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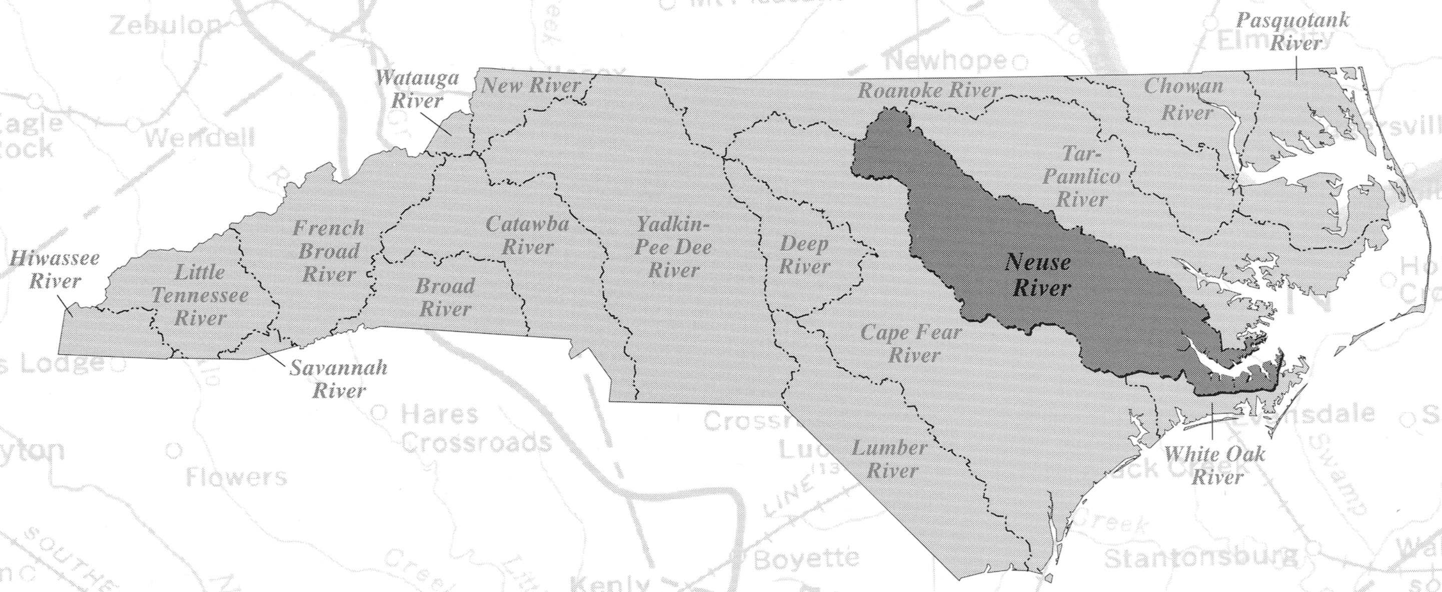
Low-Flow Characteristics and Discharge Profiles for Selected Streams in the Neuse River Basin, North Carolina

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 98-4135



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GLOSSARY

Base flow. The contribution of flow to a stream from ground water or spring discharge.

Climatic year. A continuous 12-month period during which a complete annual cycle occurs. In low-flow analyses in North Carolina, the climatic year typically is from April 1 through March 31, designated by the calendar year in which the climatic year begins. For example, the 1996 climatic year is the period from April 1, 1996, to March 31, 1997. The year begins and ends during the period of increased flows so that all flows during a single dry season are included in annual values for that year.

Continuous-record gaging station. A site on a stream where continuous records of gage height are collected and for which discharge records are computed.

Drainage area. The drainage area of a stream at a specified location is that area, measured in a horizontal plane, which is enclosed by a drainage divide.

Gage height. The water-surface elevation referenced to an arbitrary gage datum, often used interchangeably with the term "stage."

Low flow. Base flow or sustained fair-weather flow.

Partial-record measuring site. A site on a stream where periodic discharge measurements are collected, usually for a period of years. The data collected at partial-record sites are often correlated with data at nearby continuous-record gaging stations to estimate low-flow characteristics at the partial-record sites.

Recurrence interval. The average interval of time within which the magnitude of an extreme event can be expected to be equaled or exceeded once. The primary recurrence intervals used in this report are 2 years and 10 years. For example, if the 7-day, 10-year low-flow discharge is 5 cubic feet per second (ft^3/s), then the annual minimum average discharge for a 7-consecutive-day period would be 5 ft^3/s or lower, on average, 1 time in 10 years, 5 times in 50 years, or 10 times in 100 years. While recurrence intervals indicate the frequency of occurrence for a particular hydrologic event, it should be noted that the event could occur more than once in a given year, in consecutive years, or not at all during the period specified by the recurrence interval.

Unit flow. Value of flow expressed in units of volume per time per square-mile drainage area. In this report, unit flow is expressed as cubic feet per second per square mile [$(ft^3/s)/mi^2$].

Water year. The 12-month period October 1 through September 30, designated by the calendar year in which the period ends. For example, the 1996 water year is the period from October 1, 1995, to September 30, 1996. Average discharge and flow-duration data are computed using the water-year time frame.

Zero-flow day. Day in which no flow occurred at a continuous-record gaging station as evidenced by a daily mean discharge of zero.

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CONVERSION FACTORS, TEMPERATURE, VERTICAL DATUM, AND ACRONYMS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	4,047	square meter
acre	0.4047	hectare
square mile (mi^2)	2.590	square kilometer
	Flow	
gallon per minute (gal/min)	0.06309	liter per second
million gallons per day (Mgal/d)	0.04381	cubic meter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer

Temperature: In this report, temperature is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by using the following equation:

$$°C = 5/9\ (°F - 32)$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Acronyms:

DWQ	Division of Water Quality
GIRAS	geographic information retrieval and analysis system
GIS	geographic information system
HA	hydrologic area
MOVE.1	Maintenance of Variance Extension
NPDES	National Pollution Discharge Elimination System
TM	Thematic Mapper
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

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ABSTRACT

An understanding of the magnitude and frequency of low-flow discharges is an important part of evaluating surface-water resources and planning for municipal and industrial economic expansion. Low-flow characteristics are summarized in this report for 50 continuous-record gaging stations and 113 partial-record measuring sites in the Neuse River Basin in North Carolina. Records of discharge collected through the 1996 water year were used in the analyses. Flow characteristics included in the summary are (1) average annual unit flow; (2) 7Q10 low-flow discharge, the minimum average discharge for a 7-consecutive-day period occurring, on average, once in 10 years; (3) 30Q2 low-flow discharge; (4) W7Q10 low-flow discharge, similar to 7Q10 discharge except that only flow during November through March is considered; and (5) 7Q2 low-flow discharge.

The potential for sustained base flows is relatively low in the upper and lower ends of the Neuse River Basin compared to the central part of the basin. Most soils in the upper part of the basin are derived from rocks of the Triassic basin. Typically, these soils tend to be poorly drained due to the presence of clay, which combined with the lower average rainfall amounts in the basin limits the infiltration of water to surficial aquifers for release as sustained base flow during drought conditions. Among sites in the upper part of the basin having zero 7Q10 discharges, the drainage areas range from less than 0.01 to about 44 square miles. For sites in this area having non-zero 7Q10 discharges, the average 7Q10 unit low flow is about 0.005 cubic foot per second per square mile. Therefore, sites with drainage areas less than about 10 square miles could be expected to have zero or minimal 7Q10 discharges (less than 0.05 cubic foot per second).

In the lower part of the basin, the presence of poorly drained soils in combination with land slopes having little or no relief also serves to limit the potential for sustained base flows. On tributaries that drain to the Neuse River downstream from its confluence with Contentnea Creek, eight sites having drainage areas ranging from 2.5 to 27 square miles were determined to have zero 7Q10 discharges. For sites in this area having non-zero 7Q10 discharges, the average 7Q10 unit low flow is about 0.01 cubic foot per second per square mile. Therefore, sites with drainage areas less than about 5 square miles could be expected to have zero or minimal 7Q10 discharges (less than 0.05 cubic foot per second).

In the central part of the basin where moderately and well-drained soils are predominant, sites having 7Q10 discharges of zero were noted on a more widespread basis and across a large range in drainage area. Drainage areas ranged from about 1 to nearly 82 square miles. Where the predominant factor at sites in the upper and lower ends of the study area is poorly drained soils, the magnitudes of low flows in the central section appear to be affected by a combination of factors that include soils, degree of terrain slope, and drainage area.

Drainage area and low-flow discharge profiles are presented for 10 streams in the Neuse River Basin; these profiles reflect a wide range in subbasin size, characteristics, and streamflow conditions. The selected streams are Perry Creek, Walnut Creek (Wake County), Poplar Creek, Swift Creek (Wake and Johnston Counties), Little River, Walnut Creek (Wayne County), Contentnea Creek, the Neuse River, Swift Creek (Pitt and Craven Counties), and the Trent River. The drainage-area profiles show downstream increases in basin size. At the mouths of streams profiled, the drainage areas range from 9 square miles to about 5,600 square miles. Low-flow discharge profiles for each stream include 7Q10, 30Q2, W7Q10, and 7Q2 discharges with contributions from major tributaries included. In the lower reaches of the Neuse River and Swift Creek (Pitt and Craven Counties) as well as much of the Trent River, low-flow discharges consist of ground-water discharge from the Castle Hayne aquifer, the most productive of the 10 aquifers in North Carolina in terms of yield, a factor attributed to the extensive occurrence of porous limestone in the aquifer.

INTRODUCTION

The need for a better understanding of low-flow hydrology and for improved techniques in determining low-flow characteristics of streams has become more critical as demands for sustained, high-quality water supplies and effective waste assimilation have increased. The simultaneous occurrence of these higher demands and recent droughts in North Carolina have increased awareness of the importance of determining low-flow characteristics.

Low flow, also referred to as base flow or sustained fair-weather flow, is composed largely of ground-water discharge from aquifers into streams. Discharges from aquifers have large spatial and temporal variations that are highly dependent on topographic, geologic, and climatic conditions in a drainage basin. The high variability of such conditions across North Carolina—and sometimes even within a drainage basin or along the same stream—results in a complex low-flow hydrology. Moreover, the characterization of low-flow hydrology is further complicated by withdrawals, point-source discharges, impoundments, and development within the drainage basin. Low flows in North Carolina typically occur at the conclusion of the growing season in late summer and early autumn, following maximum use of ground water by crops and other plants. Additionally, higher temperatures during the summer and early autumn seasons cause increased human consumption of water which, in turn, causes a higher demand for withdrawals from streams and reservoirs.

An understanding of low-flow characteristics is crucial in the evaluation of water-supply potential and reservoir-release requirements, the determination of wastewater discharges to streams, and the maintenance of aquatic habitats in streams. Where sufficient records of discharge are available at continuous- and partial-record sites, application of statistical techniques, such as those described by Riggs (1972), forms the basis for determining low-flow characteristics. However, the number of sites for which sufficient record exists to determine low-flow characteristics is far outnumbered by those locations where little or no record is available for developing low-flow estimates.

Low-flow characteristics are defined by a set of statistically derived discharge values having an associated duration and recurrence interval (or probability of occurrence). For example, the 7-day, 10-year low-flow discharge (hereafter referred to as 7Q10 discharge) is the annual lowest mean streamflow over a 7-consecutive-day period which, on average, will be exceeded in 9 out of 10 years. Stated another way, the probability is 10 percent (the inverse of the recurrence interval) that the lowest average 7-consecutive-day flow in any year will be less than the 7Q10 discharge (Giese and Mason, 1993). If the 7Q10 discharge is 5 cubic feet per second (ft^3/s), then the annual minimum average discharge for a 7-consecutive-day period would be 5 ft^3/s or lower, on average, 1 time in 10 years, 5 times in 50 years, or 10 times in 100 years.

In North Carolina, other low-flow statistics used by State regulatory agencies in determining permitting limits for withdrawals from and discharges to streams include the 30Q2, W7Q10, and 7Q2 discharges. The W7Q10 discharge, or "winter 7Q10," is defined in a similar manner as the 7Q10 discharge except that only flow during the months of November through March is considered in the analysis.

In 1991, the Division of Water Quality (DWQ, formerly the Division of Environmental Management) of the North Carolina Department of Environment and

Natural Resources, began using a basinwide approach in its assessment and management of water quality and, in particular, permitting of point-source discharges. This approach is being applied sequentially to each of the 17 major river basins in the State (fig. 1) so that all point-source discharges in a basin are permitted simultaneously. The process is repeated for each basin at 5-year intervals. In conjunction with the basinwide approach, the U.S. Geological Survey (USGS), in cooperation with the DWQ, has conducted studies to define low-flow characteristics and develop flow profiles for selected streams in a number of river basins (Weaver, 1996, 1997).

Purpose and Scope

This report presents low-flow characteristics for streams in the Neuse River Basin in North Carolina. Low-flow characteristics at existing stream-gaging stations are summarized, and drainage area and low-flow discharge profiles for selected streams in the Neuse River Basin are presented. Descriptions of a number of basin characteristics, such as impoundments, flow diversions, climate, geology, soils, and land use, are included along with a discussion of their effects on low flows.

Low-flow characteristics are summarized for 50 continuous-record gaging stations and for 113 partial-record measuring sites; statistics include the average annual unit flow and the 7Q10, 30Q2, W7Q10, and 7Q2 discharges. Although the period of record varies from site to site, records of discharge collected through the 1996 water year were used in the analyses for this report. The number of zero-flow days and discharge measurements for continuous- and partial-record sites, respectively, also are included.

Drainage area and low-flow discharge profiles are presented for 10 selected streams in the Neuse River Basin. The 10 streams were identified by DWQ from a list of streams that were prioritized on the basis of water-quality issues being addressed as well as basin characteristics being represented. The streams drain areas that reflect a wide range of basin size, characteristics, and streamflow conditions. The selected streams include Perry Creek, Walnut Creek (Wake County), Poplar Creek, Swift Creek (Wake and Johnston Counties), Little River, Walnut Creek (Wayne County), Contentnea Creek, the Neuse River, Swift Creek (Pitt and Craven Counties), and the Trent River. Discharge profiles show the relation of 7Q10, 30Q2, W7Q10, and 7Q2 discharges to river mileage for the streams.

Previous Low-flow Studies

Prior to World War II, low-flow characteristics of North Carolina streams were determined only for sites operated as continuous-record gaging stations. With the economic expansion after World War II, the USGS began to receive an increasing number of requests for

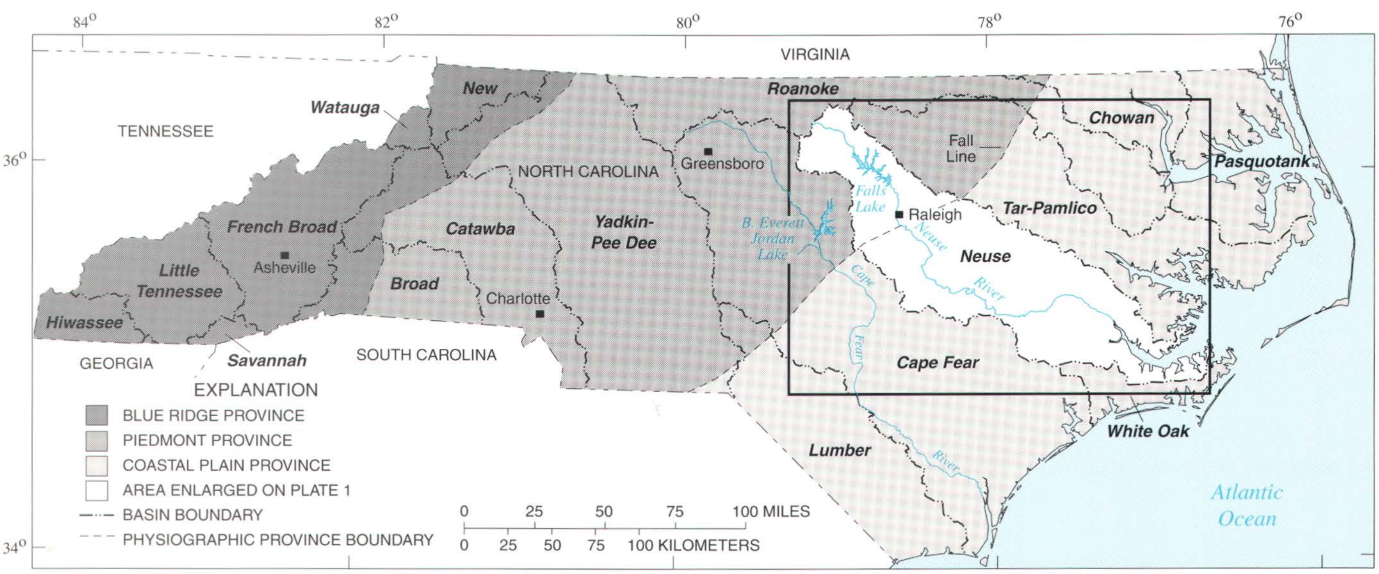

Figure 1. Locations of major river basins, the Neuse River Basin, and physiographic provinces in North Carolina.

hydrologic information for sites where no data previously had been collected (Yonts, 1971). Thus, the USGS expanded its data-collection program in the late 1940's to include partial-record measuring sites where discharge measurements were made on a periodic basis. Discharge measurements made under base-flow conditions along with observations of zero flow became the foundation of data used in the initial assessments of low-flow characteristics of streams in North Carolina. With data available from the network of partial-record measuring sites, the USGS began to respond to requests for low-flow characteristics on a site-specific basis, including those for ungaged sites.

Estimates of low-flow discharges continue to be provided, upon request, to other government agencies and private corporations. These estimates are used in assessing the capacity of streams to receive wastewater discharges and to provide withdrawals for water supply. Estimates generally are provided on a site-specific basis with little consideration of previously determined low-flow statistics upstream or downstream from the site identified in the request. In some instances, for a given stream, this has led to inconsistencies in estimates of low-flow discharges for adjacent sites.

A limited number of studies have been conducted to investigate low flows for streams in North Carolina. Goddard (1963) presented low-flow characteristics for many continuous-record gaging stations in North Carolina, along with drainage area and 7Q10 discharge profiles developed for selected mainstem rivers. Yonts (1971) reported base-flow measurements made at over 2,200 continuous-record gaging stations and partial-record measuring sites throughout the State.

Giese and Mason (1993) evaluated low-flow characteristics at 122 continuous-record gaging stations and 396 partial-record measuring sites with drainage areas between 1 and 400 square miles (mi^2) and streamflows unaffected by regulation or diversions. Sites were characterized on the basis of similarity in their ranges of low-flow discharges and potential to sustain base flow. Ten hydrologic areas (HA's) were delineated, and regression equations, which related low flows to basin characteristics, were derived to determine flow characteristics at ungaged sites (fig. 2). Equations for only 4 of the 10 areas—HA10, representing the mountains and western Piedmont; HA3, the Sand Hills; and HA5 and HA9, the eastern and central Piedmont, respectively—had standard

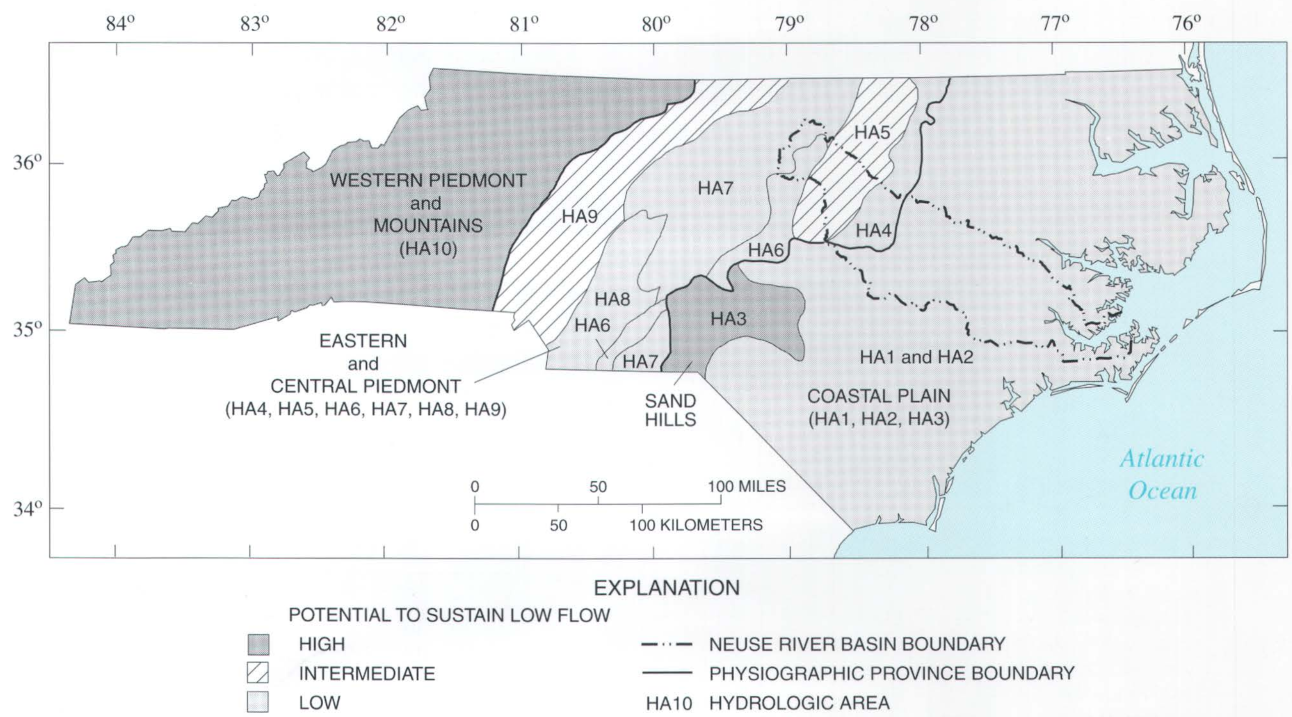

Figure 2. Hydrologic areas (HA's) of similar potential to sustain low flows in North Carolina (modified from Giese and Mason, 1993).

errors that were considered small enough to permit use of the equations in estimating low-flow characteristics at the ungaged sites. The large standard errors computed for equations in the remaining HA's reflect the complex relation between low-flow hydrology and geologic, topographic, and climatic factors. High standard errors for low-flow regression equations also were reported in a 1970 comprehensive study of low flows in which 47 USGS Districts participated (each District representing the State in which it is located) (Riggs, 1973). Some Districts reported standard errors well in excess of 100 percent, and others were unable to derive useful low-flow relations.

Evett (1994) investigated the effects of urbanization and land-use changes on low flows. Negative trends in low flows were detected from data at selected continuous-record gaging stations in the Asheville, Charlotte, Greensboro, and Raleigh municipalities (fig. 1) as well as gaging stations in nearby rural areas. While the conclusions tended to support the investigation's hypothesis of decreasing low flows with increasing urbanization, Evett (1994) described the results as being statistically inconclusive.

Weaver (1996) conducted a study of low-flow characteristics in the Roanoke River Basin as part of the DWQ's program of basinwide assessment and management of water quality in major river basins in North Carolina. Low-flow characteristics were summarized for 82 streamflow sites in North Carolina (79 sites) and Virginia (3 sites), and profiles of drainage area and low-flow discharge were developed for 10 selected streams that vary widely in basin size, characteristics, and streamflow conditions. The streams included were Town Fork Creek, Hogans Creek, Mayo River, Buffalo Creek, Smith River, Country Line Creek, Dan River, Marlowe Creek, Hyco River, and Roanoke River. Drainage-area profiles show increases in drainage areas as streams travel their course within the basin. At the mouths, drainage areas for profiled streams range from 22 mi^2 to about 9,700 mi^2. Low-flow discharges for each stream include 7Q10, 30Q2, W7Q10, and 7Q2 discharges in a continuous profile, and contributions from major tributaries also are included.

Weaver (1997) also investigated low-flow characteristics in the Deep River Basin in the central Piedmont Province of North Carolina. The Deep River drains slightly more than 1,440 mi^2 and is tributary to the Cape Fear River, a major river whose basin is located immediately south of the Neuse River Basin (fig. 1). Low-flow characteristics were summarized for 7 continuous-record gaging stations and 23 partial-record measuring sites. Drainage-area and low-flow discharge profiles were developed for the Deep River and are presented in a similar manner to those for the Roanoke River Basin (Weaver, 1996). The methods used for this study are the same as those previously used by Weaver (1996, 1997), and the presentation of results is similar to the previous presentation of results for the Roanoke and Deep Rivers.

Acknowledgments

The author acknowledges the staffs of the North Carolina Divisions of Water Quality and Water Resources for their assistance in compiling information about point-source discharge permits, water withdrawals, and impoundments. Likewise, additional information concerning flow diversions provided by many superintendents and operators at local water-treatment plants, as well as wastewater-treatment facilities in the Neuse River Basin, was helpful in the assessment of flow modifications on low-flow characteristics.

Finally, the author gratefully acknowledges the contributions of Mr. Steve Carlson and Mr. Gerald Strickland, of the U.S. Geological Survey, to the investigation of low-flow characteristics in the Neuse River Basin. Mr. Carlson's research into and efforts in compiling information about the geology and soils in the basin are the basis of much of the discussion on this subject. Mr. Strickland's development of the drainage-area profiles presented in this report are the foundation of the corresponding low-flow discharge profiles developed by the author.

DESCRIPTION OF THE NEUSE RIVER BASIN

The Neuse River Basin drains an area of about 5,600 mi^2 in parts of central eastern North Carolina (Seaber and others, 1987). The headwaters of the Neuse River begin in Orange and Person Counties, and the river flows in a general southeasterly direction through the Piedmont and Coastal Plain Provinces before entering the Pamlico Sound near Maw Point in Pamlico County (pl. 1). The nature of the drainage system within the Neuse River Basin varies greatly from the headwaters to the mouth.

Ground elevations in the Neuse River Basin decrease from northwest to southeast. Average elevations range from approximately 650 to 800 feet (ft) above sea level along the basin boundary in Orange and Person Counties to near sea level at New Bern and points downstream. The highest elevation in the Neuse River Basin is nearly 900 ft above sea level near the drainage area divide south of Roxboro in Person County (pl. 1).

The Neuse River Basin includes parts of 6 of the 10 hydrologic areas (HA's) identified by Giese and Mason (1993; fig. 2). The areas of the basin within the HA's delineated for the central and eastern Piedmont have varying levels of potential for sustaining base flow during droughts (fig. 2). Median 7Q10 discharges for streams in HA7, HA6, HA5, and HA4 are 0.005, 0.0, 0.065, and 0.0 cubic feet per second per square mile ([ft^3/s]/mi^2), respectively. Giese and Mason (1993) identified a correlation between the potential to sustain base flow and well yields reported by Daniel (1989), who related rock type to well yields. Thus, these HA's were delineated primarily on the basis of geology. The HA having the lowest potential for sustained base flow is HA6, defined by Giese and Mason (1993) as the Triassic basin HA. Numerous sites that lie within HA6 in the Neuse River Basin were determined to have no potential for sustained base flows. The eastern areas of the Neuse River Basin are in HA1 and HA2 in the Coastal Plain and have low potential to sustain base flow in streams. Median 7Q10 discharges for sites in HA's 1 and 2 are 0.0 and 0.006 (ft^3/s)/mi^2, respectively (Giese and Mason, 1993). Low topographic relief results in low hydraulic gradients in the water table and provides little potential to move ground water toward streams.

The effects of geologic and climatic factors at sites having different sustained base flows can be seen in the flow-duration curves for two sites having identical drainage areas in the study area (fig. 3). Base flows for the gaging station at Nahunta Swamp near Shine (site 432, pl. 1) are higher than those at the gaging station on Little River near Orange Factory (site 51, pl. 1). During the 1962–96 water years, flows at site 432 were 6.5 ft^3/s or greater 95 percent of the time, whereas flows at site 51 were 1.5 ft^3/s or greater 95 percent of the time. Differences between base flows at the two sites increase as the exceedence level increases. Site 51 is located in HA7, the Carolina Slate Belt HA, which is characterized by the presence of metavolcanic and metaigneous rocks (Giese and

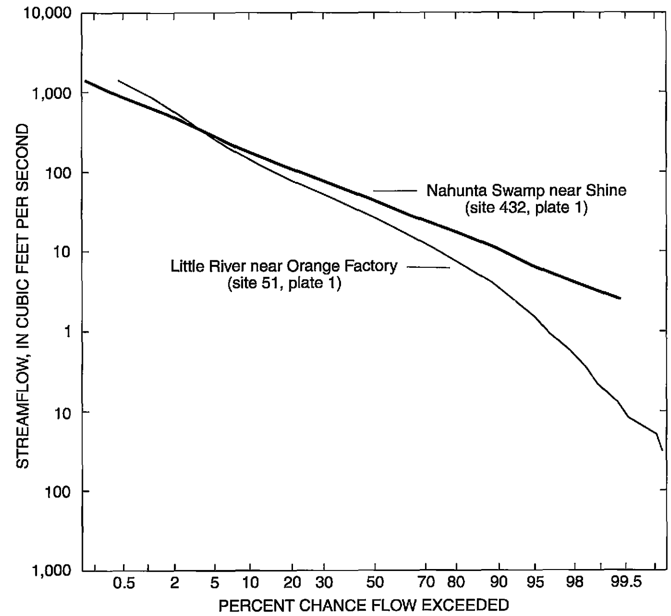

Figure 3. Flow-duration curves for the Little River near Orange Factory (site 51) and Nahunta Swamp near Shine (site 432).

Mason, 1993). These rocks are described as being among the lowest-yielding units and have low values (median 7Q10 discharge of 0.005 [ft^3/s]/mi^2) for low-flow characteristics when compared to sites in other HA's. Site 432 is in HA1 (clay soils) and HA2 (sandy soils) where the geology is defined by alternating layers of sand, silt, clay, and limestone (Giese and Mason, 1993). Average annual rainfall amounts in the Nahunta Swamp Basin in Wayne and Greene Counties are approximately 4 inches (in.) greater than those in the Little River Basin in Orange and Durham Counties (pl. 1). The individual effects of geologic and climatic factors that contribute to the overall determination of base flows cannot be quantified separately at either site. However, the likely presence of sandy soils in combination with higher rainfall amounts apparently results in higher base flows at site 432 than at site 51.

Drainage System

The Neuse River Basin consists of four subbasins, hydrologic units 03020201 to 03020204, as defined in the USGS National Water Data Network system of hydrologic units (Seaber and others, 1987) (fig. 4; table 1). The cumulative drainage area of the four subbasins is about 5,600 mi^2, which differs from the nearly 6,200 mi^2 identified by the DWQ in their basinwide assessment of water quality (North Carolina

Figure 4. Hydrologic units in the Neuse River Basin, North Carolina.

Table 1. Code, name, and drainage area of USGS hydrologic units in the Neuse River Basin, North Carolina (from Seaber and others, 1987)

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

USGS hydrologic unit code (fig. 4)	Name	Drainage area (mi^2)
03020201	Upper Neuse [River]	2,380
03020202	Middle Neuse [River]	1,080
03020203	Contentnea [Creek]	1,010
03020204	Lower Neuse [River]	1,120
	Total	5,590

Department of Environment, Health, and Natural Resources, 1993). The difference reflects boundary delineations used by the USGS and DWQ in the lower end of the basin. The study area for the Neuse River Basin is defined in this report by the four USGS hydrologic units (fig. 4). Records of streamflow in these areas are used to determine the low-flow characteristics presented in this report.

Major Rivers and Tributaries

The Neuse River, the mainstem in the Neuse River Basin, begins as the West Fork Eno River in northern Orange County in the Piedmont of North Carolina. The river becomes the Neuse at the confluence of the Eno and Flat Rivers in Durham County and flows in a general southeasterly direction through the Coastal Plain toward New Bern, in Craven County, and drains into the Pamlico Sound near Maw Point (pl. 1). In 1983, the confluence of the Eno and Flat Rivers was submerged in Falls Lake, and the Neuse River has since been commonly regarded as starting in Wake County at Falls Lake dam. Much of the Neuse River Basin is characterized by the rolling and hilly topography of the headwaters, which gradually changes to gentle, rolling terrain with little relief, then to nearly level land surfaces in the Coastal Plain.

The length of the Neuse River is nearly 270 miles (mi) from New Bern to the headwaters of the West Fork Eno River; the length of the river from New Bern to Falls Lake dam is approximately 190 mi (pl. 1). The drainage area of the Neuse River Basin is about 5,600 mi^2 and includes the Neuse River estuary (Seaber and others, 1987; table 1). At New Bern, where the Neuse River changes from riverine to estuarine, the drainage area of the river is nearly 4,500 mi^2. Major tributaries to the Neuse River include the Flat River (175 mi^2) in Person and Durham Counties; Crabtree Creek (146 mi^2) and Walnut Creek (46 mi^2) in Wake County; Swift Creek (289 mi^2) in Wake and Johnston Counties; Little River (317 mi^2) in Wake, Johnston, and Wayne Counties; Contentnea Creek (1,010 mi^2) in Wilson and Greene Counties, Swift Creek (330 mi^2) in Pitt and Craven Counties; and the Trent River (519 mi^2) in Lenoir and Jones Counties.

Tides from the Pamlico Sound affect flows in the lower reaches of the Neuse River and in other streams in the lower part of the basin. The actual extent of tidal effects in streams has not been identified (Giese and others, 1985). However, gage height and streamflow records from recently installed gaging stations on the Neuse River, Swift Creek in Pitt and Craven Counties, and the Trent River are beginning to give a better understanding of the flow dynamics in the lower reaches. At the partial-record measuring site on the Neuse River near Fort Barnwell (site 460, pl. 1; operated as a continuous-record gaging station since October 1996), streamflow records show no evidence of "negative" or reverse flow. However, continual shifts in the stage-discharge rating suggest the probability of backwater effects from tides; that is, streamflow decreases in response to incoming tides. At the gaging stations on Swift Creek at NC 43 near Streets Ferry (site 477, pl. 1) and on the Trent River at Pollocksville (site 500, pl. 1), flows in both upstream and downstream directions have been observed, indicating the presence of tidal flows at these locations. At the long-term gaging stations on the Neuse River at Kinston (site 361, pl. 1) and on the Trent River near Trenton (site 494, pl. 1), streamflow records do not show any effects from tides.

Major Flow Modifications

Previous discussions have alluded to the complex nature of low-flow hydrology due to geologic, topographic, and climatic factors. An additional complexity in the determination of low-flow characteristics results from the existence of major flow modifications. These modifications can be classified in two general categories—impoundments and diversions of flow. The ongoing addition and, in some instances, removal of these modifications result in continual changes to the low-flow characteristics.

Impoundments

Impoundments result from the construction of dams on streams and are used to store water for a variety of purposes, including supply, recreation, irrigation, and cooling water. The effects of impoundments on downstream low-flow characteristics vary because of changes in streamflow patterns that result from storage, diversions of water (for supply purposes) that commonly occur within the impoundments, and to a smaller extent, evaporation from the impoundments. Post-impoundment flow durations for downstream flows, particularly below major impoundments, are generally different from pre-impoundment conditions. The most common, and usually most obvious, change in flow durations for streams downstream from impoundments is the reduction in peak flood discharges observed in post-impoundment flows. In a similar manner, some impoundments—particularly those operating under minimum flow releases—serve to augment downstream flows during droughts and thus increase low flows observed below the dam relative to pre-impoundment conditions.

Approximately 550 impoundments with dams having structural heights exceeding 15 ft were identified in the study area (North Carolina Department of Environment, Health, and Natural Resources, unpub. data, 1993). A map showing the dams' locations, generated by using a geographic information system (GIS) coverage of the State's inventory of dams, indicates that the vast majority of dams are in the Upper Neuse River Basin (hydrologic unit 03020201). The topography of stream channels and adjacent floodplains in this hydrologic unit provide more suitable locations for building dams. Many are privately owned impoundments having relatively small surface areas at the spillway level. These impoundments primarily are used as (1) farm ponds, which provide water for irrigation and help reduce sediment discharges to streams; (2) recreational lakes at campgrounds and park facilities; or (3) landscape features (ponds) in developed areas.

A number of impoundments in the Neuse River Basin cause widespread inundation of the river valley immediately upstream from the dam. The impoundment having the largest surface area is Falls Lake (12,490 acres) in Wake, Durham, and Granville Counties (pl. 1); the length of the lake at normal pool is nearly 22 mi (North Carolina Department of Environment, Health, and Natural Resources, 1992). Other major impoundments in the study area having surface areas exceeding 200 acres are Little River Reservoir (530 acres) and Lake Michie (508 acres) in Durham County; Lake Butner (374 acres) in Granville County; Lake Crabtree (520 acres), Lake Wheeler (550 acres), and Lake Benson (440 acres) in Wake County; and Buckhorn Reservoir (750 acres) and Wiggins Mill Reservoir (200 acres) in Wilson County. These lakes, owned and operated by nearby municipalities, are primarily used for water supply, flood control, and recreation.

The effect of impoundments on downstream flows is usually determined by minimum flow releases assigned to the dam. Minimum flow releases can occur in one of two forms: (1) a release based on operations that involve the opening and closing of gates at the dam to adjust the amount of discharge, or (2) a release based on the structural characteristics of the dam's flow-release system, such as a riser-barrel orifice commonly found in smaller impoundments. Not all impoundments in the Neuse River Basin have been assigned minimum flow releases. At Falls Lake, the minimum flow release varies by season from 65 ft^3/s during the winter months to 100 ft^3/s during the summer months. In addition to minimum releases at the dam, flow releases also are adjusted in order to meet target discharges at the long-term gaging station on the Neuse River near Clayton (site 248, pl. 1). These target flows are 184 ft^3/s and 254 ft^3/s during the winter and summer months, respectively.

The presence of minimum flow releases at other smaller impoundments varies across the Neuse River Basin. Variations in the presence of minimum flow releases at smaller impoundments within the basin apparently reflect the age of the dam more than any other factor (James Mead, Division of Water Resources, oral commun., 1997). Increased awareness of environmental concerns during the past few decades has resulted in revised procedures for assessing the effects of dams on downstream flows. The impoundments at Little River Reservoir and Lake Crabtree are two such examples; both dams were constructed in the mid-1980's.

At Little River Reservoir in Durham County, minimum flow releases currently are set at 6 ft^3/s and 2 ft^3/s during the periods December 1 to May 31 and June 1 to November 31, respectively (George Carter, City of Durham, oral commun., 1997). However, no minimum release is specified for nearby Lake Michie, built in the mid-1920's and similar in size to Little River Reservoir. At Lake Crabtree in Wake County, a flow-release mechanism in the dam currently results in a minimum release of approximately 2.6 ft^3/s (Robert Williams, Natural Resources Conservation Service, oral commun., 1997). However, no minimum releases have been assigned to nearby Lake Wheeler or Lake Benson, two small impoundments built in Wake County in 1957 and 1925, respectively, and similar in size to Lake Crabtree.

Other impoundments also operate under varying minimum-release requirements. At Buckhorn Reservoir in Wilson County on Contentnea Creek, the minimum release is 1.3 ft^3/s (James Mead, Division of Water Resources, written commun., 1998). Downstream on Contentnea Creek at Wiggins Mill Reservoir in Wilson County, no minimum flow releases are required; however, the City of Wilson maintains a minimum flow release of about 1.0 ft^3/s below Wiggins Mill Reservoir.

Milburnie Dam on the Neuse River near Raleigh is the only dam in the Neuse River Basin operated for hydroelectric-power production. No minimum flow release has been assigned at Milburnie Dam (James Mead, Division of Water Resources, written commun., 1998). However, the dam is required to operate in a "run-of-river" mode; that is, flows upstream and downstream from the structure must be approximately equal.

Attempts to understand changes in flow patterns brought about as a result of impoundments often focus on changes that occur after a dam has been constructed because once constructed, most dams become permanent fixtures. In the Neuse River, however, removal of the Quaker Neck Dam (pl. 1) in Wayne County began in December 1997 for the purposes of opening upstream reaches of the Neuse River and its tributaries to fish migration and spawning (The News and Observer, Raleigh, N.C., December 18, 1997). The changes, if any, in low-flow characteristics of the Neuse

River currently are unknown and are likely better understood pending continued data collection at long-term downstream gaging stations (sites 344, 361; pl. 1). Similarly, a dam located on the Little River at a state-owned hospital facility near Goldsboro was removed in Spring 1998 to improve fish migration and spawning in upstream reaches (W.L. Yonts, Division of Water Resources, written commun., 1998).

Diversions

Diversions that occur as withdrawals or point-source discharges have the effect of immediately altering downstream low flows by an amount equal to the diversion rate. Withdrawals are commonly made by municipalities and by some major industries. Additionally, some withdrawals are made by farms for agricultural and livestock operations. The State of North Carolina currently requires registration of withdrawals that equal or exceed 1 million gallons per day (Mgal/d) (approximately 1.5 ft^3/s). A total of 65 registered withdrawals were identified within the Neuse River Basin (Thomas Irving, Division of Water Resources, written commun., 1997). Knowledge of low-flow characteristics is important when withdrawals are being made because the State requires that decreased flows downstream from the withdrawals must be sufficient to sustain downstream uses during drought conditions, including the assimilation of treated effluent.

Point-source discharges into streams are permitted through the issuance of National Pollution Discharge Elimination System (NPDES) permits. In North Carolina as well as in other States, permits that set limits for discharges of treated effluent are based, in part, on the 7Q10 discharge. Similar to withdrawals, flows upstream from the discharge point must be sufficient to assimilate the treated effluent while maintaining other uses of the stream. As of 1998, DWQ has issued 185 NPDES permits for point-source discharges within the Neuse River Basin (Charles Weaver, Division of Water Quality, oral commun., 1998). The number of NPDES permits continuously evolves as a result of the addition and rescission of permitted discharges in the basin. Within the Neuse River Basin, 28 permit holders (21 municipal, 7 industrial) are designated by the DWQ as major dischargers. Major dischargers generally are defined as facilities discharging more than 1 Mgal/d or facilities having discharges that include high levels of toxicants or metals.

Data describing major withdrawals and point-source discharges in the study area were obtained from the different State agencies that monitor flow diversions. For selected facilities, average surface-water withdrawals and point-source discharges reported for calendar year 1996 were compiled into a summary that lists the magnitudes of streamflow changes in the affected streams (table 2). In most instances, point-source discharges were paired with a corresponding surface-water withdrawal on the same stream, often a short distance upstream from the discharge point. The NPDES permit number and permitted flow rate assigned to the permit also are listed for each facility.

Some of the facilities that discharge into streams do not obtain water through surface-water withdrawals. Rather, withdrawals are made from ground-water wells (primarily in the Coastal Plain) or are transferred from other facilities. An additional form of withdrawal listed with the State agencies is that made by large mining operations, which remove ground water from mining pits as part of the quarry operation. In the study area, withdrawals by numerous quarry operations in Durham, Wake, Johnston, and Wilson Counties were registered with the State. However, these are not listed in table 2 because withdrawal and point-source discharge rates are not documented. Also not listed in table 2 are withdrawals and point-source discharges for a number of farming or agricultural-research operations that withdraw water primarily for irrigation purposes. Most of these withdrawals are from ground-water wells or small ponds located on property owned by the operations.

