10.2	15.5	4.37	20.4	4.18	3,726	32.4	23.3	23.6	43.4	5.08	11,817
WaterYearEnding.2008	2008	366	2.17	0.115	1.49	3.07	0.405	795	12.3	1.10	10.1	14.8	1.20	4,512
WaterYearEnding.2009	2009	365	5.07	1.36	3.05	7.95	1.26	1,852	23.5	6.62	18.7	29.3	2.72	8,594

Total Phosphorus—Continued

Total phosphorus annual flux and loads			PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Water year	NDAYS	PAC annual flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/yr)	kg/ season	Percent of SPAC load
WaterYearEnding.2006	2006	365	43.7	50.4	31.0	59.8	7.37	15,952	–667	–17.0
WaterYearEnding.2007	2007	365	40.3	64.0	26.5	58.9	8.30	14,710	–833	–22.4
WaterYearEnding.2008	2008	366	14.1	2.01	11.2	17.5	1.60	5,165	–142	–17.9
WaterYearEnding.2009	2009	365	30.2	15.6	22.9	39.1	4.13	11,024	579	31.2

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_I), Spartanburg County, South Carolina, water years (October–September) 2006–2009.

[kg/d, kilograms per day; NDAYS, number of days]

Suspended Sediment

Suspended sediment seasonal flux and loads				SPAC [South Pacolet River (02154790)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	7,751	14,046,737	2,619	18,008	4,054	713,094
SeasonEndingMarch2006	winter	2006	90	5,452	5,969,917	2,007	12,022	2,625	490,650
SeasonEndingJune2006	spring	2006	91	134,927	265,813,654,354	1,301	881,278	520,435	12,278,384
SeasonEndingSeptember2006	summer	2006	92	100,844	72,781,072,133	1,983	607,643	275,046	9,277,612
SeasonEndingDecember2006	fall	2007	92	39,639	5,105,985,114	1,779	204,262	72,270	3,646,831
SeasonEndingMarch2007	winter	2007	90	570,590	2,809,161,790,551,910	16.8	2,243,350	53,001,997	51,353,118
SeasonEndingJune2007	spring	2007	91	2,076	138,631	1,401	2,965	401	188,920
SeasonEndingSeptember2007	summer	2007	92	528	15,222	321.147	819	128	48,532
SeasonEndingDecember2007	fall	2008	92	687	18,489	408.620	1,086	174	63,221
SeasonEndingMarch2008	winter	2008	91	1,828	178,536	1,092	2,881	460	166,384
SeasonEndingJune2008	spring	2008	91	1,068	38,553	694	1,574	225	97,224
SeasonEndingSeptember2008	summer	2008	92	3,145	2,508,405	781	8,686	2,131	289,380
SeasonEndingDecember2008	fall	2009	92	777	27,324	435	1,287	219	71,513
SeasonEndingMarch2009	winter	2009	90	41,951	16,553,716,483	638	261,598	129,556	3,775,577
SeasonEndingJune2009	spring	2009	91	22,912	2,568,121,123	667	129,357	51,660	2,085,010
SeasonEndingSeptember2009	summer	2009	92	2,459	727,751	1,016	5,037	1,048	226,258

Suspended Sediment—Continued

Suspended sediment seasonal flux and loads				NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	20,190	68,036,006	7,472	44,376	9,671	1,857,492
SeasonEndingMarch2006	winter	2006	90	6,587	4,146,049	3,254	11,945	2,247	592,839
SeasonEndingJune2006	spring	2006	91	43,948	678,888,795	9,200	132,229	33,693	3,999,288
SeasonEndingSeptember2006	summer	2006	92	61,609	1,950,948,758	9,756	210,541	56,731	5,668,068
SeasonEndingDecember2006	fall	2007	92	46,749	1,352,183,052	8,285	152,046	40,078	4,300,888
SeasonEndingMarch2007	winter	2007	90	167,205	82,598,586,293	7,663	857,321	301,689	15,048,423
SeasonEndingJune2007	spring	2007	91	6,257	2,112,479	3,754	9,818	1,558	569,362
SeasonEndingSeptember2007	summer	2007	92	2,045	323,759	1,117	3,446	600	188,128
SeasonEndingDecember2007	fall	2008	92	2,209	346,356	1,110	3,955	735	203,196
SeasonEndingMarch2008	winter	2008	91	5,301	2,785,808	2,472	10,009	1,953	482,371
SeasonEndingJune2008	spring	2008	91	2,794	435,670	1,622	4,499	740	254,294
SeasonEndingSeptember2008	summer	2008	92	10,968	31,486,850	2,147	34,078	8,805	1,009,085
SeasonEndingDecember2008	fall	2009	92	2,859	880,135	1,055	6,297	1,374	263,050
SeasonEndingMarch2009	winter	2009	90	18,961	125,082,922	4,690	52,452	12,879	1,706,487
SeasonEndingJune2009	spring	2009	91	22,826	64,860,504	9,720	45,837	9,396	2,077,193
SeasonEndingSeptember2009	summer	2009	92	14,711	38,062,567	4,876	34,576	7,835	1,353,370

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Suspended Sediment—Continued

