CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE BROAD RIVER BASIN

4.1 INTRODUCTION

This chapter provides a detailed overview of water quality and use support ratings in the Broad River Basin. It is divided into two major parts and five sections.

Water Quality Monitoring and Assessment

- **Section 4.2** describes six water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ's) Water Quality Section as well as other programs local to the basin (Section 4.2.2). Basinwide data summaries are presented for several of the DWQ programs.
- **Section 4.3** presents a summary of the ambient monitoring data for the basin.
- **Section 4.4** presents a narrative summary of water quality findings for each of the subbasins in the basin. This summary is based on the DWQ monitoring programs described in Section 4.2 Also included are watershed maps which show the locations of monitoring sites.

Use-Support Ratings

- **Section 4.5** introduces the concept of use-support ratings and describes how they are derived. Using this approach, water quality for specific surface waters in the basin is assigned one of the following four use-support ratings: fully supporting uses, fully supporting but threatened, partially supporting or not supporting uses.
- **Section 4.6** presents the use support ratings for many streams in the Broad basin through a series of tables and figures. Included is a color-coded use support map of the basin (Figure 4.20).

4.2 WATER QUALITY MONITORING PROGRAMS

4.2.1 DWQ Programs

DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a list of the six major monitoring programs, each of which is briefly described in the following text and Appendix II.

- Benthic macroinvertebrate monitoring,
- Fish population and tissue monitoring,
- Lakes assessment (including phytoplankton monitoring),
- Aquatic toxicity monitoring,
- Special studies and chemical/physical water quality investigations, and
- Ambient water quality monitoring (covering the period 1991-1995).

Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers, streams and estuaries. The benthic organisms collected most often in freshwater monitoring are aquatic insect larvae. The use of benthos data has proven to be a reliable water quality assessment tool (especially in freshwaters), as 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.

For freshwater streams and rivers, criteria have been developed to assign five bioclassifications ranging from Poor to Excellent to each benthic sample. The bioclassifications include Excellent, Good, Good- Fair, Fair and Poor. The bioclassifications are based on the number of different kinds of species (taxa) present in three groups of pollution-intolerant insect larvae: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). These three groups are used to develop EPT ratings. Likewise, ratings can be assigned with a Biotic Index (Appendix II). 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 (i.e. a greater number of different kinds of species) are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is inadequately assessed by a taxa richness analysis alone. Different classification criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

Benthic Macroinvertebrate Sampling in the Broad Basin

Since 1983, 108 benthic macroinvertebrate samples have been collected at 69 different locations within the Broad River basin. Of these 108 samples, an Excellent bioclassification was found for 6%, 34% were Good, 37% were Good-Fair, 17% were Fair and 6% were Poor. In 1995, during basinwide assessment, 33 sites were sampled which give a better indication of present water quality of mainstem and major tributary sites. Of these sites, 9% were Excellent, 46% were Good, 33% were Good-Fair, 12% were Fair and none were Poor. The results of benthic macroinvertebrate sampling for all sites in the Broad River Basin are presented in the individual subbasin discussion in sections 4.4.1 - 4.4.6.

Fisheries Monitoring

~~To the public, the condition of the fishery is one of the most meaningful indicators of ecological~~ integrity. 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 will affect the abundance, species composition, and condition of the fish population. Two types of fisheries monitoring are conducted by DWQ and described briefly below. The first, called Fish Community Structure, involves assessing the overall health of the fish community. The second, called Fish Tissue Analysis, involves analyzing fish tissues to determine whether they are accumulating metals or organic chemicals. This information is useful as an indicator of water quality and is also used to determine whether human consumption of these fish poses a potential health risk.

Fish Community Structure

As noted above, fish community structure involves assessing the overall health of the fish community as a means of assessing the quality of the ecosystem in which the fish reside. Fish community structure is assessed using a method called the North Carolina Index of Biotic Integrity (NCIBI). This method, which is a modification of Karr's IBI (1981), was developed as a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The index, (which is described in more detail in Appendix II), incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. At this time there is no NC Index of Biotic Integrity developed for fish communities in lakes.

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.

Fish Community Structure in the Broad Basin

In 1995, six sites in subbasins 030801, -02, -04, and -06 were sampled and evaluated using the North Carolina Index of Biotic Integrity. The NCIBI Scores at these six sites ranged from 46 to 54 and the NCIBI ratings were: Good-Excellent (1 site), Good (4 sites), and Fair-Good (1 site). These data are presented below.

Table 4.1 Fish Community Structure Collections in the Broad River Basin, 1995.

Site	Road	County	Subbasin	Drainage Area (mi^2)	Date	NC IBI Score	NC IBI Rating[1]
Cove Creek	SR 1381	Rutherford	01	42.6	6/19/95	52	G
Green River	SR 1302	Polk	02	245.0	6/19/95	52	G
N.Fk. First Broad River	SR 1728	Rutherford	04	14.2	6/20/95	54	G-E
First Broad R.	SR 1530	Cleveland	04	60.5	6/20/95	50	G
Beaverdam Cr.	NC 150	Cleveland	04	16.9	6/20/95	50	G
N. Pacolet R.	SR 1501	Polk	06	49.3	6/19/95	46	F-G

1 The NCIBI Ratings shown are: G-E = Good-Excellent, G = Good, and F-G = Fair-Good.

Fish Tissue Analysis

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Therefore, by analyzing fish tissue, determinations about what chemicals are in the water can be made. 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 available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Therefore, results from fish tissue monitoring can serve as an important indicator of contamination of sediments and surface water. Fish tissue analysis results are also 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* and U.S. Environmental Protection Agency (EPA) recommended *screening values* for contaminants.

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 parameters accompanied by their FDA criteria are presented in Appendix II. At present, the FDA has only developed metals action level criteria for mercury (1.0 ppm). Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of DWQ.

Fish Tissue Analyses in the Broad Basin
Fish tissue samples were collected at 8 sites within the Broad River basin between 1988 and 1996 and were analyzed for metals contaminants. The 1996 sample collections were part of a special study to assess mercury contamination in the North Pacolet River near the Town of Tryon WWTP. All fish tissue samples collected throughout the Broad River basin between 1988 and 1996 contained levels of metals contaminants below EPA and FDA criteria. Mercury results from the North Pacolet River were also well below these limits.

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 Lakes Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. 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.

One way to evaluate the health of a lake is to examine the growth of phytoplankton. Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to the availability of nutrients (phosphorus and nitrogen) and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton may be useful as indicators of nutrient overenrichment (see following paragraph on trophic status) and are often collected with water quality samples from lakes. Prolific growths of phytoplankton sometimes result in "blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. These blooms, which are often due to high concentrations of nutrients, may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An Algal Bloom Program was initiated in 1984 to document suspected algal blooms with species identification, quantitative biovolume, and density estimates. Usually, an algal sample with a biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected.

The Algal Growth Potential Test (AGPT) measures the potential of a lake to support algal growth and to determine whether algal growth is limited by nitrogen, by phosphorus, or co-limited by both nutrients. When a waterbody supports algal growth at bloom levels without additional increases in nitrogen and/or phosphorus, the system may be subject to frequent nuisance algal blooms. The test exposes a standard alga, Selenastrum capricornutum, to the test water (this constitutes the control). Additional test samples are enriched with nitrogen or phosphorus. When one of these nutrients is added to a water sample which is growth limiting to that nutrient, the resulting mean standing crop (MSC) will generally reflect the level of added nutrient. In some cases, the bioavailable nitrogen and phosphorus in a sample may approach their optimum ratio for growth of the test alga and the addition of nutrients may not clearly identify the limiting nutrient. A waterbody may be protected from nuisance algal blooms if an AGPT value is consistently less than or equal to 5 mg/l.

Another measure of water quality in lakes is the North Carolina Trophic State Index (NCTSI). This is a numerical index used to evaluate the trophic status of lakes, and it can be used to determine whether the designated uses of a lake have been threatened or impaired by pollution. Trophic status is a relative measure of nutrient enrichment and productivity. The NCTSI score is based on total phosphorus, total organic nitrogen, secchi depth (water clarity indicator) and chlorophyll *a*. Based on this index, a lake is assigned one of five trophic status classifications: Oligotrophic, Mesotrophic, Eutrophic, Hypereutrophic and Dystrophic. Oligotrophic lakes are those that have the lowest levels of enrichment and generally have good clarity and no problems with algal blooms. At the other end of the spectrum are eutrophic and hypereutrophic lakes which have a lot of plant productivity which can cause nuisance problems and have little clarity in the water column. Dystrophic lakes are acidic blackwater lakes scattered throughout the coastal plain. Their NCTSI scores are highly skewed because of their natural discoloration. Further details of the NCTSI can be found in Appendix II.

Lakes Studies in the Broad River Basin

Five lakes in the Broad River basin have been sampled as part of the Lakes Assessment Program. These lakes are presented below by subbasin.

SUBBASIN 030801	SUBBASIN 030803	SUBBASIN 030805
Lake Lure	Lake Summit	Lake Montonia
	Lake Adger	Kings Mountain Reservoir

All of the lakes sampled have been assigned the trophic status classification of oligotrophic based on the NCTSI score. Each lake is individually discussed in the appropriate subbasin section with a focus on the most recent available data. Kings Mountain Reservoir was monitored intensively during the growing seasons of 1991 through 1993 as part of the reference lake program to determine if this lake was representative of a minimally impacted lake in the region of the state in which it is located. All of the lakes in this basin were sampled most recently by DWQ in 1995 except for Lake Montonia, which was most recently sampled in 1996.

Three lakes have been sampled for the potential of supporting algal growth with the Algal Growth Potential Test (AGPT) in the Broad River Basin. These are Lake Lure, Kings Mountain Reservoir and Lake Montonia. The AGPT results are described in each of the appropriate subbasin discussions.

Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of certain wastewater treatment discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Types of discharges sampled include wastewater treatment plants that receive waste from industrial users and industrial facilities (i.e. textiles, metal finishers) that discharge effluent from their process operations. Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. 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 Broad Basin**</u>

There are twenty-two facilities in the Broad River Basin that are required to monitor the toxicity of their effluent. These facilities are listed in Appendix II.

Special Studies and Chemical/Physical Characterizations

Water quality simulation models are often used for the purpose of determining wasteload allocations. These models must accurately 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 in-stream 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 verification. Intensive water quality surveys are performed on water bodies below existing or proposed wastewater dischargers and usually consist of a time-of-travel dye study, flow measurements, physical and chemical samples, long-term biochemical oxygen demand (BOD_{lt}) analysis, water body channel geometry, and effluent characterization analysis.

<u>**Special Studies and Chemical/Physical Characterizations in the Broad River Basin**</u>

In recent years, there have been no studies in the Broad basin as described above.

Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine stations 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:

<u>Fixed Monitoring Stations</u>
Point source
Nonpoint source
Baseline Water Supply

<u>Rotating Monitoring Stations</u>
Basinwide Information
HQW & ORW

Parametric coverage is tiered by the waterbody's assigned surface water quality classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added based on other classifications. Table 4.2 presents the parameters monitored for the classifications assigned to waters in the Broad River Basin. The next section (4.3) summarizes the results of ambient monitoring done in the Broad basin.

Table 4.2 Ambient Monitoring System Freshwater Parametric Coverage Pertinent to the Broad River Basin.

Class C and Class B 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 (Membrane 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

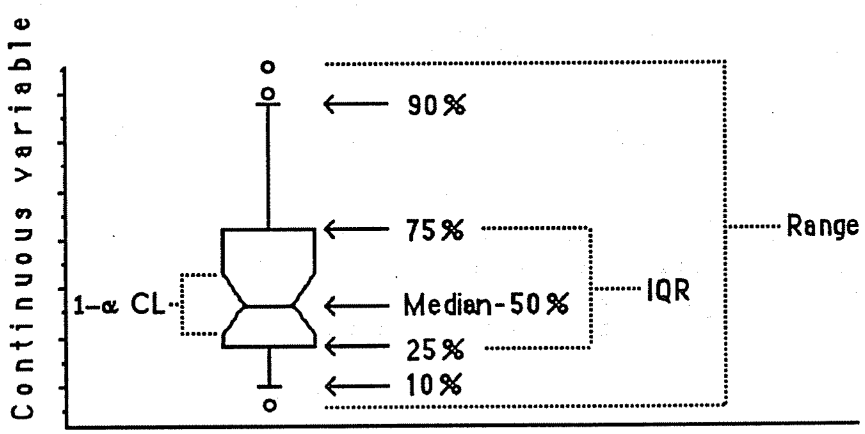
Water Supply
Chloride, total coliforms, manganese, total dissolved solids

PLUS any additional parameters of concern for individual station locations.

*Action level water quality standard.

Ambient water quality data are often summarized using box and whisker plots (for example see Figure 4.4). Figure 4.1 provides an explanation of how to interpret the plots.

Box and whisker plot are useful for the visual comparison of single variable data sets. 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.

Figure 4.1 Interpreting Box and Whisker Plots

4.2.2 Local Water Quality Monitoring Programs

Environmental Quality Institute - University of North Carolina in Asheville: Volunteer Water Information Network (VWIN)

The Volunteer Water Information Network (VWIN) is a partnership of groups and individuals dedicated to preserving water quality in western North Carolina (Maas, et. al., 1996). Local environmental organizations provide administrative support, while the UNC Environmental Quality Institute provides technical assistance in the form of laboratory analysis of water samples, statistical analyses of water quality results, and written interpretation of the data. Volunteers collect samples once a month from designated sites in the region. The partnership has 130 sites in seven counties in western North Carolina. The programs for Buncombe County, Henderson County, Polk County and Lake Lure all have sites within the Broad River Basin. Table 4.3 provides further information on these programs. Locations of the sites that are in the Broad basin are illustrated in Figure 4.2. Results of the sampling efforts are presented in the individual subbasin characterizations in section 4.4.

Table 4.3 VWIN Sampling Sites in the Broad River Basin

VWIN Group	Map Symbol	Number of Sites in Basin	General Results
Buncombe County	b	1	This site in the headwaters of the Broad River exhibited good water quality.
Lake Lure	l	10	The first year of sampling in this program revealed areas where sedimentation is a problem and showed that the lake slowly recovered from the effects of the September 1996 flood.
Henderson County	h	4	Results indicate that the Green River has high water quality but that there are increasing levels of tubididty.
Polk County	p	10	The summary report for Polk County sampling sites indicates that sedimentation is the most commonly occurring problem observed.

4.3 SUMMARY OF AMBIENT MONITORING DATA FOR THE BROAD RIVER BASIN

The AMS stations for the basin are listed in Table 4.4. North Carolina has 9 stations in the Broad River Basin. Two stations are located on the mainstem of the Broad River, two are on the Second Broad River, and two are on the First Broad River. The remainder of the stations are on Cove Creek, Sugar Branch and Buffalo Creek. The locations of these stations are illustrated in Figure 4.3.

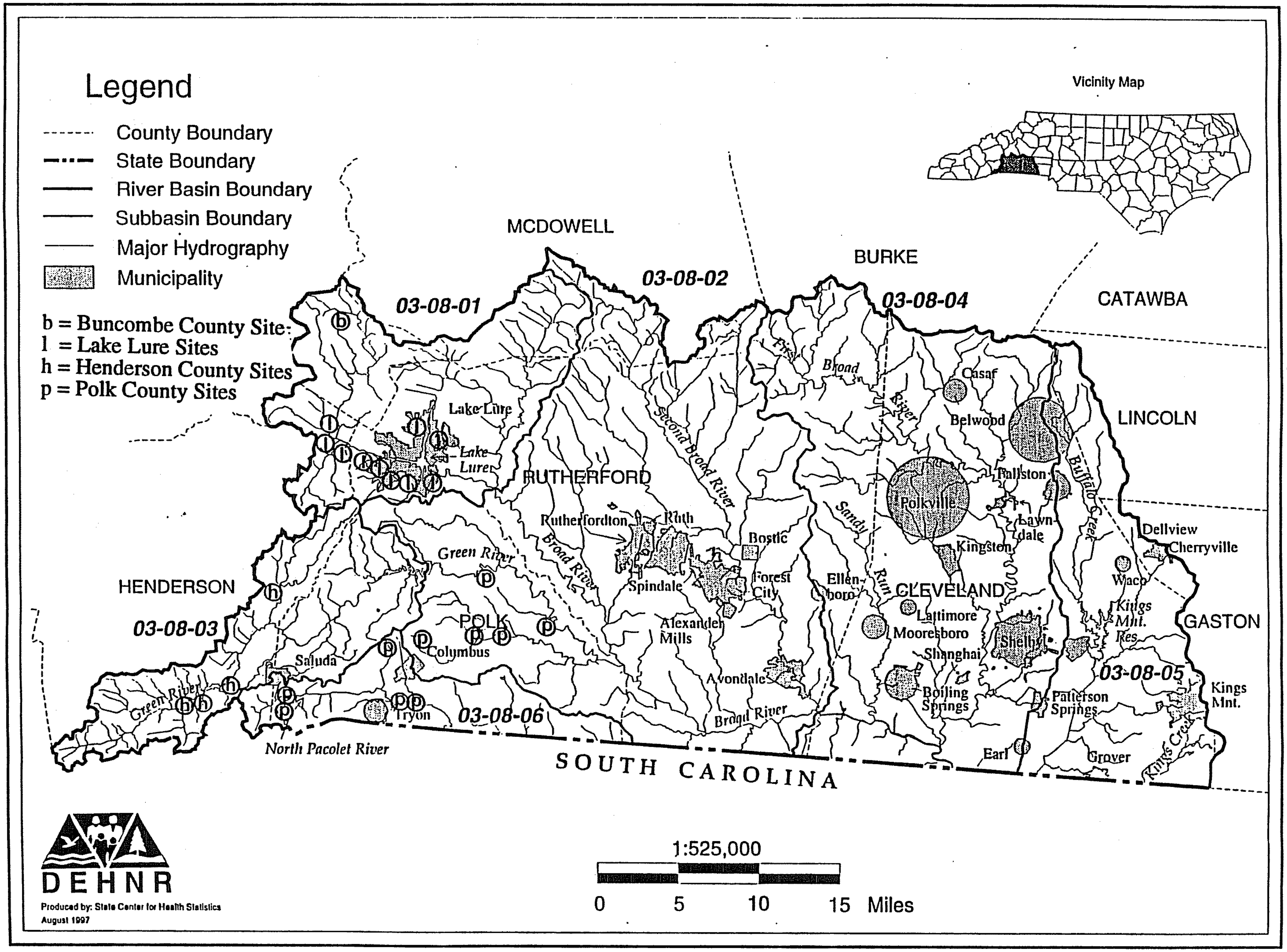


Figure 4.2 Location of Citizen Monitoring Program Sampling Sites in the Broad River Basin

Table 4.4 Ambient Monitoring System Stations Within the Broad Basin.

Primary No	STORET No	Station Name	Subbasin
02149000	A1510000	COVE CREEK AT US 64 AND US 74 NEAR LAKE LURE NC	030801
0214906350	A1520000	BROAD RIVER AT SR 1181 NEAR ROCK SPRINGS NC	030801
02150495	A2700000	SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	030802
02151000	A4400000	SECOND BROAD RIVER AT CLIFFSIDE NC	030802
02151500	A4700000	BROAD RIVER AT NC 150 NEAR BOILING SPRINGS	030804
02152100	A4800000	FIRST BROAD RIVER NEAR CASAR NC	030804
02152596	A6400000	FIRST BROAD RIVER NEAR EARL NC	030804
02152610	A6450000	SUGAR BRANCH AT NC 150 NEAR BOILING SPRINGS NC	030804
02153456	A8600000	BUFFALO CREEK NEAR GROVER NC	030805

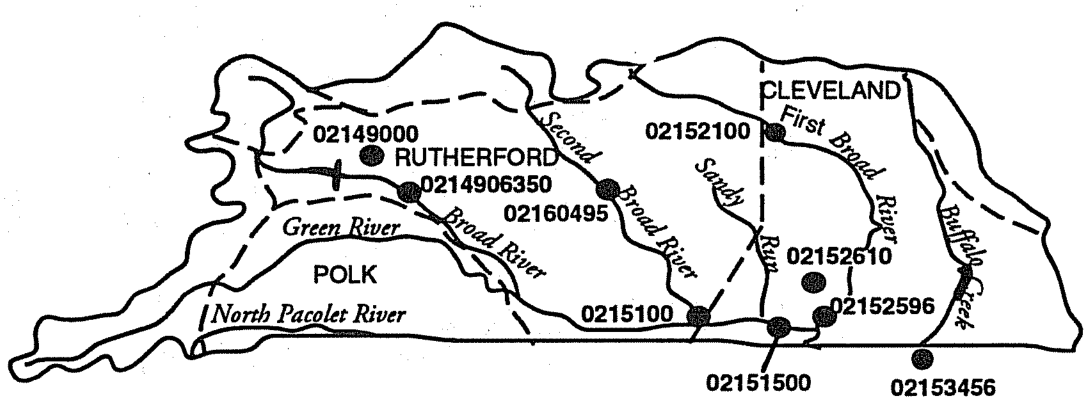


Figure 4.3. Location of Ambient Monitoring Stations in the Broad River Basin

Table 4.5 summarizes by parameter data collected at ambient stations in the Broad Basin where there are one or more excursions (or deviation) from the numerical water quality criteria. Each station includes the following information:

- parameter that exceeds the criterion
- total number of samples
- number of samples with less than the detection level recorded
- the number of samples for that parameter that represented an excursion from a water quality criterion

It should be noted that there are limitations to ambient water quality data. Because of the limited sampling frequency, the water quality sample may not be taken during a significant water quality event. It also 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 to expect chronic toxicity of 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 totals from Table 4.5 as total samples, total excursions and percent excursions of total samples for each ambient station.