In the Neuse River Basin, the largest withdrawal and, correspondingly, the largest point-source discharge are made by the City of Raleigh for municipal supply purposes. In 1996, the city withdrew an average of 43.0 Mgal/d from the Neuse River via Falls Lake and discharged an average 33.9 Mgal/d into the Neuse River just upstream from the Johnston County line. Other significant withdrawals are made by the Cities of Durham and Goldsboro. The 1996 average withdrawal for Durham represents the sum of the withdrawals made from Lake Michie and Little River Reservoir (table 2). The significant difference between the average withdrawal (27.6 Mgal/d) and point-source discharge (9.4 Mgal/d) by the City of Durham is a result of an interbasin transfer to the Cape Fear River Basin (fig. 1; table 2). The average point-source discharge (8.7 Mgal/d) by the City of Goldsboro is

Table 2. Summary of selected flow modifications by surface-water withdrawals and point-source discharges to streams in the Neuse River Basin, 1996

[Mgal/d, million gallons per day (1 Mgal/d is equivalent to approximately 1.5 cubic feet per second); NPDES, National Pollution Discharge Elimination System; N/A, not applicable; UT, unnamed tributary; WWTP, wastewater-treatment plant; N/D, not documented. For streams profiled in this report, river miles to the nearest tenth are listed in parentheses beside stream names]

County	Facility name	Purpose	Source of withdrawal	Average withdrawal (Mgal/d)	Destination of point-source discharge	Average point-source discharge (Mgal/d)	NPDES permit number	Permitted NPDES discharge (Mgal/d)
Orange	Orange-Alamance Water System	Public water supply	Eno River (via Corporation Lake, mile 298.2)	0.84	Eno River (mile 298.1)	0.02	NC0082759	0.05
Orange	Town of Hillsborough	Public water supply	Eno River (via Lake Ben Johnson, mile 296.6)	1.6	Eno River (mile 292.9)	1.3	NC0026433	3.0
Granville	John Umstead Hospital (Butner)	Public water supply	Knap of Reeds Creek (via Lake Butner, also known as Holt Reservoir)	2.2	Knap of Reeds Creek[a]	2.2	NC0026824	3.5
Granville	Town of Creedmoor	Public water supply	Ledge Creek (via Lake Rogers)	.28	N/A[b]	N/A[b]	N/A[b]	N/A[b]
Durham	City of Durham	Public water supply	Flat River (8.2 Mgal/d via Lake MIchie) Little River (19.4 Mgal/d via Little River Reservoir)	27.6	Ellerbee Creek	9.4	NC0023841[c]	20.0
Wake	Heater Utilities (Wildwood Green)	Public water supply	Ground-water wells	N/A	UT Lower Barton Creek	.05	NC0063614	.1
Wake	Town of Wake Forest	Public water supply	Smith Creek[d]	.56	Neuse River (mile 227.7)	.87	NC0030759	6.0
Wake	Heater Utilities (Beachwood)	Public water supply	Transfer from City of Raleigh	N/A	Neuse River (mile 217.5)	.01	NC0060577	.1
Wake	Town of Cary	Public water supply	Jordan Lake (Cape Fear River Basin)	N/A[e]	Crabtree Creek (North WWTP) Middle Creek (South WWTP)	3.7 4.2	NC0048879 NC0065102	4.45 6.4
Wake	Carolina Water Service (Ashley Hill)	Public water supply	Ground-water wells	N/A	Poplar Creek (mile 2.2)	.03	NC0051322	.125
Wake	City of Raleigh	Public water supply	Neuse River (via Falls Lake, mile 233.0)	43.0	Neuse River (mile 208.8)	33.9	NC0029033	60.0
Johnston	Town of Clayton	Public water supply	Transfer from Johnston County	N/A	Little Creek	.95	NC0025453	1.5
Wake	Town of Apex	Public water supply	Jordan Lake (Cape Fear River Basin)	N/A[e]	UT Middle Creek	1.1	NC0064050	1.8
Wake	Town of Fuquay Varina (proposed WWTP)	Public water supply	Transfer from City of Raleigh and Harnett County	N/A	Terrible Creek	.06	NC0066516	6.0
Johnston	Johnston County	Public water supply	Neuse River (mile 190.0)	3.5[f]	Neuse River (mile 183.3)	3.1	NC0030716	4.5
Johnston	Town of Smithfield	Public water supply	Neuse River (mile 185.7)	4.0	N/A[g]	N/A[g]	N/A[g]	N/A[g]

Table 2. Summary of selected flow modifications by surface-water withdrawals and point-source discharges to streams in the Neuse River Basin, 1996—Continued

[Mgal/d, million gallons per day (1 Mgal/d is equivalent to approximately 1.5 cubic feet per second); NPDES, National Pollution Discharge Elimination System; N/A, not applicable; UT, unnamed tributary; WWTP, wastewater-treatment plant; N/D, not documented. For streams profiled in this report, river miles to the nearest tenth are listed in parentheses beside stream names]

County	Facility name	Purpose	Source of withdrawal	Average withdrawal (Mgal/d)	Destination of point-source discharge	Average point-source discharge (Mgal/d)	NPDES permit number	Permitted NPDES discharge (Mgal/d)
Johnston	Town of Benson	Public water supply	Transfer from Johnston County	N/A	Hannah Creek	1.3	NC0020389	1.5
Johnston	Town of Kenly	Public water supply	Transfer from Johnston County	N/A	Little River (mile 35.7)	.46	NC0064891	.52
Johnston	Town of Princeton	Public water supply	Transfer from Johnston County	N/A	Little River (mile 22.4)	.19	NC0026662	.275
Wayne	Wayne County	Public water supply	Ground-water wells	N/A	Neuse River (Genoa WWTP, mile 132.8)	.11	NC0030392	.4
Wayne	Carolina Power and Light	Cooling water	Neuse River (mile 144.8)	N/D[h]	Neuse River (mile 144.8)	N/D[h]	NC0003417	N/D[h]
Wayne	City of Goldsboro	Public water supply	Neuse River[i] (mile 136.7)	6.3	Neuse River (mile 131.1)	8.7[j]	NC0023949	10.1
Lenoir	Town of La Grange	Public water supply	Ground-water wells	N/A	Moseley Creek	.56	NC0021644	.75
Lenoir	City of Kinston	Public water supply	Ground-water wells	N/A	Neuse River (Peachtree WWTP, mile 84.4) (Northside WWTP, mile 78.0)	5.1 1.6	NC0020541 NC0024236	6.75 4.5
Lenoir	DuPont (Kinston)	Manufacturing	Ground-water wells	N/A	Neuse River (mile 73.8)	1.4	NC0003760	3.6
Wake	Town of Zebulon	Public water supply	Little River (mile 67.8)	.54	UT Moccasin Creek	.96[k]	NC0079316	1.85
Wilson	City of Wilson	Public water supply	Contentnea Creek (5.5 Mgal/d via Wiggins Mill Reservoir, mile 78.0) Toisnot Swamp (2.4 Mgal/d via Toisnot Lake)	7.9	Contentnea Creek (mile 75.0)	10.3[l]	NC0023906	12.0
Wilson	Town of Stantonsburg	Public water supply	Ground-water wells	N/A	Contentnea Creek (mile 57.0)	.30	NC0057606	.375
Greene	Town of Snow Hill	Public water supply	Ground-water wells	N/A	Contentnea Creek (mile 31.1)	.25	NC0020842	.25
Greene	Maury Sanitary Land District	Public water supply	Ground-water wells	N/A	Contentnea Creek (mile 21.8)	.16	NC0061492	.225
Greene	Town of Walstonburg	Public water supply	Ground-water wells	N/A	Thompson Swamp	.06	NC0020362	.138
Greene	Town of Farmville	Public water supply	Ground-water wells	N/A	Little Contentnea Creek	1.8	NC0029572	3.5
Lenoir	Contentnea Sewerage District	Public water supply	Ground-water wells	N/A	Contentnea Creek (mile 2.1)	1.8	NC0032077	2.85

Table 2. Summary of selected flow modifications by surface-water withdrawals and point-source discharges to streams in the Neuse River Basin, 1996—Continued

[Mgal/d, million gallons per day (1 Mgal/d is equivalent to approximately 1.5 cubic feet per second); NPDES, National Pollution Discharge Elimination System; N/A, not applicable; UT, unnamed tributary; WWTP, wastewater-treatment plant; N/D, not documented. For streams profiled in this report, river miles to the nearest tenth are listed in parentheses beside stream names]

County	Facility name	Purpose	Source of withdrawal	Average withdrawal (Mgal/d)	Destination of point-source discharge	Average point-source discharge (Mgal/d)	NPDES permit number	Permitted NPDES discharge (Mgal/d)
Craven	Weyerhaeuser (New Bern)	Industrial	Neuse River (mile 51.6)	20.0	Neuse River (mile 46.3)	19.4	NC0003191	32.0
Craven	Craven County Wood Energy	Cooling water	Ground-water wells	N/A	Bachelor Creek	.22	NC0075281	.425
Craven	Town of Vanceboro	Public water supply	Ground-water wells	N/A	Mauls Swamp	.14	NC0031828	.25
Craven	City of New Bern	Public water supply	Ground-water wells	N/A	Neuse River (mile 40.4)	3.2	NC0025348	4.7
Craven	Town of River Bend	Public water supply	Ground-water wells	N/A	Trent River (mile 7.1)	.14	NC0030406	.33
Craven	CWS Systems, Inc. (NE Craven Utilities)	Public water supply	Ground-water wells	N/A	Neuse River (mile 31.0)	.24	NC0033111	.60
Craven	City of Havelock	Public water supply	Ground-water wells	N/A	East Prong Slocum Creek	1.3	NC0021253	1.5
Craven	USMC Air Station (Cherry Point)	Public water supply	Ground-water wells	N/A	Slocum Creek	2.3	NC0003816	3.6
Pamlico	Oriental WWTP	Public water supply	Ground-water wells	N/A	Smith Creek	.12	NC0057011	.10

[a] Prior to current NPDES permit, facility discharged to nearby Picture Creek under NPDES permit NC0058416 (permitted flow 0.1 Mgal/d).

[b] Wastewater from Creedmoor treated and released by wastewater-treatment facility operated by John Umstead Hospital (Butner).

[c] City of Durham also has wastewater-treatment plant that discharges to New Hope Creek in Cape Fear River Basin under separate NPDES permit.

[d] Town of Wake Forest also obtains water via transfer from the City of Raleigh.

[e] Towns of Cary and Apex jointly operate a water-treatment plant that withdraws water from B. Everett Jordan Lake in the Cape Fear River Basin. Apex receives up to 23 percent of the daily withdrawal; average daily withdrawal from Jordan Lake in 1996 was 10.5 Mgal/d.

[f] Water-treatment plant opened in September 1996. Maximum treatment capacity is 4.0 Mgal/d; estimated average withdrawal of 3.5 Mgal/d is based on observations of plant operations since the facility opened (James Davis, Johnston County water-treatment plant, oral commun., 1997). Facility distributes water to nearby small municipalities, which treat their own wastewater.

[g] Wastewater from Smithfield treated and released by wastewater-treatment facility operated by Johnston County.

[h] No records are available to determine average flow diversions by Carolina Power and Light at this powerplant in Wayne County. Pumps used for making withdrawals are capable of pulling nearly 32 Mgal/d when operated full-time in the summer seasons, and average point-source discharge is typically about 3 Mgal/d (H. Sideras, Carolina Power and Light, oral commun., 1997).

[i] City of Goldsboro also withdraws from the Little River (mile 4.0) on an emergency basis.

[j] While the City of Goldsboro treats some wastewater from some smaller nearby entities, much of the difference between the average withdrawal and point-source discharge is attributed to infiltration of rainfall runoff into the pipe network that drains to the wastewater-treatment plant system.

[k] Beginning in June 1996, the Town of Zebulon purchased water from the City of Raleigh; the higher value for average point-source discharge reflects the treatment of wastewater withdrawn from the Little River and purchased from Raleigh.

[l] Wastewater from nearby Black Creek and Lucama treated and released by wastewater-treatment facility operated by City of Wilson.

higher than the average withdrawal (6.3 Mgal/d) reported for 1996 (table 2). While this difference is partly attributed to treatment of waste received from nearby smaller municipalities, part of the difference is attributed to infiltration of rainfall runoff into the pipe network that drains to the treatment facility. The largest nonmunicipal withdrawal occurs in Craven County—an average of 20 Mgal/d was withdrawn from the Neuse River in 1996 by the Weyerhaeuser Company for industrial use (table 2).

Climate

The climate in the Neuse River Basin, as throughout most of North Carolina, consists of long, hot, humid summers and short, mild winters with brief periods of more moderate, milder conditions during the spring and autumn seasons. The average annual temperature (1961–90) in the study area ranges from 58 °F in the headwaters of the Neuse River Basin to about 62 °F in the area of the basin near the mouth of the Neuse River near Maw Point (fig. 5A). Records collected by the National Weather Service at selected observation stations in and near the study area indicate that the average temperature ranges from a minimum of about 40 °F in January to a maximum of about 78 °F in July (National Oceanic and Atmospheric Administration, 1996). In all areas of the Neuse River Basin, temperature extremes in the summer reach levels exceeding 90 °F for long periods of consecutive days.

Average annual precipitation (1961–90) at selected observation stations in and around the study area ranges from nearly 44 in. in the headwaters of the basin to 52 in. near the mouth of the Neuse River near Maw Point (fig. 5B). The higher temperatures and more abundant moisture in the Coastal Plain reflect the moderating effects exerted by the Atlantic Ocean on the climate in that region (Kopec and Clay, 1975). On a monthly basis, the highest amounts of rainfall occur during July and August. Minimum monthly rainfall averages indicate that the lowest amounts of rainfall generally occur during April at the observation stations in the upper half of the Neuse River Basin, and the lowest amounts occur during October and November at stations in the lower half of the basin. Most rainfall occurring during the warmer months comes from isolated, convective-type storms that arise in the late afternoons and evenings as a result of daytime heating. Rainfall occurring during cooler months is from more organized frontal storms that cover broad areas of the region.

Since 1900, there have been seven major droughts in North Carolina (Zembrzuski and others, 1991). The drought of longest duration affecting streams in the Neuse River Basin occurred during 1950–57 when low flows having a recurrence interval between 30 and 90 years were observed across the State. At the USGS gaging station at Flat River at Bahama (site 74, pl. 1) in Durham County, the lowest daily mean discharge (0.27 ft^3/s) and instantaneous discharge (0.23 ft^3/s) were recorded on September 24, and 26, 1968, respectively, for the period of record (July 1925 to September 1994) (U.S. Geological Survey, 1961–96, published annually). Other near-record low flows occurred at long-term gaging stations on the Eno River (site 20, pl. 1), Middle Creek (site 284, pl. 1), and Contentnea Creek (site 439, pl. 1) in the fall of 1954 during the 1950–57 drought. Notable droughts affecting streams in the study area also occurred during 1966–71 and 1985–88 (Zembrzuski and others, 1991).

Geology and Soils

Diverse geology and soils in the Neuse River Basin have varying degrees of effects on the potential for sustained base flows. The geology indirectly affects the potential for sustained base flow through the soils, or overburden, into which the underlying rock units are transposed through the processes of physical and chemical weathering. The extent of fractures in underlying rocks also may be an indicator of the potential to sustain base flow. Because the fractures are conduits for water, a rock unit having an abundance of fractures has a higher degree of storage capacity than does a unit having fewer fractures. In a similar manner, soils that exhibit higher degrees of permeability allow for greater movement of water between surficial aquifers and stream channels than do soils with low permeabilities that limit water movement.

Geology in the Neuse River Basin can be divided into two general regions which roughly correspond to the Piedmont and Coastal Plain Provinces. Most of the study area within the Piedmont is underlain by belts of metamorphic and metavolcanic rocks ranging in age from late Proterozoic to early Paleozoic (North Carolina Geological Survey, 1985). These underlying rocks include granite, granitic gneiss, schist, slate, and phyllite (fig. 6A). The noted exception is the Triassic (early Mesozoic) basin across parts of Wake, Durham, and Granville Counties that is underlain by basalt and fine-grained sedimentary rocks, which include sandstone, siltstone, and shale. These rocks have been characterized as having low porosity and permeabilities (Brown, 1988). The lower permeabilities characteristic of soils derived from Triassic basin rocks support a lower potential for sustained base flows compared to those of the older igneous and metamorphic bedrock. As discussed further in later sections of this report, many sites within

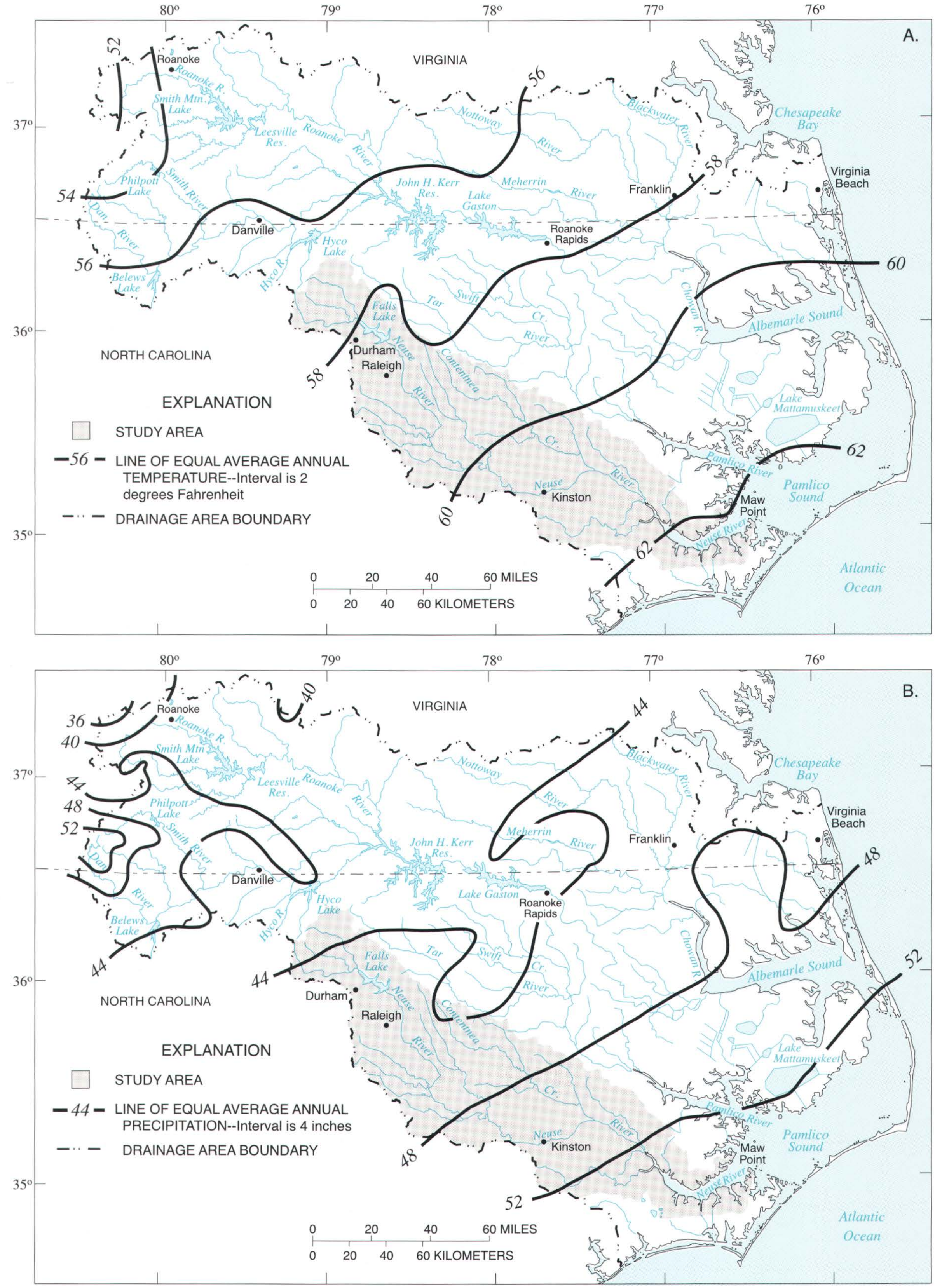

Figure 5. Average annual (A) temperature and (B) precipitation in the Neuse River Basin, 1961–90 (modified from McMahon and Lloyd, 1995).

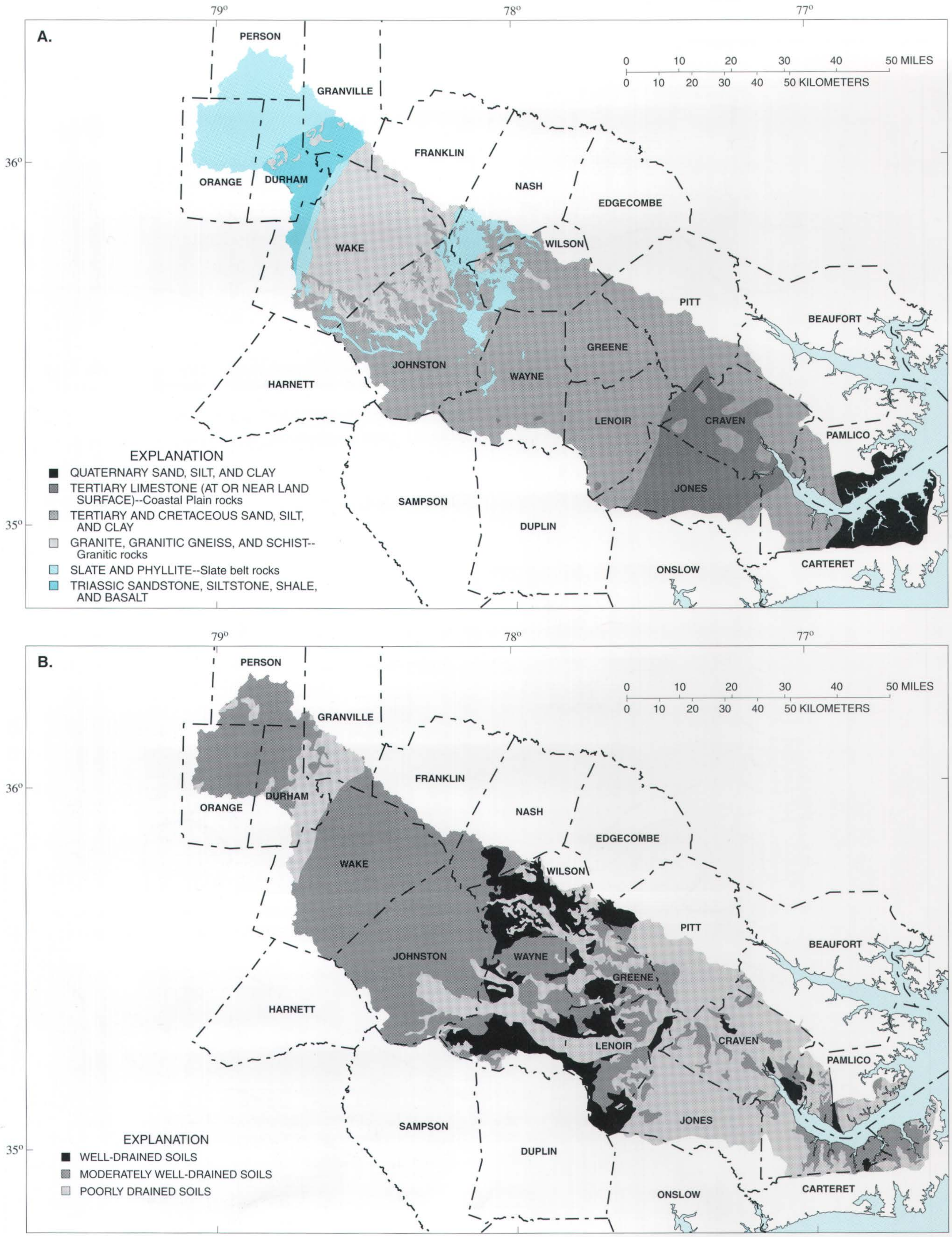

Figure 6. (A) Geology and (B) soil hydrologic groups in the Neuse River Basin, North Carolina (modified from McMahon and Lloyd, 1995).

the Triassic basin were determined to have 7Q10 discharges equal to zero flow.

The transition from the Piedmont to the Coastal Plain occurs in central Johnston County and western Wilson County, and surface features are initially dissected and rolling with a gradual change from well drained and gently rolling to flat surfaces. In the Coastal Plain, most of the basin is underlain by unconsolidated sediments of Cretaceous to Tertiary age. These sediments are composed of alternating layers of sand, silt, and clay (North Carolina Geological Survey, 1985) (fig. 6A). The Yorktown and Duplin Formations are two dominant geologic units in this area; other units present to a lesser extent include the Peedee, Castle Hayne, and River Bend Formations. A small segment of the basin, lying along the eastern end of the Coastal Plain near the mouth of the Neuse River, is underlain by sediments of Quaternary age, and includes layers of sand, silt, and clay (North Carolina Geological Survey, 1985) (fig. 6A).

Soil surveys conducted by the U.S. Department of Agriculture in the counties within the Neuse River Basin have resulted in the identification of numerous soils associations, or groups of soils having similar characteristics (U.S. Department of Agriculture, various soil surveys, 1912–95). The identification of a predominant soils association throughout the study area is difficult because of the evolving classification methods used in the county soil surveys. However, some soil characteristics that are common among the associations can be recognized, as discussed below.

In the Piedmont, soil associations are moderate to well drained with increasing slopes toward the western edges of the Neuse River Basin. These soils are firm, weathered clay loams derived from igneous and sedimentary bedrock (U.S. Department of Agriculture, various soil surveys, 1912–95). Soils derived from shale and sandstone bedrock of the Triassic basin also occur in this area of the basin. The White Store-Creedmoor association is the predominant soils association from the Triassic basin. The low permeability of the underlying bedrock apparently overrides any drainage characteristic of this soils association and results in a lower potential for sustained base flows relative to the potential in areas occupied by older, weathered clay loams. In the Coastal Plain, the most extensive soils association consists of poorly drained loams, usually along interstream divides having slopes of less than 1 percent (U.S. Department of Agriculture, various soil surveys, 1912–95). In the upper Coastal Plain in Johnston, Wilson, Wayne, and Greene Counties, soils associations contain some moderately drained soils with slightly higher slopes than those in the lower Coastal Plain (U.S. Department of Agriculture, 1994, 1983, 1974b, and 1980, respectively).

Data compiled from Tant and others (1974) indicate that most of the upper half of the study area is covered by soils that are moderately well drained (table 3; fig. 6B). Exceptions to this include areas of Wake, Durham, and Granville Counties where soils from the Triassic basin are poorly drained. The soil hydrologic groups and associated minimum infiltration rates of soils provide an indicator of the water storage within the overburden (Musgrave and Holtan, 1964). Because base flow is defined as sustained flow from ground water or springs, and has no surface-runoff component, the streams in the study area that are covered by moderately well-drained soils will have a high potential for sustained flow during dry conditions, assuming all other factors are equal. Streams in areas underlain by poorly drained soils would be expected to

Table 3. Soil hydrologic groups in the Neuse River Basin, North Carolina [compiled from Musgrave and Holtan (1964) and Tant and others (1974); adapted from McMahon and Lloyd (1995)]

[mi^2, square mile. Soil characteristics and minimum infiltration rates for soil hydrologic groups are described in table footnotes. Sections of the study area not included (approx. 150 mi^2) are those covered by some of the water bodies and those with unknown soil hydrologic groups. Differences in total drainage area from those listed in other tables reflect differences in scale of map and accuracy of methods used by source to compute areas]

Well drained		Moderately well drained		Poorly drained	
Soil group	Area (mi^2)	Soil group	Area (mi^2)	Soil group	Area (mi^2)
A[a]	579	A/C	235	A/D	113
A/B	46	B[b]	2,124	B/D	1,325
		B/C	443	C[c]	33
				C/D	241
				D[d]	311

[a] Soil Group A—Deep sands, deep loesses, and aggregated soils having minimum infiltration rates of approximately 0.30 to 0.45 inch per hour.

[b] Soil Group B—Shallow loess and sandy loam soils having minimum infiltration rates of approximately 0.15 to 0.30 inch per hour.

[c] Soil Group C—Clay loams, shallow sandy loams, soils low in organic matter, and soils high in clay content having minimum infiltration rates of approximately 0.05 to 0.15 inch per hour.

[d] Soil Group D—Swelling soils, heavy plastic clays, and certain saline soils having minimum infiltration rates of approximately 0 to 0.05 inch per hour.

have low potential for sustained flows during dry periods. In the lower half of the study area, many of the soils are characterized as poorly drained. Moderately and poorly drained soils occupy nearly 37 and 52 percent, respectively, of the study area. The only occurrences of well-drained soils in the study area (11 percent) are in the central part where these well-drained soils are interspersed with moderately and poorly drained soils (fig. 6B).

Land Use

Land-use information for the study area was obtained from the U.S. Environmental Protection Agency (USEPA) land-cover information developed from remotely sensed data collected using the Landsat Thematic Mapper (TM) sensor (Vogelmann and others, 1998). The USEPA land-cover information was compiled from aerial photographs taken primarily during the spring seasons of 1991, 1992, and 1993. Information is processed into 15 land-use classes that have been established for eventual development of a consistent and generalized land-cover data base for all of the United States (Vogelmann and others, 1998). In the Neuse River Basin, 6 general categories were identified from the 15 land-use classes in the study area (table 4).

Land use in the Neuse River Basin is mostly rural. Slightly more than 71 percent of the study area is classified as agricultural or forested (table 4). Five percent of the study area is developed land and includes the largest municipalities in the study area—the urban areas of Raleigh in Wake County and Durham in Durham County. Other municipalities within the study area include, from northwest to southeast, Hillsborough in Orange County, Apex and Cary in Wake County, Wilson in Wilson County, Goldsboro in Wayne County, Kinston in Lenoir County, and New Bern in Craven County (pl. 1). Much of the percentage shown in table 4 for water (4.2 percent) consists of the Neuse River estuary, which begins at New Bern. Other water bodies, such as Little River Reservoir, Lake Michie, Falls Lake, Buckhorn Reservoir, and other smaller impoundments in the Neuse River Basin, account for less than 1 percent of the study area. Wetlands occupy more than 18 percent of the study area and occur primarily in the lower Coastal Plain of the study area.

Land use in much of North Carolina has evolved considerably since the early 1980's. Prior to the Landsat TM data (Vogelmann and others, 1998), the USGS geographic information retrieval and analysis system (GIRAS) was the most recent and comprehensive land-use data available to permit a quantitative assessment of changes in land use within the Neuse River Basin. Information in the GIRAS data base was compiled from aerial photographs taken

Table 4. Areas and percentages of land-use categories in the Neuse River Basin, North Carolina

[mi^2, square mile. Differences in total drainage area from those listed in other tables reflect differences in scale of map and accuracy of methods used by source to compute areas]

Land-use category	Extent and percentage of study area covered by land-use category [a]	
	(mi^2)	(percent)
Developed (includes urban areas)	285	5.0
Agricultural	1,669	29.5
Forested	2,367	42.0
Water	239	4.2
Wetlands	1,030	18.2
Barren (includes quarries, gravel pits, and transitional areas such as clear-cut areas)	64	1.1
Total	5,654	100.0

[a] From U.S. Environmental Protection Agency land-cover data set (Vogelmann and others, 1998).

during the late 1970's and mid-1980's (Mitchell and others, 1977). In a similar manner as that completed by McMahon and Lloyd (1995), land-use data in the Neuse River Basin from the GIRAS data base were compared with more recent land-use information from the Landsat TM. However, comparisons between similar categories in the data bases are limited as a result of patterns in percentage changes which conflict with actual observed changes occurring in the Neuse River Basin. For example, comparison of the earlier data base with more recent land-use data indicates a reduction in the percentage of developed land as opposed to observed increases in developed land with the most significant changes occurring in the upper parts of the basin in the Raleigh and Durham municipalities. Population growth in these areas since the mid-1980's has resulted in the widespread conversion of agricultural and forested areas to developed land cover. Also unlikely is the significant percentage increase (from 7 to 18 percent) in wetlands that is suggested by differences in the two data bases. The changes in the percentage of wetlands and other land-use categories likely reflect the methods and resolution of techniques used in compiling the information for each data base.

LOW-FLOW CHARACTERISTICS IN THE NEUSE RIVER BASIN

Low-flow characteristics were determined for selected gaging stations in the Neuse River Basin. Historical records of gage height and streamflow from 508 sites were compiled (pl. 1); streamflow records were examined (table 5, p. 68–101) for selection of sites where low-flow characteristics could be determined. Records of discharge collected through the 1996 water year were used. Of the 508 sites, 40 were continuous-record gaging stations, 448 were partial-record measuring sites, and 20 were sites having a combination of continuous- and partial-record discharges. The period of record varies from site to site. The low-flow characteristics for selected sites in the Neuse River Basin are presented in this section.

Continuous-Record Gaging Stations

Low-flow characteristics based on continuous records of discharge were developed for 50 sites—35 of the 40 continuous-record gaging stations and 15 of the 20 sites that have both continuous- and partial-record discharges. Most of these sites were analyzed by using frequency curves (Riggs, 1972); a small number required other graphical correlation techniques, as explained below. The magnitude and frequency of low flows for the continuous-record gaging stations are shown in table 6. Not all sites having continuous records could be used to determine low-flow characteristics. Of the 40 sites having continuous-record discharges only, low-flow characteristics were not included in table 6 for five sites. Among these five sites, two sites (55, 260) are affected by significant regulation upstream from the site, site 477 is significantly affected by tides, site 485 has records of gage height only, and discharge records for site 50 were combined with records at downstream site 51 to develop a long-term set of records for use in determining low-flow characteristics. Of the 20 sites having both continuous- and partial-record discharges, low-flow characteristics likewise were not included in table 6 for five sites. Site 99 is affected by significant diversions upstream from the site, site 210 is located just upstream from another site (212) for which low-flow characteristics were published, site 254 had records of medium- and high-range discharges, site 500 is significantly affected by tides, and low-flow characteristics for site 236 were determined from records of partial-record discharges.

Table 6. Magnitude and frequency of annual low-flow characteristics at selected continuous-record gaging stations in the Neuse River Basin, North Carolina

[mi^2, square mile; climatic years, the annual period from April 1 to March 31 and identified by the year in which the period begins; (ft^3/s)/mi^2, cubic foot per second per square mile; ft^3/s, cubic foot per second; SR, secondary road; PR, gaging station having less than 10 years record of daily mean discharge, treated as a partial-record site where low-flow characteristics were developed by using correlation techniques; U, unregulated flow; C, estimates based on correlation techniques; <, less than; G, estimates based on best-fit curves developed graphically from the log-Pearson analyses; R, regulated flow; LP, estimates based on log-Pearson frequency distribution; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of analysis (climatic years)	Number of observed days of flow		Average annual unit flow [(ft^3/s)/mi^2]	Low-flow characteristics (ft^3/s)				Flow	Method of analysis
					Equal to zero flow	Less than or equal to 7Q10		7Q10	30Q2	W7Q10	7Q2		
9	02084903	Sevenmile Creek tributary at SR 1120 near Buckhorn	1.34	PR	9	9	0.9	0	0	0	0	U	C
10	02084904	Sevenmile Creek tributary at I-85 near Miles	.004	PR	336	336	.9	0	0	0	0	U	C
11	02084905	Sevenmile Creek tributary at SR 1144 near Miles	1.57	PR	0[a]	0	.9	0	< .05	< .05	0	U	C
13	02084908	Sevenmile Creek tributary at I-85 near Efland	.29	PR	140	140	.9	0	0	0	0	U	C
14	02084909	Sevenmile Creek near Efland	14.1	1988-95	41	41	1.0	0	.2	.3	.06	U	G
20	02085000	Eno River at Hillsborough	66.0	1928-70, 1986-95	0	267	1.0	.5	5.3	2.2	3.2	R[b]	LP
36	02085070	Eno River near Durham	141	1964-95	0	62	.9	.7	7.2	4.3	4.1	R[b]	LP
51	02085220	Little River near Orange Factory[c]	80.4	1962-95[d]	10	351	.9	.07	4.0	1.5	2.0	U	LP
52	0208524090	Mountain Creek at SR 1617 near Bahama	8.0	PR	0	0	1.2	< .05	.2	.06	.1	U	C
74	02085500	Flat River at Bahama[c]	149	1926-95	0	287	1.0	1.0	8.2	2.5	4.7	U	LP
76	02086000	Dial Creek near Bahama[c]	4.76	1926-70, 1990	539	539	.9	0	.3	.1	.2	U	LP
84	02086500	Flat River at dam near Bahama	168	1928-58, 1962-65, 1983-90	32	246	.9	.05	5.0	.3	2.1	R[e]	LP
85	0208650112	Flat River tributary near Willardville	1.14	PR	326	326	1.1	0	< .05	0	0	U	C
89	02086624	Knap of Reeds Creek near Butner	43.0	1983-94	0	14	1.0	1.4	3.2	3.1	2.4	R[b]	LP
103	02087000	Neuse River near Northside	535	1928-79	0	179	1.0	10.0	44.8	18.3	29.0	R[f]	LP
105	0208700780	Little Lick Creek above SR 1814 near Oak Grove	10.1	1983-94	0	0	1.1	0[g]	N/A[g]	N/A[g]	N/A[g]	U	LP
119	02087052	Smith Creek at Grissom	6.23	PR	0	0	1.0	.1	1.0	1.0	.6	U	C
135	02087183	Neuse River near Falls	771	1971-78	0	37	1.1	15.0	48.8	29.8	32.7	R[b]	G
				1984-95	0	6	.8	57.9	86.3	56.3	82.6	R[h]	LP
144	02087190	Neuse River at U.S. Hwy 1 near Neuse	792	PR	0	10	1.1	12.6	51.9	27.9	33.3	R[b]	C
153	0208721055	Perry Creek at SR 2012 near Millbrook	2.43	PR	1	32	1.1	.2	.6	.4	.4	U	C

Table 6. Magnitude and frequency of annual low-flow characteristics at selected continuous-record gaging stations in the Neuse River Basin, North Carolina—Continued

[mi², square mile; climatic years, the annual period from April 1 to March 31 and identified by the year in which the period begins; (ft³/s)/mi², cubic foot per second per square mile; ft³/s, cubic foot per second; SR, secondary road; PR, gaging station having less than 10 years record of daily mean discharge, treated as a partial-record site where low-flow characteristics were developed by using correlation techniques; U, unregulated flow; C, estimates based on correlation techniques; <, less than; G, estimates based on best-fit curves developed graphically from the log-Pearson analyses; R, regulated flow; LP, estimates based on log-Pearson frequency distribution; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of analysis (climatic years)	Number of observed days of flow: Equal to zero flow	Number of observed days of flow: Less than or equal to 7Q10	Average annual unit flow [(ft³/s)/mi²]	Low-flow characteristics (ft³/s): 7Q10	30Q2	W7Q10	7Q2	Flow	Method of analysis
154	0208721290	Perry Creek tributary at Neuse	1.07	PR	0[a]	0	1.1	0	0.1	0.05	0.05	U	C
188	0208726005	Crabtree Creek at SR 1649 near Raleigh	76	PR	11	13	.9	.3	3.7	1.7	1.9	R[i]	C
212	02087324	Crabtree Creek at U.S. 1 at Raleigh	121	PR	5	12	1.2	2.0	13.0	7.8	7.9	R[i]	C
216	0208732810	Marsh Creek at SR 2030 at Millbrook	1.44	PR	0	0	1.1	< .05	.3	.2	.1	U	C
220	0208732885	Marsh Creek near New Hope	6.84	1986-95	0	12	1.4	.3	1.5	.9	.8	U	LP
248	02087500	Neuse River near Clayton	1,150	1928-78 1984-95	0 0	110 41	1.0 .9	70.0 148	195 249	139 170	141 215	R[b] R[h]	LP LP
284	02088000	Middle Creek near Clayton[c]	83.5	1940-95	19	99	1.1	.3	9.0	4.5	4.4	U	LP
311	02088315	Beaverdam Creek near Grantham	5.01	PR	64	64	1.2	< .05	.2	.2	.1	U	C
330	02088470	Little River near Kenly	191	1965-88	0	19	1.0	1.6	13.1	12.3	8.0	R[b]	LP
335	02088500	Little River near Princeton	232	1930-95	0	151	1.1	2.5	22.7	16.6	12.8	R[b]	LP
341	02088682	Big Ditch at Retha Street at Goldsboro	2.17	PR	16	16	1.2	< .05	.3	.2	.2	U	C
344	02089000	Neuse River near Goldsboro	2,399	1930-78 1984-95	0 0	97 671	1.1 1.0	120 207	380 400	220 256	282 316	R[b] R[h]	LP LP
351	02089216	Daileys Creek near Liddell	3.80	PR	0	0	1.2	.4	1.4	1.1	1.2	U	C
352	02089222	Bear Creek near Parkstown	4.27	PR	15	15	1.2	0	.2	.08	.09	U	C
355	02089252	Bear Creek at Mays Store	57.7	PR	0	0	1.1	7.9	19.0	15.0	14.3	U	C
361	02089500	Neuse River at Kinston	2,692	1930-78 1984-95	0 0	123 12	1.1 1.0	200 250	520 550	340 360	405 430	R[b] R[h]	LP LP
386	02090380	Contentnea Creek near Lucama	161	1965-95	0	41	1.0	.3	10.6	3.8	5.0	R[b]	LP
393	02090500	Contentnea Creek near Wilson	237	1930-53	0	79	1.0	.3	17.0	2.5	9.0	R[j]	LP
397	02090512	Hominy Swamp at Phillips Street at Wilson	7.92	PR	0[a]	0	1.1	0	.07	< .05	< .05	U	C
411	02090625	Turner Swamp near Eureka[c]	2.10	1969-86	0	76	1.0	.3	.5	.3	.4	U	LP
430	0209096970	Moccasin Run near Patetown	1.89	1988-95	0	33	1.5	.1	.4	.4	.2	U	G
432	02091000	Nahunta Swamp near Shine	80.4	1954-95	0	131	1.0	2.6	11.7	10.0	7.7	U	LP
439	02091500	Contentnea Creek at Hookerton	733	1929-95	0	161	1.1	30.1	94.6	57.5	67.3	R[b]	LP
451	02091700	Little Contentnea Creek near Farmville	93.3	1957-86	0	59	1.2	.1	4.0	1.3	1.7	U	LP

Table 6. Magnitude and frequency of annual low-flow characteristics at selected continuous-record gaging stations in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; climatic years, the annual period from April 1 to March 31 and identified by the year in which the period begins; $(ft^3/s)/mi^2$, cubic foot per second per square mile; ft^3/s, cubic foot per second; SR, secondary road; PR, gaging station having less than 10 years record of daily mean discharge, treated as a partial-record site where low-flow characteristics were developed by using correlation techniques; U, unregulated flow; C, estimates based on correlation techniques; <, less than; G, estimates based on best-fit curves developed graphically from the log-Pearson analyses; R, regulated flow; LP, estimates based on log-Pearson frequency distribution; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of analysis (climatic years)	Number of observed days of flow: Equal to zero flow	Number of observed days of flow: Less than or equal to 7Q10	Average annual unit flow [$(ft^3/s)/mi^2$]	Low-flow characteristics (ft^3/s): 7Q10	30Q2	W7Q10	7Q2	Flow	Method of analysis
470	02091960	Creeping Swamp near Calico[c]	9.8	PR	443	443	1.1	0	0	0	0	U	C
471	02091970	Creeping Swamp near Vanceboro[c]	27	1971-84	602	602	1.3	0	0	0	0	U	LP
472	02092000	Swift Creek near Vanceboro	182	1950-88[k]	59	199	1.1	2.1	11.2	6.2	7.5	U	LP
475	02092020	Palmetto Swamp near Vanceboro[c]	24.2	PR	126	126	1.1	0	0	0	0	U	C
494	02092500	Trent River near Trenton	168	1951-95	0	99	1.1	1.4	8.4	3.5	4.8	U	LP
504	0209257120	W.P. Brice Creek below SR 1101 near Riverdale	11.2	PR	33	89	1.2	.3	2.0	1.2	1.2	U	C

[a] No daily mean discharges equal to zero were observed during the period of record available for low-flow analyses at this site. However, low-flow analyses at this site indicate that the 7Q10 discharge is zero.

[b] Low-flow characteristics reflect effects of some minor regulation and/or diurnal fluctuation during periods of low flow caused by industries and/or small impoundments upstream from the station. At some sites, low-flow characteristics may reflect the effects of diversions upstream from the station.