Suspended sediment seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	29,446	472,293,739	5,731	91,725	23,727	2,709,039	138,453	19.4
SeasonEndingMarch2006	winter	2006	90	9,446	31,372,025	2,591	24,731	5,920	850,184	–233,306	–47.6
SeasonEndingJune2006	spring	2006	91	32,552	671,394,112	4,154	121,511	34,134	2,962,255	–13,315,417	–108.4
SeasonEndingSeptember2006	summer	2006	92	38,028	656,214,781	7,375	118,666	30,719	3,498,613	–11,447,067	–123.4
SeasonEndingDecember2006	fall	2007	92	26,406	488,775,782	4,348	88,728	23,728	2,429,317	–5,518,402	–151.3
SeasonEndingMarch2007	winter	2007	90	46,959	3,428,437,018	3,804	205,674	63,320	4,226,325	–62,175,216	–121.1
SeasonEndingJune2007	spring	2007	91	9,416	12,884,224	4,030	18,845	3,853	856,841	98,559	52.2
SeasonEndingSeptember2007	summer	2007	92	4,310	3,523,482	1,640	9,306	2,006	396,484	159,824	329.3
SeasonEndingDecember2007	fall	2008	92	3,183	1,962,814	1,037	7,558	1,722	292,857	26,440	41.8
SeasonEndingMarch2008	winter	2008	91	4,824	5,718,086	1,560	11,502	2,627	438,961	–209,794	–126.1
SeasonEndingJune2008	spring	2008	91	3,805	2,242,394	1,554	7,853	1,642	346,235	–5,283	–5.4
SeasonEndingSeptember2008	summer	2008	92	10,756	59,755,097	1,277	41,276	11,759	989,516	–308,949	–106.8
SeasonEndingDecember2008	fall	2009	92	2,746	1,620,541	873	6,613	1,518	252,614	–81,949	–114.6
SeasonEndingMarch2009	winter	2009	90	13,273	89,730,095	2,603	41,202	10,642	1,194,596	–4,287,468	–113.6
SeasonEndingJune2009	spring	2009	91	36,388	368,781,658	10,745	91,440	21,456	3,311,307	–850,896	–40.8
SeasonEndingSeptember2009	summer	2009	92	15,550	62,303,152	4,605	39,015	9,148	1,430,633	–148,995	–65.9

Dissolved Orthophosphate

Dissolved orthophosphate seasonal flux and loads				SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	1.1341	0.0086	0.9530	1.3394	0.0986	104.3370	3.1458	0.1022	2.5457	3.8445	0.3317	289.4109
SeasonEndingMarch2006	winter	2006	90	1.1848	0.0086	1.0036	1.3892	0.0984	106.6339	3.8208	0.1249	3.1501	4.5917	0.3681	343.8730
SeasonEndingJune2006	spring	2006	91	0.9195	0.0311	0.6052	1.3405	0.1885	83.6708	3.3082	0.0789	2.7629	3.9294	0.2978	301.0501
SeasonEndingSeptember2006	summer	2006	92	0.9508	0.0194	0.6900	1.2781	0.1505	87.4720	2.5149	0.0644	2.0344	3.0746	0.2657	231.3736
SeasonEndingDecember2006	fall	2007	92	1.3611	0.0522	0.9552	1.8823	0.2373	125.2215	3.2254	0.1232	2.5664	4.0020	0.3667	296.7401
SeasonEndingMarch2007	winter	2007	90	3.3797	2.5684	1.2505	7.4294	1.6192	304.1767	5.4462	0.3679	4.3140	6.7844	0.6311	490.1554
SeasonEndingJune2007	spring	2007	91	0.6989	0.0016	0.6175	0.7880	0.0435	63.6014	3.3161	0.0795	2.7734	3.9336	0.2962	301.7653
SeasonEndingSeptember2007	summer	2007	92	0.2621	0.0002	0.2318	0.2953	0.0162	24.1147	1.3518	0.0169	1.1065	1.6352	0.1350	124.3687
SeasonEndingDecember2007	fall	2008	92	0.3663	0.0003	0.3278	0.4081	0.0205	33.7039	1.6158	0.0173	1.3587	1.9073	0.1401	148.6558
SeasonEndingMarch2008	winter	2008	91	0.7763	0.0021	0.6834	0.8783	0.0497	70.6461	3.2327	0.0847	2.6755	3.8714	0.3054	294.1764
SeasonEndingJune2008	spring	2008	91	0.4465	0.0005	0.3992	0.4977	0.0251	40.6297	2.3668	0.0441	1.9634	2.8283	0.2208	215.3743
SeasonEndingSeptember2008	summer	2008	92	0.2971	0.0003	0.2539	0.3456	0.0234	27.3358	1.2401	0.0136	1.0148	1.5004	0.1240	114.0858
SeasonEndingDecember2008	fall	2009	92	0.3924	0.0003	0.3510	0.4373	0.0220	36.1035	1.5787	0.0167	1.3259	1.8656	0.1378	145.2445
SeasonEndingMarch2009	winter	2009	90	1.1857	0.0444	0.8120	1.6736	0.2207	106.7169	3.4363	0.0999	2.8265	4.1382	0.3349	309.2634
SeasonEndingJune2009	spring	2009	91	1.0202	0.0120	0.8074	1.2719	0.1187	92.8378	4.1161	0.1338	3.4127	4.9215	0.3853	374.5682
SeasonEndingSeptember2009	summer	2009	92	0.4599	0.0005	0.4096	0.5145	0.0268	42.3082	1.9082	0.0315	1.5685	2.2995	0.1867	175.5537

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Dissolved Orthophosphate—Continued

