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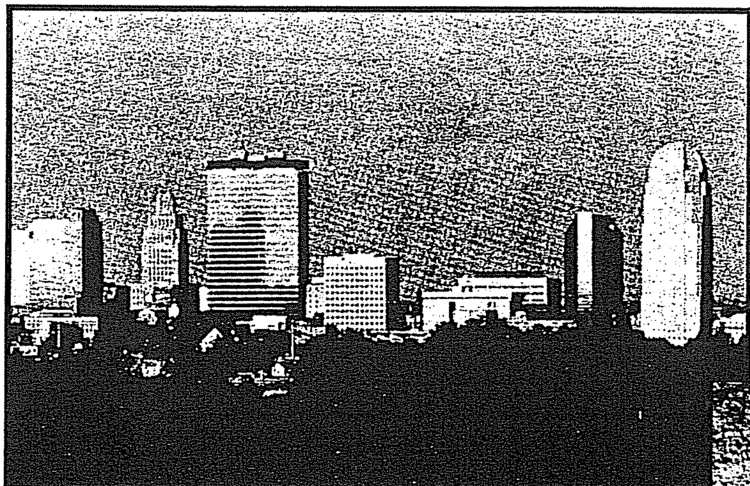
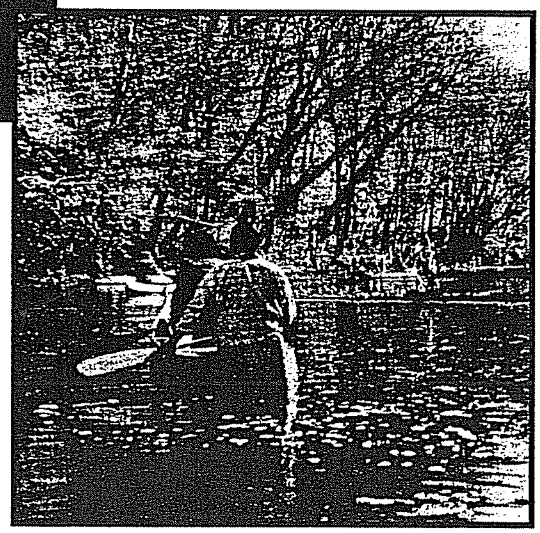
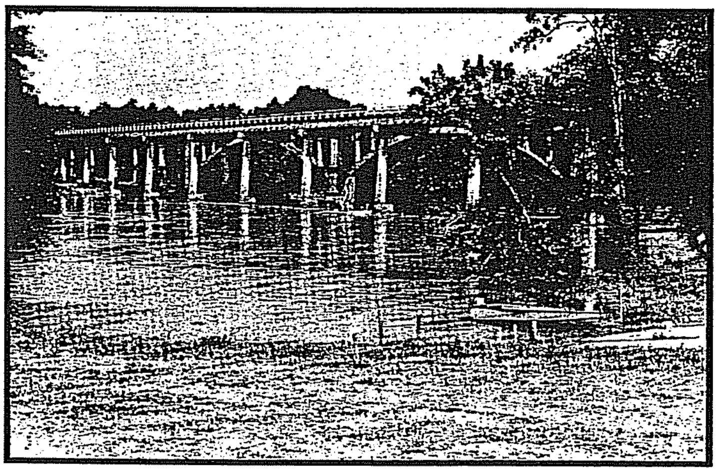
YADKIN-PEE DEE RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN







North Carolina Department of Environment and Natural Resources
Division of Water Quality • Water Quality Section • May, 1998

Michael F. Easley, Governor
William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

April 22, 2003

Thank you for your interest in North Carolina's water quality issues. Enclosed is the basinwide water quality plan that you recently requested from the Division of Water Quality (DWQ).

The basinwide planning program aims to identify and restore full use to impaired waters, identify and protect highly valued resource waters, and protect the quality and intended uses of North Carolina's surface waters while allowing for sound economic planning and reasonable growth. North Carolina relies on the input and experience of its public to ensure that the water quality plans are effective. DWQ coordinates plan development; however, plan implementation and effectiveness entails the coordinated efforts and endorsement of many agencies, groups, local governments, and the general public. Your participation is essential for us to achieve our goals.

Our website (http://h2o.enr.state.nc.us/wqs/) provides detailed information on our program, other basin plans, current events, publications, and rules and regulations. Please visit us at this site.

DWQ appreciates your interest in water quality issues, and we hope to continue working with you into the future. Please contact me if you have any further questions or ideas on specific basins at (919) 733-5083, ext. 354.

Sincerely,

Darlene Kucken
Basinwide Planning Program Coordinator

Enclosure

ADDENDUM: Use Support Changes for the Yadkin River Basin
March 2000

The fully supporting but threatened (support-threatened, ST) category is no longer used as a use support rating. In the past, ST was used to identify a water that was fully supporting but had some notable water quality problems. ST could represent constant, degrading, or improving conditions. North Carolina's use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that are characterized by declining water quality. In addition, the US EPA requires the inclusion of ST waters on the 303(d) list in its proposed revision (August, 1999) to the 303(d) list rules (Appendix VII). Due to the difference between US EPA's and North Carolina's definitions of ST, North Carolina no longer uses this term. Because North Carolina has used fully supporting but threatened as a subset of fully supporting (FS) waters, those waters formerly called ST are now rated FS. This change is reflected in the 305(b) report for 2000. Based on this change, use support ratings for all basins have been altered.

Use support ratings of Cedar Creek (subbasin 05), Jimmys Creek (subbasin 07), Long Branch (subbasin 13), and Wicker Branch (subbasin 14) have been revised based on new biological information. Portions of these streams were formerly rated PS but are now not rated (NR). These revised ratings are reflected in the 2000 303(d) list and 305(b) report.

Revised use support ratings for the Yadkin River basin are presented below.

Streams and Rivers

Table 4.9 Use Support Status Determinations by Subbasin for Yadkin-Pee Dee River Basin (*Found on p. 4-80 of this plan.*)

Use Support Status for Freshwater Streams (Miles) (1992-1996)					
Subbasin	**Fully Supporting**	**Partially Supporting**	**Not Supporting**	**Not Evaluated**	**Total Miles**
03-07-01	891.1	0.0	0.0	0.0	891.1
03-07-02	687.5	0.5	1.4	0.0	689.4
03-07-03	124.4	16.2	1.7	29.9	172.2
03-07-04	406.0	49.5	8.1	33.8	497.4
03-07-05	111.5	0.0	0.0	11.7	123.2
03-07-06	677.5	17.2	0.0	0.0	694.7
03-07-07	103.6	46.5	18.6	34.6	203.3
03-07-08	177.5	27.3	0.0	6.7	211.5
03-07-09	305.7	0.0	0.0	0.0	305.7
03-07-10	143.9	37.2	9.0	97.1	287.2
03-07-11	139.4	48.2	11.0	87.6	286.2
03-07-12	221.1	31.0	22.0	19.1	293.2
03-07-13	171.1	13.8	0.0	17.8	202.7
03-07-14	149.4	57.8	16.8	182.5	404.5
03-07-15	366.8	0.0	0.0	0.0	366.8
03-07-16	153.6	27.7	6.1	50.8	238.2
03-07-17	77.2	9.2	0.0	37.5	123.9
Total	4907.3	380.1	94.7	609.1	5991.2
Percent	82	7	<2	10	

Lakes

High Rock Lake, Lake Corriher, Lake Lee, and Lake Twitty are now considered fully supporting. *(Refer to Table 4.11 on p. 4-84 of this plan.)*

YADKIN-PEE DEE RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

May 1998

Prepared by:

North Carolina
Division of Water Quality
Water Quality Section
P.O. Box 29535
Raleigh, NC 27626-0535

(919) 733-5083

This document was approved and endorsed by the NC Environmental Management Commission on May 14, 1998 to be used as a guide by the NC Division of Water Quality in carrying out its Water Quality Program duties and responsibilities on the Yadkin-Pee Dee River Basin.

Cover Photo Credits
Top Left: Skyline of Winston-Salem, Wachovia Bank
Bottom Left:
Right:

- A general water quality document is being prepared to supplement this and other basin plans. Two appendices in the draft plan were moved to this new document.

FOREWORD

Most water users in the basin, including industry, agriculture, tourists, and residents, rely on water for basic needs. These needs include water supply and/or disposal of treated wastewater. In addition, many businesses and residents of the basin rely directly or indirectly on the waters of the basin to meet their recreational needs and supply an economic base through tourism. The lakes of the Yadkin-Pee Dee River basin are well known for recreation activities including fishing, boating and swimming. To these groups and the public they serve, it is important that the basin's waters support viable fisheries, that the waters be relatively safe (low risk of contracting water-borne disease) and that they be aesthetically desirable (free of objectionable colors, odors and smells). Yet maintaining clean water becomes increasingly difficult and more expensive as the population grows, as land is developed and as competition for resources heighten.

The majority of the waters in the basin are supporting their designated uses, based on Division of Water Quality monitoring data. The Use-Support assessment methodology used by DWQ found about 9 percent of stream miles to be impaired. However, there are reasons to be concerned about the quality of the large number of support threatened waters in the basin. In addition, many streams have not been monitored by DWQ, so there are potentially other streams with water quality problems.

Some areas of the basin have experienced significant population growth between 1970 and 1990. This growth rate is expected to continue. The construction of roads, driveways, commercial and recreational areas and homes must be undertaken with proper care to prevent sediments from reaching surface waters. In addition, timber harvesting and agricultural activities should use best management practices to avoid erosion and the resulting sedimentation to streams.

Preserving and enhancing the quality of water in the basin is beyond the capabilities of any one agency or group. State and federal government regulatory programs will play an important part, but much of the responsibility will be at the local level. Those who live, work and recreate in the basin have the most at stake.

This document provides a summary of the causes and sources of water pollution in the basin, the status of the basin's water quality, a summary of water quality rules and statutes that apply to water quality protection in the basin, and recommended strategies to protect and enhance the quality of the surface waters in the Yadkin-Pee Dee River basin. The *Yadkin-Pee Dee River Basinwide Water Quality Management Plan* will be used a guide by the NC Division of Water Quality (formerly Division of Environmental Management) in carrying out its water quality program responsibilities in the basin.

Beyond that, it is hoped that the plan will provide a framework for cooperative efforts between the various stakeholders in the basin toward a common goal of improving and protecting the basin's water resources while accommodating reasonable economic growth.

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EXECUTIVE SUMMARY

NORTH CAROLINA'S BASINWIDE APPROACH TO WATER QUALITY MANAGEMENT - PURPOSE OF YADKIN-PEE DEE RIVER BASIN PLAN

Basinwide management is a watershed-based water quality management initiative being implemented by the North Carolina Division of Water Quality (previously Division of Environmental Management). The *Yadkin-Pee Dee River Basinwide Water Quality Management Plan* is the sixteenth basinwide water quality management plan prepared by the Division of Water Quality (DWQ) in a series of plans being prepared for all seventeen of the state's major river basins. DWQ uses the plans as guides in carrying out its water quality programs in each river basin.

The basinwide water quality management plans are not new regulatory documents. They are planning documents used to communicate the State's rationale, approaches and long-term water quality management strategies to policymakers, the regulated community and the general public. Each plan is completed and approved prior to the scheduled date for basinwide discharge permit renewals. The plans are then evaluated, based on follow-up water quality monitoring, and updated at five year intervals.

DWQ uses this approach as a means to report to the public on the current status of water quality in the basin, major water quality concerns and issues, projected trends in development and water quality, the long-range water quality goals for the basin, and recommended point and nonpoint source management options.

The *Yadkin-Pee Dee River Basinwide Water Quality Management Plan* will be updated in 2002. Basinwide NPDES permitting in the Yadkin-Pee Dee River basin is scheduled to begin in July, 1998.

GOALS OF THE BASINWIDE APPROACH

The primary goals of DWQ's basinwide program are:

1) to identify and restore full use to impaired waters,
2) to identify and protect highly valued resource waters and biological communities of special importance, and
3) to manage the causes and sources of pollution so as to ensure the protection of those waters currently supporting their uses while allowing for reasonable economic growth.

In addition, DWQ uses this approach as a means to better identify water quality problems, develop appropriate management strategies, maintain and protect water quality and aquatic habitat, assure equitable distribution of waste assimilative capacity for dischargers, and improve public awareness and involvement in the management of the state's surface waters.

PUBLIC WORKSHOPS

Upper Yadkin-Pee Dee River Basin Workshops

The Northwest Piedmont Council of Governments, in conjunction with Centralina Council of Governments was awarded a 205j grant to assist DWQ with the preparation and coordination of public input for the Yadkin-Pee Dee workshops for the upper portion of the basin. A series of four meetings were held in Jonesville (March 15, 1996), Salisbury (March 22, 1996), Winston-Salem (May 17, 1996) and Salisbury (August 22, 1997). Details on these meetings can be found in Chapter 6 and Appendix IV.

The initial meeting allowed people to select a breakout group from a choice of areas of concern for the basin. These were eventually conbsolidated into four groups which included: Water Quality (Point Source), Economic Development, Future Growth and Development and Water Quality (Nonpoint Source). Planning sessions were held in which the information from the workshops was summarized for presentation at the May meetings. Follow-up meetings, held in May, were intended to disseminate the summaries compiled at the planning sessions and to give attendees the opportunity to provide comments and suggestions. A summary of the subcommittees goals and recommended action plans is presented in Appendix IV.

Each subcommittee developed: 1) a goal, 2) a series of recommendations, 3) a list of agencies that could implement the recommendation, 4) suggested potential funding sources for implementation of the recommendation, and 5) a timetable for completion of the recommendation.

Lower Yadkin-Pee Dee River Basin Workshops

Two workshops were held for the lower Yadkin-Pee Dee River basin in Albemarle on August 22, 1996. The workshops were conducted to provide an overview of the basin schedule and information specific to the lower portion of the basin. After presentations, the group broke out into small discussion groups. Each group was asked to respond to three questions: 1) What are the priority water quality related issues in the basin?; 2) Are there any specific waterbodies in the basin that are experiencing water quality problems?; 3) What efforts have been undertaken to improve water quality?

Lower Yadkin-Pee Dee River basin workshop participants identified the following categories as the primary areas of concern to the basin (Table 1). An effort has been made to address these issues in the development of the plan. Several issues identified by workshop participants that were not addressed in the plan were listed in Chapter 7 for future activities. A full summary of the workshops can be found in Chapter 6 and Appendix IV.

Table 1 Primary Areas of Concern for Participants of the Lower Yadkin-Pee Dee River Basin Workshops

Equity between Point Source and Nonpoint Source Issues	Research and Monitoring Needs (See Chp 7, Section 7.3.7))
Agriculture BMPs and Waste Mgt.	Urban Development
Policy Issues	Recreation Impacts
NPS Pollution/Sedimentation	Point Source Pollution
Forestry Practices and BMPs	Loss of Riparian Zones
Water Supplies	Lake Management

YADKIN-PEE DEE RIVER BASIN OVERVIEW

The Yadkin-Pee Dee River basin is the second largest river basin in the state, covering 7,213 square miles. It includes eighty-three municipalities and all or part of twenty-four counties. The basin is primarily located within the piedmont physiographic region of the state (Figure 2.1), but also drains the mountain and coastal plain regions. Streams within each region are affected by the soils, geology and topography characteristic of that region.

The basin originates on the eastern slopes of the Blue Ridge Mountains in Caldwell, Wilkes and Surry Counties (Figure 1). A small portion of the Yadkin River headwaters originates in Virginia. It flows northeasterly for about 100 miles, then flows to the southeast until it joins the Uwharrie River to form the Pee Dee River. The Pee Dee River continues flowing southeasterly through South Carolina to the Atlantic Ocean. The North Carolina portion of the basin contains approximately 5,991 miles of freshwater streams and rivers.

To aid in locating the streams and lakes within the basin, this plan presents the basin as the upper Yadkin River basin (Figure 2.3) and the lower Yadkin River basin (Figure 2.4). The upper Yadkin River basin contains subbasins 03-07-01 through 03-07-07, which drain to High Rock Lake. The lower Yadkin River basin contains subbasins 03-07-08 through 03-07-17 which drain to the remaining chain lakes and the Pee Dee River.

Forest land, covers approximately 49 percent of the basin. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 30 percent of the land area. The urban and built-up category comprises roughly 11 percent and exhibited the most dramatic change between 1982 and 1992 (38 percent increase). Other categories that showed substantial changes during this period were pasturelands (19 percent increase) and the "Other" category, which includes rural transportation (26 percent increase). Both cultivated and uncultivated cropland decreased by a total of 46 percent in the basin between 1982 and 1992. It is likely that some of this cropland was converted to pastureland and to urban and built-up areas. Major land use activities in the basin include agriculture (crops and swine, poultry and cattle operations) and construction activities related to growth. Iredell County has the largest dairy cattle population in the state.

There are a number of High Quality and Outstanding Resource Waters in the basin and many state and federally listed threatened and endangered species. The Yadkin-Pee Dee River basin contains a high number of lakes, including a series of "chain" lakes on the mainstem of the river, which attract many tourists to the area.

Based on 1990 census data, the population of the basin was 1.2 million people. The most populated areas are in and near Winston-Salem and Charlotte. The overall population density is 163 persons per square mile versus a statewide average of 123 persons per square mile. While much of the basin contains rural areas surrounding small towns, many of the small to large cities have high density areas. The percent population growth over the ten year period between 1980 to 1990 was 10 percent.

ASSESSMENT OF WATER QUALITY IN THE YADKIN-PEE DEE RIVER BASIN

An assessment of water quality information collected by DWQ and other agencies indicate that 82% of the waters within the basin are supporting their designated uses. However, the uses of half of these waters (41%) are threatened. In addition, 9% of the waters are considered impaired. Of the 29 lakes monitored by DWQ, the majority are supporting their designated uses but are nutrient-enriched (eutrophic or mesotrophic). Below is a summary of monitoring data reflective of water quality in the basin. More details on this information can be found in Chapter 4.

Summary of DWQ Monitoring Data

Benthic Macroinvertebrates - These are primarily bottom-dwelling aquatic insect larvae such as species of mayflies, stoneflies, and caddisflies that are used as biological indicators of water quality. Measurements of the number and diversity of these organisms at strategic sampling sites is an important means of assessing water quality.

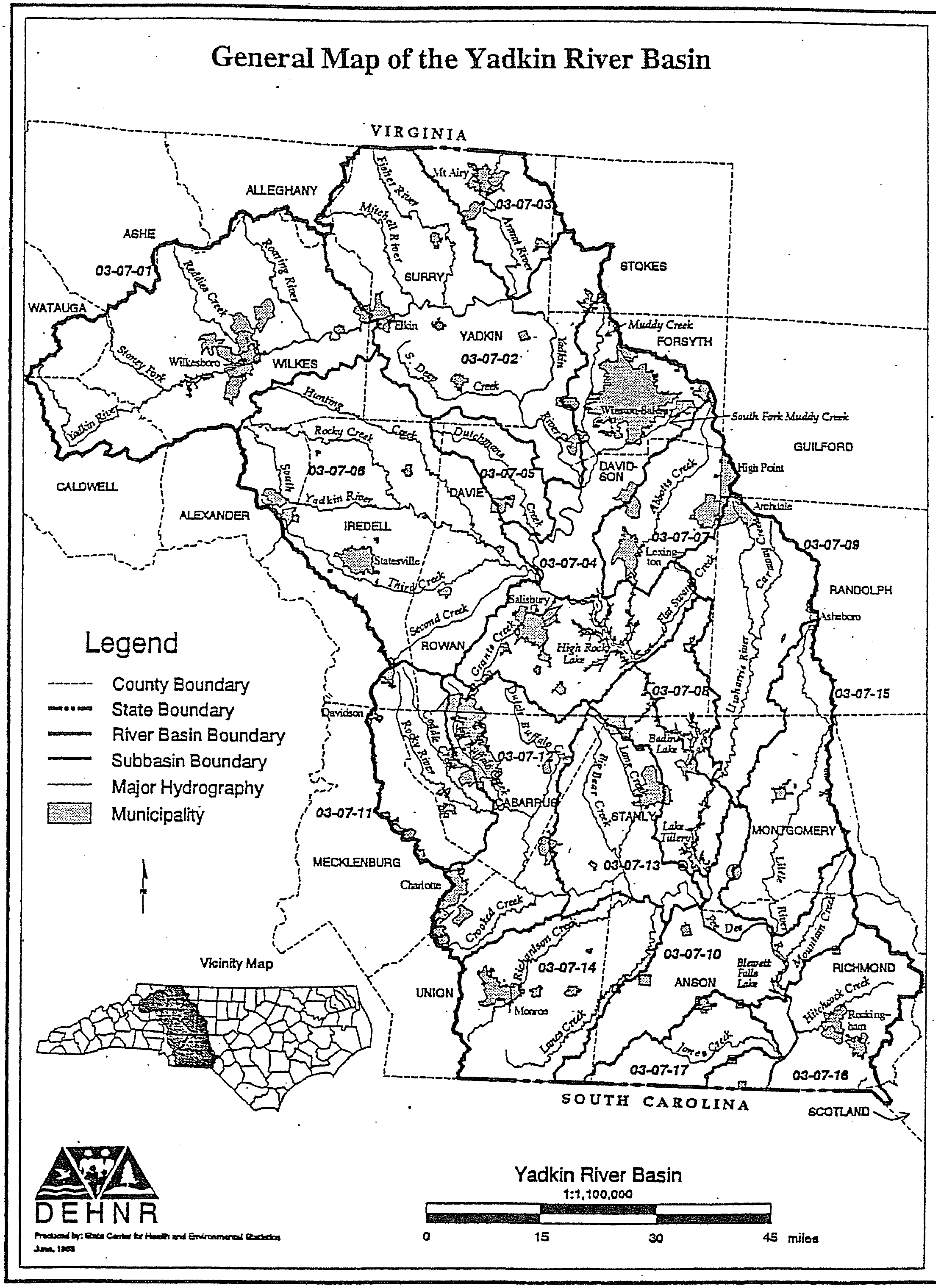


Figure 1 General Map of the Yadkin-Pee Dee River Basin

During the 1996 Yadkin basin sampling, macroinvertebrates were collected at 105 sites. The 1996 basin sampling targeted mainstem sites and major tributaries in all the subbasins and gave a good representation of present water quality in the basin. Of the 105 basin samples, 11 were Excellent (10%), 30 were Good (29%), 46 were Good-Fair (44%), 14 were Fair (13%), and 4 sites were rated as Poor (4%).

Fish Community Sampling - During the spring of 1996, 55 fish community sites, representing at least one site per subbasin, were sampled and evaluated using the North Carolina Index of Biotic Integrity (NCIBI). These 55 sites were rated as: Good-Excellent-6 (11%), Good-23 (42%), Fair-Good-6 (11%), Fair-13 (24%), Poor-Fair-2 (4%), Poor-1 (2%), and Not Rated-4 (7%).

Fish Tissue Analysis - Sample collections were performed at nine sites within the drainage in 1996. DWQ confirmed extensive mercury contamination of the Abbotts Creek embayment of High Rock Lake in 1981, but followup remedial actions have brought mercury concentrations back down to background levels.

Lakes Assessments - Twenty-nine lakes were sampled in the Yadkin River Basin. The majority of these lakes were sampled in 1994 or 1995. Twenty six lakes were fully supporting their designated uses. Two lakes were rated partially supporting their uses (Rockingham City Lake and Hamlet City Lake). Long Lake was listed as not supporting because it was drained in 1995 to facilitate sediment removal from the lake's basin.

Ambient Monitoring - Water quality data collected at 45 sites in the Yadkin River basin were evaluated for the period 1992-1996. Yadkin River mainstem water quality indicates highest total phosphorus and nitrogen concentrations at the Yadkin College site. Water quality at tributary ambient sites showed patterns of low dissolved oxygen levels and pH at some sites. Elevated fecal coliform bacteria levels are commonly found throughout the basin.

Use-Support Ratings

Use-support ratings are a method to analyze water quality information and to determine whether the quality is sufficient to support the uses for which the waterbody has been classified by the State. The word *uses* refers to activities such as swimming, fishing and water supply. All surface waters in the state have been assigned a classification.

DWQ has collected chemical and biological water quality monitoring data throughout the basin, some of which are summarized above. Available data for a particular stream segment has been assessed to determine the overall *use support* rating; that is, whether the waters are *fully supporting*, *support-threatened*, *partially supporting*, or *not supporting* their uses. Fully supporting and support-threatened streams are not considered impaired. Streams referred to as *impaired* are those rated as either partially supporting or not supporting their uses.

Although the majority of the streams have good to excellent bioclassifications and few standards were violated at the ambient stations, nonpoint source effects such as increased sedimentation, were evident at many of the sampling sites. There are also some point source discharges that pose water quality concerns in the portion of the basin draining into High Rock Lake. Those waters considered Impaired, and some select support threatened waters based on monitoring data, are discussed below by subbasin.

Use support ratings in the Yadkin River basin, described more fully in Chapter 4, are summarized below. Of the 5,991 miles of freshwater streams and rivers in the Yadkin-Pee Dee basin, use support ratings were determined for 91% or 5,408 miles with the following breakdown:

	Miles	Percent of Total
SUPPORTING	**4930**	**82%**
Fully supporting:	(2436)	(41%)
Support-threatened:	(2494)	(41%)
IMPAIRED	**478**	**9%**
Partially supporting:	(383)	(7%)
Not supporting:	(95)	(2%)
NOT EVALUATED:	**584**	**9%**

MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

The primary water quality issues discussed in this basin plan relate to concerns presented to DWQ as priority issues, or those that have been identified as causing water quality impacts or impairment. Discussion on these categories follows.

- **Growth Management** - Proactive planning efforts at the local level are needed to assure that development is done in a manner that maintains the good water quality that is presently attracting people to the area. These planning efforts will need to find a balance between water quality protection, natural resource management and economic growth. Growth management requires planning for the needs of future population increases as well as developing a strong tourism base. These actions are critical to water quality management and the quality of life for the residents of the basin. Urban and residential impacts on water quality and trends in the basin are discussed in Chapter 3, Section 3.4.2. Some local initiatives are presented in Chapter 5, Section 5.6.3. Refer to Section 6.5 for recommended management strategies relating to planning for growth and development.
- **Urban Stormwater** - Surface waters can be significantly impacted by urban stormwater runoff. The impacts of urban and residential runoff on water quality in the basin are discussed in Chapter 3, Section 3.4.2. Some local initiatives are presented in Chapter 5, Section 5.6.3. Refer to Section 6.5 for recommended management strategies relating to controlling potential water quality problems related to urban stormwater runoff.
- **Sedimentation** - Erosion, and the resulting sedimentation, are prevalent throughout the basin. Workshop participants (Section 6.2.2) and Nonpoint Source Team members (Section 6.2.3) have expressed the view that the priority issue for the basin is sedimentation. Many waters in the basin are thought to be impacted or impaired, at least in part, by sedimentation (Chapter 4, Section 4.5). The sources of sedimentation are discussed in detail in Chapter 3, programs to address erosion and sedimentation are discussed in Chapter 5, some of the actions being taken at the local level are discussed in Chapter 5, Section 5.6. General management strategies for controlling sedimentation are presented in Section 6.5.
- **Nutrients** - Eutrophication of High Rock Lake is the primary focus of nutrient strategies in this basin plan. Nutrients are discussed in Chapter 3. Water quality on each monitored lake is presented in Chapter 4. Management strategies pertaining to High Rock Lake are presented in Section 6.3. General management strategies for controlling nutrients from urban and industrial stormwater are presented in Section 6.5.
- **Fecal Coliform Bacteria** - Ambient monitoring stations throughout the basin have identified waterbodies with elevated fecal coliform bacteria (Chapter 4). Fecal coliform bacteria sources are discussed in Chapter 3. General management strategies to address nonpoint sources of fecal coliform bacteria are presented in Section 6.5.
- **Oxygen Consuming Wastes** - Many streams within the Yadkin-Pee Dee River basin are low or zero flow streams. Regulations currently exist for streams with 7Q10 and/or 30Q2 equal to zero cubic feet per second (cfs). These regulations were developed to prohibit new or expanded discharges of oxygen-consuming wastes to zero flow streams. Existing facilities

were evaluated for alternatives to discharge. Many facilities found alternatives and some chose to build new tertiary treatment facilities (which are allowed to discharge under the regulations). General management strategies for oxygen-consuming wastes and management strategies for specific streams within the basin are presented in Section 6.5.7.

- **Agricultural Nonpoint Source Pollution -** Agriculture can contribute to degraded water quality through contributions of excess nutrients, fecal coliform bacteria, toxic chemicals and erosion problems from runoff. Chapter 3, Section 3.2 discusses these causes of impairment and Section 3.4 provides a discussion on agricultural contributions to water quality impacts. Chapter 6, Section 6.5.2 presents some suggested management strategies to reduce the negative impacts agricultural activites can have on water quality.

RECOMMENDED MANAGEMENT STRATEGIES FOR RESTORING AND PROTECTING IMPAIRED WATERS AND SELECT "THREATENED" WATERS

Those waters in the basin that are considered impaired based on DWQ monitoring data are presented in Table 2. A summary of the management strategy developed for this waterbody is also presented. Some additional streams with known water quality problems which have not led to impairment but for which a management strategy has been developed are presented in summary in Table 3. For more details on water quality problems or management strategies for these waters, refer to Chapter 6, Section 6.3.

These waterbodies are impaired, at least in part, due to nonpoint sources of pollution. The tasks of identifying nonpoint sources of pollution and developing management strategies for these impaired waterbodies, is very resource-intensive. Accomplishing these tasks is overwhelming, given the current limited resources of DWQ, other agencies (e.g.-Division of Land Resources, Division of Soil and Water Conservation, Cooperative Extension Service, etc.) and local governments. Therefore, only limited progress towards restoring those NPS impaired waterbodies can be expected during this five-year cycle unless substantial resources are put towards solving NPS problems. Due to these restraints, this plan has no NPS management strategies for most of the streams with NPS problems.

DWQ plans to further evaluate the impaired waterbodies in the Yadkin-Pee Dee River basin in conjunction with other NPS agencies and develop management strategies for a portion of these impaired waterbodies for the second Yadkin River Basinwide Water Quality Management Plan, in accordance the requirements of Section 303(d).

Table 2 Partially Supporting or Not Supporting Monitored Waters in the Yadkin-Pee Dee River Basin*

Subbasin	Waterbody	Use Support Rating	Potential Sources	Recommended Mgt. Strategy*
030703	Ararat R. below Mt Airy	PS	NP,P	Actions by local governments and agencies are needed to reduce NPS pollution. The Division will continue to evaluate instream data submitted by the City of Mount Airy.*
030703	Lovills Cr. at SR 1371	PS	NP	Further investigation is necessary to determine actions needed.*
030703	Heatherly Cr.	PS & NS	NP,P	Continued monitoring will quantify improvements with the removal of the Pilot Mountain WWTP discharge.*
030704	Reynolds Cr.	PS	NP,P	Sequoia WWTP should submit an engineering alternatives analysis.*
030704	Salem Cr. - Middle Fork	PS	NP	Action by Forsyth County and the City of Winston Salem are needed to improve water quality. DWQ will reevaluate the model to determine if wasteload allocation should be revised.*
030704	Grants Cr.	PS	P,NP	DWQ will monitor for improvement after the City of Salisbury's discharges are eliminated. If the creek is still impaired after the Salisbury discharge is removed, DWQ will identify other point sources of pollution and the options for these sources.*
030706	Fourth Cr. below Statesville	PS	NP	Pollutant sources must be identified, along with methods to reduce nutrient loading.*
030707	Brushy Fork at SR1810	PS	NP	Additional activity by local governments and agencies and the Nonpoint Source Team are needed.*
030707	Hamby Cr. at I-85, SR2031 (Abbotts Cr. watershed)	NS	NP,P	No new dischargers of oxygen-consuming wastes should be permitted. Thomasville and Lexington should serve as regional WWTPs for future wastewater needs.*
030708	Lick Cr. at SR2351, NC8	PS	P,NP	New dischargers, including the Town of Denton's proposed outfall, should receive advanced tertiary limits for oxygen-consuming wastes.*
030708	Little Mtn Cr.	PS	NP,P	New or expanding discharges should receive advanced tertiary limits for oxygen-consuming wastes under the current zero flow regulations. Low dissolved oxygen levels will be evaluated and appropriate actions pursued during FERC relicensing.*
030710	Pee Dee R. below Lake Tillery	PS	NP	New or expanding discharges to the Pee Dee River below Lake Tillery should meet limits no less stringent than 15 mg/l BOD5, 4 mg/l NH3N and 5 mg/l DO. Appropriate mitigative actions will be pursued during FERC relicensing.*

Table 2 Partially Supporting or Not Supporting Monitored Waters in the Yadkin-Pee Dee River Basin* (Cont'd)

030710	Brown Cr. at SR1627	PS	NP	No new discharges should be permitted in this watershed.*
030711	upper Rocky River	NS (a portion is rated support threatened)	NP	New or expanding dischargers above Mallard Creek should receive limits of 5 mg/l BOD and 2 mg/l NH3N. New or expanding discharges below Mallard Creek will receive total BODu limits 32 mg/l. Model results will be used to evaluate specific scenarios for future allocations in the river. The City of Charlotte and Cabarrus and Mecklenburg Counties should investigate pollution sources and develop mitigation plans to protect the river from further degradation.*
030711	Coddle Cr. at NC49	PS	NP	The NC Division of Water Resources has requested a minimum streamflow, intended to maintain downstream habitat, from the Coddle Creek impoundment (Chp 2, Sect 2.9). This minimum flow may or may not improve water quality at the DWQ downstream sampling site. DWQ will continue to monitor for improved effects. The Town of Concord is encouraged to take steps to reduce nonpoint source runoff to Coddle Creek.*
030712	Goose Cr.	NS	NP,P	A field-calibrated QUAL2E model will be developed to evaluate assimilative capacity of the creek.*
030712	N. & S. Fork Crooked Cr.	PS	P,NP	DWQ recommends that no additional oxygen-consuming wastes be permitted in N. Fork Crooked Creek until data are available to evaluate the impact of existing loading. No additional loading of oxygen-consuming wastes will be permitted in S. Fork Crooked Creek.*
030713	Long Lake	NS	NP	Long Lake is drained and under a local restoration project.
030714	Richardson Cr. below Monroe	PS	NP,P	No new discharges of oxygen-consuming wastes should be permitted above Monroe's WWTP.*
030714	Lanes Cr.	NS & PS	NP	Every alternative to discharge should be thoroughly examined before a new outfall is considered.*
030716	Cartledge Cr. at SR 1142	PS	NP	Additional activity by local governments and agencies are needed to develop a plan to reduce nonpoint source pollution.*
030716	Hitchcock Cr. at SR 1109	NS	NP	No additional loads of oxygen-consuming wastes within 4 miles of mouth of creek should be permitted.*
030716	Rockingham City Lake	PS	NP	Local restoration actions will need to be taken.*
030716	Hamlet City Lake	PS	NP	Local restoration actions are planned.*
030717	N. Fork Jones Cr. at SR 1121 and S. Fork Jones Cr., Anson Cnty	PS	NP	Before any new outfalls are permitted, it is recommended that additional data be collected to aid in assessing assimilative capacity. Additional investigation is necessary to identify specific nonpoint sources of contamination.*

Notes: NS = Not Supporting PS = Partially Supporting
NP = Nonpoint Sources P = Point Sources
* - Only limited progress towards developing and implementing NPS strategies for these impaired waters can be expected without additional resources.

Table 3 Recommended TMDLs and Management Strategies for Addressing Oxygen-Consuming Wastes with Reference to Subbasin Summaries.

Map Reference #	Subbasin	Receiving Stream	Management Strategy	Chp. 6 Sect.
1	030704	Grants Creek	If DO violations continue after Salisbury has relocated, other sources of pollution will need to be identified.	6.3.4-E
2	030704	Salem Creek & Muddy Creek	Reevaluate QUAL2E model to determine if the wasteload allocation for the Archie Elledge Plant should be revised.	6.3.4-E
3	030705	Cedar Creek	To aid in assessing the assimilative capacity, additional water quality data should be collected before permitting new dischargers.	6.3.4-F
4	030706	Second Creek (North)	Field calibrated model should be considered for assessing the potential impact of new or expanding dischargers.	6.3.4-G
5	030707	Rich Fork	No additional loadings of oxygen-consuming wastes should be permitted.	6.3.4-H
6	030707	Abbotts Creek watershed	No new dischargers of oxygen-consuming wastes should be permitted. Thomasville and Lexington should serve as regional WWTPs for future wastewater needs.	6.3.4-H
7	030708	Mountain Cr. arm of Lake Tillery	Low dissolved oxygen levels in the Mountain Cr. arm of Lake Tillery will be evaluated. Appropriate actions will be pursued during FERC relicensing.	6.3.4-I
8	030708	Upper Lake Tillery	Low dissolved oxygen levels in the upper reaches of Lake Tillery will be evaluated. Appropriate actions will be pursued during FERC relicensing.	6.3.4-I
9	030708	Clarks Creek	Further evaluation and updated flow information should be obtained if the Mt. Gilead discharge remains, or new discharges locate to this creek.	6.3.4-I
10	030708	Yadkin River	Low dissolved oxygen levels below High Rock Lake dam will be evaluated and appropriate actions pursued during FERC relicensing.	6.3.4-I
11	030710	Pee Dee River	New or expanding discharges to the Pee Dee River below Lake Tillery should meet limits no less stringent than 15 mg/l BOD5, 4 mg/l NH3N and 5 mg/l DO. Appropriate mitigative actions will be pursued during FERC relicensing.	6.3.4-K
12	030710	Brown Creek	No new discharges should be permitted in this watershed.	6.3.4-K
13	030711	Mallard Cr & Rocky R. watershed upstrm of Mallard Cr	New or expanding discharges, if permitted, should receive limits of 5 mg/l BOD and 2 mg/l NH3N.	6.3.4-L
14	030711	Rocky River below Mallard Creek	New or expanding discharges are to receive BODu limits equal to 32 mg/l.	6.3.4-L
15	030712	Goose Creek	Field calibrated model will be developed to evaluate assimilative capacity of the creek.	6.3.4-M
16	030712	Crooked Creek	Before any new outfalls are permitted, it is recommended that additional chemical/physical data be collected to aid in assessing the assimilative capacity of the proposed receiving stream.	6.3.4-M
17	030712	South Fork Crooked Creek	No additional loads of oxygen-consuming wastes will be permitted.	6.3.4-M

Table 3 Recommended TMDLs and Management Strategies for Addressing Oxygen-Consuming Wastes with Reference to Subbasin Summaries (cont'd).

18	030712	North Fork Crooked Creek	No additional loads of oxygen-consuming wastes until data has been collected on the creek to determine impacts from existing facility.	6.3.4-M
19	030712	Rocky River	New or expanding dischargers to the river between the Rocky River Regional WWTP and the confluence with Muddy Creek will receive total BODu limits of approx. 32 mg/l. In addition, DWQ is planning to request USGS to develop a low flow profile for the river so that the QUAL2E model can be extended to the mouth of the river.	6.3.4-M
20	030713	Long Creek	The City of Albemarle should optimize treatment processes. More stringent BOD_5 limits will be considered.	6.3.4-N
21	030714	Richardson Creek	No new discharges of oxygen-consuming wastes should be permitted above Monroe's WWTP.	6.3.4-O
22	030716	Hitchcock Creek	No additional loads of oxygen-consuming wastes within 4 miles of mouth of creek should be permitted.	6.3.4-Q
6.3.4-Q	030716	Marks Creek	Additional loadings of oxygen-consuming wastes are not recommended. If future expansions are to be reconsidered, it is recommended that DWQ analyze the feasibility of developing a field calibrated model in order to assess the assimilative capacity of the stream.	
6.3.4-Q	030716	Pee Dee River	Low dissolved oxygen levels below Blewett Falls Lake dam will be evaluated and appropriate actions pursued during FERC relicensing.	
6.3.4-R	030717	Jones Creek and Deadfall Creek catchments	Before any new outfalls are permitted, it is recommended that additional chemical/physical data be collected to aid in assessing the assimilative capacity of the proposed receiving stream.	

POTENTIAL RECLASSIFICATION TO HIGH QUALITY WATERS OR OUTSTANDING RESOURCE WATERS

Based on DWQ monitoring, there are several waterbodies that may be considered eligible for reclassification to HQW or ORW (Table 4).

Table 4 Potential HQW/ORW Waters in the Yadkin-Pee Dee River Basin

Subbasin	Waterbodies
030701	Buffalo Creek, Stoney Fork, Mulberry Creek, Roaring River and Middle Prong Roaring River
030706	upper South Yadkin River, Hunting Creek, North Little Hunting Creek and Rocky Creek
030710	Mountain Creek
030714	West Fork Little River
030716	Beaverdam Creek, Bones Fork Creek and Rocky Fork Creek

FUTURE INITIATIVES IN THE YADKIN-PEE DEE RIVER BASIN

Nonpoint Source Control Strategies and Priorities/Nutrient Reduction Efforts

Improving knowledge of and controlling nonpoint source pollution will be a high priority over the next five years. Nonpoint source pollution is primarily responsible for the impaired and threatened waters in the Yadkin-Pee Dee River basin. The following two initiatives are underway to address the protection of surface waters from nonpoint sources of pollution.

- Establishment of nonpoint source basin teams in each basin. DWQ has begun to establish a nonpoint source team in each of the state's 17 major river basins. Two nonpoint source teams have been established for the upper and the lower Yadkin-Pee Dee River basin. Refer to Chapter 7, Section 7.2.2 for further description.

- Interagency Water Quality Monitoring. DWQ has begun the process of coordinating with other natural resource agencies on the idea of interagency water quality monitoring across the state. Refer to Chapter 7, Section 7.2.3 for more information.

Efforts to Improve NC's Sedimentation and Erosion Control Program

Recently, there has been an initiative in the Division of Land Resources to address sediment and turbidity water quality problems across the state. The Sedimentation and Erosion Control Commission recognized the need to evaluate the implementation of the existing programs. A Technical Advisory Committee was established to develop recommendations for the Commission. The Commission supported the recommendations and instructed staff to implement the ones which can be implemented without rule or statute changes and establish a schedule to implement the others. The changes are expected to result in program implementation improvements and reduction in sediment losses to our streams.

The North Carolina Wetlands Restoration Program

The North Carolina Wetlands Restoration Program (NCWRP) was established by the General Assembly in 1996. The purpose of the NCWRP is to protect and improve water quality, flood prevention, fisheries, wildlife and plant habitats, and recreational opportunities through the protection and restoration of wetlands and riparian areas. The NCWRP will accomplish this purpose by implementing projects that will restore wetland and riparian area functions and values throughout North Carolina.

Beginning July 1, 1997, comprehensive Basinwide Restoration Plans will be developed for each river basin in conjunction with the Basinwide Water Quality Management Plans. GIS-based mapping methodologies will be used to assess the status of existing wetlands and riparian area resources within each basin and to identify degraded wetlands and riparian areas. Potential restoration sites will be prioritized based on the ability of the restored sites to address problems that have been identified in the Basinwide Water Quality Management Plans. The Yadkin-Pee Dee River Basinwide Restoration Plan will be one of the first plans developed. See Chapter 7, Section 7.3.2 for more details.

National Pollutant Discharge Elimination System (NPDES) Program

In the next five years, efforts will be continued to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes to municipal wastewater treatment plants so as to maintain reduced toxicity in effluent wastes;

- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or the use of alternative disinfectants for new or expanding facilities;
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for expansion well before they reach capacity.

Longer-term objectives will include refinement of overall management strategies. Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling byproducts of the treatment process (including reuse of nonpotable treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

Use of Discharger Self-Monitoring Data

DWQ will continue to make greater use of discharger self-monitoring data to augment the data it collects through the programs described in Chapter 4. Quality assurance, timing and consistency of data from plant to plant will be issues of importance. Also, a system will need to be developed to enter the data into a computerized database for later analysis.

In an effort to improve the qualtiy and consistency of self-monitoring data, DWQ is working with a coalition of dischargers in the Yadkin-Pee Dee river basin to develop a strategic monitoring plan that is similar, and in compliment to, DWQ's ambient monitoring system. Similar programs are effectively used in the lower Neuse and Cape Fear River basins. See Chapter 7, Section 7.3.4.

Promotion of Non-Discharge Alternatives/Regionalization

DWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including connection to an existing WWTP or land-applying wastes are preferred from an environmental standpoint. If the Division determines that there is an economically reasonable alternative to a discharge, DWQ may recommend denial of the NPDES permit.

Coordinating Basinwide Management with Other Programs

The basinwide planning process helps to identify and prioritize waterbodies in need of protection or restoration efforts and provides a means of disseminating this information to other water quality protection programs. The potential exists to identify wastewater treatment plants in need of funding for improvements through DWQ's Construction Grants and Loan Program. The plans can also assist in identifying projects and waterbodies applicable to the goals of the Clean Water Management Trust Fund, Wetlands Restoration Program, or Section 319 grants program. Finalized basin plans are provided to these program offices for their use and to other state and federal agencies.

Improved Data Management and Expanded Use of Geographic Information System (GIS) Computer Capabilities

DWQ is in the process of centralizing and improving its computer data management systems. Most of its water quality program data including permitted dischargers, effluent limits, compliance information, water quality data and stream classifications, will be put in a central data center which will be made accessible to most staff at desktop computer stations. Much of this information is also being entered into the state's GIS computer system. As all this information is made available to the GIS system, including land use data from satellite or air photo interpretation, and as the system becomes more user friendly, the potential to graphically display the results of water quality data analysis will be tremendous.

Improved Monitoring and Assessment of Erosion Impacts

Sedimentation is perceived by the workshop participants and the Yadkin-Pee Dee River basin NPS Teams as one of the highest priorities in the basin. Many streams are impacted or impaired, at least in part, due to sedimentation. Erosion is evident throughout the basin. The fact that sedimentation is visible and aesthetically unpleasant helps make it a higher profile issue. The extent of sedimentation problems can be difficult to diagnose with the monitoring methods historically used by DWQ and many other state water quality agencies. Suspended solids sampling conducted on a scheduled monthly basis is likely to miss most of the high-flow periods during which the majority of sediment is transported. Benthic monitoring techniques may not always identify the effects of sedimentation, which can impact aquatic organisms by reducing and altering available habitat.

Some of the actions that DWQ and others will take towards improving monitoring and assessment of erosion impacts are:

- DWQ currently does not have adequate means of quantifying the effects of sedimentation on water quality. DWQ recognizes the need to improve its targeting and monitoring capabilities in order to further identify sediment problems as well as to facilitate and support efforts to restore degraded areas. This points to the need for targeted management efforts coupled with a monitoring strategy which effectively measures sediment transport under both average and extreme conditions. DWQ will work toward developing interagency resources for enhancing the ability to measure and model erosion and sediment levels, to identify sediment source areas, and to recommend appropriate management practices. DWQ will initiate discussions among staff and other agencies to determine how these issues can best be addressed given current resource constraints. DWQ will also try to determine what, if any, programmatic changes can be made to gain better knowledge on sedimentation.
- Locally-based watershed improvement efforts represent an important mechanism for restoring streams and watersheds degraded by sedimentation. The Division is working with several such projects in the Yadkin-Pee Dee River basin and will continue to do so. Funding for such efforts can come from a number of sources (See Appendix VI), including the Agricultural Cost Share Program, Section 319 grants and the Clean Water Management Trust Fund. The Division's role in such projects can include assistance with problem identification and targeting, monitoring and other technical assistance.
- DWQ is currently working with the Division of Land Resources, Division of Forest Resources and Division of Soil and Water Conservation to develop a Memorandum of Agreement for Turbidity. Turbidity is an indicator of sedimentation in a waterbody. The intent of the agreement is to establish a relationship between the agencies that better defines each agency's responsibility for activities related to turbidity. The turbidity standard is not being changed under this agreement.

Additional Research and Monitoring Needs

DWQ staff has identified some additional research and monitoring needs that would be useful for assessing and, ultimately, protecting and restoring the water quality of the Yadkin-Pee Dee River basin. The following list is not inclusive. Rather, it is meant to stimulate ideas for obtaining more information to better address water quality problems in the basin. With the newly available funding programs (Clean Water Management Trust Fund and Wetlands Restoration Program) and the existing Section 319 grant program, it may be desirable for grant applicants to focus proposals on the following issues:

- More resources are needed to address nonpoint sources of pollution. Identifying nonpoint sources of pollution and developing management strategies for impaired waterbodies, given the current limited resources available, is an overwhelming task. Therefore, only limited progress towards restoring NPS impaired waterbodies can be expected unless substantial resources are put towards solving NPS problems.
- Long-range water supply planning for the upper portion of the basin is needed. The proposed water withdrawal by the City of Winston-Salem has the potential to reduce low flow conditions in the mainstem of the Yadkin River enough to affect the River's waste assimilative capacity.
- Growth management/urban stormwater planning (specifically for the Rocky River drainage out of Charlotte and in the Winston-Salem area) are needed. Increased population in these areas will demand more water and generate more wastewater. In addition, conversion of land from forests and farms will increase impervious surfaces and produce higher than natural streamflows and cause erosion. Streams in these areas will likely become impaired unless this growth is planned for and managed properly.
- Need to update the sediment studies of the 1970's to the 1990's. This information would be used to predict future trends and to assess the effectiveness of major sediment control efforts (e.g.- the Farm Bill).
- There is a lack of data on impacts of summer low-flow conditions on aquatic life. The lack of flowing water during summer months can severely reduce the diversity of aquatic fauna. This problem has not been investigated in North Carolina and further research will be required to determine the effect of water withdrawals (e.g.- for irrigation) on stream life.
- Determining sedimentation rates and volumes in the Chain Lakes would be very useful.
- Document the impact of animal wastes in areas of high cattle (e.g.-Iredell County) and poultry (e.g.-Union County) production. There is a need for separating out the impact from organic loading, nutrient loading and other nonpoint sources.
- Need improved monitoring of small streams. These streams are currently ignored because of their size, but they are a source of pollution and this source will increase as growth occurs.
- The following comments and questions, as presented by the participants of the Lower Yadkin-Pee Dee River basin workshop, require attention:
  1. More data are needed to determine what percentage of water quality problems are due to agriculture.
  2. There needs to be a better understanding of, and more education on, color impacts from wastewater discharges.
  3. Need to identify both NPS and point source pollution contributions/contributors. What data do we have? Is it based on good science?
  4. Need better identification of the causes and sources of pollution in impaired streams. More resources should be put into determining why stream miles are impaired- "what is the source of poor water quality?" This is needed to develop appropriate management strategies.
  5. Identify problems before establishing regulations.
  6. Need more research on urban BMPs.
  7. We need education for farmers and better access to research.

CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose of this Basinwide Water Quality Management Plan is to report to citizens, policy makers and the regulated community on:

- the current status of surface water quality in the basin,
- major water quality concerns and issues,
- projected trends in development and water quality,
- the long-range water quality goals for the basin, and
- recommended point and nonpoint source management options.

This Plan presents strategies for management of both point and nonpoint sources of pollution. The Division of Water Quality (previously Division of Environmental Management) is preparing a basinwide water quality management plan for each of the state's 17 major river basins, as shown in Figure 1.1.

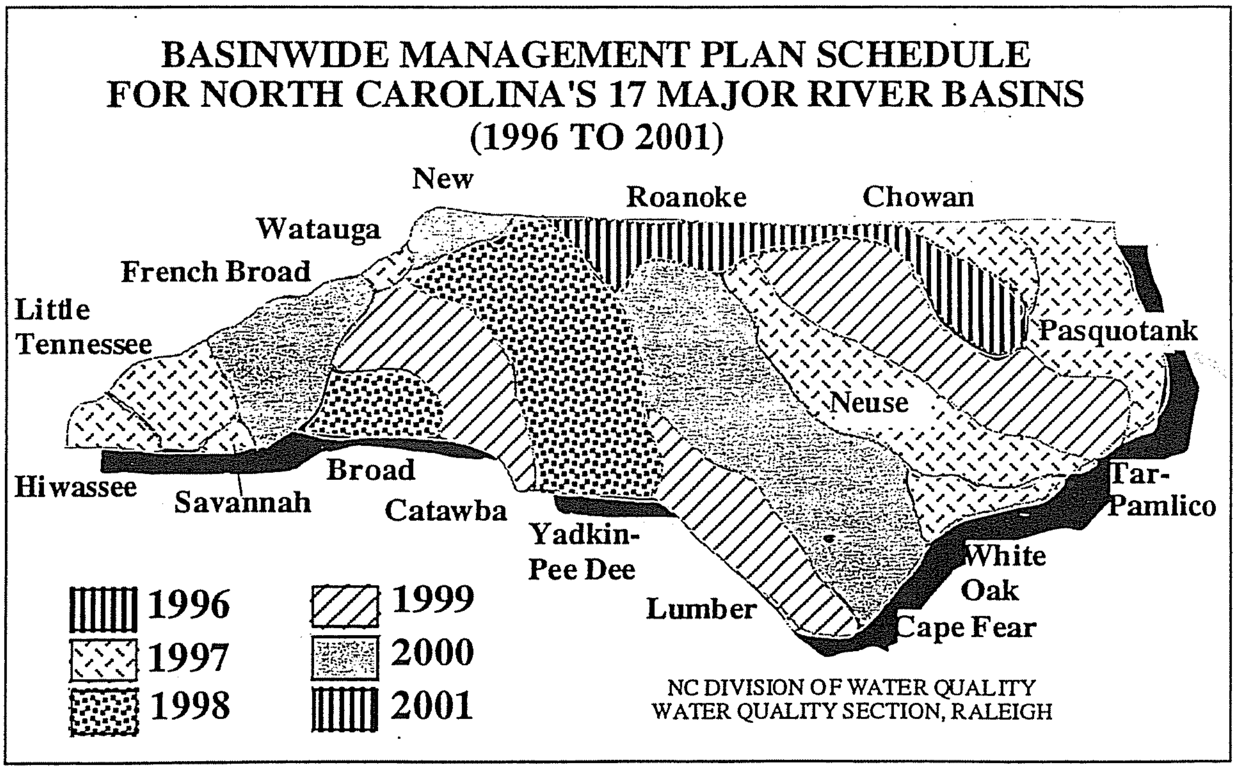


Figure 1.1 Basinwide Management Plan Schedule (1996 to 2001)

1.2 GUIDE TO USE OF THIS DOCUMENT

CHAPTER 1: Introduction - This chapter provides a non-technical description of the purpose of this plan, the basinwide water quality management approach and how this approach will be administered. The description of the basinwide management approach is based primarily on a 54-page framework document entitled *North Carolina's Basinwide Approach to Water Quality Management: Program Description - Final Report/August 1991* (Creager and Baker, 1991).

CHAPTER 2: General Basin Description- Some of the specific topics covered in this chapter include:

- an overview of the major features such as location, rainfall, population, physiography, etc.
- hydrology of the basin and its subbasins
- a summary of land cover within the basin based on results of a 1982 and 1992 Nationwide Resources Inventory (NRI) conducted by the US Department of Agriculture Natural Resources Conservation Service.
- population growth trends and densities by subbasin using 1970, '80 and '90 census data.
- major water uses in the basin and DWQ's program of water quality classifications and standards.

CHAPTER 3: Causes of Impairment and Sources of Water Pollution - This chapter describes both point and nonpoint sources of pollution. It also describes a number of important causes of water quality impacts including sediment, biochemical oxygen demand (BOD), toxic substances, nutrients, color, fecal coliform bacteria and others. Pollutant loading in the basin and general water quality problem areas are discussed.

CHAPTER 4: Water Quality and Use Support Ratings - This chapter describes the various types of water quality monitoring conducted by DWQ, summarizes water quality in each of the subbasins in the basin and presents a summary of use support ratings for those surface waters that have been monitored or evaluated.

CHAPTER 5: Water Quality Programs and Program Initiatives in the Basin - Chapter 5 summarizes the existing point and nonpoint source control programs available to address water quality problems. These programs are management tools available for addressing the priority water quality concerns and issues that are identified in Chapter 6. Chapter 5 also describes the concept of Total Maximum Daily Loads (TMDLs). TMDLs represent management strategies aimed at controlling point and nonpoint source pollutants. This chapter also describes various program initiatives being implemented in the basin to address water quality problems.

CHAPTER 6: Major Water Quality Concerns and Recommended Management Strategies - Water quality issues identified in Chapters 2, 3 and 4 are evaluated and prioritized based on use-support ratings, degree of impairment, and the sensitivity of the aquatic resources being affected. Recommended management strategies, or TMDLs, are presented that describe how the available water quality management tools and strategies described in Chapter 5 will be applied in the basin. This includes generalized wasteload allocations for dischargers and recommended programs and best management practices for controlling nonpoint sources.

CHAPTER 7: Future Initiatives - This chapter presents future initiatives for protecting or improving water quality in the basin. These may include both programmatic initiatives such as improving permit compliance, or basin-specific initiatives such as developing strategies for restoring impaired waters.

1.3 NORTH CAROLINA'S BASINWIDE MANAGEMENT APPROACH

Introduction - Basinwide water quality management is a watershed-based management approach being implemented by DWQ which features basinwide permitting, integrating existing point and nonpoint source control programs, and preparing basinwide management plans. DWQ is applying this approach to each of the seventeen major river basins in the state as a means of better identifying water quality problems, developing appropriate management strategies, maintaining and protecting water quality and aquatic habitat, and assuring equitable distribution of waste assimilative capacity for dischargers.

After conducting public workshops to identify areas of concern and major issues, a basinwide management plan is prepared for each basin. The plans are circulated for public review and are presented at public meetings in each river basin. The management plan for a given basin is completed and approved preceding the scheduled date for basinwide discharge permit renewals in that basin. The plans are then evaluated, based on followup water quality monitoring, and updated at five year intervals.

DWQ began formulating the idea of basinwide management in the late 1980s, established a basin permitting schedule in 1990, began basinwide monitoring activities in 1990, and published a basinwide program description in August 1991. Basinwide management entails coordinating and integrating, by major river basin, DWQ's water quality program activities. These activities, which are discussed further in Section 1.4, include permitting, monitoring, modeling, nonpoint source assessments, and planning.

Water Quality Program Benefits - Several benefits of basinwide planning and management to North Carolina's Water quality program include:

- ***Improved program efficiency.*** By reducing the area of the state covered each year, monitoring, modeling, and permitting efforts can be focused. As a result, *efficiency increases* can be achieved for a given level of funding and resource allocation.
- ***Increased effectiveness.*** The basinwide approach is in consonance with basic ecological watershed management principles, leading to *more effective* water quality assessment and management. Linkages between aquatic and terrestrial systems are addressed (e.g., contributions from nonpoint sources). All inputs to aquatic systems and potential interactive, synergistic and cumulative effects are considered.
- ***Better consistency and equitability*** . By clearly defining the program's long-term goals and approaches, basinwide plans will encourage *consistent* decision-making on permits and water quality improvement strategies. Consistency and greater attention to long-range planning will promote a *more equitable* distribution of assimilative capacity, explicitly addressing the trade-offs among pollutant sources and allowances for economic growth.
- ***Increased public awareness of the state's water quality protection programs.*** The basinwide plans are an educational tool for increasing public awareness of water quality issues within the basin.
- ***Basinwide management promotes integration of point and nonpoint source pollution assessment and controls.*** Once waste loadings from both point and nonpoint sources are established, management strategies can be developed to prevent overloading of the receiving waters and to allow for a reasonable margin of safety to ensure compliance with water quality standards.

Basinwide Planning Schedule - The following table presents the overall basin schedule for all 17 major river basins in the state. Included are the dates for permit reissuance and the dates by which management plans are to be completed for each basin.

Table 1.1. Basinwide Permitting and Planning Schedule for North Carolina's 17 Major River Basins.

Basin	Begin NPDES Permit Issuance	*Final Plan Receives EMC Approval	Public Mtgs. and Draft out For Review	EMC/WQC Approval For Public Meetings	Inhouse Draft due for Staff Review	DWQ Biological Data Collection
Neuse	4/1993	**2/1993**	11/1992	9/1992	7/1992	Summer 91
Lumber	11/1994	**6/1994**	2/1994	11/1993	7/1993	Summer 91
Tar-Pamlico	1/1995	**12/1994**	9/1994	7/1994	5/1994	Summer 92
Catawba	4/1995	**2/1995**	11/1994	9/1994	7/1994	Summer 92
Fr. Broad	8/1995	**5/1995**	2/1995	12/1994	10/1994	Summer 92
New	11/1995	**7/1995**	6/1995	4/1995	3/1994	Summer 93
Cape Fear	1/1996	**9/1995**	6/1995	5/1995	4/1995	Summer 93
Roanoke	1/1997	**9/1996**	4/1996	2/1996	9/1995	Summer 94
White Oak	6/1997	**2/1997**	9/1996	7/1996	4/1996	Summer 94
Savannah	8/1997	**5/1997**	2/1997	12/1996	6/1996	Summer 94
Watauga	9/1997	**4/1997**	12/1997	10/1996	6/1996	Summer 94
Little Tenn.	10/1997	**5/1997**	2/1997	12/1996	7/1996	Summer 94
Hiwassee	12/1997	**5/1997**	2/1997	12/1996	7/1996	Summer 94
Chowan	1/1998	**9/1997**	6/1997	3/1997	11/1996	Summer 95
Pasquotank	2/1998	**9/1997**	6/1997	3/1997	11/1996	Summer 95
Neuse	4/1998	9/1998	7/1998	5/1998	3/1998	Summer 95
Yadkin	7/1998	**5/1998**	2/1998	12/1997	9/1997	Summer 96
Broad	11/1998	7/1998	4/1998	2/1998	11/1997	Summer 95
Lumber	11/1999	5/1999	2/1999	12/1998	8/1998	Summer 96
Tar-Pamlico	9/1999	5/1999	2/1999	12/1998	10/1998	Summer 97
Catawba	4/2000	10/1999	6/1999	4/1999	12/1998	Summer 97
Fr. Broad	8/2000	2/2000	10/1999	7/1999	3/1999	Summer 97
New	11/2000	5/2000	2/2000	12/1999	8/1999	Summer 98
Cape Fear	1/2001	7/2000	2/2000	12/1999	8/1999	Summer 98
Roanoke	1/2002	7/2001	2/2001	12/2000	8/2000	Summer 99

* Dates in bold print denote plans approved by the EMC

The number of plans to be developed each year varies from one to six and is based on the total number of permits to be issued each year. For example, the Cape Fear basin, the state's largest, has about as many dischargers as all six of the small basins in 1997. This has been done in order to balance the permit processing workload from year to year. In years where more than one basin is scheduled to be evaluated, an effort has been made to group at least some of the basins geographically in order to minimize travel time and cost for field studies and public meetings.

Plans to be updated every five years - The earliest basin plans will likely not achieve all of the long-term objectives for basinwide management outlined above. However, plans are updated every 5 years. Updated plans will incorporate additional data and new assessment tools (e.g., basinwide water quality modeling) and management strategies (e.g., for reducing nonpoint source contributions) as they become available.

Basinwide Plan Preparation, Review and Public Involvement - Preparation of an individual basinwide management plan is a five year process which is broken down into four phases as described below.

Year	**Activity**
Year 1 to 3	Water Quality Data Collection/Identification of Goals and Issues: Year 1 entails identifying sampling needs and canvassing for information. It also entails coordinating with other agencies, the academic community and local interest groups to begin establishing goals and objectives and identifying and prioritizing problems and issues. Biomonitoring, fish community and tissue analyses, special studies and other water quality sampling activities are conducted in Years 2 and 3 by DWQ's Environmental Sciences Branch (ESB). These studies provide information for assessing water quality status and trends throughout the basin and provide data for computer modeling.
Year 3 to 4	Data Assessment and Model Preparation: Modeling priorities are identified early in this phase and are refined through assessment of water quality data from the ESB. Data from special studies are then used by DWQ's Technical Support Branch (TSB) to prepare models for estimating potential impacts of waste loading from point and nonpoint sources using the TMDL approach. Preliminary water quality control strategies are developed based on modeling, with input from local governments, the regulated community and citizen groups during this period.
Year 4	Preparation of Draft Basinwide Plan: The draft plan, which is prepared by DWQ's Planning Branch, is due for completion by the end of year 4. It is based on support documents prepared by DWQ's Environmental Sciences Branch (water quality data) and the Technical Support Branch (modeling data and recommended pollution control strategies). Preliminary findings are presented at informal meetings through the year with local governments and interested groups, and comments are incorporated into the draft.
Year 5	Public Review and Approval of Plan: At the beginning of year 5, the draft plan, after approval of the Environmental Management Commission (EMC), is circulated for review and public meetings are held. Revisions are made to the document, based on public comments, and the final document is submitted to the EMC for approval midway through year 5. Basinwide permitting begins at the end of year 5.

Implementation - The implementation of basinwide planning and management will occur in phases. Permitting activities and associated routine support activities (field sampling, modeling, wasteload allocation calculations, etc.) have already been rescheduled by major river basin. All National Pollutant Discharge Elimination System (NPDES) permit renewals within a basin occur within a prescribed time period after completion of the final basin plan, and will be repeated at five year intervals.

Nonpoint source management proposals will be implemented by several different avenues. The Water Quality Section is setting up nonpoint source (NPS) teams for each basin. These teams are made up of representatives of nonpoint source agencies, resource agencies, and special interest groups. The NPS teams are responsible for prioritizing specific watersheds for follow-up investigations, educational efforts, and best management practice (BMP) implementation. Funding for BMP implementation will be sought from sources such as existing cost-share monies or from federal Section 319 grants. In addition to projects in specific watersheds, the NPS team will develop programmatic action plans for each category of nonpoint source pollution. The action plans detail voluntary actions that agencies and groups have committed to complete to protect and improve water quality in the basin. Many of the action plan items involve increased educational efforts or enforcement of existing programs.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE DWQ WATER QUALITY SECTION

The Division of Water Quality is the lead state agency for the regulation and protection of the state's surface waters. The Division is comprised of four sections: Water Quality, Groundwater, Construction Grants and Loans, and the Water Quality Laboratory.

The primary responsibilities of the Division of Water Quality are to maintain or restore an aquatic environment to sufficient quality to protect the existing and best intended uses of North Carolina's surface waters and to ensure compliance with state and federal water quality standards. The Division receives both state and federal allocations as well as funding through permit fee collections. Policy guidance is provided by the Environmental Management Commission. The major areas of responsibility are water quality monitoring, permitting, planning, modeling (wasteload allocations) and compliance oversight.

The Central office is divided into five branches, each branch is subdivided into units (Figure 1.2). The Planning Branch is responsible for developing surface water quality standards and classifications, nonpoint source program planning, administering the basinwide management program, modeling nonpoint pollution sources, developing use support ratings and supporting related GIS capabilities. It also coordinates the development of TMDLs and wasteload allocations for dischargers, provides primary computer modeling support, and coordinates EPA water quality planning grants and the implementation of the Comprehensive Conservation and Management Plan (CCMP) that resulted from the Albemarle-Pamlico Estuarine Study (APES).

The Regional Program Management Coordination Branch is responsible for providing increased communication and coordination of the water quality program. The responsibilities include the water supply watershed protection program, State Environmental Policy Act coordination for the Section, the operator training and certification program, emergency response, the development and administration of the enterprise wide database management system, and coordination and program management activities between the central and seven regional offices. The Environmental Technologies Unit is responsible for providing better access to data managed by the Water Quality Section so as to facilitate information exchange and analysis with the public as well as internal users. The Technical Assistance and Certification Unit rates the complexity of operation of wastewater treatment plants, provides training and operator certification commensurate with the plant operating needs, and provides technical assistance as requested by wastewater treatment systems. The Local Government Assistance Unit assists local governments in meeting the requirements of the water supply watershed protection program, managing the collection system permitting program, coordinating water quality state environmental policy act responsibilities and managing the EPA 205(j) grants program. The Branch also has the responsibility of ensuring program coordination through the seven Regional Offices.

The Environmental Sciences Branch is responsible for all biological and chemical water quality monitoring, discharger coalition water quality monitoring, and evaluations including benthic macroinvertebrate monitoring (biomonitoring), fish tissue, and fish communities studies. The Branch is also responsible for effluent toxicity testing and evaluations, biological laboratory certification, algal and aquatic macrophyte analyses, long term biochemical and sediment oxygen demand, and lakes assessments. The Branch interacts heavily in 305(b) use-support assessments and in water quality standards review and development. The Neuse River Rapid Response Team is coordinated through the Environmental Sciences Branch. The Branch is in the process of developing simplified public access to water quality information via the World Wide Web.

The Point Source Branch is responsible for permitting, compliance and enforcement of wastewater discharges into our state's surface waters. Permitting and enforcement programs include the municipal industrial pretreatment program, state and federal stormwater programs, and the National

Pollutant Discharge Elimination System (NPDES) program. Modeling is conducted to determine the receiving stream's ability to assimilate the discharge and protect the streams uses and surface water standards.

The Non-discharge Branch is responsible for permitting, compliance and enforcement of wastewater discharges that are **not** directly into our state's surface waters. Examples of these include spray irrigation systems, sludge applications, reuse systems and groundwater remediation projects. This branch also handles the section's activities related to wetlands including 401 certifications, wetland policy and mitigation, and DOT and dredging project reviews.

The seven Regional Offices carry out activities such as wetland reviews, compliance evaluations, permit reviews and facility inspections for both discharging and nondischarging systems, ambient water quality monitoring, state environmental policy act reviews, stream reclassification reviews, pretreatment program support and operator training and certification assistance. In addition, they respond to water quality emergencies such as oil spills and fish kills, investigate complaints and provide information to the public. Figure 1.3 shows the location of the regional offices and the counties that they serve.

REFERENCES CITED: CHAPTER 1

Creager, C.S., and J. P. Baker, 1991, North Carolina's Basinwide Approach to Water Quality Management: Program Description, DWQ Water Quality Section, Raleigh, NC.

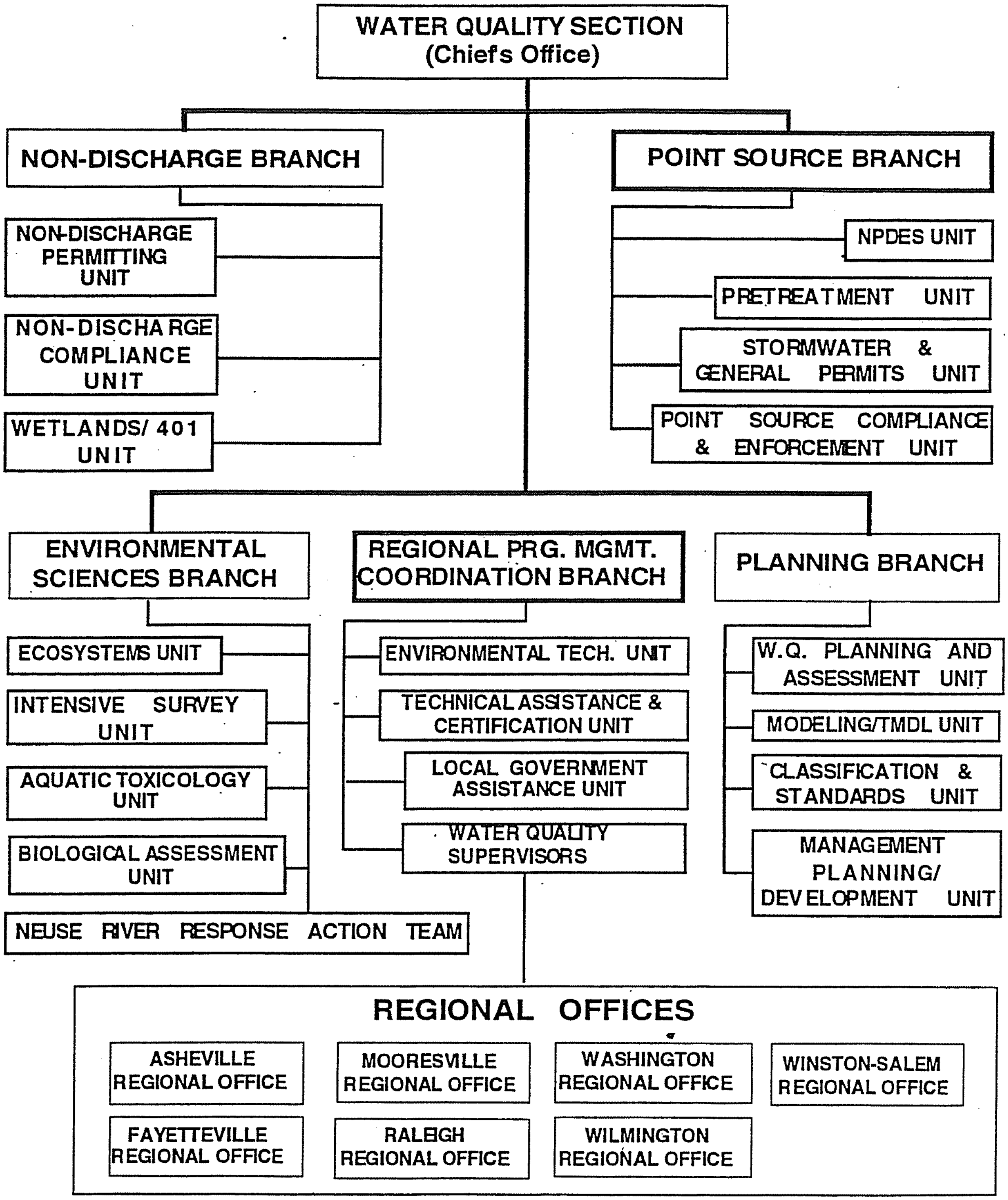
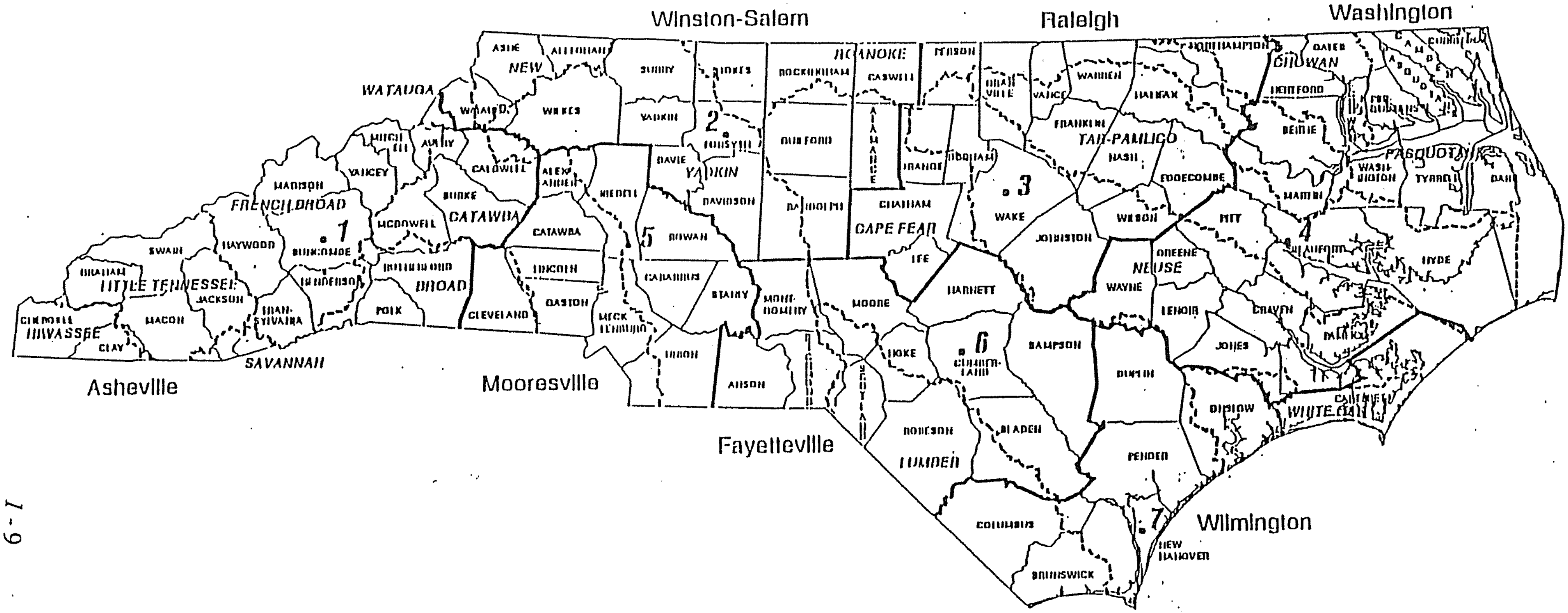


Figure 1.2 Organizational Structure of the DWQ Water Quality Section

N.C. Department of Environment and Natural Resources
Central & Regional Offices (with river basins)



1 - ARO
Mr. Roy Davis
Regional Supervisor
59 Woodfin Place
Asheville, NC 28801
(704) 251-6208
Fax (704) 251-6452

2 - WSRO
Mr. Larry Coble
Regional Suppervisor
585 Waughtown Street
Winston-Salem, NC 27107
(919) 771-4600
Fax (919) 771-4631

3 - Central Office
DENR, DWQ
Water Quality Section
P.O. Box 29535
Raleigh, NC 27626-0535
(919) 733-5083
Fax (919) 733-9919

3 - RRO
Mr. Ken Schuster
Regional Supervisor
3800 Barrett Drive
Raleigh, NC 27609
(919) 571-4700
Fax (919) 571-4718

4 - WaRO
Mr. Jim Mulligan
Regional Supervisor
1424 Carolina Avenue
Washington, NC 27889
(919) 946-6481
Fax (919) 975-3716

5 - MRO
Mr. Keith Overcash
Regional Supervisor
919 North Main Street
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Fax (704) 663-6040

6 - FRO
Mr. Tommy Stevens
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7 - WIRO
Mr. Rick Shiver
Regional Supervisor
127 Cardinal Drive Extension
Wilmigton, NC 28405-3845
(910) 395-3900
Fax (910) 350-2004

Figure 1.3 Location of Division of Water Quality Regional Offices

– – – River Basin Boundaries ——— Regional Office Boundaries

CHAPTER 2

GENERAL BASIN DESCRIPTION

2.1 YADKIN-PEE DEE RIVER BASIN OVERVIEW

The Yadkin-Pee Dee River basin is the second largest river basin in the state, covering 7,213 square miles. It includes eighty-three municipalities and all or part of twenty-four counties. The basin is primarily located within the piedmont physiographic region of the state (Figure 2.1), but also drains the mountain and coastal plain regions. Streams within each region are affected by the soils, geology and topography characteristic of that region.

The basin originates on the eastern slopes of the Blue Ridge Mountains in Caldwell, Wilkes and Surry Counties (Figure 2.2). A small portion of the Yadkin River headwaters originates in Virginia. It flows northeasterly for about 100 miles, then flows to the southeast until it joins the Uwharrie River to form the Pee Dee River. The Pee Dee River continues flowing southeasterly through South Carolina to the Atlantic Ocean. The North Carolina portion of the basin contains approximately 5,991 miles of freshwater streams and rivers.

To aid in locating the streams and lakes within the basin, this plan presents the basin as the upper Yadkin River basin (Figure 2.3) and the lower Yadkin River basin (Figure 2.4). The upper Yadkin River basin contains subbasins 03-07-01 through 03-07-07, which drain to High Rock Lake. The lower Yadkin River basin contains subbasins 03-07-08 through 03-07-17 which drain to the remaining chain lakes and the Pee Dee River.

Based on 1990 census data, the population of the basin was 1.2 million people. The most populated areas are in and near Winston-Salem and Charlotte. The overall population density is 163 persons per square mile versus a statewide average of 123 persons per square mile. While much of the basin contains rural areas surrounding small towns, many of the small to large cities have high density areas. The population of the basin grew by 10 % between 1980 and 1990.

Approximately one-half of the land comprising the Yadkin-Pee Dee River basin is forested. Statistics provided by the US Department of Agriculture, Natural Resources Conservation Service (NRCS) indicate that during the ten-year period from 1982 to 1992, there was a decrease in cultivated and uncultivated croplands. The NRCS data also shows an increase in urban and built-up lands, pasture lands and "Other" lands, which primarily includes rural transportation (roads, railroads, rights of way). Major land use activities in the basin include agriculture (crops and swine, poultry and cattle operations) and construction activities related to growth. Iredell County has the largest dairy cattle population in the state.

There are a number of High Quality and Outstanding Resource Waters in the basin and many state and federally listed threatened and endangered species, as discussed later in this chapter. The Yadkin-Pee Dee River basin contains a high number of lakes which attract many tourists to the area.

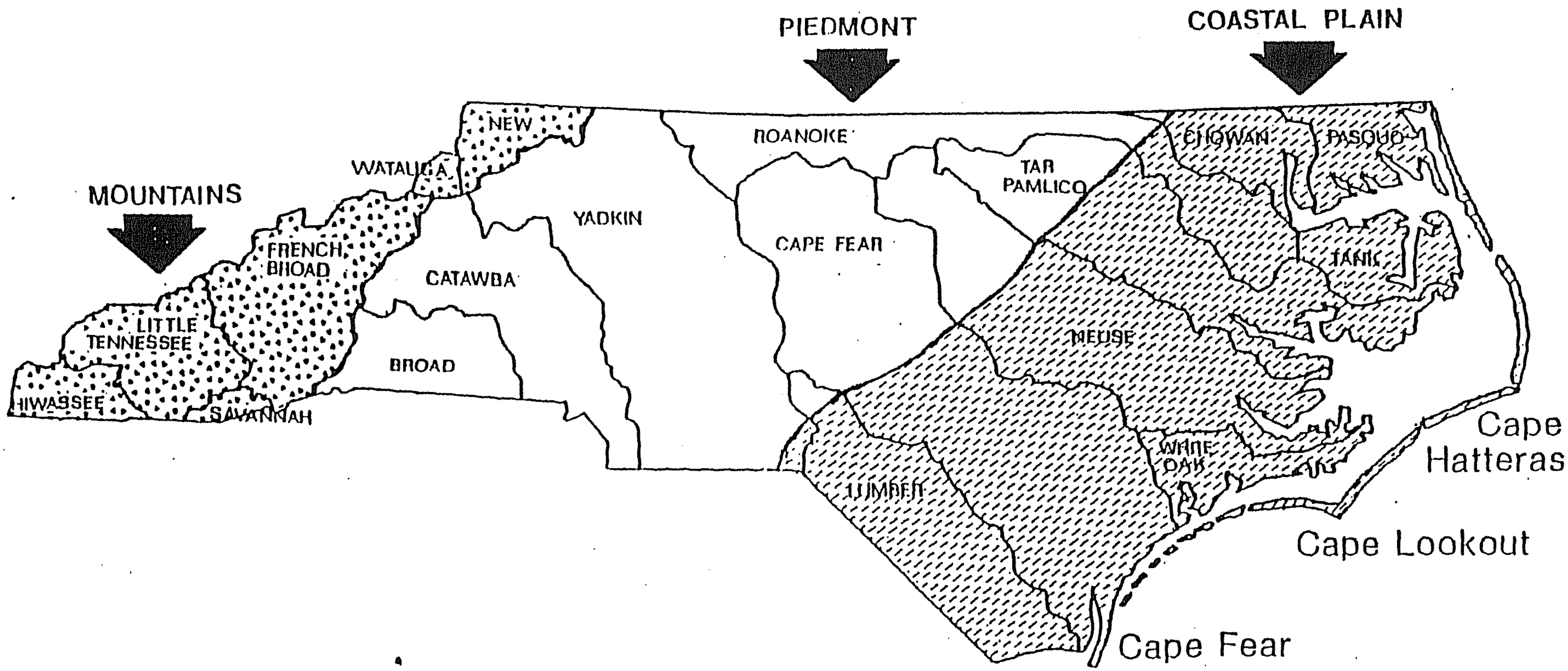


Figure 2.1 Physiographic Regions and Major River Basins of North Carolina

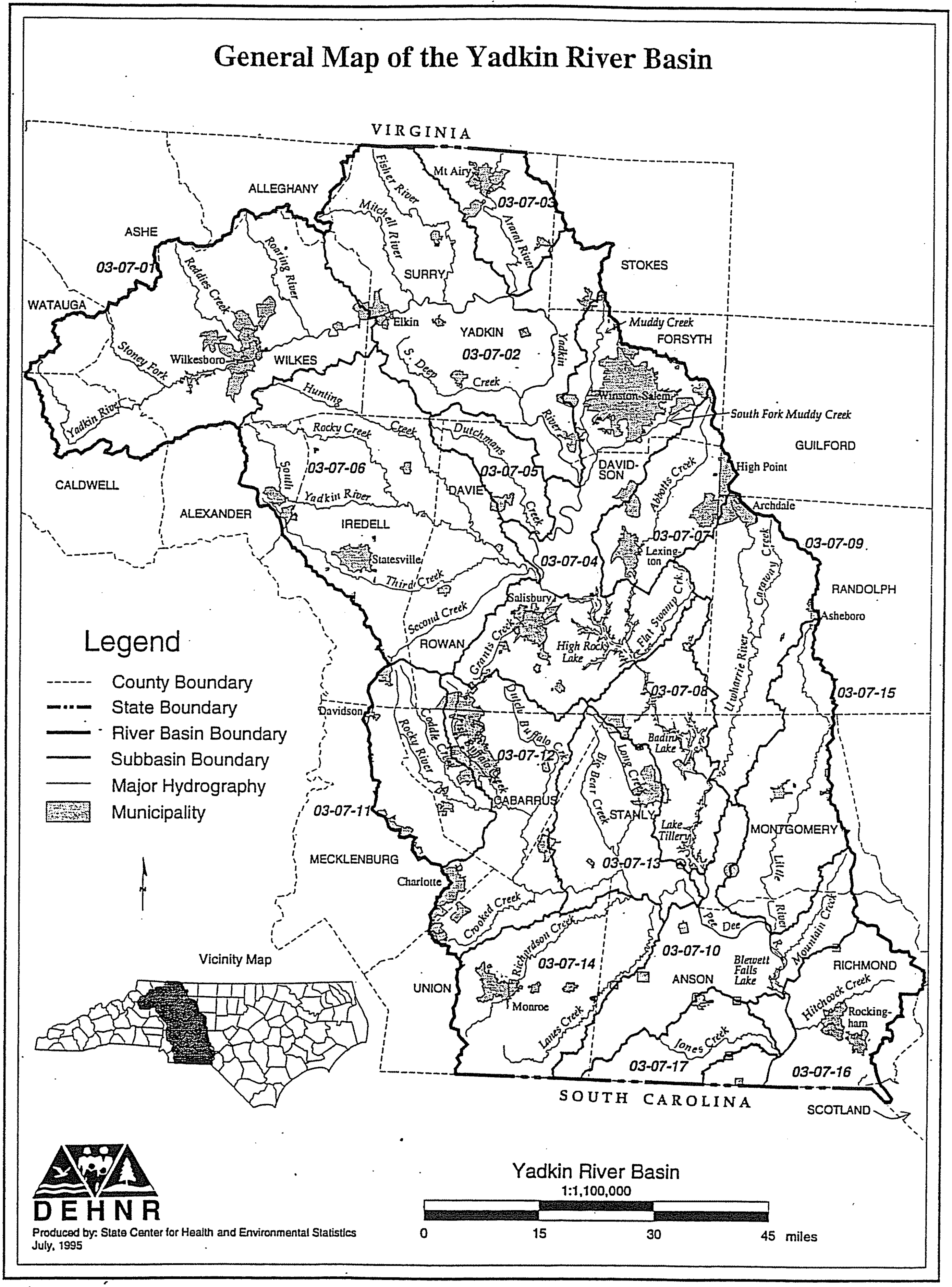


Figure 2.2 General Map of the Yadkin-Pee Dee River Basin

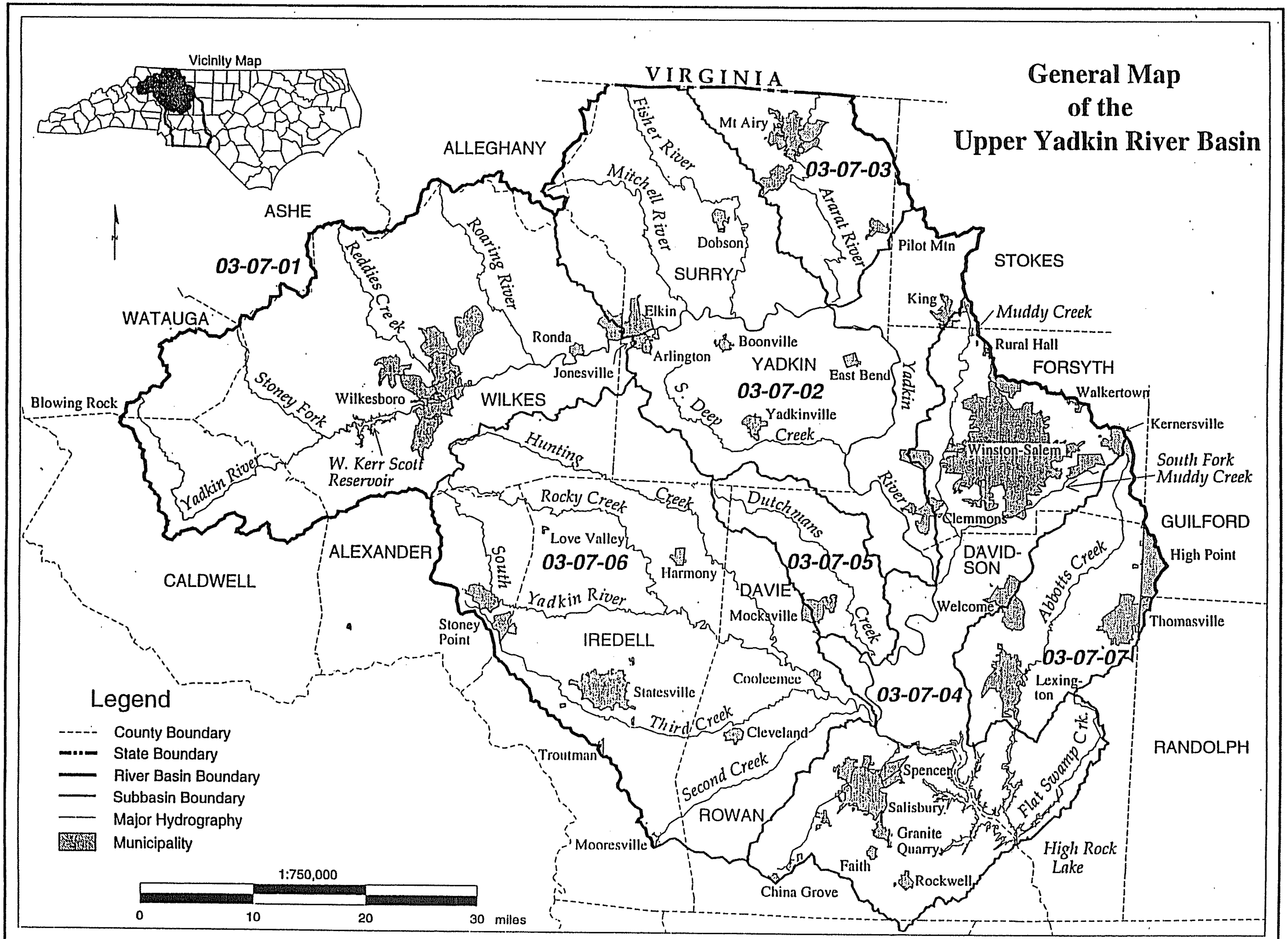


Figure 2.3 General Map of the Upper Yadkin River Basin

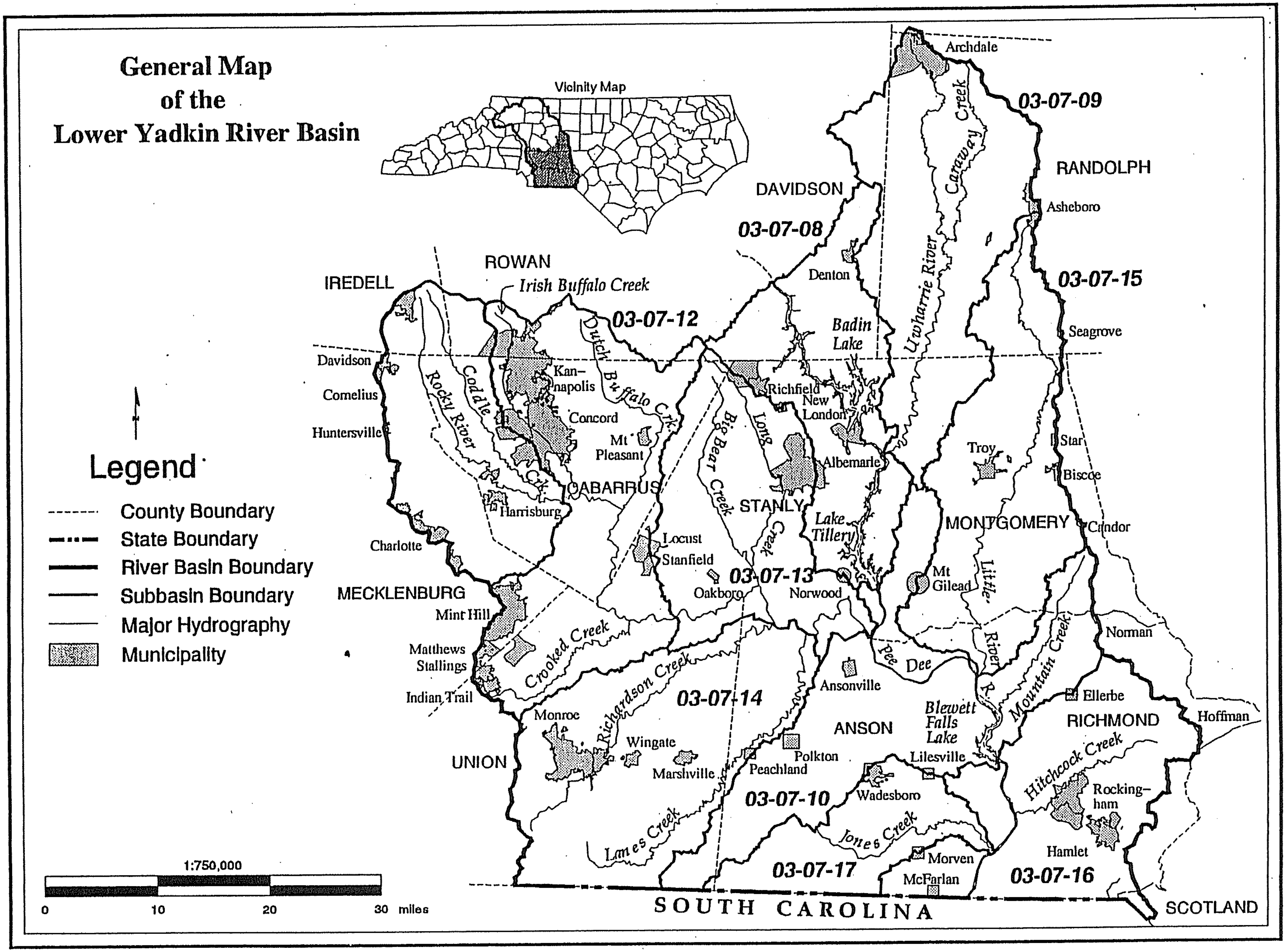


Figure 2.4 General Map of the Lower Yadkin River Basin

2.2 COMPARISON OF STATE AND FEDERAL HYDROLOGIC AREAS

The Yadkin-Pee Dee River basin is divided into seven major hydrologic areas (8-digit hydrologic units) by the U.S. Water Resources Council and the U.S. Geological Survey (USGS). These major hydrologic areas are further subdivided into seventeen subbasins by DWQ for management purposes (denoted by 6-digit numbers). Table 2.1 presents a comparison between the USGS hydrologic units and DWQ's subbasins codes.

Table 2.1 Hydrologic Divisions in the Yadkin-Pee Dee River Basin

Major Tributaries	USGS 8-digit Hydrologic Units	DWQ Subbasin 6-digit Codes (Fig 2.2)
Upper Yadkin River Stoney Fork, Reddies Creek, Roaring River	03040101	03-07-01
Mitchell River Fisher River S. Deep Creek	03040101	03-07-02
Ararat River	03040101	03-07-03
High Rock Lake Muddy Creek S. Fork Muddy Creek	03040101	03-07-04
Dutchmans Creek	03040101	03-07-05
S. Yadkin River Hunting Creek, Rocky Creek Third Creek, Second Creek	03040102	03-07-06
Abbotts Creek	03040103	03-07-07
Lower Yadkin River Badin Lake Lake Tillery	03040103 03040104	03-07-08
Uwharrie River Caraway Creek	03040103	03-07-09
Blewett Falls Lake Brown Creek Mountain Creek	03040104	03-07-10
Rocky River Coddle Creek	03040105	03-07-11
Dutch Buffalo Creek Irish Buffalo Creek	03040105	03-07-12
Big Bear Creek Long Creek	03040103 03040105	03-07-13
Richardson Creek Lanes Creek	03040105 03040202*	03-07-14
Little River	03040104	03-07-15
Hitchcock Creek	03040201	03-07-16
Jones Creek	03040201	03-07-17

* - An insignificant portion of this HU is within NC and is therefore not included in the land cover information in Section 2.4.

2.3 LOCAL GOVERNMENT AND PLANNING JURISDICTIONS

The basin encompasses portions of twenty-four counties, six Lead Regional Organizations (Council of Governments) and two Districts of the North Carolina League of Municipalities (Table 2.2).

Table 2.2 Local Governments and Planning Units within the Yadkin-Pee Dee River Basin

	County	% of County in basin**	Region	League District	Municipalities
Upper Yadkin-Pee Dee River					
	Alexander	30	E	X	Taylorsville
	Alleghany	1	D	X	none
	Ashe	1	D	X	none
	Caldwell	40	E	X	none
	Davidson	95	G	IX	High Point* Lexington Thomasville
	Davie	100	I	IX	Cooleemee Mocksville
	Forsyth	85	I	IX	Clemmons High Point* Kernersville* King* Rural Hall Winston-Salem
	Guilford	1	G	IX	High Point* Archdale*
	Iredell	75	F	X	Harmony Love Valley Mooresville Statesville Troutman
	Rowan	95	F	IX	China Grove Cleveland East Spencer Faith Granite Quarry Landis Rockwell Salisbury Spencer
	Stokes	15	I	IX	King*
	Surry	100	I	X	Dobson Elkin* Mount Airy Pilot Mountain
	Watauga	3	D	X	Blowing Rock*
	Wilkes	100	D	X	Elkin* North Wilkesboro Ronda Wilkesboro
	Yadkin	100	I	X	Arlington Boonville East Bend Jonesville Yadkinville

Table 2.2 Local Governments and Planning Units within the Yadkin-Pee Dee River Basin (Cont'd)

Lower Yadkin-Pee Dee River					
	Anson	100	H	VIII	Ansonville Lilesville McFarlan Morven Peachland Polkton Wadesboro
	Cabarrus	100	F	VIII	Concord Harrisburg Kannapolis* Mount Pleasant
	Davidson	5	G	IX	Denton
	Iredell	5	F	X	Davidson*
	Mecklenburg	40	F	VIII	Charlotte* Cornelius* Davidson* Huntersville* Matthews* Mint Hill*
	Montgomery	95	H	VII	Biscoe* Candor* Mount Gilead Star* Troy
	Randolph	45	G	IX	Archdale* Asheboro* High Point* Seagrove*
	Richmond	95	H	VII	Dobbins Heights Ellerbe Hamlet Hoffman* Norman* Rockingham
	Rowan	5	F	IX	Kannapolis*
	Scotland	1	N	VII	none
	Stanly	100	F	VII	Albemarle Badin Locust New London Norwood Oakboro Richfield Stanfield
	Union	100	F	VIII	Marshville Monroe Wingate

* Located in more than one county
** Estimated by DWQ staff

Key to Region Name and Location

Region	*Name*	*Location*
D	Region D Council of Governments	Boone
F	Centralina Council of Governments	Charlotte
G	Piedmont Triad Council of Governments	Greensboro
H	Pee Dee Council of Governments	Rockingham
I	Northwest Piedmont Council of Governments	Winston-Salem
N	Lumber River Council of Governments	Lumberton

2.4 LAND COVER, POPULATION AND GROWTH TRENDS

2.4.1 General Land Cover

Land cover information in this section is from the US Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) National Resources Inventory (NRI) of 1992 and 1982 (USDA, 1994). The NRI is a multi-resource national inventory based on soils and other resource data collected at scientifically selected random sample sites. It is considered accurate to the 8-digit hydrologic unit scale established by the US Geological Survey (NRCS, 1993).

Table 2.3 summarizes acreage and percentage of land cover from the 1992 NRI for the basin as a whole and for the major watershed areas within the basin as defined by the USGS 8-digit hydrologic units (Refer to Section 2.2 for a comparison between state and federal hydrologic divisions). Land cover types identified by the NRI as occurring in the Yadkin-Pee Dee River basin include cultivated cropland, uncultivated cropland, pastureland, forest land, federal lands, urban and built-up lands, and other (rural transportation, small water areas and census waters). Descriptions of these land covers can be found in Table 2.4.

Forest lands (both private and federal forests) cover approximately 51% of the basin. Federal forest lands (approximately 2%) are within the Pee Dee Wildlife Refuge, the Uwharrie National Forest and the Blue Ridge Parkway. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 30% of the land area. The urban and built-up category comprises roughly 11% and exhibited the most dramatic change since 1982 (38% increase). Other categories that showed substantial increases were pasturelands (19%) and the "Other" category (26%), which includes rural transportation (roads, rights of way, railroads). Both cultivated and uncultivated cropland decreased by a total of 46% in the basin. It is likely that some of this cropland was converted to pastureland and to urban and built-up areas. These land cover changes are presented in Figure 2.5.

Several state agencies including the NC Department of Transportation (NCDOT) and the Department of Environment and Natural Resources (DENR) are working with the state's Center for Geographic Information and Analysis (CGIA) to develop statewide land cover information based on recent satellite imagery. However, until these other land coverages become available, the 1992 NRI data is the most recent comprehensive data for the basin as a whole.

2.4.2 Population and Growth Trends in the Basin

Population

Based on 1990 census data, 1.2 million people live in the basin. Table 2.5 presents census data for 1970, 1980, and 1990, the percent population change and population density (persons/square mile) within each subbasin. It also includes land and water areas by subbasin.

Table 2.3 Estimated Land Use Acreage for the Yadkin-Pee Dee River Basin - 1982 vs 1992 (Source: Natural Resources Inventory, 1992)

	MAJOR WATERSHED AREAS*																	
	Upper Yadkin		South Yadkin		Lower Yadkin		Upper Pee Dee		Rocky		Lower Pee Dee		1992 TOTALS		1982 TOTALS		% Change since 1982
LAND COVER	Acres (1000s)	%	Acres (1000s)	%	Acres 1000s	%	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	% of Total	Acres (1000s)	% of Total	
Cult. Crop	196.7	13	96.1	17	71.8	10.2	42.6	7.4	212.3	24	40.1	12.7	659.6	14.5	877.6	19.3	-24.8
Uncult. Crop	48.3	3.2	12.1	2.1	0	0	1.6	0.2	11.1	1.3	7.9	2.5	81	1.8	104	2.3	-22.1
Pasture	233.2	15.5	117	20.8	103	14.7	33.7	5.8	135.7	15.3	18.4	5.8	641	14	536.7	11.8	+19.4
Federal	17.2	1.1	0	0	23.1	3.3	32.1	5.6	0	0	0.8	0.2	73.2	1.6	72.2	1.6	+1.4
Forest	765.9	50.9	250	44.3	339.4	48.4	383.4	66.4	292.7	33	201	63.7	2232.4	49.1	2305.4	50.7	-3.2
Urban & built-up	148.6	9.8	51.9	9.2	95.2	13.6	34.2	5.9	133.9	15.1	20.4	6.5	484.2	10.7	351.6	7.7	+37.7
Other	93	6.1	36.7	6.5	68	9.7	49.8	8.6	100.7	11.3	26.8	8.5	375	8.2	298.9	6.6	+25.5
Totals	1502.9	100	563.8	100	700.5	100	577.4	100	886.4	100	315.4	100	4546.4	100	4546.4	100.0	
% of Total Basin		33.1		12.4		15.4		12.7		19.5		6.9		100			
Subbasin Numbers	30701, -02,-03 -04, -05		030706		030707, -0708, -0709, -0713		030710, -0715		030711, -0712, -0713, -0715		030716, -0717						
8-Digit Hydraulic Units	03040101		03040102		03040103		03040104		03040105		03040201						

* = Watershed areas as defined by the 8-Digit Hydraulic Units do not necessarily coincide with subbasin titles used by DWQ.

Table 2.4 Description of Land Cover Types (1992 NRI - USDA SCS)

Land Cover Type (No.)	Land Cover Description
1) Cultivated Cropland	Land used for the production of adapted crops for harvest, including row crops, small-grain crops, hay crops, nursery crops, orchard crops, and other specialty crops. The land may be used continuously for these crops or they may be grown in rotation with grasses and legumes.
2) Uncultivated Cropland	Summer fallow, aquaculture in crop rotation, or other cropland not planted (may include cropland in USDA set-aside or similar short-term program).
3) Pastureland	Land used primarily for production of introduced or native forage plants for livestock grazing. This category includes land that has a vegetative cover of grasses, legumes, and /or forbs, regardless of whether or not it is being grazed by livestock.
4) Forest Land	Land at least 10 percent stocked by single-stemmed trees of any size which will be at least 4 meters at maturity, and land bearing evidence of natural regeneration of tree cover and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction, is a canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification of forest land is 1 acre, and the area must be at least 1,000 feet wide.
5) Urban and Built-up Land	Includes airports, playgrounds with permanent structures, cemeteries, public administration sites, commercial sites railroad yards, construction sites, residences, golf courses, sanitary landfills, industrial sites, sewage treatment plants, institutional sites, water control structure spillways and parking lots. Highways, railroads, and other transportation facilities are considered part of this category if surrounded by other urban and built-up areas. Tracts of less than 10 acres that do not meet this category's definitions (e.g., small parks or water bodies) but are completely surrounded by urban and built-up lands are placed in this category.
6) Other	<u>Rural Transportation</u>: Consists of all highways, roads, railroads, and associated rights-of-way outside Urban and Built-up areas; private roads to farmsteads, logging roads; and other private roads (but not field lanes). <u>Small Water Areas:</u> Water bodies less than 40 acres in size and streams less than one-half mile wide. <u>Census Water</u>: Large water bodies consisting of lakes and estuaries greater than 40 acres and rivers greater than one-half mile in width. <u>Minor Land:</u> Lands not in one of the other categories.

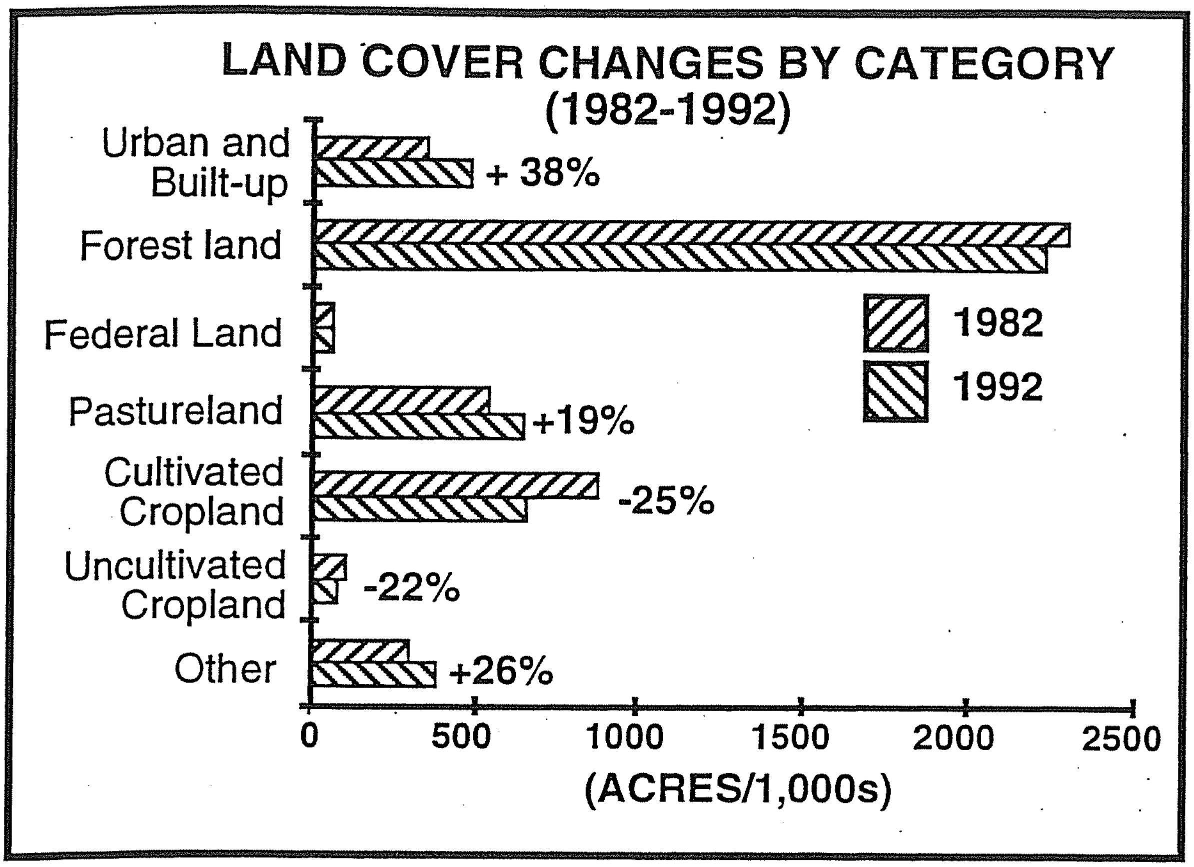


Figure 2.5 Land Cover Changes from 1982 to 1992 for the Yadkin Pee/Dee River Basin (Source of Data: USDA-NRCS 1992 NRI)

Figure 2.6 and 2.7 show 1990 population densities by census block group for the upper and lower Yadkin-Pee Dee River basin, respectively. In the upper Yadkin River basin, Forsyth County is the most densely populated county due to Winston-Salem. The lower Yadkin River basin has greater population density in Rowan, Cabarrus, Mecklenburg, Union and Stanly Counties due to urbanized areas and overflow from the City of Charlotte.

The overall population density was 163 persons per square mile versus a statewide average of 123 persons per square mile. Subbasin population densities range from 67 persons per square mile in subbasin 03-07-10 near Blewett Falls Lake to over 400 persons per square mile in subbasins 03-07-04 and -07 near Winston-Salem. Population density in the Yadkin-Pee Dee River basin can be compared to its neighboring river basins, the Cape Fear and the Catawba. The Cape Fear basin averages 160 persons per square mile and the Catawba basin averages over 300 persons per square mile.

In using these data, it should be noted that some of the population figures are estimates because the census block group boundaries do not generally coincide with subbasin boundaries. The census data are collected within boundaries such as counties and municipalities. By contrast, the subbasin lines are drawn along natural drainage divides separating watersheds. Therefore, where a census block group straddles a subbasin line, the percentage of the population that is located in the subbasin is estimated. This is done by simply estimating the percentage of the census block group area located in the subbasin and then taking that same percentage of the total census block group population and assigning it the subbasin. This method assumes that population density is evenly

Table 2.5 Yadkin-Pee Dee River Basin Population (1970, 1980, and 1990), Percent Population Change and Land Area Summaries

SUBBASIN	POPULATION (Number of Persons)			POPULATION CHANGE (%)			POPULATION DENSITY (Persons/Square Mile)			LAND AND WATER AREAS			
										Total Land and Water Are		Water Area	Land Area
	1970	1980	1990	1970-80	1980-90	1970-90	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-07-01	51,090	60,347	62,655	18	4	23	61	73	75	530,783	830	3	827
03-07-02	63,657	81,690	90,781	28	11	43	77	99	110	526,384	822	4	818
03-07-03	31,796	36,036	36,299	13	1	14	160	182	183	126,786	198	0	198
03-07-04	263,246	286,610	325,945	9	14	24	372	405	461	467,120	730	23	707
03-07-05	8,455	10,705	11,800	27	10	40	65	82	90	83,485	130	0	130
03-07-06	78,567	88,267	94,594	12	7	20	86	97	104	580,680	907	1	906
03-07-07	88,845	95,844	101,019	8	5	14	376	405	427	151,885	237	1	236
03-07-08	15,392	19,942	18,811	30	-6	22	55	72	67	188,280	294	17	277
03-07-09	29,482	32,081	41,702	9	30	41	76	83	108	248,198	388	3	385
03-07-10	15,015	17,510	15,397	17	-12	3	37	43	38	260,499	407	7	400
03-07-11	67,277	64,388	78,047	-4	21	16	243	232	282	177,233	277	0	277
03-07-12	107,947	107,706	125,021	0	16	16	249	248	288	278,219	435	1	434
03-07-13	31,261	35,025	37,644	12	7	20	100	112	120	199,743	312	1	311
03-07-14	38,419	43,235	50,084	13	16	30	91	103	119	268,433	420	2	418
03-07-15	16,445	18,307	20,432	11	12	24	47	52	58	224,554	351	1	350
03-07-16	36,295	42,025	41,561	16	-1	15	110	128	127	212,141	331	4	327
03-07-17	36,295	42,025	41,561	16	-1	15	110	128	127	212,141	331	4	327
Totals	979,484	1,081,743	1,193,353	10	10	22	134	148	163	4,736,564	7400	72	7,328

Note: Population, land area and water area were derived from 1970, 1980 and 1990 census data.

distributed throughout a census block group, which is not always the case. However, the level of error associated with this method is not expected to be significant for the purposes of this document. It is also important to note that the census block groups change each ten years so comparisons between years must be considered approximate.

Growth Trends

Figure 2.8 presents the percent population growth by subbasin for the entire Yadkin-Pee Dee River basin. The percent population growth over the last ten year census period (1980 - 1990) was 10 percent, which is somewhat below the statewide average of 12.7 percent. Three subbasins experienced 25-50 percent growth between 1970 - 1990: subbasin 03-07-02 containing Elkin, subbasin 03-07-09 containing Archdale and Asheboro, and subbasin 03-07-14 containing Monroe and growth overflow from Charlotte.

Many municipalities throughout the basin are experiencing steady growth. Growth rates for the twenty-five municipalities within the Yadkin-Pee Dee River basin having populations over 5,000 can be found in Table 2.6. These municipalities represent 30 percent of all the municipalities in the basin. According to the Office of State Planning, 14 of these municipalities are on the list of the top fifty fastest growing municipalities in the state. For many of these municipalities, the rate of growth is in large part due to annexation of areas having existing populations. However, for many of these municipalities there is significant population growth occurring without annexations.

In the upper portion of the basin, the counties with the largest, densest and most urbanized populations are adjacent of the major urban centers of the Piedmont Triad (Greensboro, Winston-Salem and High Point) and Charlotte/Mecklenburg County. These two large urbanized areas are part of the Piedmont Crescent, a rapidly developing region stretching across the middle of the state from Charlotte to Raleigh. This area is one of the most rapidly developing regions in the entire country, and is an extension of the Atlanta/Charlotte Corridor, which *is* the most rapidly developing region of the country. The development in the Crescent is reaching out from the major urban centers and basically follows Interstate 85. This growth will eventually result in a solid band of urbanized counties from Raleigh to Charlotte (Northwest Piedmont Council of Governments, 1996).

Table 2.7 shows the projected percent change in growth between 1990 and 2020 for counties within the basin (Office of State Planning, 1996). Since river basin boundaries do not coincide with county boundaries, these numbers are not directly applicable to the Yadkin-Pee Dee River basin. They are instead presented as an estimate of possible county-wide population changes.

As can be expected, the counties with the largest anticipated population growth are those adjacent to the major urban centers of the Piedmont Crescent. The significance of this pattern of growth is that the Piedmont Crescent (running roughly East-West) bisects the upper Yadkin River Basin, (which runs North-South). Increasing development will result in an increased demand for water, while at the same time increasing the threat to water quality (Northwest Piedmont Council of Governments, 1996).

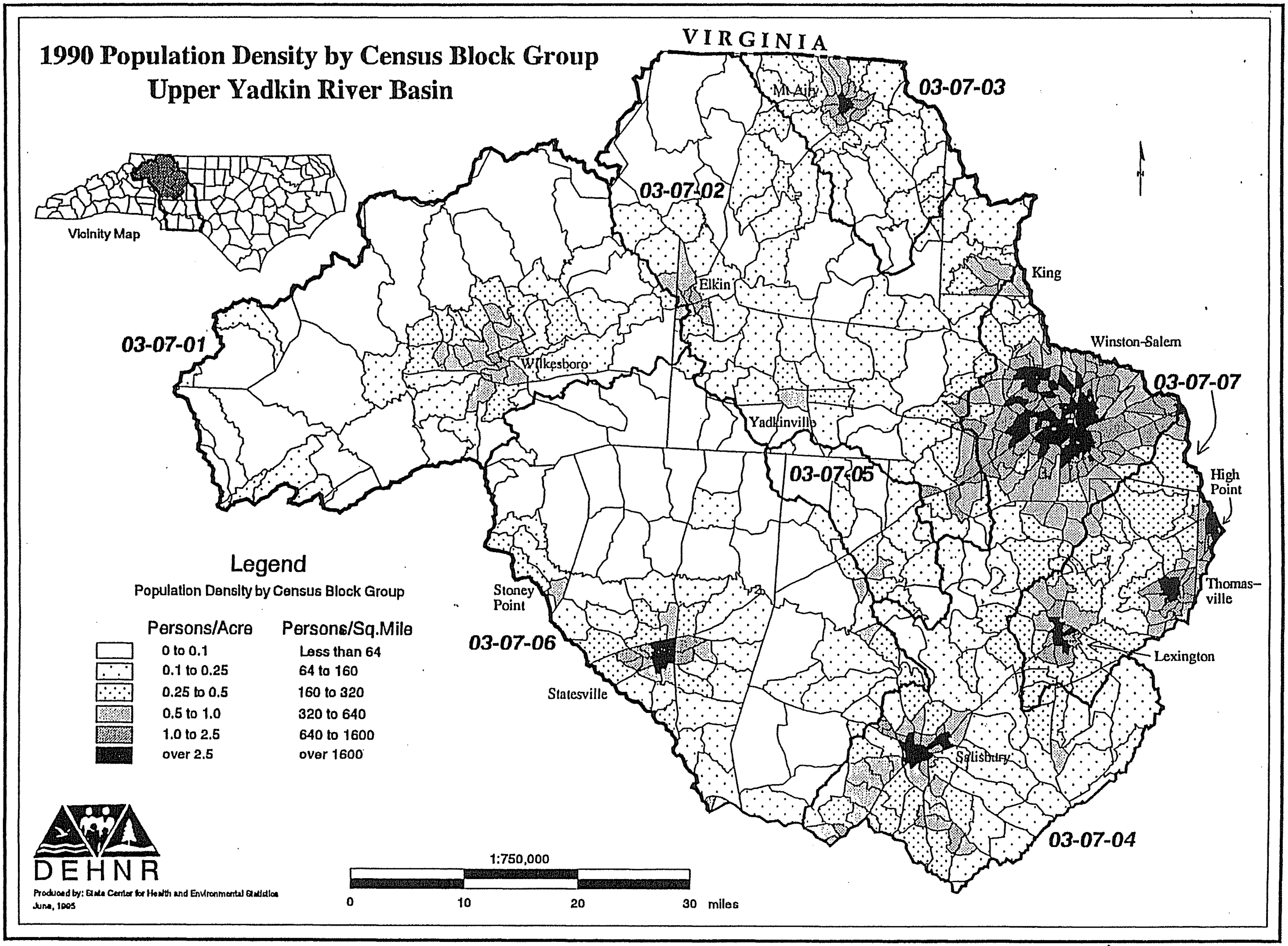


Figure 2.6 1990 Population Density by Census Block Group for the Upper Yadkin River Basin

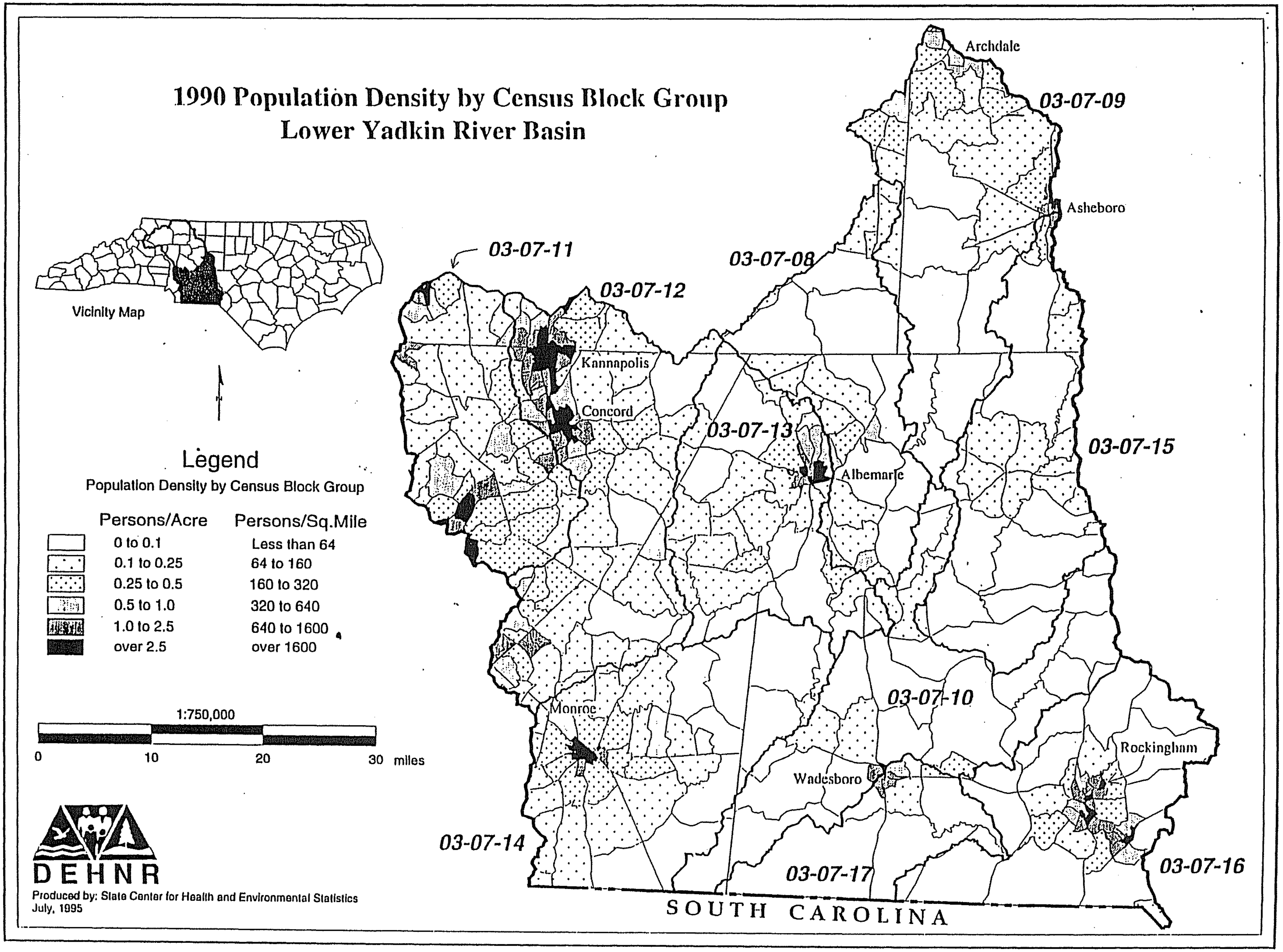


Figure 2.7 1990 Population Density by Census Block Group for the Lower Yadkin River Basin

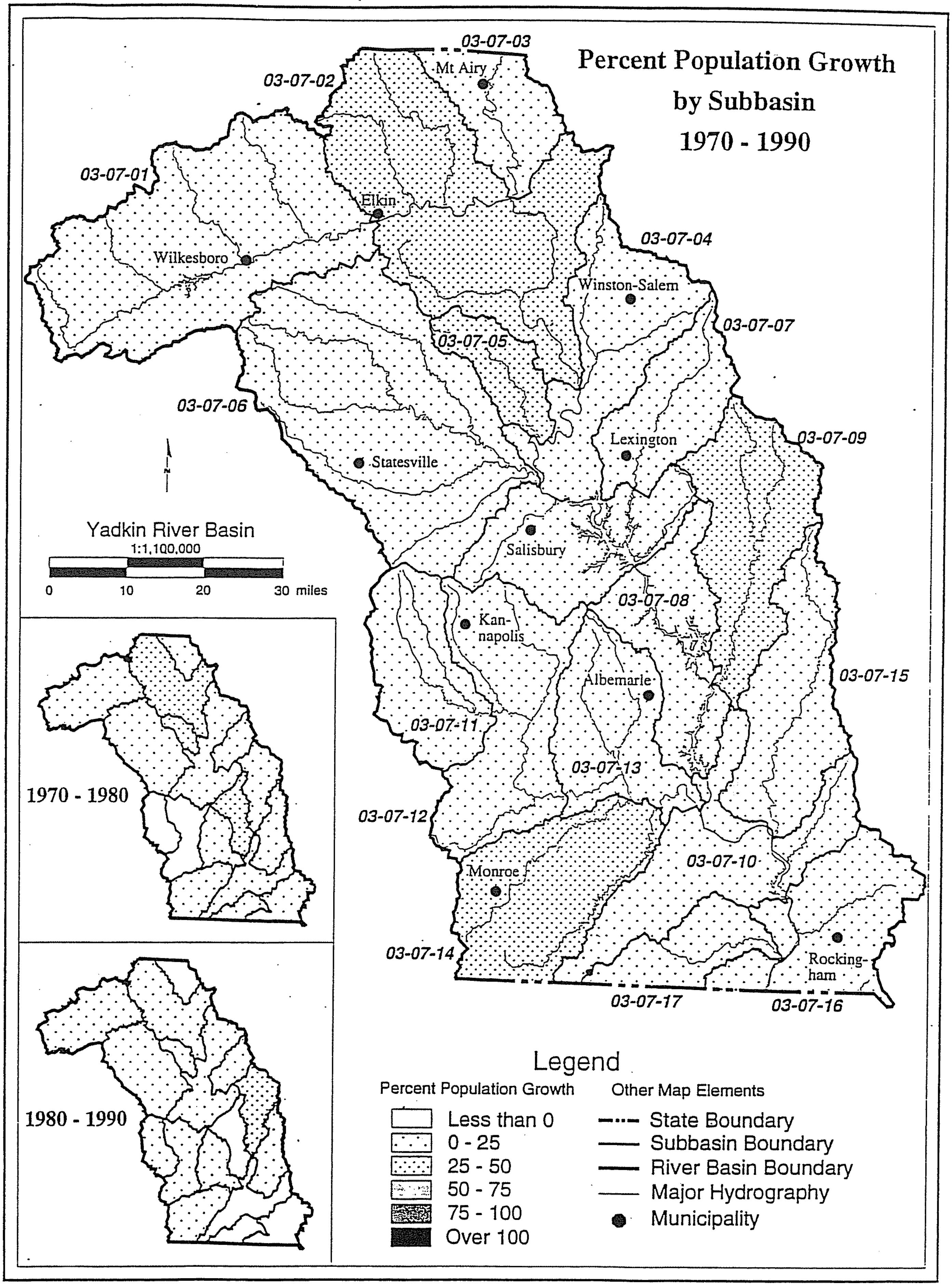


Figure 2.8 Percent Population Growth by Subbasin for Yadkin-Pee Dee River Basin

Table 2.6 Population and Percent Change for Municipalities Located Wholly or Partly in the Yadkin-Pee Dee River Basin with Populations Greater Than 5,000 during 1980 to 1995. (Source: North Carolina Municipal Population 95. Office of State Planning, Fall 1996.)

County	Municipality	Apr-80	Apr-90	Jul-95	Percent Change (1980-90)	Percent Change (1990-95)
Cabarrus	**Concord**	16,942	27,347	35,468	61.4	29.7
	Kannapolis	21,902	21,241	25,610	-3.0	20.6
Davidson	Lexington	15,711	16,581	17,053	5.5	2.8
	Thomasville	14,144	15,915	16,174	12.5	1.6
Forsyth	Clemmons	4,842	6,020	6,520	24.3	8.3
	Kernersville*	5,875	10,899	13,146	85.5	20.6
	Winston-Salem	131,855	143,485	165,750	8.8	15.5
Iredell	**Mooresville**	8,575	9,317	12,536	8.7	34.5
	Statesville	18,622	17,567	21,655	-5.7	23.3
Mecklenburg	**Charlotte***	315,474	395,934	469,809	25.5	18.7
	Cornelius*	1,460	2,581	7,901	76.8	206.1
	Davidson*	3,241	4,046	5,189	24.8	28.3
	Huntersville*	1,294	3,023	7,343	133.6	142.9
	Matthews*	1,648	13,651	18,362	728.3	34.5
	Mint Hill*	7,915	11,615	15,859	46.7	36.5
Randolph	Archdale*	5,187	6,679	7,486	28.8	12.1
	Asheboro*	15,252	16,362	17,971	7.3	9.8
	High Point*	29	41	45	41.4	9.8
Richmond	Rockingham	8,300	9,399	10,114	13.2	7.6
Rowan	Salisbury	22,677	23,626	24,543	4.2	3.9
	Kannapolis*	8,401	8,468	8,818	.1	4.1
Stanly	Albemarle	15,110	14,940	15,903	-1.1	6.4
Surry	Mount Airy	6,862	7,156	7,818	4.3	9.3
Union	**Monroe**	12,639	16,385	21,273	29.6	29.8
	Weddington	848	3,803	5,203	348.5	36.8

* - The numbers reported reflect municipality population, however these municipalities are not entirely within the basin. The intent is to demonstrate growth for municipalities located wholly or partially within the basin.

Cities in **Bold Print** - These municipalities are listed among the top fifty fastest growing municipalities in the state between 1990 and 1995. Growth rates are in large part due to annexation of existing populations between 1990 and 1995.

Table 2.7 Past and Projected Population and Percent Change (1990 to 2020) by County (Source: Office of State Planning 1996)

	County	1990	2020	% Change
Upper Yadkin	Alexander	27,544	32,101	16.5
	Alleghany	9,590	8,678	-9.5
	Ashe	22,200	19,500	-12.2
	Caldwell	70,709	72,556	2.6
	Davidson	126,671	158,165	24.9
	Davie	27,850	35,233	26.5
	Forsyth	265,870	318,780	19.9
	Guilford	347,420	405,636	16.8
	Iredell	92,930	122,957	32.3
	Rowan	110,605	141,986	28.4
	Stokes	37,223	46,866	25.9
	Surry	61,704	64,971	5.3
	Watauga	36,952	43,161	16.8
	Wilkes	59,393	54,931	-7.5
	Yadkin	30,488	34,843	14.3
Subtotal		1,327,149	1,560,364	17.6
Lower Yadkin	Anson	23,470	17,978	-23.4
	Cabarrus	98,930	135,616	37.1
	Davidson	126,670	158,165	24.9
	Iredell	92,930	122,957	32.3
	Mecklenburg	511,433	860,623	68.3
	Montgomery	23,346	25,453	9.0
	Randolph	106,546	147,197	38.2
	Richmond	44,518	43,028	-3.3
	Rowan	110,605	141,986	28.4
	Scotland	33,763	37,226	10.3
	Stanly	51,765	60,302	16.5
	Union	84,210	128,023	52.0
Subtotal		1,308,186	1,878,554	43.6
Total		2,635,335	3,438,918	61.4

2.5 IMPORTANT NATURAL RESOURCES

The Yadkin-Pee Dee River basin is geologically unique and encompasses ecoregions ranging from mountains with cold water streams, foothills with cool water streams, slow-moving piedmont streams and even streams with coastal plain characteristics. The basin contains six major reservoirs, the Pee Dee Wildlife Refuge and the Uwharrie National Forest, which provide many recreational opportunities within a short drive of a growing urban area. In addition, forest land comprises major land use acreage in the basin and provides a significant source of income to residents of the basin.

2.5.1 Lakes

Lakes

There are many lakes within the Yadkin-Pee Dee River basin. These lakes are used for a variety of purposes including water supply reservoirs, hydropower, recreation and for scenic and aesthetic values. W. Kerr Scott Reservoir, located upstream of Wilkesboro, is the first of the mainstem Yadkin River lakes. This reservoir has 1,450 acres and is the uppermost lake in the basin (subbasin 03-07-01).

The Yadkin Chain Lakes are a chain of six impoundments, beginning with High Rock Lake, on the Yadkin-Pee Dee River. Table 2.8 shows the lakes (in downstream order) and pertinent information for each lake. Yadkin, Inc. is the owner and operator of four of the reservoirs and hydroelectric power generation facilities located. High Rock Lake serves as the principle storage reservoir for the project. The three reservoirs located downstream of High Rock include Tuckertown, Narrows and Falls. These lakes serve as limited storage reservoirs. The reservoirs serve an important function in the efficient operation of the power generating facilities. They also provide other significant benefits including enhanced recreational opportunities, downstream flow augmentation and, to some degree, downstream flood control.

A summary of water quality for the 29 monitored lakes in the basin can be found in individual subbasin summaries of Chapter 4. Summary statistics on these monitored lakes are presented in Chapter 4, Table 4.2.

Table 2.8 Yadkin-Pee Dee River Basin Chain Lakes

Lake Name	Subbasin	Surface Area (in acres)	Ownership
High Rock Lake	03-07-04	12,200	Yadkin, Inc
Tuckertown Reservoir	03-07-08	2,550	Yadkin, Inc
Badin Lake (Narrows Reservoir)	03-07-08	5,350	Yadkin, Inc
Falls Lake	03-07-08	203	Yadkin, Inc
Lake Tillery	03-07-08	5,264	CP&L
Blewett Falls Lake	03-07-10	2,570	CP&L

2.5.2 Federal and Forest Lands

Uwharrie National Forest

The entire Uwharrie National Forest (approximately 50,000 acres) is within the Yadkin-Pee Dee River basin. The forest is a prime recreation area for hiking, camping, mountain biking and off-road vehicles. Commercial timber activities also occur within the forest (approximately 5,000 -

8,000 acres annually). Timber harvesting activities within the forest typically require leaving vegetated riparian corridors of 100 - 400 feet along perennial streams.

Pee Dee Wildlife Refuge
Situated on the banks of the Pee Dee River in the lower portion of the basin (Subbasin 03-07-10), the refuge contains 8,443 acres of bottomland hardwood forest and upland pine. The refuge contains several ponds and many creeks flow through the refuge lands. The refuge provides habitat for migrating waterfowl, neotropical birds, amphibians and mammals. The refuge also serves as a demonstration area for management and restoration of private lands, as well as a model for sound land stewardship.

Non-Industrial Forest Lands
Forested lands can offer significant water quality protection measures by reducing and filtering rainfall runoff, stabilizing soils and minimizing loading of organic matter to streams. Over 2 million timberland acres are estimated to be in the Yadkin-Pee Dee River basin. Of these, from 38,000 to 47,000 acres are estimated by the NC Division of Forest Resources to have been harvested annually between 1979 and 1995 (totaling 1.73 percent to 2.02 percent of total timberland acres in the basin). Reforestation, consisting of tree plantings and/or natural regeneration, takes place after harvesting. In the Yadkin-Pee Dee River basin, approximately 9,550 to 11,000 acres were replanted between 1987 and 1996. Numbers for acres reforested through regeneration are not available.

2.5.3 Natural Heritage Priority Sites

The North Carolina Natural Heritage Program (NHP), within the NC Department of Environment and Natural Resources (DENR), compiles the priority list of "Natural Heritage Areas" as required by the Nature Preserves Act (NCGS Chapter 113-A-164 of Article 9A). The list is based on the program's inventory of natural diversity in the state (DEHNR 1995). Natural areas (sites) are evaluated on the basis of the occurrences of rare plant and animal species, rare or high quality natural communities and geologic features. The global and statewide rarity of these elements and the quality of their occurrence at a site relative to other occurrences determine a site's priority rating. The sites included on this list are the best representatives of the natural diversity of the state and therefore have priority for protection. Inclusion on the list does not imply that any protection or public access exists. Figures 2.9 and 2.10 show the Natural Heritage Priority Sites and the Federal lands within the basin. More complete information on the natural areas may be obtained from the NHP of the NC Division of Parks and Recreation by contacting Linda Pearsall at (919) 733-7701.

2.5.4 Wetlands

Wetlands can be very important in watershed planning because they perform a variety of services beneficial to society. Wetlands provide important protection for flood prevention to protect property values, streambank stabilization to prevent erosion and downstream sedimentation, water purification (especially for nitrogen and phosphorus), habitat for aquatic life, wildlife habitat and endangered species protection. These values vary greatly with wetlands type. Some wetlands provide all of these uses and others do not. Wetlands adjacent to intermittent and permanent streams are most important to protecting water quality in those streams, as well as downstream lakes and estuaries.