[c] Low-flow characteristics previously published in Giese and Mason (1993). Where different, estimates in this report supersede the previous estimates.

[d] Period of analysis is based on combined daily mean discharges at continuous-record stations 02085220 (site 51, Sept. 1961–Sept. 1987) and 0208521324 (site 50, Oct. 1987–Sept. 1996).

[e] Site immediately downstream from dam at Lake Michie; low-flow characteristics reflect flow releases from the dam.

[f] Flows at site during period of record were regulated by Lake Michie and reflective of other flow diversions, including an interbasin transfer to the Cape Fear River Basin.

[g] Estimates of low-flow characteristics limited to 7Q10 discharge. Prior to November 1994, streamflows affected by NPDES discharge into Little Lick Creek from wastewater-treatment plant upstream from station. The 7Q10 discharge of zero is estimated on the basis of low-flow characteristics for downstream partial-record site at 02087010 (site 107) having drainage area of 19.4 mi^2 (see table 7).

[h] Low-flow characteristics reflect effects of regulation of flows by Falls Lake in Wake County.

[i] Low-flow characteristics based on streamflow data were adjusted for the effects of an NPDES discharge into Crabtree Creek below the dam at Lake Crabtree and upstream from the station; however, low-flow characteristics reflect effects of regulation by Lake Crabtree.

[j] Low-flow characteristics reflect effects of regulation by Wiggins Mill Reservoir and withdrawals made by City of Wilson from the reservoir during the period of analysis. Because of increases in average withdrawals, low-flow characteristics likely do not reflect current low-flow characteristics, which cannot be determined. Correspondingly, low-flow characteristics for this site were not used in development of low-flow profiles for Contentnea Creek.

[k] Channel was canalized in 1954 from a point 12.2 miles upstream to a point 2.5 miles downstream from the gaging station.

Estimates of low-flow discharges for continuous-record gaging stations having more than 10 years of record were developed by using frequency curves (Riggs, 1972) (fig. 7). The curves depict the relation between recurrence interval and the lowest average annual discharge for a specified number of days at a gaging station. Frequency curves were developed for annual (climatic year) 7-day and 30-day lowest average discharges as well as for the winter (November through March) 7-day lowest average discharge and then fitted with the log-Pearson Type III frequency distribution. The computed log-Pearson distribution generally corresponds closely to the distribution of annual low flows for sites having long-term periods of record (fig. 7). The method of analysis for these sites is denoted as "LP" in table 6. For sites 14, 135 (records prior to regulation by Falls Lake), and 430, which have short-term records of 8 to 10 years, analyses using the log-Pearson Type III frequency distribution yielded best-fit curves, which were developed graphically from the Weibull plots. The method of analysis for these sites is denoted as "G" in table 6. The remaining gaging stations having less than 10 years of record, and usually less than 5 years, were treated as partial-record measuring sites using the methods of correlation (described below and denoted as "C" in table 6).

Seven gaging stations in the study area have records of daily mean discharge on the Neuse River; low-flow characteristics are presented in table 6 for six of the seven stations. The low-flow characteristics at four stations (sites 135, 248, 344, and 361) are presented for pre- and post-regulation flow conditions associated with the presence of Falls Lake, the largest impoundment in the study area. Falls Lake was constructed in the late 1970's and early 1980's. A common base period, the 1984–95 climatic years (April 1, 1984—March 31, 1996), was used to analyze post-regulation discharges at these sites. For analyses of pre-regulation discharges, the available period of record up through the 1978 climatic year (ending March 31, 1979) was used at these same sites and at two additional sites (103 and 144), which were discontinued before the construction of Falls Lake. Low-flow characteristics could not be determined at one station (site 254 at Smithfield) because records of discharge prior to October 1970 are limited to medium and high streamflows. Analyses of the remaining years of streamflow record at site 254 did not produce reliable estimates of low flows for either pre- or post-regulation periods.

Where low-flow characteristics at the Neuse River gaging stations are listed in table 6 for pre- and

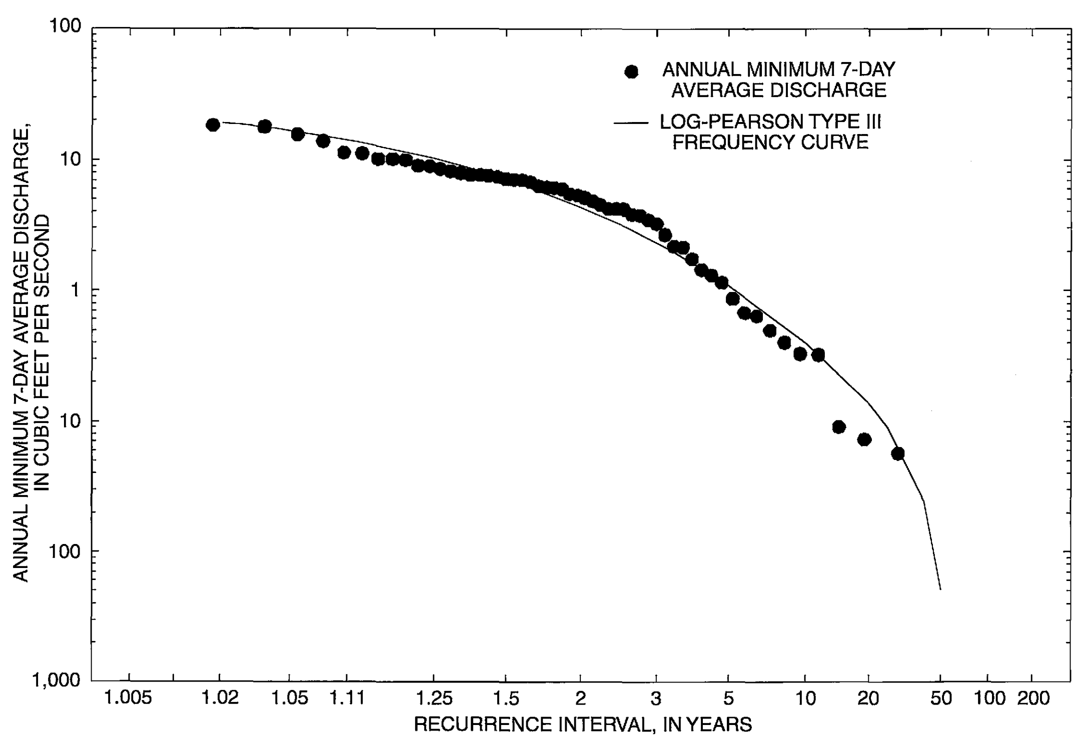

Figure 7. Low-flow frequency curve of annual minimum 7-day discharges using log-Pearson Type III frequency distribution at Middle Creek near Clayton (site 284).

post-regulation periods (sites 135, 248, 344, and 361), only the values for post-regulation flow conditions are used in the discharge profiles presented in this report. Pre-regulation values are listed for comparison purposes only and are intended to provide a means of quantifying the effects of Falls Lake on downstream flows. The effects are most significant at site 135, immediately downstream from the dam, with increases in the low-flow discharges ranging from 80 to nearly 300 percent (table 6). Downstream from the dam, as the ratio of drainage area at a given site to drainage area at the dam increases, the effects of regulation become less significant when compared to pre-regulation conditions. At site 361 at Kinston, where the drainage-area ratio is nearly 3.5, increases between pre- and post-regulation low flows range from 10 to 30 percent.

The common base period (1984–95) used for a number of sites on the Neuse River downstream from Falls Lake was not applied to the analyses of low flows at other gaging stations. While this period reflects flow conditions in the Neuse River since the construction of Falls Lake, it does not realistically represent a sufficient period of time for use in low-flow analyses at other gaging stations where longer-term records of discharge are available. A number of sites have records of discharge during severe droughts of the 1950's and 1960's, periods when many record low flows were set. Thus, except for sites where the period of analysis indicated in table 6 is 1984–95 climatic years, low-flow characteristics reflect the available periods of record.

Twenty-two continuous-record gaging stations having less than 10 years of record were treated as partial-record measuring sites for the analysis of low-flow characteristics; the method of analysis is denoted by "C" in table 6, and the period of analysis is denoted as "PR." Daily mean discharges at these sites were correlated with concurrent flows at nearby long-term continuous-record gaging stations where low-flow characteristics are known. At these sites, available periods of record were used in the correlations.

The presence of upstream regulation and/or diversions in flows is denoted as "R" in table 6; where flows at a gaging station are largely regarded as being unaffected by human-induced flow modifications during the period of record, the flow is denoted as "U." By definition, the term "regulation" refers to the artificial manipulation of the flow in a stream (Langbein and Iseri, 1960), an effect only achieved by the presence of a dam having a flow-release system that can be operated to adjust the magnitudes of flow in the stream. In this report, the low-flow characteristics at gaging stations where the flow has been denoted as "R" in table 6 also may reflect the effects of diversions and/or diurnal fluctuations caused by industries and/or small impoundments upstream from the station. Gaging stations denoted as "R" are footnoted to clarify the type of effects on the low-flow characteristics. Low-flow characteristics for the regulated sites can be considered valid as long as these effects of regulation and/or diversions continue to exist.

For sites downstream from flow diversions, no efforts were made to adjust the records of daily mean discharges for changes in flow caused by withdrawals from and point-source discharges to streams. Records of daily flow diversions necessary for making proper adjustments to USGS streamflow records usually are unavailable. In most instances, only annual average flow diversions can be obtained. However, beyond the daily fluctuations in flow diversions, overall average withdrawals and point-source discharges have increased during the past few decades as a result of development and population increases. Thus, efforts to adjust streamflow records at USGS gaging stations on the basis of average flow diversions could result in unreliable estimates of low-flow characteristics. The exception to this occurred at two gaging stations on Crabtree Creek (sites 188 and 212; table 6) in Wake County. Preliminary low-flow analyses at these two sites depicted significant increases in unit low flows between the two locations. With available daily records of point-source discharges from the northern wastewater-treatment facility for the Town of Cary, daily mean discharges at these sites were adjusted to remove the effects of the flow inputs. Discharges from the Town of Cary include flows from an interbasin transfer because Cary's water supply is Jordan Lake in the Cape Fear River Basin (table 2, fig. 1). The low-flow characteristics listed at these two sites reflect the adjusted discharges and, hence, the flow is denoted as "U" in table 6.

Partial-Record Measuring Sites

Using the techniques discussed by Riggs (1972), low-flow characteristics were determined for 112 of the 448 sites in the Neuse River Basin identified as having partial-record data and for 1 of the 20 combined sites that have both continuous- and partial-record discharges (table 7). Sites having 10 or more discharge measurements were included in the analyses of low-

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; $(ft^3/s)/mi^2$, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements		Average annual unit flow [$(ft^3/s)/mi^2$]	Low-flow characteristics (ft^3/s)			
					Flow	Zero flow		7Q10	30Q2	W7Q10	7Q2
4	02084812	East Fork Eno River near Cedar Grove[a]	11.46	1958, 1964, 1966, 1968	4	0	0.9	0.2	1.5	0.9	1.0
5	02084890	Eno River near Carr[a]	26.7	1954-55, 1958, 1960-64, 1966, 1968, 1970, 1986-87	21[b]	0	.9	.2	3.0	2.0	1.8
18	02084916	Eno River at water-supply intake near Hillsborough	60.4	1954-55, 1958, 1968, 1974-75	9	0	.9	.4	4.5	1.9	2.7
22	02085006	Cates Creek near Hillsborough[a]	4.18	1954-55, 1968, 1970, 1973-74	10	2	.9	< .05	.1	< .05	.06
35	02085059	Crooked Creek near Durham	4.56	1958, 1964, 1966, 1968	4	1	1.0	0	0	0	0
39	02085114	Forrest Creek near Cedar Grove	.62	1954, 1964, 1966, 1968, 1972-73	10	2	.9	0	< .05	0	0
40	02085118	Forrest Creek near Schley	3.00	1954, 1968, 1972-73	10	2	.9	0	< .05	0	0
42	02085130	South Fork Little River near Quail Roost[a]	38.2	1954, 1958, 1961-68	24	0	1.0	.1	2.5	.8	1.4
45	02085190	North Fork Little River tributary near Rougemont	1.00	1953, 1961-76	22[c]	4	.9	0	0	0	0
47	02085201	Buffalo Creek near Rougemont	5.48	1958, 1964, 1966, 1968	4	3	.9	0	0	0	0
48	02085210	North Fork Little River near Orange Factory[a]	29.7	1954, 1961-68	23	1	1.0	< .05	.7	.2	.3
54	0208524950	Little River tributary at Fairntosh	.86	1994-96[d]	28	0	1.0	0	0	0	0
56	02085262	Little River near Weaver[a,e]	104	1954, 1958, 1964, 1966, 1968, 1970	6	0	.9	.2	5.8	3.7	3.4
58	02085302	South Flat River near Hurdle Mills	6.22	1974-76, 1978-84	31	1	1.0	0	.1	.08	.08
69	02085390	North Flat River at Timberlake[a]	33.0	1958, 1964-68, 1970	15	0	.9	.2	1.8	1.1	1.3
70	02085413	Deep Creek near Surl	11.6	1958, 1964, 1966, 1968	4	3	.9	0	0	0	0
72	02085430	Deep Creek near Moriah[a]	32.5	1958, 1963-68, 1970	17	4	1.0	0	.2	0	0
75	02085810	Muddy Branch at Bahama	.64	1961-66, 1968, 1970	23	5	.9	0	0	0	0
77	02086101	Horner Ford Creek at Bahama	.28	1961-64, 1968, 1970	9	2	.9	0	0	0	0
78	02086121	Horner Ford Creek tributary near Bahama	.28	1961-64, 1970	8	3	.9	0	0	0	0
79	02086275	Dry Creek near Bahama[a]	1.24	1961-64, 1966, 1968, 1970	10	5	1.0	0	0	0	0

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; (ft^3/s)/mi^2, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements		Average annual unit flow [(ft^3/s)/mi^2]	Low-flow characteristics (ft^3/s)			
					Flow	Zero flow		7Q10	30Q2	W7Q10	7Q2
80	02086287	Dry Creek tributary near Bahama	0.24	1961-64, 1966, 1968, 1970	10	3	0.9	0	0	0	0
81	02086291	Dry Creek tributary no. 2 near Bahama	2.08	1961-64, 1966, 1968, 1970	10	6	.9	0	0	0	0
82	02086300	Rocky Creek near Bahama	2.30	1958, 1961-64, 1966, 1968, 1970	11	1	.9	0	0	0	0
83	02086351	Rocky Creek tributary near Bahama	.50	1961-64, 1968, 1970	9	7	.9	0	0	0	0
86	02086570	Knap of Reeds Creek near Butner	29.9	1954-55, 1958, 1961-66, 1968-69	34	1	.9	.07	1.4	.5	.7
107	02087010	Little Lick Creek near Redwood[a]	19.4	1954, 1958, 1964-68, 1970, 1972-73	23	9	1.0	0	.1	0	0
112	02087024	Ledge Creek tributary no. 2 near Northside	3.86	1958, 1961, 1964, 1968, 1970	6	6	1.0	0	0	0	0
118	02087046	Robertson Creek at NC 56 near Creedmoor	9.28	1954, 1958, 1968, 1970	6	5	1.0	0	0	0	0
121	02087060	Beaverdam Creek near Creedmoor[a]	44.2	1954-55, 1957-59, 1968, 1970	19	7	1.1	0	1.1	.2	.5
124	02087080	New Light Creek near Purnell	19.2	1954-58, 1968, 1970	18	0	1.0	1.6	3.8	2.4	3.1
125	02087120	Upper Barton Creek near Bayleaf	12.4	1952, 1954-58, 1968, 1970	19	0	1.0	.5	3.1	1.7	1.9
127	02087160	Lower Barton Creek near Bayleaf	13.1	1951-54, 1958, 1968	20	0	1.0	1.5	3.3	2.5	2.7
131	02087175	Horse Creek near Wake Forest	21.2	1949-55, 1958-59, 1963, 1968	28	0	1.0	3.6	7.9	6.0	6.4
136	0208718385	Hattels Branch at NC 96 at Youngsville	.1	1972-75	9	1	1.0	0	0	0	0
140	02087187	Richland Creek at NC 98 at Wake Forest[a]	7.66	1972-74	6	0	1.1	.5	2.2	1.6	1.5
141	02087188	Richland Creek near Forestville	10.5	1954-55, 1968, 1972-74	11	0	1.1	.8	2.7	1.9	1.8
146	02087194	Austin Creek at Wake Forest[a]	3.98	1958-59, 1968	3	0	1.1	.1	1.6	.7	.8
159	02087220	Harris Creek near Wake Crossroads[a]	9.85	1954-59, 1961-64	22	0	1.1	1.0	3.2	2.3	2.1
162	02087229	Neuse River near Raleigh	877	1927, 1954-55, 1974	9	0	1.1	39[f]	130	86	88
164	0208723280	Crabtree Creek at SR 1615 near Cary	3.83	1973-74	6	2	1.1	0[g]	N/A[g]	N/A[g]	N/A[g]
168	02087236	Crabtree Creek at Morrisville	14.7	1932, 1961-62, 1968, 1972-74	10	4	1.1	0[g]	N/A[g]	N/A[g]	N/A[g]
169	0208723750	Licks Creek near Morrisville	.3	1972-75	8	4	1.1	0	0	0	0

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; $(ft^3/s)/mi^2$, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements		Average annual unit flow [$(ft^3/s)/mi^2$]	Low-flow characteristics (ft^3/s)			
					Flow	Zero flow		7Q10	30Q2	W7Q10	7Q2
171	02087238	Stirrup Iron Creek at Nelson	7.09	1958, 1962, 1966, 1968	4	4	1.1	0	0	0	0
176	02087246	Little Brier Creek near Nelson	8.58	1955, 1962, 1968, 1970	6	4	1.1	0	0	0	0
177	02087249	Stirrup Iron Creek near Morrisville	25.4	1961-62, 1968, 1972-74	10	3	1.1	0	< .05	0	0
178	02087251	Crabtree Creek near Cary[a]	52.2	1961-62, 1968, 1982-92, 1995-96	50	0	1.1	.2	1.2	.8	.8
195	02087270	Hare Snipe Creek near Millbrook[a]	7.22	1961-68, 1970	17	0	1.0	.2	1.2	.8	.7
199	02087275	Crabtree Creek at U.S. Hwy 70 at Raleigh	97.6	1932, 1942, 1947, 1949-50, 1952-56, 1958, 1960-63, 1968, 1973, 1978	43	0	1.1	.4	5.0	2.4	2.6
200	02087290	Mine Creek near Millbrook[a]	8.87	1951-55, 1958, 1961-62, 1968	17	0	1.1	.8	3.2	2.4	2.4
209	02087320	Big Branch near Millbrook[a]	3.78	1951-55, 1958, 1961-62, 1968	17	0	1.1	.7	1.8	1.4	1.4
236	02087359	Walnut Creek at Sunnybrook Road at Raleigh	29.4	1973-75	12[h]	0	1.1	.3	7.0	4.5	4.5
240	02087370	Big Branch near Garner	11.8	1953-58, 1960, 1970, 1972-73, 1976, 1979-80	30	0	1.1	.5	2.6	1.9	1.8
245	02087410	Poplar Creek near Knightdale[a]	8.83	1954-58, 1960, 1963, 1970	14	0	1.1	.9	3.2	2.5	2.4
256	02087580	Swift Creek near Apex	21.0	1958, 1961-71, 1992-95	57	0	1.1	0	.4	.1	.1
258	0208758450	Dutchmans Branch near McCullers Crossroads	5.23	1987-92	16	0	1.1	0	.1	< .05	< .05
262	02087610	Swift Creek near McCullers[a]	55.2[i]	1932, 1949-53	16	0	1.1	.1	4.9	2.9	2.6
266	0208772185	Swift Creek near Drug Store	86.6	1984-97	40	1	1.1	.3	7.0	3.6	3.5
268	02087761	Little Creek above Clayton	3.84	1954-55, 1958, 1971, 1986	9	1	1.1	0	.3	.2	.1
274	02087885	Middle Creek at Durham and Southern Railway near Apex	.70	1973-76, 1979-80	13	1	1.1	0	0	0	0
283	0208796545	Terrible Creek at SR 1404 at Five Points	4.92	1973-75	9	1	1.1	0	.1	< .05	< .05
285	02088030	Middle Creek near Smithfield	129.4	1949-56, 1958, 1974, 1976, 1978, 1980-83	48	0	1.1	.6	16.0	8.0	7.9
286	0208807310	Black Creek near Willow Springs	3.87	1973-74, 1978, 1980	9	2	1.1	0	< .05	< .05	0
288	02088090	Black Creek near Four Oaks[a]	81.9	1949-55, 1958-59, 1974-75	19	1	1.1	0	0.3	< 0.05	< 0.05

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; (ft^3/s)/mi^2, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements: Flow	Number of measurements: Zero flow	Average annual unit flow [(ft^3/s)/mi^2]	Low-flow characteristics (ft^3/s): 7Q10	30Q2	W7Q10	7Q2
301	02088240	Hannah Creek near Blackman	34.7	1957-65	14	3	1.1	0[g]	N/A[g]	N/A[g]	N/A[g]
307	02088275	Mill Creek near Cox Mill[a]	185	1954, 1958, 1965-68, 1971, 1974, 1976, 1978-84	43[j]	0	1.2	.7	15.7	10.7	7.0
310	02088310	Buck Swamp near Dudley[a]	15.5	1949-59	22	1	1.2	< .05	1.8	1.2	.6
315	02088332	Neuse River near Stevens Mill	2,024	1963-64, 1974, 1976, 1978, 1980-84	40	0	1.0	160[f]	310	200	245
320	0208837825	Little River at U.S. 401 near Harris Crossroads	8.33	1974-76, 1979	6	0	1.1	.1	.5	.5	.4
321	02088380	Cedar Fork near Rolesville	4.41	1960-64, 1966, 1968	15	0	1.1	< .05	.5	.3	.2
324	02088415	Little River at NC Highway 42 at Hares Crossroads	104	1969-72	11	0	1.1	1.1	8.9	8.3	5.4
326	02088434	Buffalo Creek at Poole Road near Wendell[a]	15.8	1955, 1958, 1972-74	9	1	1.1	.2	1.5	.9	.9
329	02088465	Buffalo Creek near Bagley	58.5	1954, 1958, 1965-68, 1971	9	1	1.1	.3	3.3	2.8	2.0
331	02088480	Little Buffalo Creek near Kenly[a]	9.34	1965-68, 1971	7	4	1.1	0	0	0	0
338	0208858110	Little River at NC 581 near Asylum	284	1974, 1976, 1978	6	0	1.1	4.6	31.7	24.1	19.2
345	02089020	Stoney Creek at Goldsboro	21.6	1949-55, 1957-58	21	0	1.2	.3	2.2	1.2	1.3
348	02089116	Neuse River near Whitehall	2,471	1972-73	9	0	1.1	175[f]	450	300	363
349	02089120	Walnut Creek near Best[k]	9.71	1955-63	16	0	1.2	.7	2.4	2.0	1.8
354	02089240	Bear Creek near La Grange[a]	49.2	1954-66, 1968, 1970	23	0	1.1	6.3	11.3	9.3	9.0
360	02089380	Falling Creek at Falling Creek	45.4	1949-55, 1957	19	0	1.2	1.7	5.8	4.1	4.0
362	02089580	Deep Run at Deep Run[a]	6.1	1949-54, 1956-57, 1966	18	0	1.1	.2	1.4	.8	.8
363	02089620	Southwest Creek near Woodington	37.7	1956-57, 1959-66	16	1	1.2	.3	3.1	2.2	1.6
368	02089690	Stonyton Creek near Graingers[a]	36	1954, 1956-57, 1965-68, 1970-71	14	1	1.1	< .05	.6	.2	.2
369	02089730	Mosley Creek near Grifton	45.7	1954-55, 1957, 1964-68, 1971	10	1	1.2	.1	.9	.4	.5
372	02089946	Moccasin Creek near Zebulon[a]	29.8	1950-54, 1957-58, 1963, 1966	20	1	1.1	.09	2.6	1.4	1.2
384	02090360	Turkey Creek near Connor	74.2	1958, 1965-68, 1971-73	13[b]	1	1.1	.05	1.8	.8	.6
395	02090507	Hominy Swamp at SR 1321 at Wilson	1.5	1969-70, 1972-73	7	1	1.1	0[g]	N/A[g]	N/A[g]	N/A[g]
396	02090509	Hominy Swamp at U.S. 264A at Wilson	5.35	1969-70, 1972-73	9	2	1.1	0	0.09	0	< 0.05

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; $(ft^3/s)/mi^2$, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements		Average annual unit flow [$(ft^3/s)/mi^2$]	Low-flow characteristics (ft^3/s)			
					Flow	Zero flow		7Q10	30Q2	W7Q10	7Q2
406	02090580	Black Creek near Black Creek	32.1	1955-59, 1961-64	17	6	1.1	0	.2	.05	0
408	02090590	Great Swamp near Black Creek	38.8	1958, 1965-68, 1971	9	0	1.1	0	.3	.09	< .05
410	02090620	Aycock Swamp near Stantonsburg	11.5	1958, 1965-68, 1971	9	0	1.1	0	.4	.2	.07
413	02090634	Contentnea Creek near Stantonsburg	389	1969-70, 1972-74, 1978, 1980-85	32	0	1.1	2.6	23.5	12.4	12.4
417	02090720	Toisnot Swamp near New Hope	30	1932, 1954, 1957-59, 1961-64, 1969	19	0	1.1	2.5	5.2	4.7	4.0
427	02090960	Nahunta Swamp near Pikeville	19	1957, 1961-73	22	0	1.2	.6	2.6	2.2	1.7
431	02090980	The Slough near Saulston	21.3	1957, 1960-66	12	0	1.2	.8	3.6	3.1	2.4
433	02091040	Nahunta Swamp near Snow Hill	90	1949-54, 1957, 1967-68	20	0	1.2	2.8	13.5	11.5	8.7
435	02091241	Contentnea Creek at U.S. 258 at Snow Hill	694	1969-70, 1972-74, 1978, 1980	10	0	1.2	25.8	88.2	51.7	61.2
437	02091480	Rainbow Creek near Glenfield	12	1954-57, 1960-65	13[1]	0	1.2	1.4	2.8	2.2	2.3
441	02091544	Wheat Swamp near Hugo[a]	20.5	1956-57	4	1	1.2	.3	1.8	1.3	1.2
443	02091574	Contentnea Creek near Hugo	789	1956-57, 1969-70, 1973-74	10	0	1.1	33.1	107	64.3	75.5
449	02091664	Little Contentnea Creek at NC 121 near Farmville	55.1	1956, 1969-70, 1972, 1974	!0	0	1.2	< .05	1.7	.5	.6
456	02091740	Little Contentnea Creek at Scuffleton	172	1956-57, 1965-66, 1969-70, 1980	14	0	1.2	.2	10.0	2.9	4.0
460	02091814	Neuse River near Fort Barnwell	3,900	1970, 1972-73, 1976, 1978, 1980-82, 1985-91, 1995-96	30	0	1.1	400	855	570	675
461	02091820	Core Creek near Fort Barnwell	59	1949-58	22	0	1.1	.5	2.3	1.2	1.5
468	02091910	Swift Creek near Coxville	78.2	1956-57, 1960-70, 1974-75	27	0	1.1	.2	3.2	1.0	1.2
486	0209218190	Trent River at NC 11 near Deep Run	3.2	1974-76, 1980-84	34	1	1.2	.1	.5	.3	.3
490	02092230	Joshua Creek near Combs Fork	12.1	1965-68, 1970-71	9	1	1.2	0[g]	N/A[g]	N/A[g]	N/A[g]
492	02092290	Rattlesnake Branch near Comfort	2.5	1954, 1957, 1961-71	14[c]	2	1.3	0[g]	N/A[g]	N/A[g]	N/A[g]
496	02092520	Vine Swamp near Kinston	6.30	1954, 1957, 1961-71	13[c]	2	1.2	0[g]	N/A[g]	N/A[g]	N/A[g]
497	02092540	Beaver Creek near Phillips Crossroads	33	1956-57, 1960-68, 1970	20	0	1.2	.2	1.1	.4	.5
498	02092549	Musselshell Creek near Trenton	9.7	1954, 1957, 1965-68, 1970-71	10	1	1.2	< 0.05	1.8	0.9	0.8

Table 7. Magnitude and frequency of annual low-flow characteristics at selected partial-record measuring sites in the Neuse River Basin, North Carolina—Continued

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; $(ft^3/s)/mi^2$, cubic foot per second per square mile; ft^3/s, cubic foot per second; <, less than; SR, secondary road; N/A, not available]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Number of measurements		Average annual unit flow [$(ft^3/s)/mi^2$]	Low-flow characteristics (ft^3/s)			
					Flow	Zero flow		7Q10	30Q2	W7Q10	7Q2
505	02092590	Upper Broad Creek near Olympia	21	1950-54, 1956-59	14	6	1.2	0[g]	N/A[g]	N/A[g]	N/A[g]
506	02092620	Upper Broad Creek tributary near Grantsboro	3.0	1957-58, 1961-73	15[c]	1	1.2	0[g]	N/A[g]	N/A[g]	N/A[g]

[a] Low-flow characteristics previously published in Giese and Mason (1993). Where different, estimates in this report supersede the previous estimates.

[b] Low-flow characteristics based on combined partial-record measurements at 02084890 (site 5) and 02084896 (site 6). Initially, 25 measurements are available in the combined record of discharges; however, four measurements were made on concurrent dates resulting in 21 measurements used in the analyses. Discharges at site 6 were adjusted by drainage area prior to analyses.

[c] Record of measurements consists mostly of crest-gage (flood) discharges, which limit the determination of estimates for all low-flow characteristics. At site 45, record of four zero-flow discharges in combination with small drainage basin (1.00 mi^2) suggests that all low-flow characteristics are zero flow. At other indicated sites, only zero-flow 7Q10 discharge can be estimated.

[d] Discharge measurements were made in conjunction with water-quality sampling at site.

[e] Site now inundated by impoundment; low-flow characteristics represent pre-impoundment conditions.

[f] Low-flow characteristics reflect pre-impoundment flow conditions prior to regulation by Falls Lake upstream from station.

[g] Estimates for all low-flow characteristics cannot be determined based on available data; however, multiple observations of zero flow at site or zero-flow 7Q10 discharge at downstream site allow estimate of zero-flow 7Q10 at indicated site.

[h] Site operated as continuous-record gaging station since May 1996. Low-flow characteristics based on combined partial-record measurements at 02087359 (site 236) and 02087355 (site 233).

[i] Drainage area revised to 41.8 mi^2 (table 5) when site and road were relocated upstream from a tributary draining to original location. Original drainage area used when performing flow analyses. Low-flow characteristics reflect streamflow conditions prior to construction of Lake Wheeler.

[j] Low-flow characteristics based on combined partial-record measurements at 02088270 (site 306) and 02088275 (site 307).

[k] Site now in backwater of dam located 0.5 mile downstream; low-flow characteristics represent flow conditions prior to existence of dam.

[l] Low-flow characteristics based on combined partial-record measurements at 02091480 (site 437) and 02091486 (site 438).

flow characteristics, as well as sites where low-flow characteristics previously have been published or for which knowledge of low-flow discharges were necessary in the development of discharge profiles.

Discharge measurements at the partial-record measuring sites were plotted with concurrent flows at nearby index sites, typically continuous-record gaging stations where low-flow characteristics had been determined (fig. 8). Correlation plots were then examined to determine if a relation exists between the concurrent flows. Index sites for possible use in the correlation analysis of concurrent flows were selected by using several factors, including proximity of the partial-record and index sites, as well as similarity in such basin characteristics as drainage area and topography.

Defining the relation between concurrent flows is usually based on either statistical techniques or graphical interpretation whereby visually fitted lines are drawn between the concurrent flows (Riggs, 1972). In this investigation, both statistical and graphical methods were used to establish the relation between the concurrent flows. When applying the statistical method, the Maintenance of Variance Extension (MOVE.1) technique was used as opposed to the least-squares regression technique, which has been shown to provide biased estimates of low-flow characteristics (Stedinger and Thomas, 1985). As a general rule, computed MOVE.1 relations having correlation coefficients greater than 0.8 were used to derive the estimates of low flows. For cases in which the correlation coefficient was less than 0.8 or the relation was nonlinear, visually fit correlations were applied to more adequately describe the relation between concurrent flows.

At most partial-record measuring sites, correlations of the discharge measurements with concurrent flows at multiple index sites yielded several

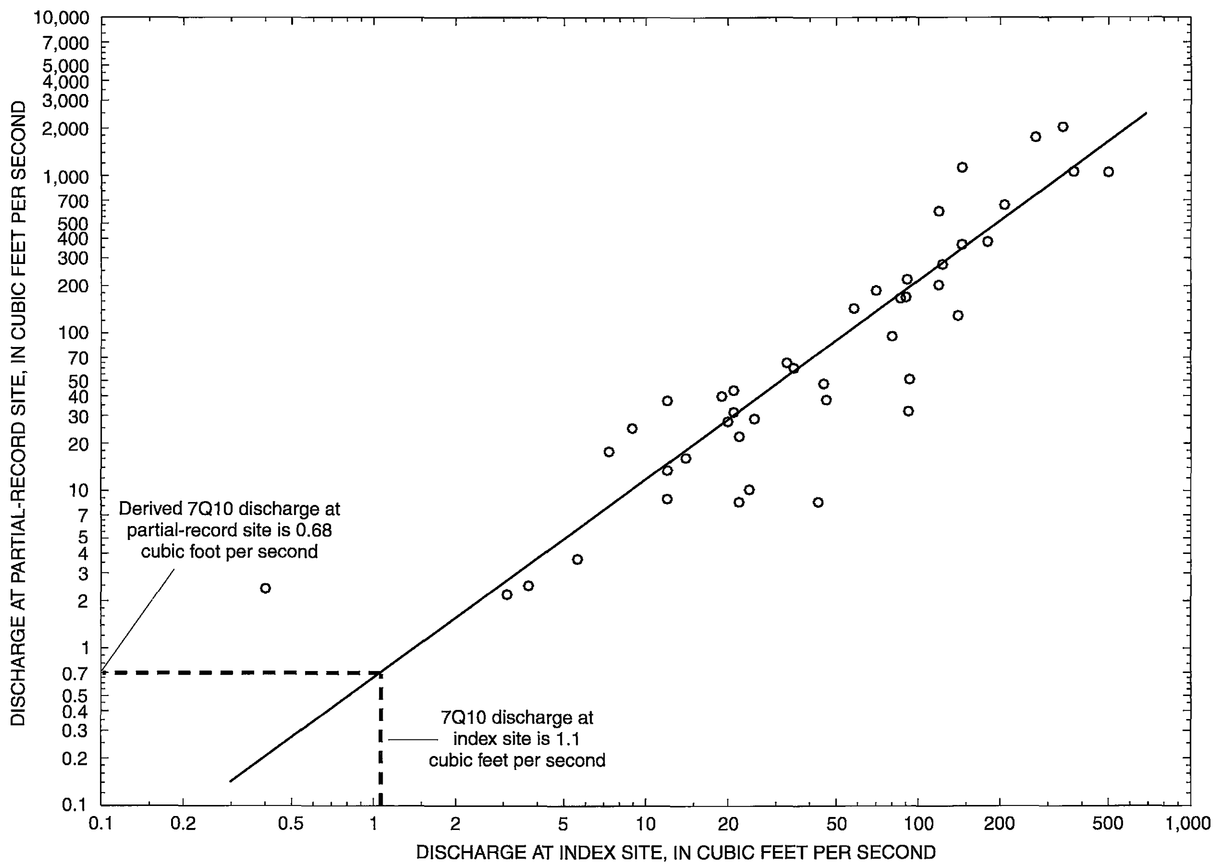

Figure 8. Correlation of concurrent discharge at partial-record site at Mill Creek near Cox Mill (site 307) and at the index site at Little Coharie Creek near Roseboro (Cape Fear River Basin).

relations from which estimates of low-flow discharges could be determined. From each relation, estimates of low-flow discharges were derived from the individual correlation plot. Thus, to determine overall estimates of low-flow discharges (7Q10, 30Q2, W7Q10, and 7Q2) for each partial-record measuring site, individual estimates derived from each correlation were averaged. However, individually derived estimates from poor correlations, where visually fit lines could not be established or otherwise were deemed suspect, were not included in the average for overall estimates.

Low-flow characteristics for the partial-record measuring sites reflect unregulated conditions with the exception of one site on the Neuse River. Low-flow discharges listed for site 460 during the period following the 1982 water year reflect regulated conditions from Falls Lake (table 7). However, because the ratio of drainage area at site 460 to that at the dam is slightly greater than 5.0, the effects of regulation may be nonexistent. Additionally, backwater effects from tidal influences downstream from site 460 may also affect flows. For the remaining partial-record measuring sites listed in table 7, the presence of minor regulation and/or flow diversions in the record of discharge measurements is not documented. However, discharge measurements at some of these sites most likely reflect some effects of flow modifications, particularly at such streams as Crabtree Creek, Swift Creek (Wake County), Little River, and Contentnea Creek.

As previously discussed, the Neuse River Basin includes parts of 6 of the 10 HA's identified by Giese and Mason (1993). Regional equations are available for computing low-flow characteristics at sites within HA5. Giese and Mason (1993) identified HA5 as part of the Raleigh Belt, a zone of metamorphic and intrusive rocks which includes a predominance of felsic metaigneous, felsic gneiss, and schist rock units. Further, they noted that streams in HA5 have higher unit low flows than those in the surrounding HA's of the Coastal Plain (HA1 and HA2) and the eastern and central Piedmont (HA4 and HA6). Low-flow characteristics based on the regional equations for HA5 are computed by using the drainage area for the site of interest, and Giese and Mason (1993) reported that the standard errors of estimates range from 49 percent (30Q2 equation) to 92 percent (7Q10 equation).

Low-flow characteristics based on regional equations at 10 partial-record measuring sites in HA5 in the Neuse River Basin and analysis of partial-record data as previously outlined (table 7) are presented in table 8. Differences between the regional estimates and data estimates vary among the 10 sites listed. Five of the 10 sites (146, 159, 200, 209, and 245) have regional estimates that are lower than the data estimates. The remaining five sites have higher regional estimates than the data estimates; the most significant differences, ranging from nearly 600 to 700 percent, are noted at site 178 on Crabtree Creek. For most sites, differences between the low-flow characteristics can be attributed to the general nature of residual errors associated with use of a statistical regression to compute estimates. At site 178 on Crabtree Creek, however, use of the HA5 regional equations does not account for part of the basin's presence within the adjacent HA6 (Triassic basin). As depicted on the map of hydrologic areas by Giese and Mason (1993), site 178 occurs within HA5. However, the headwaters of this 52.2-mi^2 basin begin in HA6, a factor which is not reflected in the regional estimates but is reflected in the lower data estimates. Still, the regional equations provided by Giese and Mason (1993) are useful for computing estimates at locations where no other data are available to assess low-flow characteristics. Further, their conclusions regarding relatively higher unit low flows in the part of HA5 that lies within the Neuse River Basin are confirmed by the increased unit low flows from Durham and western Wake Counties to central and eastern Wake County.

Table 8. Low-flow characteristics for partial-record measuring sites and regional equations in Hydrologic Area 5 (HA5) (Giese and Mason, 1993) within the Neuse River Basin, North Carolina

[mi^2, square mile; water years, the annual period from October 1 to September 30 and identified by the year in which the period ends; ft^3/s, cubic foot per second. First line of low-flow characteristics are those listed in table 7 for the indicated site. The second line of low-flow characteristics are based on the regional equations (computed to two significant figures) presented for HA5 in Giese and Mason (1993)]

Site index no. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (water years)	Low-flow characteristics (ft^3/s)			
					7Q10	30Q2	W7Q10	7Q2
140	02087187	Richland Creek at NC 98 at Wake Forest	7.66	1972-74	0.5 .58	2.2 1.7	1.6 1.3	1.5 1.2
146	02087194	Austin Creek at Wake Forest	3.98	1958-59, 1968	.1 .41	1.6 1.0	.7 .80	.8 .74
159	02087220	Harris Creek near Wake Crossroads	9.85	1954-59, 1961-64	1.0 .66	3.2 2.1	2.3 1.6	2.1 1.5
178	02087251	Crabtree Creek near Cary	52.2	1961-62, 1968, 1982-92, 1995-96	.2 1.6	1.2 8.4	.8 6.1	.8 5.5
195	02087270	Hare Snipe Creek near Millbrook	7.22	1961-68, 1970	.2 .56	1.2 1.6	.8 1.3	.7 1.2
200	02087290	Mine Creek near Millbrook	8.87	1951-55, 1958, 1961-62, 1968	.8 .62	3.2 1.9	2.4 1.5	2.4 1.4
209	02087320	Big Branch near Millbrook	3.78	1951-55, 1958, 1961-62, 1968	.7 .40	1.8 .96	1.4 .77	1.4 .71
245	02087410	Poplar Creek near Knightdale	8.83	1954-58, 1960, 1963, 1970	.9 .62	3.2 1.9	2.5 1.5	2.4 1.4
262	02087610	Swift Creek near McCullers	55.2	1932, 1949-53	.1 1.6	4.9 8.8	2.9 5.2	2.6 4.7
326	02088434	Buffalo Creek at Poole Road near Wendell	15.8	1955, 1958, 1972-74	.2 .85	1.5 3.1	.9 2.4	.9 2.2

Occurrence of Zero or Minimal 7Q10 Discharge

Estimated 7Q10 discharges at 61 of the 163 sites were determined to be zero (tables 6, 7). In addition to the sites having zero 7Q10 discharge, 11 sites have 7Q10 discharges reported to be less than 0.05 ft^3/s. In a previous report on the low-flow characteristics in the Roanoke River Basin, Weaver (1996) defined minimal 7Q10 discharges as those reported to be less than 0.1 ft^3/s, a threshold used by Giese and Mason (1993) in their reporting of low-flow characteristics for streams in North Carolina. In this report, minimal 7Q10 discharges have been re-defined to a lower threshold of 0.05 ft^3/s, the minimum flow allowed by DWQ in its evaluation of NPDES permits.

When the sites in the Neuse River Basin were arranged in order of ascending drainage area, there was no clear indication of a maximum drainage area below which 7Q10 discharges are generally zero. The sites having zero or minimal 7Q10 discharges were combined and plotted on a map to determine what other factors, if any, may account for the low potential to sustain base flow. Estimates of zero or minimal 7Q10 discharges occur in two general sections of the study area—in the upper end of the Neuse River Basin in Orange, Person, Durham, Granville, and western Wake Counties and in the lower end of the study area in Jones, Craven, Pamlico, and Pitt Counties. In the central section of the study area, occurrences of zero or minimal 7Q10 discharges were noted, though in a more scattered pattern than in the upper and lower ends of the basin. The areas of the basin where zero or minimal 7Q10 discharges could be expected for small- to mid-size basins are identified on plate 1 (shaded areas).