Table 4.5 Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Parameter. January 1990 to December 1994.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Samples Excur
02149000	COVE CREEK AT US 64 AND US 74 NEAR LAKE LURE	Turbidity (NTU)(50)	38	0	5
0214906350	BROAD RIVER AT SR 1181 NEAR ROCK SPRINGS NC	Turbidity (NTU)(50)	24	0	1
02150495	SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	Turbidity (NTU)(50)	27	0	2
02151000	SECOND BROAD RIVER AT CLIFFSIDE NC	Turbidity (NTU)(50)	39	0	4
02151500	BROAD RIVER AT NC 150 NEAR BOILING SPRINGS	Turbidity (NTU)(50)	24	0	2
02152596	FIRST BROAD RIVER NEAR EARL NC	Turbidity (NTU)(50)	37	0	3
02152610	SUGAR BRANCH AT NC 150 NR BOILING SPRINGS NC	Turbidity (NTU)(50)	37	0	2
02153456	BUFFALO CREEK NEAR GROVER NC	Turbidity (NTU)(50)	36	0	3
02152100	FIRST BROAD RIVER NEAR CASAR NC	Total Residue (mg/l)(500)	37	0	1
02150495	SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	Mercury (µg/l)(0.012)	25	24	1
02152610	SUGAR BRANCH AT NC 150 NR BOILING SPRINGS NC	Mercury (µg/l)(0.012)	37	35	2
0214906350	BROAD RIVER AT SR 1181 NEAR ROCK SPRINGS NC	Manganese (µg/l)(50)	16	0	6
02150495	SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	Manganese (µg/l)(50)	16	1	9
02152100	FIRST BROAD RIVER NEAR CASAR NC	Manganese (µg/l)(50)	30	10	1

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	Water Quality Class	Samples Total	Excursions	%Excursions
02149000	COVE CREEK AT US 64 AND US 74 NEAR LAKE LURE NC	C	364	8	2.2
0214906350	BROAD RIVER AT SR 1181 NEAR ROCK SPRINGS NC	WSIV	298	9	3.0
02150495	SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	WSIV	326	16	4.9
02151000	SECOND BROAD RIVER AT CLIFFSIDE NC	C	403	8	2.0
02151500	BROAD RIVER AT NC 150 NEAR BOILING SPRINGS	C	237	8	3.4
02152100	FIRST BROAD RIVER NEAR CASAR NC	WSIV	510	5	1.0
02152596	FIRST BROAD RIVER NEAR EARL NC	C	396	19	4.8
02152610	SUGAR BRANCH AT NC 150 NR BOILING SPRINGS NC	C	396	22	5.6
02153456	BUFFALO CREEK NEAR GROVER NC	C	385	12	3.1

As Tables 4.5 and 4.6 indicate, there have been some, although infrequent, excursions from water quality standards. Sampling results are generally within acceptable ranges, including those for dissolved oxygen and pH (acidity). Data in Table 4.5 show excursions of the manganese criterion at all three water supply sites in the basin. The three sites with the most excursions (with the highest number being only 5.6%) are First Broad River at Earl, Second Broad River near Logan and Sugar Branch. It is particularly interesting to note the number of stations with excursions from the turbidity standard. In fact, there are excursions against the turbidity criterion for every site in the basin except the First Broad River at Casar. Turbidity is an indicator of sedimentation. Figure 4.4 illustrates the distribution of turbidity data for each ambient station in the basin.

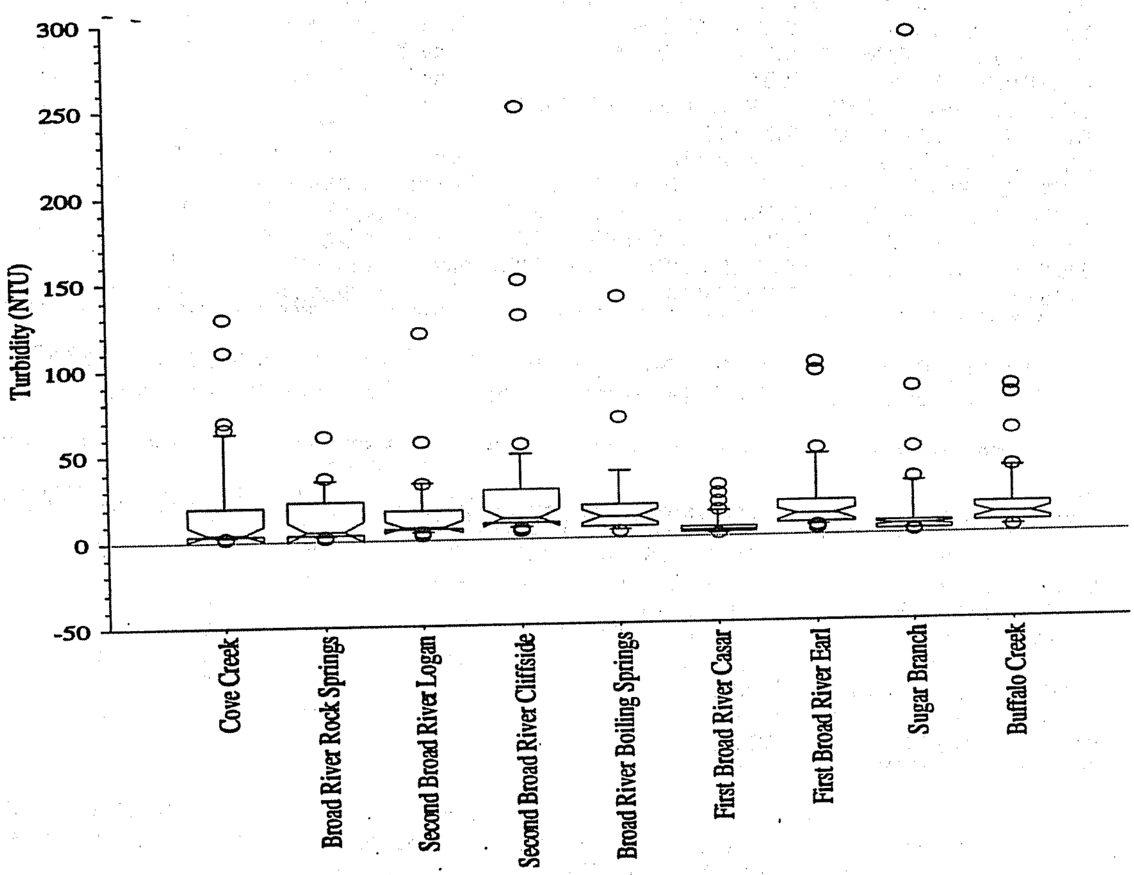


Figure 4.4 Turbidity distribution from ambient monitoring system sites in the Broad River Basin; 1992 - 1996.

Fecal coliform bacteria behave differently than most other water quality parameters, and these differences must be considered when using them to evaluate water quality. Available information was reviewed to identify potentially impaired waters and locate potential sources of pollutants in order that targeting efforts and appropriate management strategies can be developed. As sampled in the ambient monitoring system, 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 Broad River Basin has three sites reporting a geometric mean of greater than 200/100ml. Table 4.7 provides a sumary of the results of fecal coliform sampling conducted between 1992 and 1996. The distribution of the fecal coliforms from the mainstem stations is shown in Figure 4.5. This shows the sites with high fecal numbers mainly in lower reaches of the basin at First Broad River at Earl, Sugar Branch and Buffalo Creek. However, the Buffalo Creek site had only nine samples taken throughout the reporting period.

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

Site	Total Samples	Geometric Mean	Samples >200/100ml	Percent >200/100ml	First Sample	Last Sample
COVE CREEK AT US 64 AND US 74 NEAR LAKE LURE	34	10.4	3	8.8	3/3/93	12/10/96
BROAD RIVER AT SR 1181 NEAR ROCK SPRINGS NC	24	12.0	2	8.3	1/24/95	12/10/96
SECOND BROAD RIVER AT SR 1538 NEAR LOGAN NC	27	45.3	4	14.8	10/19/94	12/10/96
SECOND BROAD RIVER AT CLIFFSIDE NC	33	47.5	4	12.1	9/2/93	12/10/96
BROAD RIVER AT NC 150 NEAR BOILING SPRINGS	23	89.4	6	26.1	10/26/94	11/20/96
FIRST BROAD RIVER NEAR CASAR NC	28	44.3	3	10.7	5/5/92	11/20/96
FIRST BROAD RIVER NEAR EARL NC	27	208.3	16	59.3	5/5/92	11/20/96
SUGAR BRANCH AT NC 150 NR BOILING SPRINGS NC	27	260.2	18	66.7	5/5/92	11/20/96
BUFFALO CREEK NEAR GROVER NC	27	203.8	9	33.3	5/5/92	11/20/96

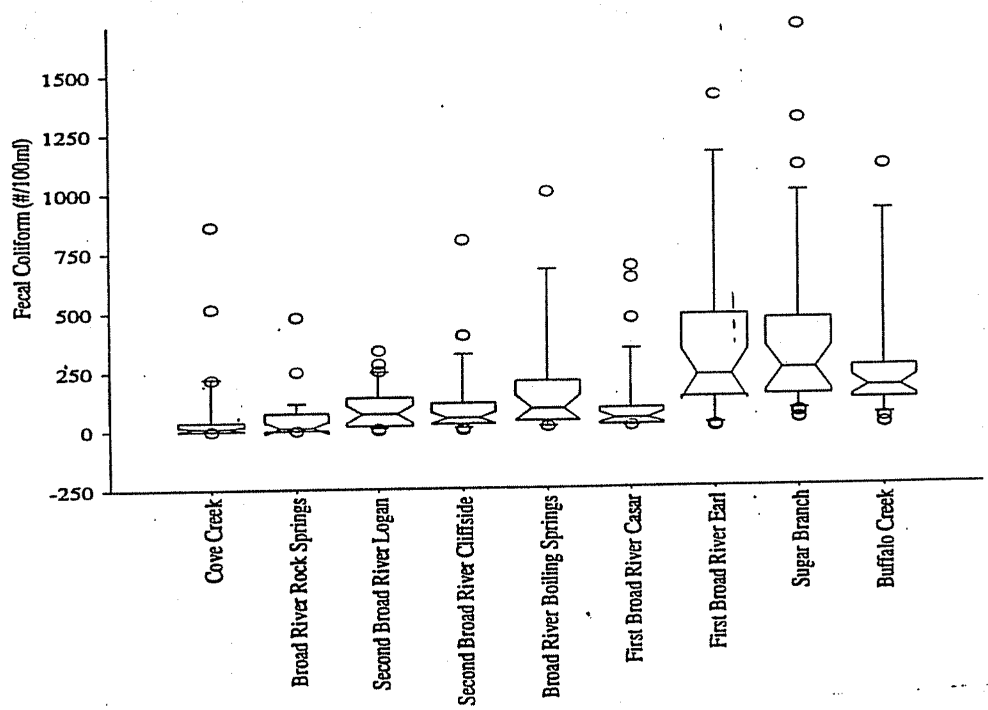


Figure 4.5 Fecal coliform distribution from ambient monitoring system sites in the Broad River Basin; 1992 - 1996.

4.4 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

4.4.1 Subbasin 01 - Upper Broad River basin, including Lake Lure and Cove Creek

Description
This subbasin is in the mountain ecoregion and contains Lake Lure, the uppermost reaches of the Broad River upstream of Lake Lure, and all of its tributaries, and approximately 5 river miles of the tailwater reach of the Broad River below Lake Lure. Figure 4.6 provides a map of the subbasin, including the location of sampling sites. Land use within the Lake Lure watershed is predominantly forested with some urban and agricultural uses. Cove Creek is the only large tributary to the Broad River in this subbasin, below Lake Lure. Most of the waters in this subbasin are currently classified as C Trout and are protected for natural trout propagation and survival of stocked trout. Portions of the Broad River corridor are becoming more developed, which may lead to water quality problems.

Overview of Water Quality
Rivers and streams in this subbasin have generally good water quality with very few violations of chemical water quality standards. Both the Broad River above Lake Lure and a downstream site on Cove Creek received Excellent bioclassifications in 1995 (Table 4.8). The Cove Creek site was given a Good NCIBI rating. Good to Excellent bioclassifications have been recorded during most benthic macroinvertebrate surveys since 1983. A Fair bioclassification was assigned to the Broad River below Lake Lure at US 64/74 in 1984. The regulated nature of the Broad River at this point may be partially responsible for the lower bioclassification.

Lake Lure is a large impoundment located in the mountains of Rutherford County, adjacent to the Town of Lake Lure. Lake Lure has alternated between mesotrophic and oligotrophic from 1981 to 1995 and is currently considered oligotrophic. Fish tissue samples were collected at Lake Lure in 1995 and results showed metals concentrations below levels of concern. There are 14 VWIN monitoring sites in and around the lake. The lake is discussed in detail later in this section.

The VWIN program described earlier in this chapter has one monitoring site on the upper Broad River in Buncombe County. Results of the volunteer sampling indicate that the upper Broad River has high water quality as compared to 48 other sampling sites in the county (Maas, et. al., 1997a).

Benthic Macroinvertebrates
Two locations were sampled for benthic macroinvertebrates in this subbasin during the 1995 basinwide investigations (Table 4.8). Both sites were selected to determine water quality conditions from previously unassessed reaches of the upper Broad River and Cove Creek. Benthic macroinvertebrate samples have been collected from 4 locations in this subbasin since 1983.

Table 4.8 Basin Assessment Sites in Broad Subbasin 030801, 1995, Taxa Richness Values and Bioclassifications.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-1	Broad R	950710	Buncombe	SR 2802	82/43	Excellent
B-3	Cove Cr	950710	Rutherford	SR 1381	-/37	Excellent

Note: Map # refers to number on subbasin map

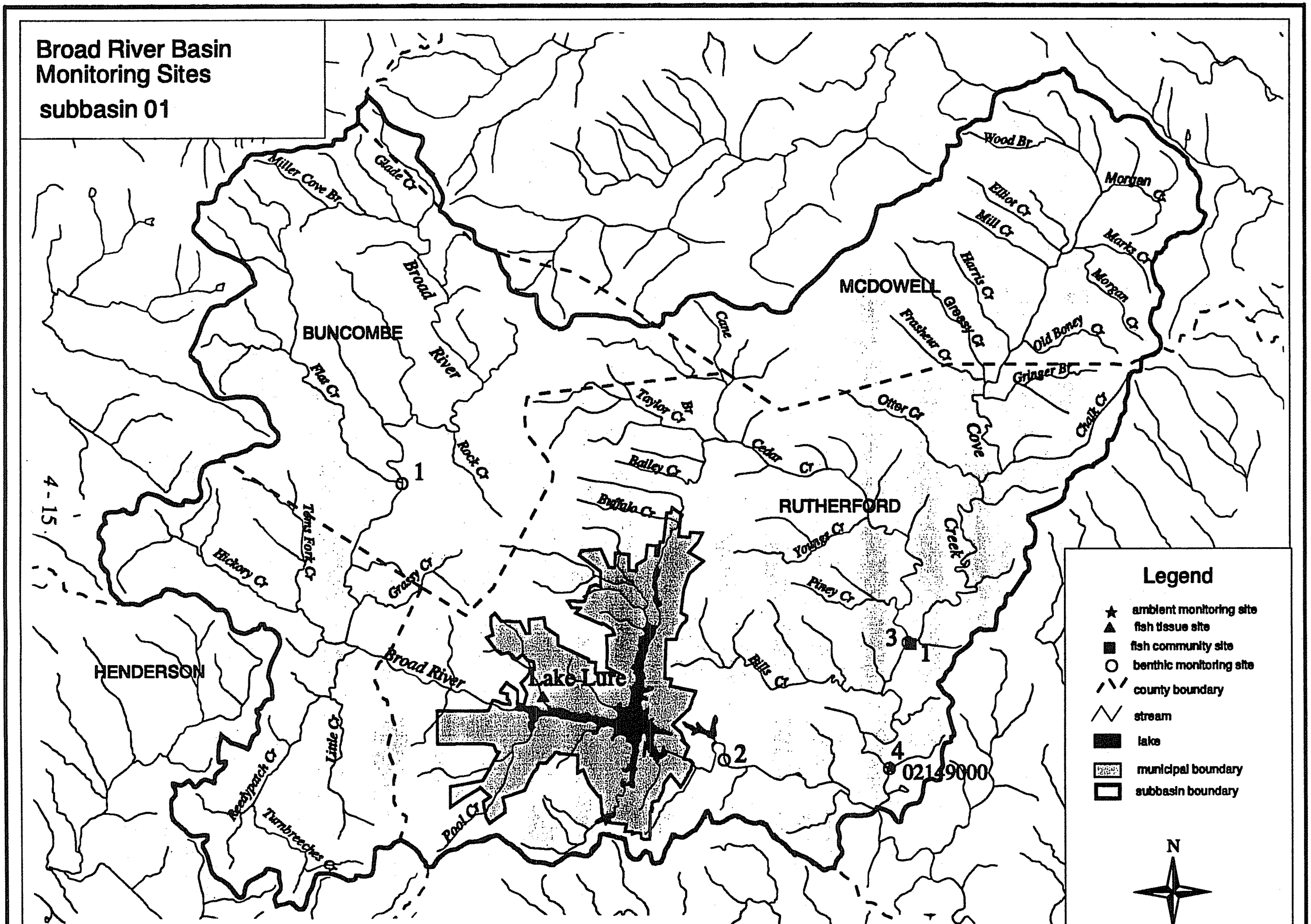


Figure 4.6 Locations of Sampling Stations for Broad Subbasin 01

The Broad River at SR 2802 in Buncombe County was selected to represent water quality conditions in the Broad River above Lake Lure. This is a previously unassessed reach of the Broad River. An Excellent bioclassification was given to this location (EPT taxa richness = 43). The catchment above this location appears to be forested or in small private farms. The Broad River at this point has a substrate dominated by boulder and rubble and received a very high NC habitat score (81). The catchment below this location becomes more developed, particularly along the river corridor near the communities of Bat Cave and Chimney Rock. Additional investigations could be conducted on the Broad River upstream of Lake Lure to assess the effects of development along the river corridor. In 1984, a benthic macroinvertebrate sample was collected at the Broad River near US 64/74 below the dam at Lake Lure. This reach was given a Fair bioclassification. These results may reflect the effects of flow regulation on the benthos in this reach of the Broad River.

An Excellent bioclassification also was given to Cove Creek at SR 1381. Despite the Excellent bioclassification, this site had a very sandy substrate, possibly reflecting the effects of nonpoint source runoff. Benthic macroinvertebrate data have been collected from Cove Creek during earlier investigations (Good bioclassification), however, the US 64/74 location is near the confluence with the Broad River and may receive more nonpoint source runoff.

Fish Community Structure and Fish Tissue

Only one site, Cove Creek, was sampled for fish community structure in this subbasin during 1995 (Table 4.9). Cove Creek was considered a smallmouth bass-cool water stream by Messer, et al. (1965).

Table 4.9 Basin Fish Community Assessment Sites in the Broad River Subbasin 030801, North Carolina Index of Biotic Integrity (NCIBI) Score, and Rating, 1995.

Site	Waterbody	Location	County	Drainage Area (mi^2)	Date	NCIBI Score	NCIBI Rating
F-1	Cove Cr	SR 1381	Rutherford	42.6	6/19/95	52	Good

The fish community found in Cove Creek was assessed a Good ecological health rating. Middle range scores were received for the number of species of darters and sunfish collected and for the percentage abundances of omnivores and insectivores. All other metrics were scored as a 5 which represents conditions which would be expected for undisturbed streams. The most abundant species collected was the fieryblack shiner. Sportfish collected included redbreast sunfish and smallmouth bass.

Lakes Assessment - Lake Lure

Lake Lure is a large impoundment located in the mountains of southwestern North Carolina (Rutherford County), adjacent to the Town of Lake Lure, which owns the lake. Figure 4.7 provides a schematic diagram of the lake, showing locations of sampling sites. The shoreline has been developed with houses and vacation lodges. This lake has a maximum depth of 164 feet (50 meters). Major tributaries to the lake are the Broad River, Buffalo Creek, and Cane Creek. Land use within the watershed is predominantly forested with some urban and agricultural uses. A small municipal golf course is located to the southeast of the lake and a larger golf course resort complex (Fairfield Mountains) with two 18 hole golf courses is located to the north, adjacent to the Buffalo Creek arm. Development is continuing along the lakeshore and, to a lesser extent, along the tributaries to the lake. A new development is planned within a 1,000 acre parcel located to the north of Fairfield Mountains and to the east of the Lake Lure dam (Albert Moore, District Conservationist, NRCD District Office, Rutherford County).

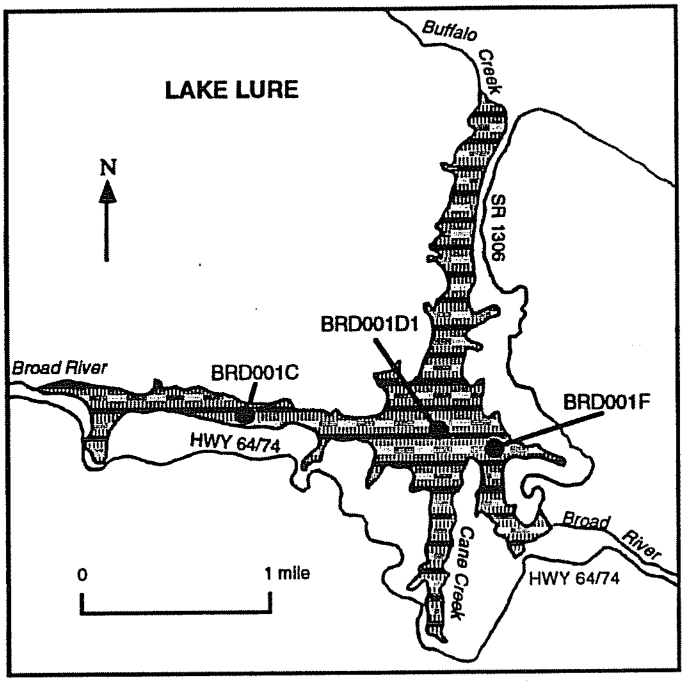


Figure 4.7 Lake Lure, Subbasin 01 of the Broad River Basin

Lake Lure was sampled on July 31, 1995. Thermal stratification was noted at all three stations. Field notes stated that the water had a greenish appearance at station BRD001C and the chlorophyll *a* value was higher at this station (11 µg/l) than at the other two stations (6 µg/l and 5 µg/l). All of these values are well within the state standard of 40 µg/l. The Secchi reading was also noticeably lower at BRD001C (1.3 meters) than at BRD001D1 (2.4 meters) and BRD001F (2.2 meters). Station BRD001C is shallower (six meters) than stations BRD001D1 and BRD001F (19.5 meters and 14.5 meters respectively). The NCTSI score in 1995 (-2.9) indicated that the lake was oligotrophic on the day it was sampled.

