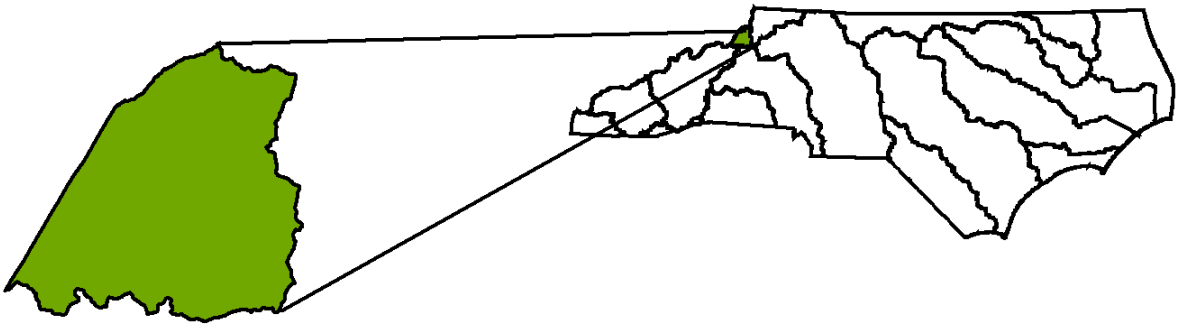
Watauga River Basinwide Water Quality Plan

January 2007



North Carolina Department of
Environment and Natural Resources

Division of Water Quality
Basinwide Planning Unit

Watauga River Basinwide Water Quality Plan

January 2007

Prepared by:
Michelle Raquet
michelle.raquet@ncmail.net
(919) 733-5083 ext. 367

NC Department of Environment and Natural Resources
Division of Water Quality
Planning Section – Basinwide Planning Unit
1617 Mail Service Center
Raleigh, NC 27699-1617

This document was approved and endorsed by the NC Environmental Management Commission on January 11, 2007 to be used as a guide by the NC Division of Water Quality in carrying out its Water Quality Program duties and responsibilities in the Watauga River basin. This plan is the third five-year update to the Watauga River Basinwide Water Quality Plan approved by the NC Environmental Management Commission in April 1997.

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Executive Summary

Basinwide water quality planning is a watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. Basinwide water quality plans are prepared by the North Carolina Division of Water Quality (DWQ) for each of the seventeen major river basins in the state. Each basinwide plan is revised at five-year intervals. While these plans are prepared by DWQ, their implementation and the protection of water quality entail the coordinated efforts of many agencies, local governments and stakeholders throughout the state.

The goals of basinwide planning are to:

- Identify water quality problems and restore full use to Impaired waters.
- Identify and protect high value resource waters.
- Protect unimpaired waters while allowing for reasonable economic growth.

DWQ accomplishes these goals through the following objectives:

- Collaborate with regional and local agencies to develop appropriate management strategies. This includes providing agencies information related to financial and funding opportunities.
- Assure equitable distribution of waste assimilative capacity.
- Evaluate the cumulative effects of pollution.
- Improve public awareness and involvement.
- Regulate point and nonpoint sources of pollution where other approaches are unsuccessful.

This document is the third five-year update of the *Watauga River Basinwide Water Quality Plan*. The first basin plan for the Watauga River basin was completed in 1997 and the second in 2002. The format of the plan was revised in response to comments received during the first and second planning cycles. DWQ replaced much of the general information in the first two plans with more detailed information specific to the Watauga River basin. For this plan, a greater emphasis was placed on identifying water quality concerns on the watershed level in order to facilitate protection and restoration efforts.

Basin Overview

The Watauga River basin is situated in the far northwest corner of the state between the French Broad River basin to the south and the New River basin to the north. The entire watershed drains northwest into Tennessee where it flows into the Watauga River Reservoir (Figure *iii*). The Watauga River itself is a major tributary to the Holston River, which eventually flows to the Tennessee River. The basin is the second smallest in the state, containing nearly 280 stream miles and encompassing only 205 square miles.

The North Carolina portion of the Watauga River basin is located entirely in the Blue Ridge Province of the Appalachian Mountains. Major tributaries to the Watauga River include Boone Fork, Cove Creek, Buckeye Creek, and the Elk River. Two counties (Avery and Watauga) are

entirely or partially contained within the basin. DWQ subdivides all river basins into subbasins. The Watauga River basin contains one subbasin (Figure *iv*).

Information presented in this basinwide water quality plan is based on data collected from September 1999 to August 2004. Specific watershed characteristics and water quality concerns are included in Chapter 1.

DWQ identifies the stressors to water quality as specifically as possible depending on the amount of information available in a particular watershed. Most often, the source of the stressor is based on the predominant land use in a watershed. In the Watauga River basin, habitat degradation, nutrient enrichment and temperature were all identified as possible stressors. Impervious surfaces, construction activities, pasture, agriculture, and stormwater outfalls were identified as potential sources. Water quality decline can often be attributed to a combination of many stressors that can lead to habitat and water quality degradation. In some way, every person, industry, landowner, and municipality in the basin impacts water quality. Therefore, every resident of the basin must play a role in management strategies designed to protect and restore the streams, lakes and rivers of the basin.

Use Support Summary

Use support assessments based on surface water classifications form the foundation of this basinwide plan. Surface waters are classified according to their best-intended use. Determining how well a waterbody supports its use (use support rating) is an important method of interpreting water quality data and assessing water quality.

Biological, chemical and physical monitoring data collected between September 1999 and August 2004 were used to assign use support ratings in the Watauga River basin. A total of 5.9 miles (6.6 percent) of monitored streams are Impaired in the Watauga River basin. The impairments are associated with habitat degradation and nonpoint source runoff related to agricultural and residential land use. Table *i* presents a summary of the Impaired waters and the associated stressors. Current status and recommendations for restoration of water quality for the Impaired water is discussed in Chapter 1. Current use support ratings for assessed streams are also presented on the subbasin map in Chapter 1 (Figure 3).

Use support methodology has changed significantly since the 2002 revision of the *Watauga River Basinwide Water Quality Plan*. In the previous plan, surface waters were rated fully supporting (FS), partially supporting (PS), not supporting (NS) and not rated (NR). FS was used to identify waters that were meeting their designated use. Impaired waters were rated PS and NS, depending on the degree of degradation. NR was used to identify waters with no data or those that had inconclusive data.

The *2002 Integrated Water Quality Monitoring and Assessment Report Guidance* issued by the Environmental Protection Agency (EPA) requests that states no longer subdivide the Impaired category. In agreement with this guidance, North Carolina no longer subdivides the Impaired category and rates waters as Supporting (S), Impaired (I), Not Rated (NR), or No Data (ND). These ratings refer to whether the classified uses of the water (such as water supply, aquatic life, primary/secondary recreation) are being met. Detailed information on use support methodology is provided in Appendix IX.

Table *i* Summary of Impaired Waters in the Watauga River Basin

Stream/ River Name	Assessment Unit Number (AU#)	Subbasin	Class	Miles	Category	Water Quality Stressor/Source
Beaverdam Creek	8-19	04-02-01	C Tr	5.9	Aquatic Life	Habitat degradation from Land Use Practices (i.e., agriculture, residential)

Use Support Category	Total Impaired Freshwater Miles	Percent of Impaired Monitored Streams
Aquatic Life	5.9 mi	6.6
Recreation	0.0	0.0
Fish Consumption	0.0	0.0
Water Supply	0.0	0.0

DWQ use support methods were developed to assess ecosystem health and human health risk through the development of use support ratings for five categories: aquatic life, fish consumption, recreation, shellfish harvesting, and water supply. These categories are tied to the uses associated with the primary classifications applied to North Carolina rivers, streams and lakes. A full description of the classifications is available in the DWQ document titled *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina* (www.ncwaterquality.org/csu/).

Water Quality Standards and Classifications

Throughout the Watauga River basin, water quality is generally good and even excellent. Chapter 2 discusses water quality standards and classifications and includes maps showing the designated Water Supply (WS) watersheds, High Quality Waters (HQW) and Outstanding Resource Waters (ORW).

In the Watauga River basin, several municipalities and smaller outlying communities are being pressured to expand. This often involves construction and/or development in areas of pristine waters. Many of the streams the Watauga River basin have the supplement classification of HWQ or ORW. Management strategies are associated with these supplemental classifications and are intended to prevent degradation of water quality below present levels from point and nonpoint sources of pollution. A brief summary of these strategies and the administrative code under which the strategies are found are included in Chapter 1.

Water Quality Stressors

Water quality stressors are identified when impacts have been noted to biological (benthic and fish) communities or water quality standards have been violated. Whenever possible, water quality stressors are identified for Impaired waters as well as waters with notable impacts (Figure *i* and *ii*).

Figure *i* Stressors Identified in the Watauga River Basin

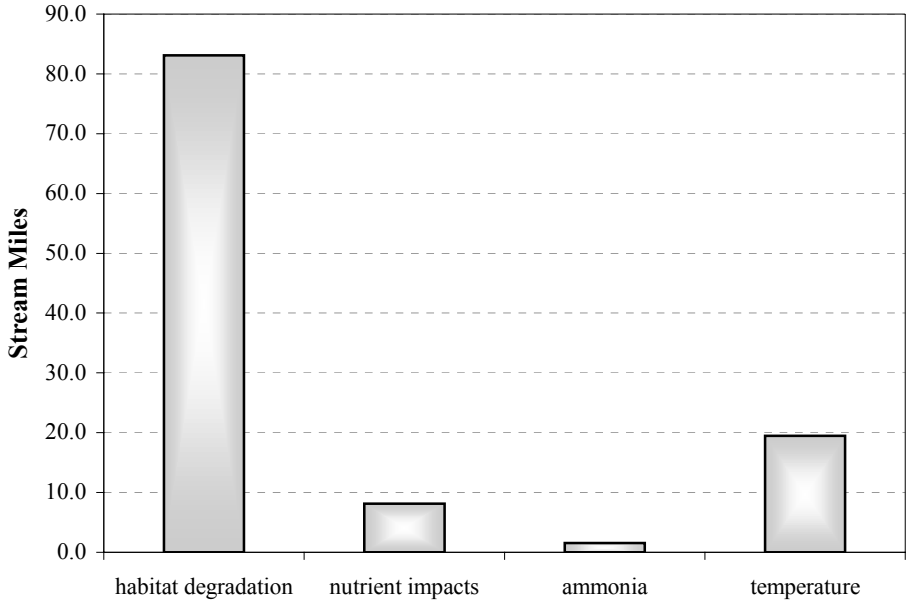
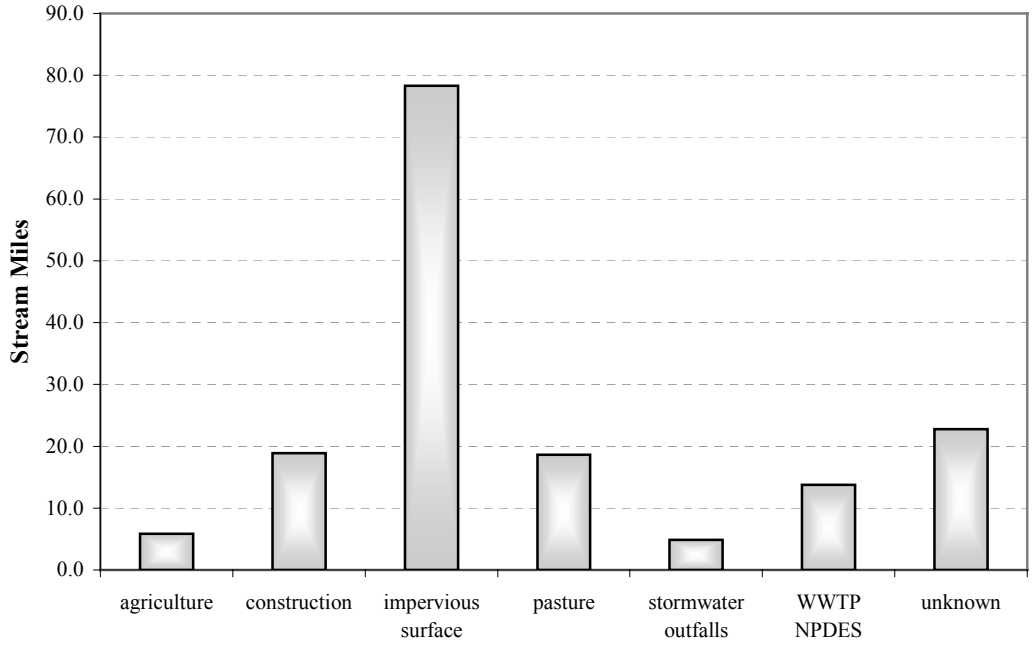


Figure *ii* Sources of Identified Stressors in the Watauga River Basin



One of the most noted water quality stressors is instream habitat degradation. Instream habitat degradation is identified where there is a notable reduction in habitat diversity or a negative change in habitat. Sedimentation, streambank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, loss of woody habitat, and streambed scour are all associated

with habitat degradation. These stressors are typically a result of increased flow of stormwater runoff due to land use changes or to sediment runoff from land-disturbing activities. Streams with noted habitat degradation are discussed in Chapter 1.

Other chemical and biological factors can also impact water quality. These include excess algal growth, low dissolved oxygen, nitrogen and phosphorus levels, pH, and fecal coliform bacteria. Chapter 3 provides definitions and recommendations for reducing impacts associated with physical, chemical and biological factors.

Population Growth and Changes in Land Use

The Watauga River basin encompasses all or portions of two counties and six municipalities. In 2000, the overall population in the basin (based on the percent of the county land area in the basin) was 23,675. The most populated areas are located in and around the towns of Boone and Banner Elk.

Watauga River Basin Statistics (North Carolina Portion)

Total Area: 205 sq. miles
Freshwater Stream Miles: 278.3 mi
No. of Counties: 2
No. of Municipalities: 6
No. of Subbasins: 1
Population (2000): 23,675*
Pop. Density (2000): 115 persons/sq. mile*

Water Quality Statistics

Aquatic Life
Percent Monitored Streams: 32.3%
Percent Supporting: 88.2%
Percent Impaired: 6.6%
Percent Not Rated: 5.2%

Recreation
Percent Monitored Streams: 7.0%
Percent Supporting: 100%

* Estimated based on % of county land area that is partially or entirely within the basin, not the entire county population.

Between 1990 and 2000, both counties in the basin experienced an increase in population. Avery County saw an increase of about 2,500 persons (13.4 percent) while Watauga County had an increase of nearly 6,000 persons (13.4 percent). County populations are expected to grow by another 7,000 people (10.1 percent) by 2020. This would result in a total population of over 66,000 people in the two counties in the Watauga River basin. Population growth trends and the accompanying impacts to water quality are discussed in Chapters 3 and 4.

Expanding populations are typically characterized by a loss of natural areas and an increase in impervious surface. Based on the current land cover information provided by the National Resources Inventory (USDA-NRCS, 2001), between 1982 and 1997 there was a 100 percent decrease (2,000 acres) in cultivated cropland in the Watauga River basin. Uncultivated cropland and pastureland also decreased by nearly 1,300 acres (33.3 percent and 0.4 percent, respectively). Urban and built-up areas increased by nearly 8,100 acres, or 218.9 percent. Much of this land cover change is accounted for in the areas around Beech Mountain and Sugar Mountain, where population increased by 29.7 percent and 71.2 percent, respectively, from 1990 to 2000. Land cover tables and statistics are included in Appendix III. Population statistics are included in Appendix I.

Growing populations not only require more water, but they also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams and groundwater. The impacts on rivers, lakes and streams can be significant and permanent if stormwater runoff is not

controlled. Just as water demand and use increases, some of the potential water supply is also lost (Orr and Stuart, 2000).

Impacts from Steep Slope Disturbance

Dramatic elevation changes and steep slopes define mountain topography. Building sites perched along mountainsides provide access to unparalleled vistas and are a major incentive for development. However, construction on steep slopes presents a variety of risks to the environment and human safety.

Poorly controlled erosion and sediment from steep slope disturbance negatively impact water quality, hydrology, aquatic habitat and threaten human safety and welfare. Soil types, geology, weather patterns, natural slope, surrounding uses, historic uses and other factors all contribute to unstable slopes. Improper grading practices disrupt natural stormwater runoff patterns and result in poor drainage, high runoff velocities and increased peak flows during storm events. There is an inherent element of instability in all slopes and those who choose to undertake grading and/or construction activities should be responsible for adequate site assessment, planning, designing and construction of reasonably safe and stable artificial slopes.

Local communities also have a role in reducing impacts from steep slope development. These impacts can also be addressed through the implementation of city and/or county land use and sediment and erosion control plans. Land use plans are a non-regulatory approach to protect water quality, natural resources and sensitive areas. In the planning process, a community gathers data and public input to guide future development by establishing long-range goals for the local community over a ten- to twenty-year period. They can also help control the rate of development, growth patterns and conserve open space throughout the community. Land use plans examine the relationship between land uses and other areas of interest including quality-of-life, transportation, recreation, infrastructure and natural resource protection (Jolley, 2003).

Impacts from Stormwater Runoff

Stormwater runoff is rainfall or snowmelt that runs off the ground or impervious surfaces (i.e., buildings, roads, parking lots, etc.) instead of absorbing into the soil. In some cases, stormwater runoff drains directly into streams, rivers, lakes and oceans. In other cases, particularly urbanized areas, stormwater drains into streets and manmade drainage systems consisting of inlets and underground pipes, commonly referred to as a storm sewer system. Stormwater runoff is a primary carrier of nonpoint source pollution in both urbanized and rural areas. The impact of stormwater runoff is particularly severe in developing areas where recently graded lands are highly susceptible to erosion. Water quality impacts are also evident in urbanized areas where stormwater runoff is increased by impervious surfaces and is rapidly channeled through ditches or curb and gutter systems into nearby streams. For more information on stormwater as it relates to growth and development, refer to Chapter 4.

There are several different stormwater programs administered by DWQ. Two of these programs affect communities in the Watauga River basin. The goal of DWQ stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state via stormwater runoff. These programs accomplish this goal by controlling the source(s) of pollution. Chapter 5 contains more information federal and state stormwater programs.

Septic Systems and Straight Pipes
In the Watauga River basin, wastewater from many households is not treated at a wastewater treatment plant (WWTP). Instead, it is treated on-site through the use of permitted septic systems. However, wastewater from some homes illegally discharges directly into streams through what is known as a "straight pipe". In some cases, wastewater can also enter streams through failing septic systems. In highly susceptible areas, wastewater from failing septic systems or straight pipes can contaminate a drinking water supply or recreational water with nutrients, disease pathogens and endocrine disturbing chemicals.

In order to protect human health and maintain water quality, the NC Wastewater Discharge Elimination (WaDE) Program is actively helping to identify and remove straight pipes (and failing septic systems) in western North Carolina. The program uses door-to-door surveys to locate straight pipes and failing septic systems and offers deferred loans or grants to assist homeowners in eliminating straight pipes and repairing septic systems. More information on WaDE and the DWQ wastewater programs can be found in Chapter 5.

Agriculture and Water Quality
Excess nutrient loading, pesticide and/or herbicide contamination, bacterial contamination, and sedimentation are often associated with agricultural activities, and all can impact water quality. Chapter 6 provides information related to agricultural activities in the Watauga River basin and also identifies funding opportunities for best management practices (BMP). During this five-year assessment period, the North Carolina Agricultural Cost Share Program (NCACSP) funded BMPs totaling more than $87,000. BMPs include planned systems for reducing soil erosion and nutrient runoff and planned systems for protecting streams and streambanks.

In several streams throughout the basin, DWQ noted evidence of and observed several areas where livestock had direct, easy access to the streams. Fencing, or livestock exclusion, prevents livestock from entering a stream and provides an area of vegetative cover, which can secure streambanks, lower stream velocities, trap suspended sediments, and decrease downgradient erosion. Livestock exclusion is also effective in reducing nutrient, bacteria and sediment loads in a stream (Line and Jennings, 2002). Of the $87,000 of NCACSP funds spent on BMPs in the Watauga River basin, over 85 percent ($74,300) was spent on 14,000 feet of fence and 38 alternate water sources. For more information on NCACSP, see Chapter 6.

Besides pasturelands and row crops, Christmas tree production also has a significant presence in the Watauga River basin. Most of the tree plantations in western North Carolina are above 3,000 feet in elevation and are often located on steep, highly erodible slopes (NCSU Cooperative Extension Service, April 2005). Between 2003 and 2006, 20.5 acres of Christmas Tree Conservation Cover were installed in the Watauga River basin. NCACSP funding totaled $2,330. More information related to Christmas tree production can be found in Chapter 1.

Forestry and Water Quality
Based on land cover information provided by the North Carolina Center for Geographic Information and Analysis (CGIA) and the USDA-NRCS, 53 percent (76,800 acres) of land in the Watauga River basin consists of forestland. Ninety-two percent of the forestland is privately owned with the remaining eight percent owned by the State Parks System (Brown, 2004). No stressors associated with land clearing or forestry activities were noted or identified in the

Watauga River basin. Where forest harvesting is identified as a potential source of water quality impact, DWQ will notify the NC Division of Forest Resources (DFR) to investigate potential violations. Chapter 7 presents more information related to the impacts of forestry on water quality.

Water Resources
Chapter 8 presents information related to minimum streamflow requirements, interbasin transfers, water quality drought conditions and source water protection. The chapter also includes the federal cataloging units, commonly known as hydrologic units, as they relate to the state subbasin boundaries.

Natural Resources
Several rare and endemic aquatic species can be found in the Watauga River basin. Many of these species, and ecological communities in which they exist, are found nowhere else in the State. Chapter 9 presents information related to the ecological significance of the basin and identifies endangered and threatened species, significant natural heritage areas and aquatic habitats, and public conservation lands that are locally significant.

Local Involvement
Local organizations and agencies are able to combine professional expertise and local knowledge not present at the state and federal level. This allows groups to holistically understand the challenges and opportunities of local water quality concerns. Involving a wide array of people in water quality projects also brings together a wide range of knowledge and interests and encourages others to become involved and invested in these projects. Working in cooperation across jurisdictional boundaries and agency lines opens the door to additional funding opportunities and eases the difficulty of generating matching or leveraged funds. This could potentially allow local entities to do more work and be involved in more activities because funding sources are diversified. The most important aspect of these local endeavors is that the more localized the project, the better the chances for success.