In the upper end of the study area, the presence of poorly drained soils—that is, soils having low infiltration rates—is a primary factor in numerous occurrences of zero 7Q10 discharges. This part of the study area is composed of tributaries draining to the Neuse River upstream from its confluence with New Light Creek (partially inundated by Falls Lake) downstream of the Wake-Durham County line (pl. 1). Also included in this area are the headwaters of Crabtree Creek, Swift Creek, and Walnut Creek in western Wake County. Not all soils in this upper end of the basin are classified as poorly drained (fig. 6B). Some moderately drained soils occurring in parts of Orange and Person Counties within the Neuse River Basin also are characterized as having infiltration rates in the lower range among the soil hydrologic groups. An additional factor that may be considered at sites underlain by moderately drained soils in this area is the average annual rainfall amounts which increase from west to east across the basin (fig. 5B). Much of the water that comes in contact with the soils in this area most likely enters the streams as overland runoff and does not infiltrate into surficial aquifers for later release during drought conditions. Among sites having zero 7Q10 discharges, the drainage areas range from less than 0.01 mi^2 (site 10) to about 44 mi^2 (site 121). For sites in this area having non-zero 7Q10 discharges, the average 7Q10 unit low flow is about 0.005 $(ft^3/s)/mi^2$. Therefore, sites with drainage areas less than about 10 mi^2 could be expected to have zero or minimal 7Q10 discharges (less than 0.05 ft^3/s). Within the HA's delineated by Giese and Mason (1993), the upper end of the study area occurs within HA7 and HA6 (fig. 2) where they reported drainage areas of 3 mi^2 and 45 mi^2, respectively, as those drainage areas below which 7Q10 discharges generally are zero. Giese and Mason's (1993) drainage-area threshold for HA6 is comparable to the range of drainage areas (10.1 mi^2 to 44.2 mi^2) for sites (105, 107, and 121) within the portion of this area underlain by the Triassic basin and which have been observed to have 7Q10 discharges equal to zero.

Likewise, in Jones, Craven, Pamlico, and Pitt Counties in the lower end of the study area, the extensive cover of poorly drained soils and low topographic relief likely accounts for the presence of sites having zero or minimal 7Q10 discharges. For sites in this area having non-zero 7Q10 discharges, the average 7Q10 unit low flows is about 0.01 $(ft^3/s)/mi^2$. Therefore, sites with drainage areas less than about 5 mi^2 could be expected to have zero or minimal 7Q10 discharges (less than 0.05 ft^3/s). The lower end of the study area is within HA1 (clay soils) and HA2 (sandy soils) with soils of HA1 tending to be predominant (Giese and Mason, 1993). For HA1 and HA2, Giese and Mason reported drainage areas of 35 mi^2 and 2 mi^2, respectively, as those below which 7Q10 discharges generally are zero. On tributaries which drain to the Neuse River downstream from its confluence with Contentnea Creek (pl. 1), eight sites having drainage areas ranging from 2.5 mi^2 (site 492) to 27 mi^2 (site 471) were determined to have zero 7Q10 discharges. Of these eight sites, six are located on streams tributary to Swift Creek and the Trent River, two large tributaries to the Neuse River in the lower end of the study area. Aside from poorly drained soils, the land-surface slope in the lower part of the Coastal Plain physiographic province is also a likely factor in the occurrence of zero or minimal 7Q10 discharges. The presence of little or no relief results in streams that have very little slope for moving flow downstream. This observation is consistent with the conclusions of Giese and Mason (1993) in which streams in the Coastal Plain have very low potential for sustained base flow.

Assessing the occurrence of zero or minimal 7Q10 discharges in the central section of the study area is more complex. This large area is composed of streams draining to the Neuse River between its confluences with New Light Creek (Wake County) and Contentnea Creek (pl. 1). The dominant soils in this area are well and moderately drained (fig. 6B). Even though categorized as moderately drained soils, occurrences of soils having some poor drainage (A/C group, table 3) are present in the Black Creek and Hannah Creek Basins from extreme southern Wake County into southern Johnston County. Other occurrences of poorly drained soils are present along reaches of the Neuse River, Contentnea Creek, and along other smaller streams draining basins known to be swamp terrain. Sites having a 7Q10 discharge of zero and large drainage areas (288, 301, 406, 408, and 410) mostly occur in the basins occupied by poorly drained soils or characterized as swamp. Among the sites in this area of moderately and well-drained soils having zero or minimal 7Q10 discharges, drainage areas range from about 1 mi^2 (site 154) to nearly 82 mi^2 (site 288, Black Creek subbasin). Because many other sites in this area with drainage areas in this same range have 7Q10 discharges exceeding minimal levels (greater than 0.05 ft^3/s), it is difficult to identify areas that may be considered "zero-flow" zones. Where poorly drained soils are the predominant factor at sites in the upper and lower ends of the study area, the magnitudes of low flows in the central section appear to be affected by a combined set of factors which include soils, degree of terrain slope, and drainage area. Assessing the potential for the 7Q10 discharge being zero in the central section of the study area will, for a given site, require an examination of the low-flow characteristics listed for nearby sites (tables 6, 7).

DISCHARGE PROFILES FOR SELECTED STREAMS IN THE NEUSE RIVER BASIN

Discharge profiles of low flows were developed for the Neuse River and selected tributaries to the Neuse River. The tributaries, which vary in basin size and characteristics, include Perry Creek, Walnut Creek (Wake County), Poplar Creek, Swift Creek (Wake and Johnston Counties), Little River, Walnut Creek (Wayne County), Contentnea Creek, Swift Creek (Pitt and Craven Counties), and the Trent River. Drainage-area profiles also were developed for each of these streams to document the relation between basin size and low-flow characteristics.

River miles shown on the profiles were determined by using the USEPA's River Reach Files (Bondelid and others, 1990), which are GIS coverages of rivers and streams. The coverages, digitized from 1:100,000-scale USGS topographic maps, provide a comprehensive representation of the hydrology in a given area. River mileages computed for each stream begin at zero at the mouth and increase upstream toward the headwaters.

Profiles are presented for the 7Q10, 30Q2, W7Q10, and 7Q2 low-flow discharges. Low-flow characteristics (tables 6, 7) for streams where profiles were developed serve as anchor points in the discharge profiles. These points serve as references for computing other low-flow discharges at upstream and downstream locations. Low-flow discharges at the ungaged locations on the profile were determined by linear interpolation between the nearest upstream and downstream anchor points. Profiles developed for Perry Creek, Poplar Creek, and Walnut Creek (Wayne County) show only one anchor point, and low-flow discharges at the ungaged locations on the profile were determined by using the unit low flows for the site at the anchor point. For each of these profiles, comparison of the unit low flows at the anchor point and nearby sites on other streams where low-flow characteristics have been determined yielded favorable comparison and thus provided a basis for using the unit low flows at the anchor point for estimating low flows at the ungaged locations. For the Walnut Creek (Wake County), Swift Creek (Pitt and Craven Counties), and Trent River profiles, low-flow discharges estimated for some sites are not included in the compilation of low-flow characteristics (tables 6, 7). For these cases, available records of discharge were used to estimate low flows to assist in the development of the profiles. While deemed reliable for the purposes of developing profiles, the estimates are not included in the compilation of low-flow characteristics pending confirmation of estimates through collection and analyses of additional records of discharge. Because these estimates are not included in the compilations, anchor points were not used on the low-flow discharge profiles at these sites.

Low flows from tributaries were estimated where the increase in drainage area from a tributary was 5 percent or greater of the drainage area immediately upstream from the tributary. Exceptions to this are for Swift Creek (Pitt-Craven Counties) and Trent River; many sites on tributaries in these basins exhibit zero-value 7Q10 discharges and, as discussed in later sections, receive ground-water discharge from an underlying aquifer.

Profiles for the Neuse River, Contentnea Creek, Trent River, and both Swift Creeks include actual measurements of discharge obtained synoptically at multiple points along streams. Streamflows at selected locations on these streams were measured in September 1997 during a period of extended dry conditions. The profiles of actual measurements provide a "snapshot" of the conditions when flows in many streams were at or near 30Q2 or 7Q2 discharge conditions. Discharges at unmeasured locations between the measured points are linearly interpolated.

Changes in flow caused by impoundments and instream withdrawals and point-source discharges (table 2) were not noted on the discharge profiles. Where a point-source discharge occurs, the ratio of the discharge amount to the 7Q10 discharge generally is insignificant, except for some of the smaller basins profiled in this report. Furthermore, and more importantly, a point-source discharge usually is preceded by a withdrawal at a nearby upstream location. Analysis of these withdrawals and associated major point-source discharges indicated that the ratio of net loss of flow (between withdrawal and discharge points) to 7Q10 discharge is usually insignificant.

No profiles for Crabtree Creek were developed in this report. Crabtree Creek drains 146 mi^2 of central Wake County where land-use cover is highly urbanized as a result of growth in the City of Raleigh. Low-flow characteristics are presented for two gaging stations on Crabtree Creek (sites 188 and 212; table 6). Unit low flows between the two gaging stations increase by factors ranging from two to four. This increase in unit low flows reflects the transition from poorly drained soils of the Triassic basin in western Wake County to moderately drained soils weathered from granitic rocks underlying much of central and eastern Wake County (fig. 6). Further, flows in Crabtree Creek include an NPDES point-source discharge having a permitted flow of nearly 7 ft^3/s (4.45 Mgal/d). The low-flow characteristics presented in table 6 have been adjusted to remove the effects of these point-source discharges and, thus, represent "natural-flow" conditions at the two gaging stations. Provided that streamflow monitoring continues at the two existing gaging stations, a better understanding of the low-flow characteristics in Crabtree Creek will permit a more accurate assessment of the changes in unit low flows in this highly urbanized area and possibly permit future development of discharge profiles for Crabtree Creek.

Perry Creek

Perry Creek drains nearly 12 mi^2 of central Wake County and flows directly into the Neuse River (pl. 1). Land use in this small basin has become urban as a result of rapidly expanding municipal influences from the City of Raleigh. The drainage-area profile was developed for the 3.7-mi reach of Perry Creek between a continuous-record gaging station at site 153 and the mouth of the creek (fig. 9A). The total length of Perry Creek is about 5.7 mi. Several unnamed tributaries contribute flow to Perry Creek, and a small number of lakes are located on Perry Creek, the largest of which is Greshams Lake.

Continuous records of streamflow at two gaging stations (sites 153 and 154) were used in the development of low-flow discharge profiles for Perry Creek (fig. 9B). The 7Q10 discharge at the mouth of Perry Creek is about 0.9 ft^3/s. Unit low flows at site 153 are very similar to unit low flows at nearby sites and, thus, were used to develop the estimates of low flows depicted in the profiles. The unit low flows reflect a relatively high potential for sustaining base flows and are characteristic of streams in most of central Wake County, which is underlain by moderately drained soils. The effects of small lakes on low flows in Perry Creek, if any, are not evident from the profiles. No known minimum releases exist for the lake. NPDES records provided by DWQ indicate that a point-source discharge having a permitted flow of nearly 0.04 ft^3/s (0.025 Mgal/d) enters Perry Creek via Greshams Lake. From the profile, the 7Q10 discharge for Perry Creek just upstream from the dam is estimated at about 0.25 ft^3/s (fig. 9B).

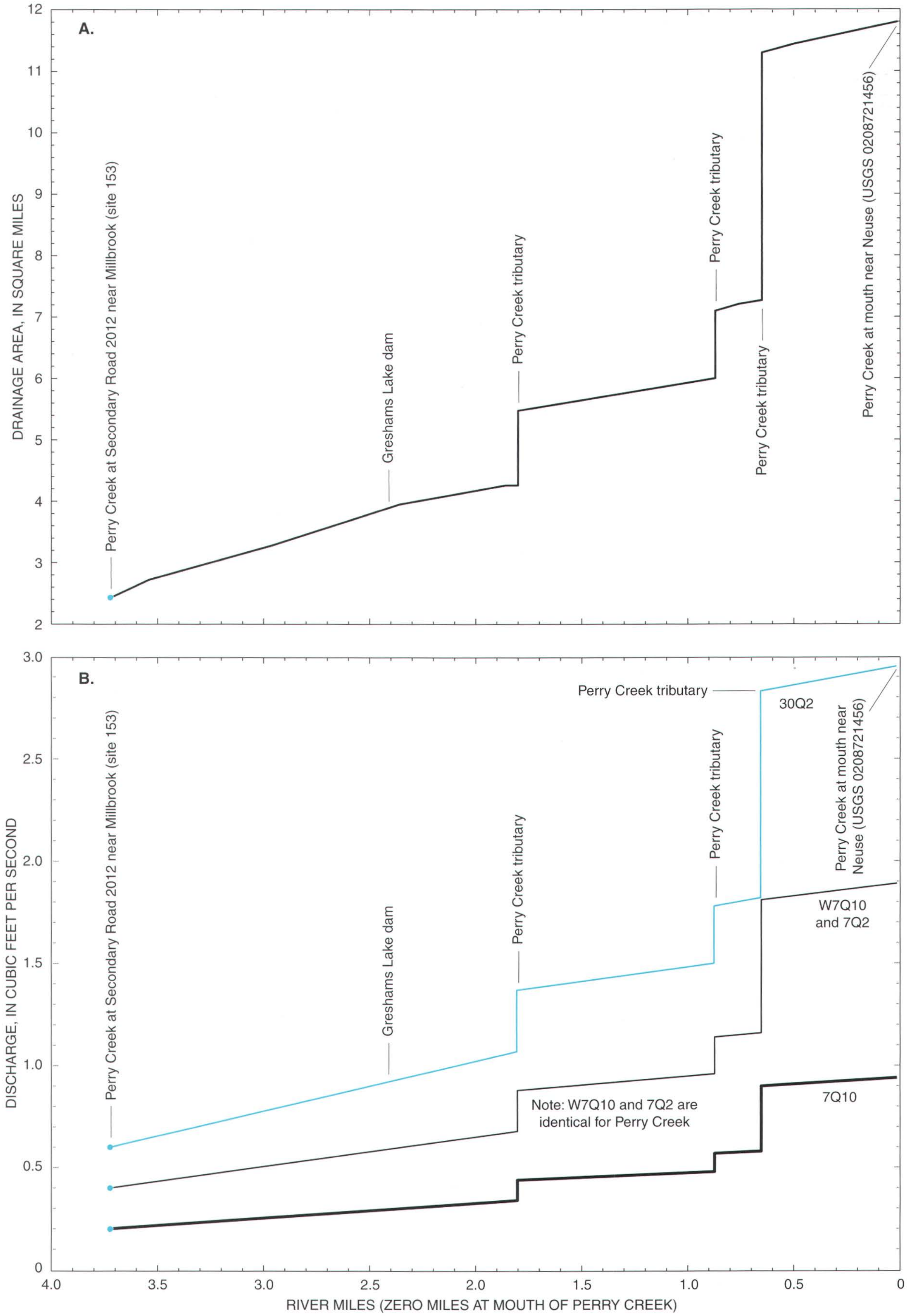

Figure 9. Relation of river miles to (A) drainage area and (B) low-flow discharges for Perry Creek.

Walnut Creek (Wake County)

Walnut Creek drains 46 mi^2 in south-central Wake County and is a tributary of the Neuse River (pl. 1). The drainage-area profile depicts the reach of Walnut Creek between site 224 (river mile 14.9) and the mouth (fig. 10A). Walnut Creek is about 18 mi in total length. Tributaries to Walnut Creek include Simmons Branch, Bushy Branch, Rocky Branch, Wildcat Branch, and Big Branch, which is the largest tributary (12 mi^2 or about 26 percent of the Walnut Creek Basin). Land use in the basin is mostly urban and suburban because of the stream's location in the Cary and southern Raleigh municipalities.

Partial-record discharges at four sites (224, 228, 236, and 241) on Walnut Creek were analyzed to determine low-flow characteristics for use in developing discharge profiles. As previously discussed, some low-flow estimates used in the development of profiles are not included in the compilation of low-flow characteristics (tables 6, 7). Estimates for sites 224, 228, and 241 were used only for development of the profiles for Walnut Creek; low-flow characteristics at site 236 are listed in table 7 and denoted by the anchor point on the profiles (fig. 10B).

Low-flow discharge profiles for Walnut Creek represent a stream in which unit low flows change from relatively low to higher values between the headwaters and mouth (fig. 10B). The headwaters of Walnut Creek

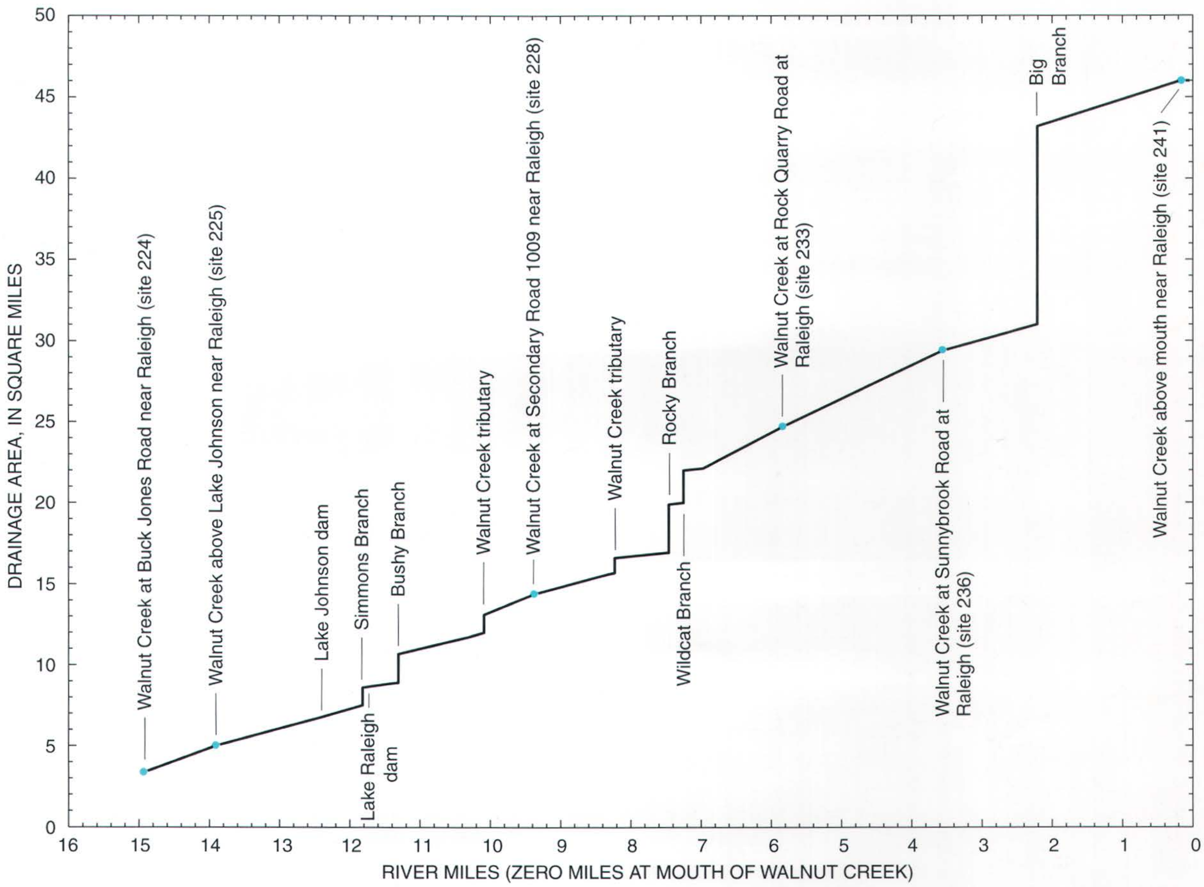

Figure 10A. Relation of river miles to drainage area for Walnut Creek (Wake County).

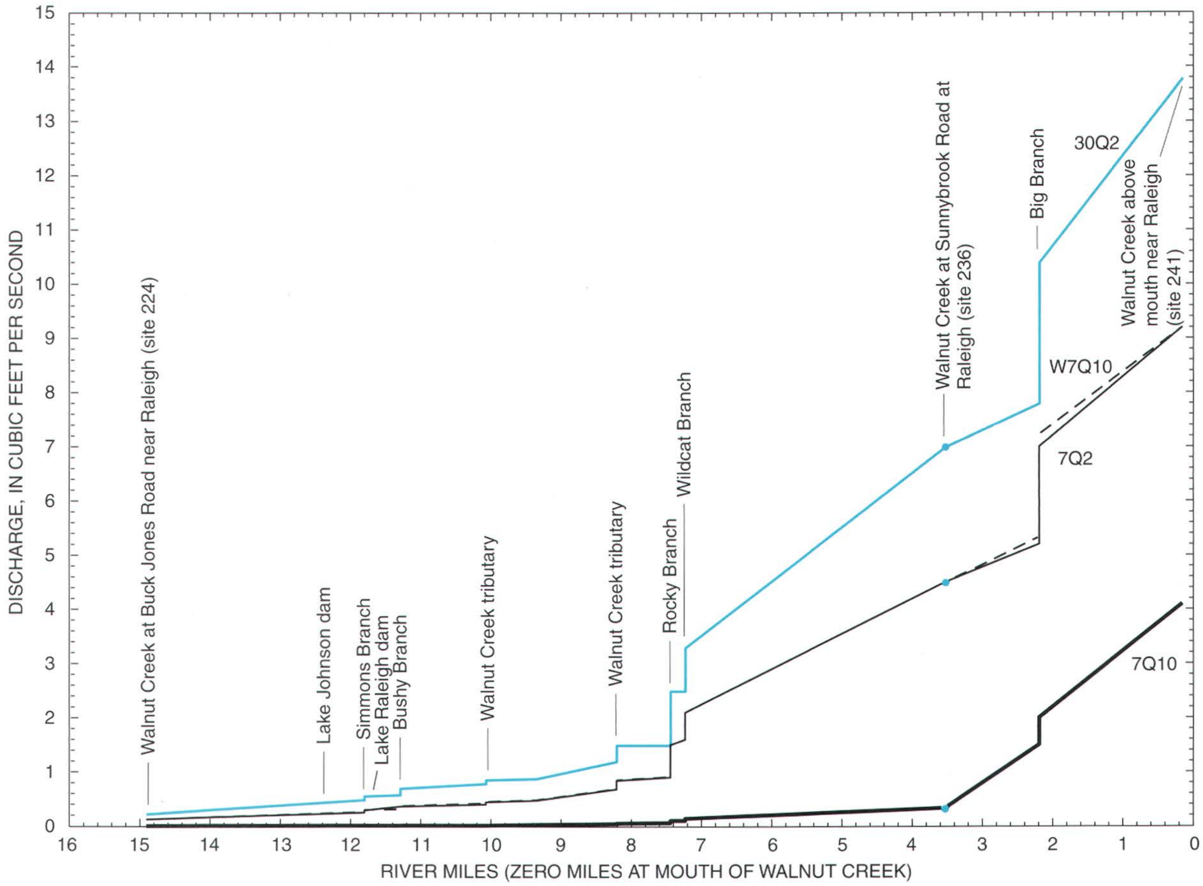

Figure 10B. Relation of river miles to low-flow discharges for Walnut Creek (Wake County).

are close to the boundary between the poorly drained soils of the Triassic basin and the moderately drained soils weathered from granitic rocks underlying much of Wake County (fig. 6). Hence, flows in the upper reaches of Walnut Creek have a relatively low potential for sustained base flows. Lake Johnson and Lake Raleigh, two impoundments with no known minimum release, also are located in the upper reaches of Walnut Creek. As Walnut Creek winds along its course to the mouth, the potential for sustained base flows increases significantly, as depicted in the changing slopes shown on the discharge profiles (fig. 10B). Between site 228 (river mile 9.4) and the mouth, the 7Q10 discharge increases from less than 0.05 ft^3/s to slightly more than 4 ft^3/s (fig. 10B). In this same reach, the drainage area increases from about 14 to 46 mi^2; this is equivalent to an increase of unit low flows from 0.003 to 0.087 $(ft^3/s)/mi^2$. NPDES records indicate that two point-source discharges enter Walnut Creek in the vicinity of site 233 (pl. 1). However, total permitted flows from these discharges are less than 0.01 ft^3/s compared to the 7Q10 discharge of 0.2 ft^3/s for Walnut Creek at site 233, estimated from the low-flow profile (fig. 10B).

Poplar Creek

Poplar Creek is 9 mi^2 in basin size at its mouth in southeastern Wake County and enters the Neuse River just upstream from the point where the Neuse River crosses into Johnston County (pl. 1). Poplar Creek is approximately 5.7 mi in total length; the drainage-area profile for this stream shows the increases in basin size from about river mile 4.0 to the mouth (fig. 11A).

Low-flow discharge profiles indicate that Poplar Creek is a stream having relative high potential for sustained base flows (fig. 11B). As with Perry Creek, the unit low flows are attributed to the moderately drained soils weathered from granitic rocks underlying much of Wake County (fig. 6). The unit low flows for partial-record measuring site 245 on Poplar Creek are similar in value to the average of the unit low flows at nearby partial-record measuring sites in Wake County. Hence, the unit low flows at site 245 were used to compute the low-flow characteristics at all locations on Poplar Creek. Records of NPDES point-source discharges identify three permits for discharges into Poplar Creek. The total of the permitted flows is about 0.4 ft^3/s compared to the 7Q10 discharge (0.9 ft^3/s, table 7) at site 245 just upstream from the mouth. One point-source discharge has a permitted flow of 0.125 Mgal/d (nearly 0.2 ft^3/s, table 2) and is located at site 244. From the low-flow profile, the estimated 7Q10 discharge for Poplar Creek at site 244 is 0.55 ft^3/s (fig. 11B).

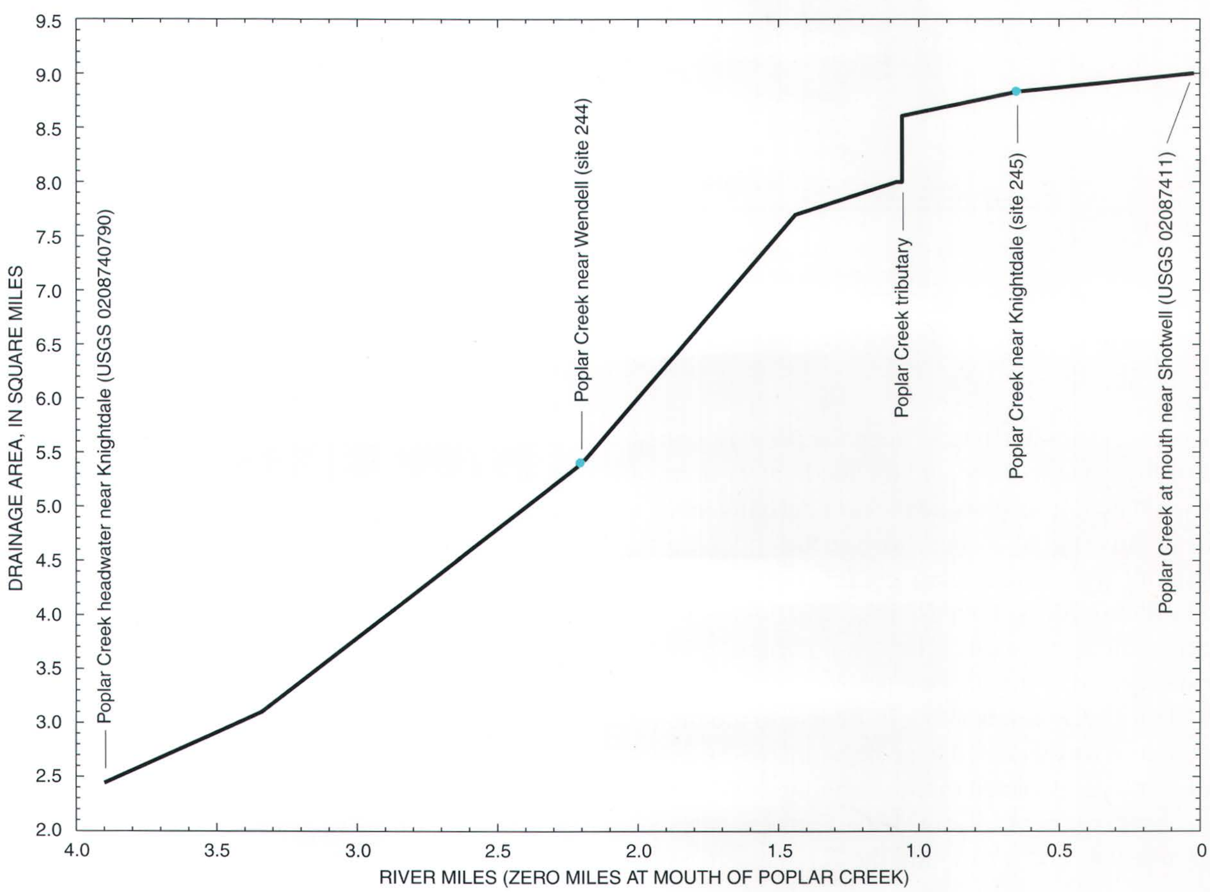

Figure 11A. Relation of river miles to drainage area for Poplar Creek.

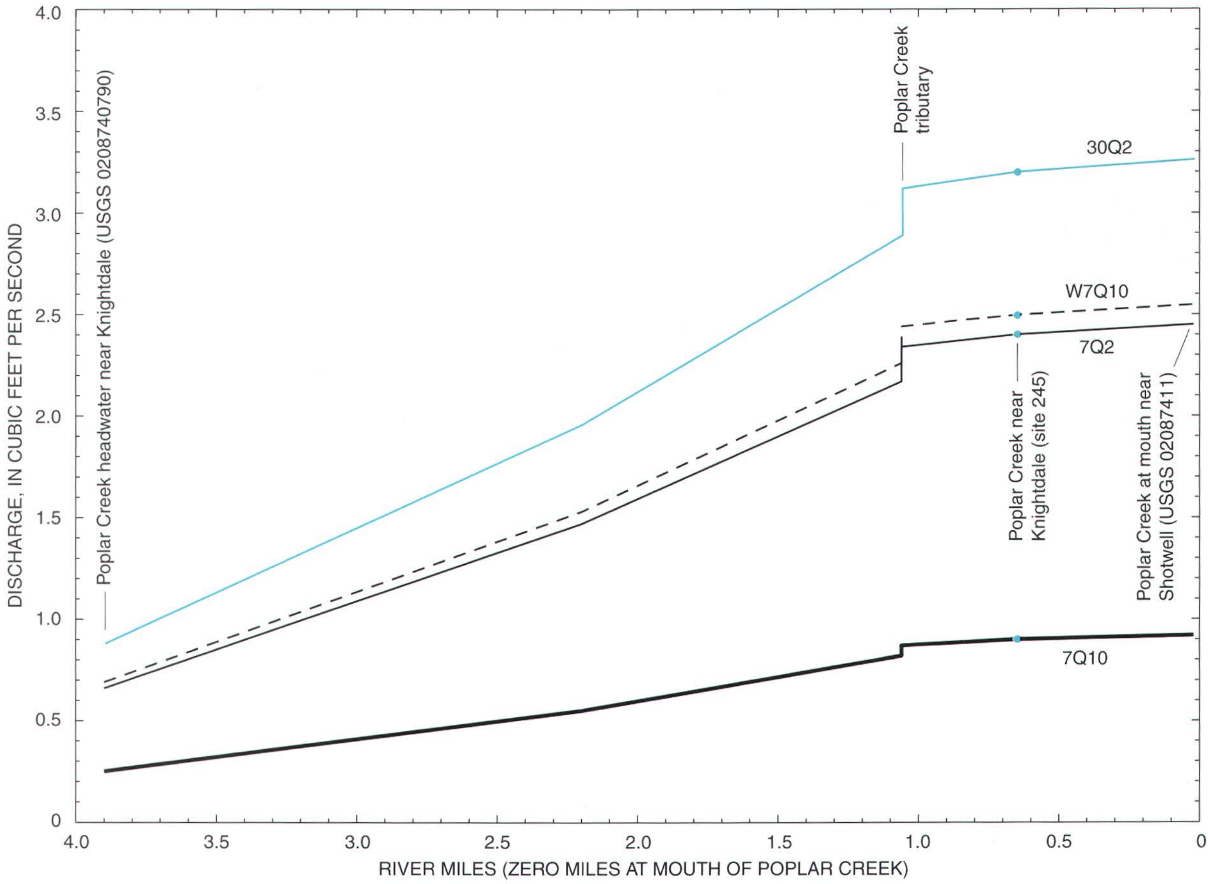

Figure 11B. Relation of river miles to low-flow discharges for Poplar Creek.

Swift Creek (Wake and Johnston Counties)

Swift Creek drains parts of southern Wake and Johnston Counties with its headwaters originating between Apex and Cary (pl. 1). At its mouth near Smithfield, where Swift Creek drains into the Neuse River, the drainage area is 289 mi^2 (fig. 12A). The largest tributary to Swift Creek is Middle Creek, which contributes 132 mi^2 (45 percent) to Swift Creek just upstream from its mouth. Other tributaries to Swift Creek include White Oak Creek and Little Creek.

Similar to the profiles shown for Walnut Creek in Wake County, the low-flow discharge profiles for Swift Creek indicate that the potential for sustained base flows increases between the headwaters and mouth (fig. 12B). The headwaters of Swift Creek are close to the transitional area between the poorly drained soils of the Triassic basin and the moderately drained soils weathered from granitic rocks underlying much of Wake County (fig. 6). Therefore, flows in the upper reach have almost no potential for sustained 7Q10 discharges. Downstream from Lake Wheeler, low-flow profiles depict increasing flows and apparently reflect an area of relatively higher potential for sustained base flows. Existence of a transition area is further indicated by a profile of actual measurements obtained on September 23, 1997, at selected locations along Swift Creek. At the gaging station below Lake Wheeler (site 260), the measured discharge was 0.03 ft^3/s, whereas the discharge measured at downstream site 265 below Lake Benson dam was 6.25 ft^3/s (fig. 12B). In this same reach, the drainage area increases from about 35.8 to 66.3 mi^2; this is equivalent to an increase of unit low flows from 0.0008 to 0.094 $(ft^3/s)/mi^2$. From site 265 below Lake Benson downstream to other measured sites (266, 273), the slope of the measured-discharge profile indicates a small range in variation among the unit low flows, decreasing from about 0.09 to 0.07 $(ft^3/s)/mi^2$.

Lake Wheeler and Lake Benson, which were constructed in 1957 and 1925, respectively (Powell, 1968), are impoundments of Swift Creek in Wake County. Currently, no minimum flow releases are required for either lake (James Mead, Division of Water Resources, written commun., 1998). Flow releases from Lake Wheeler and Lake Benson have not been subjected to active regulation and, thus, the dams operate as "run-of-river" structures. The low-flow profiles indicate that effects on low flows from each impoundment are different. While the dams at each impoundment have similar dimensional characteristics and flow-release capabilities, reductions in downstream flows below Lake Wheeler are more significant than those below Lake Benson. Examination of daily mean discharges at site 260 below Lake Wheeler indicates numerous occurrences of zero flow. Low-flow characteristics at site 262, based on discharges obtained prior to the construction of Lake Wheeler and thus not shown on low-flow profiles, further indicate a reduction in unit low flows as a result of the construction of the dam.

Records of NPDES point-source discharges identify four permits for Swift Creek and its tributaries in the vicinities of Lake Wheeler and Lake Benson. The total permitted flows among these permits is about 0.13 ft^3/s compared to the 7Q10 discharge of 0.3 ft^3/s at downstream site 266 near Drug Store (table 7).

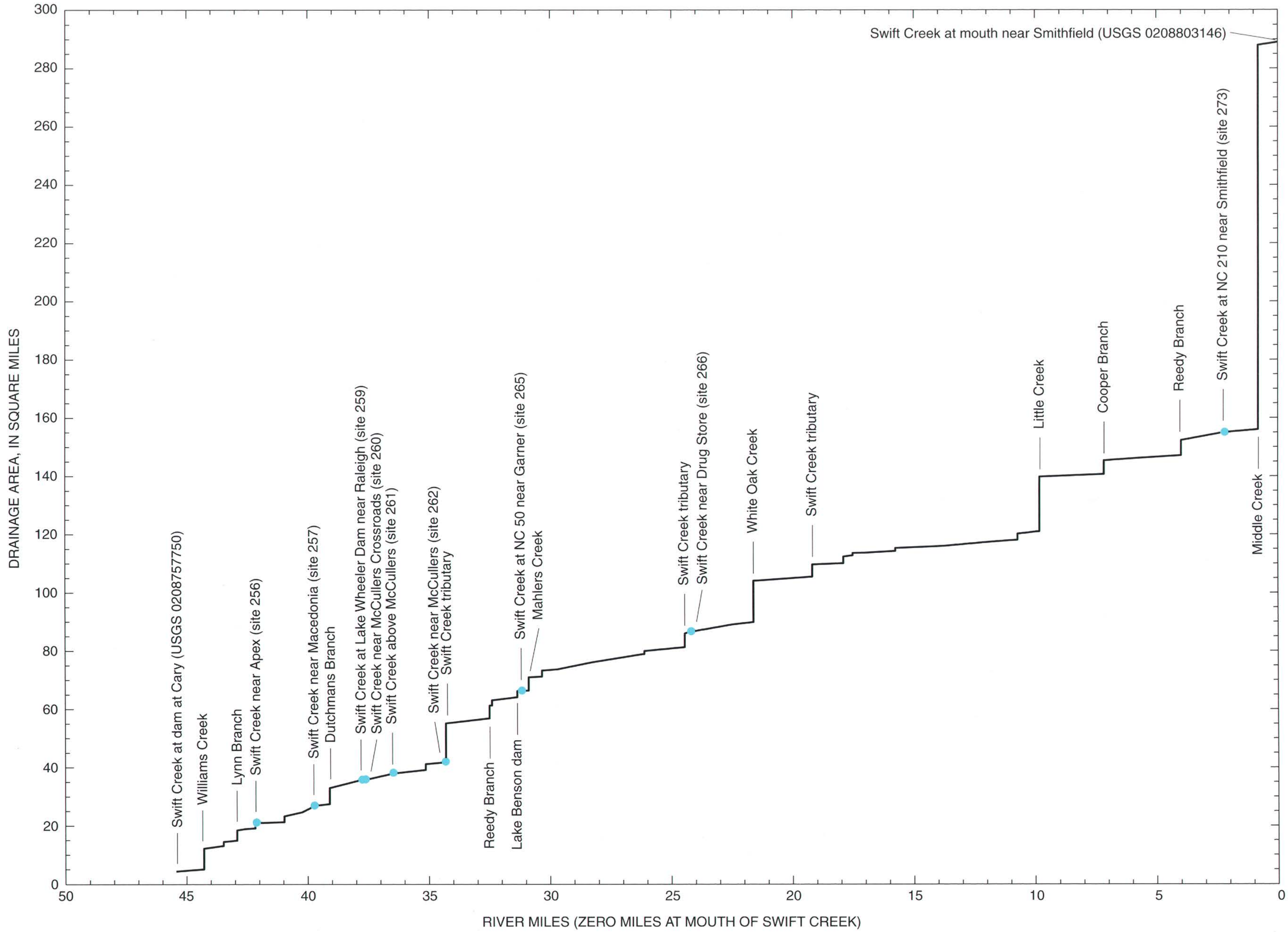

Figure 12A. Relation of river miles to drainage area for Swift Creek (Wake and Johnston Counties).

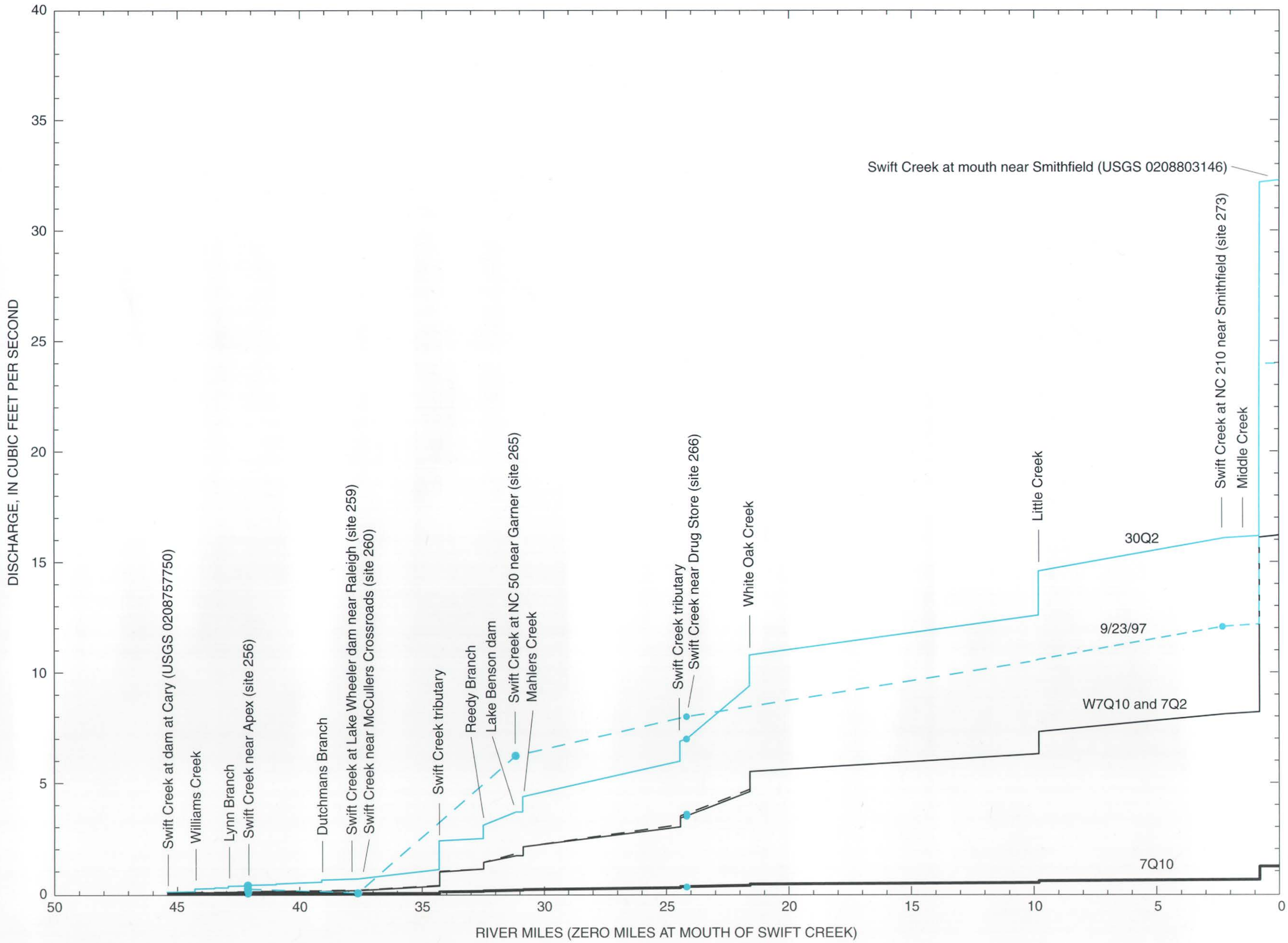

Figure 12B. Relation of river miles to low-flow discharges for Swift Creek (Wake and Johnston Counties).

Little River

The Little River is the largest and last major tributary to enter the Neuse River within the upper Neuse River Basin (hydrologic unit 03020201) (fig. 4). About 85 mi in total length, the river winds its way through Franklin, Wake, Johnston, and Wayne Counties before merging with the Neuse River just west of Goldsboro (pl. 1). The drainage area at the mouth is slightly more than 317 mi^2 (fig. 13A). The largest tributary to the Little River is Buffalo Creek; other significant tributaries include Little Buffalo Creek, Cattail Creek, Little Creek, Spring Branch, and Mill Creek.

Throughout most of its entire reach, the low-flow profiles for Little River reflect unit low flows that result in moderately to highly sustained base flows compared to the profiles for Walnut and Swift Creeks in Wake and Johnston Counties (fig. 13B). Unit low flows for 7Q10 discharges range from about 0.010 $(ft^3/s)/mi^2$ at the headwaters to 0.016 $(ft^3/s)/mi^2$ in the lower reaches just upstream from the mouth. Downstream from the gaging station at site 330, overall slopes in the profiles increase significantly indicating increases in the unit low flows. The increases are attributed to the river's course through the Fall Line, an area of transition from the Piedmont Province to the Coastal Plain. The Fall Line is characterized by increased occurrences of rock outcrops and variations in channel slopes, which likely correspond to increases in unit low flows in the Little River.