Lake Lure was previously sampled by DWQ in 1981, 1982, 1983, 1985 and 1989. In 1983, surface pH was less than the state water quality lower limit of 6.0 s.u. Nutrient and chlorophyll *a* values remained consistent and metals were less than the applicable state water quality standards except for copper (50 µg/l) and mercury (0.5 µg/l) which were detected in 1981. These values were greater than the applicable state water quality standards for these metals. From 1981 to 1989, the NCTSI score for Lake Lure fluctuated between oligotrophic and mesotrophic.

Historical data collected at Lake Lure from 1981 to 1995 for the four constituents of the NCTSI (total phosphorus, total organic nitrogen, Secchi depth and chlorophyll *a*) are summarized (Figure 4.8). Total phosphorus concentrations were highest at the upstream sampling site located in the Broad River arm of the lake (BRD001C), decreasing downstream to the sampling site nearest the dam (BRD001F). The lowest mean and median values for total organic nitrogen were observed at the mid-lake sampling site (BRD001D1) and the highest values for total organic nitrogen were observed in the upstream lake sampling site (BRD001C).

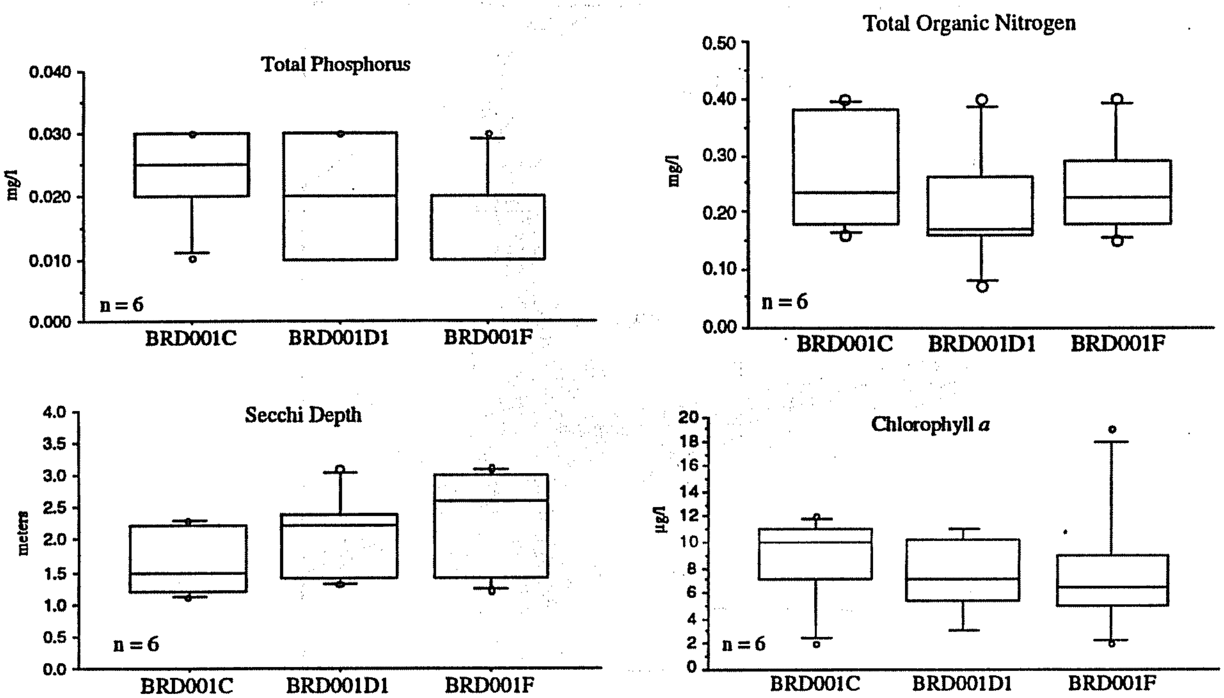


Figure 4.8 Lake Lure NCTSI Data Analysis from Lake Sampling Events, 1981 through 1995.

From 1981 to 1995, Secchi depth values were lower at the upstream sampling site, increasing in depth further downstream. Lakewide mean Secchi depth for this time period was 2.0 meters. Chlorophyll *a* values demonstrated the same upstream to downstream trend observed with total phosphorus. The upstream lake sampling site had the highest value for chlorophyll *a* observed in the lake from 1981 to 1995 (19 µg/l in 1989).

In July of 1996, the Town of Lake Lure began monitoring the lake as part of the VWIN program described earlier in this chapter. The first report of this effort was released in August of 1997 (Maas, et. al., 1997c). There are 14 VWIN monitoring sites in and around the lake. Results of the first year of monitoring revealed that two streams feeding the lake (a stream that runs through a public golf course and Cane Creek) exhibited problems with sedimentation and nutrient loading. These values were due to the complete draining of a small lake at the headwaters of the creek. Accumulated sediment is making its way into the Cane Creek arm of the lake (Robert Washburn, Town of Lake Lure, Lake Lure Committee, pers. com.). Results also revealed that the lake slowly recovered from high turbidity levels caused by the September, 1996 flood (see next paragraph). Depletion of dissolved oxygen levels in bottom waters due to stratification was also recorded. Continued monitoring will provide further information on the quality of the lake and the waters that feed it.

On September 4, 1996, more than 11 inches of rain fell in the Broad River basin in the vicinity of Bat Cave and Lake Lure. The flood water significantly raised the level of the Broad River, resulting in a flood that was believed to be the worst in the area in 80 years. Extensive bank erosion occurred on the Broad River above Lake Lure and on its tributaries. The Lake Lure Town Council approved bids in January 1997 for a dredging project in the western end of the lake (Broad River arm) to remove accumulated sediment. The project, which had been planned prior to the September 1996 flood, was initiated in February of 1997 and completed the following April at a cost of $1,232,000. An estimated 232,000 cubic yards of sediment were removed.

Lake Lure supports a sport fishery consisting of sunfish, crappie, largemouth bass and trout (Fish, 1968). In 1986, a survey was conducted to investigate the rainbow trout fishery in Lake Lure. This study was conducted to address angler concerns of the declining rainbow trout fishery in the lake. The three year study discovered that suitable habitat for trout (i.e., water temperature and dissolved oxygen) had declined since the 1950's (Goudreau and Brown, 1988). The Town of Lake Lure finances the stocking of the lake with trout and bass.

4.4.2 Subbasin 02 - Middle portion of the Broad River, including Walnut Creek, Mountain Creek, the lower Green River and the Second Broad River

Description

This subbasin includes the middle portion of the Broad River watershed (approximately 35 river miles from below the dam at Lake Lure to the confluence of the Second Broad River near the Cleveland/Rutherford County line,) the entire Second Broad River drainage, and the lower drainage of the Green River. These streams are found within the piedmont ecoregion and contain the urban areas of Rutherfordton, Spindale, and Forest City. Other significant tributary catchments of the Broad River include Mountain, Cleghorn, and Floyd Creeks. Large tributary systems of the Second Broad River include Catheys Creek and Robinson Creek. The Broad River, from the confluence of Cove Creek to the town of Rutherfordton, is currently classified as WS-IV and the Second Broad River from its headwaters to 0.5 miles above the Cone Mills water supply intake is currently classified as WS-IV or WS-V. Sedimentation is a major habitat quality problem in the subbasin and is responsible for habitat degradation in many catchments. Many of the streams have a shifting sand bottom. Eight permitted discharges have design flows of $\geq$ 0.5 MGD, of which 5 discharge within the Second Broad River catchment (Spindale WWTP, Burlington Industries, Forest City WTP and WWTP, and Cone Mills Corporation). Figure 4.9 provides a map showing the major hydrological features and the location of DWQ's sampling sites in this subbasin.

Overview of Water Quality

Water quality, based on benthic macroinvertebrate information, generally ranges from Good to Good/Fair in this subbasin (Table 4.10). During the 1995 basin assessment, the Broad River water quality was Good at two sites, but Good-Fair at a site in between. Good water quality was also found at Mountain Creek, the Green River, White Oak Creek and an upstream site on the Second Broad River. Cleghorn Creek, Robinson Creek, and a downstream site on the Second Broad River had Good-Fair bioclassifications. Fair water quality was found for Walnut Creek and Catheys Creek below the Spindale WWTP. Poor bioclassifications have been recorded only prior to 1987. Water quality deterioration is associated with large point source dischargers in the Rutherfordton-Spindale area and nonpoint source runoff in other areas of the subbasin.

A fish community sample from the Green River in 1995 also noted Good water quality. Fisheries samples were collected in 1994 during a special study of the Second Broad River. Fair-Good NCIBI ratings were found at Catheys Creek and a middle site on the Second Broad River. Upstream and downstream sites on the Second Broad had Good NCIBI ratings. Combining fisheries and benthos data, the 1994 study concluded that the overall water quality of the Second Broad River was Good-Fair, and that the major problem was sedimentation.

Benthos sampling above and below the Columbus WWTP discharge in the White Oak Creek watershed has shown improvement in water quality between 1986 and 1995. Water quality below the discharge improved from Poor to Good-Fair. This change is attributed to improved wastewater treatment and a reduction in the percent of industrial contributors.

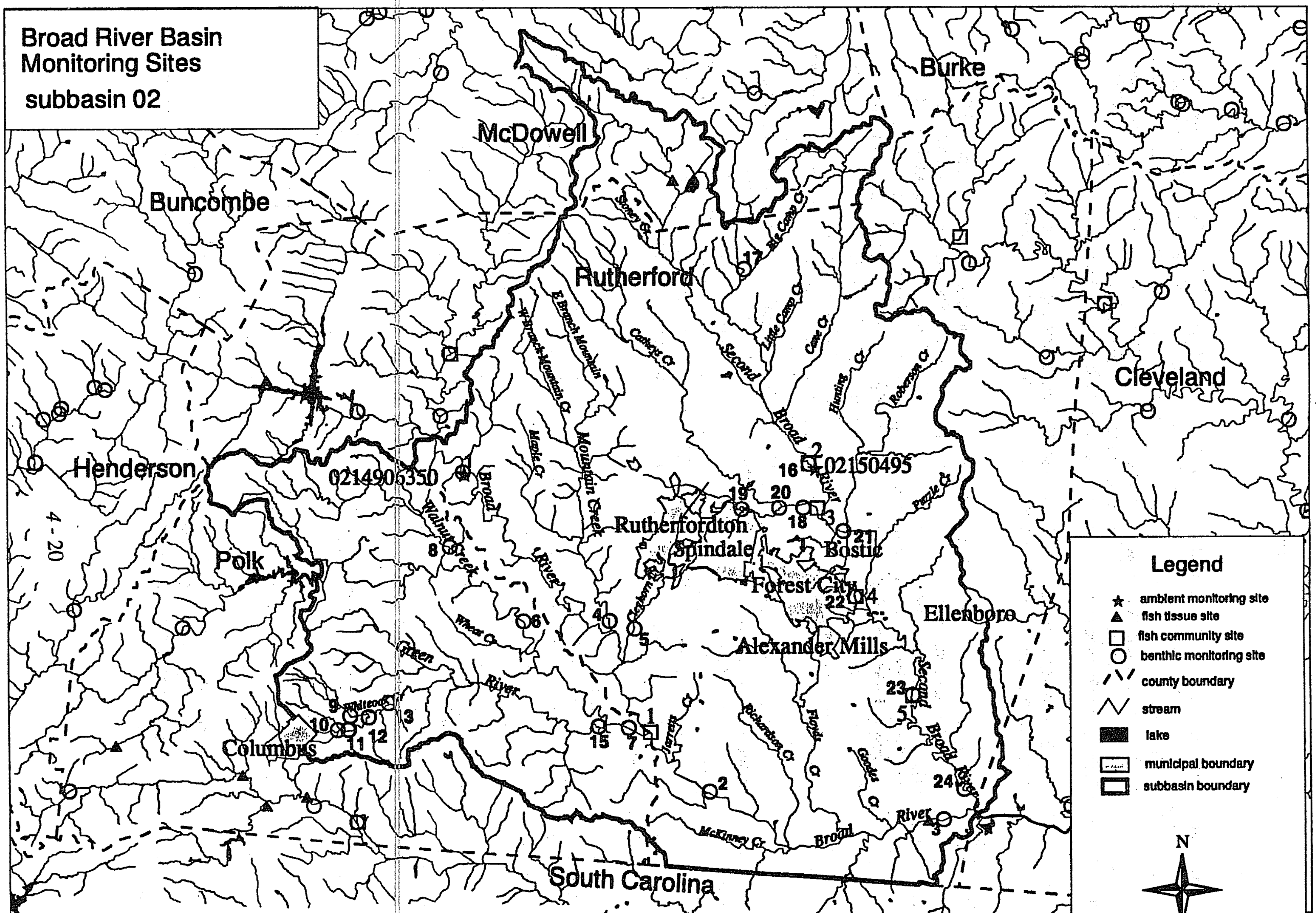


Figure 4.9 DWQ Sampling Sites in Broad Subbasin 02.

Good or Good-Fair bioclassifications have been consistently recorded from the ambient monitoring location on the Broad River at Cliffside. This site is the most downstream monitoring location in the subbasin and denotes water quality conditions prior to flowing into South Carolina. However, the gradient of the Broad River is less in the lower reaches below the ambient monitoring location. The reduction in gradient may account for sediment accumulation in the lower reaches of the river.

There are five VWIN (Polk County) monitoring sites in subbasin 02. Of all of the Polk County monitoring sites, the White Oak Creek watershed shows some of the highest turbidity and suspended solids levels (Maas, et. al., 1997b). This is likely due to agricultural or urban sources. Levels for these parameters were highest in the last year, possibly indicating a worsening situation.

Benthic Macroinvertebrates

Twelve locations were sampled for benthic macroinvertebrates in this subbasin during the 1995 basinwide investigation (Table 4.10). Six of these locations were at previously unassessed tributary sites (4) or unassessed reaches of the Broad River (2). Benthic macroinvertebrate samples have been collected from 24 locations in 030802 since 1983, including three special studies and five long-term monitoring locations. Results from earlier studies are contained in the Broad River Basin Basinwide Assessment Report (NCDENR, 1997).

Table 4.10 Benthic Macroinvertebrate Data, Broad Subbasin 02, 1995.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-1	Broad R	950712	Rutherford	SR 1181	56/28	Good
B-2	Broad R	950712	Rutherford	SR 1106	52/23	Good-Fair
B-3	Broad R	950920	Rutherford	US 221	58/29	Good
B-4	Mountain Cr	950712	Rutherford	SR 1149	-/28	Good
B-5	Cleghorn Cr	950712	Rutherford	SR 1149	49/17	Good-Fair
B-7	Green R	950711	Polk	SR 1302	52/27	Good
B-8	Walnut Cr	950711	Polk	SR 1315	-/14	Fair
B-11	White Oak Cr	950711	Polk	SR 1352	63/36	Good
B-16	Second Broad R	950713	Rutherford	SR 1538	51/26	Good
B-18	Catheys Cr	950713	Rutherford	SR 1549	-/18	Fair
B-21	Robinson Cr	950713	Rutherford	SR 1561	-/26	Good-Fair
B-24	Second Broad R	950713	Rutherford	SR 1973	42/20	Good-Fair

Note: Map # refers to number on subbasin map.

Benthic macroinvertebrate samples were collected from three mainstem Broad River locations during the 1995 basinwide sampling. Samples were collected from two previously unassessed reaches (SR 1181 and SR 1106) and at the ambient monitoring location at US 221 near Cliffside. These data suggest Good and Good/Fair bioclassifications. Despite the slightly lower EPT taxa richness value at the SR 1106 location (and a lower bioclassification) the benthic fauna at all three locations were very similar. EPT abundance values were also very low at each of these three locations (range from 73-88). In addition, very low chironomid abundances were recorded, suggesting the effects of scour. Low NC habitat scores for the Broad River sites suggest impacts to instream habitat.

Benthic macroinvertebrate samples were collected from two small, unassessed tributary catchments of the Broad River. Mountain Creek was selected as a typical tributary of the Broad River. This stream at SR 1149 is approximately 12 meters wide and has a very sandy substrate. Cleghorn Creek was chosen to assess the potential impacts of the Rutherfordton WWTP. The stream is 6-7 meters wide and also has a very sandy substrate. The field team noted that bank erosion was very severe which may account for some of the habitat deterioration. The Rutherfordton WWTP has a design flow of 1.0 MGD and an instream waste concentration of

48% under 7Q10 flow conditions. Rutherfordton is expanding the WWTP to a 3.0 MGD activated sludge discharge, which will be located below the confluence of Stonecutter and Cleghorn creeks. Mountain bioclassification criteria were used to assign Good and Good/Fair bioclassifications to Mountain and Cleghorn Creeks, respectively.

The only site surveyed on the Green River during the 1995 basinwide network was at SR 1302, which is a long-term monitoring location and will be discussed in that section (below). Two tributary streams of the Green River were sampled in 1995: Walnut Creek and White Oak Creek. Walnut Creek was selected as a typical tributary catchment in this subbasin and the survey at White Oak Creek was conducted to follow-up an earlier investigation of the Columbus WWTP. Walnut Creek at SR 1315 is near the confluence with the Green River. Only 14 EPT taxa were collected at this location and the EPT abundance also was very low (49). This site also received a low NC habitat score (63). The field team noted unstable banks with breaks in the riparian zone and a heavily embedded substrate. The landuse in the immediate vicinity of the monitoring location is primarily fallow agricultural fields. Walnut Creek received a Fair bioclassification.

Two collection sites were chosen on the Second Broad River to bracket several point source discharges in the Rutherfordton/Spindale metropolitan area. The Second Broad River at SR 1538 was selected as a reference site during an intensive investigation of the entire Second Broad River in June, 1994. This site also was sampled during the 1995 basinwide network. Both surveys resulted in Good bioclassifications using mountain bioclassification criteria. This reach of the Second Broad River has a very sandy substrate and is susceptible to the effects of scour during spate events. Despite the Good bioclassifications during both surveys, there was a large difference in EPT taxa richness numbers (26 vs. 33). These differences are particularly evident in the Ephemeroptera (10 in 1995 compared to 17 in 1994). Mayfly taxa that were either abundant or common during the 1994 survey but absent during the 1995 survey include *Baetis pluto*, *Caenis*, *Centroptilum*, *Heptagenia*, *H. marginalis*, and *Tricorythodes*. Interestingly, more Plecoptera were collected in 1995 during the July survey. *Pteronarcys dorsata* and *Tallaperla* were abundant and common, respectively in 1995, but not collected during the 1994 survey.

The Catheys Creek location was selected to follow-up information collected during a special investigation. The substrate at this location is dominated by sand and silt and the water during the 1995 survey was discolored due to the Spindale effluent. This site was initially chosen as a recovery site during an intensive investigation of the Spindale WWTP in 1988. It also was part of an intensive investigation of the entire Second Broad River basin in June 1994 and sampled in 1995 as part of the basinwide network. The bioclassification has been borderline between Good/Fair or Fair using mountain classification criteria during all three surveys. These bioclassifications reflect the impacts of the Spindale WWTP.

Robinson Creek was selected as an unassessed tributary in this subbasin. This is a small (6 meter wide) tributary of the Second Broad River with a sand and gravel dominated substrate. A Good/Fair bioclassification was assigned to Robinson Creek based on an EPT taxa richness value of 26. A Good/Fair bioclassification using mountain classification criteria is supported by a moderate EPT abundance value (104).

Long Term Benthos Locations

In subbasin 02 there are six locations that have been analyzed over a number of years to detect trends in water quality. These are described in detail below.

<u>Broad River at US 221 near Cliffside</u>

The Broad River at Cliffside is a very large river (approximately 50 meters wide) and has a sandy substrate. Benthic macroinvertebrate samples have been collected from this location on 7 different occasions. These data have given either a Good or Good-Fair bioclassification to this reach of the Broad River. Mountain bioclassification criteria are used at this location, however, this site has some characteristics of a piedmont system. EPT taxa richness values have varied from a low of 17 in 1983, to a high of 29 in 1984 and 1995 (Table 4.11). The EPT abundance values also have varied considerably (56-137). Many invertebrate taxa were collected from this location for the first time during the 1995 survey: *Neoephemera purpurea*, *Eccoptura xanthenes*, *Chimarra*, and *Amnicola*. However, there were few differences in dominant taxa between surveys suggesting that there has been little change in the fauna at this location. Antecedent flow conditions are a likely factor at least partially responsible for the composition of the benthic fauna at this site.

Table 4.11 Benthic Macroinvertebrate Sampling Results from the Broad River at US 221 near Cliffside - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
20 Sept 95	58	29	73	4.75(3.94)	Good	High
25 July 89	56	22	56	5.25(4.59)	Good-Fair	High
21 July 87	65	26	126	4.87(4.04)	Good-Fair	Normal
22 July 86	70	27	137	5.30(4.12)	Good-Fair	Low
04 Sept 85	48	21	63	4.92(3.81)	Good-Fair	Normal
30 Aug 84	66	29	117	4.46(3.55)	Good	Normal
11 Aug 83	44	17	56	5.13(4.33)	Good-Fair	Normal

Green River at SR 1302

This is the most downstream monitoring location on the Green River, prior to the confluence with the Broad River. This location is downstream of the dam at Lake Adger, therefore flow regimes are regulated. Benthic macroinvertebrate samples have been collected from this location on three different occasions. These collections have consistently suggested Good bioclassifications. However, EPT taxa richness and abundance values were much lower during the 1995 investigation compared to either the 1989 or 1987 surveys (Table 4.12). Many benthic invertebrate taxa were either reduced in abundance or not collected at all during the 1995 survey. These taxa include Baetis intercalaris, B. pluto, Hexagenia, Paragnetina fumosa, and many Chironomidae. The lower taxa richness and abundance values seen during the 1995 investigation may be partially related to high antecedent flow conditions resulting in scour of substrate material.