In 1989, the EMC passed a rule directing DWQ to review wetland fill using a review sequence of avoidance, minimization and mitigation of wetland fill. After extensive public review and debate, the NC Environmental Management Commission (EMC) passed rules to restructure the 401 Water Quality Certification Program on March 14, 1996. These rules became effective October 1, 1996. These rules do not reflect a new regulatory program since DWQ has issued approvals for wetland

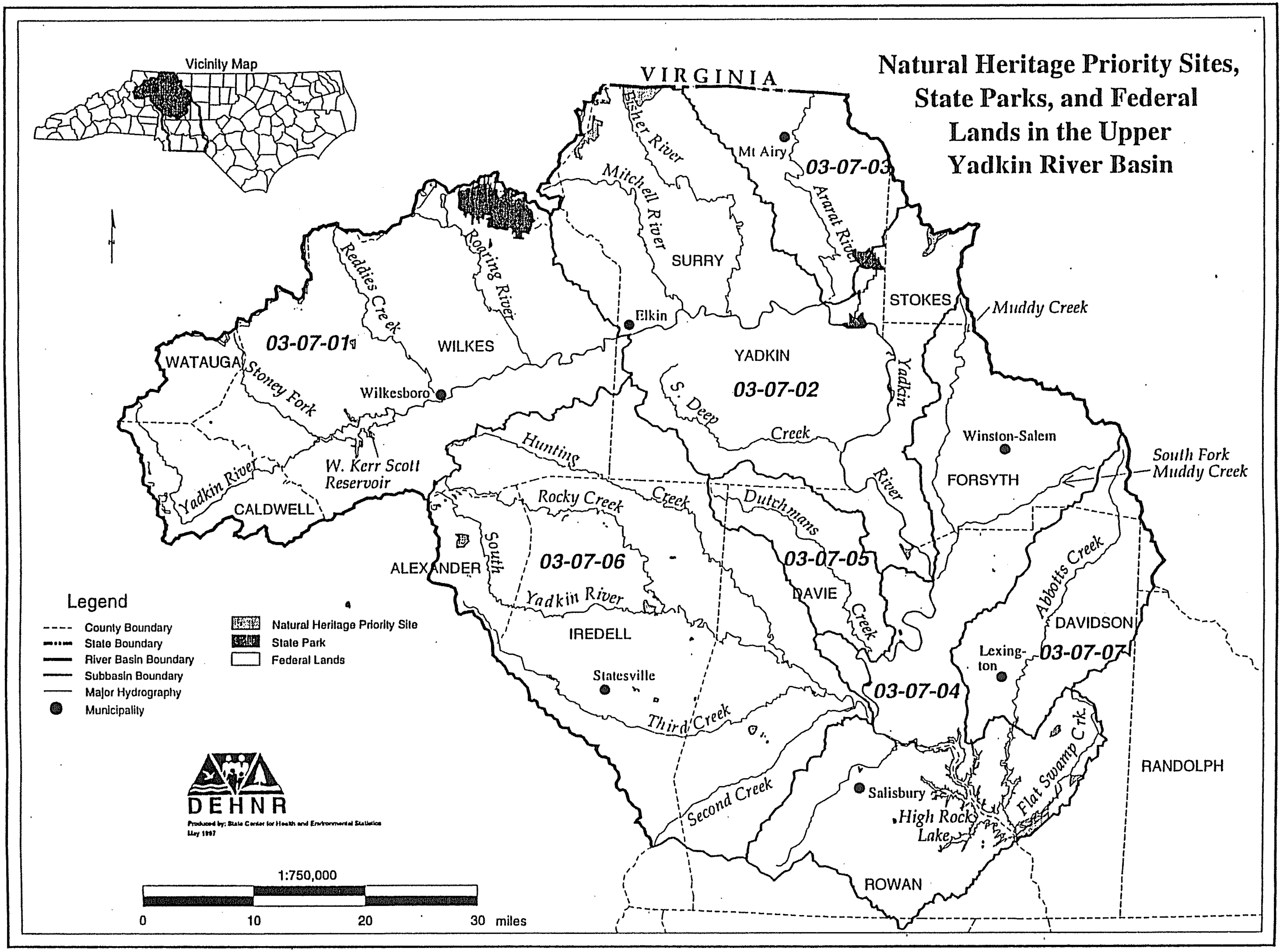


Figure 2.9 Natural Heritage Priority Sites for the Upper Yadkin-Pee Dee River Basin

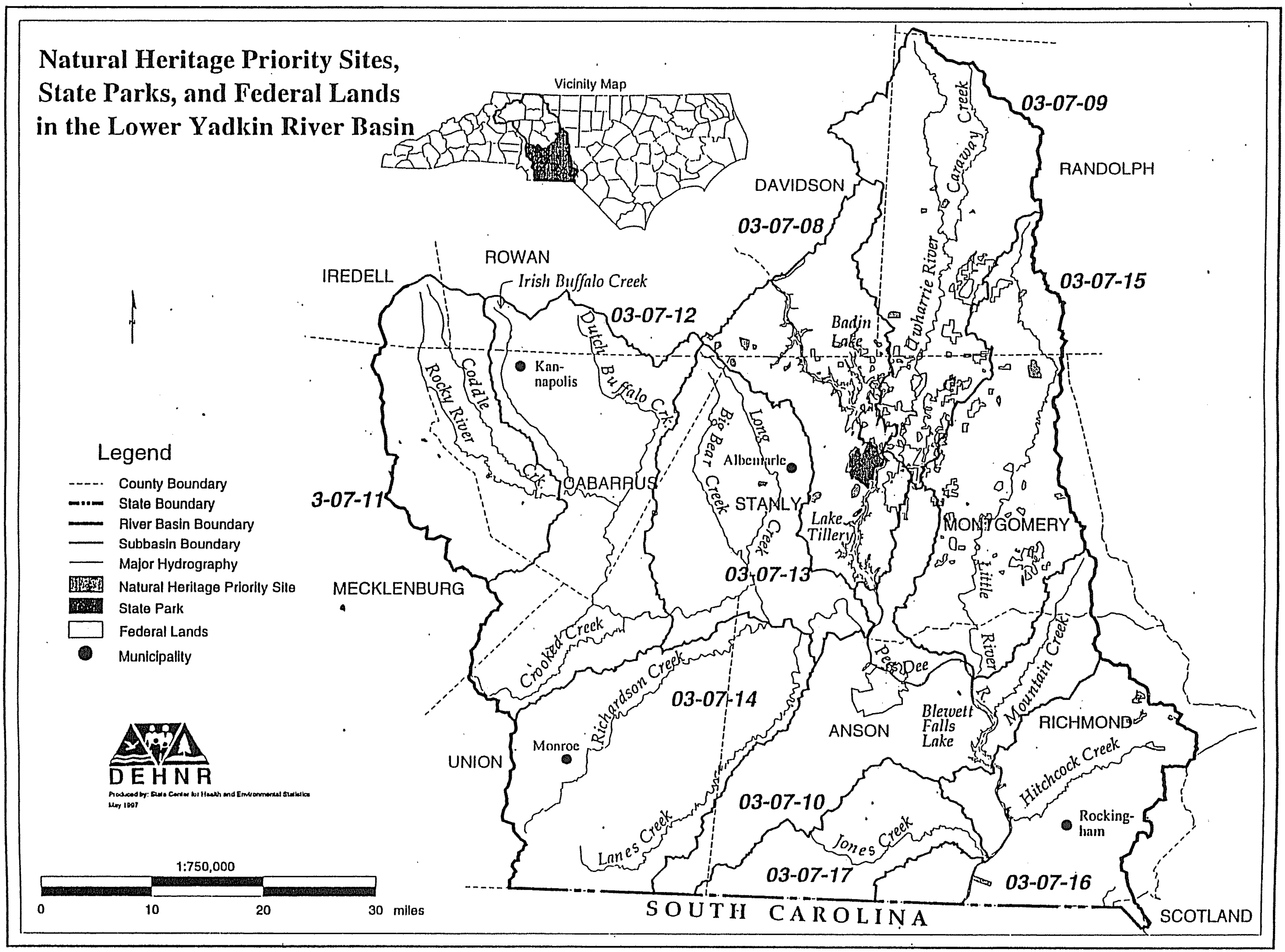


Figure 2.10 · Natural Heritage Priority Sites for the Lower Yadkin-Pee Dee River Basin

fill since the mid-1980's. These rules also consider wetland values - whether or not the wetland is providing significant uses or whether the activity would remove or degrade uses. The rules also specify mitigation ratios, locations and types to make the mitigation process more predictable and certain for the regulated community. The general approach adopted in the new EMC rules has been used by DWQ for five years. DWQ's emphasis has been, and continues to be, on water quality and the essential role that wetlands play in maintaining water quality.

Within the Yadkin-Pee Dee River basin the larger areas of wetland impacts are occurring in the more populated areas of the basin. Tables 2.9 and 2.10 show wetland impacts by subbasin as well as a breakdown of wetland impacts by wetland type. The large acreages within the subbasins are most likely associated with highway projects.

Table 2.9 Wetland Fill Activities in the Yadkin-Pee Dee River Basin

	Acres Permitted				
Subbasin Number	1993	1994	1995	1996	Total
03-07-01	2.06	1.59	0.35	1.08	5.08
03-07-02	1.76	0.78	0.68	1.51	4.73
03-07-03	6.00	0.25	0.33	0.37	6.95
03-07-04	5.60	9.95	1.33	4.21	21.02
03-07-05	0.00	0.00	0.00	0.14	0.14
03-07-06	5.21	0.70	4.21	0.10	10.22
03-07-07	2.35	4.35	0.10	4.34	11.14
03-07-08	0.00	0.93	0.19	2.30	3.42
03-07-09	0.00	1.05	5.60	0.00	6.65
03-07-10	30.58	0.00	3.31	0.00	33.89
03-07-11	7.11	2.83	11.07	7.21	24.62
03-07-12	1.54	2.37	3.57	5.36	12.84
03-07-13	50.00	6.83	0.31	0.30	57.44
03-07-14	0.00	0.00	2.47	2.42	4.89
03-07-15	0.00	0.85	0.34	2.00	3.19
03-07-16	2.21	0.50	66.98	0.33	70.02
03-07-17	0.09	0.18	0.33	1.85	2.45
Total Acres	114.51	33.16	101.17	23.52	276.69
Total No. of Projects	55	63	65	44	227

Table 2.10 Wetland Fill Activities in the Yadkin-Pee Dee River Basin by Wetland Type

	Acres Permitted					
Wetland Type	1993	1994	1995	1996	Total	Total Acres Mitigated
Bottomland Hardwood	53.39	26.85	92.65	16.25	189.14	22.56
Headwater Forest	-	1.85	3.94	8.51	14.30	4.40
Seeps	-	0.83	0.98	2.09	3.90	0.00
Freshwater Marsh	0.99	0.14	-	2.00	3.13	0.00
Wet Flat	0.10	0.10	-	2.33	2.53	0.00
Ephemeral Wetlands	-	1.15	-	-	1.15	0.00
Other Wetland Types	60.03	2.24	3.60	2.34	68.21	0.25
Total	114.51	33.16	101.17	33.52	282.36	27.21

<u>Significant Wetland Communities</u>
A number of wetland (palustrine) natural communities are found in the Yadkin Basin, but a few deserve special mention. The Hillside Seepage Bog is an extremely rare natural community. Nearly all of these sites in NC are found in the Yadkin Basin. Some are clustered in northern Iredell County, and others are clustered in Montgomery County. In general, these are very small sites (some under an acre) on gentle slopes where seepage wets the ground surface.. Species typical of both montane bogs and Coastal Plain savannas may be found, such as pitcher plants and "savanna" orchids. None of the Iredell sites are protected, and only a few of the Montgomery sites are protected (Harry LeGrand, pers. comm.).

The Upland Pool and Upland Depression Swamp Forest natural communities are sites that hold water for all or part of the year. These are sites remote from riverine areas, generally over gabbro or other mafic rocks, that have poor drainage and thus pond water. Upland Pools are extremely rare, and two of the few known examples are found in the Uwharrie National Forest. These sites generally have little or no canopy and feature shrubs and herbs as dominant vegetation. On the other hand, Upland Depression Swamp Forest features a forested canopy of wetland trees over pools. They are scattered over the Yadkin Basin, particularly in Iredell County.

The southeastern portion of the basin contains the Triassic Basin geologic zone, running northeast-southwest through Anson County. Brown Creek has a wide floodplain containing an excellent example of Piedmont/Mountain Swamp Forest; this example is protected in the Pee Dee National Wildlife Refuge. Most examples of this community in NC were flooded by the construction of Jordan and Falls Lakes. Topographic settings for swamp forest development in the Piedmont are rare, as most floodplains are narrow and support bottomland forest vegetation rather than swamp forest.

2.5.5 Rare Aquatic Faunal Species

The NC Natural Heritage Program (NHP) has records of 14 rare aquatic animal species in the NC portion of the Yadkin-Pee Dee River basin - six fishes and eight mussels. The following information was obtained from the NHP (LeGrand, pers. comm.). These species are listed by North Carolina as either Endangered, Threatened, Special Concern, or Significantly Rare (Table 2.11). Two of these are also listed by the federal government as Endangered. Endangered species are those species that are in danger of becoming extinct. Threatened species are considered likely to become endangered within the foreseeable future. Species of Special Concern have limited numbers and vulnerable populations and are in need of monitoring. Significantly Rare species are those whose numbers are small and whose populations need monitoring (NC DEHNR 1995). Federal Species of Concern were formerly considered Federal Candidate species; further biological research and field studies are needed to resolve the conservation status of these taxa.

Other non-aquatic rare species of amphibians, mammals, and plants occur along the streambanks. These non-aquatic species may be affected by water quality degradation in the basin.

Table 2.11 Rare Species in the Yadkin-Pee Dee River Basin (Source: NC Natural Heritage Program 1995)

Common Name	Scientific Name	Listing Status: State	Federal
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E
Santee chub	*Cyprinella zanema*	SR	
Carolina darter	*Etheostoma collis*	SC	
Pinewoods darter	*Etheostoma mariae*	SC	
Robust redhorse	*Moxostoma robustum*	SR	
Sandhills chub	*Semotilus lumbee*	SC	
Brook floater	*Alasmidonta varicosa*	T	FSC
Atlantic pigtoe	*Fusconaia masoni*	T	FSC
Carolina heelsplitter	*Lasmigona decorata*	E	E
Squawfoot	*Strophitus undulatus*	T	
Savannah lilliput	*Toxolasma pullus*	T	FSC
Notched rainbow	*Villosa constricta*	SR	
Eastern creekshell	*Villosa delumbis*	SR	
Carolina creekshell	*Villosa vaughaniana*	SC	

Listing abbreviations: E = Endangered, T = Threatened, SC = Special Concern, SR = Significantly Rare, FSC= Federal Species of Concern

Fishes

Shortnose sturgeon (*Acipenser brevirostrum*) Federal Endangered, State Endangered
This anadromous fish is generally found in estuarine waters but it swims up large rivers to spawn between February and May. Its historic range was from the Canadian Maritime provinces south to northeastern Florida. There is a single record (1985) in the Yadkin River basin of a gravid female from the Pee Dee River just downstream from the US 74 bridge. Most recent North Carolina records are from the lower Cape Fear River, but historically the species was found in the lower portions of a number of river basins.

Santee chub (*Cyprinella zanema*) State "Significantly Rare"
This species is endemic to portions of North and South Carolina. The North Carolina population is actually composed of two distinct entities; a Catawba drainage population and a separate population in the lower Cape Fear and Lumber drainages in the Coastal Plain. There is apparently just one record for the species in the Yadkin Basin, in the Pee Dee River near the South Carolina line.

Carolina darter (*Etheostoma collis*) State Special Concern
This fish is somewhat endemic to North Carolina. Its range is limited to a somewhat narrow Piedmont band from southern Virginia to northern South Carolina. The Yadkin basin is extremely important to the species, with 40-50% of all known NC records from this basin. In the Yadkin basin, the species is limited to the southern portion, ranging north to northern Cabarrus and southern Davidson counties.

Pinewoods darter (*Etheostoma mariae*) State Special Concern
This fish is endemic to the Sandhills region of North Carolina and adjacent South Carolina. It has one of the most restricted ranges of any fish species in the Atlantic drainages. Essentially all of the North Carolina records are from the Lumber River basin; thus the Yadkin basin portion of the Sandhills is peripheral to the species' range.

Robust redhorse (*Moxostoma robustum*) State "Significantly Rare"
This fish is shrouded in taxonomic controversy. Most references consider *Moxostoma robustum* to be the smallfin redhorse, a wide-ranging species of Atlantic drainages. However, the "true" *Moxostoma robustum* is considered to be restricted to a few known sites from North Carolina to Georgia, mainly near the Fall Line. So far, North Carolina records of this sucker are limited to one site in the Cape Fear basin and one in the Yadkin basin, from the Pee Dee River near the South Carolina line. Much remains to be learned about the distribution of this species.

Sandhills chub (*Semotilus lumbee*) State Special Concern
This sucker has a range similar to that of the pinewoods darter, being highly restricted to the Sandhills region of North Carolina and adjacent South Carolina. However, the chub's range extends beyond the Lumber drainage and is found sparingly in several streams in the Yadkin Basin in Richmond County.

Freshwater Mussels

Brook floater (*Alasmidonta varicosa*) State Threatened, Federal "Species of Concern"
This mussel ranges from Nova Scotia and New Brunswick south to South Carolina, but it is rare in the southern portion of the range. In North Carolina, it is found in streams and rivers in the Piedmont, with scattered records from the Catawba, Yadkin, and Cape Fear drainages. In the Yadkin basin, most records are from Montgomery County, particularly in streams in the Uwharrie National Forest.

Atlantic pigtoe (*Fusconaia masoni*) State Threatened, Federal "Species of Concern"
This mussel has a range from Georgia north to the James River Basin in Virginia. It was historically known from most Atlantic drainages in North Carolina, but it has rapidly declined in range and in numbers. The species is found in the lower Piedmont and upper Coastal Plain, near the Fall Line, except for a seemingly isolated population along the Black River. Only a few records are from the Yadkin Basin, all from the southeastern portion in Montgomery and Randolph counties.

Carolina heelsplitter (*Lasmigona decorata*) Federal Endangered, State Endangered
This is perhaps the most endangered species present in the Yadkin Basin. This mussel is now known from just four populations in the world -- two creeks each in NC and SC. These NC creeks are Waxhaw Creek (Catawba Basin) and Goose Creek (Yadkin Basin); both creeks are in Union County. Both known NC populations are very small and are considered precarious, since both are in heavily agricultural and rapidly developing portions of the state, near Charlotte.

Squawfoot (*Strophitus undulatus*) State Threatened
This is a very wide-ranging mussel found throughout both the Atlantic and Mississippi drainages. On the Atlantic slope it is found from the Savannah River into Canada. In North Carolina, it is found in most Piedmont drainages. In the Yadkin Basin, the records are limited to the southern portion, mostly in and near Uwharrie National Forest. Despite its wide range, it is considered Threatened in North Carolina.

Savannah lilliput (*Toxolasma pullus*) State Threatened, Federal "Species of Concern"
This mussel ranges in the Atlantic drainage, from Georgia to the Neuse River system in North Carolina. This mussel does occur in a few lakes, such as University Lake near Chapel Hill, but it is mainly a riverine species. The few NC sites are mainly from the southeastern portion of the Yadkin Basin, especially in Montgomery County.

Notched rainbow (*Villosa constricta*) State "Significantly Rare"
This mussel ranges in the Atlantic drainages from the James River in Virginia south to the Santee-Cooper system in South Carolina. It is present in most Atlantic drainages in North Carolina, but most records are clustered in the Fall Line area of the lower Piedmont and upper Coastal Plain. There are numerous records from the Yadkin Basin, all restricted to the southern portion from Randolph County southwest to Union County.

Eastern creekshell (*Villosa delumbis*) State "Significantly Rare"
This mussel ranges in the Atlantic drainage, from North Carolina into Georgia. Despite the range being restricted to just three states, it is found in a large number of basins and streams. As with most rare mollusks found in the Piedmont, the majority of records are from the Fall Line and the southern portion of the state. This is the "least rare" of the freshwater mussels tracked by NC NHP, but nonetheless populations need to be monitored.

Carolina creekshell (*Villosa vaughaniana*) State Special Concern
This mussel has a very restricted range, being found only in a small part of the southern Piedmont of NC and adjacent SC. Nearly all records are from the Yadkin Basin, ranging north to Randolph, Cabarrus, and Mecklenburg counties; it is also found in adjacent potions of the Catawba Basin. Streams in Montgomery County and southwestern Randolph County are extremely important to the long-term survival of the species.

OTHER SEMI-AQUATIC SPECIES

There are several additional rare animal species that require pools or ponds in floodplains for all or part of their life cycle. The mole salamander (*Ambystoma talpoideum*) [State Special Concern] and the four-toed salamander (*Hemidactylium scutatum*) [State Special Concern] lay eggs in wooded or semi-wooded pools in floodplains in the Yadkin Basin. The four-toed salamander ranges over most of the Piedmont and into the western Coastal Plain. The pine barrens treefrog (*Hyla andersonii*) [State "Significantly Rare"] is a Coastal Plain species found in acidic waters of pocosins, Sandhills stream margins, and bay forests. Thus, in the Yadkin Basin it is restricted only to the extreme southeastern corner in Richmond County.

The bog turtle [State and Federal Threatened due to Similarity of Appearance] is one of the rarer reptiles in North Carolina, in part owing to its restricted bog and wet meadow habitat. Though there are over 100 sites known for it in NC, most populations are small and perhaps not viable over any period of time. In the Yadkin Basin, there are a number of recent discoveries of the species in wet meadows in Surry and Wilkes counties; the species is also known from a few sites in the basin east to Forsyth County.

SIGNIFICANT RARE SPECIES AREAS

There is a noticeable clustering of rare aquatic species in the Yadkin Basin, as noted under the individual species accounts. There are three especially significant areas.

1. Goose Creek in Union County (subbasin 03-07-12). This is one of two currently known sites in NC for the Federal Endangered Carolina heelsplitter. Several other rare mollusks also occur in this creek -- squawfoot, notched rainbow, eastern creekshell, and Carolina creekshell.

2. Streams and rivers in the Uwharrie National Forest in Montgomery and southwestern Randolph County (subbasins 03-07-09 and 03-07-15). These streams host large numbers of rare mollusks, as well as the Carolina darter. Whether these streams were originally more diverse than other streams in the basin is open to speculation, but it is likely that these streams undergo much less sedimentation and other types of pollution than elsewhere because they flow through mostly

forested landscapes in the national forest. They may be the last strongholds for some species as the Piedmont becomes even more heavily impacted by humans.

3. Pee Dee River from Blewett Falls Dam to the SC line (subbasin 03-07-16). This short stretch of river is host to several rare fishes, including the Federal Endangered shortnose sturgeon (one record) and the robust redhorse.

2.5.6 Physiography and Geology of the Yadkin-Pee Dee River Basin

One of the many interesting characteristics of the Yadkin-Pee Dee River basin is its physiography and geology. The basin lies within the boundaries of all three physiographic provinces (Figure 2.1) and overlies several geologic formations.

A small portion of the basin is considered to be part of the Coastal Plain physiographic province (portions of Anson and Richmond Counties). This area is characterized by flat lands to gently rolling hills, with a maximum elevation of about 600 feet in the Sand Hills. The majority of the basin is within the Piedmont Province, with elevations ranging from 300-600 feet and gradually rising to 1,500 feet in the foothills. Piedmont topography is rolling with long ridge lines and well-rounded hills. The headwaters of the basin drain from the eastern side of the Blue Ridge mountains, marked by the Eastern Continental Divide. This area includes the counties of Wilkes and Surry.

The geology underlying the Yadkin-Pee Dee River basin has an affect on both stream water quality and water quantity. Ten low-flow hydrologic areas (HA1-HA10) were defined for North Carolina by USGS (Figure 2.11). Areas were defined by relating topography, geology, mean annual runoff, and other features to low-flow frequency characteristics including 7Q10 (annual minimum 7-day consecutive low flow, which on average, will be exceeded in 9 out of 10 years) and 30Q2 (annual minimum 30-day consecutive low flow, which on average, will be exceeded in 1 out of 2 years). The ten HA's typically form a southwest-northeast band across the State and lie within three physiographic areas - the Coastal Plain, the eastern and central Piedmont and the western Piedmont and mountains. The physiographic area boundaries as determined by USGS (Giese and Mason, 1993) differ only slightly from the physiographic provinces shown in Figure 2.1.

In general, the lowest potential for sustaining base flow to streams is in the clay and sandy soils area of the Coastal Plain (HA1 and HA2) and in the eastern and central Piedmont (HA4, HA6, HA7 and HA8). The following discussion explains the characteristics that reduce the potential for base flow in these regions (Giese and Mason, 1993). DWQ management strategies for wastewater discharges into zero flow streams is presented in Chapter 6, Section 6.5.6.

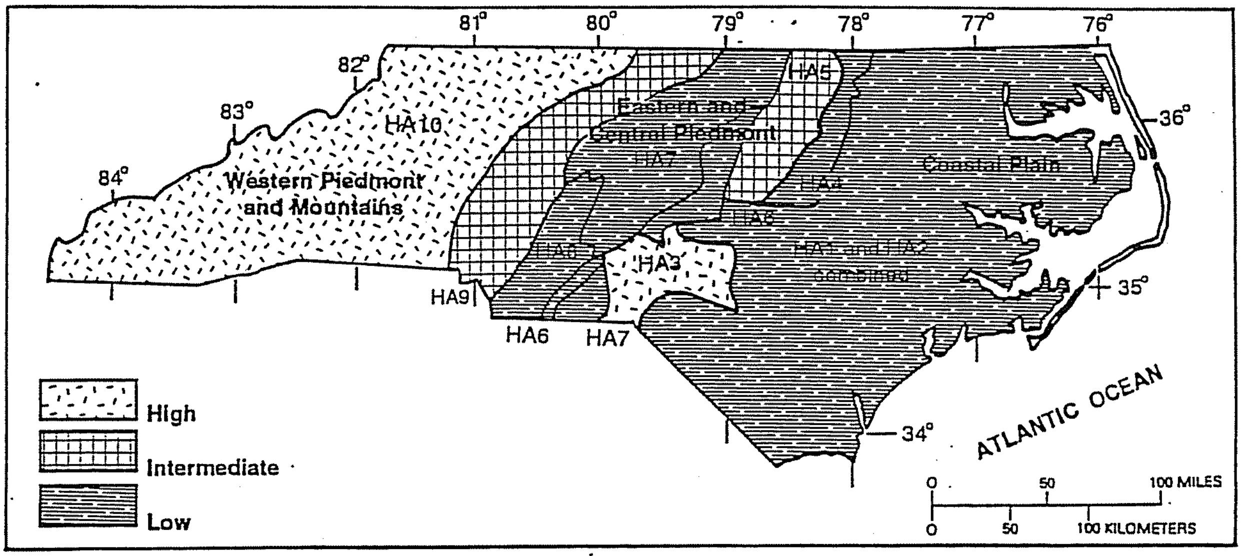
Coastal Plain Physiographic Area

The geology of this physiographic area consists of alternating layers of sand, silt, clay and limestone. This area was divided into three HA's based on soil types and topography. These are clay soils (HA1), sandy soils (HA2) and the Sand Hills (HA3). With the exception of the Sand Hills area (HA3), topographic relief is relatively flat, with the land surface dipping coastward at a rate of only a few feet per mile. Topographic relief and hydraulic gradient in the Sand Hills (HA3) is much higher.

The clay soils have the lowest low-flow values of the three HA's (median 7Q10 is 0[ft^3/s]/mi^2), sandy soils (HA2) have intermediate values (median 7Q10 is 0.006[ft^3/s]/mi^2) and the Sand Hills (HA3) have the highest values in the State (median 7Q10 is 0.318[ft^3/s]/mi^2.

The low topographic relief of HA1 and HA2 (1 to 2 feet per mile) reflects the low hydraulic gradient and reduced potential to move water to streams than in areas with greater topographic relief (i.e.-HA3). The lower low-flow values for clay soils versus sandy soils result from the lower permeability of clay soils and that a higher percentage of precipitation that falls on clay soils is not absorbed and runs off directly into streams. Clay soils also have lower hydraulic conductivity than sandy soils and thus contribute less to base flow of streams than sandy soils.

Figure 2.11 Hydrologic Areas (HA) of Similar Potential to Sustain Base Flows



Eastern and Central Piedmont Physiographic Area

Topography in this area is characterized by rolling hills and geologic formations consisting of crystalline or sedimentary rocks. This area was divided into six HA's based on soil types, topography and underlying bedrock type: the Eastern Slate Belt (HA4), the Raleigh Belt (HA5), the Triassic Basin (HA6), the Carolina Slate Belt (HA7 and HA8), and the Charlotte Belt and Milton Belt (HA9).

Of particular interest within this area is the fact that the sedimentary rocks underlying the Triassic Basin have the lowest average yield of water to wells of all rock types in the State. This low yield implies the rocks have low permeability and thus result in low base flows of streams in the region. The 7Q10 value for HA6 are zero for all but the largest drainages. The ability to discharge oxygen-consuming wastewater to these low base flow streams is limited by DWQ. The goal of DWQ for streams determined to be zero flow streams is to remove all discharges, or, if removal is not possible, advanced treatment will be required (See Chapter 6, Section 6.5.6).

In addition, the overall low permeability of residual soils derived from the Triassic sedimentary rocks results in low percolation rates for septic systems. This low permeability promotes surface runoff and shallow discharge during stormflow events (Wooten, pers. comm.).

In addition, the overall low permeability of residual soils derived from the Triassic sedimentary rocks results in low percolation rates for septic systems. This low permeability promotes surface runoff and shallow discharge during stormflow events (Wooten, pers. Comm.).

Western Piedmont and Mountains Physiographic Area

This area (HA10) has predominate rock types of gneiss and quartzite. Topographic relief is much greater in this area. Low-flow characteristics of streams in HA10 are highly variable due to the underlying rock types, topography and variation in precipitation. Some of the highest low-flow values occur in this region of the State.

2.6 LIVESTOCK OPERATIONS

In 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H.0217) to establish procedures for managing and reusing animal wastes from intensive livestock operations. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve animal populations of at least the following size: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds (chickens and turkeys) with a liquid waste system. The deadline for submittal of registrations to DWQ for existing facilities was December 31, 1993.

Senate Bill 1217, ratified in 1996 by the General Assembly, required any operator of an animal operation with a dry litter animal waste management system involving 30,000 or more birds to develop an animal waste management plan by January 1998. The plan must consist of three specific items: 1) periodic testing of soils where waste is applied, 2) development of waste utilization plans, and 3) completion and maintenance of records on site for three years.

Table 2.12 summarizes by subbasin the number of registered livestock operations, total animals, total acres in operation and total steady state live weight as of December 2, 1997. These numbers reflect only operations required to be registered by law and therefore do not represent the total number of animals in each subbasin. The location sources for this information are obtained from a variety of sources, so the location of operations may not be specific to a subbasin. Figures 2.12 and 2.13 show the general location of these operations in the upper and lower portions of the basin.

Steady State Live Weight (SSLW) is the result, in pounds, after a conversion factor has been applied to the number (head count) of swine, cattle or poultry on a farm. The conversion factors, which come from the Natural Resource Conservation Service (NRCS) guidelines, vary depending on the type of animals on the farm and the type of operation (for example there are five types of hog farms). Since the amount of waste produced varies by hog size, SSLW is the best way to compare the sizes of the farms.

The NC Department of Agriculture provides information on animal capacity by subbasin (Table 2.13). Total swine capacity represents only 2 percent of the state total, with higher concentrations in subbasin 03-07-14 (Richardson Creek drainage) and subbasin 03-07-12 (Dutch Buffalo Creek drainage). The most significant changes in swine populations have occurred in subbasin 03-07-15 (Little River drainage), subbasin 03-07-06 (South Yadkin River drainage) and subbasin 03-07-10 (Brown and Mountain Creeks drainages). The Yadkin-Pee Dee River basin contains 42 percent of the state total capacity for dairy, with 50 percent of these located in subbasin 03-07-06 (South Yadkin River drainage). The basin also contains 36 percent of the state total capacity for poultry, with the highest concentrations found in subbasin 03-07-01 (upper Yadkin River drainage) and subbasin 03-07-14 (Richardson Creek drainage).

Table 2.12 Yadkin-Pee Dee River Basin Registered Animal Operations (as of May 1998).

Subbasin	Cattle Total Animals	Cattle Total Steady State Live Weight	Total Cattle Operations	Poultry Total Animals	Poultry Total Steady State Live Weight	Total Poultry Operations	Swine Total Animals	Swine Total Steady State Live Weight	Total Swine Operations	Yadkin Animal Operations	Total Animals	Total Steady State Live Weight
03-07-01	1,870	2,183,000	8							9	1,498,911	69,086,782
03-07-02	2,576	3,606,400	12				21,330	2,302,350	3	18	23,631	7,662,750
03-07-03	455	637,000	2				3,100	439,270	2	5	890	1,251,270
03-07-04	1,461	2,045,400	6				5,570	832,210	3	10	3,830	3,262,210
03-07-05	450	630,000	2				2,250	318,825	1	3	2,450	3,464,000
03-07-06	10,354	14,315,600	52				2,830	605,150	3	59	11,895	15,471,040
03-07-07	425	595,000	2							2	425	595,000
03-07-08	170	238,000	1	52,000	208,000	1				3	52,210	502,680
03-07-09	995	1,309,000	5	52,000	208,000	1	2,650	362,775	2	10	54,570	2,436,575
03-07-10							35,922	3,529,660	6	12	24,122	4,608,660
03-07-11	1,950	2,730,000	5							5	3,470	4,858,000
03-07-12	1,100	1,540,000	5				9,520	1,470,260	5	11	6,755	3,185,260
03-07-13	275	385,000	1	384,000	1,424,000	4	3,390	373,650	1	7	449,474	2,253,888
03-07-14	808	1,131,200	4	635,000	2,427,000	8	43,842	5,674,020	19	37	817,304	9,446,440
03-07-15							25,204	2,227,620	4	4	28,404	5,919,620
03-07-16							325	43,875	1	1	325	43,875
03-07-17							20,653	1,542,514	5	5	16,786	1,542,514
TOTALS	22,889	31,345,600	105	1,123,000	4,267,000	14	176,586	19,722,179	55	201	2,995,452	135,590,564

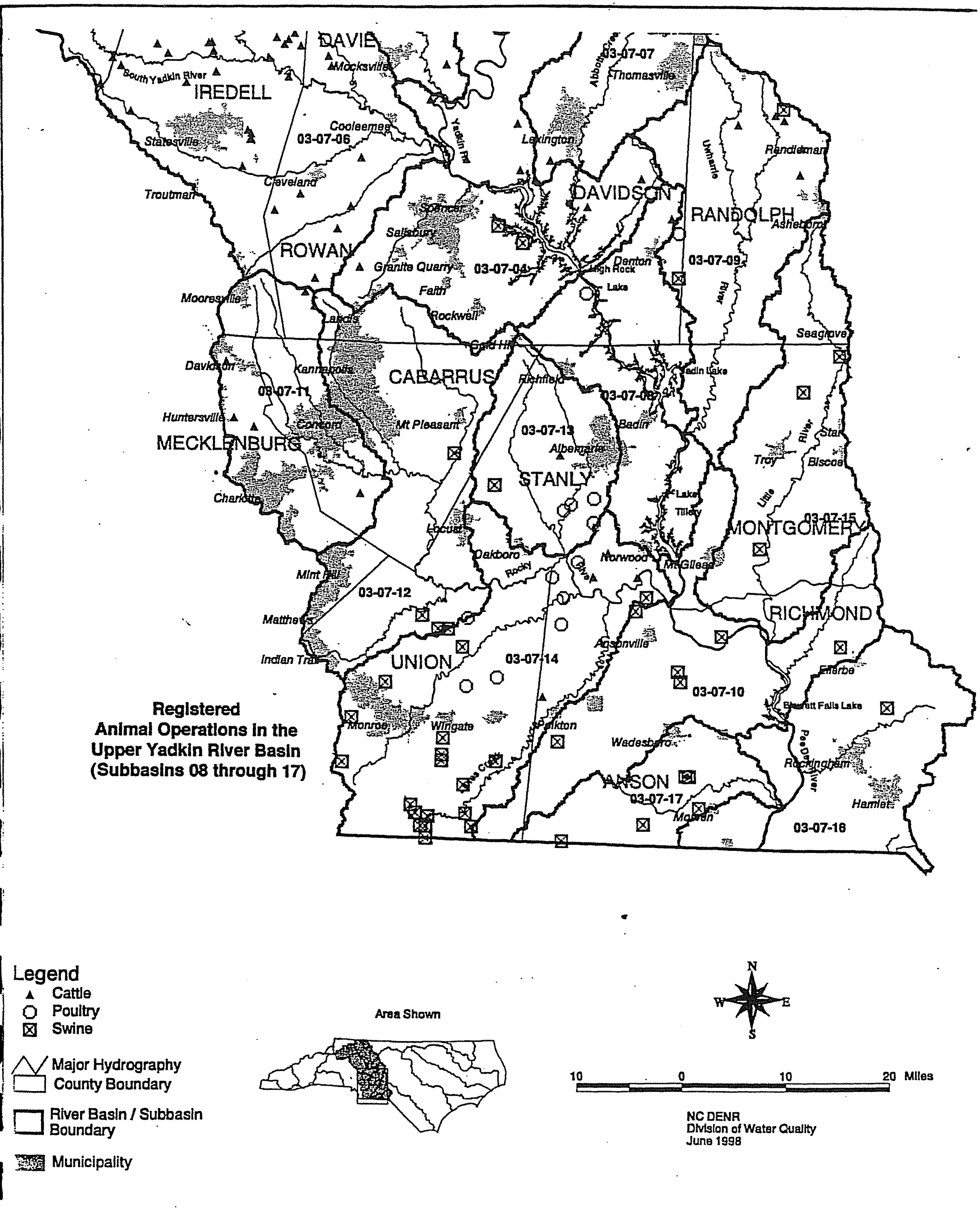


Figure 2.12 Registered Animal Operations in the Upper Yadkin-Pee Dee River Basin (as of May 1998)

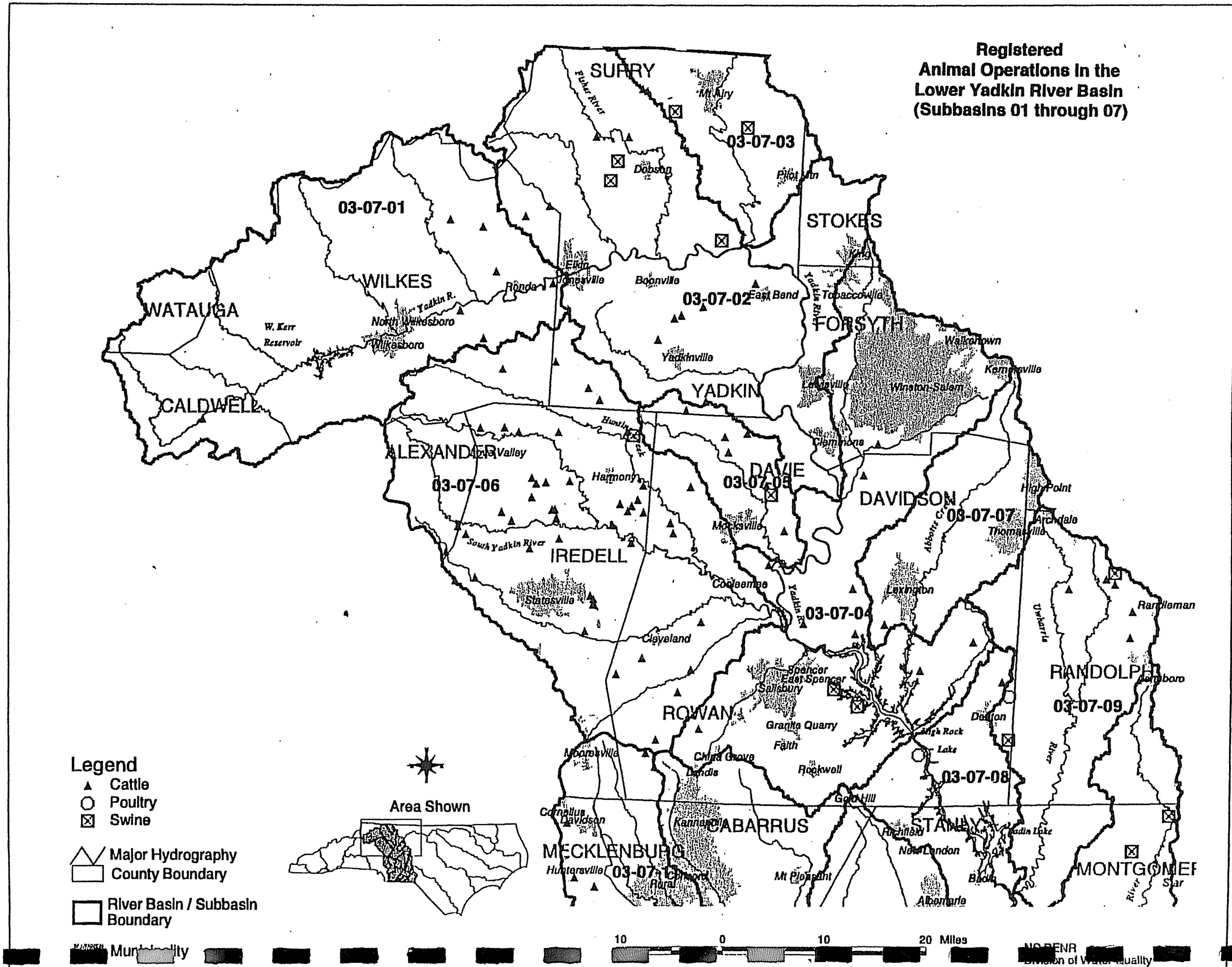

Registered
Animal Operations in the
Lower Yadkin River Basin
(Subbasins 01 through 07)
SURRY
STOKES
FORSYTH
YADKIN
WILKES
WATAUGA
CALDWELL
ALEXANDER
IREDELL
DAVIE
DAVIDSON
ROWAN
RANDOLPH
CABARRUS
STANLY
MECKLENBURG
MONTGOMERY
03-07-01
03-07-02
03-07-03
03-07-04
03-07-05
03-07-06
03-07-07
03-07-08
03-07-09
Mt Airy
Dobson
Pilot Mtn
King
Tobaccoville
Fisher River
Elkin
Jonesville
Boonville
East Bend
Yadkinville
Ronda
Yadkin R.
North Wilkesboro
Wilkesboro
W. Kerr
Reservoir
Walkertown
Kernersville
Winston-Salem
Lewisville
Clemmons
Hunting Creek
Harmony
Mocksville
South Yadkin River
Statesville
Cooleemee
Yadkin R.
Cleveland
High Point
Archdale
Thomasville
Abbotts Cr
Lexington
Uwharrie
River
Randleman
Asheboro
Spencer
East Spencer
Salisbury
Granite Quarry
Faith
China Grove
Landis
Rockwell
High Rock
Lake
Denton
Gold Hill
Mooresville
Cornelius
Davidson
Kannapolis
Huntersville
Concord
Mt Pleasant
Richfield
New London
Badin
Badin Lake
Albemarle
Star
Legend
Cattle
Poultry
Swine
Major Hydrography
County Boundary
River Basin / Subbasin
Boundary
Municipality
Area Shown
10
0
10
20 Miles
NC DENR
Division of Water Quality

Table 2.13 Estimated Populations of Swine, Dairy and Poultry in the Yadkin-Pee Dee River Basin (Source: NCDA Veterinary Division, March 1998)

Subbasin No.	1998 Swine Tot. Cap.	1994 Swine Tot. Cap.	1990 Swine Tot. Cap.	Swine Change 98-94 (%)	Swine Change 90-94 (%)	1998 Dairy Tot. Cap.	1994 Dairy Tot. Cap.	Dairy Change 98-94 (%)	1998 Poultry Total Capacity	1994 Poultry Total Capacity	Poultry Change 98-94(%)
03-07-01	537	768	783	-30%	-2%	806	1,243	-35%	18,398,350	16,876,946	9%
03-07-02	13,585	6,245	8,849	118%	-29%	4,523	6,703	-33%	6,781,475	5,198,900	30%
03-07-03	835	873	1,386	-4%	-37%	1,153	1,153	0%	323,900	325,250	0%
03-07-04	2,373	4,553	4,317	-48%	5%	3,574	4,150	-14%	31,410	25,810	22%
03-07-05	2,269	2,522	1,968	-10%	28%	1,355	2,506	-46%	325,150	210,900	54%
03-07-06	3,607	6,908	4,778	-48%	45%	20,815	28,394	-27%	7,263,805	6,579,030	10%
03-07-07	771	719	2,504	7%	-71%	963	1,203	-20%	85,600	85,100	1%
03-07-08	740	2,655	3,144	-72%	-16%	260	1,942	-87%	1,536,200	1,022,700	50%
03-07-09	2,445	3,392	2,747	-28%	23%	1,384	2,469	-44%	1,559,115	1,140,557	37%
03-07-10	23,384	13,029	9,213	79%	41%	138	138	0%	4,269,000	4,208,680	1%
03-07-11	332	677	739	-51%	-8%	3,173	1,642	93%	210,794	220,594	-4%
03-07-12	7,260	15,513	13,272	-53%	17%	515	1,336	-61%	6,085,444	5,210,044	17%
03-07-13	17,437	3,710	5,241	370%	-29%	1,025	1,747	-41%	3,674,750	3,260,295	13%
03-07-14	31,811	23,483	25,861	35%	-9%	969	1,161	-17%	16,050,832	13,961,182	15%
03-07-15	21,097	14,985	8,275	41%	81%	0	360	-100%	3,789,753	3,435,300	10%
03-07-16	12,902	4,694	4,622	175%	2%	0	2	-100%	3,406,420	3,352,036	2%
03-07-17	15,432	2,199	3,460	602%	-36%	150	249	-40%	1,123,800	918,800	22%
TOTALS	156,817	106,925	101,159	47%	6%	40,803	56,398	-28%	74,915,798	66,032,124	13%
State Tot. %	1.60%	2%	2%			41%	42%		35%	36%	

Source: NC Department of Agriculture, Veterinary Division

2.7 SURFACE WATER CLASSIFICATIONS AND STANDARDS

All surface waters in the state are assigned a primary water classification. They may also be assigned one or more supplemental classifications. Classifications are assigned to protect uses of the waters such as swimming, aquatic life propagation or water supplies. For each classification, there is a set of water quality standards that must be met in order to protect the uses. Chapter 5 provides a more detailed summary of the state's primary and supplemental classifications including (for each classification) the best usage, water quality standards, stormwater controls and other protection requirements as appropriate. This information is derived from 15A NCAC 2B .0200 - Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina.

The waters of the Yadkin-Pee Dee River basin have a variety of surface water quality classifications applied to them (Table 2.14). The majority of the surface waters are classified as C (64%). Water Supply Watersheds within the basin range from WS-I to WS-V. Information in Table 2.14 was calculated by the Center for Health Statistics using GIS applications. The stream length summaries were calculated by first identifying the blue lines (referred to as arcs) representing stream segments, and subsequently attributing them by their class. This was an iterative process as many of the arcs were redundantly attributed (e.g. 'HQW' and 'C'), and therefore measured twice. This explains why the sum of the percentages for the various classes is greater than 100 percent.

Stream length summaries do not include the length of arcs representing pond and/or lake shorelines. Therefore, the measurement of the length of a particular stream will stop when entering an impounded area (lake), and begin again where the stream flows out of the impoundment. The lake area calculations are intended as a categorical representation of this hydrologic feature.

Table 2.14 Water Quality Classification Statistics for Streams and Lakes in the Yadkin-Pee Dee River Basin

	HQW	ORW	WS-I	WS-II	WS-III	WS-IV	WS-V	B	C	Tr
Stream Mi.	91	239	.78	776	902	1447	185	455	6,278	798
% of Total	1	2.4	0.01	7.9	9.2	14.7	1.9	4.6	63.8	8
Number of Lakes*	2	4	0	22	41	46	4	33	124	9
Lakes (in acres)	18	71	0	1,802	2,001	24,423	5,878	24,724	1,306	1,586

* - The number of lakes does not necessarily equal the total number of lakes in the basin. This number is higher than the actual number of lakes because some of the lake polygons in GIS are split by closure lines and quad boundaries in the USGS files from whence these figures were calculated.

Water Supply Watershed Protection

Water Supply Watershed Protection ordinances were required by all governments in North Carolina in 1992. Many rural counties in the basin are resistant to zoning outside of municipal boundaries, and the few counties that do have county-wide zoning have fairly permissive development standards. Watershed ordinances are therefore often the only effective land-use controls, from a water quality standpoint, for large sections of the counties. The use of agriculture BMPs in the critical areas of the watersheds is of particular importance since sediment is the primary threat to water quality in the basin (Northwest Piedmont Council of Governments, 1996).

In water supply watersheds there are three sets of regulations controlling minimum lot sizes: public health department regulations for septic tanks, zoning regulations, and watershed protection regulations. In rural areas the public health requirements are often more stringent than the watershed regulations' minimum lot sizes and therefore prevail. The requirement to protect water supply met with bitter opposition from rural counties, especially in the upper Yadkin River basin. As a result these counties adopted ordinances that were the most permissive and least restrictive allowed by the State. Forsyth and Davidson Counties, on the other hand, passed stricter standards for some portions of their watershed due to the higher degree of development in their jurisdictions. There is great pressure on the General Assembly to weaken the regulations and these pressures will continue as land values in the watersheds continue to increase (Northwest Piedmont Council of Governments, 1996).

Table 2.15 provides an estimate of the number of acres within each county that is wholly or partially within the basin that are affected by water supply classifications, total acreage within the county (does not exclude surface water acreage or municipal jurisdictions; % affected jurisdictional area would be lower), and percent of county that is affected by a water supply classification. Figures 2.14 and 2.15 depict the locations of water supply watersheds, high quality waters, and outstanding resource waters in the basin. A complete listing of classifications for all surface waters in the basin can be found in a DWQ publication entitled "Classifications and Water Quality Standards Assigned to the Waters of the Yadkin-Pee Dee River Basin Drainage Area". All pending reclassifications in the basin pertain to watersupply watersheds and are discussed below.

Because most of the counties in the upper Yadkin River basin have adopted the minimum standards established by the State, the following discussion will only address those regulations that differ from the State's (Northwest Piedmont Council of Governments, 1996).

Forsyth County and Municipalities: The watershed ordinances passed by Forsyth County and its municipalities generally follow the State's minimum standards, with higher levels of protection for three WS-III watersheds: Abbotts Creek, Salem Lake and Lake Brandt. Forsyth County has adopted provisions for intense development within watersheds and has created a Special Intense Development Allocation procedure to allocate limited areas for high density development projects that meet specific performance and policy criteria. The Town of Lewisville is considering a change to their zoning overlay map that will adopt the high density option within their watershed, but it has not been approved by the Town Council at this time.

Davidson County: The northern portion of the County is receiving considerable spill-over growth from Guilford and Forsyth Counties, so the County established 1 acre, instead of 1/2 acres, minimum lot sizes in its WS-IV watershed.

1996 Environmental Management Commission Rule Interpretation

The Environmental Management Commission (EMC) was petitioned in early 1996 to interpret the definition of Protected Area (rule 15A NCAC 2B .0202(46)) as it is used in the Water Supply Watershed Protection Program. The question was whether the Protected Area boundary for WS-IV run-of-the-river water supplies should be measured as ten miles "as-the-river-flows" or "linearly". On May 9, 1996, the EMC clarified the definition by stating that the "as-the-river-flows" method is the appropriate method for determining the Protected Area for WS-IV run-of-the-river water supplies.

Table 2.15 Yadkin River Basin Water Supply Watershed Classification Analysis

County	Water Supply Acreage	Total County Acreage	% of County in Water Supply
Alexander	53,387	168,600	32
Alleghany	1,577	150,100	1
Anson	35,144	343,800	10
Cabarrus	33,253	233,300	14
Caldwell	53,768	303,600	18
Davidson	156,754	362,600	43
Davie	100,800	170,800	59
Forsyth	88,749	264,900	34
Guilford	202,649	420,700	48
Iredell	166,991	380,100	44
Mecklenburg	59,967	351,600	17
Montgomery	94,405	321,000	29
Randolph	128,498	505,300	25
Richmond	124,406	306,900	41
Rowan	152,785	335,000	46
Stanly	65,746	259,100	25
Stokes	97,231	291,800	33
Surry	105,307	345,200	31
Union	55,435	409,200	14
Watauga	22,932	201,000	11
Wilkes	234,177	485,400	48
Yadkin	135,826	215,000	63

Local governments within WS-IV ten-mile Protected Area water supplies were sent a letter of notification of the EMC's interpretation decision. Local governments were given the opportunity to submit a request to DWQ by October, 1996 to have the Protected Area boundaries within their jurisdiction changed.

In general, the Protected Area boundary for each of the potentially affected water supplies will be reduced in size. However, the proposal will allow local governments the option to: reduce the Protected Area size where water supply watershed ordinances are required; keep their current area of implementation; or as previously allowed, increase the area of water supply protection implementation within the local government's jurisdiction within the WS-IV run-of-the-river water supply watershed.

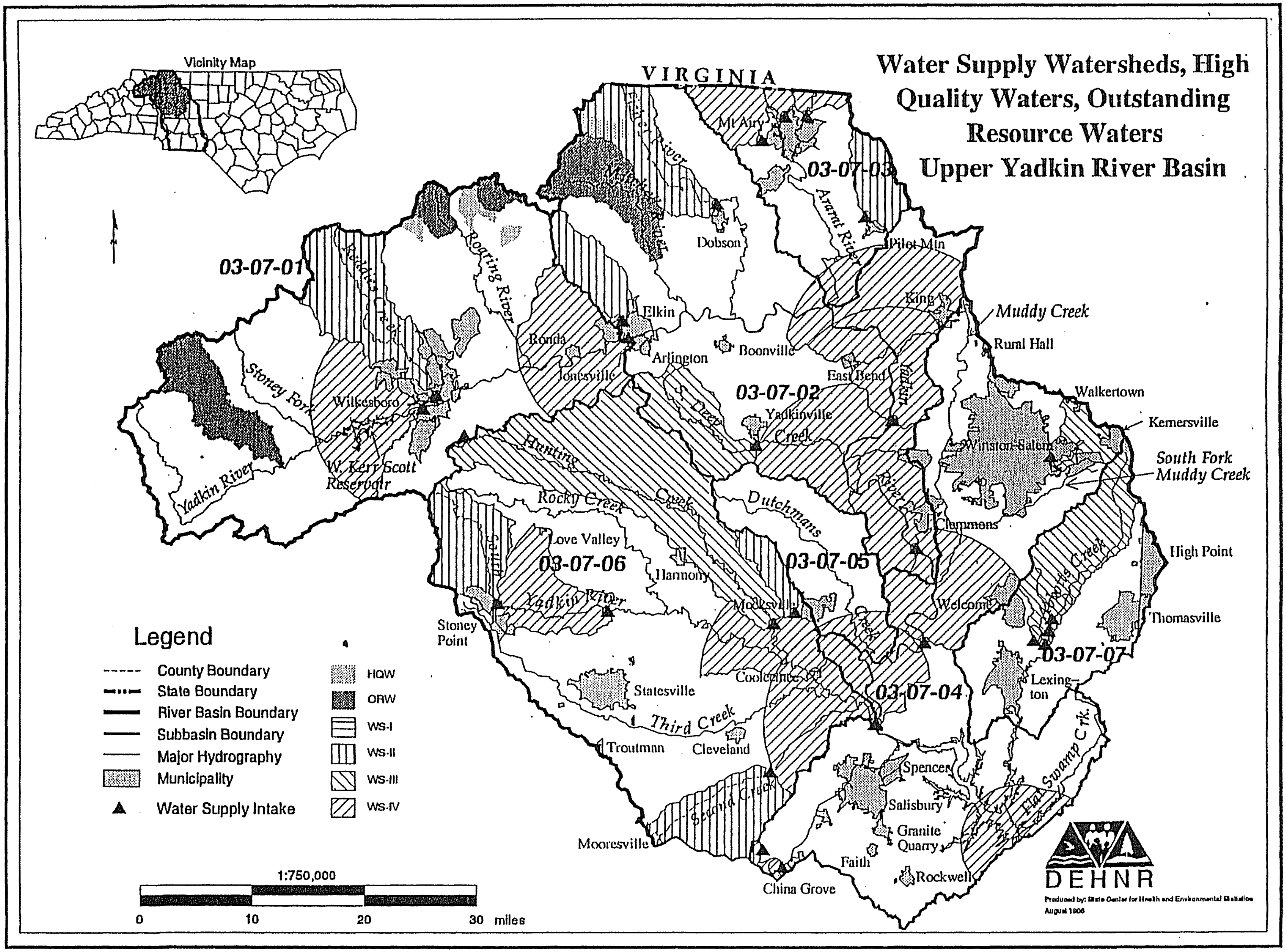


Figure 2.14 Water Supply Watersheds in the Upper Yadkin-Pee Dee River Basin

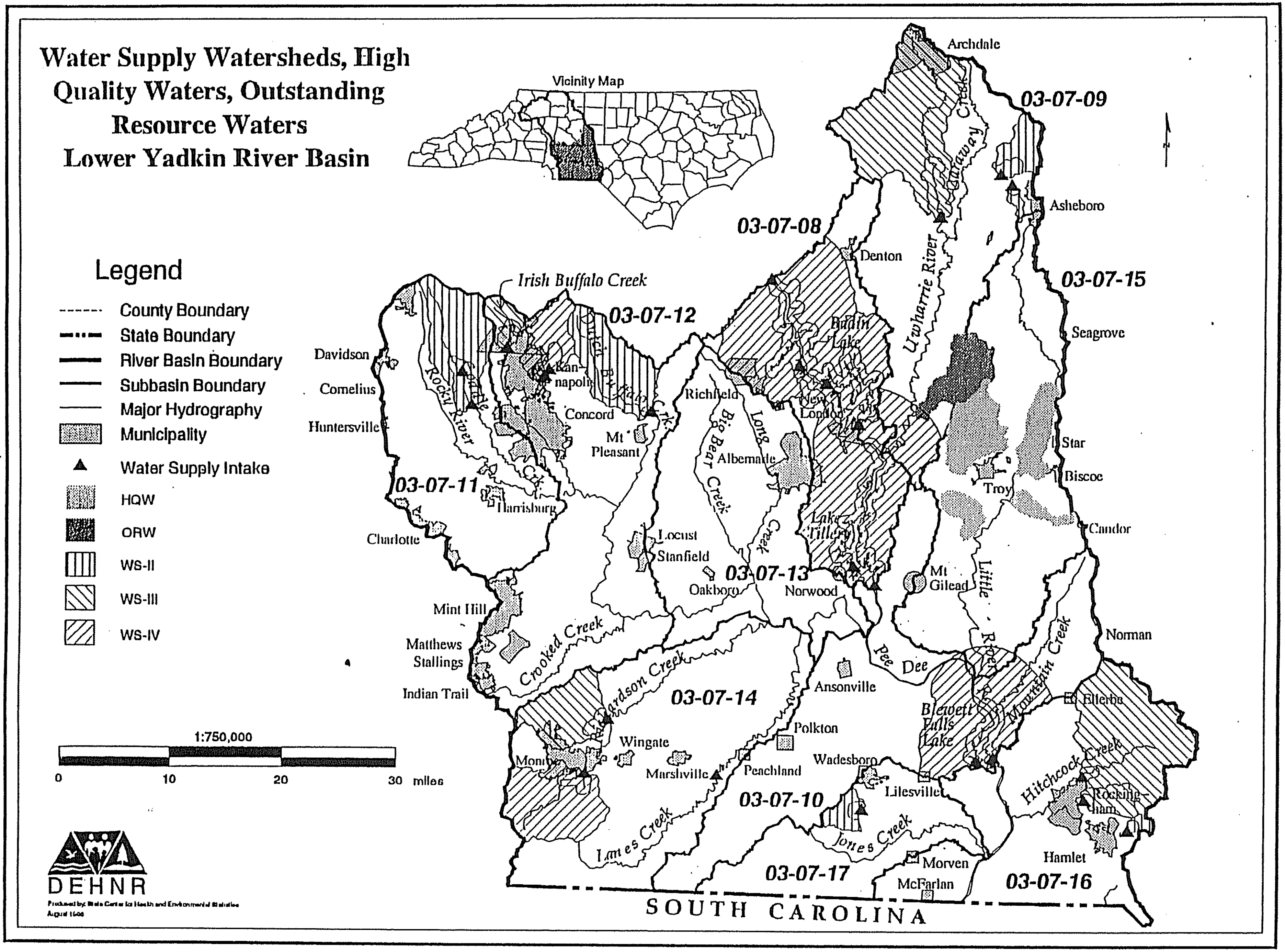


Figure 2.15 Water Supply Watersheds in the Lower Yadkin-Pee Dee River Basin

DWQ received nine petitions to modify the WS-IV Protected Area within the Yadkin-Pee Dee River basin (Table 2.16). Public hearings were held to receive comments on the proposed changes. The petitions were approved by the Environmental Management Commission in December 1997, with the exception of Wilkesboro and Winston-Salem. The effective date for the approved modifications is August 1, 1998. Those modifications still pending will go to public hearings in May 1998.

Table 2.16 Water Supply Modifications in the Yadkin-Pee Dee River Basin

Waterbody	Status	County
S.Yadkin R. - Cooleemee	approved	Davie, Iredell, Rowan
Yadkin R. - Davidson County	approved	Davidson, Davie, Forsyth
Yadkin R. - Davie County	approved	Davie, Forsyth, Yadkin
Yadkin R. - Jonesville	approved	Wilkes, Yadkin
Yadkin R. - King	approved	Forsyth, Stokes, Surry, Yadkin
Yadkin R. - Salisbury	approved	Davidson, Davie, Rowan
Yadkin R. - Wilkesboro	pending	Wilkes, Yadkin
Yadkin R. - Winston-Salem *	approved & pending	Davie, Forsyth

2.8 WATER USE IN THE YADKIN-PEE DEE RIVER BASIN

2.8.1 Water Use Reported by Local Governments

In 1989, the North Carolina General Assembly adopted a law that requires local governments that operate public water supply systems to develop and approve a Local Water Supply Plan (GS 143-355 (l)). In order to assure the availability of adequate supplies of good water quality to protect public health and to support desirable growth, the North Carolina Division of Water Resources (DWR) is compiling a State Water Supply Plan Database pursuant to GS 143-355 (m)). The Database contains information reported in the Local Water Supply Plans. The State Water Supply Plan will identify potential water use conflicts among water suppliers and identify ways to better coordinate water supply programs.

The information in the State Water Supply Plan database has been submitted by local government water systems in their 1992 Water Supply System Reports and maps which are part of their adopted Local Water Supply Plans pursuant to G.S. 143-355(l). Plans in this database are labeled as "adopted" or "draft" plans.

Plans labeled "adopted" have been reviewed by DWR for internal consistency, reasonableness and completeness and have been acknowledged by DWR as meeting the minimum requirements of the law. Plans labeled "draft" have not yet completed this process. None of the data has been field verified. Consistency between plans has not been considered. The State Water Supply Plan database is still receiving data. Information in the database may be corrected or updated at any time by the local government. This data will be updated at least once every five years.

As of January 1997, seventy-five local government water systems got some or all of their water from the Yadkin River basin and are represented in the State Water Supply Plan database. The following summary includes information on current and future population and water use of these systems based on estimates received from local governments. As reported by local governments, populations serviced by these systems from present (1992) through the year 2020 is expected to increase by 55 percent (an average of 16 percent per 10 year planning period). Present water use profile for these systems indicates an average daily water use of 151 million gallons per day

(MGD). Comparing this present rate (1992) with projected future consumption shows an expected 74 percent increase in water use by the year 2020 (an average of 20 percent per 10 year planning period).

Note that these estimates reflect a percentage of systems' total population or water use based on the proportion of a systems' water withdrawn from the Yadkin basin. For example: if a water system gets all of its water from the Yadkin-Pee Dee River basin it would have 100% of its population represented; a system that has some of its land area in the Yadkin-Pee Dee River basin but has all of its water withdrawn from outside the basin would not have any of its population represented; and a system that gets some (but not all) of its water from the Yadkin-Pee Dee River basin would have a proportion of its total population represented, based on the proportion of the systems' water withdrawn from the Yadkin basin.

2.8.2 Water Use Reported by United States Geological Survey

USGS water use information for the Yadkin-Pee Dee River basin (HUCs 03040101, 03040102, 03040103, 03040104, 03040105, 03040201, and 03040202) indicates that the total water withdrawals for the basin were 260.79 MGD (Table 2.17). Groundwater sources supplied 52 MGD of this and the remaining 209 MGD was withdrawn from surface water sources.

Table 2.17 Yadkin River Basin Water Withdrawals for 1990 (MGD)

Withdrawal Category	Groundwater	Surface Water	Total Water
Public Water Supply	7.74	132.69	140.43
Commercial Self Supply	0.45	0.00	0.45
Domestic Self Supply	22.58	0.00	22.58
Industrial Self Supply	11.91	22.46	34.37
Electric Power Self Supply	0.00	29.48	29.48
Mining Self Supply	0.58	10.36	10.94
Livestock Self Supply	8.90	1.71	10.66
Irrigation Self Supply	0.03	11.85	11.88
Total	52.24	208.55	260.79

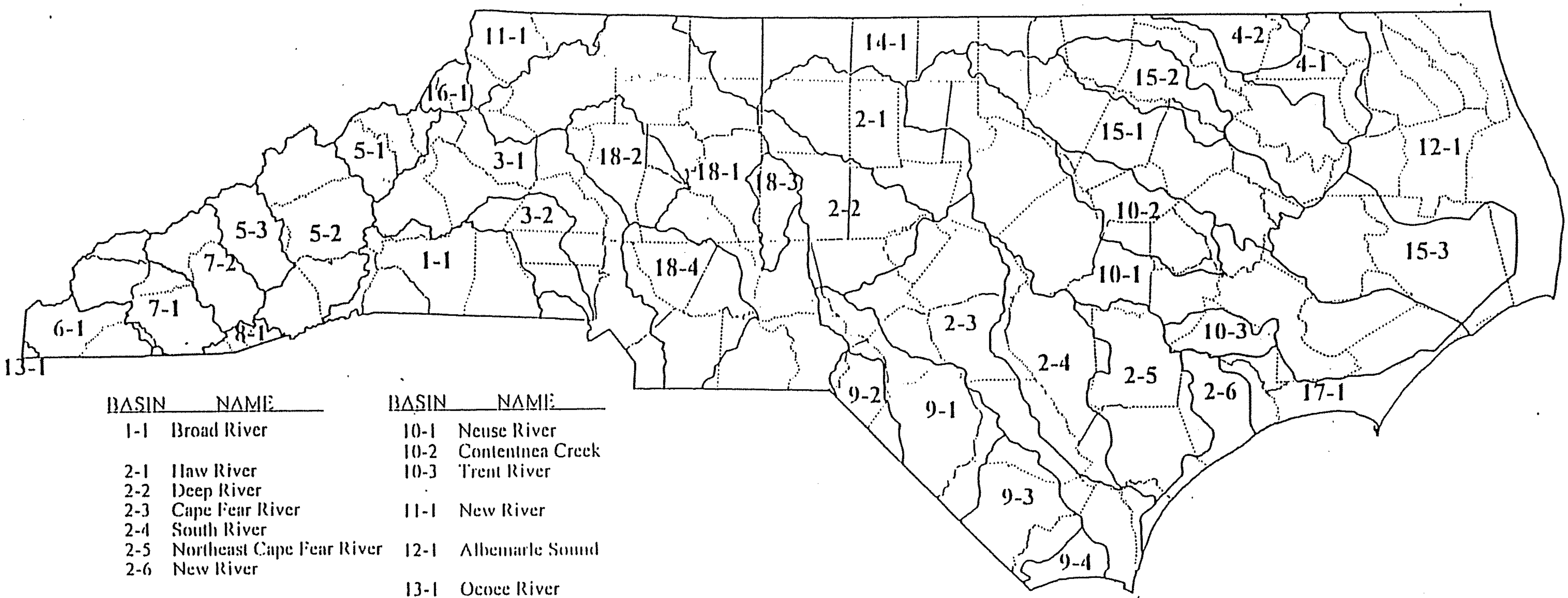
Source: USGS Water Use Database, Not Published, file retrieved from ftp site at ...130.11.144.77 in /var/ftp/pub

2.8.3 Water Withdrawal and Interbasin Transfer Registration

In 1991, the General Assembly passed G.S. 143-215.22H requiring all persons withdrawing a total of one million gallons per day or more to register that withdrawal with the Division of Water Resources. The law also mandates that interbasin transfers of one million gallons per day or more in any given day (G.S. 143-215.22G) be registered. The law was amended in 1993 to include groundwater, to add a penalty for non-compliance, to add required information, and to exempt water systems with approved local water supply plans. All new withdrawals must be registered within six months of the initial withdrawal and all withdrawals must be updated at least every five years. The law states that any person who withdraws one MGD or more must register and as a result, many water suppliers with multiple facilities were required to register all of their facilities because the sum of the withdrawals equaled one MGD or more. In addition to being registered, interbasin transfers of 2 MGD or more must also obtain a certificate from the Environmental Management Commission under G.S. 143-215.22I.

The term "interbasin transfer" is used to define transfers of surface water between any of the 38 defined river subbasin boundaries. The river basin boundaries that apply to these requirements are designated on a map entitled "Major River Basins and Sub-basins in North Carolina", which was filed in the Office of the Secretary of State on April 16, 1991. As shown in Figure 2.16, this official interbasin transfer map only designates four subbasins within the Yadkin-Pee Dee River basin, as compared to the 17 subbasins recognized by DWQ.

Figure 2.17 shows the individual registered interbasin transfers into or out of these four subbasins. There are a total of ten interbasin transfers either into or out of the subbasins of the Yadkin-Pee Dee River basin. Only seven of the transfers are into or out of the basin as a whole (Mooresville, Burlington Industries, Charlotte-Mecklenburg Utilities Department, Davidson Water, High Point, Asheboro and Montgomery County). The water transferred by Kannapolis, Albemarle and Davidson Water only crosses subbasin boundaries and therefore doesn't leave the major Yadkin-Pee Dee River basin. These transfers are 1992 average daily amounts in million gallons per day (MGD) based on 1992 Local Water Supply Plans (refer to Section 2.8.1) and registered withdrawal/transfer information. These individual transfer amounts are tallied in Table 2.18 for both the subbasin and major basin levels.



BASIN	NAME
1-1	Broad River
2-1	Haw River
2-2	Deep River
2-3	Cape Fear River
2-4	South River
2-5	Northeast Cape Fear River
2-6	New River
3-1	Catawba River
3-2	South Fork Catawba River
4-1	Chowan River
4-2	Meherrin River
5-1	Nolichucky River
5-2	French Broad River
5-3	Pigeon River
6-1	Hiwassee River
7-1	Little Tennessee River
7-2	Tuckasegee River
8-1	Savannah River
9-1	Lumber River
9-2	Big Shoe Heel Creek
9-3	Waccamaw River
9-4	Shallotte River

BASIN	NAME
10-1	Neuse River
10-2	Contentnea Creek
10-3	Trent River
11-1	New River
12-1	Albemarle Sound
13-1	Ococe River
14-1	Roanoke River
15-1	Tar River
15-2	Fishing Creek
15-3	Pamlico River & Sound
16-1	Watauga River
17-1	White Oak River
18-1	Yadkin River
18-2	South Yadkin River
18-3	Uwharrie River
18-4	Rocky River

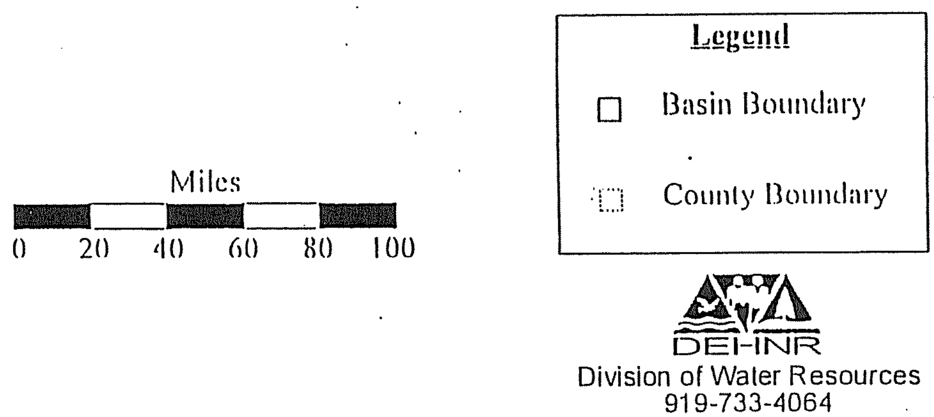
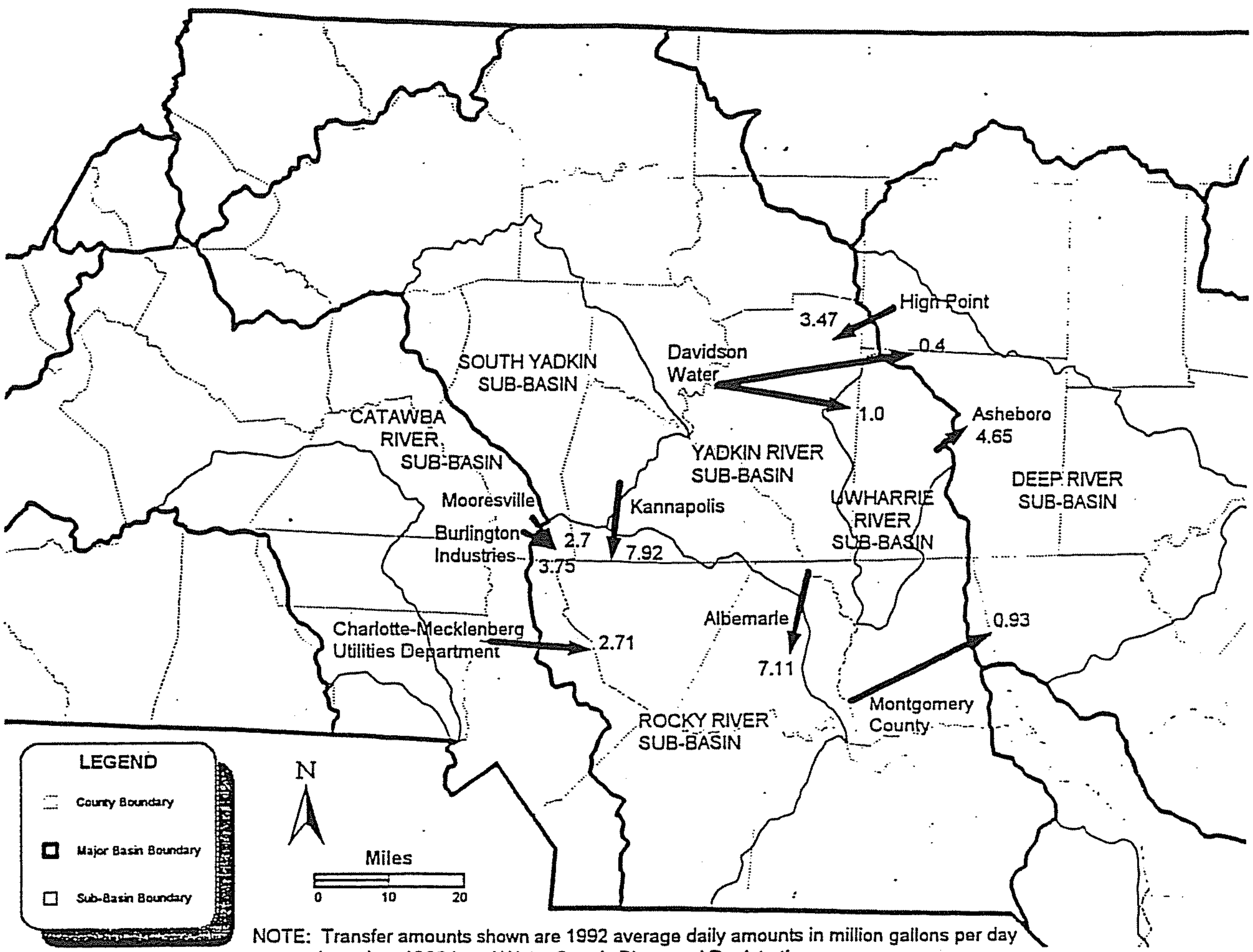


Figure 2.16 Major Subbasins in North Carolina as defined by the NC Division of Water Resources (Source: Division of Water Resources)

Figure 2.17 Registered Interbasin Transfers for the Yadkin-Pee Dee River Basin



NOTE: Transfer amounts shown are 1992 average daily amounts in million gallons per day based on 1992 Local Water Supply Plans and Registrations.

Table 2.18 Interbasin Transfer Summaries for the Yadkin-Pee Dee River Basin and Subbasins

Subbasin	Average Daily Transfer From Basin (MGD)	Average Daily Transfer To Basin (MGD)	Net Transfer (MGD)
Subbasin Level			
Yadkin River	9.44	3.47	5.97 (out)
South Yadkin River	7.92	-	7.92 (out)
Uwharrie River	4.65	1.0	3.65 (out)
Rocky River	-	24.19	24.19 (in)
Major Basin Level			
Yadkin-Pee Dee River	5.98	12.63	6.65 (in)

2.9 MINIMUM STREAMFLOW REQUIREMENTS

The NC Division of Water Resources (DWR), working with the Wildlife Resources Commission (WRC), provides minimum streamflow recommendations to maintain aquatic habitat downstream of dam releases. These requirements are then included in a project's dam safety permit issued by the Division of Land Resources. The authority for requiring a minimum release is included in the Dam Safety Law (G.S. 143-215.31(b)). Minimum flows for maintaining stream classification and water quality standards are based on water quality rules developed by DWQ. The rules for determining minimum flows to maintain aquatic habitat also include provision for existing water supply reservoirs which list several factors which must be considered in re-evaluating a minimum releases. The rules also limit the impact of any new minimum flow on an existing water supply reservoir's safe yield to no more than ten percent reduction.

DWR's Water Resources Planning Section (WRPS) is conducting a number of instream flow studies in the Yadkin-Pee Dee River Basin (Table 2.19). The WRPS operates under the rules applied to the Dam Safety Law that require dams to release minimum stream flows to adequately maintain aquatic habitat (G.S. 143-215.24.0500). They are described in the following discussion.

Subbasin 03-07-02

South Deep Creek

- The Town of Yadkinville plans to expand withdrawals up to a capacity of 5.5 MGD and develop off-stream storage for low flow periods. An instream flow study established a flow target of 15 cubic feet per second (cfs) below the town's withdrawal. An agreement established a withdrawal limit of 1.7 cfs, 20 percent of the 7Q10 (8.4 cfs, as measured downstream of the intake), when streamflow was equal to or below the 7Q10. The town can withdraw up to capacity when streamflow exceeds 8.4 cfs.

- The Yadkin County Soil and Water Conservation District and the Yadkin County Board of Commissioners are sponsoring the construction of a proposed impoundment upstream of Cranberry Creek. The dam will be subject to the NC Dam Safety Law and will be required to provide a minimum flow. The minimum flow from the dam will not be less than the 7Q10 of 4.0 cfs.

Yadkin River

- The City of Winston-Salem is proposing a new water intake and low-head weir to meet future water demands. The WRPS commented on the Environmental Impact Statement in regards to construction of riffle habitat downstream of the weir to mitigate the loss of aquatic habitat, boating access and passage, and maintaining the 7Q10 stream flow target at the Enon gage.

- The privately-owned Idols hydropower facility is located near Clemmons, NC. The facility is currently being relicensed with the Federal Energy Regulatory Commission (FERC). The DWR has completed a study that determined no minimum release will be required. However, the facility is to operate as run-of-river where outflow equals inflow.

Table 2.19 Minimum Streamflow Studies in the Yadkin-Pee Dee River Basin

Subbasin	Waterbody	Basis for Study	Outcome
03-07-02	South Deep Creek	Town of Yadkinville expansion	Minimum instream flow established
		Proposed impoundment	Project proposed - minimum instream flow established
	Yadkin River	Proposed intake	Comments provided on EIS
		FERC relicensing	Study complete - run-of-river requirement applies
03-07-03	Pauls Creek	Proposed impoundment	If project is pursued, a study is required
	Toms Creek	Proposed expansion	Study underway
	Stewarts Creek	Proposed dam raising	Minimum instream flow established
03-07-06	South Yadkin Rvr.	Hydropower requirement	Minimum instream flow established
03-07-11	Coddle Creek	Impoundment	Minimum instream flow established
03-07-16	Hitchcock Creek	Two hydropower requirement projects	Minimum instream flow established

Subbasin 03-07-03

Pauls Creek

- The Town of Mount Airy and Surry County are considering sponsoring an impoundment on Pauls Creek. The potentially impacted reach of Pauls Creek would be a special case because of a self-supporting wild trout population. The project would require an instream flow study to determine the minimum flow requirement.

Stewarts Creek

- In 1989, the Town of Mount Airy proposed raising the Stewarts Creek dam crest by five feet. The DWR established a minimum flow requirement of 19.0 cfs below the dam.

Toms Creek

- The Town of Pilot Mountain is proposing to expand its water treatment plant to accommodate a 2.4 MGD withdrawal. Off-stream storage is proposed to supplement flow during dry periods. An instream flow study is being conducted to determine the flow needed to maintain aquatic habitat. The minimum requirement will not exceed the present requirement of 10.3 cfs and will not be less than the 7Q10 of 4.7 cfs. When flows downstream of the intake are less than the minimum requirement, Pilot Mountain will still be allowed to withdraw 1.6 MGD.

Subbasin 03-07-06

South Yadkin River

- The privately-owned Cooleemee hydropower facility is located in Cooleemee, NC. The facility has a minimum flow requirement of 124 cfs in the by-passed reach below the dam. The facility is to operate as run-of-river where outflow equals inflow.

Subbasin 03-07-11

Coddle Creek

- DWR has established a 6.0 cfs minimum flow from the Coddle Creek impoundment (constructed with the Town of Concord's new water treatment plant) to maintain downstream aquatic habitat.

Subbasin 03-07-16

Hitchcock Creek

- The privately-owned Steeles Mill hydropower facility is located near Cordova, NC. The facility has a minimum flow requirement of 31.5 cfs in the by-passed reach below the dam. The facility is to operate as run-of-river where outflow equals inflow.

- The privately-owned Ledbetter Dam hydropower facility is located northeast of Rockingham, NC. DWR recommended that the dam safety permit require a minimum release of 6.5 cfs when the impoundment's level is more than five feet below the crest. The outflow should be 9.5 cfs or inflow, whichever is greater, when the water level is less than or equal to five feet below the crest.

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CHAPTER 3

CAUSES OF IMPAIRMENT AND SOURCES OF WATER POLLUTION

3.1 INTRODUCTION

A number of substances cause water quality impairment. *Sources* of these substances are divided into broad categories called *point* sources and *nonpoint* sources. Point sources are typically piped discharges from wastewater treatment plants and large urban and industrial stormwater systems. Nonpoint sources can include stormwater runoff from smaller urban areas, forestry, mining, agricultural lands, rural residential development, and others. **Section 3.2** identifies and describes the major causes of impairment in the basin. **Sections 3.3** and **3.4** describe point and nonpoint source pollution in the basin.

3.2 CAUSES OF IMPAIRMENT

Causes of impairment refers to the substances which enter surface waters from point and nonpoint sources and result in water quality degradation. The major causes of water quality impairment are shown in Table 3.1. Each of these causes of impairment is discussed in the following sections.

Table 3.1 Causes of Impairment and Sources of Water Pollution

Cause of Impairment	Source Index PS	Source Index NPS	Description
Sediment		++	Mostly nonpoint source activities including: construction and mining sites, disturbed land areas, streambank erosion, cultivated farmland, removal of vegetative buffers along streams
Color	++		Generally associated with industrial wastewater or municipal plants that receive certain industrial wastes, especially textile manufacturers that dye fabrics and pulp and paper mills.
Toxic and Synthetic Substances	+	+	Pesticide applications, disinfectants (chlorine), automobile fluids, accidental spills, illegal dumping, urban stormwater runoff, leaky automobiles, illegal dumping
Oxygen-Consuming Wastes	++	+	Wastewater effluent, organic matter, leaking sewers and septic tanks, animal waste
Fecal Coliform Bacteria	+	++	Failing septic tanks and leaking sewers, animal waste, runoff from livestock operations, wildlife, improperly disinfected wastewater effluent
Nutrients	++	++	Fertilizer (on agricultural, residential, commercial and recreational lawns), animal wastes, leaky sewers and septic tanks, atmospheric deposition, municipal wastewater

++ = significant or primary source
+ = limited source that may be locally significant
a blank = little or no contribution

PS = Point Source (see Section 3.3)
NPS = Nonpoint Source (see Section 3.4)

3.2.1 Sedimentation

Introduction

Erosion is a natural process by which soil and rock material is worn away by rain, wind, and ice. Natural erosion occurs on a geologic time scale, but the process can be greatly accelerated when human activities alter the landscape. The sediment produced by erosion generally winds up in the surface waters.

Some of the activities that increase sediment loads to waterbodies include: construction activities, unpaved private access roads, state road construction, golf courses, uncontrolled urban runoff, mining, timber harvesting, agriculture, and livestock operations.

Some of the adverse impacts of sediment include:

- Streambank erosion: Streams with high sediment load have a much greater potential to scour the streambank. Also, as the streambed fills in with sediment, the stream will widen to carry the flow. Streambank erosion causes the loss of valuable property.
- Damaged aquatic communities: Sediment damages aquatic life by destroying stream habitat, clogging gills, and reducing water clarity.
- Polluted water: Sediment often carries other pollutants with it, including nutrients, bacteria, and toxic/synthetic chemicals. This pollution can also threaten public health if drinking water sources and fish tissue become contaminated.
- Increased costs for treating drinking water: Sedimented waters require costly filtration to make them suitable for drinking. Water supply reservoirs lose storage capacity when they become filled with sediment, necessitating expensive dredging efforts.

Programs and best management practices aimed at addressing sedimentation are briefly described in Chapter 5. General recommendations to reduce sedimentation are listed in Chapter 6, Section 6.5.

North Carolina does not have a numeric water quality standard for suspended sediment. However all point source dischargers must at a minimum meet federal effluent guidelines (e.g. 30 mg/l for domestic dischargers) for total suspended solids (TSS). The biochemical oxygen demand (BOD) limits required for most point sources usually necessitate a degree of treatment that assures the removal of solids to a level below federal requirements. A TSS limit of 10 mg/l is required for discharges to those High Quality Waters (HQW) which are trout waters or primary nursery areas, and a limit of 20 mg/l is required for discharges to other HQWs.

North Carolina *has* adopted a numerical instream turbidity (measurement of water clarity) standard as follows:

- 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters;
- 25 NTU in lakes and reservoirs not designated as trout waters;
- 10 NTU in trout waters.

Land disturbing activities are considered to be in compliance with the standard if approved best management practices have been implemented.

Effects of Sedimentation

Sedimentation is often divided into two categories: *suspended load* and *bed load*. Suspended load is composed of small particles that remain in suspension in the water. Bed load is composed of larger particles that slide or roll along the stream bottom. Suspension of load types depends on water velocity and stream characteristics. Biologists are primarily concerned with the *concentration* of the suspended sediments and the *degree of sedimentation* on the streambed (Waters, 1995).

The concentration of suspended sediments affects the availability of light for photosynthesis, as well as the ability of aquatic animals to see their prey. Several researchers have reported reduced feeding and growth rates by fish in waters with high suspended solids. In some cases it was noted that young fish left those stream segments with turbid conditions. Suspended sediments can clog the gills of fish and reduce their respiratory abilities. These forms of stress may reduce the tolerance level of fish to disease, toxicants and chronic turbid conditions (Waters, 1995).

The degree of sedimentation affects both the habitat of aquatic macroinvertebrates and the quality and amount of fish spawning and rearing habitat. Degree of sedimentation can be estimated by observing the amount of streambed covered, the depth of sedimentation, and the percent saturation of interstitial space or embeddedness. Eggs and fry in interstitial spaces may be suffocated by the sediments thereby reducing reproductive success (Waters, 1995). Effects of sedimentation on macroinvertebrates can be seen in alterations in community density, diversity, and structure (Lenat et al., 1979).

The findings of academic research have noted the potential impact of sedimentation on fisheries, in particular on wild trout populations. Inorganic sediments can affect trout productivity in three ways: direct effects - impairment of respiration, feeding habits, and migration patterns; reduced egg hatching and emergence due to decreased water velocity and dissolved oxygen; and, trophic effects - reduction in prey (macroinvertebrates). As fine suspended solids increase in the waters, the dissolved oxygen, permeability, and apparent velocity decrease (West, date unknown).

The impact of sedimentation on fish populations depends on both concentration and degree of sedimentation, but impact severity can also be affected by the duration (or dose) of sedimentation. Suspended sediments may occur at high concentrations for short periods of time, or at low concentrations for extended periods of time. The greatest impacts to fish populations will be seen at high concentrations for extended time periods. The use of a dose-response matrix in combination with field investigations can help predict the impact of suspended sediments on various life stages of fish populations (Newcombe, 1996).

Sedimentation impacts streams in several other ways. Eroded sediments may gradually fill lakes and navigable waters and may increase drinking water treatment costs. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals and pesticides.

Sedimentation Processes

Sedimentation involves two stages: the movement of eroded material from its original site to a stream channel and movement through the channel network. During both of these stages, sediment movement is discontinuous, driven by the episodic nature of storm events. While some sediment may move directly from field or construction site to a stream and then to the watershed outlet during the course of a single storm, most sediment does not move in this manner. Rather, a particle of eroded material is generally remobilized and redeposited by a number of storms as it works its way through the watershed. Depending upon storm characteristics and antecedent soil conditions, one storm in a given basin may result in the delivery of only a small percentage of eroded material to a stream, while another event may remobilize large quantities of previously eroded material.

The proportion of eroded material reaching a given point on a river or stream is often referred to as the sediment delivery ratio (SDR) (Novotny and Chester, 1989; Walling, 1983). SDRs calculated for the Carolinas and Georgia (Roehl, 1962) indicate that only about 10% of the material eroded from moderate sized drainages (100 square km) leaves those watersheds on an annual basis. For extremely small basins (1 square km) the SDR is about 50%. While specific estimates vary, researchers have repeatedly found that the delivery ratio declines as basin size increases. Sediment storage occurs in all watersheds, but especially in larger ones. This stored material can, if not stabilized, serve as a source of sediment for a long time after the original erosion occurs. However, over a period of years or even decades a large percentage of eroded material may never reach the lower portions of a watershed.

The sediment load carried by a stream thus reflects both past and present land use activities. Load measurements alone, however, tell us little about the source of the sediment or the amount of ongoing erosion. Under many conditions, the amount of sediment carried by a stream will increase as erosion in the watershed increases and decrease as watershed erosion declines (referred to as a "supply limited" stream). However a stream has only a finite capacity for transporting sediment. Once the supply of sediment exceeds the capacity of a stream to carry it, any additional sediment reaching the stream will be deposited in channels and on floodplains rather than carried out of the watershed (referred to as "transport limited"). These stored deposits can be remobilized into the stream years or decades later if the rate of upland erosion declines to levels below the transport capacity.

Measuring Sediment Loads

Under supply limited conditions suspended sediment can be a useful indicator of active erosion in a particular basin. Suspended sediment concentrations are very sensitive to landscape disturbance. As a measurement tool it has broad appeal due to its conceptual simplicity. The primary problem with using suspended sediment as a monitoring tool is its inherent variability. Representative samples are difficult to obtain because suspended sediment levels vary tremendously over time. Suspended sediment concentrations in a river vary dramatically with streamflow. Sampling during high flows is critical for the accurate estimation of suspended sediment loads. Significant differences in suspended sediment concentrations can also occur with depth. In particular, concentrations are often lower near the surface since fine material is generally distributed throughout the water column, while coarser particles remain closer to the stream bed.

Most sampling schemes take individual or composite samples at regular time intervals (e.g. daily). Since high flows are relatively rare, a sampling system based on equal time intervals will result in: 1) a large number of samples at relatively low flows, when suspended sediment concentrations are low; and 2) very few samples at high flows, when most of the suspended sediment transport occurs. This is both inefficient and results in a high level of uncertainty with regard to the total sediment load. For a clear picture of sediment dynamics in a particular watershed, sediment sampling programs should be carefully designed using staged, point integrated, or depth integrated samplers to include measurements at relatively high flows. The accurate characterization of suspended sediment concentrations thus requires the use of depth-integrating samplers and other methods that maximize the likelihood that the sample taken represents average conditions in the water column (Edwards and Glysson, 1988).

Because of these sampling requirements, few studies have attempted to estimate suspended sediment loads in North Carolina. Total suspended solids (TSS) is measured at the Division of Water Quality's ambient monitoring stations. The TSS parameter is similar to suspended sediment, but is based on a grab sample rather than depth-integrated sampling. Moreover, since ambient data are collected on a regularly scheduled basis (usually monthly), high flows are undersampled at most sites. TSS data can be useful for confirming the cause of high turbidity levels and to support the targeting of nonpoint source programs, but they are likely to yield substantial underestimates if used to calculate sediment loads.

Sediment and Streamflow

Storm flows have important effects on stream channel morphology and bed load particle size. Higher flows move larger particles. Storm flows are also important in determining the stability of large woody debris in the stream and the rate of bank erosion. Increased bank erosion and channel migration affects the riparian vegetation and can increase the amount of active sediment in the stream channel.

The vast majority of the sediment transport occurs during high flows, as sediment transport capacity increases exponentially with discharge. The ability of a stream to transport the incoming sediment will help determine whether there is deposition or erosion within the stream channel. The relationship between sediment load and sediment transport capacity affects habitat types, channel morphology and bed load particle size. Increased magnitude of storm flows due to urbanization have been shown to cause rapid channel erosion and severe decline in fish habitat quality.

In developing areas, the erosive forces brought by increased flood flows must be addressed at the source—increased runoff—for instream restoration efforts to be successful. Recent studies underscore the importance of overall watershed imperviousness in determining water and habitat quality. Increased impervious cover in a watershed has many direct impacts on streams in the watershed. Streams broaden or deepen to accommodate larger flushes of water, specialized habitats such as pool and riffle structures and overhanging vegetation are lost, instream water quality declines, stream temperatures rise and the biodiversity of aquatic insect and fish populations decreases. Each of these impacts has been shown to increase with higher levels of watershed imperviousness.

A change in the size of storm flows can also have important consequences for human life and property. Structures such as bridges, dams, and levees are designed according to a presumed distribution of peak flows. If the size of the peak flows is increased, this could reduce the factor of safety and lead to more frequent and severe damage.

Sediment and Streambank Erosion

Streambank erosion can contribute sediment loads to a stream. Streambank erosion can result from clearing instream obstacles or streamside vegetation, livestock trampling stream banks, or higher than normal floods resulting from increased impervious surfaces. The bank material, vegetation type, and vegetation density affect the stability and form of the streambanks. Change in any one of these factors is likely to be reflected in the size and shape of the stream channel, including the banks.

Streambank stability refers to the inclination of the stream bank to change in form or location over time. Streambank stability can be an important indicator of watershed condition and can directly affect several designated uses of streams. A higher incidence of bank instability can be initiated by natural events that disrupt the quasi-equilibrium of the stream, or by human disturbance. Unstable banks contribute sediment to the stream channel by slumps and surface erosion. Because all the material from an eroding streambank is delivered directly to the stream channel, the adverse impact of bank instability can be much greater than the adverse effects of a comparable area of eroding hillslope.

Even in undisturbed streams some streambank instability usually occurs. In valleys with a defined floodplain there is often lateral migration through bank erosion and point bar accretion. In V-shaped valleys there is less opportunity for lateral migration and bank instability may stem from the input and eventual removal of obstructions resulting from fallen trees, landslides, or debris flows.

Although in some cases the erosion of one bank will be matched by deposition on the opposite bank, streambank erosion caused by human activities generally increases stream width. The corresponding increase in stream surface area allows more direct solar radiation to reach the stream surface and this will raise maximum summer water temperatures.

Actively eroding streambanks typically had little or no riparian vegetation, and the loss of this vegetation adversely affects a wide range of wildlife species, reduces available forage for domestic livestock, and increases the long-term input of organic matter into the aquatic ecosystem. Both the increase in summer water temperatures and the loss of fish cover along an eroding stream bank will be exacerbated by the reduction in riparian cover.

Historic practices of disturbing the stream channel and removing large woody debris have been shown to increase the amount of fine sediment in the steam channel. Removal of, or a reduction in, the riparian vegetation is another mechanism by which management activities can increase the amount of fine sediments. Grazing often exacerbates the effect of reducing the vegetative cover by simultaneously trampling the vegetation, compacting the soil, and trampling the streambanks. The use of structural techniques such as bank sloping, use of tree roots for stabilization, buffer strips, and fencing cattle out of streams can greatly reduce streambank erosion. One study found that fencing cattle out of streams reduced average annual soil loss by 40% and nearly a 60% reduction in average sediment concentration during stormflow events (Owens et al., 1996). Urban stormwater management measures can also lessen the potential for streambank erosion.

Stream Modification

Natural streams around the world have certain physical characteristics in common, regardless of location and geologic conditions. One of the most important of these characteristics is known as bankfull stage. The bankfull stage corresponds to the flow at which channel maintenance is most effective, that is, the discharge that results in the average size and shape of channels.

Almost all natural streams have a bankfull discharge with a recurrence interval of 1-1.5 years. In other words, natural stream channels do not form with the capacity to carry a 50 year, 25 year, or even 2 year storm without overflow. Natural channels on average can carry the flow from an annual storm without overflow. In streams that have not been channelized or manipulated by human activities, streamflows larger than a typical annual event are generally carried in both the channel and a floodplain.

Humans have modified many natural streams by increasing the capacity of the stream channel to carry high flows, sometimes to carry even the flow from a 50 or 100 year storm. Such modifications are conceived in the name of flood control and are often used to justify development of floodplains for human usage.

Most engineering channel designs give a great deal of attention to conveyance of floodwaters. Very few channel designs include close attention to sediment conveyance. Given that the equilibrium channel size tends toward a bankfull discharge with a 1-1.5 year recurrence interval, larger stream channels will naturally alter sediment transport processes. For example, a channel that has been straightened and enlarged to carry a 50 year storm, will begin building a smaller channel, point bars, floodplains, meanders, etc. as a result of the natural physical behavior of sediment and the frequency distribution of streamflows. As a result, streams have become unstable; they lose their equilibrium shape and slope and erode, degrade, and aggrade rapidly. Such unstable channel conditions can ultimately lead to degraded water quality as result of excessive sediment loads.

Sedimentation Trends in the Southeast Piedmont

In the 19th and early 20th centuries, erosion increased dramatically in the southern piedmont due to the agricultural practices of the time and the large proportion of the land planted in row crops (Trimble, 1994). Erosion then began a sharp decline beginning around 1920 as some farmland was taken out of production and the implementation of various conservation practices was initiated. By 1967 levels of erosive land use in the southeastern piedmont were only 1/5 to 1/3 of their peak levels (Trimble, 1974). USDA data show that row cropped acreage accounted for about 45% of the North Carolina piedmont in 1937, but declined to about 18% by 1990 (Richter et al, 1995).

Urban impacts on numerous streams increased in recent decades, due both to the input of sediment eroded from upland areas and to streambank erosion caused by the increase in impervious surfaces and the resulting increase in storm runoff. Nonetheless, most large piedmont river basins are experiencing less erosion today than earlier in this century.

By 1970 the suspended sediment discharges of large rivers in the southeast had declined to one third to one half their 1910 levels (Meade and Parker, 1985; Meade and Trimble, 1974). Yet given the decline in agricultural erosion and the amount of material trapped by impoundments, suspended sediment loads are not nearly as low as one might expect. Many scientists have concluded that sediment stored in river channels and floodplains is contributing to the present load (Meade et al, 1990; Meade, 1982; Meade and Trimble, 1974; Jacobson and Coleman, 1986; Phillips, 1991). This material was deposited on floodplains and in channels during periods of high erosion when sediment supply to the channel network exceeded transport capacity. Evidence from the Maryland piedmont (Jacobson and Coleman, 1986), for example, indicates that high yields can persist after active erosion has declined as streams rework floodplain material deposited during previous decades and build a new floodplain at a lower elevation.

It is likely that many large rivers in the southern piedmont are presently moving some amount of stored sediments, deposited earlier during times of intensively erosive agricultural land use, through their channel networks. When erosion declines, stored sediment is first removed from tributary streams and later from larger rivers (Meade et al, 1990; Trimble, 1983). It is thus reasonable to expect that a further reduction in upland erosion in many small rural basins will result in lower sediment yields for those watersheds. How quickly control efforts in small watersheds will result in lower sediment yields in the larger rivers to which they drain is a more difficult question.

Statistics compiled by the US Department of Agriculture, Natural Resource Conservation Service (formerly known as the Soil Conservation Service) indicate a statewide decline in overall erosion from 1982 to 1992 (USDA, NRCS, 1992) as shown in Table 3.2.

Table 3.2 Overall Erosion Trends in North Carolina

	1982	1987	1992
Area (1,000 acres)	33,708.2	33,708.2	33,708.2
Gross Erosion (1,000 tons/yr)	46,039.5	43,264.6	36,512.9
Erosion Rate (Tons/Yr/Ac)	1.1	1.4	1.3

The most widely used tool to evaluate erosion at the landscape level is the Universal Soil Loss Equation (USLE). The NRCS statistics also indicate a statewide reduction in estimated erosion from cropland using the USLE (Table 3.3). Although tons/acre/year is a standard unit of measurement for erosion, it does not reflect the high spatial and temporal variability of erosion. Sediment impacts do not in generally originate from a county wide "average" area; the majority of sediment comes from localized high impact areas. It is very easy to average out a sediment impact over a whole watershed or county or state area and thereby give the impression that the problem is less significant than it actually is in the immediate area. It makes much more sense from a management perspective to target sediment reduction in a high impact area from 40 tons/acre to 2 tons/acres, rather than reduce erosion from cropland in general from 6.5 to 6.3 tons/acre. This points to the need for targeted management efforts coupled with a monitoring strategy which effectively measures sediment transport under both average and extreme conditions.

Table 3.3 USLE Erosion on Cultivated Cropland in North Carolina

	1982	1987	1992
Cropland Area (1,000 acres)	6,318.7	5956.8	5538.0
Gross Erosion (1,000 tons/yr)	40,921.4	37475.3	30,908.3
Erosion Rate (Tons/Yr/Ac)	6.5	6.3	5.6

While there is an overall 10-year downward trend statewide in the erosion rate on agricultural lands, the erosion rate per acre and the 10-year trends vary by region as shown in Table 3.4. The greatest decline in erosion is seen in the Southern Piedmont and Sand Hills with a small uptrend in the tidewater area and a significant increase in the mountains. In the mountain region, it is noted that while the 10-year trend is up, the five-year trend from 1987 to 1992 was down. The reasons for the dramatic changes in the mountain basin erosion rates are not fully known.

Table 3.4 North Carolina Erosion on Major Land Resource Areas (MLRA)

	1982	1987	1992
Blue Ridge Mountains	12.7	20.8	18.3
Southern Piedmont	12.3	12.0	10.5
Carolina and Georgia Sand Hills	6.0	5.6	5.1
Southern Coastal Plain	3.9	3.9	4.0
Atlantic Coast Flatwoods	3.2	3.1	3.2
Tidewater Area	1.4	1.5	1.6

Sedimentation Trends in the Yadkin-Pee Dee River Basin

A number of streams in the basin are impaired by sedimentation. These include the Ararat River, Fourth Creek, Brushy Fork, Hamby Creek, Brown Creek, Coddle Creek, Goose Creek Richardson Creek, Lanes Creek, Hitchcock Creek and North Fork Jones Creek. The water quality of many other streams in the basin is threatened by sedimentation and erosion. The following discussion on erosion, sediment loads, USGS gaging station data and sediment fate and transport relates specifically to the Yadkin-Pee Dee River basin. Suggested general management strategies for reducing sedimentation are presented in Chapter 6, Section 6.5.

Historic Erosion Rates in the Basin

In 1979 the USDA conducted an erosion and sediment inventory for the entire Yadkin-Pee Dee basin. While the results of this inventory do not necessarily reflect erosion rates in the mid-1990s, they do provide us with a picture of historical conditions. Based on 1978 land use data, the USDA study estimated erosion from agricultural and urban areas, as well as other sources.

As shown in Table 3.5, erosion rates ranged from 5.6 tons/acre per year in Yadkin County to 1.5 tons/acre per year in Montgomery County. Erosion rates were considerably higher for subbasins and counties in the upper portion of the basin than for most areas in the lower basin.

Table 3.5 Average Annual Erosion Rates for the Yadkin-Pee Dee River Basin (Based on 1978 Land Use)

Subbasin	Average Erosion (Tons /Acre/Year)
01	2.6
02	3.6
03	4.5
04	4.8
05	5.2
06	5.1
07	4.3
Upper Basin Avg.	4.1
08	3.2
09	2.2
10	2.0
11	3.3
12	3.6
13	3.4
14	3.4
15	1.6
16	1.8
17	2.0
Lower Basin Avg.	2.7
Avg. for whole basin	3.5

County	Average Erosion (Tons /Acre/Year)
Yadkin	5.6
Iredell	5.3
Davie	5.2
Forsyth	5.1
Rowan	5.0
Davidson	4.7
Surry	4.6
Stokes	4.3
Alexander	4.2
Union	3.8
Stanly	3.6
Cabarrus	3.3
Wilkes	2.7
Watauga	2.7
Mecklenburg	2.4
Anson	2.0
Randolph	2.0
Caldwell	1.7
Richmond	1.7
Montgomery	1.5

Source: USDA, 1979. Yadkin Pee Dee River Basin, North Carolina and South Carolina. Erosion and Sediment Inventory

A recent study conducted at Duke University (Richter et al 1995) estimated gross soil erosion from rural areas in the upper third of the basin (the 2280 square mile area draining to the USGS gage on the Yadkin River at Yadkin College--consisting primarily of Wilkes, Surry, Yadkin and Forsyth Counties). This study found that gross erosion rates declined from 6.4 tons/acre per year in the 1950s to 5.3 tons/acre per year in the 1980s, due primarily to a reduction in cultivated area. Improved agricultural practices implemented in the early 1990s were estimated to have reduced gross soil erosion even further, to 3.7 tons/acre per year.

Historic Sediment Loads

The only comprehensive study of suspended sediment loading in North Carolina, conducted by the USGS (Simmons, 1993), involved the assessment of sedimentation at 152 sites statewide during the 1970-79 period. Selected data are shown in Table 3.6. The comparison is limited to unimpounded rivers (the Haw and Neuse were not yet impounded at the time this study was conducted.)

Table 3.6 Major North Carolina Rivers: Mean Annual Suspended Sediment Yield at Selected Stations*, 1970-79. Source: Simmons CE, 1993

Piedmont/Coastal Plain	Tons/ Sq Mi	Yadkin Mainstem	Tons/ Sq Mi	Mountains	Tons/ Sq Mi
Dan R near Francisco (129)	270	Yadkin R at Patterson (29)	380	French Broad R at Rosman (68)	190
Dan R near Wentworth (1053)	440				
Dan R nr Mayfield (1778)	350	Yadkin R at Elkin (869)	350	French Broad R at Blantyre (296)	260
Tar R near Tar River (167)	180	Yadkin R at Siloam (1226)	390	French Broad R at Bent Ck (676)	240
Tar R at Louisburg (427)	70				
		Yadkin R at Enon (1694)	470	French Broad R at Asheville (945)	410
Haw R at Haw River (606)	260				
Haw R nr Haywood (1689)	170	Yadkin R at Yadkin College (2280)	530	French Broad R at Marshall (1332)	500
Cape Fear at Lillington (3464)	120				
		Pee Dee R nr Rockingham (6860)	55		
Neuse R near Northside (535)	140				
Neuse R near Clayton (1150)	190				
Neuse R at Kinston (2690)	31				
Catawba R nr Marion (172)	360				
Broad R nr Boiling Springs (875)	390				

* - Drainage areas in square miles in parentheses

The Yadkin mainstem carried a relatively high sediment load compared to other piedmont rivers. This may be due in part to higher discharge. The Catawba and Broad Rivers had loads comparable to the Yadkin in their upper reaches. These rivers are similar to the Yadkin in that they rise in the Blue Ridge and quickly enter the piedmont. However, the piedmont portion of the Catawba is heavily impounded and the Broad River never attains the Yadkin's size. According to the study, the Yadkin's sediment yield per square mile increases as drainage area increases, even after flow additions from mountain areas become minimal. The French Broad also shows this pattern. Simmons (1993) notes that rivers flowing from one physiographic province to another tend to retain the sediment transport characteristics of the province of origin.

Table 3.7 summarizes data for all Yadkin-Pee Dee sites included in the USGS study. Sites are listed in downstream order. Note that the Little Yadkin River and streams draining the Winston-Salem area (Salem and Muddy Creeks) transported extremely large amounts of sediment during the period of 1970-79. In general, loads were lower in the southern portion of the basin. This is consistent with the erosion estimates presented earlier. The Dutchmans Creek site is the only station in the basin believed to represent background conditions (Simmons, 1993). Loads on the

Pee Dee near Rockingham clearly illustrate sediment trapping by the mainstem lakes, although the relatively moderate loads from tributaries in the lower basin are also a factor.

Table 3.7 Yadkin/Pee Dee River Basin: Mean Annual Suspended Sediment Yield, 1970-79. Source: Simmons CE, 1993

STATION (listed in downstream order)	Drainage Area (Sq Mi)	County	Tons/ Sq Mi
YADKIN R at Patterson (02111000)	29	Caldwell	380
Elk Ck at Elkville (02111180)	48	Wilkes	440
Reddies R at N Wilkesboro (02111500)	89	Wilkes	490
Roaring R at Roaring River (02112120)	128	Wilkes	330
YADKIN R at Elkin (02112250)	869	Yadkin	350
Mitchell R nr State Road (02112360)	79	Surry	220
Fisher R nr Copeland (02113000)	128	Surry	350
YADKIN R at Siloam (02113500)	1226	Yadkin	390
Ararat R at Ararat (02113850)	231	Surry	430
Little Yadkin R at Dalton (02114450)	43	Stokes	610
YADKIN R at Enon (02115360)	1694	Forsyth	470
Salem Ck nr Atwood (02115856)	66	Forsyth	410
Muddy Ck nr Muddy Creek (02115860)	186	Forsyth	410
S Fork Muddy Ck nr Clemmons (02115900)	43	Forsyth	470
YADKIN R at Yadkin College (02116500)	2280	Davidson	530
Humpy Ck near Fork (02117030)	1.1	Davie	190
S Yadkin R nr Mocksville (02118000)	306	Rowan	290
Hunting Ck nr Harmony (02118500)	155	Iredell	440
Leonard Ck nr Bethesda (02121493)	5.2	Davidson	390
Dutchmans Ck nr Uwharrie (02123567)	3.4	Montgomery	41
Big Bear Ck nr Richfield (02125000)	56	Stanly	200
Gourdvine Ck nr Olive Branch (02125557)	8.8	Union	290
Lanes Ck nr Trinity (02125696)	4.9	Union	220
Wicker Branch nr Trinity (02125699)	5.8	Union	150
Rocky R nr Norwood (02126000)	1372	Stanly	200
Little R nr Star (02128000)	106	Montgomery	140
PEE DEE R nr Rockingham (02129000)	6860	Richmond	55

<u>Present Sedimentation Rates in the Basin based on the Yadkin College USGS Gage Station Sediment Data</u>

While sediment data have been collected very infrequently at most locations, the USGS has been making daily suspended sediment measurements at the Yadkin College gage (station 02116500) since 1951. This represents one of the longest sets of continuously-collected sediment data in the world, but was largely unanalyzed until Professor Dan Richter at Duke University began studying it several years ago. Located where US 64 crosses the river (below the confluence with Muddy Creek, but upstream of the South Yadkin), the Yadkin College site has a drainage area of 2280 square miles and provides a good picture of sediment transport in the upper portion of the Yadkin River.

Annual suspended sediment transport at Yadkin College is quite variable, ranging from 0.08 tons/acre per year to 1.2 tons/acre per year (Richter et al, 1995). Most of the annual variation in sediment transport (79%) was attributed to variations in discharge. A clear seasonal pattern exists in the relationship between sediment concentration and discharge (Richter et al, 1995; Korfmacher, 1996). From May to October, the sediment carried per unit of discharge can be twice as high as during the other months. This is attributed to the higher erosivity of rainfall during the summer. As a result, the increases in sediment load during the winter months are less than might be anticipated given the higher winter streamflows (75,000 mg/mo over November-April; 62,000 mg/mo during May-October).

The time series analyses conducted by Richter et al (1995) on monthly sediment data indicated that the suspended sediment loads carried by the Yadkin River, while still quite high, declined by 30% over the period from 1951 to 1990. Interpretation of aerial photos of 185 one km^2 sample areas found that row-cropped area was one-half of the 1950s acreage, while residential and urban areas increased by 80% since the 50's. Richter and colleagues (1995) concluded that the observed decline in sediment load is not as great as one would expect given the changes in rural land use and agricultural practices. They noted that urban and suburban sources of sediment in the basin have likely increased significantly and may account for this discrepancy, although movement of previously eroded materials out of channel or floodplain storage may also be a factor.

Sediment Fate and Transport.

One of the defining characteristics of suspended sediment transport is that most of the load is transported during a relatively small number of storm events (Meade et. al., 1990). Transport characteristics for 1970-79 are listed below for four stations in the Yadkin-Pee Dee basin (Simmons, 1993).

	25% of Total Transport	50% of Total Transport
Elk Creek at Elkville	0.1% of time	0.4 % of time
Yadkin River at Elkin	0.5 % "	2.4% "
South R. near Mocksville	0.7% "	2.6% "
Big Bear Ck. near Richfield	0.1% "	0.6% "

Analysis of the 1951-90 record for the Yadkin River at Yadkin College (Richter et al, 1995) indicated that 10% of the days (36 to 37 high flow days per year) carry 71% of the sediment, while 1% of the days (3-4 days per year) carry 26% of the suspended load.

Phillips (1991) developed a sediment budget for the Pee-Dee River system as a whole, which includes the Lumber and Waccamaw Rivers and discharges to Winyah Bay near Georgetown, SC. This study indicated that only 32% of the material eroded from upland areas in the basin reaches the channel network. Only 12% of the sediment reaching stream channels is actually delivered to Winyah Bay, the remainder being deposited on floodplains or trapped in reservoirs.

Storage of sediment in reservoirs clearly has a significant impact on sediment loads in the mainstem. From 1970-79, the sediment load at Yadkin College, above the chain lakes, was almost 10 times as high as the load carried by the Pee Dee River near Rockingham (Table 3.7). An estimated 73-78% of the suspended sediment transported by the Yadkin mainstem is trapped by the six lakes (Harned and Meyer, 1983; Fischer, 1993). It is likely that much of this material remains in High Rock Lake, the largest and most upstream of these impoundments.

3.2.2 Oxygen-Consuming Wastes

Oxygen-consuming wastes, or Biochemical Oxygen Demand (BOD), include decomposing organic matter or chemicals that reduce dissolved oxygen in the water column through chemical reactions or biological activity. Maintaining a sufficient level of dissolved oxygen in the water is critical to most forms of aquatic life, especially trout.

A number of factors affect dissolved oxygen concentrations. Higher dissolved oxygen is produced by *turbulent actions*, such as waves, rapids and waterfalls, which mix air and water. *Lower water temperature* also generally allows for retention of higher dissolved oxygen concentrations. Therefore, the cool swift-flowing streams of the mountains are generally high in dissolved oxygen. Lower dissolved oxygen levels tend to occur more naturally in warm, slow-moving waters. In some cases, dissolved oxygen levels may naturally decrease in the warmer months below the state standard. In addition, high inputs of effluent from wastewater treatment plants during low flow conditions may significantly decrease dissolved oxygen from natural conditions. In general, the lowest dissolved oxygen concentrations occur during the warmest summer months and particularly during low flow periods. *Water depth* is also a factor. In deep slow-moving waters, such as reservoirs or estuaries, dissolved oxygen concentrations may be very high near the surface due to wind action and plant (algae) photosynthesis but may be entirely depleted (anoxic) at the bottom.

Sources of dissolved oxygen depletion may include wastewater treatment plant effluent, the decomposition of organic matter (such as leaves, dead plants and animals) and organic waste matter that is deposited, washed or discharged into the water. Sewage from human and household wastes is high in organic waste matter, as is waste from trout farms. Bacterial decomposition can rapidly deplete dissolved oxygen levels unless these wastes are adequately treated at a wastewater treatment plant. In addition, some chemicals may react with and bind up dissolved oxygen. Industrial discharges with oxygen consuming wasteflow may be resilient instream and continue to use oxygen for a long distance downstream.

<u>Oxygen-Consuming Wastes in the Yadkin-Pee Dee River Basin</u>
Management strategies are being recommended for those streams with known dissolved oxygen problems resulting from point source dischargers. A summary of these strategies is presented in Chapter 6, Section 6.5, with specific management strategies presented in Section 6.3.

3.2.3 Nutrients

The term *nutrients* in this document refers to the two major plant nutrients, phosphorus and nitrogen. These are common components of fertilizers, animal and human wastes, vegetation, aquaculture and some industrial processes.

Nutrients in surface waters come from both point and nonpoint sources. Nutrients are beneficial to aquatic life in small amounts. However, when conditions are favorable, excessive nutrients can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries.

Algal blooms, through respiration and decomposition, can deplete the water column of dissolved oxygen and can contribute to serious water quality problems. In addition to problems with low dissolved oxygen, blooms can be aesthetically undesirable, result in an unbalanced food web, impair recreational use, impede commercial fishing and pose difficulties for water treatment in water supply reservoirs. Excessive growth of larger plants, or macrophytes, such as milfoil, alligator weed and Hydrilla, can also be problematic by limiting recreation.

Dissolved oxygen depletion from nutrient overenrichment and algal growth fluctuates seasonally and even over the course of a day. In the presence of sunlight, oxygen is produced by algae and other plants through the process of photosynthesis. At night, however, photosynthesis and dissolved oxygen production slow down and oxygen is consumed by algae through respiration. During the summer months, this daily cycle of daytime oxygen production and night time depletion often results in the supersaturation of surface waters by oxygen during sunny days and low dissolved oxygen concentrations during late night and early morning hours. Supersaturation refers to dissolved oxygen levels greater than the saturation value for a given temperature and atmospheric pressure. Excessive dissolved gas levels can be lethal to fish populations by inhibiting respiratory processes. Additionally, algae may settle to the bottom of a waterbody and contribute to sediment oxygen demand as they decompose through bacterial action. This decomposition lowers dissolved oxygen concentrations in the bottom waters of lakes and other bodies of water.

Reservoir and Lake Eutrophication

Bodies of water which are nutrient rich and which support high levels of algal or macrophyte growth are often referred to as eutrophic. Eutrophication is a natural process which occurs as lakes and reservoirs gradually accumulate nutrients and sediments. As lakes age, they generally become more nutrient rich and biologically productive. Nutrients, soil or organic matter added by human activities can greatly accelerate this process. This is sometimes referred to as cultural eutrophication. As a group, reservoirs tend to have higher inflows and nutrient and sediment loads than natural lakes and are thus more likely to be eutrophic. In North Carolina this is especially true of piedmont reservoirs.

The classical lake succession sequence (Figure 3.1) is usually depicted as a unidirectional progression corresponding to a gradual increase in lake productivity from oligotrophy to hypereutrophy. The trophic states are:

- **Oligotrophic** - Nutrient-poor and low biological productivity. More typical of cold-water lakes.
- **Mesotrophic** - Intermediate nutrient availability and biological productivity.
- **Eutrophic** - Nutrient-rich and highly productive.
- **Hypereutrophic** - Extreme productivity characterized by algal blooms or dense macrophyte populations (or both) frequently having a high level of sedimentation.

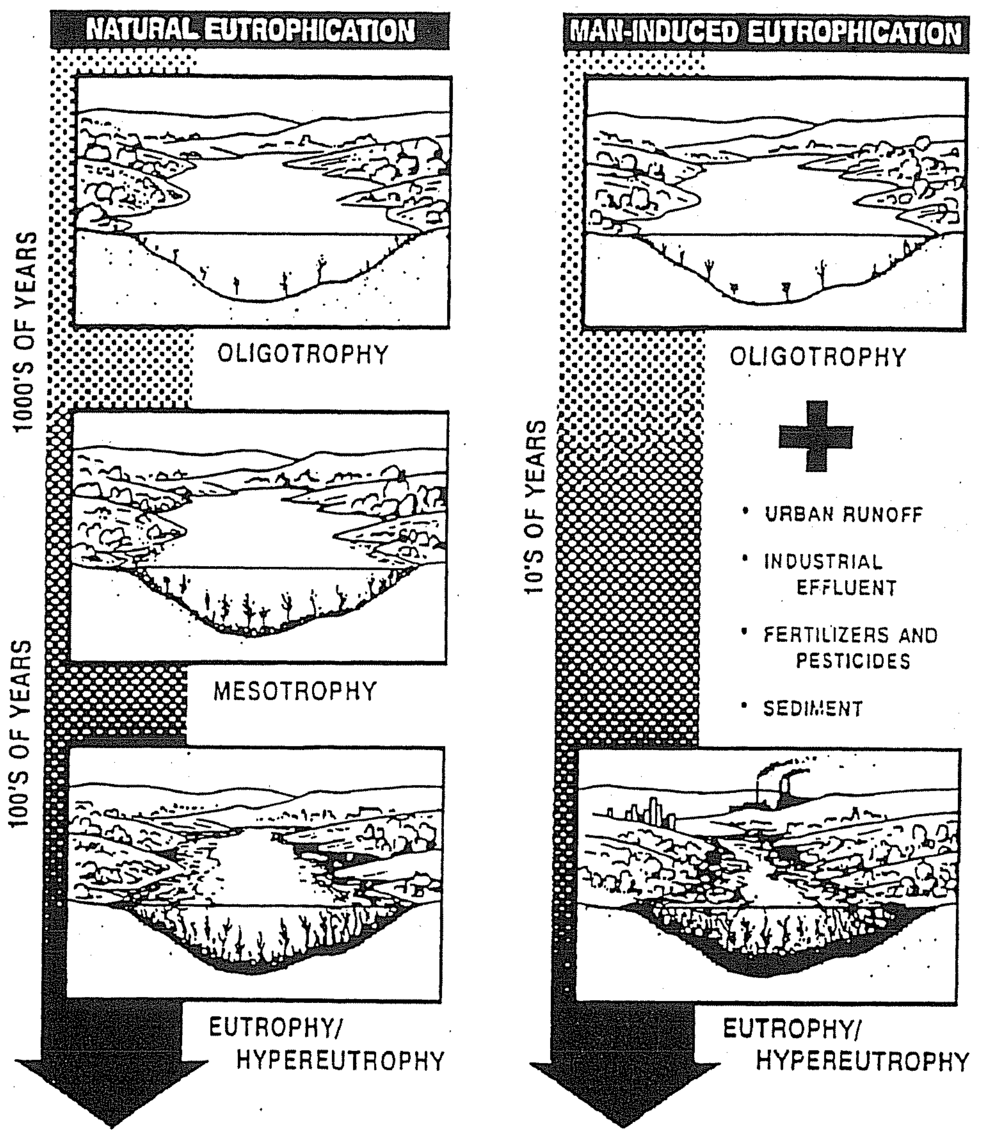
However, there is evidence that changes in lake trophic status are not necessarily gradual or unidirectional. If watersheds remain relatively undisturbed, lakes can retain the same trophic status for thousands of years. Rapid changes in lake nutrient status and productivity are often a result of human-induced disturbances to the watershed rather than gradual enrichment and filling of the lake basin through natural means.

Eutrophic conditions--that is, high levels of nutrients and algal productivity--can but do not necessarily interfere with the uses of a waterbody. Some lakes and reservoirs can support substantial algal growth without significant interference with recreational activity or risk to aquatic organisms. Free-flowing streams with relatively undisturbed watersheds tend to have low nutrient levels. Increased nutrient inputs can affect aquatic life in streams, for example by supporting increased growth of benthic algae which in turn support a fish community that differs somewhat from what would otherwise be expected. Nutrient loading can cause some degradation of water quality in free-flowing piedmont streams, but does not generally result in water quality impairment.

North Carolina has a chlorophyll *a* standard of 40 µg/l (micrograms per liter) for lakes, reservoirs and slow moving waters not designated as trout waters, and 15 µg/l for trout waters. Chlorophyll *a* is a constituent of most algae and is a widely used indicator of algal biomass. Total dissolved gas levels in excess of 110 percent of saturation are also a violation of standards.

Agricultural and urban runoff, wastewater treatment plants and atmospheric deposition are the main sources of nutrients reaching North Carolinas water bodies. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges are from human wastes, food residues, some cleaning agents and industrial processes.

Figure 3.1 Natural versus Man-Induced Eutrophication



Nutrient Loading

Effective January 1, 1988 the General Assembly limited the quantity of phosphates in household laundry detergents to 0.5 percent. A statewide study of 23 municipal wastewater plants found that this phosphate detergent "ban" significantly reduced the amount of phosphorus entering wastewater treatment plants and resulted in an average reduction of 33 percent in the mass phosphorus load discharged from these facilities (NCDEM, 1991). The Concord Rocky River WWTP (now operated by Cabarrus County as the Rocky River Regional WWTP), which exhibited a 37 percent decline in discharged phosphorus load, was the only facility from the Yadkin basin included in the study. Whether these reductions in effluent phosphorus lead to substantial declines in instream phosphorus levels depends on the relative contributions of point sources and nonpoint sources to the phosphorus loading of a particular waterbody. While this has not been evaluated for streams in the Yadkin basin, an analysis of several sites elsewhere in the state found reductions in ambient phosphorus levels downstream of major WWTPs (NCDEM, 1991).

It is important to distinguish between the nutrient loading to streams in a watershed (the 'end of pipe' or 'edge of field' loads) and the nutrients reaching a particular lake or estuary (the delivered load). Nutrients entering surface waters may be delayed for some time before reaching a downstream lake and may exist in a different chemical form by the time they arrive. For example, dissolved orthophosphorus from fertilizer or discharged wastewater may adsorb to suspended sediments once it enters a stream. Since sediment transport is episodic, occurring primarily during storms, the sediment-attached phosphorus may take weeks or months to reach a lake or estuary where it may potentially contribute to algal growth. In some cases--such as the loss of nitrogen to the atmosphere via denitrification--nutrients can leave the aquatic system entirely. It is the delivered load that influences algal growth and these nutrient 'fate and transport' issues can sometimes be significant.

Phosphorus is usually the limiting nutrient in most freshwaters. Nutrient limitation can vary seasonally, however, and nitrogen can be limiting in situations where significant amounts of phosphorus have been added by human activity. Since algae use nitrogen and phosphorus in more or less fixed amounts, the ratio of nitrogen to phosphorus in a lake (the N:P ratio) is commonly used to evaluate which major nutrient is likely to be limiting. Algal growth potential tests are another method used to assess nutrient limitation. Algal growth potential tests (AGPT) are conducted by adding sufficient quantities of N or P to a water sample and observing the response of a test alga under controlled conditions.

Nutrients in the Yadkin/Pee Dee River Basin

Control of nutrients, especially phosphorus, is an important water quality concern in the Yadkin basin. There are four lakes in the basin rated as threatened due to nutrient overenrichment (see Chapter 4, Section 4.2). These include High Rock Lake, Lake Corriher, Lake Lee and Lake Monroe. Two lakes are partially supporting their uses (Rockingham City Lake and Hamlet City Lake) due to nutrients. Nutrient management strategies are presented in chapter 6.

The primary concern is the nutrient loading to High Rock Lake (subbasin 03-07-04), which drains the entire upper basin and thus serves as the repository for much of the nutrients and sediment for a 4000 square mile watershed. The tributary streams feeding the arms of High Rock Lake have relatively low inflows. Nutrient loadings from point sources dominate in Grants, Crane and Abbotts Creeks. Most of the inflow to the lake, and most of the nutrient loading, enters from the mainstem of the Yadkin River. Given the high flushing rate and high rate of nutrient turnover, algal production in the mainstem of the reservoir is largely determined by summer loading rather than the annual load.

Runoff from shoreline development (including fertilized lawns and inputs from septic tanks) are other potential sources of nutrients to High Rock Lake, especially the arms and embayments. A precise estimate of the number of shoreline homes is not available, but data on pier licenses issued by Yadkin, Incorporated can serve as an estimate of shoreline homes. Yadkin, Incorporated had issued 2,614 pier licenses as of 1993, about 2/3 of them in Davidson County. Dense development is apparent in a number of areas, including along the Swearing and Abbotts Creek arms. Nutrient loading from this development has never been specifically quantified, but it is clear that many relatively old septic systems are located on small lots close to the reservoir. New areas of the shoreline continue to be developed. If not managed appropriately, this development could potentially make a substantial contribution to the nutrient load of arms of the lake, especially those arms with relatively low watershed loadings. Yadkin, Incorporated has developed a draft Shoreline Management Plan which includes recommendations for shoreline buffers (see Chapter 5, Section 5.6.4 for more information). The use of buffers along the shoreline could significantly reduce nutrient runoff from lawns into the lake. Water quality conditions in High Rock Lake are discussed in Chapter 4 and Chapter 6.

Summer phosphorus loading was examined for three years on the Yadkin River at Yadkin College, located below Winston- Salem but above the confluence with the South Yadkin River. Results indicate that during years of average and higher flows, nonpoint sources of phosphorus dominated, while point source inputs account for 25-30 percent of the summer loading. Point source inputs accounted for 50-66 percent of the phosphorus load at Yadkin College during low flow summers.

Ambient monitoring station (AMS) data from 1992 - 1996 show higher concentrations of nutrients at the Yadkin College station and Spencer (below South Yadkin River watershed) on the mainstem. Nutrient data from the AMS tributaries show several sites with both high total phosphorous and total nitrogen concentrations. Lanes and Richardson Creeks (subbasin 03-07-14) are impaired at least in part due to the large number of animal operations in these watersheds. Rich Creek and the Rocky River near Davidson (subbasin 03-07-11) are especially high in phosphorous, while Richardson Creek is especially high in nitrogen.

3.2.4 Toxic Substances

Regulation 15A NCAC 2B. 0202(36) defines a toxicant as "any substance or combination of substances ... which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, has the potential to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions or suppression in reproduction or growth) or physical deformities in such organisms or their offspring or other adverse health effects". Toxic substances frequently encountered in water quality management include chlorine, ammonia, organics (hydrocarbons and pesticides) heavy metals and pH. These materials are toxic to different organisms in varying amounts. The effects may be evident immediately, or may only be manifested after long-term exposure or accumulation in living tissue.

North Carolina has adopted standards and *action levels* for several toxic substances. These are contained in 15A NCAC 2B .0200. Usually limits are not assigned for parameters which have action levels unless 1) monitoring indicates that the parameter may be causing toxicity or, 2) federal guidelines exist for a given discharger for an action level substance. This process of determining action levels exists because these toxic substances are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics and/or associated waste characteristics. Water quality based limits may also be assigned to a given NPDES permit if data indicate that a substance is present for which there is a federal criterion but no water quality standard.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major NPDES dischargers and any discharge containing complex (industrial) wastewater. This test shows whether the effluent from a treatment plant is toxic, but it does not identify the specific cause of toxicity. If the effluent is found to be toxic, further testing is done to determine the specific cause.

This follow-up testing is called a toxicity reduction evaluation (TRE). WET testing is discussed in Chapter 4. Other testing, or monitoring, done to detect aquatic toxicity problems include fish tissue analyses, chemical water quality sampling and assessment of fish community and bottom-dwelling organisms such as aquatic insect larvae. These monitoring programs are discussed in Chapter 4.

Each of the parameters below can be toxic if sufficient in quantity or concentration.

pH

Changes in pH to surface waters are primarily through point source discharges. However, changes can also occur with the introduction of substances in the form of spills to a waterbody. As the pH of a water decreases, metals are more bioavailable within the water column and are therefore more toxic to the aquatic organisms. As the pH increases, metals are precipitated out of the water column and less toxic to aquatic organisms. If a surface water has had chronic introductions of metals and the pH gradually or dramatically decreases, the metals in the substrate will become more soluble and be readily available in the water column. While lower pH values may not be toxic to the aquatic organisms, the lower values can have chronic effects on the community structure of macroinvertebrates, fish, and phytoplankton. Macroinvertebrates will show a shift from intolerant species to tolerant species and have less community diversity.

The NC standard for pH in surface fresh waters is 6.0 to 9.0. Trout reproduction is adversely affected in waters with pH values below 5.5.

Metals

Municipal and industrial dischargers and urban runoff are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals; the most common metals in municipal NPDES permits are cadmium, chromium, copper, nickel, lead, mercury, silver and zinc. Each of these, with the exception of silver, is also monitored through the ambient network along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals from these industries through a *pretreatment program.* Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream. Nonpoint sources of pollution from urban runoff are controlled through best management practices, stormwater control programs, and sedimentation and erosion control plans.

Chlorine

Chlorine is commonly used as a disinfectant at NPDES discharge facilities which have a domestic (i.e.- human) component. These discharges are a major source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but it can have significant toxic effects on sensitive aquatic life such as trout and mussels. North Carolina has adopted a freshwater standard for trout waters of 17 µg/l (micrograms per liter). For all other waters an action level of 17 µg/l is applied to protect against chronic toxicity. It is recommended that new and expanding discharges provide dechlorination or alternate wastewater disinfection. A total residual chlorine limit is assigned based on the freshwater action level of 17 µg/l or a maximum concentration of 28 µg/l for protection against acute effects in the mixing zone. Federal guidelines for residual chlorine of 8 µg/l for chronic effects and 13 µg/l for acute effects are used in saltwaters. In 1993, letters were sent to existing facilities with chlorine monitoring requirements. These letters encouraged permittees to examine their effluent chlorine levels and noted that limits may be implemented in the future. At this time, the State requires chlorine limits for all trout waters and any new or expanding facilities using chlorine for disinfection.

Ammonia (NH_3)

Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste products also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina. However, DWQ has agreed to address ammonia toxicity through an interim set of instream criteria of 1.0 mg/l in the summer (April - October) and 1.8 mg/l in the winter (November - March). Currently, limits will be given no less than 2 mg/l in summer and 4 mg/l in winter, unless dissolved oxygen problems or modeling analysis dictate stricter limits. These interim criteria are under review, and the State may adopt a standard in the future.

Toxic substances in the Yadkin/Pee Dee River Basin (with subbasins in parentheses)

The number of facilities required to conduct toxicity testing in the basin has increased over the past 10 years (1986-1996) from four to sixty-four (Table 3.8). Facilities were not included in any given year unless data was available for the full year. The percentage of dischargers meeting their toxicity permit limits has increased from 59% to 93%. This table represents a two-stage process. The first stage toward increasing the number of dischargers meeting their permit limits was to solve the most do-able problems. This effort included working with the facilities to improve housekeeping problems. The second stage is gaining a better understanding of toxicity problems and learning how to reduce toxicity at the source. The increased number of dischargers represents a significant reduction in toxic chemicals being discharged to surface waters by individual dischargers in the basin.

Table 3.8 Status of Toxicity Testing in the Yadkin-Pee Dee River Basin

Year	No. Facilities	No. Tests*	% Meeting Permit Limits**
1986	4	44	59
1987	6	59	59
1988	19	206	54
1989	31	320	63
1990	39	422	86
1991	51	595	87
1992	54	635	89
1993	57	667	88
1994	59	688	89
1995	61	717	89
1996	64	750	93

* - "No. Tests" is not the actual number of tests performed, but the number of opportunities for limit compliance evaluation. Assumptions were made about compliance for months where no monitoring took place based on data previous to that month. Facilities compliant in a given month were assumed to be in compliance during months following until the next actual monitoring event. This same policy was applied to facilities in noncompliance.

** - This number was calculated by determining whether a facility was meeting its ultimate permit limit during the given time period, regardless of any SOCs in force.

In spite of these efforts on the part of DWQ and NPDES dischargers to reduce toxic chemicals, there are still some toxicity test failures in the basin. The Town of Mount Airy (discharge to Ararat River, subbasin 03-07-03)) has often failed its toxicity tests in the past, but this problem has improved during the last three years. Pilot Mountain has caused toxicity problems in Heatherly Creek (03-07-03). The town has since relocated its discharge to the Ararat River. DWQ will continue to evaluate water quality in Heatherly Creek and the Ararat River. An upgrade of Winston-Salem's Elledge Plant in 1995 has reduced effluent toxicity in Salem Creek (03-07-04). PPG (discharge to North Potts Creek, 03-07-04) has been working to identify sources of toxicity in its effluent. The Norfolk Southern Railway facility (to South Potts Creek, 03-07-04) has had persistent toxicity problems. A cove in the southernmost arm of Badin Lake has historically shown detectable concentrations of cyanide (03-07-08). ALCOA completed remediation construction activities in 1996 that removed cyanide from the discharge into this cove. Dye Branch and the headwaters of the Rocky River (03-07-11) are impacted by the Mooresville WWTP, which has had frequent toxicity failures.

Ambient monitoring data from 1992 - 1996 show high pH distributions for two sites (Town Creek and Abbotts Creek Cotton Grove, 03-07-04). Conductivity, a general measure of total dissolved ions in the waterbody, is relatively low in the upper basin, however it increases sharply at the Yadkin College station and median values remain slightly elevated along the mainstem. Many of the tributary ambient sites show elevated conductivity levels. The most upstream site on the Rocky River (near Davidson, 03-07-11) has significantly higher levels of conductivity than other sites in the basin.

Additional discussion of these issues can be found in Chapter 4, Section 4.3 and Chapter 6, Section 6.3 in the respective subbasin summaries.

3.2.5 Fecal Coliform Bacteria

Fecal coliform bacteria are typically associated with the intestinal tract of warm-blooded animals. Common sources of fecal coliform bacteria include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations, wildlife and improperly disinfected wastewater effluent.

Fecal coliform bacteria are widely used as indicators of the potential presence of waterborne pathogenic organisms (which cause such diseases as typhoid fever, dysentery, and cholera). Fecal coliform bacteria in treatment plant effluent are controlled through disinfection methods including chlorination (sometimes followed by dechlorination), ozonation or ultraviolet light radiation.

Due to the high number of animal operations and increasing development in the basin, the chances of bacterial contamination in streams is relatively high in some subbasins. Failing septic systems, straight piping to streams and animal operations without appropriate best management practices can cause elevated bacterial levels in streams.

Fecal Coliform Bacteria in the Yadkin/Pee Dee River Basin (with subbasins in parentheses)
Based on ambient monitoring data from 1992 - 1996, overall fecal coliform levels are higher in the upper portion of the Yadkin River mainstem (to Yadkin College) than the lower portion. Many tributaries also have elevated levels of fecal coliform. Of particular concern are the following waters. The Yadkin River in the vicinity of Roaring River (03-07-01) is support threatened due to fecal coliform bacteria. Fecal coliform levels are also elevated in the Roaring River and the Yadkin River at NC 64 and NC 150 (03-07-01). Nonpoint sources of pollution may be contributing to this problem, however two point source dischargers on the Roaring River (Wilkesboro and North Wilkesboro) have exceeded their fecal coliform limits during the past few years. North Wilkesboro is currently under a Special Order by Consent (SOC). The Ararat River (03-07-03) is threatened due in part to fecal coliform violations from the rest area on I-77 operated by the Virginia Department of Transportation. Muddy, Salem and Grants Creeks (03-07-04) are often high in fecal coliform, likely due to nonpoint sources. Elevated fecal coliform levels are seen throughout the South Yadkin River subbasin (03-07-06), with nonpoint sources of pollution and animal operations as the likely source. Abbotts, Rich Fork and Hamby Creek (03-07-07) exhibit fecal coliform standard violations. The upper Rocky River (03-07-11) and Hitchcock Creek (03-

07-16) have fecal coliform levels that exceed the standard and nonpoint sources are considered the problem. The Rocky River (03-07-11) and Irish Buffalo Creek (03-07-12) have high fecal coliform levels due to nonpoint sources. Goose Creek (03-07-12) is, in part, impacted by discharges from the Hunley Creek subdivision.

Additional discussion of these issues can be found in Chapter 4, Section 4.3 and Chapter 6, Section 6.3 in the respective subbasin summaries.

3.2.6 Color

Color in wastewater is generally associated with industrial wastewater or with municipal plants that receive certain industrial wastes, especially from textile manufacturers that dye fabrics and pulp and paper mills. For colored wastes, 15A NCAC 2B .02113(f) states that the point sources shall discharge only such amounts that will not render the waters injurious to public health, secondary recreation, aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. NPDES permit requirements regarding color are included on a case-by-case basis since no numeric standard exists for color, and because a discharger may have high color values but no visual impact instream due to dilution or the particular color of the effluent. Chapter 6 discusses ongoing efforts to study color and to develop a realistic approach to addressing this problem.

Color in the Yadkin-Pee Dee River Basin
Town of Mount Airy WWTP (subbasin 03-07-03) has historically had high levels of color in its effluent. DWQ will continue to work with this facility to reduce effluent color.