Several small municipalities have flow diversions which occur in the Little River. In 1996, the Town of Zebulon withdrew an average of about 0.54 Mgal/d (0.8 ft^3/s; table 2) from an impounded reach of the Little River upstream from site 322 (drainage area 55.0 mi^2, at approximately river mile 68). As indicated by the profile, this average withdrawal is equivalent to the estimated 7Q10 discharge in the reach upstream from this site (fig. 13B). Other flow diversions are point-source discharges from the Towns of Kenly and Princeton. The Town of Kenly is permitted to discharge up to about 0.52 Mgal/d (0.8 ft^3/s; table 2) downstream from site 330 where the 7Q10 discharge is 1.6 ft^3/s (table 6). Likewise, Princeton is permitted to discharge up to about 0.275 Mgal/d (0.4 ft^3/s, table 2) downstream of site 335 where the 7Q10 discharge is 2.5 ft^3/s (table 6).

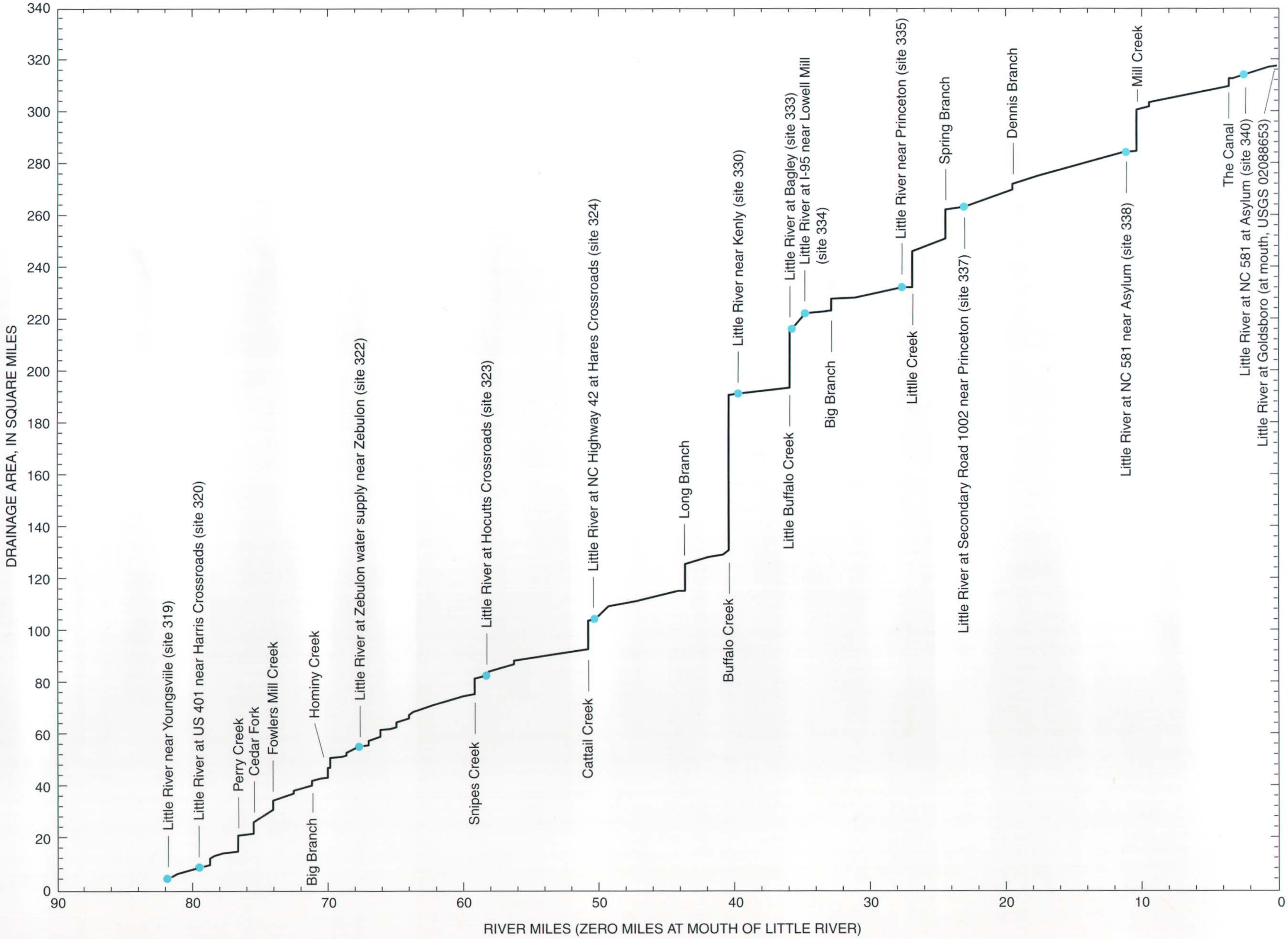

Figure 13A. Relation of river miles to drainage area for the Little River.

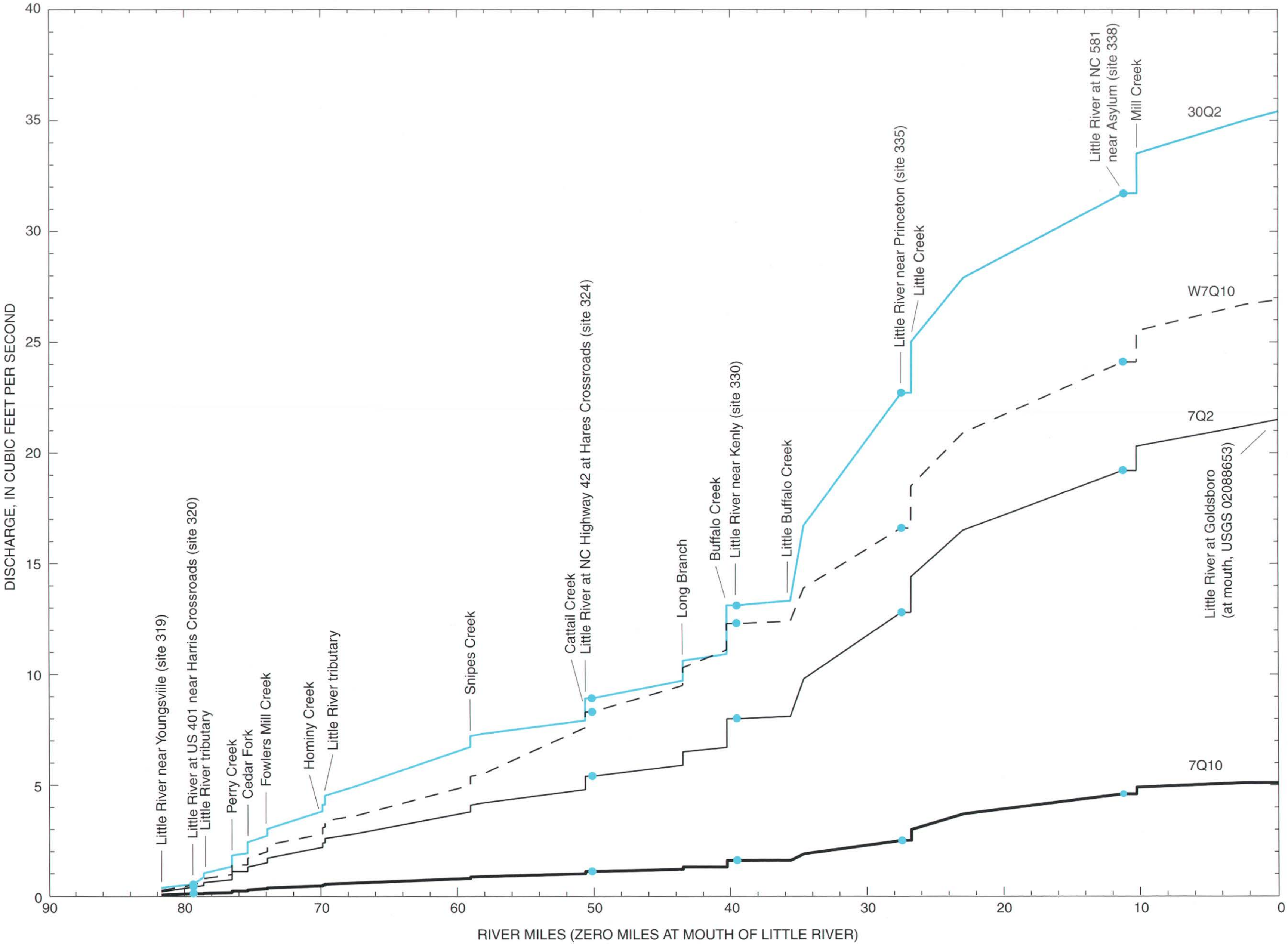

Figure 13B. Relation of river miles to low-flow discharges for the Little River.

Walnut Creek (Wayne County)

Walnut Creek drains slightly more than 20 mi^2 at its mouth where it flows into the Neuse River (pl. 1); the total length of Walnut Creek is about 8.3 mi. The drainage-area profile indicates the increases in basin size from river mile 5.5 to the mouth (fig. 14A). Mira Branch, the only tributary for which drainage-area information was available, enters Walnut Creek just downstream from the dam on Lake Wackena, a small impoundment of Walnut Creek.

Unit low flows at site 349 on Walnut Creek were used to determine the low-flow discharges at other locations on the stream (fig. 14B). The discharge measurements used to determine low-flow characteristics at site 349 (table 7) were obtained prior to the construction of Lake Wackena; thus, the low-flow profiles for Walnut Creek reflect the pre-impoundment flow conditions in the stream. No minimum flow releases are known to exist for Lake Wackena, and no further discharge measurements at locations downstream from the dam have been obtained since its construction. Thus, the effects of the impoundment on downstream low flows in Walnut Creek currently cannot be quantified. The average unit low flows at site 349 and other nearby sites in southeastern Wayne County and western Lenoir County were similar in value. The favorable comparison of average unit low flows from other sites to the unit low flows at site 349 suggest that low-flow profiles shown for Walnut Creek are representative of "natural-flow" conditions during droughts. Moderately and well-drained soils are present along Walnut Creek in parts of this subbasin (fig. 6A). According to NPDES records, there is one permitted discharge in the Walnut Creek Basin located downstream from site 350. The permitted flow for this discharge is less than 0.1 ft^3/s compared to the 7Q10 discharge (1.5 ft^3/s) estimated from the profile for the mouth of Walnut Creek (fig. 14B).

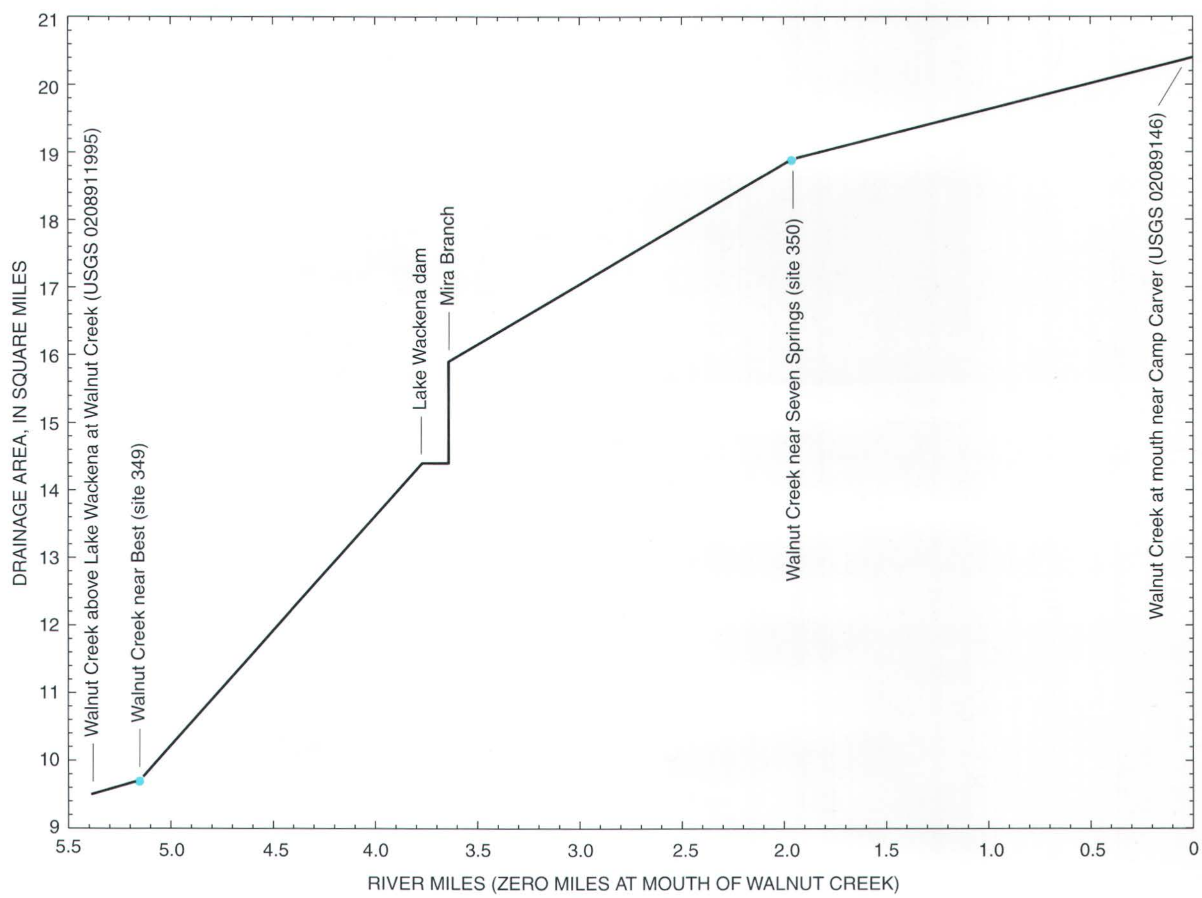

Figure 14A. Relation of river miles to drainage area for Walnut Creek (Wayne County).

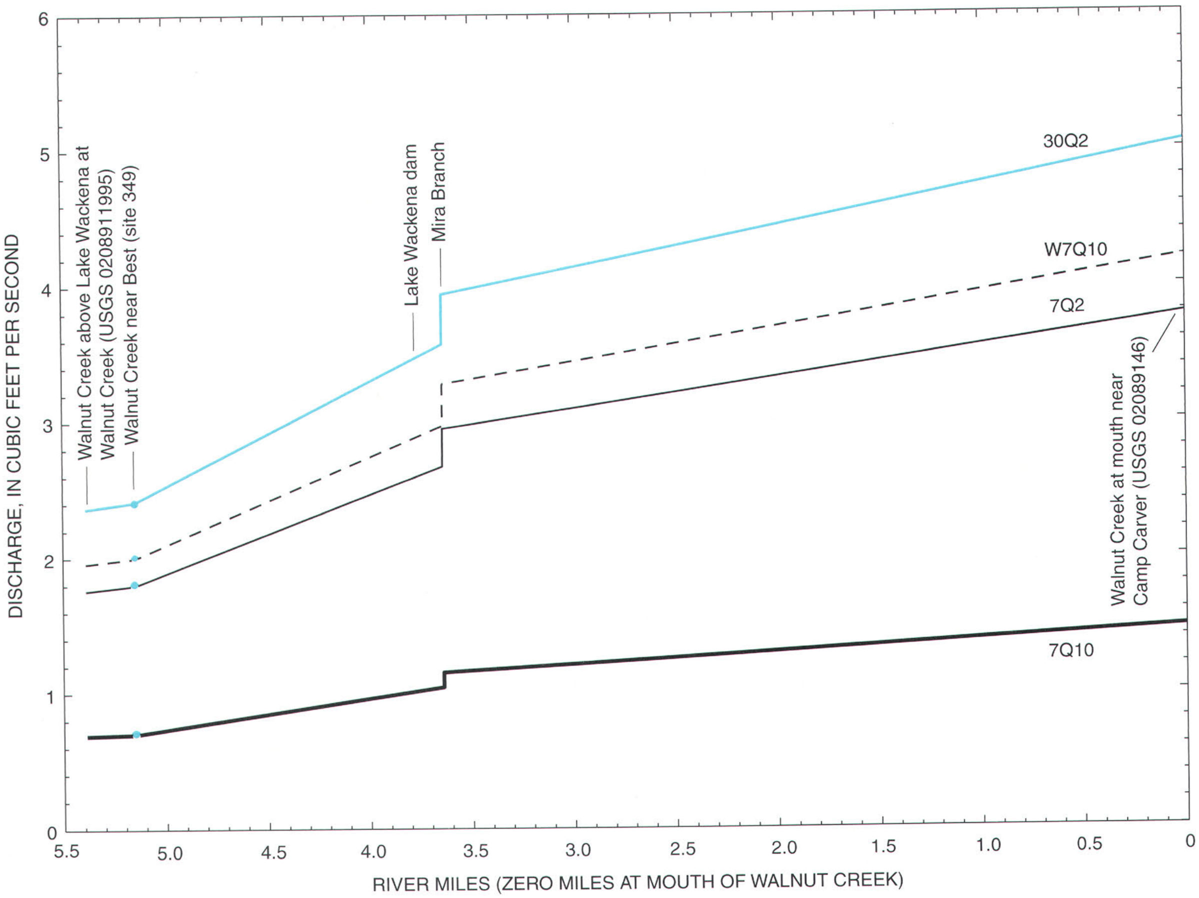

Figure 14B. Relation of river miles to low-flow discharges for Walnut Creek (Wayne County).

Contentnea Creek

Contentnea Creek and its tributaries compose hydrologic unit 03020203 (fig. 4). At the mouth where it enters the Neuse River, the drainage area is 1,010 mi^2 (fig. 15A). Approximately 121 mi in length, Contentnea Creek begins as Moccasin Creek in southern Franklin County. At the confluence of Moccasin Creek and Turkey Creek in Wilson County, the stream becomes known as Contentnea Creek (pl. 1). The largest tributary to Contentnea Creek is Little Contentnea Creek; other significant tributaries include Black Creek, Toisnot Swamp, and Nahunta Swamp. Two impoundments—Buckhorn Reservoir and Wiggins Mill Reservoir—are on Contentnea Creek in Wilson County and result in inundation of the river valley upstream from the dams. Buckhorn Reservoir, constructed in 1976, is the larger of the two reservoirs with a surface area of 750 acres and begins at the confluence of Moccasin Creek and Turkey Creek. Wiggins Mill Reservoir, formed in 1773 and previously known by various other names including Contentnea Lake (Powell, 1968), is located about 16 mi downstream from Buckhorn Reservoir and has a surface area of about 200 acres (North Carolina Department of Environment, Health, and Natural Resources, 1992).

Low-flow profiles indicate the stream can be divided into three reaches, each having distinctly different potentials for sustained base flows (fig. 15B). The first reach is defined by the section of profiles upstream from the dam at Wiggins Mill Reservoir. Slopes of the profiles suggest moderate potentials for sustained base flows from the headwaters of Moccasin Creek to the dam at Wiggins Mill Reservoir. The required minimum release at Buckhorn Reservoir is 1.3 ft^3/s; the 7Q10 discharge at the continuous-record gaging station (site 386) downstream from the dam is 0.3 ft^3/s and is based on the full period of record (1965–95) at the gaging station (table 6). An analysis of the record since the completion of the reservoir in 1976 indicated no difference between the 7Q10 discharge for full period of record at the station and the post-regulation period (1977–95). Post-regulation streamflow records at the gaging station below the dam show a number of daily mean discharges less than the required flow release. However, most of these discharges occurred during a drought in 1980–82 that affected streams across the State (Zembrzuski and others, 1991). Minimum-flow releases during extended droughts have been difficult to maintain (James Mead, Division of Water Resources, oral commun., 1998), a reflection of the 7Q10 discharge being significantly less than the required minimum release. No minimum-flow releases are required at Wiggins Mill Reservoir although the City of Wilson maintains an open gate at the lower reservoir, which results in a minimum of 1.0 ft^3/s being released downstream (James Mead, Division of Water Resources, written commun., 1998).

The second reach is defined by Contentnea Creek between the dam at Wiggins Mill Reservoir and partial-record measuring site 413 just upstream from Toisnot Swamp near Stantonsburg (fig. 15B). Low-flow discharges at this reach are primarily affected by regulation of flows from Wiggins Mill Reservoir as well as the water-supply withdrawals and corresponding return point-source discharges by the City of Wilson. Withdrawals are made from the reservoir and the point-source discharges occur within 3 mi downstream from the dam (fig. 15B). Consequently, low-flow profiles between the two diversions do not reflect actual conditions, which include a sudden decrease at the withdrawal location and a corresponding sudden increase at the point-source discharge. As indicated in table 2, the average return discharge for 1996 by the City of Wilson was 10.3 Mgal/d, compared to the average withdrawal from Contentnea Creek of 5.5 Mgal/d (plus 2.4 Mgal/d from Toisnot Lake) for the same period. The higher return discharge reflects the city's treatment of additional wastewater from other smaller municipalities in Wilson County. The increase in net flow between the two diversions is indicated on the profiles by the increase in the low flows in Contentnea Creek immediately below the reservoir (fig. 15B). Downstream from the point-source discharge, overall slopes shown in the profiles are similar to the first reach. Low-flow discharges at site 393 immediately below the dam are not included on the profiles in this reach because low-flow characteristics are based on flow conditions and withdrawal rates during the 1930–53 period (table 6). Withdrawal rates from the reservoir have increased since that period and no records of discharge are available for determining current low-flow characteristics.

The third reach is Contentnea Creek from its confluence with Toisnot Swamp to the mouth. Low-flow profiles indicate a significant increase in potential for sustained base flows (fig. 15B). Soil hydrologic groups in this area are characterized by a mix of well-

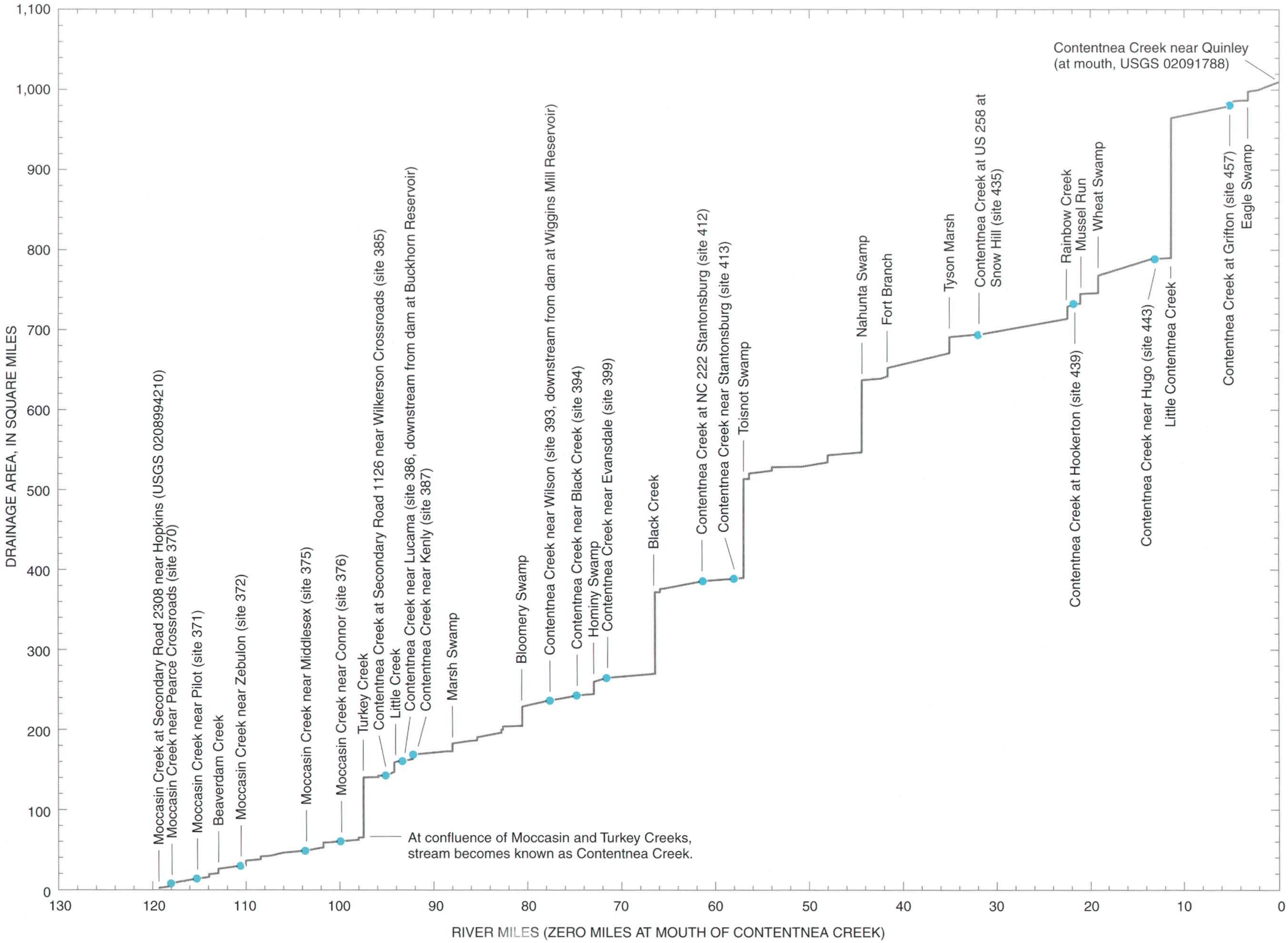

Figure 15A. Relation of river miles to drainage area for Contentnea Creek.

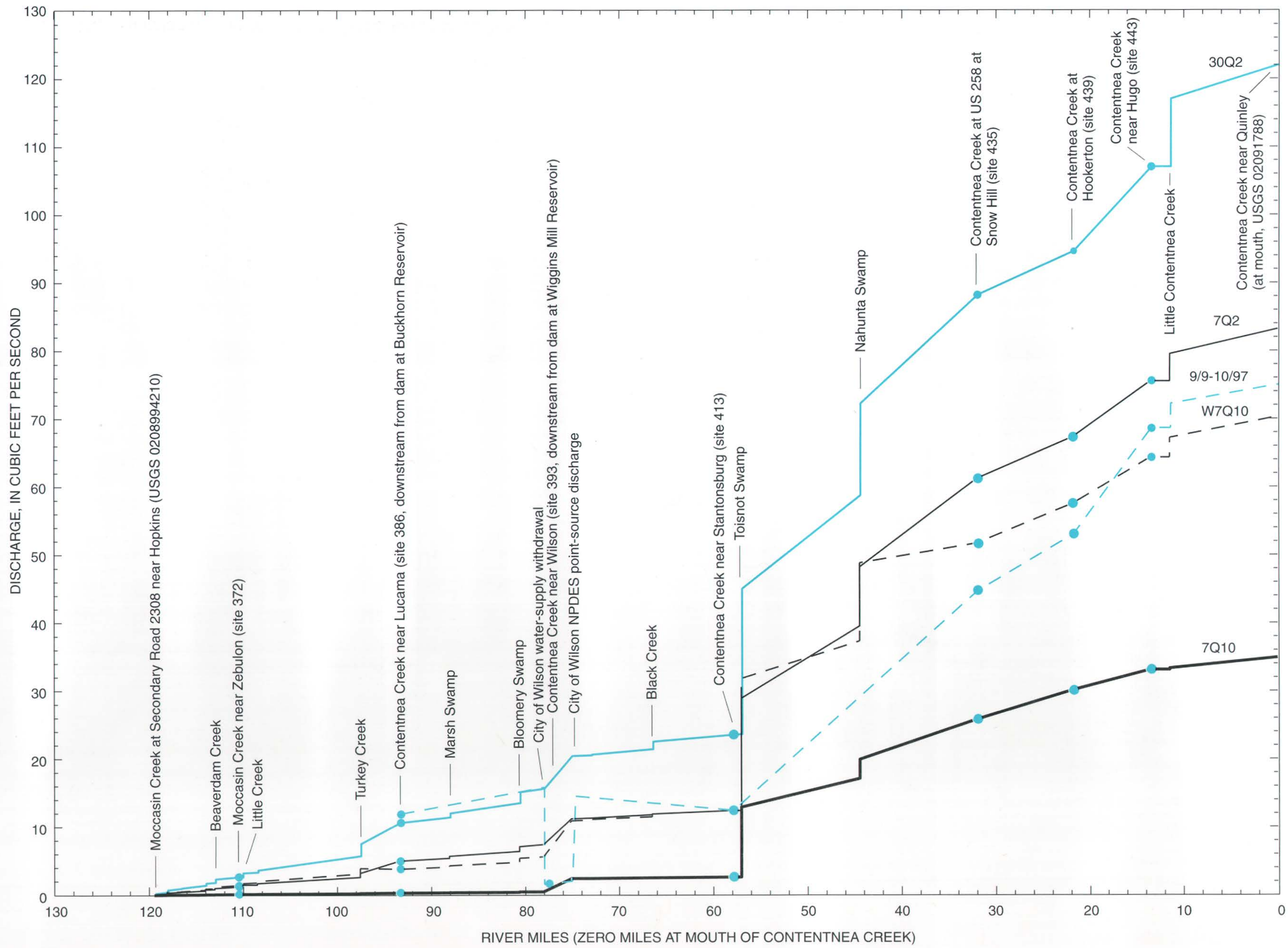

Figure 15B. Relation of river miles to low-flow discharges for Contentnea Creek.

and moderately drained soils with some poorly drained soils adjacent to the stream channels. The high potential for sustained base flows in the Toisnot Swamp and Nahunta Swamp tributaries contributes to the low flows depicted in this third reach of the Contentnea Creek. Just upstream from the mouth, the low-flow profiles indicate a decrease in potential for sustained base flows, resulting from the relatively lower unit low flows in the flow contributions from Little Contentnea Creek.

In addition to the point-source discharge by the City of Wilson, eight other NPDES point-source discharges in the Contentnea Creek Basin have varying magnitudes of permitted flows and have correspondingly varying effects on the low flows in Contentnea Creek. Five of the eight discharges have permitted flows less than 1.5 ft^3/s each. As suggested by the profiles, the point-source discharge by the Town of Zebulon (permitted flow 1.85 Mgal/d or nearly 2.9 ft^3/s into Little Creek, tributary of Moccasin Creek) does not appear to significantly affect the low flows in Contentnea Creek. However, the flows of Little Creek, which has a drainage area of 6.2 mi^2 at its mouth, are likely dominated by this point-source discharge. Conversely, point-source discharges by the Town of Farmville (permitted flow 3.5 Mgal/d or about 5.4 ft^3/s into Little Contentnea Creek) and by Contentnea Sewerage District (permitted flow 2.85 Mgal/d or 4.4 ft^3/s into Contentnea Creek) apparently do not comprise a significant portion of the 7Q10 discharge of 33.1 ft^3/s at the partial-record measuring site near Hugo (site 443, table 7).

Discharge measurements at selected locations along Contentnea Creek are profiled to indicate flow conditions along the stream during September 9–10, 1997 (fig. 15B). Included in this profile are the average withdrawal and point-source discharges by the City of Wilson during the same 2-day period. Overall, slopes in the profile of actual measurements roughly parallel the low-flow profiles, particularly between sites 386 and 393 and between sites 413 and 443. These measurements provide a confirmation of the computed low-flow profiles shown for Contentnea Creek. A decrease in discharge is indicated for the reach between the City of Wilson's point-source discharge and partial-record measuring site 413 near Stantonsburg. Possible explanations for a decrease in flows include irrigation pumping or other normally infrequent withdrawal(s) which may have occurred during the 2-day period.

Neuse River

Of the three river basins—Tar-Pamlico, Neuse, and Cape Fear River Basins (fig. 1)—that are completely within North Carolina, the Neuse River Basin is the smallest at nearly 5,600 mi^2, compared to the Tar-Pamlico River Basin at approximately 7,500 mi^2 and the Cape Fear River Basin at approximately 9,700 mi^2 (fig. 1; Seaber and others, 1987). The drainage-area profile shows the basin size increases from the headwaters of the West Fork Eno River in Orange County to the mouth of the Neuse River near Maw Point in Pamlico County (fig. 16A). From its headwaters to the mouth, the Neuse River is nearly 310 mi in length. Along its length, the river can be subdivided into three reaches. The first reach is about 46 mi long and consists of the Eno River in Orange and Durham Counties with Little River and Flat River as its two largest tributaries. Where the Eno and Flat Rivers merge to form the Neuse River, the drainage area is 435 mi^2. In the second reach, 32 mi of the Neuse River is inundated as part of Falls Lake (drainage area 771 mi^2 at dam), the largest impoundment in the basin. The third reach, 232 mi in length, is the Neuse River between the dam and its mouth near Maw Point. The largest tributary to the Neuse River is Contentnea Creek, which drains 1,010 mi^2 or 18 percent of the basin. Other large tributaries include Crabtree Creek (146 mi^2), Swift Creek (289 mi^2) in Wake and Johnston Counties, Little River (317 mi^2), Swift Creek (334 mi^2) in Pitt and Craven Counties, and the Trent River (519 mi^2).

Low-flow discharge profiles were developed for the reach of the Neuse River between Falls Lake dam (site 135, drainage area 771 mi^2) and site 460 at Fort Barnwell (drainage area 3,900 mi^2) (fig. 16B). Low-flow discharges used in the profiles for the long-term continuous-record gaging stations (sites 135, 248, 344, and 361; table 6) on the Neuse River are based on post-regulation flows since the construction of Falls Lake. Low-flow discharges used in the profiles for the partial-record measuring site at Fort Barnwell (site 460, table 7; operated as a continuous-record gaging station since October 1996) are based on the records of miscellaneous measurements during the 1970–96 water years. Downstream from Fort Barnwell, flows in the river are subject to tidal effects, a factor not readily quantified in low-flow characteristics using available streamflow data and techniques of analysis.

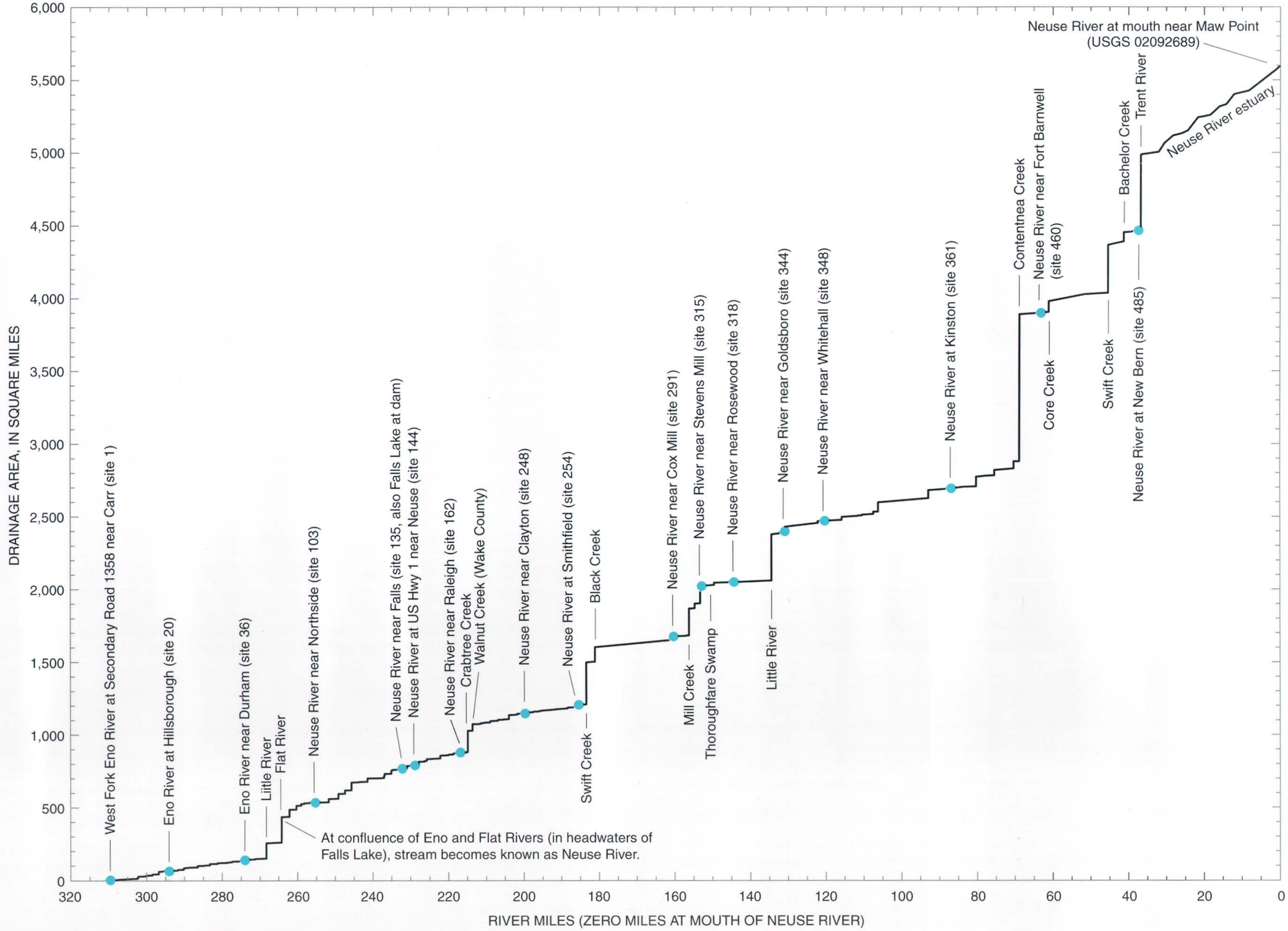

Figure 16A. Relation of river miles to drainage area for the Neuse River.

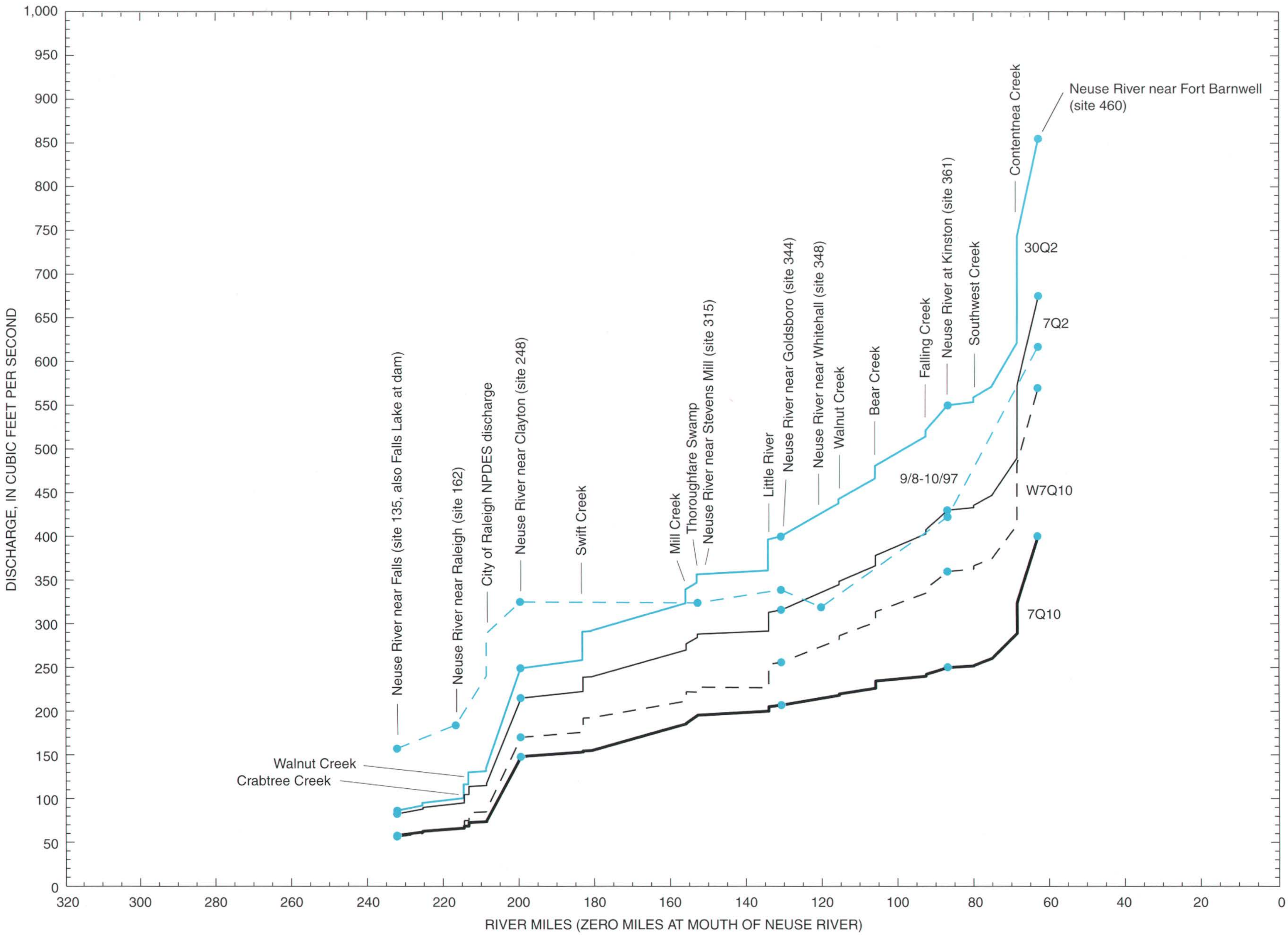

Figure 16B. Relation of river miles to low-flow discharges for the Neuse River.

The low-flow profiles indicate moderate and steady increases in discharge from Falls Lake dam to Fort Barnwell (fig. 16B). Two sections of the profiles indicate significant and rather sudden increases in low-flow discharges. The first section, between Walnut Creek (Wake County) and the gaging station near Clayton (site 248), includes an NPDES point-source discharge having a permitted flow of 60 Mgal/d (about 93 ft^3/s, table 2). Additionally, tributaries draining to this section of the Neuse River also have relatively high potentials for sustained base flows, attributed to the moderately drained soils weathered from granitic rocks underlying much of Wake County (fig. 6).

The second reach of the Neuse River, for which low-flow profiles indicate significant increases in discharge, occurs between Kinston in Lenoir County and Fort Barnwell in Craven County (fig. 16B) and is about 24 mi in length. Increases in low-flow characteristics between sites 361 and 460 range from 55 to 60 percent (tables 6 and 7). The drainage area increases from 2,692 mi^2 (site 361) to about 3,900 mi^2 (site 460); most of the increase is associated with Contentnea Creek, which merges with the Neuse River upstream from Fort Barnwell. However, unit low flows at the mouth of Contentnea Creek are much lower relative to the unit low flows at sites 361 and 460 on the Neuse River. For example, the increase in 7Q10 discharge between Kinston and Fort Barnwell is 150 ft^3/s, yet only 35 ft^3/s is attributed to Contentnea Creek (fig. 16B). Tributary contributions and the permitted flows from NPDES point-source discharges do not completely account for the increase in 7Q10 discharge between Kinston and Fort Barnwell, indicating the presence of another source of discharge to the Neuse River in this reach.

Winner and Coble (1996) mapped the hydrogeologic framework of aquifers underlying the Coastal Plain of North Carolina. In addition to the surficial aquifer, nine confined aquifers were identified, and their geologic and hydrologic properties were discussed. Results of the mapping indicate direct contact between the Neuse River channel and the Castle Hayne aquifer between Kinston and Fort Barnwell (Winner and Coble, 1996, pl. 18). The Castle Hayne aquifer is described as the most productive of the 10 aquifers in terms of yield, a factor attributed to the extensive occurrence of porous limestone in the aquifer. Throughout much of its thickness, this aquifer has an average composition of 80 to 90 percent permeable material (Winner and Coble, 1996). Thus the sudden increase in discharge shown in low-flow profiles for the Neuse River between Kinston and Fort Barnwell is likely the result of ground-water discharge from the Castle Hayne aquifer directly into the Neuse River. Maps of the Castle Hayne aquifer in Winner and Coble (1996, pl. 18) show that direct contact between the Neuse River and the aquifer extends downstream to a point near the confluence with Swift Creek. Direct contact with this aquifer also is noted in the part of the study area drained by Core Creek, a tributary to the Neuse River just downstream from Fort Barnwell (Winner and Coble, 1996). Therefore, it is likely that the Castle Hayne aquifer contributes flow to the Neuse River for another 10–12 miles downstream from Fort Barnwell.