Table 4.12 Benthic Macroinvertebrate Sampling Results from the Green River at SR 1302 - 1987 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
11 July 95	52	27	93	4.32(3.98)	Good	High
26 July 89	83	35	131	4.67(4.02)	Good	High
21 July 87	74	33	149	4.70(4.06)	Good	Normal

White Oak Creek at SR 1352

Benthic macroinvertebrate samples have been collected from this location on White Oak Creek on three occasions. An initial survey was conducted in 1986 as part of a toxicological evaluation of the Columbus WWTP. The Columbus WWTP discharges to a UT of White Oak Creek approximately 10 river miles upstream of this location. In May of 1995, a sample was collected as part of an investigation of dischargers across the state. The July 1995 survey was part of the basinwide network. Good bioclassifications were assigned to this site during the two full scale collections done in 1995 (Table 4.13). A Good/Fair bioclassification was given to this site in 1986. The May and October collections have been seasonally corrected for this comparison. Seasonal differences in the population structure of the benthic fauna are evident in these data.

While these differences complicate trend analyses, there does not appear to be a change in the overall biological integrity between investigations.

Table 4.13 Benthic Macroinvertebrate Sampling Results from White Oak Creek at SR 1352 - 1986 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
11 July 95	63	36	106	4.41(3.89)	Good	High
15 May 95	84	38	131	4.54(3.00)	Good	High
29 Oct 86	-	24	92	-(3.87)	Good/Fair	Normal

Second Broad River at SR 1538

The Second Broad River at SR 1538 was selected as a reference site during an intensive investigation of the entire Second Broad River (B-950215) in June, 1994. This site also was sampled during the 1995 basinwide network. Both surveys resulted in Good bioclassifications using mountain bioclassification criteria (Table 4.14). This reach of the Second Broad River has a very sandy substrate and is susceptible to the effects of scour during spate events. Despite the Good bioclassifications during both surveys, there was a large difference in EPT taxa richness numbers (26 vs 33). These differences are particularly evident in the Ephemeroptera (10 in 1995 compared to 17 in 1994). Mayfly taxa that were either abundant or common during the 1994 survey but absent during the 1995 survey include *Baetis pluto*, *Caenis*, *Centroptilum*, *Heptagenia, H. marginalis*, and *Tricorythodes*. Interestingly, more Plecoptera were collected in 1995 during the July survey. *Pteronarcys dorsata* and *Tallaperla* were abundant and common, respectively in 1995, but not collected during the 1994 survey.

Table 4.14 Benthic Macroinvertebrate Sampling Results from Second Broad River at SR 1538 - 1994 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
13 July 95	51	26	122	4.35(3.57)	Good	High
23 June 94	68	33	140	4.50(3.85)	Good	High

Catheys Creek at SR 1549

Catheys Creek at SR 1549 is near the confluence with the Second Broad River. The substrate at this location is dominated by sand and silt and the water during the 1995 survey was discolored due to the Spindale effluent. This site was initially chosen as a recovery site during an intensive investigation of the Spindale WWTP in 1988 (B-880516). It also was part of an intensive investigation of the entire Second Broad River basin in June 1994 (B-950215) and sampled in 1995 as part of the basinwide network. The bioclassification has been borderline between Good/Fair or Fair using mountain classification criteria during all three surveys (Table 4.15). These bioclassifications reflect the impacts of the Spindale WWTP. The EPT taxa richness value was slightly higher in 1995, but still resulted in a Fair bioclassification. In addition, there was a curious lack of several taxa in 1995 that were common or abundant in 1994. These EPT taxa are *Perlesta placida*, *Cheumatopsyche*, *Lype diversa*, and *Oecetis persimilis*.

Table 4.15 Benthic Macroinvertebrate Sampling Results from Catheys Creek at SR 1549 - 1988 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
13 July 95	-	18	64	-(3.94)	Fair	High
27 June 94	49	17	98	5.17(3.57)	Good/Fair	High
23 Mar 88	-	15	70	-(3.98)	Fair	Normal

Second Broad River near SR 1973 near Cliffside

Benthic macroinvertebrate samples have been collected from the Second Broad River near Cliffside on six occasions (Table 4.16). This site is located below US 221A and the Cone Mills cooling water reservoir. Samples have been collected from this location during summer surveys in 1983, 1985, 1987, 1989, 1991 and 1995. In June, 1994, an intensive investigation was conducted on the Second Broad River, however, benthic macroinvertebrate samples were not collected at this location due to high flows (B-950215). The field team reported that the substrate at this location during the 1995 investigation was completely dominated by recently deposited, shifting sand (95%). The increase in sand as the dominant substrate material in 1995 is a result of a breech of the cooling water lake at the Cone Mills facility. Benthic macroinvertebrate surveys have found Good/Fair or Fair bioclassifications at this location using mountain classification criteria, with the exception of data from 1983, when a Poor bioclassification was assigned. The Poor or Fair collections are characterized by low EPT taxa richness values (9-17) and a low abundance of Plecoptera. Organic loading problems were apparent only in 1983, when tubificid oligochaetes were abundant. The 1995 collection resulted in a Good/Fair bioclassification. The Good/Fair bioclassification from this site in 1995 is very surprising considering the dominance of recently deposited sand. Apparently, the bank habitats support enough structure, above the benthic habitats that were buried in sand, to maintain the macroinvertebrate community. Taxa richness numbers were lower, during the 1995 survey when compared to the 1991 survey, within the Trichoptera (5 vs 12) and Mollusca (0 vs. 4) groups. *Hydropsyche betteni* and *Corbicula fluminea*, which had been either common or abundant during all previous investigations, were not collected during the 1995 survey. Many Trichoptera that were collected during the 1991 investigation that are considered 'top of the rock' species were not collected in 1995 (*Glossosoma*, *Hydroptila*, *Lepidostoma*, *Micrasema wataga*, and *Protoptila*). Based on these comparisons, it appears that some changes in the benthos community had taken place due to the recently deposited sand, but that these changes had not seriously affected the overall bioclassification of this reach of the Second Broad River.

Table 4.16 Benthic Macroinvertebrate Sampling Results from Second Broad River near SR 1973 near Cliffside - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
13 July 95	42	20	95	5.43(4.70)	Good/Fair	High
08 July 91	59	25	120	5.21(4.39)	Good/Fair	Normal
25 July 89	60	17	70	6.11(5.18)	Fair	High
21 July 87	65	25	104	5.60(4.42)	Good/Fair	Normal
04 Sept 85	44	15	45	5.99(4.77)	Fair	Normal
11 Aug 83	26	9	13	7.83(4.24)	Poor	Normal

Fish Community Structure and Fish Tissue

Five sites within subbasin 02 of the Broad Basin have been sampled for fish community structure in 1994 and 1995. Results of these samples are presented in Table 4.17.

Table 4.17 Fish Community Assessment Sites in the Broad River Subbasin 030802, North Carolina Index of Biotic Integrity (NCIBI) Score, and Rating, 1994 and 1995.

Site	Waterbody	Location	County	Drainage Area (mi^2)	Date	NCIBI Score	NCIBI Rating
F-1	Green R	SR 1302	Polk	245	6/19/95	52	Good
F-2	Second Broad R	SR 1538	Rutherford	86.2	6/20/94	50	Good
F-3	Catheys Cr	SR 1549	Rutherford	44.0	6/20/94	46	Fair-Good
F-4	Second Broad R	US 74	Rutherford	168	6/20/94	46	Fair-Good
F-5	Second Broad R	US 221A	Rutherford	199	6/20/94	52	Good

The Green River at SR 1302 is a sand and gravel bottom stream whose flow is controlled by the upstream Lake Adger discharge. This site was rated only as Good because of 1) lower than expected scores for the number of taxa which were collected for a stream with a drainage area of 245 mi^2, 2) only two species of sunfish were collected, and 3) only one piscivore (or 0.2% of all fish) was collected. The most abundant species were the fieryblack shiner and the seagreen darter. Sportfish collected included redbreast sunfish, bluegill, and largemouth bass.

The Second Broad River at SR 2538 is located above Forest City and has a predominantly sand bottom. This site was rated as Good, but there were fewer than expected number of species of darters and sunfish collected and the trophic structure was slightly skewed towards more omnivores and less insectivores and piscivores than expected. These types of deviations from the expected are usually indicators of instream habitat impairment and nutrient enrichment. The most abundant species collected was the omnivorous bluehead chub. Sportfish collected included the redbreast sunfish, bluegill, and largemouth bass.

The monitoring site at Catheys Creek at SR 1549 was below the Spindale WWTP and had a shifting sand substrate. The fish community was rated as Fair-Good. The lower than expected scores for the trophic metrics, darter and sunfish diversity metrics, and the total fish abundance metric were indicative of habitat (sedimentation) and nutrient enrichment. Only 119 fish were collected, the fewest of any of the four sites monitored in 1994. The most abundant species collected was the bluehead chub. Sportfish collected included redbreast sunfish, bluegill, and smallmouth and largemouth bass.

The second site on the Second Broad River (at US 74) has a drainage area that is approximately twice the size of the upstream monitoring site. At US 74, this site was downstream from Catheys Creek and adjacent to Forest City. In 1964, the Second Broad River at US 74 was heavily silted by sand dredging operations and also received treated waste effluent from Forest City. The fishery resource was considered poor and in a 300-foot section of stream which was sampled, only 55 fish representing 5 species were collected (Messer, et al. 1965). Thirty years later, improvements in the fish community were evident as the community was rated Fair-Good with 163 fish collected representing 13 species. Nutrient enrichment and habitat impairment were still evident by the skewed trophic structure and the low diversity of intolerant species, darters, and minnow species. The most abundant species collected were the redbreast sunfish and the Santee chub.

The lowermost site monitored on the Second Broad River was located near Caroleen at US 221A; it was rated as Good. The river at this site has a rocky substrate. Sedimentation is reduced at the site because an upstream mill dam serves as an efficient sand and sediment trap. The rockier substrate contributed to a more diverse and abundant fish community. More species of fish (23) were collected at this site than at the other three sites monitored within the Second Broad River watershed. A diverse assemblage of 11 species of minnows (including the intolerant greenfin shiner, whitefin shiner, spottail shiner, and highback chub) and 5 species of sunfish were collected at this site. However, with a skewed trophic structure due to the abundance of omnivores and with only one species of darter being collected, there were signs of longterm habitat deterioration and elevated nutrient levels. The most abundant species collected was the bluehead chub. Six species of sportfish were represented at this site: redbreast, green, and redear sunfishes, warmouth, bluegill, and largemouth bass.

The most recent fish tissue samples taken in this subbasin were in 1988 at the Second Broad River below Mt. Vein Church near the McDowell/Rutherford County line. These were analyzed for mercury and showed concentrations below levels of concern.

4.4.3 Subbasin 03 - Green River drainage above Lake Adger

Description

Subbasin 030803 contains the headwater reaches of the Green River and streams within this subbasin are in the mountain ecoregion. This section of the Green River has been dammed at two locations to form Lake Summit and Lake Adger. The Hungry River is the only large tributary catchment. Figure 4.10 shows the major hydrology in this subbasin along with the location of DWQ sampling sites.

Most of the high-gradient tributary systems are currently classified as C Trout. Rainbow, brown, and brook trout have been collected from streams in this subbasin (Menhinick, 1991) suggesting that many of these streams are capable of supporting reproducing trout populations. Apple orchards are a significant land use in upper reaches of many tributary catchments including the Hungry River. Lower reaches of many catchments are farmed, and residential development is found throughout the watershed. Sedimentation is the dominant problem in the subbasin, as the subbasin only has a few small permitted dischargers. Sources of nonpoint runoff include agriculture (primarily apple orchards), and residential development. Recent acquisition by the Wildlife Resources Commission of the Green River Game Land between Lake Summit and Lake Adger on the Green and Hungry rivers will provide an important buffer in this area. The Green River Preserve on the headwaters of the Green River serve a similar function.

Overview of Water Quality

During an Outstanding Resources Water study in 1993, Excellent bioclassifications were assigned to the upper reaches of the Green River above Lake Summit and to Rock Creek, a tributary of the Green River. Other Green River sites, above Lake Summit in 1993 and below the lake in 1995, had Good bioclassifications. Good/Fair bioclassifications have been found from low elevation tributaries of Lake Summit (Joe and Freeman Creeks) in 1989 and the Hungry River in 1995.

Lake Summit is a reservoir used to produce hydroelectric power and owned by Duke Power. The dam was built and the lake filled in 1920. The watershed is mostly forested with some small farms. Lake Summit is used extensively for recreational purposes (fishing, swimming, boating) and supports a sport fishery consisting of sunfish, catfish, crappie and largemouth bass. The results of an ORW survey in 1989 indicated that Lake Summit and its watershed had good water quality and were valuable waters of the state. However, neither excellent water quality or outstanding resource value were identified. The lake is considered oligotrophic.

Lake Adger is another impoundment located below Lake Summit, and is used to generate hydroelectric power. Fishing and boating are common on the reservoir, and the lake supports a sport fishery consisting of sunfish, crappie, catfish, carp, largemouth bass and trout. This lake is also oligotrophic. Fish tissue samples were collected at Lake Adger in 1995 and analyzed for metals contaminants. Results indicated metals concentrations below levels of concern.

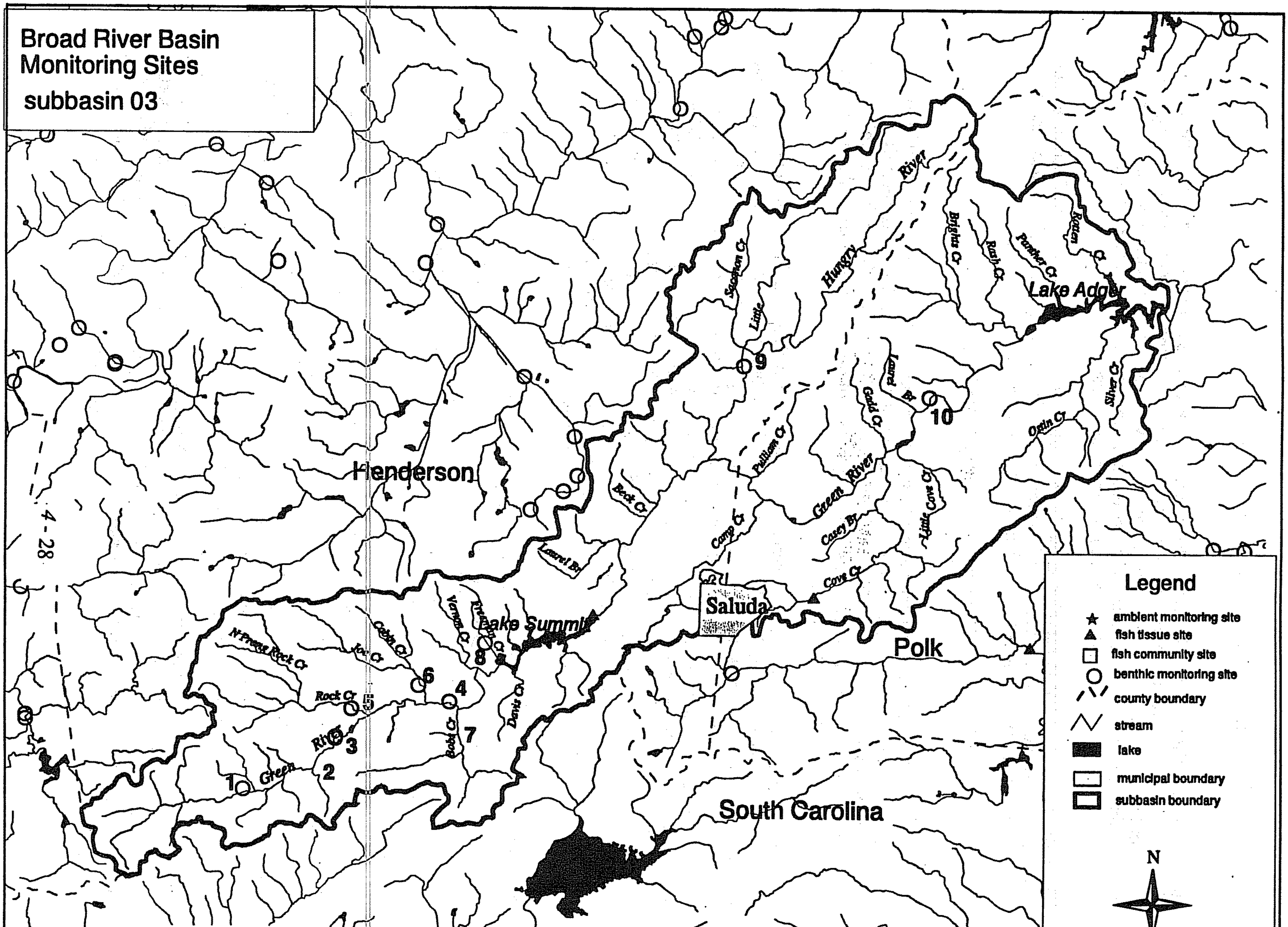


Figure 4.10 DWQ Sampling Sites in Broad Subbasin 03.

Henderson County has four VWIN monitoring sites in the upper Green River watershed. Results indicate that this area has high water quality, although there appears to be increasing turbidity, suspended solids and nitrogen (Maas, et.al., 1996).

Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected from two locations as part of the 1995 basinwide monitoring network (Table 4.18). Benthic macroinvertebrate samples have been collected from 10 locations in 030803 since 1983, including one special study.

Table 4.18 Basin Assessment Sites in Broad Subbasin 030803, 1995, Taxa Richness Values and Bioclassifications.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-9	Hungry R	950710	Henderson	SR 1799	-/25	Good-Fair
B-10	Green R	950710	Polk	SR 1151	54/25	Good

Note: Map # refers to number on subbasin map.

Two benthic macroinvertebrate samples were collected from previously unassessed locations during the 1995 basinwide network in this subbasin: the Green River at SR 1151 and the Hungry River at SR 1799. The Green River location was selected to determine water quality of the Green River below Lake Summit but above Lake Adger. A Good bioclassification was given to this location. This site was given a high NC Habitat score (76) but breaks in the riparian zone were common and SR 1151 (which is a dirt road) runs parallel to the river. Despite the regulated nature of this reach of the Green River, EPT abundance was low (79) suggesting that scour during high flow events affected the benthos. The substrate at this monitoring location was very sandy (60%).

Benthic macroinvertebrates also were collected from the Hungry River. The collection site at SR 1799 received an NC Habitat score of 71 and had a substrate dominated by sand and gravel (65%). The benthic fauna was dominated by intolerant taxa including Epeorus rubidus, Baetis pluto, Serratella serrata, and Dolophilodes. Apple orchards are common in the catchment; however, runoff from these orchard areas do not appear to seriously affect the benthos.

Two ORW/HQW investigations were conducted in the upper Green River catchment in 1989 and 1993 (Table 4.19). Results of the initial investigation in 1989 were inconclusive, therefore, a follow-up investigation was conducted in 1993. More intensive collection methods were used at many of the mainstem collection locations during the follow-up survey. The results of the 1993 survey indicated that two sites on the upper Green River and Rock Creek were Excellent and were eligible for HQW classification. Results of this investigation also noted low pH values at all locations. Values were below the 6.0 water quality standard for C trout streams. However, widespread occurrence of low pH readings at many ORW sites in the North Carolina mountains suggests that low pH values should not exclude the Green River from consideration for HQW classification. Following these studies, a separate request for reclassification to B Tr was received by the Planning Branch. As of 1997, sampling for the B reclassification still needed to be completed, after which the two requests would be brought forward together to the EMC.

Table 4.19 Benthic Macroinvertebrate Special Studies, Broad River Subbasin 030803, 1989-1995.

Site #	Creek	Date	Study	County	Road	S/SEPT	Rating
B-1	Green River	931027	Green River ORW	Henderson	SR 1106	78/42	Exc
		890118	Green River ORW	Henderson	SR 1106	-/40	Good
B-2	Green River	890118	Green River ORW	Henderson	nr SR 1106	87/42	Good
B-3	Green River	931027	Green River ORW	Henderson	SR 1104	103/51	Exc
B-4	Green River	931027	Green River ORW	Henderson	SR 1103	94/39	Good
B-5	Rock Creek	931028	Green River ORW	Henderson	SR 1106	-/37	Exc
		890119	Green River ORW	Henderson	SR 1106	-/32	Good
B-6	Joe Creek	890119	Green River ORW	Henderson	SR 1106	-/28	G/F
B-7	Bobs Creek	890119	Green River ORW	Henderson	SR 1103	-/35	Good
B-8	Freeman Creek	890118	Green River ORW	Henderson	SR 1115	-/20	G/F

Note: Map # refers to number on subbasin map.

Fish Tissue

Fish tissue samples were collected at Lake Summit and Lake Adger in 1995 and analyzed for metals contaminants. Results indicated metals concentrations below levels of concern.