3.3 POINT SOURCES OF POLLUTION

3.3.1 Defining Point Sources

Point source refers to a discharge that enter surface waters through a pipe, ditch or other well-defined point of discharge. The term applies to wastewater and stormwater discharges from a variety of sources. Wastewater point source discharges include municipal (city and county) and industrial wastewater treatment plants and small domestic wastewater treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. Stormwater point source discharges include stormwater collection systems for municipalities which serve populations greater than 100,000 and stormwater discharges associated with certain industrial activities as defined in the Code of Federal Regulations [40 CFR 122.26(a)(14)]. The primary pollutants associated with point source discharges are oxygen-demanding wastes, nutrients, sediment, color, and toxic substances including chlorine, ammonia and metals.

Point source dischargers in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state. Discharge permits are issued under the NPDES program which is delegated to DWQ by the EPA. See Chapter 5, Water Quality Programs and Program Initiatives in the Basin, for a description of the NPDES program and permitting strategies. Definitions and examples of the various categories can be found in Table 3.8.

Table 3.8 Definitions of Categories of NPDES Permits

CATEGORY	DEFINITION	EXAMPLES
Major vs. Minor discharges (NC00 Facilities)	For publicly owned treatment works, any facility discharging over 1 MGD is defined as a Major discharge. For industrial facilities, the EPA provides evaluation criteria including daily discharge, toxic pollutant potential, public health impact and water quality factors. Any facilities which do not meet the criteria for Major status are defined as Minor discharges.	NC0020761 - Town Of North Wilkesboro (2 MGD) NC0005312 - Chatham Manufacturing, Inc. (4 MGD)
General Permits (NCG Permit Facilities)	Permits for dischargers in categories which all have similar discharges, operations and monitoring, and limits. Generally minor effect on receiving stream individually.	Most stormwater permits.
100% Domestic	A system which treats wastewater containing household-type wastes (bathrooms, sinks, washers, etc.).	Housing subdivision WWTPs, schools, mobile home parks.
Municipal	A system which serves a municipality of any size.	NC0049867 - Town of Clevelend (0.3 MGD) and NC0023884 - City of Salisbury (7.5 MGD)
Process Industrial	Water used in an industrial process which must be treated prior to discharge.	NC0004944 - Hoechst-Celanese [Salisbury]
Nonprocess Industrial	Wastewater which requires no treatment prior to discharging[1].	NC0006114 - Butler Manufacturing Company (Salisbury)
Stormwater Facilities	Discharges of runoff from rainfall or snow melt. NPDES permits are required for "stormwater discharges associated with industrial activity" and from municipal stormwater systems for towns over 100,000 in population.	"Stormwater discharges associated with industrial activity" include most types of manufacturing plants. Landfills, mines, junkyards, steam electric plants, transportation terminals and any construction activity which disturbs 5 acres or more during construction.

1. Non-contact cooling water may contain biocides; however, the biocides must be approved by the DWQ Aquatic Toxicology Unit. The approval process predicts that the chemicals involved have no detrimental effect on the stream when discharged with the non-contact cooling water.

3.3.2 Wastewater Point Source Discharges in the Yadkin-Pee Dee River Basin

There are 525 permitted NPDES wastewater dischargers in the Yadkin-Pee Dee River basin, 284 are covered under individual permits and 241 are covered under general permits. The locations of the individual permitted facilities are shown in Figure 3.2 and Figure 3.3. Table 3.9 lists the major dischargers (≥1.0 MGD) with number designations as shown on the maps. Appendix II lists the wastewater dischargers in the Yadkin-Pee Dee River basin along with a summary of general information on each discharger. Table 3.10 provides a summary of total and average discharge for each category of permitted facility.

3.3.3 Stormwater Point Source Discharges in the Yadkin-Pee Dee River Basin

Excluding construction general permits, there are 602 general stormwater permits and 26 individual stormwater permits issued within the river basin. Activities covered under the general stormwater

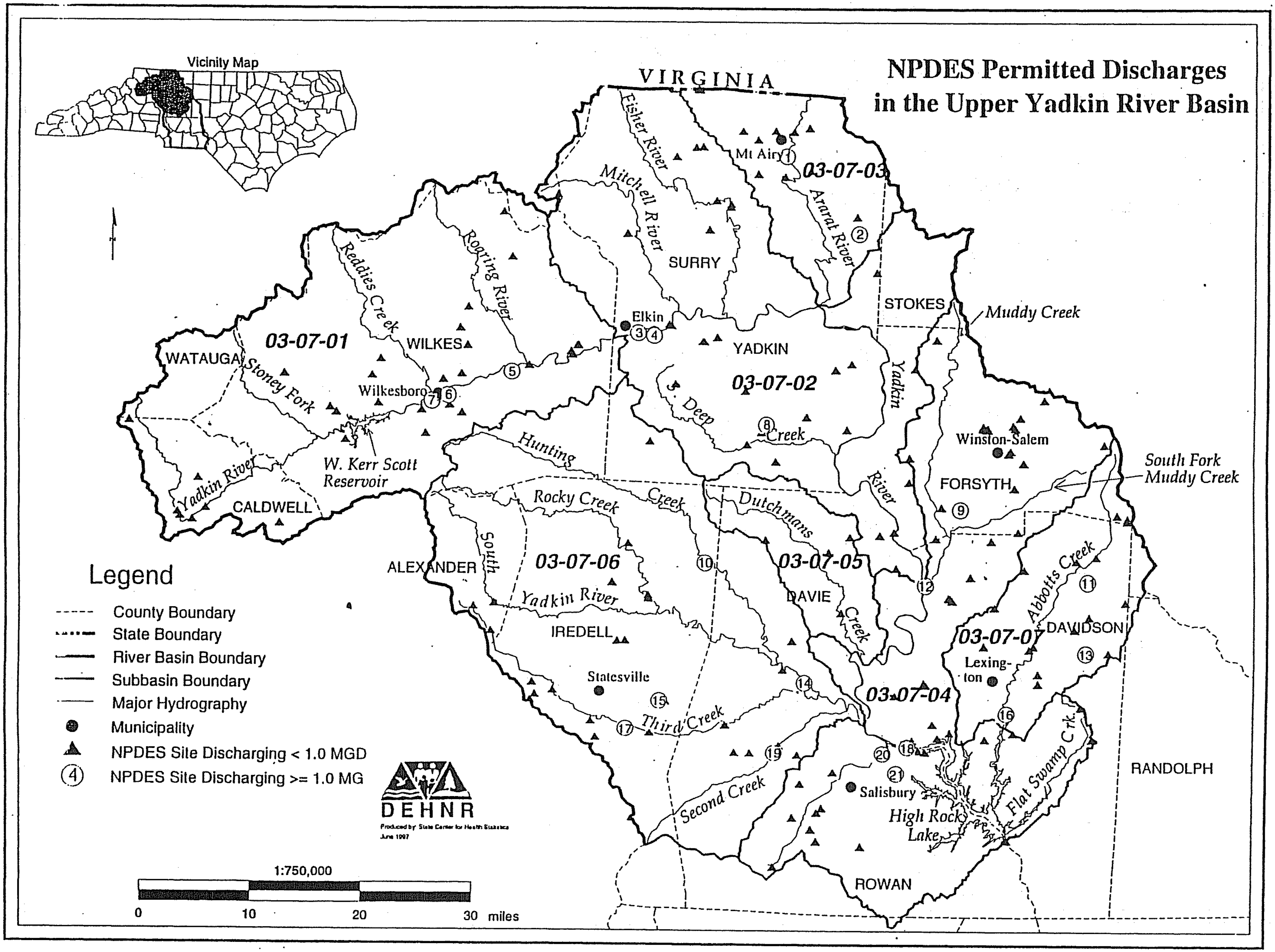
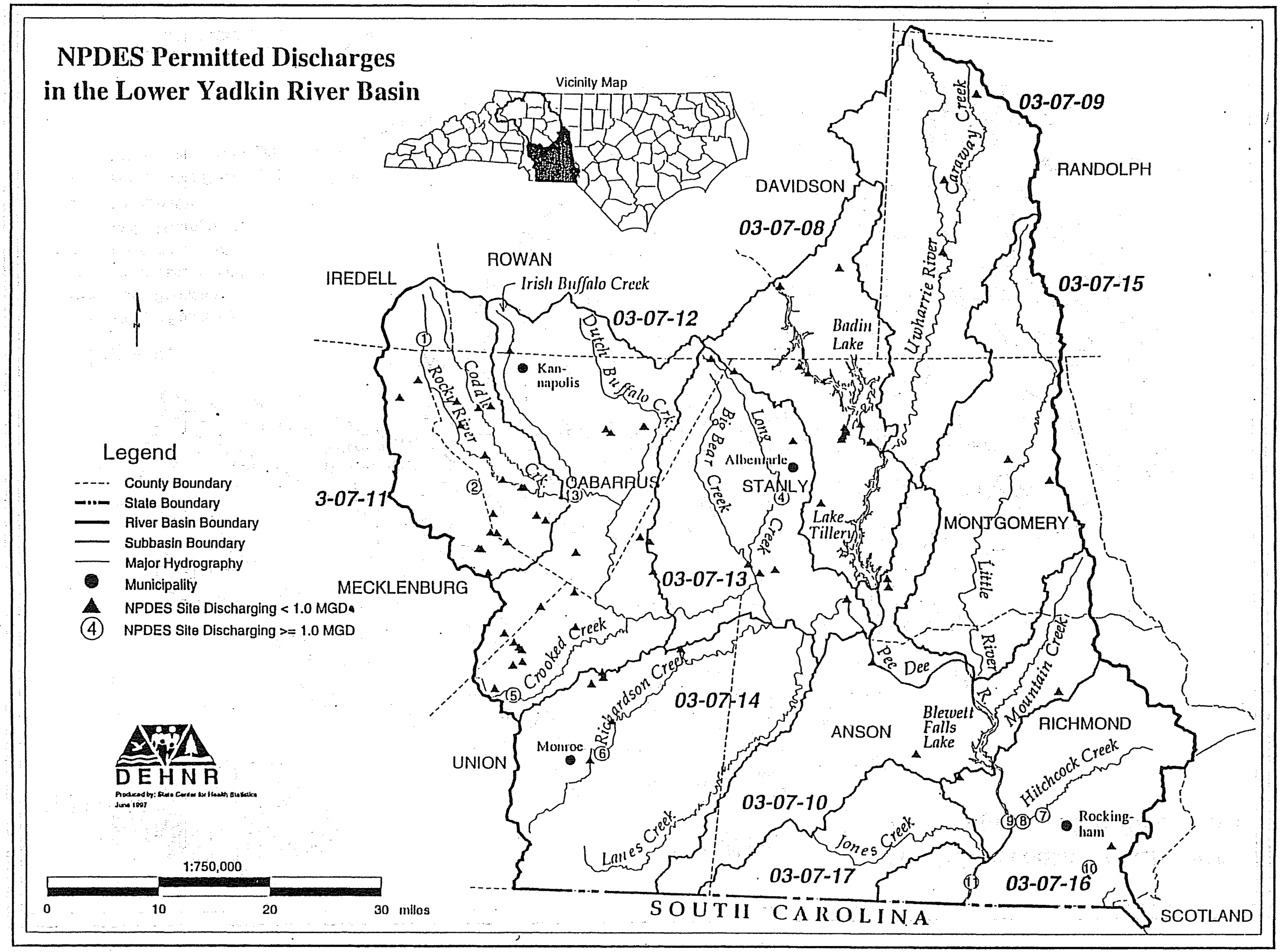


Figure 3.2 Map of NPDES Wastewater Permittees in the Upper Yadkin-Pee Dee River Basin



F[illegible] 3.[illegible] Ma[illegible] NP[illegible] Wa[illegible]ater P[illegible]nitte[illegible] the [illegible]ver [illegible]in-P[illegible]Dee [illegible]r Ba[illegible]

Table 3.9 Major dischargers ($\geq$1 MGD) in the Yadkin-Pee Dee River Basin

Map Number	Facility	Design Flow (MGD)	Receiving Stream
Upper Yadkin-Pee Dee River Basin			
1	Town of Mt. Airy WWTP	7.0	Ararat River
2	Town of Pilot Mtn. WWTP	3.0	Ararat River
3	Town of Elkin WWTP	1.8	Yadkin River
4	Chatham Manufacturing Inc.	4.0	Yadkin River
5	ABT Co	1.0	Yadkin River
6	Town of N. Wilkesboro WWTP	2.0	Yadkin River
7	Town of Wilkesboro WWTP	4.9	Yadkin River
8	Town of Yadkinville WWTP	2.5	N. Deep Creek
9	Winston-Salem (Elledge Plant) WWTP	30.0	Salem Creek
10	Holly Farms Poultry	0.5	Hunting Creek
11	City of High Point-West Side WWTP	6.2	Rich Fork
12	City of Winston-Salem WWTP	21.0	Yadkin River
13	Town of Thomasville WWTP	4.0	Hamby Creek
14	Town of Cooleemee WWTP	1.5	South Yadkin River
15	Town of Statesville WWTP	6.0	Fourth Creek
16	City of Lexington WWTP	5.5	Abbotts Creek
17	City of Statesville WWTP	4.0	Third Creek
18	Fieldcrest Mills, NC Finishing	4.25	Yadkin River
19	Hoeschst Celanese	1.27	N Second Creek
20	City of Salisbury WWTP	7.5*	Grants Creek
21	City of Salisbury	5.0*	Town Creek
Lower Yadkin-Pee Dee River Basin			
1	Town of Mooresville WWTP	5.2	Dye Creek
2	Charlotte-Mecklenburg Utility District	6.0**	Mallard Creek
3	Cabarrus County Water and Sewer Authority	24.0**	Rocky River
4	City of Albemarle WWTP	16.0	Long Creek
5	Union County WWTP	1.9	S Fork Crooked Creek
6	City of Monroe WWTP	11.0	Richardson Creek
7	City of Rockingham WWTP	9.0	Pee Dee River
8	Burlington Klopman Fabrics	1.2	Hitchcock Creek
9	Burlington Klopman Fabrics	1.2	Hitchcock Creek
10	City of Hamlet WWTP	1.0	Marks Creek
11	Anson County Regional WWTP	3.5	Pee Dee River

* - Combined capacity will increase to 20 MGD when a new outfall is completed on the Yadkin River.
** - Environmental Assessments are underway for facility expansions.

Table 3.10 Summary of NPDES Dischargers and Permitted and Actual Flows for the Yadkin-Pee Dee River Basin

	SUBBASIN																	
FACILITY CATEGORIES	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	TOTAL
Total Facilities	38	76	17	137	10	43	60	15	15	4	34	32	12	17	3	11	1	525
NC00 Facilities	34	33	14	50	5	32	19	12	4	2	29	23	9	8	2	8	0	284
NCG Facilities	4	43	3	87	5	11	41	3	11	2	5	9	3	9	1	3	1	241
Total Permitted Flow (MGD)	9.18	10.22	10.22	77.62	0.73	15.84	15.90	2.18	0.35	0.30	13.72	28.16	17.27	11.03	1.44	14.95	0.00	229.10
***Major Discharges**	3	3	3	7	0	4	3	1	0	0	2	2	1	2	0	5	0.	36
Total Permitted Flow (MGD)	7.90	8.30	10.09	75.30	0.00	12.77	15.70	0.00	0.00	0.00	11.20	25.90	16.00	11.00	0.00	14.95	0.00	209.11
***Minor Discharges**	31	30	11	43	5	28	16	11	4	2	27	21	8	6	2	3	0	248
Total Permitted Flow (MGD)	1.28	1.92	0.13	2.32	0.73	3.07	0.20	2.18	0.35	0.30	2.52	2.26	1.27	0.03	1.44	0.00	0.00	19.99
100% Domestic Wastewater	29	24	8	25	3	18	14	2	2	1	22	18	4	4	1	1	0	176
Total Permitted Flow (MGD)	1.37	2.14	1.61	1.16	0.04	0.77	0.23	0.55	0.03	0.12	1.86	2.44	0.77	0.03	0.60	1.00	0.00	14.71
Municipal Facilities	3	5	2	5	1	6	3	3	0	1	2	3	3	1	2	3	0	43
Total Permitted Flow (MGD)	6.98	4.96	10.00	58.25	0.68	12.02	15.70	1.70	0.00	0.18	11.20	26.35	17.25	11.00	1.44	13.50	0.00	191.21
Major Process Industrial	1	1	1	3	0	1	0	1	0	0	0	0	0	1	0	2	0	11
Total Permitted Flow (MGD)	1.00	4.00	0.09	4.30	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.45	0.00	12.11
Minor Process Industrial	5	5	2	7	0	4	1	0	2	1	1	3	2	1	0	0	0	34
Total Permitted Flow (MGD)	0.99	0.82	0.02	0.83	0.00	1.72	0.01	0.00	0.32	0.12	0.03	0.13	0.00	0.00	0.00	0.00	0.00	4.98
Nonprocess Industrial	1	2	1	7	0	3	1	2	0	0	2	3	1	1	0	2	0	26
Total Permitted Flow (MGD)	0.00	0.00	0.02	0.35	0.01	0.55	0.00	0.47	0.00	0.00	0.64	0.07	0.00	0.00	0.00	0.00	0.00	2.10

*** NC00 / Individual permit facilities**

Flow data from NC00 / Individual facilities only; this table does not include flow data from Stormwater or NCG facilities.

permits include: construction; mining/borrow pits; metal waste recycling and manufacture of metal products and equipment; manufacture of timber products; apparel, printing, paper, leather, and rubber products manufacturing; food, tobacco, cleaning preparations, perfumes, cosmetics, and drug manufacturing and public warehouse storage; manufacture of stone, clay, glass, and concrete products; vehicle maintenance, transportation, and postal service activities, public warehousing and petroleum bulk stations and terminals; manufacture of paints, varnishes, lacquers, enamels and allied products; used automobile parts and scrap yards; wastewater treatment works; landfills; non-metal waste scrap and recycling; ready mixed concrete production; manufacture of asphalt paving mixtures and blocks; production of textile mill products; and furniture and fixture manufacturing.

The primary source of concern from industrial facilities is the contamination of stormwater from contact with exposed materials. In addition, poor housekeeping can lead to significant contributions of sediment and other water quality pollutants. To address these issues, each NPDES stormwater permitted facility must develop a Stormwater Pollution Prevention Plan (SPPP) that addresses the facility's potential impacts on water quality. Facilities or activities identified as having significant potential to impact water quality are also required to perform analytical monitoring to characterize the pollutants in their stormwater discharges. A description of the program requirements can be found in Section 5.4.2. Recommended strategies for controlling stormwater can be found in Section 6.5.3.

Both the Cities of Winston-Salem and Charlotte have NPDES stormwater permits. These programs are discussed in more detail in Chapter 5, Section 5.6.

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) pollution refers to runoff that enters surface waters through stormwater, snowmelt or atmospheric deposition (e.g. acid rain). There are many types of land use activities that are a source of nonpoint source pollution including land development, construction, forestry operations, mining operations, crop production, animal feeding lots, failing septic systems, landfills, roads and parking lots. As noted earlier, stormwater from large municipalities (>100,000 people) and from certain industrial sites is considered a point source since NPDES permits are required for piped discharges of stormwater from these areas. However, a discussion of urban runoff will be included in this section.

Sediment and nutrients are major pollution-causing substances associated with nonpoint source pollution. Others include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur intermittently, depending on rainfall events. The majority of water quality problems, including stream impairment, in the basin are from nonpoint source pollution. Below is a brief description of major categories of nonpoint sources of pollution in the Yadkin/Pee Dee River basin.

3.4.1 Agriculture

There are a number of activities associated with agriculture that can serve as sources of water pollution. Land clearing and plowing make soils susceptible to erosion, which can then cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) can be washed from fields, orchards, or improperly designed storage or disposal sites. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters. Concentrated animal feed lot operations or dairy farms without adequate waste management systems or fencing to keep animals away from streams can be a significant source of oxygen consuming wastes, fecal coliform bacteria, sediment and nutrients.

Sediment production and transport has historically been greatest from row crops and cultivated fields (Waters, 1995; Lenat et al. 1979). However, trends in sediment loss from cropland have been downward with the gradual reduction of cultivated cropland acreage, implementation of the 1985 and 1990 Farm Bills, and greater use of best management practices (BMPs) such as no-till farming, contour plowing, terracing, conservation tillage and grassed waterways. Other recommended BMPs aimed at reducing sedimentation from agricultural land include maintaining a vegetated buffer between fields and streams, and fencing cattle and dairy cows from streams. These BMPs protect streambanks from trampling and protect streamside vegetation. The use of these and other BMPs to reduce erosion can mitigate the impacts of sedimentation (Lenat, 1984). This is evidenced in the USDA, NRCS data in Table 3.3 which show a decline in cropland erosion rates on a per acre basis.

<u>Agriculture in the Yadkin-Pee Dee River Basin</u>

Animal wastes are of particular interest in the Yadkin-Pee Dee River Basin because of the high number of cattle and poultry production operations (See Chapter 2, Section 2.6). At present, widespread water quality impacts from animal operations have not been documented, but localized impacts are evident. There are potential concerns associated with nitrate-nitrogen movement through the soil from poorly constructed lagoons and from wastes applied in excess of agronomic rates.

Figure 3.4 presents a comparison between the amount of nutrients generated through manure and the amount of nutrients needed for crop and forage production for each county in the basin. These nutrient data were reported in "Livestock Manure Nutrient Assessment in North Carolina" (Barker and Zublena, 1995). A percentage greater than 100 means that there are more nutrients generated in manure than can be used by the crops and forage grown in that county. Plant recoverable manure nutrients are those that remain from the time the animal voids the manure until the time it is transported to the field for spreading (in other words, the nutrients that can be recovered or taken up and used by the plants). During this period, much of the nutrients can be lost through drying or dilution, surface runoff, volatilization or microbial digestion. Since different manure management systems either conserve or sacrifice varying amounts of nutrients, an estimate was made of the percentage of farms using specific systems. These percentages were applied to the manure characteristics appropriate for the specific method which gave the remaining nutrients after storage and treatment losses.

As indicated in Figure 3.4, most counties in the basin have manure production far in excess of crop nutrient requirements for that county. Most notably are Alexander, Anson, Montgomery, Randolph, Richmond, Stanly, Union, Wilkes and Yadkin Counties. This figure does not take into account commercial fertilizer applications in the counties. Alternatives to cropland application need to be considered in these counties, such as application on forest land or transportation/distribution of the collectable manure to counties that have capacity and could use this nutrient source in lieu of commercial fertilizers.

Chapter 5 discusses agricultural nonpoint source control programs and general management strategies for controlling agriculture related sedimentation.

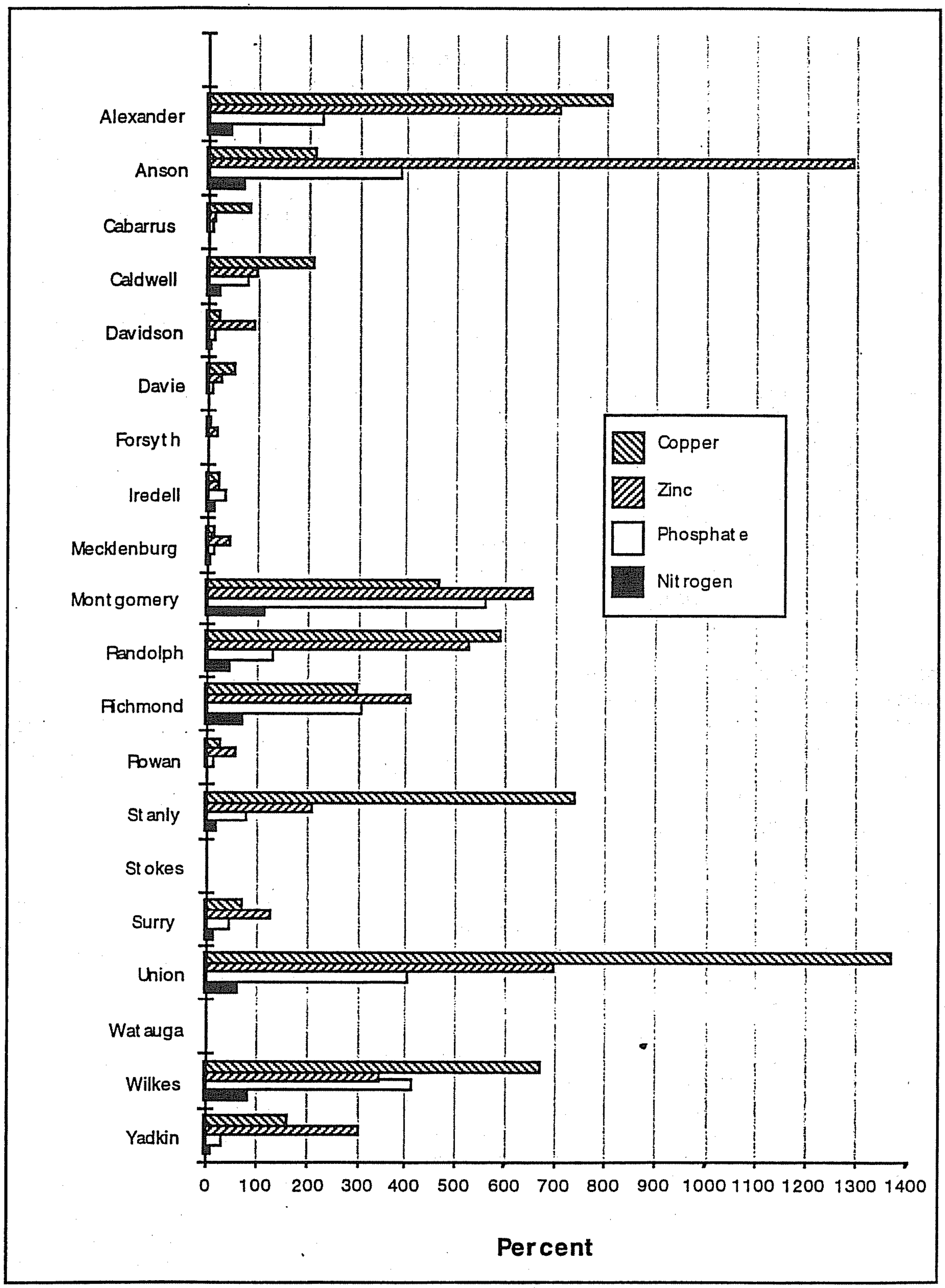


Figure 3.4 Percent of Agronomic Nutrient Needs Supplied by Recoverable Plant Available Manure Nutrients for Counties in the Yadkin River Basin (Barker and Zublena, 1995)

3.4.2 Urban/Residential

It is commonly known that urban streams are often polluted streams (Mulholland and Lenat, 1992). As a rule, runoff from urbanized areas is more localized, but can often be more severe, than agricultural runoff. Any type of land-disturbing activity such as land clearing or excavation can result in soil loss and cause sedimentation of the waters in the watershed. The rate and volume of runoff in urban areas is much greater than in undeveloped areas due both to the high concentration of impervious surface areas and to storm drainage systems that rapidly transport stormwater to nearby surface waters. This increase in volume and rate of runoff can result in streambank erosion and sedimentation in surface waters. Some potential impacts of stormwater runoff include:

- Polluted water: Numerous pollutants may be present in urban stormwater, including sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, trace metals, road salt, and toxic/synthetic chemicals. These pollutants can impair aquatic life, reduce recreational value and threaten public health if drinking water sources and fish tissue become contaminated.
- Flooding: Flooding damages public and private property, including infrastructure. It can also threaten public safety.
- Eroded streambanks: Sediment clogs waterways and fills lakes and reservoirs. It can also smother the plants and animals in waterbodies and destroy the habitat necessary for reproduction of fish and aquatic animals. The erosion of streambanks causes loss of valuable property as stream width grows.
- Increased Flow Variability: High flows caused by runoff from impervious surfaces can increase erosion and alter the aquatic habitat and fauna.
- Economic impacts: The economy can be impacted from a loss of recreation-related business and an increase in drinking water treatment costs.

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There is abundant information on the effects of urban runoff on macroinvertebrates (Lenat and Eagleson, 1981; Crawford and Lenat, 1989). Stream organisms are affected not only by water quality, but also by the character of the physical habitat. One component of stream habitat is flow regime. Most fish and macroinvertebrates in streams require flowing water and may be adversely affected by either extreme high or low flow. Development within a catchment may affect streamflow by increasing flow variability and/or altering base streamflow.

Natural streams with forested watersheds and vegetated riparian zones experience little overland runoff. Most rainfall percolates through the soil and enters the groundwater. Therefore, natural streamflow is primarily the result of groundwater inputs. Both urban development and agricultural land use may include structures intended to prevent flooding by routing water directly to streams. This is especially true for urban landscapes where large amounts of impervious surfaces promote overland flow at the expense of groundwater recharge. The immediate result is high streamflow following rainfall, which can scour the stream bottom. Scouring is the physical movement of bedload, which disrupts the stream biology and habitat. The long-term result of increased overland flow is to accentuate summer low flows, due to the reduction of groundwater storage. Many streams in developed areas may stop flowing during summer months. This type of stress may severely limit the diversity of the aquatic fauna.

In addition, many streams are used as a source of irrigation water and this practice can reduce streamflow. The use of nearby well water might also reduce streamflow. In streams which normally experience low summer flows (especially in the Slate Belt region), water withdrawals for irrigation (or other uses) might be sufficient to convert a permanent stream into an intermittent stream. The lack of flowing water in the summer months can severely reduce the diversity of the aquatic fauna. This problem has not been investigated in North Carolina and further research is needed.

Storm drainage systems, including curb and guttered roadways, also allow pollutants to reach surface waters quickly and with little or no filtering. Pollutants include lawn care products such as pesticides and fertilizers; automobile-related pollutants such as fuel, lubricants, abraded tires and brake linings; lawn and household wastes (often dumped in storm sewers); road salts, and fecal coliform bacteria (from animals and failing septic systems). The diversity of these pollutants makes it very challenging to attribute water quality degradation to any one pollutant.

Replacement of natural vegetation with pavement, removal of streamside buffers and managed lawns reduce the ability of the watershed to filter pollutants before they enter the stream. The chronic introduction of these pollutants and increased flow and velocity into a stream results in degraded waters. Many urban streams are rated as biologically poor.

<u>Urban Stormwater Impacts and Growth Trends in the Yadkin-Pee Dee River Basin</u>
The population density map presented in Chapter 2 is an indicator of where urban development and potential urban stream impacts are likely to occur as a result of this development. As summarized in Chapter 4, Section 4.5, it is estimated that there are approximately 266 miles of streams in the basin considered impaired by urban runoff. Those subbasins with the highest number of impaired stream miles associated with urban runoff include subbasins 03-07-04 (includes Winston-Salem), 03-07-07 (includes High Point, Thomasville and Lexington) and 03-07-11 (includes a portion of Charlotte and Mecklenburg County).

There has been significant growth in the Yadkin-Pee Dee River basin and pressures on lake, river and stream quality will mount as growth continues. Impacts to water quality from growth and development can include sedimentation, streambank erosion and degradation from a variety of stormwater runoff pollutants including fertilizers, pesticides and toxic chemicals. These impacts translate to higher water supply treatment costs, reduced recreational opportunities and a greatly reduced quality of life for area residents.

There are many factors that influence the pattern of development within the Yadkin River Basin, as noted by the Northwest Piedmont Council of Governments (1996). The following discussion is exerpted from the Council of Governments report. Some key factors include:

- thriving urban centers;
- location of the Piedmont relative to national markets;
- infrastructure; and
- local land-use controls.

Thriving Urban Centers

The major urban centers of the region, the Piedmont Triad and Charlotte/Mecklenburg, are thriving urban areas that are very attractive to business and individuals because of their high quality of life. These urban centers have resulted in a tremendous increase in residential growth in the surrounding, previously rural, counties as people seek to escape the pressures of the cities yet remain within commuting distance of their places of employment. A classical concentric pattern of development around the urban core is emerging as residents move to the suburbs. Service industries follow residential growth, and the process repeats itself as the urban fringe becomes part of the urban mass. These development patterns are clearly evidenced in the population density maps in Chapter 2.

The significance of this growth pattern is that, since the two major urban centers are on either end of the Yadkin River basin, growth will result across the basin. This pattern will likely follow the major roads so commuters can minimize their daily commute and to allow industry better access to major highways. Three major highways, I-40, I-77 and I-85, link the two urban centers. The importance of the Interstates to future growth patterns is further discussed below.

As seen in the population data in Chapter 2, counties close to the urban centers (such as Iredell and Davie) will become increasingly urbanized as development spills over from the urban counties. The northeast section of Davie County, for instance, has seen so much residential development in the past decade that large sections of the county are almost urban in nature. Citizens of one community are discussing incorporation and it is likely that three or four new municipalities will be created in the Piedmont Triad alone within the next five years. Similar patterns of development are occurring in the northern part of Davidson County and the southern portions of Iredell and Rowan Counties. On the other hand, counties that are not adjacent to urban cores, such as Surry, Wilkes and Caldwell, will remain predominately rural since they are out of the development path. Watauga will see significant population growth but its development will be primarily residential to accommodate a growing tourism industry and retiree population (Northwest Piedmont Council of Governments, 1996).

Location

The Piedmont Triad and Charlotte/Mecklenburg areas are very advantageously positioned for multi-state commercial enterprises. The region is equidistant from the Midwest industrial states and the large markets of the Northeast and Atlanta. A business in this region is usually within one days drive from major markets and suppliers, which, when combined with the fairly low cost of land and labor in the region, makes the area very desirable for industry. North Carolina has been one of the top three states in industrial recruitment and the State's location is one of the key elements of its success (Northwest Piedmont Council of Governments, 1996).

Infrastructure

Planners and economic developers often say that "development follows infrastructure." Industry needs traditional infrastructure such as roads, water and sewer. In addition, telecommunications infrastructure is increasingly important as both service and manufacturing industry looks towards automation to increase productivity.

Transportation: The creation of an efficient transportation network is important to economic development. North Carolina has the second largest state highway system in the country despite being the 25th largest state in size. The Upper Yadkin River basin is bisected by Interstates I-40, I-77 and I-85, with a fourth interstate being planned. In addition, there are many federal and state highways running through the region.

The creation of this road network has had a significant impact on development patterns in the upper Yadkin River basin: it promotes urban sprawl by easing commuting times, results in lower transportation costs (making the basin desirable for industry) and provides close proximity to major markets (making it attractive for new or relocating industry). The close proximity of industrial parks to interstate interchanges or major highways is evidence of the importance of transportation to development in the basin. With development following the transportation network, the future will see continued development radiating out from the urban centers along major highways.

Water and Sewer: Availability of water and sewer service is another key factor shaping the pattern of development in the region, particularly for industrial development. Residential development typically only requires water service since septic tanks can be installed in most counties. However, commercial buildings or multi-family residential units usually produce more waste than can be processed by septic tanks and require sewer service.

The majority of the region's water and sewer services are provided by municipalities. As a result, greater development is usually found in close vicinity to towns with water and sewer systems. This is particularly the case with industrial development since it requires sewer. Many of the larger water systems have extended their water lines beyond town boundaries, and by charging non-municipal users double rates, generate additional revenue for the system.

This availability of water outside of municipal boundaries has created a rapid rate of residential development in unincorporated areas of the counties adjacent to the urban centers of the Piedmont Triad and Charlotte. As these newly urbanized areas begin incorporating, many will seek to expand their infrastructure to accommodate commercial development and strengthen their tax base, thus continuing the spread of urban growth (Northwest Piedmont Council of Governments, 1996).

Land-Use Controls

Zoning can be an effective method of protecting water resources since it enables governments to eliminate or restrict potentially harmful activities in environmentally sensitive areas. Zoning is not widely used as a tool for water quality protection. This is due to both public opposition to land-use regulations and the lack of government resources. Opposition to land-use regulations is a widespread and potent force in rural counties of North Carolina and is often politically undesirable for an elected official to advocate zoning. Typically, only when a county starts urbanizing and begins to suffer the pain of uncontrolled development does public opinion begin to shift (Northwest Piedmont Council of Governments, 1996).

Table 3.11 shows which counties in the upper basin have passed zoning ordinances. Mecklenburg County in the lower portion of the basin also has zoning regulations. Additionally, almost all municipalities in the region have zoning and the larger cities also control development within their extraterritorial jurisdiction area.

Table 3.11 Status of Zoning Regulations for Counties within the Upper Yadkin-Pee Dee River Basin

County	Zoning
Alexander	Limited areas - not county wide
Caldwell	county-wide
Davidson	county-wide
Davie	county-wide
Forsyth	county-wide
Iredell	county-wide
Rowan	none
Stokes	county-wide
Surry	none
Watauga	Limited areas - not county wide
Wilkes	none
Yadkin	Limited area (60,000 acres zoned)

Source: Northwest Piedmont Council of Governments, 1996

Zoning efforts have not proven effective in controlling urban sprawl, although they have been fairly effective in separating residential and industrial uses. Development within the region is primarily market driven, with the availability of infrastructure being the major determining factor of where development occurs. Zoning classifications outside of municipalities are generally liberal, and counties are so eager to expand their tax base that they are quick to rezone, particularly for industrial development (Northwest Piedmont Council of Governments, 1996).

A major reason that zoning has been generally ineffective in preventing sprawl is the lack of effective comprehensive land-use planning in the region. This has resulted in ad-hoc zoning decisions that often fail to take into account the fabric of the entire community. While political and economic beliefs make it difficult for government to place strict controls on growth, comprehensive planning can indirectly influence growth by such methods as building infrastructure where the local government wants development to occur.

Comprehensive planning has occasionally resulted in effective land-use controls that protect the upper Yadkin River basin from environmental damage. Protection of the Yadkin River was identified in a comprehensive plan done by Forsyth County in the mid-1980's (refer to Chapter 5 for more details). As a result of this plan, the County implemented land-use measures that limit development near the river (Northwest Piedmont Council of Governments, 1996).

Management strategies for addressing urban runoff are presented in Chapter 6, Section 6.5.

3.4.3 Construction

Construction activities that entail excavation, grading or filling (such as road construction or land clearing for development) can produce significant sedimentation if not properly controlled. Sedimentation from developing urban areas can be a major source of pollution due to the cumulative number of acres disturbed in a basin. As a pollution source, construction activities are typically temporary, but the impacts can be severe and long lasting (see discussion in Section 3.2.1).

<u>Construction Activities in the Yadkin-Pee Dee River Basin</u>
Construction-related sedimentation is addressed through the Sedimentation Pollution Control Act (see Chapter 5, Section 5.6). As summarized in Chapter 4, Table 4.9, it is estimated that there are approximately 90 miles of streams in the basin thought to be impaired by construction. Those subbasins with the highest number of impaired stream miles associated with construction include subbasins 03-07-07 (includes portions of High Point and Thomasville, and Lexington) and 03-07-12 (includes a portion of Cabarrus and Mecklenburg Counties). The NC Division of Land Resources reports a total of 535 construction sites approved for the Yadkin-Pee Dee River basin for 1996-1997, totaling 4,324 acres to be disturbed. Recommended management strategies for construction activities can be found in Chapter 6, Section 6.5.

3.4.4 Timber Harvesting

Undisturbed forested areas are an ideal land cover for water quality protection. They stabilize the soil, filter rainfall runoff and produce minimal loadings of organic matter to waterways. In addition, forested stream buffers can filter impurities from runoff from adjoining nonforested areas. Improper timber harvesting can destroy these buffers and destabilize soils. It is critical that all efforts be made to minimize sediment loss and runoff so as to protect other natural resources in this basin.

Improper forest management practices can adversely impact water quality in a number of ways. This is especially true in mountainous regions where steep slopes and fragile soils are widespread. Without proper BMPs, large clearcutting operations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. This results in both downstream flooding and contribute to stream bank erosion (Waters 1995).

Careless harvesting and road and stream crossing construction can transport sediment to downstream waters. Streams with sedimentation may require many years to restore. Sedimentation due to forestry practices is most often associated with the construction and use of logging roads, particularly when roads are built near streams (Waters 1995), skid trails and decks. Density and length of logging roads can be major factors in the amount of sedimentation produced.

Timber harvest inspections are conducted by the NC Division of Forest Resources (DFR). A recent limited statewide sampling survey (based on 196 site inspections statewide) showed overall compliance rate with forestry BMPs and Forest Practice Guidelines (FPGs) was 95% (Henson 1996). A summary of DFR activities and past accomplishments in the Yadkin-Pee Dee River basin is reported in Chapter 5.

Timber Harvesting in the Yadkin-Pee Dee River Basin

Overall, BMP compliance in the Yadkin-Pee Dee River basin is very good according to the Division of Forest Resources. Overall, 91% of activities were in compliance with all landowner types at least 85% in compliance. Compliance rates are reported by DFR as follows: permanent logging roads (87%), skid trails and temporary roads (91%), Streamside Management Zones (97%) with minimized and correct stream crossings and all BMPs were installed correctly. SMZs in the basin were usually free of activity and ground cover along perennial streams was no more than 20% bare ground.

3.4.5 Onsite Wastewater Disposal

Septic systems receive wastewater from a household or business. The septic tank removes some wastes, but the soil drainfield provides further absorption and treatment. Septic tanks can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, if the tank or drainfield malfunction or are improperly placed, constructed or maintained, nearby wells and surface waters may become contaminated.

Some of the potential problems from malfunctioning septic system include:

- Polluted groundwater: Pollutants in sewage include bacteria, nutrients, toxic substances, and oxygen-consuming wastes. Nearby wells can become contaminated by septic tanks.
- Polluted surface water: Often, groundwater carries the pollutants mentioned above into surface waters, where they can harm aquatic ecosystems. Septic tanks can also leak into surface waters both through or over the soil.
- Risks to human health: Septic system malfunctions can endanger human health when they contaminate nearby wells, drinking water supplies, and fishing and swimming areas.

Pollutants associated with onsite wastewater disposal may also be discharged directly to surface waters through *straight pipes* (i.e., direct pipe connections between the septic system and surface waters). If these discharges cannot be eliminated, they must be permitted under the NPDES program and must meet applicable effluent limitations.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas. Fecal coliform bacteria contamination from failing septic systems is of particular concern in waters used for swimming, tubing, water supply and other related activities.

3.4.6 Solid Waste Disposal

Solid wastes may include household wastes, commercial or industrial wastes, refuse or demolition waste, infectious wastes or hazardous wastes. Improper disposal of these types of wastes can serve as a source of a wide array of pollutants. The major water quality concern associated with modern solid waste facilities is controlling the leachate and stabilizing the soils used for covering many disposal facilities. Properly designed, constructed and operated facilities should not significantly effect water quality.

Groundwater and surface water monitoring is required at all permitted Municipal Solid Waste Sites (MSW) and all Construction and Demolition landfills. Monitoring efforts have been required since July 1989. All MSW landfills must have a liner system in place by January 1, 1998. All existing unlined landfills must close at this same time.

Watts Farm Low-Level Radioactive Waste (LLRW) Disposal Site in Wilkes County

The Watts Farm LLRW operated as a disposal site for about one year beginning in July 1978 and included burial of materials in pits within a fenced area. This authorized disposal area includes a trench approximately 25 feet wide by 12 feet deep by 60 feet long. Buried material is reported to consist of two types: 1) crushed glass and plastic scintillation vials, and 2) vermiculite and dry laboratory wastes. The materials are considered low-level radioactive and hazardous. All dry wastes and most crushed vials are believed to be buried in metal drums; although approximately 500 cubic feet are reported to have been dumped loose into a burial trench. Ground water sampling is being conducted with five monitoring wells to determine if offsite leachate is present. All monitoring samples have had negative results. Investigations were conducted at the Watts Farm LLRW Disposal Site in July and August, 1996 to determine the actual sites of waste disposal. No waste was found outside of the fenced area. Waste material will be excavated from the site and shipped for treatment and/or disposal. Soil will be excavated and analyzed for contamination and removed and shipped for treatment and/or disposal if necessary. Clean soil will be backfilled. The site will be graded to original contours and seeded. This excavation work was to be completed in 1997.

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CHAPTER 4

WATER QUALITY IN THE YADKIN-PEE DEE RIVER BASIN

4.1 INTRODUCTION

This chapter provides an overview of water quality and use support ratings in the Yadkin-Pee Dee River Basin.

DWQ Water Quality Monitoring and Assessment

- **Section 4.2** presents a summary of water quality monitoring programs conducted by DWQ's Environmental Sciences Branch (NCDEM, 1996) as well as information reported by researchers and other agencies.
- **Section 4.3** presents a narrative summary of water quality findings for each of the subbasins. The summary is based on the monitoring approaches described in Section 4.2. Subbasin maps showing the locations of DWQ monitoring sites are also included.

Use-Support Ratings

- **Section 4.4** describes the use support concept and the methodology for developing use support ratings. Using this approach, surface waters in the basin are assigned one of four ratings: fully supporting, fully supporting but threatened, partially supporting, or not supporting uses.
- **Section 4.5** presents a series of tables, figures, and a color-coded use support map for many of the streams in the basin.

4.2 WATER QUALITY MONITORING PROGRAMS

DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a list of the five major monitoring programs from which data is available for this basin. Each of these is briefly described in the following text.

- Benthic macroinvertebrate monitoring (Section 4.2.1),
- Fish population and tissue monitoring(Section 4.2.2),
- Lakes assessment (including phytoplankton monitoring) (Section 4.2.3),
- Aquatic toxicity monitoring (Section 4.2.4),
- Chemical/Physical characterizations (Section 4.2.5)
- Sediment oxygen demand (Section 4.2.6), and
- Ambient monitoring system (Section 4.2.7).

4.2.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates are organisms that live in and on the bottom of rivers and streams. These organisms are primarily aquatic insect larvae. The use of macroinvertebrate data has proven to be a reliable water quality monitoring tool because these organisms are relatively immobile and sensitive to subtle changes in water quality. Since many organisms in a community have life cycles of six months to one year, the effects of short term pollution (such as an oil or chemical spill) will generally not be overcome until the following generation appears. The benthic community also responds to and shows the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign a bioclassification rating to each benthic sample based on the number of different species present in the pollution-intolerant groups of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies); or commonly referred to as EPTs. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina. The ratings fall into five categories ranging from Poor to Excellent. Likewise, ratings can be assigned with a Biotic Index (Appendix III). This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis.

Macroinvertebrate Sampling in the Yadkin-Pee Dee River Basin
From 1983 through 1996, 522 macroinvertebrate samples were collected at 330 sites, providing a very large database for water quality analysis throughout the basin (Appendix III). During the 1996 Yadkin basin sampling, macroinvertebrates were collected at 105 sites. The 1996 basin sampling targeted mainstem sites and major tributaries in all the subbasins and gives a good representation of present water quality in the basin. Of the 105 basin samples, 11 were Excellent (10%), 30 were Good (29%), 46 were Good-Fair (44%), 14 were Fair (13%), and 4 sites were rated as Poor (4%).

4.2.2 Fisheries Monitoring

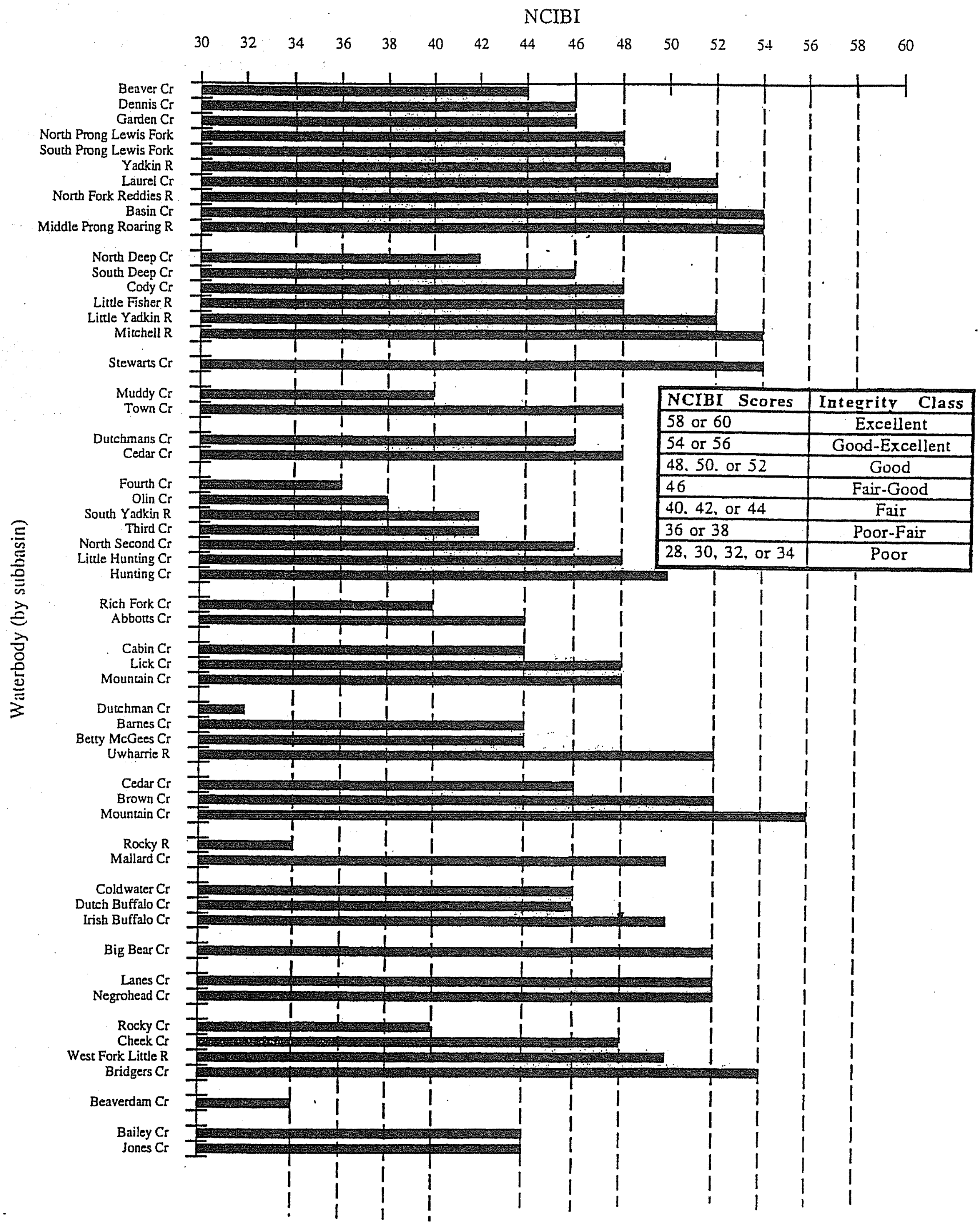
The condition of the fishery is one of the most meaningful indicators of ecological integrity to the public. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web (such as macroinvertebrates) will affect the abundance, species composition, and condition of the fish population. Two types of fisheries monitoring are conducted by DWQ and are described briefly below.

Fish Community Assessment

The first method involves assessing the overall health of the fish community. This information can be used as an indicator of water quality. The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981). The NCIBI was developed to assess the biological integrity of streams by examining the structure and health of the fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. At this time DWQ has no Index of Biotic Integrity calculated for fish populations in lakes and the NCIBI is not used for high elevation trout streams due to their naturally limited fish diversity.

Fish Community Sampling in the Yadkin-Pee Dee River Basin
During the spring of 1996, 55 fish community sites, representing at least one site per subbasin, were sampled and evaluated using the North Carolina Index of Biotic Integrity (NCIBI). These 55 sites included streams rated with the NCIBI as: Good-Excellent-6, Good-23, Fair-Good-6, Fair-13, Poor-Fair-2, Poor-1, and Not Rated-4. Figure 4.1 shows all streams with fish community analysis and their relative comparison to other sites and overall rating.

Figure 4.1 Comparative NCIBI Rating of Fish Community Assessment Sites, 1996.



Fish Tissue Analysis

The second monitoring method involves analyzing fish tissues to determine whether they are accumulating chemicals. This information is also useful as a water quality indicator and can be used to determine whether human consumption of fish poses a potential health risk.

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species has been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be ingested by fish or shellfish either directly or through aquatic food webs (defined as bioaccumulation). Therefore, results from fish tissue monitoring can serve as an important indicator of contamination as well as indicators for human, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

<u>Fish Tissue Analysis in the Yadkin-Pee Dee River Basin</u>
Fish tissue samples were collected at 39 sites within the Yadkin River basin between 1978 and 1996. Sample collections were performed at nine sites within the drainage in 1996. DWQ confirmed extensive mercury contamination of the Abbotts Creek embayment of High Rock Lake in 1981, but followup remedial actions have brought mercury concentrations back down to background levels. For a complete discussion, refer to Section 4.3.7.

4.2.3 Lakes Assessment Program (including Phytoplankton)

Lake assessments have been conducted at publicly accessible lakes, lakes which supply domestic drinking water, and lakes where water quality problems have been observed. Data are used to determine the general health, or trophic state, of each lake. The North Carolina Trophic State Index (NCTSI) is a measure of nutrient enrichment and productivity. Lakes are also evaluated on whether the designated uses of the lake have been threatened or impaired by pollution. This index is explained more fully in Appendix III.

<u>Lakes Assessed in the Yadkin-Pee Dee River Basin</u>
There were 29 lakes in the Yadkin River Basin sampled as part of the Lakes Assessment Program (Table 4.1). The majority of these lakes were sampled most recently by DWQ in 1994 or 1995. Of the twenty six lakes fully supporting their designated uses, four were listed as threatened, which identifies some cause for concern for water quality. Two lakes were rated as partially supporting their uses. Long Lake was listed as not supporting because it was drained in 1995 to facilitate sediment removal from the lake's basin. Table 4.2 provides some background on each of the lakes. Each lake is discussed in its subbasin section with a focus on the most recent available data. Figure 4.2 illustrates the trophic status of each of the monitored lakes in the basin.

Phytoplankton are microscopic algae found in lakes. Phytoplankton populations respond to nutrient availability and other environmental factors, and are therefore useful as indicators of eutrophication. Prolific phytoplankton growth can result in "blooms", which can be unsightly and can cause various water quality problems, including elevated surface dissolved oxygen concentrations and percent oxygen saturation values. Chlorophyll *a* concentrations are used as a measure of algae blooms. During monitoring of some lakes within the basin, surface dissolved oxygen concentrations were measured above the state standard, yet chlorophyll *a* concentrations were low. In these cases, it is possible there was a blue-green algae bloom (which contain only low levels of chlorophyll *a*) causing the high surface dissolved oxygen concentrations.

Table 4.1 Lakes Assessed in the Yadkin-Pee Dee River Basin by Subbasin

030701	**030704**	**030707**	**030708**	**030709**	**030710**
Kerr Scott Res	High Rock Lake	Lake Thom-A-Lex	Badin Lake	Back Creek Lake	Blewett Falls Lake
	Lake Corriher		Falls Lake	Lake Bunch	
	Lake Wright		Lake Tillery	Lake Reese	
	Salem Lake		Tuckertown Res	McCrary Lake	
	Winston Lake			Ross Lake	
030712	**030713**	**030714**	**030716**	**030717**	
Kannapolis Lake	Long Lake	Lake Lee	Water Lake	Wadesboro City Pond	
Lake Concord		Lake Monroe	Hamlet City Lake		
Lake Fisher		Lake Twitty (Lake Stewart)	Roberdel Lake		
			Rockingham City Lake		

4.2.4 Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations (Eagleson et al.1990; Mount 1985). Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DWQ's Aquatic Toxicology Unit. The Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

<u>Aquatic Toxicity Monitoring in the Yadkin-Pee Dee River Basin</u>

There are seventy facilities in this basin that currently monitor effluent toxicity as permit requirements. Whole effluent toxicity monitoring results for all dischargers in the Yadkin-Pee Dee Basin are presented in Appendix III and toxicity test results are discussed in each subbasin summary.

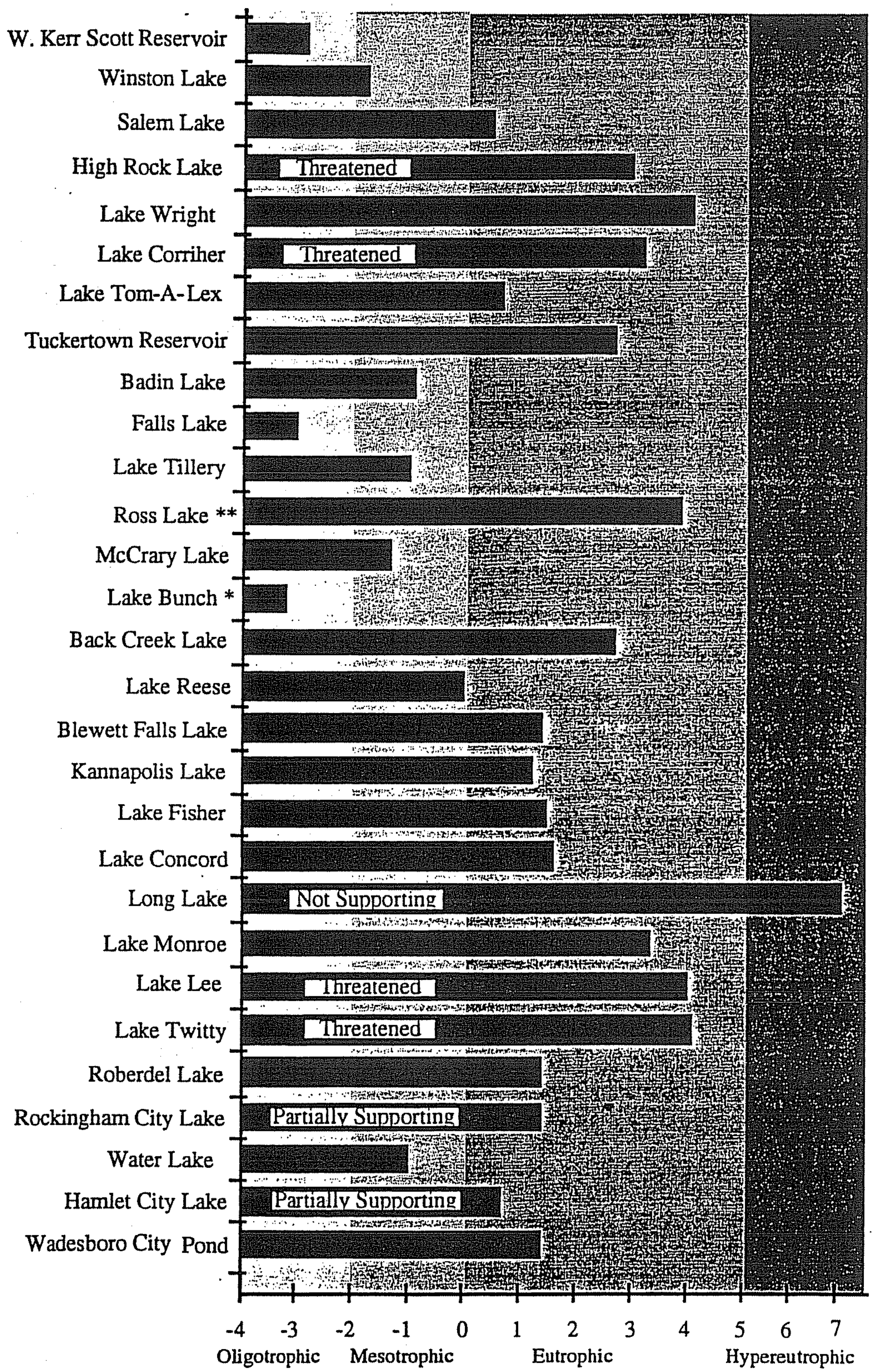
4.2.5 Chemical/Physical Characterizations

Water quality simulation models are often used for the purpose of developing wasteload allocations. These models must adequately predict water body responses to different waste loads so that appropriate effluent limits can be included as requirements in National Pollutant Discharge Elimination System (NPDES) permits. Where large financial expenditures or the protection of water quality is at risk, models should be calibrated and verified with actual field data. Because sufficient historical data are often lacking, intensive water quality surveys are required to provide the field data necessary to accomplish model calibration and verifications. Intensive water quality surveys are performed on water bodies below existing or proposed wastewater discharges and usually consist of a time-of-travel study, flow measurements, physical and chemical samples, long-term biochemical oxygen demands (BOD_{lt}) analysis, waterbody channel geometry, and effluent characterization analysis.

Table 4.2 Characteristics of Sampled Lakes in the Yadkin-Pee Dee River Basin

Lake Name	County Name	Subbasin	Size (acres)	Drainage Area (sq. mi.)	Max. Depth (in ft.)	Mean Depth (in ft.)	Class	Retention Time (in days)	Ownership	Year Built	Sample Date	Primary Uses
Kerr Scott Res.	Wilkes	30701	1450	348	46	39	B-Tr		US ACOE	1962	Aug-94	Flood Control, Low Flow Augmentation, Recreation
High Rock Lake	Davidson/Rowan	30704	12,200	3,929	62	16	WS-IV, WS-V&B	3.6-50.8	Yadkin Inc.	1927	Jul-94	Water Supply, Hydropower, Recreation
Lake Corriher	Rowan	30704	17	1.9	16.4	7.9	WS-IV		Town of Landis	1953	Aug-94	Water Supply
Lake Wright	Rowan	30704	29	1.9	19.7	9.8	WS-II		Town of Landis	1955	Aug-94	Secondary Water Supply
Salem Lake	Forsyth	30704	360	25.5	36	18	WS-III CA		Winston-Salem	1919	Sep-94	Water Supply
Winston Lake	Forsyth	30704	25	6.6	18	8	C		Winston-Salem	1919	Aug-90	Recreation
Lake Tom-A-Lex	Davidson	30707	650	39.4	26		WSIII-CA		Thomasville/ Lexington	1957	Jul-94	Water Supply
Badin Lake	Stanly/ Montgomery	30708	5350	4116	174	46	WS-IV&B	28	Yadkin, Inc.	1917	Jul-94	Water Supply, Hydropower, Recreation
Falls Lake	Stanly/ Montgomery	30708	203	2552	52	33	WS-IV&B	Run-of-river	Yadkin, Inc.		Jul-94	Water Supply, Hydropower, Recreation
Lake Tillery	Stanly/ Montgomery	30708	5264	4834	69	33	WS-IV&B	15	CP&L	1928	Jul-94	Water Supply, Hydropower, Recreation
Tuckertown Res.	Stanly/ Montgomery	30708	2550	4210	52	33	WS-IV CA, B	Run-of-river	Yadkin Inc.	1962	Jul-94	Water Supply, Hydropower, Recreation
Back Creek Lake (Lake Lucas)	Randolph	30709	250	15.7	26		WS-II CA		Asheboro	1946	Aug-94	Primary Water Supply
Lake Bunch	Randolph	30709	30	2.3	29	10	WS-II CA		Asheboro	1932	Aug-94	Secondary Water Supply
Lake Reese	Randolph	30709	600	100	33	16	WS-III		Asheboro	1983	Aug-94	Water Supply, Recreation
McCrary Lake	Randolph	30709	15	0.8	15		WS-II		Asheboro	1924	Aug-94	Water Supply
Ross Lake	Randolph	30709	5		3	2	WS-II		Asheboro	1916	94	Secondary Water Supply
Blewett Falls Lake	Anson/ Richmond	30710	2570	6784	39	36	WS-IV&B	Run-of river	CP&L	1912	Jul-94	Water Supply, Hydropower, Recreation
Kannapolis Lake	Rowan	30712	270	11	33		WS-III CA		Atlantic American Prop.	1938	Aug-95	Water Supply
Lake Concord	Cabarrus	30712	100	4	16	12	WS-IV CA		Concord	1930s	Aug-95	Secondary Water Supply
Lake Fisher	Cabarrus	30712	277	0.8	36	15	WS-IV CA		Concord	1948	Aug-95	Water Supply
Long Lake (Albermarle City Lake)	Stanly	30713	79	31	39	3	C		Albemarle	1922	94	Recreation
Lake Lee	Union	30714	125	51	10	5	WS-IV CA		Monroe	1927	Sep-95	Water Supply
Lake Monroe	Union	30714	140	9	36	18	WS-IV		Monroe	1955	Sep-95	Water Supply, Recreation
Lake Twitty (Lake Stewart)	Union	30714	82	36	66		WS-III		Monroe	1972	Aug-95	Water Supply, Recreation
Rockingham City	Richmond	30716	27	20		2.3	WS-III CA		Rockingham		Aug-95	Secondary Water Supply
Hamlet City Lake	Richmond	30716	100	10	7	3	C		Hamlet	1930s	Aug-95	
Roberdel Lake	Richmond	30716	100	140	16		WS-IIICA		Rockingham	1930s	Aug-95	Primary Water Supply
Water Lake	Richmond	30716	47	3		10	WS-II CA		Hamlet		Aug-95	Water Supply
City Pond (Wadesboro)	Anson	30717	100		16		WS-II CA			1938	Aug-95	Water Supply

Figure 4.2 Yadkin-Pee Dee River Basin NSTSI Scores (based on last assessment date)



*Reference Lake

**Ross Lake was last surveyed by DEM in 1989. This lake no longer exists.

4.2.6 Sediment Oxygen Demand

If oxygen depletion is suspected due to the characteristics of benthic sediments then sediment oxygen demand (SOD) studies may be performed. Each stream reach is divided into a series of model segments. The number of stream segments that must be evaluated with an intensive survey depends on the individual study and the spatial resolution desired. Raw data from these studies are available on request (NCDWQ, 1996).

Sediment Oxygen Demand in the Yadkin-Pee Dee River Basin
During 1992 and 1993, Sediment Oxygen Demand (SOD) studies were conducted in the Yadkin River Basin. The purpose of these tests was to provide water quality data for assimilative capacity modeling of the Yadkin River. Data from Grants Creek and Muddy Creek indicated elevated SOD resulting from the presence of oxygen consuming sediments in that area downstream from Grants Creek. Data from the Abbotts Creek/Hamby Creek tests indicated moderate SOD resulting from the presence of oxygen consuming sediments in Rich Fork Creek and low SOD in Abbotts Creek.

4.2.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine (saltwater) water quality monitoring stations (about 380 statewide) strategically located for the collection of physical and chemical water quality data (or water quality parameters). Sampling stations are sited under one or more of the following monitoring designations:

Fixed Monitoring Stations
Point source
Nonpoint source
Baseline Water Supply

Rotating Monitoring Stations
Basinwide Information
HQW & ORW

Water quality parameters are arranged by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, Class C waters are assigned minimum monthly parameters. Additional parameters are assigned to waters with classifications such as trout waters and water supplies. Water quality parameters are shown in Table 4.3. Ambient water quality are often summarized using box and whisker plots (Figure 4.4 through Figure 4.17). Figure 4.3 provides an explanation of how to interpret the plots.

Ambient Monitoring Summary
Water quality data collected at 45 sites in the Yadkin River basin were evaluated for the period 1992-1996. Because the methodology for determining parametric coverage within the AMS program has recently been revised, some stations have little or no data for several parameters. However, for the purpose of standardization, data summaries include all parameters that will be sampled in the future.

Table summaries of ambient water chemistry data for all Ambient Monitoring System (AMS) stations within the Yadkin Basin are located in the DWQ Yadkin River Assessment Report (NCDWQ,1996). These tables summarize data for common selected chemical parameters and include station summary information, descriptive statistics for parametric data, water quality criteria information for the station's classification, a yearly breakdown of selected parametric data and descriptive statistics for parametric data from summer months.

There are 12 mainstem stations located along the Yadkin-Pee Dee River mainstem and 33 stations on tributary streams. AMS stations for the Yadkin-Pee Dee River basin are listed in Table 4.4. Refer to subbasin maps within this chapter for station locations.

Table 4.3 Ambient Monitoring System Freshwater Parametric Coverage.

C WATERS (minimum monthly coverage for all stream stations)

Field Parameters: dissolved oxygen, pH, conductivity, temperature

Nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite

Physical Measurements: total suspended solids, turbidity, hardness

Bacterial: fecal coliforms (Millipore Filter method)

Metals: aluminum (no present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*

TROUT WATERS

No changes or additions

WATER SUPPLY

Chloride, total coliforms, manganese, total dissolved solids

NUTRIENT-SENSITIVE WATERS

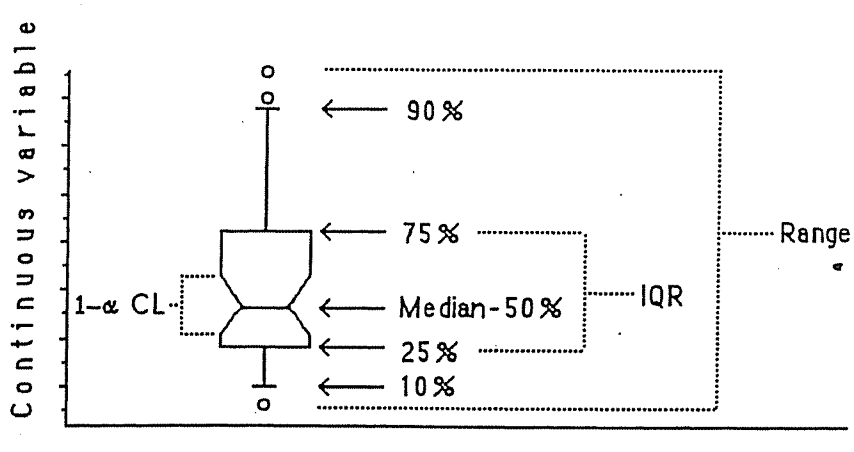
Chlorophyll *a* (where appropriate)

PLUS any additional parameters of concern for individual station locations.

*Action level water quality standard.

Figure 4.3 Box and Whisker Plots

Box and whisker plots are useful for comparing sets of data comprised of a single variable by the visualization of selected order statistics. After the data have been ordered from low to high, the 10th, 25th, 50th, 75th, and 90th percentiles are calculated for plot construction. Box and whisker plots display the following important information: 1) the interquartile range (IQR) which measures the distribution and variability of the bulk of the data (located between the 25th and 75th percentiles), 2) the desired confidence interval (1- CL) for measuring the statistical significance of the median (50th percentile), 3) indication of skew from comparing the symmetry of the box above and below the median, 4) the range of the data from the lowest to highest values, and 5) the extreme values below the 10th percentile and above the 90th percentile (depicted as dots).



Visual comparison of confidence level notches about the medians of two or more box plots can be used to roughly perform hypothesis testing. If the box plots represent data from samples assumed to be independent, then overlapping notches indicate no significant difference in the samples at a prescribed level of confidence. Formal tests should subsequently be performed to verify preliminary conclusions based on visual inspection of the plots.

Table 4.4 Ambient Monitoring System Stations Within the Yadkin Basin.

Primary No	Storet No	Station Name	Subbasin
Yadkin River Mainstem			
02111000	Q0060000	Yadkin River At NC 268 At Patterson NC	030701
02112000	Q0390000	Yadkin River At NC 18 268 At Wilkesboro NC	030701
02112152	Q0690000	Yadkin River At Sr 2327 At Roaring River NC	030701
02112250	Q0810000	Yadkin River At Us 21 Business At Elkin NC	030702
02115360	Q2040000	Yadkin River At Sr 1605 At Enon NC	030702
02116500	Q2810000	Yadkin River At Us 64 At Yadkin College NC	030704
02121031	Q4660000	Yadkin River At NC 150 Near Spencer NC	030704
02122500	Q6120000	Yadkin River At Sr 1002 At High Rock NC	030704
02123736	Q7150000	Pee Dee River At NC 731 Near Shankle NC	030708
02127500	Q9160000	Pee Dee River At NC 109 Near Mangum NC	030710
02129000	Q9400000	Pee Dee River At Us 74 Near Rockingham NC	030716
02130000	Q9980000	Pee Dee River At Sr 9 At Cheraw SC	030716
Yadkin River Tributaries			
02111180	Q0220000	Elk Creek At NC 268 At Elkville NC	030701
02112120	Q0660000	Roaring River At Sr 1990 Near Roaring River NC	030701
02113850	Q1780000	Ararat River At Sr 2019 At Ararat NC	030703
02114101	Q1950000	Ararat River At Sr 2080 Near Siloam NC	030703
02114450	Q2020000	Little Yadkin River At Us 52 At Dalton NC	030702
02115856	Q2510000	Salem Creek At A Elledge WWTP Near Atwood NC	030704
02115860	Q2600000	Muddy Creek At Sr 2995 Near Muddy Creek NC	030704
02118000	Q3460000	South Yadkin Rvr At Sr 1159 Near Mocksville NC	030706
02118500	Q3484000	Hunting Creek At Sr 2115 Near Harmony NC	030706
Yad108e	Q3735000	Fourth Creek At Sr 2308 Near Elmwood NC	030706
02120521	Q3934500	Third Creek At Sr 1970 Near Woodleaf NC	030706
02120780	Q4120000	Second Ck At Us 70 Near Barber NC	030706
02120975	Q4600000	Grants Creek At Spencer	030704
0212140080	Q5360000	Town Creek At Sr 2168 Near Duke NC (Crane Creek)	030704
0212147355	Q5780000	Rich Fork At Sr 1800 Near Thomasville NC	030707
0212148889	Q5906000	Hambys Creek At Sr 2790 Near Holly Grove NC	030707
02121500	Q5930000	Abbotts Creek At Sr 1243 At Lexington NC	030707
02121602	Q5970000	Abbots Creek At NC 47 Near Cotton Grove NC	030704
0212160350	Q5990000	Abbotts Creek At Sr 2294 Near Southmont NC	030704
02123500	Q6810000	Uwharrie River At NC 109 Near Uwharrie NC	030709
02123567	Q6820000	Dutchmans Creek At Sr 1150 Near Uwharrie NC	030709
02123881	Q7330000	Rocky River At Sr 2420 Near Davidson NC	030711
02124374	Q8090000	Irish Buffalo Creek At Sr 1132 Near Faggarts NC	030712
02124401	Q8210000	Rocky River At Us 601 Near Concord NC	030712
0212467550	Q8360000	Goose Creek At Sr 1524 Near Mint Hill NC	030712
02125126	Q8720000	Long Crk At Sr 1954 Near Rocky Rvr Springs NC	030713
02125482	Q8917000	Richardson Creek At Sr 1649 Near Fairfield NC	030714
02126000	Q9120000	Rocky River At Sr 1935 Near Norwood NC	030713
0212740615	Q9155000	Brown Creek At Sr 1627 Near Pinkerton NC	030710
02128000	Q9200000	Little River At Sr 1340 Near Star NC	030715
02129341	Q9660000	Hitchcock Creek At Sr 1109 At Cordova NC	030716
02129527	Q9777000	Jones Creek At NC 145 Near Pee Dee NC	030717
0212955844	Q9940000	Marks Creek At Sr 1812 Near Hamlet NC	030716

Table 4.5 summarizes, by parameter, data excursions at ambient stations in the basin. Fecal coliform data are discussed separately later in this section. Each station is listed with associated parameter and water quality criterion, along with total number of samples, those samples having less than detection level and the number of samples with an excursion from the criterion. Only parameters with excursions are listed for each site and only those sites with excursions more than 10 percent of the time are listed. It should be noted that the criteria are presented as numerical and represent instantaneous measurements. The actual standard may include a narrative, such as turbidity, and as in some metals criteria, may be based on extended exposure at or above the criteria which may result in chronic toxicity to the most sensitive species of organism. Therefore, the table is useful for relative comparisons between locations and screening areas where frequent excursions of individual or multiple parameters suggest waters that might be targeted for more detailed evaluations and/or specific management strategies. A more thorough evaluation can include review of temporal and spatial trends, association of concentrations to flow, degree of excursion from the criterion, or use of other analytical methods. Table 4.6 shows the grouping of data from summarized AMS station data excursions represented as total samples, total excursions and percent excursions of total samples.

Table 4.5 Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria (by parameter for those sites with excursions more than 10% of the time). January 1992 to December 1996.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Samples Excur
02122500	YADKIN RIVER AT SR 1002 AT HIGH ROCK NC	Dissolved Oxygen (mg/l)(5)	20	0	4
02123736	PEE DEE RIVER AT NC HWY 731 NEAR SHANKLE NC	Dissolved Oxygen (mg/l)(5)	43	0	9
0212740615	BROWN CREEK AT SR 1627 NEAR PINKERTON NC	Dissolved Oxygen (mg/l)(5)	15	0	4
0212955844	MARKS CREEK AT SR1812 NEAR HAMLET NC	Dissolved Oxygen (mg/l)(5)	13	0	4
02130000	PEE DEE RIVER AT SC HWY 9 AT CHERAW SC	Dissolved Oxygen (mg/l)(5)	4	0	0
0212140080	TOWN CREEK AT SR 2168 NEAR DUKE NC (CRANE CREEK)	pH (SU)(9)	21	0	3
02129341	HITCHOCK CREEK AT SR 1109 AT CORDOVA NC	pH (SU)(9)	14	0	3
0212955844	MARKS CREEK AT SR1812 NEAR HAMLET NC	pH (SU)(9)	13	0	4
02121602	ABBOTS CREEK AT NC HWY 47 NR COTTON GROVE NC	Chlorophyll a (Corr)(µg/l)(40)	28	1	4
02113850	ARARAT RIVER AT SR 2019 AT ARARAT NC	Turbidity (NTU)(50)	19	0	2
02114450	LITTLE YADKIN RIVER AT US HWY 52 AT DALTON NC	Turbidity (NTU)(50)	18	0	3
02115360	YADKIN RIVER AT SR 1605 AT ENON NC	Turbidity (NTU)(50)	19	0	3
02118000	SOUTH YADKIN RIVER AT SR 1159 NR MOCKSVILLE NC	Turbidity (NTU)(50)	19	0	2
02118500	HUNTING CREEK AT SR 2115 NEAR HARMONY NC	Turbidity (NTU)(50)	20	0	2
YAD108E	FOURTH CREEK AT SR 2308 NEAR ELMWOOD NC	Turbidity (NTU)(50)	6	0	0
02120521	THIRD CREEK AT SR 1970 NEAR WOODLEAF NC	Turbidity (NTU)(50)	22	0	3
02120975	GRANTS CR AT SPENCER	Turbidity (NTU)(50)	21	0	4
02121031	YADKIN RIVER AT NC HWY 150 NEAR SPENCER NC	Turbidity (NTU)(50)	8	0	2
0212140080	TOWN CREEK AT SR 2168 NEAR DUKE NC (CRANE CREEK)	Turbidity (NTU)(50)	21	0	4
02123881	ROCKY RIVER AT SR2420 NEAR DAVIDSON NC	Turbidity (NTU)(50)	20	0	4
02124374	IRISH BUFFALO CK AT SR 1132 NR FAGGARTS NC	Turbidity (NTU)(50)	20	0	2
02124401	ROCKY RIVER AT US HWY 601 NEAR CONCORD NC	Turbidity (NTU)(50)	19	0	6
0126000	ROCKY RIVER AT SR 1935 NEAR NORWOOD NC	Turbidity (NTU)(50)	42	0	6
02114450	LITTLE YADKIN RIVER AT US HWY 52 AT DALTON NC	Total Residue (mg/l)(500)	14	0	2
02112152	YADKIN RIVER AT SR2327 AT ROARING RIVER NC	Manganese (µg/l)(50)	7	0	4
02114450	LITTLE YADKIN RIVER AT US HWY 52 AT DALTON NC	Manganese (µg/l)(50)	7	0	2
02115360	YADKIN RIVER AT SR 1605 AT ENON NC	Manganese (µg/l)(50)	9	0	3
02116500	YADKIN RIVER AT US HWY 64 AT YADKIN COLLEGE NC	Manganese (µg/l)(50)	6	0	2
02118000	SOUTH YADKIN RIVER AT SR 1159 NR MOCKSVILLE NC	Manganese (µg/l)(50)	7	0	7
02118500	HUNTING CREEK AT SR 2115 NEAR HARMONY NC	Manganese (µg/l)(50)	10	1	2
02120521	THIRD CREEK AT SR 1970 NEAR WOODLEAF NC	Manganese (µg/l)(50)	9	0	8
02120780	SECOND CK AT US HWY 70 NEAR BARBER NC	Manganese (µg/l)(50)	9	0	9
02121031	YADKIN RIVER AT NC HWY 150 NEAR SPENCER NC	Manganese (µg/l)(50)	8	0	6
02121602	ABBOTS CREEK AT NC HWY 47 NR COTTON GROVE NC	Manganese (µg/l)(50)	9	0	9
0212160350	ABBOTTS CK AT SR 2294 NR SOUTHMONT DURACELL	Manganese (µg/l)(50)	12	0	8
02122500	YADKIN RIVER AT SR 1002 AT HIGH ROCK NC	Manganese (µg/l)(50)	8	0	6
02123736	PEE DEE RIVER AT NC HWY 731 NEAR SHANKLE NC	Manganese (µg/l)(50)	7	0	4

Notable water quality problems or concerns relating to the AMS data are mentioned within the subbasin sections that follow. A summary of AMS data for mainstem and tributary sites is provided here..

Summary of Yadkin-Pee Dee River Mainstem

Figures 4.4 and 4.5 show the distribution of dissolved oxygen and pH data from the active stations along the Yadkin-Pee Dee mainstem. Dissolved oxygen concentrations remain relatively the same and within acceptable levels until the Spencer station below the confluence of the South Yadkin River. Concentrations below High Rock Lake, Lake Tillery (at Shanklee) and Blewett Falls Lake (at Rockingham) drop to levels below the standard (5 mg/l) at least 10 percent of the time. The Mangum site (below the confluence with the Rocky River watershed) has median values of dissolved oxygen at about 6 mg/l and values below the standard 25 percent of the time. The pH concentrations remain stable along the mainstem.

Conductivity values for the mainstem are relatively low for stations in the upper basin, however they increase at the Yadkin College station and continue to increase along the mainstem (Figure 4.6). Conductivity values are typically most affected by point source dischargers, but can also be somewhat affected by nonpoint source runoff.

Table 4.6 Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Total Samples. January 1992 to December 1996.

Station Number	Station Name	Wtr Quality Classific.	Sample Total	# Excrns	% Excrsns
02111000	YADKIN R AT NC HWY 268 AT PATTERSON NC	C Tr	247	2	0.8
02111180	ELK CREEK AT NC HWY 268 AT ELKVILLE NC	B ORW	187	5	2.7
02112000	YADKIN RIVER AT WILKESBORO NC	C	236	3	1.3
02112120	ROARING RVR AT SR 1990 NEAR ROARING RVR NC	B WSIV	214	5	2.3
02112152	YADKIN RIVER AT SR2327 AT ROARING RIVER NC	WSIV	91	10	11.0
02112250	YADKIN RIVER AT US HWY 21 BUS AT ELKIN NC	C	178	3	1.7
02113850	ARARAT RIVER AT SR 2019 AT ARARAT NC	C	178	6	3.4
02114101	ARARAT RIVER AT SR 2080 NEAR SILOAM NC	WSIV	89	3	3.4
02114450	LITTLE YADKIN RVR AT US HWY 52 AT DALTON NC	WSIV	255	10	3.9
02115360	YADKIN RIVER AT SR 1605 AT ENON NC	WSIV	330	22	6.7
02115856	SALEM CK AT A ELLEDGE WTP AT W-S NC	C	70	6	8.6
02115860	MUDDY CREEK AT SR 2995 NR MUDDY CREEK NC	C	238	7	2.9
02116500	YADKIN RVR AT US 64 AT YADKIN COLLEGE NC	WSIV	260	6	2.3
02118000	SOUTH YADKIN RVR AT SR 1159 NR MOCKSVILLE	WSIV	279	13	4.7
02118500	HUNTING CREEK AT SR 2115 NEAR HARMONY NC	WSIII	220	10	4.5
YAD108E	FOURTH CREEK AT SR 2308 NEAR ELMWOOD NC	C	60	6	10.0
02120521	THIRD CREEK AT SR 1970 NEAR WOODLEAF NC	WSIV	233	21	9.0
02120780	SECOND CK AT US HWY 70 NEAR BARBER NC	WSIV	292	19	6.5
02120975	GRANTS CR AT SPENCER	C	247	12	4.9
02121031	YADKIN RIVER AT NC HWY 150 NEAR SPENCER NC	WSV	103	10	9.7
0212140080	TOWN CREEK AT SR 2168 NEAR DUKE NC (CRANE CREEK)	C	214	11	5.1
0212147355	RICH FORK AT SR1800 NEAR THOMASVILLE NC	C	241	26	10.8
0212148889	HAMBYS CRK AT SR 2790 NEAR HOLLY GROVE NC	C	68	2	2.9
02121500	ABBOTTS CREEK AT SR 1243 AT LEXINGTON NC	C	273	9	3.3
02121602	ABBOTS CRK AT NC 47 NR COTTON GROVE NC	B WSV	379	22	5.8
0212160350	ABBOTTS CK AT SR 2294 NR SOUTHMONT DURACE	B WSIV	585	21	3.6
02122500	YADKIN RIVER AT SR 1002 AT HIGH ROCK NC	B WSIV	241	12	5.0
02123500	UWHARRIE RVR AT NC109 NEAR UWHARRIE NC	WSIV	252	2	0.8
02123567	DUTCHMANS CREEK AT SR 1150 NR UWHARRIE NC	WSIV	344	0	0.0
02123736	PEE DEE RIVER AT NC HWY 731 NEAR SHANKLE NC	B WSV	298	15	5.0
02123881	ROCKY RIVER AT SR2420 NEAR DAVIDSON NC	C	235	10	4.3
02124374	IRISH BUFFALO CK AT SR 1132 NR FAGGARTS NC	C	188	10	5.3
02124401	ROCKY RIVER AT US HWY 601 NEAR CONCORD NC	C	228	12	5.3
0212467550	GOOSE CREEK AT SR 1524 NEAR MINT HILL NC	C	53	1	1.9
02125126	LONG CRK AT SR 1954 NEAR ROCKY RVR SPRINGS	C	235	4	1.7
02125482.	RICHARDSON CRK AT SR 1649 NEAR FAIRFIELD NC	C	228	2	0.9
02126000	ROCKY RIVER AT SR 1935 NEAR NORWOOD NC	C	250	11	4.4
0212740615	BROWN CREEK AT SR 1627 NEAR PINKERTON NC	C	139	5	3.6
02127500	PEE DEE RIVER AT NC HWY 109 NEAR MANGUM NC	C	80	3	3.8
02128000	LITTLE RIVER AT SR 1340 NEAR STAR NC	C HQW	208	1	0.5
02129000	PEE DEE RVR AT US HWY 74 NR ROCKINGHAM NC	C	181	3	1.7
02129341	HITCHOCK CREEK AT SR 1109 AT CORDOVA NC	C	122	6	4.9
02129527	JONES CREEK AT NC HWY 145 NEAR PEE DEE NC	C	129	1	0.8
0212955844	MARKS CREEK AT SR1812 NEAR HAMLET NC	C	120	8	6.7
02130000	PEE DEE RIVER AT SC HWY 9 AT CHERAW SC	C	39	1	2.6

Nutrient data for the mainstem sites are shown in Figures 4.7 through Figure 4.10. Total phosphorous distributions are shown in Figure 4.7, with the highest concentrations at the Yadkin College site. The distribution of nitrate/nitrite nitrogen and total Kjeldahl nitrogen (Figures 4.8 and 4.9) are similar in appearance, with the highest nitrogen concentrations at the Yadkin College and Spencer (below the South Yadkin River confluence) stations. The higher concentrations of nutrients at both of these sections may be indicative of the higher erosivity rates in the upper portion of the basin. Both of these sites are demonstrating the concentrations of nutrients entering High Rock Lake just downstream. In addition, the High Rock station just downstream of High Rock Lake indicates the highest concentrations of ammonia nitrogen (Figure 4.10).

Summary of Yadkin-Pee Dee River Tributary AMS Sites

Figure 4.11 shows the distribution of dissolved oxygen concentrations from the Yadkin-Pee Dee River tributaries. There are four tributaries with noticeably lower dissolved oxygen levels (more than 25 percent of the samples were below the acceptable level of 5 mg/l). These sites are on Brown Creek and Marks Creek and two sites are on Abbotts Creek.

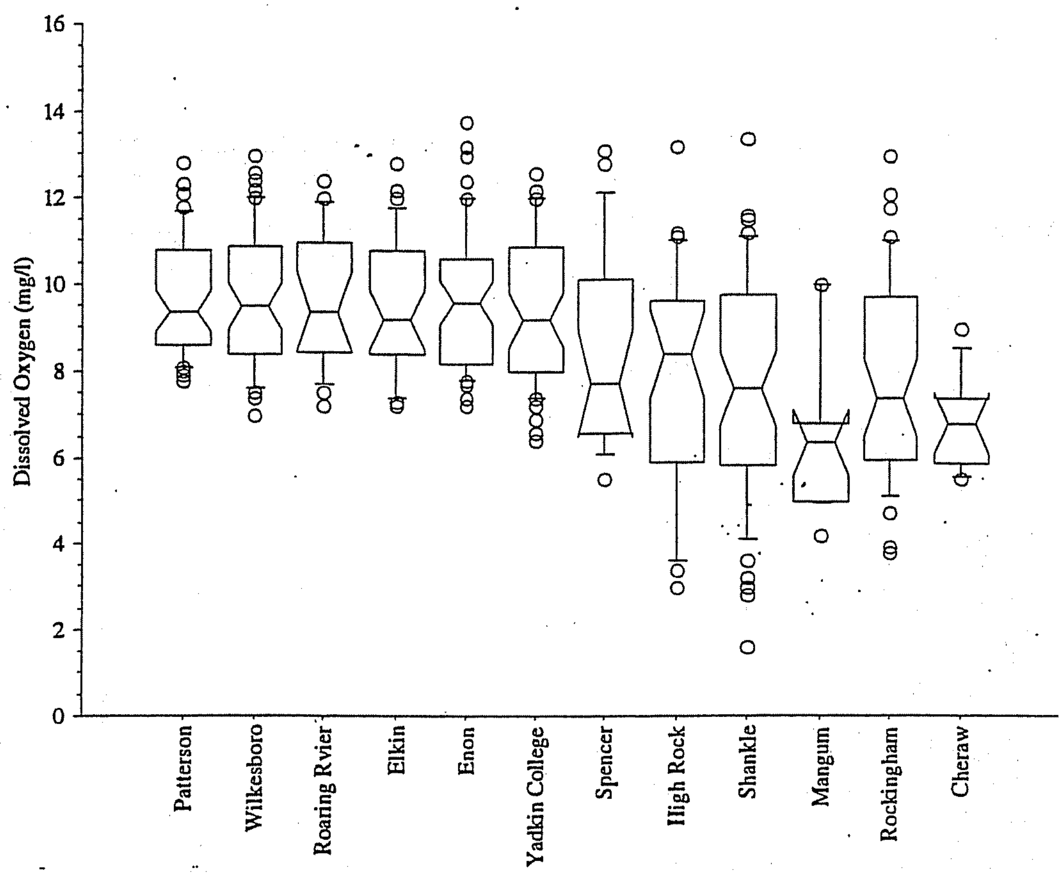


Figure 4.4 Dissolved Oxygen Concentrations from Yadkin-Pee Dee River Mainstem Sites. 1992-1996

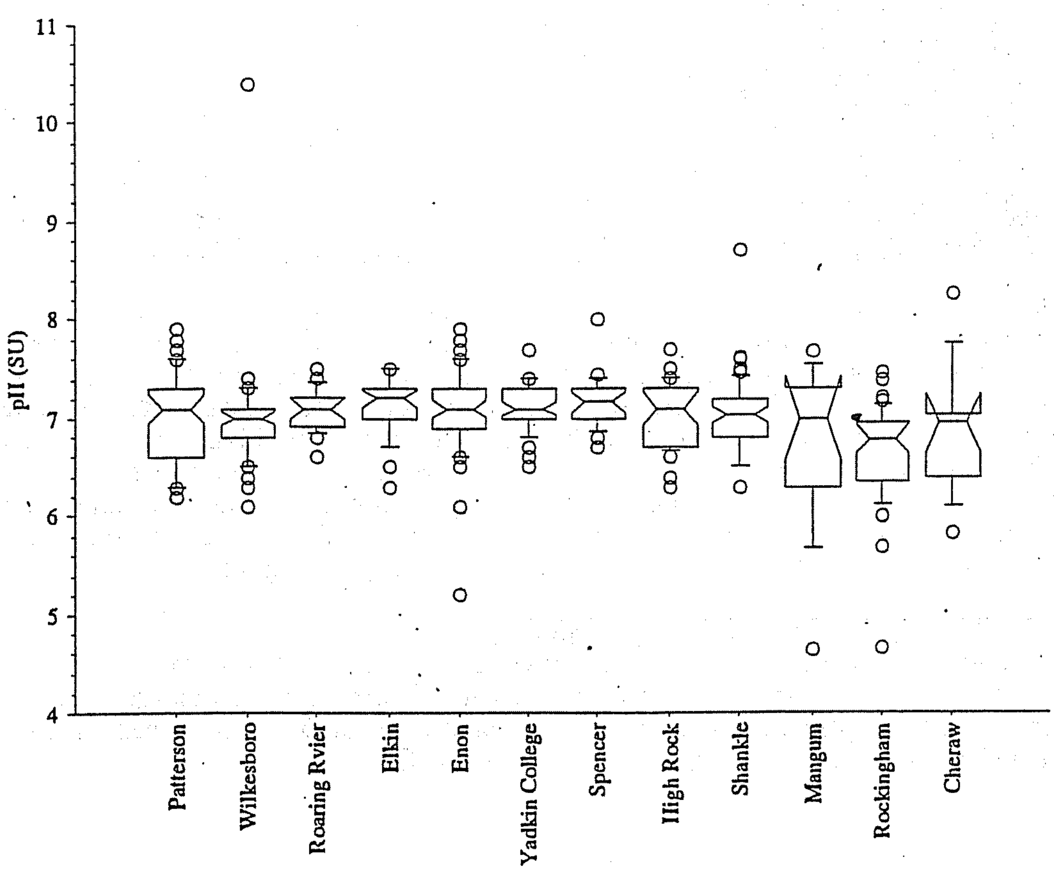


Figure 4.5 pH Distribution from Yadkin-Pee Dee River Sites. 1992-1996.

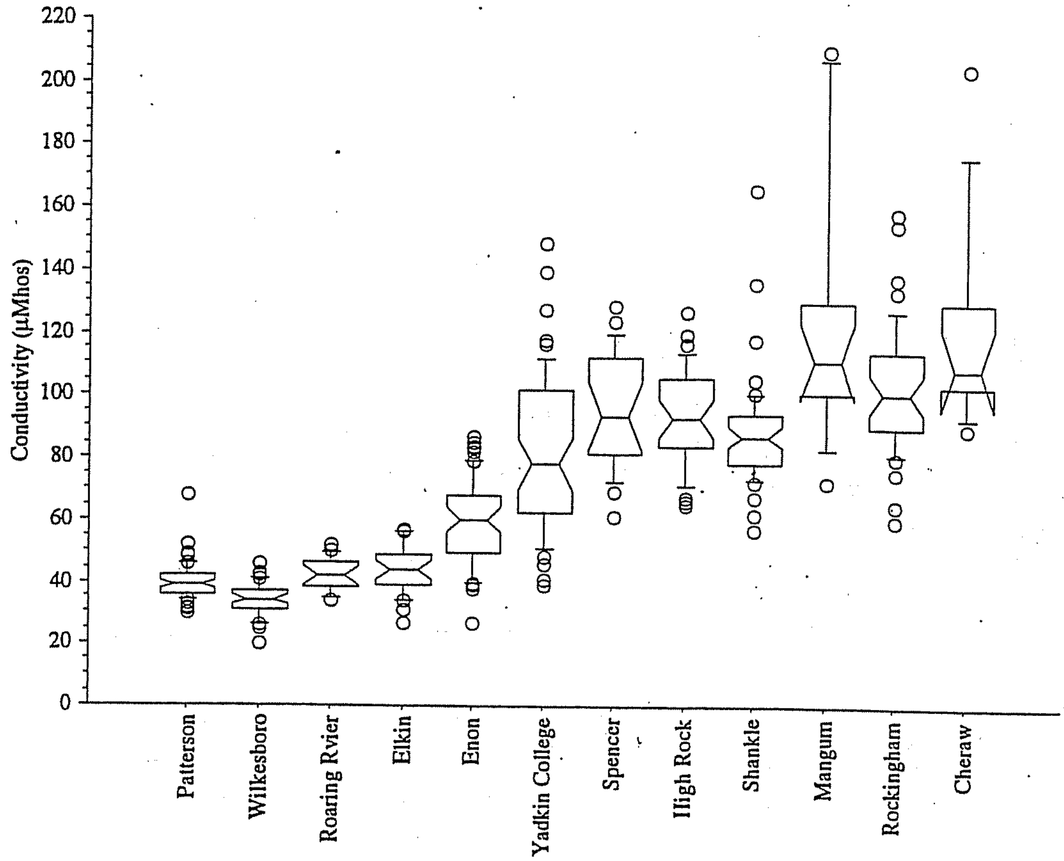


Figure 4.6 Conductivity Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996.

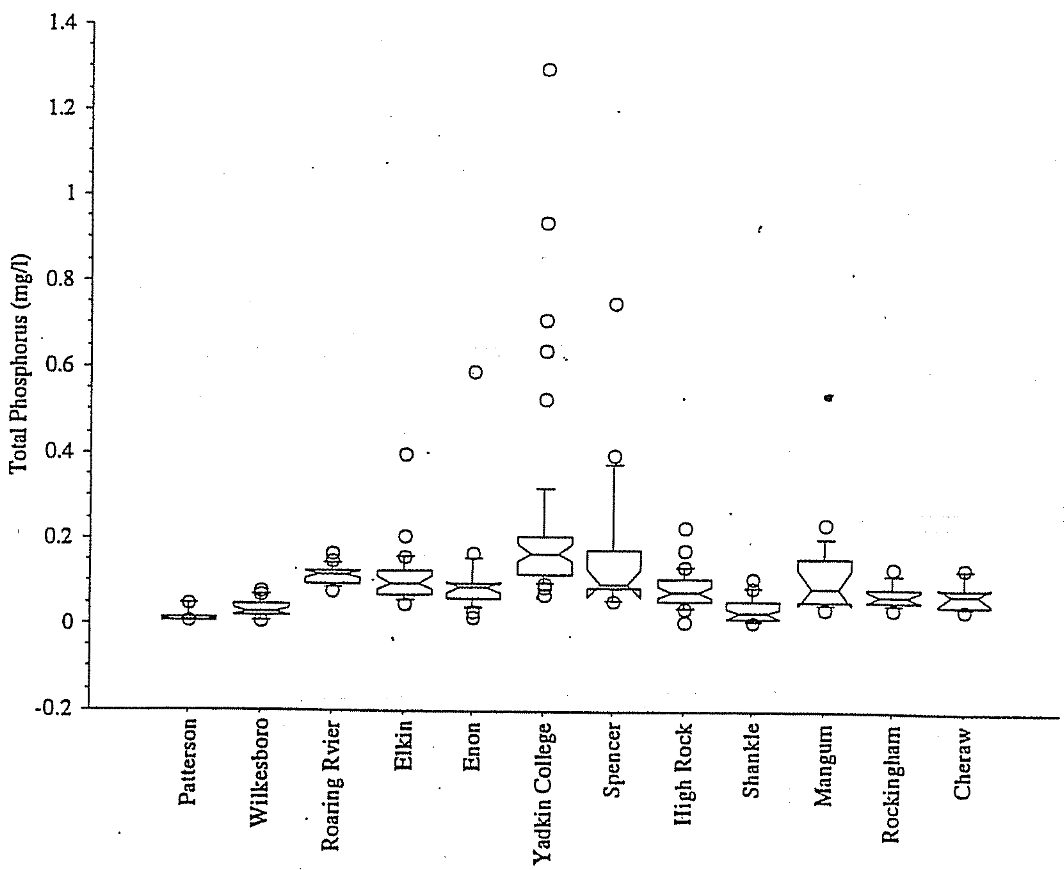


Figure 4.7 Total Phosphorous Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996.

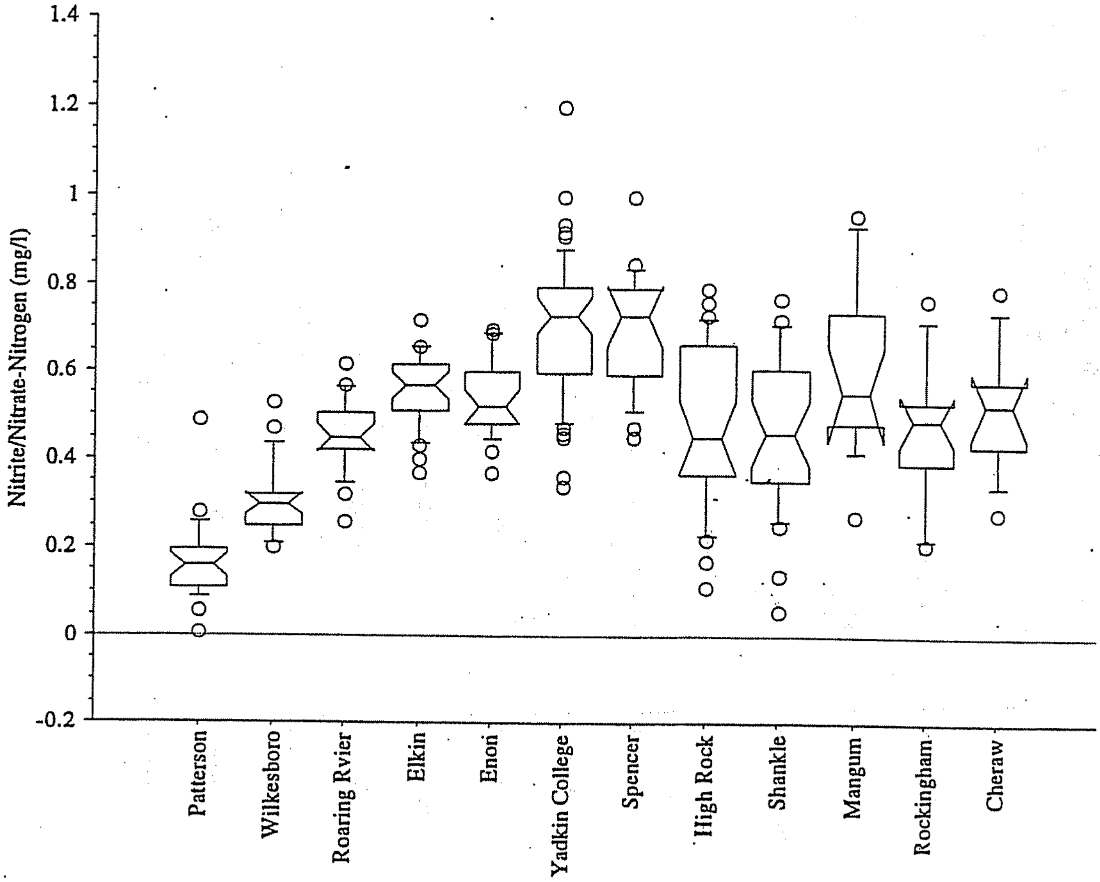


Figure 4.8 Nitrate/Nitrite Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996.

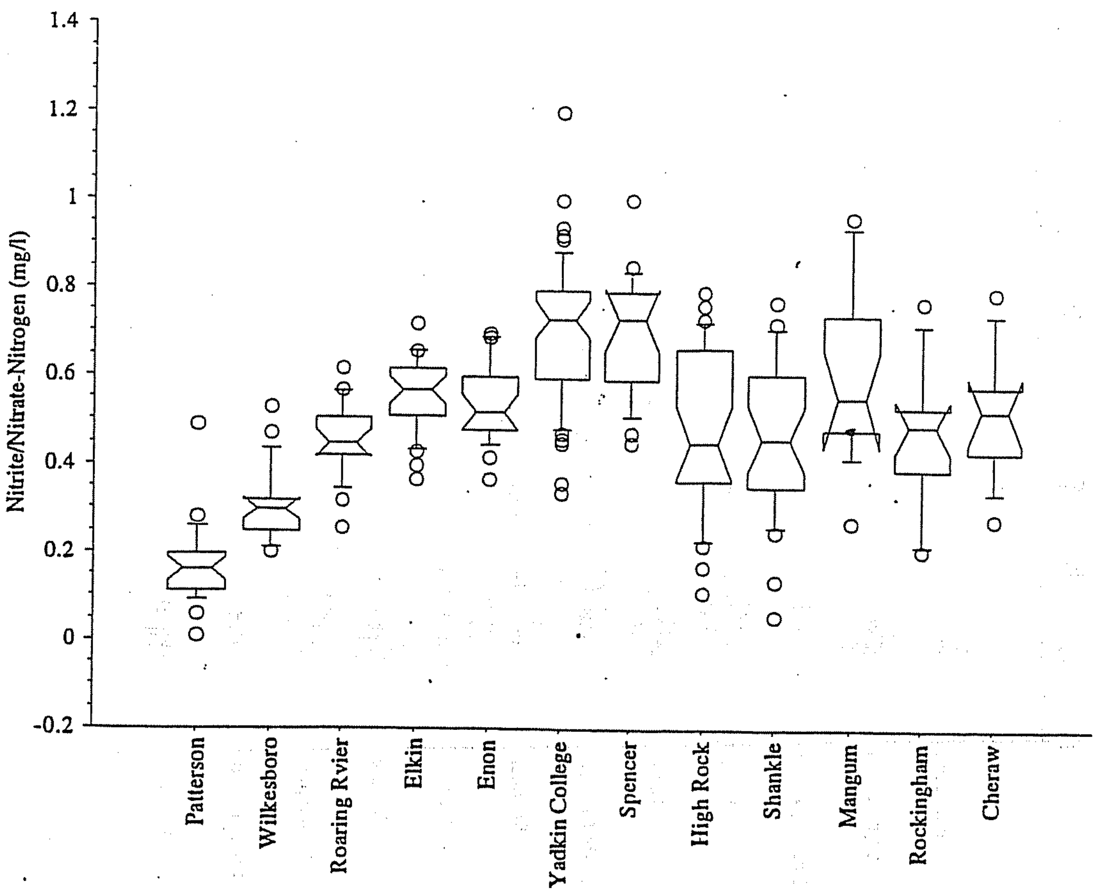


Figure 4.9 Total Kjeldahl Nitrogen Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996

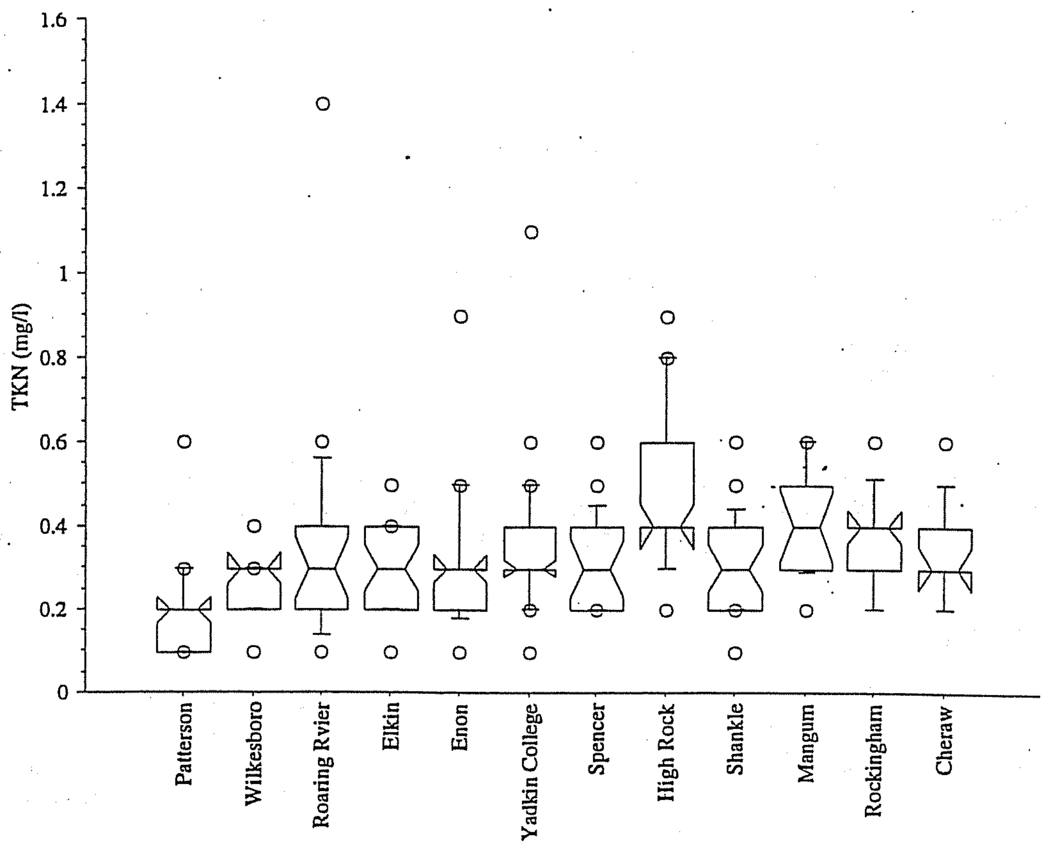


Figure 4.10 Ammonia Nitrogen Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996.

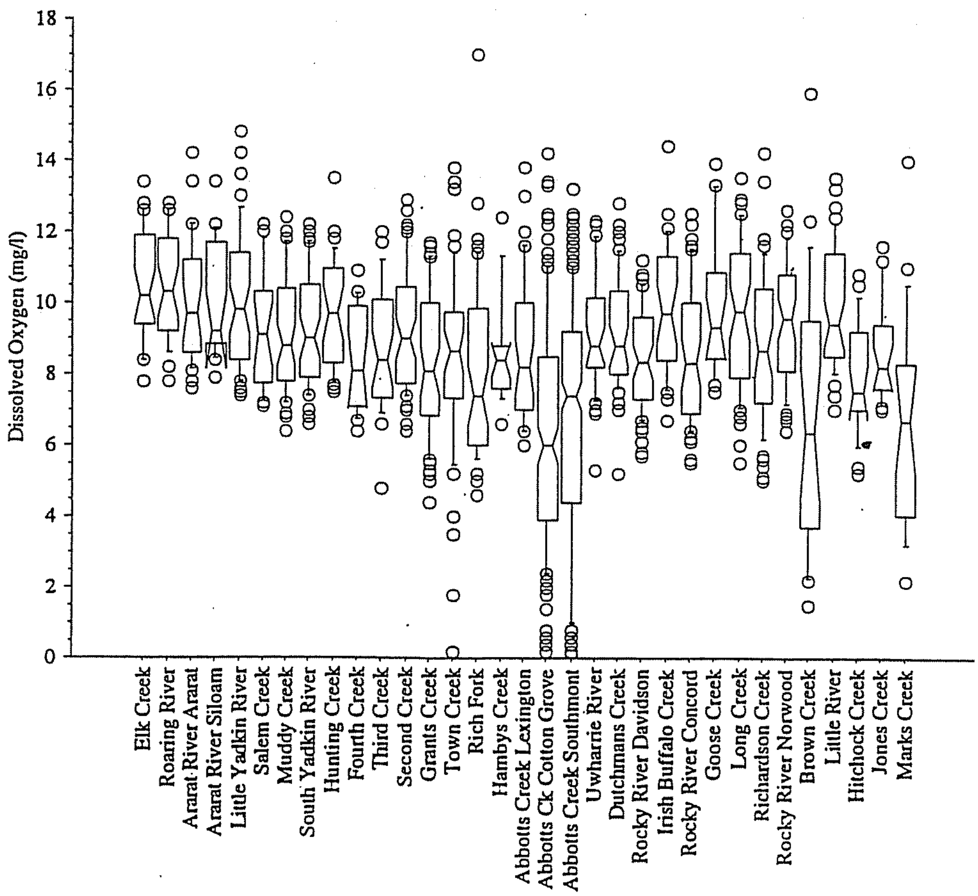


Figure 4.11 Dissolved Oxygen Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

The pH distributions (Figure 4.12) show two sites (Crane Creek and Abbotts Creek Cotton Grove) which have the 75th percentile of their distribution above the acceptable range for pH in freshwater streams (9 s.u.).

Many of the tributary sites show elevated conductivity levels (Figure 4.13) as compared to the Yadkin-Pee Dee River mainstem AMS sites. The most upstream site on the Rocky River (near Davidson) that is significantly higher than other sites in the basin. Conductivity values are typically most affected by point source dischargers, but can also be somewhat affected by nonpoint source runoff.

Nutrient data for the AMS tributary sites are shown in Figures 4.14 and 4.15. There are several sites with both high total phosphorous and total nitrogen concentrations. Rich Fork and the Rocky River near Davidson are especially high in phosphorous, while Richardson Creek is especially high in nitrogen. Nutrients in these creeks can be from either point or nonpoint sources.

<u>Fecal Coliform Bacteria</u>

Fecal coliform bacteria behave differently than most other water quality parameters, and these differences must be considered when evaluating water quality. Available information was reviewed to identify potentially impaired waters and locate potential sources of pollutants in order to help develop appropriate management strategies. Fecal coliform bacteria are most useful as a screening tool to estimate the cumulative inputs from multiple sources, but in some instances can be used to locate a single large source of bacteria.

The primary screening tool used in establishing potential fecal coliform levels is the geometric mean. The most severe problems are identified for sites with 10 or more fecal coliform samples within the last 5 years and that have a geometric mean exceeding 200 colonies/100 ml. This information will be reflected in the use support rating for that stream or river.

<u>Fecal Coliform in the Yadkin-Pee Dee River Basin</u>

Fecal coliform bacteria are commonly found throughout the Yadkin-Pee Dee River basin at levels that exceed the state standard. Summary fecal coliform information is listed in Table 4.7. The Yadkin River Basin has 18 sites (40% of AMS sites) reporting a geometric mean greater than 200 colonies/100 ml. The distribution of fecal coliform at the mainstem stations is shown in Figure 4.16. This shows the sites with high fecal numbers mainly in the upper part of the river, Wilkesboro to Yadkin College. The distribution of fecal coliform for the tributaries (Figure 4.17) also shows most of the sites with high fecal levels to be in the upper portion of the basin. Water quality problems associated with fecal coliform bacteria are discussed in Chapter 3 and management strategies to control fecal coliform bacteria are discussed in Chapter 6.

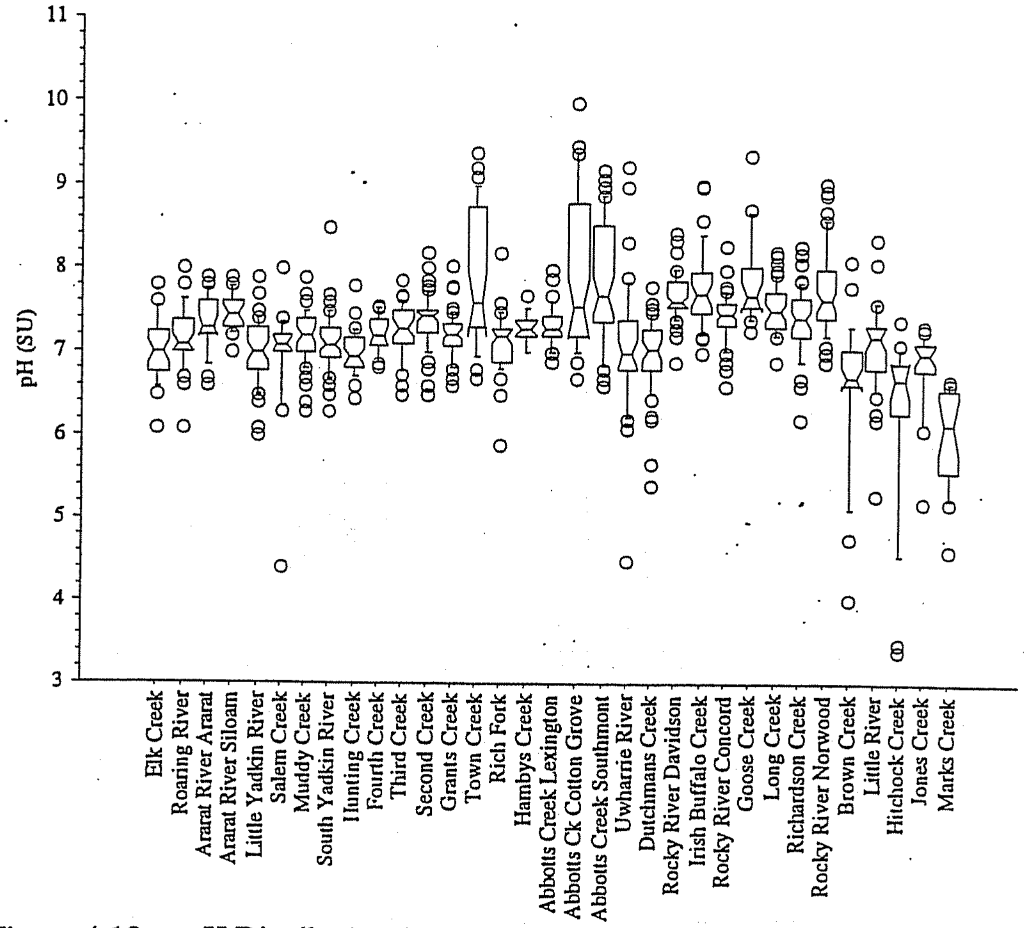


Figure 4.12 pH Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

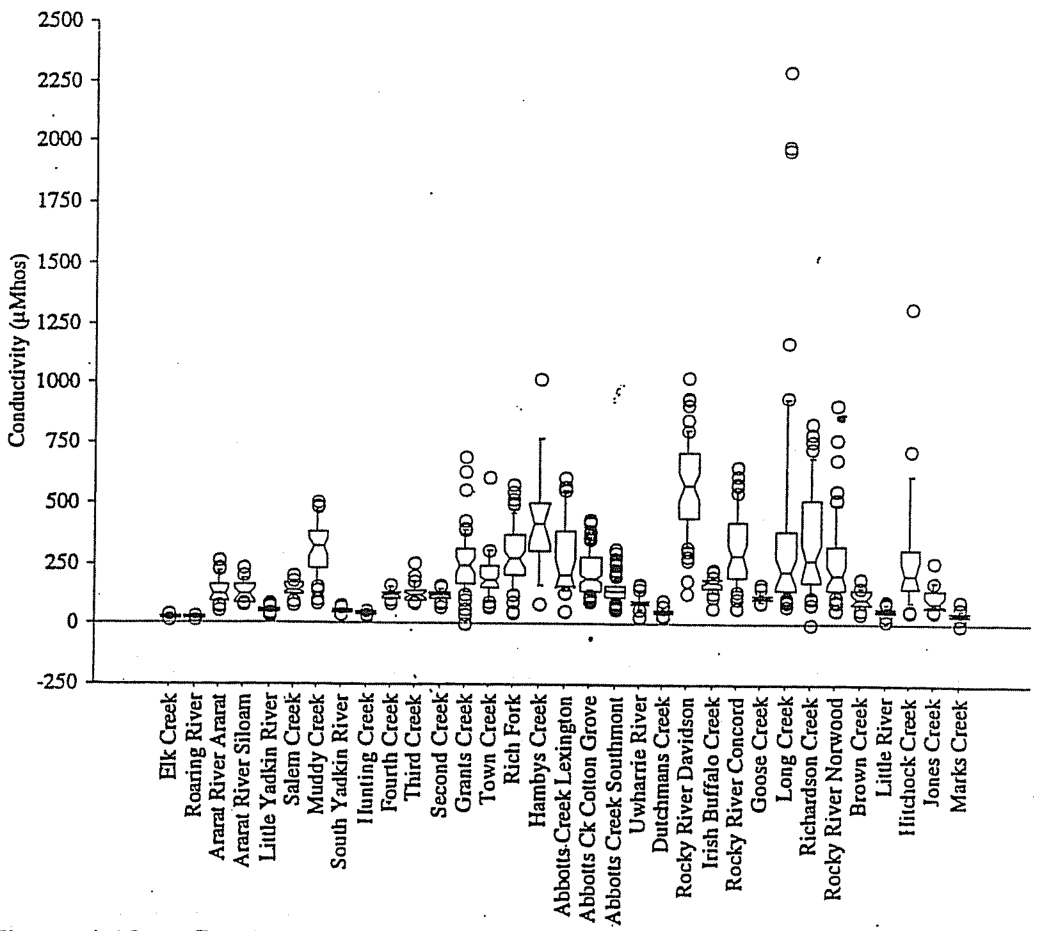


Figure 4.13 Conductivity Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

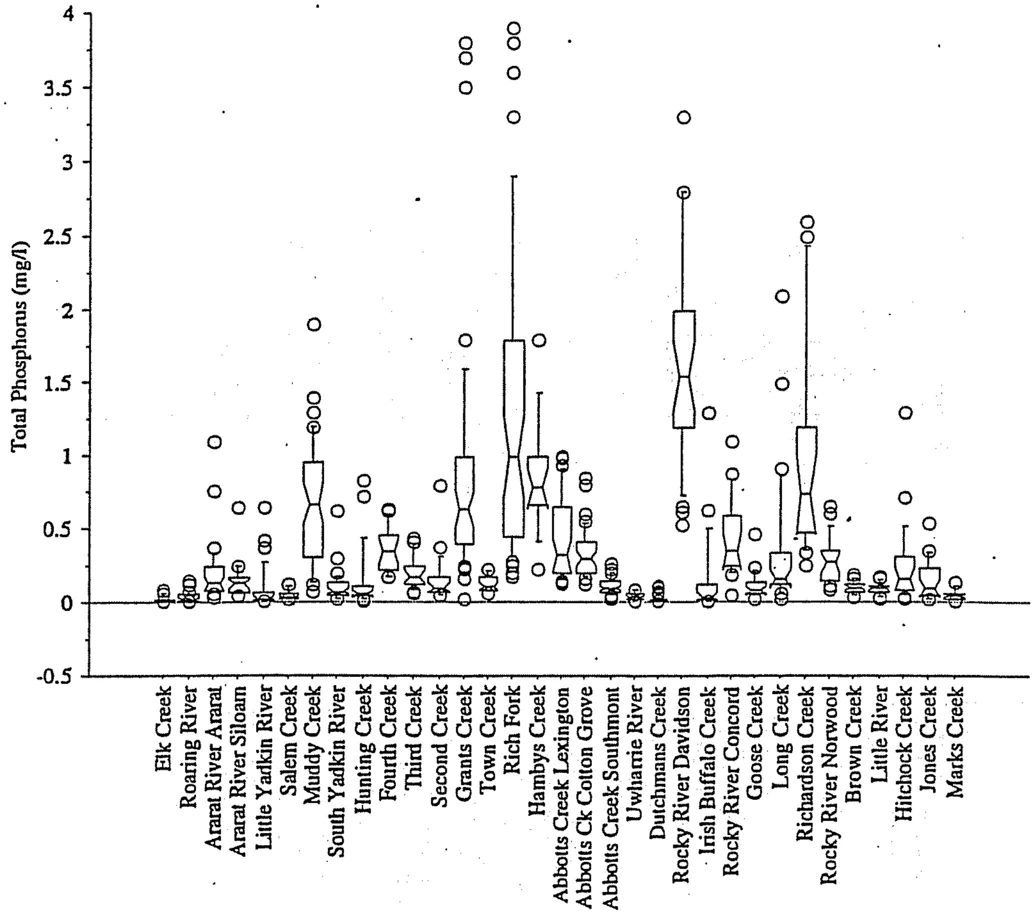


Figure 4.14 Total Phosphorous Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

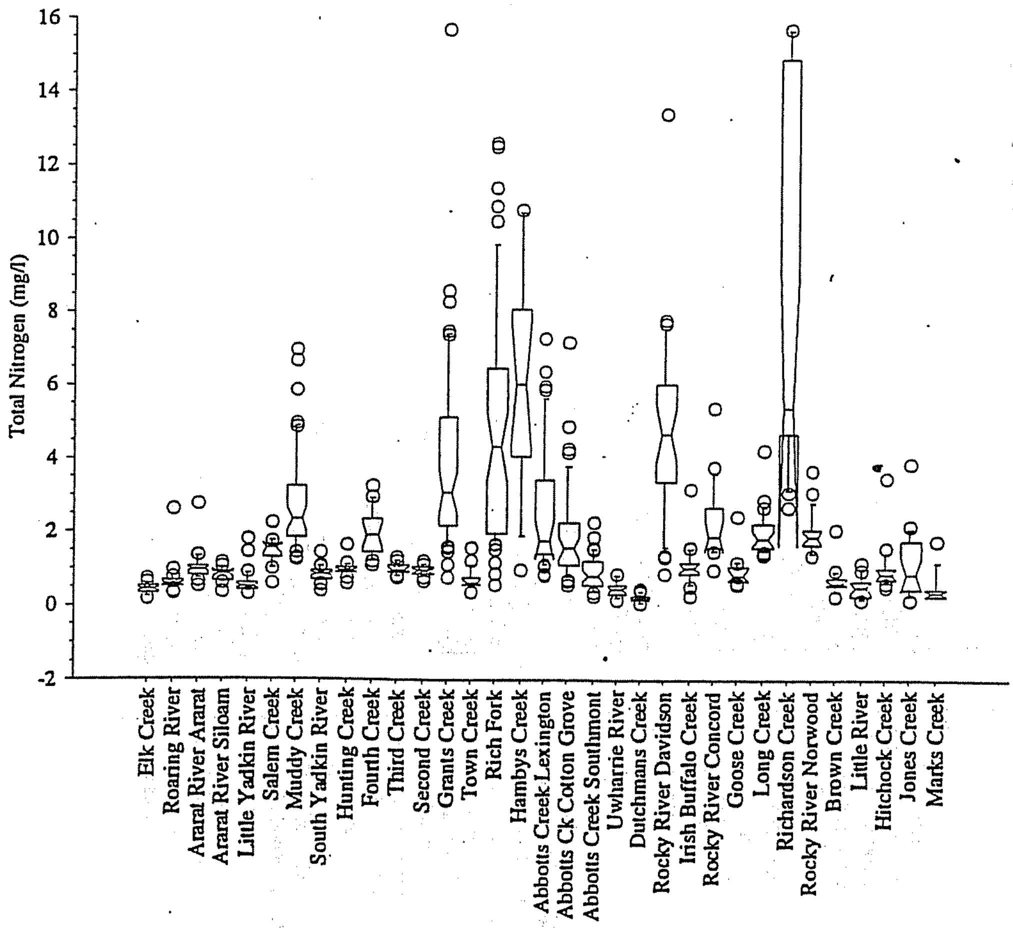


Figure 4.15 Total Nitrogen Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

Table 4.7 Fecal Coliform summary data for the Yadkin River Basin. 1992 to 1996.

Site	Total Smpls	Geometric Mean	Samples >200/100ml	Percent	First >200/100ml	Last
Yadkin R At NC Hwy 268 At Patterson	37	9.6	2	5.4	9/29/92	9/30/96
Elk Creek At NC Hwy 268 At Elkville NC	17	68.2	3	17.6	5/15/95	10/15/96
Yadkin River At Wilkesboro NC	17	83.4	5	29.4	5/15/95	10/15/96
Roaring Rvr At SR 1990 Nr Roaring Rvr	17	139.2	9	52.9	5/15/95	10/15/96
Yadkin Rvr At SR2327 At Roaring R NC*	17	346.1	13	76.5	4/12/95	10/15/96
Yadkin Rvr At US 21 Bus At Elkin NC	18	189.2	10	55.6	5/4/95	11/5/96
Ararat River At SR 2019 At Ararat NC*	18	299.8	12	66.7	5/4/95	11/5/96
Ararat River At SR 2080 Near Siloam NC	19	166.4	10	52.6	4/12/95	11/5/96
Little Yadkin Rvr At US 52 At Dalton NC	17	125.4	6	35.3	5/4/95	11/5/96
Yadkin River At SR 1605 At Enon NC	56	113.1	19	33.9	2/10/92	11/7/96
Salem Ck At A Elledge Wtp At W-S NC*	18	1,004.2	16	88.9	4/11/95	11/4/96
Muddy Crk At SR2995 Nr Muddy Crk NC*	15	692.6	13	86.7	5/1/95	11/4/96
Yadkin Rvr At US 64 At Yadkin College	13	146.8	5	38.5	5/1/95	11/4/96
S Yadkin Rvr At SR 1159 Nr Mocksville*	15	620.0	12	80.0	5/1/95	11/4/96
Hunting Creek At SR 2115 Nr Harmony*	17	536.5	14	82.4	4/24/95	10/21/96
Fourth Creek At SR2308 Nr Elmwood NC*	17	1,206.8	15	88.2	6/20/95	11/13/96
Third Creek At SR1970 Near Woodleaf NC*	19	820.1	18	94.7	4/27/95	11/13/96
Second Ck At US Hwy 70 Near Barber NC*	19	680.0	15	78.9	4/27/95	11/13/96
Grants Cr At Spencer*	21	609.3	16	76.2	7/8/92	11/13/96
Yadkin River At NC Hwy 150 Nr Spencer	19	168.5	4	21.1	4/27/95	11/13/96
Town Creek At SR 2168 Near Duke NC	19	37.4	4	21.1	6/26/95	11/13/96
Rich Fork At SR1800 Nr Thomasville NC*	50	227.0	28	56.0	1/2/92	10/1/96
Hambys Crk At SR 2790 Nr Holly Grove*	12	580.3	7	58.3	5/2/95	11/7/96
Abbotts Crk At SR1243 At Lexington NC*	15	659.1	11	73.3	5/2/95	11/12/96
Abbots Crk At NC 47 Nr Cotton Grove	17	72.8	5	29.4	4/11/95	11/6/96
Abbotts Ck At SR 2294 Nr Southmnt Dura	18	51.0	5	27.8	4/11/95	11/12/96
Yadkin Rvr At SR 1002 At High Rock NC	30	32.7	3	10.0	7/14/92	11/12/96
Uwharrie Rvr At NC Hwy 109 Nr Uwharri	15	45.9	2	13.3	9/20/94	10/3/96
Dutchmans Crk At SR 1150 Nr Uwharrie	16	23.5	0	0.0	9/20/94	10/3/96
Pee Dee Rvr At NC Hwy 731 Nr Shankle	49	19.5	2	4.1	1/6/92	10/23/96
Rocky River At SR2420 Nr Davidson NC*	17	789.8	14	82.4	5/2/95	10/30/96
Irish Buffalo Ck At SR 1132 Nr Faggarts*	16	392.2	14	87.5	4/26/95	10/28/96
Rocky River At US Hwy 601 Nr Concord*	16	368.6	8	50.0	5/2/95	10/23/96
Goose Creek At SR 1524 Near Mint Hill	9	617.1	6	66.7	12/4/95	10/28/96
Long Crk At SR 1954 Nr Rocky Rvr Sprng	16	174.8	6	37.5	7/6/92	10/23/96
Richardson Creek At SR 1649 Nr Fairfield	16	112.9	4	25.0	4/26/95	10/23/96
Rocky River At SR 1935 Nr Norwood NC	18	85.3	4	22.2	8/9/93	10/23/96
Brown Creek At SR 1627 Near Pinkerton	10	61.9	1	10.0	5/15/95	10/7/96
Pee Dee Rvr At NC Hwy 109 Nr Mangum	13	84.2	3	23.1	5/17/95	10/7/96
Little River At SR 1340 Near Star NC	17	42.7	0	0.0	9/20/94	11/7/96
Pee Dee Rvr At US 74 Nr Rockingham	13	22.4	0	0.0	4/12/95	10/30/96
Hitchock Crk At SR 1109 At Cordova NC*	12	379.0	8	66.7	5/9/95	10/30/96
Jones Crk At NC Hwy 145 Near Pee Dee	10	85.8	1	10.0	5/9/95	10/30/96
Marks Creek At SR1812 Near Hamlet NC	10	80.8	1	10.0	5/1/95	10/28/96
Pee Dee River At Sc Hwy 9 At Cheraw Sc	10	61.8	2	20.0	5/23/95	10/30/96

*** - Sites with 10 or more fecal coliform samples within the last 5 years, that have a geometric mean exceeding 200/100ml, are considered highest priority. This information is used to determine the Use Support Rating for that stream or river.**

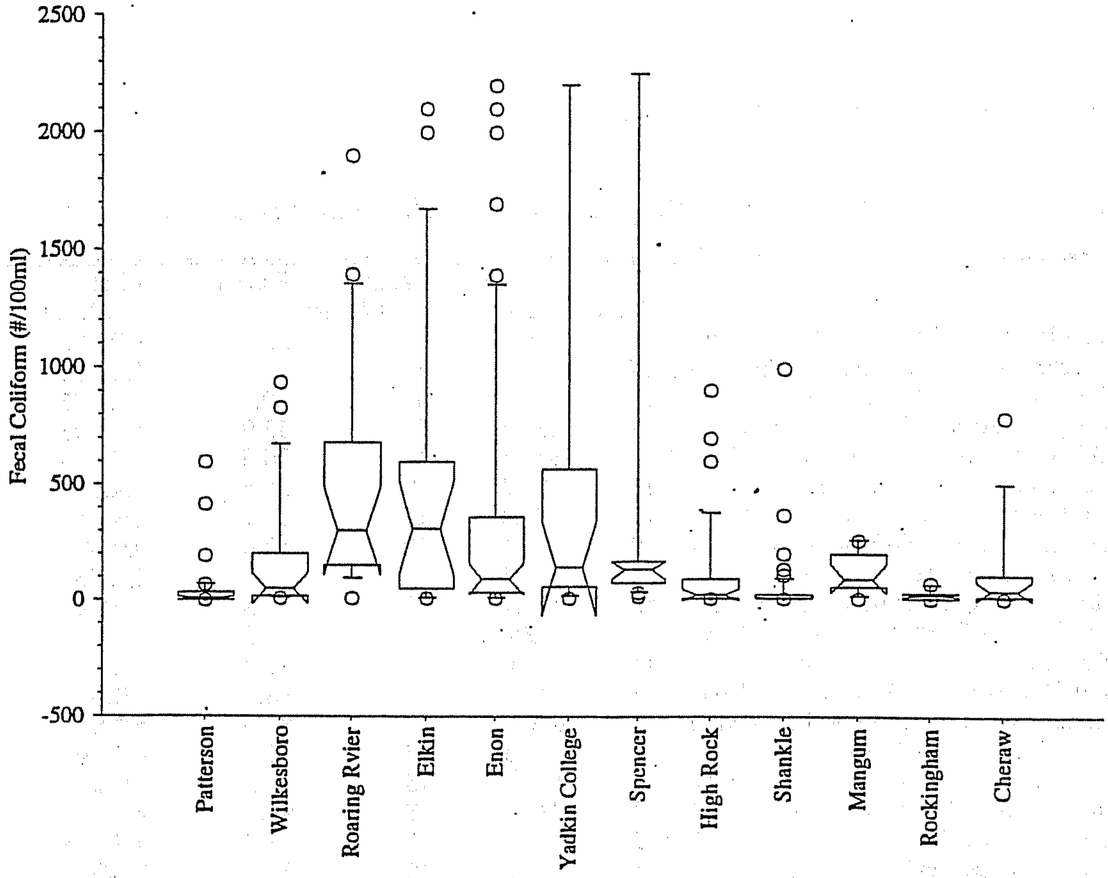


Figure 4.16 Fecal Coliform Distribution from Yadkin-Pee Dee River Mainstem Sites. 1992-1996.

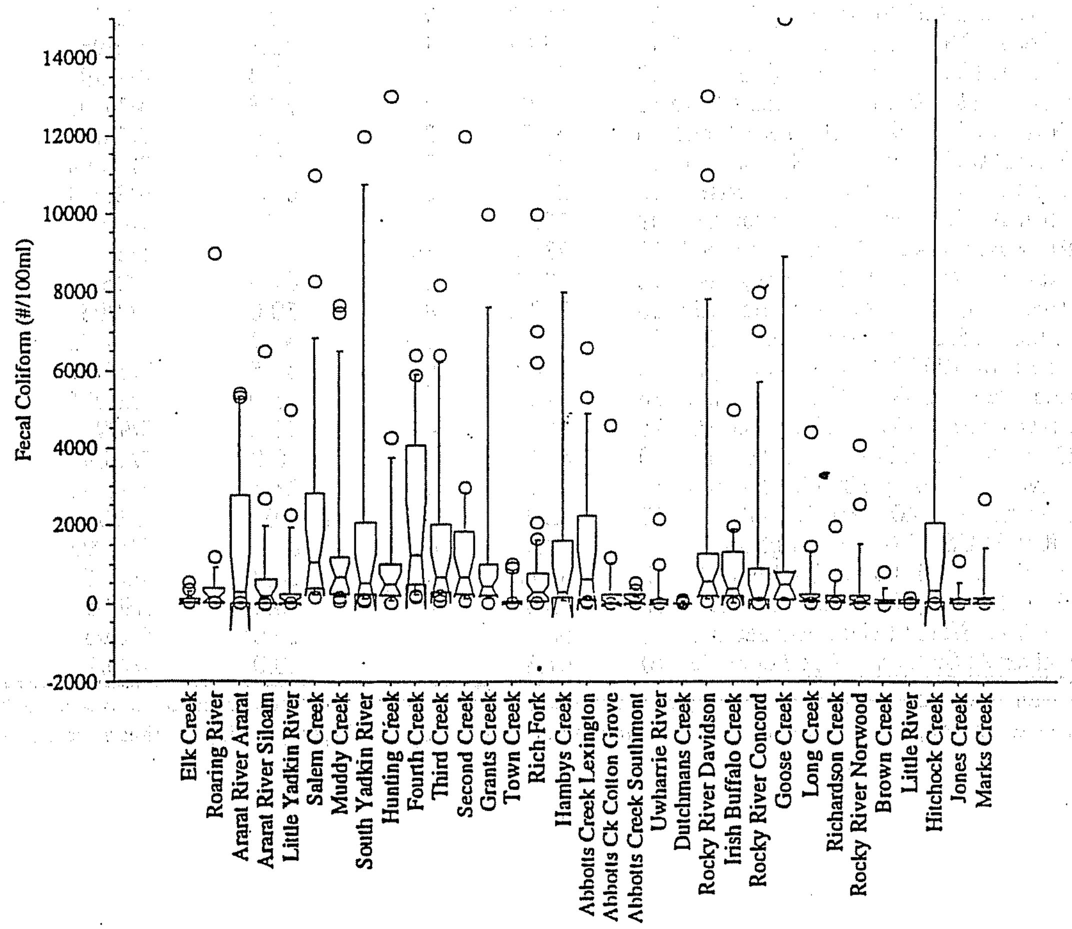


Figure 4.17 Fecal Coliform Distribution from Yadkin-Pee Dee River Tributary Sites. 1992-1996.

4.3 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

Water quality is summarized below for each of the seventeen subbasins in the Yadkin-Pee Dee River basin. Each subbasin is composed of one or more major watersheds. Accompanying subbasin maps indicate the sample sites for benthic macroinvertebrates, fish community, fish tissue and ambient monitoring. Appendix III provides more detailed data for all the sampling sites in the basin. The following summaries are based on data from the draft Yadkin Basin Assessment Report for the Yadkin-Pee Dee River basin (NC DWQ, 1997).

4.3.1 Yadkin River Headwaters (Subbasin 03-07-01)

Description

This subbasin is in the mountain ecoregion of the state. Many of the streams are trout streams, and in terms of fisheries, are considered mountain cold water and foothills cool water types (Figures 4.18 and 4.19). W. Kerr Scott Reservoir lies within this subbasin. The subbasin contains the cities of Wilkesboro and North Wilkesboro, which have permits to discharge to the Yadkin River. Two other major dischargers are ABTCO Inc. and Carolina Mirror Co., which discharge to the Yadkin River and an unnamed tributary (UT) to Mulberry Creek, respectively.