A profile of actual discharge measurements at selected locations on the Neuse River is included in the low-flow profiles for the Neuse River (fig. 16B). The measurements used to develop this profile were obtained during September 8–10, 1997, a period of base-flow conditions throughout much of the Neuse River Basin. The profile indicates that flow conditions in the Neuse River were above 30Q2-discharge conditions between Falls Lake dam and Mill Creek, the last major tributary in Johnston County. In Wayne County, flows transition to 7Q2-discharge conditions in the remainder of the Neuse River to Fort Barnwell. The slope of the measured profile between Kinston and Fort

Barnwell increases significantly and provides a confirmation of the slopes for the low-flow profiles. Between Clayton and Goldsboro, the measured profile suggests a loss in flows between several points. Changes in flows resulting from water withdrawals and point-source discharges are not detailed in the profile. Further, the presence of discharges greater than 30Q2-flow conditions in the upper reaches of the profile compared to 7Q2 conditions in the lower reaches suggests a change in flows as a result of thunderstorms over parts of the upper Neuse River Basin during the measurement period.

Twenty-four NPDES point-source discharges exist for the Neuse River downstream from Falls Lake dam. Additionally, four water-supply withdrawals (Johnston County, Town of Smithfield, City of Goldsboro, Weyerhaeuser Company) also occur in the Neuse River downstream from Falls Lake. The largest point-source discharge has a permitted flow of 60 Mgal/d (about 93 ft^3/s, table 2) compared to the 7Q10 discharge (75 ft^3/s) estimated from the profiles for the point just downstream from Poplar Creek in Wake County (fig. 16B). Other permitted point-source discharges for Johnston County, City of Goldsboro, City of Kinston (both plants), and the DuPont industrial facility near Kinston have permitted flows of 4.5, 10.1, 11.25, and 3.6 Mgal/d, respectively (table 2). The permitted flows are equivalent to about 7.0, 15.6, 17.4, and 5.6 ft^3/s, respectively, compared to the post-regulation 7Q10 discharges at the gaging stations at Goldsboro and Kinston (sites 344, 361) of 207 and 250 ft^3/s, respectively (table 6). Aside from plant capacities, no limits generally exist for water-supply withdrawals. The largest average withdrawal downstream from Falls Lake dam in 1996 was 20 Mgal/d (nearly 31 ft^3/s, table 2). The three water-supply withdrawals by Johnston County, Town of Smithfield, and City of Goldsboro averaged 3.5, 4.0, and 6.3 Mgal/d (5.4, 6.2, and 9.7 ft^3/s), respectively, during 1996 (table 2).

As part of its assessment and management of water-quality issues, the DWQ uses a flow model for low flows in the Neuse River between Falls Lake dam and New Bern. The model is based on an assumption of steady low-flow conditions for winter (November through March) and summer (April through October) periods. The model allocates the flow in two subreaches of the Neuse River—from Falls Lake dam to the gaging station near Clayton (site 248) and from the Clayton gage to New Bern. In addition to seasonal minimum flow releases (100 ft^3/s in the summer and 65 ft^3/s in the winter) required at Falls Lake dam, flows in the first reach also are allocated so as to maintain target flows at the Clayton gage (254 ft^3/s in the summer and 184 ft^3/s in the winter). The model also incorporates maximum changes caused by flow diversions; the maximum changes reflect permitted flows assigned to NPDES point-source discharges and withdrawals defined by current or future plant capacities for various municipalities.

The USGS discharge profiles are based on analyses of observed discharges at numerous gaging stations and, thus, are hydrologic assessments of the flows at these stations. Effects of daily flow diversions, particularly at long-term gaging stations, are included in the record of discharge collected at the sites. However, the daily flow diversions usually do not equal the maximum changes seen in the DWQ models. The DWQ's incorporation of maximum changes caused by flow diversions is consistent with their role in managing and assessing water-quality issues by planning for flow allocations under "worst-case" low-flow conditions, as mandated by State regulations.

Swift Creek (Pitt and Craven Counties)

Swift Creek drains about 330 mi^2 in parts of Pitt and Craven Counties and merges with the Neuse River just north-northwest of New Bern (pl. 1). The drainage-area profile indicates increases in the basin size between site 463 (approximately river mile 43) and the mouth (fig. 17A). Swift Creek is about 45 mi in total length. The largest tributaries to Swift Creek are Clayroot Swamp and Little Swift Creek; other significant tributaries include Fork Swamp, Palmetto Swamp, and Mauls Swamp. As suggested by tributary names, much of the study area drained by Swift Creek is swampy terrain.

The low-flow profiles for Swift Creek depict the flows between Winterville (site 463) and Vanceboro (site 472) (fig. 17B). No estimates of low-flow discharges for the site (477) at Streets Ferry are included in the compilations (tables 6, 7) or shown on the profiles because less than 2 years of data exist for this site and because the effects of tides on low-flow discharges currently cannot be quantified in analyses. Downstream from the partial-record measuring site (468) near Coxville, profile slopes indicate increases in low-flow discharges. The slopes of the low-flow profiles between Winterville (site 463) and Coxville (site 468) are confirmed by a measured profile on September 9, 1997, for selected locations in this reach of Swift Creek. The measured profile indicates that flows were between 30Q2- and 7Q2-discharge conditions on this date. No measurement was obtained at site 472 near Vanceboro because measuring conditions were unsuitable.

As with the lower reach of Neuse River between Kinston and Fort Barnwell, low-flow profiles for Swift Creek indicate the occurrence of ground-water discharge from underlying aquifers (fig. 17B). Estimates of low flows at gaging stations on Creeping Swamp (tributary to Clayroot Swamp) and Palmetto Swamp (sites 470, 471, and 475) are zero (table 6). Because of the extensive occurrence of poorly drained soils throughout the Swift Creek Basin, other tributary contributions to Swift Creek during low-flow conditions are likely minimal, if not zero. Correspondingly, no flow contributions from tributaries are shown in these profiles. However, increases in unit low flows between Coxville (site 468) and Vanceboro (site 472) indicate the addition of flow from a source other than tributary contributions or NPDES point-source discharges. This source is most likely ground-water discharge from the surficial aquifer, which is underlain by the Castle Hayne aquifer. Despite the presence of a confining unit between the surficial and Castle Hayne aquifers, Winner and Coble (1996) noted that the potential for significant upward flow of ground water into stream channels still exists.

There are no records of NPDES point-source discharges into Swift Creek. One point-source discharge having a permitted flow of about 0.4 ft^3/s (0.25 Mgal/d) occurs in Mauls Swamp just upstream from its confluence with Swift Creek.

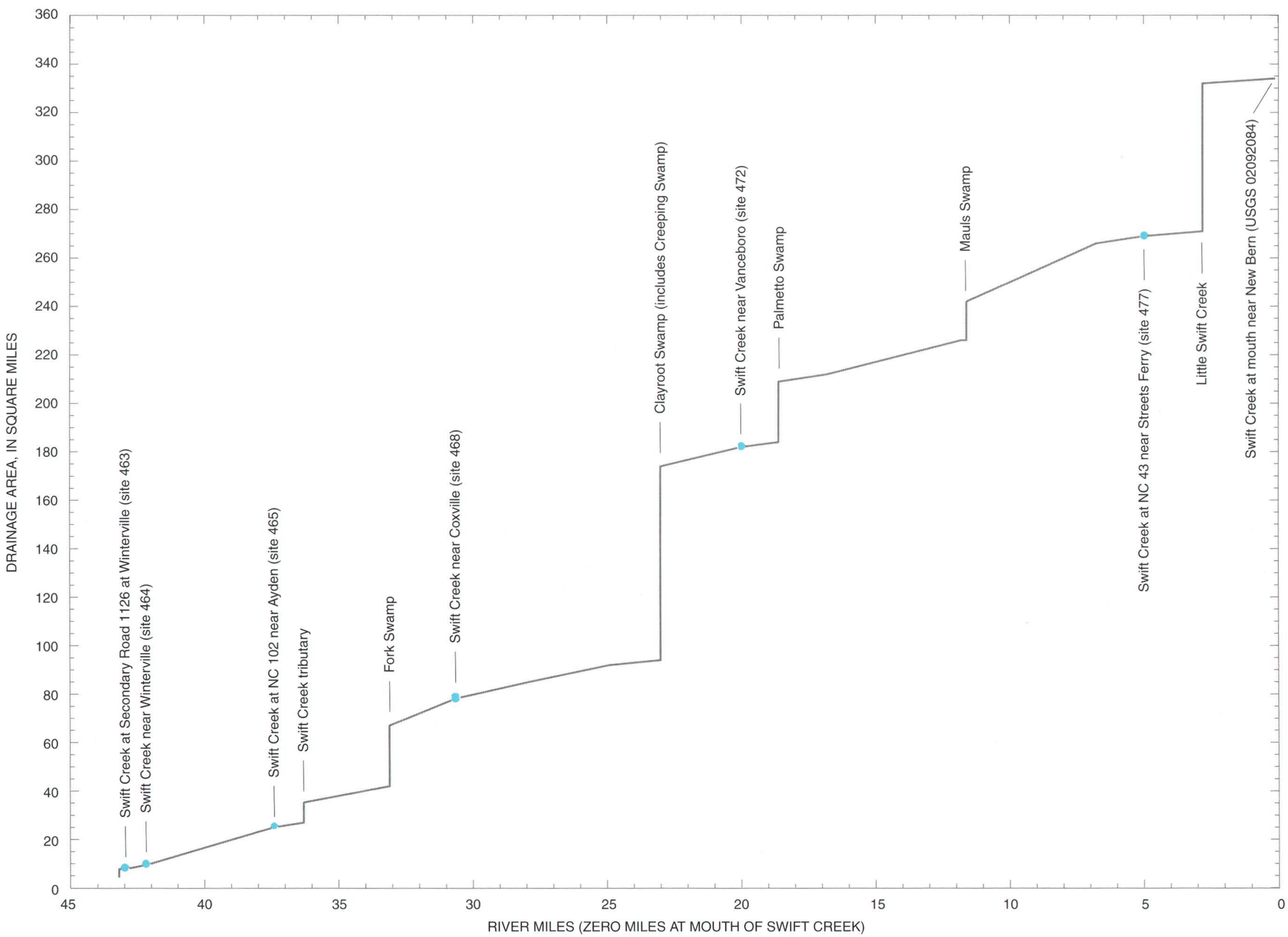

Figure 17A. Relation of river miles to drainage area for Swift Creek (Pitt and Craven Counties).

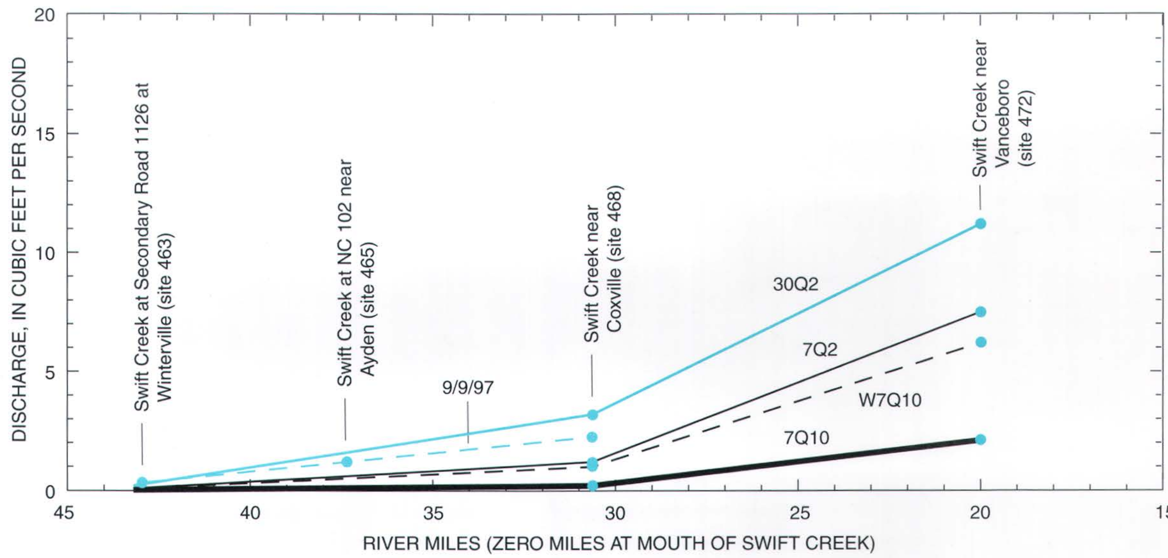

Figure 17B. Relation of river miles to low-flow discharges for Swift Creek (Pitt and Craven Counties).

Trent River

At the mouth, the Trent River Basin is about 520 mi^2 and drains parts of Lenoir, Jones, and Craven Counties (pl. 1). The river drains to the upper reaches of the Neuse River estuary at New Bern. The Trent River is nearly 87 mi in length; drainage areas for the Trent River were profiled from site 486 near Deep Run to the mouth (fig. 18A). Major tributaries to the Trent River include Tuckahoe Creek, Beaver Creek, and Brice Creek.

Low-flow profiles shown for the Trent River are limited to the reach of the river between Deep Run (site 486) and Trenton (site 494) (fig. 18B). Downstream from Trenton, flows gradually become subject to the effects of tides. Similar to that noted for the site on Swift Creek at Streets Ferry (site 477, see preceding section), no estimates of low-flow discharges for the site (500) on Trent River at Pollocksville are included in the compilations (tables 6, 7) or shown on the profiles. This site also has less than 2 years of data, and as previously discussed, the effects of tides on low-flow discharges cannot be readily quantified using available techniques of low-flow analyses. For the upper reach shown in the profiles, tributaries apparently do not contribute flows to the Trent River during extended drought periods (fig. 18B). This observation is supported by comparison of the low-flow discharges listed in tables 6 and 7 for the sites near Deep Run (486) and Trenton (494); unit low flows decrease significantly between the two sites suggesting that, while the drainage area increases, flow contributions from tributaries are minimal at best. Further support for this observation also is provided by table 7 where the occurrence of zero 7Q10 discharges is noted for a number of sites (490, 492, 496) tributary to the Trent River.

Although low-flow profiles for the reach downstream from Trenton are currently not available, the Castle Hayne aquifer likely contributes ground-water discharge to the Trent River and some of its tributaries. Winner and Coble (1996, pl. 18) indicated that the Castle Hayne aquifer, the most productive aquifer identified in North Carolina, discharges directly into the Trent River in the form of upward leakage. Between the river's confluence with Tuckahoe Creek and its entry into Craven County, the stream channel cuts into the Castle Hayne aquifer. The effects of ground-water discharge from the Castle Hayne aquifer also appear to affect the low-flow characteristics of some tributaries to the Trent River. The 7Q10 discharges for Beaver Creek (site 497) and Musselshell Creek (site 498) have magnitudes which, relative to other nearby tributaries, may include discharge from the Castle Hayne aquifer (table 7).

There are three permitted point-source discharges having a total permitted flow of about 0.475 Mgal/d (0.7 ft^3/s). Two of the three discharges, including the largest discharge permitted at about 0.33 Mgal/d (0.5 ft^3/s, table 2), are located in tidally affected reaches downstream from Pollocksville.

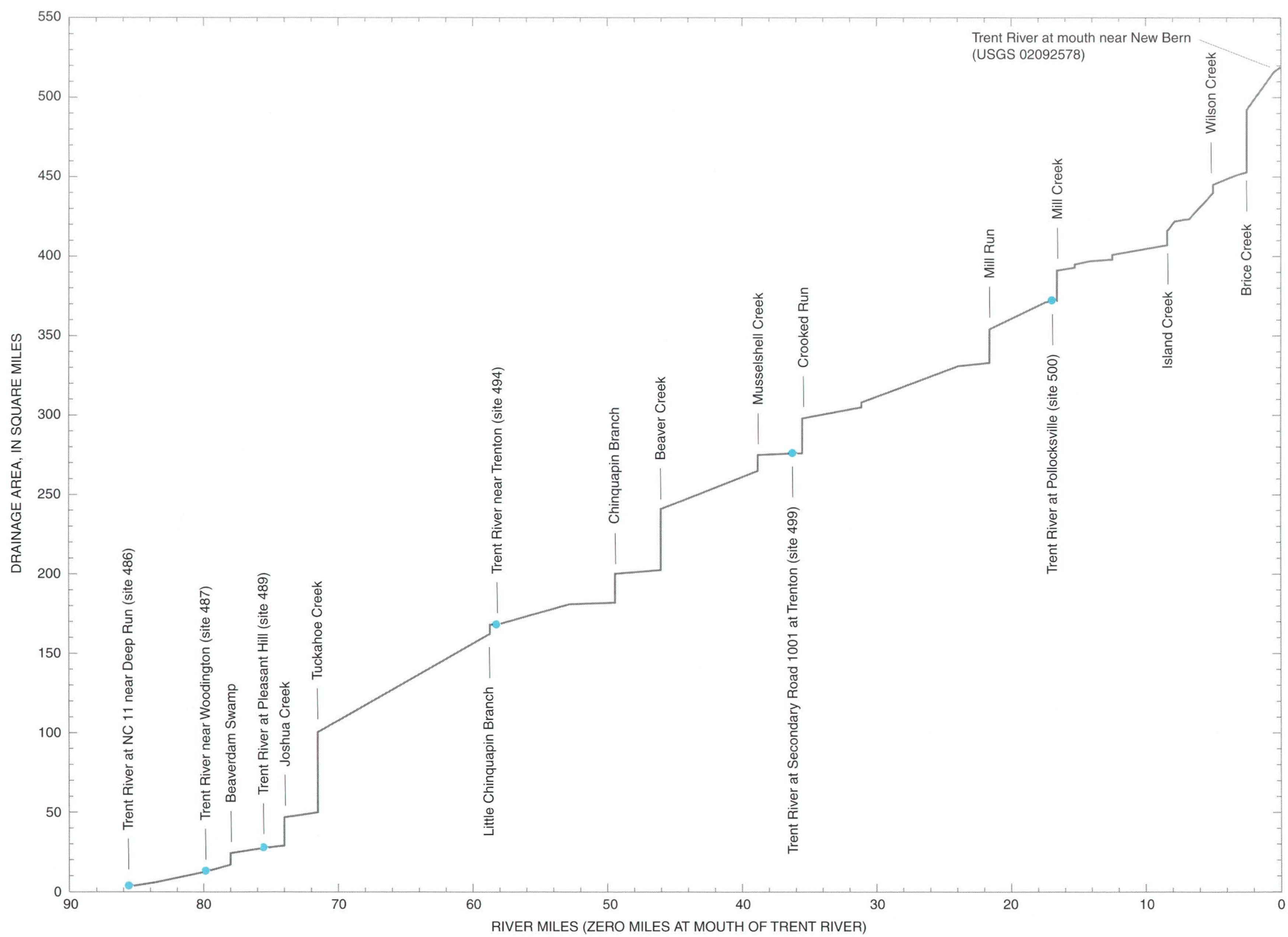

Figure 18A. Relation of river miles to drainage area for the Trent River.

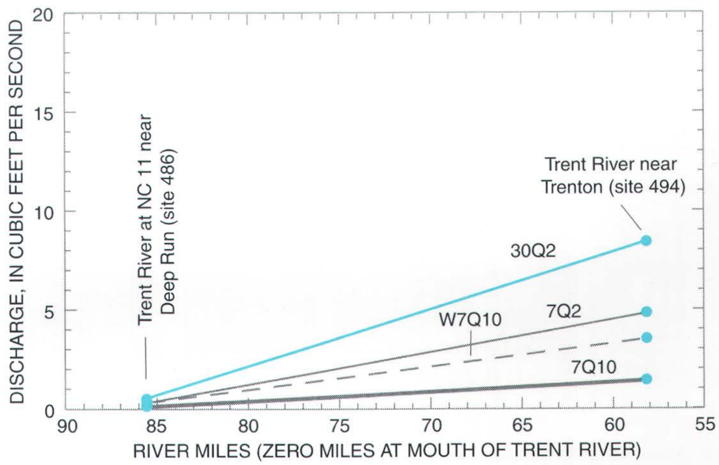

Figure 18B. Relation of river miles to low-flow discharges for the Trent River.

Provided that streamflow monitoring continues at the sites on Swift Creek at Streets Ferry (site 477) and Trent River at Pollocksville (site 500), a better understanding of low-flow characteristics may be possible with additional streamflow data and with the development of techniques for assessing low flows in tidally affected reaches. Additionally, a better understanding may possibly permit future extension of the low-flow profiles in the lower reaches of Swift Creek and the Trent River.

SUMMARY

This report describes low-flow characteristics for the Neuse River Basin in North Carolina through the 1996 water year and 1995 climatic year. Low-flow characteristics are summarized for a number of existing gaging stations in the study area, and drainage area and low-flow discharge profiles are presented for selected rivers and streams. Estimates of low flows presented in this report were prepared in cooperation with the North Carolina Division of Water Quality (DWQ, formerly known as the Division of Environmental Management) of the Department of Environment and Natural Resources. In 1991, the DWQ began using a basinwide approach in its assessment of water-quality conditions in North Carolina; part of the assessment includes the simultaneous evaluation of National Pollution Discharge Elimination System (NPDES) permits for point-source discharges to streams in the basin. The Neuse River Basin is one of 17 major river basins selected by the DWQ for the purposes of conducting the basinwide assessments.

Located in central eastern North Carolina, the Neuse River drains about 5,600 mi^2 and is nearly 310 mi between its headwaters (West Fork Eno River) in Orange County and its mouth near Maw Point in Pamlico County. The largest tributary to the Neuse River is Contentnea Creek. The Neuse River Basin is the smallest of the three river basins (Tar-Pamlico, Neuse, and Cape Fear River) that are completely within North Carolina. The upper one-third of the basin is in the Piedmont Province and is characterized by rolling and hilly topography. The lower two-thirds of the basin is in the Coastal Plain and is characterized by a gradual transition from gentle, rolling hills with little relief to nearly level land surfaces.

Selected basin characteristics and their known effects on low-flow characteristics are described in this report. Major flow modifications caused by impoundments and diversions from and into streams in the study area were examined to determine the effects on low-flow characteristics. Nearly 550 impoundments with structural heights exceeding 15 feet were identified in the investigation. The largest impoundment in the basin is Falls Lake, in Wake and Durham Counties, which has a surface area of nearly 12,500 acres. Eight other major impoundments with surface areas exceeding 200 acres exist in the basin. Although the effects of these impoundments on downstream low flows vary, the primary effect is downstream dependence upon the presence of a minimum flow release at the dam. Not all of the major impoundments identified in this report have minimum

flow releases. Among these impoundments, those constructed since the mid-1980's generally have been assigned minimum releases as a result of the revised procedures for evaluating the effects of dams on downstream flows.

A total of 65 withdrawals exceeding 1 Mgal/d are registered with the State of North Carolina; most are made by municipalities and major industries for water supply and manufacturing purposes. The State also permits 185 point-source discharges under the NPDES permitting system; 28 are deemed by the State as being major discharges. A number of major withdrawals and point-source discharges can be paired and thus result in negligible effects on low flows. The largest withdrawal and, correspondingly, the largest point-source discharge in the basin is made by the City of Raleigh, which withdrew and discharged an average of 43.0 and 33.9 Mgal/d, respectively, in 1996. Other significant flow diversions exceeding 5 Mgal/d were made by the Cities of Durham and Goldsboro. In the Coastal Plain, some facilities that discharge to streams do not make surface-water withdrawals, but rather obtain water supplies from ground water or by transfer from other facilities. Other flow modifications having potentially significant effects on low flows are unknown withdrawals in small to mid-size basins that are not required to register with the State. Often made for irrigation or de-watering (mining) purposes, the cumulative effect of multiple withdrawals, particularly in small to mid-size subbasins that have low potential to sustain base flows, could be to further reduce the availability of flow in nearby streams for assimilating effluent from point-source discharges. Some withdrawals, identified but not documented in this report, include those made at a number of quarry operations or at farming and agricultural-research operations in the basin.

Variability of average rainfall amounts occurring in the Neuse River Basin is partly reflected in the potential to sustain low flows in the study area. Annual rainfall amounts in the lower parts of the basin were about 8 inches higher than in the headwaters. A comparison of two sites—Little River in Durham County and Nahunta Swamp in Greene County—in the basin with identical drainage areas revealed a higher 7Q10 discharge at Nahunta Swamp. Overall, soil hydrologic groups in the subbasins drained by each site were identified as moderately drained. Thus, the higher 7Q10 discharge at Nahunta Swamp likely reflects the higher average annual rainfall at that site.

Available documentation of soils was examined to determine the effects on low flows in the study area. Soil hydrologic groups, when mapped throughout the study area, generally correspond to the potential to sustain base flows. Some soils in parts of the headwaters of the Neuse River Basin, particularly those derived from Triassic basin rocks, are classified as having low infiltration rates and reflect the low potential to sustain base flows for streams in that area. Numerous sites in western Wake County and Durham County have zero or minimal 7Q10 discharges (defined as less than 0.05 ft^3/s). Many soils in the study area within the lower Coastal Plain also are classified as having low infiltration rates. Similarly, the potential for sustaining base flows at many of the gaging stations in this area is low. Many soils in the central part of the basin are classified as moderately and well drained.

Land use in the basin is mostly rural; slightly over 71 percent is classified as agricultural or forested. Five percent of the basin is urban with Raleigh and Durham in Wake and Durham Counties, respectively, being the largest municipalities in the study area. Wetlands occupy more than 18 percent of the study area, primarily adjacent to streams in the lower parts of the basin in the Coastal Plain. Changes in land use are difficult to quantify because of the methods and resolution of techniques used in compiling information for different land-use data bases. The most notable changes have been the widespread conversion of agricultural and forest covered land to developed land in the Raleigh and Durham municipalities.

Surface-water data were identified and compiled for 508 sites in the study area. Low-flow characteristics (7Q10, 30Q2, W7Q10, and 7Q2) were determined for 163 sites (50 continuous-record and 113 partial-record). At four gaging stations having continuous records of daily mean discharge on the Neuse River downstream from Falls Lake, a common base period (1984–95 climatic years) was selected for use in determining low-flow characteristics. This period reflects the regulation of flows by Falls Lake since its construction. When unit low flows were plotted on a map of the study area, two general areas of zero or minimal 7Q10 discharges were recognized. A number of sites in the upper part of the basin, as well as many of the sites in lower areas of the Coastal Plain, have zero or minimal 7Q10 discharges. The poorly sustained base flows are reflective of soils having low infiltration rates; little water is stored in the surficial aquifers in these areas which results in little to no water being available for release to streams during extended dry periods. Occurrences of zero or minimal 7Q10 discharges in the central part of the basin were noted, though on a more widespread basis. In that area, low flows are more likely affected by a combination of factors (soils, degree of terrain slope, and drainage area), whereas in the upper and lower ends of the basin, the predominant factor in occurrences of zero or minimal 7Q10 discharges is the presence of poorly drained soils.

Drainage area and low-flow discharge profiles were developed for 10 streams and rivers in the study area. Streams profiled in this report include the Neuse River (between Falls Lake and Fort Barnwell) and selected tributaries to the Neuse River. The selected tributaries include Perry Creek, Walnut Creek (Wake County), Poplar Creek, Swift Creek (Wake and Johnston Counties), Little River, Walnut Creek (Wayne County), Contentnea Creek, the Neuse River, Swift Creek (Pitt and Craven Counties), and the Trent River. The low-flow discharge profiles indicate the 7Q10, 30Q2, W7Q10, and 7Q2 discharges. For the Neuse River and selected tributaries, a profile of discharge measurements obtained at multiple points in September 1997 provides a "snapshot" of actual flow conditions during a period of extended dry conditions.

Perry Creek, Poplar Creek, and both Walnut Creeks (Wake County and Wayne County) each drain less than 50 mi^2. Low-flow characteristics at Perry Creek and Poplar Creek have relatively high potential for sustained base flows as a result of the moderately drained soils weathered from granitic rocks underlying much of Wake County. Similarly, low-flow characteristics in the lower reaches of Walnut Creek in Wake County reflect relatively high potentials for sustained base flows although low flows in its headwaters are not as sustained, most likely a result of its proximity to the Triassic basin, an area that contains poorly drained soils. Low flows in Walnut Creek in Wayne County apparently reflect the presence of moderately and well-drained soils in parts of the subbasin.

Swift Creek (Wake and Johnston Counties) and Little River drain 289 mi^2 and 317 mi^2, respectively, of the central part of the Neuse River Basin. Similar to Walnut Creek in Wake County, low-flow discharge profiles for Swift Creek indicate a stream in which the potential for sustained base flows increases between the headwaters and its mouth, a result of transition from poorly drained soils to moderately drained soils. Discharge profiles for the Little River indicate moderately to highly sustained base flows, particularly in the middle and lower reaches partly as a result of the river's movement through the Fall Line.

Contentnea Creek, the largest tributary to the Neuse River, has a drainage area 1,010 mi^2 at its mouth. The stream begins as Moccasin Creek and merges with Turkey Creek to become Contentnea Creek. Two impoundments, Buckhorn Reservoir and Wiggins Mill Reservoir, are on Contentnea Creek and affect the low flows on the stream through flow releases from the dams. Overall, low-flow discharge profiles for Contentnea Creek reflect moderate potential for sustained base flow. Infiltration rates for soils in the subbasin and, in particular, along tributary streams in Wilson County are classified as well drained. Some occurrence of poorly drained soils were noted along Contentnea Creek, but the effects of these soils on low flows are apparently superseded by the effects of the well-drained soils. NPDES point-source discharges in the Contentnea Creek subbasin have varying magnitudes of permitted flows and have correspondingly varying effects on the low flows in Contentnea Creek. The most significant effect on base flow occurs on the stream below Wiggins Mill Reservoir where the City of Wilson has a withdrawal and point-source discharge occurring within 3 miles. Higher amounts from the point-source discharge result in an increase in low-flow discharge profiles in the downstream reaches.

Swift Creek (Pitt and Craven Counties) and the Trent River drain 334 mi^2 and 519 mi^2, respectively, and are in the lower parts of the study area in the lower Coastal Plain. Most soils in both subbasins are classified as being poorly drained, and numerous zero- and minimal 7Q10 discharges were noted, particularly for tributary streams. Low-flow profiles were not developed for the lower reaches of Swift Creek and the Trent River due to the presence of tidal influences which cannot be readily quantified using available techniques of low-flow analyses. However, ground-water discharge from the underlying Castle Hayne aquifer appears to be a component of the overall flows in these streams despite the absence of contributing flows from tributaries. The Castle Hayne aquifer is composed of permeable material derived from the extensive presence of porous limestone in the aquifer.

The drainage-area profile for the Neuse River shows increases in basin size between the headwaters and its mouth. The low-flow profiles indicate changes in low-flow characteristics between Falls Lake and Fort Barnwell. Overall, low-flow profiles show moderate and steady increases in discharge for much of this reach. The most prominent feature noted in the low-flow profiles is the significant and sudden increase in low flows between Kinston (site 361) and Fort Barnwell (site 460). Despite a nearly 45-percent increase in drainage area, tributary contributions do not account for the increase in low flows in this reach. As with nearby Swift Creek and the Trent River, increases in this reach are primarily a result of ground-water discharge from the underlying Castle Hayne aquifer. Effects of regulation by Falls Lake dam can be observed in changes between pre- and post-regulation streamflows as far downstream as Kinston. Twenty-four NPDES point-source discharges were noted for the Neuse River downstream from Falls Lake; additionally, four water-supply withdrawals also occur in that reach.

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Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected

[mi^2, square mile; SR, secondary road; N/A, not applicable; SEO, sewage effluent outfall. Sites shaded in gray indicate those sites for which low-flow characteristics have been developed. Period of record for continuous-record sites (site type 1) is shown in months and years; period of record for partial-record sites (site type 2) is shown in water years in which discharge measurements were made]

Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
1	0208480110	West Fork Eno River at SR 1358 near Carr	36°12'17"	79°11'23"	Orange	Cedar Grove	1.43	Eno River	03020201	2	1974	3	0
2	0208480325	West Fork Eno River at SR 1004 near Cedar Grove	36°08'21"	79°10'13"	Orange	Cedar Grove	11.0	Eno River	03020201	2	1986-87	2	0
3	0208481111	East Fork Eno River at Dam near Cedar Grove	36°08'45"	79°08'57"	Orange	Cedar Grove	9.08	Eno River	03020201	2	1986-87	4	0
4	02084812	East Fork Eno River near Cedar Grove	36°08'14"	79°09'59"	Orange	Cedar Grove	11.46	Eno River	03020201	2	1958, 1964, 1966, 1968	4	0
5	02084890	Eno River near Carr	36°07'24"	79°09'20"	Orange	Efland	26.7	Neuse River	03020201	2	1960-64, 1966, 1968, 1970	13	0
6	02084896	Eno River near Cedar Grove	36°06'07"	79°08'35"	Orange	Efland	33.4	Neuse River	03020201	2	1954-55, 1958, 1960-61, 1968, 1986-87	12	0
7	02084898	McGowan Creek near Efland	36°05'14"	79°10'04"	Orange	Efland	4.54	Eno River	03020201	2	1964, 1966, 1968, 1986-87	5	2
8	02084901	Eno River below dam near Efland	36°05'02"	79°08'28"	Orange	Efland	41.2	Neuse River	03020201	2	1986	1	0
9	02084903	Sevenmile Creek tributary at SR 1120 near Buckhorn	36°02'59"	79°11'16"	Orange	Efland	1.34	Sevenmile Creek	03020201	1	July 1981 - July 1982	N/A	N/A
10	02084904	Sevenmile Creek tributary at I-85 near Miles	36°04'39"	79°12'37"	Orange	Efland	0.004	Sevenmile Creek	03020201	1	June 1981 - July 1982	N/A	N/A
11	02084905	Sevenmile Creek tributary at SR 1144 near Miles	36°04'11"	79°12'07"	Orange	Efland	1.57	Sevenmile Creek	03020201	1	June 1981 - July 1982	N/A	N/A
12	02084907	Sevenmile Creek at SR 1120 near Efland	36°03'57"	79°10'08"	Orange	Efland	8.52	Eno River	03020201	2	1973-74	3	0
13	02084908	Sevenmile Creek tributary at I-85 near Efland	36°04'18"	79°09'38"	Orange	Efland	0.29	Sevenmile Creek	03020201	1	June 1981 - July 1982	N/A	N/A
14	02084909	Sevenmile Creek near Efland	36°03'56"	79°08'39"	Orange	Efland	14.1	Eno River	03020201	1	July 1981 - July 1982, June 1987 - Sept. 1996	N/A	N/A
										2	1964, 1968	2	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

[mi^2, square mile; SR, secondary road; N/A, not applicable; SEO, sewage effluent outfall. Sites shaded in gray indicate those sites for which low-flow characteristics have been developed. Period of record for continuous-record sites (site type 1) is shown in months and years; period of record for partial-record sites (site type 2) is shown in water years in which discharge measurements were made]

Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
15	02084910	Rocky Run near Hillsborough	36°03'44"	79°08'15"	Orange	Efland	2.53	Sevenmile Creek	03020201	2	1964, 1968, 1986-87	4	0
16	02084911	Sevenmile Creek near Hillsborough	36°04'14"	79°08'09"	Orange	Efland	17.1	Eno River	03020201	2	1954, 1958, 1968	3	1
17	0208491175	Eno River at dam near Hillsborough	36°04'15"	79°07'51"	Orange	Efland	59.9	Neuse River	03020201	2	1986	1	0
18	02084916	Eno River at water-supply intake near Hillsborough	36°04'13"	79°07'47"	Orange	Efland	60.4	Neuse River	03020201	2	1954-55, 1958, 1968, 1974-75	9	0
19	02084917	Eno River tributary no. 2 at Hillsborough	36°03'35"	79°07'53"	Orange	Efland	1.42	Eno River	03020201	2	1964, 1968	2	1
20	02085000	Eno River at Hillsborough	36°04'18"	79°05'49"	Orange	Hillsborough	66.0	Neuse River	03020201	1	Oct. 1927 - Sept. 1971, Oct. 1985 - Sept. 1996	N/A	N/A
										2	1973	4	0
21	0208500575	Cates Creek at SR 1200 near Hillsborough	36°03'42"	79°05'27"	Orange	Hillsborough	4.45	Eno River	03020201	2	1973-74	4	0
22	02085006	Cates Creek near Hillsborough	36°03'55"	79°05'14"	Orange	Hillsborough	4.18	Eno River	03020201	2	1954-55, 1968, 1970, 1973-74	10	2
23	02085011	Eno River at U.S. 70 near Hillsborough	36°04'32"	79°04'17"	Orange	Hillsborough	73.2	Neuse River	03020201	2	1972-73	3	0
24	0208501550	Eno River at SR 1561 near Hillsborough	36°05'06"	79°03'43"	Orange	Hillsborough	82.5	Neuse River	03020201	2	1973	5	0
25	02085016	Eno River near Schley	36°04'45"	79°00'28"	Orange	Hillsborough	99.4	Neuse River	03020201	2	1954-55, 1964, 1966, 1968, 1973	9	0
26	02085020	Stony Creek tributary near Hillsborough	36°03'01"	79°02'14"	Orange	Hillsborough	0.8	Stony Creek	03020201	2	1959, 1961-71	12	0
27	02085028	Stony Creek at University	36°02'18"	79°02'05"	Orange	Hillsborough	6.61	Eno River	03020201	2	1964, 1966	2	0
28	02085029	Stony Creek tributary at SR 1712 at University	36°02'39"	79°01'35"	Orange	Hillsborough	1.33	Stony Creek	03020201	2	1973-74	4	0
29	02085034	Eno River near University	36°02'47"	79°00'40"	Orange	Hillsborough	113	Neuse River	03020201	2	1973, 1976, 1978, 1980	9	0
30	0208503880	Eno River at SR 1568 near University	36°02'42"	78°59'23"	Orange	Northwest Durham	120[a]	Neuse River	03020201	2	1973, 1975	3	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

[mi^2, square mile; SR, secondary road; N/A, not applicable; SEO, sewage effluent outfall. Sites shaded in gray indicate those sites for which low-flow characteristics have been developed. Period of record for continuous-record sites (site type 1) is shown in months and years; period of record for partial-record sites (site type 2) is shown in water years in which discharge measurements were made]

Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
31	02085039	Eno River near Huckleberry Spring	36°03'37"	78°58'42"	Durham	Northwest Durham	121	Neuse River	03020201	2	1973-75, 1978	5	0
32	0208503930	Eno River at SR 1403 near Huckleberry Spring	36°03'45"	78°57'45"	Durham	Northwest Durham	124.2	Neuse River	03020201	2	1973-74	3	0
33	02085049	Eno River at SR 1003 near Durham	36°04'18"	78°56'06"	Durham	Northwest Durham	130[a]	Neuse River	03020201	2	1973-75	4	0
34	02085056	Warren Creek tributary near Huckleberry Spring	36°03'19"	78°56'09"	Durham	Durham North	0.9[a]	Warren Creek	03020201	2	1973-74	3	0
35	02085059	Crooked Creek near Durham	36°04'38"	78°55'04"	Durham	Northwest Durham	4.56	Neuse River	03020201	2	1958, 1964, 1966, 1968	4	1
36	02085070	Eno River near Durham	36°04'20"	78°54'30"	Durham	Northwest Durham	141	Neuse River	03020201	1	Aug. 1963 - Sept. 1996	N/A	N/A
										2	1963	1	0
37	02085079	Eno River near Weaver	36°04'19"	78°51'47"	Durham	Northeast Durham	148	Neuse River	03020201	2	1954-55, 1958, 1968, 1972-74, 1976, 1978-80[b], 1983-87, 1989-96	167	2
38	02085111	South Fork Little River near Caldwell	36°09'27"	79°00'58"	Orange	Caldwell	22.7	Little River	03020201	2	1958, 1964, 1966, 1968	4	0
39	02085114	Forrest Creek near Cedar Grove	36°08'18"	79°06'28"	Orange	Caldwell	0.62	South Fork Little River	03020201	2	1954, 1964, 1966, 1968, 1972-73	10	2
40	02085118	Forrest Creek near Schley	36°08'21"	79°04'53"	Orange	Caldwell	3.00	South Fork Little River	03020201	2	1954, 1968, 1972-73	10	2
41	02085124	Forrest Creek near Hillsborough	36°08'24"	79°01'30"	Orange	Caldwell	7.32	South Fork Little River	03020201	2	1954, 1958, 1968	4	1
42	02085130	South Fork Little River near Quail Roost	36°08'44"	78°57'44"	Durham	Rougemont	38.2	Little River	03020201	2	1954, 1958, 1961-68	24	0
43	02085134	South Fork Little River near Orange Factory	36°08'57"	78°56'50"	Durham	Rougemont	39.0	Little River	03020201	2	1964	1	0

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
44	02085169	North Fork Little River near Caldwell	36°11'03"	79°01'26"	Orange	Caldwell	13.3	Little River	03020201	2	1958, 1964, 1966, 1968	4	1
45	02085190	North Fork Little River tributary near Rougemont	36°11'41"	79°00'43"	Orange	Caldwell	1.00	North Fork Little River	03020201	2	1953, 1961-76	22	4
46	02085196	North Fork Little River near Schley	36°10'50"	78°58'31"	Orange	Rougemont	20.3	Little River	03020201	2	1958, 1964, 1966, 1968	4	1
47	02085201	Buffalo Creek near Rougemont	36°11'05"	78°57'04"	Durham	Rougemont	5.48	North Fork Little River	03020201	2	1958, 1964, 1966, 1968	4	3
48	02085210	North Fork Little River near Orange Factory	36°09'48"	78°56'54"	Durham	Rougemont	29.7	Little River	03020201	2	1954, 1961-68	23	1
49	0208521240	Little River tributary near Fox Run	36°08'34"	78°55'26"	Orange	Rougemont	0.43	Little River	03020201	2	1986	1	1
50	0208521324	Little River at SR 1461 near Orange Factory	36°08'30"	78°55'10"	Durham	Rougemont	78.2	Eno River	03020201	1	Oct. 1987 - Sept. 1996	N/A	N/A
51	02085220	Little River near Orange Factory	36°08'20"	78°54'24"	Durham	Rougemont	80.4	Eno River	03020201	1	Sept. 1961 - Sept. 1987	N/A	N/A
										2	1930, 1954-59, 1961	19	0
52	0208524090	Mountain Creek at SR 1617 near Bahama	36°08'58"	78°53'49"	Durham	Rougemont	8.0	Little River	03020201	1	Oct. 1994 - Sept. 1996	N/A	N/A
53	02085241	Mountain Creek near Orange Factory	36°08'42"	78°53'32"	Durham	Durham North	8.47	Little River	03020201	2	1958, 1964, 1966, 1968	4	1
54	0208524950	Little River tributary at Fairntosh	36°06'56"	78°51'30"	Durham	Northeast Durham	0.86	Little River	03020201	2	1994-96[c]	28	0
55	0208524975	Little River below Little River tributary at Fairntosh	36°06'46"	78°51'35"	Durham	Northeast Durham	98.9	Neuse River	03020201	1	Oct. 1995 - Sept. 1996	N/A	N/A
56	02085262	Little River near Weaver	36°04'56"	78°51'25"	Durham	Northeast Durham	104	Eno River	03020201	2	1954, 1958, 1964, 1966, 1968, 1970	6	0
57	02085284	Eno River near Willardville	36°05'31"	78°49'27"	Durham	Northeast Durham	259	Neuse River	03020201	2	1954, 1964, 1968	3	0
58	02085302	South Flat River near Hurdle Mills	36°17'40"	79°03'54"	Person	Hurdle Mills	6.22	Flat River	03020201	2	1974-76, 1978-84	31	1