Lakes Assessment

Lake Summit

Lake Summit is a reservoir located in the mountains of southwestern North Carolina. The lake, used to produce hydroelectric power, is owned by Duke Power. The dam was built and the lake filled in 1920. Lake Summit has an average retention time of 75 days. The major tributary to the lake is the Green River. Figure 4.11 provides a general map of the lake. The watershed is mostly forested with some small farms. Many single family homes are located around the shore of the lake. In 1994, the area around the lake was zoned residential from a distance that extends out approximately 1,000 feet from the shore (Matt Mattison, Henderson County Planning Director, pers. com.). Lake Summit is used extensively for recreational purposes (fishing, swimming, boating, etc.) and supports a sport fishery consisting of sunfish, catfish, crappie and largemouth bass (Fish, 1968). The Town of Tuxedo is located along the northwestern shore of the lake and US Highway 25 runs northeast to southwest through the western portion of the watershed. A number of summer camps are located in the watershed and these contribute significantly to the increase in the summer population (Robert Carter, District Conservationist, NRCD District Office, Henderson County, pers. com.) Two of these camps are located near the lake and use septic tanks systems for their wastewater disposal (Matt Mattison, Planning Director, Henderson County, pers com.)

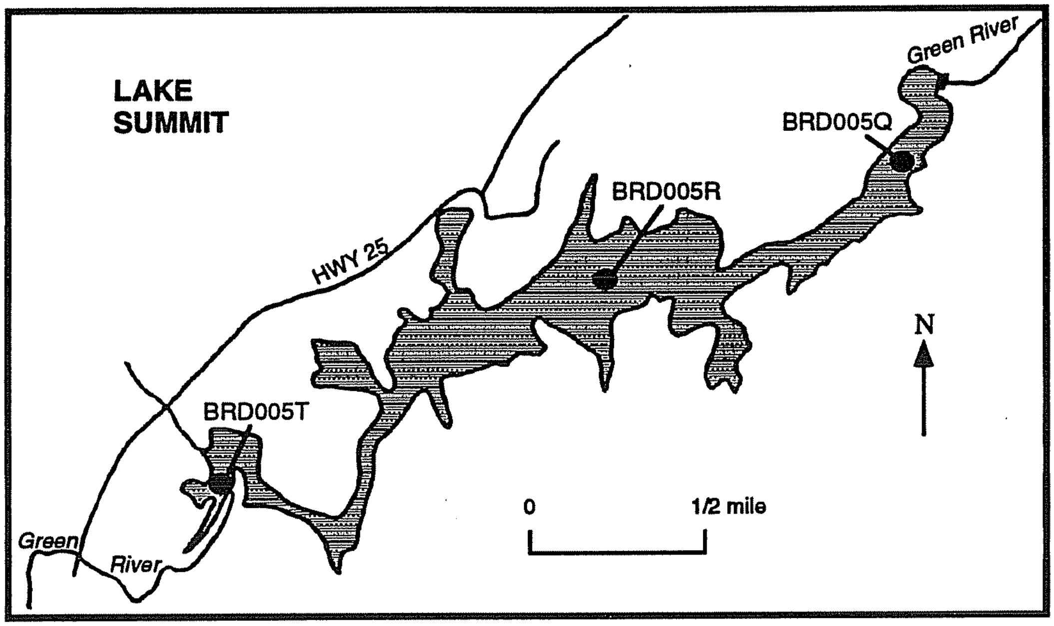


Figure 4.11 General Map of Lake Summit, Broad Subbasin 03

Lake Summit was most recently sampled by DWQ on July 31, 1995 as part of the ambient lakes monitoring program. The lake was stratified at the two deeper sampling stations while the upstream, shallower station (BRD005T) was mixed. The NCTSI was -4.0 in 1995 which indicated that Lake Summit was oligotrophic on the day it was sampled. The low nutrient values and chlorophyll *a* concentrations throughout the lake supported this trophic status classification.

Previously sampled in 1989 by DWQ (NC DEM, 1989), Lake Summit's mean surface dissolved oxygen was slightly elevated. The surface pH value at the upstream sampling site (BRD005T) was at the state water quality lower limit of 6.0 s.u. Nutrient and chlorophyll *a* values were similar to those observed in 1995. Cryptomonas ovata , a motile, unicellular alga commonly found throughout North Carolina, dominated phytoplankton biovolume estimates throughout the lake. In 1989, Lake Summit had a NCTSI score of -2.8, indicating that the lake was oligotrophic on the day it was sampled.

Lake Adger
Lake Adger is an impoundment located in the mountains of southwestern North Carolina. Currently owned by Northbrook Hydro, this reservoir is used to generate hydroelectric power. Fishing and boating are common on the reservoir. The lake supports a sport fishery consisting of sunfish, crappie, catfish, carp, largemouth bass and trout (Fish, 1968). The dam was built in 1925 and has a maximum depth of 72 feet (22 meters) and a mean depth of 26 feet (eight meters). The average retention time is 21 days. The major tributary to the lake is the Green River and smaller tributaries include Panther and Rotten Creeks to the north and Ostin and Silver Creeks to the south. Figure 4.12 provides a general map of the lake. A residential development is located in the southern Lake Adger watershed, west of Ostin Creek. Most of the watershed is primarily forested woodlands with some croplands and single family homes.

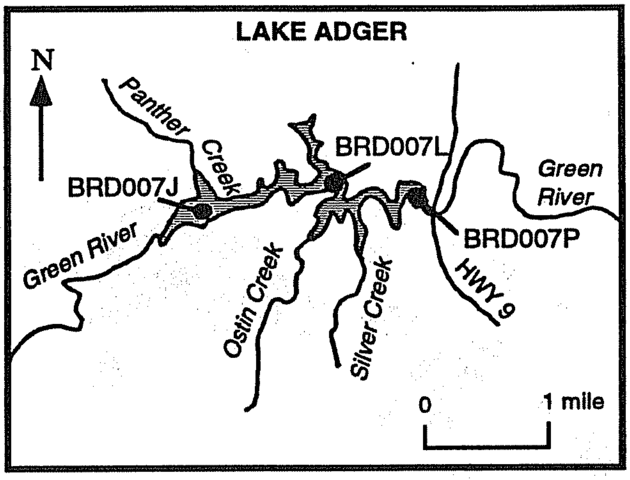


Figure 4.12 General map of Lake Adger, Broad subbasin 03

Lake Adger was sampled on July 31, 1995. Sampling was conducted immediately following a rainfall event, however, physical and chemical parameters did not reflect a significant increase in turbidity or nutrient loading as compared with data collected in 1989. Physical measurements indicated stratified conditions at the two deeper sampling stations while the more shallow station (BRD007J) was mixed. The NCTSI score in 1995 was -4.0, indicating that Lake Adger was oligotrophic on the day it was sampled. Lake Adger was previously sampled by DWQ in 1989. Surface dissolved oxygen was slightly elevated, however, surface pH was close to neutral. Total phosphorus was higher in 1989 as compared with values observed in 1995. This was also true for the nitrite plus nitrate value. In 1989, Lake Adger was determined to be oligotrophic (NCTSI score = -2.7).

As of 1996, there were no public complaints or comments regarding the water quality of Lake Adger. In the past, a sand pumping operation located upstream of the lake had produced complaints regarding sedimentation of the lake. However, this facility has not been in operation for several months in 1997 (Stuart Walker, District Technician, NRCS District Office, Polk County, pers. com.) Lake Adger, which had been previously owned by Duke Power Company, was sold in December 1996 to Northbrook Hydro, and the land surrounding the lake which had belonged to Champion has been sold to Lake Adger Developers, Inc. The 3,250 acre parcel is planned for future development into a private, low density residential and equestrian community. (Mark Maxwell, Planning and Community Development Director, Polk County, pers. com.).

4.4.4 Subbasin 04 - First Broad River and lower portion of Broad River in NC

Description

Subbasin 04 contains the First Broad River and its tributaries. Figure 4.13 provides a map of this subbasin showing DWQ's sampling sites. This geographic area is a transitional zone between ecoregions, with some streams exhibiting mountain characteristics, while other streams are more piedmont in nature. Land use is mainly a mixture of agriculture and forest. The town of Shelby is the largest urban area. The Shelby WWTP (6.0 MGD) is one of three NPDES permitted dischargers in the subbasin with a permitted flow of 0.5 MGD or greater. The other major dischargers are Cleveland Mills (0.78 MGD) and PPG Industries (1.3 MGD).

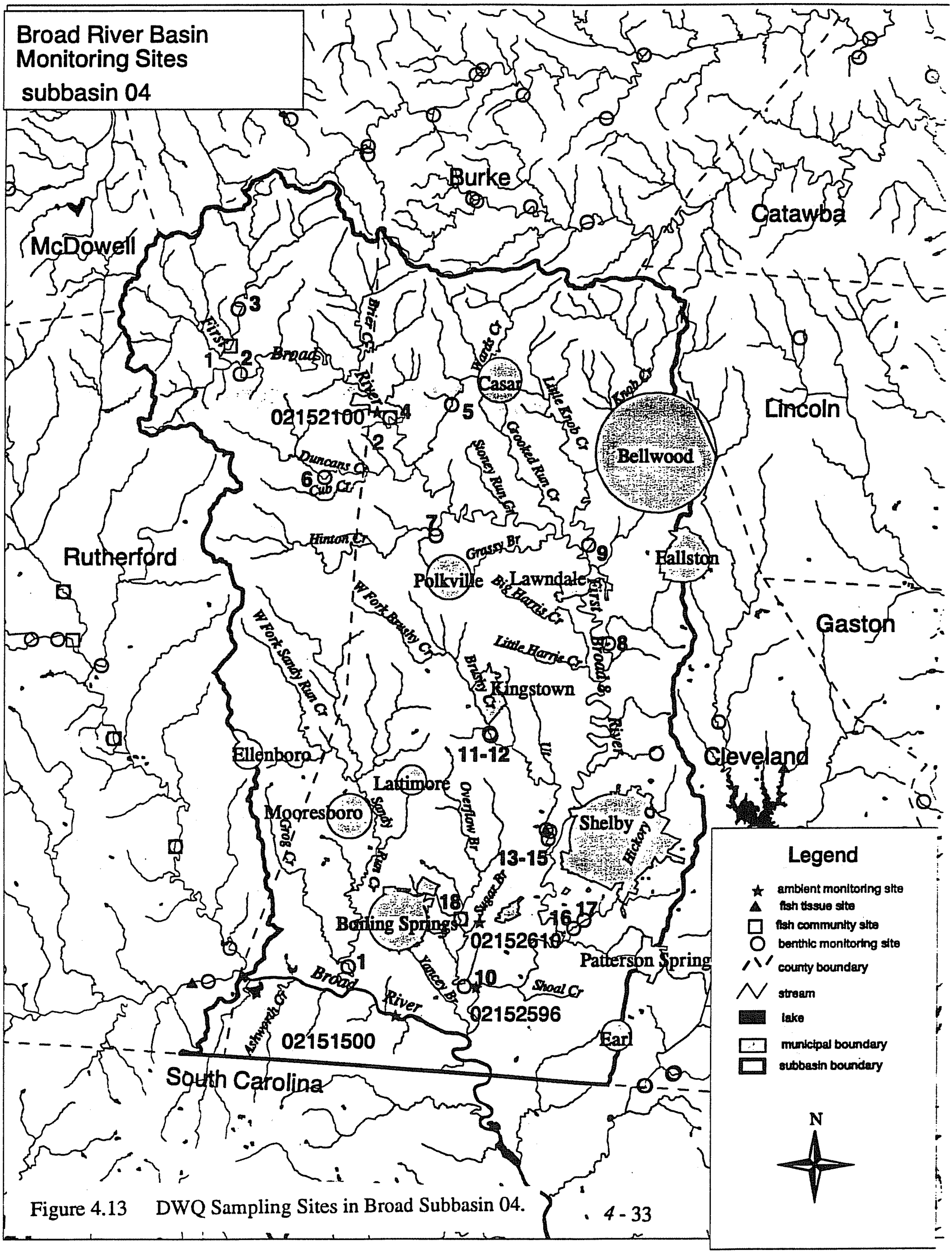


Figure 4.13 DWQ Sampling Sites in Broad Subbasin 04.

Overview of Water Quality

Recent macroinvertebrate data indicated Good water quality in the First Broad River in the area near Casar with a slight decrease to Good-Fair near Earl. These ratings have been found consistently since 1983. Excellent water quality was documented in the North Fork First Broad River, a headwater tributary to the First Broad in 1995. Other tributary streams with Good water quality include Duncans Creek, and Knob Creek, while Sandy Run Creek and Hinton Creek had Good-Fair bioclassifications. The only recent data indicating Fair water quality were from Beaverdam Creek below some small dischargers. Brushy Creek was sampled above and below PPG Industries in 1995 and Good water quality was found at both sites.

Fish community sampling in 1995 found similar water quality as the benthos data for sites on the North Fork First Broad River and the First Broad River, but had a Good NCIBI rating for Beaverdam Creek.

Benthic Macroinvertebrates

Benthic macroinvertebrate samples were taken from nine sites in this subbasin during the 1995 basinwide assessment. Results of these surveys are presented in Table 4.20.

Table 4.20 Basin Assessment Sites in Broad Subbasin 030804, 1995, Taxa Richness Values and Bioclassifications.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-1	Sandy Run Cr	950711	Cleveland	SR 1195	61/28	Good-Fair
B-3	N Fk F Broad R	950710	Rutherford	SR 1728	84/40	Excellent
B-4	First Broad R	950710	Cleveland	SR 1530	93/40	Good
B-6	Duncans Cr	950710	Cleveland	SR 1749	-/28	Good
B-7	Hinton Cr	950710	Cleveland	NC 226	-/22	Good-Fair
B-8	First Broad R	950711	Cleveland	SR 1809	72/30	Good
B-9	Knob Cr	950711	Cleveland	SR 1004	76/32	Good
B-10	First Broad R	950712	Cleveland	SR 1140	51/19	Good-Fair
B-18	Beaverdam Cr	950711	Cleveland	NC 150	57/20	Fair

Note: Map # refers to number on subbasin map.

Sandy Run Creek is potentially affected by nonpoint runoff from logging, agricultural activities, and the Boiling Springs WWTP (0.3 MGD) discharge. The site was chosen to evaluate this combination of possible problems. Sandy Run Creek at the sampling location was approximately 18 meters wide with a predominantly boulder and rubble substrate. The area around the site was mostly forested with a few clear cut areas and small pastures. Although this stream has both mountain and piedmont characteristics, it was rated using mountain criteria. The Good-Fair bioclassification assigned to this site suggested that the point and nonpoint source inputs to the stream were having some impacts to the stream fauna.

Duncans Creek was sampled as a possible HQW stream because it flows through a relatively undeveloped area. At the collection site, the stream was seven meters wide. Boulder and rubble were present, but sand composed the highest percentage (40%) of the substrate. Heavy bank erosion was noted along the sampling area. The site was located in an area that was half wooded and half fields and pastures. Duncans Creek was assigned a Good bioclassification with 28 EPT taxa collected (the lowest number of taxa included in the Good range). Of the 12 Trichoptera taxa collected, all but three were rare. Duncans Creek is not suitable for HQW classification because it did not receive a bioclassification of Excellent.

Hinton Creek is located just south of Duncans Creek and has similar land uses in its catchment. Hinton Creek also was sampled as a potential HQW stream. Severely eroded unstable banks were observed at the collection site. An estimated 60% of the substrate was sand with only a trace of boulder and rubble. The stream was approximately 8 meters wide at the site. Hinton

Creek received a Good-Fair bioclassification. The stream fauna at the collection site appeared to be affected by the high degree of sedimentation in the stream and agricultural runoff. Hinton Creek also did not qualify for HQW classification.

The First Broad River at SR 1809 was sampled because there was no prior macroinvertebrate data from this section of the river, and because the site is below the Cleveland Mills discharge (0.78 MGD). The river at this location was estimated to be 24 meters wide with sand as the dominant substrate component. Land use around the site was typical for the area: a combination of wooded and clear cut areas with pastures and fields. This site was assigned a Good bioclassification. This rating suggested that the Cleveland Mills discharge and any nonpoint runoff reaching the First Broad River, were having little impact on its macroinvertebrate community at this location.

Benthic macroinvertebrates were collected from Knob Creek because of the lack of data from the catchment. The stream had a mostly sand substrate and was approximately 11 meters wide at the sampling location. The site was surrounded by wooded sections and clear cuts, with a few fields and some pasture areas. Knob Creek received a Good bioclassification at this site.

Prior to the basinwide survey, no macroinvertebrate data had been collected from Beaverdam Creek. Water quality in the stream is potentially affected by several small dischargers and nonpoint runoff in the catchment. The stream was eight meters wide with severely eroded banks and a shifting sand bottom at the collection site. A sand dredging operation was adjacent to the site. The site was given a Fair bioclassification. Effluent from the discharging facilities, nonpoint runoff, and habitat degradation probably all contributed to the low rating.

Long Term Benthos Sites

In subbasin 04 there are three locations that have been analyzed over a number of years to detect trends in water quality. These are described in detail below.

North Fork First Broad River at SR 1728

The North Fork First Broad River is a montane stream with over half of its substrate composed of boulder and rubble. The stream is approximately 10 meters wide and the area around the site is primarily forested. The bioclassification at the site changed from Good in 1989 to Excellent in 1995 (Table 4.21). Although the bioclassification changed, there was no real change in water quality at the site, as the 35 EPT taxa collected in 1989 was only one taxa short of meeting the criteria for an Excellent rating. The 1995 BI of 3.54 was the lowest value ever recorded in this subbasin.

Table 4.21 Benthic Macroinvertebrate Sampling Results from North Fork First Broad River at SR 1728 - 1989 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
10 July 95	84	40	208	3.54(2.98)	Excellent	Normal
24 July 89	-	35	169	-(3.21)	Good	Normal

First Broad River at SR 1530 near Casar

The river at this sampling location was rated using mountain criteria. The substrate is mostly boulder and rubble and the stream was estimated to be 15 meters wide. The land around the site is primarily wooded. This site has been sampled five times since 1986 and has been assigned a Good bioclassification each time (Table 4.22). Biotic Index values have shown a slight but constant improvement for the period of record.

Table 4.22 Benthic Macroinvertebrate Sampling Results from First Broad River at SR 1530 near Casar - 1986 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
10 July 95	93	40	152	4.11(3.42)	Good	Normal
28 Oct 93	-	35	125	-(3.35)	Good	Low
24 July 89	92	37	140	4.21(3.62)	Good	Normal
27 July 88	97	43	204	4.40(3.61)	Good	Low
22 July 86	91	37	147	4.73(3.71)	Good	Low

First Broad River at SR 1140 near Earl

The First Broad River at this location is a low gradient, sand bottom stream with an estimated width of 27 meters. Land use in the area is mixed with only 25 percent wooded. This site has received a Good-Fair bioclassification every year that it has been sampled with the exception of 1985 when low total and EPT taxa richness values and high BI value were documented (Table 4.23). These changes in the macroinvertebrate community were probably due to increased nonpoint source runoff to the stream and scour. The stream flows in this area were estimated to be over 200 percent of normal for a 30 day period prior to the time the sample was collected. Although the EPT taxa richness in 1995 was the second lowest recorded from the site, it was offset by the BI which was the best recorded at the site.

Table 4.23 Benthic Macroinvertebrate Sampling Results from First Broad River at SR 1140 near Earl - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
12 July 95	51	19	80	5.37(4.47)	Good-Fair	Normal
25 July 89	73	23	95	5.63(4.50)	Good-Fair	Normal
21 July 87	69	26	116	5.64(4.01)	Good-Fair	Normal
05 Sept 85	44	12	29	6.77(5.21)	Fair	High
11 Aug 83	57	21	93	5.93(4.60)	Good-Fair	Normal

Fish Community Structure

In 1995, sampling was conducted at one site on the upper First Broad River, a site on North Fork First Broad River in the upper part of the watershed, and a site on Beaverdam Creek in the lower part of the watershed (Table 4.24). The North Fork First Broad River site and the First Broad River site is located in the mountain ecoregion, whereas Beaverdam Creek is located in the piedmont.

Table 4.24 Basin Fish Community Assessment Sites in the Broad River Subbasin 030804, North Carolina Index of Biotic Integrity (NCIBI) Score, and Rating, 1995.

Site	Waterbody	Location	County	Drainage Area (mi^2)	Date	NCIBI Score	NCIBI Rating
F-1	N Fk First Broad R	SR 1728	Rutherford	14.2	6/20/95	54	Good-Excellent
F-2	First Broad R	SR 1530	Cleveland	60.5	6/20/95	50	Good
F-3	Beaverdam Cr	NC 150	Cleveland	16.9	6/20/95	50	Good

Note: Map # refers to number on subbasin map.

The North Fork First Broad River is trout waters and was rated as Good-Excellent. Middle range scores were received for the number of species of darters, sunfish, and intolerant species collected. All other metrics were scored as a 5 which represents conditions which would be expected for an undisturbed stream. The most abundant species collected was the rosyside dace; sportfish were represented by rainbow trout and smallmouth bass. No sunfish were collected, although redbreast sunfish were collected by Messer, et al. (1965) at this site.

In 1965, the First Broad River at SR 1530 was described as fast moving with deep pools and abundant cover and shade (Messer, et al. 1965). The lack of game fish populations was attributed to frequent flooding during periods of moderate rainfall (Messer, et al. 1965). In 1995, the fish community was rated as Good. Despite abundant cover, only one species of sunfish, the redbreast sunfish, was collected. The trophic structure was also skewed with fewer than expected percentage of piscivores and a greater than expected percentage of omnivores collected as contrasted to an undisturbed site. The fieryblack shiner and the bluehead chub were the most abundant species collected. The sportfish were represented by the redbreast sunfish and the smallmouth bass.

Messer, et al. (1965) described Beaverdam Creek at NC 150 as a swift, turbid, sandy-bottom stream with very little suitable habitat for game fish. Of the eight species collected in 1964, the dominant species was the bluehead chub (77% or 754 out of the 957 of the fish collected). Only one species of sunfish was collected-the redbreast sunfish; and only seven of them were collected.