The collaboration of local efforts is key to water quality improvements, and DWQ applauds the foresight and proactive response by locally based organizations and agencies to protect water quality. There are many excellent examples of local agencies and groups using these cooperative strategies throughout the state. Several local watershed projects are highlighted throughout Chapter 1. Chapter 10 also examines the local, regional and federal initiatives underway in the Watauga River basin.

Recommended Management Strategies for Restoring Impaired Waters
Beaverdam Creek is newly Impaired based on the most recent biological data and will likely be placed on the 2008 303(d) list. Land use primarily consists of open pastures; however, row crops and residential properties are also scattered throughout the watershed. DWQ will continue to monitor water quality in Beaverdam Creek and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff.

The task of quantifying nonpoint source runoff and developing management strategies for any Impaired water is very resource intensive. This task is overwhelming, given the current limited resources of DWQ, other state and federal agencies and local governments. DWQ will collaborate with other local and state agencies and watershed groups that deal with nonpoint source pollution issues to develop management strategies for the Impaired and notable waters throughout the next *Watauga River Basinwide Water Quality Plan* assessment period.

Waters on the North Carolina 303(d) List

For the next several years, addressing water quality impairment in waters that are on the state's 303(d) list will be a DWQ priority. Section 303(d) of the federal Clean Water Act requires states to develop a list of waters not meeting water quality standards or which have Impaired uses. States are also required to develop Total Maximum Daily Loads (TMDLs) or management strategies for 303(d) listed waters to address impairment. EPA issued guidance in August 1997 that called for states to develop schedules for developing TMDLs for all waters on the 303(d) list within 8-13 years. Information regarding 303(d) listing and reporting methodology can be found in Appendix VII.

Challenges Related to Achieving Water Quality Improvements

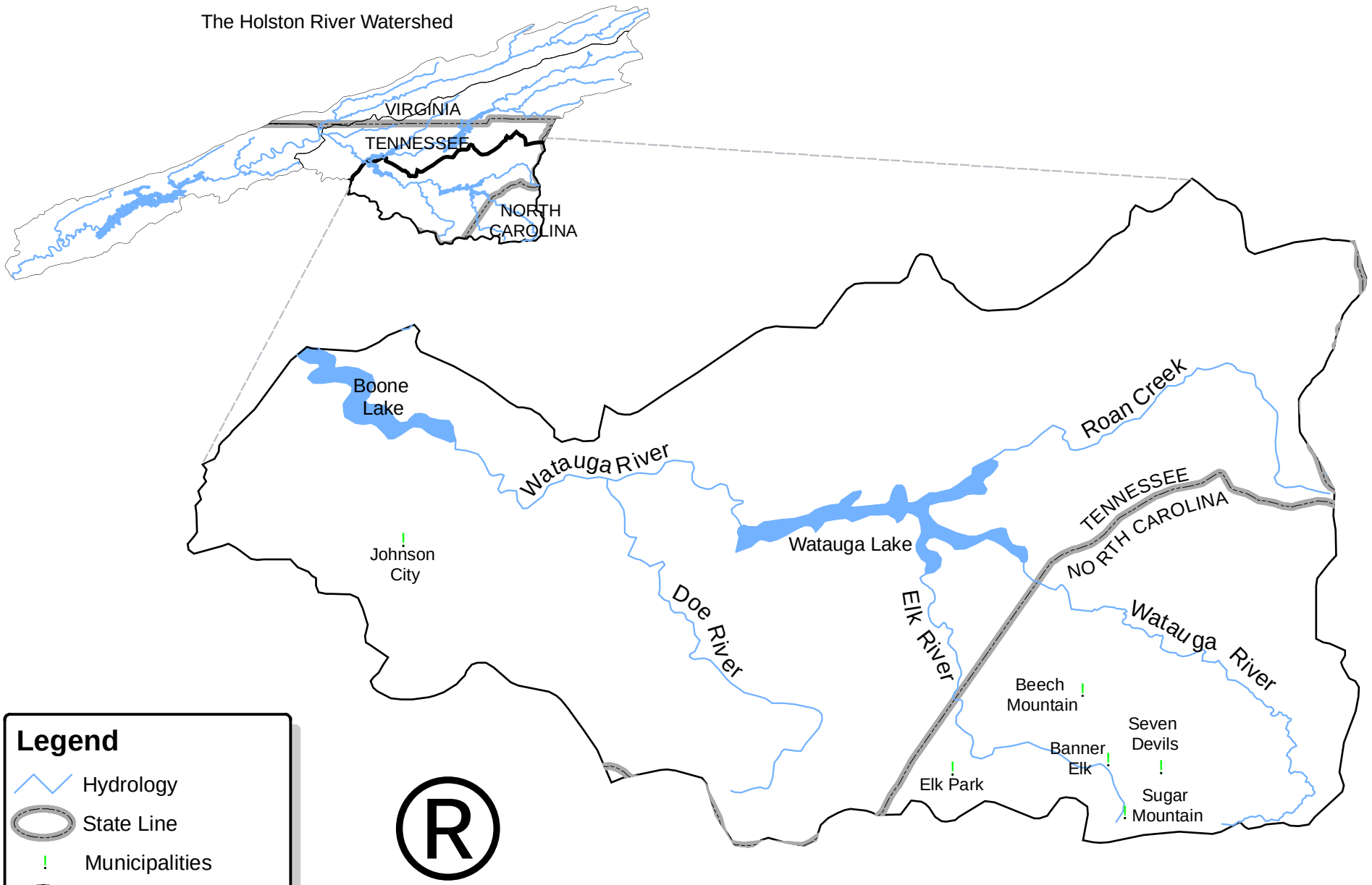
To achieve the goal of restoring Impaired waters in the Watauga River basin, DWQ will need to work closely with other state agencies and stakeholders to identify and control pollutants. The costs of restoration can be high, but several programs exist to provide funding for restoration efforts. These programs include the Clean Water Management Trust Fund (CWMTF), the NC Agricultural Cost Share Program (NCACSP), and the Ecosystem Enhancement Program (NCEEP).

Across the state, balancing economic growth and water quality protection will be a tremendous challenge. Point source impacts on surface waters can be measured and addressed through the basinwide planning process, but these often do not represent the greatest threat to water quality. The cumulative effects of nonpoint source pollution are the primary threat to water quality and habitat degradation in many areas across the state and throughout the Watauga River basin. Nonpoint source pollution can be identified through the basinwide plan, but actions to address these impacts must be taken at the local level. Such actions should include:

- Develop and enforce local erosion control ordinances.
- Require stormwater best management practices for existing and new development.
- Develop and enforce buffer ordinances.
- Conduct comprehensive land use planning that assesses and reduces the impact of development on natural resources.

This basinwide plan presents many water quality initiatives and accomplishments that are underway throughout the basin. These actions provide a foundation on which future initiatives can be built.

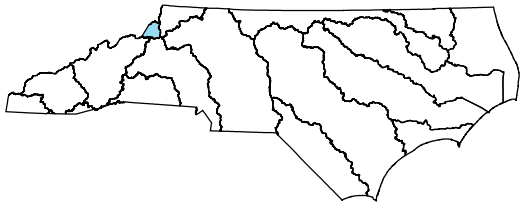
Figure 1 General Map of the Entire Watauga River Basin



* Data provided by National Atlas.

Planning Section
Basinwide Planning Unit
December 4, 2006

Figure 2 General Map of the Watauga River Basin in North Carolina



Division of Water Quality
Basinwide Planning Unit
June 28, 2006

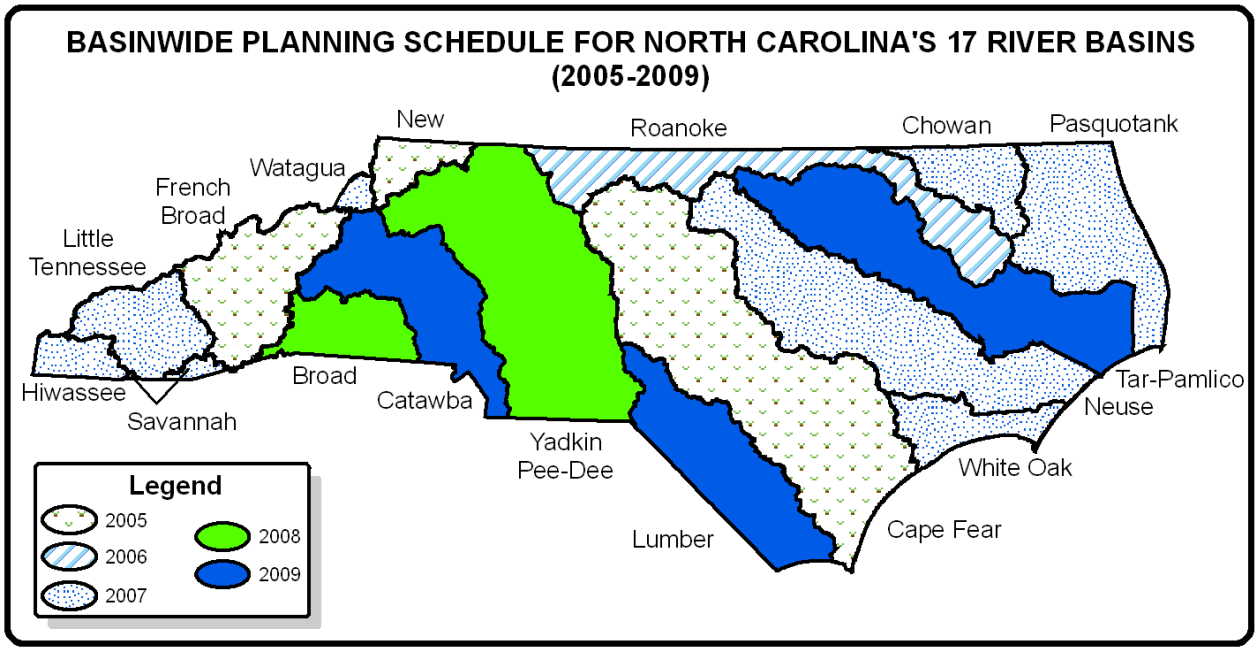
Introduction

What is Basinwide Water Quality Planning?

Basinwide water quality planning is a watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. Basinwide water quality plans are prepared by the NC Division of Water Quality (DWQ) for each of the 17 major river basins in the state (Figure 1 and Table 1). Preparation of a basinwide water quality plan is a five-year process, which is broken down into three phases (Table 2).

While these plans are prepared by DWQ, their implementation and the protection of water quality entail the coordinated efforts of many agencies, local governments and stakeholder groups throughout the state. The first cycle of plans was completed in 1998. Each plan is updated at five-year intervals.

Figure 1 Basinwide Planning Schedule (2005 to 2009)



Goals of Basinwide Water Quality Planning

The goals of basinwide planning are to:

- Identify water quality problems and restore full use to Impaired waters.
- Identify and protect high value resource waters.
- Protect unimpaired waters yet allow for reasonable economic growth.

DWQ accomplishes these goals through the following objectives:

- Collaborate with other agencies to develop appropriate management strategies. This includes providing agencies information related to financial and funding opportunities.
- Assure equitable distribution of waste assimilative capacity.
- Evaluate cumulative effects of pollution.
- Improve public awareness and involvement.
- Regulate point and nonpoint sources of pollution where other approaches are not successful.

Benefits of Basinwide Water Quality Planning

Basinwide planning and management benefits water quality by:

- Focusing resources on one river basin at a time.
- Using sound ecological planning and fostering comprehensive NPDES permitting by working on a watershed scale.
- Ensuring better consistency and equitability by clearly defining the program's long-term goals and approaches regarding permits and water quality improvement strategies.
- Fostering public participation to increase involvement and awareness about water quality.
- Integrating and coordinating programs and agencies to improve implementation of point and nonpoint source pollution reduction strategies.

How You Can Get Involved

To assure that basinwide plans are accurately written and effectively implemented, it is important for citizens and local stakeholders to participate in all phases of the planning process. You may contact the basinwide planner responsible for your basin anytime during the plan's development. Upon request, the basin planner can also present water quality information and basin concerns to local stakeholder groups.

To make the plan more inclusive, DWQ is coordinating with the local Soil and Water Conservation Districts (SWCD), council of governments, NC Cooperative Extension Service, the county Natural Resources Conservation Service (NRCS), and stakeholder groups to develop language and identify water quality concerns throughout the basin. Citizens and local communities can also be involved during the planning process by contacting their county extension service or local SWCD.

During the public comment period, the draft plan is available online and by request for a period of at least 30 days. DWQ welcomes written comments and questions during this phase of the planning process and will incorporate comments and suggestions when appropriate.

Division of Water Quality Functions and Locations

For more information on the basinwide planning process, DWQ activities, or contacts, visit www.ncwaterquality.org/basinwide/ or call (919) 733-5083 and ask for the basin planner responsible for your basin of interest. You can also contact the appropriate Regional Office (Figure 2) for additional information. For general questions about the Department of Environment and Natural Resources, contact the Customer Service Center at 1-877-623-6748.

Table 1 Basinwide Planning Schedule (2004 to 2011)

Basin	DWQ Biological Data Collection	Draft Out For Public Review	Final Plan Receives EMC Approval	Begin NPDES Permit Issuance
Chowan	Summer 2005	7/2007	9/2007	11/2007
Pasquotank	Summer 2005	7/2007	9/2007	12/2007
Neuse	Summer 2005	352007	7/2007	1/2008
Broad	Summer 2005	10/2007	1/2008	7/2008
Yadkin-Pee Dee	Summer 2006	3/2008	5/2008	9/2008
Lumber	Summer 2006	3/2008	5/2008	7/2009
Tar-Pamlico	Summer 2007	3/2009	5/2009	9/2009
Catawba	Summer 2007	3/2009	5/2009	12/2009
French Broad	Summer 2007	3/2009	5/2009	7/2010
New	Summer 2008	6/2010	5/2010	1/2011
Cape Fear	Summer 2008	6/2010	9/2010	2/2011
Roanoke	Summer 2004	7/2006	9/2006	1/2007
White Oak	Summer 2004	3/2007	5/2007	6/2007
Savannah	Summer 2004	1/2007	3/2007	8/2007
Watauga	Summer 2004	11/2006	1/2007	9/2007
Hiwassee	Summer 2004	1/2007	3/2007	8/2007
Little Tennessee	Summer 2004	1/2007	3/2007	10/2007

Note: A basinwide plan was completed for all 17 basins during the second cycle (1998 to 2003).

Table 2 Five-Year Planning Process for Development of an Individual Basinwide Plan

Years 1 – 2 **Water Quality Data Collection and Identification of Goals and Issues**	• Identify sampling needs • Conduct biological monitoring activities • Conduct special studies and other water quality sampling activities • Coordinate with local stakeholders and other agencies to continue to implement goals within current basinwide plan
Years 2 – 3 **Data Analysis and Collect Information from State and Local Agencies**	• Gather and analyze data from sampling activities • Develop use support ratings • Conduct special studies and other water quality sampling activities • Work with state and local agencies to establish goals and objectives • Identify and prioritize issues for the next basin cycle • Develop preliminary pollution control strategies • Coordinate with local stakeholders and other state/local agencies
Years 3 – 5 **Preparation of Draft Basinwide Plan, Public Review, Approval of Plan, Issue NPDES Permits, and Begin Implementation of Plan**	• Develop draft basinwide plan based on water quality data, use support ratings, and recommended pollution control strategies • Circulate draft basinwide plan for review and present draft plan for public review • Revise plan (when appropriate) to reflect public comments • Submit plan to Environmental Management Commission for approval • Issue NPDES permits • Coordinate with other agencies and local interest groups to prioritize implementation actions • Conduct special studies and other water quality sampling activities

Some Other Reference Materials

There are several reference documents and websites that provide additional information about basinwide planning and the basin's water quality. These include:

- *A Citizen's Guide to Water Quality Management in North Carolina* (August 2000) This document includes general information about water quality issues and programs to address these issues. It is intended to be an informational document on water quality. Visit the website at http://h2o.enr.state.nc.us/basinwide/WQ%20citizen%20guide%20on%20the%20web.pdf to download this document.
- *Basinwide Assessment Report: Watauga River Basin* (April 2005). This technical report presents physical, chemical, and biological data collected in the Watauga River basin. This report can be found on the DWQ Environmental Sciences Section (ESS) website at http://www.esb.enr.state.nc.us/Basinwide/WAT2005.pdf.
- *Watauga River Basinwide Water Quality Management Plan* (April 1997) and *Watauga River Basinwide Water Quality Plan* (February 2002). These first basinwide plans for the Watauga River basin present water quality data, information, and recommended management strategies for the first two five-year cycles.

How to Read the Basinwide Plan

CHAPTER 1: SUBBASIN AND WATERSHED INFORMATION

- Summarizes information and data by subbasin, including:
  - Recommendations from the previous basin plan.
  - Achievements, current priority issues and concerns.
  - Impaired waters and water with notable impacts.
  - Goals and recommendations for the next five years by subbasin.

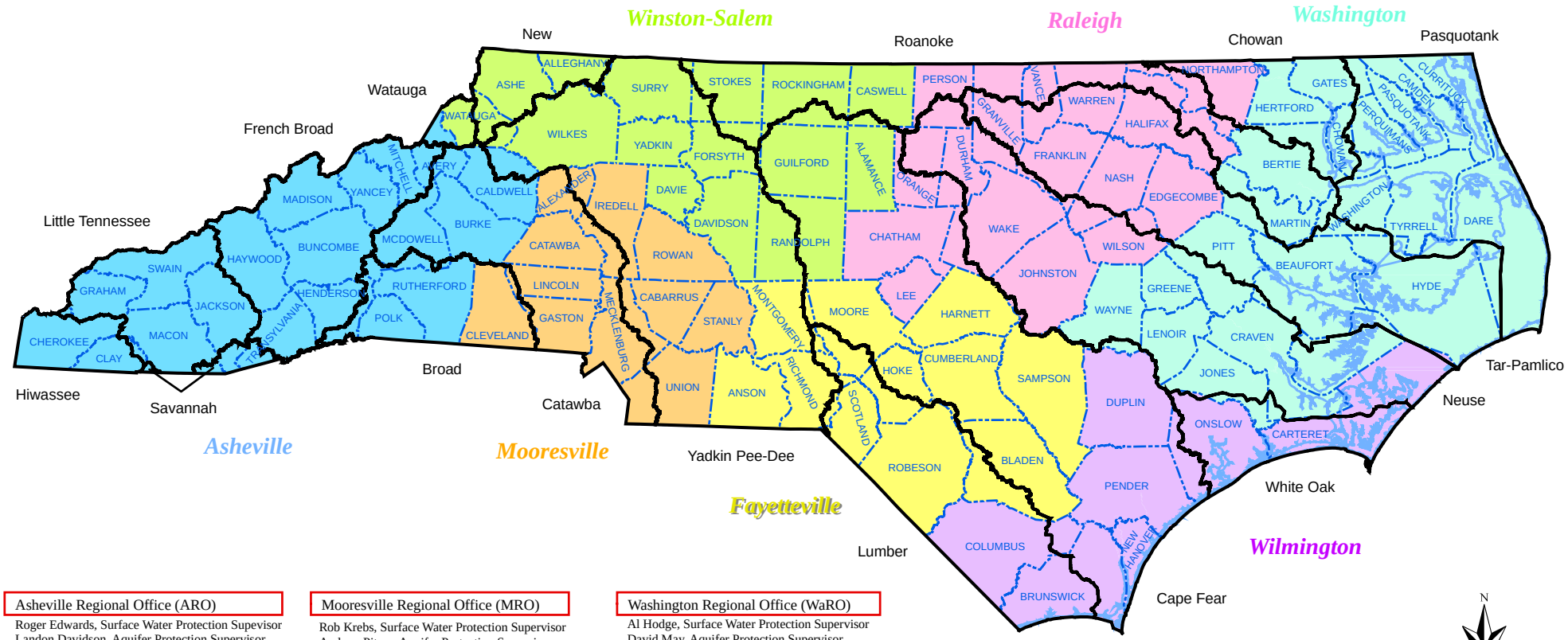
CHAPTERS 2 – 10: GENERAL BASINWIDE ISSUES

- Presents information on various topics of interest to the protection and restoration of water quality in the basin, including:
  - Stream classifications.
  - Population and land cover changes.
  - Water quality stressors.
  - Agricultural, forestry and permitting activities in the basin.
  - Water and natural resources.
  - Local initiatives.

APPENDICES

- Population and land use changes over time and local governments in the basin.
- Water quality data collected by DWQ, use support methodology and 303(d) listing.
- NPDES dischargers and general stormwater permits.
- Points of contact, and a glossary of terms and acronyms.