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59	02085306	South Flat River at Hurdle Mills	36°16'39"	79°02'42"	Person	Hurdle Mills	17.3	Flat River	03020201	2	1958, 1964, 1966	3	0
60	02085320	South Flat River at SR 1120 near Hurdle Mills	36°15'43"	79°00'45"	Person	Hurdle Mills	10	Flat River	03020201	2	1974-75, 1979	4	0
61	02085327	Aldridge Creek near Hurdle Mills	36°16'39"	79°00'05"	Person	Hurdle Mills	9.07	South Flat River	03020201	2	1958, 1964, 1966, 1968	4	0
62	02085348	South Flat River near Timberlake	36°15'25"	78°57'48"	Person	Roxboro	51.1	Flat River	03020201	2	1958, 1964, 1966, 1968	4	0
63	0208535580	North Flat River at SR 1142 near Roseville	36°20'30"	79°01'29"	Person	Hurdle Mills	5.27	Flat River	03020201	2	1974, 1976, 1980	7	0
64	02085356	North Flat River near Paynes Tavern	36°20'06"	79°00'49"	Person	Hurdle Mills	6.54	Flat River	03020201	2	1964, 1966, 1968	3	1
65	02085357	North Flat River tributary 2 at Allens Level	36°20'00"	79°01'00"	Person	Hurdle Mills	0.47	North Flat River	03020201	2	1968	1	1
66	0208535888	North Flat River tributary at SR 1195 at Roxboro	36°21'50"	78°59'23"	Person	Roxboro	0.2	Flat River	03020201	2	1974-75	6	0
67	0208535895	Unnamed tributary to North Flat River near Roxboro	36°22'30"	78°59'40"	Person	Roxboro	1[a]	North Flat River	03020201	2	1974-75	3	0
68	02085369	North Flat River near Allens Level	36°19'20"	78°59'30"	Person	Roxboro	14.2	Flat River	03020201	2	1958, 1966	2	0
69	02085390	North Flat River at Timberlake	36°17'24"	78°56'43"	Person	Timberlake	33.0	Flat River	03020201	2	1958, 1964-68, 1970	15	0
70	02085413	Deep Creek near Surl	36°19'52"	78°53'24"	Person	Roxboro	11.6	Flat River	03020201	2	1958, 1964, 1966, 1968	4	3
71	02085422	Deep Creek near Timberlake	36°16'15"	78°52'57"	Person	Roxboro	27.9	Flat River	03020201	2	1974-75	3	0
72	02085430	Deep Creek near Moriah	36°14'24"	78°53'20"	Person	Rougemont	32.5	Flat River	03020201	2	1958, 1963-68, 1970	17	4
73	02085477	Flat River near Quail Roost	36°12'00"	78°53'12"	Durham	Rougemont	146	Neuse River	03020201	2	1997	1	0
74	02085500	Flat River at Bahama	36°10'57"	78°52'44"	Durham	Rougemont	149	Neuse River	03020201	1	July 1925 - Sept. 1996	N/A	N/A
75	02085810	Muddy Branch at Bahama	36°10'16"	78°52'47"	Durham	Durham North	0.64	Flat River	03020201	2	1961-66, 1968, 1970	23	5
76	02086000	Dial Creek near Bahama	36°10'36"	78°51'24"	Durham	Lake Michie	4.76	Flat River	03020201	1	Oct. 1925 - Sept. 1971, Aug. 1989 - Sept. 1991	N/A	N/A

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi²)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
77	02086101	Horner Ford Creek at Bahama	36°09'36"	78°52'27"	Durham	Durham North	0.28	Lake Michie	03020201	2	1961-64, 1968, 1970	9	2
78	02086121	Horner Ford Creek tributary near Bahama	36°09'29"	78°51'42"	Durham	Durham North	0.28	Horner Ford Creek	03020201	2	1961-64, 1970	8	3
79	02086275	Dry Creek near Bahama	36°10'44"	78°49'50"	Durham	Lake Michie	1.24	Lake Michie	03020201	2	1961-64, 1966, 1968, 1970	10	5
80	02086287	Dry Creek tributary near Bahama	36°10'36"	78°50'13"	Durham	Durham North	0.24	Dry Creek	03020201	2	1961-64, 1966, 1968, 1970	10	3
81	02086291	Dry Creek tributary no. 2 near Bahama	36°10'28"	78°50'41"	Durham	Durham North	2.08	Dry Creek	03020201	2	1961-64, 1966, 1968, 1970	10	6
82	02086300	Rocky Creek near Bahama	36°10'30"	78°49'20"	Durham	Lake Michie	2.30	Lake Michie	03020201	2	1958, 1961-64, 1966, 1968, 1970	11	1
83	02086351	Rocky Creek tributary near Bahama	36°10'04"	78°48'46"	Durham	Durham North	0.50	Rocky Creek	03020201	2	1961-64, 1968, 1970	9	7
84	02086500	Flat River at dam near Bahama	36°08'55"	78°49'43"	Durham	Lake Michie	168	Neuse River	03020201	1	Aug. 1925 - Oct. 1959, Aug. 1961 - Sept. 1966, Oct. 1982 - Sept. 1990, Oct. 1992 - Sept. 1993.	N/A	N/A
										2	1991-92, 1994-97	7	0
85	0208650112	Flat River tributary near Willardville	36°07'54"	78°50'00"	Durham	Lake Michie	1.14	Flat River	03020201	1	Mar. 1988 - Mar. 1990, Oct. 1994 - Sept. 1996	N/A	N/A
86	02086570	Knap of Reeds Creek near Butner	36°09'27"	78°46'27"	Granville	Lake Michie	29.9	Neuse River	03020201	2	1954-55, 1958, 1961-66, 1968-69	34	1
87	02086597	Knap of Reeds Creek at SR 1120 near Butner	36°08'34"	78°47'19"	Granville	Durham North	3.8[a]	Neuse River	03020201	2	1972-73	7	0
88	02086599	Knap of Reeds Creek at Butner	36°08'27"	78°47'43"	Granville	Lake Michie	39.8	Neuse River	03020201	2	1954-55	4	0

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89	02086624	Knap of Reeds Creek near Butner	36°07'40"	78°47'55"	Granville	Lake Michie	43.0	Neuse River	03020201	1	Oct. 1982 - Sept. 1995	N/A	N/A
										2	1980-82, 1996	15	0
90	0208662450	Knap of Reeds Creek tributary near Butner	36°07'13"	78°47'27"	Granville	Northeast Durham	2[a]	Knap of Reeds Creek	03020201	2	1972-74, 1976, 1978	6	0
91	02086699	Ellerbe Creek near Huckleberry Springs	36°01'23"	78°56'33"	Durham	Northwest Durham	2.73	Neuse River	03020201	2	1958, 1966, 1968	3	0
92	02086720	Ellerbe Creek at Hillandale Road at Durham	36°01'19"	78°56'11"	Durham	Durham North	2.86	Neuse River	03020201	2	1967-70	4	0
93	02086760	Dye Creek at Guess Road at Durham	36°01'09"	78°54'50"	Durham	Durham North	0.81	Ellerbe Creek	03020201	2	1967-70	4	0
94	02086774	Ellerbe Creek above Goose Creek near Durham	36°01'41"	78°51'57"	Durham	Durham North	10.4	Neuse River	03020201	2	1951, 1964	3	0
95	02086790	Goose Creek at East Geer Street at Durham	36°00'13"	78°52'50"	Durham	Durham North	1.48	Ellerbe Creek	03020201	2	1967-70	4	0
96	02086799	Goose Creek at Durham	36°01'28"	78°51'39"	Durham	Durham North	6.55	Ellerbe Creek	03020201	2	1954, 1964	3	2
97	0208679920	Ellerbe Creek at SR 1669 near Weaver	36°01'41"	78°51'55"	Durham	Northeast Durham	17.4	Neuse River	03020201	2	1991	1	0
98	02086824	Ellerbe Creek below Goose Creek near Durham	36°01'42"	78°51'54"	Durham	Durham North	17.1	Neuse River	03020201	2	1972-73	7	0
99	02086849	Ellerbe Creek near Gorman	36°03'33"	78°49'58"	Durham	Northeast Durham	21.9	Neuse River	03020201	1	Oct. 1982 - Apr. 1989, Oct. 1991 - Sept. 1995	N/A	N/A
										2	1972-73, 1976, 1978, 1980-82, 1996	26	0
100	02086935	Neuse River tributary at I-85 near Butner	36°05'00"	78°46'00"	Granville	Northeast Durham	5.05	Neuse River	03020201	2	1974-75	4	1
101	02086949	Panther Creek at Redwood	36°03'04"	78°46'32"	Durham	Durham North	5.21	Neuse River	03020201	2	1957, 1968	2	2

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102	02086974	Neuse River tributary no. 2 at Redwood	36°02'42"	78°46'05"	Durham	Durham North	1.81	Neuse River	03020201	2	1957, 1968	2	2
103	02087000	Neuse River near Northside	36°02'54"	78°44'59"	Wake	Creedmoor	535	Neuse River	03020201	1	July 1927 - Sept. 1980	N/A	N/A
104	0208700550	Little Lick Creek near Oak Grove	35°58'56"	78°49'29"	Durham	Durham South	4.9[a]	Neuse River	03020201	2	1972-73	8	0
105	0208700780	Little Lick Creek above SR 1814 near Oak Grove	35°59'11"	78°47'58"	Durham	Southeast Durham	10.1	Neuse River	03020201	1	Oct. 1982 - Sept. 1995	N/A	N/A
										2	1996	3	0
106	02087008	Little Lick Creek at SR 1814 near Oak Grove	35°59'11"	78°47'57"	Durham	Southeast Durham	10.1	Neuse River	03020201	2	1972-73	7	0
107	02087010	Little Lick Creek near Redwood	36°00'57"	78°45'38"	Durham	Northeast Durham	19.4	Neuse River	03020201	2	1954, 1958, 1964-68, 1970, 1972-73	23	9
108	02087016	Ledge Creek above Lake near Creedmoor	36°08'34"	78°42'19"	Granville	Creedmoor	6.99	Neuse River	03020201	2	1958	1	1
109	02087018	Holman Creek near Creedmoor	36°08'11"	78°41'50"	Granville	Creedmoor	7.11	Ledge Creek	03020201	2	1958, 1964	2	2
110	02087021	Ledge Creek at Creedmoor	36°07'45"	78°42'20"	Granville	Creedmoor	17.5	Neuse River	03020201	2	1974-75	5	0
111	0208702110	Ledge Creek at SR 1110 near Creedmoor	36°07'00"	78°42'30"	Granville	Creedmoor	20[a]	Neuse River	03020201	2	1972-73	5	0
112	02087024	Ledge Creek tributary no. 2 near Northside	36°04'32"	78°43'17"	Granville	Creedmoor	3.86	Ledge Creek	03020201	2	1958, 1961, 1964, 1968, 1970	6	6
113	02087029	Lick Creek near Oak Grove	35°58'06"	78°46'10"	Durham	Southeast Durham	8.75	Neuse River	03020201	2	1968	1	1
114	02087030	Lick Creek near Durham	35°58'50"	78°44'19"	Durham	Bayleaf	13.8	Neuse River	03020201	2	1958, 1961-71	14	2
115	02087033	Lick Creek near Rogers Store	35°59'45"	78°43'27"	Durham	Bayleaf	16.4	Neuse River	03020201	2	1954, 1964, 1968	3	3
116	02087036	Laurel Creek near Rogers Store	35°59'00"	78°43'08"	Durham	Bayleaf	2.77	Lick Creek	03020201	2	1954, 1964, 1966, 1968	4	1
117	02087041	Beaverdam Creek near Mount Energy	36°05'26"	78°38'23"	Granville	Creedmoor	12.7	Neuse River	03020201	2	1958, 1964, 1968	3	3
118	02087046	Robertson Creek at NC 56 near Creedmoor	36°07'18"	78°39'43"	Granville	Creedmoor	9.28	Beaverdam Creek	03020201	2	1954, 1958, 1968, 1970	6	5

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119	02087052	Smith Creek at Grissom	36°05'18"	78°36'08"	Granville	Grissom	6.23	Beaverdam Creek	03020201	1	Feb. 1984 - Apr. 1985	N/A	N/A
										2	1964, 1968-69	3	1
120	02087053	Smith Creek near Grissom	36°04'16"	78°38'15"	Granville	Creedmoor	9.08	Beaverdam Creek	03020201	2	1958, 1966, 1969	3	1
121	02087060	Beaverdam Creek near Creedmoor	36°03'19"	78°40'38"	Wake	Creedmoor	44.2	Neuse River	03020201	2	1954-55, 1957-59, 1968, 1970	19	7
122	02087063	Little Beaverdam Creek near Purnell	36°02'27"	78°40'20"	Wake	Creedmoor	3.76	Beaverdam Creek	03020201	2	1955, 1958, 1968	3	3
123	02087072	New Light Creek near Grissom	36°03'77"	78°34'36"	Granville	Grissom	1.85	Neuse River	03020201	2	1968	1	0
124	02087080	New Light Creek near Purnell	36°00'48"	78°37'43"	Wake	Creedmoor	19.2	Neuse River	03020201	2	1954-58, 1968, 1970	18	0
125	02087120	Upper Barton Creek near Bayleaf	35°58'21"	78°39'18"	Wake	Bayleaf	12.4	Neuse River	03020201	2	1952, 1954-58, 1968, 1970	19	0
126	02087140	Lower Barton Creek tributary near Raleigh	35°54'44"	78°40'55"	Wake	Bayleaf	0.66	Neuse River	03020201	2	1961-71	11	0
127	02087160	Lower Barton Creek near Bayleaf	35°58'01"	78°38'07"	Wake	Bayleaf	13.1	Neuse River	03020201	2	1951-54, 1958, 1968	20	0
128	02087162	Neuse River at SR 2003 near Bayleaf	35°58'06"	78°37'57"	Wake	Bayleaf	732	Atlantic Ocean	03020201	2	1972-73	6	0
129	02087173	Horse Creek tributary at SR 1140 near Pocomoke	36°02'33"	78°31'03"	Franklin	Creedmoor	1.1[a]	Horse Creek	03020201	2	1976, 1979	3	0
130	02087174	Horse Creek near Forestville	35°58'44"	78°33'43"	Wake	Wake Forest	12.0	Neuse River	03020201	2	1958, 1968	2	0
131	02087175	Horse Creek near Wake Forest	35°58'08"	78°35'29"	Wake	Wake Forest	21.2	Neuse River	03020201	2	1949-55, 1958-59, 1963, 1968	28	0
132	0208717902	Little Falls Creek at SR 2006 near Six Forks	35°54'36"	78°36'49"	Wake	Wake Forest	0.9[a]	Honeycutt Creek	03020201	2	1973-74	4	0
133	02087181	Honeycutt Creek at Falls	35°56'25"	78°35'16"	Wake	Wake Forest	8.58	Neuse River	03020201	2	1955, 1958	2	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
134	02087182	Neuse River at Falls	35°56'27"	78°34'57"	Wake	Wake Forest	771	Atlantic Ocean	03020201	2	1968-70	20	0
135	02087183	Neuse River near Falls	35°56'25"	78°34'56"	Wake	Wake Forest	771	Atlantic Ocean	03020201	1	July 1970 - Sept. 1996	N/A	N/A
136	0208718385	Hattels Branch at NC 96 at Youngsville	36°01'15"	78°28'26"	Franklin	Franklinton	0.1[a]	Richland Creek	03020201	2	1972-75	9	1
137	0208718440	Hattels Branch at U.S. 1A near Youngsville	36°00'55"	78°29'29"	Franklin	Franklinton	1.35	Richland Creek	03020201	2	1972-74	8	0
138	02087185	Richland Creek tributary at Wake Forest	36°00'00"	78°30'00"	Wake	Wake Forest	0.23	Richland Creek	03020201	2	1954-55, 1968	4	0
139	02087186	Richland Creek at Wake Forest	35°59'44"	78°30'40"	Wake	Wake Forest	6.15	Neuse River	03020201	2	1954-55, 1968, 1970	8	0
140	02087187	Richland Creek at NC 98 at Wake Forest	35°58'41"	78°31'28"	Wake	Wake Forest	7.66	Neuse River	03020201	2	1972-74	6	0
141	02087188	Richland Creek near Forestville	35°57'42"	78°32'33"	Wake	Wake Forest	10.5	Neuse River	03020201	2	1954-55, 1968, 1972-74	11	0
142	02087189	Richland Creek near Wyatt	35°56'50"	78°33'10"	Wake	Wake Forest	12.6	Neuse River	03020201	2	1955	2	0
143	0208718995	Neuse River above U.S. Hwy 1 near Neuse	35°54'36"	78°33'27"	Wake	Wake Forest	790[a]	Atlantic Ocean	03020201	2	1972-73, 1975	3	0
144	02087190	Neuse River at U.S. Hwy 1 near Neuse	35°54'32"	78°33'18"	Wake	Wake Forest	792	Atlantic Ocean	03020201	1	Oct. 1959 - Sept. 1971 (medium/high flows only prior to Oct. 1969)	N/A	N/A
										2	1954-55, 1968	5	0
145	02087193	Smith Creek at Wake Forest	35°58'09"	78°29'20"	Wake	Rolesville	3.38	Neuse River	03020201	2	1959, 1968, 1974-75	7	0
146	02087194	Austin Creek at Wake Forest	35°57'41"	78°29'12"	Wake	Rolesville	3.98	Smith Creek	03020201	2	1958-59, 1968	3	0
147	02087196	Hatters Branch at Wake Forest	35°58'21"	78°29'44"	Wake	Rolesville	1.82	Smith Creek	03020201	2	1959, 1968	2	0
148	02087203	Smith Creek at Forestville	35°56'55"	78°30'32"	Wake	Wake Forest	12.8	Neuse River	03020201	2	1972-74	6	0

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149	0208720330	Smith Creek at SR 2044 near Forestville	35°55'44"	78°31'40"	Wake	Wake Forest	21[a]	Neuse River	03020201	2	1972-74	5	0
150	02087204	Smith Creek near Rolesville	35°55'10"	78°32'04"	Wake	Wake Forest	22.6	Neuse River	03020201	2	1954-55, 1968, 1970	6	0
151	02087206	Mill Creek near Wake Crossroads	35°54'22"	78°31'36"	Wake	Wake Forest	1.12	Neuse River	03020201	2	1955, 1968	2	0
152	02087208	Toms Creek near Wake Crossroads	35°54'21"	78°32'39"	Wake	Wake Forest	3.39	Mill Creek	03020201	2	1955, 1968	2	0
153	0208721055	Perry Creek at SR 2012 near Millbrook	35°52'30"	78°35'48"	Wake	Raleigh East	2.43	Neuse River	03020201	1	Mar. 1986 - Sept. 1989	N/A	N/A
154	0208721290	Perry Creek tributary at Neuse	35°53'47"	78°34'46"	Wake	Raleigh East	1.07	Perry Creek	03020201	1	Oct. 1985 - Sept. 1988	N/A	N/A
155	02087216	Neuse River at Wake Crossroads	35°53'02"	78°31'43"	Wake	Wake Forest	835	Atlantic Ocean	03020201	2	1972	1	0
156	02087217	Hodges Mill Creek near Rolesville	35°51'06"	78°29'17"	Wake	Knightdale	5.33	Neuse River	03020201	2	1955	1	0
157	02087218	Hodges Mill Creek near Knightdale	35°51'16"	78°29'54"	Wake	Knightdale	6.17	Neuse River	03020201	2	1967	1	0
158	02087219	Hodges Mill Creek near Milburnie	35°51'22"	78°30'46"	Wake	Raleigh East	7.92	Neuse River	03020201	2	1955	1	0
159	02087220	Harris Creek near Wake Crossroads	35°51'53"	78°30'53"	Wake	Raleigh East	9.85	Hodges Mill Creek	03020201	2	1954-59, 1961-64	22	0
160	02087224	Neuse River at Buffalo Road near Raleigh	35°50'53"	78°31'49"	Wake	Raleigh East	859	Atlantic Ocean	03020201	2	1972-73	5	0
161	02087226	Beaverdam Creek near Knightdale	35°49'03"	78°30'11"	Wake	Raleigh East	3.43	Neuse River	03020201	2	1955	1	0
162	02087229	Neuse River near Raleigh	35°47'35"	78°32'21"	Wake	Raleigh East	877	Atlantic Ocean	03020201	2	1927, 1954-55, 1974, 1997	10	0
163	0208723010	Mango Creek at SR 2516 near Knightdale	35°46'37"	78°31'32"	Wake	Raleigh East	3.6[a]	Neuse River	03020201	2	1973-75	7	1
164	0208723280	Crabtree Creek at SR 1615 near Cary	35°47'26"	78°49'56"	Wake	Cary	3.83	Neuse River	03020201	2	1973-74	6	2
165	0208723397	Coles Branch 2.4 miles from mouth at Cary	35°47'30"	78°47'37"	Wake	Cary	0.1[a]	Crabtree Creek	03020201	2	1973-75	8	2

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
166	0208723425	Coles Branch near Cary	35°47'29"	78°48'23"	Wake	Cary	1.2[a]	Crabtree Creek	03020201	2	1974-75	6	0
167	0208723560	Crabtree Creek tributary at Morrisville	35°49'30"	78°48'46"	Wake	Cary	0.9[a]	Crabtree Creek	03020201	2	1972	1	0
168	02087236	Crabtree Creek at Morrisville	35°49'15"	78°49'27"	Wake	Cary	14.7	Neuse River	03020201	2	1932, 1961-62, 1968, 1972-74	10	4
169	0208723750	Licks Creek near Morrisville	35°50'45"	78°49'49"	Wake	Cary	0.3[a]	Crabtree Creek	03020201	2	1972-75	8	4
170	0208723757	Licks Creek at Morrisville	35°49'55"	78°48'57"	Wake	Cary	0.9[a]	Crabtree Creek	03020201	2	1973-75	7	3
171	02087238	Stirrup Iron Creek at Nelson	35°52'57"	78°50'10"	Durham	Southeast Durham	7.09	Crabtree Creek	03020201	2	1958, 1962, 1966, 1968	4	4
172	02087240	Stirrup Iron Creek tributary near Nelson	35°53'06"	78°49'37"	Durham	Durham South	0.25	Stirrup Iron Creek	03020201	2	1961-73	20	0
173	02087241	Stirrup Iron Creek near Nelson	35°51'35"	78°49'05"	Wake	Cary	9.22	Crabtree Creek	03020201	2	1962, 1968	2	1
174	0208724350	Little Brier Creek tributary at U.S. 70 near Leesville	35°54'36"	78°46'45"	Wake	Southeast Durham	1.15	Little Brier Creek	03020201	2	1974-75	6	1
175	0208724375	Little Brier tributary at SR 1645 near Leesville	35°54'00"	78°47'15"	Wake	Durham South	2.2[a]	Little Brier Creek	03020201	2	1974-75	7	2
176	02087246	Little Brier Creek near Nelson	35°52'55"	78°48'07"	Wake	Southeast Durham	8.58	Brier Creek	03020201	2	1955, 1962, 1968, 1970	6	4
177	02087249	Stirrup Iron Creek near Morrisville	35°50'34"	78°48'15"	Wake	Cary	25.4	Crabtree Creek	03020201	2	1961-62, 1968, 1972-74	10	3
178	02087251	Crabtree Creek near Cary	35°50'15"	78°46'52"	Wake	Cary	52.2	Neuse River	03020201	2	1961-62, 1968, 1982-92, 1995-96	50	0
179	0208725110	Crabtree Creek at I-40 near Cary	35°50'19"	78°46'49"	Wake	Cary	52[a]	Neuse River	03020201	2	1973	4	0
180	0208725115	Crabtree Creek near Tysonville	35°50'29"	78°44'40"	Wake	Raleigh West	54.8	Neuse River	03020201	2	1984	1	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
181	02087254	Crabtree Creek below Reedy Creek near Raleigh	35°50'27"	78°44'34"	Wake	Raleigh West	59.4	Neuse River	03020201	2	1930, 1958, 1962, 1968	4	0
182	02087256	Sycamore Creek near Lynn Crossroads	35°54'03"	78°45'56"	Wake	Southeast Durham	2.39	Crabtree Creek	03020201	2	1968, 1974-75	8	2
183	0208725625	Sycamore Creek tributary at SR 1837 at Leesville	35°54'10"	78°44'50"	Wake	Bayleaf	1.31	Sycamore Creek	03020201	2	1974-75	4	0
184	0208725650	Sycamore Creek tributary at U.S. 70 near Leesville	35°53'53"	78°45'42"	Wake	Southeast Durham	2.16	Sycamore Creek	03020201	2	1974-75	4	0
185	02087258	Sycamore Creek near Cary	35°51'13"	78°44'51"	Wake	Raleigh West	10.0	Crabtree Creek	03020201	2	1962, 1968	2	0
186	02087259	Sycamore Creek near Asbury	35°50'51"	78°43'35"	Wake	Raleigh West	11.4	Crabtree Creek	03020201	2	1961-62, 1968	3	1
187	02087260	Turkey Creek near Leesville	35°50'51"	78°43'29"	Wake	Raleigh West	4.57	Sycamore Creek	03020201	2	1961-62, 1968	3	0
188	0208726005	Crabtree Creek at SR 1649 near Raleigh	35°50'43"	78°43'29"	Wake	Raleigh West	76[a]	Neuse River	03020201	1	Dec. 1987 - Feb. 1993	N/A	N/A
189	02087264	Richlands Creek near Asbury	35°50'02"	78°43'14"	Wake	Raleigh West	6.36	Crabtree Creek	03020201	2	1961-62, 1968	3	0
190	02087266	Crabtree Creek near Asbury	35°50'42"	78°43'08"	Wake	Raleigh West	83.3	Neuse River	03020201	2	1962, 1968	2	0
191	0208726620	Crabtree Creek at SR 1664 near Raleigh	35°50'41"	78°42'43"	Wake	Raleigh West	84[a]	Neuse River	03020201	2	1973	4	0
192	0208726825	Hare Snipe Creek near Leesville	35°53'28"	78°42'04"	Wake	Bayleaf	1.44	Crabtree Creek	03020201	2	1974-75	4	0
193	0208726850	Hare Snipe Creek 2.3 miles above mouth near Leesville	35°52'45"	78°41'55"	Wake	Bayleaf	3.8[a]	Crabtree Creek	03020201	2	1974-75	5	0
194	0208726875	Hare Snipe Creek near Six Forks	35°52'25"	78°41'55"	Wake	Raleigh West	3.84	Crabtree Creek	03020201	2	1974-75	5	0
195	02087270	Hare Snipe Creek near Millbrook	35°50'43"	78°41'19"	Wake	Raleigh West	7.22	Crabtree Creek	03020201	2	1961-68, 1970	17	0

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												Flow	Zero flow
196	02087273	House Creek near Raleigh	35°49'23"	78°41'06"	Wake	Raleigh West	2.20	Crabtree Creek	03020201	2	1963	1	0
197	02087274	House Creek near Method	35°50'06"	78°40'30"	Wake	Raleigh West	2.89	Crabtree Creek	03020201	2	1961-62, 1968	3	0
198	0208727450	Crabtree Creek at SR 1670 near Raleigh	35°50'11"	78°40'31"	Wake	Raleigh West	97[a]	Neuse River	03020201	2	1973	1	0
199	02087275	Crabtree Creek at U.S. Hwy 70 at Raleigh	35°50'15"	78°40'26"	Wake	Raleigh West	97.6	Neuse River	03020201	2	1932, 1942, 1947, 1949-50, 1952-56, 1958, 1960-63, 1968, 1973, 1978, 1997	44	0
200	02087290	Mine Creek near Millbrook	35°51'19"	78°39'43"	Wake	Raleigh West	8.87	Crabtree Creek	03020201	2	1951-55, 1958, 1961-62, 1968	17	0
201	02087296	Crabtree Creek at Lassiters Mill at Raleigh	35°49'41"	78°39'03"	Wake	Raleigh West	110	Neuse River	03020201	2	1961-62	2	0
202	0208729610	Crabtree Creek at Lassiter Mill Road near Raleigh	35°49'41"	78°39'03"	Wake	Raleigh West	110[a]	Neuse River	03020201	2	1973, 1997	6	0
203	02087304	Southwest Prong Beaverdam Creek at Raleigh	35°48'56"	78°39'41"	Wake	Raleigh West	1.86	Beaverdam Creek	03020201	2	1963	1	0
204	02087307	Southeast Prong Beaverdam Creek at Raleigh	35°48'56"	78°39'41"	Wake	Raleigh West	1.18	Beaverdam Creek	03020201	2	1963	1	0
205	02087308	Beaverdam Creek at Raleigh	35°49'28"	78°39'00"	Wake	Raleigh West	3.63	Crabtree Creek	03020201	2	1961-62	2	0
206	0208731190	Crabtree Creek at Anderson Drive at Raleigh	35°49'16"	78°37'34"	Wake	Raleigh West	111	Neuse River	03020201	2	1997	1	0
207	02087318	Big Branch at Millbrook	35°51'04"	78°37'22"	Wake	Raleigh East	1.13	Crabtree Creek	03020201	2	1951, 1968	2	0
208	02087319	Big Branch near Raleigh	35°49'59"	78°37'36"	Wake	Raleigh West	2.19	Crabtree Creek	03020201	2	1967	1	0
209	02087320	Big Branch near Millbrook	35°49'17"	78°37'46"	Wake	Raleigh West	3.78	Crabtree Creek	03020201	2	1951-55, 1958, 1961-62, 1968	17	0

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210	02087322	Crabtree Creek at SR 2030 near Raleigh	35°48'57"	78°37'33"	Wake	Raleigh West	119	Neuse River	03020201	1	Feb. 1988 - Sept. 1989	N/A	N/A
										2	1961-62, 1973, 1997	7	0
211	02087323	Crabtree Creek at Old Farmers Market at Raleigh	35°48'47"	78°37'05"	Wake	Raleigh East	120	Neuse River	03020201	2	1984-89	30	0
212	02087324	Crabtree Creek at U.S. 1 at Raleigh	35°48'40"	78°36'43"	Wake	Raleigh East	121	Neuse River	03020201	1	July 1990 - Sept. 1996	N/A	N/A
										2	1973-75	7	0
213	0208732544	Pigeon House Branch at Raleigh	35°47'37"	78°38'35"	Wake	Raleigh West	0.59	Crabtree Creek	03020201	2	1984-92, 1994-96	48	0
214	02087326	Pigeon House Branch at U.S. Hwy 1 at Raleigh	35°48'17"	78°37'03"	Wake	Raleigh East	4.25	Crabtree Creek	03020201	2	1961-62	2	0
215	02087327	Marsh Creek tributary No. 1 near Raleigh	35°49'36"	78°34'48"	Wake	Raleigh East	0.39	Marsh Creek	03020201	2	1967	1	0
216	0208732810	Marsh Creek at SR 2030 at Millbrook	35°51'13"	78°36'12"	Wake	Raleigh East	1.44	Crabtree Creek	03020201	1	Mar. 1986 - Sept. 1989	N/A	N/A
217	0208732850	Marsh Creek tributary at New Hope	35°50'42"	78°35'05"	Wake	Raleigh East	0.2[a]	Marsh Creek	03020201	2	1972	1	1
218	0208732855	Marsh Creek tributary near Millbrook	35°50'10"	78°35'20"	Wake	Raleigh East	0.5[a]	Marsh Creek	03020201	2	1972-73	2	0
219	0208732880	Marsh Creek tributary no. 2 near Wilders Grove	35°49'23"	78°35'09"	Wake	Raleigh East	0.6[a]	Marsh Creek	03020201	2	1972, 1975	6	0
220	0208732885	Marsh Creek near New Hope	35°48'59"	78°35'37"	Wake	Raleigh East	6.84	Crabtree Creek	03020201	1	Jan. 1984 - Sept. 1996	N/A	N/A
221	02087329	Marsh Creek near Raleigh	35°48'17"	78°35'29"	Wake	Raleigh East	8.41	Crabtree Creek	03020201	2	1961-62	2	0
222	02087331	Crabtree Creek at U.S. 64 near Raleigh	35°47'28"	78°35'12"	Wake	Raleigh East	138	Neuse River	03020201	2	1961-62, 1973, 1997	7	0
223	02087334	Crabtree Creek at mouth near Knightdale	35°45'56"	78°32'24"	Wake	Raleigh East	146	Neuse River	03020201	2	1961-62, 1997	4	0

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224	02087337	Walnut Creek at Buck Jones Road near Raleigh	35°46'22"	78°44'15"	Wake	Raleigh West	3.36	Neuse River	03020201	2	1963, 1973	7	0
225	02087338	Walnut Creek above Lake Johnson near Raleigh	35°46'09"	78°43'25"	Wake	Raleigh West	5.25	Neuse River	03020201	2	1930, 1932, 1952	3	0
226	02087341	Simmons Branch near Raleigh	35°46'00"	78°42'02"	Wake	Raleigh West	1.16	Walnut Creek	03020201	2	1953	1	0
227	02087343	Bushy Branch near Raleigh	35°46'10"	78°41'23"	Wake	Raleigh West	1.89	Walnut Creek	03020201	2	1953	1	0
228	0208734550	Walnut Creek at SR 1009 near Raleigh	35°45'30"	78°39'51"	Wake	Raleigh West	14.4	Neuse River	03020201	2	1972-73	6	0
229	02087349	Rocky Branch at Dan Allen Drive at Raleigh	35°46'55"	78°40'20"	Wake	Raleigh West	0.56	Walnut Creek	03020201	2	1966-67	2	0
230	02087350	Rocky Branch at Carmichael Gymnasium at Raleigh	35°46'50"	78°40'09"	Wake	Raleigh West	0.78	Walnut Creek	03020201	2	1966-67	2	0
231	02087351	Rocky Branch at Raleigh	35°45'30"	78°38'25"	Wake	Raleigh West	2.97	Walnut Creek	03020201	2	1953	1	0
232	02087354	Wildcat Branch at Raleigh	35°45'20"	78°38'10"	Wake	Raleigh West	1.94	Walnut Creek	03020201	2	1953	2	0
233	02087355	Walnut Creek at Rock Quarry Road at Raleigh	35°45'44"	78°36'52"	Wake	Raleigh East	24.7	Neuse River	03020201	2	1963, 1973-74	7	0
234	02087356	Walnut Creek tributary near Raleigh	35°46'05"	78°36'10"	Wake	Raleigh East	0.26	Walnut Creek	03020201	2	1967	1	0
235	02087357	Walnut Creek tributary 2 near Raleigh	35°44'57"	78°36'46"	Wake	Garner	0.76	Walnut Creek	03020201	2	1967	1	0
236	02087359	Walnut Creek at Sunnybrook Road at Raleigh	35°45'30"	78°35'00"	Wake	Raleigh East	29.4	Neuse River	03020201	1	May 1996 - Sept. 1996	N/A	N/A
										2	1973-75	6	0
237	02087367	Big Branch near Auburn	35°42'38"	78°33'53"	Wake	Garner	2.20	Walnut Creek	03020201	2	1967, 1974-75	5	0
238	02087368	Big Branch tributary near Garner	35°43'28"	78°34'24"	Wake	Garner	1.08	Big Branch	03020201	2	1945, 1955, 1974-75	7	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
239	02087369	Little Arm Branch near Garner	35°43'40"	78°36'02"	Wake	Garner	2.26	Big Branch	03020201	2	1967	1	0
240	02087370	Big Branch near Garner	35°44'28"	78°34'06"	Wake	Garner	11.8	Walnut Creek	03020201	2	1953-58, 1960, 1970, 1972-73, 1976, 1979-80	30	0
241	02087376	Walnut Creek above mouth near Raleigh	35°45'00"	78°32'05"	Wake	Garner	46.0	Neuse River	03020201	2	1973, 1997	6	0
242	02087386	Neuse River tributary No. 5 near Knightdale	35°45'15"	78°30'31"	Wake	Raleigh East	2.29	Neuse River	03020201	2	1954, 1972-74	6	0
243	02087396	Neuse River near Knightdale	35°43'36"	78°30'51"	Wake	Garner	1,081	Atlantic Ocean	03020201	2	1955, 1968, 1972-74	6	0
244	02087408	Poplar Creek near Wendell	35°44'55"	78°27'58"	Wake	Clayton	5.40	Neuse River	03020201	2	1967	1	0
245	02087410	Poplar Creek near Knightdale	35°43'51"	78°28'40"	Wake	Clayton	8.83	Neuse River	03020201	2	1954-58, 1960, 1963, 1970	14	0
246	02087416	Neuse River at County Line near Knightdale	35°42'08"	78°28'43"	Wake	Clayton	1,097	Neuse River	03020201	2	1973	1	0
247	02087499	Neuse River tributary above SR 1705 near Clayton	35°39'05"	78°24'11"	Johnston	Clayton	1.3[a]	Neuse River	03020201	2	1979	1	0
248	02087500	Neuse River near Clayton	35°38'50"	78°24'21"	Johnston	Clayton	1,150	Atlantic Ocean	03020201	1	July 1927 - Sept. 1996	N/A	N/A
249	0208753180	Mill Creek at SR 1929 at Selma	35°32'41"	78°17'45"	Johnston	Selma	3.6[a]	Neuse River	03020201	2	1973-74	5	1
250	02087532	Mill Creek at Selma	35°32'35"	78°18'02"	Johnston	Selma	4.05	Neuse River	03020201	2	1955, 1972-74	7	3
251	02087533	Mill Creek near Selma	35°32'41"	78°18'38"	Johnston	Selma	4.36	Neuse River	03020201	2	1972-73	3	0
252	0208754505	Little Poplar Creek at SR 1900 near Powhatan	35°35'27"	78°23'45"	Johnston	Powhatan	1.76	Poplar Branch	03020201	2	1986	1	1
253	02087552	Poplar Branch near Smithfield	35°32'18"	78°21'02"	Johnston	Selma	11.1	Neuse River	03020201	2	1954	1	0

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254	02087570	Neuse River at Smithfield	35°30'46"	78°21'00"	Johnston	Selma	1,206	Atlantic Ocean	03020201	1	Oct. 1959 - Sept. 1991 (medium/high flows only prior to Oct. 1970)	N/A	N/A
										2	1925, 1955, 1968	3	0
255	02087578	Williams Creek at dam near Apex	35°44'48"	78°49'04"	Wake	Apex	2.22	Swift Creek	03020201	2	1963	1	0
256	02087580	Swift Creek near Apex	35°43'07"	78°45'09"	Wake	Apex	21.0	Neuse River	03020201	2	1958, 1961-71[b], 1992-95, 1997	58	0
257	02087584	Swift Creek near Macedonia	35°42'00"	78°43'00"	Wake	Lake Wheeler	26.9	Neuse River	03020201	2	1954	1	0
258	0208758450	Dutchmans Branch near McCullers Crossroads	35°41'28"	78°43'30"	Wake	Lake Wheeler	5.23	Swift Creek	03020201	2	1987-92	16	0
259	02087588	Swift Creek at Lake Wheeler Dam near Raleigh	35°41'39"	78°41'39"	Wake	Lake Wheeler	35.8	Neuse River	03020201	2	1973-74	3	0
260	0208758850	Swift Creek near McCullers Crossroads	35°41'33"	78°41'34"	Wake	Lake Wheeler	35.8	Neuse River	03020201	1	Dec. 1987 - Sept. 1996	N/A	N/A
261	02087590	Swift Creek above McCullers	35°41'15"	78°40'52"	Wake	Lake Wheeler	38.0	Neuse River	03020201	2	1930, 1949-50, 1954-55	8	0
262	02087610	Swift Creek near McCullers	35°40'55"	78°39'12"	Wake	Lake Wheeler	41.8[d]	Neuse River	03020201	2	1932, 1949-53	16	0
263	02087641	Reedy Branch near Raleigh	35°40'04"	78°36'44"	Wake	Lake Wheeler	5.21	Swift Creek	03020201	2	1953	1	0
264	02087671	Swift Creek tributary near Raleigh	35°40'04"	78°36'44"	Wake	Garner	2.04	Swift Creek	03020201	2	1932, 1953	2	0
265	0208770150	Swift Creek at NC 50 near Garner	35°39'39"	78°36'37"	Wake	Garner	66.3	Neuse River	03020201	2	1997	2	0
266	0208772185	Swift Creek near Drug Store	35°36'47"	78°32'57"	Johnston	Edmondson	86.6	Neuse River	03020201	2	1984-97	40	1
267	02087731	White Oak Creek near Clayton	35°37'04"	78°31'42"	Johnston	Edmondson	13.5	Swift Creek	03020201	2	1958, 1986	2	1
268	02087761	Little Creek above Clayton	35°39'18"	78°28'52"	Johnston	Clayton	3.84	Swift Creek	03020201	2	1954-55, 1958, 1971, 1986	9	1
269	02087771	Little Creek at Clayton	35°38'39"	78°27'55"	Johnston	Clayton	5.52	Swift Creek	03020201	2	1972-74	5	0

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270	02087791	Little Creek below Clayton	35°36'53"	78°27'37"	Johnston	Powhatan	9.67	Swift Creek	03020201	2	1972-75	7	0
271	02087821	Little Creek near Wilson Mills	35°34'30"	78°26'37"	Johnston	Polkton	17.3	Swift Creek	03020201	2	1953, 1958	2	0
272	0208783865	Reedy Branch at U.S. 70A near Powhatan	35°35'31"	78°24'23"	Johnston	Powhatan	1.10	Swift Creek	03020201	2	1986	1	1
273	02087851	Swift Creek at NC 210 near Smithfield	35°31'07"	78°22'54"	Johnston	Powhatan	155	Neuse River	03020201	2	1997	2	0
274	02087885	Middle Creek at Durham and Southern Railway near Apex	35°42'24"	78°49'48"	Wake	Apex	0.70	Swift Creek	03020201	2	1973-76, 1979-80	13	1
275	02087904	Middle Creek near Apex	35°40'46"	78°49'28"	Wake	Apex	5.58	Swift Creek	03020201	2	1972-74	6	0
276	02087910	Middle Creek near Holly Springs	35°39'40"	78°48'17"	Wake	Apex	8.62	Swift Creek	03020201	2	1961-71, 1973-75	16	0
277	0208791055	Basal Creek downstream from Bass Lake near Fuquay-Varina	35°38'32"	78°48'09"	Wake	Apex	8.85	Middle Creek	03020201	2	1973-74	5	1
278	0208792250	Middle Creek at SR 1301 near Holly Springs	35°39'08"	78°47'18"	Wake	Apex	20.4	Swift Creek	03020201	2	1973-74	4	0
279	02087946	Middle Creek near Banks	35°38'32"	78°44'33"	Wake	Lake Wheeler	33.2	Swift Creek	03020201	2	1958	1	0
280	0208795190	Mills Branch at SR 1390 at McCullers	35°39'21"	78°42'37"	Wake	Lake Wheeler	0.93	Middle Creek	03020201	2	1973-74	4	0
281	02087952	Mills Branch at Banks	35°38'38"	78°42'36"	Wake	Lake Wheeler	1.33	Middle Creek	03020201	2	1973-74	5	0
282	0208791017	Basal Creek at NC Highway 55 near Fuquay-Varina	35°37'12"	78°48'48"	Wake	Fuquay-Varina	4.2[a]	Middle Creek	03020201	2	1973-74	4	0
283	0208796545	Terrible Creek at SR 1404 at Five Points	35°36'46"	78°45'24"	Wake	Fuquay-Varina	4.92	Middle Creek	03020201	2	1973-75	9	1
284	02088000	Middle Creek near Clayton	35°34'10"	78°35'30"	Johnston	Edmondson	83.5	Swift Creek	03020201	1	Oct. 1939 - Sept. 1996	N/A	N/A
285	02088030	Middle Creek near Smithfield	35°30'27"	78°24'07"	Johnston	Powhatan	129.4	Swift Creek	03020201	2	1949-56, 1958, 1974, 1976, 1978, 1980-83	48	0
286	0208807310	Black Creek near Willow Springs	35°34'12"	78°43'53"	Wake	Angier	3.87	Neuse River	03020201	2	1973-74, 1978, 1980	9	2