Dissolved orthophosphate seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/ season)	kg/ season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	3.7319	0.1458	2.9927	4.5981	0.4101	343.3354	–50.413	–48.3
SeasonEndingMarch2006	winter	2006	90	3.9400	0.1721	3.1477	4.8711	0.4403	354.6035	–95.903	–89.9
SeasonEndingJune2006	spring	2006	91	2.5243	0.0435	2.0857	3.0277	0.2405	229.7127	–155.008	–185.3
SeasonEndingSeptember2006	summer	2006	92	2.3948	0.0387	1.9926	2.8541	0.2200	220.3230	–98.523	–112.6
SeasonEndingDecember2006	fall	2007	92	3.6399	0.1688	2.8434	4.5906	0.4465	334.8738	–87.088	–69.5
SeasonEndingMarch2007	winter	2007	90	6.3730	2.7918	3.6740	10.3142	1.7077	573.5715	–220.761	–72.6
SeasonEndingJune2007	spring	2007	91	2.6826	0.0650	2.1875	3.2559	0.2729	244.1123	–121.254	–190.6
SeasonEndingSeptember2007	summer	2007	92	1.3296	0.0158	1.0858	1.6117	0.1343	122.3236	–26.160	–108.5
SeasonEndingDecember2007	fall	2008	92	1.6580	0.0168	1.3934	1.9582	0.1442	152.5400	–29.820	–88.5
SeasonEndingMarch2008	winter	2008	91	2.8922	0.0734	2.3616	3.5062	0.2923	263.1914	–101.631	–143.9
SeasonEndingJune2008	spring	2008	91	1.9261	0.0238	1.6138	2.2810	0.1704	175.2765	–80.728	–198.7
SeasonEndingSeptember2008	summer	2008	92	1.2840	0.0202	1.0099	1.6095	0.1532	118.1262	–23.296	–85.2
SeasonEndingDecember2008	fall	2009	92	1.6285	0.0163	1.3675	1.9245	0.1422	149.8185	–31.529	–87.3
SeasonEndingMarch2009	winter	2009	90	3.6669	0.1670	2.8743	4.6107	0.4437	330.0254	–85.955	–80.5
SeasonEndingJune2009	spring	2009	91	4.1653	0.2371	3.2368	5.2776	0.5215	379.0453	–88.361	–95.2
SeasonEndingSeptember2009	summer	2009	92	1.8803	0.0220	1.5779	2.2235	0.1648	172.9866	–44.875	–106.1

Dissolved Phosphorus

Dissolved phosphorus seasonal flux and loads				SPAC [South Pacolet River (02154790)]						NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC vari- ance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/ season)	NPAC seasonal flux (kg/d)	NPAC vari- ance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/ season)
SeasonEndingDecember2005	fall	2006	92	1.401	0.056	0.985	1.933	0.243	128.877	6.235	0.359	5.107	7.538	0.621	573.632
SeasonEndingMarch2006	winter	2006	90	1.203	0.038	0.858	1.642	0.201	108.306	7.051	0.379	5.878	8.388	0.641	634.545
SeasonEndingJune2006	spring	2006	91	1.218	0.041	0.817	1.748	0.238	110.822	8.590	0.480	7.243	10.114	0.733	781.691
SeasonEndingSeptember2006	summer	2006	92	1.552	0.085	1.025	2.256	0.316	142.761	7.100	0.449	5.828	8.567	0.699	653.211
SeasonEndingDecember2006	fall	2007	92	1.549	0.089	1.027	2.244	0.312	142.493	6.193	0.381	5.029	7.544	0.642	569.713
SeasonEndingMarch2007	winter	2007	90	3.030	0.517	1.818	4.755	0.754	272.681	9.603	0.986	7.741	11.777	1.031	864.255
SeasonEndingJune2007	spring	2007	91	0.882	0.011	0.689	1.112	0.108	80.248	8.479	0.466	7.163	9.965	0.715	771.555
SeasonEndingSeptember2007	summer	2007	92	0.299	0.002	0.225	0.389	0.042	27.524	4.155	0.144	3.435	4.982	0.395	382.295
SeasonEndingDecember2007	fall	2008	92	0.336	0.003	0.243	0.453	0.054	30.917	3.389	0.068	2.879	3.961	0.276	311.751
SeasonEndingMarch2008	winter	2008	91	0.753	0.013	0.546	1.012	0.119	68.478	6.150	0.275	5.142	7.297	0.550	559.676
SeasonEndingJune2008	spring	2008	91	0.479	0.004	0.365	0.619	0.065	43.622	6.173	0.275	5.167	7.316	0.549	561.716
SeasonEndingSeptember2008	summer	2008	92	0.376	0.003	0.270	0.510	0.061	34.616	3.728	0.114	3.080	4.471	0.355	342.935
SeasonEndingDecember2008	fall	2009	92	0.373	0.003	0.270	0.503	0.060	34.351	3.316	0.066	2.815	3.880	0.272	305.085
SeasonEndingMarch2009	winter	2009	90	1.130	0.039	0.769	1.604	0.214	101.719	6.460	0.314	5.377	7.696	0.592	581.370
SeasonEndingJune2009	spring	2009	91	1.283	0.028	0.966	1.671	0.180	116.727	10.225	0.727	8.582	12.089	0.895	930.450
SeasonEndingSeptember2009	summer	2009	92	0.665	0.008	0.496	0.873	0.097	61.157	5.474	0.229	4.558	6.521	0.501	503.626

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Dissolved Phosphorus—Continued