North Carolina Department of Environment and Natural Resources
Division of Water Quality Regional Offices



Asheville Regional Office (ARO)

Roger Edwards, Surface Water Protection Supevisor
Landon Davidson, Aquifer Protection Supervisor
2090 US Highway 70
Swannanoa, NC 28778
COURIER 12-59-01
Phone: (828) 296-4500
Fax: (828) 299-7043

Avery	Haywood	Polk
Buncombe	Henderson	Rutherford
Burke	Jackson	Swain
Caldwell	Macon	Transylvania
Cherokee	Madison	Yancey
Clay	McDowell	
Graham	Mitchell	

Mooresville Regional Office (MRO)

Rob Krebs, Surface Water Protection Supervisor
Andrew Pitner, Aquifer Protection Supervisor
610 East Center Avenue / Suite 301
Mooresville, NC 28115
COURIER 09-08-06
Phone: (704) 663-1699
Fax: (704) 663-6040

Alexander	Lincoln
Cabarrus	Mecklenburg
Catawba	Rowan
Cleveland	Stanly
Gaston	Union
Iredell	

Washington Regional Office (WaRO)

Al Hodge, Surface Water Protection Supervisor
David May, Aquifer Protection Supervisor
943 Washington Square Mall
Washington, NC 27889
COURIER 16-04-01
Phone: (252) 946-6481
Fax: (252) 946-9215
Fax: (252) 975-3716

Beaufort	Gates	Pamlico
Bertie	Greene	Pasquotank
Camden	Hertford	Perquimans
Chowan	Hyde	Pitt
Craven	Jones	Tyrrell
Currituck	Lenoir	Washington
Dare	Martin	Wayne

Winston-Salem Regional Office (WSRO)

Steve Tedder, Surface Water Protection Supervisor
Sherri Knight, Aquifer Protection Supervisor
585 Waughtown Street
Winston-Salem, NC 27107
COURIER 13-15-01
Phone: (336) 771-5000
Fax: (336) 771-4631

Alamance	Forsyth	Watauga
Alleghany	Guilford	Wilkes
Ashe	Randolph	Yadkin
Caswell	Rockingham	
Davidson	Stokes	
Davie	Surry	

Fayetteville Regional Office (FRO)

Belinda Henson, Surface Water Protection Supervisor
Art Barnhardt, Aquifer Protection Supervisor
225 Green Street
Systel Building Suite 714
Fayetteville, NC 28301-5043
COURIER 14-56-25
Phone: (910) 433-3300
Fax: (910) 486-0707

Anson	Moore
Bladen	Richmond
Cumberland	Robeson
Harnett	Sampson
Hoke	Scotland
Montgomery	

Raleigh Regional Office (RRO)

Chuck Wakild, Surface Water Protection Supervisor
Jay Zimmerman, Aquifer Protection Supervisor
3800 Barrett Drive
Raleigh, NC 27609
COURIER 52-01-00
Phone: (919) 791-4200
Fax: (919) 571-4718

Chatham	Johnston	Vance
Durham	Lee	Wake
Edgecombe	Nash	Warren
Franklin	Northampton	Wilson
Granville	Orange	
Halifax	Person	

Wilmington Regional Office (WiRO)

Ed Beck, Surface Water Protection Supervisor
Charlie Stehman, Aquifer Protection Supervisor
127 Cardinal Drive Extension
Wilmington, NC 28405-2845
COURIER 04-16-33
Phone: (910) 796-7215
Fax: (910) 350-2004

Brunswick	New Hanover
Carteret	Onslow
Columbus	Pender
Duplin	

Central Office

DENR
DIVISION OF WATER QUALITY
1617 MAIL SERVICE CENTER
RALEIGH NC 27699-1617
COURIER 52-01-00
Phone: (919) 733-7015
Fax: (919) 733-2496

NCDENR

Planning Section
Basinwide Planning Unit
January 2007

Chapter 1
Watauga River Subbasin 04-02-01

Including the: Watauga River, Boone Fork, Laurel Fork, Cove Creek, Beaverdam Creek, Beech Creek, Elk River and Cranberry Creek

1.1 Subbasin Overview

Subbasin 04-02-01 at a Glance

Land and Water Area

Total area:	205 mi²
Land area:	203 mi²
Water area:	<2 mi²

Population (County)

2000 Est. Pop.:	23,675 people
Pop. Density:	115 persons/mi²

Land Cover (percent)

Forest/Wetland:	87%
Water:	<1%
Urban:	<1%
Cultivated Crop:	<1%
Pasture/ Managed Herbaceous:	13%

Counties

Avery and Watauga

Municipalities

Beech Mountain, Banner Elk, Seven Devils, Elk Park, Sugar Mountain, and (Western) Boone

Aquatic Life Monitored Streams Summary

Total Streams:	90.0 mi
Total Supporting:	79.4 mi
Total Impaired:	5.9 mi
Total Not Rated:	4.7 mi

The entire North Carolina portion of the Watauga River basin is contained within the boundaries of subbasin 04-02-01. This includes both the Watauga and Elk River watersheds. Much of the land is mountainous with elevations ranging from 2,100 feet at the Tennessee state line to over 5,900 feet at Calloway Peak on Grandfather Mountain.

Nearly 87 percent of the land is forested; however, some of these forested areas are being rapidly developed with seasonal or second homes and recreational areas (i.e., golf courses and campgrounds). Development in or near stream corridors and on steep slopes has the potential to impact water quality throughout the subbasin with nonpoint source runoff and numerous small point source dischargers. The population in urban areas around the Town of Boone is increasing. Between 1990 and 2002, population increased by 4 percent. Refer to Appendix I for more information about population growth and trends. Refer to Appendix III for information regarding changes in land use.

There are 29 individual NPDES wastewater discharge permits in this subbasin with a total permitted flow of 3.92 MGD. The two largest facilities are the Valley Creek and Sugar Mountain wastewater treatment plants (WWTP). The Sugar Mountain and Beech Mountain (Pond Creek) WWTPs are required by permit to monitor their whole effluent toxicity (WET). Both facilities are currently in compliance. Refer to Appendix VI for the listing of NPDES permit holders.

A map including the locations of the NPDES facilities and water quality monitoring stations is presented in Figure 3. Table 3 contains a summary of assessment unit numbers (AU#) and lengths, streams monitored, monitoring data types, locations and results, along with use support

Figure 3 Watauga River Subbasin 04-02-01

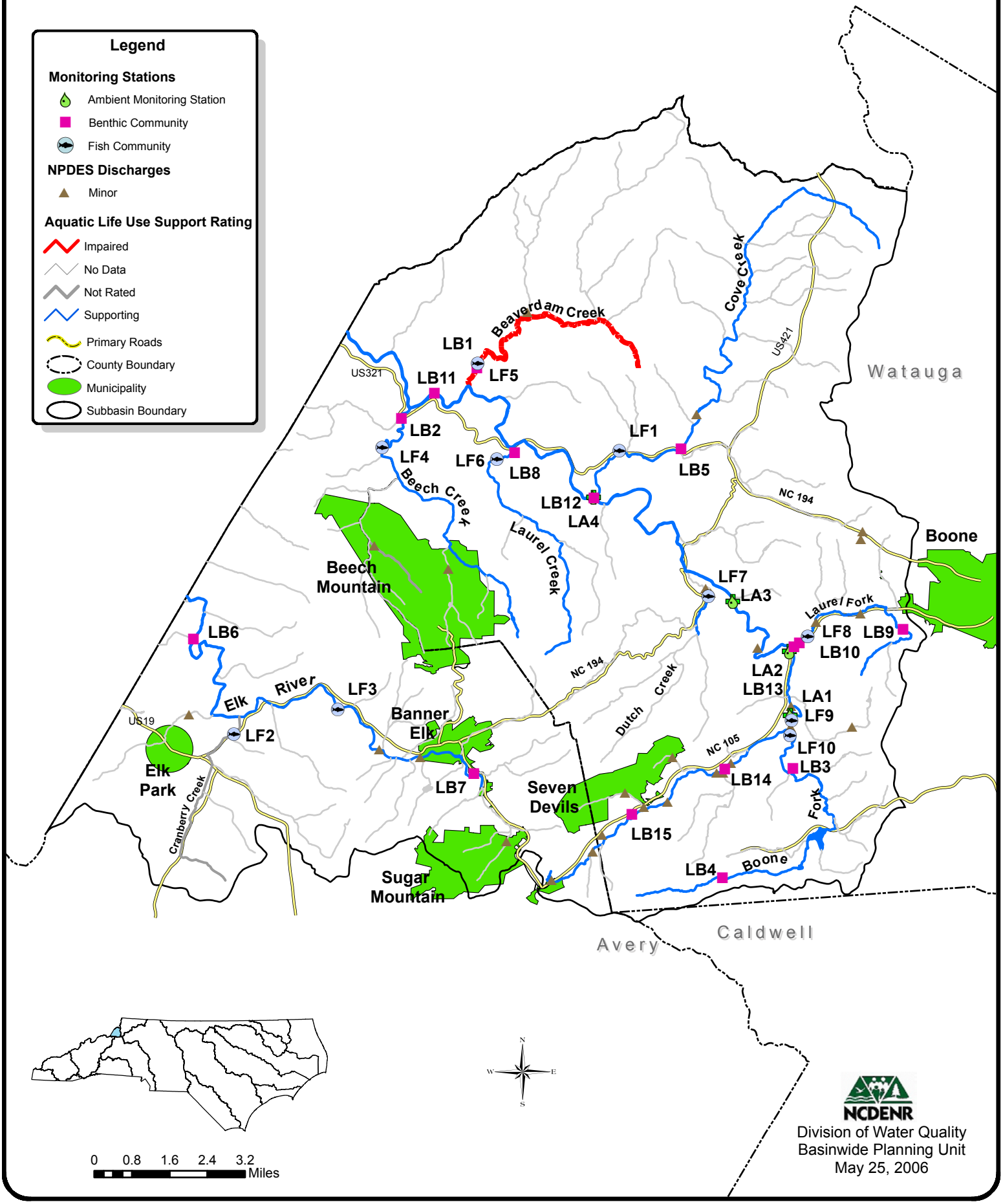


Table 3 DWQ Assessment and Use Support Ratings Summary for Monitored Waters in Subbasin 04-02-01

AU Number	Classification	Length/Area	Description	Aquatic Life Assessment					Recreation Assessment			Stressors	Sources
				AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result		
Beaverdam Creek													
8-19	C;Tr	5.9 FW Miles		I					ND			Habitat Degradation	Agriculture
	From source to Watauga River				LB1	G	2004					Habitat Degradation	Pasture
					LF5	P	2004						
Beech Creek													
8-20	C;Tr	7.6 FW Miles		S					ND			Habitat Degradation	Impervious Surfac
	From source to Watauga River				LB2	E	2004						
					LF4	NR	2004						
Boone Fork (Price Lake)													
8-7	C;Tr,ORW	8.4 FW Miles		S					ND			Habitat Degradation	Impervious Surfac
	From source to Watauga River				LF10	G	2004						
					LB4	E	2004						
					LB3	E	2004						
Cove Creek													
8-15	C	12.8 FW Miles		S					ND			Habitat Degradation	Construction
	From source to Watauga River				LF1	GF	2004					Habitat Degradation	Pasture
					LB5	G	2004						
Cranberry Creek													
8-22-16	C;Tr	4.7 FW Miles		NR					ND			Habitat Degradation	Unknown
	From source to Elk River				LF2	NR	2004						
Dutch Creek													
8-12-(1.5)	C;Tr	0.9 FW Miles		S					ND			Habitat Degradation	Unknown
	From Clark Creek to Watauga County SR 1112				LF7	GF	2004						
Elk River													
8-22-(14.5)	B;Tr	8.1 FW Miles		S					ND			Nutrient Impacts	Unknown
	From Peavine Branch to North Carolina-Tennessee State Line				LB6	G	2004					Habitat Degradation	Impervious Surfac
					LF3	NR	2004						
Elk River (Mill Pond)													
8-22-(3)	C;Tr	4.2 FW Miles		S					ND			Habitat Degradation	Impervious Surfac
	From Sugar Creek to Peavine Creek				LB7	GF	2004						

Table 3 DWQ Assessment and Use Support Ratings Summary for Monitored Waters in Subbasin 04-02-01

AU Number	Classification	Length/Area		Aquatic Life Assessment					Recreation Assessment				
Description				AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result	Stressors	Sources
Laurel Creek													
8-17	C;Tr	6.1	FW Miles	S					ND			Habitat Degradation	Construction
From source to Watauga River					LB8	G	2004					Habitat Degradation	Impervious Surfac
					LF6	NR	2004						
Laurel Fork													
8-10	C;Tr	4.9	FW Miles	S					ND			Habitat Degradation	Stormwater Outfal
From source to Watauga River					LB10	GF	2004					Habitat Degradation	Impervious Surfac
					LB9	NI	2004						
					LF8	NR	2004						
WATAUGA RIVER													
8-(1)	B;Tr,HQW	19.5	FW Miles	S	LA1	NCE			S	LA1	NCE	Temperature	Impervious Surfac
					LA2	NCE				LA2	NCE	Habitat Degradation	Impervious Surfac
					LA3	NCE				LA3	NCE	Habitat Degradation	WWTP NPDES
					LA4	NCE				LA4	NCE		
From source to U.S. Hwy. 321 Bridge					LB15	E	2004						
					LB14	G	2004						
					LB13	E	2004						
					LB12	E	2004						
					LF9	GF	2004						
8-(16)	B;HQW	6.8	FW Miles	S					ND				
From U.S. Hwy. 321 to North Carolina-Tennessee State Line					LB11	E	2004						

Table 3 DWQ Assessment and Use Support Ratings Summary for Monitored Waters in Subbasin 04-02-01

AU Number	Classification	Length/Area Description	Aquatic Life Assessment					Recreation Assessment				
			AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result	Stressors	Sources

AL - Aquatic Life
REC - Recreation

LF - Fish Community Survey
LB - Benthic Community Survey
LA - Ambient Monitoring Site

Miles/Acres
FW- Fresh Water

E - Excellent
G - Good
GF - Good-Fair
F - Fair
P - Poor
NI - Not Impaired

S - Supporting, I - Impaired
NR - Not Rated
NR*- Not Rated for Recreation (screening criteria exceeded)
ND-No Data Collected to make assessment
Results
CE-Criteria Exceeded > 10% and more than 10 samples
NCE-No Criteria Exceeded

Aquatic Life Rating Summary

S	m	79.4	FW Miles
NR	m	4.7	FW Miles
I	m	5.9	FW Miles
NR	e	1.6	FW Miles
ND		186.7	FW Miles

Recreation Rating Summary

S	m	19.5	FW Miles
NR	e	1.7	FW Miles
ND		257.0	FW Miles

Fish Consumption Rating Summary

I	e	278.1	FW Miles

ratings for waters in the subbasin. Refer to Appendix IX for the use support methodology applied to the Watauga River basin.

Waters in the following sections and in Table 3 are identified by an assessment unit number (AU#). This number is used to track defined segments in the water quality assessment database, list 303(d) Impaired waters, and to identify waters throughout the basinwide water quality plan. The AU# is a subset of the DWQ index number (classification identification number). A letter attached to the end of the AU# indicates that the assessment is smaller than the DWQ index segment. No letter indicates that the AU# and the DWQ index segment are the same.

There were 13 benthic macroinvertebrate samples and 10 fish community samples collected during this assessment period. Data were also collected from four ambient monitoring stations. Overall, water quality in the subbasin is very good, with the majority of the sites receiving a bioclassification of Good or Excellent based on the macroinvertebrate data. Three sites in the basin improved in 2004 compared to the previous samples collected in 1999. These include two sites on the Watauga River (Section 1.4.7) and one on lower Boone Fork (Section 1.4.1). Two sites on the mainstem of the Elk River showed a decline in water quality (Section 1.4.9). The upstream site above the Town of Banner Elk declined from a Good in 1999 to a Good-Fair in 2004, and the downstream site near the state line declined from an Excellent in 1999 to a Good in 2004. The primary water quality problem is nonpoint source runoff (i.e., sediment and nutrients). Based on the macroinvertebrate data, nonpoint source runoff appeared to have some impacts (Good and Good-Fair ratings) on some segments of the Watauga River, Elk River, Cove Creek, Beaverdam Creek, Laurel Fork and Laurel Creek. Many of the sites that were sampled have roads that run parallel to the stream, leading to narrow riparian zones with frequent breaks and little shading.

All of the fish community sites in this subbasin were sampled by DWQ for the first time in 2004. The 2004 basinwide assessment will therefore serve as a baseline for fish communities sampled during the 2009 basinwide assessment period. The most commonly collected species were the central stoneroller and the northern hog sucker. Both were collected at all ten sampling sites. Brown trout and the blacknose dace were also very common species. With the exception of Cove Creek [AU# 8-15], all of the fish community sites are designated trout (Tr) waters by DWQ. The NC Wildlife Resources Commission (WRC) also manages portions of the basin as hatchery supported trout waters. Wild and stocked trout were collected at all of the 2004 fish community sites. Refer to the *2005 Watauga River Basinwide Assessment Report* at www.ncwaterquality.org/esb/Basinwide/WAT2005.pdf and Appendix IV for more information on DWQ monitoring.

Eleven sites are also monitored by the Volunteer Water Information Network (VWIN). Several of these sites correspond with DWQ sites and provide additional qualitative information. This program is managed by the University of North Carolina Asheville (UNCA) Environmental Quality Institute (EQI) and relies on volunteers to collect water samples monthly for chemical analysis. Parameters monitored include major nutrients, turbidity, suspended solids, pH, alkalinity, conductivity and heavy metals such as zinc, copper and lead (Patch, *et al*., February 2006). VWIN monitoring stations are listed in Appendix V.

1.2 Use Support Assessment Summary

All surface waters in the state are assigned a classification appropriate to the best-intended or designated use of that water. Waters are regularly assessed by DWQ to determine how well they are meeting the designated use. For aquatic life, an Excellent, Good, Good-Fair, Fair, or Poor bioclassification are assigned to a stream based on the biological data collected by DWQ. Aquatic life samples include benthic macroinvertebrates, fish community, and ambient monitoring. Methodologies related to assigning aquatic life bioclassifications and use support assessment are included in Appendices IV and IX, respectively. Appendix X provides definitions of the terms used throughout this basin plan.

Table 4 Summary of Use Support Ratings by Category in Subbasin 04-02-01

Use Support Rating	Aquatic Life	Recreation
Monitored Waters		
Supporting	79.4 mi (88.2%)	19.5 mi (100%)
Impaired*	5.9 mi (6.6%)	0
Not Rated	4.7 mi (5.2%)	0
Total	**90.0 mi**	**19.5 mi**
Unmonitored Waters		
Supporting	0	0
Impaired	0	0
Not Rated	1.6 mi	1.7 mi
No Data	186.7 mi	257.0 mi
Total	**188.3 mi**	**258.7 mi**
Totals		
All Waters**	**278.3 mi**	**278.2 mi**

* The noted percent Impaired is the percent of monitored miles/acres only.
** Total Monitored + Total Unmonitored = Total All Water.

In subbasin 04-02-01, use support was assigned for the aquatic life, recreation, fish consumption and water supply categories. Waters are Supporting, Impaired, Not Rated, and No Data in the aquatic life and recreation categories on a monitored or evaluated basis. Waters are Impaired in the fish consumption category on an evaluated basis based on fish consumption advice issued by the Department of Health and Human Services (DHHS). All waters are Supporting in the water supply category on an evaluated basis based on reports from Division of Environmental Health (DEH) regional water treatment plant consultants.

Table 3 identifies those waters monitored during this assessment period. The table includes assessments for aquatic life and recreation, along with the identified stressors and sources. Table 4 provides a summary of use support ratings and includes total miles for Supporting, Impaired, Not Rated, and No Data waters.

1.3 Status and Recommendations of Previously and Newly Impaired Waters

No streams were identified as Impaired in the previous basin plan (2002). However, the following waters are newly Impaired based on recent biological and/or ambient data and will likely be placed on the 2008 303(d) list. The current status and recommendations for addressing these waters are presented below, and each is identified by an AU#. Information regarding 303(d) listing and reporting methodology is included in Appendix VII.

1.3.1 Beaverdam Creek [AU# 8-19]

2002 Recommendations
Based on the benthic macroinvertebrate data, nonpoint source runoff appeared to have some impacts on the habitat in Beaverdam Creek. Voluntary implementation of BMPs was encouraged and continued monitoring was recommended.

Current Status
Beaverdam Creek, from source to the Watauga River (5.9 miles), is Impaired in the aquatic life category due to a Poor fish bioclassification at site LF5. The number of fish collected and the total number of species were the lowest of any of the fish sites sampled in the subbasin. The numerically dominant species collected was an omnivorous river chub. Two wild rainbow trout were also collected, along with a number of omnivore and herbivore species. Very few insectivore species were collected. Based on the number and types of fish species collected, Beaverdam Creek is exhibiting an unbalanced ecological system.

Benthic macroinvertebrates were also collected in Beaverdam Creek. The benthic community received a Good bioclassification at site LB1. The species abundance and richness decreased from the previous assessment period and contained a mix of intolerant and tolerant species.

Overall, the instream habitat was good during the time of sampling and consisted primarily of riffles with high gradient plunge pools. Within the sampling reach, riparian zones were wide and intact, the streambanks were stable, and there was adequate shading. Just upstream, however, land use consisted of scattered residential development, pastureland and rowcrops. Cattle had direct, easy access to the stream, and the riparian corridor was narrow. One minor discharge (<1 MGD) is located two miles upstream of the sampling site; however, no violations have been reported for this facility.

2007 Recommendations
Based on the current aquatic life use support, DWQ recommends that Beaverdam Creek be listed on the 2008 303(d) list. DWQ will continue to monitor water quality in Beaverdam Creek and work with local agencies to encourage appropriate agricultural (e.g., livestock exclusion fencing, watering tanks, riparian buffer) and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff.

Water Quality Initiatives
In 2005, the Watauga County Soil and Water Conservation District (SWCD) worked with a local landowner to construct a chicken litter storage area. Funding was provided by the NC Agricultural Cost Share Program (ACSP). The Watauga County SWCD plans to work with additional landowners to install appropriate agricultural and residential stormwater BMPs throughout this watershed.

1.4 Status and Recommendations for Waters with Noted Impacts

Based on DWQ's most recent use support methodologies, the surface waters discussed in this section are Supporting their designated uses. However, notable water quality problems and

concerns were documented for these waters during this assessment. Attention and resources should be focused on these waters to prevent additional degradation and facilitate water quality improvements. DWQ will notify local agencies of these water quality concerns and work with them to conduct further assessments and to locate sources of water quality protection funding. Education on local water quality issues and voluntary actions are useful tools to prevent water quality problems and to promote restoration efforts. The current status and recommendations for addressing these waters are presented below, and each is identified by an AU#. Refer to Section 1.1 for more information about AU#. Nonpoint source program agency contacts are listed in Appendix VIII.

1.4.1 Boone Fork [AU# 8-7]

Current Status
Boone Fork, from source to the Watauga River (8.4 miles), is Supporting in the aquatic life category due to Excellent benthic bioclassifications at sites LB3 and LB4 and a Good fish bioclassification at site LF10. Boone Fork is a designated trout (Tr) and outstanding resource water (ORW) by DWQ.