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287	02088076	Black Creek near Macks	35°28'00"	78°33'00"	Johnston	Benson	64.1	Neuse River	03020201	2	1958	1	0
288	02088090	Black Creek near Four Oaks	35°28'09"	78°27'26"	Johnston	Four Oaks	81.9	Neuse River	03020201	2	1949-55, 1958-59, 1974-75	19	1
289	0208810395	Black Creek at U.S. Highway 301 near Four Oaks	35°28'02"	78°23'27"	Johnston	Four Oaks	99.0	Neuse River	03020201	2	1974	1	0
290	02088116	Bawdy Creek near Princeton	35°24'21"	78°12'59"	Johnston	Princeton	22.3	Neuse River	03020201	2	1954	1	1
291	02088119	Neuse River near Cox Mill	35°22'27"	78°11'47"	Johnston	Grantham	1677	Atlantic Ocean	03020201	2	1956, 1968, 1976, 1978, 1980	7	0
292	02088131	Raccoon Swamp near Princeton	35°22'00"	78°10'00"	Johnston	Grantham	2.46	Neuse River	03020201	2	1954, 1958	2	2
293	0208813560	Mill Creek at SR 1124 near Parkers Mill	35°17'14"	78°25'52"	Johnston	Four Oaks	20.1	Neuse River	03020201	2	1974-75	7	0
294	02088136	Mill Creek at Overshot	35°18'51"	78°21'10"	Johnston	Four Oaks	46.7	Neuse River	03020201	2	1958	1	0
295	02088140	Stone Creek near Newton Grove	35°20'25"	78°21'54"	Johnston	Four Oaks	27.8	Mill Creek	03020201	2	1955, 1961-71	14	0
296	02088210	Hannah Creek near Benson	35°24'13"	78°31'02"	Johnston	Benson	2.68	Mill Creek	03020201	2	1954, 1961-71	13	1
297	02088216	Driving Branch near Benson	35°23'12"	78°30'55"	Johnston	Benson	1.73	Hannah Creek	03020201	2	1972-74	6	2
298	02088217	Hannah Creek near Alaska	35°23'50"	78°30'00"	Johnston	Benson	12.2	Mill Creek	03020201	2	1973-75	7	2
299	02088218	Hannah Creek below Benson	35°24'00"	78°30'00"	Johnston	Four Oaks	12.7	Mill Creek	03020201	2	1955	4	2
300	02088221	Stony Fork near Four Oaks	35°25'08"	78°29'20"	Johnston	Four Oaks	7.98	Hannah Creek	03020201	2	1958	1	0
301	02088240	Hannah Creek near Blackman	35°23'50"	78°26'00"	Johnston	Four Oaks	34.7	Mill Creek	03020201	2	1957-65	14	3
302	02088248	Juniper Swamp near Four Oaks	35°25'12"	78°24'40"	Johnston	Four Oaks	4.17	Hannah Creek	03020201	2	1958	1	1
303	02088251	Juniper Swamp tributary near Four Oaks	35°25'35"	78°24'20"	Johnston	Four Oaks	1.40	Juniper Swamp	03020201	2	1958	1	1

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304	02088256	Hannah Creek near Four Oaks	35°24'10"	78°21'50"	Johnston	Four Oaks	62	Mill Creek	03020201	2	1956	1	0
305	02088266	Hannah Creek near Bentonville	35°22'10"	78°18'20"	Johnston	Four Oaks	68.3	Mill Creek	03020201	2	1955	1	1
306	02088270	Mill Creek at Cox Mill	35°20'31"	78°12'51"	Johnston	Grantham	174	Neuse River	03020201	2	1974, 1976, 1978-84	34	0
307	02088275	Mill Creek near Cox Mill	35°20'42"	78°11'04"	Johnston	Grantham	185	Neuse River	03020201	2	1954, 1958, 1965-68, 1971, 1997	10	0
308	02088129	Moccasin Swamp near Princeton	35°23'26"	78°09'40"	Johnston	Princeton	27.2	Neuse River	03020201	2	1958	1	1
309	02088288	Thoroughfare Swamp near Dudley	35°15'13"	78°06'52"	Wayne	Southwest Goldsboro	33.0	Neuse River	03020201	2	1954, 1958	2	2
310	02088310	Buck Swamp near Dudley	35°15'41"	78°05'20"	Wayne	Southwest Goldsboro	15.5	Thorough-fare Swamp	03020201	2	1949-59	22	1
311	02088315	Beaverdam Creek near Grantham	35°17'08"	78°15'17"	Wayne	Newton Grove North	5.01	Thorough-fare Swamp	03020201	1	Apr. 1978 - Dec. 1982	N/A	N/A
312	0208831520	Falling Creek near Dobbersville	35°15'57"	78°16'57"	Wayne	Newton Grove North	3.8[a]	Beaverdam Creek	03020201	2	1972-74	8	2
313	02088319	Beaverdam Creek at Grantham	35°17'33"	78°07'13"	Wayne	Southwest Goldsboro	37.2	Thorough-fare Swamp	03020201	2	1958	1	1
314	0208832825	Thoroughfare Swamp at mouth at Stevens Mill	35°21'19"	78°08'01"	Wayne	Grantham	119	Neuse River	03020201	2	1997	1	0
315	02088332	Neuse River near Stevens Mill	35°21'00"	78°08'00"	Wayne	Grantham	2,024	Atlantic Ocean	03020201	2	1963-64, 1974, 1976, 1978, 1980-84, 1997	41	0
316	02088337	Beaverdam Creek near Princeton	35°26'46"	78°08'18"	Wayne	Princeton	2.24	Neuse River	03020201	2	1972-73	5	0
317	02088346	Beaverdam Creek near Rosewood	35°23'09"	78°05'39"	Wayne	Northwest Goldsboro	15.3	Neuse River	03020201	2	1954, 1958	2	1
318	02088364	Neuse River near Rosewood	35°21'38"	78°04'41"	Wayne	Southwest Goldsboro	2,050	Atlantic Ocean	03020201	2	1956, 1972-73	5	0

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319	02088378	Little River near Youngsville	35°59'00"	78°26'00"	Franklin	Rolesville	3.84	Neuse River	03020201	2	1966	1	0
320	0208837825	Little River at U.S. 401 near Harris Crossroads	35°57'38"	78°24'24"	Franklin	Rolesville	8.33	Neuse River	03020201	2	1974-76, 1979	6	0
321	02088380	Cedar Fork near Rolesville	35°55'00"	78°23'27"	Wake	Rolesville	4.41	Neuse River	03020201	2	1960-64, 1966, 1968	15	0
322	02088383	Little River at Zebulon water supply near Zebulon	35°49'19"	78°21'10"	Wake	Zebulon	55.0	Neuse River	03020201	2	1974-75	4	0
323	02088401	Little River at Hocutts Crossroads	35°44'00"	78°17'00"	Johnston	Flowers	82.4	Neuse River	03020201	2	1958	1	0
324	02088415	Little River at NC Highway 42 at Hares Crossroads	35°40'00"	78°15'32"	Johnston	Flowers	104	Neuse River	03020201	2	1969-72	11	0
325	02088420	Long Branch near Selma	35°38'11"	78°15'06"	Johnston	Flowers	7.07	Little River	03020201	2	1955-58, 1961-71	20	0
326	02088434	Buffalo Creek at Poole Road near Wendell	35°46'31"	78°23'03"	Wake	Knightdale	15.8	Little River	03020201	2	1955, 1958, 1972-74	9	1
327	02088441	Buffalo Creek above Lake Wendell near Wendell	35°45'01"	78°21'37"	Johnston	Zebulon	20.5	Little River	03020201	2	1955, 1972-73	5	0
328	02088457	Buffalo Creek near Jordan	35°39'49"	78°20'18"	Johnston	Flowers	37.6	Little River	03020201	2	1958	1	0
329	02088465	Buffalo Creek near Bagley	35°35'18"	78°12'43"	Johnston	Kenly West	58.5	Little River	03020201	2	1954, 1958, 1965-68, 1971	9	1
330	02088470	Little River near Kenly	35°35'20"	78°11'18"	Johnston	Kenly West	191	Neuse River	03020201	1	July 1964 - Sept. 1989	N/A	N/A
331	02088480	Little Buffalo Creek near Kenly	35°37'18"	78°09'40"	Johnston	Kenly West	9.34	Little River	03020201	2	1965-68, 1971	7	4
332	02088482	Little Buffalo Creek near Beulahtown	35°36'28"	78°09'44"	Johnston	Kenly West	19.6	Little River	03020201	2	1964	1	1
333	02088484	Little River at Bagley	35°34'58"	78°09'33"	Johnston	Kenly West	216	Neuse River	03020201	2	1974	3	0
334	02088487	Little River at I-95 near Lowell Mill	35°34'11"	78°09'45"	Johnston	Kenly West	222	Neuse River	03020201	2	1974	3	0
335	02088500	Little River near Princeton	35°30'40"	78°09'38"	Johnston	Kenly West	232	Neuse River	03020201	1	Feb. 1930 - Sept. 1996	N/A	N/A
336	02088542	Spring Branch at Rains Crossroads	35°30'36"	78°08'31"	Johnston	Kenly West	10.3	Little River	03020201	2	1958	1	1

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337	0208854250	Little River at SR 1002 near Princeton	35°28'56"	78°08'37"	Johnston	Princeton	260[a]	Neuse River	03020201	2	1973-74	3	0
338	0208858110	Little River at NC 581 near Asylum	35°26'46"	78°02'36"	Wayne	Northwest Goldsboro	284	Neuse River	03020201	2	1974, 1976, 1978	6	0
339	02088584	Little River tributary near Pikeville	35°27'06"	78°01'39"	Wayne	Northwest Goldsboro	8.99	Neuse River	03020201	2	1958	1	0
340	02088632	Little River at NC 581 at Asylum	35°23'55"	78°01'35"	Wayne	Northwest Goldsboro	314	Neuse River	03020201	2	1980-81, 1997	3	0
341	02088682	Big Ditch at Retha Street at Goldsboro	35°22'16"	78°00'15"	Wayne	Southwest Goldsboro	2.17	Howell Branch	03020202	1	Feb. 1980 - Sept. 1984	N/A	N/A
342	02088949	Neuse River tributary No. 3 at Genoa	35°20'00"	78°01'00"	Wayne	Southwest Goldsboro	4.67	Neuse River	03020202	2	1954-55, 1957	3	0
343	02088969	Carroway Creek at SR 1918 near Genoa	35°19'14"	78°00'24"	Wayne	Southwest Goldsboro	4.98	Neuse River	03020202	2	1955	1	0
344	02089000	Neuse River near Goldsboro	35°20'14"	77°59'51"	Wayne	Goldsboro	2,399	Atlantic Ocean	03020202	1	Feb. 1930 - Sept. 1996	N/A	N/A
345	02089020	Stoney Creek at Goldsboro	35°22'32"	77°57'01"	Wayne	Goldsboro	21.6	Neuse River	03020202	2	1949-55, 1957-58	21	0
346	02089034	Stoney Creek near Goldsboro	35°20'54"	77°58'57"	Wayne	Goldsboro	25.4	Neuse River	03020202	2	1955	1	0
347	02089091	Sleepy Creek near Dudley	35°15'06"	77°57'13"	Wayne	Goldsboro	9.66	Neuse River	03020202	2	1954, 1957	3	0
348	02089116	Neuse River near Whitehall	35°15'40"	77°54'40"	Wayne	Goldsboro	2,471	Atlantic Ocean	03020202	2	1972-73, 1997	10	0
349	02089120	Walnut Creek near Best	35°18'57"	77°53'01"	Wayne	Goldsboro	9.71	Neuse River	03020202	2	1955-63	16	0
350	02089144	Walnut Creek near Seven Springs	35°16'54"	77°52'08"	Wayne	La Grange	18.9	Neuse River	03020202	2	1954-55	2	0
351	02089216	Daileys Creek near Liddell	35°12'30"	77°48'32"	Lenoir	Seven Springs	3.80	Hardy Mill Run	03020202	1	Apr. 1978 - Sept. 1981	N/A	N/A
352	02089222	Bear Creek near Parkstown	35°22'22"	77°48'10"	Greene	Goldsboro	4.27	Neuse River	03020202	1	Mar. 1978 - Dec. 1982	N/A	N/A
353	02089228	West Bear Creek at New Hope	35°22'48"	77°52'13"	Wayne	Goldsboro	13.2	Bear Creek	03020202	2	1957	1	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

[mi[2], square mile; SR, secondary road; N/A, not applicable; SEO, sewage effluent outfall. Sites shaded in gray indicate those sites for which low-flow characteristics have been developed. Period of record for continuous-record sites (site type 1) is shown in months and years; period of record for partial-record sites (site type 2) is shown in water years in which discharge measurements were made]

Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi²)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
354	02089240	Bear Creek near La Grange	35°18'51"	77°48'56"	Lenoir	Goldsboro	49.2	Neuse River	03020202	2	1954-66, 1968, 1970	23	0
355	02089252	Bear Creek at Mays Store	35°16'28"	77°47'40"	Lenoir	La Grange	57.7	Neuse River	03020202	1	Oct. 1987 - Sept. 1996	N/A	N/A
356	02089263	Bear Creek near Mays Store	35°14'56"	77°47'05"	Lenoir	Seven Springs	60.0	Neuse River	03020201	2	1954, 1957	2	0
357	02089287	Moseley Creek above SEO near La Grange	35°19'04"	77°46'35"	Lenoir	La Grange	1.90	Falling Creek	03020202	2	1973-74	5	1
358	0208931510	Moseley Creek at SR 1518 near La Grange	35°18'33"	77°45'15"	Lenoir	Goldsboro	9.13	Falling Creek	03020202	2	1973-74	4	0
359	02089356	Gum Swamp near Falling Creek	35°18'00"	77°41'50"	Lenoir	Kinston	6.1[a]	Falling Creek	03020201	2	1957	1	0
360	02089380	Falling Creek at Falling Creek	35°15'40"	77°41'30"	Lenoir	Kinston	45.4	Neuse River	03020201	2	1949-55, 1957, 1997	20	0
361	02089500	Neuse River at Kinston	35°15'29"	77°35'09"	Lenoir	Kinston	2,692	Atlantic Ocean	03020202	1	Feb. 1930 - Sept. 1996	N/A	N/A
362	02089580	Deep Run at Deep Run	35°08'27"	77°41'35"	Lenoir	Deep Run	6.1	Southwest Creek	03020202	2	1949-54, 1956-57, 1966	18	0
363	02089620	Southwest Creek near Woodington	35°11'25"	77°37'20"	Lenoir	Rivermont	37.7	Neuse River	03020202	2	1956-57, 1959-66	16	1
364	02089628	Southwest Creek near Kinston	35°13'16"	77°34'30"	Lenoir	Deep Run	49.5	Neuse River	03020201	2	1954-55, 1957, 1997	4	2
365	02089683	Briery Run near Kinston	35°18'20"	77°36'50"	Lenoir	Kinston	4.0[a]	Stonyton Creek	03020201	2	1955, 1957	2	2
366	02089688	Stonyton Creek near Harveytown	35°18'30"	77°31'30"	Lenoir	Kinston	30[a]	Neuse River	03020202	2	1972-74	5	1
367	0208968950	Jericho Run tributary at Harveytown	35°17'02"	77°33'20"	Lenoir	Kinston	0.4[a]	Jericho Run	03020202	2	1972-74	5	0
368	02089690	Stonyton Creek near Graingers	35°19'05"	77°29'44"	Lenoir	Kinston	36[a]	Neuse River	03020202	2	1954, 1956-57, 1965-68, 1970-71	14	1
369	02089730	Mosley Creek near Grifton	35°19'51"	77°25'39"	Lenoir	Grifton	45.7	Neuse River	03020202	2	1954-55, 1957, 1964-68, 1971	10	1
370	02089944	Moccasin Creek near Pearce Crossroads	35°53'47"	78°18'39"	Franklin	Bunn West	8.03	Contentnea Creek	03020203	2	1969	1	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites	
												Flow	Zero flow
371	02089945	Moccasin Creek near Pilot	35°52'16"	78°16'56"	Franklin	Zebulon	14[a]	Contentnea Creek	03020203	2	1958, 1966	2	0
372	02089946	Moccasin Creek near Zebulon	35°48'48"	78°15'27"	Nash	Zebulon	29.8	Contentnea Creek	03020203	2	1950-54, 1957-58, 1963, 1966	20	1
373	0208995250	Little Creek at Zebulon	35°49'00"	78°18'07"	Wake	Zebulon	1[a]	Moccasin Creek	03020203	2	1972, 1974-75	6	1
374	02090000	Little Creek near Zebulon	35°48'45"	78°16'07"	Wake	Zebulon	5.00	Moccasin Creek	03020203	2	1958, 1972, 1974-75	8	0
375	0209009050	Moccasin Creek near Middlesex	35°45'16"	78°13'16"	Nash	Middlesex	48.7	Contentnea Creek	03020203	2	1972-74	4	0
376	02090144	Moccasin Creek near Connor	35°43'48"	78°11'23"	Wilson	Stancils Chapel	60.6	Contentnea Creek	03020203	2	1958	1	0
377	02090214	Turkey Creek near Bailey	35°46'26"	78°09'46"	Nash	Middlesex	50.9	Moccasin Creek	03020203	2	1958	1	0
378	0209024850	Bailey Branch at Bailey	35°47'15"	78°07'11"	Nash	Bailey	1.6[a]	Camp Branch	03020203	2	1972-74	5	1
379	02090249	Camp Branch near Bailey	35°46'52"	78°07'48"	Nash	Middlesex	4.29	Haw Branch	03020203	2	1955	1	0
380	02090284	Haw Branch near Bailey	35°46'30"	78°08'41"	Nash	Middlesex	7.84	Turkey Creek	03020203	2	1955, 1972-73	5	0
381	0209032250	Cattail Branch at Middlesex	35°47'07"	78°12'28"	Nash	Middlesex	0.3[a]	Beaverdam Creek	03020203	2	1972-75	6	3
382	02090323	Cattail Branch at Middlesex	35°46'50"	78°12'20"	Nash	Middlesex	0.61	Beaverdam Creek	03020203	2	1972-74	4	0
383	0209035950	Turkey Creek near Connor	35°44'22"	78°09'43"	Wilson	Stancils Chapel	73[a]	Contentnea Creek	03020203	2	1972-73	5	1
384	02090360	Turkey Creek near Connor	35°43'41"	78°10'22"	Wilson	Stancils Chapel	74.2	Contentnea Creek	03020203	2	1958, 1965-68, 1971	8	0
385	0209036050	Contentnea Creek at SR 1126 near Wilkerson Crossroads	35°41'55"	78°08'08"	Wilson	Stancils Chapel	140[a]	Neuse River	03020203	2	1974-76	5	0

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
386	02090380	Contentnea Creek near Lucama	35°41'29"	78°06'38"	Wilson	Lucama	161	Neuse River	03020203	1	Sept. 1964 - Sept. 1996	N/A	N/A
387	02090390	Contentnea Creek near Kenly	35°41'10"	78°05'45"	Wilson	Lucama	169	Neuse River	03020203	2	1957-59, 1961-64	13	0
388	02090412	Marsh Swamp at Rock Ridge	35°42'10"	78°03'50"	Wilson	Lucama	9.6[a]	Contentnea Creek	03020203	2	1954, 1958	2	1
389	02090422	Little Swamp at Rock Ridge	35°42'07"	78°02'57"	Wilson	Lucama	3.05	Contentnea Creek	03020203	2	1954	1	1
390	02090447	Mill Branch near Scotts	35°42'37"	78°00'06"	Wilson	Lucama	3.66	Contentnea Creek	03020203	2	1954	1	1
391	02090452	Shepard Branch near Scotts	35°42'42"	77°59'46"	Wilson	Wilson	4.40	Contentnea Creek	03020203	2	1954	1	1
392	02090472	Bloomery Swamp near Wilson	35°43'15"	77°58'23"	Wilson	Wilson	23.2	Contentnea Creek	03020203	2	1954, 1958	2	1
393	02090500	Contentnea Creek near Wilson	35°41'15"	77°56'52"	Wilson	Wilson	237	Neuse River	03020203	1	Feb. 1930 - Dec. 1954	N/A	N/A
										2	1997	1	0
394	02090504	Contentnea Creek near Black Creek	35°40'08"	77°54'38"	Wilson	Wilson	243	Neuse River	03020203	2	1969-70	3	0
395	02090507	Hominy Swamp at SR 1321 at Wilson	35°45'02"	77°57'35"	Wilson	Winstead Crossroads	1.5[a]	Contentnea Creek	03020203	2	1969-70, 1972-73	7	1
396	02090509	Hominy Swamp at U.S. 264A at Wilson	35°44'00"	77°55'36"	Wilson	Wilson	5.35	Contentnea Creek	03020203	2	1969-70, 1972-73	9	2
397	02090512	Hominy Swamp at Phillips Street at Wilson	35°42'39"	77°55'00"	Wilson	Wilson	7.92	Contentnea Creek	03020203	1	Aug. 1978 - Sept. 1985	N/A	N/A
398	02090516	Hominy Swamp near Evansdale	35°41'32"	77°54'22"	Wilson	Wilson	9.75	Contentnea Creek	03020203	2	1969-70, 1972-74, 1976	10	0
399	02090519	Contentnea Creek near Evansdale	35°38'34"	77°53'25"	Wilson	Wilson	265	Neuse River	03020203	2	1969-70, 1972-73	5	0
400	0209055995	Black Creek tributary at Lucama	35°38'37"	78°01'20"	Wilson	Lucama	2.5	Black Creek	03020203	2	1972-74, 1976, 1978	7	1

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites	
												Flow	Zero flow
401	02090560	Lee Swamp tributary at Lucama	35°38'22"	78°01'39"	Wilson	Lucama	2.8	Lee Swamp	03020203	2	1954, 1958-59, 1961-71, 1993-95	17	1
402	0209056250	Lee Swamp near Lucama	35°38'03"	78°01'20"	Wilson	Lucama	10[a]	Black Creek	03020203	2	1972-74	5	2
403	02090566	Black Creek near Lucama	35°37'40"	78°00'20"	Wilson	Lucama	20[a]	Contentnea Creek	03020203	2	1956, 1972-74	7	2
404	0209057190	Black Creek tributary at Lucama	35°39'04"	77°59'55"	Wilson	Wilson	2.9[a]	Black Creek	03020203	2	1972-74	5	2
405	02090572	Black Creek tributary near Lucama	35°38'36"	77°59'15"	Wilson	Wilson	5.41	Black Creek	03020203	2	1954, 1980	2	0
406	02090580	Black Creek near Black Creek	35°38'16"	77°58'19"	Wilson	Wilson	32.1	Contentnea Creek	03020203	2	1955-59, 1961-64	17	6
407	0209058180	Black Creek at Black Creek	35°38'07"	77°56'50"	Wilson	Wilson	38.9	Contentnea Creek	03020203	2	1972-74	5	2
408	02090590	Great Swamp near Black Creek	35°36'32"	77°57'09"	Wilson	Fremont	38.8	Black Creek	03020203	2	1958, 1965-68, 1971	9	0
409	02090609	Aycock Swamp near Fremont	35°32'19"	77°56'03"	Wayne	Fremont	3.53	Black Creek	03020203	2	1972-73	4	0
410	02090620	Aycock Swamp near Stantonsburg	35°35'39"	77°53'18"	Wilson	Fremont	11.5	Black Creek	03020203	2	1958, 1965-68, 1971	9	0
411	02090625	Turner Swamp near Eureka	35°34'14"	77°52'47"	Wayne	Fremont	2.10	Black Creek	03020203	1	June 1968 - Sept. 1987	N/A	N/A
412	02090629	Contentnea Creek at NC 222 at Stantonsburg	35°36'08"	77°49'53"	Wilson	Stantonsburg	386	Neuse River	03020203	2	1969-70, 1972-73	7	0
413	02090634	Contentnea Creek near Stantonsburg	35°35'10"	77°48'43"	Wilson	Stantonsburg	389	Neuse River	03020203	2	1969-70, 1972-74, 1978, 1980-85, 1997	33	0
414	02090662	Toisnot Swamp at Stanhope	35°51'27"	78°05'18"	Nash	Bailey	6.84	Contentnea Creek	03020203	2	1958	1	0
415	02090664	Toisnot Swamp near Stanhope	35°50'54"	78°03'34"	Nash	Bailey	9.97	Contentnea Creek	03020203	2	1949	1	0
416	02090674	Beaverdam Creek near Bailey	35°47'40"	78°04'06"	Nash	Bailey	1.50	Toisnot Swamp	03020203	2	1958	1	0

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417	02090720	Toisnot Swamp near New Hope	35°49'20"	77°59'50"	Nash	Winstead Crossroads	30[a]	Contentnea Creek	03020203	2	1932, 1954, 1957-59, 1961-64, 1969	19	0
418	02090741	Toisnot Swamp near Wilson	35°44'50"	77°54'20"	Wilson	Wilson	49[a]	Contentnea Creek	03020203	2	1956	3	0
419	02090748	Toisnot Swamp at Wilson	35°44'02"	77°53'24"	Wilson	Wilson	56.4	Contentnea Creek	03020203	2	1933	1	0
420	02090758	Toisnot Swamp at U.S. 264 near Wilson	35°41'50"	77°51'18"	Wilson	Saratoga	65.2	Contentnea Creek	03020203	2	1933, 1958, 1969-70	5	0
421	02090780	Mill Branch near Wilson	35°42'24"	77°47'11"	Wilson	Saratoga	2.6[a]	Whiteoak Swamp	03020203	2	1954-56, 1960-71	16	1
422	02090796	Whiteoak Swamp near Drivers Store	35°41'04"	77°48'31"	Wilson	Saratoga	25.2	Toisnot Swamp	03020203	2	1969-70	3	0
423	02090805	Toisnot Swamp near Drivers Store	35°39'22"	77°49'36"	Wilson	Saratoga	99.9	Contentnea Creek	03020203	2	1969-70	4	0
424	02090816	Toisnot Swamp near Saratoga	35°36'43"	77°48'19"	Wilson	Stantonsburg	114.7	Contentnea Creek	03020203	2	1969-70	3	0
425	02090820	Toisnot Swamp near Stantonsburg	35°35'52"	77°47'46"	Wilson	Stantonsburg	121.9	Contentnea Creek	03020203	2	1933, 1956-59, 1961	10	0
426	02090891	Beamans Run near Walstonburg	35°32'50"	77°44'30"	Greene	Walstonburg	7.9[a]	Contentnea Creek	03020203	2	1957	1	0
427	02090960	Nahunta Swamp near Pikeville	35°30'49"	77°58'56"	Wayne	Fremont	19[a]	Contentnea Creek	03020203	2	1957, 1961-73	22	0
428	0209096845	The Slough at Pikeville	35°29'56"	77°59'27"	Wayne	Goldsboro	0.5[a]	Nahunta Swamp	03020203	2	1972-75	7	3
429	0209096855	The Slough near Pikeville	35°28'47"	77°57'35"	Wayne	Goldsboro	1.84	Nahunta Swamp	03020203	2	1973-74	5	2
430	0209096970	Moccasin Run near Patetown	35°28'46"	77°54'37"	Wayne	Goldsboro	1.89	The Slough	03020203	1	Apr. 1988 - Sept. 1996	N/A	N/A
431	02090980	The Slough near Saulston	35°28'15"	77°51'40"	Wayne	Goldsboro	21.3	Nahunta Swamp	03020203	2	1957, 1960-66	12	0

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432	02091000	Nahunta Swamp near Shine	35°29'20"	77°48'22"	Greene	Jason	80.4	Contentnea Creek	03020203	1	Apr. 1954 - Sept. 1996	N/A	N/A
433	02091040	Nahunta Swamp near Snow Hill	35°30'30"	77°44'20"	Greene	Walstonburg	90[a]	Contentnea Creek	03020203	2	1949-54, 1957, 1967-68	20	0
434	02091141	Fort Run near Contentnea	35°29'50"	77°43'30"	Greene	Snow Hill	10[a]	Contentnea Creek	03020203	2	1954, 1957	2	0
435	02091241	Contentnea Creek at U.S. 258 at Snow Hill	35°27'27"	77°40'11"	Greene	Snow Hill	694	Neuse River	03020203	2	1969-70, 1972-74, 1978, 1980, 1997	11	0
436	02091430	Shepherd Run near Snow Hill	35°26'06"	77°38'42"	Greene	Snow Hill	1.47	Contentnea Creek	03020203	2	1953, 1955, 1957-73	27	0
437	02091480	Rainbow Creek near Glenfield	35°24'30"	77°37'20"	Greene	Hookerton	12[a]	Contentnea Creek	03020203	2	1960-65	8	0
438	02091486	Rainbow Creek at Hookerton	35°25'30"	77°35'40"	Greene	Hookerton	15[a]	Contentnea Creek	03020203	2	1954-57	5	0
439	02091500	Contentnea Creek at Hookerton	35°25'44"	77°34'59"	Greene	Hookerton	733	Neuse River	03020203	1	Nov. 1928 - Sept. 1996	N/A	N/A
440	02091529	Mussel Run near Hookerton	35°26'20"	77°34'00"	Greene	Hookerton	11[a]	Contentnea Creek	03020203	2	1955-57	3	0
441	02091544	Wheat Swamp near Hugo	35°23'10"	77°33'57"	Greene	Hookerton	20.5	Contentnea Creek	03020203	2	1956-57	4	1
442	02091559	Polecat Branch near Hookerton	35°26'00"	77°32'40"	Greene	Hookerton	3.2[a]	Contentnea Creek	03020203	2	1954-55, 1957	3	0
443	02091574	Contentnea Creek near Hugo	35°24'46"	77°29'51"	Lenoir	Ayden	789	Neuse River	03020203	2	1956-57, 1969-70, 1973-74, 1997	11	0
444	02091589	Little Contentnea Creek tributary near Walstonburg	35°36'20"	77°40'40"	Greene	Walstonburg	3.0[a]	Little Contentnea Creek	03020203	2	1972-74	4	1
445	02091604	Little Contentnea Creek near Fountain	35°36'42"	77°37'00"	Pitt	Farmville	36[a]	Contentnea Creek	03020203	2	1956-57	4	0

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446	02091618	Langs Mill Run at NC 222 at Fountain	35°40'18"	77°38'50"	Pitt	Fountain	3.1[a]	Black Swamp	03020203	2	1974-75	3	0
447	02091619	Langs Mill Run at Fountain	35°39'50"	77°38'00"	Pitt	Fountain	4.6[a]	Black Swamp	03020203	2	1973-75	4	1
448	02091634	Black Swamp near Farmville	35°37'30"	77°35'30"	Pitt	Farmville	12[a]	Little Contentnea Creek	03020203	2	1957	1	1
449	02091664	Little Contentnea Creek at NC 121 near Farmville	35°36'19"	77°34'27"	Pitt	Farmville	55.1	Contentnea Creek	03020203	2	1956, 1969-70, 1972, 1974	10	0
450	02091679	Little Contentnea Creek near Bell Arthur	35°35'08"	77°32'28"	Pitt	Farmville	64.3	Contentnea Creek	03020203	2	1969-70, 1972, 1974	5	0
451	02091700	Little Contentnea Creek near Farmville	35°32'40"	77°30'41"	Pitt	Farmville	93.3	Contentnea Creek	03020203	1	Oct. 1956 - Sept. 1987	N/A	N/A
										2	1952-54, 1956	8	0
452	02091712	Middle Swamp near Marlboro	35°33'54"	77°35'45"	Pitt	Farmville	14[a]	Little Contentnea Creek	03020203	2	1972-74	3	0
453	02091716	Middle Swamp near Lizzie	35°32'36"	77°34'01"	Greene	Farmville	20[a]	Little Contentnea Creek	03020203	2	1954, 1957	2	2
454	02091732	Sandy Run near Lizzie	35°31'53"	77°33'32"	Greene	Farmville	29[a]	Middle Swamp	03020203	2	1954, 1957	2	2
455	02091737	Little Contentnea Creek near Willow Green	35°31'30"	77°31'15"	Greene	Farmville	145[a]	Contentnea Creek	03020203	2	1969-70	3	0
456	02091740	Little Contentnea Creek at Scuffleton	35°27'24"	77°29'09"	Pitt	Ayden	172	Contentnea Creek	03020203	2	1956-57, 1965-66, 1969-70, 1980, 1997	15	0
457	02091764	Contentnea Creek at Grifton	35°22'12"	77°26'47"	Pitt	Grifton	980[a]	Neuse River	03020203	2	1969-70, 1972	6	0
458	02091786	Eagle Swamp near Grifton	35°21'40"	77°26'30"	Lenoir	Grifton	9.7[a]	Contentnea Creek	03020203	2	1954-55, 1957	3	0

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
459	02091810	Halfmoon Creek near Fort Barnwell	35°17'58"	77°21'14"	Craven	Fort Barnwell	4.9[a]	Neuse River	03020202	2	1961-76	16	0
460	02091814	Neuse River near Fort Barnwell	35°18'40"	77°18'20"	Craven	Fort Barnwell	3,900[a]	Atlantic Ocean	03020202	2	1970, 1972-73, 1976, 1978, 1980-82, 1985-91, 1995-96, 1997	31	0
461	02091820	Core Creek near Fort Barnwell	35°15'10"	77°17'10"	Craven	Fort Barnwell	59[a]	Neuse River	03020201	2	1949-58	22	0
462	02091824	Core Creek tributary near Fort Barnwell	35°16'40"	77°18'10"	Craven	Fort Barnwell	8.1[a]	Neuse River	03020201	2	1954, 1957	2	1
463	0209184590	Swift Creek at SR 1126 at Winterville	35°32'16"	77°25'07"	Pitt	Greenville SW	7.6[a]	Neuse River	03020202	2	1974-76, 1978, 1980, 1997	8	0
464	02091849	Swift Creek near Winterville	35°31'40"	77°25'30"	Pitt	Greenville SW	9.5[a]	Neuse River	03020202	2	1956, 1973-75	6	0
465	02091859	Swift Creek at NC 102 near Ayden	35°28'10"	77°24'00"	Pitt	Ayden	25[a]	Neuse River	03020202	2	1956-57, 1974-75, 1997	9	1
466	02091874	Fork Swamp near Ayden	35°29'20"	77°22'00"	Pitt	Gardnerville	17[a]	Swift Creek	03020202	2	1957	1	1
467	0209187450	Fork Swamp at NC Hwy 102 near Ayden	35°28'11"	77°21'23"	Pitt	Gardnerville	21[a]	Swift Creek	03020202	2	1973-75	4	1
468	02091910	Swift Creek near Coxville	35°24'07"	77°19'54"	Pitt	Gardnerville	78.2	Neuse River	03020202	2	1956-57, 1960-70, 1974-75, 1997	28	0
469	02091954	Clayroot Swamp near Gardnerville	35°23'32"	77°15'49"	Pitt	Gardnerville	46[a]	Swift Creek	03020202	2	1957	1	1
470	02091960	Creeping Swamp near Calico	35°25'46"	77°11'12"	Beaufort	Wilmar	9.8	Clayroot Swamp	03020202	1	Mar. 1971 - Mar. 1977	N/A	N/A
										2	1971	1	0
471	02091970	Creeping Swamp near Vanceboro	35°23'30"	77°13'46"	Craven	Wilmar	27[a]	Clayroot Swamp	03020202	1	Mar. 1971 - Sept. 1985	N/A	N/A
										2	1971	1	1
472	02092000	Swift Creek near Vanceboro	35°20'42"	77°11'45"	Craven	Vanceboro	182	Neuse River	03020202	1	Jan. 1950 - Sept. 1989	N/A	N/A
473	02092015	Fork Swamp at Wilmar	35°22'59"	77°07'08"	Beaufort	Hackney	4.5[a]	Palmetto Swamp	03020202	2	1970	1	1

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
474	02092018	Palmetto Swamp at U.S. 17 near Vanceboro	35°21'40"	77°08'50"	Craven	Vanceboro	16[a]	Swift Creek	03020202	2	1970-71	2	2
475	02092020	Palmetto Swamp near Vanceboro	35°20'18"	77°10'16"	Craven	Vanceboro	24.2	Swift Creek	03020202	1	Mar. 1971 - Sept. 1976	N/A	N/A
										2	1956-71	34	4
476	02092040	Poplar Branch near Vanceboro	35°16'13"	77°08'55"	Craven	Vanceboro	3.6[a]	Swift Creek	03020202	2	1957, 1964-68, 1970-71	9	1
477	0209205053	Swift Creek at NC 43 near Streets Ferry	35°13'56"	77°06'52"	Craven	Askin	269	Neuse River	03020202	1	July 1996 - Sept. 1996	N/A	N/A
478	02092052	Little Swift Creek near Cayton	35°15'10"	77°00'10"	Craven	Ernul	26[a]	Swift Creek	03020202	2	1957	1	0
479	02092061	Pine Tree Swamp near Cayton	35°15'00"	77°00'00"	Craven	Askin	1.8[a]	Little Swift Creek	03020202	2	1957	1	1
480	02092069	Little Swift Creek tributary near Askin	35°14'00"	77°02'20"	Craven	Askin	1.23	Little Swift Creek	03020202	2	1957	1	1
481	02092120	Bachelor Creek near New Bern	35°09'00"	77°10'20"	Craven	Jasper	32.4	Neuse River	03020202	2	1942, 1956-57, 1960-71	18	0
482	0209213705	Mills Branch at SR 1431 near Bridgeton	35°09'04"	77°02'09"	Craven	Askin	0.8[a]	Neuse River	03020204	2	1973	1	1
483	0209213765	Mills Branch tributary No.1 at U.S. Highway 17 near Bridgeton	35°08'59"	77°01'38"	Craven	Askin	1.6[a]	Mills Branch	03020204	2	1973	1	0
484	02092141	Jack Smith Creek tributary at Tryon Street at New Bern	35°06'31"	77°04'04"	Craven	New Bern	1[a]	Jack Smith Creek	03020204	2	1956	2	2
485	02092162	Neuse River at New Bern	35°06'33"	77°01'59"	Craven	New Bern	4,467	Atlantic Ocean	03020204	1	(gage height only) Mar. 1988 - Sept. 1996	N/A	N/A
486	0209218190	Trent River at NC 11 near Deep Run	35°06'23"	77°43'15"	Lenoir	Deep Run	3.2[a]	Neuse River	03020204	2	1974-76, 1980-84	34	1
487	02092186	Trent River near Woodington	35°05'47"	77°38'21"	Lenoir	Deep Run	12.6	Neuse River	03020204	2	1964	1	1
488	02092202	Beaverdam Swamp near Pleasant Hill	35°04'49"	77°38'30"	Lenoir	Deep Run	6.02	Trent River	03020204	2	1957	1	1
489	02092210	Trent River at Pleasant Hill	35°04'03"	77°35'25"	Jones	Deep Run	27.5	Neuse River	03020204	2	1965-68, 1970-71	8	0
490	02092230	Joshua Creek near Combs Fork	35°05'36"	77°34'25"	Jones	Deep Run	12.1	Trent River	03020204	2	1965-68, 1970-71	9	1

Table 5. Summary of continuous-record gaging stations and partial-record measuring sites in the Neuse River Basin in North Carolina where records of gage height and streamflow were collected—Continued

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Site index no. (pl. 1)	USGS downstream order number	Station name	Latitude	Longitude	County	USGS topographic quadrangle	Drainage area (mi^2)	Tributary to	Hydrologic unit code	Site type	Period of record	Number of measurements for partial-record sites: Flow	Number of measurements for partial-record sites: Zero flow
491	02092262	Tuckahoe Swamp near Hargetts Crossroads	34°59'40"	77°40'00"	Jones	Potters Hill	23.1	Trent River	03020204	2	1954, 1957	2	2
492	02092290	Rattlesnake Branch near Comfort	35°00'31"	77°35'50"	Jones	Deep Run	2.5[a]	Tackahoe Swamp	03020204	2	1954, 1957, 1961-71	14	2
493	02092390	Tuckahoe Creek near Pleasant Hill	35°01'55"	77°34'47"	Jones	Deep Run	49.7	Trent River	03020204	2	1957, 1966-68, 1970-71	6	0
494	02092500	Trent River near Trenton	35°03'54"	77°27'24"	Jones	Phillips Crossroads	168	Neuse River	03020204	1	Jan. 1951 - Sept. 1996	N/A	N/A
495	02092514	Big Chinquapin Branch near Phillips Crossroads	35°04'50"	77°25'10"	Jones	Phillips Crossroads	16[a]	Trent River	03020204	2	1956-57	2	0
496	02092520	Vine Swamp near Kinston	35°09'29"	77°33'16"	Lenoir	Rivermont	6.30	Beaver Creek	03020204	2	1954, 1957, 1961-71	13	2
497	02092540	Beaver Creek near Phillips Crossroads	35°08'00"	77°26'58"	Jones	Dover	33[a]	Trent River	03020204	2	1956-57, 1960-68, 1970	20	0
498	02092549	Musselshell Creek near Trenton	35°04'58"	77°21'11"	Jones	Trenton	9.7[a]	Trent River	03020204	2	1954, 1957, 1965-68, 1970-71	10	1
499	0209254950	Trent River at SR 1001 at Trenton	35°04'05"	77°20'55"	Jones	Trenton	276[a]	Neuse River	03020204	2	1974	1	0
500	02092554	Trent River at Pollocksville	35°00'38"	77°13'10"	Jones	Pollocksville	370[a]	Neuse River	03020204	1	July 1996 - Sept. 1996	N/A	N/A
										2	1974	1	0
501	0209256110	Wilson Creek at SR 1278 near Trent Woods	35°05'41"	77°06'22"	Craven	New Bern	3.66	Trent River	03020204	2	1973-75	4	0
502	02092569	Brice Creek at SR 1100 at Croatan	34°57'56"	76°58'26"	Craven	Catfish Lake	12[a]	Trent River	03020204	2	1976	1	0
503	02092571	Brice Creek at Riverdale	34°59'40"	77°00'20"	Craven	Catfish Lake	20[a]	Trent River	03020204	2	1942, 1957	2	2
504	0209257120	W.P. Brice Creek below SR 1101 near Riverdale	34°58'09"	77°02'55"	Craven	Catfish Lake	11.2	Brice Creek	03020204	1	Apr. 1986 - Sept. 1991	N/A	N/A
505	02092590	Upper Broad Creek near Olympia	35°11'00"	76°58'00"	Pamlico	Reelsboro	21[a]	Neuse River	03020204	2	1950-54, 1956-59	14	6

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506	02092620	Upper Broad Creek tributary near Grantsboro	35°08'06"	76°56'31"	Pamlico	Reelsboro	3.0	Upper Broad Creek	03020204	2	1957-58, 1961-73	15	1
507	02092626	Goose Creek near Scotts Store	35°06'12"	76°53'33"	Pamlico	Upper Broad Creek	25[a]	Neuse River	03020204	2	1957	1	1
508	02092636	East Prong Slocum Creek near Cherry Point	34°52'57"	76°54'32"	Craven	Havelock	8.31	Slocum Creek	03020204	2	1973	1	0

[a] Approximate drainage area.
[b] Discharge measurements obtained after this water year made in conjunction with water-quality sampling at site.
[c] Discharge measurements made in conjunction with water-quality sampling at site.
[d] Drainage area revised from 55.2 mi^2 when site and road were relocated upstream from a tributary draining to original location. Previous drainage area used in low-flow analyses and is thus shown for this site in tables 7 and 8.

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