Dissolved phosphorus seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	8.935	1.991	6.422	12.109	1.455	821.985	119.476	92.7
SeasonEndingMarch2006	winter	2006	90	7.888	1.308	5.824	10.448	1.182	709.888	–32.963	–30.4
SeasonEndingJune2006	spring	2006	91	7.081	0.678	5.500	8.975	0.888	644.364	–248.149	–223.9
SeasonEndingSeptember2006	summer	2006	92	8.359	1.269	6.289	10.894	1.177	769.029	–26.943	–18.9
SeasonEndingDecember2006	fall	2007	92	8.335	1.723	5.990	11.298	1.358	766.792	54.586	38.3
SeasonEndingMarch2007	winter	2007	90	11.022	3.873	7.578	15.506	2.030	991.984	–144.951	–53.2
SeasonEndingJune2007	spring	2007	91	7.630	0.797	5.959	9.624	0.936	694.345	–157.458	–196.2
SeasonEndingSeptember2007	summer	2007	92	4.456	0.376	3.340	5.826	0.636	409.933	0.113	0.4
SeasonEndingDecember2007	fall	2008	92	4.017	0.222	3.132	5.075	0.497	369.591	26.923	87.1
SeasonEndingMarch2008	winter	2008	91	5.977	0.620	4.529	7.742	0.821	543.906	–84.248	–123.0
SeasonEndingJune2008	spring	2008	91	5.305	0.444	4.071	6.796	0.696	482.763	–122.575	–281.0
SeasonEndingSeptember2008	summer	2008	92	4.052	0.297	3.040	5.294	0.576	372.821	–4.731	–13.7
SeasonEndingDecember2008	fall	2009	92	3.907	0.214	3.041	4.944	0.486	359.452	20.016	58.3
SeasonEndingMarch2009	winter	2009	90	7.088	1.012	5.245	9.369	1.055	637.875	–45.213	–44.4
SeasonEndingJune2009	spring	2009	91	11.010	1.953	8.415	14.153	1.467	1001.890	–45.286	–38.8
SeasonEndingSeptember2009	summer	2009	92	6.521	0.688	4.986	8.380	0.868	599.954	35.170	57.5

Total Nitrogen

Total nitrogen seasonal flux and loads				SPAC [South Pacolet River (02154790)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	101.029	136.561	79.161	127.071	12.242	9294.637
SeasonEndingMarch2006	winter	2006	90	115.343	161.956	91.594	143.364	13.226	10380.834
SeasonEndingJune2006	spring	2006	91	125.586	1709.550	61.215	229.899	43.630	11428.325
SeasonEndingSeptember2006	summer	2006	92	109.804	680.118	64.976	174.180	28.064	10101.939
SeasonEndingDecember2006	fall	2007	92	142.165	1329.438	82.637	228.632	37.537	13079.139
SeasonEndingMarch2007	winter	2007	90	500.268	170751.962	92.982	1592.139	415.713	45024.086
SeasonEndingJune2007	spring	2007	91	69.940	30.985	59.139	82.135	5.871	6364.562
SeasonEndingSeptember2007	summer	2007	92	16.576	2.431	13.629	19.970	1.619	1524.974
SeasonEndingDecember2007	fall	2008	92	23.334	2.867	19.760	27.365	1.941	2146.718
SeasonEndingMarch2008	winter	2008	91	69.791	35.977	58.204	83.000	6.331	6350.940
SeasonEndingJune2008	spring	2008	91	40.100	10.214	33.756	47.285	3.454	3649.094
SeasonEndingSeptember2008	summer	2008	92	23.025	5.449	17.741	29.391	2.977	2118.260
SeasonEndingDecember2008	fall	2009	92	25.238	3.610	21.309	29.679	2.137	2321.888
SeasonEndingMarch2009	winter	2009	90	140.242	1877.764	72.714	245.617	44.619	12621.754
SeasonEndingJune2009	spring	2009	91	124.456	501.022	84.424	177.038	23.722	11325.454
SeasonEndingSeptember2009	summer	2009	92	36.389	15.332	28.825	45.329	4.216	3347.804

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Nitrogen—Continued

Total nitrogen seasonal flux and loads				NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	206.704	693.991	157.856	265.920	27.622	19016.807
SeasonEndingMarch2006	winter	2006	90	192.948	383.770	155.853	236.200	20.522	17365.328
SeasonEndingJune2006	spring	2006	91	201.932	534.007	154.050	260.018	27.087	18375.785
SeasonEndingSeptember2006	summer	2006	92	181.931	648.754	131.058	246.109	29.435	16737.677
SeasonEndingDecember2006	fall	2007	92	289.672	3167.106	190.277	423.043	59.661	26649.800
SeasonEndingMarch2007	winter	2007	90	587.835	73782.791	221.416	1277.808	276.559	52905.164
SeasonEndingJune2007	spring	2007	91	152.920	200.016	125.842	184.083	14.873	13915.718
SeasonEndingSeptember2007	summer	2007	92	50.779	32.453	40.208	63.277	5.894	4671.670
SeasonEndingDecember2007	fall	2008	92	66.741	36.729	54.630	80.732	6.666	6140.170
SeasonEndingMarch2008	winter	2008	91	152.465	254.143	121.911	188.342	16.970	13874.300
SeasonEndingJune2008	spring	2008	91	92.661	75.032	75.912	111.998	9.216	8432.181
SeasonEndingSeptember2008	summer	2008	92	62.370	44.418	47.281	80.756	8.557	5738.084
SeasonEndingDecember2008	fall	2009	92	66.900	37.479	54.260	81.596	6.982	6154.809
SeasonEndingMarch2009	winter	2009	90	221.235	1468.015	152.261	310.961	40.637	19911.120
SeasonEndingJune2009	spring	2009	91	261.366	806.390	206.381	326.498	30.689	23784.274
SeasonEndingSeptember2009	summer	2009	92	107.444	208.187	80.185	141.014	15.554	9884.848