Upstream, Boone Fork is a relatively small stream. Substrate is a good mix of bolder, rubble and cobble. Many intolerant benthic species were collected at site LB4. These species support the ORW designation, overall excellent water quality and favorable habitat conditions. Downstream, Boone Fork (below Price Lake) is 13 meters wide with a rocky substrate and has the potential to be impacted by Price Lake (i.e., flow regime and temperature). The benthic bioclassification improved from a Good (1999) to an Excellent (2004) during this assessment period.

The fish sample (LF10) was collected just upstream of the confluence with the Watauga River. The instream riparian and watershed characteristics were of exceptional high quality. A private fishing club known for its stocked trophy trout manages this reach of Boone Fork. Seven very large stocked rainbow trout, a stocked "golden trout" and one wild young-of-year rainbow trout were collected and released.

2004 Hurricane Damage
Several tributaries throughout the Boone Fork watershed were impacted by the hurricanes of 2004. One tributary that was impacted was Cold Prong (AU# 8-7-1). The excessive amount of rain and consequent heavy stream flows during the hurricanes severely damaged a dam on Appalachian Crest Lake, a privately owned 40-acre impoundment. Stormwater and sediments entered Boone Fork and Price Lake in the Julian Price Memorial Park.

Working with the local resource agency staff, the Blue Ridge Parkway and the Division of Land Resources (DLR) Safe Dam Program, the dam was breached and a 600-foot conveyance was placed through the dam. Large stone and vegetation was used to stabilize the breached section, and currently, there are no plans to reconstruct the dam. If the dam were to be reconstructed however, design plans would need to be reviewed by DLR and the Safe Dam Program, and Watauga County would be responsible for reviewing and approving any sediment and erosion control plan associated with dam reconstruction.

2007 Recommendations
Information and data collected during post-hurricane surveys was collected outside of the assessment period and was not used for use support determination. Information collected post-hurricane will be used during the next assessment period (September 2004 through August 2009). DWQ will work with DLR should the dam at Appalachian Crest Lake be reconstructed. Because Boone Fork is designated ORW and Tr by DWQ, extra precautions need to be taken to protect the excellent water quality in the watershed.

1.4.2 Laurel Fork [AU# 8-10]

2002 Recommendations
Although supporting its designated use, habitat degradation was noted throughout the Laurel Fork watershed. Sedimentation, narrow riparian zones and stormwater runoff from residential and commercial properties were identified as stressors to water quality. DWQ recommended that appropriate BMPs be installed to stabilize streambanks and reduce sediment loads.

Current Status
Laurel Fork, from source to the Watauga River (4.9 miles), is Supporting in the aquatic life category due to a Good-Fair benthic bioclassification at site LB10. The sampling site was located 0.5 mile upstream of the confluence with the Watauga River. Instream habitats were good, consisting of high gradient plunge pools, chutes and rocks.

Laurel Fork also received a Not Rated fish bioclassification at site LF8 because trout stream-specific criteria and metrics have not been developed. Ten species were collected from Laurel Fork, but the numbers were low and many were herbivorous species indicating an unbalanced ecological system. Conductivity was elevated at the time of sampling for both benthic and fish (135 µmhos/cm and 109 µmhos/cm). Conductivity is an indicator of nonpoint source and point source runoff in a stream segment.

In addition to DWQ biological sampling, VWIN has sampled water chemistry in Laurel Fork for two years (2003 – 2005). Laurel Fork is below average when compared to other VWIN sampling sites. Readings for median turbidity and suspended solids are elevated, and sediment is more frequent and higher during rain events when compared to other sites in the basin. Conductivity and nutrients (nitrate/nitrite-nitrogen) are also higher. Sediment, conductivity and nutrients are often indications of existing and continued land disturbing activities in a watershed (Patch, *et al*., February 2006).

Special Studies
Laurel Fork receives nonpoint source and stormwater runoff from heavily urbanized areas of western Boone. Laurel Fork also receives runoff from several permitted stormwater facilities. For the past several years, local citizens and resource agency staff have noted periods when water clarity is reduced and the stream runs either “milky white” or “cloudy”. The periods are episodic and duration varies. Several complaints are on file with DWQ.

DWQ regional staff in conjunction with the NC (Watauga County) Cooperative Extension Service (CES), the Watauga County Planning Department, and the NC Department of Transportation (DOT) began an extensive investigation into the source of the “milky” substance.

As part of the investigation, the DWQ Winston-Salem Regional Office (WSRO) requested that a special study be conducted in the Laurel Fork watershed during the 2004 basinwide sampling cycle. In addition to the benthic sample collected at site LB10 (below the permitted stormwater dischargers), there was a sample collected upstream at site LB9. Site LB9 is 1.5 miles upstream of site LB10, and there are many land use changes between the two sites, including the stormwater discharges and several commercial and residential properties. Due to its small size and narrow stream width, site LB9 was given a Not Impaired benthic bioclassification. Several intolerant species were collected at site LB9, which indicates that the overall water quality is good in this upstream sampling reach.

Between 2004 and 2005, DWQ regional staff conducted several stormwater compliance inspections for Vulcan Quarry (Permit NCG020251), Chandler Concrete (Permit NCG140101) and Maymead Materials (Permit NCG160141). DWQ found that BMPs were properly installed and maintained and stormwater records were in order for Vulcan Quarry and Maymead Materials. A compliance evaluation inspection for Chandler Concrete in July 2005, however, revealed that three storm drains on Chandler's property were acting as stormwater conveyances. The storm drains were located in the main drive and parking areas of the property. The investigation by DWQ and the Department of Transportation (DOT) concluded that the storm drains were allowing stormwater to leave the property undetected, discharging directly into Laurel Fork. The facility is designed to capture most of the stormwater on site. Stormwater in ponded areas should be pumped to holding basins and used for concrete mixing operations.

In August 2005, DWQ issued a Notice of Violation (NOV) to Chandler Concrete. The NOV included several recommendations for preventing stormwater from leaving the property. These included closing the three storm drains and installing berms to deflect flow from the drains. Concrete curbs were also recommended and installed on Chandler's property to aid in the capture of stormwater. Back-up generators have also been installed to ensure stormwater is pumped to the holding basins.

Although an NOV has not been issued to Vulcan Quarry, DWQ regional staff is working closely with the foreman and managers of the facility to monitor stormwater runoff. Nearly 99 percent of the stormwater runoff and wash water used on site is captured and recycled. Vulcan Quarry has installed back-up generators on pumping stations, and employees are trained and reminded on a regular basis to turn on sump pumps in the truck washing area. The sump pumps capture the wash water and pump it to holding basins for later use in another area of the facility.

DOT has also been active in the Laurel Fork watershed and recently cleaned a culvert that had been blocked with rocks and runoff material. Much of the material was from Vulcan Quarry. Fine particulate material trapped in the culvert was likely resuspended during each rain event and therefore contributing to the "milky white" and "cloudy" appearance of the stream.

Cooperative efforts in the Laurel Fork watershed allowed for DWQ, DOT and local resource agencies to identify potential sources of the "milky white" substance and work with stormwater discharges to install appropriate measures to limit impacts to the stream. The Watauga River Conservation Partners (WRCP) have also played a crucial role in this watershed by educating local citizens on water quality concerns and practices that can be implemented to protect water quality. DWQ will continue to work with the permitted facilities to ensure compliance.

Land Cover and Average Slope Evaluation
To determine the effects of land use and slope on areas monitored by VWIN, the UNCA Environmental Quality Institute (EQI) evaluated land cover and average slope using ArcGIS 9.0 and land cover classifications from the USGS 2001 Land Cover Database. This evaluation was part of a special project initiated by EQI to determine the vulnerability of streams to erosion and runoff during heavy rain events. Laurel Fork had one of the highest percentages of land categorized as rural/semi-rural (non-forested) or urban/suburban (25.2 percent and 5.9 percent, respectively). The average slope is 30 percent upstream of the VWIN monitoring site making Laurel Fork a highly vulnerable area for flash flood damage during heavy rain events (Patch, *et al*., February 2006). Future planning and restoration activities should incorporate measures to protect streams and human welfare during heavy rain and flash flood events.

2007 Recommendations
DWQ will continue to monitor Laurel Fork and work with local agencies to encourage urban stormwater BMPs. DWQ will also continue stormwater inspections and work with permitted facilities to ensure compliance. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Because Laurel Fork is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

1.4.3 Dutch Creek [AU# 8-12-(1.5)]

Current Status
Dutch Creek, from Clark Creek to State Route 1112 (0.9 miles), is Supporting in the aquatic life category due to a Good-Fair fish bioclassification at site LF7. The sample site is located approximately one mile above the confluence with the Watauga River in Valle Crucis. Instream habitat is good with riffles, runs and pools. Substrate consisted mostly of cobble and gravel.

Of all of the fish community samples collected in this subbasin, Dutch Creek contained the highest number of species (19) and total number of fish (775). The NC Wildlife Resources Commission (WRC) annually stocks Dutch Creek with 800 brook, rainbow and brown trout from March to June. Multiple age groups of wild brown trout, including young-of-year, indicated a natural reproducing population in addition to the stock trout.

2007 Recommendations
DWQ will continue to monitor Dutch Creek and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Because Dutch Creek is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

1.4.4 Cove Creek [AU# 8-15]

Current Status
Cove Creek, from source to the Watauga River (12.8 miles), is Supporting in the aquatic life category due to a Good benthic bioclassification at site LB5 and a Good-Fair fish

bioclassification at site LF1. The sample site is located along the US 321 corridor, about one mile above the confluence with the Watauga River. The watershed encompasses approximately 33 square miles and contains a mix of rural residential and agricultural land use. Historic and current agricultural use (pasturelands) has created extremely narrow riparian zones, streambank instability and sedimentation throughout the watershed. Instream habitats were poor, consisting of sandy runs, riffles and chutes. New residential development was noted in the upper portion of the watershed, and elevated conductivity measurements were noted during the time of biological sampling (116 µmhos/cm and 95 µmhos/cm).

In addition to DWQ biological sampling, VWIN has sampled water chemistry in Cove Creek for two years (2003 – 2005). Cove Creek is below average when compared to other VWIN sampling sites. Conductivity and nutrients (nitrate/nitrite-nitrogen) are higher than other sites sampled in the basin. Conductivity and nutrients are often indications of existing and continued land disturbing activities in a watershed (Patch, *et al*., February 2006).

Post-Hurricane Special Study

During a three-week period in September 2004, the storm remnants of three hurricanes (Frances, Ivan and Jeanne) lead to widespread flooding throughout the central and northern mountains of western North Carolina. To assess the biological impacts of the hurricanes, DWQ staff requested a post-hurricane special study. Two sites were selected for sampling and included Cove Creek and the Watauga River near Sugar Grove (Section 1.4.7). The data collected during the post-hurricane surveys was collected outside of the assessment period and was not used for use support determination. Information collected during this special study will be used during the next assessment period (September 2004 through August 2009).

Samples collected post-hurricane showed very few physical or water quality differences. Flows were much greater post-hurricane (December 2004) than those collected during normal basinwide monitoring (August 2004). Conductivity was much lower in Cove Creek (91 µmhos/cm) post hurricane. This difference is largely due to the increased flow during the post-hurricane sampling.

Instream habitat for Cove Creek [AU# 8-15] included cobble and gravel riffles, runs and chutes, moderately embedded substrate, and infrequent pools. The streambanks were narrow, sparsely vegetated with an open canopy. The differences in habitat scores pre- and post-hurricane were slight. The benthic bioclassification dropped from Good to Good-Fair at site LB5. Fish diversity decreased slightly and the bioclassification dropped from Good-Fair to a Fair at site LF1. Both DWQ and local resource agency staff believe that the benthic and fish populations will rebound and return to pre-hurricane conditions.

Land Cover and Average Slope Evaluation

To determine the effects of land use and slope on areas monitored by VWIN, the UNCA EQI evaluated land cover and average slope using ArcGIS 9.0 and land cover classifications from the USGS 2001 Land Cover Database. This evaluation was part of a special project initiated by EQI to determine the vulnerability of streams to erosion and runoff during heavy rain events. Cove Creek had one of the highest percentages of land categorized as rural/semi-rural (non-forested) or urban/suburban (27.8 percent and 0.7 percent, respectively). The average slope is 24 percent upstream of the VWIN monitoring site making Cove Creek a vulnerable area for flash flood

damage during heavy rain events (Patch, *et al*., February 2006). Future planning and restoration activities should incorporate measures to protect streams and human welfare during heavy rain and flash flood events.

2007 Recommendations

DWQ will continue to monitor Cove Creek and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff.

1.4.5 Laurel Creek [AU# 8-17]

Current Status

Laurel Creek, from source to the Watauga River (6.1 miles), is Supporting in the aquatic life category due to a Good benthic bioclassification at site LB8. Laurel Creek is a small stream (five meters wide) with a drainage area of approximately seven square miles. The sampling site was located 0.5 mile above the confluence with the Watauga River. Overall, the habitat is good; however, the substrate was embedded and contained a high percentage of sand (25 percent). Land use in Laurel Creek has historically consisted of rural residential and agricultural lands; however, much of the agricultural land is being converted to residential properties.

Laurel Creek also received a Not Rated fish bioclassification at site LF6 because trout stream-specific criteria and metrics have not been developed. Very few species (4) and total number of fish (103) were collected. Six wild brown trout of multiple age groups were collected from Laurel Creek, including one young-of-year, indicating a reproducing population. The WRC manages this section of Laurel Creek as Hatchery Supported Trout waters and annually stocks 900 brook, rainbow and brown trout from March through June. Laurel Creek was the most natural of the high gradient trout streams that was sampled in the subbasin.

2007 Recommendations

DWQ will continue to monitor Laurel Creek and work with local agencies to encourage appropriate stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Because Laurel Creek is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

1.4.6 Beech Creek [AU# 8-20]

Current Status

Beech Creek, from source to the Watauga River (7.6 miles), is Supporting in the aquatic life category due to an Excellent benthic bioclassification at site LB2. This sampling site is located approximately 0.5 mile above the confluence with the Watauga River and contains a substrate of boulders and rubble. Overall, the instream habitat is good; however, houses are located on either side of the stream, greatly reducing the width and the effectiveness of the riparian corridor. This benthic site is the only known North Carolina locality for the intolerant caddisfly, *Ceratopsyche walkeri*. The species is abundant in the high-current riffles found in Beech Creek. During this assessment period, Beech Creek and Boone Fork (Section 1.4.2) were the only tributaries to the Watauga River that received Excellent bioclassifications.

Even though the downstream segment received an Excellent bioclassification, Beech Creek also received a Not Rated fish bioclassification at site LF4. Beech Creek could not be rated for fish because trout stream-specific criteria and metrics have not been developed. The sampling site is located approximately 1.5 miles above the confluence with the Watauga River, upstream of site LB2. Overall, the instream habitat is good with riffles, fast chutes, fast runs, and plunge pools. The substrate primarily consists of cobbles and boulders; however, effects of severe flash flooding were evident with undercut streambanks and household debris scattered throughout the sampling reach. Eight species were collected for a total of 368 fish. The redbreast sunfish was the numerically dominant species (48 percent); however, the number is unnaturally high compared to other mountain streams. DWQ believes that the redbreast sunfish were once located in the Beech Mountain Reservoir. The reservoir is approximately 3 miles upstream of the sampling location. Migration or flooding likely caused the fish to move from the reservoir to the sampling location. Multiple age groups of two wild trout species were also collected, indicating reproducing populations. WRC manages this section of Beech Creek as Hatchery Supported Trout Waters and annually stocks 600 brook, rainbow and brown trout from March to May.

From the benthic sampling site, the watershed is approximately 20 square miles, contains a mix of forested, agricultural and residential area, and receives stormwater runoff from the Town of Beech Mountain. Two minor wastewater treatment facilities are also located in the watershed. The two facilities are the Pond Creek WWTP (Permit NC0069761) with a permitted discharge of 0.4 MGD and the Grassy Gap WWTP (Permit NC0022730) with a permitted discharge of 0.08 MGD. Both are managed by the Town of Beech Mountain.

2007 Recommendations

DWQ will continue to monitor Beech Creek and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Because Beech Creek is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

1.4.7 Grassy Gap Creek [AU# 8-20-3-3]

Current Status

Grassy Gap Creek, from source to Buckeye Creek (1.6 miles), is Not Rated on an evaluated basis in the aquatic life category due to significant noncompliance issues with ammonia permit limits at the Grassy Gap WWTP (Permit NC0022730). To better meet discharge limits, the Grassy Gap WWTP discharge relocated to Buckeye Creek [AU# 8-20-3] in February 2004. The facility has completed a comprehensive wastewater systems analysis and is continually working to replace sewer lines and updating the collection system. In 2005, the Town of Beech Mountain received over $1.2 million from the NC Construction Grants and Loans Program (CG&L) to upgrade the town's WWTPs. To learn more about CG&L, refer to Section 10.3.3.

2007 Recommendations
DWQ will continue to work with the Grassy Gap WWTP to improve facility function and increase compliance. In addition, DWQ will work with local resource agencies to identify education and BMP opportunities throughout the Beech Creek watershed.

1.4.8 Watauga River [AU# 8-(1) and 8-(16)]

2002 Recommendations
The benthic sample collected near Foscoe decreased from an Excellent to a Good-Fair bioclassification. This decline in bioclassification indicates that impacts to water quality are present. Sedimentation, lack of pool habitat, narrow riparian corridors, and frequent breaks in the riparian corridor were all noted as habitat problems. Several new homes and commercial properties were constructed throughout the upper portion of the watershed. Residential and agricultural BMPs should be carefully installed and maintained.

Current Status
The Watauga River, from source to the North Carolina-Tennessee state line (26.3 miles), is Supporting in the aquatic life category due to Good and Excellent benthic bioclassifications at sites LB14 (Foscoe), LB13 (NC 105), LB12 (Sugar Grove) and LB11 (Peoria). The river also received a Good-Fair fish bioclassification at site LF9 (Shull Mills). Overall, instream habitat throughout the watershed is good; however, there is evidence of increased development activities throughout the entire area resulting in narrow riparian corridors, sediment, and periphyton growth along the river's edge.

In the upstream section near Foscoe (LB14), substrate is a good mix of bedrock, boulder and rubble. Located below a cluster of small permitted WWTP facilities, the river also receives runoff from agricultural and residential properties and areas under development in and around the Town of Seven Devils. The entire length of the Watauga River is given the supplemental classification for high quality waters (HQW). The HQW designation is assigned to those waters that are Excellent based on DWQ chemical and biological sampling. Since 1985, this site has fluctuated between Excellent and Good-Fair. The most recent Good bioclassification is an improvement from the Good-Fair rating in 1999; however, the Watauga River is not consistently meeting the criteria of an Excellent bioclassification for HQW.

Out of the ten fish samples monitored in the subbasin, site LF9 has the second highest number of species (16) and total number (469) collected, which resulted in a Good-Fair bioclassification. Wildlife Resources Commission (WRC) manages this section of the Watauga River as delayed harvest trout waters. From March to May, approximately 3,500 rainbow, brook and brown trout are stocked with 600 more added in July followed by another 2,200 in October and November. Despite the abundance of species and numbers, the river is not meeting the criteria of an Excellent bioclassification for HQW.

At site LB12 (Sugar Grove), the river is 17 meters wide, encompasses 92 square miles, and receives runoff from several forested, agricultural and residential areas as well as discharge from several minor NPDES facilities. The velocity of the river is also slower in this downstream section. Consequently, fine sediments tend to settle out near the streambanks. The habitat score

was slightly lower in this section of the river due to infrequent riffles, minimal shading and narrow riparian corridors. Conductivity was higher at site LB12 (100 µmhos/cm) indicating an increase in watershed disturbance (i.e., development and land clearing activities). Biologists noted heavy periphyton growth along the river's edge. Periphyton algal growth is often an indication of nutrient enrichment from both point and nonpoint sources.

In the recreational use support category, the Watauga River is Supporting due to no criteria exceeded for fecal coliform bacteria levels at sites LA1, LA2, LA3, and LA4. Physical and chemical parameters are also evaluated at these ambient sampling sites to assess potential water quality stressors and impacts to aquatic life. Data from these ambient stations indicate that temperature is a water quality stressor at sites LA1 (Shull Mills), LA3 (Valle Crucis) and LA4 (Sugar Grove). Narrow and sparsely vegetated riparian corridors offer little shade to these wide river sections. New development activities throughout the entire watershed increases the amount of impervious surface cover, potentially raising the temperature of stormwater entering tributaries that lead to the Watauga River.

Watauga River Special Study

To investigate water quality and watershed concerns, the uppermost segment of the Watauga River was part of a special study requested by the Winston-Salem Regional Office (WSRO) during the 2004 basinwide sampling cycle. The site (LB15) was selected a control site upstream of development around the Town of Seven Devils. Site LB14 served as the downstream comparison site, below development activities. Site LB15 received an Excellent benthic bioclassification. Site LB14 received a Good bioclassification (discussed above). Species richness and abundance were higher at site LB15 compared to site LB14; however, conductivity was higher upstream at site LB15 (91 µmhos/cm) than downstream at site LB14 (71 µmhos/cm) indicating more disturbances in the uppermost part of the watershed. Biologists noted that at the time of sampling, several small tributaries appeared to be contributing sediment to the Watauga River. Several of the collected specimens were coated with a reddish-orange silt and/or sediment. Despite these inputs, however, the uppermost part of the watershed near Seven Devils (LB15) supports a more pollution intolerant benthic community than the downstream Foscoe site (LB14).

Post-Hurricane Special Study

To assess the biological impacts of the September 2004 hurricanes, DWQ staff requested a post-hurricane special study. Two sites were selected for sampling and included the Watauga River near Sugar Grove and Cove Creek (Section 1.4.4). The data collected during the post-hurricane surveys was collected outside of the assessment period and was not used for use support determination. Information collected during this special study will be used during the next assessment period (September 2004 through August 2009).