Overview of Water Quality

Ambient water chemistry samples were collected at three sites on the Yadkin River from Patterson to Roaring River, and on the Roaring River and Elk Creek. The Yadkin River sites show a downstream increase in turbidity, nitrogen, phosphorus, and fecal coliform bacteria. Fecal coliform bacteria greater than 200 colonies/100 ml were observed in a high percentage of the samples from Yadkin River at Wilkesboro (29%), Yadkin River at Roaring River (86%), Roaring River (57%) and Elk Creek (66%).

The Yadkin River in this subbasin had Good water quality in 1996 at both the Patterson and North Wilkesboro sites, an improvement from the early to mid 1980s, when the latter site was consistently rated Good-Fair using macroinvertebrate data. Twenty-two species of fish were collected at the Patterson site. This was the second greatest number of species in a sample from the entire Yadkin River basin in 1996. Improvements observed at some Yadkin River sites are thought to be associated with improved wastewater treatment at the North Wilkesboro and Wilkesboro WWTPs. ABTCO has a 1.0 MGD discharge to the Yadkin River below Wilkesboro and is a large contributor of biochemical oxygen demand (BOD) and total suspended solids (TSS) to the river. A special macroinvertebrate study in 1993 indicated the discharge was having an impact to the river.

Smaller streams in the subbasin generally have Good or Excellent water quality based on macroinvertebrate data, though Good-Fair ratings are found in areas of development, such as Moravian Creek. This stream appears to have suffered from sedimentation, possibly from nearby road construction, local agriculture or runoff from the Town of Moravian Falls. The North and South Prongs of Lewis Fork had Good water quality using both fish and macroinvertebrate data. Dennis Creek received a Good bioclassification using macroinvertebrate data. Water quality in the lower section of the Roaring River was Good, using macroinvertebrate data in the 1980's, but improved to Excellent when sampled in 1996. Fish community sampling of the Middle Prong Roaring River resulted in a Good-Excellent rating for fish. The North Fork Reddies River had a Good fish rating. Buffalo Creek had an Excellent bioclassification in 1996, as did the lower section of Stoney Fork and Mulberry Creek. Beaver Creek, a tributary of the Yadkin River had the lowest fish rating (Fair) in the subbasin. The site was below an animal operation, had a sandy substrate, and the streambanks were highly eroded. A Good fish rating was given to Laurel Creek, a tributary of Elk Creek, and sampling of Elk Creek also resulted in a Good macroinvertebrate rating.

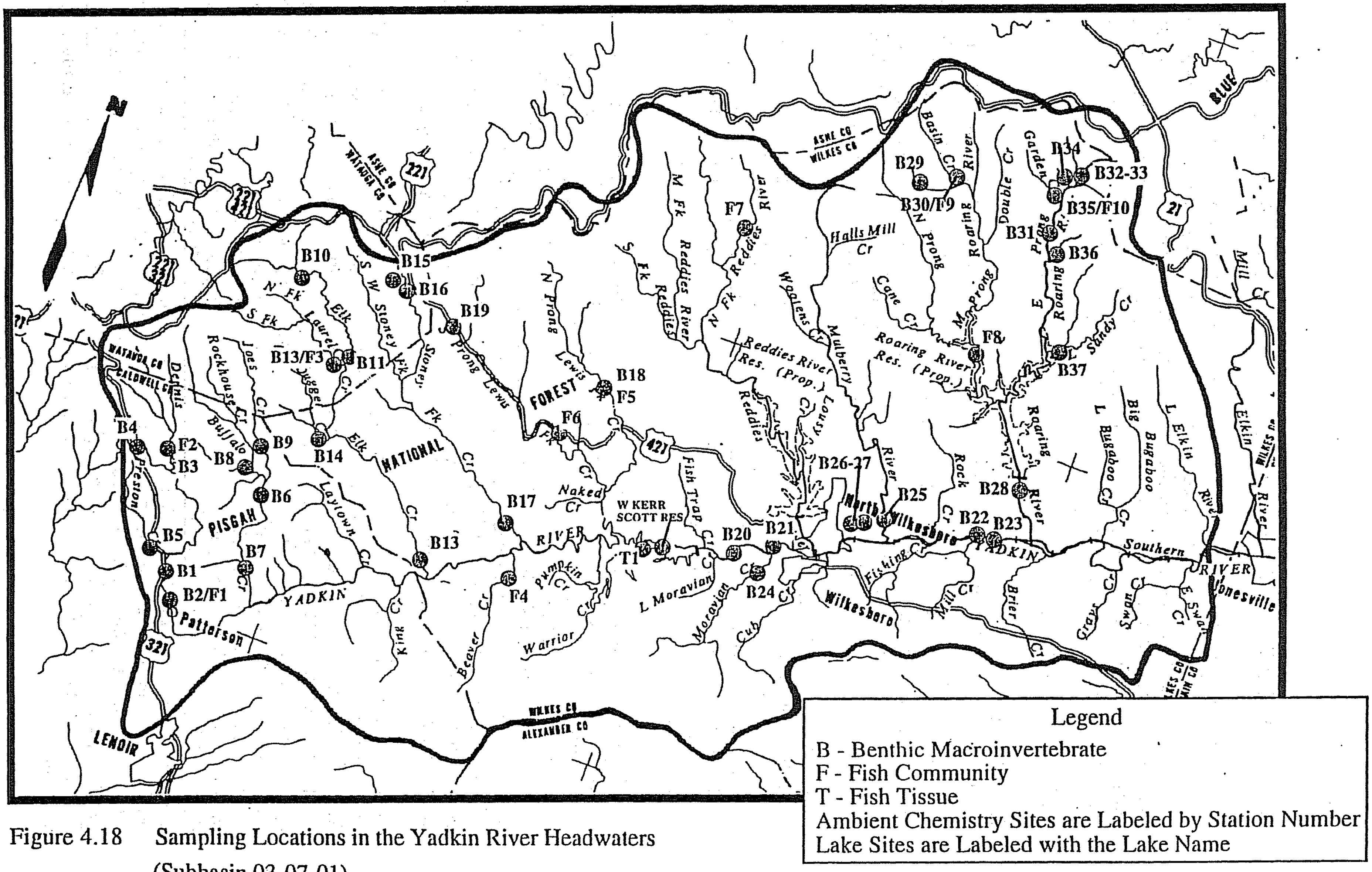
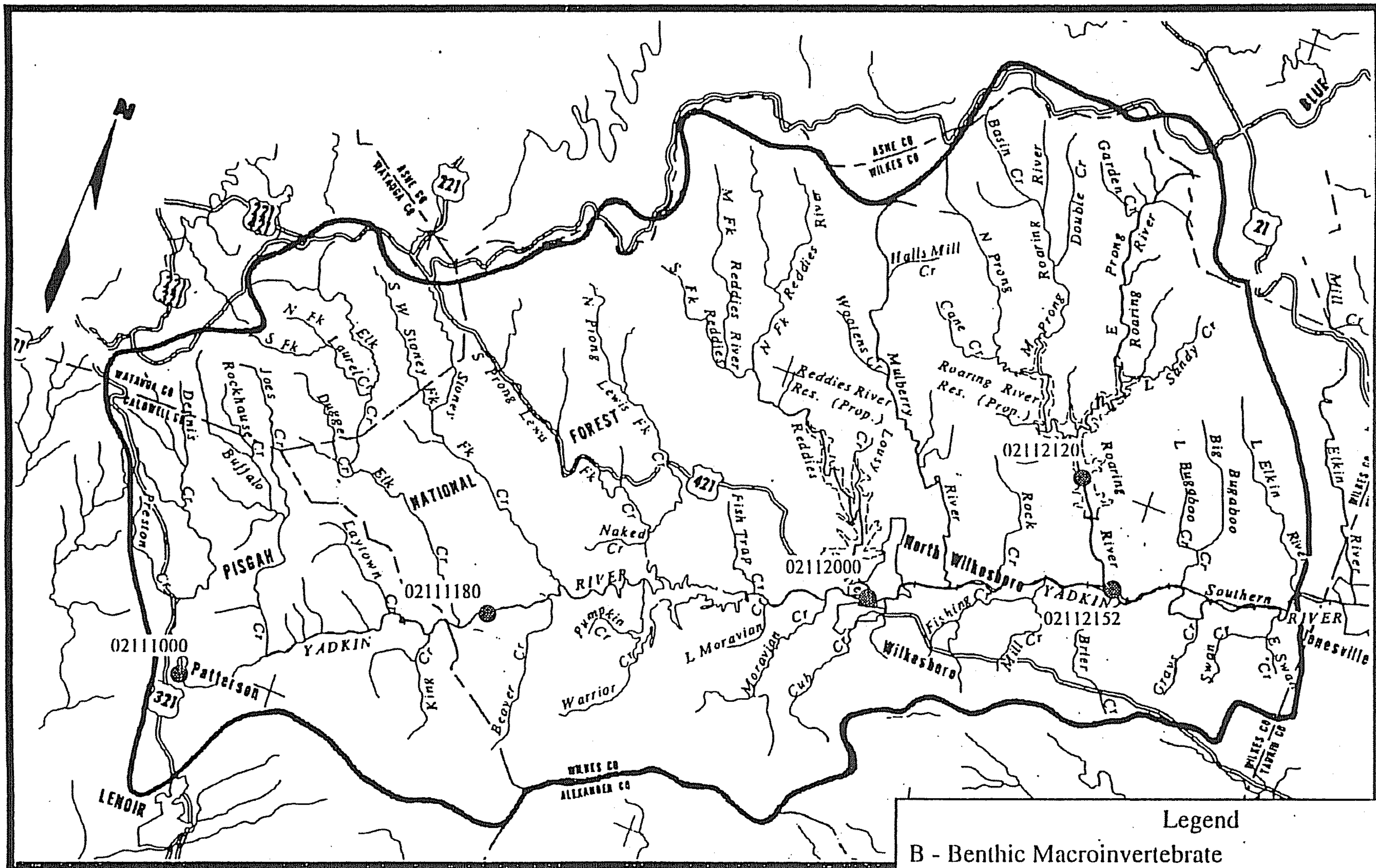


Figure 4.18 Sampling Locations in the Yadkin River Headwaters (Subbasin 03-07-01)



Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.19 Sampling Locations in the Yadkin River Headwaters (Subbasin 03-07-01)

Streams that have been classified as Outstanding Resource Waters are: Elk Creek and its tributaries, Basin Creek and its tributaries, Bullhead Creek and its tributaries, and Widows Creek. Garden Creek, Pike Creek and lower Big Sandy Creek are designated High Quality Waters.

Special Studies

Macroinvertebrates were collected above and below ABTCO (formerly Abitibi Price) in 1993. It was found that ABTCO was having an impact on the Yadkin River, including an increase in turbidity and changes in habitat and biological rating from Good above to Good-Fair below the discharge.

Potential HQW/ORW Streams

If petitioned, at least portions of Buffalo Creek, Stoney Fork, Mulberry Creek and Roaring River and Middle Prong Roaring River may qualify for reclassification to either Outstanding Resource Waters (ORW) or High Quality Waters (HQW).

Lakes Assessment Program

W. Kerr Scott Reservoir has been sampled by DWQ in 1981, 1982, 1985, 1989 and 1994. During the most recent sampling the lake was determined to be oligotrophic and fully supporting its designated uses. See Section 4.2.3 for characteristics of W. Kerr Scott Reservoir.

Aquatic Toxicity Monitoring

Five facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: ABTCO, Inc., Carolina Mirror, North Wilkesboro WWTP, Sealed Air Corp. 001 and Wilkesboro WWTP. The North Wilkesboro WWTP is under a Special Order of Consent (SOC) from September 1995 to July 1998.

4.3.2 Mitchell River, Fisher River and South Deep Creek Watersheds (Subbasin 03-07-02)

Description

This subbasin contains the Yadkin River from the N.C. State line (Surry County) and into Davie County (Figures 4.20 and 4.21). The major tributaries include Mitchell River, Fisher River, Little Yadkin River, Deep Creek, Forbush Creek and Logan Creek. This area is in the mountain ecoregion of the state, although some of the streams in the eastern and southern portions of the subbasin begin to exhibit piedmont stream characteristics such as slower flows and sandy substrates.

The land is largely forested or used for agriculture, with only small residential communities. Elkin is the largest town in the subbasin, followed in size by Yadkinville and Dobson. Many discharger permits have been issued in this subbasin, but only three have a discharge > 0.5 MGD: Elkin WWTP and Chatham Manufacturing (both into the Yadkin River), and Yadkinville WWTP (into North Deep Creek).

Overview Of Water Quality

The Yadkin River received a Good-Fair bioclassification at two sampling locations in 1996: US 21 at Elkin and SR 1003, Surry County. Each of these sites had been rated Fair during previous collections. The Little Yadkin River at US 52 exceeded water quality criteria for turbidity and total residue in more than 10% of the samples.

Figure 4.20 Sampling Locations in the Mitchell River, Fisher River and South Deep Creek Watersheds (Subbasin 03-07-02)

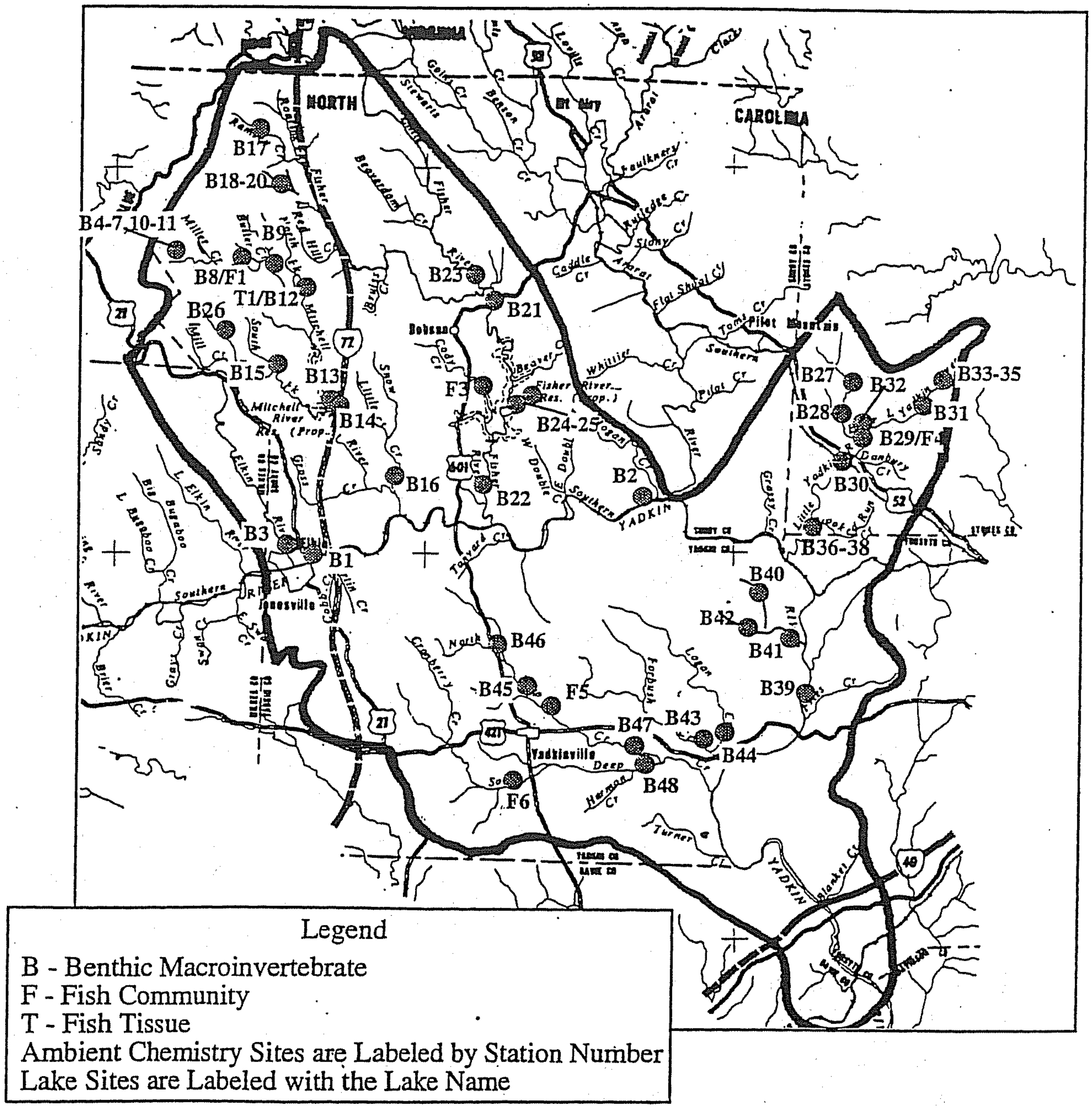
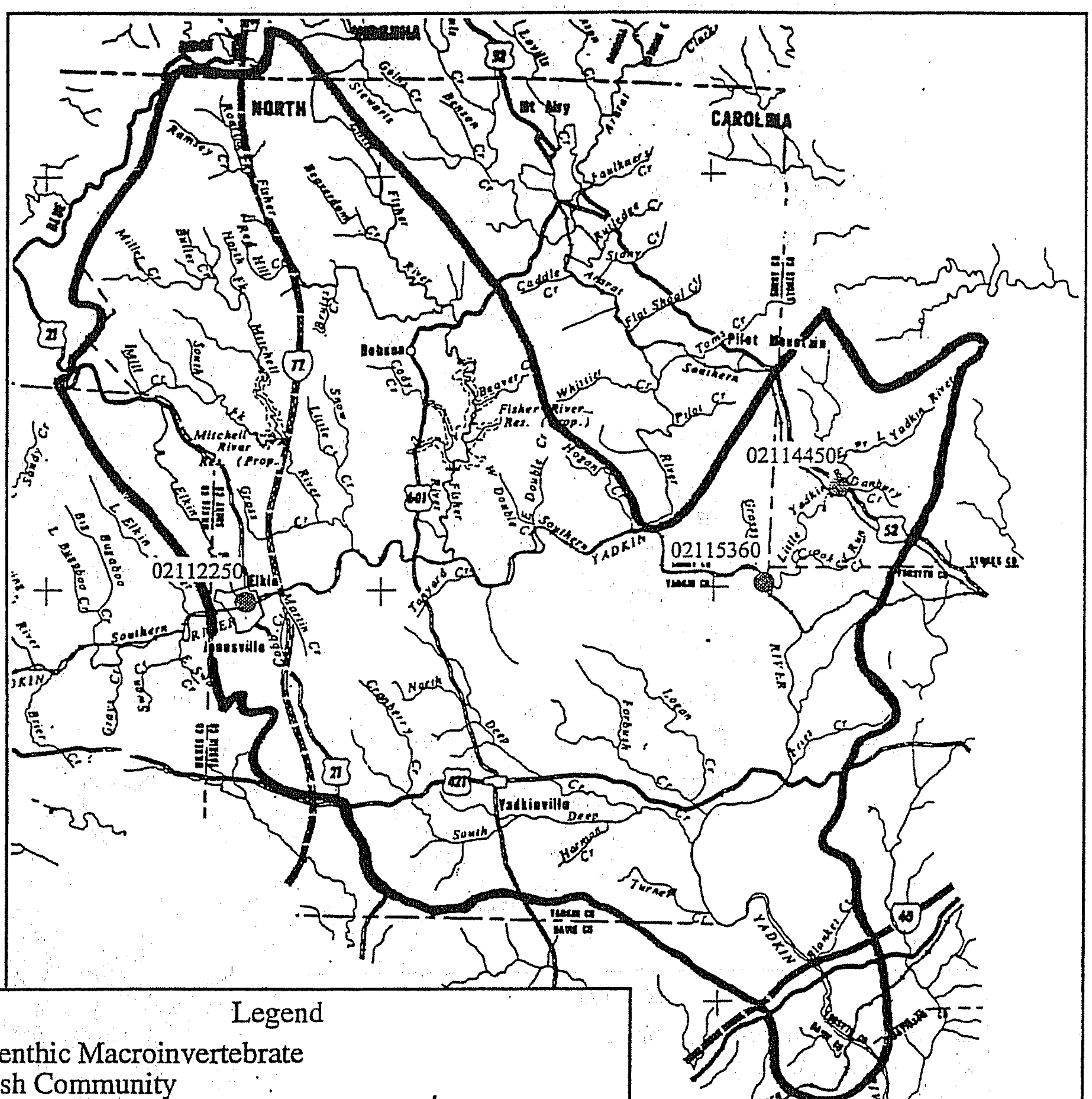


Figure 4.21 Sampling Locations in the Mitchell River, Fisher River and South Deep Creek Watersheds (Subbasin 03-07-02)



Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Of the major tributaries to the Yadkin River in this subbasin, the Mitchell River had the best water quality, which was reflected in both the fish and the macroinvertebrate communities. There were two macroinvertebrate samples on the Mitchell River in 1996. One was in the upper reach, below the community of Devotion which received an Excellent rating; the other site was near the mouth and received a Good rating. This watershed has experienced residential development as well as agricultural use. Fish community was sampled at SR 1330, about midway between the macroinvertebrate sites and assigned a NCIBI rating of Good-Excellent. This was the highest NCIBI in this subbasin.

Tributaries to Yadkin River with Good bioclassifications include Snow Creek and Fisher River. Elkin Creek, Little Yadkin River, Forbush Creek, and Logan Creek all have been assigned a Good-Fair bioclassification using macroinvertebrate data.

Little Yadkin River received a Good NCIBI; this stream had a diverse fish community, but the data indicated slight nutrient enrichment. Observations during macroinvertebrate sampling and during special studies on the headwaters of this stream have noted an embedded substrate with silt deposits in many of the pools. Chemistry data from Little Yadkin River at US 52, near Dalton, indicated some elevated turbidity values.

<u>**Special Studies**</u>
The Little Yadkin nonpoint investigation was a study to assess the effectiveness of 22 small dams that were to be built in the East Prong Little Yadkin River watershed. The dams were to trap the sediments in the headwaters so the sediments would not further degrade the water quality, which was Good-Fair, in the Little Yadkin River. The 1987 study was intended to sample the condition of the streams before the dams were built. Since that study, the Little Yadkin or its tributaries have been sampled five times. To complicate this study, the locations of some of the dams had to be moved from the original plan. This meant the macroinvertebrate sites also had to be changed during some of the surveys, to try to sample where the most impact would be found. In 1994 (the last year of the study) 14 of the 22 dams had been constructed. Although slight changes in the benthic community were found over the time of this study, it was thought the changes reflected natural variation in the community or the effect of flow more than the effect of the dams.

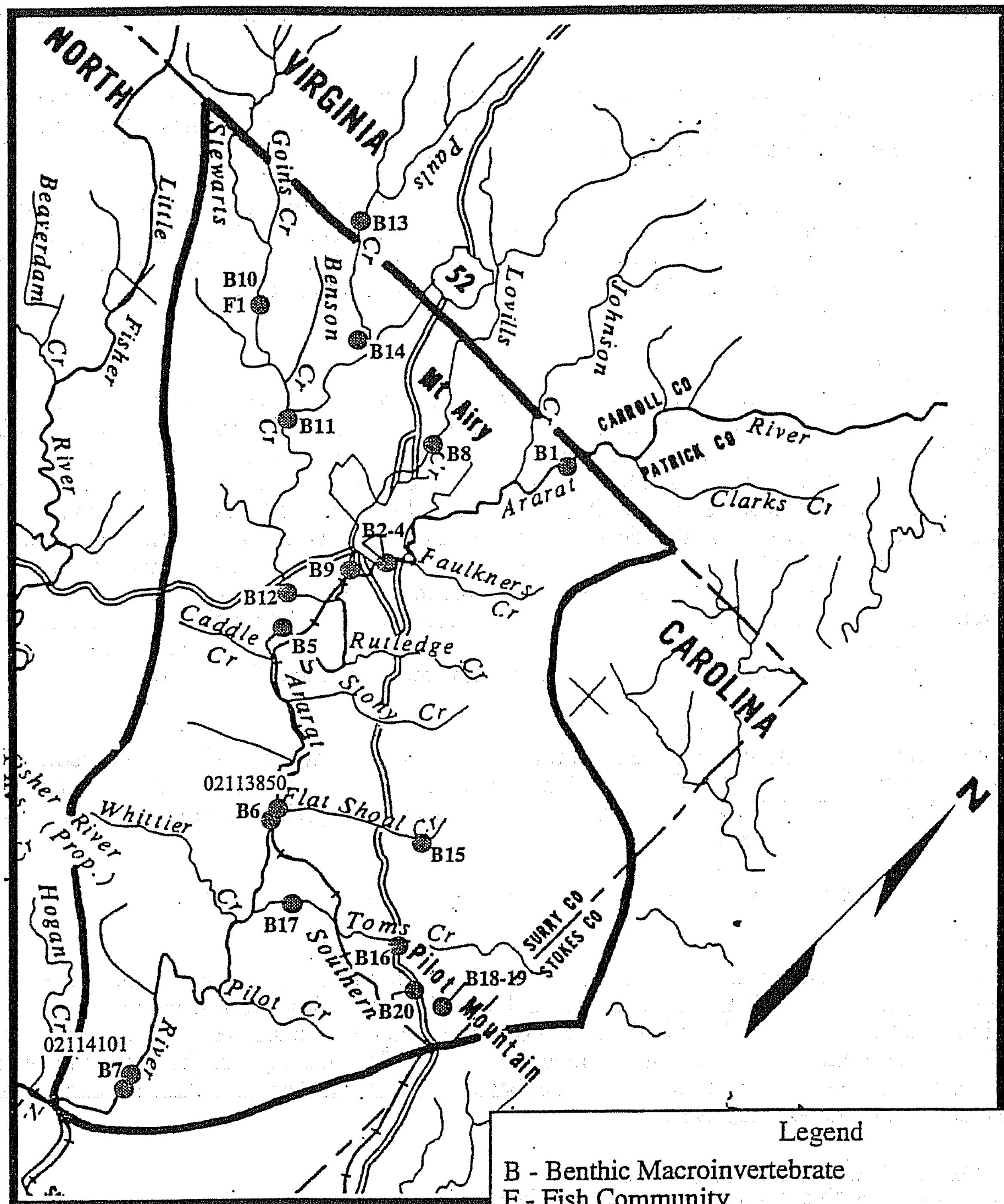
<u>**Aquatic Toxicity Monitoring**</u>
Five facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Boonville WWTP, Chatham Manufacturing, Elkin WWTP, Wayne Farms-Dobson Plant and Yadkinville WWTP. Boonville WWTP experienced several test failures in 1995, but passed all tests in 1996.

4.3.3 Ararat River Watershed (Subbasin 03-07-03)

<u>**Description**</u>
This subbasin, which contains the Ararat River and its tributaries, originates in the mountains of Virginia (Figure 4.22). The Ararat River and its tributaries flow generally south into North Carolina and empty into the Yadkin River east of Elkin. Land use in the area is mostly agriculture. The Ararat River and its tributaries have moderate to swift flow throughout the year, and turbidity can become a problem after a rainfall. This subbasin contains Mt. Airy and Pilot Mountain, which both discharge to the Ararat River.

<u>**Overview Of Water Quality**</u>
Three macroinvertebrate sites on the Ararat River had Good-Fair bioclassifications in 1996. For the lower two sites, this is an improvement from the Fair bioclassifications found in prior sampling. Smaller tributaries of the Ararat have similar or lower ratings. Stewarts Creek and Flat Shoals Creek were rated Good-Fair using macroinvertebrate data, while a more upstream site on

Figure 4.22 Sampling Locations in the Ararat River Watershed (Subbasin 03-07-03)



Legend

B - Benthic Macroinvertebrate

F - Fish Community

T - Fish Tissue

Ambient Chemistry Sites are Labeled by Station Numb

Lake Sites are Labeled with the Lake Name

Stewarts Creek received a Good-Excellent NCIBI rating. Lovills Creek was Good-Fair at an upstream site, and Fair at a site in Mt. Airy. Water quality has changed very little in this stream in the past decade.

Ambient monitoring, as recent at 1994, has documented impacts from the Mt. Airy WWTP on the Ararat River and Pilot Mountain WWTP on Heatherly Creek and Toms Creek. The Pilot Mountain discharge was moved in July 1996 to the Ararat River. Fecal coliform bacteria appear to be a chronic problem at ambient sites. Suspended sediments are also a problem in this subbasin, with the Ararat River regularly having total residue and conductivity values double that of the Yadkin River.

Aquatic Toxicity Monitoring

Four facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Mt. Airy WWTP, Pilot Mountain WWTP, Proctor Silex and the VA Dept. Of Transportation. Mt. Airy WWTP has only failed three toxicity tests in three years, while Pilot Mountain WWTP failed the first and passed the next two toxicity tests since they moved their discharge to the Ararat River. The Virginia Department of Transportation had several failures in 1995 but passed all tests in 1996.

4.3.4 High Rock Lake and Muddy Creek Watersheds (Subbasin 03-07-04)

Description

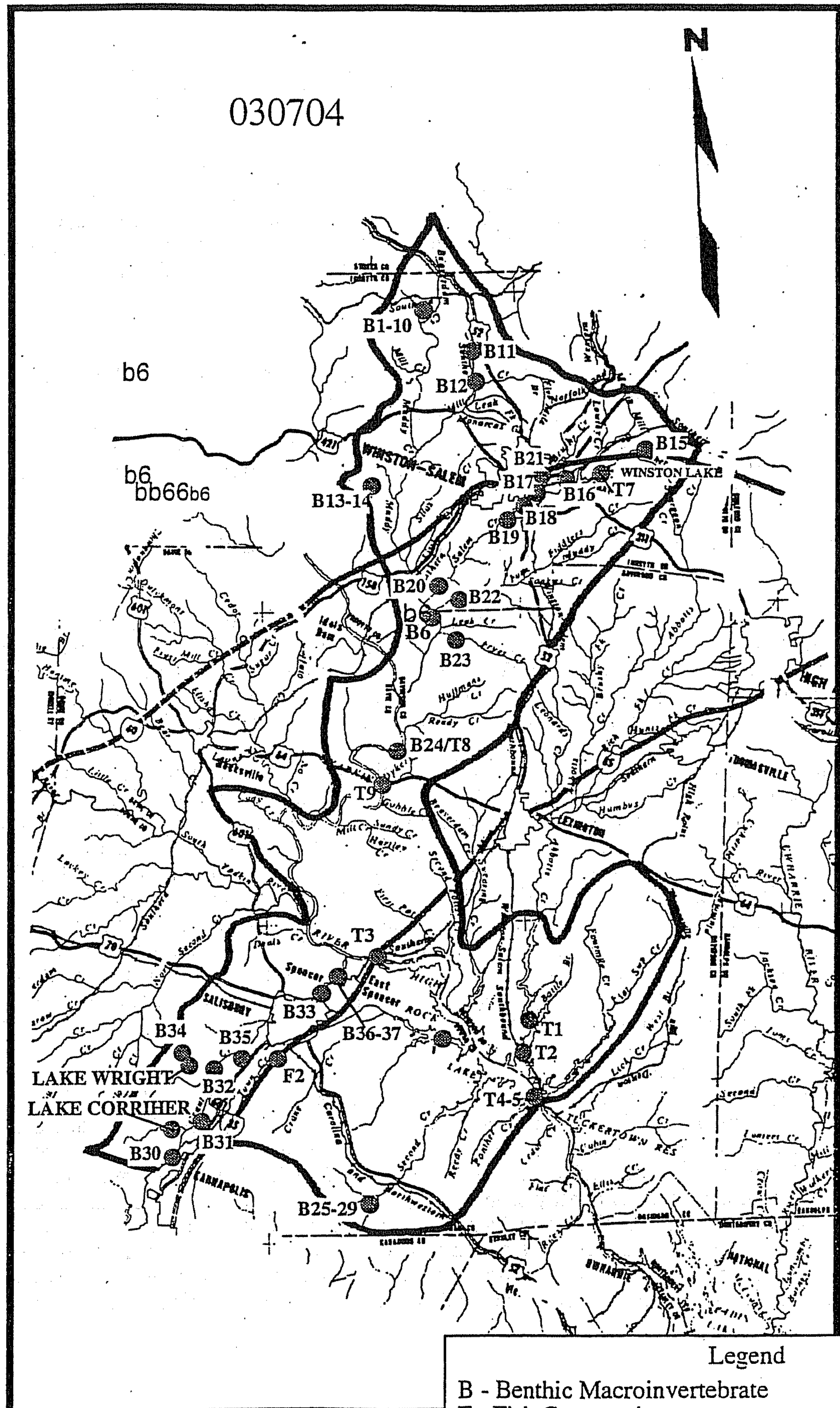
This subbasin is located in the piedmont ecoregion and includes the cities of Winston-Salem, Salisbury and Spencer (Figure 4.23 and 4.24). Muddy Creek is the largest stream in this subbasin, with one tributary (Salem Creek) draining a heavily urbanized portion of Winston-Salem. Grants Creek, in the southwest part of the subbasin, runs through Salisbury, Spencer and East Spencer. This subbasin includes a segment of the Yadkin River, including High Rock Lake.

Winston-Salem is one of the largest urban areas in North Carolina, with many streams potentially affected by urban runoff and/or permitted dischargers. It is often difficult to differentiate between the effects of these two pollutant sources. There are many permitted dischargers in this subbasin, although a substantial number of these are small residential dischargers. Dischargers with a permitted flow >0.5 MGD in the Muddy Creek drainage include Winston-Salem Archie Elledge WWTP (Salem Creek) and RJ Reynolds (UT Silas Cr.). Dischargers with a permitted flow >0.5 MGD in the Salisbury/Spencer area include PPG Industries (N Potts Cr.), Spencer WWTP (Grants Cr.), and Salisbury WWTP (Town Cr. and Grants Cr.). Agricultural land use affects most other streams outside of the urban areas. This subbasin is located in an area of easily eroded soils. Consequently, streams in areas of urban or agricultural land use are affected by sediment inputs, and have large amounts of coarse sand.

Overview Of Water Quality

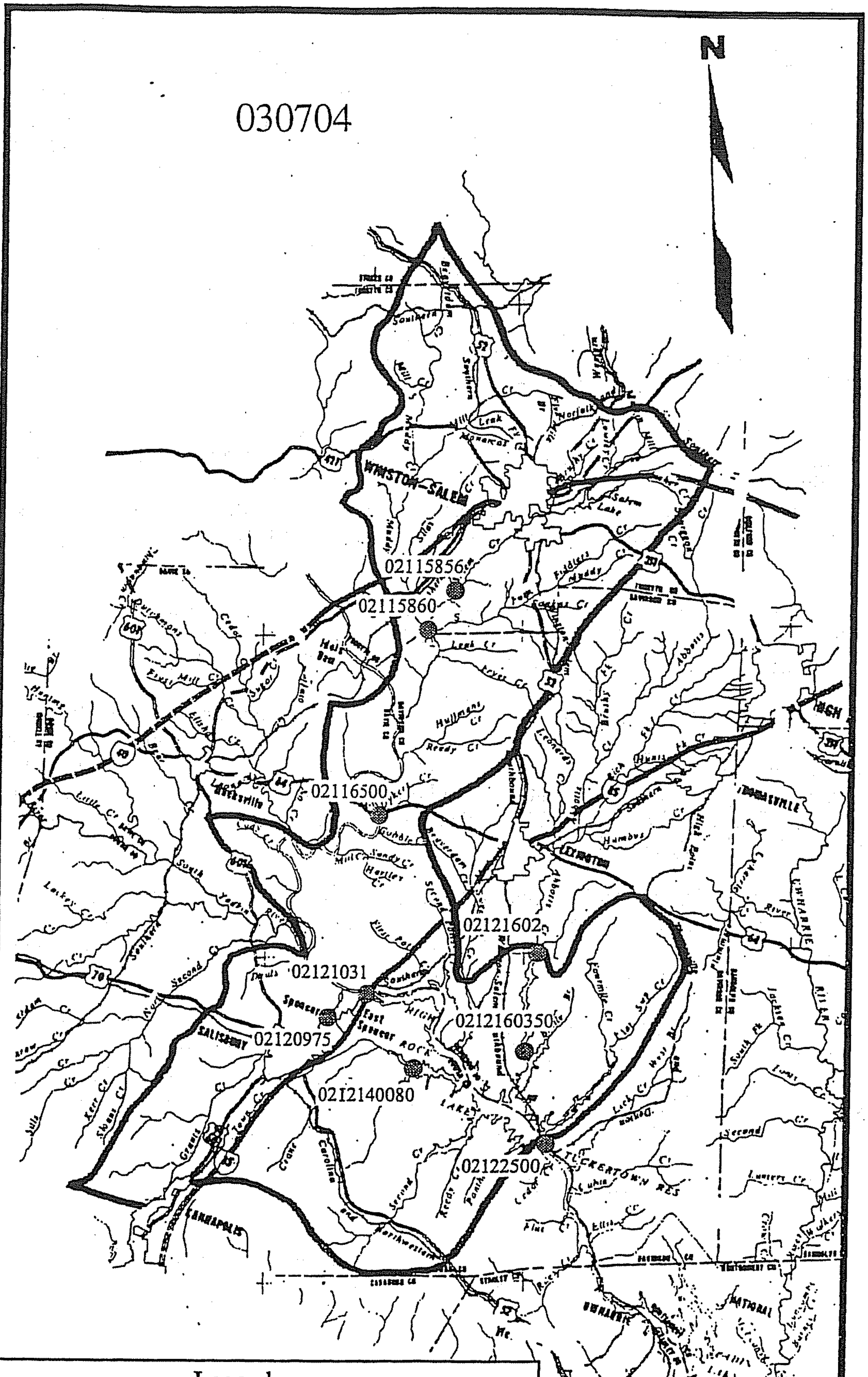
Numerous DWQ special macroinvertebrate studies have examined the effects of permitted dischargers on stream biota. Upstream-downstream studies (prior to 1996) had demonstrated problems in the headwaters of Muddy Creek, Salem Creek, Muddy Creek below Salem Creek, Grants Creek, Town Creek, Second Creek, and Reynolds Creek. The 1996 macroinvertebrate sampling demonstrated that water quality problems still exist in parts of Muddy Creek (Good-Fair at two sites) and Salem Creek (Good-Fair at an upstream site and Fair at two downstream sites), although improvements in wastewater treatment and/or control of urban runoff have reduced the severity of these problems. These improvements are apparent in both effluent toxicity and stream biota. A fish community sample from Muddy Creek resulted in a Fair NCIBI rating.

Figure 4.23 Sampling Locations in the High Rock Lake and Muddy Creek Watersheds (Subbasin 03-07-04)



Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Numb

Figure 4.24 Sampling Locations in the High Rock Lake and Muddy Creek Watersheds (Subbasin 03-07-04)



Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

The Forsyth County Environmental Affairs Department (FCEAD) has been conducting physical and chemical monitoring in Muddy Creek and its tributaries since 1988. Twelve sites are currently being sampled. FCEAD data indicate elevated levels of total phosphorus throughout the Muddy Creek watershed, although levels are highest in Salem and Muddy Creeks, downstream of Winston Salem's Archie Elledge WWTP. Elevated concentrations of metals such as lead and cadmium are also evident, especially at the more urban sites such as Peters Creek and Salem Creek.

The severe effects of urban runoff have been seen in the Poor bioclassifications assigned to Grants Creek and Town Creek during special studies in 1990. The 1990 macroinvertebrate sample from Town Creek looked at a downstream segment within a heavily urban area, but an upstream 1996 fish site (in a more residential area) had a Good rating. In urban areas, many small dischargers also potentially contribute to the problems associated with urban runoff. Urban streams usually had poor habitat, but the invertebrate communities also suggested toxic conditions.

Most streams in agricultural areas were assigned a Good-Fair rating, often with a severely degraded habitat. The normal rocky riffle areas of piedmont streams were reduced or entirely eliminated by massive inputs of coarse sand, reducing the available habitat for benthic macroinvertebrate and fish. Typical agricultural streams with a Good-Fair bioclassification include South Fork Muddy Creek, lower Grants Creek, Salem Creek above Salem Lake, Second Creek, and Fryes Creek.

Extensive mercury contamination was identified in the lower reaches of Abbotts Creek by the Division of Water Quality as early as 1981. Fish tissue results showed mean mercury levels exceeding the FDA and EPA limits for tissue and the State Health Director subsequently placed the Abbotts Creek embayment under a fish consumption advisory in August 1981. A major source for the contamination was poorly treated wastewater and contaminated soils associated with the Duracell USA battery plant in Lexington. Removal of the contaminated soils, improvements in wastewater treatment from the site, and natural processes resulted in a gradual decline of mercury levels to the point where the State Health Director was able to lift the fish consumption advisory on Abbotts Creek in March of 1992. Sampling since 1992 shows mercury continuing to decline gradually to background levels.

Fourteen facilities currently monitor effluent toxicity as a permit requirement. Existing (1996) toxicity problems were recorded only for PPG Industries, with a permitted flow of 0.6 MGD to North Potts Creek. Many other dischargers were found to be toxic when the toxicity program was initiated, but have since shown large improvements.

Chemical samples from ambient sites indicate that most streams in this area are very turbid, but low dissolved oxygen is rarely a problem. Point source dischargers and urban runoff lead to high conductivity levels in Salem Creek, Muddy Creek, Grants Creek, Abbotts Creek, and Crane Creek. Many of these streams also have high levels of total phosphorus and nitrogen, but long term data indicates that these concentrations have been reduced by improved wastewater treatment.

Lakes Assessment Program

Winston Lake

Around the turn of the century, Winston Lake was the water supply for the Town of Winston. After the Towns of Winston and Salem were consolidated, Winston Lake was the primary water supply for the newly formed city. The lake was eventually abandoned as a water supply and is presently used for recreation such as fishing.

The lake was most recently sampled by DWQ on August 15, 1990 and was found to be mesotrophic and fully supporting its designated uses.

An engineering analysis of the Winston Lake dam was conducted in 1981 (Soil & Material Engineers, Inc., May 1981). This dam, according to the Army Corps of Engineers' Flood Screening Criteria was judged to be seriously inadequate at the time and was determined to be unsafe until corrective measures were taken. A recommendation was made for overtopping the earthen portion of the dam, to remove sediment from the lake to increase storage capacity, to take corrective actions to repair the bypass control mechanism and remove accumulated debris at the spillway. At the time of this study, accumulated sediment in the lake was estimated to range from a depth of two feet to almost 13 feet. In 1986, Winston Lake was drained and mechanically dredged. Spoil from this project was used to build a driving range at a nearby golf course.

Salem Lake

Salem Lake is a water supply reservoir which provides approximately 33% of the drinking water for the City of Winston-Salem and Forsyth County. Located within the City of Winston-Salem, the lake has a long history of supplying water for growing communities in and around Winston-Salem. The Town of Salem first began using Salem Creek as a water supply in 1877. Salem and the nearby Town of Winston prospered and became interdependent, consolidating into the City of Winston-Salem in 1913. Subsequent growth in the area brought a demand for a larger water supply. In 1919, a dam was built on Salem Creek to create Salem Lake.

The watershed of Salem Lake includes portions of the Towns of Kernersville and Walkertown. Feeding the lake are five major tributaries: Lowery, Martin Mill, Kerners Mill, Smith and Fishers Branch Creeks, plus numerous smaller streams. Approximately half of the land in the watershed is forested with the remaining land use split between agriculture and urban areas. Sedimentation and runoff from the urban development and agricultural areas have sparked concerns about the water quality of the lake.

Salem Lake was most recently sampled on September 1, 1994. The lake was determined to be eutrophic and fully supporting its uses. See Section 4.2.3 for more information on Salem Lake.

High Rock Lake

High Rock Lake is an impoundment of the Yadkin River located downstream of W. Kerr Scott Reservoir. The dam that impounds High Rock Lake was originally built in 1927 by the Yadkin Corporation to provide hydroelectric power. Because water from the lake is used to generate hydroelectric power, the discharge rate from High Rock Lake remains fairly constant although the inflow varies. This variation causes considerable fluctuations in lake level and affects the hydraulic retention time. A two year study conducted by the University of North Carolina (Weiss et. al, February 1981) in 1977 and 1978 found residence times ranging from 3.6 days to 50.8 days depending on inflow to the impoundment.

The watershed of the lake is characterized by rolling hills. Half of the land is forested, over one quarter is agricultural, and the remainder is urbanized. The drainage basin includes several major urban areas of the Central Piedmont including Winston-Salem, Salisbury, Lexington and High Point. High Rock Lake is classified WS-V from its headwaters to and including Crane and Swearing Creeks. From this point to 0.6 mile upstream of the dam, the lake is classified WS-IV and B. Within 0.6 mile of the dam, the lake is classified WS-IV CA and B. The Abbotts Creek Arm of High Rock Lake is classified WS-V and B. See Section 4.2.3 for more information on lake characteristics.

Data on water quality in High Rock Lake are available from several sources: the DWQ lakes monitoring program; DWQ ambient monitoring; monitoring by NPDES dischargers; and special studies conducted by the Division.

The eutrophic condition of High Rock Lake has been documented by studies dating back more than 20 years. DWQ has sampled 8 sites on High Rock Lake in 1981-86, 1989, 1990 and 1994 as part of its Lakes Assessment Program. Five sites are located on the mainstem of the lake, while three are at the mouth of lake arms. Monitoring data for these sites are summarized in Figure 4.25. Overall, these results indicate very elevated levels of both phosphorus and nitrogen and high levels of algal growth. Chlorophyll *a* levels on the lake average 32 µg/l, with one third of the samples being in violation of the 40 µg/l chlorophyll *a* standard. Lakewide chlorophyll and phosphorus levels during the 1981-86 and 1989-94 periods were almost identical. Percent oxygen saturation in excess of the 110% state standard is not unusual. Secchi depths are generally less than 1 meter, with a median of 0.6 meters. Because elevated dissolved oxygen levels may impact fishery resources in the reservoir, the uses of High Rock Lake are threatened.

Clear gradients in phosphorus and chlorophyll concentrations exist in the reservoir. Phosphorus levels in the mainstem generally decline in the downstream direction. Algal levels in the mainstem are lowest in the uppermost portion of the reservoir, above Swearing Creek, and are highest in the middle portion, between Swearing Creek and Abbotts Creek. The upper portion of the lake is relatively shallow and riverine. Turbidity levels are high (ranging from 20 to 300 NTU at Yad1391A) and violations of the 25 NTU standard are common. Secchi depths range from 0.1 to 0.4 meters, and evidence of sedimentation is widespread. Phosphorus levels are extremely high in this area, but algal growth is limited by turbidity and rapid flushing. Nonetheless, chlorophyll *a* levels average 24 µg/l, indicating a substantial amount of algal biomass. The highest algal growth is found in the middle portions of the mainstem where turbidity is low enough to allow sufficient light penetration, detention times are somewhat longer, and nutrient levels remain high. In the two stations located in the middle portion of the mainstem (Yad152A and Yad152C), 45 to 50% of the chlorophyll samples exceed the standard.

Three sites on the Crane Creek and Abbotts Creek arms of the lake are monitored as part of the Division's ambient monitoring network. Nutrient levels are extremely high in these arms, both of which receive substantial point source inputs. Average chlorophyll levels are similar to the mainstem, but peak concentrations can exceed 200 µg/l, compared with peak concentrations of 90 µg/l on the mainstem. Nuisance blooms and fish kills have been reported on Abbotts Creek.

Conditions on Abbotts Creek tend to be worse during dry years, though an extremely dry year has not occurred since 1988. During the summer of 1988, average June-August concentrations at the Center Street ambient station (above Lexington's outfall) were 0.7 mg/l for total phosphorus and 0.5 mg/l for PO4, while levels of nitrate ranges from 2.6 to 5 mg/l. Nutrient levels of this magnitude during periods of low flow illustrate the importance of point source loading control to this arm. Monthly sampling on the Abbotts Creek arm of the lake showed persistent bloom conditions from May through October of 1988 (NCDEM, 1989) and numerous chlorophyll *a* violations, including levels as high as 280 µg/l. Similar conditions occurred in 1996, when chlorophyll levels exceeded 150 µg/l for three months at the HWY. 47 ambient station (Figure 4.26). At the SR 2294 monitoring site near Southmont, chlorophyll *a* exceeded 65 µg/l during four months in 1996, reaching a high of 95 µg/l in August. Chlorophyll *a* violations occurred as early as March and as late in the year as November.

In 1996, chlorophyll levels in the Crane Creek arm exceeded the 40 µg/l standard in every month from June through November, with measured levels as high as 190 µg/l (Figure 4.26). Ambient phosphorus levels averaged 0.15 mg/l during this period. Algal blooms occurred as early as February.

Figure 4.25

HIGH ROCK LAKE SAMPLING STATIONS: NUTRIENT AND CHLOROPHYLL DATA, 1981 - 1994

YAD1391A

MEAN CHLOR A (ug/l)	24
% CHLOR A>40 ug/l	30%
MEAN TP (mg/l)	0.16
MEAN TP(mg/l)	0.97
N	10

YAD152A

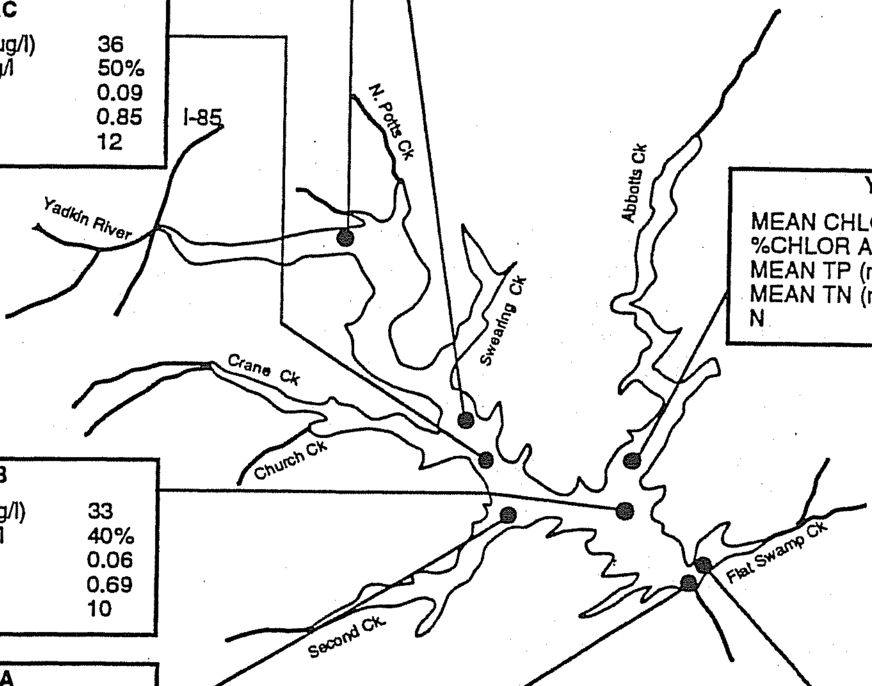
MEAN CHLOR A (ug/l)	39
%CHLOR A>40 ug/l	45%
MEAN TP (mg/l)	0.11
MEAN TN (mg/l)	0.90
N	11

YAD152C

MEAN CHLOR A (ug/l)	36
%CHLOR A>40 ug/l	50%
MEAN TP (mg/l)	0.09
MEAN TN (mg/l)	0.85
N	12

LAKEWIDE AVERAGE

	81-94	81-86	89-94
MEAN CHLOR A (ug/l)	32	32	33
%CHLOR A>40 ug/l	34%	35%	32%
MEAN TP (mg/l)	0.09	0.09	0.08
MEAN TN (mg/l)	0.82	0.90	0.62
N	82	60	22



YAD169A

MEAN CHLOR A (ug/l)	31
%CHLOR A>40 ug/l	27%
MEAN TP (mg/l)	0.07
MEAN TN (mg/l)	0.65
N	11

YAD169B

MEAN CHLOR A (ug/l)	33
%CHLOR A>40 ug/l	40%
MEAN TP (mg/l)	0.06
MEAN TN (mg/l)	0.69
N	10

YAD156A

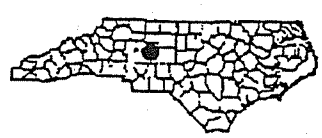
MEAN CHLOR A (ug/l)	39
%CHLOR A>40 ug/l	30%
MEAN TP (mg/l)	0.10
MEAN TN (mg/l)	0.92
N	10

YAD169E

MEAN CHLOR A (ug/l)	27
%CHLOR A>40 ug/l	11%
MEAN TP (mg/l)	0.05
MEAN TN (mg/l)	0.78
N	9

YAD169F

MEAN CHLOR A (ug/l)	25
%CHLOR A>40 ug/l	33%
MEAN TP (mg/l)	0.07
MEAN TN (mg/l)	0.85
N	9



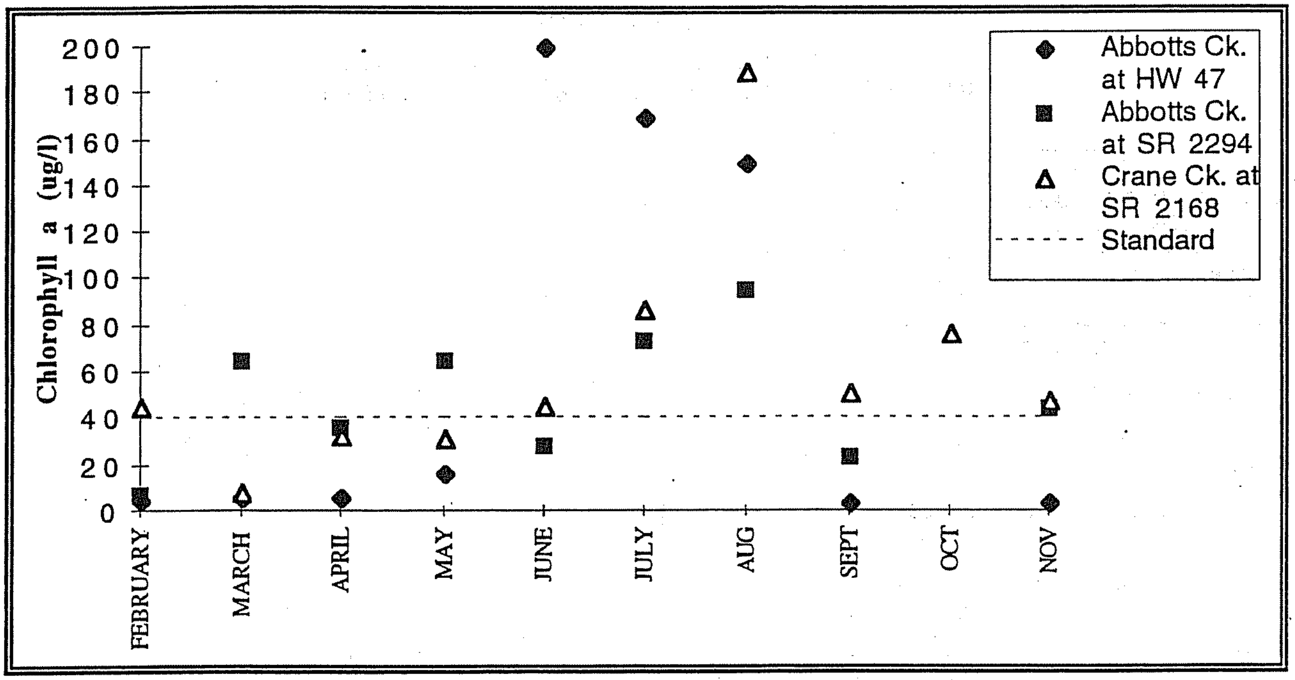


Figure 4.26 1996 Chlorophyll *a* Levels at Abbotts Creek and Crane Creek Ambient Stations

An intensive study conducted by the Division during the summers of 1989 and 1990 found chlorophyll *a* violations on all arms of the lake sampled: North Potts Creek, Swearing Creek, Crane Creek, Second Creek, Abbotts Creek, Flat Swamp Creek (NCDEM, 1993). PPG, Inc. sampled the North Potts and Swearing Creek arms of the lake during the summers of 1995 and 1996. Exceedances of the chlorophyll standards were found at all four stations on North Potts Creek during both years. Chlorophyll a averaged 72 µg/l and 47 µg/l during 1995 and 1996 respectively. The mean chlorophyll *a* levels at the four Swearing Creek stations was 55 µg/l and 45 µg/l for the two years. Oxygen saturation levels exceeding the state standard of 110% were found in both arms during both years, with values as high as 135% observed.

In 1975, the Department of Natural and Economic Resources, Division of Environmental Management conducted a study of High Rock Lake and its principal tributaries to determine the effects of the wastewater treatment control program, compliance with Water Quality Standards and to assess the biological condition of High Rock Lake (NCDEHNR, 1975). The survey was conducted to provide interim information requested by the High Rock Lake Association regarding the water quality of High Rock lake for water-body contact recreation. Data was collected from June through September, 1975. High Rock Lake was determined to be an over-enriched system with nutrient inputs coming from both point and nonpoint sources. High fecal coliform levels identified in stream reaches where there were no known point source discharges indicated the impact of rainfall runoff. Sedimentation and erosion were identified as on-going problems which contributed to high turbidities in High Rock Lake and its tributaries during rainfall events. At the time of the study, the main body of the lake did not violate water quality standards and was considered satisfactory for swimming and other body contact recreational activities.

A study was completed in 1981 investigating the water characteristics of the upper Yadkin River and its tributaries, and the interaction of various water quality components upon entering High Rock Lake (Weiss et. al, February 1981 and March 1981). Data was collected from October 1977 to September 1978. High Rock Lake was found to be nutrient rich and capable of developing substantial algal populations when the reservoir retention time was greater than 30 days. Algal growth was especially likely during the months of July through September. The lake was also found to act as an effective phosphorus trap, reducing total phosphorus concentrations by 40% to 84% of that entering the impoundment as compared to that in the water discharged. Sediment control and nutrient reduction for wastewater discharged into the upper Yadkin River were recommended to improve the water quality of the lake.

While problems associated with eutrophication have been the major water quality issue on High Rock Lake, high mercury levels in the Abbotts Creek arm of the lake were also a concern until recently. Mercury entered the creek from a poorly treated wastewater and contaminated soils associated with the Duracell battery plant. Routine fish tissue analyses for mercury levels began in 1981. Monitoring conducted in October of 1987 found that 18.5% of the fish collected had tissue concentrations of mercury above the FDA action level. Largemouth bass was the species with the highest mercury levels. The State Health Director issued an advisory limiting the consumption of fish from Abbotts Creek. An analysis of fish collected from Abbotts Creek in 1989 suggested that the fish had received continued inputs of mercury. In 1990, a Clean Lakes Phase I grant was received for mercury monitoring in Abbots Creek. The monitoring program was designed to map distribution of mercury throughout Abbotts Creek with emphasis on fish tissue and sediment concentrations, to identify and quantify sources of mercury in the watershed and evaluate potential restoration alternatives. Removal of the contaminated soils, improvements in wastewater treatment from the site, and natural processes resulted in a gradual decline of mercury levels to the point where the State Health Director was able to lift the fish consumption advisory on Abbotts Creek in March of 1992. Sampling since 1992 shows mercury continuing to decline gradually to background levels.

Lake Wright

Lake Wright is owned by the Town of Landis for secondary water supply during times of low flow. The watershed is forested with some agricultural areas (primarily row crops) located upstream of the lake. Grants Creek is the major inflow to Lake Wright which has controlled access and is not used for recreation. Lake Wright was most recently sampled in August 1994. At this time the lake was eutrophic, but fully supporting its uses. See Section 4.2.3 for more information on Lake Wright.

Lake Corriher

Lake Corriher is a small water supply lake owned by the Town of Landis. The lake drainage area is primarily agricultural. Topography in the watershed is characterized by gently rolling hills. Grants Creek is the main tributary to this lake. See Section 4.2.3 for characteristics of Lake Corriher.

Lake Corriher was most recently sampled on August 25, 1994. Percent oxygen saturation at this sampling site was 111%, which was greater than the state water quality standard of 110% for dissolved gasses. Surface algal mats were observed and the mean chlorophyll a concentration was 21 µg/l. Phytoplankton analysis determined that an algal bloom was present at the dam sampling site. Metals were below DWQ laboratory detection levels except for copper (14 µg/l) which was greater than the action level of 7 µg/l. This concentration of copper was the result of lake treatments with copper sulfate to control algal blooms. In 1994, Lake Corriher was eutrophic and rated as threatened due to elevated percent oxygen saturation, elevated copper concentration and documented algal blooms.

Aquatic Toxicity Monitoring

Fourteen facilities in this subbasin currently monitor effluent toxicity as a permit requirement, while RJ Reynolds Tobacco Co. monitors at three outfalls per an administrative letter. These include: Duke Power-Buck Steam, Fieldcrest Mills, Fieldcrest Mills-Salisbury-103, Lucent Technologies, Inc., Norfolk & Western Railway Co., Norfolk Southern Railway Co., PPG Industries, RJ Reynolds Tobacco, Salisbury-Grants Cr. WWTP, Salisbury-Town Cr. WWTP, Scarlett Acres, Spencer WWTP, Winston-Salem Elledge WWTP and Winston-Salem Lower Muddy Cr.

Norfolk Southern Railway Co. (South Potts Creek) had several test failures in 1995 and one failure in 1996. They have passed the most recent tests. PPG Industries (North Potts Creek arm of High Rock Lake) is under a Special Order of Consent (SOC) from December 18, 1996 to July 1, 1997 for chronic test failures.

4.3.5 Dutchmans Creek Watershed (Subbasin 03-07-05)

Description
This subbasin is comprised of Dutchmans Creek and its tributaries (Figure 4.27). These streams are all in Davie County, which is in the Piedmont ecoregion of the state. Mocksville's WWTP (into Dutchmans Creek) is the only permitted discharge >0.5 MGD. Most of this small watershed is rural, with forest or agriculture being the most common land use.

Overview of Water Quality
Biological sampling in Dutchmans Creek and Cedar Creek indicated some stress in both streams. Fish community sampling rated Dutchmans Creek as Fair-Good. The lack of a variety of darters in the sampling indicates some type of habitat degradation. While the macroinvertebrate community was diverse on Dutchmans Creek, habitat degradation was observed during the collections. The water quality was rated Good, however there seemed to be some stress from nonpoint sources.

Cedar Creek received a Good NCIBI rating at SR 1437, but only a Good-Fair bioclassification rating at US 158. The fish community was diverse, but did not contain intolerant species and had fewer than expected species of darters and suckers. The macroinvertebrate site (US 158) suffered from enrichment, heavy erosion along its banks and lack of a riparian zone. Other observations that caused concern included absence of riffles and most other instream habitat and the presence of cows with direct access to the stream.

One facility in this subbasin currently monitors effluent toxicity as per a permit requirement. That facility is Mocksville WWTP, which discharges to Dutchmans Creek.

4.3.6 South Yadkin River Watershed (Subbasin 03-07-06)

Description
This subbasin consists of the South Yadkin River and its tributaries (Figure 4.28 and 4.29). These tributary streams comprise large watersheds in Iredell, Davie, and Rowan counties. Except for the headwater sections of Hunting Creek and North Hunting Creek (Wilkes and Yadkin Counties), which are located in the mountain ecoregion, the majority of this subbasin is located in the piedmont ecoregion. There are 31 permitted dischargers in this subbasin, the largest of which are two Statesville WWTPs, which discharge to Fourth Creek and Third Creek. Land use within this subbasin is mainly forest and cultivated cropland.

Overview Of Water Quality
Eleven sites were sampled for benthic macroinvertebrates as part of the basinwide assessment program in 1996. Water quality in the upper part of this subbasin is Good to Excellent. Excellent sites include the upper South Yadkin River, Hunting Creek and North Little Hunting Creek. Sites receiving a Good bioclassification were a downstream site on the South Yadkin River, Rocky Creek, Patterson Creek, Fourth Creek and Third Creek. However, some of the rare species that have been collected previously from the upper South Yadkin River watershed (Hunting Creek) were not collected in 1996. Taxa richness and intolerant EPT taxa abundance have also decreased from prior collections at Hunting Creek. These changes have not yet resulted in a lower bioclassification, but it could be a warning that the system is beginning to suffer the effects of

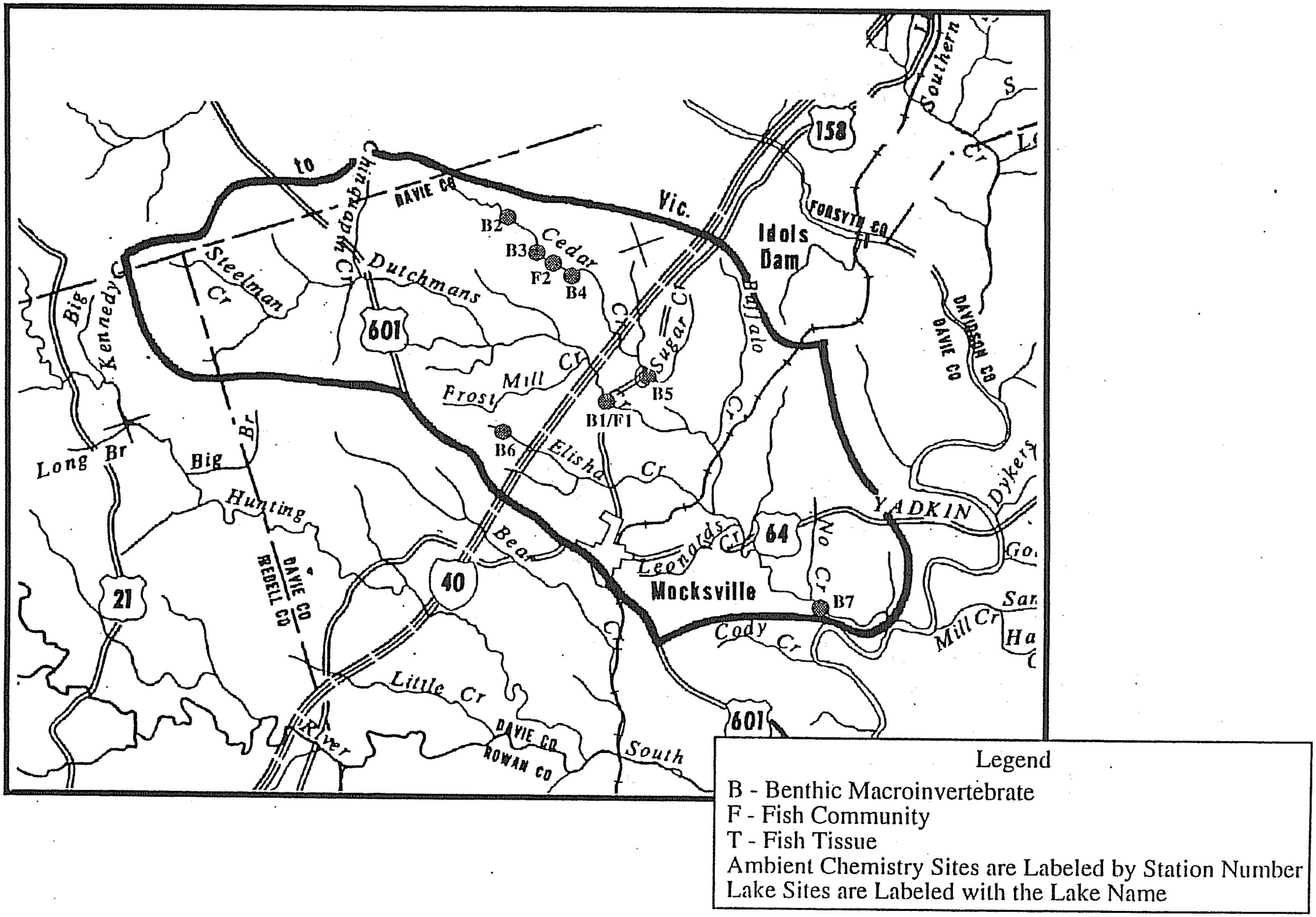


Figure 4.27 Sampling Locations in the Dutchmans Creek Watershed (Subbasin 03-07-05)

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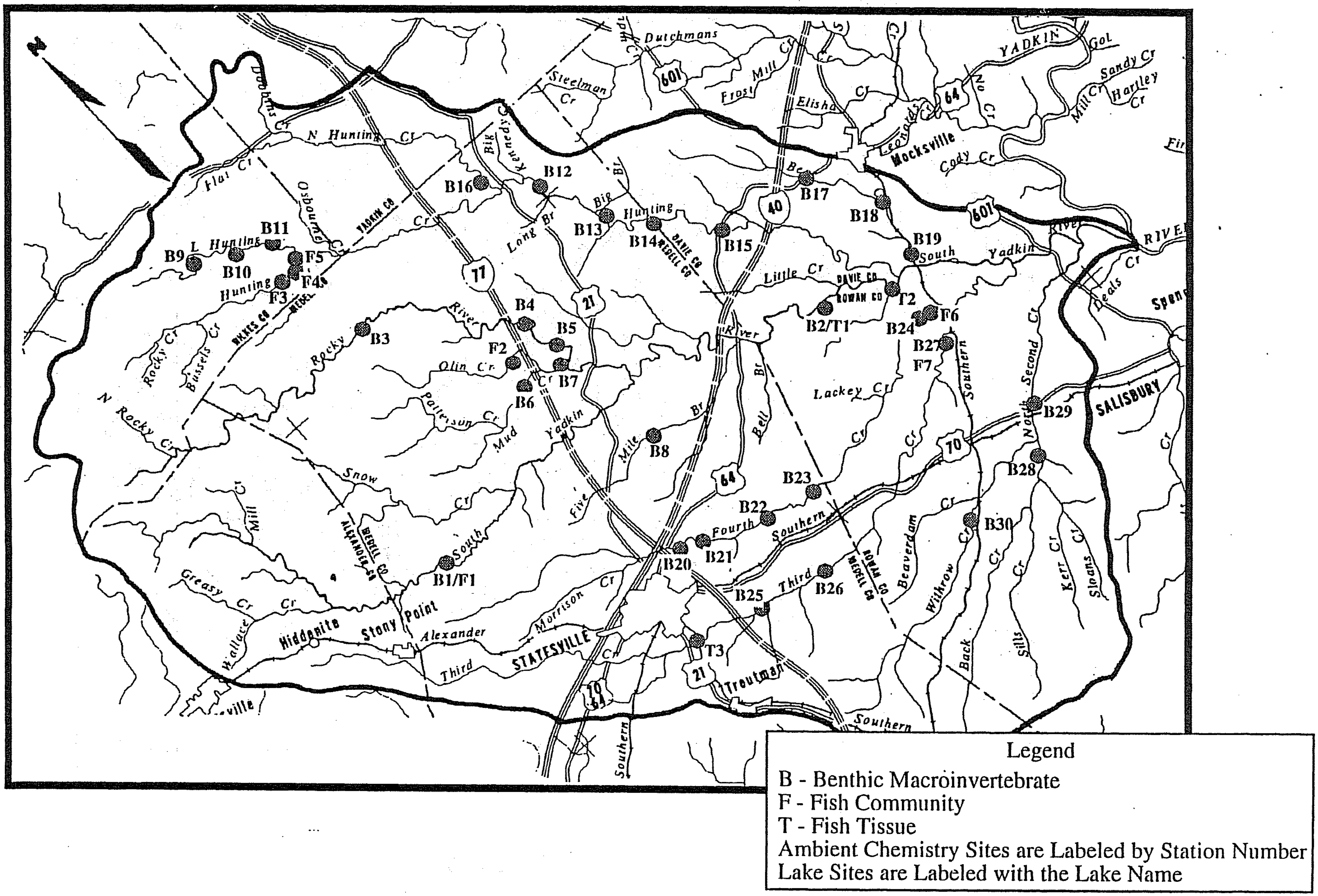


Figure 4.28   Sampling Locations in the South Yadkin River Watershed (Subbasin 03-07-06)

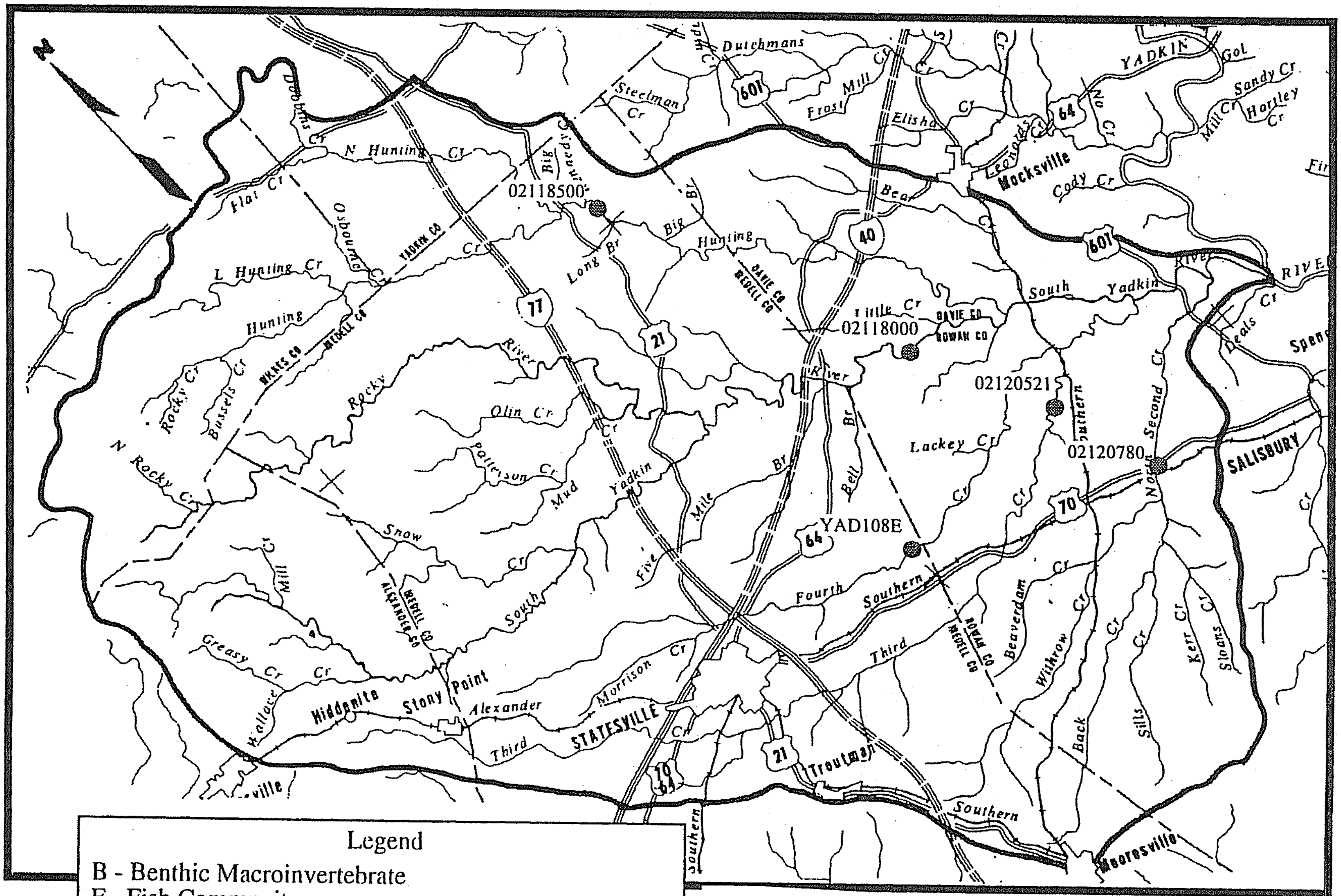


Figure 4.29 Sampling Location in the South Yadkin River Watershed (Subbasin 03-07-06)

nonpoint source pollution. The North Second Creek watershed, including Withrow Creek is comprised of a more pollution tolerant benthic community (Good-Fair bioclassification) than the upper South Yadkin watershed. Of the 40 macroinvertebrate samples taken in this subbasin since 1983, 70% rated either Good or Excellent, 28% rated Good-Fair and 2% rated Fair.

The fish community structure was evaluated at seven streams in this subbasin in 1996. The NCIBI ratings ranged from Poor-Fair at Olin Creek to Good at Hunting and Little Hunting Creeks. Fish and macroinvertebrates were collected at four sites: South Yadkin River, Little Hunting Creek, Third Creek and North Second Creek. The two types of ratings agreed at North Second Creek, but the NCIBI rated the other sites lower than the macroinvertebrates did. Due to the lack of suitable habitat as a result of prolonged sedimentation, these streams have suffered a depression in total number of fish as well as species diversity. Where the fish (NCIBI) rating was lower than the macroinvertebrate rating, the sites were characterized as having sandy substrates, infrequent and narrow riffles, eroded banks, and a riparian zone with many breaks allowing runoff to enter the stream. The major physical difference in the site where the ratings agreed was that the riparian zone of North Second Creek was wide and intact, protecting the stream from some nonpoint runoff. The fish community structure in the South Yadkin River, Olin Creek, Hunting Creek, and Little Hunting Creek show signs of nutrient enrichment. However, sampling at Hunting Creek at NC 115 indicated an increase in the NCIBI, from Fair to Good, since 1992.

All ambient chemistry monitoring sites experienced turbidity, iron, manganese, copper, and fecal coliform concentrations that were elevated during 1995, another indication of sediment and bacteria laden nonpoint source runoff.

Potential HQW/ORW Streams

If petitioned, streams that could be investigated for HQW/ORW reclassification based on benthic macroinvertebrate data are: the upper portion of the South Yadkin River, Hunting Creek, and North Little Hunting Creek. Rocky Creek was rated Good (borderline Excellent) and could also be included. Reclassification could provide these streams in rapidly developing areas with the protection they need to remain streams of high water quality.

Aquatic Toxicity Monitoring

Twelve facilities in this subbasin currently monitor effluent toxicity as per a permit requirement: Cleveland WWTP, Cooleemee WWTP, Hoechst Celanese Corp., Hoechst Celanese/Needmore Rd, Mocksville WWTP, Roscoe's Grocery, Sackner Products, Southern States Coop./SS Fertilizer, Statesville Fourth Cr. WWTP, Statesville Third Cr. WWTP, NC Dept. Of Transportation and Tyson Foods Inc.-Harmony Division. Of the twelve facilities that currently monitor effluent toxicity as a permit requirement, one was out of compliance for most of 1996, and was not consistently compliant in 1995. This facility is Tyson Foods, Inc. Harmony Division (formerly Holly Farms) which discharges to Hunting Creek.

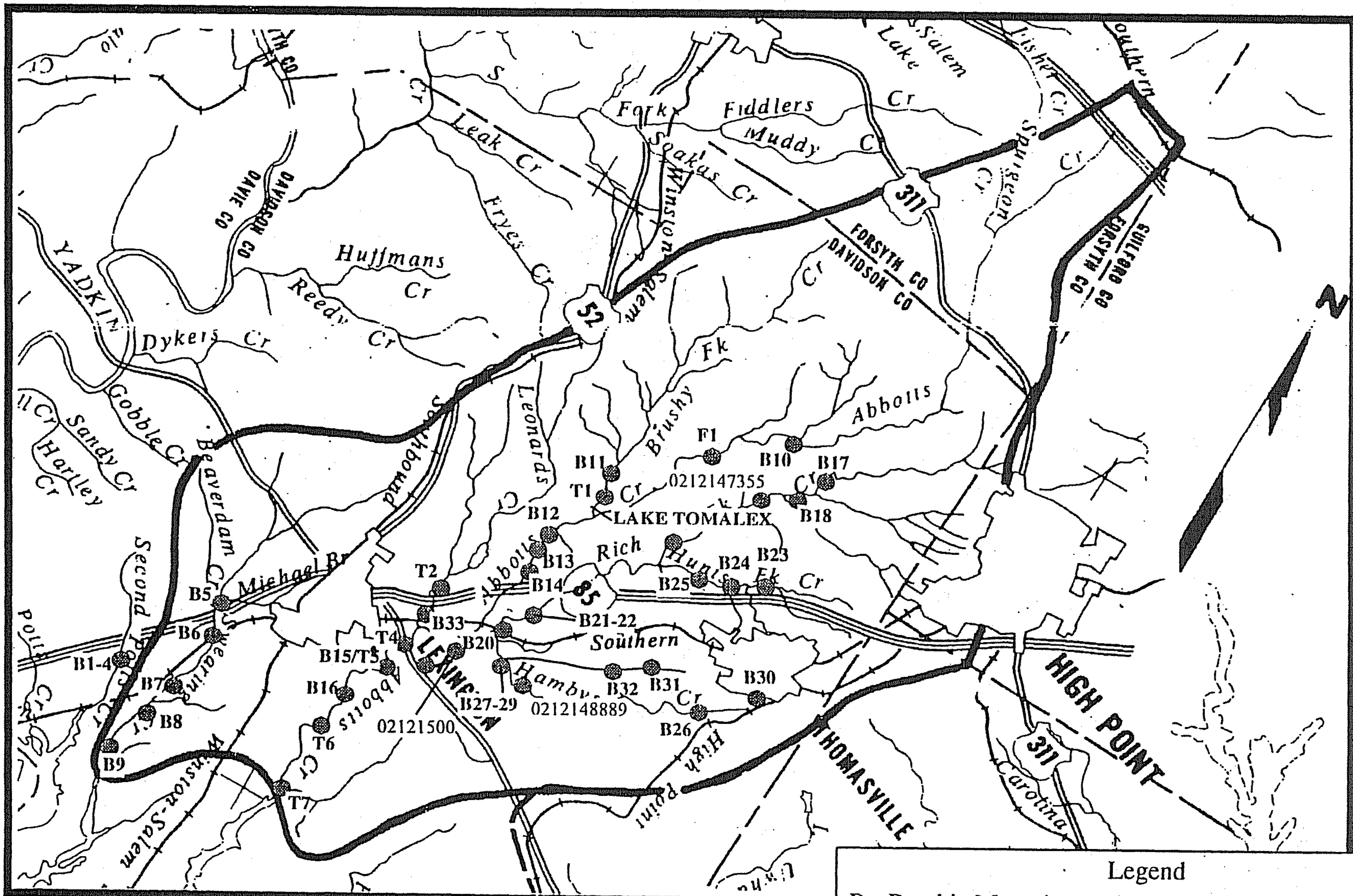
4.3.7 Abbotts Creek Watershed (Subbasin 03-07-07)

Description

The Abbott's Creek subbasin is located in the western Piedmont of North Carolina and is contained primarily in Davidson County, with headwaters in Forsyth County (Figure 4.30). Urban areas in the subbasin include Lexington, Thomasville and part of High Point. Abbotts Creek is the largest tributary to High Rock Lake from this subbasin. Land use within this subbasin contains industry, urban areas and agriculture.

Overview of Water Quality

There are 32 permitted dischargers in this subbasin, the largest of which is the High Point Westside WWTP (6.2 MGD to Rich Fork), Lexington WWTP (5.5 MGD to Abbotts Creek) and Thomasville WWTP (4 MGD to Hamby Creek). The large number of dischargers in this relatively



Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.30 Sampling Locations in Abbotts Creek Watershed (Subbasin 03-07-07) small subbasin is reflected in the general water quality, which is only Good-Fair. The water quality problems encountered in this subbasin are due both to point source dischargers and nonpoint source runoff.

Benthic macroinvertebrate have been surveyed at thirty three sites in this subbasin since 1983 for a total of 44 collections. Of these, 23% received a rating of Good-Fair, 50% were Fair, and 27% rated as Poor. Six sites were sampled in 1996 as part of the basinwide assessment program. Bioclassifications were: Poor at Hamby Creek, Fair at Brushy Fork, Good-Fair at Swearing Creek and Abbotts Creek, and Good at Leonard Creek. All stream sites were turbid at the time of sampling.

The fisheries community structure was assessed at two locations, Abbotts Creek and Rich Fork, both resulting in a rating of Fair. The fish community in Abbotts Creek indicated nutrient enrichment. Degradation of habitat and a discharge from the High Point Westside WWTP are having an adverse affect on the community in Rich Fork.

Chemical analysis of samples from the three ambient monitoring sites indicated elevated fecal coliform concentrations. Rich Fork near Thomasville and Hamby Creek near Holly Grove experienced maximum fecal coliform concentrations of 7000/100ml and 6000/100ml, respectively. Concentrations of copper, iron and nitrate/nitrite were also frequently elevated. This can be indicative of nonpoint runoff.

Fish Tissue Analyses

Fish tissue samples were collected at 7 sites within this subbasin from 1980 to 1994. Mercury contamination was identified in the upper reaches of Abbotts Creek and Leonards Creek around Lexington through DWQ studies in 1981. Sampling showed contamination to be the most prevalent in Abbotts Creek near NC-47 where over half of historical fish tissue samples have exceeded the FDA or EPA limits for mercury. The State Health Director placed the Abbotts Creek embayment under a fish consumption advisory in August 1981. A major source for the contamination was poorly treated wastewater and contaminated soils associated with the Duracell USA battery plant in Lexington. Removal of the contaminated soils, improvements in wastewater treatment from the site, and natural processes resulted in a gradual decline of mercury levels in the Abbotts Creek system to the point where the State Health Director was able to lift the fish consumption advisory on Abbotts Creek in March of 1992. Sampling since 1992 shows mercury continuing to decline gradually to background levels.

Lakes Assessment Program

Lake Thom-A-Lex

Lake Thom-A-Lex (also known as the Lexington-Thomasville Reservoir) is a water supply reservoir for the cities of Thomasville and Lexington. A forested buffer surrounds the lake and land use within the watershed includes pasturelands and row crops. Abbotts Creek was dammed to form the lake. Lake Thom-A-Lex was most recently sampled by DWQ on July 19, 1994. This lake is eutrophic and fully supports its designated uses. See Section 4.2.3 for more information on Lake Thom-A-Lex.

Aquatic Toxicity Monitoring

Five facilities in this subbasin currently monitor effluent toxicity as per a permit requirement: Dixie Yarns, Inc., High Point Care Center, High Point Westside WWTP, Lexington Regional WWTP and Thomasville WWTP. High Point Westside WWTP had four failures in 1996. The Thomasville WWTP reported a failed test at least once per year (quarterly tests) since 1994.

4.3.8 Yadkin-Pee Dee from High Rock Lake Dam to Lake Tillery, including Badin Lake (Subbasin 03-07-08)

Description

This subbasin includes the Yadkin River and tributaries from the High Rock Lake dam to the Lake Tillery dam (Figure 4.31). Badin Lake and Lake Tillery are the principal lakes in this region. This subbasin includes Albemarle (in part) and Denton. There are no dischargers with a permitted flow greater than 0.5 MGD in this subbasin, although some dischargers to smaller streams may affect the aquatic fauna. Regional Office staff note that Denton is planning an expansion to 0.6 MGD and will relocate to Lick Creek. All streams are located in the slate belt portion of the piedmont ecoregion. These streams usually have a rocky substrate, but may have very low flow during drought conditions.

Overview of Water Quality

Dischargers were found to affect two streams in this subbasin: Little Mountain Creek (ALCOA and Greater Badin WWTP) and Lick Creek (Denton WWTP). The low flow encountered during the 1996 macroinvertebrate surveys would not have provided much dilution for these dischargers, therefore samples were collected during a period of maximum potential impact to stream fauna. A downstream site on Lick Creek was rated as Good-Fair by macroinvertebrate samples in 1985 under normal flow conditions, but declined to a Fair rating in 1996 during low flow. Fish collections assigned a Good rating to this stream, although there was evidence of nutrient enrichment. Nonpoint sources, including agricultural and urban runoff, are likely contributors to water quality degradation on these creeks.

Various kinds of nonpoint source runoff may affect streams in this subbasin. Earlier surveys showed that urban runoff affected UT Lick Creek (Poor), and similar problems might be occurring in small streams draining Badin and Mt. Gilead. Agricultural land use is widespread, and both erosion and nutrient inputs may affect stream fauna. Enrichment was evident in some streams, especially Mountain Creek and Clarks Creek, although both streams had Good bioclassifications. A downstream site on Clarks Creek was rated Good-Fair.

Lakes Assessment Program

Tuckertown Reservoir

Tuckertown Reservoir is a eutrophic, run-of-the-river lake used to generate hydroelectric power and for recreational uses. As with other impoundments in the Yadkin chain lake system, land use in the watershed is primarily forest and agriculture, though some of the land is urban and rangeland. Tuckertown Reservoir was sampled on July 19, 1994 and was determined to be fully supporting, but the lake is eutrophic. See Section 4.2.3 for characteristics on Tuckertown Reservoir.

Tuckertown Reservoir was previously sampled in 1981, 1982, 1984, 1986, and 1989 by DWQ. In 1981, percent oxygen saturation was greater than the state water quality standard of 110% at both sampling stations (134.8% and 189.5%). Mean chlorophyll a was 45 µg/l and was greater than the state water quality standard of 40 µg/l. In 1982, percent oxygen saturation near the dam (134.8%) was greater than the state water quality standard of 110% for dissolved gasses. Chlorophyll a ranged from 25 µg/l at the mid-lake sampling site to 40 µg/l (the State standard) near the dam. The chlorophyll a value observed near the dam was at the state water quality standard of 40 µg/l. In 1984, percent oxygen saturation in the lake (136.6% and 114.2%) was greater than the state water quality standard for dissolved gasses. Mean chlorophyll a was 53 µg/l and was greater than the state water quality standard of 40 µg/l. In other sampling years, parameters were acceptable.

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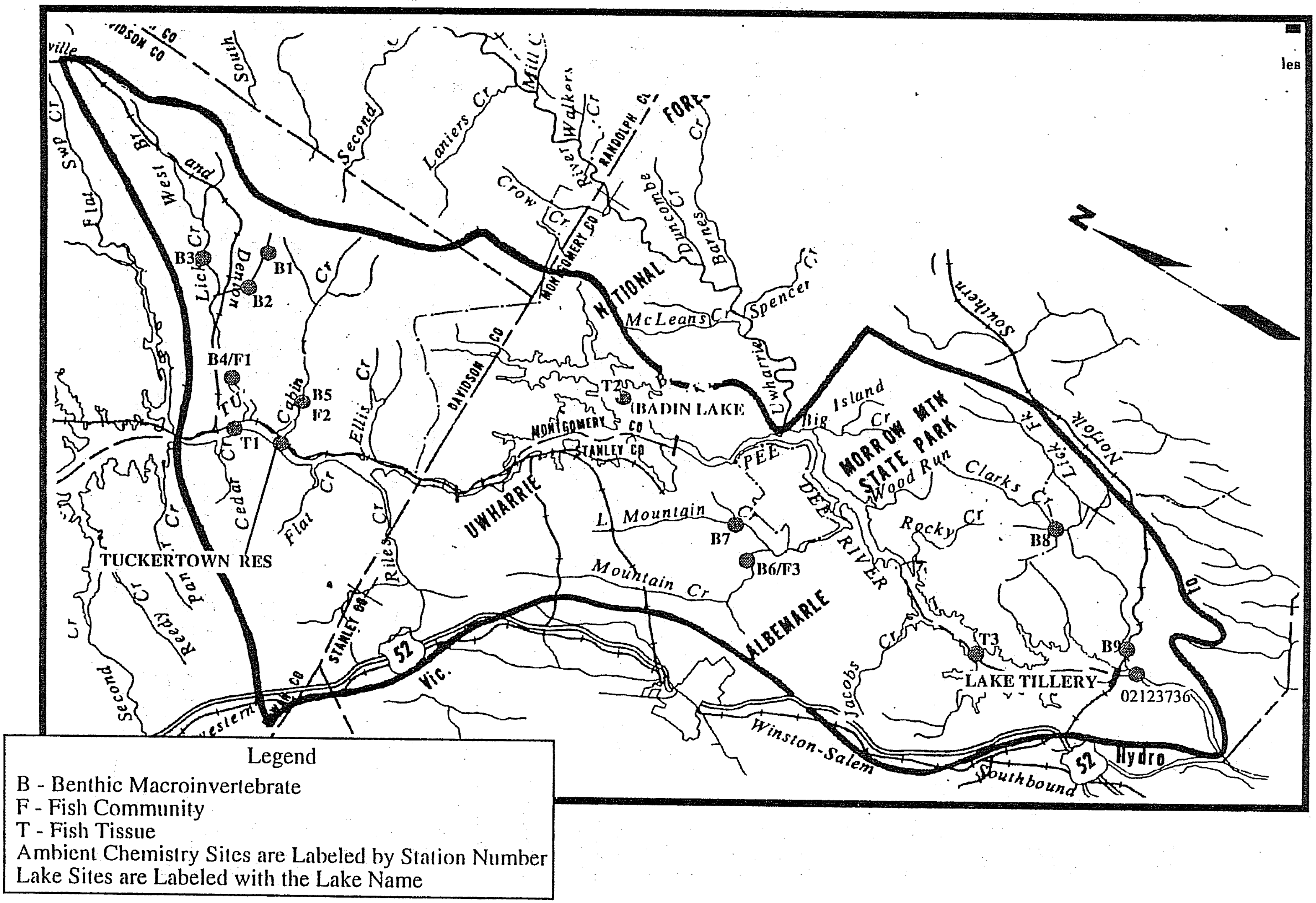

Figure 4.31 Sampling Locations in the Yadkin-Pee Dee River from High Rock Lake Dam to Lake Tillery, including Badin Lake (Subbasin 03-07-08)

Badin Lake

Badin Lake, also known as Narrows Reservoir, receives the majority of its inflow from the discharge of Tuckertown Reservoir. The lake has an average hydraulic retention time of 28 days. The land use in the watershed is mainly forest, with some agriculture.

When sampled in 1994, low surface dissolved oxygen levels were found at all stations (4.1 to 6.4 mg/l) except in the Beaverdam Creek arm (6.4 mg/l). These values were greater than the instantaneous standard value of 4.0 mg/l. A copper value of 42 ug/l was found at the mid-lake sampling station. This value was greater than state water quality action level of 7 µg/l for copper. Cyanide values of 5 ug/l were found at the sampling station in the Yadkin River arm and in the southernmost arm near the Town of Badin. These values are equal to the water quality standard of 5 ug/l. In 1994, the lake was borderline mesotrophic/eutrophic and fully supported its designated uses.

Badin Lake was previously sampled annually from 1981 through 1987, and in 1990. The only violation of the state chlorophyll a standard was observed in 1986 in the Yadkin River arm (46 µg/l).

Nutrient enrichment, particularly within the arms of Badin Lake, has been an ongoing concern. The construction of Uwharrie Point, a residential development located on the central peninsula (located between the Yadkin River and Beaverdam Creek arms of Badin Lake) and which extends into the central portion of the reservoir was of significant concern in 1990 and 1991. This development includes an 18-hole golf course. Nutrient contributions from the construction activities and from management of the golf course turf (application of fertilizers), concerns for loss of fish habitat due to clear cutting of water willow along the shore line, and concerns related to sedimentation due to landclearing for construction activities on the peninsula resulted in water quality monitoring of the lake near the peninsula in January and September, 1990.

The ALCOA facility, located at the most downstream arm of the lake, was up for permit renewal in 1994. Discharge from this facility was found to contain cyanide and fluoride. Historic instream monitoring conducted by ALCOA had shown sporadic samples with cyanide levels exceeding state water quality standards. Due to this problem, as well as concerns for contaminated groundwater flowing into the lake arm, ALCOA was requested by DWQ to submit plans for and execute an approved water quality study to collect data necessary for the permit renewal decision (Johnson, 1994). The instream smapling conducted under the study was completed in 1996 and did not show andy detectable concentrations of cyanide.

Falls Lake

Falls Lake is a small, run-of-the-river impoundment located between Badin Lake and Lake Tillery on the Yadkin River. The topography of the watershed is hilly with forest and some agriculture. See Section 4.2.3 for more information on Falls Lake.

The lake was sampled on July 28, 1994 and was determined to be oligotrophic.. This score is lower than historic TSI values found for Falls Lake that have generally indicated mesotrophic status. Falls Lake fully supported its designated uses.

Falls Lake was previously sampled in 1981, 1983 through 1986, and 1989. During the years 1981 through 1986, Falls Lake has experienced dissolved oxygen values which were below the state water quality standard for instantaneous dissolved oxygen measurement (4.0 mg/l).

Lake Tillery

The major inflows into Lake Tillery are the Yadkin River, Uwharrie River, Mountain Creek, and Little Mountain Creek. Most of the watershed is forested, though agriculture is another major land use. Lake Tillery was sampled by DWQ on July 26, 1994 and found to be fully supporting its designated uses. See Section 4.2.3 for more information on Lake Tillery.

Lake Tillery was previously sampled by DWQ in 1981 through 1984, 1986 and 1989. In 1983, percent oxygen saturation (range = 122.5 to 160.7%) was greater than the state water quality standard of 110% at all of the lake sampling stations. Metals were below DWQ laboratory detection levels except for lead (100 µg/l) which was detected at the mid-lake sampling station. This concentration was greater than the state water quality standard of 25 µg/l. In 1984, metals were below DWQ laboratory detection levels except for copper (60 µg/l) at the mid-lake sampling station. This concentration was greater than the state water quality action level of 7 µg/l. In 1989, metals were below DWQ laboratory detection levels except for copper (2.2 µg/l), aluminum (65 µg/l) and lead (26 µg/l). The concentration of lead was greater than the state water quality standard of 25 µg/l.

Lake Tillery ranked eleventh out of 16 North Carolina lakes in overall trophic quality in 1973 as part of the National Eutrophication Survey (USEPA, 1975). Because of the short retention time (15 days), Lake Tillery was described as an "over-enriched", slow moving river in the study. Survey data indicated that Lake Tillery was eutrophic and algal assays determined that the lake was phosphorus limited in 1973.

Lake Tillery (and the Pee Dee River immediately below the Tillery Hydroelectric Plant) were monitored during 1992 by Carolina Power & Light Company (CP&L) to gather limnological and fishery resource data (CP&L, 1993). Dissolved oxygen throughout the water column in the main body of the reservoir showed a gradual depletion with depth as water temperatures increased. Operation of the Yadkin Falls Hydroelectric Plant (deep water release) strongly influenced the dissolved oxygen concentration in the upstream portion of Lake Tillery. Dissolved oxygen gradually decreased in this region of the reservoir so that by July and September, dissolved oxygen was less than the NC state water quality standard of 4.0 mg/l for an instantaneous reading.

Aquatic Toxicity Monitoring

Three facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. ALCOA monitors effluent toxicity at five outfalls. Facilities currently monitoring are: ALCOA-002, -005, -011, -012, and -013, Denton WWTP and Mt. Gilead WWTP. ALCOA-005 experienced one test failure in 1995 and two failures in 1996. Alcoa has been working to resolve their toxicity failures and the facility did not experience toxicity failures in 1997. Both Denton and Mt. Gilead WWTPs have had test failures in 1995 and 1996.

4.3.9 Uwharrie River Watershed (Subbasin 03-07-09)

Description

This subbasin is composed of the Uwharrie River and its tributaries (Figure 4.32). Headwater streams drain portions of Thomasville, Randleman, and Asheboro, but there is little concentrated development in the lower portion of this subbasin. The southern half of the Uwharrie basin is within the Uwharrie National Forest. There are no major permitted dischargers in this subbasin. The Uwharrie River is within the piedmont ecoregion, but some streams draining the Uwharrie mountains have montane characteristics.

All of this subbasin is within the Slate Belt, but certain geological subdivisions of the Slate Belt appear to have ecological significance. The sandiest streams were observed in the northern portion of the subbasin, where the underlying rocks are metamudstone and meta-argillite. More rocky streams were observed in the southern portion of the subbasin where the underlying rocks are metavolcanic.

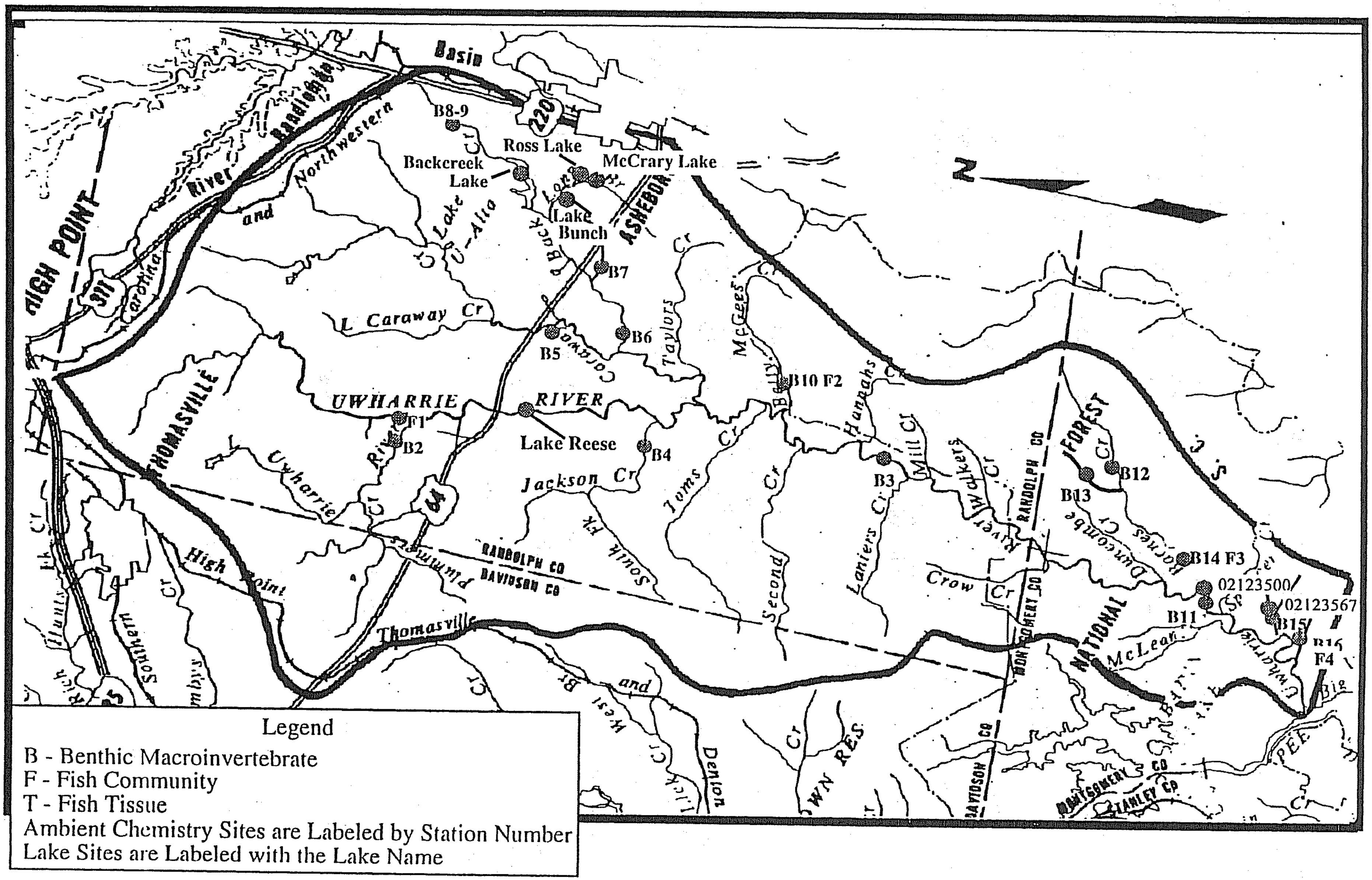

Figure 4.32 Sampling Locations in the Uwharrie River Watershed (Subbasin 03-07-09)

Overview Of Water Quality

Nonpoint source runoff results in turbid water, bank erosion, and high nutrient levels in many streams outside of the Uwharrie National Forest. Many streams affected by nonpoint source runoff (agriculture) received a Good-Fair rating from 1996 macroinvertebrate samples, including the upper part of the Uwharrie River, Little Uwharrie River, Jackson Creek, Caraway Creek, and Back Creek. This portion of the Uwharrie subbasin is associated with deeply entrenched channels, steep banks and severe bank erosion. The most degraded habitat was observed at the Uwharrie River at SR 1406. Minimally disturbed streams in the Uwharrie National Forest (Barnes Creek, Dutchmans Creek) received an Excellent rating. Barnes Creek has been classified as an Outstanding Resource Water based on earlier DWQ surveys. The middle and lower portion of the Uwharrie River received a Good Rating in 1996. There have been no significant long-term changes in water quality, but field notes indicate a decline in the abundance of macroinvertebrates in the Uwharrie River and an increase in periphyton growth.

Fish collections produced quite different results. The upstream site on the Uwharrie River received a Good rating, in spite of heavy sedimentation. Two streams in the Uwharrie National Forest (Betty McGees Creek, Barnes Creek) received Fair ratings, with some suggestion of nutrient enrichment in Betty McGees Creek. DWQ biologists will be investigating the reason for the low IBI score at Barnes Creek, and will probably resample this site.

Lakes Assessment Program

Ross Lake

Ross Lake is a back-up water supply for the City of Asheboro. In 1994, the dam for Ross Lake was found to have been breached and the lake remains drained. Ross Lake was last sampled by DWQ on July 27, 1989. The lake appeared muddy and sample results confirmed this with turbidity levels (50 NTU) exceeding water quality standards. The observed concentrations of iron and manganese in Ross Lake were greater than the applicable state water quality standards for these metals. Ross Lake in 1989 was considered eutrophic. See Section 4.2.3 for more detailed characteristics.

McCrary Lake

McCrary Lake is a water supply for the City of Asheboro. The dam was rebuilt in 1984 for safety reasons. McCrary Lake is primarily used to regulate flow upstream of Lake Bunch. McCrary Lake was sampled by DWQ on July 27, 1989 and was considered oligotrophic. McCrary Lake was resampled on August 23, 1994. At this time the lake was mesotrophic. See Section 4.2.3 for more detailed characteristics.

Lake Bunch

Lake Bunch was built in 1932 on an unnamed tributary to Cedar Fork, which eventually flows into Back Creek Lake. The height of the dam was increased in 1942, but storms washed out the spillway in 1946. The spillway was rebuilt and then refurbished in 1990-1991 for cosmetic and safety reasons. Land in the small drainage area is mostly wooded.

Lake Bunch was monitored on July 27, 1989. At that time, percent saturation of dissolved oxygen (147.9%) was greater than the state water quality standard of 110%. Metals were below DWQ laboratory detection levels except for iron (1700 µg/l) and manganese (225 µg/l). The value for iron was greater than the state water quality action level of 1 mg/l and manganese exceeded the state water quality standard of 200 µg/l.

Lake Bunch was one of sixteen lakes selected statewide as representative of a minimally impacted lake by which other lakes in the same region will be compared. To determine the lake's suitability as a reference lake, Lake Bunch was monitored by DWQ from 1991 through 1993, three times each year for a total of nine sampling events. Of the nine sampling events, two were oligotrophic, five were mesotrophic, and two were eutrophic.

Lake Bunch was most recently sampled on August 23, 1994. The lake was oligotrophic and fully supporting its designated uses.

Back Creek Lake (Lake Lucas)
Back Creek Lake (also called Lake Lucas) is the primary water supply for the City of Asheboro. The reservoir is part of a public park where fishing, boating, and swimming are common. Hypolimnetic aerators have been installed near the water intake structure to improve the quality of the water before it is withdrawn for treatment. The watershed is drained by Back Creek and Greenes Branch. Approximately half of the drainage area is wooded and the rest is cultivated.

Back Creek Lake was sampled by DWQ on July 27, 1989. The concentration of iron was greater than the state water quality standard of 1 mg/l. Chlorophyll a was greater than the state water quality standard of 40 µg/l at the upstream and mid-lake sampling sites (58 and 81 µg/l, respectively). Back Creek Lake was sampled on August 23, 1994. Back Creek Lake fully supports its uses.

Lake Reese
The City of Asheboro impounded the Uwharrie River and Caraway Creek to form Lake Reese, a water supply also used for recreation. Farms and residential areas exist in the drainage area and bordering the lake shore near the upper end of the lake. Lake Reese is only used after the primary water supply (Back Creek Lake) has a three-foot drop in level. The lake was sampled by DWQ on August 7, 1989 and all parameters were within acceptable ranges. On August, 25, 1994, Lake Reese was again monitored. Lake Reese was borderline eutrophic and fully supporting its uses.

Aquatic Toxicity Monitoring
One facility in this subbasin currently monitors effluent toxicity as per a permit requirement. That facility is Furniture Illustrators, Inc.

4.3.10 Pee Dee River from Lake Tillery Dam to Blewett Falls (Subbasin 03-07-10)

Description
This subbasin consists of the portion of the Pee Dee River and its tributaries (with the exception of the Little River in subbasin 03-07-15) from the Rocky River confluence to the dam at Blewett Falls Lake (Figure 4.33). Although the subbasin is located entirely in the piedmont ecoregion of the state, Brown Creek (the largest tributary to the Pee Dee in this subbasin) and many of its tributaries have coastal plain characteristics and very little flow during the summer. In contrast, Mountain Creek and its tributaries have good flow during the summer and are located in hilly topography more typical of the piedmont. Land use in this subbasin is primarily a combination of forest and agriculture. The town of Wadesboro is the largest urban area. This subbasin contains 8 permitted dischargers all of which are small (<0.5 MGD).

Overview Of Water Quality
There are currently two ambient monitoring stations located in this subbasin: Brown Creek at SR 1627 near Pinkerton, and the Pee Dee River at NC 109 near Mangum. Elevated levels of manganese and iron were observed at both locations and are indicative of nonpoint runoff.

Four macroinvertebrate samples have been collected in subbasin 10 since 1983. Sampling was conducted at Brown and Mountain Creeks in 1996. A sample collected on Brown Creek received a Fair bioclassification, most likely due to the effects of nonpoint runoff and reduced flows during the summer. Mountain Creek, which generally has good flow during the summer, received an

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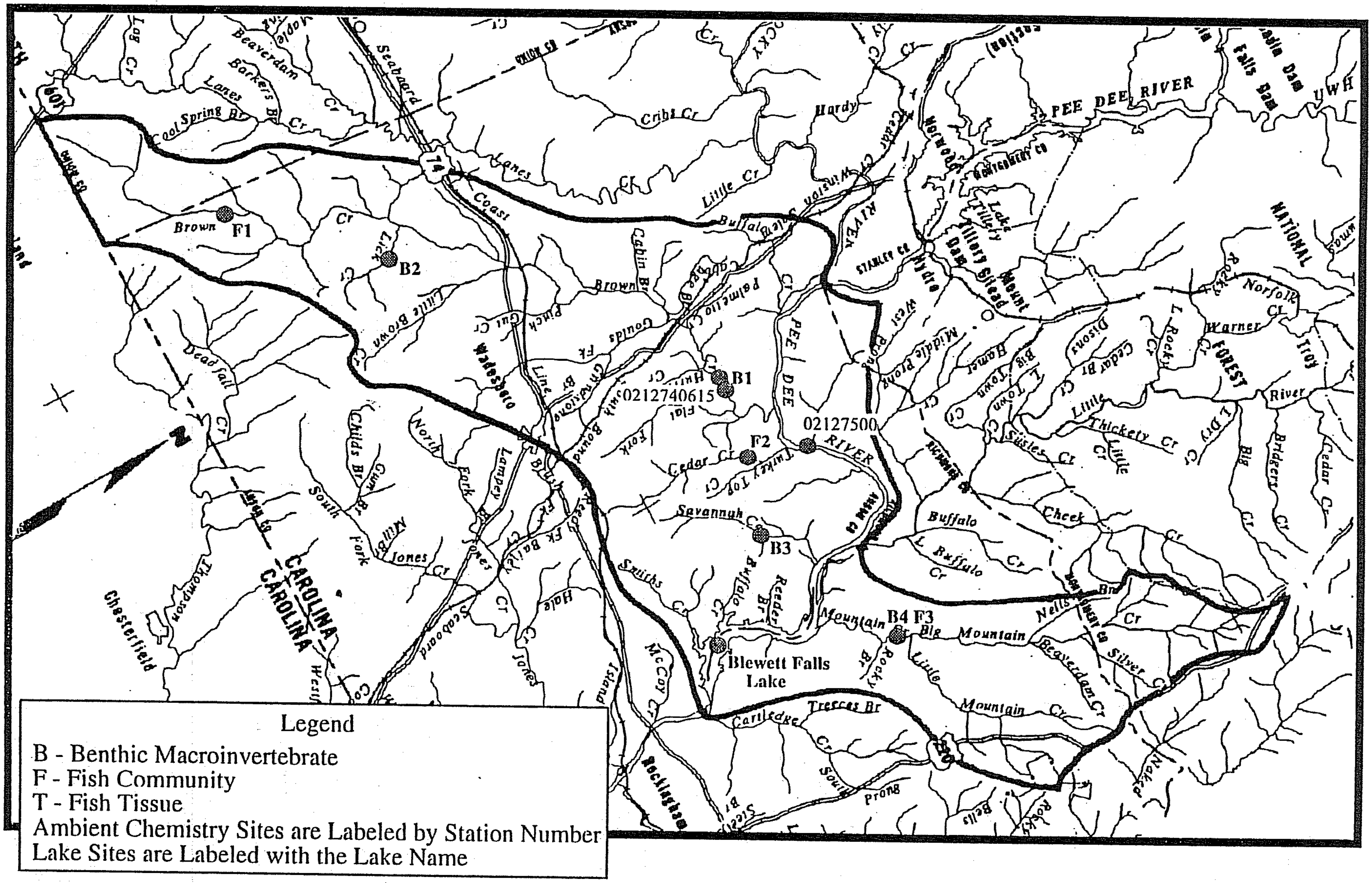

Figure 4.33 Sampling Locations in the Pee Dee River from Lake Tillery Dam to Blewett Falls (Subbasin 03-07-10)

Excellent bioclassification. Prior special studies produced a Good-Fair rating for Lick Creek in the upper portion of the Brown Creek drainage and a Poor rating for Savannah Creek. No flow was observed at either site during 1996 investigations.

Fish community assessments were performed at 3 sites during 1996. NCIBI ratings ranged from Fair-Good at Cedar Creek to Good-Excellent at Mountain Creek. Fish community ratings in upper Brown Creek and lower Cedar Creek indicated effects from siltation, habitat degradation, and nutrient enrichment. Mountain Creek was one of only six streams in the Yadkin basin with an NCIBI rating of Good-Excellent. Fish tissue samples were collected at Blewett Falls Lake during 1996. Sixteen samples composed of bass, crappie and catfish were analyzed for metals contaminants. Mercury levels exceeding FDA and EPA criteria were detected in one catfish sample.

Potential HQW/ORW Streams

The macroinvertebrate and fish data collected from Mountain Creek at SR 1150 indicated Excellent water quality for the stream. Based on this information, the Mountain Creek catchment could be resampled, if petitioned, to determine if the stream warrants reclassification to HQW/ORW.

Lakes Assessment Program

Blewett Falls Lake

Blewett Falls Lake is a run-of-the-river impoundment. Land use is mostly forested, with some agriculture and a small amount of urban development. As is true of the other Chain Lakes in North Carolina, Blewett Falls Lake receives the majority of its inflow from the discharge of the upstream reservoir, Lake Tillery. See Section 4.2.3 for more characteristics of the lake.

Blewett Falls Lake was one of 16 North Carolina lakes assessed in 1973 for the National Eutrophication Survey (USEPA, 1975). Survey data indicated that the reservoir was eutrophic. However, because of the short retention time (approximately seven days), Blewett Falls Lake more closely resembled a slow-moving, over-enriched river.

Blewett Falls Lake was previously sampled in 1981 through 1986. During this period, the reservoir was predominantly eutrophic. In 1981, percent oxygen saturation (182.9%) was greater than the state water quality standard of 110% for dissolved gases. The chlorophyll a value of 43 µg/l was greater than the state water quality standard of 40 µg/l. In 1982, chlorophyll a (40 µg/l) was at the state water quality standard limit for this parameter and the lake was hypereutrophic. In 1983 the lake showed a dramatic change to mesotrophic conditions. Blewett Falls Lake was most recently sampled by DWQ on July 26, 1994. The lake was eutrophic but fully supporting its uses.

Aquatic Toxicity Monitoring

One facility in this subbasin currently monitors effluent toxicity as per a permit requirement. That facility is Ellerbe WWTP, which had one test failure in both 1995 and 1996.

4.3.11 Upper Rocky River and Coddle Creek (Subbasin 03-07-11)

Description

This subbasin includes the uppermost reach of the Rocky River watershed, primarily in Cabarrus County (Figure 4.34). This reach runs approximately 25 river miles from its headwaters near Mooresville to its confluence with Irish Buffalo Creek. This subbasin contains the urban areas of Mooresville and Concord.

Coddle Creek, a large tributary of the Rocky River, and many of its smaller tributaries are classified as water supply (WS-II). All other tributaries and the entire Rocky River in this subbasin have been given a C water use classification.

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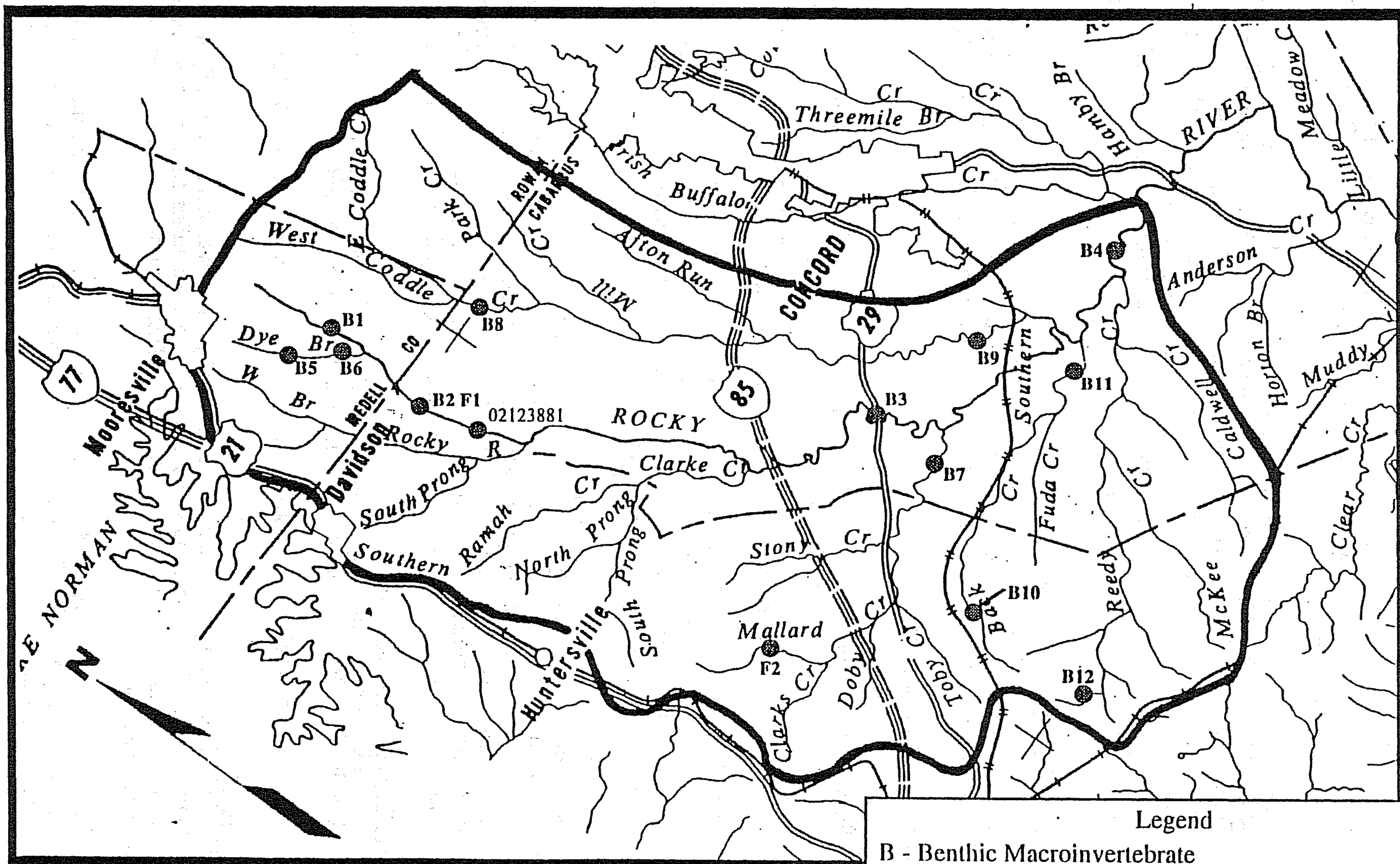


Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.34 Sampling Locations in the Upper Rocky River and Coddle Creek Watersheds (Subbasin 03-07-11)

Upper reaches of the Rocky River and tributaries within this subbasin are within the Piedmont ecoregion. Streams are typically sandy, reflecting the effects of nonpoint source runoff. During low and normal flow conditions, flow in many streams is confined to small meanders within a very sandy channel. Stream substrates are typically very unstable and the water becomes extremely turbid during high flow conditions. Due to the extremely sandy nature of the stream substrates within this subbasin, permanent instream habitat is generally reduced and benthic macroinvertebrate and fish populations are limited.

Overview Of Water Quality

Ambient water quality data are currently being collected from one location in this subbasin: Rocky River at SR 2420 near Davidson. This location is below the Mooresville/Rocky River WWTP which discharges to Dye Branch. Results of intensive investigations of this facility have indicated that the waste is having an impact to Dye Branch below the discharge point. Water chemistry summaries indicate that the flow from this facility is also having an effect at the ambient monitoring location for conductivity, fecal and total phosphorus. In addition, 1996 biological samples collected from the ambient monitoring location have resulted in Fair and Poor bioclassifications for macroinvertebrate and fish community surveys. Good-Fair and Fair water quality conditions have been consistently recorded from most sites in this subbasin. These water quality conditions are primarily the result of nonpoint source runoff and, in some instances, point source discharges. Agriculture and suburban development are two land-disturbing activities responsible for nonpoint source problems. A Fair bioclassification was assigned in 1996 to Coddle Creek which drains much of the suburban area of Concord. Good/Fair (in 1985) and Good (in 1996) biological ratings (benthic macroinvertebrate and fish community, respectively) were given to Mallard Creek below the CMUD/Mallard Creek WWTP.

Aquatic Toxicity Monitoring

Three facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Chemical Specialties, Inc., CMUD-Mallard Cr. WWTP and Mooresville WWTP.

4.3.12 Middle Rocky River, Dutch Buffalo, Irish Buffalo, Goose and Crooked Creeks (Subbasin 03-07-12)

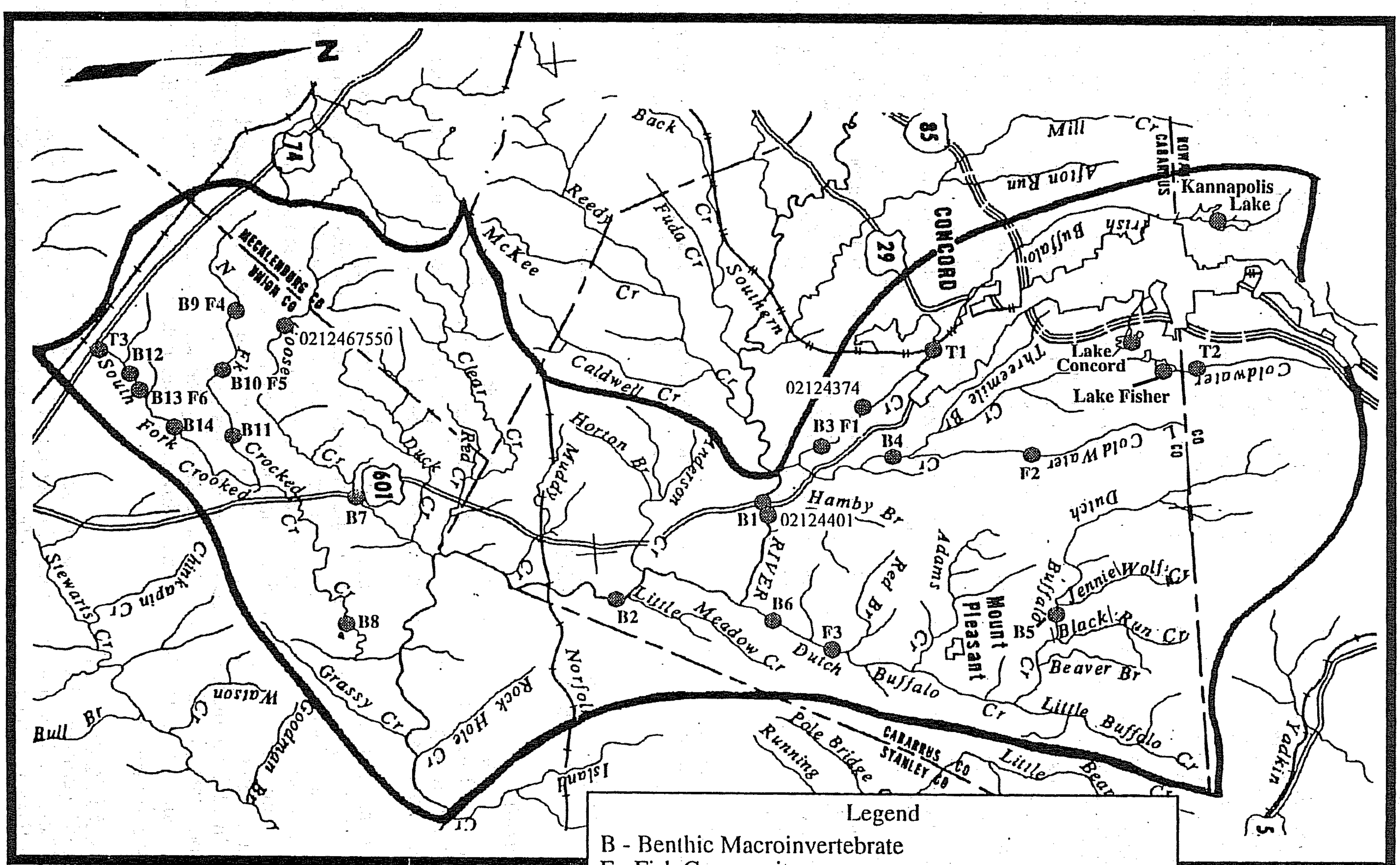
Description

This subbasin contains a 20 mile section of the Rocky River and four large tributaries: Irish Buffalo Creek, Dutch Buffalo Creek, Goose Creek and Crooked Creek (Figure 4.35). Concord is the only large metropolitan area in the subbasin. Upper reaches of Irish Buffalo and Dutch Buffalo Creeks have water supply classifications (WS-II, WS-III, and WS-IV).

Streams within this subbasin are contained within two distinct ecoregions. Tributaries found in the northern half of the subbasin (Irish Buffalo and Dutch Buffalo Creeks) are within the piedmont ecoregion and are dominated by sandy substrates. Streams found within the southern half of the subbasin (Goose and Crooked Creeks) are typical slate belt streams. These streams have substrates dominated by layered bedrock material and boulder/rubble. Erosion from slate belt soils can produce high turbidity from inputs of suspended clays, but little sandy material accumulates as bedload. In addition, these two stream types are physically very different. Stable habitat is limited in piedmont streams within this subbasin, accounting for scour during spate events, while stable habitat is dominant in slate belt streams. However, slate belt streams are susceptible to lack of flow during dry periods.

Overview Of Water Quality

There are 41 permitted dischargers in this subbasin, although most of these are small (< 0.5 MGD). There are three ambient monitoring locations in this subbasin: Irish Buffalo Creek at SR 1132 near Faggarts, Rocky River at US 601 near Concord, and Goose Creek at SR 1524 near



Legend

B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.35 Sampling Locations in the Middle Rocky River, Dutch Buffalo, Irish Buffalo.

Mint Hill. The Rocky River location monitors water quality conditions of the middle reaches of this system. Water quality for conductivity and fecal coliform were elevated from 1991-1995. A Good/Fair bioclassification had been given to this site based on benthic macroinvertebrate surveys conducted in 1996 and 1989.

The other two ambient monitoring locations are in urban/suburban (Irish Buffalo Creek) and agricultural (Goose Creek) catchments. Goose Creek is affected by unstable streambanks and intense development, including construction of a golf course. Good/Fair and Good biological ratings have been given to benthic macroinvertebrate and fish community structure samples, respectively, from the ambient monitoring site on Irish Buffalo Creek during 1996 investigations. A Poor bioclassification was assigned to Goose Creek based on data from a benthic macroinvertebrate survey conducted during the 1996 basinwide investigation.

Good-Fair water quality was recorded from four sites in the northern half of this subbasin during 1996. These streams are typical piedmont streams having very sandy substrates. This includes data from two ambient monitoring locations (Rocky River and Irish Buffalo Creek) and two other tributaries (Dutch Buffalo and Coldwater Creeks). Fair-Good NCIBI scores also were given to Dutch Buffalo and Coldwater Creeks. Fair and Poor water quality conditions have been recorded from many monitoring locations in the southern half of the catchment including Goose and Crooked Creeks and data collected during a special investigation. Streams in this area are slate belt streams which have substrates dominated by layered bedrock and boulder/rubble. These bioclassifications appear to be primarily the result of nonpoint source runoff.

Fish tissue samples have been collected from Irish Buffalo Creek, Lake Fisher and South Fork Crooked Creek. Results indicated that all metals were below FDA and EPA listing criteria.

<u>Special Studies</u>

Data from all special studies conducted in this subbasin since 1983 are presented in the DWQ Yadkin River Assessment Report (NCDWQ, 1997) if more detailed information is needed.

The Union County/Crooked Creek WWTP is in the process of applying for an increase in its permitted flow and DWQ is requiring the facility to relocate its discharge point from South Fork Crooked Creek to the North Fork Crooked Creek, due to greater flow in the North Fork. These data were collected to document water quality conditions prior to the relocation. North Fork Crooked Creek rated Fair to Good-Fair at three sampling locations.

Lakes Assessment Program

<u>Kannapolis Lake</u>

The City of Kannapolis uses the lake as a water supply, although it is owned by Atlantic American Properties. Access to the lake is strictly controlled. Land use in this drainage area is residential, agricultural, and forested. See Section 4.2.3 for more detailed characteristics.

Kannapolis Lake was sampled on August 2, 1995. Surface saturation of dissolved oxygen was 141.9% near the dam and 130.6% near the SR 1104 bridge (mid-lake). These values were greater than the state water quality standard of 110% for dissolved gasses. At this time Kannapolis Lake was eutrophic. All uses were supported at the time of this assessment, however, the elevated values for dissolved oxygen saturation on the day the lake was sampled are a point of concern. Kannapolis Lake was previously sampled by DWQ on August 8, 1989. All parameters were within the acceptable ranges.

<u>Lake Fisher</u>

Lake Fisher is a water supply for the City of Concord. Access to the lake is strictly controlled. Although the majority of this watershed is forested, some residential land use also exists. See

Section 4.2.3 for more information on the Lake Fisher. Lake Fisher was sampled on August 8, 1989 by DWQ. Mean chlorophyll a (43 µg/l) was greater than the state water quality standard of 40 µg/l with the highest concentration (64 µg/l) observed at the mid-lake sampling site. Levels of phytoplankton reached bloom proportions at all three lake sampling sites. Lake Fisher was resampled on August 2, 1995. Surface dissolved oxygen saturation values at the mid-lake sampling site (118.8%) and near the dam (122.8%) were greater than the state water quality standard of 110% for dissolved gasses. Lake Fisher was eutrophic but fully supporting its uses.

Lake Concord

The lake is used as a back-up water supply for the City of Concord. The upstream watershed is primarily urban although there is a forested buffer around the lakeshore. Lake Concord was sampled in August of 1989 and 1995. The predominance of small filamentous blue-green algae in 1989 indicated an over-enriched system. Lake Concord is eutrophic but supporting its uses based on 1989 and 1995 samplings.

Aquatic Toxicity Monitoring

Three facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Concord Rocky R WWTP, Genwove US, Ltd., Union County WWTP #2.

4.3.13 Lower Rocky River Watershed (Subbasin 03-07-13)

Description

Yadkin River subbasin 13 contains the lowermost reach of the Rocky River prior to the confluence with the Pee Dee River (Figure 4.36). This 25 river mile reach forms the Stanly County boundary. Big Bear Creek and Long Creek are the only major tributaries and Albemarle is the only significant urban area. The Rocky River and all tributary catchments within this subbasin have been classified as C waters. There are less than 20 permitted dischargers in the subbasin, with four having a permitted flow >0.5 MGD.

Overview Of Water Quality

This subbasin has two ambient stations: Rocky River near Norwood and Long Creek near Rocky River Springs. Both sites experience elevated conductivity, fecal coliform bacteria and copper values.

The Rocky River is potentially affected by a variety of point source and nonpoint source problems. During low flow (low dilution) periods, this site has had elevated conductivity values. At high flow, this site receives a high sediment load. In spite of these problems, the Rocky River near Norwood has consistently received a macroinvertebrate rating of Good or Good-Fair.

Long Creek at Rocky River Springs is downstream of two wastewater treatment plants (Albemarle and Oakboro), and also receives agricultural and urban nonpoint source runoff. Macroinvertebrate data showed an improvement from Fair in 1983-1986 to Good-Fair in 1989 and 1996 at the ambient location.

Good and Good/Fair bioclassifications were given to Big Bear and Stoney Run Creeks, respectively based on benthic macroinvertebrate surveys. Stoney Run Creek is a very small tributary of Big Bear Creek and flow was restricted to very small channels, possibly accounting for lower taxa richness values than during higher flow periods. Higher water quality in these catchments is due to a combination of slate belt geology and a general lack of disturbance. A fish community sample from Big Bear Creek also resulted in a Good score.

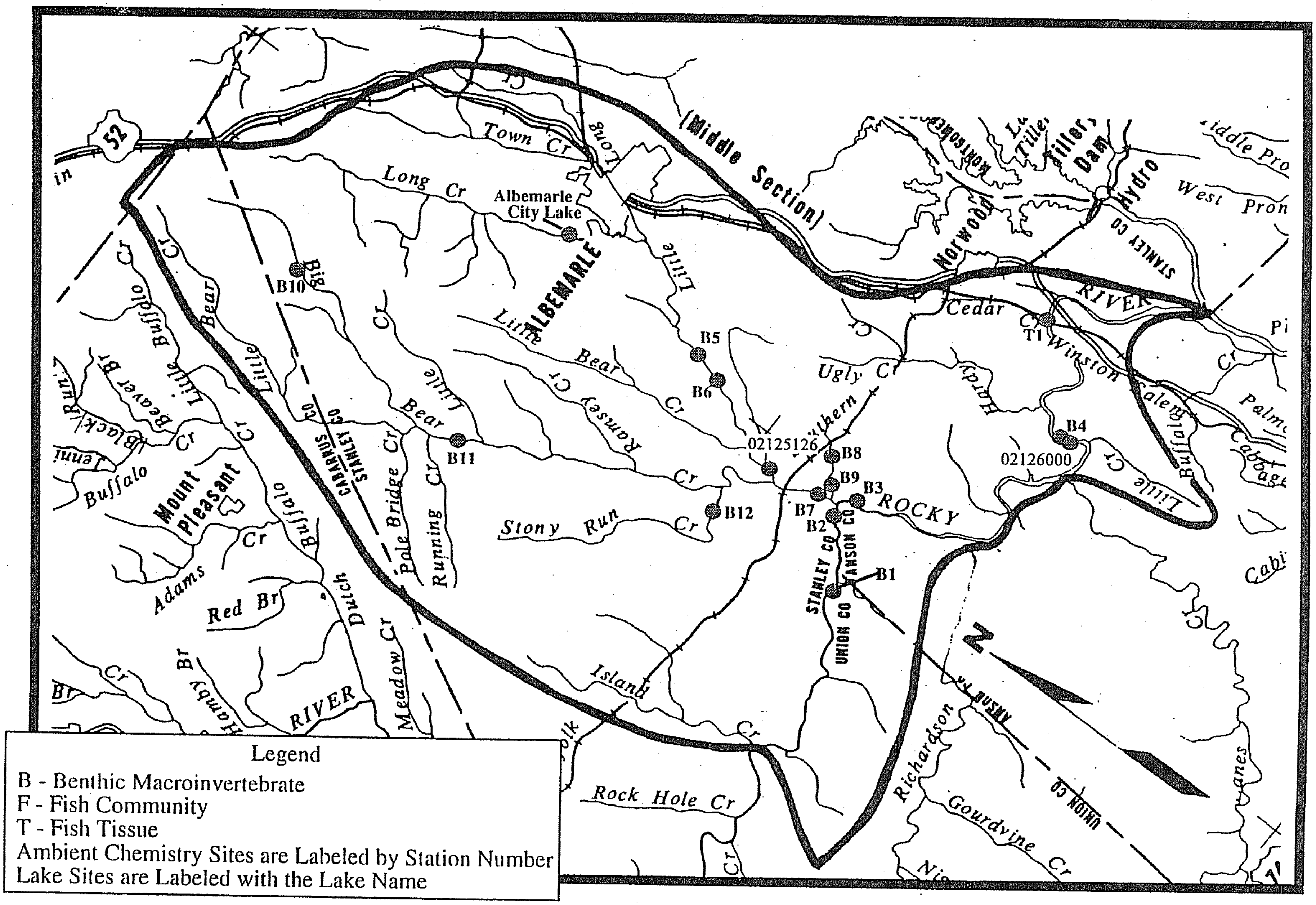


Figure 4.36 Sampling Locations in the Lower Rocky River Watershed (Subbasin 03-07-13)

Lakes Assessment Program

Long Lake (Albemarle City Lake)
The lake was used by the City of Albemarle as a water supply for more than 30 years (Jaynes, June 13, 1989). In 1950, the lake use was changed to solely recreation. In the late 1970's, the town bought 74 acres of land on the north side of the lake for a public park. The drainage area consists of rolling land dominated by agriculture (approximately 65%), forested areas (30%) and residential areas (5%). The only point source discharge in the watershed is from the Vulcan Materials Quarry located approximately seven miles upstream of Long Lake. This quarry has a general permit (No. NCG020108) for dewatering of the mines. Minimal self-monitoring of the effluent is required by the permit. See Section 4.2.3 for more detailed characteristics.

Long Lake was sampled by DWQ on July 28, 1981 as part of the Clean Lakes Survey (DNRCD, 1982). Chlorophyll a was 73 µg/l and was greater than the state standard of 40 µg/l. Sedimentation was noted as the primary source of problems at the time of sampling. The lake was hypereutrophic at the time it was sampled. This lake has been drained since 1986 and does not currently support its designated uses.

In 1986, Long Lake was drained in order to carry out repairs on the dam. At that time, the extent of sedimentation became evident and the City of Albemarle began to investigate ways to remove the sediment and restore the lake. In 1989, the City of Albemarle requested assistance from NCDWQ to pursue Clean Lakes funding to restore Long Lake. The EPA Clean Lake's Program approved funding for a Phase I Diagnostic-Feasibility study on February 5, 1990. The overall objective of this study was the development of a restoration and management plan for Long Lake. The developed plan (prepared by Coastal Environmental Services, Inc.) was submitted in the Phase II Restoration Project Grant Application in April, 1993. The plan included dredging of the lake, development of an in-lake biofilter and implementation of agricultural Best Management Practices (BMP's). The purpose of the biofilters and BMP's was to reduce future loading of sediments and nutrients entering the lake. Once this plan was developed, funding from the EPA was approved for Phase II of the project (implementation of the plan and restoration of the lake). The City of Albemarle was required to provide matching funds for this project. To date, 45% of the project has been funded and only a portion of the total restoration of the lake has been completed (NCDEHNR, 1995).