Total Nitrogen—Continued

Total nitrogen seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	393.336	3278.468	288.800	523.516	60.031	36186.868	7875.424	84.7
SeasonEndingMarch2006	winter	2006	90	317.060	1724.651	240.800	409.856	43.215	28535.360	789.198	7.6
SeasonEndingJune2006	spring	2006	91	227.433	1062.273	160.885	312.422	38.782	20696.397	–9107.712	–79.7
SeasonEndingSeptember2006	summer	2006	92	217.932	1210.028	154.000	299.640	37.274	20049.771	–6789.845	–67.2
SeasonEndingDecember2006	fall	2007	92	437.950	8952.574	274.581	663.962	99.913	40291.411	562.473	4.3
SeasonEndingMarch2007	winter	2007	90	1080.084	734902.412	212.609	3346.727	863.736	97207.568	–721.683	–1.6
SeasonEndingJune2007	spring	2007	91	171.846	300.256	138.964	210.155	18.183	15637.979	–4642.301	–72.9
SeasonEndingSeptember2007	summer	2007	92	64.306	62.023	49.851	81.648	8.126	5916.122	–280.522	–18.4
SeasonEndingDecember2007	fall	2008	92	89.054	79.863	71.653	109.399	9.641	8192.986	–93.902	–4.4
SeasonEndingMarch2008	winter	2008	91	185.470	451.451	145.401	233.172	22.427	16877.805	–3347.435	–52.7
SeasonEndingJune2008	spring	2008	91	99.003	95.551	80.178	120.912	10.404	9009.271	–3072.005	–84.2
SeasonEndingSeptember2008	summer	2008	92	80.014	77.992	59.930	104.688	11.444	7361.308	–495.036	–23.4
SeasonEndingDecember2008	fall	2009	92	86.557	75.233	69.406	106.656	9.515	7963.215	–513.481	–22.1
SeasonEndingMarch2009	winter	2009	90	356.468	6644.038	218.925	549.323	84.822	32082.159	–450.715	–3.6
SeasonEndingJune2009	spring	2009	91	450.934	7615.436	297.576	656.088	91.882	41035.019	5925.291	52.3
SeasonEndingSeptember2009	summer	2009	92	131.130	442.555	93.549	178.851	21.828	12063.936	–1168.716	–34.9

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Dissolved Nitrate plus Nitrite

Dissolved nitrate plus nitrite seasonal flux and loads				SPAC [South Pacolet River (02154790)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	45.421	25.720	35.981	56.579	5.262	4178.760
SeasonEndingMarch2006	winter	2006	90	63.071	33.547	52.035	75.751	6.056	5676.424
SeasonEndingJune2006	spring	2006	91	41.641	14.819	33.836	50.704	4.308	3789.338
SeasonEndingSeptember2006	summer	2006	92	33.655	18.401	25.652	43.369	4.529	3096.234
SeasonEndingDecember2006	fall	2007	92	48.486	38.178	36.968	62.462	6.517	4460.670
SeasonEndingMarch2007	winter	2007	90	120.532	276.394	89.813	158.404	17.539	10847.900
SeasonEndingJune2007	spring	2007	91	41.112	11.822	34.466	48.661	3.624	3741.184
SeasonEndingSeptember2007	summer	2007	92	9.990	0.715	8.359	11.846	0.890	919.117
SeasonEndingDecember2007	fall	2008	92	14.808	1.279	12.511	17.404	1.249	1362.379
SeasonEndingMarch2008	winter	2008	91	44.802	14.627	37.423	53.206	4.030	4076.977
SeasonEndingJune2008	spring	2008	91	25.747	4.816	21.455	30.642	2.346	2342.933
SeasonEndingSeptember2008	summer	2008	92	10.363	0.848	8.464	12.560	1.046	953.372
SeasonEndingDecember2008	fall	2009	92	15.957	1.539	13.476	18.761	1.349	1468.085
SeasonEndingMarch2009	winter	2009	90	55.668	30.029	44.822	68.342	6.008	5010.103
SeasonEndingJune2009	spring	2009	91	53.952	24.886	44.145	65.283	5.398	4909.588
SeasonEndingSeptember2009	summer	2009	92	17.639	2.740	14.450	21.321	1.755	1622.809

Dissolved Nitrate plus Nitrite—Continued

Dissolved nitrate plus nitrite seasonal flux and loads				NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	119.299	102.469	99.182	142.285	11.006	10975.467
SeasonEndingMarch2006	winter	2006	90	123.335	103.975	103.183	146.260	10.999	11100.172
SeasonEndingJune2006	spring	2006	91	87.924	44.512	73.818	103.930	7.688	8001.053
SeasonEndingSeptember2006	summer	2006	92	77.130	32.128	64.786	91.133	6.727	7095.953
SeasonEndingDecember2006	fall	2007	92	130.310	182.024	103.596	161.806	14.871	11988.521
SeasonEndingMarch2007	winter	2007	90	209.226	728.930	158.475	271.097	28.791	18830.354
SeasonEndingJune2007	spring	2007	91	84.834	34.665	72.740	98.354	6.539	7719.869
SeasonEndingSeptember2007	summer	2007	92	31.213	6.282	26.237	36.855	2.711	2871.576
SeasonEndingDecember2007	fall	2008	92	49.197	10.126	42.285	56.911	3.734	4526.143
SeasonEndingMarch2008	winter	2008	91	97.320	54.042	82.338	114.228	8.142	8856.101
SeasonEndingJune2008	spring	2008	91	55.289	12.717	47.678	63.763	4.106	5031.285
SeasonEndingSeptember2008	summer	2008	92	31.319	4.486	26.240	37.089	2.770	2881.303
SeasonEndingDecember2008	fall	2009	92	48.134	9.682	41.274	55.804	3.709	4428.369
SeasonEndingMarch2009	winter	2009	90	111.039	103.407	90.443	134.914	11.358	9993.506
SeasonEndingJune2009	spring	2009	91	116.996	104.285	96.585	140.435	11.198	10646.681
SeasonEndingSeptember2009	summer	2009	92	54.694	12.866	46.637	63.737	4.365	5031.835