Instream habitat in the Watauga River was still a good mix of boulders, rubble, sand, gravel, and silt. Post-hurricane sampling showed a substantial decline in species richness and diversity. Despite the decline, however, the benthic bioclassification only dropped from an Excellent (August 2004) to a Good (December 2004) at site LB12. Both DWQ and local resource agency staff believe that the benthic population will rebound and return to pre-hurricane conditions.

2007 Recommendations
DWQ will continue to monitor the Watauga River and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. County, city and town councils should work to implement stormwater BMPs and reevaluate land use ordinances to incorporate low-impact development (LID) design criteria.

Because the Watauga River is designated HQW and Tr by DWQ, extra precautions need to be taken to protect the excellent water quality throughout the watershed. Precautions should also be taken to preserve the pollution intolerant benthic macroinvertebrate communities found throughout the Watauga River watershed. In addition, DWQ should reevaluate the HQW management strategies and identify ways to prevent degradation of these waters.

Water Quality Initiatives
Several restoration projects are underway throughout the entire watershed. One project is the Camp Yonahlossee Restoration project, which includes restoring 700 feet of stream channel, enhancing 0.5 acre of a mountain bog and planting a riparian corridor along the streambanks. Project partners include the Division of Water Resources, the NC Cooperative Extension Service Center, Watauga County, Watauga County SWCD, and the Yonaholosee Property Owners Association (POA) with the POA funding nearly one-third of the project total of $253,000. The Watauga County SWCD will oversee the project and provide technical support. The project will be a demonstration project for the surrounding mountain communities. It is estimated that over 400 tons of soil will be saved, reducing sediment loads in Lance Creek [AU# 8-8-(1) and 8-8-(2)], a tributary to the Watauga River.

With help from the U.S. Geological Survey (USGS), the NC Rural Economic Development Center, the High Country Council of Governments, and Appalachian State University (ASU) Geology Department, the Town of Seven Devils is conducting studies related to steep slope hazards. The study also includes an evaluation of water resources and the "carrying capacity" for population growth now and in the future. The results will aid the town and the county in land use decisions and projected water demand.

1.4.9 Cranberry Creek [AU# 8-22-16]

Current Status
Cranberry Creek, from source to the Elk River (4.7 miles), is Not Rated in the aquatic life category due to a Not Rated fish bioclassification at site LF2. Cranberry Creek could not be rated for fish because trout stream-specific criteria and metrics have not been developed. The sampling site is located approximately 0.5 mile above its confluence with the Elk River. There are no permitted discharges in the watershed; however, conductivity was elevated (63 μmhos/cm) for this mountain stream. Overall instream habitat was moderate and consisted of cobble riffles, pools and runs. The number of fish species (6) and number of individuals (93) collected was low, but typical, for a high-gradient trout stream. Brown and rainbow trout were caught and both species has multiple age groups, including young-of-year, indicating reproducing populations.

Land use in the Cranberry Creek watershed is a mix of forest, agriculture and residential. It may be possible that the elevated conductivity levels noted on the day of sampling are associated with failing septic systems and/or straight pipes in the watershed. Within the sampling reach, one side of the stream had stable streambanks and a good riparian corridor; however, the other streambank was unstable, had poor riparian cover, and lawns were mowed down to the stream's edge.

2007 Recommendations
DWQ will continue to monitor Cranberry Creek and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to demonstrate the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Septic systems should be maintained and straight pipes (if any) eliminated. DWQ will work with the NC Wastewater Discharge Elimination Program (WaDE) and the local health department to identify failing septic systems and straight pipes. Because Cranberry Creek is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

1.4.10 Elk River [AU# 8-22-(3) and AU# 8-22-(14.5)]

Current Status
The Elk River, from Sugar Creek to the North Carolina – Tennessee state line (12.3 miles), is Supporting in the aquatic life category due to a Good-Fair and Good benthic bioclassification at sites LB7 and LB6, respectively. Sampling at both basinwide sites, however, noted a decline in aquatic communities. Site LB7 received Good benthic bioclassifications in 1994 and 1999 but declined to a Good-Fair in 2004. Site LB6 received Excellent benthic bioclassifications in 1994 and 1999 but declined to a Good in 2004. Conductivity was also elevated at both locations (82 and 83 µmhos/cm, respectively) in 2004. The decline in the aquatic community is most likely associated with new construction activities throughout the Elk River watershed.

Site LB7 is located just upstream of the Town of Banner Elk. Here, the substrate is highly embedded, consists of a high amount of silt and sand (45 percent), and is not favorable to benthic colonization. Stormwater runoff from the surrounding residential and impervious land cover likely contributed to the decline in bioclassification.

Site LB6 is located 1.3 miles upstream of the state line, near the confluence with Mill Creek. Sand comprised nearly 30 percent of the substrate here, but there was less silt than at site LB7. The substrate was less embedded than the upstream sampling reach (LB7). Despite little shade and periphyton growth (indication of nutrient enrichment), there was a mix of tolerant and intolerant benthic macroinvertebrates collected at this site and several intolerant species were collected for the first time.

The Elk River also received a Not Rated fish bioclassification at site LF3 because trout stream-specific criteria and metrics have not been developed. The sampling location is located just downstream of the Town of Banner Elk. Three permitted NPDES discharge facilities are located upstream. None of these facilities have violated permit limits during the last two years of the assessment period. Substrate consisted mainly of cobble with some boulders and gravel.

Overall, instream habitat was good, consisting of runs and riffles. The riparian corridor was fairly open and was primarily grass cover. Even though two wild species of trout (rainbow and brown) were caught in this segment of the Elk River, this mountain stream no longer exhibits natural trout stream characteristics. Characteristics of Southern Appalachian type trout streams include the presence of plunge pools, low conductivity, elevation, clear and swift waters, and vegetated (shaded) riparian zones.

2007 Recommendations

DWQ will continue to monitor the Elk River and work with local agencies to encourage appropriate agricultural and residential stormwater BMPs. Public education is also needed to show the importance of good riparian zones and the use of BMPs to reduce habitat degradation and impacts from stormwater runoff. Because the Elk River is designated Tr by DWQ, extra precautions (i.e., buffer requirements and temperature controls) need to be taken to protect the fisheries in the watershed.

Water Quality Initiatives

To protect water quality in the Town of Banner Elk, the town installed a stormwater collection system, which includes a 150,000-gallon underground detention/storage vault and treatment wetlands. The project was installed during 2001 and has become a demonstration project for many mountain communities. Stormwater from the 65-acre downtown area is collected and transported via the stormwater collection system (curb and gutters) to the underground detention vault where it is stored and cooled. Sediment and debris settle out in the vault before it is released to the wetlands at a controlled rate to prevent flooding. The treatment wetlands then trap additional sediment and pollutants before flowing into Shawneehaw Creek [AU# 8-22-7], a tributary to the Elk River. Funding for the Banner Elk stormwater collection system and wetlands was provided by the Blue Ridge Resource Conservation & Development (RC&D) Council, the Clean Water Management Trust Fund (CWMTF) and the Town of Banner Elk. Funding was also used to establish a 1.3-mile greenway along Shawneehee Creek.

The NC Ecosystem Enhancement Program (NCEEP) has implemented one stream mitigation project in the Elk River watershed. It is located on Hanging Rock Creek [AU# 8-22-5], a 2.6-mile tributary to the Elk River, just outside the Town of Banner Elk. The project consisted of approximately 2,800 feet of stream restoration and 1,000 feet of stream enhancement. NCEEP project is in the third year of post-construction monitoring. For more information about NCEEP water quality initiatives, see Section 10.3.1.

1.5 Additional Water Quality Issues within Subbasin 04-02-01

The previous sections discussed water quality concerns for specific stream segments. The following section discusses issues that may threaten water quality in the subbasin that are not specific to particular streams, lakes or reservoirs. The issues discussed may be related to waters near certain land use activities or within proximity to different pollution sources.

This section also discusses ideas, rules and practices in place to preserve and maintain the pristine waters of the Watauga River basin. This is particularly important since many of the waters are designated as high quality or outstanding resource waters (HQW and ORW, respectively). Special management strategies, or rules, are in place to better manage the

cumulative impact of pollutant discharges, and several landowners have voluntarily participated in land conservation, stabilization, and/or restoration projects.

1.5.1 Biological Assessments Post-Hurricane

During a three-week period in September 2004, the storm remnants of three hurricanes (Frances, Ivan and Jeanne) lead to widespread flooding throughout the central and northern mountains of western North Carolina. Rainfall estimates for the combined three storms totaled more than 20 to 30 inches in some watersheds. Runoff from the storms produced flash floods throughout the region with peak flows in the excess of 10,000 cubic feet per second (cfs) in the headwater streams. For many streams, this is approximately 500 times the average flow. Some of the rivers exceeded 50,000 cfs. Several of the peak stream flows were within the 25 to 50 year recurrence interval. Others were within the 200 to 500 year recurrence interval with a few even surpassing the 500-year recurrence interval. Many of the instream and riparian habitats were affected by flash floods and included:

- Scoured substrates;
- Displaced and/or removed sediment and silts;
- Eroded and denuded streambanks;
- Eroded gravel bars;
- Damaged instream and riparian vegetation; and
- Deposition of household debris.

Flooding was particularly acute in the Watauga River near Valle Crucis. Even though the flooding inundated supply stores, petroleum storage facilities and wastewater treatment plants, there were no significant fish kills greater than 25 fish reported during or after the floods (DWQ, April 2005).

To assess the biological impacts of the hurricanes, DWQ staff requested a post-hurricane special study. Two sites were selected for sampling and included Cove Creek and the Watauga River near Sugar Grove. Both are basinwide sampling sites and are discussed in Sections 1.4.5 and 1.4.8, respectively. The data collected during the post-hurricane surveys was collected outside of the assessment period and was not used for use support determinations. Information collected during this special study will be used during the next assessment period (September 2004 through August 2009).

1.5.2 Emergency Watershed Protection (EWP) Projects

The Emergency Watershed Protection (EWP) Program is designed to remove threats to life and property in the nation's watershed in the aftermath of natural disasters such as floods, hurricanes, tornadoes, wildfires, drought, windstorms, and volcanic activities. The EWP Program is administered by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and provides technical and financial assistance to local sponsoring authorities (i.e., city, county, conservation district, state agency). Funds available through the EWP Program can cover up to 75 percent of the construction cost of emergency measures or up to 90 percent in limited resource areas. The remaining cost share must come from local sources and can be in the form of cash or in-kind services. Projects that can be addressed through EWP

include debris-clogged stream channels, undermined and unstable streambanks, damaged upland sites stripped of protective vegetative cover, and water control structures and public infrastructures that jeopardize the health and safety of downstream life and resources (USDA NRCS, December 2004). EWP projects in North Carolina have typically involved stream debris removal, streambank stabilization, revegetation, and stabilization of landslide areas where the impairment posed a threat to life and/or property.

The remnants of three hurricanes in September 2004 caused widespread damage throughout Avery and Watauga County. Avery County received a total of $3.2 million for EWP projects. A total of $720,000 was spent in the Elk River Watershed of the Watauga River basin. Several contiguous projects were along the Elk River while several smaller projects were along tributaries to the river. Repair included streambank stabilization, debris removal and plantings to replace lost vegetation. Watauga County received approximately $1.3 million for EWP projects. Repairs included debris removal, streambank stabilization, and landslide stabilization. For more information about the EWP Program, visit http://www.nrcs.usda.gov/programs/ewp/.

1.5.3 Management Strategies for Water Quality Protection

Municipalities and smaller outlying communities are continuing to expand. This can involve construction and land-disturbing activities in areas of pristine waters throughout the region. High Quality Water (HQW) and Outstanding Resource Water (ORW) are supplemental classifications to the primary freshwater classification(s) placed on a waterbody. Management strategies are associated with the supplemental HQW and ORW classifications that are intended to protect water quality. Below is a brief summary of these strategies and the administrative code under which the strategies are found. More detailed information can be found in the document entitled *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina* (NCDENR-DWQ, 2004). This document is available on-line at www.ncwaterquality.org/admin/rules/codes_statutes.htm. Definitions of the primary and supplemental classifications can be found in Chapter 2.

In waters classified as HQW, new discharges and expansions of existing discharges may, in general, be permitted provided that the required tertiary effluent limits are met. New discharges must be able to provide treatment for oxygen consuming wastes, total suspended solids, nutrients, and toxic substances. In addition, new facilities must have emergency systems in place. The total volume from all of the discharges in the receiving stream cannot exceed the total instream flow under summer low flow (7Q10) conditions. If there is an increase in permitted pollutant loading, expanding NPDES WWTP facilities must be able to provide the same treatment as new facilities. In some cases, more stringent limitations are set to ensure that the cumulative effects from all discharges with oxygen consuming wastes do not decrease dissolved oxygen and biochemical oxygen demand below background levels. Discharges from new single-family residential structures into surface waters are prohibited. When a discharge from an existing single-family home fails and no other treatment option is available, a septic tank, dual or recirculation sand filters, disinfection, and step aeration should be installed (15A NCAC 2B .0224). HQWs are rated as excellent based on biological and physical/chemical characteristics, designated by NC Wildlife Resources Commission (WRC) as native and special trout waters, or are classified as SA, WS-I or WS-II.

Like HQWs, ORWs are rated excellent based on biological and physical/chemical characteristics, but they also have an outstanding resource value (e.g., outstanding fish habitat and fisheries, unusually high levels of water-based recreation, special ecological or scientific significance). No new discharge or expansions on existing discharges are permitted in watersheds designated as ORW (15A NCAC 2B .0225).

In accordance with rules established by the NC Sedimentation Control Commission, any proposed construction projects disturbing more than one acre of land are required to submit a sediment/erosion control plan to the Division of Land Resources (DLR) Land Quality Section (LQS) or the locally administered sediment/erosion control program. When the project is near a waterbody, DLR notifies DWQ and more stringent development standards may be required as part of the sediment/erosion control plan approval process. To ensure the protection of HQW and ORW waters, projects are permitted under the following stormwater management options:

Low Density Option: This option is permitted when the built upon area is less than 12 percent of the total land area or the proposed development is for single-family residential homes on lots one acre or greater. Stormwater must be transported by vegetated conveyances and cannot lead to a discrete stormwater collection system (e.g., a constructed collection system such as a wet detention pond). Thirty-foot vegetated buffers must remain between the development activities and the stream.

High Density Option: The high density option is used when the built upon area is greater than 12 percent of the total land area or the proposed development is for single-family residential homes on lots less than one acre. Structural stormwater controls must be constructed (i.e., wet detention ponds, stormwater infiltration systems, innovative systems) and must be designed to control runoff from all surfaces affected by one inch of rainfall or more.

In addition, more stringent stormwater management measures may be required on a case-by-case basis where it is determined additional measures are needed to protect and maintain existing and anticipated uses of the water. When DWQ receives a request for a permit for a discharge from a new subdivision, construction of a new sewer line, or for a 401 certification, DWQ determines the stream classification and notifies the local government and the applicant of these requirements. Rules associated with stormwater management can be found in 15A NCAC 2H .1000.

1.5.4 Best Management Practices – Christmas Tree Conservation Cover

Christmas tree production in western North Carolina is an important industry generating nearly $100 million in yearly wholesale income. An estimated 2,000 Christmas tree growers are growing over 30,000 acres of Christmas trees. Most of the tree plantations in western North Carolina are above 3,000 feet in elevation and are often located on steep, highly erodible slopes (NCSU Cooperative Extension Service, April 2005).

To address sediment, pesticide and nutrient runoff, the NC Agriculture Cost Share Program (NCACSP) adopted a new best management practice (BMP) in March 2003. Under the Christmas Tree Conservation Cover BMP, grass, legumes or other approved plantings should be planted and maintained on fields with no previously established groundcover to reduce soil

erosion and improve water quality. Other improvements include reduced off-site sedimentation and pollution from dissolved and sediment-attached substances.

Between 2003 and 2006, 20.5 acres of Christmas Tree Conservation Cover were installed in the Watauga River basin. NCACSP funding totaled $2,230. For more information on the NCACSP, see Chapter 8. For more information related to Christmas tree production and BMPs, visit http://www.ces.ncsu.edu/fletcher/programs/xmas/.

Chapter 2
North Carolina Water Quality Classifications and Standards

2.1 Description of Surface Water Classifications and Standards

North Carolina's Water Quality Standards Program adopted classifications and water quality standards for all the state's river basins by 1963. The program remains consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters (HQW), and unique and special pristine waters with outstanding resource (ORW) values.

2.1.1 Statewide Classifications

All surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water. In addition to primary classifications, surface waters may be assigned a *supplemental* classification. Most supplemental classifications have been developed to provide special protection to sensitive or highly valued resource waters. Table 5 briefly describes the best uses of each classification. A full description is available in the document titled: *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina* (Administrative Code Section 15A NCAC 2B .0200). Information on this subject is also available at DWQ's website www.ncwaterquality.org/csu/.

2.1.2 Statewide Water Quality Standards

Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the waterbody to support the uses associated with each classification. Some of the standards, particularly for HQW and ORW waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are discussed briefly below. The water quality standards for Class C and SC waters establish the basic protection level applicable to all state surface waters of the state. The other primary and supplemental classifications have more stringent standards than for Class C and SC, and therefore, require higher levels of protection.

Some of North Carolina's surface waters are relatively unaffected by pollution sources and have water quality higher than the standards that are applied to the majority of the waters of the state. In addition, some waters provide habitat for sensitive biota such as trout, juvenile fish, or rare and endangered aquatic species. In the Watauga River basin, many streams hold the supplemental classification of HWQ, ORW, and/or Tr. Below is a brief description of each of these classifications.

High Quality Waters (Class HQW)
There are 32.4 stream miles of HQW waters in the Watauga River basin (Figure 4). HQW management strategies are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. The HQW designation requires that new wastewater discharge facilities and facilities that are expanding beyond the currently permitted loadings

Table 5 Primary and Supplemental Surface Water Classifications

PRIMARY FRESHWATER AND SALTWATER CLASSIFICATIONS	
Class*	**Best Uses**
C and SC	Aquatic life propagation/protection and secondary recreation.
B and SB	Primary recreation and Class C and SC uses.
SA	Suitable for commercial shellfish harvesting and SB and SC uses.
WS	*Water Supply (WS)*: Assigned to watersheds based on land use characteristics. The WS classifications have management strategies to protect the surface water supply. For WS-I through WS-IV, these include limits on point source discharges and local programs to control nonpoint source and stormwater runoff. A WS Critical Area (CA) has more stringent protection measures and is designated within one-half mile from a WS intake or WS reservoir. All WS classifications are suitable for Class C uses.
WS-I	Generally located in natural and undeveloped watersheds.
WS-II	Generally located in predominantly undeveloped watersheds.
WS-III	Generally located in low to moderately developed watersheds.
WS-IV	Generally located in moderately to highly developed watersheds.
WS-V	Generally upstream of and draining to Class WS-IV waters. No categorical restrictions on watershed development or treated wastewater discharges.
SUPPLEMENTAL CLASSIFICATIONS	
Class	**Best Uses**
Sw	*Swamp Waters*: Waters that have low velocities and other natural characteristics that are different from adjacent streams (i.e., lower pH, lower levels of dissolved oxygen).
Tr	*Trout Waters*: Provides protection to freshwaters for natural trout propagation and survival of stocked trout.
HQW	*High Quality Waters*: Waters that have excellent water quality, primary nursery areas and other functional nursery areas. By definition, Class WS-I, WS-II and SA are HQW.
ORW	*Outstanding Resource Waters*: Unique and special waters of exceptional state or national recreational or ecological significance which require special protection.
NSW	*Nutrient Sensitive Waters*: Waters subject to excessive plant growth and requiring limitations on nutrient inputs.

* Primary classifications beginning with "S" are assigned to saltwaters.

address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume, nutrients (in nutrient sensitive waters) and toxic substances.

For nonpoint source pollution, development activities which drain to and are within one mile of HQWs and which require (1) a Sedimentation and Erosion Control Plan in accordance with rules established by the NC Sedimentation Control Commission or (2) an approved local erosion and sedimentation control program must control runoff using either a low-density or high-density option. The low-density option requires a 30-foot vegetated buffer between development activities and the stream; whereas, the high-density option requires structural stormwater controls (i.e., stormwater infiltration system, wet detention ponds). In

Criteria for HQW Classification

- Waters rated as Excellent based on DWQ's chemical and biological sampling.
- Streams designated as native or special native trout waters by the Wildlife Resources Commission (WRC).
- Waters designated as primary nursery areas or other functional nursery areas by the Division of Marine Fisheries.
- Waters classified by DWQ as WS-I, WS-II or SA.

addition, the Division of Land Resources (DLR) requires more stringent erosion controls for land-disturbing projects within one mile of and draining to HQWs.

Outstanding Resource Waters (Class ORW)

There are 10.4 stream miles of ORW waters in the Watauga River basin (Figure 4). These waters have excellent water quality (rated based on biological and chemical sampling as with HQWs) and an associated outstanding resource.

The requirements for ORW waters are more stringent than those for HQWs. Special protection measures that apply to North Carolina ORWs are set forth in Rule 15A NCAC 2B .0225. At a minimum, no new discharges or expansions are permitted, and a 30-foot vegetated buffer or stormwater controls are required for new developments. In the Watauga River basin, ORW management strategies are required in the Boone Fork watershed (Figure 4 and Section 1.4.1)

Outstanding Resource Values for ORW Designation include one or more of the following:

- an outstanding fisheries resource;
- a high level of water-based recreation;
- a special designation such as National Wild and Scenic River or a National Wildlife Refuge;
- within a state or national park or forest; or
- a special ecological or scientific significance.

Primary Recreation (Class B)

There are 43.9 stream miles classified for primary recreation in the Watauga River basin. Waters classified as Class B are protected for primary recreation, include frequent and/or organized swimming, and must meet water quality standards for fecal coliform bacteria. Sewage and all discharged wastes into Class B waters must be treated to avoid potential impacts to the existing water quality.