Part of the Phase II project included monitoring of Long Creek by NCDWQ (NCDEHNR, 1995). Monitoring at three stations on Long Creek began on October 1994 and ran through November 1995. Total nitrogen at the three sampling sites was consistently above 0.55 mg/l, the value at which this nutrient is considered to be elevated. Total phosphorus values ranged from 0.01 mg/l to 0.25 mg/l with a mean value above 0.05 mg/l at each of the three sampling sites. Nutrient loading was observed to increase during periods of high flow in Long Creek and decrease during low flow periods. This relationship suggested the source of nutrients to be from non-point sources. This same relationship was observed with fecal coliform bacteria. The geometric means for eight sampling events at each of the three stations were above the state water quality standard of 200 colonies/100 ml (849/100 ml, 495/100 ml and 222/100 ml). Hardness levels fluctuated between sampling events. Fluctuations in this parameter is unusual since this hardness is commonly determined by the surrounding geography of a water body. Total residue levels also appeared to fluctuate with hardness values. Neither parameter concentrations appeared to increase with rainfall, which indicated that their sources might be related to a point source discharge. Further monitoring was recommended to determine the cause.

Aquatic Toxicity Monitoring

Four facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Albemarle WWTP, Carolina Solite Corp.-002, Norwood WWTP and

Oakboro WWTP. The Albemarle WWTP had several test failures in 1995 and one failure in January 1996. Oakboro WWTP experienced two consecutive failures in 1996.

4.3.14 Richardson and Lanes Creeks Watershed (Subbasin 03-07-14)

Description

This subbasin includes the catchments of Richardson and Lanes Creek, two large tributaries of the Rocky River (Figure 4.37). Monroe is the largest urban area in this subbasin. Small headwater reaches and tributaries of both Richardson and Lanes Creeks have various water supply classifications, but reaches of both catchments are classified as C waters.

Most of the streams in this subbasin are described as slate belt streams and generally have large bedrock ledges and boulder/rubble dominated substrates. Erosion from slate belt soils can produce high turbidity from inputs of suspended clays, but little sandy material accumulates as bedload. Small streams in this subbasin are similar to other small slate belt streams in that they tend to dry up, or are reduced to a series of small pools during low flow periods.

Overview Of Water Quality

Numerous confined animal feeding operations (CAFOs) are found in the Richardson and Lanes Creek catchments . For example, Union County (which is within this subbasin) has 66 CAFOs compared to 30 in Anson County, 16 in Cabarrus County, and 23 in Stanly County. Swine operations comprise 74% of these operations. All of the monitoring locations surveyed during the 1996 benthic basinwide investigation had prolific growths of filamentous green algae, indicating that these streams are receiving large inputs of nutrients.

There are 17 permitted dischargers in the subbasin and only the Monroe WWTP is a major discharger. DWQ maintains one ambient monitoring location in this subbasin: Richardson Creek at SR 1649 near Fairfield, located below the Monroe WWTP. Unusually high nutrient values have been collected from this location. Despite the low number of nutrient samples collected (n=8) median total phosphorus and median nitrate/nitrite-nitrogen concentrations were extremely high. Benthic macroinvertebrate samples from this location have consistently produced Fair bioclassifications. The substrate at this location was covered with prolific growths of algae, also illustrating the effects of nutrient loading. A Good/Fair bioclassification was given to the most downstream location on Richardson Creek in 1996, suggesting that some recovery is taking place. A similar trend was observed in Lanes Creek. A Poor bioclassification was assigned to an upstream collection location and a Fair bioclassification at a site near the confluence with the Rocky River. Macroinvertebrate sampling for a nonpoint source study in 1988 and 1989 found Fair water quality at several sites in the upper Lanes Creek watershed.

Good ecological health ratings were given to two sites in this subbasin based on fish community analyses. These two sites are Negrohead Creek, a small tributary of Richardson Creek, and a site on Lanes Creek near the confluence of the Rocky River. Seven specimens of the Carolina darter (a species of Special Concern) were collected at the Lane Creek location.

Lakes Assessment Program

Lake Monroe

Lake Monroe is a secondary water supply for the City of Monroe and is also used for recreation. Richardson Creek is the main tributary to the lake. The drainage area consists of rolling hills with forested and cultivated land uses. Lake Monroe was eutrophic and fully supporting its designated uses when sampled on September 7, 1995. Lake Monroe was previously sampled on August 9, 1989 by DWQ. See Section 4.2.3 for more detailed characteristics of Lake Monroe.

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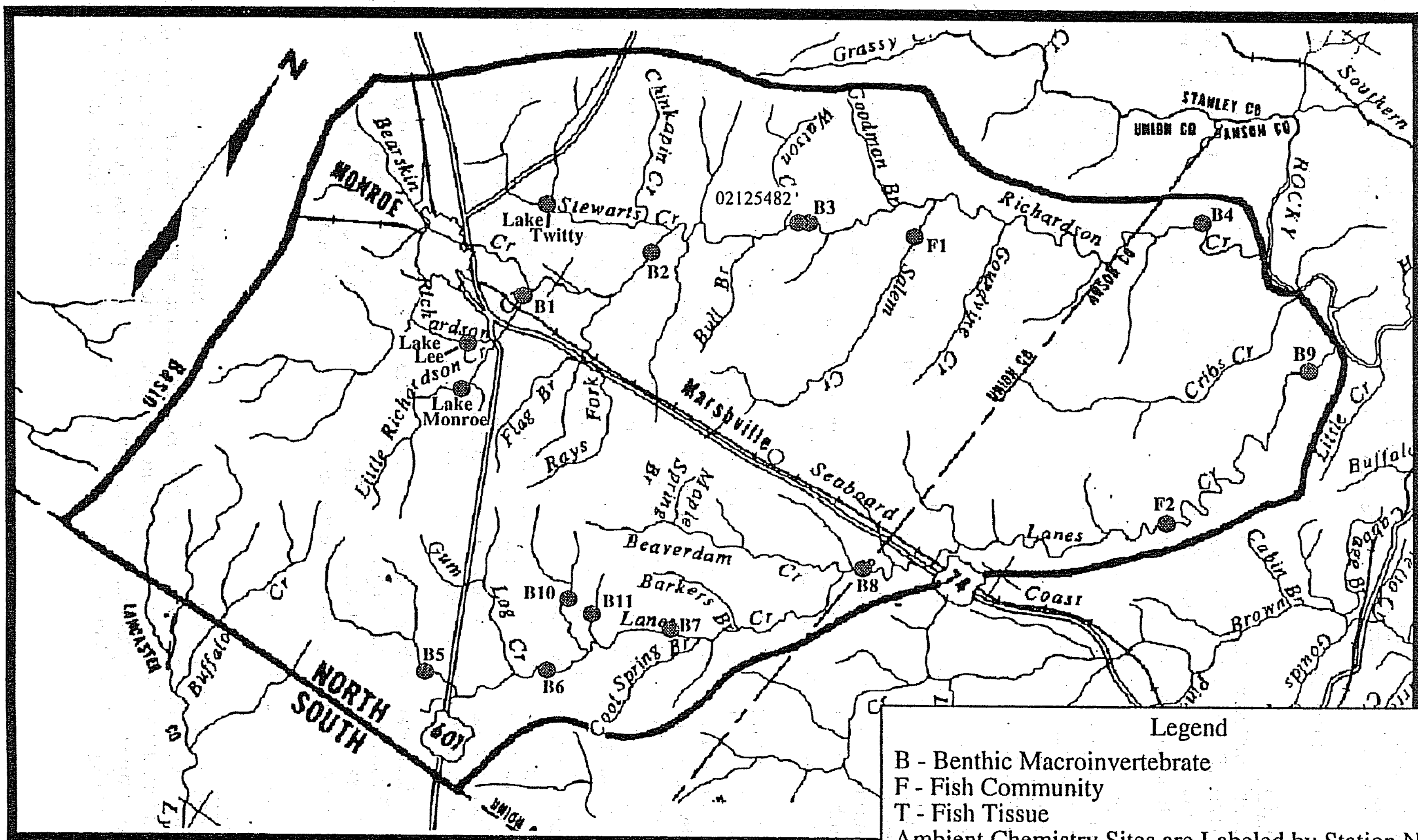

Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.37 Sampling Location in the Richardson and Lanes Creeks Watershed (Subbasin 03-07-14)

Lake Lee

Lake Lee is a secondary water supply for the City of Monroe. Land use consists of forested and agricultural regions along with some urban/residential areas. Richardson Creek is the major inflow to Lake Lee. See Section 4.2.3 for more detailed characteristics of Lake Lee.

Lake Lee was sampled on September 7, 1995. The lake was approximately three feet below normal due to construction work on the dam. Consequently, observed water quality conditions of the lake may not have been truly representative. Surface scum, low Secchi values, and a greenish water color were observed. Surface dissolved oxygen was elevated (11.1 mg/l) at the most upstream of the three stations. This value is equal to 134% dissolved gases, exceeding the water quality standard for percent total dissolved gases (110%). Elevated dissolved oxygen is often an indicator of increased algal activity. In response to the surface value at the sampling station in the Richardson Creek arm of the lake, a phytoplankton sample was collected. Analysis of the sample indicated a bloom of predominantly green and blue-green algae. Lake Lee is a particularly enriched waterbody with the potential for water quality problems. Lake Lee was eutrophic and the lake is considered threatened due to a documented algal bloom and violations of the water quality standard for total dissolved gases.

Lake Lee was previously sampled by DWQ on August 9, 1989. The lakewide mean chlorophyll a value (51 µg/l) was greater than the state water quality standard of 40 µg/l. The highest value (69 µg/l) was observed at the sampling site near the dam. As in 1995, past sampling of Lake Lee has shown particularly high phytoplankton biovolume and density. Metals were below DWQ laboratory detection levels except for aluminum, iron and manganese. The manganese concentration was greater than the state water quality standard of 200 µg/l. In 1989, Lake Lee was hypereutrophic.

Lake Twitty (Lake Stewart)

Lake Twitty is owned by the City of Monroe as a water supply reservoir and is also used for recreation. The main tributaries to the lake are Stewart Creek and Chinkapin Creek. The drainage area for Lake Twitty is predominately forested and agricultural areas. See Section 4.2.3 for more detailed characteristics of Lake Twitty.

When sampled by DWQ on August 9, 1989, the lake was eutrophic. Lake Twitty was most recently sampled by DWQ on August 30, 1995. The percent oxygen saturation was greater than the state standard of 110% for dissolved gases at all three sampling stations, with a mean surface dissolved oxygen saturation of 144%. The lake was eutrophic when sampled. Many houses and fields, including both pastureland and cornfields, were observed around the shoreline of the lake indicating possible sources for the high nutrients and correspondingly eutrophic conditions found. The uses of Lake Twitty were determined to be threatened due to dissolved oxygen saturation standards violations at each of the lake sampling sites.

Aquatic Toxicity Monitoring

Two facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Monroe WWTP and Teledyne-Allvac.

4.3.15 Little River Watershed (Subbasin 03-07-15)

Description

This subbasin contains the Little River and its tributaries (Figure 4.38) to the Pee Dee River. The land is mostly forested, with a large portion of the subbasin within the Uwharrie National Forest. The Town of Troy is the largest urban area in the subbasin.

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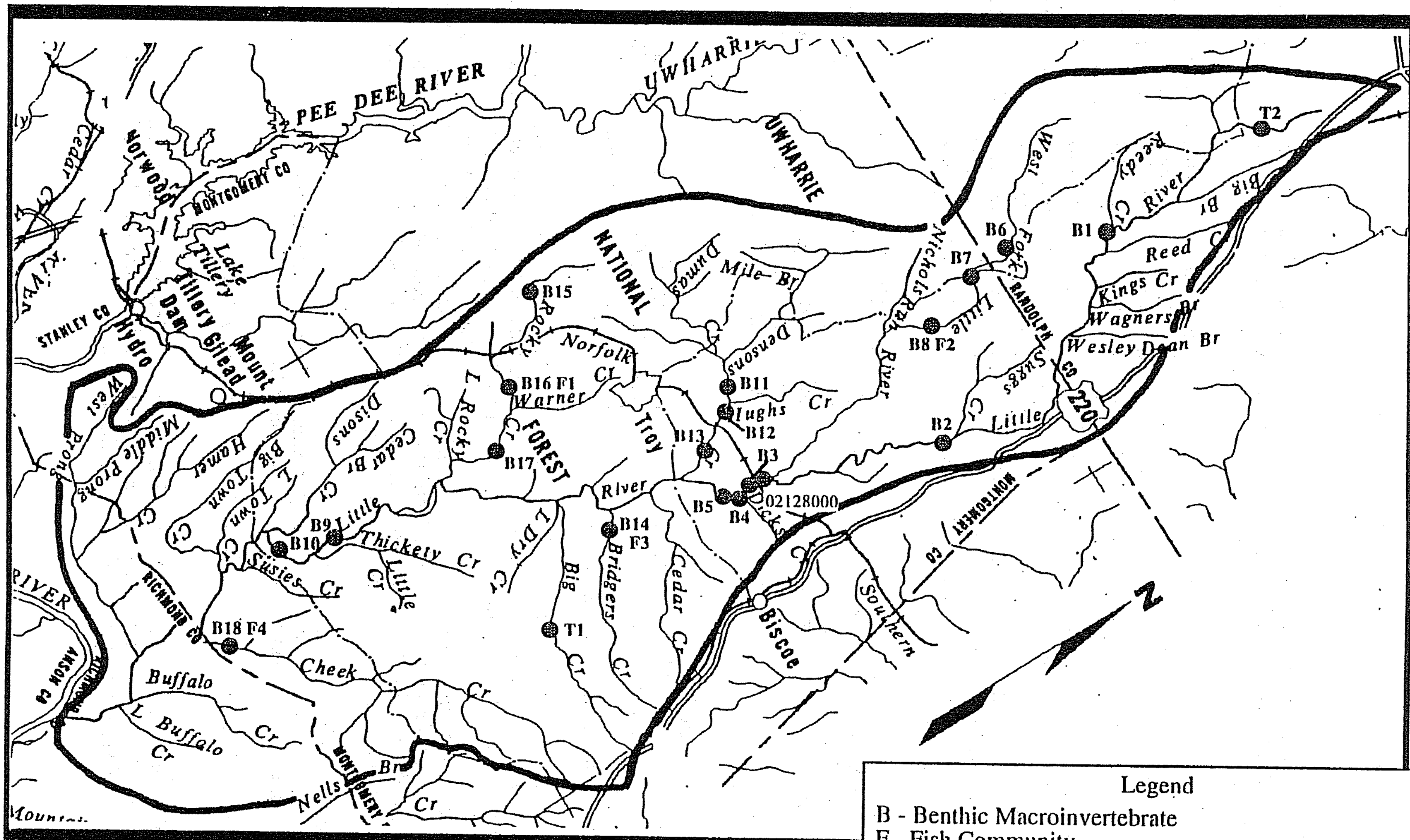


Legend
B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.38 Sampling Locations in the Little River Watershed (Subbasin 03-07-15)

Overview Of Water Quality
According to macroinvertebrate data, water quality in the Little River drainage varies from Good-Fair at an upper reach site in 1989, to Excellent in the middle sections (currently HQW from Suggs Creek to Densons Creek)) to Good in the lower portion. Nonpoint runoff appears to affect the upper sections while the lower portion is impacted by Troy WWTP (to Densons Creek) and Biscoe WWTP (to Hickory Branch) and nonpoint runoff. Both facilities are currently passing self-monitoring toxicity tests. Monthly water chemistry samples from an ambient site on the Little River near Star indicated elevated levels of phosphorus between 1994 and 1995.

Other HQW streams include Bridgers Creek, all but the lower segment of Densons Creek, and the lower portion of Rocky Creek. Recent macroinvertebrate data has indicated Excellent water quality in the West Fork Little River as well. Good-Fair bioclassifications observed in Cheek Creek suggest further influences from nonpoint runoff.

Fish community assessments were performed at four sites during 1996. Fish ratings correlated well with bioclassifications provided in macroinvertebrate studies and ranged from Fair in Rocky Creek to Good-Excellent in Bridgers Creek. A lower fish rating in Rocky Creek indicated effects from habitat degradation or recent disturbances. Bridgers Creek was one of six streams in the Yadkin basin rated as high as Good-Excellent during 1996 assessments.

Fish tissue assessments were performed at two sites within the subbasin since 1985. Metals contaminants were examined in fish from Big Creek and the Little River. All metals results were lower than FDA and EPA criteria.

Potential HQW/ORW Streams
Macroinvertebrate results from West Fork Little River at SR 1311 indicated Excellent water quality at the site. Based on this information, the stream could be evaluated for HQW reclassification if petitioned.

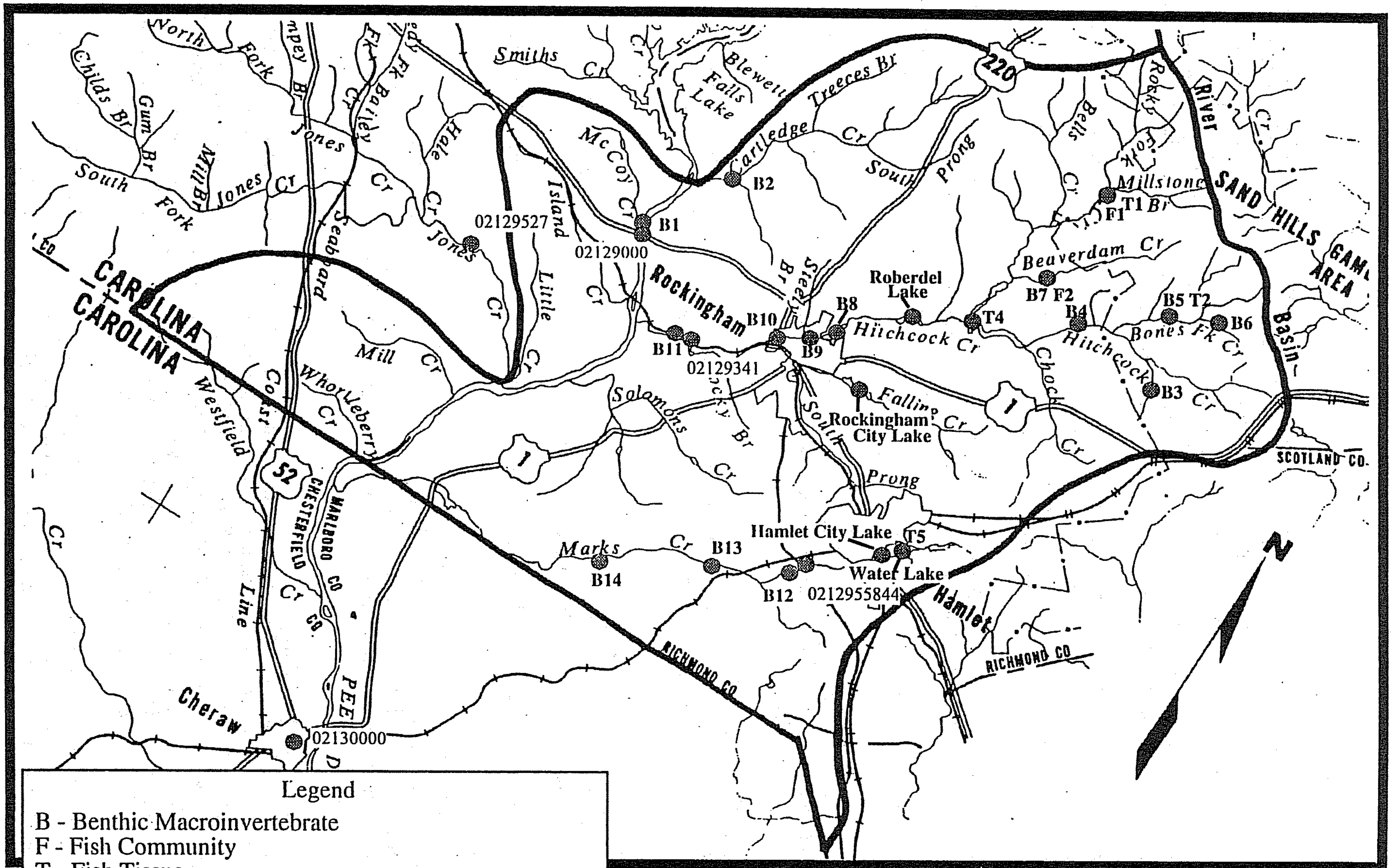
Aquatic Toxicity Monitoring
Two facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Biscoe WWTP and Troy WWTP.

4.3.16 Pee Dee River Mainstem and Hitchcock Creek (Subbasin 03-07-16)

Description
This subbasin consists of the segment of the Pee Dee River from below Blewett Falls Lake to the South Carolina state line (Figure 4.39). With the exception of the Towns of Rockingham and Hamlet, most of the land use in the subbasin is forest or agriculture. Most of the subbasin is located within the piedmont ecoregion, but streams in the northeast portion drain the sandhills region of the coastal plain.

Overview Of Water Quality
Streams and lakes in this subbasin showed a wide range in water quality from Poor to Excellent and included a fish consumption advisory on one of the lakes for mercury. Ambient water chemistry data from the Pee Dee River at US 74 at Rockingham showed occasional exceedence of state water quality standards for dissolved oxygen (4 mg/l, instantaneous) and action levels for copper. Turbidity measurements on occasion were also elevated and approached the state standard. Benthic macroinvertebrate data has shown water quality at this site to be Good-Fair from 1985 to 1990. This site is in the regulated reach of the Pee Dee River below Blewett Falls dam.

A macroinvertebrate site in the lower reaches of Hitchcock Creek received a Poor bioclassification, compared to a Good rating at an upstream sandhills site. This site is below several NPDES permitted discharges (Laurel Hill Paper, Burlington Industries, and the Rockingham WWTP).



Legend

B - Benthic Macroinvertebrate
F - Fish Community
T - Fish Tissue
Ambient Chemistry Sites are Labeled by Station Number
Lake Sites are Labeled with the Lake Name

Figure 4.39 Sampling Locations in the Pee Dee River Below Blewett Falls Lake and Hitchcock Creek Watershed (Subbasin 03-07-16)

Water chemistry data also showed evidence of significantly impaired water quality. Other large dischargers in this subbasin include Hamlet WWTP (to Marks Creek) and Anson County Regional WWTP (to Pee Dee River). Macroinvertebrate data from Marks Creek, above the Hamlet WWTP showed improvement from Fair in 1991 to Good-Fair in 1996. Sampling below the WWTP in 1991 did not clearly indicate impacts solely from the WWTP.

Beaverdam Creek, Bones Fork Creek, and Rocky Fork Creek, have been rated as Good-Excellent or Excellent based on either benthic macroinvertebrate or fish community data between 1984 and 1996. These streams lie within the relatively protected watersheds of the Sandhills Game Area.

Potential HQW/ORW Streams

Three streams in this subbasin, Beaverdam Creek, Bones Fork Creek, and Rocky Fork Creek, have been rated as Good-Excellent or Excellent based on either benthic macroinvertebrate or fish community data between 1984 and 1996. The streams' relatively protected watersheds lie within the Sandhills Game Area and, if petitioned, these streams could be resurveyed to determine their qualification for High Quality Water status.

Fish Tissue Analysis

Fish tissue samples have been collected at six sites within this subbasin. One site was sampled in 1996. Significant mercury contamination was identified at Ledbetter Lake in Richmond County during sampling in 1993. Over half of the samples collected from Ledbetter contained mercury exceeding FDA and/or EPA limits. Five bowfin samples collected from the PeeDee River near Rockingham also contained mercury above the FDA or EPA limits.

Lakes Assessment Program

Roberdel Lake

Roberdel Lake is the primary water supply reservoir for the City of Rockingham. The lake is dystrophic with characteristics of a blackwater/cypress swamp lake. The main tributary to the lake is Hitchcock Creek. The watershed consists of mostly forested areas with some residential area close to the lake. See Section 4.2.3 for more detailed characteristics of the lake.

Most recent sampling of Roberdel Lake by DWQ occurred on August 24, 1995. Roberdel lake was fully supporting designated uses. When previously sampled by DWQ on August 9, 1989, this lake was found to be dystrophic. An iron value of 1200 µg/l was found at the station near the dam. This value was greater than the state standard of an action level of 1.0 mg/l (1000 µg/l).

Rockingham City Lake

Rockingham City Lake is a secondary water supply reservoir for the City of Rockingham. The lake is used for approximately one-third of the total water supply for the City. This lake is dystrophic with numerous aquatic macrophytes present. Observed land uses in the watershed include forested areas, agricultural areas consisting of crop production, and slight residential and urban development. See Section 4.2.3 for detailed characteristics of the lake.

Rockingham City Lake was sampled on August 19, 1992. Water quality characteristics consistent with the dystrophic nature of this lake were found. Macrophytes were observed covering from 25-50% of the total surface area of the lake in 1992.

Rockingham City Lake was sampled by DWQ on August 24, 1995. Water quality characteristics typical of a dystrophic lake were found. The lake appeared to be partially filled by accumulated sediment. This lake was determined to be Partially Supporting its designated use as a water supply due to nuisance levels of aquatic macrophytes and sedimentation which has reduced the lake's capacity.

Water Lake

Water Lake is the water supply reservoir for the City of Hamlet. The watershed is relatively undisturbed. The main tributary to the lake is Mark's Creek. See Section 4.2.3 for more information on Water Lake.

Water Lake was sampled by DWQ as part of the ambient lakes program on August 9, 1989. Percent oxygen saturation at one of the two sampling sites (133.2%) was greater than the state water quality standard of 110% for dissolved gasses. On this date, the lake was oligotrophic.

In 1991 and 1992, Water Lake was sampled three times each year as a reference lake for the purpose of obtaining data from a lake in the sandhills region with good water quality. When it was discovered during the sampling period that the lake had been treated several times with copper sulfate, a recommendation was made not to use Water Lake as a reference lake.

Water Lake was sampled by DWQ on August 24, 1995 and was mesotrophic. The uses of Water Lake were determined to be fully supporting since nutrient data from only one of the two lake sampling stations was evaluated and were not considered to be representative of the lake.

Hamlet City Lake

Hamlet City Lake is a small, shallow lake located in Hamlet. The area immediately around the lake drains urban areas, however most of the drainage basin is undeveloped. The lake has had historical water quality problems related to aquatic macrophytes and sedimentation. Future restoration of the lake is planned to help alleviate these problems. See Section 4.2.3 for detailed characteristics of the lake.

Since its construction in the mid-1930's, Hamlet City Lake has received runoff from the urbanized drainage area which contributed to sedimentation of the lake. Between 1958 and 1960, the lake was drained and accumulated sediments were excavated (USACOE, February 1989). In the mid-1980's, local officials of the Town of Hamlet actively pursued recreational development of Hamlet City Lake. The Army Corps of Engineers (Wilmington District), surveyed the lake in 1988 to determine sediment thickness and types. This survey discovered the presence of hydrocarbon compounds in lake sediment samples (USACOE, February 1989). Chemical and biological assessment of sediment samples from the lake determined that contaminants were of known ecological concern (i.e., USEPA priority pollutants). This raised a concern that runoff from sites where lake sediment would be deposited after removal from the lake bed might be potentially toxic to aquatic life (USACOE, May, 1990).

Hamlet City Lake was sampled by DWQ once in 1981, 1987, 1988, and 1990. Aquatic macrophyte coverage in the lake during these years ranged from 60% to 75%. The lake was mesotrophic during these years. In 1988, a value of 1.2 mg/l for iron was found at the most downstream station in the lake. This value was greater than the state water quality action level of 1.0 mg/l for iron. In 1990, iron was again greater than the state action level at the most downstream station in the lake.

Hamlet City Lake was most recently sampled by DWQ on August 24, 1995. The mean dissolved oxygen value was 5.2 mg/l and above the water quality standard of 4.0 mg/l. The mean surface pH value in the lake was 5.7 s.u. and was below the state standard of 6.0 standard units. These low values may be due to the swampy nature of this lake. Water lilies covered approximately 20% of the lake's surface area. The lake was eutrophic and Partially Supporting its designated uses as a water supply because of macrophytes and sedimentation which has reduced the depth and capacity of this lake.

In 1995, the Army Corps of Engineers prepared an Environmental Assessment for the removal of accumulated sediment and debris from Hamlet City Lake (USACOE, November 1995). While sediment removed from the lake would be deposited off-site, no mention was made of potential risks from the petrochemical and heavy metal contaminants in the sediment (Trumbower and Tyndall, 1996).

Aquatic Toxicity Monitoring
Five facilities in this subbasin currently monitor effluent toxicity as per a permit requirement. Those facilities are: Anson Co. WWTP, Burlington Ind.-Richmond, Hamlet WWTP, Laurel Hill Paper Co. and Rockingham WWTP.

4.3.17 Jones Creek Watershed (Subbasin 03-07-17)

Description
This subbasin contains the Jones Creek and Deadfall Creek catchments (Figure 4.40). Most of the middle and lower portions of the Deadfall Creek catchment are located in a section of the Carolina Slate Belt. The upper portions of both the North Fork and South Fork Jones Creek are also in the slate belt section. There are no large urban areas, with only the fringes of Wadesboro draining into the subbasin. Since the Anson County WWTP discharge was moved in 1995, there are no NPDES permitted dischargers in this subbasin. Land use in the area is primarily a combination of forest and agriculture.

Overview Of Water Quality
Streams evaluated with benthic macroinvertebrates in 1996 were classified as Fair (North Fork Jones Creek) or Good-Fair (Jones Creek and South Fork Jones Creek). Bailey Creek and Jones Creek showed signs of nutrient enrichment based on the fish community data (NCIBI ratings of Fair). The first collection of sea lampreys from the Yadkin River basin was made from Bailey Creek. Urban stormwater runoff from the Town of Wadesboro may be contributing aqueous copper concentrations in Jones Creek which are approaching state water quality action levels.

Lakes Assessment Program

Wadesboro City Pond
Wadesboro City Pond is the water supply reservoir for the City of Wadesboro. The drainage area for the lake is composed of mostly forested areas and some agricultural areas. The major inflow to the reservoir is North Fork Jones Creek. Wadesboro City Pond was sampled by DWQ on August 30, 1995 and August 9, 1989 and determined to be eutrophic but fully supporting its designated uses.

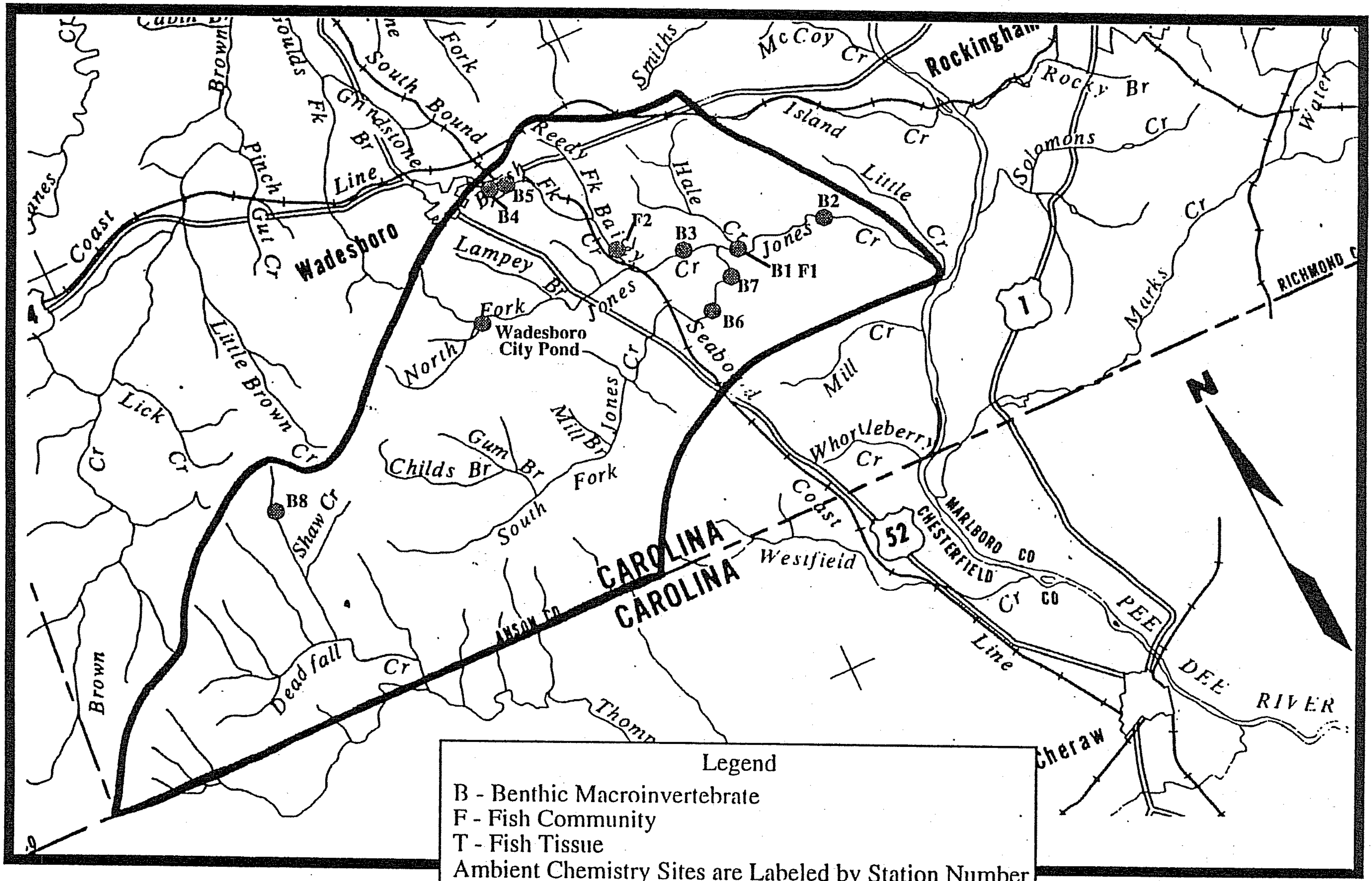


Figure 4.40 Sampling Locations in the Jones Creek Watershed (Subbasin 03-07-17)

4.4 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.4.1 Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a waterbody supports its designated uses (*use support* status) is another important method of interpreting water quality data and assessing water quality. Use support assessments for the Yadkin-Pee Dee River basin are presented in Section 4.5.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are fully supported, partially supported or are not supported. For instance, waters classified for fishing and water contact recreation (class C) are rated as fully supporting if data used to determine use support (such as chemical/physical data collected at ambient sites or benthic macroinvertebrate bioclassifications) did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as ST, PS or NS, depending on the degree of exceedence.

Streams rated as either partially supporting or nonsupporting are considered *impaired.* A waterbody is fully supporting but threatened (ST) for a particular designated use when it fully supports that use now, but may not in the future unless pollution prevention or control action is taken. This rating describes waters for which actual monitored or evaluated data indicate an apparent declining trend (i.e., water quality conditions have deteriorated, compared to earlier assessments, but the waters still support uses). Although these waters are currently supporting uses, they are treated as a separate category from waters fully supporting uses. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired. This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

4.4.2 Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for impaired waters. Data used in the use support assessments include biological data, chemical/physical data and lakes assessment data. Although there is a general procedure for analyzing the data and determining a waterbodys' use support rating, each stream segment is reviewed individually, and best professional judgment is applied during these determinations.

The use support ratings compiled by DWQ should be interpreted with caution. The methodology used to determine the ratings must be understood, as should the purpose for which the ratings were generated. The intent of this use-support assessment was to gain an overall picture of water quality, how well these waters support the uses for which they were classified, and the relative contribution made by different categories of pollution within the basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DWQ used the data mentioned above. The specific methodology used is presented in Appendix III.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important not to manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is the greatest source of water quality degradation. However, this does not mean that point source control measures are unnecessary. All categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

The threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to consider any source (or potential source) of pollution in developing appropriate management and control strategies. The potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

4.4.3 Assigning Use Support Ratings

At the beginning of each assessment, all data are reviewed by subbasin with the monitoring staff, and ratings are adjusted where necessary based on best professional judgment. Discrepancies between data sources are resolved during this phase of the process. For example, a stream may be sampled for both macroinvertebrate and fish community structure, and the bioclassification may differ from the NCIBI (i.e., the bioclassification may be S while the NCIBI may be PS). To resolve this, the final rating may defer to one of the samples (resulting in S or PS), or, it may be a compromise between both of the samples (resulting in ST).

After reviewing the existing data, ratings are assigned to the streams. If one data source exists for the stream, the rating is assigned based on the translation of the data value as discussed above. If more than one source of data exists for a stream, the rating is assigned according to the following hierarchy:

Benthic Bioclassification / Fish Community Structure
Chemical/Physical Data
Monitored Data > 5 years old
Compliance / Toxicity Data

This is only a general guideline for assigning use support ratings and not meant to be restrictive. Each segment is reviewed individually and the resulting rating may vary from this process based on best professional judgment which takes into consideration site specific conditions.

After assigning ratings to streams with existing data, streams with no existing data were assessed. Streams that were direct or indirect tributaries to streams rated S or ST received the same rating (with an evaluated basis) if they had no known significant impacts, based on a review of the watershed characteristics and discharge information. Streams that were direct or indirect tributaries to streams rated PS or NS were assigned a Not Evaluated (NE) rating.

4.4.4 Revisions to Methodology Since 1992 - 93 305(b) Report

Methodology for determining use support has been revised. In the 1992-1993 305(b) Report, evaluated information from older reports and workshops were included in the use support process. Streams rated using this information were considered to be rated on an evaluated basis. In the current use support process, this older, evaluated information has been discarded, and streams are now rated using only monitored information (including current and older monitoring data). Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

- If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.
- If a stream is a tributary to a monitored segment of a stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored segment rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

These changes resulted in a reduction in streams rated on an evaluated basis. In addition, fish consumption advisories are no longer used in determining the use support rating.

The basinwide process allows for concentrating more resources on individual basins during the monitoring phase. Therefore, more streams were monitored, and more information was available to use in the use support process.

4.5 USE SUPPORT RATINGS FOR THE YADKIN-PEE DEE RIVER BASIN

4.5.1 Streams and Rivers

Of the 5,991 miles of freshwater streams and rivers in the Yadkin-Pee Dee basin, use support ratings were determined for 91% or 5,408 miles with the following breakdown:

	Miles	Percent of Total
SUPPORTING	**4930**	**82%**
Fully supporting:	(2436)	(41%)
Support-threatened:	(2494)	(41%)
IMPAIRED	**478**	**9%**
Partially supporting:	(383)	(7%)
Not supporting:	(95)	(2%)
NOT EVALUATED:	**584**	**9%**

Although the majority of the streams have good to excellent bioclassifications and very few standards were violated at the ambient stations, nonpoint source effects such as increased sedimentation, were evident at many of the sampling sites. Table 4.8 provides information on streams and stream segments that were monitored. This includes bioclassification and collection date for macroinvertebrate samples, fish community structure bioclassification, ambient monitoring station information, problem parameters such as sediment, potential sources of pollution (point or nonpoint), and the overall use support rating.

Table 4.9 presents the use support determinations by subbasin and Figures 4.41 and 4.42 are color maps showing use support for all monitored and evaluated waters in the basin.

Potential sources of impairment, as summarized in Table 4.10, are based on the best available information and previous assessments. When a stream segment had more than one source listed, the total stream segment information was added to each source. This means that the miles of stream impaired by the combination of all sources may be more than the total miles of partially supporting or not supporting streams. As an example, if a 10-mile long stream segment was rated impaired as a result of both point sources and urban runoff, then 10 miles would be entered under both the urban column and point source column. Where the sources of impairment could not be identified, mileage for that segment was entered in the source unknown column.

Information on sources of impairment indicated that all 478 miles of impaired streams were impaired by nonpoint sources and 167 miles (35%) were impaired by point sources. Agriculture was the most widespread nonpoint source, followed by urban runoff and construction.

4.5.2 Lakes

Use support ratings were determined for 29 reservoirs in the Yadkin-Pee Dee River basin. Table 4.11 shows the use support determinations for each lake sampled in each subbasin. Of these, 22 fully supported their uses, four were support threatened, two were partially supporting (Rockingham City Lake and Hamlet City Lake) and one was not supporting (Long Lake).

							Chem	<----------Benthic---------->					Fish Comm.		Overall		Potential
	Station	Station					Rating	Bioclassification					Bioclass	Problem	Use Suport		Sources
Name of Stream	Number	Location	Class	Index #	Waterbod	Miles	92-96	92	93	94	95	96	92-96	Parameter	Rating	Basis	(P,NP)
YADKIN RIVER	02111000	Yadkin River amb/bugs at Patterson, NC Hwy 2	C Tr	12-(1)	30701	34.3	S					Good	Good		S	M	NP
YADKIN RIVER			WS-IV Tr	12-(25.5)	30701	2.2									S	ME	NP
Dennis Creek		Dennis Creek at SR 1372, Caldwell Co.	C Tr	12-7	30701	3.4						Good	Fair-Good		S	M	NP
Buffalo Creek		Buffalo Cr, be Buffalo Cove, & SR 1504, Caldwe	C Tr	12-19	30701	14.8						Excellent			S	M	NP
Laurel Creek		Laurel Creek, off SR 1508 at mouth, Wilkes	C Tr ORW	12-24-8	30701	3.4							Good		S	M	
Elk Creek	02111180	Elk Creek amb. at Elkville, NC 268, bugs at SR	B ORW	12-24-(10)	30701	8.8	S					Good			S	M	
Beaver Creek		Beaver Cr fish at SR 1131 Wilkes	C Tr	12-25	30701	9.6							Fair	Sed	ST	M	NP
Stony Fork		Stony Fork Cr, off SR 1500, Watauga	C Tr	12-26-(1)	30701	10.9						Good			S	M	
Stony Fork		Stony Fork Cr, SR 1135, Wilkes	C	12-26-(7)	30701	15.2						Excellent		Sed	S	M	NP
Stony Fork			WS-IV	12-26-(11)	30701	1.5								Sed	S	ME	NP
YADKIN RIVER (W. Kerr Scott Res)		Lakes Data	WS-IV&B Tr	12-(27)	30701	5.8									S	M	
North Prong Lewis Fork		N Pr Lewis Fk, fish/bugs SR 1304, Wilkes	WS-IV	12-31-1-(5.5)	30701	7.6						Good	Good	Sed	S	M	NP
South Prong Lewis Fork		South Prong Lewis Fork US 421, Wilkes	C Tr	12-31-2-(1)	30701	10.1					Good			Sed	S	M	NP
South Prong Lewis Fork		S Pr Lewis Fk SR 1154, Wilkes	WS-IV	12-31-2-(7)	30701	4.7							Good		S	M	NP
South Prong Lewis Fork			C	12-31-2-(6)	30701	1.3									S	ME	NP
YADKIN RIVER			WS-IV	12-(34)	30701	2.8									S	ME	
YADKIN RIVER			WS-IV CA	12-(36.5)	30701	0.5									S	ME	
YADKIN RIVER	02112000	Yadkin River amb. & bugs at 18/268 N. Wilkesb	C	12-(38)	30701	11.2	S		Good-Fair/Good			Good		Sed	S	M	
Moravian Creek		Moravian Cr. NC 18 Wilkes	C	12-39	30701	11.0						Good-Fair		Sed	ST	M	NP
North Fork Reddies River		N Fk Reddies River SR 1501, Wilkes	WS-II Tr	12-40-4	30701	11.3							Good		S	M	
Mulberry Creek		Mulberry Cr, NC 268, Wilkes	C	12-42	30701	19.2						Excellent			S	M	
YADKIN RIVER	02112152	Yadkin River below ABT & SR 2327 at Roaring F	WS-III	12-(45)	30701	13.5	ST		Good-Fair					Sed,Fecal	ST	M	NP
Roaring River	02112120	Roaring River,SR 1990, Wilkes	B	12-46-(0.5)	30701	7.4	S					Excellent			S	M	
Roaring River			WS-IV&B	12-46-(5.5)	30701	3.3									S	ME	
Basin Creek		Basin Creek at SR 1730, Wilkes Co.	C Tr ORW	12-46-2-2	30701	6.3							Good-Excellent		S	M	
Middle Prong Roaring River		Middle Prong Roaring River SR 1002, Wilkes	C	12-46-2-(6)	30701	3.4							Good-Excellent		S	M	
Garden Creek		Garden Creek at SR 1739, Wilkes Co.	C Tr HQW	12-46-4-6	30701	4.9							Fair-Good		S	M	
YADKIN RIVER	02112250	Yadkin River at US 21 Elkin, Yadkin Co.	C	12-(53)	30702	21.6	S					Good-Fair		Sed	ST	M	NP
Mitchell River		Mitchell River above and below Sams Branch, fi	B Tr ORW	12-62-(1)	30702	8.9						Excell	Good-Excellent		S	M	
Mitchell River		Mitchell River at SR 1315, Surry Co.	C Tr ORW	12-62-(7)	30702	7.3									S	ME	
Mitchell River			C ORW	12-62-(12)	30702	4.2									S	ME	
Mitchell River		Mitchell River at 1001 & I-77, Surry Co.	C	12-62-(12.5)	30702	7.6						Good			S	M	
Snow Creek		Snow Fork at SR 1121, Surry Co.	C	12-62-15	30702	9.9						Good			S	M	
Fisher River		Fisher River US 601 & NC 268 Surry	C	12-63-(9)	30702	21.4						Good		Sed	S	M	NP
Fisher River			WS-II CA	12-63-(8.5)	30702	1.0								Sed	S	ME	NP
Little Fisher River		L Fisher R SR 1480, Surry	C	12-63-10-(2)	30702	8.8						Good	Good	Sed	S	M	
Little Beaver Creek		Little Beaver Creek at NC 268 Yadkin	C	12-63-13a	30702	2.9									ST	ME	NP
Cody Creek		Cody Cr NC 268 Surry	C	12-63-14	30702	6.9							Good		S	M	
YADKIN RIVER	02116500	Yadkin River at US Hwy 64	WS-IV CA	12-(97.5)	30702	0.8	S								S	M	
YADKIN RIVER (including	02115360	Yadkin R SR 1003 nr Siloam,Surry , amb at SR	WS-IV	12-(67.5)	30702	12.3	S					Good-Fair			ST	M	
YADKIN RIVER			WS-IV CA	12-(78.3)	30702	0.5									ST	ME	
YADKIN RIVER			WS-IV	12-(78.7)	30702	5.8									ST	ME	
Little Yadkin River	02114450	Little Yadkin River at SR 1236, Stokes	WS-IV	12-77a	30702	1.2	PS					Good-	Good	Turb	ST	M	NP
Little Yadkin River		Little Yadkin River at SR 1104 nr Dalton, Stoke	WS-IV	12-77b	30702	2.0		Good		Good					S	M	NP
West Prong Little Yadkin		West Prong Little Yadkin at SR 1160	WS-IV	12-77-1-(2)	30702	4.2									ST	M	
East Prong Little Yadkin		East Prong Little Yadkin at SR 1220	B	12-77-2-(1)	30702	3.5		Good-Fair		Good-Fair					ST	M	NP
East Prong Little Yadkin		East Prong Little Yadkin at Stokes SR 1166 &	WS-IV&B	12-77-2-(2)	30702	5.2				Good-Fair					ST	M	NP
Danbury Creek			WS-IV	12-77-3	30702	4.4									ST	M	NP
Forbush Creek		Forbush Creek SR 1570, Yadkin Co.	WS-IV	12-83-(0.7)	30702	10.0						Good-Fair		Sed	ST	M	NP
Logan Creek		Logan Cr, SR 1571, Yadkin Co	WS-IV	12-83-2-(0.7)	30702	7.6						Good-Fair		Sed	ST	M	NP
North Deep Creek		N Deep Cr SR 1503, NC 601, Fish at SR 1605 \	C	12-84-1-(0.5)	30702	12.8			Good-Fair				Fair		ST	M	
North Deep Creek		N Deep Cr SR 1510, Yadkin Co	WS-IV	12-84-1-(2.5)	30702	6.4			Good-Fair			Good-Fair			ST	M	
South Deep Creek		S Deep Cr SR 1152, Yadkin Co	WS-III	12-84-2-(1)	30702	12.1							Fair-Good	Sed	S	M	NP
South Deep Creek		S Deep Cr SR 1710, Yadkin Co	WS-IV	12-84-2-(5)	30702	6.6						Good		Sed	S	M	NP
South Deep Creek			WS-III CA	12-84-2-(4.5)	30702	0.5	I							Sed	S	ME	NP

Table 4.8 Use Support Information for Monitored Stream Segments in the Yadkin-Pee Dee River Basin (Sheet 2 of 4)

Name of Stream	Station Number	Station Location	Class	Index #	Waterbod	Miles	Chem Rating 92-96	Benthic Bioclassification 92	93	94	95	Fish Comm. 96	Fish Comm. Bioclass 92-96	Problem Parameter	Overall Use Suport Rating	Basis	Potential Sources (P,NP)
Ararat River		Arrat River at NC 104, Surry Co.	WS-IV Tr	12-72-(1)	30703	2.4						Good-Fair		Sed	ST	M	NP
Johnson Creek			WS-IV Tr	12-72-3	30703	1.8									ST	ME	NP
Ararat River			WS-IV	12-72-(4)	30703	0.3									ST	ME	
Ararat River			WS-IV	12-72-(4.2)	30703	0.5								Sed	ST	ME	NP
Ararat River		Ararat River at US 52, ab WWTP, Surry	C	12-72-(4.5)a	30703	4.2				Good-Fair				Sed	ST	M	
Ararat River		Ararat River be Mt Airy WWTP	C	12-72-(4.5)b	30703	10.3				Fair				Sed	PS	M	NP,P
Ararat River	02113850	Ararat River at SR 2026 at Ararat, Surry	C	12-72-(4.5)c	30703	9.3	ST					Good-Fair		Sed ,Fecal	ST	M	NP
Ararat River	02114101	Ararat River at SR 2080 near Siloam, Surry	C	12-72-(18)	30703	4.5	ST					Good-Fair		Sed ,Fecal	ST	M	NP
Lovills Creek (Lovell		Lovills Creek at SR 1700, Surry Co.	WS-IV	12-72-8-(1)	30703	2.6						Good-Fair			ST	M	
Lovills Creek (Lovell		Lovills Creek at SR 1371, Surry Co.	C	12-72-8-(3)	30703	4.2						Fair			PS	M	NP
Stewarts Creek		Stewarts Creek at SR1622, Surry Co.	WS-IV Tr	12-72-9-(1)	30703	5.1							Good-Excellent	Sed	S	M	NP
Stewarts Creek		Stewarts Cr, NC 89, Surry	WS-IV	12-72-9-(4)	30703	4.0						Good-Fair		Sed	ST	M	NP
Stewarts Creek		Stewarts Cr SR 2258, Surry	C	12-72-9-(8)	30703	7.3						Good-Fair			ST	M	
Stewarts Creek			WS-IV CA	12-72-9-(7.5)	30703	0.8									ST	ME	
Flat Shoal Creek		Flat Shoal Creek at SR 1827, Surry Co.	C	12-72-13	30703	8.2						Excellent			S	M	
Heatherly Creek		Heatherly Creek above WWTP	C	12-72-14-5a	30703	1.7				Fair					PS	M	NP
Heatherly Creek		Heatherly Creek below WWTP and Hwy 52	C	12-72-14-5b	30703	1.7				Poor					NS	M	NP,P
YADKIN RIVER (Including	02121031	Yadkin River at NC 150 near Spencer, Lakes - S	WS-IV	12-(108.5)	30704	12.5	PS							Turb	ST	M	
YADKIN RIVER (Including	upper portion of	High Rock Lakes - ST	WS-IV&B	12-(114)	30704	6.2									ST	M	
YADKIN RIVER (Tuckertown	02122500	Yadkin River at SR 1002 at High Rock Lake, Tuc	WS-IV&B CA	12-(124.5)	30704	17.6	PS							DO	S	M-lakes	
YADKIN RIVER		Yadkin River at SR-1447 Forsyth	WS-IV	12-(93.5)	30704	12.8									S	ME	
Muddy Creek	02115860	Muddy Creek SR 1898, & SR-2995, fish at SR	C	12-94-(0.5)	30704	26.3	ST					Good-	Fair	Sed,Fecal	ST	M	NP
Muddy Creek			WS-IV	12-94-(12.5)	30704	5.3								Sed	ST	ME	NP
Reynolds Creek		Reynolds Creek, below Sequola WWTP, Forsyth	C	12-94-9b	30704	1.7				Fair					PS	M	NP,P
Reynolds Creek		Reynolds Creek, ab Sequola WWTP, Forsyth	C	12-94-9a	30704	1.7				Good					S	M	NP
Salem Creek (Middle Fork, Muddy Cr, Salem		Salem Cr, SR 1657, ab lake, Forsyth	WS-III CA	12-94-12-(1)	30704	2.7						Good-Fair			ST	M	NP
Salem Creek (Middle Fork	02115856	Salem Cr SR 1902 & SR 1991	C	12-94-12-(4)	30704	11.7	ST					Fair		Fecal,Turb	PS	M	NP
South Fork Muddy Creek		S Fk Muddy Cr SR 2902, Forsyth	C	12-94-13	30704	14.5						Good-Fair		Sed	ST	M	NP
Grants Creek	02120975	Grants Creek at Spencer, off SR-1910 Rowan	C	12-110	30704	17.9	PS					Good-Fair		Fecal, Turb	PS	M	P,NP
Crane Creek	0212140080	Crane Cr at SR 2168 nr Duke NC	C	12-115-(2)	30704	13.3	PS							Sed,Chla,	ST	M-Lake	NP
Town Creek		Town Creek SR 1526 Rowan	C	12-115-3a	30704	6.5							Good	Sed	S	M	NP
Dutchman Creek		Dutchman Creek NC 801, Davie Co	WS-IV	12-102-(15.5)	30705	7.5						Good		Sed	S	M	
Dutchman Creek		Dutchman Creek US 158 Davie Co	C	12-102-(2)	30705	20.0						Good	Good-Fair	Sed	ST	M	
Cedar Creek		Cedar Creek SR 1437, Davie Co.	C	12-102-13-(2)b	30705	0.5							Good		S	M	
Cedar Creek		Cedar Creek below Quarry at I 40, Davie Co.	C	12-102-13-(2)c	30705	3.4						Good-Fair			ST	M	
South Yadkin River		South Yadkin River SR 1561, Iredell Co	WS-IV	12-108-(5.5)	30706	14.2						Excell	Fair		ST	M	
South Yadkin River	02118000	South Yadkin River SR 1159, Davie Co	WS-IV	12-108-(12.5)	30706	14.5	PS					Good		Fecal,Turb	ST	M	
South Yadkin River			WS-II	12-108-(1)	30706	16.6									ST	ME	
South Yadkin River			WS-II CA	12-108-(5.3)	30706	0.6									ST	ME	
South Yadkin River		South Yadkin River SR-1561, Iredell Co	WS-IV CA	12-108-(9.3)	30706	0.5									ST	ME	
South Yadkin River			WS-IV	12-108-(9.7)	30706	27.4									ST	ME	
South Yadkin River			WS-IV CA	12-108-(19)	30706	0.7									ST	ME	
South Yadkin River			WS-IV	12-108-(19.5)	30706	9.0									ST	ME	
Rocky Creek (Rocky River)		Rocky Creek at SR 1862, SR 1884, SR 1890 Ire	C	12-108-11	30706	42.3						Good		Sed	S	M	NP
Patterson Creek		Pattern Creek at SR 1890, SR 1892, Iredell Co.	C	12-108-11-3	30706	10.5						Good			S	M	
Hunting Creek	02118500	Hunting Creek amb at SR 2115, bugs at SR 24	WS-III	12-108-16-(0.5)	30706	48.7	PS	Good	Excellent			Excell	Good	Sed,Fecal,	ST	M	NP
Hunting Creek		Hunting Creek at NC 64	WS-III CA	12-108-16-(11)	30706	0.7									S	ME	NP
Sam Branch			WS-III	12-108-16-2-1	30706	2.1									ST	M	
North Little Hunting		North Little Hunting Cr SR 1829, Iredel	WS-III	12-108-16-6	30706	23.9						Excellent		Sed	S	M	NP
Bear Creek		Bear Creek US 64, Davie Co	C	12-108-18-(1)	30706	4.2				Good-Fair					ST	M	NP
Bear Creek		Bear Creek SR 1139 & SR 1116, Davie Co	WS-IV	12-108-18-(1.5)	30706	6.4									ST	ME	NP
Fourth Creek	YAD108E	Fourth Creek bugs/amb @ SR 2308, Iredell Co	C	12-108-20-(1)b	30706	9.5	PS							Sed, Fecal	PS	M	NP
Fourth Creek		Fourth Creek bugs at SR 1003, fish at SR 1985	WS-IV	12-108-20-(3.5)	30706	7.7						Good	Poor-Fair	Sed	PS	M	NP
Third Creek (Third Creek	02120521	Third Creek at SR-1970 near Woodleaf, Iredell C	WS-IV	12-108-20-4-(7)	30706	4.8	PS					Good	Fair	Sed, Fecal	ST	M	NP

Table 4.8 Use Support Information for [illegible] River Basin (continued)

Name of Stream	Station Number	Station Location	Class	Index #	Waterbod	Miles	Chem Rating 92-96	Benthic Bioclassification 92	93	94	95	96	Fish Comm. Bioclass 92-96	Problem Parameter	Overall Use Suport Rating	Basis	Potential Sources (P,NP)
Second Creek (North Se	02120780	North Second Cr SR 1526, US 70, Rowan	WS-IV	12-108-21	30706	10.8	PS					Good-	Fair-Good	Sed, Fecal	ST	M	NP
Withrow Creek		Withrow Cr SR 1547, Rowan Co	C	12-108-21-3-(0.5)	30706	9.7						Good-Fair		Sed	ST	M	NP
Withrow Creek			WS-IV	12-108-21-3-(4)	30706	1.4								Sed	ST	ME	NP
Swearing Creek		Swearing Cr SR 1147, SR 1104, NC 47, Davids	C	12-113	30707	14.1						Good-Fair		Sed	ST	M	NP
Abbotts Creek	02121500	Abbots Cr, I-85, amb at SR 1243, Davidson	WS-V&B	12-118.5	30707	8.5	ST							Fecal,Sed	ST	M-lake	NP
Abbotts Creek		Abbots Cr SR 1755, Davdson	WS-III	12-119-(1)	30707	19.3						Good-Fair			ST	M	NP
Abbotts Creek		Abbots Cr SR 1755, Davdson	WS-III CA	12-119-(4.5)	30707	5.3						Fair			ST	M	NP
Abbotts Creek		Abbots Cr SR 2208, Davdson	C	12-119-(6)	30707	7.7						Good-Fair			ST	M	NP
Brushy Fork		Brushy Fork, SR 1810, Davidson	WS-III	12-119-5-(1)	30707	9.3						Fair		Sed	PS	M	NP
Brushy Fork			WS-III CA	12-119-5-(7)	30707	0.5								Sed	PS	ME	NP
Hamby Creek	0212148889	Hamby Cr, I-85 , SR 2031, SR 2025, Davidson	C	12-119-7-4	30707	12.5	ST					Poor		Fecal, Sed	NS	M	NP,P
Rich Fork	0212147355	Rich Fork amb at 1800, bugs at SR 1784, NC 1	C	12-119-7	30707	20.7	ST						Fair	Fecal	PS	M	NP,P
Leonard Creek		Leonard Cr SR 1844, Davidson	C	12-119-8-(3)	30707	2.2						Good-Fair			ST	M	NP
YADKIN RIVER (Including upper portion of High		Falls Lake = S	WS-IV&B	12-(136.3)	30708	2.0									S	M-lakes	
YADKIN RIVER (Including upper portion of High		Falls Lake = S	WS-IV&B CA	12-(136.7)	30708	1.5									S	M-lakes	
Lick Creek		Lick Cr SR 2351, NC 8, Davidson Co	WS-IV	12-126-(3)	30708	7.4						Fair	Good		PS	M	P,NP
Lick Creek			C	12-126-(0.5)	30708	7.2									PS	ME	NP
Lick Creek			WS-IV CA	12-126-(4)	30708	1.8									ST	ME	
Cabin Creek		Cabin Creek at NC 8, Davidson Co.	WS-IV	12-127-(2)	30708	6.7						Good-Fair			ST	M	NP
Cabin Creek			C	12-127-(1)	30708	3.3									ST	ME	NP
Cabin Creek			WS-IV CA	12-127-(3)	30708	0.6									ST	ME	NP
PEE DEE RIVER	02127500	Pee Dee River NC 109 near Mangum NC	WS-IV&B	13-(23.5)	30708	5.7	PS							pH	PS	M	NP
PEE DEE RIVER	02123736	Pee Dee River near Shankle	WS-III&B CA	13-(1)	30708	14.0								DO	S	M-lake	NP
PEE DEE RIVER (Incl Blewett Falls Lake bel		Lakes = S	WS-IV&B CA	13-(26.5)	30708	6.7									S	M-lake	NP
Mountain Creek		Mountain Cr SR 1720, Stanly Co	WS-IV	13-5-(0.7)	30708	7.6						Good	Good		S	M	
Mountain Creek			C	13-5-(0.3)	30708	4.5									S	ME	
Mountain Creek			WS-IV CA	13-5-(2)	30708	0.5									S	ME	
Little Mountain Creek		Little Mountain Cr, SR 1720, Stanly Co	WS-IV	13-5-1-(2)	30708	5.0						Fair			PS	M	NP,P
Little Mountain Creek			C	13-5-1-(1)	30708	2.0									PS	ME	NP,P
Clarks Creek		Clarks Cr SR 1174, SR	C	13-16a	30708	11.4						Good		Sed	S	M	NP
Clarks Creek		Clarks Cr SR 1103, SR	C	13-16b	30708	1.5						Good-Fair		Sed	ST	M	NP
Uwharrie River		Uwharrie R SR 1406, Randolph	WS-III	13-2-(0.5)	30709	28.2						Good-	Good	Sed	ST	M	NP
Little Uwharrie River		Little Uwharrie River SR 1405, Randolph	WS-III	13-2-1	30709	12.4						Good-Fair			ST	M	
Uwharrie River	02123500	Uwharrie River SR 1143, Randolph Co	C	13-2-(1.5)	30709	26.3	S					Good			S	M	NP
Uwharrie River		Uwharrie River NC 109 Montgomery Co	WS-IV	13-2-(17.5)	30709	8.6						Good			S	M	NP
Uwharrie River			WS-III CA	13-2-(1.3)	30709	7.3									S	ME	NP
Uwharrie River			WS-IV CA	13-2-(25)	30709	1.0									S	ME	NP
Jackson Creek		Jackson CR SR 1312, Randolph	C	13-2-2	30709	9.6						Good-Fair			ST	M	
Caraway Creek (Including		Caraway Cr SR 1331, Randolph Co	C	13-2-3	30709	25.4						Good-Fair		Sed	ST	M	NP
Back Creek (Back Creek		Lakes = S	WS-II CA	13-2-3-3-(0.7)	30709	2.5									S	M-Lakes	
Back Creek (Back Creek		Back Cr SR 1318, Randolph Co	C	13-2-3-3-(1.5)	30709	7.0						Good-Fair			ST	M	
Barnes Creek		Barnes Creek at SR-1307, Montgomery Co.	WS-IV ORW	13-2-18-(2.5)	30709	0.8						Excellent			S	M	
Barnes Creek		Barnes Creek at SR-1307, Montgomery Co.	C ORW	13-2-18-(0.5)	30709	10.3									S	ME	
Dutchmans Creek	02123567	Dutchmans Creek SR-1150 Montgomery	WS-IV	13-2-24	30709	4.6	S					Excellent			S	M	NP
PEE DEE RIVER (Incl Blew	02123736	Pee Dee River NC 731 near Shankle	WS-V&B CA	13-(15.5)	30710	15.2	PS							DO	PS	M	NP
Brown Creek	0212740615	Brown Creek at SR-1627 Anson	C	13-20b	30710	22.0	PS					Fair		Sed,DO,pH	PS	M	NP
Brown Creek		Brown Creek SR 1230 Anson	C	13-20a	30710	21.0							Good	Sed	S	M	NP
Mountain Creek		Mountain Cr SR 1150, Richmond	WS-IV	13-28-(0.5)	30710	4.6						Excellent			S	M	NP
Mountain Creek			WS-IV CA	13-28-(4)	30710	1.1									S	ME	NP
Rocky River	02123881	Rocky River SR 1142, SR 2420 Mecklenburg Co	C	13-17a	30711	9.2	PS					Fair	Poor	Fecal,Turb	NS	M	NP
Rocky River	02126000	Rocky River SR 1935, Stanly Co	C	13-17d	30711	10.7	PS					Good		Turb	S	M	NP
Rocky River	02124401	Rocky River SR 1132, NC 601, NC 24/27, Cab	C	13-17c	30711	48.0	PS					Good-	Good-Fair	Fecal,Turb	ST	M	NP

Table 4.8 Use Support Information for Monitored Stream Segments in the Yadkin-Pee Dee River Basin (Sheet 4 of 4)

Name of Stream	Station Number	Station Location	Class	Index #	Waterbod	Miles	Chem Rating 92-96	Benthic Bioclassification 92	93	94	95	96	Fish Comm. Bioclass 92-96	Problem Parameter	Overall Use Suport Rating	Basis	Potential Sources (P,NP)
Coddle Creek		Coddle Cr Nc 49 Cabarrus	C	13-17-6-(5.5)	30711	13.7						Fair	Fair	Sed	PS	M	NP
Irish Buffalo Creek		lakes = S	WS-III CA	13-17-9-(1)	30712	2.6									S	M-lake	NP
Irish Buffalo Creek	02124374	Irish BUffalo Cr SR 1132, Cabarrus	C	13-17-9-(2)	30712	17.4	ST					Good-	Good	Sed,Fecal	ST	M	NP
Cold Water Creek		Coldwater Cr NC 49, Cabarrus	C	13-17-9-4-(1.5)	30712	12.7						Good-	Fair-Good	Sed	ST	M	
Cold Water Creek			WS-IV CA	13-17-9-4-(1)	30712	2.4								Sed	S	M-lakes	
Dutch Buffalo Creek		Dutch Buffalo Creek NC 200 Cabarrus	C	13-17-11-(5)	30712	10.4						Good-Fair		Sed	ST	M	NP
Dutch Buffalo Creek		Dutch Buffalo Creek SR 1006 Cabarrus	WS-II CA	13-17-11-(4.5)	30712	1.0								Sed	ST	ME	NP
Goose Creek	021246550	Goose Cr US 601 Union Co	C	13-17-18	30712	17.0	ST					Poor		Fecal,Sed	NS	M	NP,P
Crooked Creek		Crooked Cr SR 1547, Union	C	13-17-20	30712	13.1						Fair			PS	M	NP,P
North Fork Crooked Creek		N Fk Crooked Cr SR 1520, Union	C	13-17-20-1a	30712	7.5					Fair		Good		PS	M	P,NP
North Fork Crooked Creek		N Fk Crooked Cr SR 1004, Union	C	13-17-20-1c	30712	1.7					Fair				PS	M	P,NP
North Fork Crooked Creek		N Fk Crooked Cr SR 1514, Union	C	13-17-20-1b	30712	1.7					Good-Fair				ST	M	
South Fork Crooked Creek		South Fork ab SR 1515, Union	C	13-17-20-2a	30712	5.0					Poor				NS	M	NP
South Fork Crooked Creek		South Fork SR 1515, SR 1367 Union	C	13-17-20-2b	30712	8.7					Fair		Fair/Good		PS	M	NP,P
Long Creek	02125126	Long Cr at SR 1954, Stanly	C	13-17-31c	30713	1.0	S					Good-Fair			ST	M	NP
Big Bear Creek		Big Bear Creek SR 1134, Stanly	C	13-17-31-5b	30713	17.0						Good	Good		S	M	
Stony Run		Stony Run Cr SR 1970,Stanly	C	13-17-31-5-5	30713	9.7						Good-Fair		Sed	ST	M	NP
Richardson Creek (Lake Lee)			WS-IV CA	13-17-36-(3.5)	30714	3.2									ST	M-lake	NP
Richardson Creek	02125482	Richardson Creek at SR 1649, Union Co.	C	13-17-36-(5)b	30714	5.6	S					Fair		Sed	PS	M	NP,P
Richardson Creek		Richardson Creek at SR 1600, Anson Co.	C	13-17-36-(5)c	30714	19.9						Good-Fair			ST	M	NP
Stewarts Creek (Lake Twitty/ Stewart)		lakes -ST	WS-III CA	13-17-36-9-(4.5)	30714	2.9								Sed	ST	M-lake	NP
Negro Head Creek		Negro Head Creek SR 1006, Union	C	13-17-36-15	30714	12.8							Good	Sed	S	M	NP
Lanes Creek		Lanes Cr SR 1901 Union Co	WS-V	13-17-40-(1)b	30714	9.9						Poor		Sed	NS	M	NP
Lanes Creek		Lanes Cr SR 1612, SR 1432, Anson Co	C	13-17-40-(12)	30714	26.9						Fair	Good		PS	M	NP
Little River	02128000	Little River SR 1349, SR 1340, SR 1340 nr Sta	C HQW	13-25-(11.5)	30715	12.6	S				Excell	Excellent			S	M	
West Fork Little River		West Fork Little River SR 1115 Randolph, NC 1	C	13-25-15	30715	21.4				Excellent/Good			Good		S	M	
Little River		Little River NC 731, Montgomery Co	C	13-25-(19)b	30715	10.4						Good			S	M	NP
Little River			WS-IV	13-25-(37.5)	30715	3.9									S	ME	NP
Densons Creek		Densons Cr NC 134, SR 1323, Montgomery co	C HQW	13-25-20-(1)	30715	5.3		Good							S	M	
Densons Creek		Densons Cr SR 1324, Montgomery Co	C	13-25-20-(9)	30715	3.2		Good-Fair							S	M	
Rocky Creek		Rocky Cr SR 1134, NC 24/27 Montgomery Co	C	13-25-30-(0.3)	30715	6.8						Good-	Fair		ST	M	
Cheek Creek		Cheek Cr SR 1541, Montgomery	C	13-25-36	30715	15.4						Good-Fair			ST	M	
PEE DEE RIVER	02129000	Pee Dee River near Rockingham, US Hwy 74, Ri	C	13-(34)	30716	15.2	S								ST	M	NP
Cartledge Creek		Cartledge Cr SR 1142, Richmond Co	C	13-35	30716	10.5						Fair			PS	M	NP
Hitchcock Creek (McKinney		Hitchcock CR SR 1486, Richmond Co	WS-III	13-39-(1)	30716	11.8						Good			S	M	
Rocky Fork Creek (Mill		Rocky Fork Cr SR 1487, Richmond Co	WS-III	13-39-8	30716	10.0							Good-Excellent		S	M	
Beaver Dam Creek		Beaverdam Cr SR 1486, Richmond Co	WS-III	13-39-8-7	30716	5.5						Excellent			S	M	
Hitchcock Creek (Midway	02129341	Hitchcock Cr Sr 1109, Richmond	C	13-39-(10)b	30716	6.1	PS					Poor		Fecal,pH,S	NS	M	NP,P
Hitchcock Creek (Midway		lakes = S	WS-III CA	13-39-(8.5)	30716	2.2									S	M-lake	NP
Marks Creek (Everetts La	0212955844	Marks Creek near Hamlet at SR-1812, NC 177,	C	13-45-(2)a	30716	6.3	NS					Good-Fair		Sed,DO,PH	ST	M	NP
Jones Creek	02129527	Jones Creek near Pee Dee, NC Hwy 145, & SR	C	13-42	30717	12.3	S	Good-Fair				Good-	Fair		ST	M	
North Fork Jones Creek		Lakes - S	WS-II CA	13-42-1-(0.3)	30717	1.3									S	M-lakes	
North Fork Jones Creek		North Fork Jones Cr SR 1121, Anson	C	13-42-1-(0.5)	30717	8.4		Good-Fair				Fair		Sed	PS	M	NP
Bailey Creek		Bailey Cr SR 1811 Anson	C	13-42-1-3	30717	2.1							Fair		ST	M	
South Fork Jones Creek		S Fk Jones Cr below WWTP, Anson	C	13-42-2b	30717	0.8		Fair						Sed	PS	M	NP
South Fork Jones Creek		S Fk Jones Cr Sr 1821, ab WWTP, Anson	C	13-42-2a	30717	15.0		Good-Fair				Good-Fair		Sed	ST	M	

Table 4.9 Use Support Determinations by Subbasin

Use Support Status For Freshwater Streams (Miles) (1992-1996)						
Subbasin	S	ST	PS	NS	NE	Total Miles
03-07-01	786.6	104.5	0	0	0	891.1
03-07-02	405.9	281.6	0.5	1.4	0	689.4
03-07-03	18.7	105.7	16.2	1.7	29.9	172.2
03-07-04	102.1	303.9	49.5	8.1	33.8	497.4
03-07-05	23.7	87.8	11.7	0	0	123.2
03-07-06	191.2	486.3	17.2	0	0	694.7
03-07-07	0	103.6	53.3	18.6	27.8	203.3
03-07-08	163.6	13.9	27.3	0	6.7	211.5
03-07-09	178.1	127.6	0	0	0	305.7
03-07-10	135.4	8.5	37.2	9	97.1	287.2
03-07-11	43.6	95.8	48.2	11	87.6	286.2
03-07-12	7.8	213.3	31	22	19.1	293.2
03-07-13	75.1	96	14.6	0	17	202.7
03-07-14	25.3	124.1	61.1	16.8	177.2	404.5
03-07-15	205	161.8	0	0	0	366.8
03-07-16	69.5	84.1	27.7	6.1	50.8	238.2
03-07-17	4.3	72.9	9.2	0	37.5	123.9
Total	2435.9	2471.4	404.7	94.7	584.5	5991.2
Percentage	41	41	7	2	9	

Table 4.10 Sources of Use Support Impairment within the Yadkin-Pee Dee River Basin

Subbasin	Point	Non-Point	Agriculture	Forestry	Construction	Urban Runoff	Hydromod	Source Unknown
030701	0	0	0	0	0	0	0	0
030702	0	1.9	0.5	0	0	1.4	0	0
030703	12	17.9	12	0	0	16.2	0	0
030704	26	44.3	39.4	0	26	44.3	0	0
030705	0	11.7	0	0	0	0	0	11.7
030706	0	17.2	17.2	0	0	0	0	0
030707	33.2	63.4	43	20.7	28.2	46.8	0	6.8
030708	14.4	27.3	27.3	5.7	0	7.4	5.7	0
030709	0	0	0	0	0	0	0	0
030710	0	46.2	37.2	15.2	0	0	15.2	9
030711	1.8	59.2	45.5	0	0	59.2	0	0
030712	48	53	13.7	0	30.7	53	0	0
030713	9	14.6	14.6	0	0	14.6	0	0
030714	12.5	77.9	77.9	0	0	0	0	0
030715	0	0	0	0	0	0	0	0
030716	10	33.8	20.5	0	10	23.3	0	0
030717	0	9.2	9.2	0	0	0	0	0
Total Miles	166.9	477.6	358	41.6	94.9	266.2	20.9	27.5
% of Total	35	100	75	9	20	56	4	6

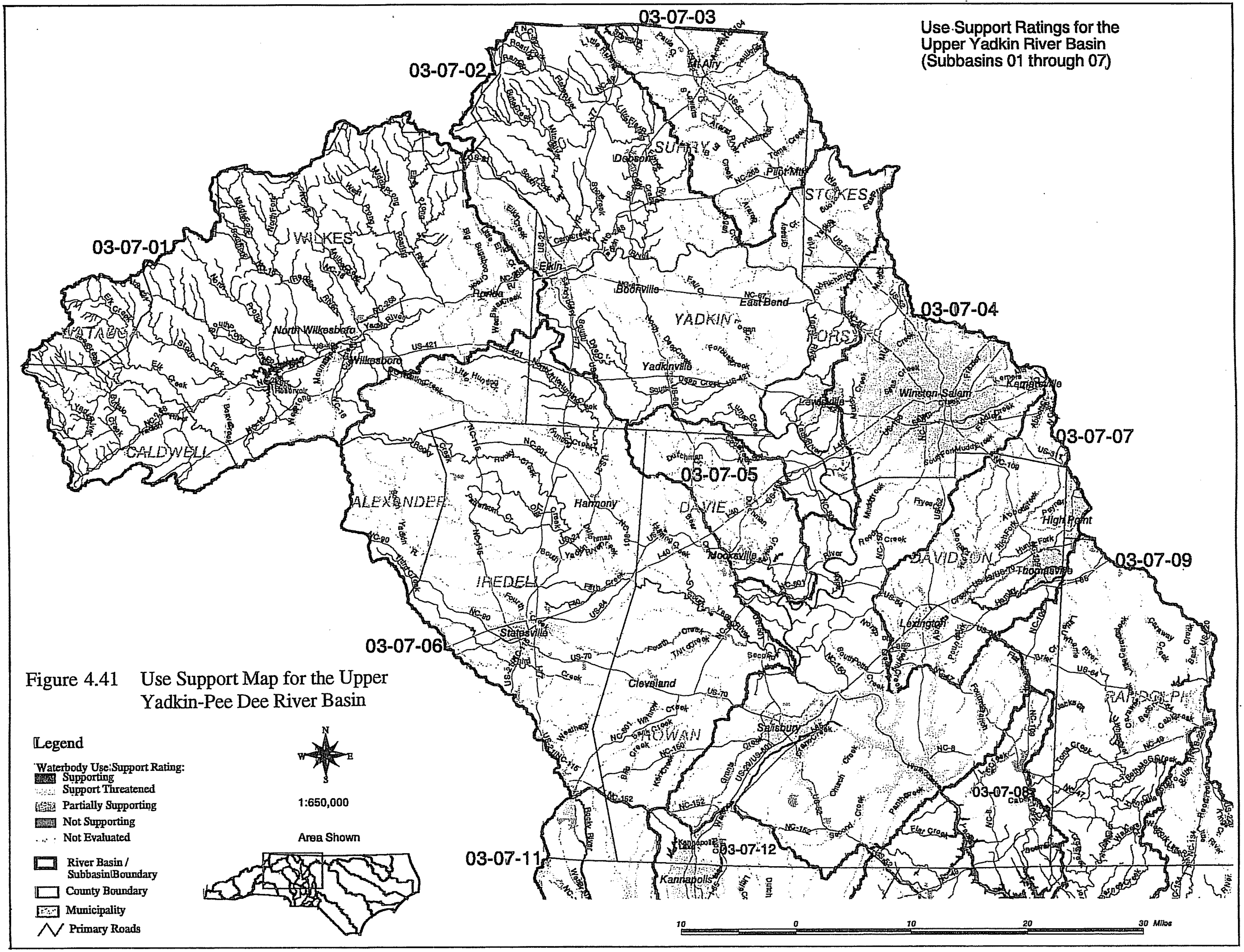


Figure 4.41 Use Support Map for the Upper Yadkin-Pee Dee River Basin

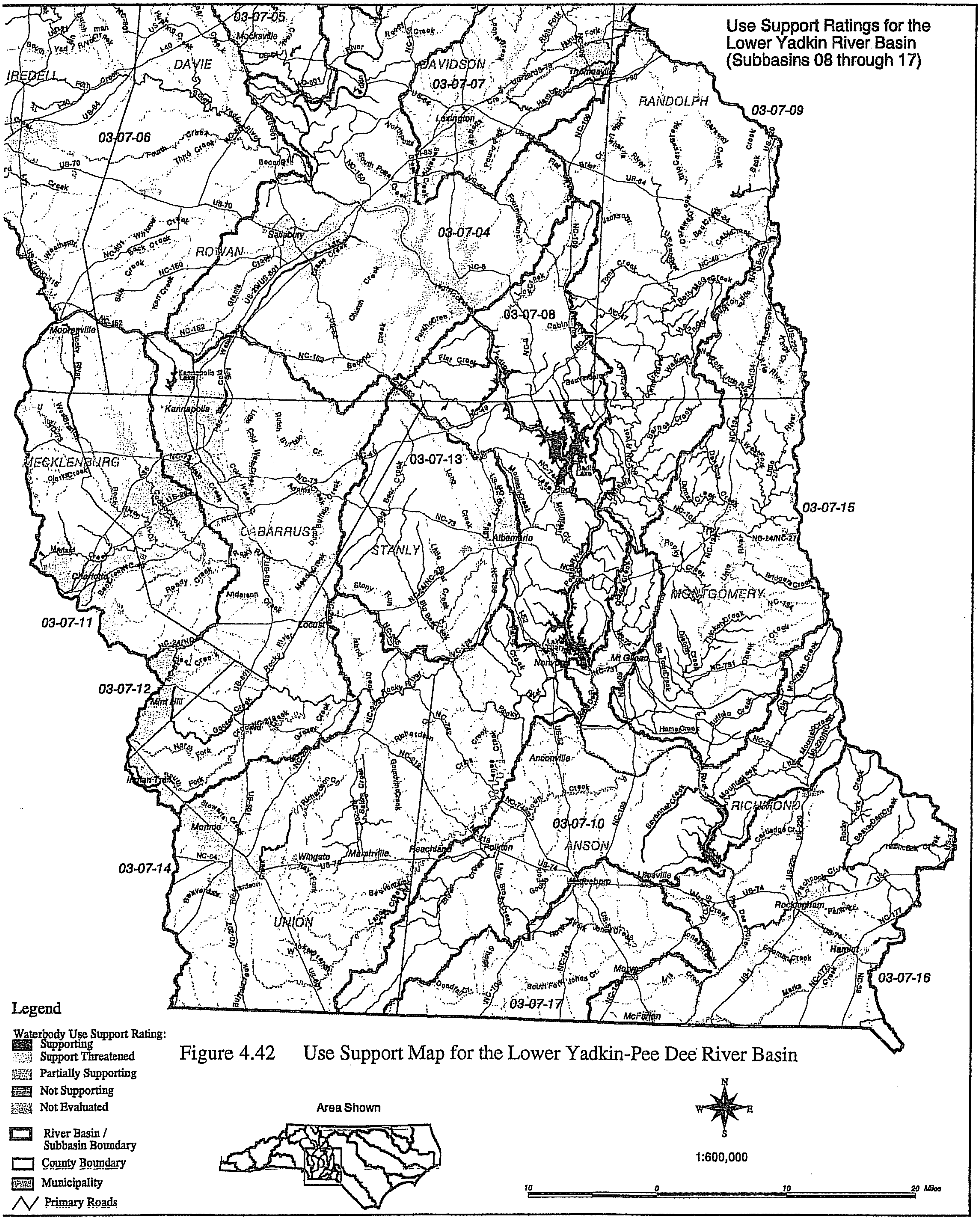


Figure 4.42 Use Support Map for the Lower Yadkin-Pee Dee River Basin

Table 4.11 Use Support Determinations for Monitored Lakes in the Yadkin-Pee Dee River Basin

LAKE NAME	COUNTY NAME	SUBBASIN	CLASS	OVERALL USE	FISH CONSUMP	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER
KERR SCOTT RES	WILKES	30701	B-Tr	S	S	S	S	S
HIGH ROCK LAKE	DAVIDSON/ROWAN	30704	WS-IV&B	T	S	S	S	S
LAKE CORRIHER	ROWAN	30704	WS-IV	T	S	S	n/a	S
LAKE WRIGHT	ROWAN	30704	WS-II	S	S	S	n/a	n/a
SALEM LAKE	FORSYTH	30704	WS-III CA	S	S	S	n/a	S
WINSTON LAKE	FORSYTH	30704	C	S	S	S	n/a	S
LAKE TOM-A-LEX	DAVIDSON	30707	WSIII-CA	S	S	S	n/a	n/a
BADIN LAKE	STANLY/MONTGOMERY	30708	WS-IV&B	S	S	S	S	S
FALLS LAKE	STANLY/MONTGOMERY	30708	WS-IV&B	S	S	S	S	n/a
LAKE TILLERY	STANLY/MONTGOMERY	30708	WS-IV&B	S	S	S	S	n/a
TUCKERTOWN RES	STANLY/MONTGOMERY	30708	WS-IV CA,I	S	S	S	S	n/a
BACK CREEK LAKE (LAKE LUCAS)	RANDOLPH	30709	WS-II CA	S	S	S	n/a	S
LAKE BUNCH	RANDOLPH	30709	WS-II CA	S	S	S	n/a	S
LAKE REESE	RANDOLPH	30709	WS-III	S	S	S	n/a	S
MCCRARY LAKE	RANDOLPH	30709	WS-II	S	S	S	n/a	S
ROSS LAKE	RANDOLPH	30709	WS-II	S	S	S	n/a	S
BLEWETT FALLS LAKE	ANSON/RICHMOND	30710	WS-IV&B	S	S	S	S	S
KANNAPOLIS LAKE	ROWAN	30712	WS-III CA	S	S	S	n/a	S
LAKE CONCORD	CABARRUS	30712	WS-IV CA	S	S	S	n/a	n/a
LAKE FISHER	CABARRUS	30712	WS-IV CA	S	S	S	n/a	S
LONG LAKE(Albermarle City Lake)	STANLY	30713	C	NS	S	NS	n/a	S
LAKE LEE	UNION	30714	WS-IV CA	T	S	S	n/a	n/a
LAKE MONROE	UNION	30714	WS-IV	S	S	S	n/a	n/a
LAKE TWITTY (LAKE STEWART)	UNION	30714	WS-III	T	S	S	n/a	n/a
ROCKINGHAM CITY LAKE	RICHMOND	30716	WS-III CA	PS	S	PS	n/a	S
HAMLET CITY LAKE	RICHMOND	30716	C	PS	S	PS	n/a	n/a
ROBERDEL LAKE	RICHMOND	30716	WS-IIICA	S	S	S	n/a	S
WATER LAKE	RICHMOND	30716	WS-II CA	S	S	S	n/a	n/a
CITY POND (WADESBORO)	ANSON	30717	WS-II CA	S	S	S	n/a	n/a

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CHAPTER 5

WATER QUALITY PROGRAMS AND PROGRAM INITIATIVES IN THE BASIN

5.1 INTRODUCTION

This chapter briefly describes the point and nonpoint source control programs available for addressing water quality problems in the Yadkin-Pee Dee River basin. It also presents a number of important water quality initiatives being implemented by federal, state, local and private interests. **Section 5.2** summarizes the state and federal legislative authorities developed to protect water quality. **Section 5.3** presents the water quality standards and classifications program. **Sections 5.4 and 5.5**, respectively, present existing point and nonpoint source pollution control programs. **Section 5.6** presents water quality program initiatives that are being implemented within the basin. **Section 5.7** discusses integration of point and nonpoint source control management strategies and introduces the concept of *total maximum daily loads* (TMDLs). **Section 5.8** provides information on potential sources of funding for both point and nonpoint water quality protection programs.

5.2 STATE AND FEDERAL LEGISLATIVE AUTHORITIES FOR NORTH CAROLINA'S WATER QUALITY PROGRAM

Authorities for some of the programs and responsibilities carried out by the Water Quality Section are derived from a number of federal and state legislative mandates outlined below. The major federal authorities (Section 5.2.1) for the state's water quality program are found in sections of the Clean Water Act (CWA). State authorities listed in Section 5.2.2 are from state statutes.

5.2.1 Federal Authorities for NC's Water Quality Program

- **Section 301** - Prohibits the discharge of pollutants into surface waters unless permitted by EPA.
- **Section 303(c)** - States are responsible for reviewing, establishing and revising water quality standards for all surface waters.
- **Section 303(d)** - Each state shall identify those waters within its boundaries for which the effluent limits required by section 301(b)(1) A and B are not stringent enough to protect any water quality standards applicable to such waters.
- **Section 305(b)** - Each state is required to submit a biennial report to the EPA describing the status of surface waters in that state.
- **Section 319** - Each state is required to develop and implement a nonpoint source pollution management program.
- **Section 402** - Establishes the National Pollutant Discharge Elimination System (NPDES) permitting program. Allows for delegation of permitting authority to qualifying states (includes North Carolina).
- **Section 404/401** - Section 404 regulates the discharge of fill materials into navigable waters and adjoining wetlands unless permitted by the US Army Corps of Engineers. Section 401 requires the Corps to receive a state Water Quality Certification prior to issuance of a 404 permit.

5.2.2 State Authorities for NC's Water Quality Program

- **G.S. 143-214.1** - Directs and empowers the NC Environmental Management Commission (EMC) to develop a water quality standards and classifications program.
  G.S. 143-214.2 - Prohibits the discharge of certain wastes to surface waters of the state without a permit.
- **G.S. 143-214.5** - Provides for establishment of the state Water Supply Watershed Protection Program.
- **G.S. 143-214.7** - Directs the EMC to establish a Stormwater Runoff Program.
- **G.S. 143-215** - Authorizes and directs the EMC to establish effluent standards and limitations.
- **G.S. 143-215.1** - Outlines methods for control of sources of water pollution (NPDES and nondischarge permits, statutory notice requirements, public hearing requirements, appeals, etc.).
- **G.S. 143-215.2** - Empowers the EMC to issue *special orders* to any person whom it finds responsible for causing or contributing to any pollution of the waters of the state within the area for which standards have been established.
- **G.S. 143-215.3** - Outlines additional powers of the EMC including provisions for adopting rules, charging permit fees, delegating authority, investigating fish kills and investigating violations of rules, standards or limitations adopted by the EMC.
- **G.S. 143-215.6A, 143-215.6B and 143-215.6C** - Includes enforcement provisions for violations of various rules, classifications, standards, limitations, provisions or management practices established pursuant to G.S. 143-214.1, 143-214.2, 143-214.5, 143-215, 143-215.1, 143-215.2. Section 6A describes enforcement procedures for civil penalties. Section 6B outlines enforcement procedures for criminal penalties. Section 6C outlines provisions for injunctive relief.
- **G.S. 143-215.74, 75A, 74B, 74C, 74D and 74E** - Refers to animal waste management and agriculture cost share.
- **G.S. 143-215.75** - Outlines the state's Oil Pollution and Hazardous Substances Control Program.
- **G.S. 143-215, 10A - 215.10G** - Requires permits and controls for animal waste systems.
- **G.S. 143-214.8 - 214.13** - Establishes a Wetland Restoration Program.
- **G.S. 143-15.3B, 113-145.1-145.7** - Establishes a Clean Water Management Trust Fund.

5.3 Surface Water Classifications and Water Quality Standards

<u>**Program Overview**</u>

North Carolina has established a water quality classification and standards program pursuant to G.S. 143-214.1. Classifications and standards are developed pursuant to 15A NCAC 2B. 0100 - Procedures for Assignment of Water Quality Standards. Waters were classified for their "best usage" in North Carolina beginning in the early 1950's, with classification and water quality standards for all the state's river basins adopted by 1963. The effort to accomplish this included identification of waterbodies (which included all named waterbodies on USGS 7.5 minute topographic maps), studies of river basins to document sources of pollution and appropriate best uses and formal adoption of standards/classifications following public hearings.

The Water Quality Standards program in North Carolina has evolved over time and has been modified to be consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters and the protection of unique and special pristine waters with outstanding resource values. Classifications and standards are applied to provide protection of uses from both point and nonpoint source pollution.

Statewide Classifications

A full description of the state's primary and supplemental classifications including, for each classification, the best usage, key numeric standards, stormwater controls and other requirements as appropriate, are available in the document titled: Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina (derived from 15A NCAC 2B .0200). A summary of these classifications follows.

Primary Classifications

Under this system, all surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water body (e.g., aquatic life support and swimming). Primary freshwater classifications include the following: *C*, *B* and *WS* (Water Supply) *I* through *WS-V*. The WS freshwater classifications may also include a *CA* designation which stands for critical area. The critical area is an area in close proximity to a water supply intake and/or the shoreline of the reservoir around which it is located. Primary saltwater classifications include *SC*, *SB* and *SA*. SC and SB are saltwater counterparts to the freshwater C and B classifications. SA is a classification assigned to waters used for shellfish harvesting. SA, WS-I and WS-II are also, by definition, considered to be High Quality Waters, as discussed below.

Supplemental Classifications

In addition to primary classifications, surface waters may be assigned a supplemental classification. The supplemental classifications include *HQW* (High Quality Waters), *ORW* (Outstanding Resource Waters), *NSW* (Nutrient Sensitive Waters), *Tr* (Trout Waters) *FWS* (Future Water Supply) and *Sw* (Swamp Waters). Most of these have been developed in order to afford special protection to sensitive or highly valued resource waters. Therefore, while all surface waters are assigned a primary classification, they may also have one or more supplemental classifications. For example, a typical freshwater stream in the mountains might have a C Tr classification where C is the primary classification followed by the Tr supplemental classification.

Statewide Water Quality Standards

Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the water body to support the uses associated with each classification. Some of the standards, particularly for HQW and ORW waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are discussed briefly below. The standards for C and SC waters establish the basic protection level for all state surface waters. With the exception of Sw, all of the other primary and supplemental classifications have more stringent standards than for C and SC and therefore require higher levels of protection.

High Quality Waters

Some of North Carolina's surface waters are relatively unaffected by pollution sources and have water quality higher than the standards that are applied to the majority of the waters of the state. In addition, some waters provide habitat for sensitive biota such as trout, juvenile fish or rare and endangered aquatic species.

In an effort to protect waters that possess such characteristics, surface waters in the following categories qualify for classification as High Quality Waters or HQW:

1) waters rated as Excellent based on chemical and biological sampling (Division of Water Quality (DWQ) assigns water quality ratings to North Carolina's surface waters based on biological and chemical data);
2) streams designated by the Wildlife Resources Commission as native and special native trout waters or primary nursery areas;
3) waters designated as primary nursery areas by the Division of Marine Fisheries; and
4) critical habitat areas designated by the Wildlife Resources Commission or the Department of Agriculture. Waters classified by the Division of Water Quality as WS-I, WS-II and SA are HQW by definition, but these waters are not specifically assigned the HQW classification because the standards for WS-I, WS-II and SA waters are at least as stringent as those for waters classified as HQW.

Special HQW protection management strategies are presented in 15A NCAC 2B.0201(d), and implemented through 15A NCAC 2B .0224. These measures are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new wastewater discharge facilities and facilities which expand beyond their currently permitted loadings address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume, nutrients (in nutrient sensitive waters) and toxic substances.

For nonpoint source pollution, development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B. 0218, and which drain to and are within one mile of HQWs will be required to control runoff from the development using either a low density or high density option described in 15A NCAC 2H. 1006. In addition, the Division of Land Quality requires more stringent sedimentation controls for land disturbing projects within one mile and draining to HQWs.

Outstanding Resource Waters

A small percentage of North Carolina's surface waters have excellent water quality (rated based on biological and chemical sampling as with HQWs) and an associated outstanding resource. The Outstanding Resource Waters rule defines outstanding resource values as:
1) outstanding fishery resource;
2) a high level of water-based recreation;
3) a special designation such as National Wild and Scenic River or a National Wildlife Refuge;
4) being within a state or national park or forest; or
5) having special ecological or scientific significance.

The requirements for ORW waters are more stringent than those for HQWs. Special protection measures that apply to North Carolina ORWs are set forth in 15A NCAC 2B .0225. At a minimum, no new discharges or expansions are permitted, and stormwater controls for most new development are required. In some circumstances, the unique characteristics of the waters and resources that are to be protected require that a specialized (or customized) ORW management strategy be developed.

5.4 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

North Carolina does not allow point source discharges without a permit. Discharge permits are issued under the authority of North Carolina General Statute (NCGS) 143.215.1 and the National Pollutant Discharge Elimination System (NPDES) program. The NPDES program was delegated to North Carolina from the US Environmental Protection Agency. These permits serve as both state and federal permits. North Carolina has a comprehensive NPDES program which includes the permitting of both wastewater and stormwater discharges. Refer to Appendix I for the Organizational Duties Flow Chart for the DWQ Water Quality Section.

NPDES permits are issued in two categories; individual or general. Individual permits are issued to a specific facility and contain site specific requirements and incorporate recommendations from the basinwide water quality management plan. Individual NPDES permits are typically issued for a five year cycle with all permits in a river basin expiring during the same period. This permitting strategy allows for comprehensive review of individual dischargers within the basin and implementation of recommendations contained in the basinwide water quality management plan. New discharge permits issued during an interim period are given a shorter cycle so that expiration coincides with the basin permitting cycle. Individual permits in the Yadkin-Pee Dee River basin are scheduled for expiration and renewal beginning in July 1998.

General permits are developed for a general type of industry and contain permit requirements that are appropriate for a typical facility within a specific industrial classification. Facilities engaged in the specific industrial activities are eligible for permit coverage under the general permit. Facilities that are deemed to be atypical or have a history of water quality problems are required to obtain an individual permit. Because general permits are specific to a type of industrial activity and are issued statewide they do not contain basin specific measures. A general permit is typically issued for a five year cycle, which expires statewide on the same date.

5.4.1 NPDES Wastewater Discharges

Under the NPDES wastewater permitting program, each NPDES discharger is assigned either *major* or *minor* status. For municipalities, all dischargers with a permitted flow of greater than 1 million gallons per day (MGD) are classified as major.

All new wastewater discharge permit applications must include an engineering proposal which includes a description of the origin, type, and flow of wastewater, a summary of waste treatment and disposal options, and a narrative description of the proposed treatment works and why the proposed system and point of discharge were selected. The summary must contain sufficient detail to assure that the most environmentally sound alternative was selected from the reasonably cost effective options. An assessment report describing the impact on waters in the area must be submitted for all applications of new discharges in excess of 500,000 gallons per day or 10 million gallons per day of cooling water or any other proposed discharge of 1 million gallons per day or more.

Under the NPDES program, wastewater treatment systems must be operated by a certified operator. Training and certification of operators is conducted by DWQ. It is the goal of the program to provide competent and conscientious professionals that will protect both the environment and public health.

The amount or loading of specific pollutants that are allowed to be discharged into surface waters are defined in the NPDES permit and are called *effluent limits*. Point source discharges generally have the most impact on a stream during low flow conditions when the percentage of treated effluent within the stream is greatest. Effluent limits are generally set to protect the stream during these low flow conditions. The standard low flow used for determining point source impacts is called the *7Q10*. This is the lowest flow which occurs over seven consecutive days and which has an average recurrence of once in ten years. Computer modeling may be used to determine the fate and transport of pollutants, reduction goals for contaminants, and to derive effluent limits for NPDES permits. A wasteload allocation is performed to ensure the effluent limits are set at levels that can be safely assimilated by the receiving stream.

Most dischargers are required to periodically sample their treated effluent. This process is called self-monitoring. Larger and more complex dischargers are also required to sample both upstream and downstream of the discharge point. NPDES facilities are required to monitor for all pollutants for which they have permit limits as well as other pollutants which may be present in their wastewater. Sampling results are submitted to DWQ each month for compliance evaluations. If limits are not being met, various legal actions may be taken against the discharger to ensure future compliance.

All domestic wastewater dischargers are required to monitor flow, dissolved oxygen, temperature, fecal coliform, BOD, ammonia, and chlorine (if they use it as a disinfectant). In addition, wastewater treatment facilities with industrial sources may have to monitor for chemical specific toxicants and/or whole effluent toxicity, and all dischargers with design flows greater than 50,000 gallons per day (GPD) monitor for total phosphorus and total nitrogen. Minimum NPDES wastewater monitoring requirements are provided in 15A NCAC 2B .0500.

Other methods of collecting point source information include effluent sampling by DWQ during inspections and special studies. The regional offices may collect data at a given facility if they believe there may be an operational problem or as a routine compliance check. DWQ may collect effluent data during intensive surveys of segments of streams.

A pretreatment program is aimed at protecting municipal wastewater treatment plants and the environment from the adverse impacts that may occur when hazardous or toxic wastes are discharged into a public system. This program requires that businesses and other entities that use or produce toxic wastes pretreat their wastes prior to discharging into a public wastewater system.

5.4.2 NPDES Stormwater Discharges

As currently defined by the NPDES program, stormwater point source discharges originate from two distinct sources; municipalities and selected industrial facilities. Subject municipalities are defined as those incorporated areas that encompass a population of 100,000 or more. There are currently two municipalities in the Yadkin-Pee Dee River basin that are subject to NPDES stormwater permitting: Winston-Salem and Charlotte. The stormwater programs of these municipalities are discussed in Section 5.6.

Stormwater discharges directly related to manufacturing, processing or raw materials storage areas at industrial plants are also subject to NPDES stormwater permitting. A complete definition of "stormwater discharge associated with industrial activity" including a comprehensive listing of subject industries can be found in 40 CFR 122.26. The types of industrial activities that are subject to permitting are typically defined by Standard Industrial Classification (SIC) codes. SIC codes have been developed by the federal Office of Management and Budget to define industries in accordance with the composition and structure of the economy.

There are currently 19 general stormwater permits available for specific types of industrial activities across the state. The general stormwater permits incorporate requirements determined to be appropriate based upon an analysis of available analytical monitoring data, input from industry and associations, site visits, and review of federal and other documents providing guidance on specific types of industries, pollutants and stormwater discharges. General permits may specify monitoring and reporting requirements for both quantitative and qualitative assessment of the stormwater discharge as well as operational inspections of the entire facility, including all stormwater systems. The specific pollutant parameters for which sampling must be performed are based upon the types of materials used and produced in the manufacturing processes and the potential for contamination of the stormwater runoff at a typical facility.

All NPDES stormwater permits require the development and implementation of a Stormwater Pollution Prevention Plan (SPPP). The SPPP requires the permitted facility to develop a comprehensive stormwater management plan. This plan is the basis for evaluating the pollution potential of the site and implementing best management practices (BMPs) to reduce pollutants in runoff from the site.

All stormwater permits specify qualitative monitoring of each stormwater outfall for the purposes of evaluating the effectiveness of the Stormwater Pollution Prevention Plan and assessing new sources of stormwater pollution. Qualitative monitoring parameters include color, odor, clarity, floating and suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution.

Stormwater permits may provide for the use of cut-off concentrations in order to minimize the required analytical monitoring for facilities which are not significant contributors to stormwater pollution. These cut-off concentrations are not intended to be effluent limits (as used in wastewater permitting), but to provide guidelines for determining which facilities are major contributors to stormwater pollution and need further monitoring. The arithmetic mean of all monitoring data collected during the term of the permit must be calculated for each parameter and compared to the permitted cut-off concentration. If the mean is below the cut-off concentration, then the facility may discontinue analytical monitoring for that parameter until the final year of the permit. This approach inhibits facilities from using the cut-off concentrations as target concentrations for purposes of evaluating the effectiveness of the Stormwater Pollution Prevention Plan while ensuring that problem facilities continue to collect analytical information on their discharges.

5.5 NONPOINT SOURCE CONTROL PROGRAMS

When rainfall or snowmelt washes off an undisturbed natural area, it contains few pollutants and a significant portion of it infiltrates into the ground. This infiltration process cleanses, reduces and delays runoff. However, human disturbances of land often cause runoff of pollutants into surface waters. For instance, runoff from agricultural lands can include fertilizers, sediment and pesticides; runoff from roads and parking lots in urban areas can include petroleum products and toxic substances (these impervious surfaces also increase flow volume and velocity); construction activities can cause runoff of sediment, etc. These are examples of *nonpoint source* (NPS) pollution. Unlike effluent from a wastewater treatment plant, NPS pollution often originates from harder to identify, widely dispersed areas. Some of the most common nonpoint sources of pollution and their causes are presented in Chapter 3.

The two approaches that are used to address nonpoint source pollution are prevention and engineered controls. Some of the methods of pollution prevention include minimizing built-upon areas, protection of sensitive areas, optimum site planning, use of natural drainage systems rather than curb and gutter, nutrient management plans, public/farmer education, storm drain stenciling, and hazardous waste collection sites. It is generally more cost-effective to prevent and minimize pollution than to build engineered controls. For example, developers who are subject to stormwater requirements often choose to build low density developments rather than bearing the expense of building engineered BMPs. Engineered BMPs also have on-going expenses associated with long-term operation and maintenance.

Engineered BMPs generally work by capturing, retaining, and treating runoff before it leaves an area. Some commonly used types of BMPs include stormwater wetlands, wet detention ponds, water control structures, bioretention areas, and infiltration basins. Often higher levels of pollutant removal can be achieved by using a combination of different control systems. The main advantage of engineered controls is that they can treat runoff from high density developments.

The current trend is toward a more comprehensive "systems approach" to managing nonpoint source pollution. This involves using an integrated system of preventive and control practices to accomplish nonpoint pollution reduction goals. This approach emphasizes site planning, protecting important natural areas such as wetlands, and finding the most cost-effective engineered controls for high density areas. Programs which are currently using the systems approach include the animal waste regulations and the regulations for coastal stormwater management and water supply watersheds. In general, the goals of the nonpoint source management program include the following:

- Continue to build and improve existing programs,
- Develop new programs to control nonpoint pollution sources that are not addressed by existing programs,
- Continue to target geographic areas and waterbodies for restoration and protection,
- Integrate the NPS Program with other state programs and management studies (e.g., Clean Water Management Trust Fund and Wetlands Restoration Program), and
- Monitor the effectiveness of BMPs and management strategies for both surface and groundwater quality.

Table 5.1 lists a number of federal and state programs that address nonpoint source pollution. These programs are listed by category based on the type of activity. Refer to Table 5.2 for a brief description of each program and the contact persons within the basin for each program.

Table 5.1 List of Nonpoint Source Programs

PROGRAM	LOCAL	STATE	FEDERAL
AGRICULTURE:			
Agriculture Cost Share Program	SWCD	SWCC, DSWC	
N.C. Pesticide Law of 1971		NCDA	
Pesticide Disposal Program		NCDA	
Animal Waste Management	SWCD	DWQ, DSWC, CES	NRCS
Laboratory Testing Services		NCDA	
Watershed Protection (PL-566)			NRCS
1985 ,1990 and 1995 Farm Bills - Conservation Reserve Program; Conservation Compliance; Sodbuster/Swampbuster; Conservation Easement; Wetland Reserve; Water Quality Incentive Program			USDA
URBAN			
Coastal Stormwater Program		DWQ	
ORW, HQW, NSW Management Strategies		DWQ	
Water Supply Watershed Protection Program	city, county	DWQ	
Stormwater Control Program	city, county	DWQ	EPA
CONSTRUCTION			
Sedimentation and Erosion Control	ordinance	DLR, DOT	
Coastal Area Management Act	ordinance	DCM	
Coastal Stormwater Program		DWQ	
ON-SITE WASTEWATER DISPOSAL			
Sanitary Sewage Systems Program	county	DEH	
SOLID WASTE DISPOSAL			
Resource Conservation and Recovery Act			EPA
Solid Waste Management Act of 1989	city, county	DSWM	
FORESTRY			
Forest Practice Guidelines		DFR	
National Forest Management Act			NFS
Forest Management Program Services		DFR	
Forestry Best Management Practices		DFR	
Forest Stewardship Program		DFR	
MINING			
Mining Act of 1971		DLR	
HYDROLOGIC MODIFICATION			
Clean Water Act (Section 404)		DCM, DWQ	COE
Rivers and Harbors Act of 1899			COE
Dam Safety Permit		DLR	
WETLANDS:			
Wetlands Restoration Program		DWQ	
Clean Water Act (Sections 401 and 404)		DWQ	COE
Wetland Reserve Program			USDA

COE: US Army Corps of Engineers
DWQ: Division of Water Quality
DFR: Division of Forest Resource
DSW: Division of Soil and Water
USDA: US Department of Agriculture
DCM: Division of Coastal Management
DLR: Division of Land Resources
DOT: Department of Transportation
DSWM: Division of Solid Waste Mgt.
NCDA: NC Department of Agriculture
NRCS: Natural Resources Conservation Service
SWCC: Soil and Water Cons. Commission
SWCD: Soil and Water Conservation District

Table 5.2 Yadkin-Pee Dee River Basin Nonpoint Source Program Description and Contacts

Agriculture			
USDA Natural Resources Conservation Service: Part of the U.S. Dept. of Agriculture, formerly the Soil Conservation Service. Technical specialists certify waste management plans for animal operations; provide certification training for swine waste applicators; work with landowners on private lands to conserve natural resources, helping farmers and ranchers develop conservation systems unique to their land and needs; administer several federal agricultural cost share and incentive programs; provide assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conduct soil surveys; offer planning assistance for local landowners to install best management practices; and offer farmers technical assistance on wetlands identification.			
Area 1 Conservationist	Jacob Crandall	828-456-6341	P.O. Box 1109, Waynesville 28786
Area 2 Conservationist	Thomas Wetmore Jr.	336-637-2400	530 W. Innes St., Salisbury 28144
County	**Contact Person**	**Phone**	**Address**
Alexander	Daniel McClure	704-632-2708	255 Liledoun Rd., Box 10, Taylorsville 28681
Anson	Robert Horton Jr.	704-694-2710	1706 Morven Rd, Wadesboro 28170
Cabarrus	Matt Kinane	704-788-2106	745 Cabarrus Ave. W., Rm 216, Concord 28025
Caldwell	Cecil Haynes	704-758-1111	120 Hospital Ave. NE, Ste 2, Lenoir 28645
Davidson	Bruce Wilson	336-242-2075	301 E. Center St., Lexington 27292
Davie	Frederick Alexander	336-757-5011	180 S. Main St., Rm. 313, Mocksville 27028
Forsyth	Dede DeBruhl	336-767-0720	1450 Fairchild Dr., Winston-Salem 27105
Iredell	Larry Hendrix	704-873-6761	201 Water St., Statesville 28677
Mecklenburg	Matt Kinane	704-788-2106	745 Cabarrus Ave. W., Rm 216, Concord 28027
Montgomery	Angela Hill	910-572-2700	2270 N. Main St., Troy 27371
Randolph	B. Barton Roberson	336-318-6490	241 Sunset Ave, Rm. 105, Asheboro 27203
Richmond	Vilma Marra	910-997-8244	125 S. Hancock St., Box 2, Rockingham 28379
Rowan	R. Bruce Rider	704-637-1604	2727-C Old Concord Rd., Salisbury 28146
Stanly	Darryl Harrington	704-982-6811	26032-C Newt Rd., Albemarle 28001
Stokes	Reggie Liddell	336-593-2846	P.O. Box 98, Danbury 27016
Surry	Richard Everhart	336-386-8109	P.O. Box 218, Dobson 27017
Union	Phil Loudermilk	704-283-2163	604 Lancaster Ave., Monroe 28112
Wilkes	Ronald Howard	336-667-5700	207 W. Main St., Rm 244, Wilkesboro 28697
Yadkin	B.J. Cook	336-679-8052	P.O. Box 8, Yadkinville 27055

Table 5.2 Yadkin-Pee Dee River Basin Nonpoint Source Program Description and Contacts (cont'd)

Agriculture (continued)

Soil & Water Conservation Districts:

Districts administer the *Agriculture Cost Share Program for Nonpoint Source Pollution Control* at the county level; identify areas needing soil and/or water conservation treatment; allocate cost share resources; sign cost share contracts with landowners; provide technical assistance for planning and implementation of BMPs; and encourage the use of appropriate BMPs to protect water quality.

County	District Chairman	Phone	Address
Alexander	Larry Payne	704-632-0638	255 Liledoun Rd., Box 10, Taylorsville 28681
Anson	Dewitt Gaddy	704-694-2710	1706 Morven Rd, Wadesboro 28170
Cabarrus	Dennis Testerman	704-788-2105	745 Cabarrus Ave. W., Concord 28027
Caldwell	Boyd Wilson	704-758-1111	120 Hospital Ave. NE, Ste 2, Lenoir 28645
Davidson	David Smith	336-242-2075	301 E. Center St., Lexington 27292
Davie	I.H. Jones	336-634-5011	180 S. Main St., Rm. 313, Mocksville 27028
Forsyth	Roy Nifong	336-631-5181	1450 Fairchild Dr., Winston-Salem 27105
Iredell	Wade Carrigan	704-873-6761	201 Water St., Statesville 28677
Mecklenburg	Owen Furuseth	704-336-2455	700 N. Tryon St., Charlotte 28202
Montgomery	Mike Haywood	910-572-2700	227-D N. Main St., Troy 27371
Randolph	Arlie Culp	336-318-6490	241 Sunset Ave, Rm. 105, Asheboro 27203
Richmond	Larry Chandler	910-997-8244	P.O. Box 727, Rockingham 28379
Rowan	Sam Correll	704-637-0783	2727-C Old Concord Rd., Salisbury 28146
Stanly	Chester Lowder	704-982-6811	26032-C Newt Rd., Albemarle 28001
Stokes	Banner Shelton	336-593-2847	P.O. Box 98, Danbury 27016
Surry	Ted Holyfield	336-386-8109	P.O. Box 218, Dobson 27017
Union	Kenneth Mills	704-283-2163	604 Lancaster Ave., Monroe 28112
Wilkes	H. Grey Ashburn	336-667-5700	207 W. Main St., Rm 244, Wilkesboro 28697
Yadkin	J. Hazel Poplin	336-679-8052	P.O. Box 8, Yadkinville 27055

Division of Soil and Water Conservation:

State agency that administers the *Agriculture Cost Share Program for Nonpoint Source Pollution Control* (ACSP). Allocates ACSP funds to the Soil & Water Conservation Districts and provides administrative and technical assistance related to soil science and engineering. Distributes Wetlands Inventory maps for a small fee.

	Contact Person		
Central Office	Donna Moffitt (ACSP)	919-715-6108	512 N. Salisbury St. Raleigh 27626
Area 2	Marlene Fields	336-771-4600	585 Waughtown St., Winston-Salem 27107
Area 3	Jerry Dorsett	336-771-4600	585 Waughtown St., Winston-Salem 27107
Area 8	Ralston James	704-663-1699	919 N. Main St., Mooresville 28115
Area 7	Kevin Williams	910-486-1541	225 Green St., Ste. 714, Fayetteville 28301

NCDA Regional Agronomists:

The NC Dept. of Agriculture technical specialists: certify waste management plans for animal operations; provide certification training for swine waste applicators;. Track and monitor the use of nutrients on agricultural lands; operate the state *Pesticide Disposal Program*, and enforce the state pesticide handling and application laws.

Central Office	Tom Ellis	919-733-7125	Box 27647 Raleigh 27611
Regional Office	Ben Knox	704-278-9414	585 Lentz Rd., Mt. Ulla 28125

Table 5.2 Yadkin-Pee Dee River Basin Nonpoint Source Program Description and Contacts (cont'd)

Education

NC Cooperative Extension Service:

Provides practical, research-based information and programs to help individuals, families, farms, businesses and communities.

County	Contact Person	Phone	Address
Alexander	Lenny Rogers	828-632-4451	255 Liledoun Rd., Box 10, Taylorsville 28681
Anson	Richard Melton	704-694-2415	P.O. Box 633, Wadesboro 28170
Cabarrus	Carl Pless	704-792-0430	P.O. Box 387, Concord 28026
Caldwell	Kevin Johnson	828-757-1290	120 Hospital Ave. NE, Ste 1, Lenoir 28645
Davidson	William Holtzmann	336-242-2081	301 E. Center St., Lexington 27292
Davie	Ronnie Thompson	336-634-6297	180 S. Main St., Rm. 313, Mocksville 27028
Forsyth	Eddie Leagans	336-767-8213	1450 Fairchild Dr., Winston-Salem 27105
Iredell	Joe Massey	704-878-3154	201 Water St., Statesville 28677
Mecklenburg	Peggy Brown	704-336-4034	700 N. Tryon St., Charlotte 28202
Montgomery	Susan Hamilton	910-576-6011	203 W. Main St., Troy 27371
Randolph	Martha Judge	336-318-6000	2222-A S. Fayetteville St., Asheboro 27203
Richmond	Deborah Crandall	910-997-8255	P.O. Box 1358, Rockingham 28380
Rowan	Amelia Watts	704-637-0571	2727-C Old Concord Rd., Salisbury 28146
Stanly	Sue Block	704-983-3987	26032-C Newt Rd., Albemarle 28001
Stokes	John Brasfield	336-593-8179	P.O. Box 460, Danbury 27016
Surry	Tim Hambrick	336-401-8025	P.O. Box 324, Dobson 27017
Union	Tom Pegram	704-283-3739	500 N. Main St., Rm 506, Monroe 28112
Wilkes	Donna Edsel	336-651-7331	110 North St., Wilkesboro 28697
Yadkin	Jack Loudermilk	336-679-2061	P.O. Box 97, Yadkinville 27055

Forestry

Division of Forest Resources:

Develop, protect, and manage the multiple resources of North Carolina's forests through professional stewardship, enhancing the quality of our citizens while ensuring the continuity of these vital resources.

Central Office	Moreland Gueth	919-733-2162	P.O. Box 29581 Raleigh 27626-0581
D-2	Mike Good	704-757-5611	1543 Wilkesboro Blvd., Lenoir 28645-8215
D-3	Craig Clarke	910-997-9220	1163 N. U.S. 1, Rockingham 28379
D-10	Reid Hildreth	336-956-2111	304 Old Hargrave Rd, Lexington 27292

Table 5.2 Yadkin-Pee Dee River Basin Nonpoint Source Program Description and Contacts (cont'd)

General Water Quality

DWQ Water Quality Section:

Control of water pollution from point sources (municipal and industrial wastewater discharges) and from nonpoint sources (agricultural drainage, urban runoff, septic tanks and land application of waste); issues permits for both discharging and on-site wastewater treatment systems; conducts compliance inspections; performs a wide variety of special studies on activities affecting water quality; administers Section 319 grant projects statewide.

Central Office	Beth McGee	919-733-5083 x575	P.O. Box 29535 Raleigh 27626
Winston-Salem Region	Steve Mauney	336-771-4600	585 Waughtown St., Winston-Salem 27107
Mooresville Region	Rex Gleason	704-663-1699	919 N Main St, Mooresville 28115

Wildlife Resources Commission:

To manage, restore, develop, cultivate, conserve, protect, and regulate the wildlife resources of the State, and to administer the laws enacted by the General Assembly relating to game, game and non-game freshwater fishes, and other wildlife resources in a sound, constructive, comprehensive, continuing, and economical manner.

Central Office	Frank McBride	919-528-9886	1142 I-85 Service Rd., Creedmoor 27522
	Wayne Chapman	704-982-9255	32511 Laton Rd., Albemarle 28001
	Kin Hodges	336-374-6446	122 Kingfisher Way, Dobson 27017

U.S. Army Corps of Engineers:

Responsible for: investigating, developing and maintaining the nation's water and related environmental resources; constructing and operating projects for navigation, flood control, major drainage, shore and beach restoration and protection; hydropower development; water supply; water quality control, fish and wildlife conservation and enhancement, and outdoor recreation; responding to emergency relief activities directed by other federal agencies; and administering laws for the protection and preservation of navigable waters, emergency flood control and shore protection. Responsible for wetlands and 404 Federal Permits.

Wilmington District	W.C. Long II	910-251-4745	P.O. Box 1890, Wilmington 28402-1890

DWQ Groundwater Section:

Groundwater classifications and standards, enforcement of groundwater quality protection standards and cleanup requirements, review of permits for wastes discharged to groundwater, issuance of well construction permits, underground injection control, administration of the underground storage tank (UST) program (including the UST Trust Funds), well head protection program development, and ambient groundwater monitoring.

Central Office	Carl Bailey	919-733-3221	P.O. Box 29578 Raleigh 27626-0578
Winston-Salem Region	S. Knight	336-771-4600	585 Waughtown St., Winston-Salem 27107
Mooresville Region	Barbara Christian	704-663-1699	919 N Main St, Mooresville 28115

Construction/Mining

DENR Division of Land Resources:

Administers the NC Erosion and Sedimentation Control Program for construction and mining operations.

Central Office	Mell Nevils - Section Chief	919-733-4574	512 N. Salisbury St., Raleigh 27626
	Tracy Davis - Mining Specialist	919-733-4574	512 N. Salisbury St., Raleigh 27626
Winston-Salem Region	Danny Hockett	336-771-4600	585 Waughtown St., Winston-Salem 27107
Mooresville Region	Steve Allred	704-663-1699	919 N Main St, Mooresville 28115

Table 5.2 Yadkin-Pee Dee River Basin Nonpoint Source Program Description and Contacts (cont'd)

Solid Waste

DENR Division of Waste Management:
Management of solid waste in a way that protects public health and the environment. The Division includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors program.

Central Office	Brad Atkinson	919-733-0692	401 Oberlin Rd, Ste 150 Raleigh 27605
Winston-Salem Region	Brent Rockett	336-771-4608	585 Waughtown St., Winston-Salem 27107
Mooresville Region	Anthony Foster	704-663-1699	919 N Main St, Mooresville 28115

On-Site Wastewater Treatment

Division of Environmental Health and County Health Departments:
Safeguard life, promote human health and protect the environment through modern environmental health science, the use of technology, rules, public education and dedication to the public trust. Services include: training and delegation of authority to local environmental health specialists concerning on-site wastewater; engineering review for wastewater systems and industrial process wastewater systems with below the ground surface discharge; technical assistance to local health departments, state agencies and industry.

Central	Frank Schutz	919-715-0141	2728 Capital Blvd, Raleigh 27604
County	**Primary Contact**	**Phone**	**Address**
Alexander		704-632-2373	322 1st Ave. SW, Taylorsville 28681
Anson	Marc Kolman	704-694-5188	P.O. Box 633, Wadesboro 28170
Cabarrus	William Pilkington	704-786-8121	715 Cabarrus Ave. W., Concord 28025
Caldwell		704-757-1200	1966-B Morganton Blvd., Lenoir 28645
Davidson	Richard Baxley	336-242-2300	P.O. Box 439, Lexington 27292
Davie	Dennis Harrington	336-634-8700	P.O. Box 665, Mocksville 27028
Forsyth	Dr. Sherman Kahn	336-727-2434	799 Highland Ave., Winston-Salem 27101
Iredell	Ray Rabe	704-878-5300	318 Turnersburg Rd., Statesville 28687
Mecklenburg	Marie Shook	704-336-2472	600 E. 4th St., Charlotte 28231
Montgomery	Mike Hanes	910-572-1393	P.O. Box 425., Troy 27371
Randolph	Mimi Cooper	336-318-6200	2222 S. Fayetteville St., Asheboro 27203
Richmond	Tommy Jarrell	910-997-8334	125 Caroline St., Rockingham 28380
Rowan	John Shaw	704-633-0411	2727 Old Concord Rd., Salisbury 28146
Stanly	Joseph Bass Jr.	704-982-9171	1000 N. First St., Ste 3, Albemarle 28001
Stokes	William Johnson	336-593-2811	P.O. Box 460, Danbury 27016
Surry	Dr. Walter Linz	336-401-8400	118 Hamby Rd., Dobson 27017
Union	Lorey White	704-283-3785	Courthouse, Box 1139, Monroe 28112
Wilkes	George O'Daniel	336-651-7464	College St., Box 30, Wilkesboro 28697
Yadkin	Gayle Brown	336-679-4203	P.O. Box 457, Yadkinville 27055

- DENR Winston-Salem Region covers the following counties within the Yadkin-Pee Dee basin: Davidson, Davie, Forsyth, Rockingham, Randolph, Stokes, Surry, Wilkes, and Yadkin.
- DENR Mooresville Region covers the following counties within the Yadkin-Pee Dee basin: Alexander, Cabarrus, Iredell, Mecklenburg, Rowan, Stanly, and Union.
- DENR Fayetteville Region covers the following counties within the Yadkin-Pee Dee basin: Richmond and Montogomery.

5.6 PROGRAM INITIATIVES IN THE YADKIN-PEE DEE RIVER BASIN

Through the development of this plan, efforts were made to identify initiatives undertaken within the basin to protect water quality. The following discussion focuses on program initiatives that have been implemented or are underway within the Yadkin-Pee Dee River basin. These initiatives demonstrate a tremendous effort to protect surface waters in the basin. There may be other initiatives underway in the basin which we are not yet aware of. Table 5.3 presents a summary of the agency or organizations that have program initiatives in the basin.

Table 5.3 Program Initiatives in the Yadkin-Pee Dee River Basin

Level of Agency	Name of Agency	Type of Initiative
Federal	U.S. Department of Agriculture - U.S. Forest Service	Land and Resource Management Plan
	US Department of Agriculture - National Resources Conservation Service	Coordination on Mitchell River Project
State	NC Division of Forest Resources	Forest Practice Guidelines Best Management Assistance Forest Stewardship Program
	NC Division of Land Resources	Sedimentation Pollution Control Act and the Mining Act
	NC Department of Transportation	Goose Creek Project
	NC Division of Water Resources	Stream Restoration Projects
	NC Division of Soil and Water Conservation	Agriculture Cost Share Program for Nonpoint Source Pollution Control
Local Govt./Agencies	Wilkes County Soil and Water Conservation District (SWCD)	Demonstration project for poultry composting and litter dry stacks
	Forsyth County	Water Quality Monitoring Program Yadkin River Conservation District
	City of Winston-Salem	Storm Water Quality Mgmnt Program Sediment Control Program
	Mecklenburg County	Erosion Control Regulations SWIM Program, Various Efforts
	City of Charlotte	SWIM Program, Storm Water Services
	City of Concord	Stormwater Ordinance
	Rowan County	Erosion Control Program
	Cabarrus County	Erosion Control Program
Corporate	Yadkin-Pee Dee River Basin Association	Voluntary dischargers group to coordinate monitoring and reporting, Clean Water Management Trust Fund Grant
	Duke Energy	Mitchell River Sediment Study
	Yadkin, Inc. (ALCOA subsidiary)	Shoreline Management Plan
Regional Organizations and Commissions	Yadkin/Pee Dee Lakes Project	Broad-Based Strategic Planning Efforts
	Yadkin River Commission	Promotes Benefits of River to the Region
	Pilot View Resource Conservation and Development, Inc.	Various Projects, Clean Water Management Trust Fund Grant
	Northwest Piedmont Council of Governments	Database Development and Environmental Scan
	The LandTrust of Central North Carolina	Acquire Conservation Easements, Clean Water Management Trust Fund Grant
	Piedmont Land Conservancy	Conservation Easements and Water Quality Projects, Clean Water Management Trust Fund Grant

5.6.1 Federal Initiatives

USDA Forest Service

The U.S. Forest Service has developed a Land and Resource Management Plan 1986-2000 for the Uwharrie National Forest. Included in this plan are many forest-wide standards developed to protect water quality within the forest. These standards pertain to logging roads, skid trails, re-establishment of vegetation, maintaining a 33-foot wide vegetated riparian zone and identifying wetlands and flood prone areas.

USDA Natural Resource Conservation Service

The Surry County Natural Resource Conservation Service is cooperating on a Clean Water Management Trust Fund grant with the Piedmont Land Conservancy on the Mitchell River watershed (see Section 5.6.6). DWQ is also cooperating on this project by providing biological sampling (macroinvertebrate and fish data) from a limited number of sites on the river. DWQ biologists also provided training on macroinvertebrate sampling techniques for three citizen monitoring teams.

5.6.2 State Agency Initiatives

NC Division of Forest Resources (DFR)

The DFR is implementing various measures for protecting water quality statewide. In 1989, the Sedimentation and Pollution Control Act (SPCA) was amended to require compliance with nine performance standards in order for forestry site disturbing activities to remain exempt from the SPCA's permitting requirements. These measures are the *Forest Practice Guidelines Related to Water Quality* (FPGs), whose compliance is accomplished through the use of BMPs. The *Forestry Best Management Practices Manual* published in 1989, guides forestry operations in protecting water quality. The following summarizes the FPGs or performance standards:

- establishment of a Streamside Management Zone,
- prohibition of debris entering streams,
- access and skid trail stream crossing protection measures,
- access road entrance restriction,
- prohibition of waste entering streams,
- waterbodies, and groundwater,
- pesticide and fertilizer application restrictions, and
- rehabilitation of project site requirements.

DFR administers the FPGs through routine filed work while preparing Forest Management Plans and as follow up to citizen complaints. DFR also conducts logger training in water quality/FPG issues through the ProLogger Program, field days and static displays at logger trade shows.

NC Division of Land Resources

The Land Quality Section of the Division of Land Resources enforces the *Sedimentation Pollution Control Act of 1973* (SPCA), the *Mining Act of 1971* (Mining Act) and the *Dam Safety Law of 1967* (Dam Safety Law). The SPCA and the Mining Act address nonpoint pollution for sedimentation from construction and mine sites. Erosion and sedimentation control measures, or BMP's, are installed to protect water quality. The SPCA has mandatory standards that must be met by all land-disturbing activities 1 acre or more in size. Agriculture and timber activities are exempt from the SPCA and Mining Act, however, timbering activities must comply with Forest Practice Guidelines.

An approved mining permit and reclamation plan are required for mining activities disturbing 1 or more acres of land. The *Mining Act* and corresponding administrative code address sediment and erosion control generally by requiring mine operators to minimize siltation of streams and other water bodies. The standards and policies set in the Sediment Program are applied in the Mining Program for temporary BMP's. However, permanent measures must be designed for larger storm events. The Mining Act also requires a detailed reclamation plan for each mine site to permanently stabilize all affected areas.

Since the inception of the SPCA, the Sedimentation Control Commission has funded many workshops for the general public, contractors and consultants, as well as educational programs for school-aged children. The SCC also supports a student education intern to help with education projects and presentations to classrooms. The DLR Land Quality Section has the following materials available:

- *Erosion and Sediment Control Field Manual*
- *Erosion and Sediment Control Video Modules*
- *Erosion and Sediment Control Inspector's Guide*
- *Erosion and Sediment Control Planning and Design Manual*
- *Erosion Patrol 3rd Grade Curriculum Supplement*
- *Muddy Water...It's More Dangerous Than You Think* Video

Land Quality Section Activities in the Yadkin-Pee Dee River Basin

The Yadkin-Pee Dee River Basin includes counties under the jurisdiction of the Mooresville, Fayetteville and Winston-Salem Regional Offices. The following information is provided by two of the regional offices, not by county or River basin (the intent in future reports is to report by River basin) and is intended to explain the workloads in these offices. Inspections within the Dam Safety Program were not provided. The mining and construction/sedimentation control programs comprise approximately 90 percent of the Land Quality Section field staff time.

		Construction Inspections	Mine Inspections
Mooresville:	FY96	1524	51
	FY97 thru 3/97	1188	69
Winston-Salem:	FY96	2073	79
	FY97 thru 3/97	1113	41

Table 5.4 provides mining and construction site numbers specific to the Yadkin River Basin and are broken into county for reference and interpretation.

Local Sedimentation and Erosion Control Programs

There are seven local programs within the Yadkin River Basin. The local programs have jurisdiction over construction sites within their areas (all mine sites are within the jurisdiction of the Land Quality Section). The following programs (Table 5.5) are either completely or partially within the Yadkin River Basin.

Table 5.4 Mining and Construction Site Activities of the Land Quality Section in the Yadkin-Pee Dee River Basin

County	Mines - Total No. of Active Sites	Mines - Acres Disturbed	Construction - Total No. of Sites Approved FY96-97	Construction - Acres Approved to be Disturbed
Mecklenburg	3	202.6	20	199
Cabarrus	9	419	116	926.8
Union	4	214.5	38	384.8
Stanly	4	176.3	20	236.8
Alexander	1	2	2	7.6
Iredell	1	80	66	465.8
Rowan	19	203.4	12	118.6
Surry	5	124.5	25	155.8
Wilkes	10	93.9	25	165
Randolph	2	33.1	31	197.8
Yadkin	4	17.2	16	63.7
Davie	4	69.5	20	222.5
Forsyth	3	165	61	285.2
Davidson	6	56	51	588.8
Watauga	1	12.4	1	5.8
Caldwell	1	13.9	3	21.2
Anson	11	1010.9	5	22.8
Richmond	9	770.1	9	80.1
Montgomery	8	235.9	14	175.5
TOTALS	105	3900.2	535	4323.6

Table 5.5 Local Administered Sedimentation and Erosion Control Programs in the Yadkin-Pee Dee River Basin

Local Program Report for FY96 & 97 thru 4/97	Total No. of Sites Approved in FY	Acres Approved to be Disturbed	Inspections Performed
City of Charlotte	32	164.2	2127
Forsyth/Winston Salem	no report		
Guilford	5	38.7	172
High Point	41	152.5	796.5
Rowan	23	120.9	195
Watauga	2	6.2	23
Mecklenburg	no report		
Totals	103	482.5	3313.5

<u>NC Department of Transportation (NC DOT)</u>

The NC Board of Transportation named five new scenic byway routes for the Uwharrie Lakes Region in April 1997. The byways provide travelers with scenic beauty, history, heritage and recreation in a driving tour format. The new byways total approximately 82 miles in a six county area (Rowan, Stanly, Anson, Richmond, Montgomery and Randolph counties).

The NC DOT is funding a three year grant to pay for a biologist to educate landowners about the need to maintain water quality in Goose Creek to protect mussel populations (Carolina heelsplitter). The heelsplitter in Goose Creek faces extinction as a result of development. NC DOT is undertaking this effort to offset damage from the building of a highway loop in eastern Mecklenburg County, including an interchange at Mint Hill. Goose Creek flows east from Mint Hill through northern Union County (subbasin 03-07-12). In cooperation with this project, wildlife officials have developed a recovery plan to boost the mussel populations. The 10-year plan relies on voluntary efforts by landowners. The US Fish and Wildlife Service can provide money to landowners to use best management practices along the creek.

NC Division of Water Resources

The NC Division of Water Resources (DWR) provides cost-share grant funds primarily to units of local governments for the purpose of water resource development projects. Grant applications should fall within the following categories: general navigation, recreational navigation, construction costs for water management projects, stream restoration, beach protection, land acquisition for recreational sites and weed control. The following projects within the basin were funded by DWR in 1995 and 1996.

Surry County Little Fisher River Stream Restoration

The absence of a buffer zone of trees and shrubs along private landholdings on the Little Fisher River resulted in decreased bank stability and accelerated bank erosion. Both state and federal agencies (U.S. Soil Conservation Service, NC Wildlife Resources Commission and Pilot View Resource Conservation and Development Inc.) coordinated to incorporate the techniques and stream restoration principles of Dave Rosgen (Wildland Hydrology Consultants, Pagosa Springs, Colorado) to restore the streambanks. The project began approximately 150 feet above SR 1397 and included six sites (totaling 466 linear feet). The purposes of the project include: stabilizing highly eroding streambanks, reduction of loss of land, reduction of sedimentation, improved fish habitat and improved aesthetics to the creek. This project was completed in 1995.

City of Winston-Salem, Church Creek Stream Restoration

As the watershed of Church Creek has been developed, the stream has changed from a shallow creek where children played to a deeply eroded ditch. Riparian vegetation of trees and shrubs has been mostly destroyed. Where a grass cover buffer exists, it is mowed to stream edges. This project was proposed by the City of Winston-Salem and Pilot View RC&D, Inc. to reduce further degradation and restore streambank stability and to encourage policy to reduce urban stormwater flows. Bioengineering techniques using revegetation of deep rooted tree and shrubs species, reducing mowing to the stream edge and some use of engineering measures such as stone check dams and development of falls and pools were used during the design of the project. This project was completed in 1995.

City of Winston-Salem, Tanners Run and Town Creek Restoration Study

Tanners Run is an urban stream flowing through historical property in the City of Winston-Salem. As a result of urbanization, the lack of streamside vegetation and high flow velocity from runoff has contributed to unstable streambanks. The project was designed to use structural engineering in combination with bioengineering to stabilize streambanks. The use of native plant species for revegetation was considered in project design. Stormwater management facilities such as detention/retention structures were also included in the design of the project. Project participants include: Pilot View Resource Conservation and Development Inc., Old Salem, Inc., City of Winston-Salem, Forsyth County, USDA-Natural Resource Conservation Service and local industrial sponsors. The project is in the beginning phase of development.

City of Mount Airy, Lovill's Creek River Trail Study

The City of Mount Airy, in cooperation with Pilot View Resource Conservation and Development Inc., USDA-Natural Resources Conservation Service, Reeves Community Center, Mt. Airy Appearance Commission and local industrial sponsors, have completed a portion of a stream stabilization project for Lovill's Creek. This project, funded by the NC Division of Water Resources, was intended to restore riparian areas through establishment of native plants. The project was also designed to install stormwater management facilities such as detention/retention structures and constructed wetlands for improving water quality and aquatic habitat. Under this funding, a master plan was developed for approximately 3 1/2 miles of stream length and a pilot segment was designed for 1/3 mile of the creek. The remainder of the project and the implementation of the master plan is on hold until finances are secured.

Surry County South Fork Mitchell River Monitoring

A stream quality monitoring network and stream restoration inventory will be developed to identify potential problem areas along the South Fork of the Mitchell River. The network will collect hydrologic, water quality and rainfall data. The inventory will allow for prioritization and targeting of restoration efforts. This project is a cooperative effort between the Surry County Soil and Water Conservation District and the Mitchell River Stream Watch group. Refer to Section 5.6.5 for more details on this project.

Big Elkin Creek

The Town of Elkin has applied to DWR for funding of a streambank stabilization project on Town Creek using bioengineering techniques.

Mill Creek Wetland and Trail Construction

The City of Winston-Salem has submitted a proposal to DWR for creating artificial wetlands and extending a greenway around the historic Bethabara.

NC Division of Soil and Water Conservation

The NC Division of Soil and Water Conservation provides cost share to local Soil and Water Conservation Districts on an annual basis through the *Agricultural Cost Share Program for Nonpoint Source Pollution Control* (NCACSP). This program was formally established in May 1987 by the General Assembly and was expanded statewide in 1989. The NCACSP cost shares BMPs for water quality protection. The program pays farmers up to 75 percent of the average cost of implementing approved BMPs and offers technical assistance to producers. The current annual statewide budget for cost-share is approximately $7 million. Table 5.6 summarizes NCACSP expenditures within the Yadkin-Pee Dee River basin (only those counties with at least five percent of land area within the basin are shown) since 1990, the first year of funding.

Between 1990 and 1997, the majority of cost-shared cropland BMPs implemented in the basin were in livestock exclusion, conservation tillage and diversions. Approximately $2,047,000 NCACSP funds were spent on BMPs for animal waste management systems, including lagoons, ponds, dry stacks, litter storage and composters. An additional one-third of this value is provided through producer contributions..

Table 5.6 Summary of NCACSP Cost Share Expenditures and Estimated Benefits in the Yadkin-Pee-Dee River Basin, 1990-1997.

County	Number of Contracts	Acres Affected	Tons Soil Saved	Total ACSP Cost Share $
Alexander	54	1,518	8,800	165,800
Anson	34	1,769	6,728	148,100
Cabarrus	105	3,734	45,966	346,400
Caldwell	21	1,058	665	58,150
Davidson	161	9,144	47,800	388,150
Davie	105	2,738	18,994	348,450
Forsyth	101	2,798	31,061	196,500
Iredell	107	2,294	6,003	556,700
Montgomery	61	3,772	9,170	137,550
Randolph	97	5,882	131,382	210,200
Richmond	45	5,709	3,162	184,050
Rowan	112	4,121	18,413	519,200
Stanly	274	16,433	91,111	566,200
Stokes	17	501	6,534	67,250
Surry	309	5,828	28,232	574,350
Union	76	4,532	1,249	447,950
Wilkes	188	5,683	23,210	776,700
Yadkin	110	5,714	24,672	467,500
TOTAL	1,977	83,228	503,152	6,159,200

5.6.3 Local Government Initiatives

Wilkes County

Wilkes County is the leading producer of broiler chickens in the state (93,000,000 birds in 1995). About five percent of the poultry are lost during production due to various causes. This amounts to about four million birds each year in Wilkes County alone. The conventional practice of burying mortalities in pits can result in problematic nutrient loading to receiving waters and raise zinc and copper levels in the soil. Secondarily, leaving poultry litter exposed to the elements causes significant losses in nutrient levels, which can end up in receiving streams.