In 1995, Beaverdam Creek was rated as Good with 488 fish collected (the most collected from any of the six sites monitored in 1995). Of the 18 species collected, the dominant species was the bluehead chub. The redbreast sunfish was still the only species of sunfish in this fish community. However, 4 species of suckers, 9 species of minnows, 3 species of darters, and 5 intolerant species were present. A skewed trophic structure (an abundance of omnivores and an absence of piscivores) and a low diversity of sunfish documented the continued presence of a certain amount of habitat degradation (e.g., nutrient enrichment) at this site.

4.4.5 Subbasin 05 - Buffalo Creek

Description

Subbasin 05 consists of Buffalo Creek and its tributaries. Land use is primarily a combination of agriculture and forest. Kings Mountain is the largest town in the subbasin. The major NPDES permitted dischargers and their receiving streams are the Kings Mountain WWTP (6.0 MGD) into Buffalo Creek; New Minette Textiles (0.6 MGD) into Lick Branch; and Hoechst-Celanese Corporation (0.8 MGD) into Buffalo Creek. Although a few streams in the northern portion of the subbasin exhibit some montane characteristics, this subbasin is considered to be in the piedmont ecoregion. Figure 4.14 provides a map of the subbasin along with locations of DWQ sampling sites.

Overview of Water Quality

Macroinvertebrate data collected during the basinwide survey in 1995 indicated Good water quality at two sites on Buffalo Creek and for Muddy Fork. The downstream site on Buffalo Creek is below the Kings Mountain WWTP, and water quality has improved there from Fair and Good-Fair ratings found between 1983 and 1988. Beason Creek and Kings Creek had Good-Fair bioclassification, while Lick Branch below Minette Textiles had Fair water quality. This last site was also Fair in 1986, but was Poor in 1983.

Kings Mountain Reservoir (also known as Moss Lake) is a water supply for the City of Kings Mountain. Major inflows to the lake include Buffalo Creek and White Oak Creek. The drainage area is characterized by rolling hills and rural land use. The NCTSI score of -2.2 indicates borderline oligotrophic/mesotrophic conditions. To determine the lake's suitability as a reference lake, Kings Mountain Reservoir was monitored by DWQ from 1991 through 1993, three times each year for a total of nine sampling events. Data collected in 1991 and 1992 indicated the

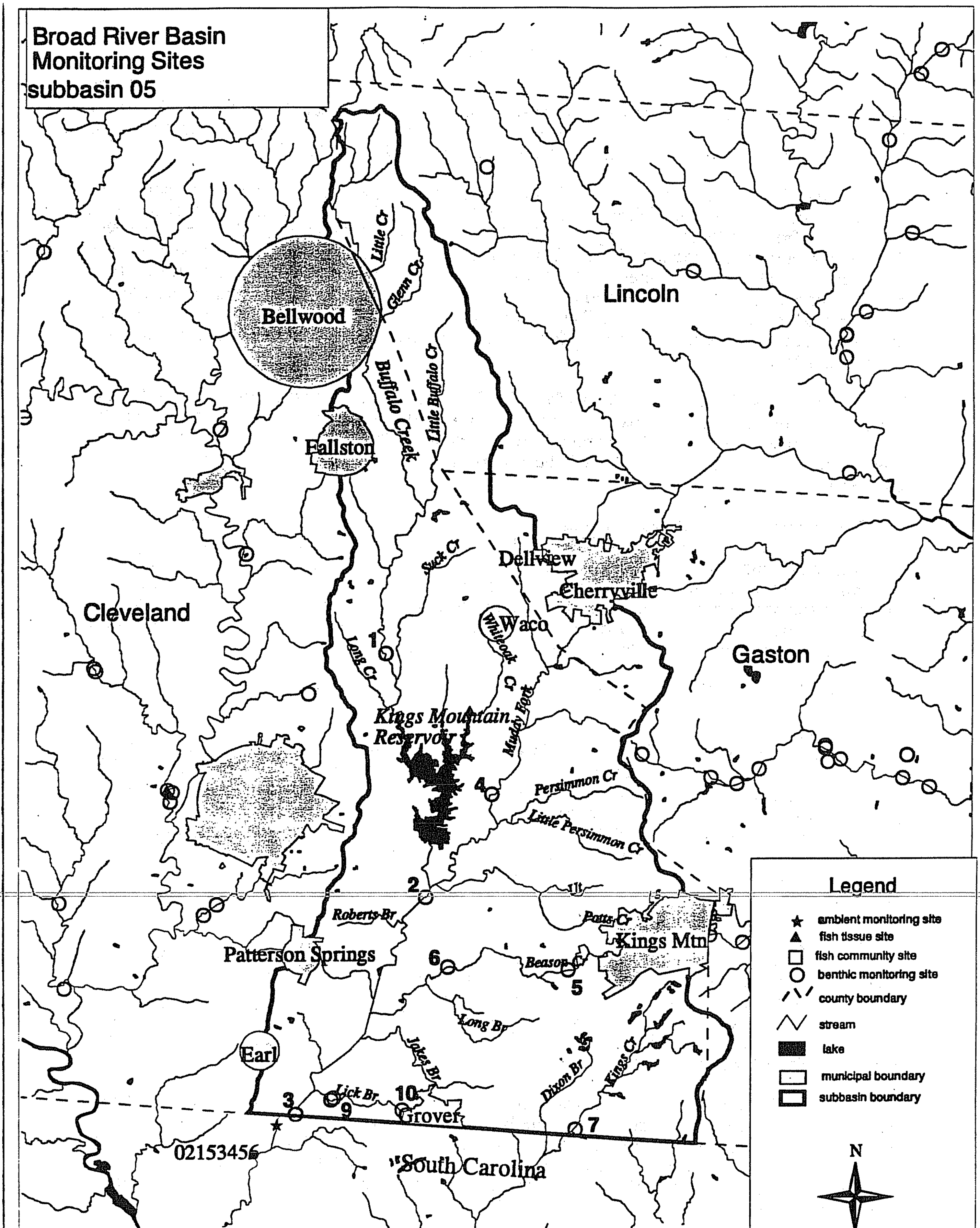


Figure 4.14 DWQ Sampling Sites in Broad Subbasin 05

presence of an algal bloom as well as elevated surface dissolved oxygen and pH. Because of symptoms of nutrient enrichment, Kings Mountain Reservoir is not suitable as a reference lake. Complaints about low numbers of fish in Kings Mountain Reservoir were confirmed during sampling efforts in 1995 to evaluate metals in fish collected from the lake. While few fish were collected, those that were analyzed showed no levels of metals above EPA or FDA human health criteria limits.

Lake Montonia is a small, man-made lake built in the 1920's. Two spring-fed ephemeral, unnamed tributaries flow into the lake. Over the six months that Lake Montonia was sampled in 1996 following a request for reclassification from B to B-HQW, the lake has been consistently oligotrophic. Mean lake nutrient values, and chlorophyll *a* concentrations were relatively similar from month to month.

Benthic Macroinvertebrates

Six sites in subbasin 05 were sampled for benthic macroinvertebrates in 1995. Results are presented in Table 4.25.

Table 4.25 Basin Assessment Sites in Broad Subbasin 030805, 1995, Taxa Richness Values and Bioclassifications.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-1	Buffalo Cr	950711	Cleveland	SR 1908	67/29	Good
B-3	Buffalo Cr	950712	Cleveland	NC 198	56/24	Good
B-4	Muddy Fk	950713	Cleveland	SR 2012	74/23	Good
B-6	Beason Cr	950712	Cleveland	SR 2246	60/19	Good-Fair
B-9	Lick Br	950712	Cleveland	SR 2227	48/6	Fair
B-10	Kings Cr	950713	Cleveland	SR 2286	57/19	Good-Fair

Note: Map # refers to number on subbasin map.

Buffalo Creek at SR 1908 was sampled because there was no prior macroinvertebrate data from the upper part of the catchment. The stream in this area has both mountain and piedmont characteristics, but was rated using piedmont criteria. The stream was 12 meters wide at the site with roughly half of the substrate consisting of boulder and rubble. One half of the area around the site was forested, the other half a mixture of pasture and fields. Buffalo Creek was assigned a Good bioclassification at this site.

Macroinvertebrates were collected from Kings Creek because no prior data had been collected from the catchment. Kings Creek at SR 2286 is approximately six meters wide and has a sand and gravel substrate. Unstable banks and severe erosion were noted along areas where fields and pastures came close to the stream. Kings Creek was assigned a Good-Fair bioclassification. This rating suggested that the combination of nonpoint runoff and effluent from the few small dischargers in the drainage was having some effect on the Kings Creek fauna.

Long Term Benthos Sites

In subbasin 05 there are four locations that have been analyzed over a number of years to detect trends in water quality. These are described in detail below.

Buffalo Creek at NC 198

The stream at the sampling location is approximately 20 meters wide and has a sand bottom. The area around the site is mostly wooded. The site is located below the Kings Mountain WWTP outfall as well as some small dischargers. The Good bioclassification in 1995 was the best recorded at this site (Table 4.26). The 1995 EPT taxa richness and EPT abundance values were both highs for this site, and the 1995 Biotic Index value was also the best observed here. These metrics suggest improvement in water quality at this site. However, water quality at the site appears to be dependent upon flow, with the higher bioclassifications recorded during periods of higher flow. This pattern indicates that the permitted dischargers above this location have a greater effect on water quality at the site than does nonpoint runoff.

Table 4.26 Benthic Macroinvertebrate Sampling Results from Buffalo Creek at NC 198 - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
12 July 95	56	24	117	5.15(4.58)	Good	Normal
27 July 88	80	14	69	6.56(5.70)	Fair	Low
06 Aug 84	55	18	84	6.06(5.24)	Good-Fair	High
14 Nov 83	59	15	50	6.86(5.33)	Fair	Low

Muddy Fork at SR 2012

The land use around the Muddy Fork site was a mixture that included mainly pasture and forest. The stream itself had a mixed substrate and was approximately 10 meters wide. The bioclassification in 1995 improved to Good from Good-Fair in 1990 and 1983 (Table 4.27). This was due to both an increase in the number of EPT taxa collected and a decrease in the Biotic Index. The EPT abundance was also the highest documented from this site. Improvement in all of these metrics does suggest an improvement in water quality for Muddy Fork at this location.

Table 4.27 Benthic Macroinvertebrate Sampling Results from Muddy Fork at SR 2012 - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
13 July 95	74	23	106	5.49(4.95)	Good	Normal
13 Sept 90	74	17	90	5.92(5.21)	Good-Fair	Normal
14 Nov 83	75	18	91	6.03(4.30)	Good-Fair	Low

Beason Creek at SR 2246

Beason Creek at the sampling location was a sand bottom stream with eroding unstable banks. Stream width at the site was estimated to be four meters. Most of the land around the site was either pasture or areas that had been clear cut. The bioclassification for this site has been Good-Fair for both years it has been sampled. The slight increase in EPT taxa richness and decrease in Biotic Index in 1995 versus 1987 were not enough to change the rating (Table 4.28).

Table 4.28 Benthic Macroinvertebrate Sampling Results from Beason Creek at SR 2246 - 1987 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
12 July 95	60	19	101	5.42(5.07)	Good-Fair	Normal
10 June 87	69	17	113	6.06(5.29)	Good-Fair	Normal

Lick Branch at SR 2227

This stream was approximately four meters wide at the collection site, and had a sand and gravel substrate. The site was located in a forested area. This site on Lick Branch is located below the current Minette Textiles discharge (IWC = 78%). Although there has been improvement in the Biotic Index since 1983, the Fair bioclassification in 1995 indicated that the effluent from the mill was still impacting the stream fauna (Table 4.29).

Table 4.29 Benthic Macroinvertebrate Sampling Results from Lick Branch at SR 2227 - 1983 through 1995.

Date	Total S	EPT S	EPT N	BI(BIEPT)	Bioclass	Flow
12 July 95	48	6	24	6.04(6.29)	Fair	Normal
17 Mar 86	51	13	60	6.60(5.26)	Fair	Low
15 Nov 83	37	6	10	7.44(6.00)	Poor	Low

Fish Tissue
Fish tissue samples were collected at Kings Mt. Reservoir in 1995. All metals results were below FDA and EPA criteria.

Lakes Assessment

Kings Mountain Reservoir
Kings Mountain Reservoir (also known as Moss Lake) is a water supply for the City of Kings Mountain. The impoundment, built in 1963, has a maximum depth of 79 feet (24 meters). Major inflows to the lake include Buffalo Creek and White Oak Creek. Figure 4.15 provides a general map of the lake. The drainage area is characterized by rolling hills and rural land use. Access to the lake is strictly controlled by a special set of regulations for the many recreational users of the lake which have been adopted to assure safety as well as to protect water quality.

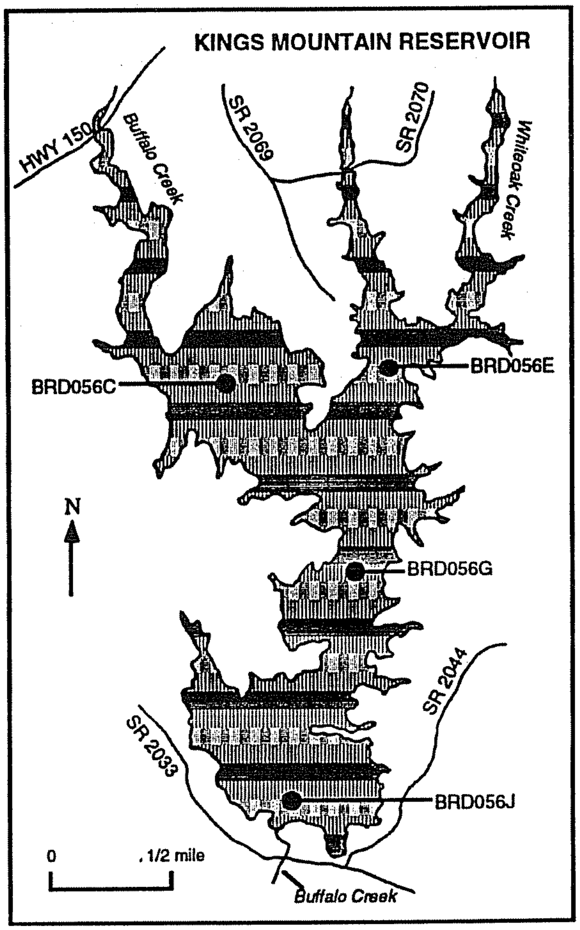


Figure 4.15 General map of Kings Mountain Reservoir (Moss Lake), Broad Subbasin 05

Kings Mountain Reservoir was sampled on August 3, 1995. The lake was stratified with hypoxic conditions at a depth of approximately six meters. The NCTSI score of -2.2 indicates borderline oligotrophic/mesotrophic conditions. Kings Mountain Reservoir supported all of its designated uses in 1995.

Kings Mountain Reservoir 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, Kings Mountain Reservoir was monitored by DWQ from 1991 through 1993, three times each year for a total of nine sampling events. Data collected in 1991 and 1992 indicated the presence of an algal bloom as well as elevated surface dissolved oxygen and pH. In 1993, the Mean Standing Crop for an AGPT test was 4.67 mg/l,. Because of these symptoms of nutrient enrichment, a recommendation was made to remove Kings Mountain Reservoir as a reference lake. In 1989, this reservoir was also sampled by DWQ as part of the ambient lakes monitoring program. Water quality values in that year were consistent with those observed in 1991 through 1993.

Historical data collected at Kings Mountain Reservoir from 1989 to 1995 for the four constituents of the NCTSI (total phosphorus, total organic nitrogen, Secchi depth and chlorophyll *a*) are summarized using box and whisker plots by Figure 4.16. The highest value for total phosphorus was 0.04 mg/l which was recorded for the sampling site near the dam (BRD056J) in July, 1993. Mean total phosphorus values were the same for all four lake sampling sites and median values were higher for the first two upstream sites (BRD056C and BRD056E), and lower at the two remaining sites (BRD056G and BRD056J). The lowest mean and median values for total organic nitrogen were observed at the Buffalo Creek arm sampling site (BRD056C) while the highest values were observed at the sampling site near the dam (BRD056J).

Figure 4.16 also shows that Secchi depth was lowest at the two upstream lake sampling sites and was greatest at the site near the dam. The lowest Secchi depth measurements from 1989 to 1995 were recorded at the Buffalo Creek arm sampling site (0.6 meter) and the Whiteoak Creek arm (0.7 meter). The greatest Secchi depth measurement (2.3 meters) was observed at the mid-lake and near dam sampling sites. Both mean and median chlorophyll *a* values for the individual lake sampling sites were not greater than 10 µg/l. The lowest value (2 µg/l) was recorded at each of the four sampling sites, and the highest value (23 µg/l) was observed at the mid-lake (June, 1991) and near dam sampling sites (June 1992).

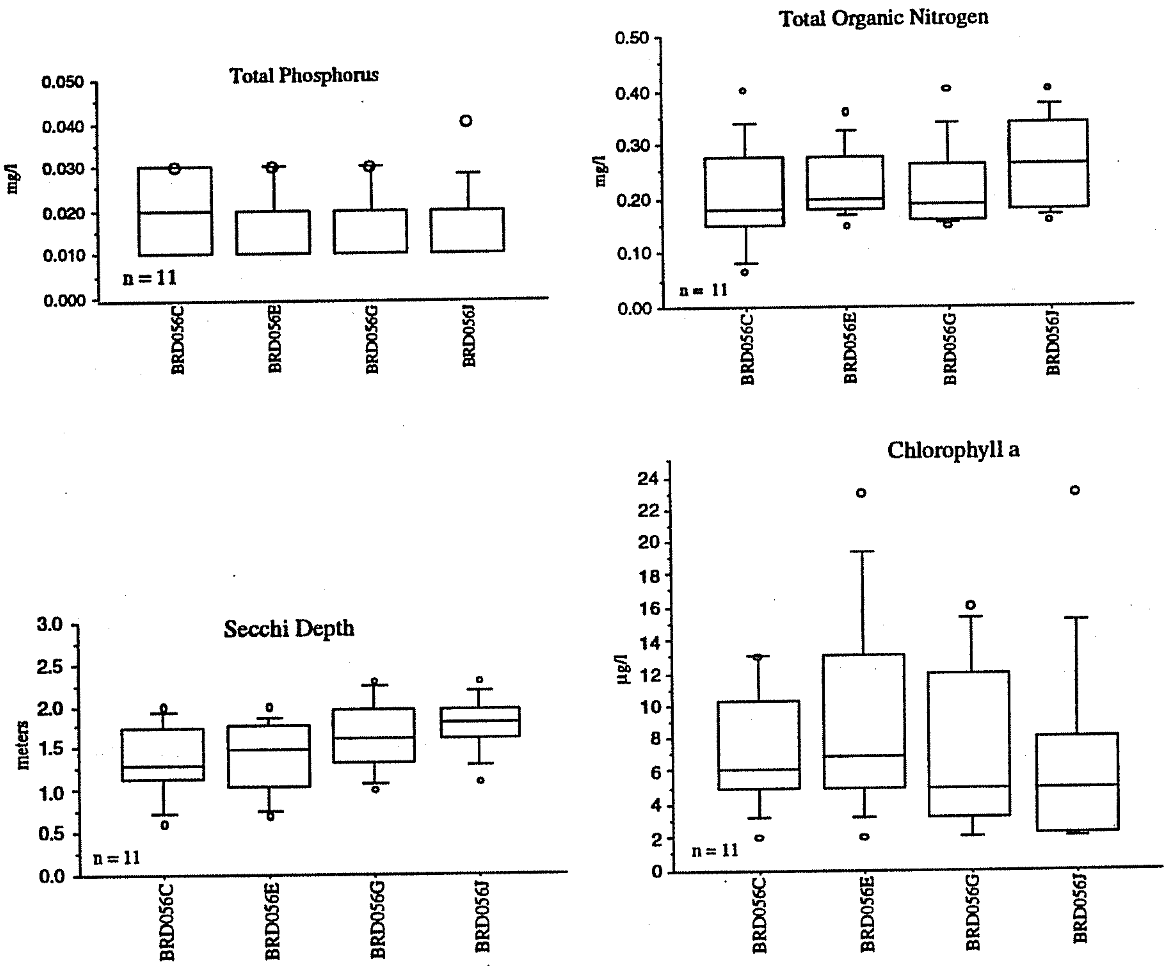


Figure 4.16 Kings Mountain Reservoir NCTSI Data Analysis from Lake Sampling Events, 1989 through 1995.

Phytoplankton populations in 1989 were dominated by blue-greens, cryptophytes, and diatoms. Lyngbya species A, a small filamentous blue-green alga, dominated density at all sampling stations. At the sampling site in the Buffalo Creek arm (BRD056C) Lyngbya species A also dominated biovolume estimates. This alga is commonly found in reservoirs and lakes throughout North Carolina and usually dominates biovolume in enriched systems.

Complaints during the early 1990's regarding the lack of fish by anglers led to an investigation which confirmed a low number of fish in the lake related to an absence of structures which would provide necessary habitats. A recommendation was made to provide artificial structures by submerging used Christmas trees into the lake to improve fishing (Chris Goudreau, Fishery Biologist, NRCD, pers. com.). The low number of fish in Kings Mountain Reservoir was confirmed during sampling efforts on September 21, 1995 to evaluate metals in fish collected from the lake. While few fish were collected, those that were analyzed showed no levels of metals above EPA or FDA human health criteria limits.

The water treatment facility at Kings Mountain Reservoir (Moss Reservoir) had received a few complaints from the public regarding problems with taste and odor (Junior Hinson, Operator, Moss Lake WTP, pers. com.). This was often the result of lake turnover rather than algal blooms. When turnover occurs, the lake reportedly becomes muddy and some problems are encountered at the water treatment facility with increased turbidity, iron and manganese in the processed water. Plant personnel had received no reports of recent fish kills in the lake.