Trout Waters

There are 141.9 stream miles classified as trout (Tr) waters in the Watauga River basin. Different water quality standards for some parameters, such as dissolved oxygen, temperature and turbidity, have been developed to protect freshwaters for natural trout propagation and survival of stocked trout. These water quality standards result in more restrictive limits for wastewater discharges to trout waters.

There are no watershed development restrictions associated with the trout classification; however, the NC Division of Land Resources (DLR), under the NC Sedimentation and Pollution Control Act (SPCA), has requirements to protect trout streams from land-disturbing activities. Under General Statue 113A-57(1), "waters that have been classified as trout waters by the Environmental Management Commission (EMC) shall have an undisturbed buffer zone 25 feet wide or of sufficient width to confine visible siltation within the twenty-five percent of the buffer zone nearest the land-disturbing activity, whichever is greater." The Sedimentation Control Commission, however, can approve land-disturbing activities along trout waters when the duration of the disturbance is temporary and the extent of the disturbance is minimal. This rule also applies to unnamed tributaries flowing to the affected trout water stream. Further clarification on classifications of unnamed tributaries can be found under Administration Code 15A NCAC 02B .0301(i)(1). For more information regarding land-disturbing activities along designated trout streams, see the DLR website at http://www.dlr.enr.state.nc.us/.

A state fishery management classification, Designated Public Mountain Trout Waters, is administered by the WRC. It provides for public access to streams for fishing and regulates fishing activities (seasons, size limits, creel limits, and bait and lure restrictions). Although many of these waters are also classified Tr by DWQ, this is not the same classification.

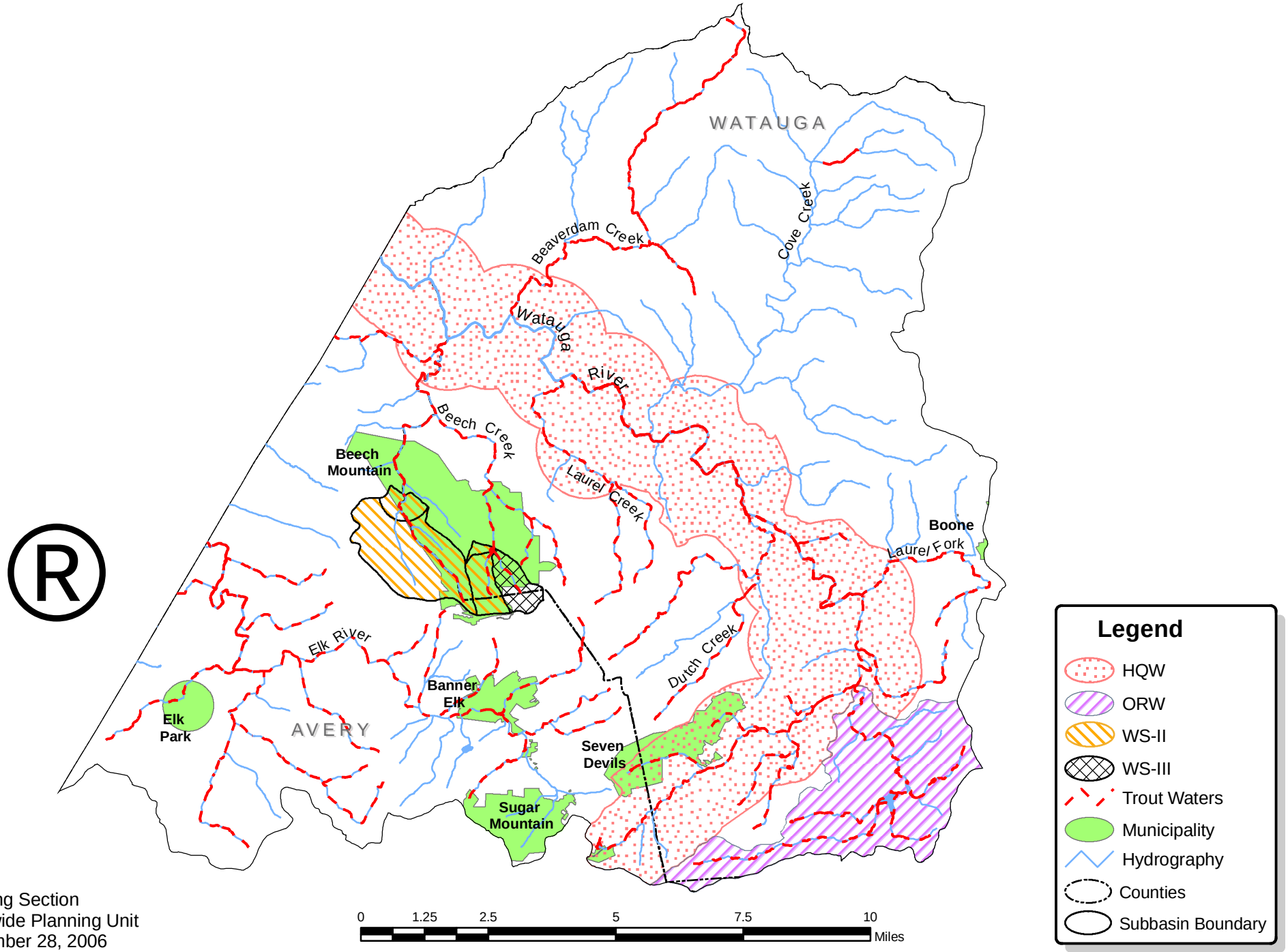
Water Supply Watersheds (Class WS)
There are 7.1 stream miles currently classified for water supply in the Watauga River basin (Figure 4). The purpose of the Water Supply Watershed Protection Program is to provide a proactive drinking water supply protection program for communities. Local governments administer the program based on state minimum requirements. There are restrictions on wastewater discharges, development, landfills and residual application sites to control the impacts of point and nonpoint sources of pollution to water supplies.

There are five water supply classifications (WS-I to WS-V) that are defined according to the land use characteristics of the watershed. The WS-I classification carries the greatest protection for water supplies. No development is allowed in these watersheds. Generally, WS-I lands are publicly owned. WS-V watersheds have the least amount of protection and do not require development restrictions. These are either former water supply sources or sources used by industry. WS-I and WS-II classifications are also HQW by definition because requirements for these levels of water supply protection are at least as stringent as those for HQWs. Those watersheds classified as WS-II through WS-IV require local governments having jurisdiction within the watersheds to adopt and implement land use ordinances for development that are at least as stringent as the state's minimum requirements. A 30-foot vegetated setback is required on perennial streams in these watersheds. The Watauga River basin currently contains WS-II and WS-III water supply watersheds (Figure 4).

2.1.3 Reclassification of Surface Waters

The classification of a surface water may be changed after a request is submitted to the DWQ Classifications and Standards Unit. DWQ reviews each request for reclassification and conducts an assessment of the surface water to determine if the reclassification is appropriate. If it is determined that a reclassification is justified, the request must proceed through the state rule-making process. To initiate a reclassification, the "Application to Request Reclassification of NC Surface Waters" must be completed and submitted to DWQ's Classifications and Standards Unit. For more information on requests for reclassification and contact information, visit http://h2o.enr.state.nc.us/csu/swcfaq.html#ClassChanges.

Figure 4 ORW, HQW, Trout Waters and Water Supply Watershed in the Watauga River Basin



Planning Section
Basinwide Planning Unit
September 28, 2006

Chapter 3
Water Quality Stressors in the Watauga River Basin

3.1 Stressor and Source Identification

3.1.1 Introduction – Stressors

Human activities can negatively impact surface water quality, even when the activity is far removed from the waterbody. The many types of pollution generated by human activities may seem insignificant when viewed separately, but when taken as a whole can be very stressful to aquatic ecosystems. Water quality stressors are identified when impacts have been noted to biological (fish and benthic) communities or water quality standards have been violated. Stressors apply to one or more use support categories and may be identified for Impaired as well as Supporting waters with noted impacts.

Identifying stressors is challenging because direct measurements of the stressor may be difficult or prohibitively expensive. DWQ staff use field observations from sample sites, special studies and data from ambient monitoring stations as well as information from other agencies and the public to identify potential water quality stressors. It is important to identify stressors and potential sources of stressors so that water quality programs can target limited resources to address water quality problems.

Cumulative Effects

While any one activity may not have a dramatic effect on water quality, the cumulative effect of land use activities in a watershed can have a severe and long-lasting impact.

Most stressors to the biological community are complex groupings of many different stressors that individually may not degrade water quality or aquatic habitat, but together can severely impact aquatic life. Sources of stressors are most often associated with land use in a watershed, as well as the quality and quantity of any treated wastewater that may be entering a stream. During naturally severe conditions such as droughts or floods, any individual stressor or group of stressors may have more severe impacts to aquatic life than during normal climatic conditions. The most common source of stressors is from altered watershed hydrology.

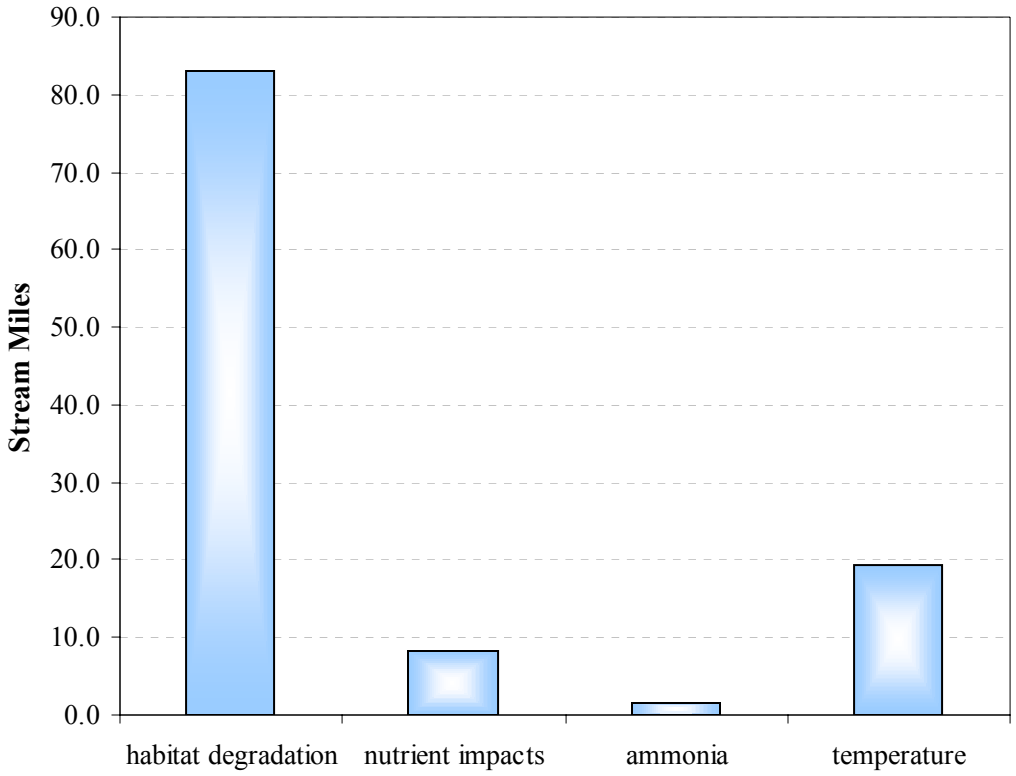
Stressors to recreational uses include pathogenic indicators such as fecal coliform bacteria, escheria coli and enterrococci. Stressors to fish consumption are mercury and any other substance that causes the issuance of a fish consumption advisory by the NC Division of Health and Human Services (NCDHHS).

3.1.2 Overview of Stressors Identified in the Watauga River Basin

The stressors noted below are summarized for all waters and for all use support categories. Figure 5 identifies stressors noted for Impaired streams and streams with noted impacts. The stressors noted in the Figure may not be the sole reason for the impairment or noted impacts. For

specific discussion of stressors to the impaired or noted waters, refer to Chapter 1. Stressor definitions and potential impacts are discussed in the remainder of this chapter (Chapter 3).

Figure 5 Stressors Identified for Impaired Streams and Streams with Noted Impacts in the Watauga River Basin



3.1.3 Introduction – Stressor Sources

Pollutants that enter waters fall into two general categories: *point sources* and *nonpoint sources*.

Point Sources

Piped discharges from:

- Municipal wastewater treatment plants
- Industrial facilities
- Small package treatment plants
- Large urban and industrial stormwater systems

Point sources are typically piped discharges and are controlled through regulatory programs administered by the state. All regulated point source discharges in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state.

Nonpoint sources are from a broad range of land use activities. Nonpoint source pollutants are typically carried to waters by rainfall, runoff, and snowmelt. Sediment and nutrients are most often associated with nonpoint source pollution. Other pollutants associated with nonpoint source pollution include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or deposited from the atmosphere into surface

waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur intermittently, depending on rainfall events and land disturbance. Given these characteristics, it is difficult and resource intensive to quantify nonpoint contributions to water quality degradation in a given watershed.

Nonpoint Sources

- Construction activities
- Roads, parking lots and rooftops
- Agriculture
- Failing septic systems and straight pipes
- Timber harvesting
- Hydrologic modifications

DWQ identifies the source of a stressor, point or nonpoint, as specifically as possible depending on the amount of information available in a watershed. Most often the source is based on the predominant land use in a watershed. Sources of stressors identified in the Watauga River basin during the most recent assessment period include urban or impervious surface runoff, construction, agriculture and pastureland. Point source discharges are also considered a water quality stressor source. In addition to these sources, many impacts originate from unknown sources.

3.1.4 Overview of Stressor Sources Identified in the Watauga River Basin

The sources noted below are summarized for all waters and for all use support categories. Figure 6 identifies sources of stressors noted for waters in the Watauga River Basin during the most recent assessment period. Refer to the subbasin chapter (Chapter 1) for a complete listing and discussion of sources by stream assessment unit number (AU#).

Wastewater treatment plants (WWTP) were noted as a potential stressor source to 13.8 stream miles (8.4 percent) in the Watauga River basin. WWTPs are just one of many sources that can contribute excess nutrients that may increase the potential for algal blooms and cause exceedances in the chlorophyll *a* standard. Better treatment technology and upgrades to facilities in the Watauga River basin are likely to decrease the number of stream miles impacted by WWTPs.

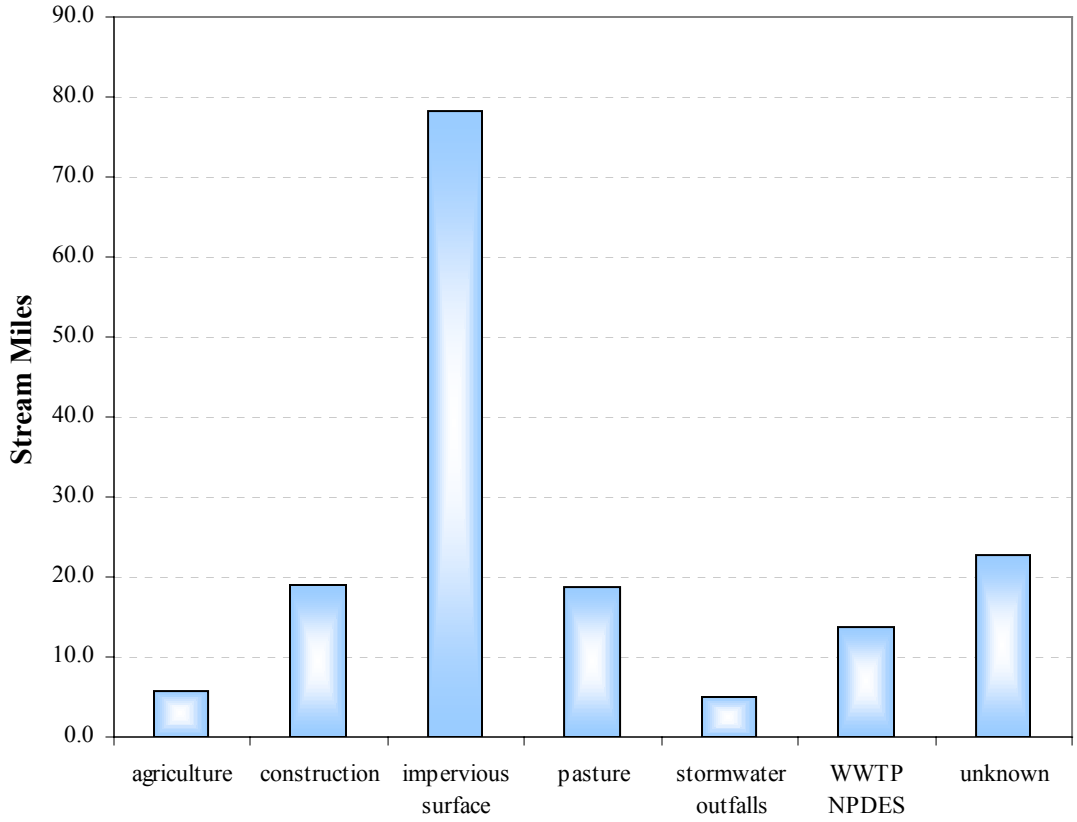
Field observations and information from the local Soil and Water Conservation Districts (SWCD) indicate that agricultural activities may be impacting water quality in several watersheds throughout the Watauga River basin. In several areas where pasture was noted as the predominant land use, cattle had direct, easy access to the stream. Agriculture was noted as a potential stressor source for 5.9 stream miles (3.6 percent). Pasture was noted as a potential stressor source for 18.6 stream miles (11.6 percent. For more information related to agricultural water quality initiatives, refer to Chapter 6.

Impervious surface accounted for noted impacts to 78.3 stream miles (48.0 percent). Impervious surface cover is often associated with increased development. Refer to Chapter 4 for more information related to population growth and land cover changes and its potential impacts on water quality.

Stressor sources could not be identified for 22.8 stream miles (14.0 percent) in the Watauga River basin. These stream segments may be in areas where sources could not be identified during field observations, but the streams had noted impacts (i.e., habitat degradation). DWQ

and the local agencies will work to identify potential sources for these stream segments during the next basinwide cycle.

Figure 6 Sources of Identified Stressors in the Watauga River Basin



3.2 Aquatic Life Stressors – Habitat Degradation

3.2.1 Introduction and Overview

Instream habitat degradation is identified as a notable reduction in habitat diversity or a negative change in habitat. This term includes sedimentation, streambank erosion, channelization, lack of riparian vegetation, loss of pools and/or riffles, loss of organic (woody and leaf) habitat, and streambed scour. These stressors to aquatic insect and fish communities can be caused by many different land use activities and less often by discharges of treated wastewater. In the Watauga River basin, 5.9 stream miles are Impaired and at least one form of habitat degradation has been identified as a stressor. There is an additional 83.1 stream miles where habitat degradation is a noted impact to water quality. Many of the stressors discussed below are either directly caused by or are a symptom of altered watershed hydrology. Altered hydrology increases both sources of stressors and delivery of the stressors to the receiving waters. Refer to the subbasin chapter (Chapter 1) for more information on the types of habitat degradation noted in a particular stream segment.

Good instream habitat is necessary for aquatic life to survive and reproduce. Streams that typically show signs of habitat degradation are in watersheds that have a large amount of land-disturbing activities (i.e., construction, mining, timber harvest, agricultural activities) or a large percentage of impervious surfaces. A watershed in which most of the riparian vegetation has been removed from streams or channelization (straightening) has occurred also exhibits instream habitat degradation. Streams that receive a discharge quantity that is much greater than the natural flow in the stream often have degraded habitat as well.

Some Best Management Practices

Agriculture

- No till or conservation tillage practices
- Strip cropping and contour farming
- Leaving natural buffer areas around small streams and rivers

Construction

- Using phased grading/seeding plans
- Limiting time of exposure
- Planting temporary ground cover
- Using sediment basins and traps

Forestry

- Controlling runoff from logging roads
- Replanting vegetation on disturbed areas
- Leaving natural buffer areas around small streams and rivers

Quantifying the amount of habitat degradation is very difficult in most cases. To assess instream habitat degradation in most streams would require extensive technical and monetary resources and then even more resources to restore them. Although DWQ and other agencies (i.e., SWCD, NRCS, town and county governments) are starting to address this issue, local efforts are needed to prevent further instream habitat degradation and to restore streams that have been impaired by activities that cause habitat degradation. As point source dischargers become less common sources of water quality impairment, nonpoint sources that pollute water and cause habitat degradation must be addressed to further improve water quality in North Carolina's streams and rivers.

3.2.2 Sedimentation

Sedimentation is a natural process that is important to the maintenance of diverse aquatic habitats. It is the process by which soil particles that washed off the landscape and stream banks are deposited within the stream. Streams naturally tend toward a state of equilibrium between erosion and deposition of sediments. As streams meander through their floodplains, the outside of the stream cuts into the bank eroding it away, while the inside of the stream deposits sediments to create sand bars further downstream. The natural process of erosion and deposition can be disrupted by human activities such as dams, dredging, agriculture, development, or logging. Construction projects or logging in the upper reaches of a watershed may worsen erosion or sediment deposition on someone else's property further downstream. If people straighten, narrow, or move stream channels without taking into consideration their natural energy, erosion and sediment deposition rates can increase, resulting in the loss of valuable agricultural land, damage to roads or structures, destruction of productive wetlands, and addition of sediments and nutrients to waterways that can degrade surface water quality and biodiversity.

Overloading of sediment in the form of sand, silt and clay particles fills pools and covers or embeds riffles that are vital aquatic insect and fish habitats. Suspended sediment can decrease primary productivity (i.e., photosynthesis) by shading sunlight from aquatic plants, thereby affecting the overall productivity of a stream system. Suspended sediment also has several effects on various fish species including avoidance and redistribution, reduced feeding efficiency

which leads to reduced growth by some species, respiratory impairment, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, 1999). Sediment filling rivers and streams decreases their storage volume and increases the frequency of floods (NCDENR-DLR, 1998). Suspended sediment also increases the cost of treating municipal drinking water.