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Dissolved Nitrate plus Nitrite—Continued

Dissolved nitrate plus nitrite seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	141.463	176.133	115.504	171.503	14.302	13014.566	–2139.660	–51.2
SeasonEndingMarch2006	winter	2006	90	151.806	195.791	124.637	183.125	14.936	13662.542	–3114.054	–54.9
SeasonEndingJune2006	spring	2006	91	86.457	44.542	72.114	102.808	7.837	7867.598	–3922.793	–103.5
SeasonEndingSeptember2006	summer	2006	92	81.477	33.963	69.143	95.366	6.694	7495.843	–2696.344	–87.1
SeasonEndingDecember2006	fall	2007	92	135.414	182.930	108.607	166.826	14.872	12458.127	–3991.063	–89.5
SeasonEndingMarch2007	winter	2007	90	250.330	1251.888	184.906	331.470	37.482	22529.664	–7148.589	–65.9
SeasonEndingJune2007	spring	2007	91	95.149	47.091	81.168	110.836	7.573	8658.570	–2802.483	–74.9
SeasonEndingSeptember2007	summer	2007	92	34.123	7.789	28.599	40.400	3.013	3139.341	–651.352	–70.9
SeasonEndingDecember2007	fall	2008	92	48.613	10.852	41.626	56.432	3.780	4472.406	–1416.116	–103.9
SeasonEndingMarch2008	winter	2008	91	104.385	64.408	88.112	122.779	8.851	9499.009	–3434.068	–84.2
SeasonEndingJune2008	spring	2008	91	60.833	16.214	52.329	70.318	4.592	5535.777	–1838.441	–78.5
SeasonEndingSeptember2008	summer	2008	92	32.650	5.475	27.287	38.756	2.928	3003.801	–830.874	–87.2
SeasonEndingDecember2008	fall	2009	92	47.296	10.407	40.446	54.969	3.707	4351.259	–1545.195	–105.3
SeasonEndingMarch2009	winter	2009	90	136.746	190.665	109.508	168.696	15.119	12307.139	–2696.469	–53.8
SeasonEndingJune2009	spring	2009	91	159.386	275.016	127.237	197.181	17.868	14504.152	–1052.117	–21.4
SeasonEndingSeptember2009	summer	2009	92	58.473	14.990	50.228	67.679	4.454	5379.542	–1275.101	–78.6

Total Organic Nitrogen

Total organic nitrogen seasonal flux and loads				SPAC [South Pacolet River (02154790)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	43.387	137.938	24.217	71.957	12.290	3991.602
SeasonEndingMarch2006	winter	2006	90	32.528	55.874	19.792	50.493	7.884	2927.521
SeasonEndingJune2006	spring	2006	91	64.977	806.679	21.532	152.738	34.612	5912.907
SeasonEndingSeptember2006	summer	2006	92	75.634	1045.309	27.410	168.411	36.994	6958.302
SeasonEndingDecember2006	fall	2007	92	58.014	429.205	26.319	111.635	22.132	5337.320
SeasonEndingMarch2007	winter	2007	90	158.613	6180.001	52.418	373.447	84.703	14275.146
SeasonEndingJune2007	spring	2007	91	23.046	16.825	15.737	32.606	4.320	2097.224
SeasonEndingSeptember2007	summer	2007	92	5.827	1.351	3.804	8.552	1.217	536.102
SeasonEndingDecember2007	fall	2008	92	6.465	1.438	4.182	9.560	1.379	594.787
SeasonEndingMarch2008	winter	2008	91	17.197	11.347	11.253	25.192	3.573	1564.892
SeasonEndingJune2008	spring	2008	91	10.742	3.836	7.171	15.484	2.130	977.560
SeasonEndingSeptember2008	summer	2008	92	12.386	13.727	5.407	24.461	4.951	1139.496
SeasonEndingDecember2008	fall	2009	92	7.396	2.012	4.720	11.055	1.625	680.413
SeasonEndingMarch2009	winter	2009	90	41.537	192.820	18.815	80.008	15.875	3738.289
SeasonEndingJune2009	spring	2009	91	44.742	116.615	25.267	73.553	12.426	4071.493
SeasonEndingSeptember2009	summer	2009	92	19.581	23.561	11.051	32.206	5.444	1801.451