The Wilkes County Soil and Water Conservation District (SWCD) received a Section 319 grant in 1994 to develop a demonstration project for poultry composting and litter dry stacks. Composting can replace the use of "dead pits". In 1995 and 1997, the Harris and Harless farms installed roofed facilities that convert poultry mortalities into viable fertilizer. This conversion prevents nutrient losses from poultry litter while keeping it in a manageable form. The SWCD developed nutrient management plans for the two farms that detail how the compost can be used beneficially as a fertilizer. The SWCD staff have produced a brochure on composting and dry stacks and promote use of these practices. Numerous informal tours of the two farms have been conducted, and there are plans to hold field days in the near future.

Forsyth County

Forsyth County created the *Yadkin River Conservation District* to help protect the Yadkin River. The district is highly restrictive, with low density residential use being the primary land use allowed. Objectives of the district are to:

- Protect water supplies;
- Maintain rural character;
- Protect sensitive natural, historical, recreational, and visual resources;
- Retain natural topography and vegetation;
- Control sedimentation and other nonpoint pollution; and
- Support and encourage agricultural activities.

Requirements within the Yadkin River Conservation District include:

- *Boundaries:* A minimum of 2,000 feet from river channel edge and all flood-prone areas up to 3,000 feet from the river.
- *Minimum Lot Size:* Three acres except for planned residential developments (PRDs). The allowed density for PRDs is determined by a formula and cannot exceed 2 units per acre in developable areas not restricted by floodplain or steep hillsides.
- *Setbacks:* Structures must be setback at least 200 feet from the river.
- *Vegetative Buffers:* A vegetated buffer along the river and all streams that shall extend 100 feet along both sides of the stream channel.
- *Permitted uses in the Stream Buffer and Floodplain:* Uses and activities were established to protect hydrologic processes, water quality, and wildlife habitat. Agriculture is permitted as long as the accepted soil conservation practices of the Soil Conservation Service are followed. Recreation facilities, utility systems, and roads and bridges are also allowed, but must be designed to minimize damage to the river.

Forsyth County Environmental Affairs Department (EAD) Water Quality Monitoring Program

In an effort to provide area decision makers and the general public with data regarding surface water quality within the 230 square mile Muddy Creek watershed, the EAD began monitoring six sites on Muddy Creek and its major tributaries during the spring of 1988. Since 1988, EAD has monitored base and storm flows six to eight times per year for a variety of physical and chemical parameters, recently expanded to include eight metals, four nutrients and 60 organic pollutants. In July 1996, EAD entered into a cooperative research agreement with UNC-Asheville's Environmental Quality Institute, doubling the number of sites monitored for physical and chemical parameters to 12. In addition, EAD instituted biological monitoring at 24 sites during 1996. Biological diversity in less urbanized subbasins was good, while urbanized streams rated lower. Early in the life of the program it became evident that sedimentation due to erosion had a major negative impact within the watershed. EAD also continues to conduct 60 to 90 field investigations per year to address water quality complaints from citizens, resulting in the cessation of numerous point and nonpoint source pollutant discharges.

Using routine monitoring data compiled through 1996, a degradation index was developed relative to the data gathered from the Salem Creek site and based on the number of parameter values over NC and federal water quality standards and guidelines for selected nutrient, metal and suspended sediment parameters. Salem Creek was chosen for comparison due to its consistent pattern of exhibiting the highest monitored values of all Muddy Creek watershed streams for the selected parameters (nutrients, metals and solids).

For further information regarding Forsyth County's water quality monitoring effort or to request a copy of EAD's 1996 Annual Report, call 910-727-8060.

City of Winston-Salem

The City of Winston-Salem has implemented a Storm Water Quality Management Program (SWQMP) to ensure that storm water is effectively controlled and storm water pollution is reduced. As part of the SWQMP, the city has identified 15 watersheds and will complete basin studies and master plans on those watersheds by the end of FY 99-2000. By the end of 1997, the city plans to draft a Storm Water Ordinance and Enforcement Response Plan, which will be modeled after the existing Sewer/Pretreatment Policies. Other activities to implement the city's SWQMP include:

- Monitoring water quality to track down pollution and stop it at the source
- Inspecting privately owned storm water control devices for effectiveness
- Inspecting industries to assist with meeting Storm Water Regulations
- Identifying and mapping the storm water collection system
- Studying flow patterns and ways to reduce erosion and flooding

The city is designing a program to educate and involve the public in improving storm water quality. Public education efforts include:

- Publishing information emphasizing what the public can do to protect storm water
- Distributing brochures at lawn and garden centers encouraging prudent usage of fertilizers, herbicides, and pesticides
- Using a brochure and video for educational opportunities with schools and civic groups
- Using a Storm Water Logo to improve public recognition

Other city actions for the past year include:

- Providing a Construction Site Sediment Control Permit Program which issued 184 permits, stabilized 652 acres, inspected 4,422 construction sites and cited 53 violations.
- See Section 5.6.2 for other projects.

City of Charlotte

Surface Water Improvement and Management (SWIM) Program

See Mecklenburg County below for a description of this cooperative program.

Charlotte Storm Water Services

The City of Charlotte has a utility fee structure to finance the activities of the Storm Water Services. These activities include the water quality program and administration of the NPDES municipal stormwater discharge permit. The storm water management program has conducted the following activities:

- Established eight in-stream chemical and bacteriological sample sites for dry weather sampling, four times per year and one in-stream sample site during storm events, four times per year.
- Promotes and is involved with Big Sweep.
- Produced "Slime Stopper", a seven minute video on nonpoint source pollution.
- Adopted the Storm Water Pollution Ordinance to address illicit connections and improper disposal.
- Adopted a Sedimentation and Erosion Control Ordinance.
- Trained 130 participants in 1995 on Erosion, Sedimentation and Other Pollutants Control Seminars.

Mecklenburg County

Erosion Control Regulations

Mecklenburg County has had a local erosion control ordinance since October 1974. Since the local program covers a smaller geographical area than the state program, the County is better able to control erosion and sediment. Developers support the local program because of faster review times.

Mecklenburg County approved 215 erosion control plans in 1996. This workload was handled by five inspectors who were also responsible for road construction in new subdivisions and drainage for all new construction outside the City of Charlotte. Because of vacancies in the plan review staff, a consulting firm was hired to complete much of the workload. Two engineers have since been hired to review subdivision, commercial drainage and erosion control plans. Mecklenburg County is currently unable to meet its goals and is hiring two additional inspectors and another plan reviewer.

Plan review and inspection services are billed on a sliding fee schedule. The developer of a one-acre commercial site is charged $1050.00 for erosion control services. A developer of a thirty-acre subdivision is charged $4750.00. Charges cover 100% of the cost of providing services.

Surface Water Improvement and Management (SWIM) Program

The City of Charlotte and Mecklenburg County Department of Environmental Protection (MCDEP) have joined in a cooperative effort to restore the quality and usability of surface waters. The Surface Water Improvement and Management (SWIM) Program began in 1995 with enhanced water quality monitoring efforts. A numerical water quality rating system was developed and incorporated into a GIS mapping program. Water quality results and maps are presented in the annual Mecklenburg County's State of the Environment Report. In the spring of 1996 an educational campaign was launched to increase public awareness of all stakeholders on current water quality conditions and to obtain public input and involvement in the SWIM program. As of February 1997, MCDEP has conducted 43 presentations to the public resulting in direct contact with 2666 Mecklenburg County citizens, mailed over 700 SWIM Alert newsletters, developed three draft basin plans for subbasins in the Catawba River drainage and developed a citizen monitoring program ("Adopt A Stream" Program) of 640 citizens and covering 73 stream miles. Citizen activities include cleanup efforts, storm drain stenciling and reporting of pollution problems. SWIM efforts could result in significant changes in development activities, improved Greenway acquisition efforts and the development of stream buffers.

The Mecklenburg County Department of Environmental Protection (MCDEP) adopted a Creek Use Policy in October 1996. The policy is intended to protect the surface waters of Mecklenburg County "for prolonged human contact and recreational opportunities and shall be suitable to support varied species of aquatic vegetation and aquatic life." Under this policy, MCDEP staff is directed to bring to the Mecklenburg County Board of County Commissioners "alternatives and potential costs to restore waterways and lakes to natural beauty and recreational use..." within 90 days of listing a waterway under the SWIM program. In January 1998, the Board voted to proceed with staff recommendations of a proposed SWIM Strategy.

The SWIM panel and staff developed a Phase I Implementation Strategy that was strongly supported at public meetings. The Strategy is a nine part plan for proactive maintenance and restoration efforts that will serve as a foundation for future phases. Phase I includes strategies aimed at 1) reducing bacteria and sediment to streams, 2) enhancing enforcement of buffer requirements in water supply watersheds, 3) potentially establishing buffers for other areas 4) improving water quality monitoring and assessment methods, 5) improving coordination with existing programs related to streams, 6) increasing community education and involvement in water quality efforts.

Additional Water Quality Programs and Efforts of Mecklenburg County Department of Environmental Protection (MCDEP)

- Storm Drain Stenciling Program - Several hundred storm drains have been stenciled by over 22 community groups.
- Issued 94 written notices of violation for water quality problems in the past year.
- Monitors 235 active stormwater permits in Mecklenburg County. MCDEP identifies problems facilities and conducts site inspections at a minimum of 24 problem facilities per year. Problems at these facilities are identified and corrected.
- Works with Charlotte Storm Water Services to monitor and inspect private BMPs and to ensure that storm water maintenance activities are adequate.
- Works with Charlotte Storm Water Services in the design and construction of pilot BMPs including compost filters, storm septors and enhanced sediment basins.
- Participating in stream trash removal campaign and stream cleanup programs.
- GIS mapping of Surface Water Quality Index annually and monthly mapping by watershed to identify problem areas.
- Quarterly and ambient monitoring at six fixed stations in the major creeks draining Charlotte.

City of Concord

The City of Concord developed a zoning ordinance in 1987 that requires new construction with more than 20,000 square feet of impervious surface cover to develop a stormwater drainage plan. No permits are issued for any such development until the drainage plan is approved by the City Engineer.

Rowan County

For over twenty years, Rowan County has administered a soil erosion and sedimentation program. The ordinance is performance-based and must operate at or above the minimum standards established by the NC DENR, Land Quality Section. The program allows for the requirement of plan revisions and additional measures to achieve adequate results whenever the original plan proves inadequate. Agricultural and mining activities are exempt from the program, as is forestry when Best Management Practices are used. Projects with land-disturbing activities of one acre or more must submit a soil erosion and sedimentation control plan for review at least 30 days prior to grading. Upon plan approval, grading may begin. Failure to obtain approval prior to grading results in the automatic assessment of a penalty. Permitted sites are inspected periodically for effectiveness and compliance with the approved plan. Enforcement, when necessary, is achieved through penalty assessments established by the County Commission. Site monitoring continues until permanent stabilization is achieved. This program has successfully eliminated the off-site loss of thousands of tons of sediment while providing an economic benefit to the developers and protecting natural resources. As of September 15, 1997, there were 57 active projects and 26 projects in closure regulated by this program.

Cabarrus County

The Cabarrus County Soil Erosion and Sedimentation Control Ordinance became effective January 1, 1998. The ordinance is being implemented in coordination with all municipalities in the county. A local program was developed and adopted by the Cabarrus Board of Commissioners in order to be able to exert more local control over land disturbing activities, to provide more frequent inspections of construction sites, and to create a more effective enforcement program by tying implementation of erosion and sediment control plans to building permits. For further information, contact the Cabarrus County Development Services at (704) 788-8137.

5.6.4 Corporate Initiatives

Yadkin-Pee Dee River Basin Association

Thirty dischargers in the Yadkin-Pee Dee River basin have voluntarily agreed to form the Yadkin-Pee Dee River Basin Association. The mission of the Association is to preserve the waters of the Yadkin-Pee Dee River through innovative and cost-effective pollution reduction strategies by:

- Forming a coalition of units of local government, public and private agencies and other interested stakeholders to secure and pool financial resources and expertise;
- Collecting and analyzing information and data and developing, evaluating and implementing strategies to reduce and control pollutant discharge;
- Providing accurate technical, management, regulatory and legal recommendations regarding the implementation of strategies and appropriate effluent limits on discharges into the Yadkin-Pee Dee River.

The Association is in the process of establishing a formal agreement with DWQ concerning surface water monitoring. The Association will subcontract with one organization to collect instream monitoring data normally collected by individual permittees. Monitoring sites and parameters have been established by DWQ such that instream monitoring is more efficient, effective, flexible and basin-oriented. This agreement will exempt participating permittees from any instream monitoring as specified by their individual NPDES permits. Water quality monitoring results will be entered into EPA's STORET database. At the time of printing, the Association was receiving bid contracts for sample collection and analysis. Once bids are received, the Association will formally enter into agreement with a signed contract.

The potential benefits of the association are many and include:

- More monitoring data will be available to compliment DWQ's ambient monitoring data,
- The data will be stored in STORET and become more accessible than the hard copies currently held in the DWQ central office.
- The Association gives the dischargers a collective voice, fostering better communication with each other and with DWQ.
- DWQ will have a point of contact for communication with the dischargers through the Association officers and committees.
- The monitoring sites were established to provide a more strategic look at water quality (which might provide a better estimate of nonpoint source pollution contributions).
- This method of sampling is more efficient because one contractor will collect all the samples. This could save the dischargers money on analyses. Administrative burden should also be reduced.
- There is the potential for special projects, nutrient trading and offsetting nonpoint source pollutants.
- The Association could work together with landowners to reduce sedimentation and improve intake water quality.
- More monitoring data can allow for better model development for individual dischargers.
- The Association will help foster a comprehensive, basinwide approach to water quality management.

In addition to this agreement, the Association has received a Clean Water Management Trust Fund grant. The grant will be used to 1) identify and prioritize two sites for restoration and two sites for protection efforts within the Yadkin-Pee Dee River basin, and 2) develop implementation plans for restoring water quality and for protecting water quality in these high priority stream segments.

For more information contact: John Vest, Utilities Director for the City of Salisbury and Chairperson for the Yadkin-Pee Dee River Basin Association at 704-638-5204.

Duke Energy

Duke Energy is cooperating with other agencies to conduct a multi-year sediment study on the South Fork of the Mitchell River in Surry County. The study will use depth-integrated composite samples collecting baseflow conditions and vertical series of single-stage samplers to collect representative samples of the rising stage of storm hydrographs.

ALCOA subsidiary Yadkin, Inc.

The Yadkin Hydroelectric Project, a federally licensed hydropower project on the lower Yadkin River, is composed of four dams and their associated reservoirs (High Rock Lake, Tuckertown Reservoir, Narrows Reservoir (or Badin Lake) and Falls Reservoir). The Yadkin Project is owned and operated by Yadkin, Inc., a subsidiary of the Aluminum Company of America (ALCOA) under license from the Federal Energy Regulatory Commission (FERC). Operation of the project provides electricity to Alcoa's Badin Works.

As a FERC licensee, Yadkin, Inc. is responsible for the safe and efficient operation of the hydropower facilities. Yadkin is also responsible for providing public access and public recreation facilities at the project, as well as ensuring the protection of important natural environmental, cultural and aesthetic resources. Yadkin is also granted authority by FERC to issue approvals for private use of the reservoirs and the reservoir shoreline, including the construction of private and commercial docks and piers.

In recent years, increasing development around High Rock Lake and Narrows Reservoir has caused Yadkin to be concerned about future management of the reservoirs and the stewardship of project resources. To provide guidance on future development and management of the reservoir shorelines, Yadkin, Inc. is in the process of developing a Shoreline Management Plan (SMP) for the project. The SMP identifies important natural resources at the project, delineates areas where impacts from new development will be minimized, and establishes a process whereby all new development will be reviewed in the future to evaluate its potential environmental impacts. The draft SMP also considers new requirements for vegetative shoreline buffers to help protect reservoir water quality and provides guidance to shoreline property owners on actions they can take to help minimize nonpoint source pollution associated with shoreline development.

For more information on the SMP or Yadkin, Inc. Projects, contact Gene Ellis at (704) 422-5606.

5.6.5 Regional Organizations and Commissions

Yadkin/Pee Dee Lakes Project

In February 1992, the Division of Community Assistance (within the NC Department of Commerce) approached the citizens of Anson, Davidson, Montgomery, Richmond, Rowan and Stanly counties (neighboring Randolph County was later added to the initiative) to gauge local interest in a joint strategic planning process. It was proposed that these counties, which are clustered along a chain of lakes on the Yadkin/Pee Dee River system and around the Uwharrie Mountains, join together in a mutual forum to explore issues that affect the balance between economic development and environmental management in the region.

From 1992 to March 1994, over 400 local residents, state and local leaders and representatives from the private sector participated in the planning process. During this time, a Steering Committee was established, fundraising for the effort began, a regional scan of resources was undertaken, a local project coordinator was hired and three citizen task forces were established (environmental management, responsible economic growth and tourism). The resulting recommendation of the task forces was to establish a permanent office (central to the region) to act as a clearing house for information on the region surrounding the Yadkin/Pee Dee Basin, and initiate innovative projects that promote eco- and heritage-tourism throughout the area. Efforts to attract people to the area while instilling a sense of protection toward the natural resources found in the region is a major focus of the Yadkin/Pee Dee Lakes Project.
The Yadkin/Pee Dee Lakes Project works with a broad base of public and private partners such as state and federal agencies, power companies, financial institutions, state and local governments, industries and concerned citizens. The basis of the programs is to create an alternative economy based on the preservation of the area's impressive natural and cultural assets. Examples of these initiatives include: establishing a recreational trail (hiking, biking, equestrian) along an abandoned railbed in Anson County; expanding the Yadkin River Trail along the Pee Dee River, working with the NC Department of Transportation to designate stretches of roads throughout the Uwharrie Lakes Region as part of the State's Scenic Byways Program; and forming an inter-county bicycle loop to tour the region. One of the Lakes Project's most significant endeavors was the creation of The Land Trust for Central North Carolina (see write-up below) to protect large tracts of land in the Yadkin/Pee Dee River corridor.

These programs have helped to promote the region as "NC's Central Park". This theme has brought about tremendous recognition for the region and visitors have begun to look at the region in a whole new light. While the assets of the region are being linked together through these efforts, there is a need for a strategy in accord with the area's natural and historic integrity. The Yadkin/Pee Dee Lakes Project is continually developing mechanisms to create jobs that depend on and protect the natural resources of the Uwharrie Lakes Region. Coordinators of the effort firmly believe that if the corridor of the Yadkin/Pee Dee River is to be preserved and retain its existing integrity, then there must be a strategy in place that consistently offers information about this vital resource to the people that will ultimately have an effect on its condition, now and into the future. Funding for such an initiative has begun, and creative partnerships have been struck to ensure that environmentally-rich and -sensitive areas are properly utilized and reverently protected.

For more information on the Yadkin/Pee Dee Lakes Project, contact Alex Cousins or Beth Bohling at (704) 422-3215.

The Yadkin River Commission

The Yadkin River Commission is an advisory group comprised of representatives appointed by the County Commissioners of Davie, Forsyth, Surry and Yadkin counties. Initiated in 1991 through an intergovernmental agreement, the commission serves as a clearinghouse of river-related information and promotes voluntary conservation programs at the local level.

The Commission's primary objective is to promote the unifying benefits of the river to the region. The Commission maintains a strong working relationship with the Nicholas School of the Environment at Duke University to support applied research on the upper Yadkin River Basin. The Commission is committed to incentive-based water quality programs which are fiscally responsible and scientifically valid.

For more information on the Yadkin River Commission, contact Glenn Simmons at (336) 727-2087.

Pilot View Resource Conservation and Development, Inc.

Pilot View Resource Conservation and Development, Inc. is a non-profit organization covering Davie, Forsyth, Stokes, Surry and Yadkin counties. Its mission is to provide a mechanism by which communities can explore and develop their natural resources for a prosperous economy and an improved quality of life. It is funded by foundations, grants, and donations, and seeks partnerships to implement project activity. Listed below are some of its active projects:

- Piedmont Bog Restoration Project (see Section 5.6.2)
- South Fork Mitchell River Project (see Section 5.6.2 and Piedmont Land Conservancy, below)
- South Deep Creek Dam Project: Yadkin County is seeking funding to build a water supply dam on South Deep Creek. The structure's primary purpose will be water supply and flood control, however sediment that would normally enter the Yadkin River will now settle out in the reservoir, helping to improve water quality downstream.
- No-till Tobacco Planter: A no-till planter has been purchased to be used for planting of tobacco and cabbage, potentially helping to reduce soil erosion by teaching farmers no-till techniques.
- Bethabara Streambank Stabilization and Wetland Trail Project (see Section 5.6.2)
- Applied Fluvial Geomorphology Workshops: These workshops give technical specialists in the environmental field the opportunity to learn new technology in the understanding of streams and rivers for stream restoration and the enhancement of aquatic and riparian wildlife.
- Old Salem Project (see Section 5.6.2)

Northwest Piedmont Council of Governments (NWPCOG)

In January of 1997, the NWPCOG signed a contract with DWQ to develop a database and environmental scan for the portion of the upper Yadkin-Pee Dee River basin served by the COG office. The NWPCOG will help identify critical water quality issues. The effort will also be coordinated with the Yadkin River Commission and Duke University. The NWPCOG and the Yadkin River Commission hope to continually update the database (an inventory of resources and land use development and water quality data) and make it available to DWQ as the basin plan is updated every five years. The data will be housed and accessible at the offices of the NWPCOG and two university libraries: Wake Forest and Duke.

In addition, three newsletters will be produced in conjunction with various development stages of the basin plan as a means of disseminating information to the public on the basin plan.

The LandTrust of Central North Carolina

The LandTrust for Central North Carolina is a private, non-profit land conservation organization established in 1995 by the leadership of The Yadkin/Pee Dee Lakes Project. Its mission is to preserve the special natural areas and rural landscapes of the lower Yadkin/Pee Dee River basin in North Carolina. The LandTrust serves a ten-county region that includes Anson, Cabarrus, Davidson, Davie, Iredell, Montgomery, Randolph, Richmond, Rowan and Stanly counties.

The LandTrust works with private and public landowners to find and preserve natural areas, agricultural lands, historic sites and open space. The LandTrust accepts donations of private property, purchases property from landowners, enters into conservation easement agreements with landowners, or accepts life estate agreements.

The LandTrust for Central North Carolina has been involved in a number of project sites in the Yadkin-Pee Dee River basin. A 1900 acre estate along 2 1/2 miles of Yadkin River shoreline in

Davie County was recently protected with a conservation easement. On a smaller scale, the first 12 acres of an eventual 60-acre preserve along the headwaters of the Rocky River in southern Iredell County were recently donated to The LandTrust. The LandTrust recently acquired a 150-acre preserve from the Catawba College. These projects have set a precedent for conservation that should result in other protective gifts in the near future.

Piedmont Land Conservancy

The Piedmont Land Conservancy (PLC) is a non-profit regional land trust formed in 1990 dedicated to protecting natural and scenic lands, farms and open space in nine north-central piedmont counties to enhance the quality of life for our communities and for futures generations. Within the Yadkin-Pee Dee River basin, PLC serves Forsyth, Stokes, Surry and Yadkin Counties.

PLC works with interested landowners and communities to protect significant natural areas such as wetlands and wildlife habitat, to protect water quality, to provide for education and recreation throughout the region, and to preserve our rural landscape and cultural heritage.

Within the upper Yadkin basin, PLC will complete Natural Heritage Inventories in Forsyth and Stokes Counties in 1997 in conjunction with the NC Natural Heritage Program (see Chapter 2, Section 2.5.3). PLC will use inventory data to prioritize protection strategies throughout upper Yadkin River basin. Inventories will also be shared with local planners, schools, colleges and universities to promote the study of local natural features.

Currently PLC is working on two projects on Muddy Creek: with NC Department of Transportation to purchase and protect wetland habitat south of Winston-Salem; and with NC Department of Cultural Resources to purchase 19 acres of steep bluff in Bethania's National Historic District. PLC is also working to protect a tributary to Silas Creek, which flows into Muddy Creek. As a long-term project, PLC is working to create recreational greenways along tributaries to Salem Creek connecting Salem Lake to Triad Regional Park on the Forsyth/Guilford County boundary.

The PLC, in cooperation with the NC Division of Water Resources, US EPA, US Fish and Wildlife, NC Agricultural Cost-Share Program and the Natural Resources Conservation Service, was granted funding from the Clean Water Management Trust Fund for a project in the Mitchell River watershed in Surry County. The outcomes of this project will include: 1) purchase 200 acres of pristine headwaters; 2) acquire 3.8 miles of riparian easements; 3) develop a comprehensive 3-5 year watershed plan; 4) facilitate protection/restoration efforts and long-term management plans including sediment and biological monitoring; 5) develop a Geographic Information System (GIS) database, maps and project evaluation format; 6) public education though newsletters and at least seven workshops and a Best Management Practice demonstration on 5,000 feet of riverbank; 7) restore and stabilize one mile of riverbank; 8) organize local committees to foster community and landowner education to protect acquired and targeted areas; and 9) evaluate success and produce a final report. A volunteer citizen monitoring group will be established to monitor long-term water quality.

5.7 Integrating Point And Nonpoint Source Pollution Control Strategies

Integrating point and nonpoint source pollution controls and determining the amount and location of the remaining assimilative capacity in a basin are key long-term objectives of basinwide management. The information is used for a number of purposes including: determining if and where new or expanded municipal or industrial wastewater treatment facilities can be allowed; setting the recommended treatment level at these facilities; and identifying where point and nonpoint source pollution controls must be implemented to restore assimilative capacity and maintain water quality standards.

Total Maximum Daily Loads

The U.S. Environmental Protection Agency (USEPA) has developed the means to help accomplish these objectives. The approach, called *total maximum daily loads (TMDL)*, uses the concept of determining the total waste (pollutant) loading from point and nonpoint sources that a waterbody (such as a stream, lake or estuary) can assimilate while still maintaining its designated uses. USEPA requires the TMDL approach pursuant to Section 303(d) of the Clean Water Act.

Under the TMDL approach, waterbodies that do not meet water quality standards are identified. States establish priorities for action, and then determine reductions in pollutant loads or other actions needed to meet water quality goals. The approach is flexible and promotes a watershed approach driven by local needs and States' priorities. The overall goal in establishing a TMDL is to establish the management actions on point and nonpoint sources of pollution necessary for a waterbody to meet water quality standards.

As DWQ improves its abilities to quantify and predict the impacts of point and nonpoint source pollution, the basinwide approach will make more innovative management strategies possible.

Other Possible Strategies

- *Agency banking* refers to the concept of holding assimilative capacity in reserve for future growth and development in the basin.
- *Pollution trading* involves trading of waste loading and stream assimilative capacity among permitted dischargers, or between point and nonpoint sources, adding flexibility to the permitting system and using the free market system as an aid to identifying the most cost effective solution to water quality protection.
- *Industrial recruitment mapping* involves providing specific recommendations on the types of industry and land development best suited to the basin's long-term water quality goals and an individual basin's ability to assimilate a particular type or quantity of discharge or nonpoint source pollutants.
- *Consolidation of wastewater discharges*, also referred to as regionalization, entails combining several dischargers into one facility. Local authorities, regulated industries, landowners, and other interested parties are encouraged to provide ideas to develop these strategies. By accommodating, to the degree possible, local needs and preferences, the probability of the plan's long-term success will be increased.

5.8 POTENTIAL SOURCES OF FUNDING FOR WATER QUALITY PROJECTS

Section 319(h) Grants:

Clean Water Act Section 319(h) grant monies are made available to the states on an annual basis by EPA. Agencies in the state that deal with NPS problems submit proposals to DWQ each year for use of these funds in various projects. Projects that have been funded in the past include BMP demonstrations, watershed water quality improvement projects, data management, educational activities, modeling, stream restoration efforts, riparian buffer establishment, and others. DWQ established a Workgroup process in 1995 for prioritizing and selecting projects from the pool of cost-share proposals and includes this list in its annual application to EPA. The Workgroup consists of representatives from the state and federal agencies that deal with NPS issues, including agricultural, silvicultural, on-site wastewater, mining, solid waste and resource protection.

Table 5.7 Funding Agencies for Assistance With Point Sources

Source	Agency and Name of Funding Source
Federal	U.S. Rural Utilities Service: Water and Wastewater Loan and Grant Program Rural Business and Cooperative Service: Rural Business Enterprise Grants Appalachian Regional Commission: Supplements to Other Federal Grants in Aid U.S. Economic Development Administration: Public Works and Development Facilities Grant Program
State	NC Division of Water Quality: Construction Grants and Loans Program NC Division of Community Assistance: Small Cities Community Development Block Grant NC Commerce Finance Center: Industrial Development Fund
Private	Rural Economic Development Center, Inc.: Supplemental and Capacity Grants Program

Table 5.8 Funding Agencies for Assistance with Nonpoint Sources

Needed NPS Assistance	Name of Funding Source
Agriculture	NC Agriculture Cost Share Program for NPS Pollution Control (NCACSP) Environmental Quality Incentives Program (EQIP) Conservation Reserve Program (CRP) Wetland Reserve Program (WRP) Small Watershed Program, PL-566 Conservation Easement Soil and Water Conservation Loan Program
Education	GTE Foundation Toyota TAPESTRY Grants National Environmental Education and Training Foundation (NEETF)
Water Quality Planning	Section 205(j) Water Quality Planning Grants
Stream Restoration	NC Division of Water Resources Stream Repair Funding
Forestry	Forestry Stewardship Incentive Program Forestry Incentives Program
Land Conservation	National Wetland Priority Conservation Plan NC Conservation Tax Credit Program Federal Wild and Scenic Rivers Program Emergency Wetlands Resources Act of 1986

The North Carolina Wetlands Restoration Program (NCWRP) is responsible for implementing wetland and stream restoration projects on a basinwide scale throughout the state. The focus of the program is to enhance water quality, flood prevention, fisheries, wildlife habitat and recreational opportunities. The NCWRP is not a grant program. However, it can compliment grant programs like the Section 319 program by taking on restoration projects identified through Section 319 grant applications. Alternatively, studies funded by Section 319 to identify suitable stream or wetland restoration sites can then be implemented by the NCWRP. The NCWRP can also directly fund other stream or wetland restoration sites identified by Nonpoint Source Teams or other means, provided those sites are located within a priority subbasin, as determined by the NCWRP. Finally, the NCWRP can perform restoration projects cooperatively with other state or federal programs, or with environmental groups. For more information on the NCWRP, contact Ron Ferrell at (919) 733-5083, ext. 358.

CHAPTER 6

MAJOR BASINWIDE WATER QUALITY CONCERNS AND RECOMMENDED MANAGEMENT STRATEGIES

6.1 INTRODUCTION

Clean water is critical to the health, economic and ecologic well-being of this region of the state. Tourism, water supplies, recreation and a high quality of life for local residents are dependent on the water resources of this basin. Fortunately, over 80% of the waters within the basin are considered to be supporting their designated uses. However, based on DWQ monitoring data, half of these waters are rated as threatened. In addition, several waterbodies are considered impaired (9%). Of the 29 lakes monitored by DWQ, the majority are supporting their designated uses but are nutrient-enriched (eutrophic or mesotrophic). High Rock Lake and Lake Corriher are threatened by nutrient enrichment. Long Lake, Rockingham City Lake and Hamlet City Lake are impaired lakes.

Sedimentation from agriculture, construction, urban development and streambank erosion is the most widespread water quality problem identified for the basin as a whole. Other concerns include growth management, urban and industrial stormwater, nutrients in lakes, fecal coliform bacteria and oxygen-consuming wastes. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge. Looking to the future, water quality in this basin will depend on the manner in which growth and development occurs.

The long range mission of basinwide management is to provide a means of addressing the complex problem of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Yadkin-Pee Dee River basin's surface waters. Growth and other priority issues are discussed in Section 6.2, below. In striving towards its mission, DWQ's highest priority near-term goals are as follows:

- **To identify and restore impaired waters in the basin**. Section 6.3 discusses impaired and threatened waters and how these waters are prioritized for restoration and protection. Priority Issues and Recommended Management Strategies are presented for each subbasin in Section 6.3.

- **To identify and protect high value resource waters and biological communities of special importance**. Section 6.4 discusses management strategies for protecting the HQW/ORW's in the basin.

- **To manage the causes and sources of pollution so as to ensure the protection of those waters currently supporting their uses while allowing for reasonable economic growth.** Major water quality issues addressed under this topic in Section 6.5 include sedimentation, nutrients, urban stormwater runoff, fecal coliform bacteria, toxic substances and oxygen-consuming wastes.

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Priority Issues as Identified by DWQ

The primary water quality issues discussed in this basin plan relate to concerns presented to DWQ as priority issues, or those that have been identified as causing water quality impacts or impairment. Discussion on these categories follows.

- **Growth Management** - Proactive planning efforts at the local level are needed to assure that development is done in a manner that maintains the good water quality that is presently attracting people to the area. These planning efforts will need to find a balance between water quality protection, natural resource management and economic growth. Growth management requires planning for the needs of future population increases as well as developing a strong tourism base. These actions are critical to water quality management and the quality of life for the residents of the basin. Urban and residential impacts on water quality and trends in the basin are discussed in Chapter 3, Section 3.4.2. Some local initiatives are presented in Chapter 5, Section 5.6.3. Refer to Section 6.5 for recommended management strategies relating to planning for growth and development.
- **Urban Stormwater** - Surface waters can be significantly impacted by urban stormwater runoff. The impacts of urban and residential runoff on water quality in the basin are discussed in Chapter 3, Section 3.4.2. Some local initiatives are presented in Chapter 5, Section 5.6.3. Refer to Section 6.5 for recommended management strategies relating to controlling potential water quality problems related to urban stormwater runoff.
- **Sedimentation** - Erosion, and the resulting sedimentation, are prevalent throughout the basin. Workshop participants (Section 6.2.2) and Nonpoint Source Team members (Section 6.2.3) have expressed the view that the priority issue for the basin is sedimentation. Many waters in the basin are thought to be impacted or impaired, at least in part, by sedimentation (Chapter 4, Section 4.5). The sources of sedimentation are discussed in detail in Chapter 3, programs to address erosion and sedimentation are discussed in Chapter 5, some of the actions being taken at the local level are discussed in Chapter 5, Section 5.6. General management strategies for controlling sedimentation are presented in Section 6.5.
- **Nutrients** - Eutrophication of High Rock Lake is the primary focus of nutrient strategies in this basin plan. Nutrients are discussed in Chapter 3. Water quality on each monitored lake is presented in Chapter 4. Management strategies pertaining to High Rock Lake are presented in Section 6.3. General management strategies for controlling nutrients from urban and industrial stormwater are presented in Section 6.5.
- **Fecal Coliform Bacteria** - Ambient monitoring stations throughout the basin have identified waterbodies with elevated fecal coliform bacteria (Chapter 4). Fecal coliform bacteria sources are discussed in Chapter 3. General management strategies to address nonpoint sources of fecal coliform bacteria are presented in Section 6.5.
- **Oxygen-Consuming Wastes** - Many streams within the Yadkin-Pee Dee River basin are low or zero flow streams. Regulations currently exist for streams with 7Q10 and/or 30Q2 equal to zero cubic feet per second (cfs). These regulations were developed to prohibit new or expanded discharges of oxygen-consuming wastes to zero flow streams. Existing facilities were evaluated for alternatives to discharge. Many facilities found alternatives and some chose to build new tertiary treatment facilities (which are allowed to discharge under the regulations). General management strategies for oxygen-consuming wastes and management strategies for specific streams within the basin are presented in Section 6.5.7.
- **Agricultural Nonpoint Source Pollution** - Agriculture can contribute to degraded water quality through contributions of excess nutrients, fecal coliform bacteria, toxic chemicals and sedimentation and erosion problems from runoff. Chapter 3, Section 3.2 discusses these

causes of impairment and Section 3.4 provides a discussion on agricultural contributions to water quality impacts. Chapter 6, Section 6.5.2 presents some suggested management strategies to reduce the negative impacts agricultural activities can have on water quality.

6.2.2 Priority Issues and Recommended Actions Identified by Workshop Participants

Upper Yadkin-Pee Dee River Basin Workshops

The Northwest Piedmont Council of Governments, in conjunction with Centralina Council of Governments was awarded a 205j grant to assist DWQ with the preparation and coordination of public input for the Yadkin-Pee Dee workshops for the upper portion of the basin. A series of four meetings were held in Jonesville (March 15, 1996), Salisbury (March 22, 1996), Winston-Salem (May 17, 1996) and Salisbury (August 22, 1997). A total of 200 people attended the meetings, with many people attending more than one meeting. Details on these meetings can be found in Appendix IV.

The initial meeting allowed people to select a breakout group from a choice of areas of concern for the basin. These were eventually consolidated into four groups which included: Water Quality (Point Source), Economic Development, Future Growth and Development and Water Quality (Nonpoint Source). Each group was asked to respond to four questions, select a spokesperson and report back to the large group. This spokesperson was also asked to participate in follow-up planning sessions. The same agenda and format was used at the next meeting. Planning sessions were held in which the information from the workshops was summarized for presentation at the May meetings. Follow-up meetings, held in May, were intended to disseminate the summaries compiled at the planning sessions and to give attendees the opportunity to provide comments and suggestions. A summary of the subcommittees goals and recommended action plans is presented in Appendix IV.

Each subcommittee developed 1) a goal, 2) a series of recommendations, 3) a list of agencies that could implement the recommendation, 4) suggested potential funding sources for implementation of the recommendation, and 5) a timetable for completion of the recommendation. DWQ has made much progress on those recommendations for which it was identified as an implementation agency. For example, in response to recommendations #'s 1-4 from Subcommittee #1: Water Quality-Point Sources - DWQ has worked with interested dischargers in the basin to assist with the formation of the Yadkin-Pee Dee River Basin Association (See Chapter 5, Section 5.6.4). DWQ coordinated with the dischargers to establish stream monitoring locations and will continue to assist the Association with further analyses where possible.

This also relates to recommendation #4 as presented by Subcommittee #4: Water Quality-Nonpoint Sources. The information gathered by the dischargers will provide data for 71 monitoring stations throughout the entire basin. DWQ is coordinating with the NPS Teams to identify potential biological sampling locations. In addition, DWQ is reviewing water quality data from local governments and others that use State certified labs for analysis (as with Forsyth County Environmental Affairs Department).

Subcommittee #4: Water Quality-Nonpoint Sources recommended (#5) that DWQ look at animal wastes and the application of animal wastes. Senate Bill 1217, ratified in 1996 by the General Assembly, requires a waste management plan for dry litter operations of 30,000 or more birds (See Chapter 2, Section 2.6). Subcommittee #4 also recommended (#7) better planning and enforcement of sedimentation laws. Refer to Chapter 7, Section 7.3.7 for a discussion on future initiatives being taken to address these concerns.

Subcommittee #2: Economic Development recommended (#3) that DWQ coordinate with other agencies to protect land use along tributaries. To this end, DWQ is working with the NPS Teams, which is made up of representatives from many agencies, to identify streams in need of restoration and protection efforts. DWQ is also working in close coordination with the Clean Water Management Trust Fund and Wetland Restoration Program staff to assure that a percentage of grant monies are applied to restoring vegetated riparian zones.

Lower Yadkin-Pee Dee River Basin Workshops

Two workshops were held for the lower Yadkin-Pee Dee River basin in Albemarle on August 22, 1996. Ninety-three people were in attendance at the daytime meeting and five attended the evening meeting. The workshops were conducted to provide an overview of the basin schedule and information specific to the lower portion of the basin. After presentations, the group broke out into small discussion groups. Each group was asked to respond to three questions: 1) What are the priority water quality related issues in the basin?; 2) Are there any specific waterbodies in the basin that are experiencing water quality problems?; 3) What efforts have been undertaken to improve water quality?

Lower Yadkin-Pee Dee River basin workshop participants identified the following categories as the primary areas of concern to the basin (Table 6.1). An effort has been made to address these issues in the development of the plan. Several issues identified by workshop participants that were not addressed in the plan were listed in Chapter 7 for future activities. A full summary of the workshops can be found in Appendix IV.

Table 6.1 Primary Areas of Concern for Participants of the Lower Yadkin-Pee Dee River Basin Workshops

Equity between Point Source and Nonpoint Source Issues	Research and Monitoring Needs (See Chp 7, Section 7.3.7))
Agriculture BMPs and Waste Mgt.	Urban Development
Policy Issues	Recreation Impacts
NPS Pollution/Sedimentation	Point Source Pollution
Forestry Practices and BMPs	Loss of Riparian Zones
Water Supplies	Lake Management

6.2.3 Priority Issues and Recommended Actions Identified by the Nonpoint Source (NPS) Team Members

DWQ has begun establishing Nonpoint Source Teams in each of the state's 17 major river basins (Chapter 7, Section 7.2.2). The teams provide descriptions of current NPS management activities within a basin, conduct assessments of NPS controls in targeted watersheds, prioritize impaired waters for development and implementation (including funding) of restoration strategies and prioritize NPS issues for remedial action.

Two NPS teams have been developed in the Yadkin basin, the "Upper" Team covering subbasins 03-07-01 through 07, and the "Lower" Team covering subbasins 03-07-08 through 17. To date, both teams have provided information on existing NPS programs and initiatives in the basin (Section 5.6), both have identified priority NPS issues (Table 6.2), and both have selected a top priority NPS-impaired water on which to focus initial restoration efforts. The Upper Team has selected Sharp's Branch, a tributary to Fourth Creek in the Statesville area, for restoration. The Lower Team has chosen Goose Creek, a tributary to the Rocky River flowing through Mecklenburg and Union Counties, for management action.

The teams will conduct more detailed assessments of these two waters early in 1998 and will develop proposals for Section 319 grant funding and funds from other sources to facilitate restoration efforts. If the teams can support development of restoration efforts in other priority watersheds in the basin during the five-year cycle, then management of more than these two impaired waters may occur during this time.

Table 6.2 NPS Priority Issues developed by the NPS Teams for the Yadkin-Pee Dee River Basin

	Category	Comments
Lower NPS Team		
	Sedimentation/Erosion	Streambank erosion problems from increased streamflows related to development. Sedimentation problems from road construction and dirt driveways. Lake shoreline erosion from wakes.
	High Nutrient Levels	Residential sources include aging septic tanks along lake shorelines. Poultry waste overapplication. Uncovered animal waste stockpiles.
	Loss of Natural Buffers to Development	Loss of buffers increases erosion problems.
Upper NPS Team		
	Erosion/Sedimentation	Streambank erosion from agricultural practices and from increased streamflows from urban areas. Increased construction in urbanizing areas is contributor. Agricultural activities contribute to erosion. Improper forestry activities contribute.
	Loss of Buffers and Wetlands	Loss of riparian areas, floodplains, and wetlands to construction and to cropland and animal agriculture.
	Pollutants from Solid Waste Facilities	Contributes to water quality problems in some areas.
	Urban Stormwater	Urban stormwater flow has increased and brought associated pollutants.
	Nutrients	Nutrient runoff is a problem from agricultural and urban areas.

6.3 STRATEGIES FOR RESTORING AND PROTECTING IMPAIRED AND SELECTED "THREATENED" WATERS

6.3.1 What Are the Impaired Waters?

Impaired waters are those waters identified in Chapter 4 as partially supporting or not supporting their designated uses based on DWQ monitoring data. Table 6.3 presents impaired waterbodies in the Yadkin-Pee Dee River basin, the sources of impairment, and summaries of the recommended management strategies.

These waterbodies are impaired, at least in part, due to nonpoint sources of pollution. The tasks of identifying nonpoint sources of pollution and developing management strategies for these impaired waterbodies, is very resource-intensive. Accomplishing these tasks is overwhelming, given the current limited resources of DWQ, other agencies (e.g.-Division of Land Resources, Division of Soil and Water Conservation, Cooperative Extension Service, etc.) and local governments. Therefore, only limited progress towards restoring those NPS impaired waterbodies can be expected during this five-year cycle unless substantial resources are put towards solving NPS problems. Due to these restraints, this plan has no NPS management strategies for most of the streams with NPS problems.

DWQ plans to further evaluate the impaired waterbodies in the Yadkin-Pee Dee River basin in conjunction with other NPS agencies and develop management strategies for a portion of these impaired waterbodies for the second Yadkin River Basinwide Water Quality Management Plan, in accordance the requirements of Section 303(d) (See Section 6.3.3, below).

6.3.2 What are the "Threatened" Waters?

Many waters in the basin have notable water quality problems but the impact of the problem is not severe enough to cause the stream to be considered impaired under the state use-support designation described in Chapter 4. These waters are rated support threatened. Where there is enough information available on these waters to make some determinations on the cause or source of degradation, these waters are mentioned within the subbasin section. Refer to Chapter 4, Section 4.5 for a list of these waterbodies, their use-support rating, source of degradation, NPS Priority rating (see Section 6.3.3), and recommended management strategies for protecting these waters from further degradation.

6.3.3 How are Waters Prioritized for Restoration or Protection?

The tasks of identifying sources of impairment and developing management strategies for NPS impaired waterbodies are highly resource-intensive. Actual implementation of NPS management strategies is an overwhelming objective given current resources. Therefore, without additional resources, only limited progress can be expected toward development and implementation of NPS strategies for the impaired waters in this basin. DWQ plans to conduct evaluations of impaired waterbodies in the Yadkin-Pee Dee River basin in conjunction with other NPS agencies and begin the process of prioritizing these waters for restoration or protection efforts. DWQ intends to develop management strategies for a portion of these impaired waterbodies for the second Yadkin-Pee Dee River Basinwide Water Quality Management Plan, in accordance with the requirements of Section 303(d) (See Section 6.3.3-B, below).

A. Priority Waters for Nonpoint Source (NPS) Management Strategies

DWQ has developed criteria to help NPS Teams to prioritize NPS-impaired waterbodies for management actions. This prioritization process will help the Teams as well as other agencies and groups allocate financial, technical and educational assistance to NPS efforts. These prioritization criteria can be summarized as follows:

- highly valued resource waters in need of restoration or protection from NPS pollution, and
- waters with impaired water quality as a result of NPS pollution.

Waters prioritized for action should have a high likelihood for successful restoration or protection.

Table 6.3 Partially Supporting or Not Supporting Monitored Waters in the Yadkin-Pee Dee River Basin*

Subbasin	Waterbody	Use Support Rating	Potential Sources	Recommended Mgt. Strategy*
030703	Ararat R. below Mt Airy	PS	NP,P	Actions by local governments and agencies are needed to reduce NPS pollution. The Division will continue to evaluate instream data submitted by the City of Mount Airy.*
030703	Lovills Cr. at SR 1371	PS	NP	Further investigation is necessary to determine actions needed.*
030703	Heatherly Cr.	PS & NS	NP,P	Continued monitoring will quantify improvements with the removal of the Pilot Mountain WWTP discharge.*
030704	Reynolds Cr.	PS	NP,P	Sequoia WWTP should submit an engineering alternatives analysis.*
030704	Salem Cr. - Middle Fork	PS	NP	Action by Forsyth County and the City of Winston Salem are needed to improve water quality. DWQ will reevaluate the model to determine of wasteload allocation should be revised.*
030704	Grants Cr.	PS	P,NP	DWQ will monitor for improvement after the City of Salisbury's discharges are eliminated. If the creek is still impaired after the Salisbury discharge is removed, DWQ will identify other point sources of pollution and the options for these sources.*
030706	Fourth Cr. below Statesville	PS	NP	Pollutant sources must be identified, along with methods to reduce nutrient loading.*
030707	Brushy Fork at SR1810	PS	NP	Additional activity by local governments and agencies and the Nonpoint Source Team are needed.*
030707	Hamby Cr. at I-85, SR2031 (Abbotts Cr. watershed)	NS	NP,P	No new dischargers of oxygen-consuming wastes should be permitted. Thomasville and Lexington should serve as regional WWTPs for future wastewater needs.*
030708	Lick Cr. at SR2351, NC8	PS	P,NP	New dischargers, including the Town of Denton's proposed outfall, should receive advanced tertiary limits for oxygen-consuming wastes.*
030708	Little Mtn Cr.	PS	NP,P	New or expanding discharges should receive advanced tertiary limits for oxygen-consuming wastes under the current zero flow regulations. Low dissolved oxygen levels will be evaluated and appropriate actions pursued during FERC relicensing.*
030710	Pee Dee R. below Lake Tillery	PS	NP	New or expanding discharges to the Pee Dee River below Lake Tillery should meet limits no less stringent than 15 mg/l BOD5, 4 mg/l NH3N and 5 mg/l DO. Appropriate mitigative actions will be pursued during FERC relicensing.*
030710	Brown Cr. at SR1627	PS	NP	No new discharges should be permitted in this watershed.*
030711	upper Rocky River	NS (a portion is rated support threatened)	NP	New or expanding dischargers above Mallard Creek should receive limits of 5 mg/l BOD and 2 mg/l NH3N. New or expanding discharges below Mallard Creek will receive total BODu limits 32 mg/l. Model results will be used to evaluate specific scenarios for future allocations in the river. The City of Charlotte and Cabarrus and Mecklenburg Counties should investigate pollution sources and develop mitigation plans to protect the river from further degradation.*

Table 6.3 Partially Supporting or Not Supporting Monitored Waters in the Yadkin-Pee Dee River Basin* (Cont'd)

030711	Coddle Cr. at NC49	PS	NP	The NC Division of Water Resources has requested a minimum streamflow, intended to maintain downstream habitat, from the Coddle Creek impoundment (Chp 2, Sect 2.9). This minimum flow may or may not improve water quality at the DWQ downstream sampling site. DWQ will continue to monitor for improved effects. The Town of Concord is encouraged to take steps to reduce nonpoint source runoff to Coddle Creek.*
030712	Goose Cr.	NS	NP,P	A field-calibrated QUAL2E model will be developed to evaluate assimilative capacity of the creek.*
030712	N. & S. Fork Crooked Cr.	PS	P,NP	DWQ recommends that no additional oxygen-consuming wastes be permitted in N. Fork Crooked Creek until data are available to evaluate the impact of existing loading. No additional loading of oxygen-consuming wastes will be permitted in S. Fork Crooked Creek.*
030713	Long Lake	NS	NP	Long Lake is drained and under a local restoration project.
030714	Richardson Cr. below Monroe	PS	NP,P	No new discharges of oxygen-consuming wastes should be permitted above Monroe's WWTP.*
030714	Lanes Cr.	NS & PS	NP	Every alternative to discharge should be thoroughly examined before a new outfall is considered.*
030716	Cartledge Cr. at SR 1142	PS	NP	Additional activity by local governments and agencies are needed to develop a plan to reduce nonpoint source pollution.*
030716	Hitchcock Cr. at SR 1109	NS	NP	No additional loads of oxygen-consuming wastes within 4 miles of mouth of creek should be permitted.*
030716	Rockingham City Lake	PS	NP	Local restoration actions will need to be taken.*
030716	Hamlet City Lake	PS	NP	Local restoration actions are planned.*
030717	N. Fork Jones Cr. at SR 1121 and S. Fork Jones Cr., Anson Cnty	PS	NP	Before any new outfalls are permitted, it is recommended that additional data be collected to aid in assessing assimilative capacity. Additional investigation is necessary to identify specific nonpoint sources of contamination.*

Notes: NS = Not Supporting PS = Partially Supporting
NP = Nonpoint Sources P = Point Sources
* - Only limited progress towards developing and implementing NPS strategies for these impaired waters can be expected without additional resources.

B. Section 303(d) of the Clean Water Act (CWA)

States are required to develop a list of waters not meeting water quality standards or which have impaired uses (partially supporting or not supporting) under Section 303(d) of the Clean Water Act. Waters may be excluded from the list if existing control strategies are expected to achieve the standards or uses. Management strategies may include both point or nonpoint programs. Waterbodies which are listed must be prioritized and a management strategy or Total Maximum Daily Load (TMDL) must be developed.

Use support ratings for the 303(d) list are based on monitoring data collected within the last five years. Further information on the 303(d) program and a complete list of waters in the Yadkin-Pee Dee River basin can be found in Appendix VII. The list includes use support ratings, major causes and sources of impairment, descriptions of potential sources of pollution and the stream priority rating.

6.3.4 Priority Issues And Recommended Management Strategies By Subbasin

The following subsections present the priority issues and recommended management strategies for each subbasin of the Yadkin-Pee Dee River basin. The major water quality concerns related to High Rock Lake are presented separately because the waterbodies of the upper Yadkin-Pee Dee River basin drain to High Rock Lake, thus these issues are not contained within one subbasin.

A. High Rock Lake

The following paragraphs summarize the major water quality concerns related to the eutrophication of High Rock Lake and DWQ's plans to develop a nutrient management strategy to address those concerns. Water quality data on High Rock Lake were presented in Chapter 4. For additional discussion of water quality issues, see the 1989-90 intensive investigation report (NCDEM, 1993), the Basinwide Assessment Report Support Document (NCDWQ, 1997b) or the recent High Rock Lake modeling report (NCDWQ, 1997a).

Located on the mainstem of the Yadkin River in Rowan and Davidson Counties (refer to Figure 2.3), High Rock Lake is operated by Yadkin, Incorporated to generate hydroelectric power. The 4000 square mile watershed includes Winston-Salem and numerous smaller municipalities, as well as significant agricultural activity. A total of 195 NPDES dischargers (individual permits) are located in the watershed. The 21 dischargers with a permitted capacity of 1 MGD or greater account for approximately 94 percent of the permitted wasteflow.

Numerous studies have documented the high nutrient loading to the lake, as well as high levels of in-lake nutrients and algal growth. Most recently, intensive investigation of the lake by DWQ in 1989 and 1990 (NCDEM, 1993) provided additional data to allow a detailed evaluation of the reservoir and to support water quality modeling (NCDWQ, 1997a). DWQ's assessment of the water quality of High Rock Lake is based both on extensive research on the reservoir over the last 20 years and data from DWQ's ongoing monitoring program.

Excessive algal growth occurs on several arms of the lake, which have substantially longer detention times than the mainstem and have little assimilative capacity for nutrients. Abbotts Creek in particular is subject to nuisance blooms. It is clear that the high nutrient loading is threatening the designated uses of this arm of the lake. Since most of the phosphorus load to this arm originates from the High Point, Thomasville and Lexington discharges, substantial reductions in the loading from these three facilities is necessary to minimize the frequency, duration and extent of algal blooms. The permitting strategy for facilities discharging to the Abbotts Creek arm is outlined in Section 6.3.4-H (subbasin 03-07-07).

The Crane and Grants Creek arms also have significant problems. Salisbury's two discharges (Town Creek WWTP and Grants Creek WWTP) account for most of the nutrient loading to these tributaries and DWQ has been working with the City to remove these discharges. Salisbury is building a new outfall on the Yadkin mainstem just above Grants Creek. The discharges into Town and Grants Creeks will cease when the new outfall becomes operational, probably in 1999. Water quality in these two arms is expected to improve once the discharges are removed.

While nutrients and lagal levels in the mainstem of the reservoir are elevated, there is no strong evidence that these conditions interfere with the designated uses of the lake. Nuisance blooms are rare and the lake is heavily used for recreation. DWQ is concerned, however, that additional loading could cause deterioration in mainstem water quality, especially during periods of low inflows. Additionally, substantial quantities of mainstem water and nutrients enter tributary arms when the lake returns to full pool following declines in water levels (NCDWQ, 1997a). Therefore, DWQ is concerned that increased nutrient loading to the mainstem of the lake may contribute to deterioration of water quality in these embayments.

DWQ's goal is to ensure that water quality conditions do not worsen in the mainstem--and in lake arms affected by the mainstem--as growth occurs in the watershed during the coming decades. Point source nutrient inputs dominate phosphorus loading to the Yadkin River during dry summers, while nonpoint sources predominate under other conditions. It appears that nonpoint sources of phosphorus to the Yadkin mainstem are stable or declining at the present time (NCDWQ, 1997a). However, if major wastewater facilities, excluding discharges to arms, were to discharge at permitted wasteflows and if effluent total phosphorus (TP) concentrations remain at current levels, the end-of-pipe phosphorus load from these dischargers would increase by 97 percent over average 1994-96 levels. TP levels in the mainstem of the reservoir are predicted to increase by approximately 30 percent under these conditions, although there is currently no means of predicting how algal levels will respond to this additional nutrient load (NCDWQ, 1997a).

By holding existing wastewater discharges to current loads, a stable phosphorus load could be attained in the short term. However, a longer term solution will require a more comprehensive approach which addresses new wastewater facilities, as well as nonpoint source loads from both urban and rural areas. DWQ believes that the classification of the High Rock Lake watershed as Nutrient Sensitive Waters (NSW) and the development of an NSW management strategy is the appropriate mechanism for addressing these concerns. NSW designation is a rule-making process which provides for extensive public input. At the present time, DWQ is evaluating the implications of recent legislation (HB 515) for NSW areas. The development of new nutrient management strategies is likely to be delayed until such time that HB515 implementation questions are resolved.

Recommendations:
DWQ's intent is to proceed with the development of a nutrient strategy for the High Rock Lake watershed during the next basin planning cycle if feasible. This process will include an assessment of whether NSW designation is appropriate for all or part of the watershed. Prior to the initiation of rule-making, DWQ will consult with stakeholders in the upper Yadkin basin regarding eutrophication problems in High Rock Lake. Stakeholders, at a minimum, should include: the upper Yadkin Nonpoint Source Team; the Yadkin-Pee Dee River Basin Association and individual dischargers; Yadkin, Incorporated; Yadkin River Commission; Northwest Piedmont Council of Governments and individual local governments; agricultural representatives; representatives of environmental and citizens' groups; and other interested parties. DWQ will work with these parties to investigate the issues and to develop appropriate nutrient management strategies.

In the interim period, DWQ strongly recommends that major dischargers in the watershed act to improve phosphorus removal. Specifically, DWQ recommends that permittees conduct an operation and maintenance assessment to identify methods of optimizing phosphorus removal with existing facilities during the next permit cycle. DWQ urges the Yadkin Pee-Dee River Basin Dischargers Association to encourage member facilities discharging in the High Rock Lake watershed to conduct these evaluations and take the necessary steps to reduce phosphorus loading to the extent practicable.

B. Yadkin River Headwaters (Subbasin 03-07-01)

This subbasin consists of the headwaters of the Yadkin River as far downstream as Elkin and includes W. Kerr Scott Reservoir. Major tributaries are the Reddies, Roaring and Mulberry Rivers, Elk Creek and Lewis Fork Creek.

Numerous streams draining the Blue Ridge Mountains have good or excellent water quality. Water quality in the upper Yadkin River at Patterson and at Wilkesboro has improved over the last decade, however sedimentation continues to be an issue. There are no impaired streams in this subbasin. In general, good stream flow has helped to minimize DO problems within the subbasin.

Yadkin River near Roaring River (Support Threatened)
The Yadkin River and many of its tributaries in the vicinity of Rhonda and Elkin is support threatened due to fecal coliform levels well over the standard. Fecal coliform levels in the Roaring River are also elevated, though not in violation of the standard. While nonpoint source contamination may be contributing to this problem, both the Wilkesboro and North Wilkesboro WWTPs have been in violation of their fecal coliform limits during the past few years. The problem is most severe with the North Wilkesboro facility, which is currently under Special Order by Consent (SOC).

ABT Company discharges into the Yadkin River just above its confluence with the Roaring River. The company manufactures exterior hardboard siding, producing an effluent with high levels of BOD and total suspended solids (TSS). Because of the low instream waste concentration and the fact that modeling analyses predict no significant impact on dissolved oxygen levels, permit limits have been developed based on federal effluent guidelines. Given the high production rate of this facility and the high load per unit of production specified by the Code of Federal Regulations, the allowable load is substantial.

Due to concerns about instream impacts, benthic macroinvertebrate data were collected in 1993 above and below the discharge. Moderate levels of stress and lower taxa richness and abundance were recorded at the downstream station, indicating that the discharge was having an impact on the biota. Turbidity was also higher at the downstream station. For the permit renewal in 1994, DWQ implemented regulation 2B.0406 (d), which states that if federal guidelines are not adequate to control solids, then settleable solids limits will be established within the range of 0.1 ml/l to 5.0 ml/l.

ABT Co. has recently initiated a new wastewater treatment system called "Clear Water" to better control solids in the effluent. A modified permit was issued in 1995 requiring the facility to reduce TSS and meet more stringent limits by January 1, 1997. The facility is now meeting these limits and conducting daily monitoring for settleable solids in addition to submitting quarterly solids minimization reports to DWQ.

Recommendations:
Given the close proximity of Wilkesboro and North Wilkesboro, the towns are encouraged to consolidate the two discharges into a single outfall to the Yadkin River.

Additional data must be collected for settleable solids and instream biota at ABT Co. to determine if the river has recovered below the discharge.

C. Mitchell River, Fisher River and South Deep Creek Watersheds (Subbasin 03-07-02)

This subbasin encompasses the Yadkin River drainage from Elkin to the confluence of the Yadkin River with Muddy Creek, with the exception of the Ararat River drainage (subbasin 03-07-03). Major tributaries include the Mitchell, Fisher and Little Yadkin Rivers and Deep Creek. There are no impaired waters, however the majority of the streams in this subbasin are threatened (Refer to Chapter 4, Section 4.5).

The Mitchell River ORW still has excellent water quality, but the effects of increasing development are evident. This watershed may require additional attention in the future to prevent deterioration. A project has been funded by the Clean Water Management Trust Fund for the Mitchell River watershed (See Chapter 5, Section 5.6). The project includes land acquisition and stream restoration activities and should enhance and protect the water quality of this watershed.

Many streams are impacted by sedimentation, including North and South Deep Creek and the Little Yadkin River, where severe streambank erosion is evident. Sedimentation is also evident in the Fisher River, although water quality generally remains good.

Recommendations:
Land use in these watersheds is largely agricultural, although development occurs in some areas. Additional investigations will be necessary to identify specific sources of sediment. A series of 22 small impoundments are being constructed on the Little Yadkin River to control sedimentation.

D. Ararat River Watershed (Subbasin 03-07-03)

This subbasin encompasses the Ararat River watershed. Tributaries include Lovills Creek, Stewarts Creek and Toms Creek. Nearly all of the waters in this subbasin are rated support threatened (Refer to Chapter 4, Section 4.5). Impaired waters in the basin include the Ararat River from Mount Airy downstream to Flat Shoals Creek, and short portions of Lovills Creek and Heatherly Creek.

Ararat River below Mt. Airy (Partially Supporting)
Much of the Ararat River is impaired due to both point source and nonpoint source pollution. Fecal coliform and turbidity levels exceed the standard and considerable sedimentation is evident. This watershed has experienced high levels of erosion. The discharge from a rest area on I-77, operated by the Virginia Department of Transportation was in violation of its fecal coliform limits for several months during each of the past several years and may be contributing to the fecal coliform problem.

The Division continues to work with the City of Mount Airy on problems associated with its discharge. The Mount Airy WWTP has historically had a high level of color in its effluent. The facility has often failed toxicity tests in the past, although the situation appears to have improved during the last three years.

Recommendations:
The VA Department of Transportation was levied a civil penalty in June 1997 for violations. The facility is working to correct its problems. The Division is continuing to evaluate instream data submitted by the City of Mount Airy which suggests possible water quality problems in the Ararat River related to oxygen-consuming wastes. No changes to Mt. Airy's wasteload allocation are recommended at this time.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan. Refer to Section 6.3.3 for a discussion on how DWQ intends to address NPS impairment in this waterbody. In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution on the Ararat River.

Lovills Creek at SR 1371 (Partially Supporting)
Approximately four miles of Lovills Creek above SR 1371 is impaired due to nonpoint sources of pollution.

Recommendations:
Further investigations are necessary to determine what mitigative measures will be needed. Additional resources are needed to help identify impairment sources and to develop management strategies for this waterbody. DWQ intends to develop NPS management strategies for this

waterbody for the second Yadkin-Pee Dee River Basin Plan. Refer to Section 6.3.3 for a discussion on how DWQ intends to address NPS impairment in this waterbody. In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution on Lovills Creek.

The City of Mount Airy, in cooperation with other agencies, has developed a master plan for approximately 3-3 1/2 miles of stream stabilization (See Chapter 5, Section 5.6.2). The project is on hold until finances can be secured.

Heatherly Creek (Partially Supporting and Not Supporting)
The discharge from Pilot Mountain's WWTP has caused toxicity problems in Heatherly Creek, which may have caused its impaired status at the time of sampling. In July of 1996, the town relocated its discharge from Heatherly Creek to the Ararat mainstem. No instream DO violations have been reported at Pilot Mountain's new monitoring sites on the Ararat River since the relocation of the outfall. The creek is also impacted by nonpoint source pollution.

Recommendations:
DWQ will continue to monitor the creek to determine if the absence of the Pilot Mountain WWTP discharge improves water quality.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution on Heatherly Creek.

E. High Rock Lake and Muddy Creek Watersheds (Subbasin 03-07-04)

This subbasin includes the Yadkin drainage from the confluence with Muddy Creek to High Rock dam, with the exception of Dutchmans Creek (subbasin 03-07-05), the South Yadkin River (subbasin 03-07-06) and Abbotts Creek (subbasin 03-07-07). Tributaries include Muddy Creek, Grants Creek, and most streams draining directly into High Rock Lake. The majority of streams in this subbasin are support threatened. Impaired waters include Grants, Reynolds and middle fork of Salem Creeks (Refer to Chapter 4, Section 4.5).

Grants Creek at Spencer (Partially Supporting)
Grants Creek is in violation of the fecal coliform and turbidity standards, probably due to nonpoint source runoff from the watershed. Water quality in Grants Creek is also impacted by the Salisbury and Spencer discharges, located downstream of the ambient station. Numerous violations of the instream DO standard have been recorded both up and downstream of the Salisbury Grants Creek WWTP (7.5 MGD). Data collected at the ambient station confirm the City's reports of substandard DO instream concentrations. The Town of Spencer operates a 0.75 MGD WWTP immediately below the Salisbury discharge. Spencer has also reported DO violations at both its upstream and downstream monitoring sites. It is difficult to assess the impact that this discharge is having on water quality in Grants Creek considering its close proximity to the larger Salisbury facility.

The City of Salisbury is permitted to discharge to Town Creek and Grants Creek. Salisbury is now constructing an outfall on the Yadkin River above Grants Creek. Effluent from the Town Creek and Grants Creek facilities will be routed to the new outfall upon its completion (probably late in 1998), and the two facilities will cease discharging at their present locations. Eventually, the City of Salisbury plans to build a 20 MGD WWTP near the new discharge site.

Recommendations for Grants Creek and Town Creek:
The Division will continue to monitor water quality conditions in both Grants and Town Creeks for signs of improvement once the Salisbury discharges are eliminated. If the creek is still impaired after the Salisbury discharge is removed, DWQ will identify other point sources of pollution and the options for these sources. These options, based on current DWQ practices, will include looking at alternatives, potential modifications to treatment systems, or possible connection to Salisbury's new facilities. Additional management strategies may include revising Spencer's wasteload allocation, if instream DO violations continue to occur. In order to minimize additional water quality impacts to Grants Creek the Town of Spencer is encouraged to consider connecting to Salisbury's collection system.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

Reynolds Creek in Forsyth County (Partially Supporting)
Approximately two miles of Reynolds Creek below the Sequoia WWTP in Forsyth County is impaired. Biological surveys indicate that water quality in Reynolds Creek is degraded below the Sequoia WWTP. Point and nonpoint sources of pollution are believed to be contributing to the impairment of the creek.

Recommendations:
An engineering alternatives analysis for the Sequoia WWTP is recommended to determine the feasibility of eliminating the discharge and connecting to the Winston-Salem - Forsyth County collection system.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

Muddy Creek (Support Threatened) **and Middle Fork Salem Creek** (Partially Supporting)
Muddy Creek is impacted and a portion of Salem Creek is impaired by both urban runoff and wastewater discharges. Elevated fecal coliform levels are commonplace in both streams: mean levels in Salem Creek are more than five times the standard. Nonpoint source contamination is the likely source of this problem. An upgrade of Winston Salem's 30 MGD Elledge plant was completed in 1995 and the ability of this facility to pass its toxicity tests has improved since that time. Biological sampling in 1996 showed some improvements in Salem Creek, though impairment is still evident. A high level of color is observed in the Elledge plant discharge, largely due to the influence of waste from tobacco manufacturing facilities. Streams in this subbasin continue to be impacted by urban runoff, and the more rural portions of the watershed show evidence of considerable sedimentation.

In 1990 the Division developed a field-calibrated QUAL2E model for Salem and Muddy Creeks, extending from Winston Salem's Archie Elledge WWTP to the Yadkin River. This model was developed in order to evaluate the assimilative capacity of these streams for oxygen-consuming wastes and to develop appropriate permit limits for the Elledge WWTP. Since the model was developed, additional instream and effluent data has been collected which suggests that the model may over-predict the assimilative capacity of Salem and Muddy Creeks.

In 1994 the model was extended into the Yadkin River as far downstream as US 64 in order to develop permit limits for Winston Salem's Muddy Creek WWTP. Results indicate that secondary BOD5 limits (30 mg/l) are adequate for the Lower Muddy Creek treatment plant. The Yadkin River section of the model is not field-calibrated, however. As additional field data becomes available for calibrating the model and extending it downstream to High Rock Lake, the Muddy Creek WWTP wasteload allocation may need revision. No instream DO violations have been reported by the facility nor from the Yadkin River ambient stations at US-64 and NC-150 during the period 1993-1996.

Recommendations:
While Winston Salem operates a NPDES stormwater program, maintaining existing water quality as the metropolitan area continues to develop may be difficult. Improvements in the water quality of Muddy Creek and its tributaries will require additional action on the part of Forsyth County and the City of Winston-Salem. Where possible, DWQ will work with the local governments to develop restoration strategies. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3).

The Division plans to reevaluate the QUAL2E model to determine if the wasteload allocation for the Archie Elledge WWTP should be revised in a future permit renewal. DWQ will continue to gather field data for extending the model downstream to better assess the assimilative capacity of the Yadkin river and the impact of the Muddy Creek WWTP discharge on Muddy Creek.

Yadkin River at NC 150 near Spencer (Support Threatened)
The section of the Yadkin River in this basin is threatened by nonpoint source pollution. The ambient stations at NC 64 (Yadkin College) and at NC 150 (in the headwaters of High Rock Lake) both have turbidity levels frequently exceeding the standard. Both sites also have elevated mean fecal coliform levels, although not above the standard. The sediment load carried by the Yadkin has declined over the past several decades, but remains quite high.

Recommendations:
The control of sediments from both urban and rural sources is necessary, though it appears that erosion in rural areas has been declining. This will be a significant challenge given the size of this watershed (2280 square miles at Yadkin College and 3452 square miles at NC 150).

F. Dutchmans Creek Watershed (Subbasin 03-07-05)

This small subbasin is comprised of Dutchmans Creek and its tributaries, located primarily in Davie County. All of the monitored waters in this subbasin are supporting their uses, however, most of the streams are support threatened (Refer to Chapter 4, Section 4.5). Dutchmans Creek, while supporting its uses, is impacted by sedimentation.

Cedar Creek (Supporting, Support Threatened at I-40)
Cedar Creek is the largest tributary to Dutchmans Creek and was assigned bioclassifications ranging from Fair to Good-Fair at various survey sites since 1990. Siltation is evident. Little physical/chemical water quality data are available for this stream. Certain reaches of the stream are believed to be highly enriched predominately from nonpoint sources, as evidenced by extensive growths of filamentous algae.

Recommendations:
Before new wastewater discharges are permitted into Cedar Creek it is recommended that additional water quality data be collected by the prospective permittee to aid in assessing the assimilative capacity of the stream.

G. South Yadkin River Watershed (Subbasin 03-07-06)

The South Yadkin River drainage makes up this large subbasin. Major tributaries include Second, Third and Fourth Creeks and Hunting Creek. Fourth Creek below Statesville is impaired. The majority of the other waters in the basin are support threatened (Refer to Chapter 4, Section 4.5). Of the 32 dischargers in the subbasin, four have permits for waste flows greater than 1.0 MGD.

Elevated fecal coliform levels are widespread throughout the subbasin. All major tributaries are in violation of the fecal coliform standard (200 colonies/100 ml), with mean levels ranging from 537-1207 colonies/100 ml. A review of discharge monitoring reports from permitted facilities in this basin indicates compliance with fecal coliform limits. As of March 1997 there were 87 registered animal operations in this subbasin, twice as many as in any other Yadkin-Pee Dee subbasin. These are primarily dairy operations.

High rates of sedimentation are also widespread, and turbidity at all monitored streams exceeds the 50 NTU standard more than 10% of the time. Aside from the Statesville area, this subbasin is largely rural. Historical levels of erosion are among the highest in the entire Yadkin basin.

Third Creek (Support Threatened) **and Fourth Creek** (Partially Supporting)
Fecal coliform levels in Third and Fourth Creeks are high upstream of Statesville's dischargers, indicating that nonpoint source runoff contamination is the probable source although several small facilities in the subbasin show occasional violations.

The two largest of these major facilities are Statesville's Third Creek and Fourth Creek WWTPs. No instream DO violations were reported by Statesville's Fourth Creek WWTP in its self monitoring reports during the period 1992-1996. There is, however, a measurable decrease in DO concentrations below the discharge. In 1993 the 7Q10 flow estimate for Fourth Creek at the outfall was revised to reflect updated USGS low flow calculation methodologies. Using the revised, lower 7Q10 estimate, a Level B modeling analysis indicates that Fourth Creek may be overallocated at Statesville's current 4 MGD permit limits. The Fourth Creek WWTP has a permit to increase its waste flow to 6 MGD once it exceeds 90% of its 4 MGD permitted flow capacity. Although the 6 MGD wasteload allocation was based on the newly revised 7Q10 estimate, the 4 MGD permit was not.

Recommendations:
To improve water quality in impaired streams and protect other waters from further degradation, the specific pollutant sources must be identified, along with methods of reducing nutrient loading. Additional activities and resources are needed to identify impairment sources and to develop management strategies for Fourth Creek. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

Given the predicted overallocation of oxygen-consuming wastes in Fourth Creek under Statesville's 4 MGD permit, consideration should be given towards reallocating this permit using the updated 7Q10 flow estimates if instream DO standard violations are recorded.

Hunting Creek (Support Threatened)
Tyson Foods, formerly Holly Farms Poultry, discharges into Hunting Creek. Until recently this facility had a maximum permitted flow of 1.7 MGD, although actual flows are typically much lower (average waste flow was 0.189 MGD during the period May 1996 through April 1997). As of October 1997, the permitted flow was reduced to 0.5 MGD at the company's request. At the 1.7 MGD permitted flow, the facility experienced difficulty passing its chronic toxicity test (failing six of eight tests in 1996). Since the spring of 1993 the facility has conducted multiple

concentration toxicity testing beyond permit requirements. This activity is commendable and should assist in evaluating the toxicity reduction efforts over time. In December 1996, Tyson Foods submitted its third "Toxicity Evaluation" report to DWQ. The facility has considered high ammonia and nitrite concentrations as a possible source of toxicity and an aerated lagoon has been installed in the primary treatment unit to enhance nitrification. The revised toxicity testing concentration based on the 0.5 MGD flow may be a more accurate estimate of the potential impacts of the discharge.

In 1990 DWQ conducted a special study to assess the biological impact of the Holly Farms discharge. Each of the three sites sampled received a bioclassification rating of excellent. The study concluded that there was no indication of water quality problems due to organic loading from the facility. However, a reduction in taxa richness and a decline in the abundance of some intolerant species suggested the possibility of impacts from toxicants in the effluent.

Most recent benthic macroinvertebrate monitoring (1996) indicate that water quality of Hunting Creek and North Hunting Creek are excellent. If petitioned, these streams could be investigated for reclassification to High Quality Waters/Outstanding Resource Waters.

Recommendations:
Tyson Foods is encouraged to conduct a thorough engineering evaluation to optimize its treatment systems and to evaluate the potential effects that modifying its treatment processes may have on its effluent toxicity.

Second Creek (Support Threatened)
Second Creek (North Second Creek) receives effluent from a Hoechst-Celanese manufacturing facility that produces polyester resins and fibers. A Level B modeling analysis indicates that Second Creek has limited assimilative capacity for additional loading of oxygen-consuming wastes. Hoechst-Celanese is the only major discharger to the stream. No instream DO violations were reported by the facility between the period 1994-1996. However, occasional low DO concentrations were reported during the summer of 1995 both up and downstream of the discharge. In 1978 time of travel (TOT) and reaeration rate studies were conducted on the stream. During the TOT study the stream flow was estimated to be 62 cfs, approximately equal to the median flow based on a USGS gauging station 0.7 miles downstream of the discharge.

Recommendations:
To more accurately estimate the assimilative capacity of Second Creek, consideration should be given towards developing a field-calibrated DO model before additional loadings of oxygen-consuming wastes are permitted in Second Creek. Updated TOT data, collected during a low flow period, is recommended for use in calibrating a Level C model. Given the close proximity of the City of Salisbury's collection system to Second Creek, and the City's plans to construct a 20 MGD facility on the Yadkin River, it is recommended that new or expanding facilities on Second Creek explore connection to Salisbury's system.

H. Abbotts Creek Watershed (Subbasin 03-07-07)

This subbasin includes the watersheds of Abbotts and Swearing Creeks, both of which discharge into High Rock Lake. All major streams in this subbasin are either threatened or impaired. Impaired waters include Brushy Fork and Hamby Creek (Refer to Chapter 4, Section 4.5). Receiving waters are heavily impacted by the subbasin's three largest dischargers: High Point Westside WWTP, Thomasville WWTP and Lexington WWTP. Nonpoint source pollution is also an issue in this subbasin, which includes both urban and agricultural areas. Ambient stations on Abbotts, Rich Fork and Hamby Creek exhibit frequent high levels of fecal coliform bacteria.

Hamby (Not Supporting) **and Abbotts Creek** (Support Threatened)
In 1993 the Division completed a field-calibrated QUAL2E model of Hamby Creek and Abbotts Creek below Thomasville. The model also included the High Point discharge by incorporating the output from the Rich Fork QUAL2E model in the analysis. The model indicates that Hamby and Abbotts Creeks have little additional assimilative capacity for oxygen-consuming wastes. Water quality sampling in these streams generally supports this conclusion. Substandard DO concentrations have been reported in Abbotts Creek above and below the Lexington discharge (Lexington's downstream sampling point is at NC-47, on the Abbotts Creek arm of High Rock Lake). Occasional DO violations have been reported both up and downstream of Thomasville's discharge. Hamby Creek is also impaired due to sedimentation and elevated fecal coliform bacteria levels.

Most of the phosphorus load to the Abbotts Creek arm of High Rock Lake originates from the High Point, Thomasville and Lexington discharges. Because of this, substantial reductions in the loading from these facilities is necessary to minimize the frequency, duration and extent of nuisance conditions in this arm of the lake.

Recommendations:
DWQ recommends that no new dischargers of oxygen-consuming wastes be permitted in the Abbotts Creek watershed, which includes Hamby Creek. Thomasville and Lexington should serve as regional treatment facilities to handle future wastewater needs. Given the limited assimilative capacity of Hamby and Abbotts Creeks both municipalities are encouraged to aggressively pursue reuse options before additional loadings of oxygen-consuming wastes are permitted.

Nutrient loading from the major facilities in this subbasin heavily impacts the Abbotts Creek arm of High Rock Lake. The Lexington, Thomasville and High Point Westside WWTPs will be required to make significant reductions in phosphorus loading. In 2003 each of these three dischargers will receive summer mass TP limits based upon its current (1997) permitted flow capacity and a TP concentration of 0.5 mg/l [mass TP limit in kg = permitted flow in MGD x 0.5 mg/l x unit conversion factor of 3.79 x number of days in the summer period]. The total mass TP limits for April-October (214 days) are as follows: High Point 2568 kg (an average of 12 kg/day), Lexington 2140 kg (10 kg/day), Thomasville 1712 (8 kg/day). These facilities will receive winter limits (November-March, 151 days) based on twice the average summer daily levels as follows: High Point 3624 kg (an average of 24 kg/day), Lexington 3020 kg (20 kg/day), Thomasville 2416 (16 kg/day). Within one year from the beginning of the 1998 permit cycle, each permittee must conduct an operation and maintenance assessment to identify methods of optimizing phosphorus removal with existing facilities and must submit a report to DWQ documenting actions taken.

As a result of this TMDL strategy, summer end of pipe TP loads to the Abbotts Creek arm will decline to one fifth of 1994-96 levels. Ambient phosphorus levels are predicted to decline by 30 to 40% in the upper portion of the Abbotts Creek arm and by 20 to 25% in the middle portion of the arm (NCDWQ, 1997a). Local governments in the Abbotts Creek watershed are strongly encouraged to implement programs to reduce nonpoint source phosphorus loading and to develop strategies for managing shoreline development.

Additional activities and resources are needed to identify impairment sources on Hamby Creek and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution on Hamby Creek.

Brushy Fork (Partially Supporting)
Approximately ten miles of Brushy Fork is considered impaired primarily due to nonpoint source pollution with sedimentation as the primary cause of impairment.

Recommendations:
Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution on Brushy Fork.

Rich Fork (Not Rated)
High Point Westside WWTP discharges to Rich Fork which has an estimated 7Q10 flow of 0.67 cfs. Substandard DO concentrations have been reported in Rich Fork since the early 1980s. High Point upgraded its treatment facilities in the mid 1980s, significantly improving the quality of its effluent. Water quality in Rich Fork improved as a result, although substandard DO concentrations continue to persist during the summer months. In 1989 the Division completed a field calibrated QUAL2E model for Rich Fork. Instream data confirms model predictions that Rich Fork is over allocated with the most pronounced DO sag occurring just above the confluence with Hamby Creek.

Recommendations:
No additional loadings of oxygen-consuming wastes [illegible] Rich Fork are recommended.

I. Yadkin-Pee Dee from High Rock Lake Dam to Lake Tillery, including Badin Lake (Subbasin 03-07-08)

This subbasin includes the Yadkin-Pee Dee River and its tributaries from High Rock dam to the Lake Tillery dam, with the exception of the Uwharrie River (subbasin 03-07-09). Four mainstem impoundments are included in this subbasin: Tuckertown Reservoir, Badin Lake, Falls Lake and Lake Tillery. Streams in this subbasin are primarily supporting their designated uses, with the exception of impairment in Little Mountain Creek and Lick Creek (Refer to Chapter 4, Section 4.5).

Little Mountain Creek (Partially Supporting)
Impairment in Little Mountain Creek [illegible] due to both nonpoint and point sources of pollution. Greater Badin WWTP, the [illegible] facility in the subbasin, has a permit to discharge 0.55 M[illegible] into Little Mountain C[illegible] [illegible] instream DO violations have been reported by the facili[illegible] and downstream s[illegible] during the period 1994-1996. Little Mountain Creek is a s[illegible] stream and is [illegible] flows during extended dry periods. The 7Q10 flow of this stream is [illegible] the 30Q2 flow is estimated to be positive (based on USGS 1991 L[illegible] Report).

ALCOA has an outfall on an UT to Little Mountain Creek upstream of Greater Badin's discharge. The outfall discharges stormwater and cooling water from its aluminum manufacturing operation near Badin. The effluent is not considered to be exerting a significant oxygen demand in the UT or Little Mountain Creek, however toxicants have been a concern in the past.

Recommendations:
New or expanding discharges into Little Mountain Creek should receive advanced tertiary [illegible] for oxygen-consuming wastes under the current zero flow regulations.

Additional activities and resources are needed to identify impairment sources and [illegible] develop management strategies for this waterbody. As resources allow, DWQ intends to de[illegible] NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Pl[illegible] (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

Mountain Creek Arm of Lake Tillery (Not Rated)
Low DO concentrations have been recorded at the Greater Badin WWTP furthest downstream station located in the Mountain Creek arm of Lake Tillery. Deep water releases from Yadkin ...rporated's Badin La... or Falls L... hydroele... ... be contributing, in part, to the ...ed low DO levels in this arm o... lake.

Recommendations:
D... will further evaluate the causes of low DO levels in the Mountain Creek arm of the Lake Tillery. In order to ... the impacts to DO levels, if any, from Badin Lake and Falls Lake hydroelectric facilities, ...dditional chemical/physical water quality data may be required in the Mount... Creek arm of Lake Tillery and the Yadkin-Pee Dee mainstem during the FERC relicensing process.

Lick Creek Watershed (Partially Supporting)
The Town of Denton has a permit to discharge 0.3 MGD into an UT to Lick Creek. The UT has an estimated 7Q10 and 30Q2 flow equal to zero. Bioclassification ratings of the UT based on macroinvertebrate surveys in 1985 and 1986 have ranged from Fair to Poor both up and downstream of Denton's outfall. Previous surveys have indicated that urban runoff may be contributing to the degraded water quality.

Recommendations:
The town is pursuing a relocation of its discharge and expansion to 0.8 MGD. Due to low stream flow (7Q10=0cfs) in Lick Creek, advanced tertiary limits for oxygen-consuming wastes are recommended (per zero flow regulations) for Denton's proposed discharge to Lick Creek.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

Lake Tillery
Dissolved oxygen levels in violation of the instantaneous standard are observed in the upp... reaches of Lake Tillery. These may be due to the operation of the Yadkin Falls Hydr...ctric Plant.

Recommendations:
DWQ will coordinate with the NC Division of Water R...es ... during the FERC relicensing of 2008 (procedures will begin in 2003) to determine i... to the current license could improve water quality on upper Lake Tillery such that ...water quality standards are met.

Yadkin River below High Ro...
The Yadkin River below High ...n often experiences low summer dissolved oxygen levels, probably from hypolim...es through the hydropower facility. The median DO below the dam during the m...-September is 4.6 mg/l.

Recom...
... should be further evaluated to determine what direction the Division should pursue ...facility begins FERC relicensing procedures in 2003. DWQ will coordinate efforts with ...NC Division of Water Resources during the relicensing process.

Clarks Creek (Supporting and Support Threatened at SR1103)
Clarks Creek is impacted by both point and nonpoint sources. Mt. Gilead WWTP, the largest facility in the subbasin, has a permit to discharge 0.85 MGD into Clarks Creek. The facility is

examining the possibility of upgrading its treatment units and/or relocating its outfall to the Pee Dee River.

Recommendations:
Observations from regional office personnel indicate that Clarks Creek has low flow during dry periods. Considering the limited flow available for the assimilation of wastewater, it is recommended that further evaluation and updated flow information from USGS be obtained if the discharge remains, or new discharges locate to this creek.

J. Uwharrie River Watershed (Subbasin 03-07-09)

This subbasin consists of the Uwharrie River and its tributaries. Monitored lakes include McCrary Lake, Lake Bunch, Back Creek Lake and Lake Reese. This subbasin has no impaired waters, although considerable sedimentation is evident on the upper portion of the watershed and many of these waters are support threatened (Refer to Chapter 4, Section 4.5). Problems in these headwaters are attributed to land use and urbanization.

Caraway Creek (Support Threatened)
The largest discharger, Countryside MHP, has a permit to discharge 0.015 MGD into a UT to Caraway Creek, a class WS-III stream. The UT has an estimated 7Q10 and 30Q2 flow equal to zero. Occasional instream DO violations, as low as 4.6 mg/l, have been reported by the facility during the period 1994-1996.

Recommendations:
If no practical alternatives to discharge are available, it is recommended that Countryside MHP's wasteload allocation be modified to advanced tertiary limits for oxygen-consuming wastes under current zero flow procedures.

K. Pee Dee River from Lake Tillery Dam to Blewett Falls Dam (Subbasin 03-07-10)

This subbasin includes the Pee Dee River and its tributaries from the Lake Tillery dam to the Blewett Falls Lake dam, with the exception of the Rocky River (subbasins 03-07-11 to 03-07-14) and the Little River (subbasin 03-07-15). The largest tributaries in this subbasin are Brown Creek and Mountain Creek. The Pee Dee River and Brown Creek are impaired waters (Refer to Chapter 4, Section 4.5).

Pee Dee River below Lake Tillery (Partially Supporting)
The Pee Dee River below Lake Tillery is impaired due to low DO levels. The cause of the substandard DO levels appears to be related to hypolimnetic discharges from CP&L's hydroelectric facility on Lake Tillery.

Recommendations:
DWQ, in coordination with the NC Division of Water Resources, will explore mitigative actions to correct this problem when the facility comes up for FERC relicensing in 2008. In addition, new or expanding discharges to the Pee Dee River in this subbasin should meet limits no less stringent than 15 mg/l BOD5, 4 mg/l NH3-N, and 5 mg/l DO.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for the Pee Dee River.

Brown Creek (Partially Supporting)
Brown Creek, the largest tributary in this subbasin, is susceptible to low flow during dry summer conditions. Although there are no permitted dischargers in its drainage area, Brown Creek received a Fair bioclassification rating in 1996. Low instream DO concentrations have been reported at the ambient station at SR 1627 near Pinkerton. Water quality appears to be negatively affected by a combination of low stream flow during dry periods and nonpoint source pollution during wetter periods. Sedimentation is also a probable cause of impairment.

Recommendations:
It is recommended that no new discharges be permitted in the Brown Creek watershed. In addition, additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

L. Upper Rocky River and Coddle Creek Watersheds (Subbasin 03-07-11)

This subbasin includes the headwaters of the Rocky River to above its confluence with Irish Buffalo Creek. Coddle Creek is the major tributary. Most of the waters in this subbasin are Support Threatened (Refer to Chapter 4, Section 4.5). The Rocky River and Coddle Creek are impaired waters.

Rocky River/Mallard Creek at SR1142 (Partially Supporting) **and Dye Branch**
Dye Branch and the headwaters of the Rocky River are significantly impacted by Mooresville's discharge, which has had frequent toxicity failures. In 1993, DWQ completed a field-calibrated dissolved oxygen model for 47.6 stream miles of the upper Rocky River area in subbasins 03-07-11 and 03-07-12, from its headwaters to the confluence with Muddy Creek (NCDEM, 1993b). The modeled area includes portions of Dye Branch and Mallard Creek, as well as the Rocky River mainstem. The model was developed to evaluate the assimilative capacity of the river and to assess the interaction between three major dischargers: Mooresville (into Dye Branch), the Charlotte-Mecklenburg Utilities District's Mallard Creek WWTP and the Rocky River Regional WWTP (in subbasin 03-07-12) operated by Cabarrus County. Fecal coliform bacteria levels and sedimentation are also problem parameters in the Rocky River.

Recommendations:
Model results indicate that Mallard Creek and the Rocky River upstream of Mallard Creek have limited assimilative capacity and that new or expanding dischargers, if permitted, should receive BAT limits (5 mg/l BOD and 2 mg/l NH3N). This recommendation may affect both the Mooresville and the CMUD-Mallard Creek WWTPs. Model results also indicate that Mooresville's permitted limits for oxygen-consuming wastes are predicted to result in violations of the DO standard in the Rocky River. However, during 1994-1996 Mooresville, on average, treated its wastewater to well below its permitted limits and no DO violations were reported by the facility during this period. The DO standard appears to be protected at Mooresville's current level of treatment and waste flow. However, should the facility wish to expand in the future, DWQ will review the limits and make modifications where they are appropriate and justifiable.

Model results indicate that there is remaining assimilative capacity in the Rocky River below Mallard Creek. New or expanding discharges are likely to receive total BODu limits of approximately 32 mg/l (BOD5 and ammonia limits will vary depending upon effluent characteristics). The model will be used to evaluate specific scenarios for the future allocation of oxygen-consuming wastes in the upper and middle reaches of the Rocky River.

Mean fecal coliform levels in the upper Rocky River far exceed the standard and turbidity violations occur frequently, indicating that nonpoint source inputs are also a problem in this subbasin. Considerable growth is occurring in this area as the Charlotte metropolitan area expands eastward. Preventing further water quality deterioration as this subbasin continues to develop is a major concern. The City of Charlotte and Cabarrus and Mecklenburg Counties are encouraged to investigate the sources of pollution along the Rocky River and develop mitigation plans to protect the river from further degradation.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3).

<u>Coddle Creek</u> (Partially Supporting)
Coddle Creek is impaired due to nonpoint source pollution primarily from the urban area of the Town of Concord. Sedimentation is problematic in this stream.

Recommendations:
The NC Division of Water Resources has requested a minimum streamflow from the Coddle Creek impoundment, which was constructed in 1997 as a water supply reservoir for the Town of Concord. The intent of the minimum streamflow is to maintain downstream aquatic habitat. Refer to Chapter 2, Section 2.9 for more details. This minimum flow may or may not improve water quality at the DWQ downstream sampling site. DWQ will continue to monitor for improved effects.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). The Town of Concord is encouraged to take steps to reduce nonpoint source runoff to Coddle Creek.

M. Middle Rocky River Watershed (Subbasin 03-07-12)

This subbasin encompasses the middle portion of the Rocky River watershed, from above Dutch Buffalo Creek to above Island Creek. The largest tributaries include Irish Buffalo Creek, Dutch Buffalo Creek, Goose Creek and Crooked Creek. Monitored lakes include Lake Concord, Lake Fisher and Kannapolis Lake. All streams in this subbasin are Support threatened with the exception of Goose Creek and the South and North Fork of Crooked Creek, which are impaired (Refer to Chapter 4, Section 4.5).

Macroinvertebrate data indicate water quality degradation in the Rocky River and Irish Buffalo Creek. Additionally, average fecal coliform levels in both streams exceed the standard and problems with turbidity are also evident. This situation is probably largely due to the influence of nonpoint sources.

<u>Goose Creek</u> (Not Supporting)
Goose Creek, with its headwaters in Mecklenburg County, flows though the slate belt in Union County before joining the Rocky River. The creek is inhabited by the federally endangered Carolina heelsplitter and several other rare mollusks. Goose Creek is impaired by nonpoint source pollution and the cumulative effect of a number of small discharges. The expansion of the Charlotte area has lead to increased development along Goose Creek, along with a number of small dischargers. Elevated fecal coliform bacteria levels and sedimentation are problem parameters for this stream. The combination of growth pressures, wastewater discharges and agricultural activities have resulted in Goose Creek's impairment.

Elevated fecal coliform levels are likely primarily due to nonpoint sources. Animals operations with cattle having access have been noted in the watershed and these animals are the most likely contributors of fecal coliform bacteria. Residential developments with a permitted discharge and septic systems may also be contributors to the elevated coliform levels. The cumulative effect of elevated chlorine and ammonia levels from the small dischargers may also be affecting the aquatic community of Goose Creek.

Recommendations:
In order to better assess the cumulative impact of the small discharge facilities to Goose Creek and evaluate the assimilative capacity of the creek, a field-calibrated QUAL2E model is being conducted in 1998. In addition, DWQ recommends that existing facilities discharging into Goose Creek receive chlorine limits at permit renewal. New or expanding dischargers are already required to dechlorinate under current regulations. DWQ is pursuing enforcement action on some of these dischargers for past violations. The facilities that had periodic problems meeting permit limits have generally taken actions to correct the problems. DWQ is developing an extensive GIS based dataset to assist in making decisions concerning appropriate wastewater discharge locations for the Union County area and Goose Creek.

In an attempt to address rapid population growth and to evaluate existing county owned treatment systems, Union County has developed a sewer system master plan which prioritizes needed improvements through the year 2015. The plan calls for the construction of a regional WWTP to provide service to the Greater Goose Creek Drainage Basin, which encompasses the upper northwest part of Union County as well as a portion of Mecklenburg and Cabarrus counties. The proposed outfall would be located on the Rocky River immediately below the confluence with Goose Creek. The Division has provided speculative limits for waste flows of 3 and 9 MGD. Goose Creek is proposed for connection to the Rocky River Regional WWTP in 2000 to 2010. DWQ is supportive of efforts to eliminate the small discharges in the Goose Creek watershed by tying them into a regional sewer system.

To improve water quality in Goose Creek, some additional efforts are underway by other agencies. The NC DOT (in an effort to offset damages from building the highway loop) has hired a biologist to educate landowners about the need to maintain water quality in Goose Creek to protect endangered mussel populations in the creek (See Chapter 5, Section 5.6.2). The NPS Team for the lower portion of the basin has chosen to focus on Goose Creek for their first project using Section 319 funding.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

Crooked Creek Watershed (Partially Supporting and Not Supporting)
Crooked Creek is impaired due to both point and nonpoint sources of pollution. In November 1996, Union County WWTP#2 relocated and expanded its discharge from South Fork Crooked Creek to North Fork Crooked Creek. Before its relocation, the facility reported numerous instream DO violations in South Fork Crooked Creek, both up and downstream of the discharge during the period 1994 to 1996. This new facility is not expected to be sufficient to provide capacity for the growth anticipated for the area. To address future wastewater needs, Union County developed a sewer system master plan which prioritizes needed improvements through the year 2015. The plan calls for the construction of a regional WWTP to provide service to the Greater Goose Creek Drainage Basin, which encompasses the upper northwest part of Union County as well as a portion of Mecklenburg and Cabarrus counties. The proposed outfall would be located on the Rocky River immediately below the confluence with Goose Creek. North Fork Crooked Creek

sewer line connections to the regional facility are proposed for 2005 and South Fork Crooked Creek sewer lines are proposed for 2015.

As with many slate belt streams in Union County, both North and South Fork Crooked Creek have little flow during dry periods. These slate belt streams have very limited, if any, capacity to assimilate wastewater. This is evidenced by the low instream DO levels during critical summer conditions (<2 mg/l), which have been recorded in South Fork Crooked Creek above all permitted discharges (Refer to Section 6.5.7 for a discussion of oxygen-consuming wastes and zero to low flow streams).

Recommendations:
The Division recommends that no additional loads of oxygen-consuming wastes be permitted in North Fork Crooked Creek until data are available to further evaluate the impact of existing loading. Per the zero flow stream regulation (See Section 6.5.7), no additional loading of oxygen-consuming wastes will be allowed in South Fork Crooked Creek. Before any new outfalls are permitted to Crooked Creek below the confluence of the North and South Forks, it is recommended that additional chemical/physical data be collected to aid in assessing assimilative capacity.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

Rocky River (Support Threatened)
DWQ completed a field calibrated QUAL2E model extending from Dye Branch in subbasin 03-07-11 down to the confluence of the Rocky River with Muddy Creek in subbasin 03-07-12. This model includes the area affected by the discharge from the Rocky River Regional WWTP. Although wastewater dominates the streamflow under 7Q10 conditions, model predictions indicate that additional assimilative capacity remains in the lower reaches of the study area.

Recommendations:
Based upon the QUAL2E modeling analysis, new or expanding discharges to the Rocky River between the Rocky River Regional WWTP and the confluence with Muddy Creek will likely receive total BODu limits of approximately 32 mg/l (BOD5 and ammonia limits will vary depending upon effluent characteristics). Improvements to the model are expected as additional data becomes available on the wastewater characteristics of the major dischargers. Additionally, DWQ is planning to request the USGS to develop a consistent low flow profile for the river in preparation for extending the QUAL2E model to the mouth of the Rocky River.

Low flows in the Rocky River watershed are difficult to assess. USGS 7Q10 estimates for various reaches of the river were made at different times using varying methodologies, and do not provide a clear picture of low flow conditions. Once these improvements have been incorporated into the model, the assimilative capacity of the streams in the study area will be reevaluated and wasteload allocations may be affected.

In an attempt to address rapid population growth and to evaluate existing county owned treatment systems, Union County has developed a sewer system master plan which prioritizes needed improvements through the year 2015. The plan calls for the construction of a regional WWTP to provide service to the Greater Goose Creek Drainage Basin, which encompasses the upper northwest part of Union County, as well as a portion of Mecklenburg and Cabarrus counties. The proposed outfall would be located on the Rocky River immediately below the confluence with Goose Creek. The Division has provided speculative limits for waste flows of 3 and 9 MGD. In order to evaluate the potential impacts from a proposed discharge of greater than 9 MGD, the Division is considering extending the calibrated Rocky River QUAL2E model further downstream.

N. Lower Rocky River Watershed (Subbasin 03-07-13)

This subbasin includes many tributaries to the Rocky River, including Big Bear Creek, Long Creek and Stony Run. There are no impaired streams, however Long Lake is impaired (Refer to Chapter 4, Section 4.5).

Long Creek (Support Threatened)
The Albemarle WWTP, the only major discharger in this subbasin, discharges to Long Creek. Dissolved oxygen measurements in Long Creek indicate that the assimilative capacity for oxygen-consuming wastes is very limited. Numerous violations of the instream DO standard have been reported both above and below the discharge. Agricultural and urban nonpoint source runoff appear to be impacting water quality in addition to Albemarle's discharge.

Recommendations:
The city is encouraged to optimize its treatment processes in order to minimize water quality impacts to the creek. Upon permit renewal consideration should be given to reducing Albemarle's summer BOD5 limit from 10 mg/l to 5 mg/l.

Long Lake (Not Supporting)
This lake is intended as a recreation water for the Town of Albemarle. The lake is currently drained and therefore not supporting its designated uses. The town has approved funding from EPA to develop a restoration and management plan for the lake. Refer to Chapter 4, Section 4.3.13 for more information.

O. Richardson and Lanes Creek Watersheds (Subbasin 03-07-14)

This subbasin, located in Union and Anson Counties, includes the lowermost reach of the Rocky River and three tributaries of the Rocky River--Lanes Creek, Richardson Creek and Cribbs Creek. Lakes include Lake Monroe, Lake Lee and Lake Twitty.
Lanes and Richardson Creeks are impaired due to nonpoint source pollution (Refer to Chapter 4, Section 4.5). In the case of Richardson Creek, the Monroe WWTP may also be contributing to the problem. These streams show evidence of substantial nutrient enrichment. The large number of confined animal operations in these watersheds are probably a factor, although further evaluation is necessary. Richardson and Lanes Creeks are located in Union County, where the streams are slower-moving and characterized by low flow (Refer to Section 6.5.7).

Richardson Creek (at SR 1649 is Partially Supporting, remainder is Support Threatened)
Monroe WWTP is the largest discharger in the subbasin. Despite the relatively large drainage area of Richardson Creek at the outfall, the creek is susceptible to low flow during dry periods, as is typical of slate belt streams in this subbasin. Instream DO violations above and below the discharge indicates that the stream has very limited assimilative capacity for wastewater. Nutrient loads to the stream from point and nonpoint sources have stimulated prolific growths of filamentous algae in certain reaches of Richardson Creek which may be contributing an additional oxygen demand. Sedimentation is also a problem parameter for the creek.

Recommendations:
No new discharges of oxygen-consuming wastes should be permitted above Monroe's WWTP. Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer

to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

<u>Lanes Creek</u> (Partially Supporting and Not Supporting)
Lanes Creek, the second largest tributary to the Rocky River within this subbasin, is impaired. Although the Lanes Creek mainstem extends over 35 miles, as with other slate belt streams, many areas along its length tend to dry up or be reduced to a series of small pools during extended dry periods. In 1996 the USGS estimated the 7Q10 of Lanes Creek near Peachland (drainage area = 87 mi^2) to be zero, with a small positive 30Q2 flow (0.1 cfs). As of 1996 there were no NPDES permitted dischargers on Lanes Creek. The Town of Marshville has requested speculative limits for a new 3.0 MGD discharge into the creek just below Peachland. Although little physical/chemical data has been collected on Lanes Creek, information gathered on other nearby creeks suggests that these slate belt streams have very limited capacity to assimilate wastewater. In addition, Lanes Creek is being impacted by sedimentation.

Recommendations:
If a discharge is proposed, physical/chemical data should be collected during critical conditions to determine existing conditions of the creek. It is recommended that every alternative to discharge be thoroughly examined before a new outfall to Lanes Creek is considered.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

P. Little River Watershed (Subbasin 03-07-15)

This subbasin, located primarily in Montgomery County, consists of the Little River and its tributaries. Water quality in this watershed is generally good and no major problems have been recorded. There are no impaired waters in this subbasin, but several waters are Support threatened (Refer to Chapter 4, Section 4.5).

<u>Hickory Branch</u> (Not Rated)
Both Troy and Biscoe WWTPs are permitted dischargers in this subbasin. The Town of Biscoe has a permit to discharge into Hickory Branch. Hickory Branch has an estimated 7Q10 and 30Q2 flow equal to zero. No instream DO violations were reported by the facility during the period 1994-1996. However, on occasion the stream at the town's upstream monitoring station was reported to be "dry". No ambient stations are located on Hickory Branch.

Recommendations:
It is recommended that at permit renewal Biscoe's permit be modified to reflect the Division's zero flow policy.

Q. Pee Dee River Below Blewett Falls Lake and Hitchcock Creek Watersheds (Subbasin 03-07-16)

This subbasin consists of the most downstream section of the Pee Dee River in NC (below Blewett Falls Lake) and all of the tributaries draining from Richmond County. Impaired waters include Cartledge Creek and Hitchcock Creek from Rockingham (Refer to Chapter 4, Section 4.5). Both the Pee Dee River and Marks Creek are Support threatened. Impaired lakes in the subbasin include Rockingham City Lake and Hamlet City Lakes.

Cartledge Creek (Partially Supporting)
Cartledge Creek is impaired due to nonpoint source inputs. Sedimentation and streambank erosion are evident. Agricultural activities in the watershed may be the cause of this problem.

Recommendations:
Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

Hitchcock Creek (Not Supporting)
Hitchcock Creek from the City of Rockingham and downstream is impaired. The creek appears to be heavily impacted by both point sources as well as urban and agricultural runoff. The creek is impaired by elevated fecal coliform bacteria, low pH levels and sedimentation. The City of Rockingham WWTP has a permit to discharge 6 MGD to Hitchcock Creek approximately 4 miles above its confluence with the Pee Dee River and two miles upstream of a small impoundment (Steele Mill Pond Dam). Laurel Hill Paper Company (0.25 MGD) and Burlington Industries (1.2 MGD) are located below the impoundment.

In 1992 a field-calibrated QUAL2E model was developed for the area from the Rockingham outfall to the mouth of Hitchcock Creek. Modeling analyses predicted that even at advanced tertiary limits (5 mg/l BOD and 2 mg/l NH_3-N) the DO levels in the pond would drop below the standard of 5 mg/l at existing permitted wasteflow (6 MGD). The City of Rockingham plans to relocate the discharge to the Pee Dee River with tertiary limits of 15 mg/l BOD5 and 4 mg/l NH_3-N and an expansion flow of 9 MGD.

Due to impacts to the creek below the impoundment, the Laurel Hill Paper Company is planning to connect to the City of Rockingham once the city installs an outfall line and pump station. Burlington Industries will remain in this section of Hitchcock Creek.

Recommendations:
The assimilative capacity of this stream for oxygen-consuming wastes is extremely limited, and any additional BOD loading is likely to cause dissolved oxygen problems. The Division recommends that no new discharges of oxygen-consuming wastes be permitted on Hitchcock Creek below the existing Rockingham outfall.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for this waterbody. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution for this creek.

Marks Creek (Support Threatened)
Marks Creek is a slow moving stream with swamp-like characteristics in certain reaches. Numerous violations of the instream DO standard have been reported both up and downstream of the Town of Hamlet's discharge. Typically, the lowest DO values are recorded at the facility's upstream sampling site and occur during the summer months. Swamp-like conditions above the discharge may be contributing to the substandard DO levels. This stream is also impacted by sedimentation.

Recommendations:
Additional BOD loading is not recommended in Marks Creek. Considering the slow moving, swamp-like nature of certain reaches in the stream, a field calibrated model would be necessary to develop a wasteload allocation for any future expansions of the Hamlet WWTP.

Pee Dee River (Support Threatened)
Anson County has a permit to discharge 3.5 MGD into the Pee Dee River approximately 12 miles downstream of Blewett Falls dam. Instream DO violations have been reported by the facility during the summer months both up and downstream of the discharge. Substandard DO concentrations in the Pee Dee River have also been recorded at the ambient station at US-74 which is located between the dam and the discharge. The problem appears to be related to low DO water released by the hydroelectric facility from lower portions of Blewett Falls Lake during stratified conditions.

Recommendations:
This situation should be further evaluated to determine what direction DWQ should pursue when the facility begins FERC relicensing procedures in 2003. DWQ will coordinate efforts with the NC Division of Water Resources on this issue.

Rockingham City Lake and Hamlet City Lake (Partially Supporting)
Rockingham City Lake and Hamlet City Lake are impaired due to sedimentation and macrophyte growth. In 1985 the Army Corps of Engineers prepared an Environmental Assessment for the removal of sediment and debris from Hamlet City Lake.

Recommendations:
Further action by local governments is necessary to restore the uses of these two lakes. Additional resources are needed to identify impairment sources and to develop management strategies for these lakes. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution in the watersheds of these lakes.

R. Jones Creek Watershed (Subbasin 03-07-17)

This subbasin consists of the Jones Creek and Deadfall Creek catchments in the southern part of Anson County. Wadesboro City Pond is in this subbasin. Portions of both North Fork and South Fork of Jones Creek are impaired and many other streams are threatened by nonpoint source pollution and possibly nutrient enrichment (Refer to Chapter 4, Section 4.5). Agriculture, logging activities and in some cases urban runoff may all be involved.

North and South Fork Jones Creek (Partially Supporting)
In 1995 Anson County relocated its outfall from South Fork Jones Creek to the Pee Dee River. There are no wastewater dischargers currently permitted in this subbasin. Stream flow in this subbasin is highly variable with many streams susceptible to low flow during dry conditions. Low flow streams typically have very limited assimilative capacity for oxygen-consuming wastes. Sedimentation is also a problem parameter for both stream lengths.

Recommendations:
Before any new discharges are permitted in this subbasin it is recommended that additional chemical/physical data be collected to aid in assessing the assimilative capacity of the proposed receiving stream.

Additional activities and resources are needed to identify impairment sources and to develop management strategies for these waterbodies. As resources allow, DWQ intends to develop NPS management strategies for this waterbody for the second Yadkin-Pee Dee River Basin Plan (refer to Section 6.3.3). In addition, local efforts are needed to develop a plan to reduce nonpoint source pollution.

6.4 IDENTIFICATION AND PROTECTION OF HIGHLY VALUED RESOURCE WATERS

6.4.1 Overview of High Quality and Outstanding Resource Waters as well as Special Classifications and Habitats

Waters considered to be biologically sensitive or of high resource value may be given protection through reclassification to HQW (high quality waters), ORW (outstanding resource waters), Tr (trout) or WS (water supply), or they may be protected through more stringent NPDES permit conditions. Waters eligible for reclassification to HQW or ORW may include native trout waters, designated critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters classified for domestic water supply purposes (WS I and II), or waters having Excellent water quality based on DWQ biological monitoring. Based on DWQ monitoring, there are several waters that received an Excellent biological rating and may be considered eligible for HQW or ORW (Table 6.4). The HQW, ORW and WS classifications generally require more stringent point and nonpoint source pollution controls than do basic water quality classifications such as C or SC. Refer to Chapter 2 for more information on classifications and standards.

There are fourteen species listed by the NC Natural Heritage Program as Special Concern, Significantly Rare, or Threatened in the Yadkin-Pee Dee River basin. These species are given special protection status by the North Carolina Wildlife Resources Commission and/or the North Carolina State Endangered Species Act (G.S. 113-331 to 113-337). The species and the status of each can be found in Section 2.5.

Table 6.4 Potential HQW/ORW Waters for the Yadkin-Pee Dee River Basin

Subbasin	Waterbodies
030701	Buffalo Creek, Stoney Fork, Mulberry Creek, Roaring River and Middle Prong Roaring River
030706	upper South Yadkin River, Hunting Creek, North Little Hunting Creek and Rocky Creek
030710	Mountain Creek
030714	West Fork Little River
030716	Beaverdam Creek, Bones Fork Creek and Rocky Fork Creek

Where waters are known to support state or federally listed endangered or threatened species or species of concern, consideration will be given during the NPDES permitting process to minimize impacts to habitat areas consistent with the requirements of the federal Endangered Species Act and North Carolina's endangered species statutes. Possible protection measures may include but are not limited to dechlorination or alternative disinfection, tertiary or advanced tertiary treatment, outfall relocation, and backup power provisions to minimize accidental plant spills. The need for special provisions will be determined on a case-by-case basis during review of individual permit applications and take into account the degree of impact and the costs of protection.

6.4.2 Strategies for Controlling Discharges to High Quality Waters (HQWs) and Outstanding Resource Waters (ORWs)

A. High Quality Waters (HQWs)

Many streams in the Yadkin-Pee Dee River basin are classified as high quality waters (Refer to Chapter 2). A distinct set of management strategies applies to wastes discharged into HQWs. New discharges and expanding discharges that have an increase in pollutant load to HQW streams are subject to the following management strategies adopted by DWQ pursuant to 15A NCAC 2B.0224 (1) and 15A NCAC 2B .0224 (1)(b)(vii):

- Discharges from new single family residences will be prohibited. Those existing subsurface systems for single family residences which fail and must discharge shall install a septic tank, dual or recirculating sand filters, disinfection and step aeration (15A NCAC 2B.0224 (1)(a)).

- All new or expanded wastewater discharges (except single family residences) will be required to meet effluent limitations for oxygen-consuming wastes as follows: BOD_5 = 5 mg/l, NH_3-N = 2 mg/l, and DO = 6 mg/l. More stringent limitations will be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen-consuming wastes will not cause the DO of the receiving water to drop more than 0.5 mg/l below background levels, and in no case below the standard. An exception is made for existing facilities that expand without increasing their permitted loading. Where background information is not readily available, evaluations will assume a percent saturation determined by staff to be generally applicable to that hydroenvironment (15A NCAC 2B .0224 (1)(b)(i)).

- Emergency Requirements: Failsafe treatment designs will be employed (except single family residences), including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs (15A NCAC 2B .0224 (1)(b)(iv).

- Volume: The total volume of treated wastewater for all discharges combined will not exceed 50 percent of the total instream flow under 7Q10 conditions (15A NCAC 2B 0.224 (1)(b)(v)).

- Toxics: In cases where complex wastes (those containing or potentially containing toxicants) may be present in a discharge, a safety factor will be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent will be allocated at one half of the normal standard at design conditions. Whole effluent toxicity will be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under design conditions. In all instances there may be no acute toxicity in an effluent concentration or 90 percent. Ammonia toxicity shall be evaluated according to EPA guidelines promulgated in "Ambient Water Quality Criteria for Ammonia - 1984"; EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784).

- North Carolina does not have a numeric water quality standard for suspended solids. Discharges to high quality waters (HQW) must meet a total suspended solids (TSS) limit of 10 mg/l for trout waters and primary nursery areas and 20 mg/l for all other HQWs.

B. Outstanding Resource Waters (ORWs)

There are a number of ORWs in the Yadkin-Pee Dee River basin (Refer to Chapter 2). No new discharges nor expansions of existing discharges directly to waters classified as ORW are permitted in accordance with 15 NCAC 2B .0225 (c)(1). Those existing discharges will be handled on a case-by-case basis following standard operating procedures.

6.5 GENERAL MANAGEMENT STRATEGIES FOR PROTECTING WATER QUALITY IN THE BASIN

6.5.1 Management Strategies for Controlling Nutrients

Control of nutrients is necessary to limit algal growth potential, to assure protection of the instream chlorophyll *a* standard, and to avoid the development of nuisance conditions in the state's waterways. Water quality problems associated with nutrients are summarized in Section 3.2.2. Point source controls are typically NPDES permit limitations on total phosphorus (TP) and/or total nitrogen (TN). Nonpoint controls of nutrients generally include best management practices (BMPs) to control nutrient loading from agricultural land, urban areas and other sources.

Assimilative capacity has been exceeded on many embayments of High Rock Lake, especially the Abbotts and Crane Creek arms. Although nuisance conditions are rare on the mainstem of High Rock Lake, nutrient levels are very high and algal blooms are common, indicating that the mainstem has probably reached its capacity to assimilate nutrients. Nutrient management strategies for High Rock Lake are discussed in Section 6.3.4-A.

Nutrient levels do not currently result in significant problems on the other lakes on the Yadkin-Pee Dee mainstem, although numerous smaller lakes on tributaries are eutrophic. Excessive macrophyte growth compromises the designated uses of Rockingham City Lake and Hamlet City Lake (see Section 6.3.1).

6.5.2 Management Strategies for Controlling Sedimentation.

Sedimentation is widespread in the Yadkin-Pee Dee River and its tributaries, especially in the upper part of the basin. While sedimentation has caused widespread water quality degradation, serious impairment is apparent in relatively few streams. However, the designated uses of numerous waterbodies are threatened by sedimentation.

Sedimentation is a widespread nonpoint source-related water quality problem that results from land-disturbing activities. The most significant of these activities include agriculture and land development (e.g., highways, shopping centers, and residential subdivisions). For each of these major types of land-disturbing activities, there are programs being implemented by various government agencies at the state, federal and/or local level to minimize soil loss and protect water quality. Some of these programs are listed in Table 6.5.

Table 6.5 State and Federal Sediment Control-Related Programs

Agricultural Nonpoint Source (NPS) Control Programs	North Carolina Agriculture Cost Share Program NC Cooperative Extension Service and Agricultural Research Service Watershed Protection and Flood Prevention Program (PL 83-566) Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA). (Includes Conservation Reserve Program, Conservation Compliance, Sodbuster, Swampbuster, Conservation Easement, Wetland Reserve and Water Quality Incentive Program)
Construction, Urban and Developed Lands	Sediment Pollution Control Act Federal Urban Stormwater Discharge Program Water Supply Protection Program ORW and HQW Stream Classification
Forestry NPS Programs	Forest Practice Guidelines National Forest Management Act Forest Stewardship Program Forest Management Assistance
Mining	The Mining Act of 1971
Wetlands Regulatory NPS Programs	Section 10 of the Rivers and Harbors Act of 1899 Section 404 of the Clean Water Act Section 401 of the Water Quality Certification (from CWA) North Carolina Dredge and Fill Act (1969)

Construction activities, private access roads, state road construction and agriculture are sources of sediment and are discussed below. Golf courses and urban stormwater are other potential sources of sediment that are discussed in separate sections. After construction is complete, poorly designed roads, trails, and driveways may continue to erode into water bodies.

Before action is taken to restore a stream channel and riparian area, it is essential to understand the cause and nature of the problem. For example, if a landowner notices that excess gravel is accumulating in the stream on their property, they should first investigate the causes on their property and, if necessary, throughout the watershed. Stabilizing a streambank can result in an expense of time and money which will have to be repeated until the underlying cause is addressed. It is important to understand that a streambank may erode for many different reasons and the cause is not always obvious. Underlying causes might be as simple as a lack of bank vegetation to hold the soil in place or as complex as changes in urban runoff, improper logging or farming techniques or other activities in the watershed.

Also, watershed inventories should not focus solely upon problem areas. Without advance planning and protection, sensitive resources, highly productive resource or critical components of natural systems are easily degraded or lost through development or overuse. Riparian buffers, wetlands, floodplains, animal movement corridors and rare species should be identified and their protection incorporated into watershed planning and management efforts.

A. Proven Techniques for Controlling Sediment and Protecting Streams

The following techniques are proven to be effective at controlling sedimentation to streams, thereby protecting the water quality of streams.

- Avoid disturbance of streams and the riparian zone. Protect existing riparian forest buffers. Restore vegetation that has been cleared from the riparian zone.

- Use BMPs for sediment control. A wide variety of agricultural BMPs have proven effective for sediment control. These include conservation tillage/residue management, filter strips and field borders, and cover crops.
- Maintain natural channels or, if modification is unavoidable, design channels based on the stability and behavior of natural stream channels. Channel designs based on natural stability principles will be less susceptible to erosion, dissipate energy more effectively, remain more stable, and provide more habitat than traditional engineered channel designs.
- Maintain pre-development peak flows, flow velocities, and flow timing to the extent possible through the use of stormwater management techniques and appropriate BMPs.
- Use best management practices such as riser basins, diversion ditches, rock dams, check dams and buffers for construction activities.

B. The Use of Riparian Buffers to Protect Water Quality and Integrity

A stream or lake and its riparian area function as one. The condition of the riparian area and its vegetation type play a central role in determining the integrity of stream channels and water quality in general. Although riparian vegetation of any kind is desirable, forests provide the greatest amount of benefit and highest potential for meeting both water quality and habitat restoration objectives. A sound scientific foundation exists to support the sediment reduction, nutrient reduction, and ecological values and functions of riparian forest buffers. The use of riparian buffers as a management tool should be promoted.

Riparian forest buffers are managed to protect water quality through control of nonpoint source pollution and maintenance of the streamside or shoreline environment. Riparian forest buffer systems are typically managed as three integrated zones which are designed to intercept surface runoff and subsurface flow. These zones comprise an area of trees, usually accompanied by shrubs and other vegetation, that is adjacent to a body of water. The riparian forest buffer is managed to:

- maintain the integrity of stream channels and shorelines by protecting streambanks and shorelines from erosion;
- reduce the impact of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and synthetic chemicals; and
- supply food, cover, and thermal protection to fish and other wildlife.

C. Construction Activities and Sedimentation

Construction activities can dramatically increase the sediment delivered to streams. Construction activities are regulated under the Sedimentation Pollution Control Act of 1973, administered by the NC Division of Land Resources (DLR). This act requires anyone disturbing more than one acre of land to submit a Sedimentation and Erosion Control Plan to DLR. Adequate erosion control measures must be designed to retain sediment on a development site during the 10-year storm. Measures located in HQW's must be designed for the 25-year storm event. Sediment basins in HQW's must also be designed for a 70 percent settling efficiency for the 40 micron particle.

Generally, a land owner must install acceptable best management practices (BMPs) when the land is disturbed by construction or development activities. Management practices may include barriers, filters, or sediment traps to reduce the amount of sediment that leaves a site. Under this act, local governments may take responsibility for reviewing and enforcing the Sedimentation and Erosion Control Program within their jurisdiction; however, their program must be at least as stringent as DLR's.

In the Yadkin-Pee Dee River basin, development pressure will increase. In order to match the pace of land disturbing activity, more staff hours will be needed within the DLR in order to effectively administer and fully enforce the provisions of the Act. At present, planning and inspection staff are stretched thinly across large geographic areas and a wide variety of projects. Careful planning prior to construction, perhaps the most important part of erosion control, may often be neglected due to lack of available staff time.

The responsibility for controlling sediment from construction activities falls on many shoulders. The parties with the greatest responsibility include: homeowners, developers/contractors, local governments, and the NC Division of Land Resources. Table 6. 6 presents actions that will help to address sediment problems associated with construction activities. No sediment control measures are 100% effective so some level of sedimentation will occur with land-disturbing activities. Education and promotion of stewardship are keys to reducing sedimentation, along with judicious strengthening of regulations and enforcement.

References/Resources:

- The following can be ordered from the NC Division of Land Resources at P.O. Box 27687, Raleigh, NC 27611, (919)733-3833:
  1) *NC Erosion and Sediment Control "Planning and Design Manual"* ($55 for in-state, $75 for out-of-state)
  2) *NC Erosion and Sediment Control "Inspector's Guide"* ($20 for in-state or out-of-state)
  3) *NC Erosion and Sediment Control "Field Manual"* ($20 for in-state or out-of-state)
  4) *NC Erosion and Sediment Control "Video Modules"* ($15 for in-state, $50 for out-of-state)
- You may also call the NC Division of Land Resources at (919)733-3833 to obtain a contact name and number for the regional office in your area.

Table 6.6 Recommended Actions to Prevent Construction-Related Sediment Problems

Homeowners & Landowners	Know and follow state and local erosion and sedimentation ordinances. Fit the development to existing site conditions. Follow natural contours and avoid flood plains and highly erodible soils to control erosion and sedimentation. Establish, maintain, and protect vegetation beside streams on your property. Buffers provide a filter for sediment and other pollutants. Carefully monitor the construction process. Ensure permanent vegetation is established and maintained on construction site ASAP. Continue to control sediment after construction is complete.
Developers/ Contractors	Fit the development to existing site conditions. It is much easier to control erosion and sedimentation from development that follows natural contours and avoids flood plains and highly erodible soils Minimize the extent and duration of exposure. Schedule construction according to weather and season. Try to pick dry times. Protect areas to be disturbed from stormwater runoff. Use dikes, diversions, and waterways to intercept runoff and divert it away from cut-and-fill slopes or other disturbed areas. To reduce erosion, install these measures before clearing and grading. Keep runoff velocities low. Convey stormwater away from steep slopes to stabilized outlets, preserving natural vegetation when possible. Inspect and maintain control structures during the construction process. If not properly maintained, some erosion control measures can cause more damage than they correct. Retain sediment onsite. Protect low points below disturbed areas. Build barriers to reduce sediment loss. When possible, construct sediment traps before other land disturbing activities. Stabilize disturbed areas as soon as possible after construction. Apply mulch and vegetation to land and line channels for protection. Consider future repairs and maintenance of these measures. Train equipment operators to execute erosion and sediment control practices.
Citizens	Report any serious sediment problems on construction sites. This would include bare soil that has not been stabilized within 30 days, brown or red runoff during a storm, or obviously malfunctioning erosion/sediment controls.
Local Govts. Without Delegated Sediment/ Erosion Control Programs	Educate citizens as to the importance of erosion and sediment control before they begin construction activities and ensure they understand their responsibilities under the State Sedimentation Pollution Control Act. Report any serious problems on construction sites. This would include bare soil that has not been stabilized within 30 days, brown or red runoff during a storm, or obviously malfunctioning erosion/sediment controls. If your resources allow, consider taking responsibility for sediment and erosion control in your jurisdiction. This will allow greater control over implementation and enforcement of the program. It will also offer the opportunity to require sediment control on developments disturbing under one acre. Maintain publicly-owned open space. Will prevent sediment loss from certain tracts of land.

Table 6.6 Recommended Actions to Prevent Construction-Related Sediment Problems (Cont'd)

Local Govts. With Delegated Sediment/ Erosion Control Programs	Educate citizens as to the importance of erosion and sediment control. Maintain publicly-owned open space. Will prevent sediment loss from certain tracts of land. Evaluate the effectiveness of current sediment control enforcement. Identify staff resource needs. When possible, coordinate efforts with other agencies such as the Dept. of Transportation, Div. of Forest Resources, and Soil and Water Conservation Districts.
NC Div. of Land Resources, Land Quality Section	Continue to promote effective implementation and maintenance of erosion and sediment control measures on construction sites. Research innovative new ways to control sediment on construction sites. Evaluate the effectiveness of current sediment control enforcement. Identify staff resource needs. When possible, coordinate efforts with other agencies such as the Dept. of Transportation, Div. of Forest Resources, and Soil and Water Conservation Districts. Encourage more delegated programs by local governments where resources allow, especially in rapidly developing areas.

D. Private Access Road Construction

Improperly designed, constructed, and maintained private access roads are a significant source of sediment. Often, landowners do not realize the importance of building driveways for lasting service. Some landowners depend entirely on their contractor to design the road. Others try to design it themselves without consulting a reputable source. The consequences of not paying attention to an access road as it is designed and constructed can be serious. In addition to losing the road and potentially losing land and property, the washed-out road can damage water quality. Table 6.7 offers suggestions for addressing these issues.

Most of the responsibility for an access road rests on the landowner. However, local governments, citizens, and state/federal agencies can also make their contribution to solving this problem.

References/Resources:

- *Guidelines for Drainage Studies,* NCDOT Hydraulic Design Unit (1995). To obtain, call NCDOT at (919)250-4128.
- *The Layman's Guide to Private Access Road Construction in the Southern Appalachian Mountains,* USDA-SCS, USDA-Forest Service, Tennessee Valley Authority, July 1985. Copies are available from DFR at 919-733-2162, ext. 255.
- You may also call the NC Division of Land Resources at (919)733-3833 to obtain a contact name and number for the regional office in your area.

E. State Road Construction

Like any impervious surface, roadway systems have the potential to generate stormwater runoff problems. Various types of pollutants from the road surface can be carried to surface waters by rainfall. In addition, roadway construction, roadside vegetation management and roadway operation and maintenance activities can contribute to stormwater pollution problems.

The Division of Water Quality is currently working with the NC Department of Transportation (DOT) to finalize a stormwater management permit for DOT activities. This permit will address pollution from stormwater runoff related to roadways, road construction, vegetation management, operation and maintenance and other related DOT activities throughout the state. The major permit

Table 6.7 Recommended Actions to Prevent Problems Associated with Private Access Roads

Homeowners	Know the state and local laws, ordinances and regulations about access road construction. Be prepared to pay the cost of constructing a good road that will last. The cost of constructing a road will vary greatly from site to site. The cost may increase due to steep or rocky land, low stability soils, or drainage needs. In the long run, it does not pay to skimp. Avoid steep grades. Sustained grades should not exceed 10% for gravel or crushed stone roads. Make sure the road has adequate drainage. Adequate drainage is necessary to control erosion. The following water sources must be considered: rainfall on the roadbed and cut/fill slopes, overland storm flows from the watershed above the road, and springs or streams intercepted by the road. Use drainage methods that protect water quality. These methods include capture areas to treat runoff and routing runoff parallel to streams. Avoid grading access road drainage ditches directly to streams. Inspect the road periodically. Check for ruts and dips in the road, the condition of the drainage outlets, and the general condition of the cut and fill slopes. Repair any problems immediately. Any problems with ruts, drainage outlets, bare areas, etc. should be repaired before a small problem turns into a large problem.
Contractors	Watch for signs of subsurface drainage problems before, during, and after construction. Some things to look for include: soils that are gray in color, areas with springs or seeps, low areas, and areas dominated by water-tolerant plants such as alders, black walnut, poplar, cattails, reeds, etc. Road and ground cover should be applied as soon as possible after construction.
Citizens	Report any serious problems with access roads. Some problems to look for include big ruts in the roadway, wash-outs, and clogged drainage outlets. You can report problems to your local government officials. If they are not able to help, contact the regional office of the NC Division of Land Resources.
Local Governments	Require properly designed and constructed roads as part of the building permit process. Institute ordinances requiring proper maintenance of private access roads.
State and Local Agencies	Provide citizens with information about how to properly construct private access roads. Investigate innovative new ways of constructing private access roads while protecting water quality.

requirements are the implementation of a comprehensive stormwater management program, monitoring programs to direct the stormwater program and annual reports to outline the effectiveness and direction of the program.

The initial emphasis of the stormwater programs will be on high volume roadway segments in sensitive water areas such as coastal areas and water supply watersheds. The stormwater management programs will try to locate and characterize pollutant problems and to develop and implement appropriate best management practices to protect surface waters.

The NCDOT has been delegated the authority to approve their own sedimentation and erosion control program. However, inspections are still conducted by the Land Quality Section of the NC Division of Land Resources. The Sediment Control Commission (SCC) and Land Quality Section still have enforcement authority over DOT projects. DOT has a number of projects with effective sedimentation and erosion control. Table 6.8 presents recommended road construction measures.

Table 6.8 Recommended Sediment Control Measures for State Road Construction

NC Dept. of Transportation	Know the state and local laws, ordinances and regulations about construction. Implement high quality sediment and erosion control. This is extremely important in areas with steep slopes. Increase training for DOT staff to ensure that sedimentation and erosion control devices are properly sized and installed. It is also important to include specific instructions for sediment and erosion control and phasing on the plans so that contractors can understand their responsibility. Inspect sedimentation and erosion control devices frequently. This is particularly important when contractors are responsible for the work.. Implement pre-, during, and post-construction water quality monitoring at selected sites. This is the only way to tell for sure if sediment and erosion controls are working effectively. Reduce the threshold of exposed area when roads are constructed on steep slopes.
Citizens and Local Governments	Contact the district DOT office if you observe sediment problems at a road construction site. Some things to watch out for include: bare soil that is not mulched and/or planted within 30 days, washed-out sediment basins and filter cloths, and soil disposal sites that are placed in or directly adjacent to creeks.

6.5.3 Management Strategies for Controlling Nonpoint Source Pollution from Agriculture

Agricultural nonpoint source (NPS) pollution is reported as the leading probable source of water quality impacts to surveyed rivers and lakes, and the third largest probable source of impairment in surveyed estuaries. It is also a major contributor to ground water contamination and wetlands degradation. Agricultural activities that may cause NPS pollution include confined animal facilities, grazing, plowing, stream access, pesticide spraying, irrigation, fertilizing, planting and harvesting. The major agricultural NPS pollutants that result from these activities are sediment, nutrients, pathogens, pesticide, and salts. Agricultural activities also can damage habitat and stream channels. Agricultural impacts on surface and groundwater can be minimized by properly managing activities that can cause NPS pollution. Table 6.9 is a list of recommendations for state and federal agencies, and farmers.

Streambank Fencing and Alternative Livestock Water Supply

Streambanks trampled by livestock can be a significant source of sediment. Streambank fencing and livestock watering facilities outside the riparian zone can help maintain the vegetation necessary for stabilizing streambanks and preventing erosion. The water quality benefits of streambank fencing have been well documented. Fencing and exclusion can create vegetative buffer strips along streams that trap sediment and reduce pesticide and nutrient runoff before they enter the stream. Streambank fencing also provides food, cover, and nesting sites for upland and aquatic wildlife. Allowing natural vegetation to re-establish can not only provide better habitat within the stream but also create a corridor for wildlife movement and a connection with other habitat.

Livestock exclusion may also improve water quality by preventing manure deposition in the stream. Cows with stream access can significantly increase fecal coliform bacteria levels for several stream miles. For example, according to Penn State University, one cow produces approximately 5.4 billion fecal coliform bacteria per day.

Table 6.9 Recommended Actions to Address NPS Pollution from Agriculture

State and Federal Agencies	Target funds to control agricultural NPS pollution. State and federal agencies should work with the Nonpoint Source Team to target funds toward the areas where they are most needed and would be most effective. Promote agricultural best management practices (BMPs). State and federal agencies should increase programs which provide cost-share, technical assistance, and economic incentives to implement agricultural BMPs. Generate more "on-the-ground" water quality improvement demonstration projects. These projects will help to generate enthusiasm for more cooperative effects between farmers and various agencies. Create education programs. These programs increase farmers' awareness of water quality impact of agricultural NPS pollution. The programs also provide farmers a set of tool to control agricultural NPS pollution. Topics can include environmentally sound BMPs for agriculture and field days for local and regional interests.
Farmers	Participate in the NPS team process. The NPS team process will provide a good opportunity to influence state policy in basinwide planning. The NPS team will describe current water quality initiatives, identify priority NPS-impaired waterbodies and implement solutions addressing these waterbodies. Participate in North Carolina Agricultural Cost Share program. The North Agricultural Cost Share program provides technical assistance and cost sharing to landowners in implementing BMPs. Practice a number of cost effective agricultural BMPs.

Exclusion from the riparian area may also improve the health of livestock. Bacteria and other disease-causing organisms entering the stream can transmit diseases between and within livestock herds. Streambank fencing reduces contact with disease-causing organisms that thrive in these environments. For example, environmental mastitis can be caused by coliform bacteria which enter teats as cows wade in streams. The first recommendation in any mastitis prevention program is to provide a clean, dry environment for the cows. Streambank fencing also reduces the risk of foot and leg injuries and can be part of an effective lameness prevention program.

Waste from Animal Operations

DWQ is currently pursuing a number of efforts to improve the management of waste generated from animal production operations. These efforts are both new and ongoing and will work toward the goal of eliminating the contribution of animal waste into North Carolina's surface waters. They include the implementation and enforcement of animal waste regulations and the training and certification of operators of animal waste systems. DWQ will continue to implement these efforts, some of which were precipitated by a number of lagoon failures in coastal basins in 1995.

References/Resources:

Management Planning/Developing Unit of the Division of Water Quality at (919)733-5083

6.5.4 Management Strategies For Industrial, Municipal and Urban Stormwater Control

Recommendations for Controlling Industrial Stormwater

Various types of industrial activities with point source discharges of stormwater are required to obtain a permit under the NPDES stormwater program. These include facilities engaged in activities such as construction, mining, vehicle maintenance, automobile wrecking and scrap recycling, ship and boat building, wastewater treatment, landfills, and the manufacture of timber products, ready mixed concrete, asphalt, metal products and equipment, textiles, furniture, food and kindred products, paints, and stone, clay, glass, and concrete products.

Surface waters can be significantly impacted by stormwater runoff from industrial facilities, particularly those that store or transfer materials out of doors. The types of chemicals, industrial operations and various ancillary sources influence the pollution potential of each individual facility. As such, industrial facilities can reduce stormwater impacts by developing a comprehensive site-specific Stormwater Pollution Prevention Plan (SPPP or Plan) which is based on an accurate understanding of the pollution potential of the site. The Plan provides a flexible basis for developing site-specific measures to minimize and control the amounts of pollutants in stormwater runoff by implementing best management practices (BMPs). With respect to stormwater, the ultimate BMP is the elimination of exposure of any significant materials to rainfall or runoff.

Facilities subject to NPDES stormwater permitting are required to develop and implement a SPPP. The SPPP approach focuses on two major objectives: 1) to identify sources of pollution potentially affecting the quality of stormwater discharges from the facility; and 2) to describe and ensure practices are implemented to minimize and control pollutants in stormwater discharges from the facility. The basic components of a SPPP include a site plan detailing the facility layout and locations of potential pollutant sources, a stormwater management plan describing materials management practices and feasibility of employing best management practices, a spill prevention and response plan, a preventive maintenance and housekeeping plan, annual employee training and semi-annual facility inspections. The facility SPPP must be periodically reviewed and updated to reflect changes at the facility.

In addition to the SPPP, all permitted facilities are required to perform qualitative monitoring. This monitoring requires the periodic inspection of each stormwater outfall. Inspections are performed for parameters including color, odor, clarity, floating and suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution. Facilities with significant stormwater pollution potential are also required to perform water quality sampling on-site.

Recommendations for Controlling Municipal Stormwater

Medium and large municipalities are required to obtain a permit under the NPDES stormwater program. Federal regulations define medium municipalities as an incorporated area or county with a population greater than 100,000 but less than 250,000. Large municipalities are defined as an incorporated area or county with a population greater than 250,000.

The municipal NPDES stormwater permitting program (also known as the MS4 program) requires each subject municipality to implement a comprehensive stormwater management program which includes securing legal authority to control stormwater discharges to the municipal storm sewer system, identifying stormwater pollutant sources, performing monitoring to generate characterization data, estimating pollutant loading and pollutant reductions, and providing a fiscal analysis demonstrating that adequate funding is available to implement the proposed stormwater management program. There are currently two municipalities within the basin that are covered under NPDES stormwater permits: Charlotte and Winston-Salem.

Recommendations for Urban Stormwater Control

Urban stormwater runoff can be a significant contributor to water quality problems. As land is converted to impervious surfaces with construction of housing developments and commercial areas, careful attention to stormwater control will be more important. Stormwater problems are likely to be centered around the urban areas in the basin. There are no municipalities in the Yadkin-Pee Dee River Basin required to obtain permits to manage stormwater runoff within their jurisdiction.

The best time to address urban stormwater impacts are when it is most effective and least costly to do so -- before development occurs. Numerous studies have demonstrated a serious decline in the health of receiving waters when 10 to 15 percent of a watershed is turned into impervious surfaces (Schueler 1995).

The entire community plays a role in controlling the quality and quantity of urban stormwater. Table 6.10 is a list of recommendations for local governments, citizens, businesses, developers, and state agencies. Table 6.11 presents a list of suggestions for keeping a green lawn while minimizing impacts to the environment. Table 6.12 presents possible substitutions for household hazardous substances.

<u>References/Resources for Urban Stormwater</u>:

- *Stormwater Management Guidance Manual*, 1993, Cooperative Extension Service
- *Stormwater Management in North Carolina: A Guide for Local Officials*, 1994, Land-of-Sky Regional Council, Asheville, NC (Eaker 1994)
- Stormwater Fact Sheets by Land-of-Sky Regional Council, 1994
  1. *Stormwater Problems and Impacts: Why all the Fuss?*
  2. *Stormwater Control Principles and Practices*
  3. *Stormwater Management Roles and Regulations*
  4. *Local Stormwater Program Elements and Funding Alternatives*
  5. *Municipal Pollution Prevention*
  6. *Managing Stormwater in Small Communities: How to Get Started*
  7. *Maintaining Wet Detention Ponds*
  8. *Plan Early for Stormwater in Your New Development*
  9. *How Citizens Can Help Control Stormwater Pollution*
- *Stormwater Best Management Practices*, 1995, NC Division of Environmental Management.
- Stormwater and General Permits Unit of DWQ: (919)733-5083.