Streambank erosion and land-disturbing activities are sources of sedimentation. Streambank erosion is often caused by high stormwater flows immediately following rainfall events or snowmelts. Watersheds with large amounts of impervious surface transport water to streams more rapidly and at higher volumes than in watersheds with more vegetative cover. In many urban areas, stormwater is delivered directly to the stream by a stormwater sewer system. This high volume and concentrated flow of water after rain events undercuts streambanks often causing streambanks to collapse. This leads to large amounts of sediment being deposited into the stream. Many urban streams are adversely impacted by sediment overloading from the watershed as well as from the streambanks. Minimizing impervious surface area and reducing the amount of stormwater outlets releasing stormwater directly to the stream can often prevent substantial amounts of erosion.

Land-disturbing activities such as the construction of roads and buildings, crop production, livestock grazing, and timber harvesting can accelerate erosion rates by causing more soil than usual to be detached and moved by water. In most land-disturbing activities, sedimentation can be controlled through the use of appropriate best management practices (BMPs). BMPs that minimize the amount of acreage and length of time that the soil is exposed during land-disturbing activities can greatly reduce the amount of soil erosion. For more information on sedimentation as it relates to changes in land use, refer to Chapter 4.

Livestock grazing with unlimited access to the stream channel and banks can also cause severe streambank erosion resulting in sedimentation and degraded water quality. Although they often make up a small percentage of grazing areas by surface area, riparian zones (vegetated stream corridors) are particularly attractive to cattle that prefer the cooler environment and lush vegetation found beside rivers and streams. This concentration of livestock can result in increased sedimentation of streams due to "hoof shear", trampling of bank vegetation, and entrenchment by the destabilized stream. Despite livestock's preference for frequent water access, farm veterinarians have reported that cows are healthier when stream access is limited (EPA, 1999). For more information on the livestock exclusion, refer to Chapter 6.

3.2.3 Loss of Riparian Vegetation

During the 2004 basinwide sampling, DWQ biologists reported degradation of aquatic communities at several sites throughout the Watauga River basin in association with narrow or nonexistent zones of native riparian vegetation. Riparian vegetation loss was common in rural and residential areas as well as in urban areas (NCDENR-DWQ, 2005). The loss of riparian vegetation and subsequent reduction of organic aquatic habitats (Section 5.2.4) is most commonly associated with land clearing for development, agriculture, pastureland and forestry. Instream organic habitat loss has also been caused by stream channelization or debris removal activities.

Removing trees, shrubs and other vegetation to plant grass or place rock (also known as riprap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for trout and other fish. Rocks lining a streambank absorb the sun's heat and warm the water. Some fish require cooler water temperatures as well as the higher levels of dissolved oxygen cooler water provides. Trees, shrubs and other native vegetation cool the water by shading it. Straightening a stream, clearing streambank vegetation, and lining the streambanks with grass or rock severely impact the habitat that aquatic insects and fish need to survive.

Establishing, conserving and managing streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. Forested buffers in particular provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). Contact DWQ for a free copy of the *Buffers for Clean Water* brochure or visit the DWQ website to download the document (www.ncwaterquality.org/Wateryouknow.htm).

3.2.4 Loss of Instream Organic Microhabitats

Organic microhabitat (i.e., leafpacks, sticks and large wood) and edge habitat (i.e., root banks and undercut banks) play very important roles in a stream ecosystem. Organic matter in the form of leaves, sticks and other materials serve as the base of the food web for small streams. Additionally, these microhabitats serve as special niches for different species of aquatic insects, providing food and/or habitat. For example, many stoneflies are found almost exclusively in leafpacks and on small sticks. Some beetle species prefer edge habitat, such as undercut banks. If these microhabitat types are not present, there is no place for these specialized macroinvertebrates to live and feed. The absence of these microhabitats in some streams in the Watauga River basin is directly related to the absence of riparian vegetation. Organic microhabitats are critical to headwater streams, the health of which is linked to the health of the entire downstream watershed. For more information related to headwater streams, refer to Chapter 4.

3.2.5 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Typical modifications are described in the text box. Although increased flooding, streambank erosion and channel instability often occur in downstream areas after channelization has occurred, flood control, reduced erosion, increased usable land area, greater navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996). Direct or immediate biological effects of channelization include injury and mortality of aquatic insects, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in the aquatic insect, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996).

Restoration or recovery of channelized streams may occur through processes, both naturally and artificially induced. In general, streams that have not been excessively stressed by the

channelization process can be expected to return to their original forms. However, streams that have been extensively altered may establish a new, artificial equilibrium (especially when the channelized streambed has been hardened). In such cases, the stream may enter a vicious cycle of erosion and continuous entrenchment. Once the benefits of a channelization project become outweighed by the costs, both in money and environmental integrity, channel restoration efforts are likely to be taken (McGarvey, 1996).

Typical Channel Modifications

- Removal of any obstructions, natural or artificial, that inhibit a stream's capacity to convey water (clearing and snagging).
- Widening, deepening or straightening of the channel to maximize conveyance of water.
- Lining the bed or banks with rock or other resistant materials.

Channelization of streams within the continental United States is extensive and promises to become even more so as urban development continues. Overall estimates of lost or altered riparian habitats within US streams are as high as 70 percent. Unfortunately, the dynamic nature of stream ecosystems makes it difficult (if not impossible) to quantitatively predict the effects of channelization (McGarvey, 1996). Channelization has historically occurred in parts of the Watauga River basin and continues to occur in some watersheds, especially in small headwater streams.

3.2.6 Dams

The consensus among river ecologists is that dams are the single greatest cause of the decline of river ecosystems (World Commission on Dams, 2000). By design, dams alter the natural flow regime, and with it virtually every aspect of a river ecosystem, including water quality, sediment transport and deposition, fish migrations and reproduction, and riparian and floodplain habitat and the organisms that rely on this habitat (Raphals, 2001). Dams also require ongoing maintenance. For example, reservoirs in sediment-laden streams lose storage capacity as silt accumulates in the reservoir.

Dams cause significant adverse impacts to the ecology of rivers and streams by blocking migration of fish to upriver spawning habitat; warming water temperatures in impoundments well above downstream conditions and accumulating sediment, which degrades water quality and often buries high quality fisheries habitat.

The siting of dams can lead to the loss of habitat resulting from the inundation of wetlands, riparian areas, and farmland in upstream areas of the impounded waterway, or erosion of these resources in downstream areas. As dams trap sediment and other pollutants, changes in water quality especially in tailwaters and downstream areas occur. They include: reduced sediment transport, decreased dissolved oxygen, altered temperature regimes, and increased levels of some pollutants, such as hydrogen sulfide, nutrients, and manganese.

Once streams are impounded, water demand dictates the artificial regulation and control of streamflow. The new flow rates and volume often do not reproduce natural conditions preceding the impoundment. Releases of impounded water with decreased levels of dissolved oxygen, high turbidity, or altered temperature can reduce downstream populations of fish and other organisms. Not only can reservoir water temperatures and oxygen content differ significantly from expected seasonal temperatures in the formerly free-flowing stream or river, but critical minimum flows

needed for riparian areas are often not maintained as well. Decreased flow in coastal areas can also increase saltwater intrusion and produce changes in the ecosystem (EPA, 1995).

3.2.7 Recommendations for Reducing Habitat Degradation

In March 2002, the Environmental Management Commission (EMC) sent a letter to the Sedimentation Control Commission (SCC) expressing seven recommendations for improving erosion and sedimentation control, based on a comprehensive performance review of the turbidity standard conducted in 2001 by DWQ staff. Specifically, the recommendations are that the EMC and SCC:

(1) Evaluate, in consultation with the Attorney General's Office, whether statutory authority is adequate to mandate temporary ground cover over a percentage of the uncovered area at a construction site within a specific time after the initial disturbance of the area. If it is found that statutory authority does not exist, then the EMC and SCC should prepare resolutions for the General Assembly supporting new legislation to this effect.

(2) Prepare resolutions supporting new legislation to increase the maximum penalty allowed in the Sedimentation Pollution Control Act from $5,000 to $25,000 for the initial response to a noncompliant site.

(3) Jointly support a review of the existing Erosion and Sediment Control Planning and Design Manual by the NC Division of Land Resources (DLR). This review should include, but not be limited to, a redesign of the minimum specifications for sedimentation basins.

(4) Evaluate, in consultation with the Attorney General's Office, whether the statutory authority is adequate for effective use of the "Stop Work Order" tool and, if found not to be adequate, to prepare resolutions for the General Assembly supporting new legislation that will enable staff to more effectively use the "Stop Work Order" tool.

(5) Support increased research into and experimentation with the use of polyacrylamides (PAMs) and other innovative soil stabilization and turbidity reduction techniques.

(6) Jointly support and encourage the awarding of significant monetary penalties for all activities found to be in violation of their Stormwater Construction General Permit, their Erosion and Sediment Control Plan, or the turbidity standard.

(7) Hold those individuals who cause serious degradation of the environment through excessive turbidity and sedimentation ultimately responsible for restoration of the area.

DWQ will continue to work cooperatively with DLR and local programs that administer sediment control in order to maximize the effectiveness of the programs and to take appropriate enforcement action when necessary to protect or restore water quality. However, more voluntary implementation of BMPs is needed for activities that are not subject to these rules in order to substantially reduce the amount of widespread sedimentation present in the Watauga River basin.

Additionally, more public education is needed basinwide to educate landowners about the value of riparian vegetation along small tributaries and the impacts of sedimentation to aquatic life.

Funding is available through numerous federal and state programs for landowners to restore and/or protect riparian buffer zones along fields or pastures, develop alternative watering sources for livestock, and fence animals out of streams (refer to Chapters 6 and 10). EPA's *Catalog of Federal Funding Sources for Watershed Protection* (Document 841-B-99-003) outlines some of these and other programs aimed at protecting water quality. A copy may be obtained by calling the National Center for Environmental Publications and Information at (800) 490-9198 or by visiting the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix VIII.

3.3 Aquatic Life Stressors – Water Quality Standards

3.3.1 Introduction and Overview

In addition to the habitat stressors discussed in the previous section, water quality standards are usually direct measurements of water quality parameters from ambient water quality monitoring stations. The water quality standards are designed to protect aquatic life. As with habitat degradation, altered watershed hydrology greatly increases the sources of these stressors as well as delivery of the stressors to the receiving waters. No water quality standards were violated in the Watauga River basin during the most recent assessment period; however, elevated temperature was identified as an aquatic life stressor in mainstem of the Watauga River.

3.3.2 Temperature

All aquatic species require specific temperature ranges in order to be healthy and reproduce. For example, trout prefer temperatures below 20 degrees C (68 degrees F) and cannot survive in the warm reservoirs of the piedmont and coastal plain where temperatures can exceed 30 degrees C (86 degrees F). An aquatic species becomes stressed when water temperatures exceed their preferred temperature range, and stressed fish are more susceptible to injury and disease.

In the Watauga River basin, the ambient monitoring stations in the Watauga River indicate that water temperature occasionally exceeds the preferred range for trout in a 19.5-mile segment. While these excursions do not constitute water quality impairment, they do suggest that precautions should be taken to ensure stream temperature is not elevated by human activities. Human activities most likely to contribute to temperature increases in the Watauga River basin include removal of shade trees along streambanks and construction of private dams and ponds. In both cases, more sunlight reaches the stream causing an increase in water temperature. Impervious surface cover also has the potential to increase water temperature. Rain that falls onto impervious surfaces absorbs heat, and the heated stormwater is transferred to nearby streams.

3.3.3 Other Aquatic Life Stressors

Other noted stressors to aquatic life are identified from WWTP NPDES compliance reports. Waters are not Impaired due to permit violations; however, these violations can be noted as

potential stressors on the system. In the Watauga River basin, ammonia was identified as a potential stressor on 1.6 stream miles during this assessment period.

3.4 Recreation Stressor

3.4.1 Fecal Coliform Bacteria

Fecal coliform bacteria live in the digestive tract of warm-blooded animals (humans as well as other mammals) and are excreted in their waste. Fecal coliform bacteria do not actually pose a danger to people or animals. However, where fecal coliform are present, disease-causing bacteria may also be present and water that is polluted by human or animal waste can harbor other pathogens that may threaten human health. Pathogens associated with fecal coliform bacteria can cause diarrhea, dysentery, cholera and typhoid fever in humans. Some pathogens can also cause infection in open wounds.

The presence of disease-causing bacteria tends to affect humans more than aquatic creatures. High levels of fecal coliform bacteria can indicate high levels of sewage or animal wastes that could make water unsafe for human contact (swimming). Fecal coliform bacteria and other potential pathogens associated with waste from warm-blooded animals are not harmful to fish or aquatic insects. However, high levels of fecal coliform bacteria may indicate contamination that increases the risk of contact with harmful pathogens in surface waters.

Under favorable conditions, fecal coliform bacteria can survive in bottom sediments for an extended period of time (Howell et *al*., 1996; Sherer et *al*., 1992; Schillinger and Gannon, 1985). Therefore, concentrations of bacteria measured in the water column can reflect both recent inputs as well as the resuspension of older inputs.

Reducing fecal coliform bacteria in wastewater requires a disinfection process, which typically involves the use of chlorine and other disinfectants. Although these materials may kill the fecal coliform bacteria and other pathogenic disease-causing bacteria, they also kill bacteria essential to the proper balance of the aquatic environment, and therefore, endanger the survival of species dependent on those bacteria.

There are a number of factors beyond the control of any state regulatory agency that contribute to elevated levels of disease-causing bacteria. Therefore, the state does not encourage swimming in surface waters. To assure that waters are safe for swimming indicates a need to test waters for pathogenic bacteria. Although fecal coliform standards have been used to indicate the microbiological quality of surface waters for swimming and shellfish harvesting for more than 50 years, the value of this indicator is often questioned. Evidence collected during the past several decades suggests that the coliform group may not adequately indicate the presence of pathogenic viruses or parasites in water.

Sources of Fecal Coliform in Surface Waters

- Urban stormwater
- Wild animals and domestic pets
- Improperly designed or managed animal waste facilities
- Livestock with direct access to streams
- Improperly treated discharges of domestic wastewater, including leaking or failing septic systems and straight pipes

The detection and identification of specific pathogenic bacteria, viruses and parasites such as *Giardia*, *Cryptosporidium* and *Shigella* are expensive, and results are generally difficult to reproduce quantitatively. Also, to ensure the water is safe for swimming would require a whole suite of tests for many organisms, as the presence/absence of one organism would not document the presence/absence of another. This type of testing program is not possible due to resource constraints.

Water quality standards for fecal coliform bacteria are intended to ensure safe use of waters for recreation and shellfish harvesting (Administrative Code 15A NCAC 2B .0200). The North Carolina fecal coliform standard for freshwater is 200 colonies/100ml based on the geometric mean of at least five consecutive samples taken during a 30-day period and not to exceed 400 colonies/100ml in more than 20 percent of the samples during the same period.

No waters in the Watauga River basin are Impaired for fecal coliform bacteria.

3.5 Fish Consumption Stressor

3.5.1 Mercury

The presence and accumulation of mercury in North Carolina's aquatic environment are similar to contamination observed throughout the country. Mercury has a complex life in the environment, moving from the atmosphere to soil, to surface water, and eventually, to biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway for mercury in the environment is through the atmosphere. Mercury emitted from industrial and municipal stacks into the ambient air can circulate around the globe. At any point, mercury may then be deposited onto land and water. Once in the water, mercury can accumulate in fish tissue and humans. Mercury is also commonly found in wastewater; however, mercury in wastewater is typically not at levels that could be solely responsible for elevated fish levels

Fish is part of a healthy diet and an excellent source of protein and other essential nutrients; however, nearly all fish and shellfish contain trace levels of mercury. The risks from mercury in fish depend on the amount of fish eaten and the levels of mercury in the fish. In March 2003, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) issued a joint consumer advisory for mercury in fish and shellfish. The advice is for women who might become pregnant, women who are pregnant, nursing mothers, and young children. Aside from being issued jointly by two federal agencies, this advisory is important because it emphasizes positive benefits of eating fish and gives examples of commonly eaten fish that are low in mercury. In the past, the FDA issued an advisory on consumption of commercially caught fish, while the EPA issued advice on recreationally caught fish.

By following these three recommendations for selecting and eating fish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury. These recommendations are:

- **Do not eat** shark, swordfish, king mackerel, or tilefish. They contain high levels of mercury.
- Eat up to 12 ounces (two average meals) a week of a variety of fish and shellfish that are lower in mercury. Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish. Another commonly eaten fish, albacore ("white") tuna, has more mercury than canned light tuna. When choosing your two fish meals, you may eat up to 6 ounces (one average meal) of albacore per week.
- Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters. Don't consume any other fish during that week.

For more detailed information, visit EPA's website at http://www.epa.gov/waterscience/fish/ or visit the FDA at http://www.cfsan.fda.gov/seafood1.html. The FDA's food information toll-free phone number is 1-888-SAFEFOOD.

The NC Department of Health and Human Services (NCDHHS) also issues fish consumption advisories and advice for those fish species and areas at risk for contaminants. NCDHHS notifies people to either limit consumption or avoid eating certain kinds of fish. While most freshwater fish in North Carolina contain very low levels of mercury and are safe to eat, several species have been found to have higher levels. More information regarding use support assessment methodology related to fish consumption advisories and advice can be found in Appendix IX.

Due to high levels of mercury in seventeen saltwater and five freshwater fish species, the NCDHHS offers the following health advice (updated March 2006).

Women of childbearing age (15 to 44 years), pregnant women, nursing women, and children under 15:

- **Do not eat** the following ocean fish: almaco jack, banded rudderfish, canned white tuna (albacore tuna), cobia, crevalle jack, greater amberjack, south Atlantic grouper (gag, scamp, red, and snowy), king mackerel, ladyfish, little tunny, marlin, orange roughy, shark, Spanish mackerel, swordfish, tilefish, or tuna (fresh or frozen).
- **Do not eat** the following freshwater fish: bowfin (blackfish), catfish (caught wild), chain pickerel (jack fish), or warmouth caught in North Carolina waters south and east of Interstate 85.
- **Do not eat** largemouth bass caught in North Carolina waters (statewide).
- Eat up to two meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

All other people:

- Eat no more than one meal (6 ounces) per week of ocean and/or freshwater fish listed above. These fish are often high in mercury.
- Eat up to four meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

For more information and detailed listing of site-specific advisories, visit the NCDHHS website at http://www.schs.state.nc.us/epi/fish/current.html or call (919) 733-3816.

Chapter 4
Population Growth, Land Cover Changes and Water Quality in Western North Carolina

Once one of the most remote and sparsely populated regions of the state, western North Carolina is now penetrated by modern interstates and highways that provide speedy access to the deepest folds of the rugged terrain. This improved access coupled with an abundance of recreational opportunities, cultural activities, and countless other amenities sets the stage for rapid population increases. With this growth comes increased pressure on the natural environment. Every person living in or visiting a watershed contributes to impacts on water quality. If water pollution is to be eliminated, each individual should be aware of these contributions and take actions to reduce them. The following section describes the most common impacts of human activity and offers suggestions to lessen those impacts.

4.1 Impacts of Population Growth and Land Cover Changes

4.1.1 Rapid Urbanization

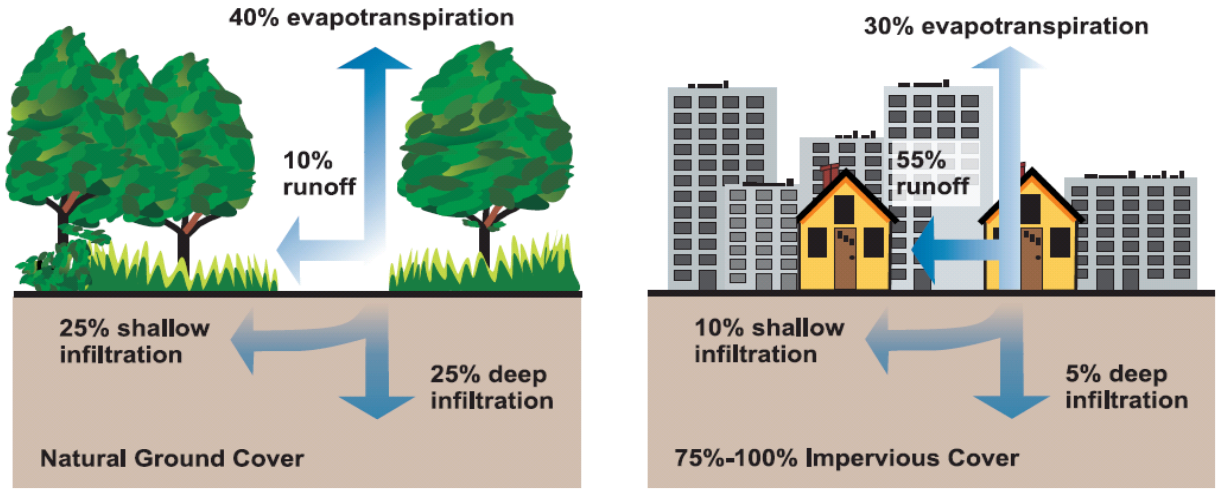
Population growth results in dramatic impacts on the natural landscape. The most obvious impact is the expansion of urban and suburban areas. New stores, roads, and subdivisions are products of growing populations. What is not so obvious is the astonishing rate at which rural landscapes are converted to developed land. Between 1982 and 1997, the United States population increased by 15 percent. Over the same period, developed land increased by 34 percent – more than double the rate of population growth (NRI, 2001; U.S. Census Bureau, 2000). Locally, the trend can be even more pronounced. For example, the urban area of Charleston, SC expanded 250 percent between 1973 and 1994 while its population grew by 40 percent (Allen and Lu, 2000).

County populations in the Watauga River basin are expected to grow by over 10 percent between 2000 and 2020 (Appendix I). If development patterns follow the trends described above, this will likely result in an increase in developed land. Such an increase in developed land poses a significant threat to water quality and stream health because it will be accompanied by a similar increase in impervious surfaces.

Impervious surfaces are materials that prevent infiltration of water into the soil and include roads, rooftops, and parking lots. Impervious surfaces alter the natural hydrology, prevent the infiltration of water into the ground, and concentrate the flow of stormwater over the landscape. In undeveloped watersheds, stormwater filters down through the soil, replenishing groundwater quantity with water of good quality.