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Organic Nitrogen—Continued

Total organic nitrogen seasonal flux and loads				NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC upper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	95.878	344.723	62.573	140.759	20.043	8820.791
SeasonEndingMarch2006	winter	2006	90	54.973	75.458	39.163	75.069	9.188	4947.584
SeasonEndingJune2006	spring	2006	91	94.116	358.429	55.613	149.461	24.118	8564.564
SeasonEndingSeptember2006	summer	2006	92	115.608	768.890	63.504	194.049	33.623	10635.931
SeasonEndingDecember2006	fall	2007	92	123.452	851.652	72.442	197.102	32.043	11357.565
SeasonEndingMarch2007	winter	2007	90	199.469	2813.820	106.775	341.286	60.451	17952.194
SeasonEndingJune2007	spring	2007	91	50.887	51.006	37.709	67.195	7.540	4630.707
SeasonEndingSeptember2007	summer	2007	92	17.025	7.097	12.198	23.137	2.799	1566.311
SeasonEndingDecember2007	fall	2008	92	19.677	7.364	14.286	26.441	3.109	1810.244
SeasonEndingMarch2008	winter	2008	91	41.003	40.470	29.048	56.255	6.963	3731.241
SeasonEndingJune2008	spring	2008	91	25.306	13.371	18.467	33.857	3.937	2302.814
SeasonEndingSeptember2008	summer	2008	92	31.082	42.509	16.549	53.392	9.499	2859.532
SeasonEndingDecember2008	fall	2009	92	20.569	9.220	14.200	28.838	3.748	1892.370
SeasonEndingMarch2009	winter	2009	90	68.502	171.922	43.550	102.712	15.176	6165.212
SeasonEndingJune2009	spring	2009	91	102.274	270.800	71.388	142.075	18.095	9306.908
SeasonEndingSeptember2009	summer	2009	92	58.682	132.991	36.790	88.969	13.389	5398.725

Total Organic Nitrogen—Continued

Total organic nitrogen seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	207.157	1779.743	133.440	307.355	44.597	19058.485	6246.092	156.5
SeasonEndingMarch2006	winter	2006	90	117.152	430.496	80.331	165.171	21.726	10543.708	2668.603	91.2
SeasonEndingJune2006	spring	2006	91	121.464	516.371	73.794	188.773	29.527	11053.229	–3424.242	–57.9
SeasonEndingSeptember2006	summer	2006	92	152.801	763.375	100.659	222.633	31.262	14057.656	–3536.577	–50.8
SeasonEndingDecember2006	fall	2007	92	205.460	2169.980	124.567	319.832	50.147	18902.342	2207.457	41.4
SeasonEndingMarch2007	winter	2007	90	373.475	11338.911	196.654	646.784	116.097	33612.748	1385.408	9.7
SeasonEndingJune2007	spring	2007	91	74.907	97.877	56.525	97.376	10.444	6816.573	88.642	4.2
SeasonEndingSeptember2007	summer	2007	92	29.352	19.898	21.266	39.514	4.668	2700.411	597.998	111.5
SeasonEndingDecember2007	fall	2008	92	34.497	21.319	25.479	45.683	5.167	3173.762	768.731	129.2
SeasonEndingMarch2008	winter	2008	91	62.946	93.502	45.128	85.495	10.328	5728.044	431.911	27.6
SeasonEndingJune2008	spring	2008	91	36.806	25.484	27.348	48.489	5.406	3349.363	68.989	7.1
SeasonEndingSeptember2008	summer	2008	92	45.486	61.980	27.244	71.480	11.364	4184.731	185.703	16.3
SeasonEndingDecember2008	fall	2009	92	32.436	20.214	23.580	43.540	5.106	2984.138	411.355	60.5
SeasonEndingMarch2009	winter	2009	90	128.125	650.026	81.741	191.571	28.170	11531.275	1627.773	43.5
SeasonEndingJune2009	spring	2009	91	209.993	1216.667	144.800	294.695	38.381	19109.400	5730.999	140.8
SeasonEndingSeptember2009	summer	2009	92	81.451	154.846	57.696	111.761	13.836	7493.497	293.322	16.3

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_I), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Phosphorus

Total phosphorus seasonal flux and loads				SPAC [South Pacolet River (02154790)]					
RowNames	Season	WY	NDAYS	SPAC seasonal flux (kg/d)	SPAC variance	SPAC lower.95	SPAC upper.95	SPAC SEP	SPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	8.325	5.585	4.497	14.148	2.487	765.863
SeasonEndingMarch2006	winter	2006	90	5.303	1.489	3.200	8.284	1.306	477.247
SeasonEndingJune2006	spring	2006	91	12.751	36.171	3.788	31.929	7.479	1160.300
SeasonEndingSeptember2006	summer	2006	92	16.593	59.706	5.471	39.123	8.880	1526.589
SeasonEndingDecember2006	fall	2007	92	10.566	14.406	4.743	20.478	4.084	972.051
SeasonEndingMarch2007	winter	2007	90	24.972	147.282	8.264	58.748	13.319	2247.499
SeasonEndingJune2007	spring	2007	91	4.224	0.658	2.792	6.137	0.857	384.372
SeasonEndingSeptember2007	summer	2007	92	1.330	0.067	0.873	1.945	0.275	122.406
SeasonEndingDecember2007	fall	2008	92	1.221	0.048	0.794	1.799	0.258	112.360
SeasonEndingMarch2008	winter	2008	91	2.786	0.309	1.799	4.125	0.597	253.518
SeasonEndingJune2008	spring	2008	91	1.905	0.139	1.232	2.818	0.407	173.361
SeasonEndingSeptember2008	summer	2008	92	2.783	0.832	1.113	5.821	1.228	256.013
SeasonEndingDecember2008	fall	2009	92	1.414	0.071	0.900	2.118	0.312	130.096
SeasonEndingMarch2009	winter	2009	90	6.623	4.737	2.961	12.872	2.573	596.065
SeasonEndingJune2009	spring	2009	91	7.921	3.739	4.424	13.131	2.241	720.834
SeasonEndingSeptember2009	summer	2009	92	4.401	1.404	2.354	7.533	1.335	404.869