Table 6.10 Recommendations for Urban Stormwater Control

Local governments	Create public education programs. These programs advise citizens on how to care for their homes, businesses, and neighborhoods while minimizing stormwater pollution. Topics to cover can include environmentally sensitive methods of caring for lawns and vehicles (see Table 6.12). Support stream clean-up programs. Clean-up programs such as Big Sweep remove harmful debris from streams and instill a sense of pride that will protect the waterbody in the long-term. Create and enforce strict penalties for improper waste disposal. In addition, local governments should protect dumpsters by fencing around them and cleaning them regularly. Institute land use planning to protect water quality. Through planning, local governments can reduce flooding by limiting the total area of impervious surfaces and directing runoff into vegetated areas or stormwater control devices. Also, planning can be used to protect surface waters by directing growth away from sensitive areas/waters such as floodplains, steep slopes, wetlands, and water supplies. Review local ordinances pertaining to parking and curb and gutter. Local ordinances often require larger parking lots than are needed. Parking lots should be designed to handle the average parking needs with overflow areas in grass. When possible, it is best to eliminate curbs and gutters to allow runoff to flow off the street or parking lot in sheet flow. Protect open spaces and streamside buffers in and around urban areas. This will preserve recreational areas and significant natural resources near the town or city. Attend stormwater workshops for local government officials. Many agencies like DWQ offer work-shops on stormwater management or reference materials. For more information, contact the DWQ Stormwater and General Permits Unit at (919)733-5083. Map the storm sewer system. If local governments map inlets, pipes, and outlets that make up their storm drain system, they will be well equipped to identify sources of observed stormwater problems. Offer hazardous waste collection days.
Citizens	Participate in stream clean-up programs. Clean-up programs remove harmful debris from streams and instill a sense of pride that will protect the waterbody in the long-term. An annual Big Sweep event is held each year in September. Stream clean-up is a great service activity for groups such as Scouts, 4-H, Rotary Clubs, etc. Practice environmentally-friendly lawn care. Table 6.12 has a list of suggestions for keeping a green lawn while minimizing harm to the environment. When possible, use less-harmful substances in the home for cleaning or painting. Any time hazardous substances are used, there is a risk that they can enter the water by interfering with the proper functioning of septic tanks, leaking out of sanitary sewers, etc. When possible, use less hazardous substances such as latex instead of oil paint (see Table 6.13). Educate adults and children about how to protect water quality. Educational materials can be obtained from the NC Office of Environmental Education, (919)733-0711. Utilize hazardous waste collection centers for paints, petroleum products, and other chemicals. Never dispose of oil, yard wastes, or other materials in storm drain inlets or dump these materials on lands. Storm drains connect directly to nearby streams without any treatment of the water. Maintain and protect riparian buffers on private property. Buffers provide a critical right of way for streams during storms. When buffers contain the 100-year floodplain, they are an extremely cost-effective form of flood insurance. Buffers remove a wide array of pollutants, including sediment, nutrients, and toxic substances. They can also increase property value. Support your local government's land use planning initiatives.

Table 6.10 Recommendations for Urban Stormwater Control (Cont'd)

Developers	Incorporate stormwater management in the planning of projects. Plan developments to reduce impervious areas (roads, driveways, and roofs). Do not build in environmentally sensitive areas such as floodplains and wetlands. (This is also a flood insurance policy.) Maintain natural drainage ways and buffers along streams.
Businesses	Maintain and protect riparian buffers on commercial property. Buffers provide a critical right of way for streams during storms. When buffers contain the 100-year floodplain, they are an extremely cost-effective form of flood insurance. Buffers remove sediment, nutrients, and toxic substances. Cover and contain waste materials. This will prevent runoff from the disposal area from becoming contaminated and polluting the receiving water. Practice good housekeeping. A clean and litter-free facility will promote good water quality. Institute hazardous waste collection sites. Automobile service centers, hardware stores, and other pertinent businesses can institute hazardous waste collection sites for used oil, antifreeze, paint, and solvents.
State and Federal Agencies	Provide technical information about urban stormwater. State and federal agencies should strive to increase their communication with local governments, businesses, and citizens. Create and maintain stormwater wetlands along streams. Like buffers, stormwater wetlands treat stormwater and reduce flows. Stormwater wetlands must be designed and maintained properly to be effective.

Table 6.11 How to Take Care of Your Lawn and Car and Protect Water Quality

If you are caring for...	This is the environmentally-friendly practice.
your lawn	• Use only fertilizers that are needed, based on soil tests and plant needs. • Keep fertilizers off driveways and sidewalks. • Avoid using fertilizers within 75 feet of any waterbody. • If you use a lawn service, request natural rather than chemical management. • Plant hardy, native species that do not require chemical inputs. • Contact your Cooperative Extension Agent for more information.
your vehicle	• Maintain motor vehicles and repair leaks promptly. • Dispose of used motor oil and antifreeze in recycling centers. • Avoid gas tank overflows during refueling.

from S.C. Dept. of Health and Environmental Control, "Turning the Tide" (1995)

Table 6.12 Substitutions for Household Hazardous Substances

Instead of...	Try...
• Ammonia-based Cleaners	• Vinegar + Salt + Water
• Abrasive Cleaners	• Lemon Dipped in Borax or Salt + Baking Soda
• Furniture Polish	• Lemon Juice + Olive Oil
• Toilet Cleaner	• Baking Soda + Toilet Brush
• Oven Cleaner	• Liquid Soap + Borax + Warm Water
• Drain Cleaners	• Boiling Water + Baking Soda + Vinegar
• Upholstery Cleaners	• Dry Cornstarch
• Mothballs	• Cedar Chips or Lavender Flowers
• Window Cleaner	• White Vinegar + Water
• Oil-Based Paints and Stains	• Water-based Paints and Stains

from S.C. Dept. of Health and Environmental Control, "Turning the Tide" (1995)

6.5.5 Management Strategies for Controlling Fecal Coliform Bacteria

Water polluted by human or animal waste can harbor numerous pathogens which may threaten human health. Since routine tests for individual pathogens are not practical, fecal coliform bacteria are widely used as an indicator of the potential presence of disease-causing microorganisms. Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and their number is generally assumed to be correlated with the number of pathogens in a water sample. They enter surface waters from a number of sources including failing on-site wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, improperly designed or managed animal waste facilities, and wild animals. Fecal coliform bacteria can be present in large numbers in runoff from developed areas and from areas frequented by livestock, and can also enter waterbodies directly from livestock with access to streams. Under favorable conditions, these bacteria can survive in bottom sediments for an extended period (Howell et al, 1996; Sherer et al, 1992; Schillinger and Gannon, 1985). Bacterial levels measured in the water column can thus reflect both recent inputs as well as the resuspension of organisms previously reaching the stream.

Elevated fecal coliform bacteria levels (in excess of the geometric mean of 200 colonies/100 ml standard) are widespread in the Yadkin basin, occurring at 18 ambient stations (see Table 6.13). On average, 75% of the samples at these sites exceeded 200 colonies/100 ml. Many of these sites lie in the upper basin: 10 of the 19 stations above High Rock Lake had a geometric mean exceeding 200 colonies/100 ml. Exceedences occurred at all 5 ambient stations in the South Yadkin drainage (SB06), which had geometric means ranging from 537 to over 1200 colonies/100ml. None of the 18 stream segments experiencing violations of the fecal coliform standard are classified for primary recreation (Class B).

The widespread nature of these high levels indicates that the problem is primarily of nonpoint source origin. Exceedences occur in areas with no significant upstream dischargers, and most facilities are in compliance with permit limits. While even facilities in compliance may have occasional events resulting in very high fecal levels in effluent, these are generally too infrequent to result in the consistently high fecal coliform levels observed at many locations. DWQ regional offices, in conjunction with nonpoint source agencies and local governments, should investigate the source of contamination. Fecal coliform problems in specific subbasins are discussed in Sections 6.3.4.

Table 6.13 Ambient Stations With Fecal Coliform Levels with Geometric Mean Exceeding 200 colonies/100 ml.

Station	Subbasin	Geometric Mean (#/100 ml)
Yadkin River at SR 2327 at Roaring River	03-07-01	346
Ararat River at SR 2019 at Ararat	03-07-03	300
Salem Ck. at Elledge WWTP, Winston Salem	03-07-04	1004
Muddy Ck. at SR 2995 near Muddy Creek	03-07-04	693
Grants Ck. at Spencer	03-07-04	609
South Yadkin R. at SR 1159 near Mocksville	03-07-06	620
Hunting Ck. at SR 2115 near Harmony	03-07-06	537
Third Ck. at SR 1970 near Woodleaf	03-07-06	820
Fourth Ck. at SR 2308 near Elmwood	03-07-06	1207
Second Ck. at US HWY 70 near Barber	03-07-06	680
Rich Fork at SR 1800 near Thomasville	03-07-07	227
Hamby Ck. at SR 2790 near Holly Grove	03-07-07	580
Abbotts Ck. at SR 1243 at Lexington	03-07-07	659
Rocky River at SR 2420 near Davidson	03-07-11	790
Irish Buffalo Ck. at SR 1132 near Faggarts	03-07-12	392
Rocky River at US HWY 601 near Concord	03-07-12	369
Goose Ck. at SR 1524 near Mint Hill	03-07-12	617
Hitchcock Ck. at SR 1109 at Cordova	03-07-16	379

Several general management strategies for addressing fecal coliform contamination include:

- Proper maintenance and pumping of the septic tank every three to five years.
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Elimination of piped unpermitted discharges of home waste (also known as "straight piping").
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments to routinely monitor waters known to be used for body contact recreation (e.g., swimming and tubing).

Septic tanks are used widely throughout this basin, particularly since many citizens live outside of the service area of a regional wastewater treatment plant. Unfortunately, many citizens are not aware of how to care for their septic tanks. Some of the actions that homeowners, local governments, and state and federal agencies can take to reduce pollution from septic tanks are listed in Table 6.14.

Table 6.14 Recommended Actions for Proper Maintenance of Septic Tanks

Homeowners	Do not put harmful substances in your septic tank. These substances include: cooking grease, oils, fats, pesticides, paints, solvents, disinfectants, and other household chemicals. These substances can kill the microorganisms that help purify the groundwater and can themselves pollute groundwater. Know the location of your system and keep heavy vehicles and plant roots away from drain field pipes. These things can compact soils and inhibit the proper functioning of the system. Conserve water and stagger intensive uses. Some intensive water uses include showers, laundry, dishwasher, etc. Look for ways to reduce (e.g.., full loads) and to not use all at once. Have your septic tank pumped out every three to five years. This is a small price to pay to ensure that your household has functioning wastewater treatment. Look for "greener grass over the septic tank." This could be a sign that the septic tank is failing. Divert overland runoff from your property away from the drainfield area. This will reduce the likelihood of saturating the soil and causing malfunctions.
County Health Departments	Require regular inspections of septic systems. Enforce severe penalties for uncorrected septic system malfunctions. Ensure that citizens understand how to maintain their septic tank when they first obtain property in the county.
NC Div. of Environmental Health	Provide leadership to county health offices. Encourage county health offices to require regular inspections. Provide public education materials.

References/Resources: Please contact the local county heath department for more specific advice.

6.5.6 Management Strategies For Controlling Toxic Substances

Toxic substances routinely regulated by DWQ include metals, organic compounds, chlorine and ammonia. Toxicants are described in Chapter 3, Section 3.2.4. Whole Effluent Toxicity (WET) testing is required on a quarterly basis for all major dischargers (≥ 1 MGD) and any discharger releasing complex (industrial) wastewater. There are 70 such facilities in the Yadkin basin. The WET test indicates whether the effluent from a treatment plant is toxic, but it does not identify the specific cause of toxicity. If the effluent is found to be toxic, further testing is done to determine the specific cause. This follow-up testing is called a toxicity reduction evaluation (TRE). WET testing is discussed further in Chapter 4, Section 4.2.4.

Assimilative Capacity

The assimilative capacity (that is, the amount of a substance a waterbody can assimilate under designated flow conditions) available for toxicants in the Yadkin River basin varies from one waterbody to another. The 7Q10 is used as the flow condition for aquatic life based standards, while average flow is used for carcinogens. In larger streams, where more dilution flow exists, there is more assimilative capacity for toxics. Toxics from nonpoint sources typically enter a waterbody during storm events. All waters must be protected from both immediate acute impacts and longer term chronic effects.

Control Strategies

Effluent limits for specific toxicants are based on the volume of the discharge and the 7Q10 flow condition of the receiving waters. Limits and monitoring requirements for point source dischargers will be determined using the techniques discussed Appendix VII. These methods utilize an EPA recommended approach which considers the maximum predicted effluent concentration and the amount of variation in effluent monitoring data. Whole effluent toxicity limits are assigned to all major dischargers and to any discharger of complex wastewater.

Nonpoint source strategies being implemented through the industrial NPDES stormwater program should also be helpful in reducing toxic substance loading to surface waters. Agricultural BMPs implemented to reduce nutrient and sediment loading from cropland are likely to result in lower pesticide inputs.

Specific facilities and waterbodies for which toxicity is a problem are discussed in Section 6.3 under the appropriate subbasin.

6.5.7 Management Strategies For Oxygen-Consuming Wastes

Maintenance of dissolved oxygen (DO) is critical to the survival of aquatic life and to the general health of North Carolina's surface waters. The daily average dissolved oxygen standard for most waters in the state, except for waters classified as trout and swamp waters, is 5.0 mg/l. Trout waters, which are prevalent in the Yadkin River headwaters, have a daily average DO standard of 6.0 mg/l. There are no classified swampwaters in the Yadkin-Pee Dee basin.

Dissolved oxygen problems exist in numerous waters in the Yadkin basin. Management strategies to address oxygen-consuming waste issues are summarized in Table 6.15 and discussed in greater detail in specific subbasin presentations in Section 6.3. Management areas for oxygen-consuming wastes are presented in Figure 6.1 and Figure 6.2.

Biochemical oxygen demand (BOD) and ammonia nitrogen (NH_3-N) associated with wastewater treatment plants are generally the types of oxygen-consuming wastes of greatest concern. During summertime conditions, when water temperature is high and streamflow is low, point source BOD and NH_3-N have the greatest impact on instream dissolved oxygen concentrations. Nonpoint source inputs, which typically occur as a result of rainfall events, have only a minor impact under these conditions. NPDES permits for wastewater discharges generally limit BOD_5 (or $CBOD_5$) and NH_3-N in order to control the effects of oxygen depletion in receiving waters. Where residual BOD is significant, management of nonpoint sources to reduce loading is recommended through implementation of best management practices. Additionally, constructed wetlands can remove between 50% and 90% of the BOD_5 from primary effluent (Bastian and Benforado (1988).

BOD/DO models are used by DWQ to determine oxygen-consuming waste limits in NPDES permits. The choice of model, North Carolina's desktop empirical model (Level B) or the field-calibrated QUAL2E model, is determined by the amount of data available for a given stream reach (see Appendix VII). Modeling is not conducted in some cases--such as for discharges to swamp-like systems, zero flow streams and HQW stream segments--where NPDES permit limitations are determined by special procedures or regulations.

Table 6.15 Recommended TMDLs and Management Strategies for Addressing Oxygen-Consuming Wastes with Reference to Subbasin Summaries.

Map Reference #	Subbasin	Receiving Stream	Management Strategy	Chp. 6 Sect.
1	030704	Grants Creek	If DO violations continue after Salisbury has relocated, other sources of pollution will need to be identified.	6.3.4-E
2	030704	Salem Creek & Muddy Creek	Reevaluate QUAL2E model to determine if the wasteload allocation for the Archie Elledge Plant should be revised.	6.3.4-E
3	030705	Cedar Creek	To aid in assessing the assimilative capacity, additional water quality data should be collected before permitting new dischargers.	6.3.4-F
4	030706	Second Creek (North)	Field calibrated model should be considered for assessing the potential impact of new or expanding dischargers.	6.3.4-G
5	030707	Rich Fork	No additional loadings of oxygen-consuming wastes should be permitted.	6.3.4-H
6	030707	Abbotts Creek watershed	No new dischargers of oxygen-consuming wastes should be permitted. Thomasville and Lexington should serve as regional WWTPs for future wastewater needs.	6.3.4-H
7	030708	Mountain Cr. arm of Lake Tillery	Low dissolved oxygen levels in the Mountain Cr. arm of Lake Tillery will be evaluated. Appropriate actions will be pursued during FERC relicensing.	6.3.4-I
8	030708	Upper Lake Tillery	Low dissolved oxygen levels in the upper reaches of Lake Tillery will be evaluated. Appropriate actions will be pursued during FERC relicensing.	6.3.4-I
9	030708	Clarks Creek	Further evaluation and updated flow information should be obtained if the Mt. Gilead discharge remains, or new discharges locate to this creek.	6.3.4-I
10	030708	Yadkin River	Low dissolved oxygen levels below High Rock Lake dam will be evaluated and appropriate actions pursued during FERC relicensing.	6.3.4-I
11	030710	Pee Dee River	New or expanding discharges to the Pee Dee River below Lake Tillery should meet limits no less stringent than 15 mg/l BOD5, 4 mg/l NH3N and 5 mg/l DO. Appropriate mitigative actions will be pursued during FERC relicensing.	6.3.4-K
12	030710	Brown Creek	No new discharges should be permitted in this watershed.	6.3.4-K
13	030711	Mallard Cr & Rocky R. watershed upstrm of Mallard Cr	New or expanding discharges, if permitted, should receive limits of 5 mg/l BOD and 2 mg/l NH3N.	6.3.4-L
14	030711	Rocky River below Mallard Creek	New or expanding discharges are to receive BODu limits equal to 32 mg/l.	6.3.4-L
15	030712	Goose Creek	Field calibrated model will be developed to evaluate assimilative capacity of the creek.	6.3.4-M
16	030712	Crooked Creek	Before any new outfalls are permitted, it is recommended that additional chemical/physical data be collected to aid in assessing the assimilative capacity of the proposed receiving stream.	6.3.4-M
17	030712	South Fork Crooked Creek	No additional loads of oxygen-consuming wastes will be permitted.	6.3.4-M

Table 6.15 Recommended TMDLs and Management Strategies for Addressing Oxygen-Consuming Wastes with Reference to Subbasin Summaries (cont'd).

18	030712	North Fork Crooked Creek	No additional loads of oxygen-consuming wastes until data has been collected on the creek to determine impacts from existing facility.	6.3.4-M
19	030712	Rocky River	New or expanding dischargers to the river between the Rocky River Regional WWTP and the confluence with Muddy Creek will receive total BODu limits of approx. 32 mg/l. In addition, DWQ is planning to request USGS to develop a low flow profile for the river so that the QUAL2E model can be extended to the mouth of the river.	6.3.4-M
20	030713	Long Creek	The City of Albemarle should optimize treatment processes. More stringent BOD_5 limits will be considered.	6.3.4-N
21	030714	Richardson Creek	No new discharges of oxygen-consuming wastes should be permitted above Monroe's WWTP.	6.3.4-O
22	030716	Hitchcock Creek	No additional loads of oxygen-consuming wastes within 4 miles of mouth of creek should be permitted.	6.3.4-Q
23	030716	Marks Creek	Additional loadings of oxygen-consuming wastes are not recommended. If future expansions are to be reconsidered, it is recommended that DWQ analyze the feasibility of developing a field calibrated model in order to assess the assimilative capacity of the stream.	6.3.4-Q
24	030716	Pee Dee River	Low dissolved oxygen levels below Blewett Falls Lake dam will be evaluated and appropriate actions pursued during FERC relicensing.	6.3.4-Q
25	030717	Jones Creek and Deadfall Creek catchments	Before any new outfalls are permitted, it is recommended that additional chemical/physical data be collected to aid in assessing the assimilative capacity of the proposed receiving stream.	6.3.4-R

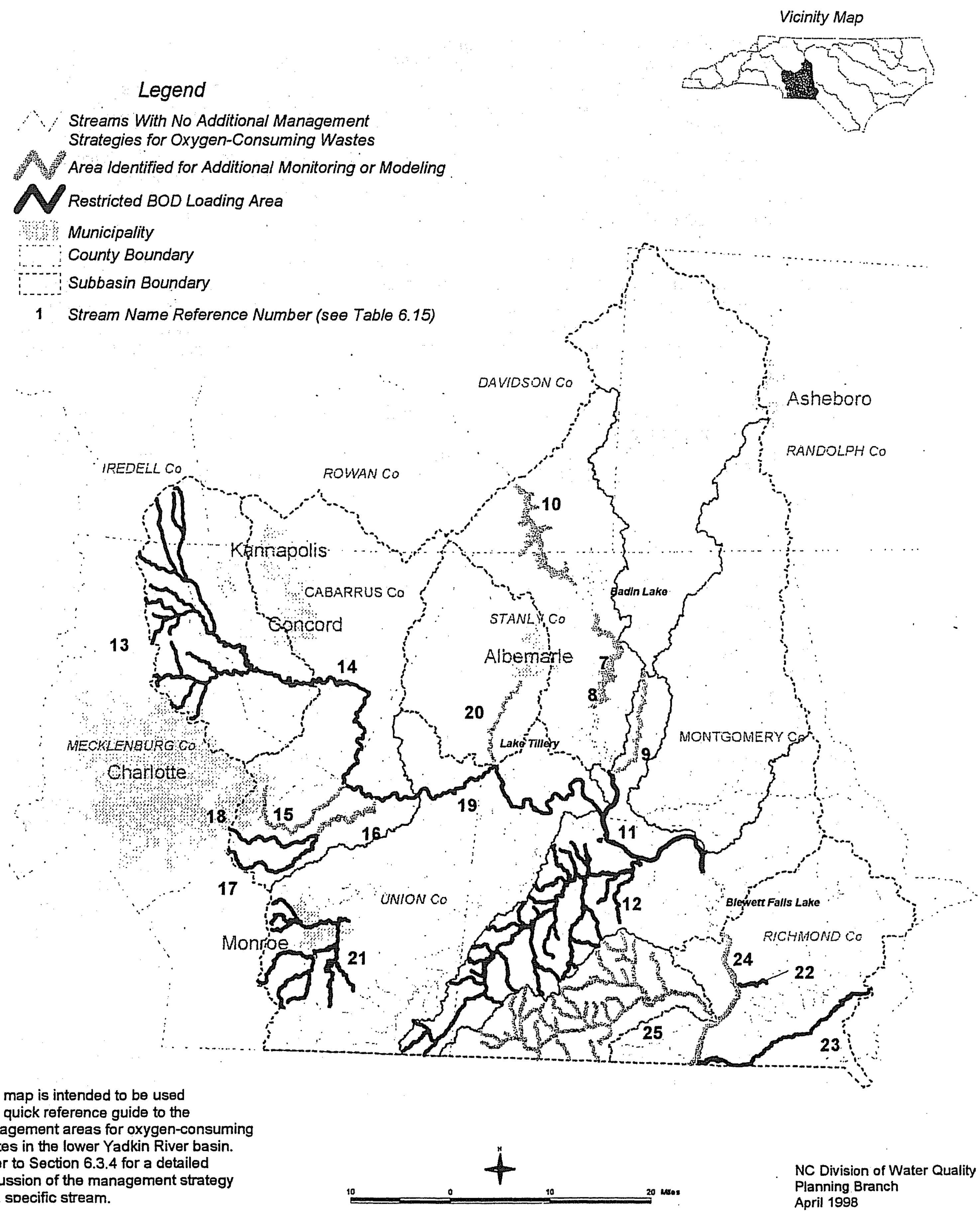
Discharges to Zero Flow Streams

Due to the preponderance of low flow streams across the state, the Division developed regulations for evaluating discharges to such waters. In 1980 a study was performed on zero flow streams (7Q10 = 0 cfs and 30Q2 = 0 cfs) to determine the effect of wastewater discharges. The study concluded that:

- steady-state models do not apply to zero flow streams, particularly those receiving waste from small discharges;
- the pool/riffle configuration of these small streams results in violations of the DO standard even when wastewater is well treated;
- small streams receiving wastes from schools, mobile home parks, subdivisions, etc. flow through populated areas where children have easy access to streams;
- noxious conditions were found in the low flow streams that were part of the study.

As a result of the study, regulations [15A NCAC 2B .0206 (d)] were developed that prohibit new or expanded discharges of oxygen-consuming wastes to zero flow streams. Existing facilities discharging to zero flow streams were evaluated for alternatives to discharge. Many facilities found alternatives to a surface water discharge, and some built new treatment plants to meet advanced tertiary limits for BOD_5 and NH_3-N. Facilities that currently discharge to a zero flow

Figure 6.2 Management Areas for Oxygen-Consuming Wastes in the Lower Yadkin River Basin



This map is intended to be used as a quick reference guide to the management areas for oxygen-consuming wastes in the lower Yadkin River basin. Refer to Section 6.3.4 for a detailed discussion of the management strategy for a specific stream.

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stream but which have not yet been evaluated will receive the following language in their NPDES permits:

> *Removal of the discharge will be required if a more environmentally sound and economically achievable alternative is available. An engineering report evaluating alternatives to discharge is due 180 days prior to permit expiration along with the permit renewal application. As part of the report, the cost of constructing a treatment facility to meet limits of 5 mg/l BOD_5, 2 mg/l NH_3-N, 6 mg/l dissolved oxygen, and 17 ug/l chlorine must also be included if there are no alternatives to a surface water discharge. Upon review of the results of the engineering report, the Division may reopen and modify this NPDES permit to require removal of the discharge, modified treatment design, and/or revised effluent limitations within a specified time schedule.*

This policy typically covers small discharges such as schools, mobile home parks, subdivisions, rest homes, etc., which discharge to zero flow stream in headwater areas. Such discharges generally do not cause significant water quality problems in the mainstem of the Yadkin-Pee Dee or larger tributaries, but they can cause localized problems in the zero flow receiving streams. Zero flow streams are common in the Yadkin basin except for the uppermost subbasins (subbasins 01-03).

The results of the 1980 study were extrapolated to facilities discharging to low flow streams (those with a 7Q10 = 0 but with a 30Q2 > 0) since similar adverse impacts are expected in these waters. Regulations [15A NCAC 2B .0206 (d)] were developed to set effluent limitations for new and expanding discharges to 5 mg/l BOD_5, 2 mg/l NH_3-N and 6 mg/l dissolved oxygen unless it is determined that these limitations will not protect water quality standards.

Low Flow Slate Belt Streams

Low flow streams are prevalent throughout the Yadkin River Basin. In 1993 the United States Geological Survey (USGS) developed a report entitled "Low Flow Characteristics of Streams in North Carolina". In this report the USGS identified ten low flow hydrologic areas by relating topography, geology, mean annual runoff, drainage area and other features to low flow frequency characteristics for numerous gaging stations across the State. Several types of hydrologic areas are located in the Yadkin River Basin including the Western Piedmont and mountains; the Charlotte and Milton Belt; the Carolina Slate Belt; the Triassic Basin and the Sand Hills.

The Carolina Slate Belt Hydrologic Area (HA) is found in parts of Union, Stanly, Davidson, Randolph and Anson Counties. In this HA many stream reaches are subject to low flows (7Q10=0 cfs), despite relatively large drainage areas, and are very slow moving with low velocities. Instream data collected above discharges in these areas typically show relatively low dissolved oxygen levels, at times below the state standard of 5.0 mg/l. Facilities wishing to expand or locate to these areas in the basin need to be aware of the need for further study by the proposed permittee before discharge will be allowed. These counties (especially Union County), have seen a great increase in growth and development, and careful and well-organized planning should be considered for a new discharge locating to this area. A Union County Sewer System Master Plan has been developed for Union County. The Master Plan is intended to guide the county in its efforts to create a regionalized wastewater approach to better accommodate rapid growth.

6.5.8 Management Strategies for Controlling Color

North Carolina regulations specify that colored wastes may be discharged only in such amounts "as will not render the receiving waters injurious to public health, secondary recreation, or to aquatic life and the wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses" [NCAC 15A 2B .0211 (3)(f)]. Colored discharges are generally not toxic. Potential toxicity is managed by the regulation of specific chemical constituents and by WET testing (see Chapter 4, Section 4.2.4). The primary issue in the regulation of color is the aesthetic quality of receiving waters and the implication of this aesthetic quality for the designated uses of those waters.

The practical application of the above regulation must take into account the various ways in which color manifests itself in the environment. Color in natural waters is rarely the result of one specific chemical. Rather, a mixture of many dissolved and suspended constituents contributes to color. The stream bed and sediments may also contribute to color. Because color is perceived differently by different people and in different light conditions, no general definition of color impairment can be specified by a simple set of criteria and enforcement of the current narrative color standard can be very subjective.

In the Yadkin Pee-Dee basin discharges with a high degree of color come primarily from certain industrial facilities and from municipal dischargers receiving highly colored industrial effluent. While colored effluent can be discharged by a number of industries, textile firms constitute the most significant source of color in the Yadkin basin.

Division staff have researched the implementation of a numeric standard, or a set of numeric water quality standards. DWQ would prefer, however, that dischargers remove color on their own initiative. If such efforts are not successful, DWQ may proceed with the development of a numeric color standard.

In order to address the problem of discolored waterbodies and to assist facilities that are attempting to reduce color in their effluent, DWQ is developing a statewide voluntary program in cooperation with the Division of Pollution Prevention and Environmental Assistance (DPPEA). The program will focus on reducing the discharge of colored wastewater from textile manufacturing and related industries, with a goal of reducing instream color to the point where color-related complaints for surface waters are nonexistent. The program will be based on building a cooperative network between facilities with highly colored effluent and a "mentor" group. The mentors will include color removal experts, textile industry associations, facilities that are already implementing color removal, and DENR staff members. Although color in itself is not a toxicant, dischargers removing color from their effluent may receive the added benefit of reducing salts, BOD and metals. DWQ and DPPEA staff are currently involved in data collection and the evaluation of various color removal proposals. Statewide workshops and conferences will be held to publicize the effort and obtain feedback on the design of the program.

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CHAPTER 7

FUTURE INITIATIVES

7.1 OVERVIEW OF YADKIN-PEE DEE RIVER BASINWIDE GOALS AND OBJECTIVES

Near-term objectives, or those achievable at least in part during the next five years, include coordinating with various agencies to implement the management strategies outlined in Chapter 6. These strategies are aimed at reducing point and nonpoint source loadings of sediment, nutrients and other pollutants. These steps are necessary to progress towards restoring impaired waters, protecting all waters from further degradation and protecting high resource value and biologically sensitive waters.

The long-term goal of basinwide management is to protect the water quality standards and uses of the surface waters while accommodating reasonable economic growth. Attainment of these goals and objectives will require determined, widespread public support; the combined cooperation of state, local and federal agencies, agriculture, forestry, industry and development interests and considerable financial expenditure on the part of all involved. With the needed support and cooperation, DWQ believes that these goals are attainable through the basinwide water quality management approach.

7.2 FUTURE ACTIVITIES IN THE YADKIN-PEE DEE RIVER BASIN

Improving the knowledge of nonpoint source pollution, and developing strategies to reduce its impact to water quality, will be a high priority for DWQ over the next five years. Nonpoint source pollution is primarily responsible for the impaired and threatened waters in the Yadkin-Pee Dee River Basin. The following initiatives (described in Section 7.2.2, 7.2.3 and 7.2.4) are underway to address the protection and restoration of surface waters from nonpoint sources of pollution.

7.2.1 The Yadkin-Pee Dee River Basin Nonpoint Source (NPS) Teams

DWQ has begun establishing Nonpoint Source Teams in each of the state's 17 major river basins (See Appendix IV). The team members voluntarily participate on the NPS Team within their existing resource constraints. Only limited progress can be expected in restoring impaired waters through the team without additional resources. The goals of the teams are to use local knowledge, expertise, and support to develop and implement management strategies that restore and protect priority NPS waterbodies in the basin in a targeted, coordinated, and ongoing manner. Key elements of these goals are the participation of local stakeholders, prioritization of NPS-affected waters and developing coordination among various agencies to more effectively manage problem nonpoint sources.

The teams provide descriptions of current NPS management activities within a basin, conduct assessments of NPS controls in targeted watersheds, prioritize impaired waters for development and implementation (including funding) of restoration strategies and NPS issues for remedial action.

A portion of the annual Section 319 grant from EPA has been set aside for the teams that have a completed basin plan. The Teams must submit an acceptable proposal to the State 319 Workgroup to obtain the funding. This funding has enabled teams to develop management activities on priority issues and watersheds.

Two NPS teams have been initiated in the Yadkin basin, the "Upper" Team covering subbasins 03-07-01 through 07, and the "Lower" Team covering subbasins 03-07-08 through 17 (See Chapter 6, Section 6.2.3). To date, both teams have provided information on existing NPS programs and initiatives in the basin (Chapter 5, Section 5.6), both have identified priority NPS issues, and both have selected a top priority NPS-impaired water on which to focus initial restoration efforts. The Upper Team has selected Sharp's Branch, a tributary to Fourth Creek in the Statesville area, for restoration. The Lower Team has chosen Goose Creek, a tributary to Rocky River flowing through Mecklenburg and Union Counties, for management action.

The teams use DWQ's use support ratings to establish an initial priority waters list, as well as their knowledge of local sources that may not be reflected in state data. Once watersheds of concern are identified, other criteria are used as factors to rank the waters. These factors include: high-value resources such as Outstanding Resource Waters, High Quality Waters, and important ecological resources (e.g., rare and listed species); Water Supply Watersheds; threats to human health; rate of decline of a water; certainty of source identification; and likelihood of successful restoration.

The teams will conduct more detailed assessments of these two waters early in 1998 and will develop proposals for Section 319 grant funding and funds from other sources to facilitate restoration efforts. If the teams can support development of restoration efforts in other priority watersheds in the basin during the five-year cycle, then management of more than these two impaired waters may occur during this time.

7.2.2 Improved Monitoring Coverage and Coordination with Other Agencies, Groups and Local Governments

Monitoring of the chemical and biological status of receiving waters will provide critical feedback on the success of the basin management strategy. As discussed in Chapter 4, monitoring data will be collected from: 1) ambient water chemistry, 2) sediment chemistry, 3) biological communities, 4) contaminant concentrations in fish and other biota, and 5) facility self-monitoring data and the Yadkin-Pee Dee River Basin Association data (See Chapter 5, Section 5.6.4 and Chapter 7, Section 7.3.2). The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

In addition to this, DWQ and other environmental agencies have been discussing the potential for coordination of field resources. If other agencies are sampling waterbodies to investigate fish or macroinvertebrate populations or wetland areas, there might also be the potential to share water quality data with these agencies. The coordination of these activities should help to better blend the activities of the various agencies.

7.3 PROGRAMMATIC INITIATIVES

7.3.1 Efforts to Improve NC's Sedimentation and Erosion Control Program

Recently, there has been an initiative in the Division of Land Resources to address sediment water quality problems across the state. The Sedimentation and Erosion Control Commission has recognized the need to evaluate the implementation of the existing programs. A Technical Advisory Committee was established, along with three subcommittees, to perform the evaluation and develop recommendations. The committee and subcommittees met for several months during the fall of 1997 and presented a list of recommendations to the Commission in November. The Commission supported the recommendations and instructed the staff to implement the ones which can be implemented without rule or statute changes and have established a schedule to implement the others. It is believed that the changes initiated will result in program implementation improvements and reduction in sediment losses to our streams.

7.3.2 The North Carolina Wetlands Restoration Program

The North Carolina Wetlands Restoration Program (NCWRP) was established by the General Assembly in 1996. The purpose of the NCWRP is to protect and improve water quality, flood prevention, fisheries, wildlife and plant habitats, and recreational opportunities through the protection and restoration of wetlands and riparian areas. The NCWRP will accomplish this purpose by implementing projects that will restore wetland and riparian area functions and values throughout North Carolina.

Beginning July 1, 1997, comprehensive Basinwide Restoration Plans will be developed for each river basin in conjunction with the Basinwide Water Quality Management Plans. GIS-based mapping methodologies will be used to assess the status of the existing wetlands and riparian area resources within each basin and to identify degraded wetlands and riparian areas. Potential restoration sites will be prioritized based on the ability of the restored sites to address problems that have been identified in the Basinwide Water Quality Management Plans. The restoration plans will provide the framework for the Wetlands Restoration Program, therefore it is essential that the public, local governments, state and federal agencies and others be involved in the development of these plans. Requests for information concerning the NCWRP and the Basinwide Restoration Plans should be sent to the following address: NC Wetlands Restoration Program, Division of Water Quality, P.O. Box 29535, Raleigh, NC 27626-0535.

7.3.3 NPDES Program Initiatives

In the next five years, efforts will be continued to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes discharged to municipal wastewater treatment plants so as to reduce effluent toxicity;
- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or use of alternative disinfection methods for new or expanding facilities;
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for enlargement well before they reach capacity.

Longer-term objectives will include refinement of overall management strategies after obtaining feedback on current management efforts during the next round of water quality monitoring. Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling byproducts of the treatment process (including reuse of nonpotable treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

7.3.4 Use of Discharger Self-Monitoring Data

DWQ will continue to make greater use of discharger self-monitoring data to augment the data it collects through the programs described in Chapter 4. Quality assurance, timing and consistency of data from plant to plant will be issues of importance. Also, a system will need to be developed to enter the data into a computerized database for later analysis.

In an effort to improve the quality and consistency of self-monitoring data, DWQ is working with a coalition of dischargers in the Yadkin-Pee Dee river basin to develop a strategic monitoring plan that is similar, and in compliment to, DWQ's ambient monitoring system. A memorandum of agreement to conduct this monitoring will be signed by both parties. The draft plan for this agreement currently contains 29 participating NPDES dischargers, including municipalities and industries, which will monitor, sample, analyze and report directly to the EPA STORET database system. Under the draft plan, the monitoring will provide data for 71 stations covering the entire NC portion of the Yadkin-Pee Dee River basin. Similar programs are effectively used in the lower Neuse and Cape Fear River basins. In portion of those basins, this monitoring data is already available through STORET and has been reported and used in the second round basin management plan for the Neuse River.

7.3.5 Promotion of Non-Discharge Alternatives/Regionalization

DWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including connection to an existing WWTP or land-applying wastes are preferred from an environmental standpoint. If the Division determines that there is an economically reasonable alternative to a discharge, DWQ may deny the NPDES permit.

7.3.6 Coordinating Basinwide Management With Other Programs

The basinwide planning process can be used by other programs as a means of identifying and prioritizing waterbodies in need of restoration or protection efforts and provides a means of disseminating this information to other water quality protection programs. For example, the plan can be used to identify and prioritize wastewater treatment plants in need of funding through DWQ's Construction Grants and Loan Program. The plans can also assist in identifying projects and waterbodies applicable to the goals of the Clean Water Management Trust Fund, Wetlands Restoration Program, or Section 319 grants program. Information and finalized basin plans are provided to these offices for their use and to other state and federal agencies.

7.3.7 Improved Data Management and Expanded Use of Geographic Information System (GIS) Computer Capabilities

DWQ is in the process of centralizing and improving its computer data management systems. Most of its water quality program data (including permitted dischargers, waste limits, compliance information, water quality data, stream classifications, etc.) will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Some of this information is also being submitted into the NC Geographic Data Clearinghouse (Center for Geographic Information and Analysis or CGIA). As this and other information (including land use data from satellite or air photo interpretation) is made available to the GIS system, the potential to graphically display the results of water quality data analysis will be tremendous.

Research Triangle Institute performed a pilot study in the Tar-Pamlico River Basin in which high priority waterbodies for nonpoint source control programs were mapped. These maps were used by the various nonpoint source agencies for planning purposes. As resources become available, this tool may be developed for other basins.

7.3.8 Improved Monitoring and Assessment of Erosion Impacts

Sedimentation is perceived by the workshop participants and the Yadkin-Pee Dee River basin NPS Teams as one of the highest priorities in the basin. Many streams are impacted or impaired, at least in part, due to sedimentation. Erosion is evident throughout the basin. The fact that sedimentation is visible and aesthetically unpleasant helps make it a higher profile issue. The extent of sedimentation problems can be difficult to diagnose with the monitoring methods historically used by DWQ and many other state water quality agencies. Suspended solids sampling conducted on a scheduled monthly basis is likely to miss most of the high-flow periods during which the majority of sediment is transported. Benthic monitoring techniques may not always identify the effects of sedimentation, which can impact aquatic organisms by reducing and altering available habitat.

Some of the actions that DWQ and others will take towards improving monitoring and assessment of erosion impacts are:

- DWQ currently does not have adequate means of quantifying the effects of sedimentation on water quality. DWQ recognizes the need to improve its targeting and monitoring capabilities in order to further identify sediment problems as well as to facilitate and support efforts to restore degraded areas. This points to the need for targeted management efforts coupled with a monitoring strategy which effectively measures sediment transport under both average and extreme conditions. DWQ will work toward developing interagency resources for enhancing the ability to measure and model erosion and sediment levels, to identify sediment source areas, and to recommend appropriate management practices. DWQ will initiate discussions among staff and other agencies to determine how these issues can best be addressed given current resource constraints. DWQ will also try to determine what, if any, programmatic changes can be made to gain better knowledge on sedimentation.
- Locally-based watershed improvement efforts represent an important mechanism for restoring streams and watersheds degraded by sedimentation. The Division is working with several such projects in the Yadkin-Pee Dee River basin and will continue to do so. Funding for such efforts can come from a number of sources (See Appendix IX), including the Agricultural Cost Share Program, Section 319 grants and the Clean Water Management Trust Fund. The Division's role in such projects can include assistance with problem identification and targeting, monitoring and other technical assistance.
- DWQ is currently working with the Division of Land Resources, Division of Forest Resources and Division of Soil and Water Conservation to develop a Memorandum of Agreement for Turbidity. Turbidity is an indicator of sedimentation in a waterbody. The intent of the agreement is to establish a relationship between the agencies that better defines each agency's responsibility for activities related to turbidity. The turbidity standard is not being changed under this agreement.

7.3.9 Additional Research and Monitoring Needs

DWQ staff has identified some additional research and monitoring needs that would be useful for assessing and, ultimately, protecting and restoring the water quality of the Yadkin-Pee Dee River basin. The following list is not inclusive. Rather, it is meant to stimulate ideas for obtaining more information to better address water quality problems in the basin. With the newly available funding programs (Clean Water Management Trust Fund and Wetlands Restoration Program) and the existing Section 319 grant program, it may be desirable for grant applicants to focus proposals on the following issues:

- <u>More resources are needed to address nonpoint sources of pollution.</u> Identifying nonpoint sources of pollution and developing management strategies for impaired waterbodies, given the current limited resources available, is an overwhelming task. Therefore, only limited progress towards restoring NPS impaired waterbodies can be expected unless substantial resources are put towards solving NPS problems.
- <u>Long-range water supply planning for the upper portion of the basin is needed.</u> The proposed water withdrawal by the City of Winston-Salem has the potential to reduce low flow conditions in the mainstem of the Yadkin River enough to affect the River's waste assimilative capacity.

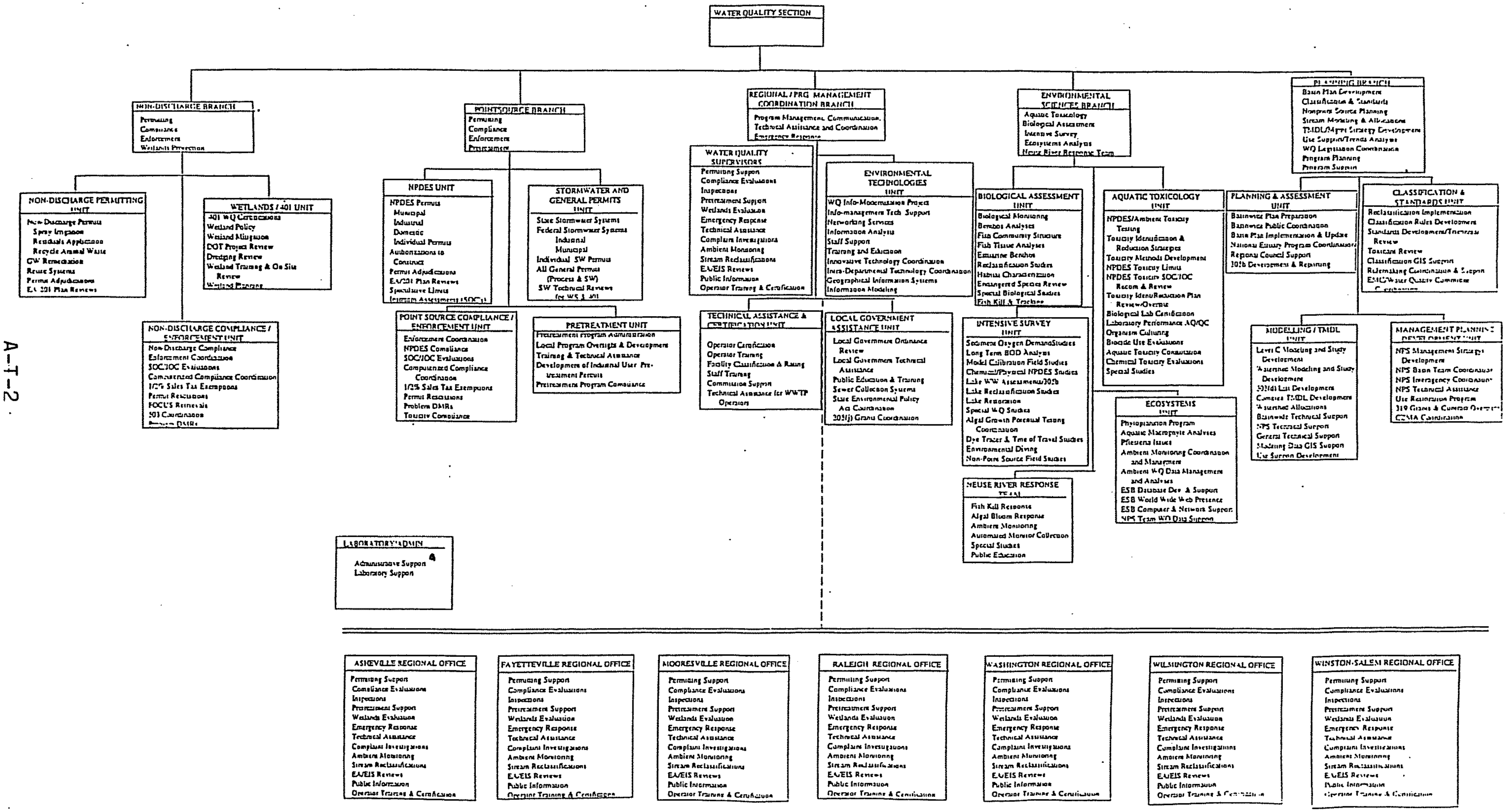
- Growth management/urban stormwater planning (specifically for the Rocky River drainage out of Charlotte and in the Winston-Salem area) are needed. Increased population in these areas will demand more water and generate more wastewater. In addition, conversion of land from forests and farms will increase impervious surfaces and produce higher than natural streamflows and cause erosion. Streams in these areas will likely become impaired unless this growth is planned for and managed properly.
- Need to update the sediment studies of the 1970's to the 1990's. This information would be used to predict future trends and to assess the effectiveness of major sediment control efforts (e.g.- the Farm Bill).
- There is a lack of data on impacts of summer low-flow conditions on aquatic life. The lack of flowing water during summer months can severely reduce the diversity of aquatic fauna. This problem has not been investigated in North Carolina and further research will be required to determine the effect of water withdrawals (e.g.- for irrigation) on stream life.
- Determining sedimentation rates and volumes in the Chain Lakes would be very useful.
- Document the impact of animal wastes in areas of high cattle (e.g.-Iredell County) and poultry (e.g.-Union County) production. There is a need for separating out the impact from organic loading, nutrient loading and other nonpoint sources.
- Need improved monitoring of small streams. These streams are currently ignored because of their size, but they are a source of pollution and this source will increase as growth occurs.
- The following comments and questions, as presented by the participants of the Lower Yadkin-Pee Dee River basin workshop, require attention:
  1. More data are needed to determine what percentage of water quality problems are due to agriculture.
  2. There needs to be a better understanding of, and more education on, color impacts from wastewater discharges.
  3. Need to identify both NPS and point source pollution contributions/contributors. What data do we have? Is it based on good science?
  4. Need better identification of the causes and sources of pollution in impaired streams. More resources should be put into determining why stream miles are impaired- "what is the source of poor water quality?" This is needed to develop appropriate management strategies.
  5. Identify problems before establishing regulations.
  6. Need more research on urban BMPs.
  7. We need education for farmers and better access to research.

APPENDIX I

Division of Water Quality, Water Quality Section
Organizational Duties Chart

WATER QUALITY SECTION
DUTIES CHART

September 8, 1997
Duties Chart



APPENDIX II

NPDES Permitted Dischargers
In The Yadkin-Pee Dee River Basin

Appendix II
NPDES Permitted Dischargers in the Yadkin-Pee Dee River Basin

Permit #	Pipe #	Facility Name	Sub-basin	Recieving Stream	Stream Classification
NC0005266	001	ABTCO	03-07-01	YADKIN RIVER	C
NC0006254	001	SEALED AIR CORPORATION	03-07-01	YADKIN RIVER	C-TROUT
NC0006696	001	CAROLINA MIRROR CORPORATION	03-07-01	UT MULBERRY CRK	C
NC0020761	001	N. WILKESBORO, TOWN-WWTP/THUR	03-07-01	YADKIN RIVER	C
NC0021717	001	WILKESBORO WWTP, TOWN OF	03-07-01	YADKIN RVR	C
NC0033138	001	WILKES CO SCH-MILLERS CREEK	03-07-01	UT REDDIES RVR	WS-II
NC0035793	001	WILKES CAREER CENTER	03-07-01	UT LITTLE CUB CRK	C
NC0035939	001	CAMP CAROLWOOD INC	03-07-01	COVE BRANCH	C-TROUT
NC0035947	001	SKILL CRAFT ENTERPRISES	03-07-01	YADKIN RIVER	C-TROUT
NC0038709	001	WILKES CO SCH-ROARING RIVER EL	03-07-01	YADKIN RIVER	WS-IV
NC0039985	001	COUNTRY SQUARE MHP	03-07-01	UT CUB CREEK	C
NC0041181	001	CALDWELL CO BOE-HAPPY VALLEY	03-07-01	YADKIN RIVER	C-TROUT
NC0041190	001	CALDWELL CO BOE-KINGS CREEK EL	03-07-01	KINGS CREEK	C-TR0UT
NC0043125	001	PATTERSON SCHOOL	03-07-01	YADKIN RIVER	C
NC0046388	001	WILKES CO BOE-E WILKES HS	03-07-01	UT HUGHES BRANCH	WS-III
NC0046418	001	WILKES CO SCH-MOUNTAIN VIEW	03-07-01	UT MULBERRY CRK	C
NC0046426	001	WILKES CO SCH-TRAPHILL ELEM	03-07-01	LITTLE SANDY CRK	C
NC0047872	001	WILKES CO SCH-W WILKES HS	03-07-01	MEADOW BRANCH	WS-IV
NC0049123	001	EHNR - STONE MOUNT. STATE PARK	03-07-01	E.PRONG ROARING RV	C-TROUT
NC0051047	001	WILKES CO BOE-C.C. WRIGHT ELEM	03-07-01	UT LITTLE CUB CRK	C
NC0055590	001	WILKESBORO, TOWN-WTP/WELBORN	03-07-01	UT MORAVIAN CRK	C
NC0055611	001	BLACKBERRY SEWER SYSTEM	03-07-01	UT YADKIN RVR	C-TROUT
NC0066877	001	NORTH WILKESBORO (TOWN OF)	03-07-01	MULBERRY CREEK	C
NC0068543	001	FOSTER-RICHARDSON REST HOME	03-07-01	NAKED CREEK	WS-IV
NC0075078	001	WILKES COUNTY AIRPORT	03-07-01	UT ROCK CREEK	C
NC0075299	001	DODGE HOUSE PROPERTIES	03-07-01	UT FISH DAM CRK	WS-IV
NC0075515	001	WILKES CO BOE-BOOMER FERGUSON	03-07-01	UT WARRIOR CRK	WS-IV
NC0076066	001	WILKES COUNTY BOARD OF ED	03-07-01	WOLF BRANCH	B
NC0077607	001	NORTH WILKESBORO DRAGWAY	03-07-01	UT NAKED CREEK	WS-IV
NC0078140	001	TEXTILE, INC.	03-07-01	YADKIN RIVER	WS-IV
NC0080748	001	U S FIBER-DIV. OF SUNCOAST	03-07-01	UT YADKIN RIVER	WS-III
NC0005312	001	CHATHAM MANUFACTURING, INC.	03-07-02	YADKIN RIVER	C
NC0006548	001	WAYNE POULTRY OF N.C., INC.	03-07-02	FISHER RIVER	C
NC0020338	001	YADKINVILLE, TOWN-WWTP	03-07-02	NORTH DEEP CREEK	C
NC0020567	001	ELKIN WWTP, TOWN OF	03-07-02	YADKIN RIVER	C
NC0020931	001	BOONVILLE WWTP, TOWN OF	03-07-02	TANYARD CREEK	C
NC0021326	001	DOBSON WWTP, TOWN OF	03-07-02	CODY CREEK	C
NC0021580	001	JONESVILLE WWTP, TOWN OF	03-07-02	SANDYBERRY CRK	C
NC0027880	001	DOC - YADKIN CO SUBSIDIARY	03-07-02	UT SOUTH DEEP CRK	C

NC0029289	001	CHATHAM MANUFACTURING, INC	03-07-02	UT NORTH DEEP CRK	C
NC0029599	001	YADKIN CO. SCH.-COURTNEY ELEM.	03-07-02	HARMON CREEK	C
NC0029602	001	YADKIN CO. SCH.-FORBUSH ELEM	03-07-02	MILL BRANCH	C
NC0029611	001	YADKIN CO SCH-EAST BEND	03-07-02	UT LOGAN CREEK	C
NC0031160	001	PILOT MTN STATE PARK	03-07-02	GRASSY CREEK	C
NC0033154	001	DAVIE CO BOE-SHADY GROVE	03-07-02	UT CARTERS CREEK	WS-IV
NC0034827	001	FORSYTH CO BOE-OLD RICHMOND	03-07-02	UT FRIES CREEK	C
NC0038997	001	ROARING GAP CLUB, INC.	03-07-02	UT MITCHELL RVR	B-TRTOR
NC0041866	001	SURRY CO BOE-MTN PARK ELEM	03-07-02	UT FLAT BRANCH	C
NC0041955	001	SURRY CO BOE-FOOTHILLS H.S.	03-07-02	BEAVERDAM CRK	C
NC0044211	001	BRINTLE ENTERPRISES	03-07-02	LITTLE FISHER RVR	C
NC0055158	001	BERMUDA CTR S.D.-WWTP	03-07-02	YADKIN RIVER	WS-IV
NC0058815	001	HOPE VALLEY, INC.	03-07-02	FISHER RIVER	C
NC0058998	001	RAYCO UTILITIES, INC	03-07-02	SMITH CREEK	WS-IV
NC0060691	002	CANDLE CORP. OF AMERICA WWTP	03-07-02	YADKIN RIVER	C
NC0061808	001	NEIGHBORS FUEL CTR	03-07-02	LITTLE FISHER RIVER	C
NC0063720	001	RAYCO UTILITIES, INC.	03-07-02	BLANKET CREEK	WS-IV
NC0064726	001	EAST BEND INDUSTRIAL PARK WWTP	03-07-02	UT YADKIN RVASIN	WS-III
NC0070459	001	YADKIN CO. SCH.-STARMOUNT HIGH	03-07-02	UT SOUTH DEEP CRK	WS-III
NC0071773	001	YADKIN CO. SCH.-FORBUSH HS	03-07-02	FORBUSH CRK	C
NC0073822	001	NC DEPT. OF TRANSPORTATION	03-07-02	FISHER RIVER	C
NC0079260	001	YADKINVILLE, TOWN-WTP	03-07-02	SOUTH DEEP CRK	WS-III
NC0083925	001	SALEM GLEN GOLF CLUB, LLC	03-07-02	YADKIN RIVER	WS-IV
NC0084212	001	DAVIE, COUNTY OF/ SPARKS RD	03-07-02	YADKIN RIVER	WS-IV
NC0084409	001	ROBERTSON & ISENHOUR PROP INC.	03-07-02	MILL CREEK	C
NC0005703	001	HAMILTON BEACH/PROCTOR SILEX	03-07-03	LOVILLS CRK	C
NC0006483	001	NORTH CAROLINA GRANITE CORP	03-07-03	ARARAT RIVER	C
NC0021121	001	MOUNT AIRY WWTP, TOWN OF	03-07-03	ARARAT RIVER	C
NC0026646	001	PILOT MOUNTAIN, TOWN-WWTP	03-07-03	HEATHERLY CREEK	C
NC0027944	001	BASSETT FURN.-NA.FURN. MT AIRY	03-07-03	ARARAT RIVER	C
NC0029190	001	DOT-SURRY CO. I-77 REST AREA	03-07-03	NAKED RUN	WS-IVTR
NC0030457	001	CROSS CREEK APPAREL, INC.	03-07-03	UT STONEY CRK	C
NC0038822	001	CENTRAL CARE, INC.	03-07-03	UT STEWARTS CRK	C
NC0039420	001	VIRGINIA DOT I-77 REST AREA	03-07-03	NAKED RUN BRANCH	WSIVTRT
NC0041904	001	SURRY CO BOE-FLAT ROCK ELEM	03-07-03	UT CHAMP CREEK	C
NC0041939	001	SURRY CO BOE-GENTRY MIDDLE	03-07-03	UT STEWARTS CRK	C
NC0041947	001	SURRY CO BOE-NORTH SURRY HIGH	03-07-03	STEWARTS CREEK	WS-IV
NC0068365	001	PILOT MOUNTAIN, TOWN OF (WTP)	03-07-03	TOMS CREEK	C
NC0085740	001	JOHN S CLARK CO-MT AIRY SITE	03-07-03	UT TO ARARAT RIVER	C
NC0004286	001	FIELDCREST CANNON PLANT 16	03-07-04	UT GRANTS CRK	C
NC0004626	001	PPG INDUSTRIES-LEXINGTON	03-07-04	N. POTTS CRK	C
NC0004707	009	RJ REYNOLDS TOBACCO COMPANY	03-07-04	BATH & LINDEN BRNH	C
NC0004774	001	DUKE POWER CO., BUCK S.S.	03-07-04	HIGH ROCK LAKE	WS-V
NC0005487	001	FIELDCREST MILLS, NC FINISHING	03-07-04	YADKIN RIVER	WS-IV&B
NC0023604	001	THOMASVILLE FURNITURE-LUMBER	03-07-04	UT FLAT SWAMP CRK	C

NC0023884*	001	SALISBURY, CITY-GRANT CRK WWTP	03-07-04	GRANTS CREEK	C
NC0023892*	001	SALISBURY (TOWN CREEK WWTP)	03-07-04	TOWN CREEK	C
NC0025593	001	SPENCER WWTP, TOWN OF	03-07-04	GRANTS CREEK	C
NC0027502	001	LANDIS WTP (TOWN OF)	03-07-04	GRANTS CREEK	C
NC0029947	001	DAVIDSON CO BOE-CHURCHLAND	03-07-04	UT S. POTTS CRK	C
NC0031950	001	DAVIDSON CO BOE-WEST DAV H.S.	03-07-04	UT NORTH POTTS CRK	C
NC0034703	001	ROWAN CO SCH-KNOLLWOOD ELEM	03-07-04	LITTLE CREEK	C
NC0035921	001	ROWAN CO BOE-FAITH ELEM SCHOOL	03-07-04	UT CRANE CREEK	C
NC0037184	001	OAK HAVEN MOBILE HOME PARK	03-07-04	UT GRANTS CRK	C
NC0037834	001	WINSTON-SALEM (ELLEDGE WWTP)	03-07-04	SALEM CREEK	C
NC0040045	001	BILLS TRUCK STOP	03-07-04	UT S. POTTS CREEK	C
NC0041599	001	DAVIDSON CO BOE-CENTRAL JR/SR	03-07-04	UT ABBOTTS CRK	WS-V&B
NC0041602	001	DAVIDSON CO BOE-SILVER VALLEY	03-07-04	UT FLAT SWAMP CRK	C
NC0042056	001	DAVIDSON CO BOE-TYRO JR HIGH	03-07-04	UT NORTH POTTS CRK	C
NC0042072	001	DAVIDSON CO BOE-NORTHWEST ELEM	03-07-04	HUFFMAN CREEK	C
NC0042439	001	WESTSIDE SWIM & RACQUET CLUB	03-07-04	DRAFT BRANCH	C
NC0042749	001	DAVIDSON CO BOE-SOUTHWOOD ELEM	03-07-04	UT SWEARING CREEK	WS-V
NC0045675	001	MAJESTIC PROPERTIES-ROWAN SITE	03-07-04	UT GRANTS CREEK	C
NC0046931	001	NORFOLK AND WESTERN RAILWAY CO	03-07-04	UT TO BRUSHY FORK	C
NC0049905	001	CHEVRON USA INC SALISBURY PLT	03-07-04	UT GRANTS CREEK	C
NC0050342	001	WINSTON SALEM, CITY-LOWER MUDD	03-07-04	YADKIN RIVER	WS-IV
NC0051489	001	THREE R'S MOBILE HOME PARK	03-07-04	LEAK CREEK	C
NC0055093	001	R.J. REYNOLDS TOBACCO COMPANY	03-07-04	BARKERS CREEK	C
NC0057223	001	BAILEY'S MHP-WWTF/FORSYTH	03-07-04	UT LITTLE CRK	C
NC0057509	001	CAROLINA WTR SERV.-SEQUOIA	03-07-04	REYNOLDS CREEK	C
NC0059218	001	CAPTAIN STEVENS SEAFOOD REST.	03-07-04	UT REEDY CREEK	WS-IV
NC0059536	001	HILLTOP HOME	03-07-04	UT YADKIN RIVER	WS-V
NC0060780	001	WAKE FOREST UNIVERSITY	03-07-04	UT SILAS CRK	C
NC0061034	001	ROWAN ASSOC.(MERCANTILE CNTR.)	03-07-04	UT TOWN CREEK	C
NC0061204	001	SCARLETT ACRES MOBILE HOME DIV	03-07-04	UT MILL CREEK	C
NC0065587	001	MID-SOUTH WAT.SYS./FRYE BRIDG	03-07-04	UT MUDDY CREEK	C
NC0067385	001	BP SERVICE STATION-SITE #24161	03-07-04	UT SALEM CREEK	C
NC0070033	001	QUAIL RUN MOBILE HOME PARK	03-07-04	MILLER CREEK	C
NC0070637	001	PIEDMONT CONVERTING, INC.	03-07-04	REEDY CREEK	WS-IV
NC0079821	001	WINSTON-SALEM, CITY OF, WTP	03-07-04	SALEM CREEK	C
NC0080853	001	LUCENT TECHNOLOGIES INC.	03-07-04	UT SALEM CREEK	C
NC0081931	001	YADKIN INC/HIGH ROCK	03-07-04	YADKIN RIVER	WS-IV&BCA
NC0083739	001	CROWN CENTRAL PETROLEUM CORP	03-07-04	UT TO SILAS CREEK	C
NC0083941	001	SHUGART ENTERPRISES, INC	03-07-04	FRYES CREEK	WS-IV
NC0084115	001	WACHOVIA SOUTHERN OIL CO.	03-07-04	UT BRUSHY FORK	C
NC0084760	001	USAIR SMITH-REYNOLDS MAINTENAN	03-07-04	BRUSHY FORK CRK	C
NC0085138	001	LOWES FOODS-S. MAIN ST	03-07-04	UT TO SMITH CREEK	WS-III
NC0021491	001	MOCKSVILLE, TOWN-DUTCHMANS CRK	03-07-05	DUTCHMAN CREEK	C
NC0024741	001	DOT-DAVIE CO. I-40 REST AREAS	03-07-05	UT SUGAR CREEK	B

NC0033146	001	DAVIE CO BOE-PINEBROOK	03-07-05	CEDAR CRK	C
NC0033162	001	DAVIE CO BOE-WILLIAM R DAVIE	03-07-05	UT GREASY CRK	C
NC0004898	001	GULISTAN CARPET,INC-TURNERSBUR	03-07-06	ROCKY CREEK	C
NC0004944	001	HOECHST CELANESE-SALISBURY	03-07-06	N SECOND CRKASIN	WS-IV
NC0005126	001	HOLLY FARMS POULTRY-HARMONY	03-07-06	HUNTING CREEK	WS-III
NC0020591	001	STATESVILLE, CITY-THIRD CREEK	03-07-06	THIRD CREEK	C
NC0023191	001	SEVEN CEDARS MHP WWTP	03-07-06	THIRD CREEK	C
NC0024872	001	COOLEEMEE WWTP, TOWN OF	03-07-06	SOUTH YADKIN RVR	C
NC0028606	001	DOT-IREDELL CO. REST AREA I-77	03-07-06	CAMEL BRANCH	C
NC0028614	001	DOT-YADKIN CO. I-77 REST AREA	03-07-06	ROCKY BRANCH	WS-III
NC0028941	001	PINE VALLEY SUBD. - EWS RAYCO	03-07-06	SETMAN BRANCH	C
NC0029238	001	IREDELL CO BOE-W. IREDELL MID.	03-07-06	UT BACK CREEK	C
NC0029742	001	DOC - IREDELL CORR CENTER#4520	03-07-06	UT FIFTH CRK	C
NC0031836	001	STATESVILLE, CITY-FOURTH CREEK	03-07-06	FOURTH CREEK	C
NC0034959	001	ROWAN CO SCH-W ROWAN HS	03-07-06	WITHROW CREEK	C
NC0037371	001	IREDELL CO BOE-N. IREDELL HIGH	03-07-06	PATTERSON CREEK	C
NC0037389	001	IREDELL CO BOE-W. IREDELL HIGH	03-07-06	UT BRADY BRANCHSN	C
NC0045012	001	HILLHAVEN NURSING HOME	03-07-06	UT THIRD CREEK	C
NC0045471	001	BARIUM SPGS SCH FOR CHILDREN	03-07-06	UT DUCK CREEK	C
NC0049867	001	CLEVELAND WWTP, TOWN OF	03-07-06	THIRD CREEK	C
NC0050903	001	MOCKSVILLE, TOWN-BEAR CREEK WW	03-07-06	BEAR CREEK	C
NC0068632	001	CRAFTMASTER FURNITURE CORP.	03-07-06	UT THIRD CREEK	C
NC0072664	001	SHURTAPE TECH,INC STNY.PNT.TP	03-07-06	THIRD CREEK	C
NC0075523	001	RDH TIRE & RETREAD	03-07-06	UT BEAVERDAM CRK	C
NC0076333	001	STATESVILLE AUTO AUCTION WWTP	03-07-06	FIFTH CREEK	C
NC0077615	001	HOMER'S TRUCK STOP	03-07-06	THIRD CREEK	C
NC0077861	001	DW NELSEN & ASSOC	03-07-06	WEATHERS CREEK	C
NC0078361	001	NORTH SECOND CREEK WWTP	03-07-06	SECOND CREEK	WS-IV
NC0079898	001	HOECHST CELANESE-NEEDMORE RD	03-07-06	SOUTH YADKIN RVR	WS-IV
NC0081779	001	SACKNER PRODUCTS	03-07-06	UT BACK CREEK	C
NC0082821	001	SOUTHERN STATES COOPERATIVE	03-07-06	FOURTH CREEK	C
NC0084042	001	ALEXANDER WTP	03-07-06	SOUTH YADKIN RVR	WS-IV
NC0085014	001	ROSCOE'S GROCERY	03-07-06	UT TO N LITTLE HUNTING	WS-III
NC0085120	001	LOWES CO-IREDELL DIST	03-07-06	UT TO ROCKY CRK	C
NC0024112	001	THOMASVILLE, TOWN OF - WWTP	03-07-07	HAMBY CREEK	C
NC0024228	001	HIGH POINT, CITY-WEST SIDE WWT	03-07-07	RICH FORK	C
NC0028037	001	LEXINGTON, CITY-WTP/1&2	03-07-07	ABBOTTS CRK	WS-III
NC0034452	001	WILLOW CREEK BUILDERS, INC.	03-07-07	ABBOTTS CREEK	WSIII
NC0036561	001	CENTERCLAIR INCORPORATED	03-07-07	UT POUNDER FORK CK	WSIII&B
NC0041491	001	PARADISE MOTEL	03-07-07	UT HUNTS FORK CRK	C
NC0041556	001	DAVIDSON CO BOE-FAIR GROVE ELE	03-07-07	UT HAMBY CREEK	C
NC0041629	001	DAVIDSON CO BOE-DAVIS TOWNSEND	03-07-07	UT HAMBY CREEK	C
NC0042081	001	DAVIDSON CO BOE-LEDFORD SR HI	03-07-07	REEDY RUN CRK	WS-III
NC0042129	001	DAVIDSON CO BOE-PILOT ELEM	03-07-07	JIMMYS CREEK	C
NC0042145	001	DAVIDSON CO BOE-MIDWAY ELEM	03-07-07	UT LEONARD CREEK	WS-III

NC0046035	001	HIGH POINT CARE CENTER	03-07-07	RICH FORK CRK	C
NC0049689	001	PLEASANT GROVE TRAILER PARK	03-07-07	UT HUNTS FORK CRK	C
NC0051713	001	LAKEVIEW MOBILE HOME PARK	03-07-07	CUDDYBUM BRANCH	WS-III
NC0055212	001	AUMAN'S MOBILE HOME PARK,L.L.C	03-07-07	RICH FORK CRK	C
NC0055786	001	LEXINGTON, CITY-REGIONAL WWTP	03-07-07	ABBOTTS CRK	WSIII&B
NC0059757	001	C & S ASSOCIATES	03-07-07	UT ABBOTT'S CRK	C
NC0084786	001	FURNITURE ILLUSTRATORS INC	03-07-07	UT TO UWHARRIE RVR	WS-III
NC0004308	002	ALUMINUM COMPANY OF AMERICA	03-07-08	YADKIN RIVER	C
NC0021105	001	MT GILEAD, TOWN-WWTP/MT GILEAD	03-07-08	CLARKS CREEK	C
NC0026689	001	DENTON, TOWN OF - WWTP	03-07-08	UT LICK CREEK	C
NC0040801	001	STONY GAP FISH HOUSE	03-07-08	UT JACOBS CRK	C
NC0074756	001	GREATER BADIN WWTP	03-07-08	LTTLE MOUNTAIN CRK	C
NC0075701	001	ALBEMARLE CITY/TUCKERTOWN WTP	03-07-08	TUCKERTOWN RSVR	WS-IV&B
NC0076775	001	YADKIN INC/FALLS POWERHOUSE	03-07-08	YADKIN RVR	WS-IV&B
NC0080322	001	MONTGOMERY COUNTY WATER T. P.	03-07-08	UT CLARKS CREEK	C
NC0081949	001	YADKIN INC/TUCKERTOWN POWERHSE	03-07-08	YADKIN RIVER	WS-IV&BCA
NC0081957	001	YADKIN INC/NARROWS POWERHOUSE	03-07-08	YADKIN RIVER	WS-IV&BCA
NC0082949	001	DENTON, TOWN OF - WTP	03-07-08	UT YADKIN RVR	WSIIIBC
NC0029246	001	SOUTHERN RAILWAY-SPENCER YARD	03-07-09	N.&S.POTTS CK/HIGH RK LK	C&WSIII
NC0040908	001	RANDOLPH CO BOE-TABERNACLE ELE	03-07-09	CARAWAY CREEK	C
NC0056201	001	COUNTRYSIDE COMMUNITIES, LCC	03-07-09	UT CARAWAY CRK	WS-III
NC0076287	001	RANDOLPH CO BOE-FARMER ELEM	03-07-09	UWHARRIE RIVER	C
NC0021784	001	ELLERBE WWTP, TOWN OF	03-07-10	TOMS BRANCHRVR	C
NC0081825	001	ANSONVILLE, TOWN-WWTP	03-07-10	PEE DEE RIVER	WSIII&B
NC0006351	001	CHEMICAL SPECIALTIES, INC. ***	03-07-11	ROCKY RIVER	C
NC0024309	001	ROSE LANE MGMT, INC., DAYS INN	03-07-11	AFTON RUN CREEK	WS-III
NC0025259	001	CAROLINA WTR SERV.-LAMPLIGHTER	03-07-11	UT MCKEE CREEK	C
NC0030210	001	CMUD-MALLARD CRK WWTP	03-07-11	MALLARD CREEK	C
NC0034711	001	CEDAR PARK ESTATES	03-07-11	REEDY CREEK	C
NC0035033	001	CAROLINA WTR SERV.-CAB. WOODS	03-07-11	UT REEDY CREEK	C
NC0041092	001	CABARRUS CO BOE-W.R. ODELL ELE	03-07-11	UT ROCKY RIVER	C
NC0046728	001	MOORESVILLE, TOWN-WWTP	03-07-11	DYE CREEK	C
NC0047091	001	SILVER MAPLE MOBILE ESTATES	03-07-11	ROCKY RIVER	C
NC0049441	001	BURLWOOD MHP	03-07-11	REEDY CREEK	C
NC0051632	001	CAROLINA WTR SERV.-HUNTWICK SD	03-07-11	FUDA CREEK	C
NC0061786	001	POPLAR TRAILS SUBDIVISION	03-07-11	UT ROCKY RIVER	C
NC0063762	001	CAROLINA VILLAGE MHP	03-07-11	ROCKY RIVER	C
NC0063932	001	WHITE FOREST WWTP	03-07-11	REEDY CREEK	C
NC0064734	001	JOHN CROSLAND COMPANY	03-07-11	MCKEE CREEK	C
NC0064751	001	RIVER HILL ESTATES	03-07-11	ROCKY RIVER	C
NC0065773	001	MID SOUTH WTR SYS - WILLOWS CR	03-07-11	UT REEDY CRK	C
NC0067172	001	MORRIS GLEN ASSOCIATION, INC.	03-07-11	ROCKY RIVER	C
NC0067644	001	ROCKY RIVER RUN SUBDIVISION	03-07-11	CALDWELL CREEK	C
NC0067920	001	RIVER RUN UTILITY CO, INC.	03-07-11	W.BRNCH ROCKY RVR	C

NC0070289	001	HUNTLEY, F. WAYNE - RIDGEWOOD	03-07-11	CALDWELL CRK	C
NC0071781	001	RAYCO UTILITIES-MCCARRON SD	03-07-11	REEDY CREEK	C
NC0073539	001	WILLOWBROOK SUBDIVISION	03-07-11	RAMAH CREEK	C
NC0074632	001	HUNTERSVILLE LAND CO	03-07-11	S PRONG CLARK CRK	C
NC0077364	001	CAROLINA WTR SVC-CABARRUS	03-07-11	CROZIRE BRANCH	C
NC0079774	001	DAVIDSON DOWNES SUBDV-ORESYBT	03-07-11	W BRANCH ROCKY RVR	C
NC0083119	001	CONCORD, CITY-CODDLE CRK WTP	03-07-11	CODDLE CREEK	C
NC0085316	001	DAVEY TREE EXPERT CO	03-07-11	TORY CREEK	C
NC0085758	001	S CENTRAL OIL CO-CROSSRDS GROC	03-07-11	UT TO LITTLE CREEK	C
NC0006220	001	KANNAPOLIS WTP, CITY OF	03-07-12	IRISH BUFFALO CRK	C
NC0030538	001	UNION CO BOE-FAIRVIEW ELEM	03-07-12	GOOSE CREEK	C
NC0031186	001	UNION CO-CROOKED CRK WWTP#3	03-07-12	S FORK CROOKED CRK	C
NC0034240	001	UNION CO BOE-HEMBY BRIDGE ELEM	03-07-12	N FORK CROOKED CRK	C
NC0034762	001	GOOSE CREEK UTILITY COMPANY	03-07-12	GOOSE CREEK	C
NC0035041	001	CAROLINA WTR SERV-HEMBY ACRES	03-07-12	N FORK CROOKED CRK	C
NC0036269	001	CABARRUS CO. W&SA-ROCKY RIVER	03-07-12	ROCKY RIVER	C
NC0041068	001	CABARRUS CO BOE-BETHEL ELEM	03-07-12	UT MUDDY CRK	C
NC0044717	001	MOUNT PLEASANT WTP (TOWN OF)	03-07-12	UT DUTCH BUFFALO CRK	C
NC0046655	001	GENWOVE U.S. LTD.	03-07-12	UT S FK CROOKED CK	C
NC0058751	001	WESTERN HILLS MOBILE HOME PARK	03-07-12	UT MEADOW CREEK	C
NC0063584	001	MID SOUTH WATER-OXFORD GLEN/RE	03-07-12	STEVENS CREEK	C
NC0064173	001	FRYE PROPERTY (GARY)	03-07-12	ADAMS CREEK	C
NC0065684	001	MID SOUTH WTR SYS-COUNTRY WOOD	03-07-12	GOOSE CREEK	C
NC0065749	001	MID SOUTH WTR SYS-ASHE PLAN	03-07-12	DUCK CREEK	C
NC0067105	001	CHANDLER,W S AND/OR ASSTS.	03-07-12		
NC0069523	001	UNION CO-TALLWOOD EST/FAIRVIEW	03-07-12	UT CLEAR CREEK	C
NC0069841	001	UNION CO-CROOKED CRK WWTP #2	03-07-12	S FORK CROOKED CRK	C
NC0072508	001	FAIRVIEW DEV.-HUNLEY CRK SUBD.	03-07-12	GOOSE CREEK	C
NC0077704	001	CABARRUS CO BOE - MT. PLEASANT	03-07-12	ADAMS CREEK	C
NC0081621	001	CABARRUS CO-MUDDY CRK WWTP	03-07-12	ROCKY RIVER	C
NC0083763	001	DIXIE YARNS INC/GW REMEDIATION	03-07-12	UT ROCK HOLE BRNCH	C
NC0085812	001	UNION CO-GRASSY BRANCH WWTP	03-07-12	CROOKED CREEK	C
NC0021628	001	NORWOOD WWTP, TOWN OF	03-07-13	ROCKY RIVER	C
NC0024244	001	ALBEMARLE,CITY OF, LONG CRK WW	03-07-13	LONG CREEK	C
NC0028169	001	CAROLINA SOLITE CORP.	03-07-13	ROCKY RIVER	C
NC0029424	001	STANLY CO SCH-LOCUST ELEM	03-07-13	UT ISLAND CREEK	C
NC0029432	001	STANLY CO SCH-AQUADALE ELEM	03-07-13	UT LONG BRANCH	C
NC0041718	001	COLONY RIDGE APARTMENTS	03-07-13	CURL TAIL CREEK	C
NC0043532	001	OAKBORO WWTP, TOWN OF	03-07-13	LONG CREEK	C
NC0044024	001	ALBEMARLE, CITY OF	03-07-13	UT LITTLE LONG CRK	C
NC0080586	001	CAROLINA STALITE COMPANY	03-07-13	UT LONG CREEK	C
NC0024333	001	MONROE WWTP, CITY OF	03-07-14	RICHARDSON CREEK	C
NC0028525	001	UNION CO BOE-PIEDMONT MIDDLE	03-07-14	UT LITTLE MILL CRK	C
NC0030562	001	UNION CO BOE-UNIONVILLE ELEM	03-07-14	UT CHINKAPIN CRK	WS-III
NC0030597	001	UNION CO BOE-NEW SALEM ELEM	03-07-14	RICHARDSON CRK	C

NC0030635	001	UNION CO BOE-PIEDMONT HS	03-07-14	UT GRASSY BRANCH	C
NC0045993	001	TELEDYNE ALLVAC-MONROE PLANT	03-07-14	RICHARDSON CREEK	C
NC0080381	001	MONROE, CITY-JOHN GLENN WTP EX	03-07-14	STEWARTS CREEK	C
NC0084344	001	SCHERER CORP/CHELSEA LABOR.	03-07-14		
NC0021504	001	BISCOE WWTP, TOWN OF	03-07-15	HICKORY BRANCH	C
NC0028916	001	TROY WWTP, TOWN OF	03-07-15	DENSONS CRK	C
NC0006041	001	LAUREL HILL PAPER COMPANY	03-07-16	HITCHCOCK CREEK	C
NC0020427	001	ROCKINGHAM, CITY-WWTP/RIVER RD	03-07-16	PEE DEE RIVER	WS-III
NC0037982	001	HAMLET WTP, CITY OF	03-07-16	CITY LAKE-MARKS CK	WS-III
NC0041408	001	ANSON COUNTY REGIONAL WWTP	03-07-16	PEE DEE RIVER	WS-III
NC0043320	001	BURLINGTON KLOPMAN FABRICS	03-07-16	HITCHCOCK CRK	C
NC0047562	001	HAMLET WWTP, CITY OF	03-07-16	MARKS CREEK	C
NC0074390	001	ANSON, COUNTY OF WTP	03-07-16	MCCOY CREEK	C
NC0081281	001	RICHMOND, COUNTY OF-WTP	03-07-16	UT PEE DEE RVR	C
* The Town of Salisbury will be undergoing an expansion, resulting in a total permitted flow of 20 mgd to the Yadkin river. Both Both Grants Creek and Town Creek facilities will be closed					

APPENDIX III

DWQ Water Quality Monitoring Programs
in the Yadkin-Pee Dee River Basin

- Use Support Methodology
- Benthic Macroinvertebrate Sampling
- Fisheries Studies
- Lakes Assessment Program
- Aquatic Toxicity Monitoring

USE-SUPPORT: DEFINITIONS AND METHODOLOGY

Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a waterbody supports its designated uses (*use support* status) is another important method of interpreting water quality data and assessing water quality. Use support assessments for the Chowan River basin are presented in Section 4.5.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are fully supported, partially supported or are not supported. For instance, waters classified for fishing and water contact recreation (class C) are rated as fully supporting if data used to determine use support (such as chemical/physical data collected at ambient sites or benthic macroinvertebrate bioclassifications) did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as ST, PS or NS, depending on the degree of exceedence.

Streams rated as either partially supporting or nonsupporting are considered *impaired*. A waterbody is fully supporting but threatened (ST) for a particular designated use when it fully supports that use now, but may not in the future unless pollution prevention or control action is taken. Although threatened waters are currently supporting uses, they are treated as a separate category from waters fully supporting uses. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired. This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for impaired waters. Data used in the use support assessments include biological data, chemical physical data, lakes assessment data, DEH shellfish sanitation surveys, and monitoring data. Although there is a general procedure for analyzing the data and determining a waterbody's use support rating, each stream segment is reviewed individually, and best professional judgment is applied during these determinations.

Interpretation of the use support ratings compiled by DEM should be done with caution. The methodology used to determine the ratings must be understood, as should the purpose for which the ratings were generated. The intent of this use-support assessment was to gain an overall picture of the water quality, how well these waters support the uses for which they were classified, and the relative contribution made by different categories of pollution within the basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DEM used the data mentioned above.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important not to manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is the greatest source of water quality degradation. However, this does not mean that there should be no point source control measures. All categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

The threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to consider any source (or potential source) of pollution in developing appropriate management and control strategies. The potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

Assessment Methodology - Freshwater Bodies

Many types of information were used to determine use support assessments and to determine causes and sources of use support impairment. A use support data file is maintained for each of the 17 river basins. In these files stream segments are listed as individual records. All existing data pertaining to a stream segment (from the above list) is entered into its record. In determining the use support rating for a stream segment, corresponding ratings are assigned to data values where this is appropriate. The following data and the corresponding use support ratings are used in the process: (note: The general methodology for using this data and translating the values to use support ratings corresponds closely to the 305(b) guidelines with some minor modifications.)

Biological Data

Benthic Macroinvertebrate Bioclassification

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S) and the Biotic Index which summarizes tolerence data for all taxa in each collection. The bioclassifications are translated to use support ratings as follows:

Bioclassification	Rating
Excellent	Supporting
Good	Supporting
Good-Fair	Support Threatened
Fair	Partially Supporting
Poor	Not Supporting

Fish Community Structure
The North Carolina Index of Biotic Integrity (NCIBI) is a method for assessing a streams biological integrity by examining the structure and health of its fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. The index is translated to use support ratings as follows:

NCIBI	Rating
Excellent	Supporting
Good-Excellent	Supporting
Good	Supporting
Fair-Good	Support Threatened
Fair	Partially Supporting
Poor-Fair	Partially Supporting
Poor	Not Supporting
Very Poor - Poor	Not Supporting
Very Poor	Not Supporting

Phytoplankton and Algal Bloom Data
Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of alga may discolor the water or form visible mats on top of the water. blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An algal sample with a biovolume larger than 5,000 mm3/m3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 micrograms per liter (the NC state standard) constitutes a bloom. A waterbody is rated ST if the biovolume, density and chlorophyll a concentrations are approaching bloom concentrations. If an algal bloom occurs, the waterbody is rated PS.

Chemical/Physical Data

Chemical/physical water quality data is collected through the Ambient Monitoring System as discussed in section 4.2.7. This data is downloaded from STORET to a desktop computer for analysis. Total number of samples and percent exceedences of the NC state standards are used for use support ratings. Percent exceedences correspond to use support ratings as follows:

Standards Violation	Rating
Criteria exceeded < 10%	Fully Supporting
Criteria exceeded 11-25%	Partially Supporting
Criteria exceeded >25%	Not Supporting

It is important to note that some waters may exhibit characteristics outside the appropriate standards due to natural conditions. These natural conditions do not constitute a violation of water quality standards.

Lakes Program Data

As discussed in section 4.2.3, assessments have been made for all publicly accessible lakes, lakes which supply domestic drinking water, and lakes where water quality problems have been observed.

Sources and Cause Data

In addition to the above data, existing information was entered for potential sources of pollution (point and nonpoint). It is important to note that not all impaired streams will have a potential source and/or cause listed for them. Staff and resources do not currently exist to collect this level of information. Much of this information is obtained through the cooperation of other agencies (federal, state and local), organizations, and citizens.

Point Source Data

Whole Effluent Toxicity Data

Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Streams that receive a discharge from a facility that have failed its whole effluent toxicity test may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a potential source of impairment.

Daily Monitoring Reports

Streams which received a discharge from a facility significantly out of compliance with permit limits may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a Point Source potential source of impairment.

Nonpoint Source Data

Information related to nonpoint source pollution (i.e., agricultural, urban and construction) was obtained from monitoring staff, other agencies (federal, state and local), 1988 nonpoint source workshops, land-use reviews, and workshops held at the beginning of each basin cycle.

Problem Parameters

Causes of use support impairment (problem parameters) such as sedimentation and low dissolved oxygen, were also identified for specific stream segments. For ambient water quality stations, those parameters which exceeded the water quality standard > 10% of the time for the review period were listed as a problem parameter. For segments without ambient stations, information from reports, other agencies, and monitoring staff were used if it was available.

Monitored vs. Evaluated

Assessments were made on either monitored (M) or evaluated (E) basis depending on the level of information that was used. Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

> If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.
> If a stream is a tributary to a monitored (segment of a) stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored (segment of a) stream rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

Assigning Use Support Ratings

At the beginning of each assessment, all data is reviewed by subbasin with the monitoring staff, and data is adjusted where necessary based on best professional judgment. Discrepancies between data sources are resolved during this phase of the process. For example, a stream may be sampled for both benthos and fish community structure, and the bioclassification may differ from the NCIBI (i.e. the bioclassification may be S while the

NCIBI may be PS). To resolve this, the final rating may defer to one of the samples (resulting in S or PS), or, it may be a compromise between both of the samples (resulting in ST).

After reviewing the existing data, ratings are assigned to the streams. If one data source exists for the stream, the rating is assigned based on the translation of the data value as discussed above. If more than one source of data exists for a stream, the rating is assigned according to the following hierarchy:

Benthic Bioclassification / Fish Community Structure
Chemical/Physical Data
Monitored Data > 5 years old
Compliance / Toxicity Data

This is only a general guideline for assigning use support ratings and not meant to be restrictive. Each segment is reviewed individually and the resulting rating may vary from this process based on best professional judgment which takes into consideration site specific conditions.

After assigning ratings to streams with existing data, streams with no existing data were assessed. Streams that were direct or indirect tributaries to streams rated S or ST received the same rating (with an evaluated basis) if they had no known significant impacts, based on a review of the watershed characteristics and discharge information. Streams that were direct or indirect tributaries to streams rated PS or NS, or that had no data were assigned a Not Evaluated (NE) rating.

Revisions to Methodology Since 1992 - 93 305(b) Report

Methodology for determining use support has been revised. In the 1992-1993 305(b) Report, evaluated information from older reports and workshops were included in the use support process. Streams rated using this information were considered to be rated on an evaluated basis. In the current use support process, this older, evaluated information has been discarded, and streams are now rated using only monitored information (including current and older monitoring data). Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.

If a stream is a tributary to a monitored segment of a stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored segment rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

These changes resulted in a reduction in streams rated on an evaluated basis.

The basinwide process allows for concentrating more resources on individual basins during the monitoring phase. Therefore, more streams were monitored, and more information was available to use in the use support process.

Fish consumption advisories are no longer used in determining the use support rating. They are now shown on a separate map, and discussed in Chapter 3. This will more clearly show what types of advisories are in effect, and where they are occurring.

SECTION 2: INTRODUCTION

INTRODUCTION

The North Carolina Division of Water Quality (DWQ), Water Quality Section, uses a whole basin approach to water quality management. Activities within the Water Quality program, including permitting, monitoring, modeling, nonpoint source assessments, and planning, are coordinated and integrated by basin, for each of the 17 major river basins within the state. All basins will be reassessed every five years. The Yadkin River basin is the 17th (last) basin to have the first round of basinwide monitoring completed.

The Environmental Sciences Branch collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning concept. In some areas there may be adequate data from several program areas to allow a fairly comprehensive analysis of ecological integrity, i.e., water quality. In other areas, data may be limited to one program area; such as only benthic macroinvertebrate data or only fisheries data, with no other information available. Such data may or may not be adequate to provide a definitive assessment of water quality, but can provide general indications of water quality. The primary program areas from which data were drawn for this assessment of the Yadkin River Basin include benthic macroinvertebrates, fisheries, lakes assessment (including phytoplankton), aquatic toxicity monitoring, chemical/physical characterizations, sediment oxygen demand and ambient monitoring system. A brief introduction to each program follows:

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since many taxa in a community have life cycles of six months to one year, the effects of short term pollution (such as a spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S). Likewise, ratings can be assigned with a North Carolina Biotic Index (BI). This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification for the qualitafive (10 sample) method. An abbreviated (4 sample) EPT method uses just the EPT criteria. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal) within North Carolina for freshwater flowing waterbodies. Details of benthos sampling, criteria, and data analysis can be found in the Biological Monitoring SOP Manual (DEHNR, 1995).

Classification Criteria by Ecoregion*

A. EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT Samples		
	Mountains	Piedmont	Coastal	Mountains	Piedmont	Coastal
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

B. Biotic Index Values (Range = 0-10)

	Mountains	Piedmont	Coastal
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good-Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	>7.00	>7.48	>7.73

*These criteria apply to flowing water systems only. Biotic Index criteria apply only to Qualitative samples.

Appendix B-1 lists all the benthic macroinvertebrate collections in the Yadkin River basin between 1983 and 1996, giving site location, DWQ classification schedule Index Number, collection date, taxa richness and biotic index values, and bioclassifications. Final bioclassifications assigned may take into account seasonal correction of both EPT taxa richness and Biotic Index value if the sample was collected outside of summer. Bioclassifications listed in this report may differ from older reports because evaluation criteria have changed since 1983. Originally, Total Taxa richness and EPT taxa richness criteria were used, then just EPT taxa richness, and now BI as well as EPT taxa richness criteria are used. Refinements of the criteria continue to occur as more data are gathered.

During the 1996 Yadkin basin sampling, benthic macroinvertebrates were collected at 105 sites. From 1983 through 1996, 522 benthos samples have been collected at 330 sites, providing a very large database for water quality analysis. The 1996 basin sampling targeted mainstem sites and major tributaries in all the subbasins, and gives a good representation of present water quality in the basin. Overall, water quality is Good-Fair to Good. Of the 105 basin samples, 46 (44%) were Good-Fair, 30 (29%) were Good, 14 (13%) were Fair, 11 (10%) were Excellent and 4 sites (4%) were rated as Poor.

FISHERIES

FISH COMMUNITY STRUCTURE ASSESSMENT METHOD

The fish communities of the Yadkin River Basin were sampled using methods developed for the application of the North Carolina Index of Biotic Integrity (NCIBI) (NCDEHNR 1995). At each sample site, a 200 meter section of stream was selected and measured. The fish in the stream were then collected using one or two backpack electrofishing units depending upon the stream's width. A seine also was used at select sites where riffles were abundant, to increase collecting efficiency. After collection, all readily identifiable fish (usually sport fishes, catfishes, and suckers) were examined for sores, lesions, fin damage, and skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Fish that could not be identified were preserved in 10% formalin and returned to the laboratory for identification, examination, and total length measurement. The resulting data were then analyzed with the NCIBI.

The NCIBI is a modification of the Index of Biotic Integrity initially proposed by Karr (1981) and Karr et al. (1986). The method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not directly correlate to water quality. For example, a stream with excellent water quality, but with poor or fair fish habitat, would not be rated excellent with this index. However, a stream which rated excellent on the NCIBI should be expected to have excellent water quality. Currently, the NCIBI is not applicable to high elevation or small, coldwater trout streams, lakes, or estuaries.

The Index incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of biological integrity using the NCIBI is provided by the cumulative assessment of 12 parameters or metrics (Appendix FC1). The values provided by the metrics are converted into scores on a 1, 3, or 5 scale. A score of 5 represents conditions which would be expected for undisturbed streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions vary greatly from those expected in undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall IBI score. Finally, the NCIBI score (an even number between 12 and 60) is then used to determine 1 of the 10 theoretical ecological integrity classes of the stream from which the sample was collected:

NCIBI Scores	Integrity Class
58 or 60	Excellent
54 or 56	Good-Excellent
48, 50, or 52	Good
46	Fair-Good
40, 42, or 44	Fair
36 or 38	Poor-Fair
28, 30, 32, or 34	Poor
24 or 26	Very Poor-Poor
12, 14, 16, 18, 20, or 22	Very Poor
——	No Fish Collected

The attributes of the non-overlapping classes are:

Integrity Class	Attributes
Excellent	Comparable to the best situations without human disturbance. All regionally expected species for the habitat and stream size, including the most intolerant forms, are present along with a full array of size classes and a balanced trophic structure.
Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant species; some species are present with less than optimal abundances or size distributions; and the trophic structure shows some signs of stress.
Fair	Signs of additional deterioration include the loss of intolerant species, fewer species, and a highly skewed trophic structure.
Poor	Dominated by omnivores, tolerant species, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; and diseased fish often present.
Very Poor	Few fish present, mostly introduced or tolerant species; and disease fin damage and other anomalies are regular.
No fish	Repeated sampling finds no fish.

Over-lapping classes share attributes with classes greater than and less than the respective NCIBI score.

YADKIN RIVER BASIN FISH COMMUNITY STRUCTURE OVERVIEW

In 1960 and 1961, the North Carolina Wildlife Resources Commission intensively sampled the fish community of the Yadkin River Basin at 199 stream sites (Tatum, et al. 1963). The river basin spans four well-defined physiographic regions—the Mountains, the Foothills, the Piedmont, and the Coastal Plain. Within these regions, four distinct types of fish habitats were defined: cold water, cool water, warm water-Piedmont, and warm water-Coastal Plain. The cold water and cool water streams are found in portions of Subbasins 030701-030703, the warm water-Piedmont streams are found in all remaining subbasins, except for most of Subbasin 030716 which is classified as warm water-Coastal Plain.

The cold water streams were found between elevations 1,200 and 4,000 ft. with the lower elevation generally marking the lower limit for streams considered to be trout streams. The trout streams were found to be cold and clear with steep gradients and rock and gravel bottoms. Tatum, et al. (1963) found that the dominant game fish were brook, brown, and rainbow trout, and the dominant non-game species were redlip shiner, bluehead chub, and rosyside dace.

Cool water streams overlapped coldwater streams at elevations between 900 and 1,500 ft. and were found to be turbid for short periods following moderate to heavy rainfall. And because of the rapid change of habitat from coldwater to warm water, a considerable overlap of fish species was found in the intervening cool water (smallmouth bass) region. Trout were found in the upper sections while largemouth bass was found in the lower sections of the region (Tatum, et al. 1963). The bottom substrates in cool water streams were dominated by gravel, boulders, and sand. In 1960 and 1961, the dominant game species were redbreast sunfish, smallmouth bass, and largemouth bass. The dominant non-game species were redlip shiner, bluehead chub, and rosyside dace.

Warm water streams within the Piedmont province of the river basin were divided into three regions: the upper, middle, and lower regions (Tatum, et al. 1963). The upper Piedmont streams, of which the South Yadkin River is the largest tributary, were extremely turbid. The substrates were primarily clay and sand with a few rock bottom streams along the south slopes of the Brushy Mountains. These sand-bottom streams offered poor fish habitat, especially for the game fish. In 1960 and 1961, the dominant game species were redbreast sunfish, green sunfish, and bluegill. The dominant non-game species were bluehead chub, creek chub, and brown bullhead.

The middle Piedmont streams provided better basic fish habitat, rocky bottoms and more fish cover, than those of the upper and lower Piedmont (Tatum, et al. 1963). However, they were still extremely turbid. The largest tributary in the entire Yadkin River Rasin, the Rocky River, is found within this region. In 1960 and 1961, the dominant game species were redbreast sunfish, green sunfish, and bluegill. The dominant non-game species were bluehead chub, redlip shiner, and brown bullhead.

Similar to the cool water streams, the lower Piedmont streams represented a transition between the Piedmont and the Coastal Plain. The headwater reaches were characteristically Piedmont while the lower reaches were characteristically Coastal Plain. As with other Piedmont streams after heavy rainfall, the streams became very turbid. The largest tributary of the Pee Dee River in the lower Piedmont is the Little River, which is impounded in several places. Blewett Falls Dam (in Subbasin 030710) is the first barrier on the Pee Dee River upstream from its mouth that is encountered by migrating anadromous fish such as striped bass, American shad, shortnose sturgeon, and Atlantic sturgeon. In 1960 and 1961, the dominant game species were redbreast sunfish, bluegill, and redfin pickerel. The dominant non-game species were bluehead chub, redlip shiner, and brown bullhead.

The smallest subregion of the Yadkin River Basin is the Coastal Plain, found in the Sandhills Region of Richmond County. Streams within this region are sand bottom, blackwater, and naturally acidic. In 1960 and 1961, the dominant game species were redbreast sunfish, bluegill, and redfin pickerel. The dominant non-game species were channel catfish, margined madtom, and golden shiner.

During the spring of 1996, 55 sites, representing at least one site per subbasin, were sampled and evaluated using the North Carolina Index of Biotic Integrity (Tables FC1-FC17). Three to five streams per rating (Excellent, Good, Good-Fair, Fair, and Poor) per basin region (Upper, Middle, and Lower) as illustrated in NCDNR&CD (1985) were selected and sampled:

1985 Stream Rating	Streams Sampled in 1996
Excellent	Dennis Cr, Basin Cr, Garden Cr, Betty McGees Cr, Barnes Cr, Dutchman Cr, Bridgers Cr, Beaverdam Cr, and Rocky Cr
Good	Laurel Cr, N Fk Reddies R, Cody Cr, Olin Cr, Cabin Cr, Mountain Cr, Cedar Cr, Big Bear Cr. and Mountain Cr
Good-Fair	Yadkin R, M Pr Roaring R, Mitchell R, S Yadkin R, Hunting Cr, Lick Cr, Uwharrie R; Coldwater Cr, Lanes Cr, Cedar Cr, and W Fk Little R
Fair	S and N Pr. Lewis Fk, S Deep Cr, L Fisher R, Stewarts Cr. Third Cr, N Second Cr, L Hunting Cr, Abbotts Cr, Dutchmans Cr, Dutch Buffalo Cr. Mallard Cr, Brown Cr, and Jones Cr
Poor	N Deep Cr, Beaver Cr. Little Yadkin R, Fourth Cr. Town Cr. Muddy Cr, Rich Fk Cr, Rocky R, Negrohead Cr. Irish Buffalo Cr, and Bailey Cr

These 55 sites represented streams previously rated with biological and chemical data and best professional judgment as Excellent-9, Good-10, Good-Fair-11, Fair-14, and Poor-11. Although the rating system used in 1985 was based on historical data, was sometimes subjective, and may not necessarily correspond to the same biological ratings used now, the rating system served as an effective screening tool for the selection of sites in the river basin from which there were no previous North Carolina Index of Biotic Integrity data. The 55 sites sampled in 1996 were also grouped into the six regions of the Yadkin River Basin that were delineated by Tatum, et al. (1963):

Physiographic Region and Fish Habitat Subregions	Streams Sampled in 1996
Mountain—Cold water	Dennis Cr, Laurel Cr, N and S Pr Lewis Fk, N Fk Reddies R, M Pr Roaring R, Basin Cr, Garden Cr, and Mitchell R
Foothills-Cool water	Beaver Cr, L Fisher R. Cody Cr. Stewarts Cr. and Yadkin R
Upper Piedmont—Warm water	S Yadkin R, Olin Cr. Hunting Cr, L Hunting Cr. Fourth Cr, Third Cr, N Second Cr, Town Cr, L Yadkin R. N Deep Cr. S Deep Cr, Cedar Cr, Dutchmans Cr, Muddy Cr, Abbotts Cr, and Rich Fk
Middle Piedmont—Warm water	Rocky R, Mallard Cr. Irish Buffalo Cr. Dutch Buffalo Cr, Coldwater Cr, Negrohead Cr, Lanes Cr. Barnes Cr. Betty McGees Cr, Dutchman Cr, Lick Cr, Cabin Cr, Uwharrie R, Mountain Cr, and Big Bear Cr
Lower Piedmont—Warm water	W Fk of the Little R, Rocky Cr. Cheek Cr. Mountain Cr, Bridgers Cr, Jones Cr, Bailey Cr, Cedar Cr. and Brown Cr
Coastal Plain—Warm water	Beaverdam Cr

These 55 sites included streams rated with the NCIBI as: Good-Excellent-6, Good-23, Fair-Good-6, Fair-13, Poor-Fair-2, Poor-1, and Not Rated-4. Some additional basic descriptive statistics (minima and maxima) from these 55 sites were:

- Drainage area (mi^2) — 1.3 (Dennis Creek) to 121 (Lanes Creek)
- Number of fish/sample — 17 (Beaverdam Creek) to 586 (Lanes Creek)
- Number of species/sample — 6 (Beaverdam Creek and Dutchman Creek) to 23 (Uwharrie River)
- NCIBI — 32 (Dutchman Creek) to 56 (Mountain Creek)

A complete summary list of all metric values for the North Carolina Index of Biotic Integrity may be found in Appendix FC4.

From these 55 sites, 64 species out of the 99 species previously known to occur within the entire Yadkin River-Pee Dee River Basin were collected (Appendix FC3). Twenty-two species would not likely have been collected from wadeable streams because of their larger river or reservoir habitat requirements (e.g. several species of suckers and catfish); and 14 species may not likely have been collected because of their rare or uncommon occurrence within the river basin (e.g., mountain redbelly dace, Phoxinus oreas and sawcheek darter, Etheostoma serrifer). Thus, only one expected species, the chain pickerel (Esox niger), was not represented in samples collected as part of the basinwide wadeable stream monitoring program.

Two species, the sea lamprey, Petromyzon marinus, and the warpaint shiner, Luxilus coccogenis, had not previously been collected by researchers from the Yadkin River Basin. The sea lamprey, an anadromous species whose distribution in North Carolina is confined to the Coastal Plain, was collected from Bailey Creek at SR 1811 in Anson County. The warpaint shiner, common in other mountain drainages but collected from Caldwell County only in the Catawba River Basin, was also collected from the Yadkin River at NC 268 in Caldwell County.

Based upon Menhinick (1991) and the present study, 101 species of freshwater fish have now been collected from the Yadkin River-Pee Dee River Basin in North Carolina (Appendix FC3). Seven of these species have been given special protection status by the United States Department of the Interior, the North Carolina Wildlife Resources Commission, or the North Carolina Natural Heritage Program under the North Carolina State Endangered Species Act (G.S 113-331 to 113-337) (LeGrand and Hall 1995):

Species	Common Name	State or Federal Status	Rank and Number of Extant Populations[1]
Acipenser brevirostrum	Shortnose sturgeon	Federal—Endangered	S1, 1-5
Acipenser oxyrhynchus	Atlantic sturgeon	State-Special Concern	S3, 21-100
Carpiodes velifer	Highfin carpsucker	State-Special Concern	S2, 6-20
Cyprinella zanema	Santee (or Thinlip) chub	State-Special Concern	S2, 6-20
Etheostoma collis	Carolina darter	State-Special Concern	S3, 21-100
Moxostoma robustum	Robust redhorse	State-Special Concern	S1, 1-5
Semotilis lumbee	Sandhills chub	State-Special Concern	S3, 21-100

[1] S1 = Critically imperiled in North Carolina because of extreme rarity or because of some factor (s) making it especially vulnerable to extirpation from North Carolina. S2 = Imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina. S3 = rare or uncommon in North Carolina (LeGrand and Hall 1995).

In the Yadkin River-Pee Dee River Basin, the shortnose sturgeon and the Atlantic sturgeon have been found as far inland as the Pee Dee River below Blewett Falls Dam, although they are more typically found in coastal waters. The highfin carpsucker has been found only in Blewett Falls Lake and the Santee (or thinlip) chub population has been found near the mouth of Jones Creek in Anson County. The Carolina darter has been found throughout the middle and lower Piedmont, whereas the Sandhills chub is restricted to Sandhill streams in the Yadkin River, Cape Fear River, and Lumber River basins. The rare robust redhorse was historically found in the lower Pee Dee River below Blewett Falls Dam.

FISH TISSUE

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Fish tissue analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with Federal Food and Drug Administration (FDA) action levels, U. S. Environmental Protection Agency (EPA) recommended screening values, and criteria adopted by the North Carolina Health Department.

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue analytes accompanied by their FDA criteria are presented below (USFDA, 1980). At present, the FDA has only developed metals criteria for mercury. Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

Food and Drug Administration (FDA) Action Levels

		Metals	
Mercury		1.0 ppm	
		Organics	
Aldrin	0.3 ppm	p,p DDE	5.0 ppm
Dieldrin	0.3 ppm	o,p DDT	5.0 ppm
Endrin	0.3 ppm	p,p DDT	5.0 ppm
o,p DDD	5.0 ppm	PCB-1254	2.0 ppm
p,p DDD	5.0 ppm	cis-chlordane	0.3 ppm
o,p DDE	5.0 ppm	trans-chlordane	0.3 ppm

In the guidance document, Fish Sampling and Analysis: Volume 1 (USEPA, 1993), EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure. These are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DWQ compares fish tissue results with EPA screening values to evaluate the need for further intensive site specific monitoring. A list of target analytes and EPA recommended screening values for the general adult population is presented below.

The North Carolina Health Department has adopted a selenium limit of 5 ppm for issuing fish consumption advisories. Total DDT includes the sum of all its isomers and metabolites (i.e. p,p DDT, o,p DDT, DDE, and DDD). Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane. Although the EPA has suggested a screening value of 7.0×10^{-7} ppm for dioxins, the State of North Carolina currently uses a value of 3.0 ppt (3×10^{-3}) in issuing fish consumption advisories.

Environmental Protection Agency (EPA) Screening Values			
Metals			
Cadmium	10.0 ppm		
Mercury	0.6 ppm		
Selenium	50.0 ppm		
Organics			
Chlorpyrifos	30.0 ppm	Heptachlor epoxide	0.01 ppm
Total chlordane	0.08 ppm	Hexachlorobenzene	0.07 ppm
Total DDT	0.3 ppm	Lindane	0.08 ppm
Dieldrin	0.007 ppm	Mirex	2.0 ppm
Dioxins	7.0×10^{-7} ppm	Total PCB's	0.01 ppm
Endosulfan (I and II)	20.0 ppm	Toxaphene	0.1 ppm
Endrin	3.0 ppm		

YADKIN RIVER BASIN OVERVIEW OF FISH TISSUE DATA

Fish tissue samples were collected at 39 sites within the Yadkin River basin between 1978 and 1996. Sample collections were performed at nine sites within the drainage in 1996.

Historically, mercury has been the most prevalent fish tissue contaminant in the Yadkin River basin. The Division of Water Quality confirmed extensive mercury contamination of the Abbotts Creek embayment of High Rock Lake in 1981. Fish tissue results showed mean mercury levels exceeding the FDA and EPA limits for tissue and the State Health Director subsequently placed the Abbotts Creek embayment under a fish consumption advisory in August 1981. A major source for the contamination was poorly treated wastewater and contaminated soils associated with the Duracell USA battery plant in Lexington. Removal of the contaminated soils, improvements in wastewater treatment from the site, and natural processes resulted in a gradual decline of mercury levels in the Abbotts Creek system to the point where the State Health Director was able to lift the fish consumption advisory on Abbotts Creek in March of 1992. Sampling since 1992 shows mercury continuing to decline gradually to background levels. Significant mercury levels were also discovered in fish from Ledbetter Lake (Richmond Co.) in 1993. The State Health Director issued a fish consumption advisory for largemouth bass from the lake which still remains in effect. Sources for mercury contamination of Ledbetter Lake are unknown, however, atmospheric deposition and other nonpoint sources are suspected since the contamination is similar to trends observed in other systems throughout the state. Metals contamination at other sites within the Yadkin drainage was observed to be minimal.

Organics analyses of fish samples throughout the Yadkin drainage were performed infrequently. Levels of DDT, chlordane, and PCB's exceeding EPA recommended screening values were detected in the Rocky River and the Pee Dee River near Rockingham in 1980 and 1981. Other organics were present throughout the drainage at trace or nondetectable levels. Future tissue studies in the Yadkin drainage should address a lack of data regarding organic contaminants.

LAKES ASSESSMENT PROGRAM (INCLUDING PHYTOPLANKTON)

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lake Assessment Program seeks to protect these waters through monitoring, and pollution prevention and control. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine the trophic state of each lake, a relative measure of nutrient enrichment and productivity, and whether the designated uses of the lake have been threatened or impaired by pollution.

Tables presented in each subbasin summarize data used to determine the trophic state and use support status of each lake. These determinations are based on information from the most recent summertime sampling (date listed). The most recent North Carolina Trophic State Index (NCTSI) value is shown, followed by the descriptive trophic state classification (O=oligotrophic, M=mesotrophic, E=eutrophic, H=hypereutrophic, D=dystrophic).

Numerical indices are often used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NCDNRCD, 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll *a* (CHL in µg/l). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the following equations:

$$TON_{Score} = \frac{Log(TON) + 0.45}{0.24} \times 0.90$$

$$TP_{Score} = \frac{Log(TP) + 1.55}{0.35} \times 0.92$$

$$SD_{Score} = \frac{Log(SD) - 1.73}{0.35} \times -0.82$$

$$CHL_{Score} = \frac{Log(CHL) - 1.00}{0.48} \times 0.83$$

$$NCTSI = TON_{Score} + TP_{Score} + SD_{Score} + CHL_{Score}$$

In general, NCTSI scores relate to trophic classifications as follows: less than -2.0 is oligotrophic, -2.0 to 0.0 is mesotrophic, 0.0 to 5.0 is eutrophic, and greater than 5.0 is hypereutrophic. When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water typical of dystrophic lakes.

YAD 01

Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Yadkin R, US 321, Caldwell	B-1	12-(1)	09/88	95/35	4.26/3.30	Good
Yadkin R, NC 268, Patterson, Caldwell	B-2	12-(1)	07/96	102/41	4.32/3.39	Good
			07/90	87/38	4.69/3.58	Good
			08/87	87/37	5.09/4.10	Good
			08/85	76/24	5.90/3.84	Good-Fair
Dennis Cr, SR 1732, Caldwell	B-3	12-7	07/96	-/32	-/2.71	Good
			09/88	-/21	-/2.99	Good-Fair
Jackson Camp Cr, SR 1372, Caldwell	B-4	12-10	09/88	-/23	-/3.14	Good-Fair
Preston Cr, US 321, Caldwell	B-5	12-12	09/88	-/29	-/3.45	Good
Buffalo Cr, be Buffalo Cove, Caldwell	B-6	12-19	09/88	-/31	-/3.25	Good
Buffalo Cr, SR 1504, Caldwell	B-7	12-19	07/96	-/41	-/3.40	Excellent
			09/88	83/32	4.51/3.27	Good
Old Field Br, SR 1502, Caldwell	B-8	12-19-9	09/88	-/26	3.24/3.24	Good-Fair
Joes Br, SR 1574, Caldwell	B-9	12-19-11	09/88	-/30	3.47/3.47	Good
Elk Cr, SR 1508, nr Triplett, Wilkes	B-10	12-24-(1)	12/87	71/38	2.90/2.31	Good
Elk Cr, SR 1508, Wilkes	B-11	12-24-(1)	12/87	101/49	3.60/2.52	Excellent
Laurel Cr, off SR 1508 at mouth, Wilkes	B-12	12-24-8	12/87	-/45	-/2.20	Excellent
Elk Cr, SR 1175, Wilkes	B-13	12-24-(10)	07/96	85/42	4.50/3.59	Good
			07/88	96/47	4.48/3.45	Excellent
			12/87	100/49	3.48/2.20	Excellent
			06/85	07/44	4.66/3.55	Good
Dugger Cr, mouth, ab SR 1162, Wilkes	B-14	12-24-11	12/87	-/38	-/2.56	Excellent
UT Stoney Fork Cr, SR 1505, Watauga	B-15	12-26-(1)	09/96	-/29	-/2.31	Good
Stoney Fork Cr, off SR 1500, Watauga	B-16	12-26-(1)	07/96	-/31	-/2.31	Good
Stoney Fork Cr, SR 1135, Wilkes	B-17	12-26-(7)	07/96	-/38	-/3.45	Excellent
N Pr Lewis Fk, SR 1304, Wilkes	B-18	12-31-1-(5.5)	07/96	-/33	-/3.32	Good
S Pr Lewis Fk, US 421, Wilkes	B-19	12-31-2-(1)	07/96	-/32	-/2.51	Good
Yadkin R, SR 1372, Wilkes	B-20	12-(36.5)	09/88	-/26	-/3.11	Good-Fair
Yadkin R, NC 18/268, N Wilkesb, Wilkes	B-21	12-(38)	07/96	72/39	4.93/3.95	Good
			06/93	73/34	5.40/4.24	Good-Fair
			08/89	75/35	4.63/4.13	Good
			08/87	67/26	5.29/4.34	Good-Fair
			07/87	-/20	-/4.41	Good-Fair
			08/86	67/27	5.46/4.19	Good-Fair
			09/85	66/21	5.63/4.71	Good-Fair
			08/84	58/29	4.62/4.08	Good-Fair
Yadkin R, ab ABT, Wilkes	B-22	12-(38)	06/93	83/37	4.77/3.79	Good
Yadkin R, bel ABT, Wilkes	B-23	12-(38)	06/93	63/25	5.12/4.37	Good-Fair
Moravian Cr, NC 18, Wilkes	B-24	12-39	07/96	-/27	-/4.25	Good-Fair
Mulberry Cr, NC 268, Wilkes	B-25	12-42	07/96	-/36	-/3.11	Excellent
UT Mulberry Cr, ab Gardner Mirr, Wilkes	B-26	12-42-9	09/90	39/17	4.50/3.39	Good-Fair
UT Mulberry Cr, be Gardner Mirr. Wilkes	B-27	12-42-9	09/90	22/3	7.79/3.03	Poor
Roaring R, SR 1990, Wilkes	B-28	12-46	07/96	98/48	4.61/3.33	Excellent
			07/88	92/43	4.66/3.41	Good
			08/85	88/36	4.70/3.23	Good
	08/83	66/35	3.83/3.29 Good			
Pike Cr, SR 1730, Wilkes	B-29	12-46-1-2	10/89	-/32	-/2.28	Excellent
Basin Cr, SR 1730, Wilkes	B-30	12-46-2-2	10/89	-/36	-/2.61	Excellent
E Pr Roaring R, SR 1002, Wilkes	B-31	12-46-4-(7)	10/89	-/28	-/2.80	Good
Bullhead Cr, SR 1739, Wilkes	B-32	12-46-4-2	10/89	-/36	-/2.38	Excellent
Rich Mt Cr, ab Bullhead Cr, Wilkes	B-33	12-46-4-2-2	10/89	-/41	-/2.07	Excellent
Widows Cr, SR 1739, Wilkes	B-34	12-46-4-4	10/89	-/34	-/2.24	Excellent

Garden Cr, SR 1739, Wilkes	B-35	12-46-4-6	10/89	-/30	-/2.56	Good
			08/89	-/30	-/2.06	Good
			12/88	-/33	-/2.15	Good
Big Sandy Cr, SR 1737, Wilkes	B-36	12-46-4-8-(2)1	10/89	-/29	-/2.83	Good
L Sandy Cr, SR 1943, Wilkes	B-37	12-46-4-10	10/89	-/30	-/3.42	Good

YAD 02

Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Yadkin R, US 21, Elkin, Yadkin	B-1	12-(53)	07/96	56/23	5.12/4.01	Good-Fair
			08/89	50/17	5.57/5.06	Fair
			07/87	58/24	5.25/4.34	Good-Fair
Yadkin R, SR 1003 nr Siloam, Surry	B-2	12-(53)	07/96	62/30	5.28/4.44	Good-Fair
			08/84	45/19	5.22/4.46	Fair
Elkin Cr, NC 268, Surry	B-3	12-54-(4.5)	07/96	-/24	-/3.56	Good-Fair
Mitchell R, ab Sams Br, Alleghany (on Reynolds Estate)	B-4	12-62-(1)	07/90	-/24	-/1.49	Good
			08/89	-/28	-/1.50	Good
			12/88	-/29	-/1.42	Excellent
			09/88	-/31	-/1.40	Excellent
Sams Br, on Reynolds Estate, Alleghany	B-5	12-62-(1)	07/90	-/15	-/1.22	Good-Fair
			08/89	-/17	-/1.86	Good-Fair
			12/88	-/20	-/1.29	Good
			09/88	-/23	-/1.65	Good
Mitchell R, be Sams Br, Alleghany (on Reynolds Estate)	B-6	12-62-(1)	07/90	-/20	-/1.23	Good
			08/89	-/22	-/1.38	Good
			12/88	-/28	-/1.35	Good
			09/88	-/30	-/1.46	Excellent
UT Mitchell R, Reynolds Estate, Surry	B-7	12-62-(1)	06/90	-/39	-/1.85	Excellent
Mitchell R, SR 1330, nr Devotion, Surry	B-8	12-62-(1)	07/96	79/38	3.83/3.02	Excellent
			02/91	-/41	-/1.98	Excellent
			10/89	-/34	-/2.63	Excellent
			08/89	-/32	-/2.75	Good
			12/88	-/39	-/2.22	Excellent
			08/88	-/33	-/2.79	Good
			06/87	91/41	3.38/2.55	Excellent
Mitchell R, SR 1330, Surry	B-9	12-62-(1)	06/87	73/32	4.44/3.29	Excellent
Roaring Gap Br, Reynolds Est, Alleghany	B-10	12-62-(1)	09/88	-/32	-/1.63	Excellent
Stewart Fk, Reynolds Estate, Surry	B-11	12-62-2	07/90	-/34	-/2.02	Excellent
			08/89	-/30	-/1.75	Excellent
			08/88	-/26	-/1.96	Good
			12/88	-/30	-/1.75	Excellent
Mitchell R, SR 1315, Surry	B-12	12-62-7	06/87	88/38	4.15/3.48	Excellent
			09/86	94/31	4.82/3.46	Good
			03/85	100/43	4.38/2.71	Excellent
Mitchell R, SR 1001, Surry	B-13	12-62-(12.5)	07/96	82/43	4.41/3.50	Good
Mitchell R, I-77, Surry	B-14	12-62-(12.5)	07/87	78/31	4.66/3.38	Good
S Fk Mitchell R, SR 1307, Surry	B-15	12-62-13	07/87	74/29	4.40/3.78	Excellent
Snow Cr, SR 1121, Surry	B-16	12-62-15	07/96	-/31	-/3.67	Good
			07/87	67/27	4.83/3.97	Good
Ramey Cr, SR 1408, Surry	B-17	12-63-3-1	10/89	-/27	-/2.54	Good
Endicott Cr, off SR 1421, ab camp, Surry	B-18	12-63-5-(1)	02/91	95/52	3.09/2.13	Excellent
L Endicott Cr, off SR 1421, Surry	B-19	12-63-5-(2)	02/91	86/48	3.07/1.92	Excellent
Endicott Cr, SR 1338, Surry	B-20	12-63-5-(3)	02/91	-/12	-/4.29	Fair
Fisher R, US 601, Surry	B-21	12-63-(9)	07/96	-/30	-/3.67	Good
Fisher R, NC 268, Surry	B-22	12-63-(9)	07/96	84/36	4.99/3.75	Good
L Fisher R, SR 1480, Surry	B-23	12-63-10-(2)	07/96	-/29	-/4.28	Good
L Beaver Cr, NC 268, Yadkin	B-24	12-63-13	07/89	63/20	5.02/4.11	Good-Fair
L Beaver Cr, at mouth, NC 268, Yadkin	B-25	12-63-13	07/89	23/2	6.83/4.21	Poor

N Pr S Fk Mitchell R, off SR 1515, Surry	B-26	12-63-13-1	06/90	-/32	-/3.18	Good
W Pr L Yadkin R, SR 1136, Stokes	B-27	12-77-1	05/90	69/35	4.14/3.28	Good
			05/89	85/35	4.92/3.60	Good
			05/88	-/37	-/3.60	Good
			05/87	83/39	4.07/3.25	Good
W Pr L Yadkin R, SR 1160, Stokes	B-28	12-77-1	06/91	73/28	4.57/3.62	Good-Fair
			05/88	-/26	-/4.22	Good-Fair
			05/87	70/30	4.77/3.98	Good
L Yadkin R, SR 1236, Stokes	B-29	12-77-(1)	07/96	54/24	4.80/4.36	Good-Fair
L Yadkin R, SR 1104, nr Dalton, Stokes	B-30	12-77-(1)	05/94	82/31	5.23/3.76	Good
			05/92	94/37	5.01/4.09	Good
			05/91	82/32	4.87/4.12	Good
			05/90	72/32	4.91/4.37	Good-Fair
			08/89	84/27	5.44/4.45	Good-Fair
			05/89	77/30	5.46/4.31	Good-Fair
			07/88	-/16	-/4.91	Fair
			05/88	-/23	-/4.10	Good-Fair
			07/87	97/32	5.02/4.12	Good-Fair
			05/87	62/25	4.99/4.22	Good-Fair
E Pr L Yadkin R, SR 1166, Stokes	B-31	12-77-2	05/91	60/25	5.15/4.50	Good-Fair
			05/90	59/27	5.19/4.72	Good-Fair
			05/89	68/21	5.22/4.47	Good-Fair
			05/88	66/25	4.78/4.01	Good-Fair
			05/87	57/28	4.33/3.51	Good-Fair
E Pr L Yadkin R, SR 1224, Stokes	B-32	12-77-2	05/94	66/30	5.16/4.48	Good-Fair
			05/91	81/30	4.81/4.22	Good-Fair
			05/90	62/26	5.23/4.25	Good-Fair
			05/89	84/29	5.30/4.05	Good-Fair
			05/88	88/29	5.33/4.13	Good-Fair
			05/87	60/29	4.45/4.01	Good
E Pr L Yadkin R, SR 1220, Stokes	B-33	12-77-2	05/94	60/25	5.26/4.01	Good-Fair
			05/92	72/28	5.13/3.97	Good-Fair
			05/91	72/28	4.72/4.11	Good-Fair
N UT E Pr Yadkin R, NC 66, Stokes	B-34	12-77-2	05/94	72/36	3.81/2.86	Good
			05/92	72/35	3.58/2.91	Good
			05/91	70/30	4.03/3.00	Good
S UT E Pr Yadkin R, NC 66, Stokes	B-35	12-77-2	05/94	60/27	4.26/3.67	Good
			05/92	70/27	4.62/3.79	Good-Fair
			05/91	62/22	4.92/3.89	Good-Fair
L Yadkin R, SR 1604, Forsyth	B-36	12-77-(3.5)	05/88	-/28	-/3.68	Good-Fair
			05/87	61/26	4.74/4.20	Good-Fair
L Yadkin R, SR 2238,	B-37	12-77-(3.5)	07/88	-/16	-/4.91	Good-Fair
Crooked Run Cr, SR 1104, Stokes	B-38	12-77-4-2	05/88	-/21	-/4.70	Good-Fair
			05/87	60/25	4.42/3.91	Good
Yadkin R, SR 1605 nr Enon, Forsyth	B-39	12-(81.5)	07/87	65/23	4.72/3.80	Good
Justice Reynolds Cr, off SR 1561, Yadkin	B-40	12-(81.5)	06/93	61/28	4.76/4.08	Good-Fair
			07/89	69/25	5.05/4.08	Good-Fair
Justice Reynolds Cr, off SR 1562, Yadkin	B-41	12-(81.5)	06/93	70/30	4.19/3.47	Good
			07/89	65/27	4.49/4.02	Good-Fair
Dill Cr, private rd, off SR 1563, Yadkin	B-42	12-(81.5)	06/93	71/26	5.01/4.53	Good-Fair
			07/89	78/25	5.24/4.33	Good-Fair
Forbush Cr, SR 1570, Yadkin	B-43	12-83	07/96	-/23	-/4.02	Good-Fair
Logan Cr, SR 1571, Yadkin	B-44	12-83-2	07/96	-/27	-/4.75	Good-Fair
N Deep Cr, SR 1503, Yadkin	B-45	12-84-1	04/93	62/26	5.05/4.60	Good-Fair

N Deep Cr, NC 601, Yadkin	B-46	12-84-1	04/93	58/27	4.95/4.34	Good-Fair
N Deep Cr, SR 1510, Yadkin	B-47	12-84-1	07/96	57/24	5.22/4.66	Good-Fair
			04/93	53/25	4.85/4.39	Good-Fair
S Deep Cr, SR 1710, Yadkin	B-48	12-84-2-(5)	07/96	56/26	4.77/4.24	Good

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Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Ararat R, NC 104, Surry	B-1	12-72-(1)	07/96	-/26	-/3.95	Good-Fair
			09/86	64/18	4.96/4.05	Good-Fair
Ararat R, US 52 bus, Surry	B-2	12-72-(4.5)	09/86	63/20	5.53/4.15	Good-Fair
Ararat R, nr US 52, ab WWTP, Surry	B-3	12-72-(4.5)	11/94	72/27	5.18/3.83	Good-Fair
			03/85	82/24	5.46/4.15	Good-Fair
Ararat R, be WWTP, Surry	B-4	12-72-(4.5)	11/94	47/13	5.65/4.09	Fair
			09/86	32/1	7.56/4.28	Poor
			03/85	45/11	6.85/4.29	Poor
Ararat R, SR 2119, Surry	B-5	12-72-(4.5)	03/85	44/10	6.62/5.08	Poor
Ararat R, SR 2026, at Ararat, Surry	B-6	12-72-(4.5)	08/96	69/20	5.72/4.62	Good-Fair
			07/90	59/17	6.04/5.02	Fair
			07/88	62/16	6.30/5.56	Fair
			09/86	50/11	6.53/5.42	Fair
			08/86	65/21	6.10/4.73	Fair
			08/84	66/24	5.92/4.62	Fair
Ararat R, SR 2080, Surry	B-7	12-72-(4.5)	08/96	42/19	5.04/4.51	Good-Fair
			09/86	61/17	5.84/4.38	Fair
Lovills Cr, SR 1700, Surry	B-8	12-72-8-(1)	07/96	-/22	-/4.75	Good-Fair
			02/86	60/25	4.34/3.56	Good-Fair
Lovills Cr, SR 1371, Surry	B-9	12-72-8-(3)	07/96	61/16	6.33/4.74	Fair
			02/86	39/12	5.42/3.75	Fair
Stewarts Cr, SR 1622, Surry	B-10	12-72-9-(1)	10/87	90/32	5.14/3.64	Good-Fair
			02/86	104/39	4.43/3.29	Good
Stewarts Cr, NC 89, Surry	B-11	12-72-9-(4)	07/96	-/23	3.83/3.83	Good-Fair
Stewarts Cr, SR 2258, Surry	B-12	12-72-9-(8)	07/96	81/27	5.38/4.37	Good-Fair
Pauls Cr, SR 690 (Carroll, VA)	B-13	12-72-9-7	10/87	62/26	4.86/3.64	Good-Fair
Brushy Fk, SR 1625, Surry	B-14	12-72-9-7-1	10/87	-/17	-/3.97	Good-Fair
Flat Shoals Cr, SR 1827, Surry	B-15	12-72-13	08/96	-/27	-/3.54	Good-Fair
			01/87	86/37	4.40/3.53	Good
Toms Cr, NC 52, Surry	B-16	12-72-14-(3.5)	01/87	56/27	5.19/4.49	Good
Toms Cr, SR 1815, Surry	B-17	12-72-14-(4)	01/87	51/16	5.66/4.58	Fair
Heatherly Cr, ab WWTP, Surry	B-18	12-72-14-5	11/94	47/17	6.05/5.11	Fair
			01/87	47/14	6.41/5.38	Fair
Heatherly Cr, bel WWTP, Surry	B-19	12-72-14-5	11/94	14/0	8.50/0.00	Poor
			01/87	25/2	8.44/7.00	Poor
Heatherly Cr, bel US 52, Surry	B-20	12-72-14-5	01/87	32/2	8.50/5.35	Poor

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Site	Site #	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Muddy Cr, SR 1620, Forsyth	B-1	12-94-(0.5)	01/85	90/29	5.40/4.63	Good
Muddy Cr, ab Westinghouse, Forsyth	B-2	12-94-(0.5)	01/89	-/22	-/4.49	Good-Fair
			10/88	-/18	-/5.46	Good-Fair
			01/85	75/22	5.73/4.99	Good-Fair
Muddy Cr, be Westinghouse, Forsyth	B-3	12-94-(0.5)	01/89	-/15	-/4.77	Fair
			10/88	-/11	-/5.81	Fair
			01/85	51/19	6.01/4.99	Fair
Muddy Cr, SR 1898, Forsyth	B-4	12-94-(0.5)	08/96	-/18	-/5.02	Good-Fair
			03/87	-/15	-/5.61	Fair
Muddy Cr, off SR 1632, Forsyth	B-5	12-94-(0.5)	01/85	71/19	6.73/5.70	Fair

Muddy Cr, SR 2995, Forsyth	B-6	12-94-(0.5)	08/96	51/18	6.26/5.27	Good-Fair
			07/85	53/17	6.47/4.92	Good-Fair
			08/83	54/8	7.38/6.04	Fair
Barkers Cr, SR 1620, Forsyth	B-7	12-94-1	03/87	-/5	-/6.47	Poor
Barkers Cr, ab Parkers Cr, Forsyth	B-8	12-94-1	03/87	-/18	-/4.68	Good-Fair
Barkers Cr, SR 1898, Forsyth	B-9	12-94-1	03/87	-/20	-/4.73	Good-Fair
Parkers Cr, SR 1620, Forsyth	B-10	12-94-1-1	03/87	-/18	-/3.50	Good-Fair
			01/85	78/33	5.01/4.50	Good
Grassy Cr, SR 1669, Forsyth	B-11	12-94-7-3	10/84	54/11	7:04/5.56	Fair
Grassy Cr, SR 1672, Forsyth	B-12	12-94-7-3	10/84	65/13	6.88/5.40	Fair
Reynolds Cr, ab Sequoia WWTP, Forsyth	B-13	12-94-9	08/94	44/17	4.64/4.16	Good
Reynolds Cr, be Sequoia WWTP, Forsyth	B-14	12-94-9	08/94	41/9	6.49/5.02	Fair
Salem Cr, SR 2657 ab lake, Forsyth,	B-15	12-94-12-(1)	08/96	-/15	-/4.97	Good-Fair
Salem Cr, ab Bath Br nr NC 52, Forsyth	B-16	12-94-12-(4)	09/83	36/4	8.20/6.60	Poor
Salem Cr, ab Tar Br, Forsyth	B-17	12-94-12-(4)	09/83	29/0	8.87/-	Poor
Salem Cr, SR 2902, Forsyth	B-18	12-94-12-(4)	08/96	53/11	7.18/5.87	Fair
			09/82	31/4	7.91/6.95	Poor
Salem Cr, SR 2991, Forsyth	B-20	12-94-12-(4)	08/96	43/8	7.14/5.74	Fair
			09/82	22/0	8.38/-	Poor
Bath Br, Stadium Dr, Forsyth	B-21	-	09/83	11/1	9.39/-	Poor
S Fk Muddy Cr, SR 2902, Forsyth	B-22	12-94-13	08/96	-/15	-/4.83	Good-Fair
Fryes Cr, NC 150, Davidson	B-23	12-94-15-(1)	09/82	53/16	5.59/4.92	Good-Fair
Yadkin R, SR 1447 or US 64, Forsyth	B-24	12-(97.5)	07/90	66/29	5.33/4.43	Good
			08/86	68/27	5.78/4.75	Good
			09/85	61/24	5.55/4.43	Good
			08/83	54/20	5.09/4.30	Good
Second Cr, SR 2335, Rowan	B-25	12-108-21	06/88	-/18	-/4.91	Good-Fair
			02/87	64/25	5.47/4.11	Good
			10/84	91/25	5.55/4.90	Good
Second Cr, SR 2337 be UT, Rowan	B-26	12-108-21	06/88	-/18	-/4.86	Good-Fair
			02/87	81/25	6.19/4.52	Good
			10/84	78/17	6.40/4.98	Good-Fair
Second Cr, SR 2338, Rowan	B-27	12-108-21	10/84	93/22	6.29/5.29	Good-Fair
UT Second Cr A, SR 2335, Rowan	B-28	12-108-21	02/87	-/17	-/4.71	Good-Fair
			06/88	-/18	-/5.29	Good-Fair
UT Second Cr B, bel WWTP,Rowan	B-29	12-108-21	06/88	-/0	-/-	Poor
Grants Cr, SR 1197, Rowan	B-30	12-110	07/83	20/3	7.56/5.58	Poor
Grants Cr, Patterson St/China Gr,Rowan	B-31	12-110	07/83	24/1	8.53/6.22	Poor
Grants Cr, SR 1506, Rowan	B-32	12-110	07/83	51/10	6.40/5.30	Good-Fair
Grants Cr, SR 1910 (Spencer), Rowan	B-33	12-110	08/96	74/20	6.33/5.20	Good-Fair
			07/89	67/20	6.14/5.21	Good-Fair
Little Cr, SR 1535, Rowan	B-34	12-110-3	09/90	46/14	5.10/4.49	Good-Fair
UT Grants Cr, SR 1500, Rowan	B-35	12-110	09/90	26/0	8.33/-	Poor
Town Cr, ab Salisbury WWTP, Rowan	B-36	12-115-3	09/90	68/9	7.82/6.34	Poor
Town Cr, I-85, Rowan	B-37	12-115-3	09/90	32/0	8.35/-	Poor

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Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Dutchmans Cr, US 158, Davie	B-1	12-102-(2)	07/96	69/24	5.56/4.66	Good
Cedar Cr, NC 801, Davie	B-2	12-102-13-(1)	06/90	-/10	-/5.98	Fair
Cedar Cr, ab Quarry, Davie	B-3	12-102-13-(2)	06/90	63/13	6.51/5.79	Fair
Cedar Cr, bel Quarry, Davie	B-4	12-102-13-(2)	06/90	69/16	6.40/5.64	Good-Fair
Cedar Cr, US 158, Davie	B-5	12-102-13-(2)	07/96	-/15	-/6.00	Good-Fair
Elisha Cr, SR 1405, Davie	B-6	12-102-15	04/88	-/27	-/4.08	Good-Fair
Dutchmans Cr, NC 801, Davie	B-7	12-102-(15.5)	07/96	83/29	6.15/4.55	Good

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Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
S Yadkin R, SR 1561, Iredell	B-1	12-108-(5.5)	08/96	70/30	4.76/4.02	Excellent
S Yadkin R, SR 1159, Davie	B-2	12-108-(9.7)	08/96	59/29	4.53/3.76	Good
			07/89	73/32	4.61/3.80	Excellent
			08/86	79/26	5.03/4.12	Good
			08/84	83/34	4.66/3.82	Excellent
Rocky Cr, SR 1862, Iredell	B-3	12-108-11	11/90	91/45	3.79/2.69	Excellent
Rocky Cr, SR 1884, Iredell	B-4	12-108-11	08/96	-/26	-/3.75	Good
Rocky Cr, SR 1890, Iredell	B-5	12-108-11	11/90	79/37	4.41/3.39	Excellent
Patterson Cr, SR 1892, Iredell	B-6	12-108-11-3	08/96	-/22	-4.24	Good
Patterson Cr, SR 1890, Iredell	B-7	12-108-11-3	11/90	77/32	5.16/4.33	Excellent
Fifth Cr, SR 2158, Iredell	B-8	12-108-13	06/89	-/25	-/4.82	Good
Hunting Cr, SR 2428, Wilkes	B-9	12-108-16-(0.5)	04/93	89/46	3.44/2.42	Excellent
Hunting Cr, NC 115 ab dredge, Wilkes	B-10	12-108-16-(0.5)	06/92	84/43	3.80/3.28	Excellent
Hunting Cr, SR 2423 bel dredge, Wilkes	B-11	12-108-16-(0.5)	06/92	85/42	4.16/3.46	Good
Hunting Cr, SR 2115,nr Harmony, Iredell	B-12	12-108-16-(0.5)	08/96	66/30	4.52/3.24	Excellent
			07/88	72/27	5.33/4.03	Good
			07/85	79/33	4.84/3.56	Excellent
			08/83	78/28	5.14/4.16	Good
Hunting Cr, SR 2120, Iredell	B-13	12-108-16-(0.5)	06/90	82/40	4.34/3.91	Excellent
Hunting Cr, SR 2127, Iredell	B-14	12-108-16-(0.5)	06/90	66/34	5.00/4.42	Excellent
Hunting Cr, US 64, Davie	B-15	12-108-16-(0.5)	06/90	-/28	-/3.79	Excellent
N Little Hunting Cr, SR 1829, Iredell	B-16	12-108-16-6	08/96	-/28	-/3.68	Excellent
Bear Cr, US 64, Davie	B-17	12-108-18-(1)	05/94	74/23	5.70/4.82	Good-Fair
Bear Cr, SR 1139, ab WWTP, Davie	B-18	12-108-18-(3.3)	04/88	77/25	5.87/5.15	Good-Fair
Bear Cr, SR 1116, bel WWTP, Davie	B-19	12-108-18-(3.3)	04/88	93/25	6.34/4.89	Good-Fair
Fourth Cr, SR 2321, Iredell	B-20	12-108-20-(1)	09/87	-/16	-/5.31	Good-Fair
Fourth Cr, SR 2322, Iredell	B-21	12-108-20-(1)	09/87	-/16	-/5.23	Good-Fair
Fourth Cr, SR 2316, ab WWTP, Iredell	B-22	12-108-20-(1)	06/89	59/18	5.81/5.39	Good-Fair
Fourth Cr, SR 2308, bel WWTP, Iredell	B-23	12-108-20-(1)	06/89	64/17	6.94/5.66	Fair
Fourth Cr, SR 1003, Rowan	B-24	12-108-20-(1)	08/96	-/23	-/5.00	Good
Third Cr, SR 2318, ab WWTP, Iredell	B-25	12-108-20-4-(0.5)	09/90	69/22	5.55/4.96	Good
		12-108-20-4-(0.5)	06/89	71/23	5.59/5.15	Good
Third Cr, SR 2359, Iredell	B-26	12-108-20-4-(0.5	09/90	72/21	5.86/4.93	Good-Fair
			06/89	69/17	5.96/5.03	Good-Fair
Third Cr, SR 1970, nr Woodleaf, Rowan	B-27	12-108-20-4-(7)	08/96	56/23	4.78/4.16	Good
			07/90	62/23	5.55/4.02	Good
			07/87	68/26	5.59/3.94	Good
North Second Cr, SR 1526, Rowan	B-28	12-108-21	08/96	-/16	-/4.75	Good-Fair
North Second Cr, US 70, Rowan	B-29	12-108-21	08/96	54/17	6.06/5.49	Good-Fair
Withrow Cr, SR 1547, Rowan	B-30	12-108-21-3-(0.5)	08/96	-/14	-/4.64	Good-Fair