There is heavy residential development along the lakeshore and some new development is occurring in the upstream area of the watershed (Junior Hinson, Operator, Moss Reservoir WTP, pers. com.). There have been some reports of problems with malfunctioning septic tanks of homes in the watershed draining to the lake (Marty Allen, Environmental Supervisor, Cleveland County Environmental Heath Department, pers. com.). The soil types in this area are not good for septic tanks and many of the home sites are small in size. This problem has been especially prevalent in the Woodbridge subdivision. Following rain events, the lake becomes muddy (Marty Allen, Environmental Supervisor, Cleveland County Environmental Heath Department, pers. com.). Increased development along the lakeshore and within the watershed has resulted in observations of both domestic trash such as paper and drink bottles, along with debris from construction sites in the lake (Jerry Earl, President, Northshores Condominium Association, pers. com.).

Lake Montonia

Lake Montonia is a small, man-made lake built in the 1920's. Two spring-fed ephemeral, unnamed tributaries flow into the lake. The tributaries are located to the east and southeast of the lake. Figure 4.17 provides a general map of the lake. The drainage area of the lake is primarily forested with 65 private homes located immediately around the lake. Approximately 25 of these homes have year round residents with the remaining homes used primarily during the summer months. Septic tanks are used for waste disposal. Most of the homes have yards that have been left in natural conditions. Portions of Crowder's Mountain State Park and Kings Pinnacle are located within the watershed. No permitted dischargers are located in the watershed.

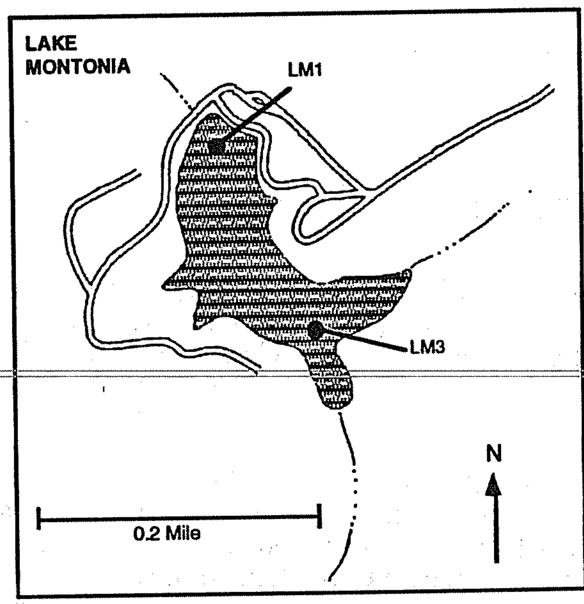


Figure 4.17 General Map of Lake Montonia, Broad subbasin 05

The Lake Montonia Board, a group of citizens concerned about the water quality of Lake Montonia, requested that the lake and its two unnamed tributaries be reclassified from their current classification of B to B HQW (High Quality Waters). The Board has requested this reclassification for the purpose of protecting the watershed of Lake Montonia from increased developmental pressures.

In response to this request, Lake Montonia was sampled six times in 1996, once in April as part of a presurvey visit, and five times from June through September. Surface dissolved oxygen was highest in April and surface water temperatures were lowest. In June, surface pH at the upstream sampling site (LM3) was at the lower limit of the state water quality standard for pH. Total phosphorus values were lowest in September and ammonia values were lowest in April.

Data collected at Lake Montonia during 1996 for the four constituents of the NCTSI (total phosphorus, total organic nitrogen, Secchi depth and chlorophyll *a*) are summarized using box and whisker plots by Figure 4.18. The highest value for total phosphorus observed at both sampling sites was 0.03 mg/l and the lowest was 0.01 mg/l and the highest total organic nitrogen value (0.30 mg/l) was observed at the sampling site near the dam (LM1).

Median Secchi depth was higher at the sampling site near the dam and lower at the upstream sampling site. The lowest and highest Secchi depths for Lake Montonia in 1996 (1.8 and 4.1 meters, respectively) were observed at the upstream lake sampling site (LM3). Chlorophyll *a* values were lowest at the upstream sampling site (LM3) and higher at the sampling site near the dam (LM1). The highest chlorophyll *a* value was observed at the dam sampling site (15 µg/l) and the lowest value was observed at the upstream lake sampling site (4 µg/l).

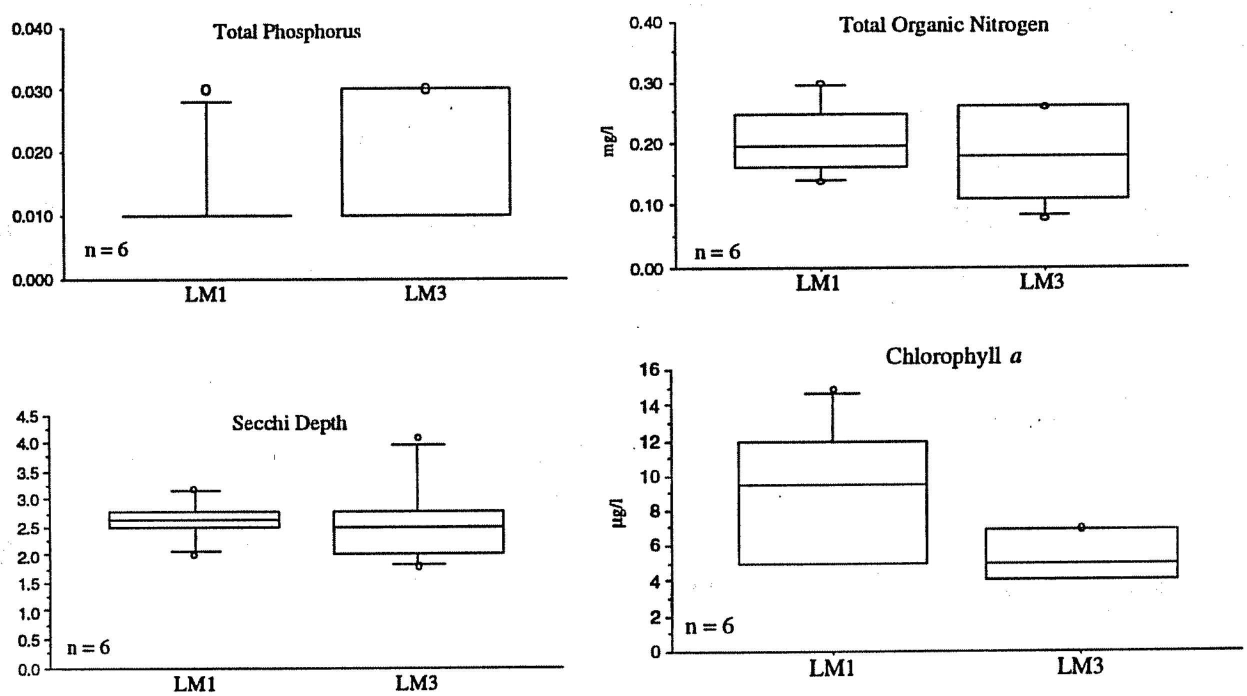


Figure 4.18 Lake Montonia NCTSI Data Analysis from Lake Sampling Events in 1996.

Over the six months that Lake Montonia was sampled in 1996, the lake has been consistently oligotrophic. Mean lake nutrient values, and chlorophyll *a* concentrations were relatively similar from month to month and Secchi depths from June through September were also similar. The mean Secchi depth in April was the greatest recorded for the lake in 1996, while the mean Secchi depth on June 13th was the lowest.

Parrot feather (Myriophyllum brasiliense) was observed in Lake Montonia in 1996, particularly in the upper end of the lake. Ornamental pink water lilies grow along three quarters of the lower lakeshore. The water lilies were observed later during the sampling season and did not present a problem for swimming and boating activities. Lake drawdowns, hand harvesting and applications of herbicides have been used by the lake residents to control aquatic macrophytes in the lake (John Still, pers. com.).

In the past five years, there have been no reports of fish kills or algal blooms on Lake Montonia (John Still, home owner, Lake Montonia, pers. com.). There have also been no complaints of illness from swimmers who use the lake (Marty Allen, Environmental Supervisor, Cleveland County Environmental Heath Department, pers. com.). Some clear-cutting had occurred within the watershed and future residential development is planned in these areas. The lake home owners association, in an effort to protect the water quality of Lake Montonia, has purchased a parcel of land directly on the lake near the upstream tributaries to be left undeveloped (John Still, home owner, Lake Montonia, pers. com.).

4.4.6 Subbasin 06 - NC Portion of the North Pacolet River

Description

Broad River subbasin 030806 contains the North Carolina section of the North Pacolet River which flows into the Broad River in South Carolina. Streams within this subbasin are in the mountain ecoregion. This is a very small subbasin containing approximately 10 river miles of the North Pacolet River and many small tributaries. The upper reaches of the North Pacolet River are currently classified as C Trout, although there have been few collection records of trout in this reach (Menhinick, 1991). The lower reaches are classified as C. Tryon is the only urban area in the subbasin. Figure 4.19 provides a map of this subbasin.

Overview of Water Quality

Very little water quality information has been collected in this subbasin. Benthic macroinvertebrates have been collected from three locations on the North Pacolet River. Good and Good/Fair bioclassifications have been assigned to these locations. The North Pacolet River near the North Carolina/South Carolina state line is a very sandy stream (80%) suggesting that sedimentation is a significant water quality problem. Fish community structure sampling of the lower North Pacolet River also had a Fair-Good NCIBI rating. This was attributed to prolonged sedimentation and erosion and nutrient enrichment.

The Tryon WWTP which discharges to Vaughn Creek is the largest discharger in the subbasin. Concerns about mercury in this effluent led to a survey of fish tissue at three sites in the North Pacolet River and Vaughn Creek in 1996. Metals levels of concern were not found at any of the sites.

There are several Polk County VWIN monitoring sites in the Pacolet watershed. Results show high levels of suspended solids and turbidity (Maas, et. al., 1997b). Also, consistently elevated levels of nutrients appear to indicate point source pollution from the Saluda wastewater treatment plant.

Benthic Macroinvertebrates

Two locations were sampled for benthic macroinvertebrates during the 1995 basinwide investigations (Table 4.30). These two locations were on previously unassessed reaches of the North Pacolet River above and below the town of Tryon.

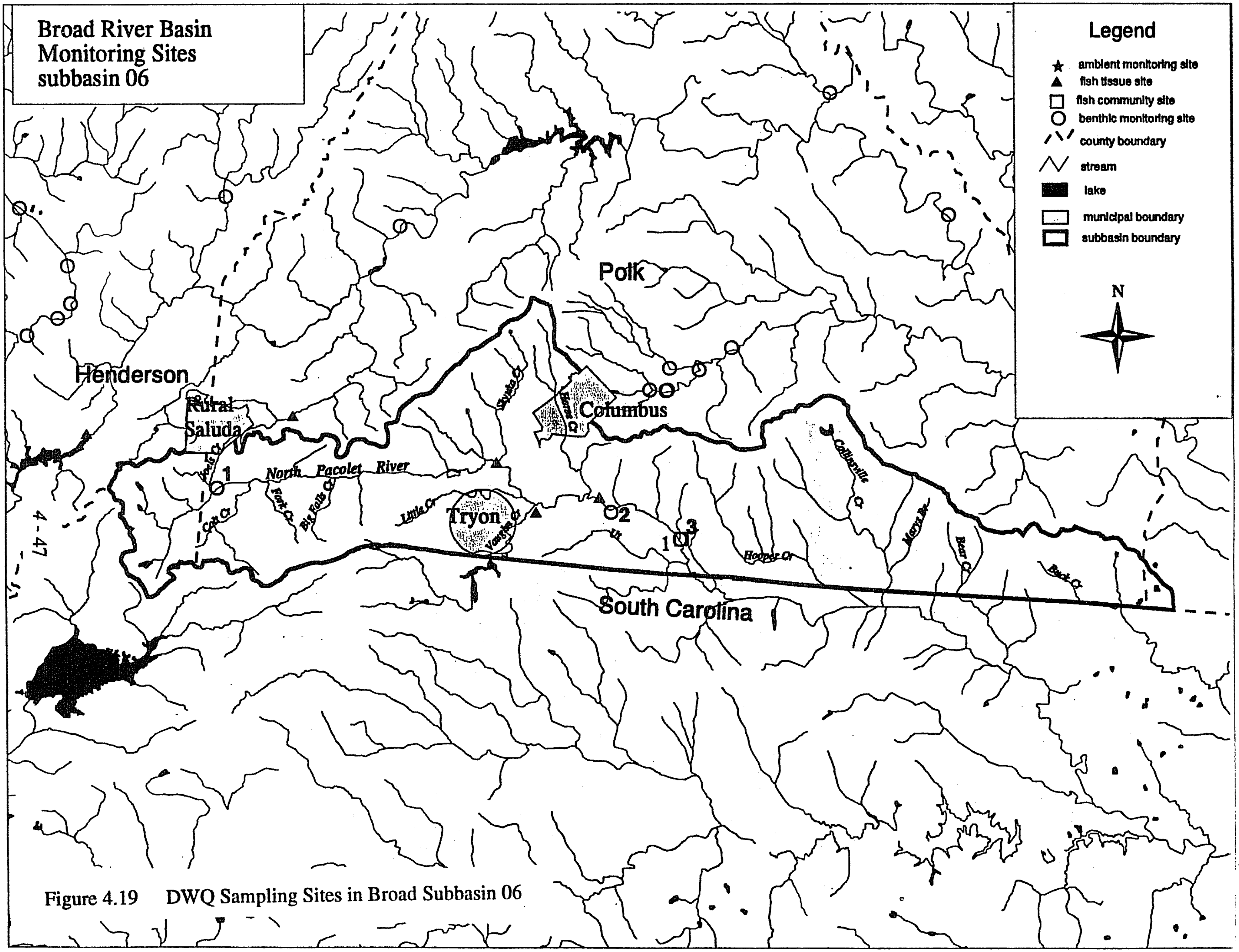


Figure 4.19 DWQ Sampling Sites in Broad Subbasin 06

Table 4.30 Basin Assessment Sites in Broad Subbasin 030806, 1995, Taxa Richness Values and Bioclassifications.

Site #	Creek	Date	County	Road	S/SEPT	Rating
B-1	N Pacolet R	950711	Polk	SR 1179	68/31	Good
B-3	N Pacolet R	950711	Polk	SR 1501	51/18	Good-Fair

Note: Map # refers to number on subbasin map.

The two sites selected on the North Pacolet River bracket the town of Tryon and the Tryon WWTP. A Good bioclassification was given to the upstream location. This location was given a NC habitat score of 59. This score, which is based on a 100 point scale, indicates that landuse and riparian zone perturbations have reduced habitat quality. This location had an urban setting, the bank vegetation was dominated by kudzu, the riparian zone was small, and breaks in the riparian zone were noted. The benthic macroinvertebrate fauna was dominated by facultative taxa including Pseudocloeon, Baetis intercalaris, Perlesta placida, and Cheumatopsyche. However, some intolerant taxa also were collected: Epeorus rubidus, Tallaperla, and Glossosoma.

The downstream site was located at SR 1501 near the North Carolina/South Carolina state line. The habitat score was very similar to the upstream location (58). The substrate was very sandy (80%) and the field team noted severe bank erosion, very infrequent sandy riffles, and a riparian zone with common breaks. The site was given a Good/Fair bioclassification. EPT abundance was significantly reduced compared to the upstream location (51 at SR 1501 compared to 134 at SR 1799). Additionally, the EPT taxa richness and biotic index values also suggest that water quality has declined between these two locations. The intolerant taxa recorded from the upstream location were not collected at the downstream location. The North Pacolet River immediately below the downstream monitoring location at SR 1501 has been channelized and the riparian zone completely removed.

Fish Community Structure and Fish Tissue
Only one site, the North Pacolet River, a tributary to the Pacolet River in South Carolina, was sampled for fish community structure in this subbasin during 1995 (see subbasin map for location). Based on the results, the lower part of the North Pacolet River at SR 1501 was rated only as Fair-Good. Similar to many of the fish communities within the Broad River basin which were sampled in 1994 and 1995, the fish community at this site had a skewed trophic structure (due to dominance by the omnivorous bluehead chub and a scarcity of piscivores), and a low diversity of sunfish and darters. These deviations from the expected fish community have resulted from prolonged sedimentation and erosion which has lead to the loss of pool and riffle habitats and nutrient enrichment-characteristic of many streams within the entire Broad River basin.

Fish tissue samples were collected at 3 sites within the Broad subbasin 06 in December 1996. Fish from all stations contained mercury levels well below FDA and EPA criteria.

4.5 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.5.1 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.

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.

4.5.2 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, lakes assessment data, 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 DWQ 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, DWQ 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.

4.5.3 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 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 tolerance data for all taxa in each collection. Use support ratings are assigned to each bioclassification 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 stream's 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. Use support ratings are assigned to each category of the NCIBI 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

<u>Phytoplankton and Algal Bloom Data</u>
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 are collected through the Ambient Monitoring System as discussed in section 4.3. The data are 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 earlier in Chapter 4, 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

<u>Whole Effluent Toxicity Data</u>
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.

<u>Daily Monitoring Reports</u>
Streams which received a discharge from a facility significantly out of compliance with permit limits may be rated ST (unless water quality data indicate 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 are less than five years old. Streams are rated on an evaluated basis under the following conditions:

> If the only existing data for a stream are more than five years old, they are 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).

4.5.4 Assigning Use Support Ratings

At the beginning of each assessment, all data are reviewed by subbasin with the monitoring staff, and data 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 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.

4.5.5 Revisions to Methodology Since 1995 - 95 305(b) Report

Methodology for determining use support has been revised. In the 1994-1995 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 are less than five years old. Streams are rated on an evaluated basis under the following conditions:

If the only existing data for a stream are more than five years old, they are 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 fully supporting but 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.

4.6 USE SUPPORT RATINGS FOR THE BROAD RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color-coded map in Figure 4.20. The following sections describe the assignment of ratings to both the fresh and salt waters in the basin.

4.6.1 Freshwater Streams and Rivers

Of the 1,472 miles of freshwater streams and rivers in the Broad basin, use support ratings were determined for 96% or 1,416 miles of water. The relative breakdown of percentages for the use support categories is as follows:

SUPPORTING 93%
- Fully supporting (67%)
- Fully supporting but threatened (26%)

IMPAIRED.. 3%
- Partially supporting (3%)
- Not supporting (0%)