Total Phosphorus—Continued

Total phosphorus seasonal flux and loads				NPAC [North Pacolet River (021545000)]					
RowNames	Season	WY	NDAYS	NPAC seasonal flux (kg/d)	NPAC variance	NPAC lower.95	NPAC pper.95	NPAC SEP	NPAC load (kg/season)
SeasonEndingDecember2005	fall	2006	92	39.586	41.805	27.786	54.734	6.898	3641.869
SeasonEndingMarch2006	winter	2006	90	20.477	7.889	15.294	26.857	2.957	1842.939
SeasonEndingJune2006	spring	2006	91	32.476	26.848	21.771	46.648	6.374	2955.300
SeasonEndingSeptember2006	summer	2006	92	46.192	75.252	29.640	68.747	10.029	4249.669
SeasonEndingDecember2006	fall	2007	92	44.332	69.161	29.382	64.273	8.941	4078.509
SeasonEndingMarch2007	winter	2007	90	55.283	134.688	34.414	84.289	12.800	4975.500
SeasonEndingJune2007	spring	2007	91	20.496	6.286	15.811	26.137	2.639	1865.161
SeasonEndingSeptember2007	summer	2007	92	9.756	1.793	7.299	12.777	1.401	897.579
SeasonEndingDecember2007	fall	2008	92	9.622	1.279	7.412	12.285	1.245	885.224
SeasonEndingMarch2008	winter	2008	91	15.111	4.050	11.311	19.780	2.165	1375.062
SeasonEndingJune2008	spring	2008	91	10.683	1.834	8.139	13.772	1.440	972.171
SeasonEndingSeptember2008	summer	2008	92	13.907	4.977	8.895	20.752	3.041	1279.485
SeasonEndingDecember2008	fall	2009	92	9.796	1.433	7.367	12.772	1.382	901.218
SeasonEndingMarch2009	winter	2009	90	22.042	11.897	15.391	30.610	3.896	1983.747
SeasonEndingJune2009	spring	2009	91	35.929	23.774	26.713	47.308	5.266	3269.499
SeasonEndingSeptember2009	summer	2009	92	26.512	17.879	18.377	37.044	4.779	2439.088

Appendix 4-B. S-LOADEST output of estimated seasonal flux and loads and associated variance, 95-percent confidence limits (Upper.95, Lower.95), and standard error of prediction (SEP) for selected constituents in the South Pacolet River at streamgaging station 02154790 (SPAC), North Pacolet River at streamgaging station 02145000 (NPAC), Pacolet River at streamgaging station 02155500 (PAC), and computed loads for the intervening drainage area between PAC site upstream to the NPAC and SPAC sites (PAC_i), Spartanburg County, South Carolina, water years (October–September) 2006–2009.—Continued

[kg/d, kilograms per day; NDAYS, number of days]

Total Phosphorus—Continued

Total phosphorus seasonal flux and loads				PAC [Pacolet River (02155500)]						PAC_i Load	
RowNames	Season	WY	NDAYS	PAC seasonal flux (kg/d)	PAC variance	PAC lower.95	PAC upper.95	PAC SEP	PAC load (kg/season)	kg/season	Percent of SPAC load
SeasonEndingDecember2005	fall	2006	92	61.911	178.478	38.914	93.674	14.050	5695.781	1288.049	168.2
SeasonEndingMarch2006	winter	2006	90	28.556	30.207	18.956	41.347	5.738	2570.031	249.845	52.4
SeasonEndingJune2006	spring	2006	91	30.805	34.600	18.753	47.799	7.458	2803.243	–1312.356	–113.1
SeasonEndingSeptember2006	summer	2006	92	53.081	100.972	34.738	77.754	11.026	4883.433	–892.825	–58.5
SeasonEndingDecember2006	fall	2007	92	57.233	170.487	34.922	88.646	13.795	5265.398	214.838	22.1
SeasonEndingMarch2007	winter	2007	90	70.263	419.680	36.968	121.751	21.868	6323.685	–899.313	–40.0
SeasonEndingJune2007	spring	2007	91	21.184	9.377	15.569	28.173	3.224	1927.785	–321.749	–83.7
SeasonEndingSeptember2007	summer	2007	92	12.967	4.714	9.095	17.941	2.264	1192.983	172.998	141.3
SeasonEndingDecember2007	fall	2008	92	12.877	3.477	9.339	17.319	2.042	1184.661	187.076	166.5
SeasonEndingMarch2008	winter	2008	91	15.770	6.861	11.035	21.862	2.772	1435.050	–193.530	–76.3
SeasonEndingJune2008	spring	2008	91	10.937	2.767	7.895	14.771	1.759	995.311	–150.221	–86.7
SeasonEndingSeptember2008	summer	2008	92	16.845	8.572	10.469	25.717	3.913	1549.750	14.251	5.6
SeasonEndingDecember2008	fall	2009	92	12.035	3.168	8.674	16.273	1.944	1107.202	75.888	58.3
SeasonEndingMarch2009	winter	2009	90	27.805	33.313	17.511	42.006	6.285	2502.495	–77.317	–13.0
SeasonEndingJune2009	spring	2009	91	49.746	73.041	34.155	70.060	9.194	4526.897	536.564	74.4
SeasonEndingSeptember2009	summer	2009	92	31.384	26.597	21.800	43.776	5.626	2887.358	43.401	10.7

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