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Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
N Potts Cr, ab UT, Davidson	B-1	12-112	10/88	14/14	5.26/5.26	Good-Fair
UT N Potts Cr, ab WWTP, Davidson	B-2	12-112	10/88	34/11	6.10/4.62	Fair
UT N Potts Cr, bel WWTP, Davidson	B-3	12-112	10/88	26/6	6.57/4.60	Fair
N Potts Cr, bel UT, Davidson	B-4	12-112	10/88	-/18	-/4.54	Good-Fair
Swearing Cr, SR 1147, Davidson	B-5	12-113	11/87	62/20	6.12/5.20	Good-Fair
Swearing Cr, SR 1104, Davidson	B-6	12-113	11/87	63/18	6.18/5.25	Good-Fair
			10/85	46/9	6.89/4.43	Fair
Swearing Cr, NC 47, Davidson	B-7	12-113	08/96	-/16	-/5.15	Good-

						Fair
Swearing Cr, ab WWTP, Davidson	B-8	12-113	10/85	72/21	6.16/4.79	Good-Fair
Swearing Cr, SR 1272, Davidson	B-9	12-113	10/85	42/7	7.33/5.68	Poor
Abbotts Cr, SR 1755, Davidson	B-10	12-119-(1)	08/96	-/16	-/4.84	Good-Fair
Brushy Fork, SR 1810, Davidson	B-11	12-119-5-(1)	08/96	-/13	-/4.65	Fair
Abbotts Cr, SR 2208, Davidson	B-12	12-119-(6)	08/96	62/17	6.43/5.82	Good-Fair
Abbotts Cr, bel new WWTP, Davidson	B-13	12-119-(6)	11/85	47/13	7.17/5.73	Fair
Abbotts Cr, I-85, Davidson	B-14	12-118.5	11/87	46/10	7.45/5.66	Fair
			08/86	46/10	7.47/6.37	Fair
			11/85	58/17	6.90/5.59	Fair
Abbotts Cr, Center St/SR 1243, Davidson	B-15	12-119-(6)	11/85	49/12	7.32/5.81	Fair
Abbotts Cr, US 27/70/Bus 85, Davidson	B-16	12-119-(6)	11/85	49/12	7.24/5.63	Fair
Rich Fk, SR 1784, Davidson	B-17	12-119-7	11/87	60/14	6.67/4.96	Fair
			11/85	62/19	6.11/5.11	Good-Fair
Rich Fk, NC 109, Davidson	B-18	12-119-7	11/85	56/10	7.83/5.35	Fair
Rich Fk, SR 1792, Davidson	B-19	12-119-7	11/87	53/10	6.84/5.88	Fair
			11/85	34/2	8.13/6.81	Poor
			09/83	18/0	8.80/0.00	Poor
Rich Fk, SR 2123, Davidson	B-20	12-119-7	09/83	35/2	8.39/5.39	Poor
Rich Fk, SR 2022, Davidson	B-21	12-119-7	11/85	50/11	7.41/5.92	Fair
Rich Fk, SR 2005, Davidson	B-22	12-119-7	11/87	57/13	6.99/5.56	Fair
			11/85	57/12	7.36/5.59	Fair
			9/83	34/3	7.89/6.63	Poor
Hunts Fk, SR 1792, Davidson	B-23	12-119-7-3	11/87	49/13	6.83/5.63	Fair
			11/85	69/15	6.84/5.62	Fair
Hunts Fk, 1/3 mi ab SR 1787, Davidson	B-24	12-119-7-3	9/83	40/4	8.49/6.43	Poor
Hunts Fk, SR 1787, Davidson	B-25	12-119-7-3	09/83	42/0	8.50/0.00	Poor
Hamby Cr, I-85 rest area, SR 2031, Davidson	B-26	12-119-7-4	11/87	44/3	7.97/5.22	Poor
			11/85	35/4	7.96/6.44	Poor
Hamby Cr, SR 2025, Davidson	B-27	12-119-7-4	08/96	-/6	-/6.36	Poor
Hamby Cr, SR 2005, Davidson	B-28	12-119-7-4	11/85	57/12	7.18/5.85	Fair
Hamby Cr, nr SR 2005 ab confl, Davidson	B-29	12-119-7-4	09/83	34/4	7.42/6.11	Fair
N Hamby Cr, SR 2085, Davidson	B-30	12-119-7-4-1	11/87	45/8	8.11/7.08	Poor
			11/85	41/7	7.50/6.61	Poor
Jimmys Cr, SR 2020, bel Quarry, Davidson	B-31	12-119-7-4-2	06/90	58/14	6.23/5.48	Fair
Jimmys Cr, ab Quarry, Davidson	B-32	12-119-7-4-2	06/90	58/15	6.22/5.74	Fair
Leonards Cr, SR 1844, Davidson	B-33	12-119-8-(3)	08/96	-/18	-/5.14	Good-Fair

YAD 08

Site	Site #	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
UT Lick Cr, NC 47, Davidson	B-1	12-126-(3)	05/86	53/4	8.23/6.23	Poor
			05/85	32/2	8.46/7.20	Poor
UT Lick Cr, SR 2505, Davidson	B-2	12-126-(3)	05/86	56/11	7.20/4.57	Fair
			05/85	23/1	8.90/-	Poor
Lick Cr, SR 2351, Davidson	B-3	12-126-(3)	05/86	84/18	6.19/5.42	Good-Fair
Lick Cr, NC 8, Davidson	B-4	12-126-(3)	08/96	-/12	-/5.51	Fair
			05/86	76/22	6.14/4.90	Good-Fair
Cabin Cr, NC 8, Davidson	B-5	12-127-(2)	08/96	-/19	-/4.57	Good-Fair
			05/86	88/17	6.05/5.06	Good-Fair
Mountain Cr, SR 1720, Stanly	B-6	13-5-(0.7)	08/96	91/25	5.50/4.86	Good
L Mountain Cr, SR 1720, Stanly	B-7	13-5-1-(2)	08/96	-/11	-/5.62	Fair
Clarks Cr, SR 1174, Montgomery	B-8	13-16	08/96	-/24	-/3.91	Good

Clarks Cr, SR 1103, Montgomery	B-9	13-16	08/96	82/26	5.84/5.06	Good-Fair

YAD 09

Site	Site #	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Uwharrie R, SR 1406, Randolph	B-1	13-2-(0.5)	08/96	-/22	-/4.91	Good-Fair
L Uwharrie R, SR 1405, Randolph	B-2	13-2-1	08/96	-/14	-/4.34	Good-Fair
Uwharrie R, SR 1143, Randolph	B-3	13-2-(1.5)	08/96	72/19	5.22/4.50	Good
Jackson Cr, SR 1312, Randolph	B-4	13-2-2	08/96	-/19	-/4.00	Good-Fair
Caraway Cr, SR 1331, Randolph	B-5	13-2-3	08/96	-/17	-/4.68	Good-Fair
Back Cr, SR 1318, Randolph	B-6	13-2-3-3-(1.5)	08/96	-/15	-/4.44	Good-Fair
Little Back Cr, SR 1327, Randolph	B-7	13-2-3-3-(1.5)	02/89	-/21	4.99/3.63	Good-Fair
UT Back Cr #1, SR 1504, Randolph	B-8	13-2-3-3-(1.5)	02/90	82/21	5.67/4.74	Good-Fair
UT Back Cr #2, SR 1512, Randolph	B-9	13-2-3-3-(1.5)	02/90	61/17	6.53/5.24	Good-Fair
Betty McGees Cr, SR 1107, Randolph	B-10	13-2-5	10/89	-/27	-/3.31	Good
Uwharrie R, NC 109, Montgomery	B-11	13-2-(17.5)	08/96	80/27	5.18/4.02	Good
			07/90	81/30	5.07/4.05	Excellent
			07/88	101/30	5.23/3.83	Good
			07/86	100/27	5.43/3.97	Good
			08/84	85/29	5.15/4.24	Good
Barnes Cr, SR 1307, Montgomery	B-12	13-2-18-(0.5)	03/88	-/30	-/3.63	Excellent
Poison Br, SR 1306, Montgomery	B-13	13-2-18-1	03/88	-/33	-/2.84	Excellent
Barnes Cr, SR 1303, Montgomery	B-14	13-2-18-(2.5)	08/96	99/36	4.29/3.14	Excellent
			07/89	84/24	4.79/3.68	Good
			07/87	-/28	-/3.96	Excellent
			07/87	90/27	4.82/3.57	Good
			08/85	87/29	4.68/3.75	Excellent
			05/85	100/36	4.76/3.75	Excellent
			10/84	97/37	4.51/3.36	Excellent
Cedar Cr, SR 1150, Montgomery	B-15	13-2-23	03/88	90/39	4.01/3.27	Excellent
Dutchman's Cr, SR 1150, Montgomery	B-16	13-2-24	08/96	63/29	3.61/2.85	Excellent
			07/85	60/24	3.96/2.98	Excellent

YAD 10

Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Brown Cr, SR 1627, Anson	B-1	13-20	08/96	70/8	7.04/6.07	Fair
Lick Cr, SR 1244, Anson	B-2	13-20-5	04/86	88/21	6.20/5.13	Good-Fair
Savannah Cr, SR 1742, Anson	B-3	13-26	09/83	33/4	6.87/5.96	Poor
Mountain Cr, SR 1150, Richmond	B-4	13-28-1-(0.5)	08/96	-/30	-/3.83	Excellent

YAD 11

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Rocky R, SR 1142, Iredell	B-1	13-17	06/85	59/18	6.08/5.10	Good-Fair
Rocky R, SR 2420, Mecklenburg	B-2	13-17	08/96	-/7	-/5.84	Fair
		13-17	06/85	57/16	6.11/5.26	Good-Fair
			03/85	64/13	6.41/4.92	Fair
Rocky R, NC 29, Cabarrus	B-3	13-17	03/85	70/19	6.12/5.06	Fair
Rocky R, SR 1132, Cabarrus	B-4	13-17	03/85	81/27	6.10/5.14	Good-Fair
Dye Branch, SR 1147, Iredell	B-5	13-17-2	09/90	52/13	6.24/5.52	Fair
			06/85	53/14	6.50/5.58	Fair
Dye Branch, SR 1142, Iredell	B-6	13-17-2	09/90	27/4	7.95/6.77	Poor
			06/85	30/4	8.14/5.78	Poor
Mallard Cr, SR 1300, Cabarrus	B-7	13-17-5	03/85	82/22	6.16/4.98	Good-Fair
Coddle Cr, SR 1612, Cabarrus	B-8	13-17-6-(0.5)	06/85	66/21	5.80/5.00	Good-Fair
Coddle Cr, NC 49, Cabarrus	B-9	13-17-6-(5.5)	08/96	-/13	-/5.40	Fair
Back Cr, SR 2827, Mecklenburg	B-10	13-17-7	10/84	64/19	6.09/4.76	Good-Fair
Fuda Cr, SR 1158, Cabarrus	B-11	13-17-7-1	03/85	74/18	6.60/5.84	Fair
UT Reedy Cr be landfill, Mecklenburg	B-12	13-17-8	10/84	44/11	6.94/5.03	Fair

YAD 12

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Rocky R, US 601, Cabarrus	B-1	13-17	08/96	56/19	6.01/5.26	Good-Fair
			07/89	66/19	6.26/5.14	Good-Fair
Rocky R, NC 24/27, Cabarrus	B-2	13-17	03/85	86/30	6.21/4.89	Good-Fair
Irish Buffalo Cr, SR 1132, Cabarrus	B-3	13-17-9-(2)	08/96	58/15	5.96/5.25	Good-Fair
Coldwater Cr, NC 49, Cabarrus	B-4	13-17-9-4-(1.5)	08/96	-/14	-/5.15	Good-Fair
Dutch Buffalo Cr, SR 1006, Cabarrus	B-5	13-17-11-(4.5)	03/85	92/24	5.77/4.70	Good-Fair
Dutch Buffalo Cr, NC 200, Cabarrus	B-6	13-17-11-(5)	08/96	59/18	6.18/5.35	Good-Fair
			07/89	74/23	5.88/5.03	Good-Fair
			07/86	78/12	6.68/5.29	Fair
Goose Cr, US 601, Union	B-7	13-17-18	08/96	-/2	-/6.09	Poor
Crooked Cr, SR 1547, Union	B-8	13-17-20	08/96	-/12	-/4.67	Fair
N Fk Crooked Cr, SR 1520, Union	B-9	13-17-20-1	09/95	46/8	6.72/5.88	Fair
N Fk Crooked Cr, SR 1514, Union	B-10	13-17-20-1	09/95	57/12	6.35/5.39	Good-Fair
N Fk Crooked Cr, SR 1004, Union	B-11	13-17-20-1	09/95	48/9	6.72/5.95	Fair
S Fk Crooked Cr, ab SR 1515, Union	B-12	13-17-20-2	09/95	59/3	7.50/6.82	Poor
S Fk Crooked Cr, SR 1515, Union	B-13	13-17-20-2	09/95	54/5	6.95/6.70	Fair
S Fk Crooked Cr, SR 1367, Union	B-14	13-17-20-2	09/95	42/8	6.75/6.19	Fair

YAD 13

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Rocky R, SR 1970, Stanly	B-1	13-17	06/91	-/16	-/3.43	Good-Fair
Rocky R ab Carolina Solite, Stanly	B-2	13-17	06/91	-/14	-/3.38	Good-Fair
Rocky R be Carolina Solite, Stanly	B-3	13-17	06/91	-/16	-/4.55	Good-Fair
Rocky R, SR 1935, Stanly	B-4	13-17	08/96	68/22	5.31/4.47	Good
			07/90	80/28	5.38/4.25	Good
			07/88	80/25	5.28/4.10	Good
			07/86	93/22	6.19/4.86	Good-Fair
			07/85	76/25	5.25/4.44	Good
			03/85	99/27	5.24/3.96	Good
			09/84	79/25	5.76/4.21	Good
			08/83	73/23	5.99/4.45	Good-Fair
Long Cr, ab WWTP, Stanly	B-5	13-17-31	08/89	67/15	6.65/5.50	Good-Fair
Long Cr, SR 1967 be WWTP, Stanly	B-6	13-17-31	08/89	56/10	6.42/5.80	Fair
Long Cr, SR 1954 (SR 1917), Stanly	B-7	13-17-31	08/96	64/14	5.61/5.06	Good-Fair
			07/89	76/22	6.08/5.13	Good-Fair
			07/86	88/12	6.88/5.64	Fair
			09/83	59/15	6.60/4.79	Fair
Lower (Little) Long Br, SR 2001, Stanly	B-8	13-17-31-4	06/91	47/7	6.63/4.70	Fair
Lower (Little) Long Br, be NC 138, Stanly	B-9	13-17-31-4	06/91	54/15	6.73/5.84	Good-Fair
Big Bear Cr, SR 1434, Stanly	B-10	13-17-31-5	08/89	-/10	-/5.59	Fair
Big Bear Cr, SR 1134, Stanly	B-11	13-17-31-5	08/96	-/24	-/3.87	Good
			07/90	88/31	5.62/4.82	Good
			07/87	97/28	5.83/4.75	Good
Stony Run Cr, SR 1970, Stanly	B-12	13-17-31-5-5	08/96	-/19	-/4.22	Good-Fair

YAD 14

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Richardson Cr, SR 1751, Union	B-1	13-17-36-(5)	09/90	57/6	7.67/7.32	Poor
			03/89	62/12	7.49/5.88	Fair
Richardson Cr, SR 1006, Union	B-2	13-17-36-(5)	09/90	55/5	7.35/6.62	Poor
			03/89	52/14	7.66/5.98	Fair
Richardson Cr, SR 1649, Union	B-3	13-17-36-(5)	08/96	46/12	6.12/5.31	Fair
			07/90	57/10	6.87/5.85	Fair
			07/87	57/10	6.88/5.64	Fair

Richardson Cr, SR 1600, Anson	B-4	13-17-36-(5)	08/96	-/18	-/3.91	Good-Fair
			08/83	69/20	6.23/5.18	Good-Fair
Lanes Cr, SR 2111, Union	B-5	13-17-40-(1)	05/89	52/9	6.42/4.40	Fair
Lanes Cr, SR 1937, Union	B-6	13-17-40-(1)	05/89	59/15	6.20/5.10	Fair
			05/88	58/13	6.61/4.84	Fair
Lanes Cr, SR 1929, Union	B-7	13-17-40-(1)	05/89	72/13	6.35/5.09	Fair
Lanes Cr, SR 1901, Union	B-8	13-17-40-(12)	08/96	-/6	-/6.21	Poor
Lanes Cr, SR 1612, Anson	B-9	13-17-40-(12)	08/96	-/11	-/4.93	Fair
Wicker Br, SR 1940, Union	B-10	13-17-40-4	05/89	60/10	6.52/5.45	Fair
			05/88	62/11	6.41/4.54	Fair
Waxhaw Br, SR 1937, Union	B-11	13-17-40-6	05/89	38/8	6.06/4.60	Fair

YAD 15

Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Little R, SR 1127, Randolph	B-1	13-25-(1)	10/89	-/22	-/4.12	Good-Fair
Little R, SR 1349, Montgomery	B-2	13-25-(11.5)	10/89	-/36	-/3.65	Excellent
Little R, ab SR 1340, Montgomery	B-3	13-25-(11.5)	11/95	89/36	4.36/3.26	Excellent
Little R, SR 1340, nr Star, Montgomery	B-4	13-25-(11.5)	08/96	98/39	5.03/3.76	Excellent
			11/95	90/36	4.46/3.48	Excellent
			10/89	-/40	-/3.47	Excellent
			07/88	106/40	4.82/3.60	Excellent
			07/85	104/40	4.27/3.49	Excellent
			08/83	80/23	5.19/4.10	Good
Little R, be SR 1340, Montgomery	B-5	13-25-(11.5)	11/95	93/34	4.64/3.39	Excellent
W Fk Little R, SR 1115, Randolph	B-6	13-25-15	02/94	88/30	4.86/3.43	Excellent
W Fk Little R, NC 134, Montgomery	B-7	13-25-15	02/94	93/32	5.10/3.42	Good
W Fk Little R, SR 1311, Montgomery	B-8	13-25-15	08/96	-/30	-/4.04	Excellent
			02/94	78/28	4.79/3.49	Good
			10/89	-/25	-/3.60	Good
Little R, SR 1565, Montgomery	B-9	13-25-(19.5)	10/89	-/21	-/3.52	Good-Fair
Little R, NC 731, Montgomery	B-10	13-25-(19.5)	08/96	76/29	5.35/4.22	Good
Densons Cr, NC 134, Montgomery	B-11	13-25-20-(1)	10/89	-/38	-/3.84	Excellent
Densons Cr, SR 1323, Montgomery	B-12	13-25-20-(9)	07/92	98/31	5.52/4.43	Good
Densons Cr, off SR 1324, Montgomery	B-13	13-25-20-(9)	07/92	75/17	5.98/5.63	Good-Fair
Bridgers Cr, SR 1519, Montgomery	B-14	13-25-24	10/89	-/31	-/3.99	Excellent
Rocky Cr, SR 1134, Montgomery	B-15	13-25-30-(0.3)	03/88	-/21	-/4.46	Good-Fair
Rocky Cr, NC 24/27, Montgomery	B-16	13-25-30-(0.3)	08/96	-/19	-/3.25	Good-Fair
Rocky Cr, SR 1549, Montgomery	B-17	13-25-30-(0.5)	03/88	104/35	4.99/3.61	Excellent
Cheek Cr, SR 1541, Montgomery	B-18	13-25-36	08/96	66/15	6.32/5.15	Good-Fair

YAD 16

Site	Site#	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Pee Dee R, US 74, nr Rockingham, Richmond	B-1	13-(34)	07/90	70/21	5.97/4.72	Good-Fair
			07/88	68/19	6.52/5.17	Good-Fair
			09/85	64/21	6.09/4.89	Good-Fair
			09/84	68/21	5.73/4.28	Good
			08/83	67/17	6.76/5.34	Fair
Cartledge Cr, SR 1142, Richmond	B-2	13-35	08/96	-/11	-/5.57	Fair
UT Hitchcock Cr, SR 1475, Richmond	B-3	13-39-(1)	10/90	61/20	5.31/3.43	Good-Fair
Hitchcock Cr, SR 1486, Richmond	B-4	13-39-(1)	08/96	-/20	-/3.58	Good
Bones Fk Cr, SR 1487, Richmond	B-5	13-39-5	11/84	72/27	4.67/2.88	Excellent
UT Bones Fk Cr, SR 1475, Richmond	B-6	13-39-5	10/90	76/25	5.85/3.78	Good
Beaverdam Cr, SR 1486, Richmond	B-7	13-39-8-7	08/96	-/27	-/3.23	Excellent
Hitchcock Cr, US 74, Richmond	B-8	13-39-(10)	10/88	-/11	-/4.72	Fair
Hitchcock Cr, ab Fox Yarns, Richmond	B-9	13-39-(10)	10/88	-/12	-/4.38	Fair
Hitchcock Cr, be Fox Yarns, Richmond	B-10	13-39-(10)	10/88	-/10	-/4.69	Fair
Hitchcock Cr, SR 1109, Richmond	B-11	13-39-(10)	08/96	40/5	7.85/6.47	Poor

Marks Cr, SR 1812, Richmond	B-12	13-45-2	08/96	59/15	6.29/4.86	Good-Fair
			02/91	63/11	6.92/5.99	Fair
Marks Cr, NC 177, Richmond	B-13	13-45-2	02/91	59/22	6.96/4.82	Good-Fair
Marks Cr, SR 1104, Richmond	B-14	13-45-2	02/91	-/12	-/5.70	Fair

YAD 17

Site	Site #	Index#	Date	S/EPT S	BI/BIEPT	Bioclass
Jones Cr, SR 1812, Anson	B-1	13-42	12/92	55/17	5.88/5.25	Good-Fair
Jones Cr, NC 145, nr Pee Dee, Anson	B-2	13-42	08/96	63/17	5.67/4.61	Good-Fair
			07/90	73/16	5.84/4.75	Good-Fair
			07/87	70/24	5.90/4.55	Good-Fair
N Fk Jones Cr, SR 1121, Anson	B-3	13-42-1-(0.5)	08/96	-/11	-/5.18	Fair
			12/92	51/15	5.85/4.52	Good-Fair
Moss Br, Mclaurin Rd, Anson	B-4	13-42-1-3-1	09/83	23/0	8.05/-	Poor
Moss Br, US 74, Anson	B-5	13-42-1-3-1	09/83	28/2	8.33/6.50	Poor
S Fk Jones Cr, SR 1821, ab WWTP, Anson	B-6	13-42-2	08/96	-/15	-/4.99	Good-Fair
			12/92	49/14	6.04/4.91	Good-Fair
S Fk Jones Cr, be WWTP, Anson	B-7	13-42-2	12/92	41/11	5.90/5.29	Fair
Shaw Cr, SR 1421, Anson	B-8	13-42-2-4	04/86	70/22	5.69/4.83	Good-Fair

Appendix FC1. Scoring criteria for the Yadkin River Basin NCIBI metrics.

No.	Metric	Score
1	**Number of species** (Appendix FC2)	Score dependent upon drainage area
2	**Number of individuals** (Appendix FC2)	Score dependent upon drainage area
3	**Number of species of darters**	
	≥ 3 species	5
	1-2 species	3
	0 species	1
4	**Number of species of sunfish and trout**	
	≥ 3 species	5
	1-2 species	3
	0 species	1
5	**Number of species of suckers**	
	≥ 2 species	5
	1 species	3
	0 species	1
6	**Number of intolerant species**	Refer to Appendix FC3
	≥ 3 species	5
	1-2 species	3
	0 species	1
7	**Percentage of tolerant individuals**	Refer to Appendix FC3
	< 20%	5
	20-45%	3
	> 45%	1
8	**Percentage of omnivorous individuals**	Refer to Appendix FC3
	< 20%	5
	20-45%	3
	> 45%	1
9	**Percentage of insectivorous individuals**	Refer to Appendix FC3
	≥ 80%	5
	40-79%	3
	< 40%	1
10	**Percentage of piscivorous individuals**	Refer to Appendix FC3
	> 5%	5
	1-5%	3
	< 1%	1

11	**Percentage of diseased fish**	
	< 2%	5
	2-5%	3
	> 5%	1
12	**Percentage of species with multiple age groups**	
	> 40% of all species have multiple age groups	5
	20-40% of all species have multiple groups	3
	< 20% of all species have multiple age groups	1

A brief explanation of each of the NCIBI metrics is presented:

1 & 2. Number of Species and Number of Individuals: The total number of species and individuals supported by streams of a given size in a given region decrease with environmental degradation. In addition, streams with larger watersheds or drainage areas can be expected to support more species and a greater number of fish. Both of these metrics are rated according to the river basin from which the sample was taken and the drainage area size at the sampling point. Drainage area size is calculated from USGS 7.5 minute series topographic maps, if not otherwise known (ambient database, USGS publications, or a USGS Masterfile printout which gives drainage areas for many streams at given road crossings).

All fish should be identified to the species level. If a fish can not be identified below the genus level and it is the only fish of that genus in the sample, it is counted as a species in the Number of Species metric. Recent exotics, such as tilapia and grass carp, are not included in the index because they are not part of the native North Carolina fish fauna.

The relative number of species and number of fish that can be expected, based upon drainage area size, for the Yadkin River Basin are presented in Appendix FC2.

3. Number of Species of Darters: Darters are sensitive to environmental degradation particularly as a result of their specific reproductive and habitat requirements (Page 1983; Kuehne and Barbour 1983). Darter habitats are degraded as a result of channelization, siltation, and reduced oxygen levels. The collection of fewer then the expected number of species of darters can indicate that some degree of habitat degradation is occurring. This metric is a count of all the species of Etheostoma and Percina in the sample.

4. Number of Species of Sunfish and Trout: Sunfish and trout species are used because they are particularly responsive to habitat degradation such as the sedimentation-in of pools and the loss of instream cover. This metric is a count of all the species of Lepomis, Enneacanthus, Acantharchus, Ambloplites, and Centrarchus, as well as all species of trout, whether native or stocked, in the sample.

5. Number of Species of Suckers: Suckers are intolerant of habitat and chemical degradation and, because they are long lived, provide a multiyear integrated perspective. They also reflect the condition of the benthic community which may be harmed by sedimentation or by sediment contamination. This metric is a count of all species within the family Catostomidae in the sample. In small ($\sim \leq 10$ mi^2), slow moving Coastal Plain (Sandhill) streams, this metric is modified to 0 species = 1, and ≥ 1 species = 5 (the intermediate score is deleted).

6. Number of Intolerant Species: Intolerant species are those which are most affected by environmental perturbations and therefore should disappear, at least as viable populations, by the time a stream is rated as "Fair". This metric is a count of all intolerant species in the sample as determined from Appendix FC3.

7. Percentage of Tolerant Individuals: Tolerant species are those which are often present in a stream in moderate numbers but as the stream degrades, they can become dominant. The number of individuals in each of the tolerant species (Appendix FC3) is summed and divided by the total number of fish collected to obtain the percentage of tolerant fish.

8-10. Percentages of Omnivorous, Insectivorous, and Piscivorous Individuals: The three trophic composition metrics—proportion of omnivores, insectivores (or specialized insectivores), and piscivores—are used to measure the divergence from expected production and consumption patterns in the fish community that can result from environmental degradation. The main cause for a shift in the trophic composition of the fish community, a greater proportion of omnivores and lesser proportion of insectivores that what is to be expected, is nutrient enrichment. The number of individuals in each of the trophic classes (Appendix FC3) is summed and divided by the total number of fish collected to obtain the percentage by that trophic class.

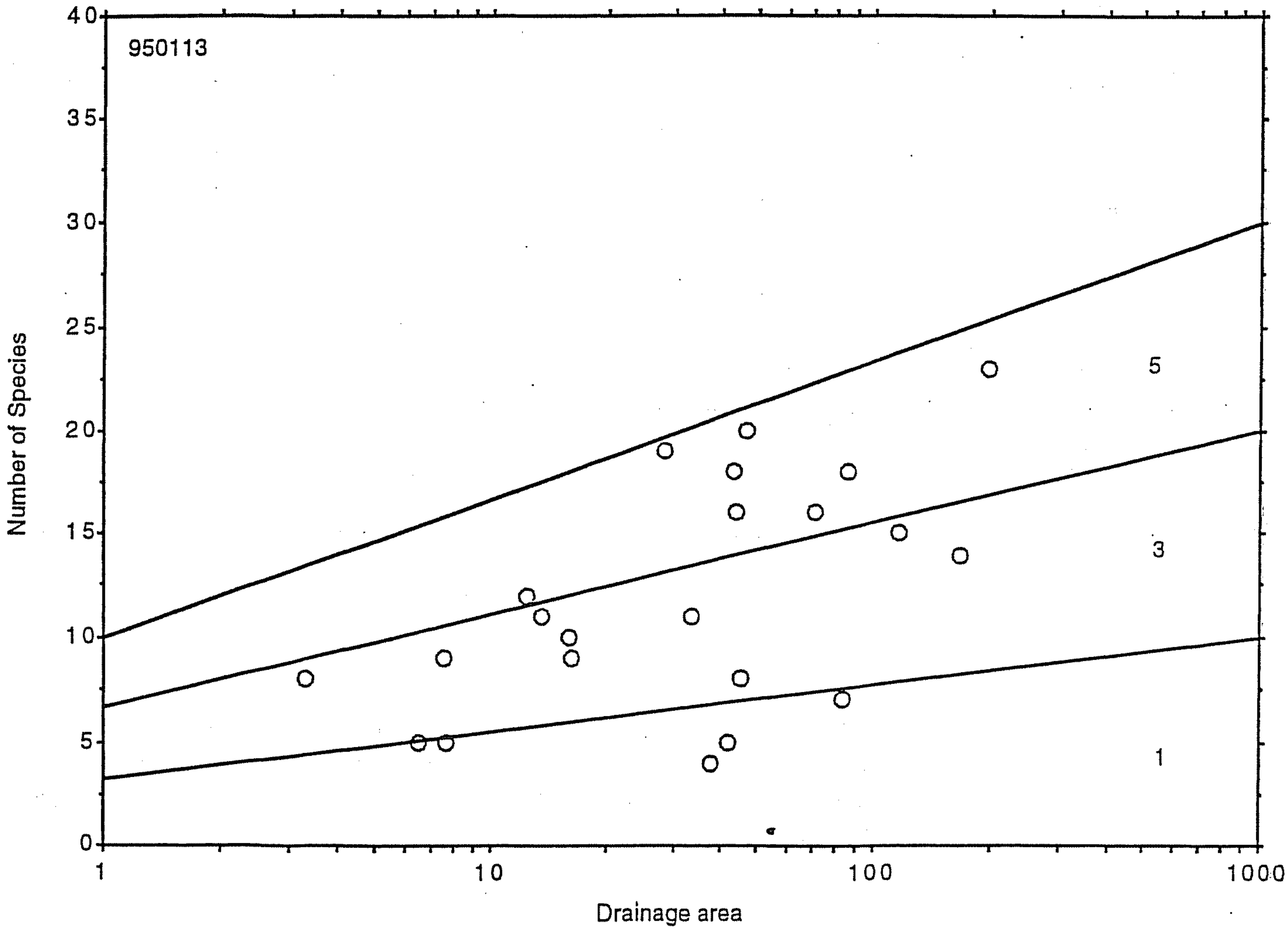
In Mountain ecoregion streams, the Percentage of Insectivores metric can be interchanged with the Percentage of Specialized Insectivores metric. The metric scores for the Percentage of Specialized Insectivores are: < 25% = 1, 25-50% = 3, and > 50% = 5. The metric (Percentage of Insectivores or Percentage of Specialized Insectivores) which yields the greatest score is then used.

Also in Mountain ecoregion streams, the Percentage of Piscivores metric is modified to the Number of Piscivorous Species metric. The metric scores for the Number of Piscivorous Species are: 0 piscivorous species collected = 1 and ≥ 1 piscivorous species collected = 5 (the intermediate score is deleted).

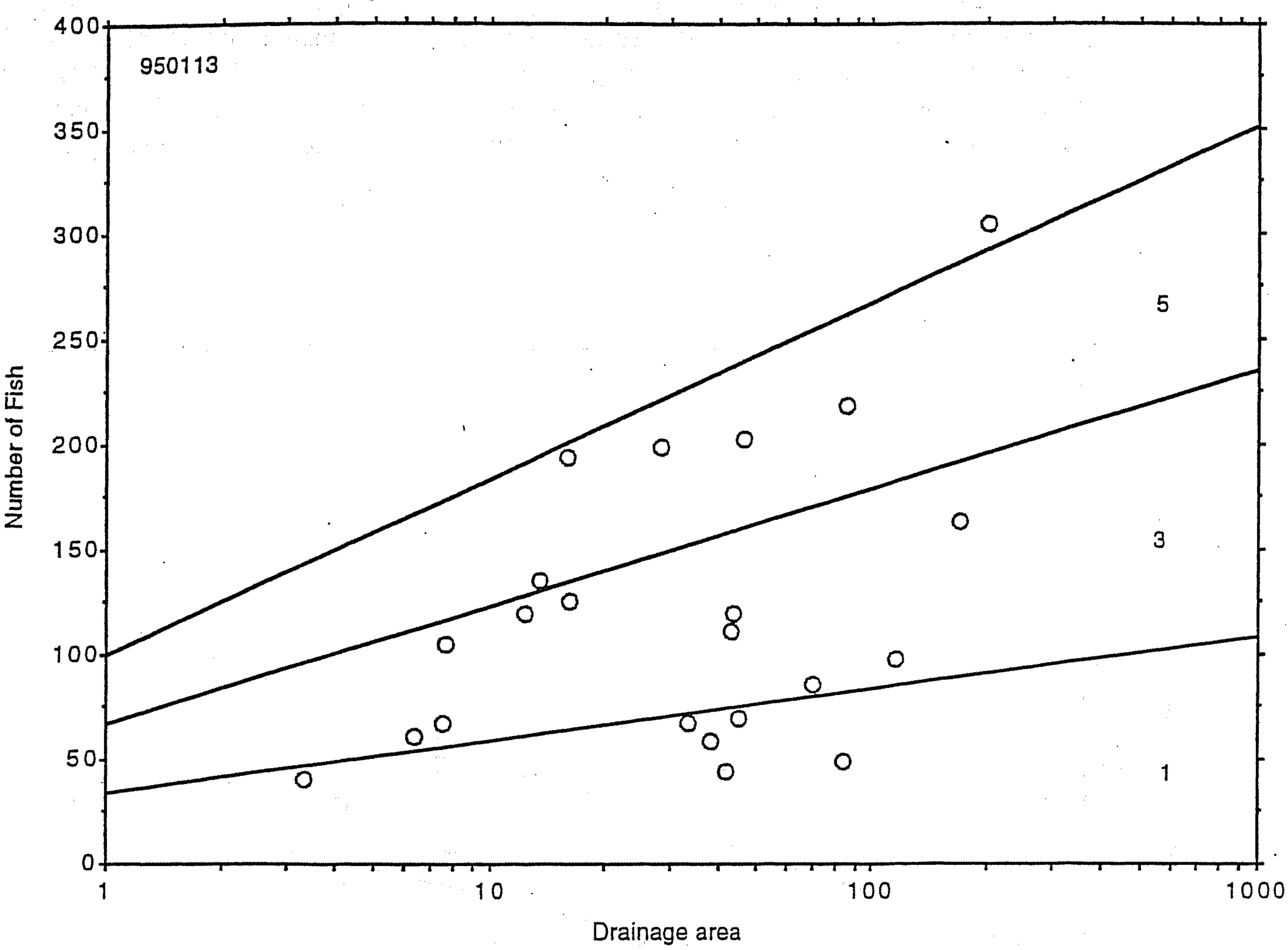
11. The Percentage of Diseased Fish: The percentage of fish with disease, tumors, fin damage, and skeletal anomalies increases as a stream is degraded. To rate this metric, the number of fish in the sample which have sores, lesions, skeletal anomalies (as evident externally), or diseased, damaged, or rotten fins is summed and divided by total number of fish collected to obtain the percentage of diseased fish. Fin or other external damage as a result of spawning should not be counted. Fish are considered to be in spawning condition when tubercles or breeding colors are evident.

12. The Percentage of Species with Multiple Age Groups (Length Distribution): For each species, the total length distribution data are used to determine the presence of different age groups and thus, the amount of reproductive success. This metric is calculated by first counting the total number of species present in the sample. Then, the total lengths of all the fish of each species are examined to determine whether or not all the fish of that species are of one or multiple age groups. Finally, the percentage of species with multiple age groups is determined by dividing the number of species with multiple age groups by the total number

of species collected in the sample. Although some species are rare and some species have fewer age groups than others, at least three individuals per species must have been collected to determine the presence of multiple age groups within the population. In some instances, professional judgment may also be used to determine the reproductive success of a particular species. Publications such as Carlander (1969 and 1977), Kuehne and Barbour (1983), Page (1983), Manooch (1984), Etnier and Starnes (1993), Jenkins and Burkhead (1993), and Rohde et al. (1994) may also be consulted to determine length-age class relationships.



Expectations and metric scores for the number of species and number of fish as functions of drainage area size (mi²) in the Yadkin River Basin.



Tolerance ratings and adult trophic guild assignments for the freshwater fishes of the Yadkin River Basin. The taxonomic list of species found within the river basin was adapted from Menhinick (1991) and results from the 1996 basinwide monitoring program.

Subbasin 030701

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Yadkin R	NC 268	Caldwell	1	12-1	85.2	5/23/96	50	G
Dennis Cr	SR 1372	Caldwell	2	12-7	1.3	5/23/96	46	F-G
Laurel Cr	SR 1508	Watauga	3	12-24-8	7.8	5/23/96	52	G
Beaver Cr	SR 1131	Wilkes	4	12-25	17.4	5/21/96	44	F
N Pr Lewis Fork	SR 1304	Wilkes	5	12-31-1-(5.5)	23.7	5/21/96	48	G
S Pr Lewis Fork	SR 1154	Wilkes	6	12-31-2-(7)	32.3	5/21/96	48	G
N Fk Reddies R	SR 1501	Wilkes	7	12-40-4	7.3	5/22/96	52	G
M Pr Roaring R	SR 1002	Wilkes	8	12-46-2-(6)	57.3	5/22/96	54	G-E
Basin Cr	SR 1730	Wilkes	9	12-46-2-2	7.1	5/22/96	54	G-E
Garden Cr	SR 1739	Wilkes	10	12-46-4-6	3.3	5/22/96	46	F-G

Subbasin 030702

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Mitchell R	SR 1330	Surry	1	12-62-1	29.1	5/16/96	54	G-E
L Fisher R	SR 1480	Surry	2.	12-63-10-(2)	21.3	5/16/96	48	G
Cody Cr	NC 268	Surry	3	12-63-14	10.8	5/16/96	48	G
L Yadkin R	SR 1236	Stokes	4	12-77-(1)	42.8	5/17/96	52	G
N Deep Cr	SR 1605	Yadkin	5	12-84-1	35.8	5/15/96	42	F
S Deep Cr	SR 1152	Yadkin	6	12-84-2-(1)	50.6	5/15/96	46	F-G

Subbasin 030703

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Stewarts Cr	SR 1622	Surry	1	12-72-9-1	24.2	5/17/96	54	G-E

Subbasin 030704

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Muddy Cr	SR 1891	Forsyth	1	12-94-(0.5)	89.2	5/14/96	40	F
Town Cr	SR 1526	Rowan	2	12-115-3	7.2	4/25/96	48	G

Subbasin 030705

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Dutchmans Cr	US 158	Davie	1	12-102-(2)	57.6	5/13/96	46	F-G
Cedar Cr	SR 1437	Davie	2	12-102-13-(2)	10.9	5/13/96	48	G

Subbasin 030706

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
S Yadkin R	SR 1561	Iredell	1	12-108-(5.5)	69.3	5/14/96	42	F
Olin Cr	SR 1892	Iredell	2	12-108-11-3-3	9.4	5/14/96	38	P-F
Hunting Cr	NC 115	Wilkes	3	12-108-16-(0.5)	29.8	5/15/96	50	G
Hunting Cr	NC 115	Wilkes	"	"	29.8	6/16/92	42	F
Hunting Cr	SR 2423	Wilkes	4	"	32.2	6/16/92	42	F
L Hunting Cr	SR 1829	Iredell	5	12-108-16-6	54.5	5/14/96	48	G
Fourth Cr	SR 1985	Rowan	6	12-108-20-(3.5)	80	4/26/96	36	P-F
Third Cr	SR 1970	Rowan	7	12-108-20-4-(7)	96.6	4/25/96	42	F
N Second Cr	SR 1526	Rowan	8	12-108-21	63.3	4/25/96	46	F-G

Subbasin 030707

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating[1]
Abbotts Cr	SR 1800	Davidson	1	12-119-(4.5)	37.1	4/24/96	44	F

Rich Fork Cr	NC 109	Davidson	2	12-119-7	25.6	4/25/96	40	F

Subbasin 030708

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Lick Cr	NC 8	Davidson	1	12-126-(3)	28	4/23/96	48	G
Cabin Cr	SR 2536	Davidson	2	12-127-(2)	18.7	4/24/96	44	F
Mountain Cr	SR 1720	Stanly	3	13-5-(0.7)	14	4/18/96	48	G

Subbasin 030709

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Uwharrie R	SR 1406	Randolph	1	13-2-(0.5)	41.3	4/24/96	52	G
Betty McGees Cr	SR 1107	Randolph	2	13-2-5	8	4/18/96	44	F
Barnes Cr	SR 1303	Montgomery	3	13-2-18-(0.5)	22.4	4/22/96	44	F
Dutchman Cr	SR 1150	Montgomery	4	13-2-24	3.4	4/22/96	32	P (NR2)

Subbasin 030710

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Brown Cr	SR 1230	Anson	1	13-20	25.2	4/16/96	52	G
Cedar Cr	SR 1709	Anson	2	13-21	8.6	6/10/96	46	F-G
Mountain Cr	SR 1150	Richmond	3	13-28-(0.5)	65.1	4/15/96	56	G-E

Subbasin 030711

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Rocky R	SR 2420	Mecklenburg	1	13-17	13.4	4/17/96	34	P
Mallard Cr	SR 2467	Mecklenburg	2	13-17-5	11.9	6/10/96	50	G

Subbasin 030712

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Irish Buffalo Cr	SR 1132	Cabarrus	1	13-17-9-(2)	45.4	4/17/96	50	G
Coldwater Cr	NC 73	Cabarrus	2	13-17-9-4-(1.5)	34.6	4/17/96	46	F-G
Dutch Buffalo Cr	SR 2622	Cabarrus	3	13-17-11-(5)	94.4	4/17/96	46	F-G
N Fk Crooked Cr	SR 1520	Union	4	13-17-20-1	10	10/3/95	48	G
N Fk Crooked Cr	SR 1514	Union	5	"	14.8	10/3/95	52	G
S Fk Crooked Cr	SR 1515	Union	6	13-17-20-2	5.3	10/3/95	44	F
S Fk Crooked Cr	SR 1515	Union	"	"	5.3	10/3/95	50	G

Subbasin 030713

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Big Bear Cr	NC 73	Stanly	1	13-17-31-5	19.1	4/18/96	52	G

Subbasin 030714

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Negrohead Cr	SR 1006	Union	1	13-17-36-15	23.6	6/10/96	52	G
Lanes Cr	SR 1432	Anson	2	13-17-40-(12)	121	4/16/96	52	G

Subbasin 030715

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Rocky Cr	NC 24/27	Montgomery	1	13-8-(2)	9.5	4/23/96	40	F
W Fk Little R	SR 1311	Montgomery	2	13-25-15	19	4/23/96	50	G
Bridgers Cr	SR 1519	Montgomery	3	13-25-24	7.3	4/22/96	54	G-E
Cheek Cr	SR 1541	Montgomery	4	13-25-36	32.3	4/23/96	48	G

Subbasin 030716

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Rocky Fork Cr	SR 1487	Richmond	1	13-39-8	14.8	8/21/90	56	G-E
Beaverdam Cr	SR 1486	Richmond	2	13-39-8-7	4.5	4/15/96	34	P (NR2)

Subbasin 030717

Site	Road	County	Map F#	Index #	D.A. (mi^2)	Date	NCIBI Score	NCIBI Rating1
Jones Cr	SR 1812	Anson	1	13-42	74	4/16/96	44	F
Bailey Cr	SR 1811	Anson	2	13-42-1-3	13	4/15/96	44	F

1 The NCIBI Ratings are: G-E = Good-Excellent, G = Good, F-G = Fair-Good, F = Fair, and P-F = Poor-Fair, and P = Poor.

2 NR = not rated, refer to the text for an explanation of the NCIBI rating.

APPENDIX IV

Yadkin-Pee Dee River Basin Workshop Comments

I. Overview of the Project

The Northwest Piedmont Council of Governments, in conjunction with Centralina Council of Governments, submitted an application for 205j Water Quality Planning funds in April 1995 to assist the North Carolina Division of Environmental Management with the preparation of and the coordination of public input for the Yadkin River Basinwide Management Plan. The project was designed to create a forum for representatives conducting the basinwide water quality study on the Yadkin River to meet with policy makers, the regulated community (i.e. industries and agencies), the academic community, local governments, and the general public in the Upper Yadkin River Basin and gather input from these groups about the major water quality concerns, priority issues and the long-range management goals for the basin. These groups would also help identify major growth areas so that this information could be included in the basinwide management plan.

Since the Yadkin River covers a great deal of the Piedmont, this project focused on the area from High Rock Lake and up which is often referred to as the Upper Yadkin River. The counties in the defined area included: Alexander, Caldwell, Davidson, Davie, Forsyth, Iredell, Rowan, Stokes, Surry, Watauga, Wilkes, and Yadkin. This project was unique in that it identified participants and stakeholders in the Upper Yadkin River Basin and asked them to participate in an initial goal setting meeting and a follow-up meeting.

Upon notification of the grant award, the Northwest Piedmont Council of Governments subcontracted with the Centralina Council of Governments to assist with coordinating public input in Rowan and Iredell Counties and to provide guidance for the overall project. A steering committee was formed to assist with the development of the Yadkin River Basin Association. A list of the members of the steering committee is in Appendix A. The goal of the steering committee was to identify the type of information needed for the basinwide management plan and determine the most feasible way to collect the information as well as assist with conducting the public meetings.

The steering committee mailed an introduction letter along with basic information about basinwide management planning and a survey which asked the recipient to identify critical water issues along the Yadkin River. A copy of the survey and the results are included in the Final Report of the Yadkin River Basinwide Management Project under "Correspondence." The steering committee, which met in the Northwest Piedmont Council of Governments' conference room, decided that in order to provide convenient access to the meetings for all participants in the Upper Yadkin River Basin, one initial goal setting meeting should be held in Jonesville and one goal setting meeting would be held in Salisbury. Follow-up meetings would be conducted in Winston-Salem and Salisbury.

In addition to the introduction letter, a press release (a copy is in Appendix A) was faxed to all of the newspapers in the target area and a segment describing the project was run on the Government Access Channel in Forsyth and Surry Counties. One month prior to the first workshop, a brochure along with a registration card was mailed to the list of possible attendees.

The initial goal setting meeting was held in Jonesville, North Carolina at the Holiday Inn. 92 persons attended the workshop, ranging from elected officials, farmers, and representatives from agencies such as the Natural Resources Conservation Service, Soil and Water Conservation Districts, etc. A copy of the agenda and registration packet is included under "Meetings." Representing the Yadkin River Commission, Glenn Simmons presented an overview of the Yadkin River which included a video prepared by the Yadkin River Commission. B.J. Cook, a representative of the Natural Resources Conservation Service in Yadkin County, presented a local perspective of the Yadkin River. Alan Clark presented an overview of basinwide management planning - the purpose and goals of a Yadkin River Basinwide Management Plan.

At this point during the workshop, attendees were given an opportunity to ask questions of the presenters and make comments about the basinwide management plan. Matthew Dolge, the Executive Director of the NWPCOG, moderated the discussion. Staff from the North Carolina Cooperative Extension Service recorded comments and questions.

During registration, the attendees were asked to select a topic for a break-out session. The possible choices which were identified as areas of concern by the survey included: Water Quality, Runoff (Point Source), Sedimentation, Wastewater, and Illegal Discharges; Water Quality, Runoff (Nonpoint Source), Sedimentation, Wastewater, and Illegal Discharges; Public Access to the Yadkin River, Recreation and Wildlife; Future Growth and Development; and Economic Development and the Carrying Capacity of the Yadkin River.

Extension Directors from the various county offices of the North Carolina Cooperative Extension Service facilitated the breakout sessions. Each breakout session were given four questions: (1) Identify problems and issues in the Yadkin River basin, (2) Specify the area of the problem or issue, (3) What recommendations do you have for addressing the issues/problems identified in question one?, (4) Who is responsible for addressing the problem/issue? The comments were recorded and are presented in this report under "Results." Each group was also asked to identify a spokesperson and identify persons who would be interested in participating in a planning session in April. A representative from each breakout session presented their comments and suggestions to the entire group and asked for comments or questions.

Another workshop was held in Salisbury, North Carolina at the Rowan County Agricultural Building. The same agenda and format for the meeting was used. Bruce Rider, representing Natural Resources Conservation Services in Rowan County, presented information on the local perspective of the Yadkin River and Mike McLaurin, representing Centralina Council of Governments, served as moderator. There were 48 attendees.

The steering committee met to discuss the results of the March meetings in Salisbury and Jonesville. The April planning session was scheduled for Friday, April 26, 1996, at the Forsyth County Agriculture Building. The comments from the March meetings were summarized and condensed to approximately a list of ten goals for each breakout session. Spokespersons from the breakout sessions in Salisbury and Jonesville, as well as persons who indicated interest in participating in the April workshop, were invited to the April planning session.

Each group was asked to review the goals from the March meetings and formulate action plans for the goals which included implementation steps, resources needed to implement and who would be responsible for implementation. The recommendations were compiled and presented at the meetings in May. Representatives from each group were asked to be prepared to make presentations at the meetings in May.

The follow-up meetings were scheduled for May 17, 1996 at the Forsyth County Agricultural Extension Center in Winston-Salem and on May 24, 1996 at the Rowan County Agricultural Extension Center in Salisbury. A copy of the agenda and the registration packet for the meeting is enclosed under "Meeting Agendas." Representing Centralina Council of Governments, Mike McLaurin welcomed everyone to the workshop and explained the purpose. There were 32 attendees at the Winston-Salem workshop and 28 attendees at the Salisbury workshop.

Alan Clark with the Division of Environmental Management presented an update on the status of the Yadkin River Basinwide Management Plan which included approximate dates of public hearings and dates for the completion of the draft and the final Plan. Mike McLaurin presented an update from across the state on activities in other basins such as the Neuse River Basin and the Catawba River Basin.

Reports from the breakout sessions in March and the planning session in April were the main part of the agenda. Bruce Rider and Patrick Grogan with the Rowan County Soil and Water Conservation District presented information from the Water Quality-Nonpoint source breakout session at the Salisbury workshop and the Winston-Salem workshop, respectively. Tommy Thompson with Sara Lee Hosiery presented reports from Economic Development and Future Growth and Development for both locations and Barbara Sifford with the City of Salisbury and Mike Blosser with ABTCO presented the report from the Water Quality - Point source group in Salisbury and Winston-Salem, respectively. Attendees were given an opportunity after each report to ask questions, make suggestions for changes or additions and make general comments on the individual reports as well as the entire Yadkin River Basinwide Management Plan.

II. Recommendations from the Subcommittees

Subcommittee #1 (Water Quality - Point Source)

Goal: Develop action plans for the following:

Nuturient and Metal Limits
Fecals
Increased cost of monitoring
Eliminate non-biologically achievable regulations
Evaluate total mass loading
Form dischargers association
Cost of treatment
Balancing point and non point source pollution

Recommendations:

1. Form Dischargers' Association to help negotiate the Yadkin Basin Plan

   Implementing Agency: The City of Salisbury, Dischargers and the Division of Environmental Management

   Funding: Public Funds at first and then money from dischargers

   Timetable: June 13, 1996

2. Develop cost/benefit analysis when establisheing permit limits for nutrients and metals. Develop a good database for water quality monitoring of what is in the river, identify treatment technology and treatment efficiencies, develop cost figures for removal by technology and provide to the state.

   Implementing Agency: DEM, EPA, Discharger's Association and Agricultural Community

   Funding: Private and Public funds, DEM, Department of Commerce

   Timetable: 1997

3. Coordination of stream monitoring efforts. Plot discharge points and monitoring frequencies. DEM should combine data collected by municipalities. Each municipality should submit samples to the state three times a month from June through September. Look at data collection methods. Separate sampling points to get a broad based represenation of the river.

Implementing Agency: DEM, Dischargers' Association, Utility companies

Funding: Collect data from DEM, Dischargers' Association

Timetable: 1997

4. Evaluate total mass loading of point and nonpoint sources of pollution. The dischargers' association should form ongoing liaison with DEM and provide resources for the study and modeling to look at the overall basin and water quality.

   Implementing Agency: Dischargers' Association, DEM

   Funding: Dischargers' Association, Data from DEM

   Timetable: 1997

5. Encourage the use of the pollution prevention program.

   Implementing Agency: DEM, NWPCOG, Municipal and County Governments

   Funding: None

   Timetable: As soon as possible

Subcommittee #2 (Economic Development)

Goals:

Establish county-wide water systems
Tourism - strategy to develop presevation
Second home development
Increase communication/cooperation between agencies
Land use along tributaries
Urban vs. Rural Issues

Recommendations:

1. Establish region-wide water systems by developing eastern/western commissions to study water and sewer needs for the region. Compile the data on the Yadkin River and develop a water use plan.

   Implementing Agency: Division of Community Assistance, Rural Economic

Development Commission, Council of Governments

Funding: Public Funds

Timetable: By 1997

2. Tourism - strategy to develop preservation; improve mass transit, improve public transportation, improve access points. Improve public awareness of available recreation areas along the Yadkin. Cooperate with Parks and Recreation; Improve communication throughout River basin. Identify historic lands, Identify and acquire public access points

   Implementing Agency: Parks and Recreation Department, Cooperative Extension Service, Council of Governments, Piedmont Land Conservancy, Counties

   Funding: Public Funds

   Timetable: By 1997

3. Land use along tributaries (1) Urban: regional management through the formulation of urban plans and zoning (2) Rural: better enforcement/management of forestry, pre-notification of harvesting, each logger should submit a plan to conduct harvesting to the local forestry service. The local forestry service should invoke size limitations. Educate farmers and forestry on the best management practices. Create a proactive approach to farmers with land bordering tributaries.

   Implementing Agency: County government, Planning Departments, Forestry Service, Division of Soil and Water Conservation, DEM, Cooperative Extension Service, NRCS

   Funding: Public Funds

   Timetable: As soon as possible

4. Sell the Yadkin River as a resource to attract environmentally conscious industries

   Implementing Agency: Piedmont Triad Partnership, Chamber of Commerce, County Commissioners

   Funding: Use resources such as videos developed by the Yadkin River Commission, Public Funds

   Timetable: As soon as possible

5. Coordinate region and/or county water/sewer availability by collecting data and evaluating the needs of the region.

Implementing Agency: Yadkin River Commission

Funding: Counties, Utility Departments and grants

Timetable: As soon as possible.

Subcommittee #3 (Future Growth and Development)

Goals:

Ensureadequate water quality and water supply
Erosion control
Education about water quality through the use of surveys, polls
Adequate land use controls
Look at zoning practices
Farmland preservation

Recommendations:

1. Create a local erosion control program.

   Implementing Agency: Division of Soil and Water Conservation, NRCS

   Funding: Permitting fees

   Timetable: As soon as possible

2. Coordinate with the already existing Yadkin River Commission to determine who would decide capacity to decide on interbasin transfer and who should coordinate recommendations for water/sewer development.

   Implementing Agency: Yadkin River Commission

   Funding: Public Funds

   Timetable: By 1997

3. Preserve farmland through tax incentives, land trusts and conservation easements
   Educate public and farmers about the benefits of farmland preservation.

   Implementing Agency: Individual Counties, County Commissioners

   Funding: Public Funds

Timetable: By 1997

4. Educate the public about the benefits of reusing water.

Implementing Agency: NC DEM

Funding: None

Timetable: Immediately

Subcommittee #4 (Water Quality - Nonpoint Source)

Goals:

Buffers
Streambank Management
Sedimentation
Urban runoff/storm sewers
Monitoring
Identify sources of contamination
Animal waste
Lack of BMPs
Solid waste pollution

Recommendations:

1. Create a comprehensive county wide stormwater management program. Restore stream banks. Create impervious cover standards

   Implementing Agency: County Planners, Managers, and County Commissioners

   Funding: Counties & County Commissioners

   Timetable: 1997

2. Best Management Practices - Agricultural Sedimentation - Increase education, cost share incentives, greater legislative support and mandatory buffers

   Implementing Agency: NC Department of Agriculture

   Funding: NC Agriculture Cost Share Program

   Timetable: As soon as possible

3. Best Management Practices - Forestry Sedimentation - Better enrollment of BMPs in timely manner, prior notification for tracts greater than five acres, require forest management plans from a consultant forester or NC Forest Service using existing voluntary standards for tracts greater than five acres, Monitor plan for implementation, reduce time to install BMPs to ten working days, Better coordination between DEHNR department.

Implementing Agency: NC Forestry Service.

Funding: Public Funds

Timetable: As soon as possible

4. Increased monitoring and identify sources of contamination through the collection of better data on smaller streams, implementing voluntary monitoring, through better use of the the Stream Watch Program. Standardized training for volunatary monitoring. Add to DEM monitoring program. Add local government monitoring. Conduct controlled studies in smaller watersheds. Create a basinwide GIS. Continue voluntary buffers but also institute mandatory buffers in specific areas.

Implementing Agency: DEM

Funding: Public funds

Timetable: Immediately

5. Look at all animal wastes and the application of waste. Create lagoons/waste storage ponds designs.

Implementing Agency: DEM

Funding: Public funds

Timetable: Immediately

6. Better enforcement of illegal dumping. Make more convenient sites and implement county-wide pick-up of bulky items. Increase eduction of programs such as Big Sweep and Adopt-a-Highway.

Implementing Agency: Counties, Recycling companies

Funding: Public and Private Funds

Timetable: As soon as possible

7. Reduce sedimentation through the use of better planning, better enforcement of DOT, better enforcement in general and shorten compliance deadline from 30 days to 10 working days.

Implementing Agency: DEM

Funding: Public Funds

Timetable: As soon as possible

RESULTS OF THE
YADKIN RIVER BASIN SURVEY

1. What is your place of work/position?

- Engineer
- County Extension Director
- Mooresville City Planner
- NC Wildlife Resources Commission, Manager - Habitat Conservation Program
- Town Manager
- Watauga County Planning Director
- County Commissioner
- NC Agricultural Extension Agent
- USDA-NRCS District Conservationist
- Town Manager - Mocksville
- Surry County Schools
- Vice President
- Yadkin County
- Planning
- Maintenance Director
- President
- PTP - President
- Yadkin EMT CEO
- Cooperative Extension (Danbury)
- Mayor
- Walkertown
- Stokes County Manager
- Town of Jonesville, Town Manager
- Manager
- Director of Public Works
- Interim Town Manager - Walkertown
- City of Winston-Salem, Utilities Superintendent
- Wayne Farms General Manager
- NC Cooperative Extension Service
- City Manager
- Wilkes County Recreation Director
- Dobson Town Manager
- Owner
- Caldwell County Schools Associate Supt.
- City Manager
- Town Manager, Rural Hall
- City of Winston-Salem, Assistant City Manager, Public Works
- NC Department of Agriculture
- Owner Don Seafood and Steak, Jubilee Junction, Charter House Motel
- Mayor, Blowing Rock, NC
- Director

2. How do you or your employer use or value the Yadkin River?

Water Supply (55)
Recreation (52)

Wastewater Discharge (50)
Economic Development (38)
Others:

- Irrigation Supply,
- Conservation Issues,
- Wildlife Habitat,
- Dredging of sand and silt,
- Stormwater Management,
- Common Sense Zoning with land owner in mins,
- Scenic Enjoyment particularly at Pilot Mountain State Park, River Islands and Rockford
- Agricultural Development
- Fisheries Management

3. Which of the following do you think are significant issues in the Yadkin River Basin?

Water Quality (87)
Wastewater Discharge (68)
Runoff/Sediment (67)
Recreation (58)
Illegal Dischargers (57)
Wildlife Habitat (56)
Economic Development (54)
Public Access (38)
Carrying Capacity of the River (36)
Others:

- Interbasin transfer (2)
- Creating buffers along river and stream corridors
- Improve fishing quality,
- Illegal and old waste dumps located adjacent to streams in the basin,
- Discharge of fecal waste and nutrients,
- Stormwater runoff,
- Tourism potential, scenic qualities,
- Flooding in Elkin,
- Surry County towns discharge wastewater in streams that feed the Yadkin,

4. What do you think needs to be done to adequately protect water quality in the Yadkin River Basin?

- Mitigate runoff problems from residential and agricultural
- Better education of public, elected and appointed decision makers (5)
- Protect natural habitats
- Protection decisions should not rest unfairly with any one section of the basin
- Control non-point source discharges and illegal discharges, sedimentation and agricultural pollution
- Better land-use management both regulatory and nonregulatory approaches
- Policing discharges, appropriate land management and zoning
- Address NPS issues, urban storm runoff, agriculture, golf courses, septic systems, etc.
- Manage waste disposal, both permitted and nonpermitted
- Insure ordinances and controls are enforced

- Continue measures to assure any discharge meets environmental standards
- Basin plan development and implementation (2)
- Reasonable regulations to control discharges
- Clean up waste water entering the River
- Wastewater regulation (2)
- Control agricultural discharges, control discharges in urban areas, improve waste treatment facilities and their discharges (3)
- Better agriculture BMPs, more stringent controls on industrial discharges like breweries and textiles
- There should be a study of the Yadkin River and monies appropriated to assure we have an ample supply of water for use in recreation, wildlife habitat, industrial/residential in the future.
- Control access-discharge intake points - runoff locations- zoning
- Gather information to make informed educated decisions concerning this matter
- Stream watch - planning for future use
- Stop illegal discharges, wastewater discharge, control run-off sediment
- Monitor discharge to the Yadkin River (2)
- Watershed master plan for water quality management
- All developing and building should be 4' above existing flood plain elevation
- Do common sense erosion control
- Increase education on the value of River, factors impeaching water quality, control of discharge
- Continue to monitor to track trends, regulate all discharges
- Development controls in rural counties that don't have them
- Restrict development - increase enforcement authority
- Land use management in all counties in basin (zoning, subdivision regulations, etc.)
- All users must be cautious in not overusing the river but no moratorium - the study should be useful
- Aggressive runoff/sediment control. Protection and government acquisition of natural habitat
- Agriculture non-point pollution education to farmers, restrict developers on sediment runoff
- Enforced water quality regulations
- Change land use practice to control erosion/sedimentation and manage stormwater.
- Establish vegetated riparian buffers would be a good start.
- House legislation to require a 50ft buffer elevating the Yadkin on both sides
- Headwaters in Watauga seem to be pretty well protected through ORW program, perhaps better control of logging would be appropriate
- Additional watershed management
- Education: County wide adoption of Basin plan, incentive based initiatives for BMP's
- Regular testing of River waters
- Sedimentation control (maybe some type of professionally controlled dredging to remove amounts of sediment)
- Complete study of the River
- Route it away from Wilkesboro - monitor for industrial and agricultural discharges and build retention ponds where level is high
- We need ordinances in place up and down the basin and it must be monitored

- Identify problem areas then develop plan to prevent further damage
- Institute strict but fair regulations that would address the future needs of this area for good water
- Strong watershed/runoff regulations, stringent discharge regulation
- Zoning in counties that do not presently have it. Public awareness
- A long range plan of removal of water and discharge of water into river
- Limited development of property along river way
- Limit discharges
- Address nonpoint sources
- Education and incentives to protect and improve
- Get farmers to have better controls on runoff and discharge
- Closer monitoring of development and farming practices to reduce the amount of pollutants and/or runoff from parking or industrial sites
- Restore wetland on entry cracks
- Erosion control
- Water quality plan developed
- Nonpoint source control
- ID problems, assess needs, develop use, protection plan based on scientific study
- Monitor all discharges and runoff, make sure that rules and regulations are followed, all streams emptying into River should be monitored for the same.
- Wastewater control with the basin flow
- Development of a comprehensive water quality plan for the basin

5. **Are there any water quality protection initiatives in your area such as:**

Streamwatch (12)
Watershed Management (43)
Local Ordinances (36)
Conservation (29)
Others:

- Yadkin River Commission (2),
- NPDES (20
- Land Trust for Central NC
- NC Agriculture Cost Share Programs
- Ordinances (Stormwater, zoning and stream planning is dictorial and value cutting),
- Trout Unlimited

6. Would you be willing to attend workshops to develop the Yadkin River Basin Plan?

Yes (76)
No (13)

SUBCOMMITTEE GOALS AND RECOMMENDED ACTION PLANS

Recommendations	Implementation Agency	Funding	Timetable
SUBCOMMITTEE #1: WATER QUALITY - POINT SOURCES			
GOALS: To Develop Action Plans for: Nutrient and metal limits; fecal coliforms; increased monitoring costs; eliminate non-biologically achievable regulations; evaluate total mass loading; form dischargers association; cost of treatment; balance point/NPS pollution; consider Urban/Rural issues			
1) Form Discharger's Association to help negotiate the Yadkin Basin Plan	City of Salis., Dischargers, Div. of Water Quality (DW(	Public, at first, then dischargers	ASAP
2) Develop cost/benefit analysis when establishing permit limits for nutrients and metals	DWQ, EPA, Discharger's Assoc. & Agric. Comm.	Priv./public funds, DWQ, others	1997
3) Coordinate stream monitoring efforts	DWQ, Discharger Assoc., Utility Companies	DWQ, Discharger Assoc., others	1997
4) Evaluate total mass loading of point and nonpoint sources of pollution	Discharger's Association & DWQ	Discharger Assoc., DWQ	1997
SUBCOMMITTEE #2: ECONOMIC DEVELOPMENT			
GOALS: Establish county-wide water systems; promote tourism based on resource preservation; address second home development; increase communication and cooperation between agencies; protect tributary corridors;			
1) Develop upper Yadkin water use plan; establish region-wide water systems and commissions for east & west sides of river.	NC Div. of Comm. Asst.,COGs, Rur. Ec. Dev. Comm.	Public funds	1997
2) Promote tourism based on Yadkin's natural and cultural resources: develop preservation plans & improve river access.	Parks & Rec Depts., Coop. Ext. Ser.,COGS, others	Public funds	1997
3) Protect land use along tributaires. 1) Urban: regional land plans and zoning, 2) Rural: address forestry and agriculture.	Local planning depts., Forest Serv., DWQ, others	Public funds	ASAP
4) Sell the Yadkin River as a resource to attract environmentally conscious industries	Chamber of Comm., Pied. Triad Part., County Comm.	Public funds, videos	ASAP
5) Coordinate region and/or county water/sewer availability by collecting data and evaluating the needs of the region.	Yad. R. Comm., NC Div. of Water Resources (DWR)	Counties, utility dept., grants	ASAP
SUBCOMMITTEE #3: WATER QUALITY - POINT SOURCES			
GOALS: Ensure adequate water quality and supply; erosion control; education about water quality through the use of surveys and polls; have adequate land use controls; look at zoning practices			
1) Create a local erosion control program.	NC Div. of Soil and Water Cons., USDA NRCS	Permitting fees	ASAP
2) Coordinate with the Yadkin River Commission on determing interbasin transfers and water/sewer planning	Yadkin River Commission, DWR,	Public funds	1997
3) Preserve farmland through tax incentives, land trusts and conservation easements	Counties and County Commissioners	Public funds	1997
SUBCOMMITTEE #4: WATER QUALITY - NONPOINT SOURCES			
GOALS: Buffers; streambank management; sedimentation control; urban runoff/stormsewer; monitoring; identify sources of contamination; animal waste; lack of BMPs; solid waste pollution.			
1) Create a comprehensive county wide stormwater management program. Restore stream banks. Limit impervious cover.	County Planners, Managers and Commissioners	Counties	1997
2) Best management practices (BMPs) for agric. sediment: increase education, cost share incentives, mandatory buffers.	NC Dept of Agric, NC Div. of Soil and Water	NC Ag Cost Share Program	ASAP
3) BMPs for forestry:	NC Forestry Service	Public funds	ASAP
4) Improve water quality monitoring & pollution source ID. Monitor smaller streams, use volunteer and local govt. data	NC Division of Water Quality (DWQ)	Public funds	Immediately
5) Look at animal wastes and the land application of waste. Create better lagoon/waste storage pond designs.	DWQ	Public funds	Immediately
6) Better enforcement of illegal dumping. Make more convenient sites and implement county-wide pickup of bulky items.	Counties and recycling companies	Public funds	ASAP
7) Reduce sedimentation through the use of better planning, better enforcement sediment control laws, quicker compliance.	DWQ, NC Division of Land Resources	Public funds	ASAP

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Quality

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director

DEHNR

January 24, 1997

MEMORANDUM

TO: Lower Yadkin/Pee Dee River Workshop Participants

FROM: Darlene Kucken, Basinwide Planner Darlene

SUBJECT: Summary of Workshop Comments and Status of Plan Development

On August 22, 1996 you attended a basinwide workshop at the Agri-Civic Center in Albemarle. The workshop was held to get your input as we began developing the Yadkin/Pee Dee Basinwide Water Quality Management Plan. This workshop focused on the lower portion of the basin. We have summarized the comments presented to us by workshop participants and have included them for your review.

Two workshops were held on August 22, one in the afternoon and one in the evening. A total of 98 people attended the two workshops (93 at the afternoon workshop and five at the evening workshop). Both workshops have been compiled into one summary.

As you recall, the workshop was divided into two parts. It began with a presentation by Alan Clark of the Division of Water Quality (DWQ) on the North Carolina Basinwide Planning Initiative. I then provided a summary of the schedule and information specific to the Lower Yadkin/Pee Dee River basin. Alex Cousins presented an overview of the Yadkin/Pee Dee Lakes Project and Rich Gannon of DWQ gave a brief report of the development of the NPS Team for the Yadkin/Pee Dee River basin. After a break, we broke into small discussion groups (these groups were color-coded). Since there were so few people at the evening meeting, discussion was held in one group.

Each group was asked to respond to three questions (see attachments for questions). Many valuable and thought-provoking responses were received. We felt we should compile these responses and provide them to you so that you might gain a better understanding of the issues that are important to the stakeholders of this basin.

In order to prepare the summary, the comments from each group were compiled. Some of the responses were recorded by the facilitators in an abbreviated manner, so it was necessary to extrapolate on the comment in order to make a complete thought or sentence. The comments were sent to the group facilitator for an accuracy check. Revisions were made as necessary to better reflect the intent of the statement to the best of the facilitators ability to remember the comment. The responses were then compiled by question, rather than by group color-code. This was done to show an overall response by stakeholders in the basin. It also allowed us to place comments within general categories (i.e. - lake management, urban development, research and monitoring, etc.) so that they might be addressed better within the plan. Please let me know if you feel your comment is not accurately represented in the summaries.

All workshop participants are receiving a copy of this summary. In addition, appropriate staff and other agencies will receive those comments that are applicable to their area of expertise. Staff and other agencies will be asked to consider the comment and determine how the comment might best be addressed during the development of the Yadkin/Pee Dee River Basinwide Water Quality Management Plan. Where possible, the comments you have provided us will be addressed in the basin plan. This summary will also be included in the plan.

The draft of the basin plan will be presented to the Water Quality Committee of the Environmental Management Commission in August 1997. At this meeting, we will be asking permission to release the plan for public review and to schedule public meetings. With the Committee's approval, the public meetings will be scheduled for the basin in October 1997. There will be a thirty day comment period on the draft after the last public meeting. During this time, you are encouraged to provide us comments on the draft basin plan. The plan will be revised based on the comments received. It will then be taken to the Environmental Management Commission in February 1998 for final approval.

We thank you for your continued interest in the water quality of the Yadkin/Pee Dee River basin. If you have any comments or questions at any time on the Yadkin/Pee Dee River Basinwide Water Quality Management Plan, please contact me at (919) 733-5083, ext. 354.

Attachments
cc w/ attachments: Alan Clark
Boyd Devane
Greg Thorpe
Steve Tedder

(1) What are the Priority Water Quality Related Issues in the Basin?

Equity

1. Need to identify the economic impacts/fairness of allowing new or expanded facilities in growing areas and capping other existing facilities on a stream at the same time
2. There should be more equity between PS and NPS; concerns that regulations are not being equally placed on NPS
3. Municipalities should be required to meet the same stringency levels as industries
4. We should look at all NPS pollution sources and apply equal regulations for all (agriculture and residential)

Research and Monitoring

1. What percent of water quality problems is coming from agriculture? We need more data.
2. There needs to be a better understanding of, and more education on, color impacts
3. Need to identify both NPS and PS contributions/contributors. What data do we have? Is it based on good science?
4. More resources should be put into determining why stream miles are impaired- "what is the source of poor water quality?"
5. Identify problems before establishing regulations
6. Need more research on urban BMPs
7. We need education for farmers and better access to research

Agriculture

1. Need to implement and enforce agricultural BMPs
2. Need better animal waste management and poultry litter disposal; over application of dry waste is a problem for many streams

Urban Development

1. Sediments are coming from more than agriculture - also coming from development
2. Stormwater runoff from impervious surfaces is increasing; development is very rapid
3. Can wastewater treatment capacity keep up with development?
4. What are the secondary effects of development on failing infrastructure?
5. There are too many growth related pressures
6. Improper use of residential lawn chemicals

Policy Issues

1. Enforce current laws - especially for septic tanks
2. Can WWTPs be regionalized?
3. More money is needed for upgrades for dischargers
4. Are existing classifications appropriate for future economic growth?
5. There is a need for assistance to dischargers (shift priorities of staff)
6. Realize society isn't perfect and have reasonable expectations
7. Maintaining industrial and economic growth while protecting water quality
8. Maintain technical assistance and cost-share for agriculture
9. Need voluntary cooperative programs rather than regulatory ones
10. Need greater effort between agriculture and industry to recycle and use waste - a "waste exchange" program
11. Need better examples of joint cooperative efforts
12. We should consider total nutrient management on site
13. Encourage organized presentations at the basin meetings by significant stakeholder groups (e.g. industry, municipalities, agriculture, etc.)
14. Politicians make policy - not local stakeholders

Recreation
1. Recreation and tourism are major attractions in the basin
2. Bank erosion from recreational use of lakes impacts water quality

Nonpoint Source Pollution Problems
1. NPS pollution is a major problem (sediment as indicator)
2. Failing septic tanks with discharge to surface water are a problem

Point Source Pollution Problems
1. Small WWTPs are water quality problems
2. Location of wastewater outfalls by municipalities may not be appropriate
3. Will municipalities be restricted when doing enviromental land applications?
4. Sewer lines following the creeks and overflowing during high rainfalls is a problem - need more buffers (could be covered by cost-share funding)

Forestry
1. Clearcutting is being done too close to sensitive waterbodies
2. Need to implement and enforce forestry BMPs

Streamside Management
1. There is destruction of riparian zones along surface waters

Water Supplies
1. Need to protect drinking water supply and quality
2. Algae blooms and sedimentation in Water Supplies

Lake Management
1. Nutrient input/eutrophication of lakes and mainstem of river
2. There should be more small flood control projects to keep sediments out of lakes
3. Septic tanks are still allowed in watersheds
4. Sediment on all lakes in the chain due to development
5. Potential WQ problems may occur with lake watershed development

Other
1. Rivers are being used as dumping grounds for various things - we need to make disposal easier at designated areas.
2. There is not enough staff to enforce erosion control
3. Sedimentation is the biggest issue
4. We should hold onto the "best" areas such as special resource waters
5. There has possibly been a decline in shad in the basin

(2) Are there any specific waterbodies in the basin that are experiencing water quality problems? If so, what kind of problems?

1. Richardson Creek - color problems; lots of industry; has populations of the Savannah Lilliput (mussel)
2. Long Creek - color problems; lots of industry
3. Lake Tillery - Foam along edge of lake; soapy; greasy
4. Rocky River - due to development and both point source and nonpoint sources of pollution; color problems; lots of industry; metals problems; increased runoff from storm events; increased sediment loading
5. High Rock Lake - problems due to sediment; coves are having problems due to septic density
6. Badin lake - due to development and package plants
7. Urban and industrial development around South Fork of the Yadkin River
8. Hydroelectric area at Hitchcock Creek & Marks Creek
9. Rocky Creek and Hunting Creek
10. Brown Creek - clearcutting in State Natural Heritage Area (the area gets no protection from this designation).
11. Septic tanks on lakes (Tuckertown lake has very little residential development) are old and may be problems
12. Crooked Creek
13. Uwharrie River mainstem has sedimentaion problems and reduced populations of mussels
14. Goose Creek subbasin has Point Source and Nonpoint Source problems, especially from golf courses, agriculture, and (mostly from) residential)

(3) What efforts have been undertaken to improve water quality? This can include local stormwater ordinances, stream restoration projects, educational efforts, dischargers going beyond requirements, etc.

Agricultural Efforts

1. Use of BMPs for agriculture and forestry
2. Agriculture efforts to protect water quality have improved in the last 4-5 yrs (no-till, terracing, cover cropping, etc.)
3. Federal Farm Bills have been developed and implemented; compliance is high
4. NC Cost-Share program helps with animal waste and litter
5. Non-discharge for animals; new swine operations are getting lagoons
6. Dry waste applicator training
7. Soil testing is being done so correct amounts of nutrients are applied
8. There are now stricter regulations on animal feedlots
9. On most streams the natural buffers are left intact
10. Lake Twitty Water Supply - a Section 319 grant for strategic BMP placement is being implemented

Point Source Controls

1. Regionalization of WWTPs
2. NPDES Permitting controls point sources
3. Charlotte stormwater permits are designed to characterize run-off from industrial sites
4. The town of Troy is improving the WWTP
5. Identification of sources of metals (esp. mercury) entering the Concord WWTP. They are trying to reduce the amount of mercury in the treated effluent.
6. There is greater cooperation between municipalities and industries

Water Quality Programs

1. Water Supply Watershed Protection Program
2. Pesticide Education & Certification programs such as container recycling by NCDA
3. Livestock Operator Certification Program
4. Wetland Reserve program
5. Food Security Act
6. Forest Cost-share program
7. 1990 Sedimentation Control Act has been implemented.

Local Initiatives

1. Local Grass Roots education efforts have been initiated (i.e. - Agriculture Producer Demonstrations such as theTri-County Field Day
2. CP&L and Yadkin Inc. are working on a shoreline management plan for Tillery, Blewett, High Rock and Badin lakes
3. Reuse of waste materials (identifying reuse options)
4. Greenways have been expanded
5. There is more local citizen involvement

APPENDIX V

Modeling Information

Modeling Information

INTRODUCTION

In order to assess the impact of pollutants on surface water quality, the Division must often develop and apply water quality models. A water quality model is a simplified representation of the physical, chemical, and biological processes which occur in a water body. The type of model used is dependent on the purpose for which it is needed, the amount of information that is available or attainable for its development, and the degree of accuracy or reliability that is warranted. In most cases, the Division develops and applies a given model to predict the response of the system to a given set of inputs that reflect various management strategies. For example, water quality models such as QUAL2E or the Division's Level B model are used to predict what the instream dissolved oxygen concentration will be under various sets of NPDES wasteflows and discharge limits. The following sections briefly summarize the types of models used by the Division.

Oxygen-Consuming Waste Models

Several factors are considered when choosing an oxygen-consuming waste model including: the type of system (stream, lake, or estuary), whether one, two, or three dimensions are needed, the temporal resolution needed, and the type of data available. Many of the factors are related. For example, in streams, flow usually occurs in one direction and one can assume that a steady state model will result in adequate predictions. A steady state model is one in which the model inputs do not change over time. However, in open water estuaries, the tide and wind affect which way water moves, and they must often be represented by 2 or 3 dimensional models. In addition, the wind and tide can affect the model reaction rates, and therefore a dynamic model must be used rather than one which is steady state. The last factor, the amount of data available, dictates whether an empirical or calibrated model will be used. An empirical model is used when little water quality information is available for a given water body, and hydraulics and decay rates are estimated through the use of equations. For example, in North Carolina's empirical stream model (referred to as a Level B analysis) velocity is determined through a regression equation developed from North Carolina stream time-of-travel (TOT) studies which includes stream slope and flow estimates as independent variables. Stream slope can be measured from a topographic map, and flow is estimated at a given site by the U.S. Geological Survey. Therefore, the empirical model can be run without TOT information specific to a given stream since parameters are estimated through the use of information which can easily be obtained in the office environment. More information regarding the empirical dissolved oxygen model used by DEM can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Field calibration of a BOD/DO model requires collection of a considerable amount of data. For example, in order to develop hydraulics equations specific to a given stream, TOT studies using rhodamine dye are recommended under at least two flow scenarios including one summer low flow period. In addition, during one summer low flow study, dissolved oxygen, temperature, long term BOD and nitrogen series data are collected. Sediment oxygen demand (SOD) data may also be collected. These data are then used to calibrate reaction rates specific to the stream. QUAL2E is the most commonly used calibrated DO/BOD model for streams in North Carolina. A copy of the model guidance can be obtained from EPA's Environmental Research Lab in Athens, Georgia, and further information on North Carolina's calibration procedures can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Data collection for an estuary DO model is even more extensive. Since the system is multi-dimensional and not steady-state, many more data are needed. Dye is often injected into a system over a period of time, and the dye cloud is then followed for a period of time which may last for days. In addition, several tide gages may need to be set up. Due to the stratification which occurs in an estuary, depth integrated data must also be collected. Calibrated estuary models which have been used by DEM include WASP and GAEST. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST is a one dimensional and is not applicable to many of North Carolina's estuaries.

Lakes are rarely modeled for BOD. Tributary arms of lakes are modeled as slow-moving streams if it is clearly indicated that the flow goes in one direction at all times. Depending on the system, a one, two, or three dimensional model may be used. If a one dimensional model is needed, the modeler may choose the Level B (if little or no data), or QUAL2E. In multidimensional lake systems, WASP will be used.

The calibrated model will be more accurate than the empirical model since it is based on data collected specifically for a given stream in the State. However, it is much more expensive to develop a calibrated model. Not only do a number of staff spend several days to weeks collecting field data (sometimes having to wait months for appropriate conditions), but it also takes the modeling staff several months to develop and document the calibrated model. An empirical model can be developed and applied in a matter of hours. Therefore, due to resource constraints, the majority of the BOD/DO models developed in North Carolina are empirical.

Eutrophication Models

Eutrophication models are used to develop management strategies to control trophic response of a system to nutrient inputs (usually total phosphorus (TP) or total nitrogen (TN)). Nutrient management strategies are typically needed in areas which are sensitive to nutrient inputs due to long residence times, warm temperature, and adequate light penetration. These characteristics are found in deep slow moving streams, ponds, lakes, and estuaries. Modeling and insitu research are used to relate nutrient loading to the trophic response to the system allowing the manager to establish nutrient targets. Models which may be used include the Southeastern Lakes Model (Reckhow, 1987), Walker's Bathtub Model (Walker, 1981), QUAL2E, and WASP.

Once the nutrient targets are known, watershed nutrient budgets are developed to evaluate the relative nutrient loadings from various point and nonpoint sources. Land use data are obtained for the basin, and export coefficients based on literature values are applied to each land use. An export coefficient is an estimate of how may pounds of nutrient will runoff from each acre of land in a given year.

Toxics Modeling

Toxics modeling is done to determine chemical specific limits which will protect to the "no chronic" level in a completely mixed stream. The standards developed for the State of North Carolina are based on chronic criteria. These chemical specific toxics limits are developed through the use of mass balance models:

$$(Cup)(Qup) + (Cw)(Qw) = (Cd)(Qd)$$ where

Cup = concentration upstream
Qup = flow upstream
Cw = concentration in wastewater (known being solved for in WLA)
Qw = wasteflow
Cd = concentration downstream (set = to standard or criteria)
Qd = flow downstream (= Qup + Qw)

When no data are available concerning the upstream concentration, it is assumed to be equal to zero. The upstream flow is the 7Q10 at the discharge point unless the parameter's standard is based on human health concerns, in which case the average flow is used.

REFERENCES CITED - MODELING APPENDIX

Reckhow, K. H., 1987. "A Cross-Sectional Analysis of Trophic State Relationships in Southeastern Lakes." Duke University School of Forestry and Environmental Studies, Durham, N.C.

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APPENDIX VI

Potential Sources of Funding for Projects
to Address Point Sources and Nonpoint Sources

Appendix VIII
Potential Sources of Funding for Projects to Address Point Sources

Funding Program	Application	Contact
U.S. Rural Utilities Service: Water and Wastewater Loan and Grant Program	For rural areas and towns up to 10,000 in population who wish to construct, enlarge, extend, or otherwise improve water or waste disposal facilities providing essential service primarily to rural residents and businesses. Applicants must provide evidence that they cannot finance desired facilities at reasonable rates and terms.	Jeff Duval Jefferson, NC (910) 246-2885
Rural Business and Cooperative Service: Rural Business Enterprise Grants	For rural areas and towns up to 50,000 in population to facilitate and support the development of small and emerging private business enterprises. This includes the construction and development of water and sewer facilities. Grants must either create or save jobs.	One of the RECD Rural Development Managers listed under "Rural Utilities Service" serving the area where the project is located.
Appalachian Regional Commission: Supplements to Other Federal Grants in Aid	For public bodies and nonprofit groups located in wester North Carolina to assist in the improvement of water and sewer facilities which will facilitate the creation or retention of industrial and commercial jobs.	Sara Stuckey NC Department of Administration 116 West Jones Street Raleigh, NC 27603-8003 (919) 733-7232
U.S. Economic Development Administration: Public Works and Development Facilities Grant Program	For any public or nonprofit agency to assist communities with funding public works and development facilities that contribute to the creation or retention of primarily private sector jobs and alleviation of unemployment and underemployment.	Dale L. Jones Economic Development Representative P.O. Box 2522 Raleigh, NC 27601 (919) 856-4570
NC Division of Water Quality: Construction Grants and Loans Program	Provides grants and loans to local government agencies for the construction, upgrade, and expansion of wastewater collection and treatment systems.	Bobby Blowe Construction Grants/Loans Section Division of Water Quality P.O. Box 29579 Raleigh, NC 27626-0579 (919) 733-6900
NC Division of Community Assistance: Small Cities Community Development Block Grant	For municipalities and counties (except for 22 entitlement cities and Wake and Cumberland Counties, which receive money directly from U.S. Dept. of Housing and Urban Development) to develop viable communities by providing decent suitable living environments and to expand economic opportunities mainily for persons of low to moderate income. Funds may be used for public water/wastewater activities.	Liz Wolfe or Phyllis Denmark Division of Community Assistance P.O. Box 12600 Raleigh, NC 27605-2600 (919) 733-2850

Appendix VIII
Potential Sources of Funding for Projects to Address Point Sources, continued

Funding Program	Application	Contact
NC Commerce Finance Center: Industrial Development Fund	For counties and their local units of government (with the same exceptions as above) which access the fund on behalf of new or existing manufacturing firms to provide a financing incentive for jobs creation in the state's most economically distressed counties. Funds may be used for a wide variety of repair, renovation, and modification type projects including sewer infrastructure.	Charles Johnson Industrial Finance Specialist 301 N. Wilmington St. P.O. Box 29571 Raleigh, NC 27626-0571 (919) 715-6558
Rural Economic Development Center, Inc.: Supplemental and Capacity Grants Program	*Supplemental Grants* - Provide funds to match federal and other grants that support necessary economic development projects in economically distressed areas. *Capacity Grants* - Enable local governments to acquire short-term capacity for the planning and writing of federal grants that address immediate economic needs.	Johnnie Southerland Senior Associate Wastewater Grants Rural Economic Development Ctr. 1200 St. Mary's Street Raleigh, NC 27605 (919) 715-2725

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
NC Agriculture Cost Share Program for NPS Pollution Control (NCACSP)	**Agriculture:** Provides up to 75% cost-share, as well as technical assistance, for practices that protect water quality in agricultural areas.	Donna Moffit NC Division of Soil and Water Conservation (919) 715-6107
Environmental Quality Incentives Program (EQIP)	**Agriculture:** Establishes conservation priority areas -- agricultural lands with significant water, soil, and related natural resource problems. Provides 5 to 10 year contracts to pay up to 75% of the cost of conservation practices such as manure management systems, IPM, and erosion control. USDA also provides technical assistance.	Tim Jones USDA, Farm Service Agency 4407 Bland Road Suite 175 Raleigh, NC 27609 (919) 790-2867
Conservation Reserve Program (CRP)	**Agriculture:** Payments to farmers who voluntarily take highly erodible land out of production for at least ten years. Annual rental payments along with 50% cost-share for establishment of permanent cover (grass, trees).	Tim Jones USDA, Farm Service Agency 4407 Bland Road Suite 175 Raleigh, NC 27609 (919) 790-2867
Emergency Conservation Program	**Agriculture:** Provides technical assistance and direct cost-share payments for agricultural producers who, without federal assistance, cannot rehabilitate their private farm land after a natural disaster. Payments are limited to 64% of the first $62,400, 40% of the second $62,400, and 20% of the cost above $125,000.	Tim Jones USDA - Farm Service Agency 4407 Bland Road Suite 175 Raleigh, NC 27609 (919) 790-2867
Farm Debt Cancellation-Conservation Easement Program	**Agriculture:** Farm Service Agency credit borrowers who have loans secured by real estate and have qualifying land may be given debt cancellation on outstanding loan balances in exchange for conservation easements. The cancellation may not exceed 33% of the principal for current borrowers, or the fair market value of the easement for delinquent borrowers.	Mickey Cochran USDA, Farm Service Agency 4407 Bland Road Suite 175 Raleigh, NC 27609 (919) 790-3057

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
Interest Assistance Program	**Agriculture:** Provides guaranteed loans to, among other things, enhance and protect land and water resources -- including pollution abatement and control. Eligible recipients include farm owners/operators who are unable to obtain financing at reasonable rates or rates that allow them to maintain a positive cash flow.	Mickey Cochran USDA, Farm Service Agency 4407 Bland Road Suite 175 Raleigh, NC 27609 (919) 790-3057
Wetland Reserve Program (WRP)	**Agriculture:** Allows farmers to sell permanent wetland easements to USDA. Also cost-share to restore altered wetlands to natural condition. Eligible land includes prior converted cropland, farmed wetlands, riparian areas along streams or water courses that link protected wetlands.	USDA - Natural Resources Conservation Service Contact your local conservationist.
Small Watershed Program, PL-566	**Agriculture:** Technical and financial assistance for projects protecting and developing small watersheds. Historic emphasis on flood control, program now requires off-site water quality benefits.	Carroll Pierce NC Division of Soil and Water Conservation (919) 715-6110
GTE Foundation	**Education:** Supports projects improving math and science for underrepresented groups.	GTE Foundation GTE Corporate Communications One Stamford Forum Stamford, CT 06904 (203) 965-3620
Toyota TAPESTRY Grants	**Education:** Supports innovative science education by teachers in environmental education and physical science.	Eric Crossley National Science Teachers Assoc. Toyota Tapestry 1840 Wilson Blvd. Arlington, VA 22201-3000 (703) 312-9258
Toshiba America Foundation	**Education:** Supports secondary school science and math education.	John Sumansky Toshiba America Foundation 1251 Avenue of the Americas Suite 4100 New York, NY 10020 (212) 596-0600
Digital Equipment Corporation	**Education:** Supports science and math education through school-based and community-linked organizations.	Programs Manager Corporate Contributions Programs Digital Equipment Corp. 110 Powder Mill Rd. MSO 1/L14 Maynard, MA 01754-1418 (508) 493-6550

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
National Environmental Education and Training Foundation (NEETF)	**Education:** Provides funds for environmental education projects that foster informed decision-making, target adults and adolescents in informal educational settings, and address environmental issues affecting health. Require at least a 50% cash match provided by a non-federal source other than the award recipient.	NEETF 915 Fifteenth St. NW Suite 200 Washington, D.C. 20005 (202) 628-8200
National Research Initiative Competitive Grants Program	**Research:** Supports research on key problems of national and regional importance in biological, environmental, physical, and social science relevant to agriculture, food, and the environment, including assessment and protection of water resources. Scientists at public and private agencies and universities are eligible.	USDA - CSREES National Research Initiative Competitive Grants Program Room 323, Aerospace Center AG Box 2241 Washington, DC 20250-22441 (202) 401-5022 (Request for proposals published annually in the *Federal Register*.)
Environmental Contaminants - Identification and Assessment	**Research:** Provides short and medium duration studies/investigations of contaminant exposure and effect to individuals and organizations with a need for such information. Applicants must provide matching funds or in-kind services	Tom Ausperger US Fish and Wildlife Service P.O. Box 33726 Raleigh, NC 27636-3627 (919) 856-4520
Environmental Contaminants - Prevention	**Research:** Provides technical and engineering support to prevent contaminant problems. No direct financial assistance is provided.	Tom Ausperger US Fish and Wildlife Service P.O. Box 33726 Raleigh, NC 27636-3627 (919) 856-4520
Environmental Geochemistry and Biogeochemistry Research Program	**Research:** Supports interdisciplinary research on how chemical and biological processes in nature alter water quality. A minimum 1% cost-share is required. Eligible recipients are scientists, engineers, and educators at universities and other not-for-profit institutions.	National Science Foundation Division of Earth Sciences Director, Environmental Chemistry and Geochemistry Program 4201 Wilson Blvd. Arlington, VA 22230 (703) 306-1554
Hydrologic Science Research Program	**Research:** Supports research in hydrologic science on the quality of waters in streams and aquifers. A minimum 1% cost-share is required. Eligible recipients are scientists, engineers, and educators at universities and other not-for-profit institutions.	National Science Foundation Division of Earth Sciences Director, Hydrologic Sciences Program 4201 Wilson Blvd. Arlington, VA 22230 (703) 306-1549

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
Water and Watersheds Research Program	**Research:** A joint NSF/EPA special awards program to support interdiciplinary teams joining the physical, biological, and socioeconomic sciences and engineering in research on water quality issues. A minimum 1% cost-share is required. Eligible recipients are scientists, engineers, and educators at universities and other not-for-profit institutions.	National Science Foundation Directorate for Biological Sciences Executive Officer 4201 Wilson Blvd. Arlington, VA 22230 (703) 306-1400
Flood Plain Management Services	**Water Quality Planning:** Provides invormation and data on floods and actions to reduce flood damage to local governments.	U.S. Army Corps of Engineers, Planning Division Directorate of Civil Works, Chief Flood Plain Management Services 20 Massachusetts Ave., NW Washington, D.C. 20314-1000 (202) 761-0169
Resource Conservation and Development Program	**Water Quality Planning:** Provides funds and technical assistance to local governments and nonprofits to plan, develop, and implement programs for resource conservation and community sustainability.	Stan Steury RC&D Executive Director Blue Ridge RC&D Council, Inc. P.O. Box 2 Boone, NC 28607 (704) 265-4005
River Basin Surveys and Investigations	**Water Quality Planning:** Provides planning assistance to local agencies to develop coordinated water and relanted land resource programs, with priority given to solving upstream flooding of rural communityies, improving water quality from agricultural nonpoint sources, abd wetland preservation, etc.	USDA, Natural Resources Conservation Service Director, Watersheds and Wetlands Division P.O. Box 2890 Washington, D.C. 20013 (202) 720-3534
Soil and Water Conservation Program	**Water Quality Planning:** Provides technical assistance to local governments for resource planning and management to improve water quality and reduce pollution.	USDA, Natural Resources Conservation Service Contact your local conservationist
Watershed Protection and Flood Preventions (Small Watershed Program)	**Water Quality Planning:** Provides monitoring, loans, cost-share, and technical assitance for the installation of land treatment measures. Provides up to 100% of the cost of structural flood prevention measures. Eligible agencies include local government, nonprofits, and SWCDs.	USDA, Natural Resources Conservation Service Contact your local conservationist.

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
Rivers, Trails, and Conservation Assistance Program	**Water Quality Planning:** Provides technical assistance for assessing resources, identifying land protection strategies, and developing organizations to address environmental concerns.	Mary Rountree Great Smokey Mountains Nat. Park 107 Park Headquarters Gatlinburg, TN 37738-4102 (423) 436-1246
Section 205(j) Water Quality Planning Grants	**Water Quality Planning:** Provides funds for planning activities such as developing plans for meeting and maintaining local water quality standards, implementing such plans, and determining the nature, extent, and causes of water quality problems.	Alan Clark Division of Water Quality Planning Branch P.O. 29535 Raleigh, NC 27607 (919) 733-5083 ext. 570
NC Division of Water Resources Stream Repair Funding	**Stream Restoration:** Provides cost-share funds and technical assistance in stream restoration projects to local governments.	Jeff Bruton Division of Water Resources P.O. Box 27687 Raleigh, NC 27611-7687 (919) 733-4064
Forestry Stewardship Incentive Program	**Forestry:** Up to 50% cost-share (max $7,500/person-yr) to enhance management of nonindustrial private forest lands to increase timber supply and improve fish and wildlife habitat and recreation.	Larry Such NC Division of Forest Resources P.O. Box 29581 Raleigh, NC 27626 (919) 733-2162 ext. 241
Forestry Incentives Program	**Forestry:** Up to 50% funding for tree planting and stand improvement to increase supplies from nonindustrial private forest lands.	Larry Such NC Division of Forest Resources P.O. Box 29581 Raleigh, NC 27626 (919) 733-2162 ext. 241
Rural Abandoned Mine Program	**Reclamation:** Direct payments of up to 100% in cost-share funds for conservation practices determined to be needed for reclamation, conservation, and development of up to 320 acres per owner of rural abandoned coal mine land or lands and waters affected by coal mining.	USDA, Natural Resources Conservation Service Contact your local conservationist.
Environmental Contaminants -- Natural Resource Damage Assessment	**Reclamation:** Provides funding for the assessment of damage to water quality and Trust resources from oil spills and/or other hazardous substance releases for individuals or organizations interested in the restoration of fish and wildlife, including aquatic habitat and water quality.	Tom Ausperger US Fish and Wildlife Service P.O. Box 33726 Raleigh, NC 27636-3627 (919) 856-4520

Appendix VIII
Potential Sources of Funding for Projects to Address Nonpoint Sources

Funding Program	Application	Contact
NC Conservation Tax Credit Program	**Land Conservation:** Allows credit against individual and corporate income taxes when real property is donated for conservation purposes. Interests in property that promote fish, wildlife, etc. conservation purposes may be donated to a qualified recipient for a substantial tax credit (currently 25% of the value of the gift up to $25,000).	Bill Flournoy NC DEHNR (919) 715-4191

APPENDIX VII

Section 303(d) of the Clean Water Act

APPENDIX VII

LIST OF 303(D) WATERS IN THE YADKIN RIVER BASIN

What is the 303(d) list?

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or which have impaired uses. Waters may be excluded from the list if existing control strategies for point and nonpoint source pollution will achieve the standards or uses. Listed waterbodies must be prioritized, and a management strategy or total maximum daily load (TMDL) must subsequently be developed for all listed waters. The 303(d) process is presented in Figure 1.

303(d) List Development

Generally, there are four steps to preparing North Carolina's 303(d) list. They are (1) gathering information about the quality of North Carolina's waters, (2) screening those waters to determine if any are impaired and should be listed; (3) determining if a total maximum daily load (TMDL) has been developed, and (4) prioritizing impaired waters for TMDL development. This document also indicates whether the Division of Water Quality (DWQ) intends to develop a TMDL as part of a Management Strategy (MS) to restore the waterbody to its intended use. The following subsections describe each of these steps in more detail.

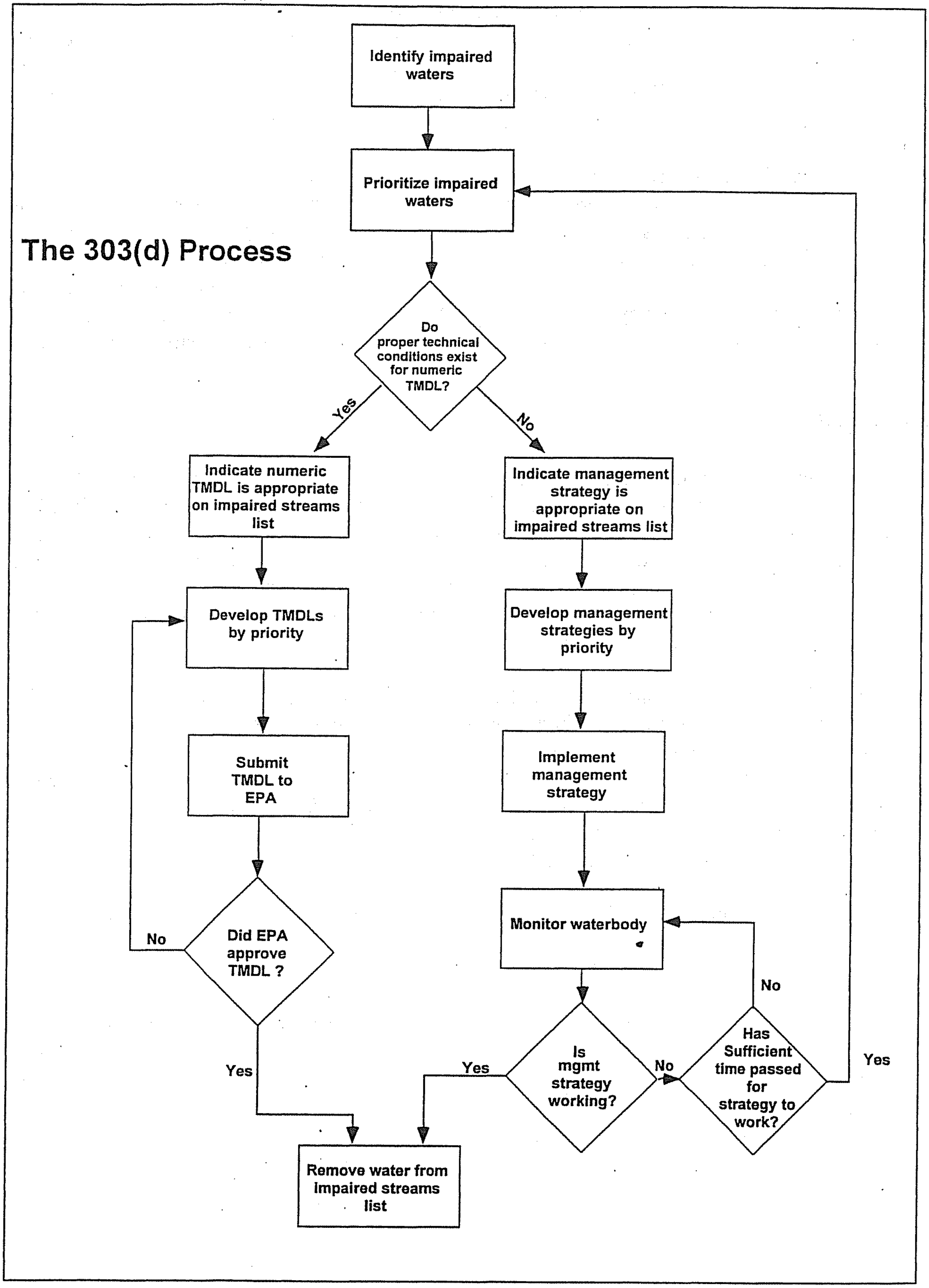
Sources of Information

For North Carolina, the primary sources of information are the basinwide management plans and accompanying assessment documents, which are prepared on a five-year cycle, and the 305(b) report, which is prepared biennially. Basinwide management plans include information concerning permitting, monitoring, modeling, and nonpoint source assessment by basin for each of the 17 major river basins within the state. Basinwide management allows the state to examine each river basin in detail and to determine the interaction between upstream and downstream point and nonpoint pollution sources. As such, more effective management strategies can be developed across the state.

The 305(b) report is used as a basis for developing the 303(d) list. Section 305(b) of the CWA requires states to report biennially to the U.S. Environmental Protection Agency (EPA) on the quality of waters in their state. In general, the report describes the quality of the state's surface waters, groundwaters, and wetlands, and existing programs to protect water quality. Information on use support, likely causes (e.g., sediment, nutrients, etc.) and sources (point sources, agriculture, etc.) of impairment are also presented.

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical, and biological data collected by DWQ were the primary sources of information used to make use support

FIGURE 1. THE 303(d) PROCESS



assessments. North Carolina has an extensive ambient and biological monitoring network throughout the state. Benthic macroinvertebrate data, which indicate taxa richness and species diversity, are an important data source. North Carolina also collects fish tissue and fish community structure data, and phytoplankton bloom data that are used in the assessments. Shellfish closure data, fish kill data, reports, predictive modeling results, toxicity data, and self-monitoring data are considered when making final use support determinations.

Data from all readily available sources outside of DWQ are considered when evaluating use support. Many other agencies, universities, industries, point sources, and environmental groups collect data on North Carolina's surface waters. Published reports and data from ongoing studies that the DWQ has knowledge of are actively solicited during the assessment phase of the basin planning cycle. Data that are not collected and analyzed following procedures outlined by the Environmental Protection Agency (EPA) are used to quality assure other monitoring that may occur in the same water and identify areas to monitor in the future. The Division therefore uses all data.

Listing Criteria

Waterbodies whose use support ratings were not supporting (NS), partially supporting (PS), and support threatened (ST) based on monitored information in the 305(b) report were considered as initial candidates for the 303(d) list. Although support threatened waters currently meet their intended uses, these waters were reviewed to determine if there were sufficient data to determine if they would become impaired in the next two years. The list was then compared to the 1996 303(d) list to determine if additional waters should be added that were included on that 303(d) list that are still considered as impaired based on evaluated information.

Fish consumption advisory information was then reviewed to determine if other waters should be added to the list. Fish consumption advisories are no longer considered when determining use support since the entire state was posted in June 1997 for the consumption of bowfin from mercury contamination. It should be noted that bowfin do not occur statewide; they are found primarily within the coastal plain. While fish consumption advisories do indicate impairment, DWQ did not want to mask other causes and sources of impairment by having the entire state or an entire basin listed as impaired due to advisories. However, DWQ believes that advisories on specific waters are cause to include the water on the 303(d) list, therefore, advisories other than statewide bowfin mercury contamination were considered when developing the state's 303(d) list.

Guidance from EPA on developing 1998 303(d) lists indicates that impaired waterbodies without an identifiable problem parameter should not be included on the 303(d) list. However, DWQ feels that waterbodies listed in the 305(b) report as impaired for biological reasons where problem parameters have not been identified, should remain on the 303(d) list. The Clean Water Act states that chemical, physical, and biological characteristics of waterbodies shall be restored. The absence of a problem parameter does not mean that the waterbody should not receive attention. Instead, DWQ should at a minimum resample those areas or initiate studies to determine why the waterbody is impaired. Thus, biologically impaired waterbodies without identifiable problem parameters are on the 1998 303(d) list. Following is a summary of waters that were added to the Yadkin 303(d) list:

- Several waters were included on the 1998 list based on updated use support information. These waters are: Reynolds Creek, Salem Creek, Fourth Creek, Grants Creek, Brushy Fork, Lick Creek, Pee Dee River, Little Mountain Creek, Rocky River, Coddle Creek, Goose Creek, Crooked Creek, North Fork Crooked Creek, South Fork Crooked Creek, Lanes Creek, Brown Creek, Cartledge Creek, Hitchcock Creek, North Fork Jones Creek, and South Fork Jones Creek.

- Long Lake, Hamlet City Lake, and Rockingham City Lake have been added to the list based on updated use support information. Long Lake was rated as impaired because it has been drained; however, there is a plan in place to restore the lake. Hamlet City Lake is rated as partially supporting its uses, but a local plan has been developed to restore the lake. Hamlet City Lake is also currently drained under an Army Corps of Engineers project to repair the dam. . Since Long Lake and Hamlet City Lake have been drained, a priority of N/A has been assigned to them.

- Ledbetter Lake was added to the 303(d) list based on a fish consumption advisory for mercury. Ledbetter Lake is privately owned and DWQ has no further physical, biological, or chemical information on the lake.

De-Listing Criteria

Waters included on the 1996 303(d) list were reviewed to determine if they may be removed from the list of impaired waterbodies. If updated use support analyses indicated that the water was meeting its uses, the waterbody was dropped from the list. Other waters were dropped from the list if an approved TMDL is on file for the water and parameter listed.

Management strategies have been developed for a number of impaired waters. These waters remain on the list unless updated use support information indicated the water met its uses. In some cases, DWQ is confident that the management strategy will restore water quality, but it may take time to restore the water. For these waters, DWQ does not propose to do further modeling on the water, but the water will continue to be monitored to determine when it meets its uses. This approach is addressed further in the prioritization section of the document. As summary of waters that were removed from the 1996 303(d) list follows:

- Several waters were included on the 1996 303(d) list that have been removed from the 1998 303(d) list since updated use support information indicates that the water is meeting its uses. These waters include: Ararat River, Toms Creek, Danbury Creek, Carter Creek, Barkers Creek, Little Creek, Abbotts Creek, Back Creek, Long Creek, one segment of Long Branch, one segment of Richardson Creek, and two segments of Marks Creek.

- Several unnamed tributaries were included on the 1996 303(d) list that do not appear on the 1998 list. Most of these tributaries drain to a water that supports its uses. These waters are: UT Mulberry Creek, South UT, UT North Potts Creek, UT Second Creek, and UT Reedy

Creek. Two other tributaries drain to waters that are considered impaired, but these waters were not included on the 303(d) list. These waters are not included in the current use support spreadsheets, and DWQ cannot determine which tributaries were listed as impaired. It is possible that these tributaries were included based on workshops that were held in the mid to late eighties, but our files have no data on them. These waters are UT Grants Creek and UT to Lick Creek. It is likely that any management strategy that is developed on Grants Creek and Lick Creek would also apply to any tributaries that may be impaired.

- The listing for Rich Fork Creek has been combined into one long segment.

Assigning Priority

North Carolina is required to prioritize its 303(d) list in order to direct resources to those waterbodies in greatest need of management. The Clean Water Act states that the degree of impairment (use support rating) and the uses to be made of the water (stream classification) are to be considered when developing the prioritization. In addition, DWQ reviews the degree of public interest and the probability of success when developing its prioritization schemes. Waters harboring endangered species are also given additional priority. A method to assign ratings to freshwaters that have recent data indicating impairment has been devised based on these criteria. A summary of the prioritization scheme is included in Figure 2.

The prioritization process results in ratings of **high, medium, and low**. Generally, waters rated with the highest priority are classified for water supply, rated not supporting, and harbor an endangered species. Waters receiving a High priority are important natural resources for the state of North Carolina and generally serve significant human and ecological uses. High priority waters will likely be addressed first within their basin cycles.

EPA recently issued guidance that suggested states should develop TMDLs and management strategies on all of their impaired waters within the next eight to thirteen years. To meet this federal guidance, the DWQ is striving to address all waters on the 1998 303(d) list that have a priority of high, medium, or low within the next 10 years. Numeric TMDLs, if proper technical conditions exist, and management strategies will be developed for these waters. The DWQ is currently reviewing its resource needs in order to meet this aggressive schedule.

FIGURE 2. PRIORITY RANKING FOR FRESHWATERS

Each of the waters on the 303(d) list were ranked in order to prioritize DWQ's resources. The ranking is based on the classification, use support rating, presence of endangered species, degree of public interest, and the probability of success. This ranking can be represented by

Rank = Σ *(classification, use support rating, endangered species, public interest, probability of success)*

Where the following numeric rankings were applied to the various categories:

Classification:
- Water supply waters (WS-1, II, III, IV) = 2
- B = 1
- C = 0
- Supplemental classifications = +1
  - Tr (Trout fishing waters)
  - NSW (Nutrient sensitive waters)
  - HQW (High quality waters)
  - ORW (Outstanding resource waters)

Use Support Rating:
- NS = 1
- PS = 0

Endangered Species present:
- Federally endangered = 2
- Other endangered or threatened = 1
- None present = 0

Public interest expressed on particular water body:
- Yes = 1
- No = 0

Probability of success (subjective criteria depending upon problem parameters, type of sources of problem parameters, availability of technical tools to calculate numeric loads, NPS/319 priorities, etc.):
- Yes = 1
- No = 0

The sum of the individual category ranking is used to determine the priority for the impaired water body. If the overall rank is between 6 and 8, the water is prioritized as high. If the overall rank is between 3 and 5, the water body is prioritized medium, and overall ranks of below 3 are prioritized as low. Each category has equal weight in the determination of the overall ranking. For example, for Little Buffalo Creek in the Cape Fear River Basin, the overall ranking and priority of medium were determined as follows:

Category	Value	Comments	Rank
Classification	WS-IV	No supp classifications	2
Use support rating	NS	None	1
Public interest	No	None	0
Endangered species	Yes, federal	Cape Fear Shiner in subbasin 11	2
Prob of success	Sediment impaired, no standard, NPS sources	None	0
Total			**5**

Other priorities have also been assigned to waters. A **Monitor** priority indicates that the waterbody is listed based on (1) data older than 5 years, (2) biological monitoring and no problem pollutant has been identified, or (3) biological monitoring that occurred in waters where we now have evidence that the biological criteria should not have been applied. These waters will be resampled before a restorative approach may be developed because more information is required about the cause of impairment. Further information on the monitoring approaches that have a Monitor priority is provided in the next section.

The final priority listed on the 303(d) list is **N/A** for not applicable. This priority was assigned to waters that DWQ believes will meet their uses based on the current management strategies. DWQ will not develop a new TMDL or management strategy for these waters unless data continue to indicate impairment and sufficient time has passed for the waterbody to respond to the management action. An example of this priority is a water impaired by a point source, and the pollutant causing the impairment has been completely removed from the point source.

Approaches to Restore Water Quality

EPA informed North Carolina at a TMDL workshop in January, that TMDLs must now be total, maximum, daily, and loads in order to be approved. Such a narrow definition of a TMDL severely limits states' abilities to develop numeric TMDLs. Given this narrow definition of a TMDL, North Carolina believes that TMDLs cannot be developed for waters impaired by sediment, turbidity, fecal coliform, and pH.

DWQ believes that TMDLs are only one tool that can be used to prioritize and direct resources for the restoration of impaired waters. There are other tools that can be used. In the management strategy approach included on the 303(d) list, the state can work to identify the causes and sources of impairment and implement strategies to reduce those sources so that water quality can ultimately be restored. As part of the management strategy approach, North Carolina may be able to develop numeric targets such as percentage reductions or other metrics that do not meet EPA's current definition of an approvable TMDL. However, DWQ would like to have adequate data and a defensible modeling approach to minimize challenges of the numeric goals which can exhaust our limited resources. DWQ is reviewing its options to address these impaired waters, and staff are currently working together to develop a process to encourage local watershed management plans. This process could include a combination of voluntary and mandatory control strategies. We anticipate that we will receive stakeholder input on the process in mid to late 1998 after it is presented to and approved by the Department's administration. DWQ has confidence that this approach will be successful in restoring impaired waters. Management strategies developed with strong stakeholder input have been shown throughout the nation to be effective in restoring water quality.

For both the numeric TMDL approach and management strategies that include alternative numeric targets, DWQ needs to ensure that defensible targets are developed. In order to have technically defensible numeric targets, the proper technical conditions are needed. EPA's guidance published in the December 28, 1978 Federal Register defined proper technical conditions as having the analytical methods, modeling techniques, and database necessary to develop a technically defensible TMDL.

North Carolina and EPA are currently reviewing methods to develop numeric targets for fecal coliform and sediment. As better models and data become available, North Carolina will review its approach column to include more TMDLs if EPA revises its current definition of a TMDL. In the interim, DWQ will develop other numeric goals when data are available to support them.

The 303(d) list contains information on whether the Division plans to pursue a numeric **TMDL** as currently defined by EPA or whether it will pursue a management strategy (**MS**). Some waters must have more data collected on them to determine the causes and sources of pollution before a management strategy or TMDL can be devised. These include the waters that are biologically impaired waters where no problem parameter has been identified or waters listed based on data older than five years.

It will be difficult to develop TMDLs or management strategies on waters where we have no problem pollutant identified even if the data were collected recently. DWQ proposes to collect more biological and chemical data to determine the causes and sources of the impairment for waters included on the list based on recent biological data. The approach for these waters is problem parameter identification or **PPI**. Monitor appears in the Priority column, corresponding to PPI in the approach column. DWQ will develop TMDLs or management strategies for these waters within two basin planning cycles from when data indicating causes and sources of impairment are available. We will collect this information on as many waterbodies as resources allow during the next basin planning cycle. DWQ is beginning to collect this information in the Cape Fear Basin this summer. We should have more information on our ability to identify the causes and sources of biological impairment these waters later this year.

Waters that are listed based on data older than 5 years may in fact be meeting their uses. Since many changes can occur within a watershed in a five-year period, conclusive information about a waterbody's use support cannot be made with older data. North Carolina will resample as many of these waterbodies that have only historical data as staffing and time permit for subsequent updates of the basin plans and 303(d) list. Waters listed based on older information are indicated by a **RES** in the Approach column of the lists to denote that they will be resampled.

A TMDL or management strategy will not be developed for waters listed based on old data or an inappropriate use of biological criteria until we have updated sampling information that indicates the water is impaired. This process will ensure that DWQ has sufficient current information to determine if the impairment exists and to help identify the source of the impairment. This will enable DWQ to focus its limited resources on watersheds that are in greatest need of management.

If guidance is issued in the future which indicates that mandatory controls are to be placed on point or nonpoint sources on the basis that it is included on a state's 303(d) list, these controls should not be applied to waters listed based on older information or biological criteria that are not applicable to the water. Mandatory controls applied to these waters simply on the basis of being included on the 303(d) list could result in high costs to the regulated community with little or no environmental benefit.

Targeted Waterbodies for TMDL Initiation by April 2000

North Carolina's focus for the next ten years is to develop strategies to restore impaired waters with a high, medium or low priority to their intended uses. Therefore, DWQ will spend significant resources deciding the best approaches and strategies for restoring waterbodies. Some waterbodies are impaired due to problem parameters that are not necessarily conducive to a TMDL. In these cases, DWQ believes that resources are better utilized by developing a management strategy instead of attempting to develop a technically defensible TMDL The highest priority water in the Yadkin River Basin, Goose creek, will be addressed first.

Nonpoint source pollution and the cumulative effect of a number of small discharges impair Goose Creek. The expansion of the Charlotte area has led to an increase in the number of small dischargers to several streams in the area, including Goose Creek. Elevated fecal coliform bacteria levels and sedimentation are problem parameters for this stream. To better assess the cumulative impact of discharges and to evaluate the assimilative capacity of Goose Creek, a field-calibrated QUAL2E model will be developed by 2000. Further work on Goose Creek will be done prior to the next basin plan in conjunction with the nonpoint source team's efforts.

Additional Guidance on Using the 303(d) List

The column headings in the 303(d) list refer to the following:

Class - The information in this column indicates the classification assigned to the particular waterbody. Stream classifications are based on the existing and anticipated best usage of the stream as determined through studies and information obtained at public hearings. The stream classifications are described in 15 A NCAC 2B .0300, and are summarized in Appendix I.

Wtrbdy - The number in this column refers to the DWQ subbasin in which the waterbody is located. The NRCS 14 digit hydrologic units nest within the DWQ subbasins. On the lakes tables, this column is entitled subbasin.

Problem Parameter - These are the causes of impairment as identified in the 305(b) report. Where no cause is listed, the rating was based on biological data, and available chemical data showed no impairment. These biological data may include benthic and fish habitat and community structure. When a problem parameter is identified, the parameter listed exceeded the state's water quality standards for that substance or was identified by scientific personnel during field studies (e.g., sediment). This parameter is a potential cause of the impairment, but there may be other, unidentified causes contributing to the impairment as well. Problem parameters included in the 303(d) list are outlined below:

Chla – chlorophyll-a
Cl – chlorine
Cu – copper
DO – dissolved oxygen
Fecal – fecal coliform bacteria
Hg – mercury

NH3 – ammonia
Nutr – nutrients
Pb – lead
pH – pH
Sed – habitat impairment due to sediment
Tox – toxicity
Turb – turbidity
Aq. Weeds – aquatic weeds

Rating - This column lists the overall use support rating. These values may be NS (not supporting), PS (partially supporting), and NE (not evaluated). A rating of not evaluated is typically assigned to waters that were sampled using biocriteria that may not apply or there is no data available on the water. These waters appeared on earlier lists, and they continue to be listed, but no TMDL or management strategy will be developed until we have updated information that the water continues to be impaired. For waters listed solely on the basis of fish consumption advisories, the rating may also be supporting (S) or supporting but threatened (ST). The 305(b) report describes these use support ratings further. On the lake tables, the overall use support rating is found in the column entitled "Overall use". Ratings for specific uses are found in the columns entitled "Fish Consump", "Aq. Life and Secondary Impact", "Swimming", and "Drinking Water".

Major Sources (P,NP) - This column indicates whether point (P) or nonpoint (NP) sources are the probable major sources of impairment.

Subcategory - This column breaks the probable point and nonpoint sources down further. A list describing what each number means is provided in Table 1.

Approach – This column indicates the approach DWQ will take to restore the waterbody. If more than one approach is listed, one is a TMDL. TMDLs are typically developed for DO, nutrients, ammonia, and metals. Management strategies are typically done for pH, sediment, turbidity, and fecal coliform. Further information on each approach is provided below.

TMDL – A numeric TMDL as currently defined by EPA will be developed (e.g. is total, maximum, daily, load).

MS – Management Strategy – These waterbodies are on the list based on data collected within the five years prior to when the use support assessment was completed. A problem pollutant has been identified, but North Carolina cannot develop a numeric TMDL as EPA currently defines it. A management strategy may contain the following elements: further characterization of the causes and sources of impairment, numeric water quality goals other than TMDLs, and best management practices to restore the water.

TABLE 1. SOURCE SUBCATEGORIES		
Category	*Subcategory*	*Description*
0		Point Sources
	01	Industrial
	02	Municipal
	03	Municipal pretreatment (indirect dischargers)
	04	Combined sewer overflows (end-of-pipe control)
	05	Storm sewers (end-of-pipe control)
	06	Schools
	08	Minor non-municipal
1		Nonpoint sources
10		Agriculture
	11	Non-irrigated crop production
	12	Irrigated crop production
	13	Specialty crop production (e.g., truck farming and orchard)
	14	Pasture land
	15	Range lots
	16	Feedlots – all types
	17	Aquaculture
	18	Animal holding/management areas
20		Silviculture
	21	Harvesting, reforestation, residue management
	22	Forest management
	23	Road construction/maintenance
30		Construction
	31	Highway/road/bridge
	32	Land development
40		Urban Runoff
	41	Storm sewers (source control)
	42	Combined sewers (source control)
	43	Surface runoff
	44	Finger canals
	45	Industrial
50		Resource Extraction/Exploration/Development
	51	Surface mining
	52	Subsurface mining
	53	Placer mining
	54	Dredge mining
	55	Petroleum activities

TABLE 1. SOURCE SUBCATEGORIES		
Category	*Subcategory*	*Description*
	56	Mill tailings
	57	Mine tailings
	58	Abandoned mines
60		Land Disposal (Runoff/Leachate from permitted areas)
	61	Sludge
	62	Wastewater
	63	Landfills
	64	Industrial land treatment
	65	On-site wastewater systems (septic tanks, etc.)
	66	Hazardous waste
70		Hydrologic/Habitat Modification
	71	Channelization
	72	Dredging, sand dipping
	73	Dam construction
	74	Flow regulation
	75	Bridge construction
	76	Removal of riparian vegetation
	77	Streambank modification/destabilization
	78	Collapsed dam
80		Other
	81	Atmospheric deposition
	82	Waste storage/storage tank leaks
	83	Highway maintenance and runoff
	84	Spills
	85	In-place contaminants
	86	Natural
	87	Marinas, harbors
	88	Airport
	89	Military activities (off-road)
90		Source Unknown
	91	General erosion (road erosion)

RES – This waterbody was identified as being impaired based on water quality data that were greater than 5 years old at the time the use support assessment was performed. This waterbody will be resampled prior to TMDL or management strategy development to ensure the impairment continues to exist. This will enable the Division to focus its limited resources on watersheds that are in greatest need of management.

PPI – Problem Parameters Identification - Available chemical data do not show any parameters in violation of the standard, but biological impairment have been noted within the five years prior to use support assessment. DWQ will resample these waters for chemical and biological data to attempt to determine the potential problem pollutants. TMDLs or management strategies will be developed within 2 basin cycles of problem parameter identification.

Priority – Priorities of high, medium and low were assigned for waters identified as being impaired based on data that were not greater than 5 years of age at the time the use support assessment was done and for which a problem pollutant has been identified. All waters assigned a priority of high, medium, or low will be addressed within the next two basin cycles. The basis of these priorities is further explained in Appendix II. Priorities of monitor and N/A have also been assigned. Further explanation on each of these is provided below:

High – Waters rated High are important resources for the state of North Carolina in terms of their human and ecological uses. Typically they are classified as water supplies, harbor federally endangered species, and are rated as not supporting. These waters will be addressed first within their basin cycles.

Medium – Waters rated Medium may be classified for water supply or primary recreational use, may have state endangered or other threatened species, and may be rated as partially or not supporting.

Low – Waters rated Low generally are classified for aquatic life support and secondary recreation (i.e., Class C waters), and harbor no endangered or threatened species.

Monitor – The waterbody is included on the 303(d) list based on: (1) data that are greater than 5 years of age when use support assessment done (denoted by RES in approach column) or (2) biological data collected within 5 years of use support assessment but no problem pollutant has been identified (available chemical data show full use support – denoted by PPI in approach column), and (3) freshwater biological criteria applied to swamp waters. In general, waters given this priority based on recent biological data will be sampled prior to waters listed based on older information and are therefore higher priority than waters listed based on older information or swamp waters. All waters with this priority will be resampled as resources allow. Waters with this priority will not have management strategy or TMDL developed for it before updated sampling or analyses of the biological criteria are done which indicates that the water continues to be impaired and a problem pollutant has been identified. Once updated sampling is done and problem pollutants have been identified, these waters will be addressed by either a management strategy or TMDL within two basin planning cycles (10 years). This approach will enable DWQ to focus its limited resources on watersheds that are in greatest need of management.

N/A – DWQ believes that its current management strategy will address the water quality impairment, but it may take a number of years before standards are met. In this case, DWQ plans to continue monitoring the water to determine if improvements are occurring, but no new management strategy or TMDL will be developed unless sufficient time has passed for improvement to occur, and data indicate the water is still impaired.

The lakes column entitled "Troph Status" refers to the trophic status of the lake, a relative description of the biological productivity of the lake. The lake may be hypereutrophic, eutrophic, mesotrophic, or oligotrophic. Oligotrophic lakes are nutrient poor and biologically unproductive, mesotrophic lakes have intermediate nutrient availability and biological productivity, eutrophic lakes are nutrient rich and highly productive, and hypereutrophic lakes are extremely eutrophic.

1998 303(d) LIST FOR THE YADKIN RIVER BASIN

Name of Stream	Description	Class	Index #	Wtrbdy	Miles	Problem Parameter(s)	Overall Rating	Major Sources (P,NP)	Major Sources Subcategory	Approach	Priority
Little Beaver Creek	From NC 268 to Fisher River	C	12-63-13b	30702	1.4		NS	NP	84- tire fire run	PPI	Monitor
Ararat River	From Mount Airy WWTP to SR 2026, at A	C	12-72-(4.5)b	30703	10.3	Sed	PS	NP,P	10,40,03	MS	Low
Faulkner Creek	From source to Ararat River	C	12-72-6	30703	6	Sed	NE	NP	40,10	RES	Monitor
Lovills Creek (Lovell	From Mount Airy Water Supply Dam to A	C	12-72-8-(3)	30703	4.2		PS	NP	40	PPI	Monitor
Heatherly Creek	From source to WWTP	C	12-72-14-5a	30703	1.7		PS	NP	10	PPI	Monitor
Heatherly Creek	WWTP to Toms Creek	C	12-72-14-5b	30703	1.7		NS	NP,P	40,03	PPI	Monitor
Reynolds Creek	From Sequoia WWTP, Forsyth to Muddy	C	12-94-9b	30704	1.7		PS	NP	10,40	PPI	Monitor
Salem Creek (Middle Fork	From Winston-Salem Water Supply Dam	C	12-94-12-(4)	30704	11.7	Fecal,Turb,Sed	PS	NP	10,40,43,03	MS	Low
Cedar Creek, including	From source to Davie County SR 1410	B	12-102-13-(1)	30705	8.5		PS	NP	90 unknown	PPI	Monitor
Cedar Creek	From Davie County SR 1410 to above Q	C	12-102-13-(2)	30705	3.2		PS	NP	90 unknown	PPI	Monitor
Fourth Creek	From SR 2308 Iredell Co 1.5 mile upstrea	C	12-108-20-(1)	30706	9.5	Sed, Fecal, Turb	PS	NP	10	MS	Low
Fourth Creek	From 1.5 mile upstream of Rowan County	WS-IV	12-108-20-(3.	30706	7.7	Sed	PS	NP	10	MS	Low
Grants Creek	From source to Yadkin River	C	12-110	30704	17.9	Fecal, Turb,Sed	PS	P,NP	02,40,30,10	MS	Low
Town Creek	From SR 1526 to Crane Cr	C	12-115-3b	30704	8.1	Sed	NS	NP,P	30,40,10	MS	Low
Brushy Fork	From Buck Br to Tom-A-Lex Lake, Abbot	WS-III CA	12-119-5-(7)	30707	0.5	Sed	PS	NP	10	RES	Monitor
Brushy Fork	From source to Buck Br	WS-III	12-119-5-(1)	30707	9.3	Sed	PS	NP	10	MS	Medium
Rich Fork	From source to Abbotts Cr	C	12-119-7	30707	20.7	Fecal	PS	NP,P	10,40,30,20,03	MS	Low
Hunts Fork	SR-1792, Davidson County	C	12-119-7-3	30707	7.5		PS		40,30	PPI	Monitor
Hamby Creek	From source to Hunts Cr	C	12-119-7-4	30707	12.5	Fecal, Sed	NS	NP,P	40,10,03	MS	Low
North Hamby Creek	From source to Hamby Cr	C	12-119-7-4-1	30707	6.1		NS	NP	40	PPI	Monitor
Jimmys Creek	From source to Hamby Creek	C	12-119-7-4-2	30707	6.8		PS	NP	90	PPI	Monitor
Lick Creek	From source to East Br Lick Cr, Yadkin R	C	12-126-(0.5)	30708	7.2		PS	NP	10	RES	Monitor
Lick Creek	From East Br Lick Cr 1 mile upstream of	WS-IV	12-126-(3)	30708	7.4		PS	P,NP	02,40,10	PPI	Monitor
PEE DEE RIVER (incl Blew	From Norwood Dam to mouth of Turkey	WS-V&B CA	13-(15.5)	30710	15.2	DO	PS	NP	10 CAOs & Cro	MS	Medium
PEE DEE RIVER	From Turkey Top Creek to .8 mile downs	WS-IV&B	13-(23.5)	30708	5.7	pH	PS	NP	10 CAOs & Cro	MS	Medium
Little Mountain Creek	From .5 mile upstream of Stanly Co SR 1	WS-IV	13-5-1-(2)	30708	5		PS	NP,P	10,upstream di	PPI	Monitor
Little Mountain Creek	From source to .5 mile upstream of Stanl	C	13-5-1-(1)	30708	2		PS	NP,P	10,us cumm di	RES	Monitor
Rocky River	From source to SR 2420, Mecklenburg	C	13-17a	30711	9.2	Fecal,Turb,Sed	NS	NP	10,40	MS	Low
Dye Creek (Branch)	From source to SR-1147, Iredell County	C	13-17-2a	30711	3.3	Sed	PS	NP	40,10	MS	Low
Dye Creek (Branch)	From SR-1147 Iredell County to Pee Dee	C	13-17-2b	30711	1.8	Sed	NS	NP,P	40,10,03	MS	Low
Clarke Creek	From source to Rocky River	C	13-17-4	30711	5.4		NE	NP	18	RES	Monitor
Coddle Creek	Source .2 mile upstream of NC Hwy 73 (	C	13-17-6-(5.5)	30711	13.7	Sed	PS	NP	40	MS	Low
McKee Creek	From source to Reedy Creek	C	13-17-8-4	30711	6.5	Sed,Fecal	NE	NP	10, 40,32,08	RES	Monitor
Clear Creek	From source to McKee Creek	C	13-17-8-4-1	30711	1.6	Sed,Fecal	NE	NP	10, 40,32	RES	Monitor
Goose Creek	From source to Rocky River	C	13-17-18	30712	17	Fecal,Sed	NS	NP,P	40,30, cumulati	MS	High
Crooked Creek	From source to Rocky River	C	13-17-20	30712	13.1		PS	NP,P	40, cum discha	PPI	Monitor
North Fork Crooked Cree	From source to SR 1514, Union Crooked	C	13-17-20-1a	30712	7.5		PS	P,NP	40, cum discha	PPI	Monitor

1998 303(d) LIST FOR THE YADKIN RIVER BASIN

Name of Stream	Description	Class	Index #	Wtrbdy	Miles	Problem Parameter(s)	Overall Rating	Major Sources (P,NP)	Major Sources Subcategory	Approach	Priority
North Fork Crooked Cree	From SR 1004 Union Co to Crooked Cre	C	13-17-20-1c	30712	1.7		PS	P,NP	40, cum discha	PPI	Monitor
South Fork Crooked Cree	From source to SR 1515 Union Co	C	13-17-20-2a	30712	5		NS	NP	10,30,40	PPI	Monitor
South Fork Crooked Cree	From SR 1515 Union Co Crooked Creek	C	13-17-20-2b	30712	8.7		PS	NP,P	10,30,40,cum.	PPI	Monitor
Little Long Creek	From source to Long Creek	C	13-17-31-4	30713	6.7		NE	NP	42,43	RES	Monitor
Long Branch(Lower Long	From source to above Carolina Solite old	C	13-17-31-7a	30713	0.8		PS	NP	10,40	PPI	Monitor
Richardson Creek	From Monroe Water Supply dam to SR 1	C	13-17-36-(5)a	30714	6.9	Sed	NS	NP,P	10-CAOs,03	MS	Low
Richardson Creek	From SR 1006 to SR 1649	C	13-17-36-(5)b	30714	5.6	Sed	PS	NP,P	10-CAOs,03	MS	Low
Lanes Creek	From SR 1929 Union Co to Marshville W	WS-V	13-17-40-(1)b	30714	9.9	Sed	NS	NP	10-CAOs	MS	Medium
Lanes Creek	From Marshville Water Supply Dam (.1 m	C	13-17-40-(12)	30714	26.9		PS	NP	10 CAOs	PPI	Monitor
Brown Creek	From NC 74 to Pee Dee	C	13-20b	30710	22	Sed,DO,pH	PS	NP	10	MS, TMDL	Medium
Cartledge Creek	From source to Pee Dee River	C	13-35	30716	10.5		PS	NP	10	PPI	Monitor
Hitchcock Creek (Midway	From below Fox Yarns, Richmond Co to	C	13-39-(10)b	30716	6.1	Fecal,pH,Sed	NS	NP	10,30,40	MS	Low
Hitchcock Creek (Midway	From dam at Roberdel Lake (rockingham	C	13-39-(10)a	30716	3.9		PS	NP	10,30,40	RES	Monitor
North Fork Jones Creek	From Wadesboro Water Supply Intake to	C	13-42-1-(0.5)	30717	8.4	Sed	PS	NP	10	MS	Low
South Fork Jones Creek	From Anson SR 1821 to Jones Creek	C	13-42-2b	30717	0.8	Sed	PS	NP	10	MS	Low
Marks Creek (Everetts Lal	From NC 177 Richmond Co to NC-SC Li	C	13-45-(2)b	30716	13.3	Sed	PS	NP	40	MS	Low

Definitions for approach:

TMDL - Proper technical conditions exist to develop a TMDL for this water body/pollutant. Usual approach for nutrients, DO, and all metals.

MS - A management strategy will be developed for this water body/pollutant. Usual approach for sediment, fecal, pH, and turbidity.

RES -Resample. Water body remains on the 303(d) list even though data are more than five years old. Waters will be resampled to obtain updated use support information.

PPI - Problem Parameter Identification. Biologically impaired waters will be resampled for biological and chemical data to attempt to determine potential problem parameters.

SWMP - Swamp Waters. Swamp waters previously evaluated using freshwater criteria will continue to be monitored and will be re-evaluated when swamp criteria are available.

1998 303(d) LIST FOR THE YADKIN RIVER BASIN - LAKES

LAKE NAME	COUNTY NAME	SUBBASIN	SIZE (acres)	CLASS	OVERALL USE	FISH CONSUMP.	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER	TROPH STATUS	PROBLEM PARAMETERS	APPROACH	PRIORITY
LONG LAKE(Albermarle	STANLY	30713	74	C	NS	S	NS	n/a	S	HYPEREUTROP	(a)	MS	N/A
HAMLET CITY LAKE	RICHMOND	30716	100	C	PS	S	PS	n/a	n/a	EUTROPHIC	(a)	MS	N/A
LEDBETTER LAKE	RICHMOND	30716	UNKNOWN	WS-III	NE	NE	NE	NE	NE	NE	FISH ADV-HG	TMDL	Medium
ROCKINGHAM CITY LA	RICHMOND	30716	27	WS-III CA	PS	S	PS	n/a	PS	DYSTROPHIC		MS	Medium

(a) Lake is currently drained.

<u>Definitions for approach</u>:

TMDL - Proper technical conditions exist to develop a TMDL for this water body/pollutant.

MS - A management strategy will be developed for this water body/pollutant.