NOT EVALUATED: 4%

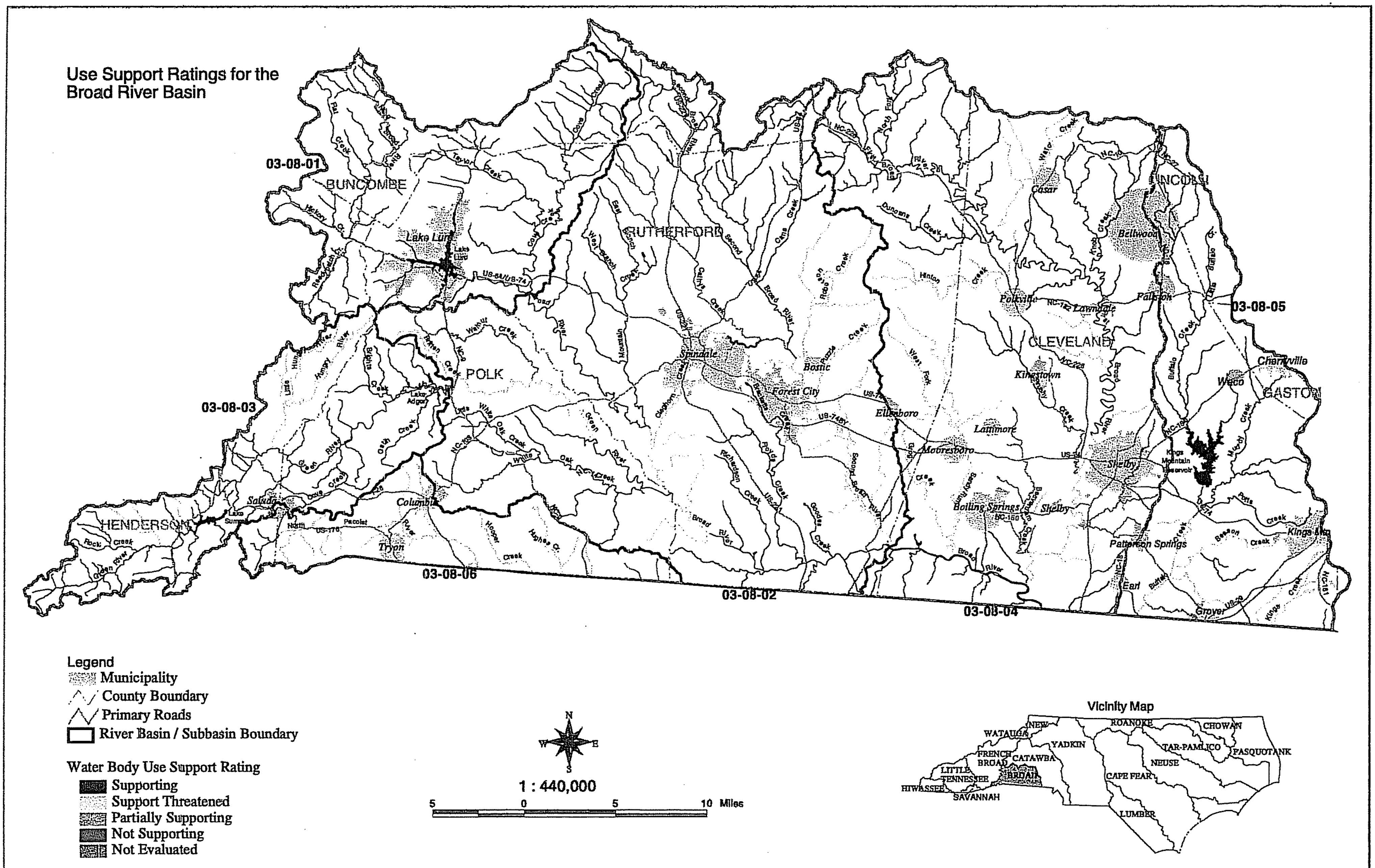


Figure 4.20 Use Support Map of the Broad River Basin

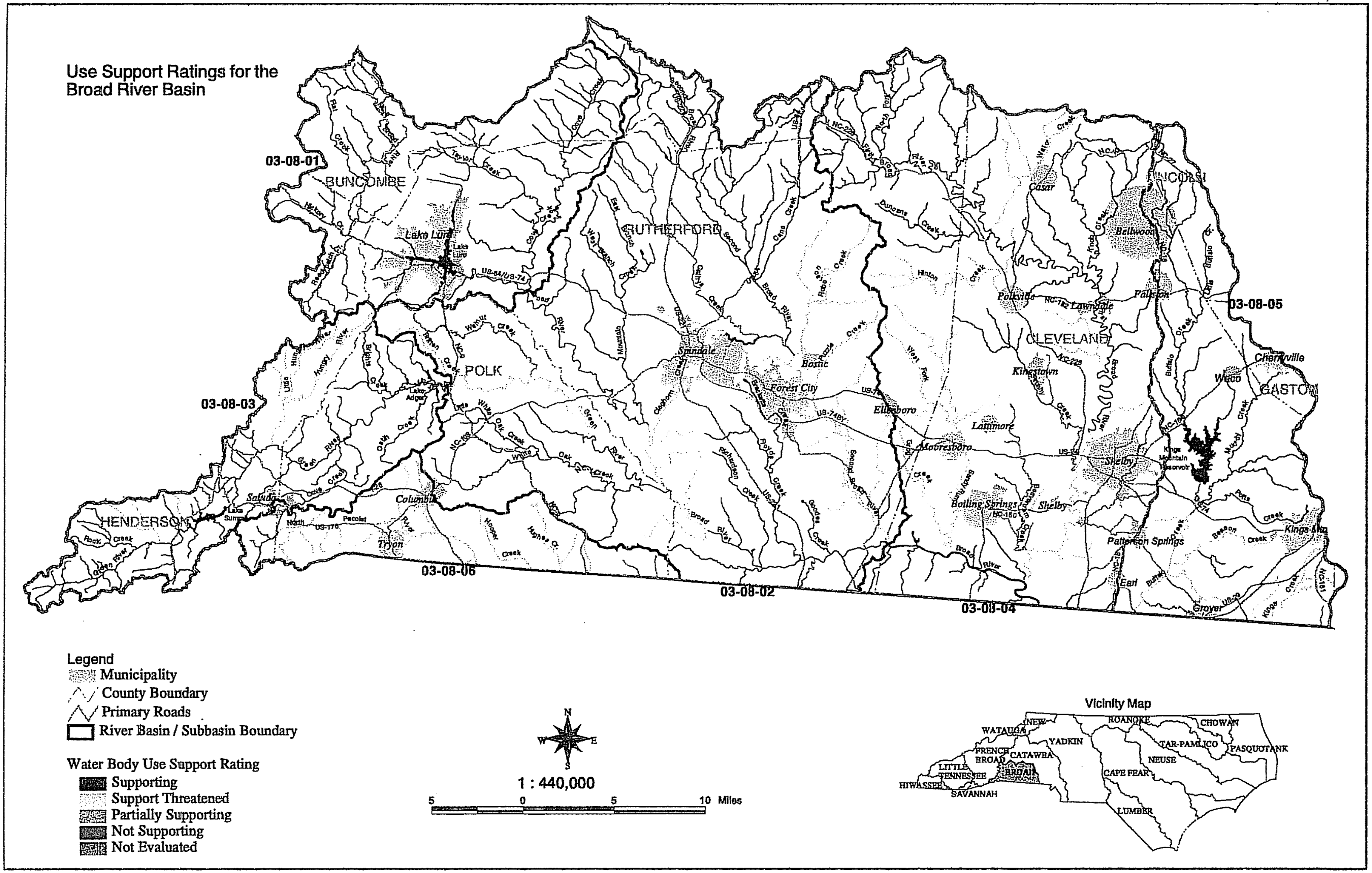


Figure 4.20 Use Support Map of the Broad River Basin

These use support values are different from the values in the 1992-1993 305(b) Report. The total waters supporting their uses appear to have increased, while those that are impaired appear to have decreased. While the water quality may have improved since the 1992-1993 305(b) report, the changes in values may also be due to revisions in the methodology for assigning use support (discussed earlier in section 4.5.5).

Table 4.32 (2 pages) provides information on streams and stream segments that were monitored as well as those evaluated based on data greater than five years old. Streams with data that were collected during the time period of 1992 through 1996 are considered to be monitored. This includes bioclassification and collection data for benthic macroinvertebrate samples, fish community structure samples, ambient monitoring station information, problem parameters such as sediment, potential sources of pollution (point or nonpoint), and the overall use support rating. All remaining streams in the basin were rated on an evaluated basis, or, if no data exists, were considered not evaluated. Table 4.31 presents the overall use support determinations by subbasin.

Table 4.31 Summary of Use Support Status for Freshwater Streams (miles) by Subbasin; 1992 - 1996

Subbasin	S	ST	PS	NS	NE	Total Miles
030801	·205.4	0	0	0	0	205.4
030802	273.3	133.9	12.1	2.5	30.1	451.9
030803	137.3	33.4	0	0	0	170.7
030804	259.7	124.8	29.1	0	21.4	435.0
030805	98.2	42.6	4.8	0	1.3	146.9
030806	6.3	53	0	0	2.9	62.2
TOTAL	980.2	387.7	46.0	2.5	55.7	1472.1
PERCENT	67	26	3	<1	4	

Impaired Freshwater Streams

In determining sources of pollution for impaired waters, observation from field staff, information from the 1988 nonpoint source workshops, and discharger daily monitoring reports were used. This does not provide a complete explanation for all potential sources of pollution in the basin. Recently, multi-agency teams have been assigned to address nonpoint source pollution in each of the river basins. As the different agencies work together within these teams, they will eventually provide more complete information on the nonpoint sources affecting the impaired waters. This section provides a summary of the impaired waters in the Broad basin, including DWQ's best information as to the cause.

In subbasin 030802, 14.6 stream miles are considered impaired. Walnut Creek is partially supporting due to sedimentation problems, possibly from agricultural activities. Field personnel noted that the banks of the creek are unstable and eroding. Catheys Creek is impaired (PS) due to both point and nonpoint sources of pollution. The Spindale wastewater treatment plant is affecting this creek in addition to nonpoint sources of pollution, (possibly agricultural activities).

In subbasin 030804, 29.1 stream miles were rated partially supporting. Beaverdam Creek is rated as partially supporting based on monitored data and the causes are likely agricultural runoff and the cumulative impact of several small wastewater treatment plants. Hickory Creek and the lower portion of Brushy Creek are both rated as partially supporting but it is based on data that are greater than five years old. Both are thought to be impacted by nonpoint source pollution from agriculture, and Hickory Creek, which runs through the City of Shelby, is also thought to be impacted by runoff from construction activities and urban areas.

Table 4.32 Use Support Status for Streams and Rivers in the Broad Basin

Name of Stream	Station Number	Station Location	Class	Index #	Subbasin	Miles	Chem Rating 91-95	Benthic Bioclassification 91	92	93	94	95	Fish Comm. 91-95	Problem Param	Overall Use Support Rating	Basis	Potential Sources (P,NP)
BROAD RIVER		Broad R SR 2802, Buncombe	C Tr	9-(1)	30801	18.6						Excellent		Sed	S	M	NP
BROAD RIVER (Lake Lure		Lakes - S	B Tr	9-(17)	30801	0									S	M-lakes	
BROAD RIVER			C	9-(22)	30801	15.9									S	M	
Cove Creek			C Tr	9-23-(1)	30801	4.3									S	M	
Cove Creek	02149000	Cove Creek SR 1381 & near L. Lure, U.S. Hwys. 64/74	C	9-23-(9)	30801	13.4	PS					Exceller	Good		S	M	
BROAD RIVER	02149635C	Broad R SR 1181, Rutherford	WS-IV	9-(23.5)	30802	14.5	S					Good			S	M	
BROAD RIVER			WS-IV CA	9-(24.5)	30802	0.5									S	M	NP
Mountain Creek		Mountain Cr SR 1149, Rutherford	WS-IV	9-25-(0.5)	30802	12.5						Good			S	M	
BROAD RIVER		Broad R SR 1106, Rutherford	C	9-(25.5)a	30802	8.4						Good-Fair			ST	M	NP
Cleghorn Creek		Cleghorn Cr SR 1149, Rutherford	C	9-26	30802	7.5						Good-Fair		Sed	ST	M	
Green River		Green River at SR 1331, Polk Co.	C	9-29-(33)b	30802	11.8				Good-Fair					ST	ED	NP
Green River		Green River at SR 1302, Polk Co.	C	9-29-(33)c	30802	10						Good			S	M	NP
Walnut Creek		Walnut Cr SR 1315, Polk	C	9-29-44	30802	8.3						Fair		Sed	PS	M	NP
Whiteoak Creek		Whiteoak Cr SR SR 1352, Polk	C	9-29-46	30802	16.3						Good			S	M	NP
Second Broad River	02150495	Second Broad River SR 1538, Rutherford	WS-IV	9-41-(10.5)	30802	11.2	S				Good	Good	Good	Sed	S	M	NP
Gap Branch		Gap Branch at SR 1512, Rutherford Co.	WS-V	9-41-11-1-(0.3)	30802	1.1									S	ED	
Second Broad River			WS-IV CA	9-41-12-(12.3)	30802	0.5								Sed	S	M	NP
Second Broad River			WS-V	9-41-12-(12.7)	30802	1								Sed	S	M	NP
Catheys Creek		Catheys CrSR 1549, Rutherford	C	9-41-13-(6)	30802	3.8					Good-	Fair		Sed	PS	M	NP,P
Hollands Creek		Hollands Creek at SR 1547, Rutherford Co.	WS-V	9-41-13-7-(1)	30802	4									ST	ED	
Hollands Creek		Hollands Creek at SR 1549, Rutherford Co.	C	9-41-13-7-(3)	30802	2.5									NS	ED	P
Roberson Creek		Roberson Cr. SR 1561, Rutherford	WS-V	9-41-14	30802	11.7						Good-Fair		Sed	ST	M	
Second Broad River		Second Broad River US 74 & US 221A Rutherford	WS-IV	9-41-(14.5)	30802	16.1						Good-Fair		Sed	ST	M	NP
Second Broad River			WS-IV CA	9-41-(24.3)	30802	0.5								Sed	ST	M	NP
Second Broad River	02151000	Second Broad River SR 1973, Rutherford	C	9-41-(24.7)	30802	2.1	S	Good-Fair				Good-Fair		Sed	ST	M	NP
Green River		Green River at 1106 nr 1106, SR 1104 SR 1103, Hend	C Tr	9-29-(1)	30803	11.2				Excellent/Good					S	M	
Rock Creek		Rock Creek at SR 1106, Henderson Co.	C Tr	9-29-12	30803	5				Excellent					S	M	
Joe Creek		Joe Creek at SR 1106, Henderson Co.	C Tr	9-29-14-(3)	30803	1.6									ST	ED	
Bobs Creek		Bobs Creek at SR 1103, Henderson Co.	C Tr	9-29-15	30803	3.6									S	ED	
Freeman Creek		Freeman Creek at SR 1115, Henderson Co.	C Tr	9-29-18	30803	2.2									ST	ED	
Hungry River		Hungry River SR 1799, Henderson	C Tr	9-29-30	30803	12.2						Good-Fair		Sed	ST	M	NP
Green River		Green River at SR 1151, Polk Co.	C	9-29-(33)a	30803	8.1						Good			S	M	NP
BROAD RIVER	02151500	Broad R, US 221, nr Cliffsid, amb at Hwy 150 Rutherfo	C	9-(25.5)b	30804	21.9	S					Good			S	M	NP
Sandy Run Creek		Sandy Run Cr, SR 1195, Cleveland Co	C	9-46	30804	17.9						Good-Fair		Sed	ST	M	NP
First Broad River		First Broad River SR 1726, Rutherford	WS-V Tr	9-50-(1)	30804	13.2									S	ED	
North Fork First Broad		North Fork First Broad River SR 1728, Rutherford	C Tr	9-50-4	30804	7.4						Exceller	Good-Exc		S	M	
First Broad River	02152100	First Broad River SR 1530 nr Casar, Cleveland	WS-IV Tr	9-50-(7.5)	30804	4.1	S			Good		Good			S	M	
First Broad River			WS-IV	9-50-(11)	30804	12.6									S	M	NP
Wards Creek			WS-IV	9-50-12	30804	9.7								Sed	ST	ED	NP
Duncans Creek		Duncans Cr SR 1749, Rutherford	WS-IV	9-50-13-(1.5)	30804	5.8						Good			S	M	
Hinton Creek		Hinton Cr NC 226, Cleveland	WS-IV	9-50-15-(1.5)	30804	10.1						Good-Fair		Sed	ST	M	NP
First Broad River			WS-IV CA	9-50-(18.5)	30804	0.8									S	M	

Table 4.32 Use Support Status for Streams and Rivers in the Broad Basin (continued)

	Station	Station					Chem	<----------Benthic---------->	Fish Comm.						Overall		Potential
							Rating	Bioclassification						Proble	Use Support		Sources
Name of Stream	Number	Location	Class	Index #	Subbasin	Miles	91-95	91	92	93	94	95	91-95	Param	Rating	Basis	(P,NP)
First Broad River		First Broad River SR 1809 Cleveland	WS-IV	9-50-(18.7)	30804	14.5						Good			S	M	
Knob Creek (Big Knob			C	9-50-19-(0.5)	30804	4.2								Sed	S	M	NP
Knob Creek (Big Knob		Knob Creek SR 1004, Cleveland	WS-IV	9-50-19-(4)	30804	9.3						Good		Sed	S	M	NP
First Broad River		First Broad River SR 1809 Cleveland	WS-IV CA	9-50-(26.5)	30804	0.8									ST	M	
First Broad River	02152596	First Broad River SR 1140 near Earl, Cleveland	C	9-50-(28)	30804	13.4	ST					Good-Fair		Fecal	ST	M	NP
Brushy Creek		Brushy Cr, ab SR 1323 and at SR 1323, Cleveland	C	9-50-29a	30804	6.6						Good			S	M	NP
Brushy Creek		Brushy Cr, be US 74 Cleveland	C	9-50-29b	30804	8.4									PS	ED	NP
Hickory Creek		Hickory Cr SR 1110 & be NC 18, Cleveland	C	9-50-30	30804	9.8									PS	ED	NP
Beaverdam Creek		Beaverdam Cr Nc 150, Cleveland	C	9-50-32	30804	10.9						Fair	Good		PS	M	NP,P
Sugar Branch	02152610	Sugar Branch near Boiling Springs, NC Hwy. 150	C	9-50-32-3	30804	2.7	ST							Fecal	ST	M	NP
Buffalo Creek		Buffalo Cr SR 1908, Cleveland	WS-III	9-53-(1)	30805	20.8						Good			S	M	NP
Buffalo Creek (Kings Mountain Res)		Lakes - S	WS-III CA	9-53-(2.9)	30805	6									S	M-Lakes	NP
Buffalo Creek		Buffalo Creek at NC 74, Cleveland Co.	C	9-53-(5)a	30805	1.6									PS	ED	NP
Buffalo Creek	02153456	Buffalo Creek at NC 198 Cleveland Co.	C	9-53-(5)b	30805	7.9	ST					Good			ST	M	NP
Muddy Fork		Muddy Fork SR 2012 Cleveland Co.	C	9-53-6	30805	13.8						Good			S	M	NP
Beason Creek		Beason Cr SR 2252, 2246, Cleveland	C	9-53-8	30805	10.2						Good-Fair		Sed	ST	M	NP
Long Branch		Long Br Battlewood Rd	C	9-53-8-1	30805	5.6									S	ED	NP
Lick Branch		Lick Cr SR 2229 & sss7, Cleveland	C	9-53-11	30805	3.2						Fair		Sed	PS	M	NP,P
Kings Creek		Kings Cr SR 2286, Cleveland	C	9-54	30805	5.3						Good-Fair		Sed	ST	M	NP
North Pacolet River		North Pacolet River SR 1179, Polk	C Tr	9-55-1-(1)a	30806	2.9						Good			S	M	NP
North Pacolet River		North Pacolet River SR 1517, Polk	C Tr	9-55-1-(1)b	30806	7.4									ST	ED	NP
Fork Creek			WS-II Tr	9-55-1-6-(1)	30806	0.7								Sed	ST	M	NP
Fork Creek			WS-II Tr CA	9-55-1-6-(2)	30806	0.6								Sed	ST	M	NP
Fork Creek			C Tr	9-55-1-6-(3)	30806	0.3								Sed	ST	M	NP
North Pacolet River		North Pacolet R SR 1501, Polk	C	9-55-1-(10)	30806	7.2						Good-Fa	Fair-Goo	Sed	ST	M	NP

KEY:
Class = DWQ Surface Water Classification
Sed = Sedimentation
S = Supporting
ST = Support - Threatened
PS = Partially Supporting
NS = Not Supporting
M = Monitored
ED = Evaluated based on data > 5 years old
P = Point Source
NP = Nonpoint Source

In subbasin 030805, 4.8 miles are consider partially supporting. Buffalo Creek is rated as impaired based on data that are greater than five years old. Impairment is thought to be caused by runoff from agriculture, construction and land disposal. Lick Branch is considered impaired based on monitored data. The wastewater discharge from New Minnette Textiles is apparantly causing impairment.

4.6.2 Lakes

There are five significant lakes in the Broad River basin that have been monitored by DWQ. These are: Lake Lure (subbasin 01); Lake Adger and Lake Summit (subbasin 03); and Kings Mountain Reservoir (Moss Lake) and Lake Montonia (subbasin 05). All lakes in the basin were sampled most recently in 1995, except for Lake Montonia which was sampled in 1996. Results of the most recent sampling indicate that all lakes are oligotrophic and are fully supporting their uses.

REFERENCES CITED: CHAPTER 4

Allen, M. March 13, 1997. Environmental Supervisor, Cleveland County Environmental Health Department. Personal communication.

Barker, R. G., B.C. Ragland, J. F. Rinehardt, and W.H. Eddins, 1991, Water Resources Data, North Carolina, Water Year 1991, U.S. Geological Survey Water-Data Report NC-91-1.

Carter, R. March 25, 1997. District Conservationist, NRCS District Office, Henderson County, NC. Personal communication.

Earl, J. March 14, 1997. President, Northshores Condominium Association. Personal communication.

Fish, F.F. 1968. A catalog of the inland fishing waters of North Carolina. Division of Inland Fisheries, North Carolina Wildlife Resources Commission. Raleigh, NC.

Goudreau, C.J. and R.J. Brown. 1988. Investigation of the Lake Lure Rainbow trout fishery, final report. Division of Boating and Inland Fisheries, North Carolina Wildlife Resources Commission. Raleigh, NC.

Goudreau, C. March 13, 1997. Fisheries Biologist, NC Wildlife Resources Commission. Personal communication.

Hinson, J. March 13, 1997. Operator, Moss Lake Water Treatment Plant, Kings Mountain, NC. Personal communication.

Maas, Richard P., Steven C. Patch and Marilyn J. Westphal. December 1996. Water Quality in the Mountains: Henderson County Volunteer Water Information Network, Year Four Report (Technical Report #96-033). Environmental Quality Institute, University of North Carolina at Asheville.

Maas, Richard P., Steven C. Patch, Marilyn J. Westphal, Caroline A. Koenings and Shannon Womble. May 1997a. Seven Year Spatial and Temporal Trends of Buncombe County Streams: The Volunteer Water Information Network (Technical Report #97-035). Environmental Quality Institute, University of North Carolina at Asheville.

Maas, Richard P., Steven C. Patch, Marilyn J. Westphal, Caroline A. Koenings and Shannon Womble. June 1997b. Polk County Stream Water Quality: Year Four (Technical Report #97-037). Environmental Quality Institute, University of North Carolina at Asheville.

Maas, Richard P., Steven C. Patch, Marilyn J. Westphal, Caroline A. Koenings and Jason M. Smith. August 1997c. Long Term Evaluation of Sediment and Pollutant Sources to Lake Lure: Year One Report (Technical Report #97-039). Environmental Quality Institute, University of North Carolina at Asheville.

Mattison, M. March 25, 1997. Planning Director, Henderson County. Personal communication.

Maxwell, M. March 25, 1997. Planning and Community Development Director, Polk County, NC. Personal communication.

Menhinick, Edward F. 1991. The Freshwater Fishes of North Carolina. North Carolina Wildlife Resources Commission. Raleigh, N.C.

Messer, J. B., Davis, J. R., Crowell, T. E. and W. C. Carnes. 1965. Survey and Classification of the Broad River and Tributaries. Final Report. Federal Aid in Fish Restoration. Job I-V, Project F-14-R. North Carolina Wildlife Resources Commission. Raleigh, NC.

Moore, A. March 14, 1997. District Conservationist, NRCS District Office, Rutherford County. Personal communication.

North Carolina Department of Environment and Natural Resources (NCDENR). 1997. Basinwide Assessment Report Document, Broad River Basin. NC Division of Water Quality, Water Quality Section, Environmental Sciences Branch, Raleigh.

NC Division of Environmental Management. 1989. Use attainability analysis of Lake Summit and its watershed (Green River) in Henderson County, NC. Raleigh, NC.

Still, J. March 18, 1997. Resident, Lake Montonia. Personal communication.

USFDA. 1980. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed, Shellfish Sanitation Branch, Washington, D.C.

United States Department of Agriculture, Natural Resources Conservation Service. 1994. National Resources Inventory, 1992. Raleigh Field Office.

Walker, S. March 25, 1997. District Technician, NRCS District Office, Polk County, NC. Personal communication.

Washburn, R. March 24, 1997 and October 30, 1997. Town of Lake Lure, Lake Lure Committee. Personal communication.