Vegetation holds down the soil, slows the flow of stormwater over land, and filters out some pollutants, by both slowing the flow of the water and trapping some pollutants in the root system. As the imperviousness of a watershed increases, the greater volume of stormwater increases the possibility of flooding and reduces the potential for pollutants to settle out, meaning that more pollution is delivered to drinking water streams and aquifers. Too much paving and hardening of

Figure 7 Impervious Cover and Surface Runoff (EPA, 2003)



Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface ruunoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

a watershed can reduce infiltration and groundwater levels which in turn can decrease the availability of aquifers, streams and rivers for drinking water supplies (Kauffman and Brant, 2000). It is well established that stream degradation begins to occur when 10 percent or more of a watershed is covered with impervious surfaces (Figure 7) (Schueler, 1995).

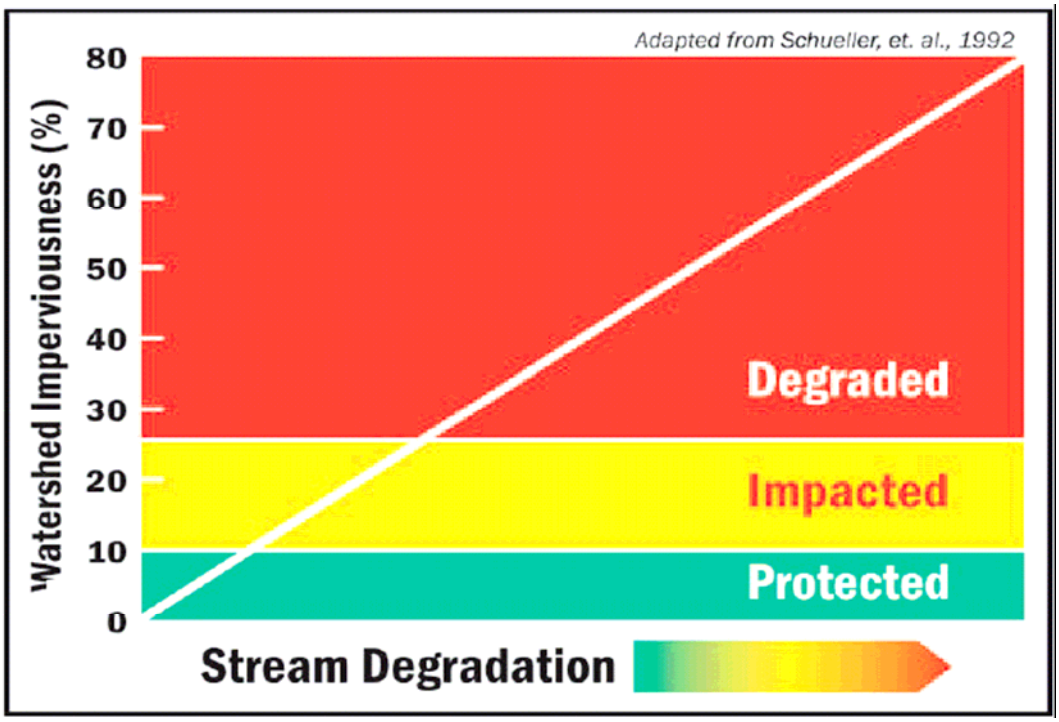
4.1.2 Population Growth and Urbanization Impacts on Aquatic Resources

Urbanization poses one of the greatest threats to aquatic resources. The small towns and communities in western North Carolina are usually not considered urban centers, but even small concentrations of urbanizing areas have significant impacts on local waterways. For example, a one-acre parking lot produces 16 times more runoff than a one-acre meadow (Schueler and Holland, 2000). A wide variety of studies over the past decade converge on a central point: when more than 10 percent of the acreage in a watershed is covered in roads, parking lots, rooftops, and other impervious surfaces, the rivers and streams within the watershed become seriously degraded. Brown trout populations have been shown to decline sharply at 10 to 15 percent imperviousness. If urbanized area covers more than 25 percent of a watershed (Figure 8), these studies point to an irreversible decline in ecosystem health (Beach, 2002 and Galli, 1991).

Greater numbers of homes, stores and businesses require greater quantities of water. Growing populations not only require more water, but they also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams, rivers, lakes and groundwater. Thus, just as demand and use increases, some of the potential water supply is lost (Orr and Stuart, 2000).

As development in surrounding metropolitan areas consumes neighboring forests and fields, the impacts on rivers, lakes, and streams can be significant and permanent if stormwater runoff is not

Figure 8 Impervious Cover and Stream Degradation



controlled (Orr and Stuart, 2000). As watershed vegetation is replaced with impervious surfaces, the ability of the landscape to absorb and diffuse the effects of natural rainfall is diminished.

Urbanization results in increased surface runoff and correspondingly earlier and higher peak streamflows after rainfall. Flooding frequency also increases. These effects are compounded when small streams are channelized (straightened) or piped, and storm sewer systems are installed to increase transport of stormwater downstream. Bank scour from these frequent high flow events tends to enlarge streams and increase suspended sediment. Scouring also destroys the variety of habitat in streams, leading to degradation of benthic macroinvertebrate populations and loss of fisheries (EPA, 1999).

4.2 Key Elements of a Comprehensive Watershed Protection Strategy

Extensive research on the impacts of development and high growth rate projections make it clear that comprehensive land use planning is necessary to protect aquatic resources. In order for land use planning to effectively protect watersheds in the long-term, tools and strategies must be applied at several scales. Effective implementation will require commitment ranging from the individual citizen to the state government. A comprehensive watershed protection plan should act on the following elements.

4.2.1 Basin Scale (Implemented by Town, County, and State Governments)

(1) Characterize the watersheds within a basin as developed or undeveloped, identifying the watersheds that are currently less than 10 percent impervious and those that are more than ten percent impervious.
(2) Focus new construction projects to the already developed watersheds first. Then assign any construction that cannot be accommodated in developed watersheds to a limited number of undeveloped watersheds. The watersheds to be developed should be determined by their ecological importance and by other regional growth considerations, such as the value of terrestrial ecosystems, the economic development potential as determined by proximity to roads and rail lines, and the disposition of landowners in the area toward land preservation and development.
(3) Adopt policies that maintain impervious surfaces in undeveloped watersheds at less than ten percent. These can include private conservation easements, purchase of development rights, infrastructure planning, urban service boundaries, rural zoning (20-200 acres per unit, depending on the area), and urban growth boundaries.
(4) Ensure that local governments develop land use plans to provide adequate land for future development within developed or developing watersheds.

4.2.2 Neighborhood Scale (Implemented by Town and County Governments)

(1) Allow residential densities that support transit, reduce vehicle trips per household and minimize land consumption. The minimum density for new development should be seven to ten net units per acre.
(2) Require block densities that support walking and reduce the length of vehicle trips. Cities that support walking and transit often have more than 100 blocks per square mile.
(3) Connect the street network by requiring subdivision road systems to link to adjacent subdivisions.
(4) Integrate houses with stores, civic buildings, neighborhood recreational facilities, and other daily or weekly destinations.
(5) Incorporate pedestrian and bike facilities (greenways) into new development and ensure these systems provide for inter-neighborhood travel.
(6) Encourage and require other design features and public facilities that accommodate and support walking by creating neighborhoods with a pleasing scale and appearance. (e.g., short front-yard setbacks, neighborhood parks, alleys, and architectural and material quality)

4.2.3 Site Scale (Implemented by Individual Property Owners, Developers, and Town and County Governments)

(1) Require application of the most effective structural stormwater practices, especially focusing on hot spots such as high-volume streets, gas stations, and parking lots.
(2) Establish buffers and setbacks that are appropriate for the area to be developed – more extensive in undeveloped watersheds than in developed watersheds. In developed watersheds, buffers and setbacks should be reconciled to other urban design needs such as density and a connected street network.

(3) Educate homeowners about their responsibility in watershed management, such as buffer and yard maintenance, proper disposal of oil and other toxic materials, and the impacts of excessive automobile use (Beach, 2002).

4.3 Focus Areas for Managing the Impacts of Population Growth

The elements of watershed protection listed in Section 4.2 above are intended to guide land use planning and population density decision-making. This section discusses specific concepts necessary to reduce the impacts of population growth.

4.3.1 Control Stormwater Runoff and Pollution

Introduction to Stormwater

Stormwater runoff is rainfall or snowmelt that runs off the ground and impervious surfaces (e.g., buildings, roads, parking lots, etc.). Because urbanization usually involves creation of new impervious surfaces, stormwater can quickly become a major concern in growing communities.

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious (nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts.

Common Pollutants in Stormwater

Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and power as it travels through the pipes. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and destroying aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, rooftops, and parking lots, which are harmful to the health and reproduction of aquatic life. The steep slopes and large elevation changes in western North Carolina intensify this effect as water rushes downhill.

Storm sewers should not be confused with sanitary sewers, which transport human and industrial wastewaters to a treatment plant before discharging into surface waters. There is no pre-treatment of stormwater in North Carolina.

Common Stormwater Pollutants

- Sediment
- Oil, grease and toxic chemicals from motor vehicles
- Pesticides and nutrients from lawns and gardens
- Viruses, bacteria and nutrients from pet waste and failing septic systems
- Road salts
- Heavy metals from roof shingles, motor vehicles and other sources
- Thermal pollution from dark impervious surfaces such as streets and rooftops

Uncontrolled stormwater runoff has many impacts on both humans and the environment. Cumulative effects include flooding, undercut and eroding streambanks, widened stream channels, threats to public health and safety, impaired recreational use, and increased costs for drinking and wastewater treatment. For more information on stormwater runoff, visit the DWQ Stormwater Permitting Unit

http://h2o.enr.state.nc.us/su/stormwater.html or the NC Stormwater information page at http://www.ncstormwater.org/. Additional fact sheets and information can also be found at http://www.stormwatercenter.net/intro_factsheets.htm and www.bae.ncsu.edu/stormwater/index.html.

Controlling Stormwater Runoff and Pollution

Many daily activities have the potential to cause stormwater pollution. Any situation where activities can contribute more pollutants to stormwater runoff is an area that should be considered for efforts to minimize stormwater impacts. A major component in reducing stormwater impacts involves planning up front in the design process. New construction designs should include plans to prevent or minimize the amount of runoff leaving the site. Wide streets, large cul-de-sacs, long driveways, and sidewalks lining both sides of the street are all features of urbanizing areas that create excess impervious cover and consume natural areas. In many instances, the presence of intact riparian buffers and/or wetlands in urban areas can reduce the impacts of urban development. Establishment and protection of buffers should be considered where feasible, and the amount of impervious cover should be limited as much as possible.

"Good housekeeping" to reduce the volume of stormwater leaving a site and reducing the amount of pollutants used in our own backyards can also minimize the impact of stormwater runoff. DWQ has published a pamphlet entitled *Improving Water Quality in Your Own Backyard: Stormwater Management Starts at Home*. The pamphlet provides information on how homeowners and businesses can reduce the amount of runoff leaving their property and how to reduce the amount and types of pollutants in that runoff. Contact DWQ for a free copy of the booklet or visit the DWQ website to download the document (www.ncwaterquality.org/Wateryouknow.htm).

Preserving the natural streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. In particular, forested buffers provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). Contact DWQ for a free copy of the *Buffers for Clean Water* brochure or visit the DWQ website to download the document (www.ncwaterquality.org/Wateryouknow.htm).

4.3.2 Protect Headwater Streams

Many streams in a given river basin are only small trickles of water that emerge from the ground. A larger stream is formed at the confluence of these trickles. This constant merging eventually forms a large stream or river. Most monitoring of fresh surface waters evaluates these larger streams. The many miles of small trickles, collectively known as headwaters, are not directly monitored and in many instances are not even indicated on maps. These streams account for approximately 80 percent of the stream network and provide many valuable services for quality and quantity of water delivered downstream (Meyer et al., 2003). However, degradation of headwater streams can (and does) impact the larger stream or river.

There are three types of headwater streams: (1) perennial (flow year-round); (2) intermittent (flow during wet seasons); and (3) ephemeral (flow only after precipitation events). All types of headwater streams provide benefits to larger streams and rivers. Headwater streams control

Figure 9 Diagram of Headwater Streams within a Watershed Boundary

flooding, recharges groundwater, maintain water quality, reduce downstream sedimentation, recycle nutrients, and create habitat for plants and animals (Meyer et *al*., 2003).

In smaller headwater streams, fish communities are not well developed and benthic macroinvertebrates dominate aquatic life. Benthic macroinvertebrates are often thought of as "fish food" and, in mid-sized streams and rivers, they are critical to a healthy fish community. However, these insects, both in larval and adult stages, are also food for small mammals, such as river otter and raccoons, birds and amphibians (Erman, 1996). Benthic macroinvertebrates in headwater streams also perform the important function of breaking down coarse organic matter, such as leaves and twigs, and releasing fine organic matter. In larger rivers, where coarse organic matter is not as abundant, this fine organic matter is a primary food source for benthic macroinvertebrates and other organisms in the system (CALFED, 1999). When the benthic macroinvertebrate community is changed or extinguished in an area, even temporarily, as occurs during land use changes, it can have repercussions in many parts of both the terrestrial and aquatic food web.

Headwater streams also provide a source of insects for repopulating downstream waters where benthic macroinvertebrate communities have been eliminated due to human alterations and pollution. Adult insects have short life spans and generally live in the riparian areas surrounding the streams from which they emerge (Erman, 1996). Because there is little upstream or stream-to-stream migration of benthic macroinvertebrates, once headwater populations are eliminated, there is little hope for restoring a functioning aquatic community. In addition to macroinvertebrates, these streams support diverse populations of plants and animals that face similar problems if streams are disturbed. Headwater streams are able to provide these important ecosystem services due to their unique locations, distinctive flow patterns, and small drainage areas.

Because of the small size of headwater streams, they are often overlooked during land use activities that impact water quality. All landowners can participate in the protection of headwaters by keeping small tributaries in mind when making land use management decisions

on the areas they control. This includes activities such as retaining vegetated stream buffers, minimizing stream channel alterations, and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed. For a more detailed description of watershed hydrology and watershed management, refer to EPA's Watershed Academy website http://www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/principle1.html.

4.3.3 Reduce Impacts from Steep Slope Disturbance

Dramatic elevation changes and steep slopes define mountain topography. Building sites perched along mountainsides provide access to unparalleled vistas and are a major incentive for development. However, construction on steep slopes presents a variety of risks to the environment and human safety.

Poorly controlled erosion and sediment from steep slope disturbance negatively impact water quality, hydrology, aquatic habitat, and can threaten human safety and welfare. Soil types, geology, weather patterns, natural slope, surrounding uses, historic uses, and other factors all contribute to unstable slopes. Steep slope disturbance usually involves some form of grading. Grading is the mechanical excavation and filling of natural slopes to produce a level working surface. Improper grading practices disrupt natural stormwater runoff patterns and result in poor drainage, high runoff velocities, and increased peak flows during storm events. There is an inherent element of instability in all slopes and those who choose to undertake grading and/or construction activities should be responsible for adequate site assessment, planning, designing, and construction of reasonably safe and stable artificial slopes.

In cases where construction activities occur on steep slopes, slope stabilization should be mandated through a Site Grading Plan and/or Site Fingerprinting. Site Grading Plans identify areas intended for grading and address impacts to existing drainage patterns. They identify practices to stabilize, maintain and protect slopes from runoff and include a schedule for grading disturbance as well as methods for disposal of borrow and fill materials. Site Fingerprinting is a low-impact development (LID) best management practice (BMP) that minimizes land disturbances. Fingerprinting involves clearing and grading only those onsite areas necessary for access and construction activities. Extensive clearing and grading accelerates sediment and pollutant transport off-site. Fingerprinting and maintenance of vegetated buffers during grading operations provide sediment control that reduces runoff and off-site sedimentation (Yaggi and Wegner, 2002).

Local communities also have a role in reducing impacts from steep slope development. These impacts can also be addressed through the implementation of city and/or county land use and sediment and erosion control plans. Land use plans are a non-regulatory approach to protect water quality, natural resources and sensitive areas. In the planning process, a community gathers data and public input to guide future development by establishing long-range goals for the local community over a ten- to twenty-year period. They can also help control the rate of development, growth patterns and conserve open space throughout the community. Land use plans examine the relationship between land uses and other areas of interest including quality-of-life, transportation, recreation, infrastructure and natural resource protection (WECO, 2003).

Sediment and Erosion Control Plans are a regulatory approach to reducing the impacts of steep slope development and ensure that land disturbing activities do not result in water quality degradation, soil erosion, flooding, or harm to human health (i.e., landslides). The Division of Land Resources (DLR) Land Quality Section (LQS) has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced during construction activities. Under the Sedimentation Pollution Control Act, cities and counties are given the option to adopt local ordinances that meet or exceed the minimum requirements established by the State. Local programs must be reviewed and approved by the NC Sedimentation Control Commission. Once approved, local staff performs plan reviews and enforces compliance. If for some reason the local program is not being enforced, the NC Sedimentation Control Commission can assume administrative control of the local program until the local government assures the State that it can administer and enforce sediment and erosion control rules. The Sedimentation and Pollution Control Act as well as an example of a local ordinance can be found on the DLR website (http://www.dlr.enr.state.nc.us/pages/sedimentation.html).

The requirements outlined in the Sedimentation Pollution Control Act were designed to be implemented statewide and may not fully capture the needs of mountain communities. For example, only projects disturbing more than one-acre of land are required to produce a sediment and erosion control plan. Many small construction projects fall below this threshold. In steep mountainous terrain, even these small disturbances can produce an astounding volume of sediment runoff. DWQ strongly encourages local governments to adopt Sediment and Erosion Control ordinances that exceed the State's minimum requirements.

4.4 The Role of Local Governments

4.4.1 Reducing Impacts from Existing Urbanization

Below is a summary of management actions recommended for local authorities, followed by discussions on large, watershed management issues. These actions are necessary to address current sources of impairment and to prevent future degradation in all streams. The intent of these recommendations is to describe the types of actions necessary to improve stream conditions, not to specify particular administrative or institutional mechanisms for implementing remedial practices. Those types of decisions must be made at the local level.

Because of uncertainties regarding how individual remedial actions cumulatively impact stream conditions and in how aquatic organisms will respond to improvements, the intensity of management effort necessary to bring about a particular degree of biological improvement cannot be established in advance. The types of actions needed to improve biological conditions can be identified, but the mix of activities that will be necessary – and the extent of improvement that will be attainable – will only become apparent over time as an adaptive management approach is implemented. Management actions are suggested below to address individual problems, but many of these actions are interrelated (NCDENR-DWQ, 2003).

Actions one through five are important to restoring and sustaining aquatic communities in watersheds, with the first three recommendations being the most important.

(1) **Feasible and cost-effective stormwater retrofit projects should be implemented throughout the watershed to mitigate the hydrologic effects of development** (e.g., increased stormwater volumes and increased frequency and duration of erosive and scouring flows). This should be viewed as a long-term process. Although there are many uncertainties, costs in the range of $1 million per square mile can probably be anticipated.

   (a) Over the short term, currently feasible retrofit projects should be identified and implemented.
   (b) In the long term, additional retrofit opportunities should be implemented in conjunction with infrastructure improvements and redevelopment of existing developed areas.
   (c) Grant funds for these retrofit projects may be available from EPA initiatives, such as EPA Section 319 funds, or the North Carolina Clean Water Management Trust Fund.

(2) **A watershed scale strategy to address toxic inputs should be developed and implemented, including a variety of source reduction and stormwater treatment methods.** As an initial framework for planning toxicity reduction efforts, the following general approach is proposed:

   (a) Implementation of available best management practice (BMP) opportunities for control of stormwater volume and velocities. As recommended above to improve aquatic habitat potential, these BMPs will also remove toxics from stormwater.
   (b) Development of a stormwater and dry weather sampling strategy in order to facilitate the targeting of pollutant removal and source reduction practices.
   (c) Implementation of stormwater treatment BMPs, aimed primarily at pollutant removal, at appropriate locations.
   (d) Development and implementation of a broad set of source reduction activities focused on: reducing non-storm inputs of toxics; reducing pollutants available for runoff during storms; and managing water to reduce storm runoff.

(3) **Stream channel restoration activities should be implemented in target areas, in conjunction with stormwater retrofit BMPs, in order to improve aquatic habitat.** Before beginning stream channel restoration, a geomorphologic survey should be conducted to determine the best areas for stream channel restoration. Additionally, it would be advantageous to implement retrofit BMPs before embarking on stream channel restoration, as restoration is best designed for flows driven by reduced stormwater runoff. Costs of approximately $200 per foot of channel should be anticipated (Haupt, et *al.*, 2002 and Weinkam, 2001). Grant funds for these retrofit projects may be available from federal sources, such as EPA Section 319 funds, or state sources including North Carolina Clean Water Management Trust Fund.

(4) Actions recommended above (e.g., stormwater quantity and quality retrofit BMPs) are likely to reduce nutrient/organic loading, and to some extent, its impacts. Activities recommended to address this loading include the identification and elimination of illicit discharges;

education of homeowners, commercial applicators, and others regarding proper fertilizer use; street sweeping; catch basin clean-out practices; and the installation of additional BMPs targeting biological oxygen demand (BOD) and nutrient removal at appropriate sites.

(5) Prevention of further channel erosion and habitat degradation will require effective post-construction stormwater management for all new development in the study area.

(6) Effective enforcement of sediment and erosion control regulations will be essential to the prevention of additional sediment inputs from construction activities. Development of improved erosion and sediment control practices may also be beneficial.

(7) Watershed education programs should be implemented and continued by local governments with the goal of reducing current stream damage and preventing future degradation. At a minimum, the program should include elements to address the following issues:

   (a) Redirecting downspouts to pervious areas rather than routing these flows to driveways or gutters;
   (b) Protecting existing woody riparian areas on all streams;
   (c) Replanting native riparian vegetation on stream channels where such vegetation is absent; and
   (d) Reducing and properly managing pesticide and fertilizer use.

4.4.2 Reducing Impacts of Future Urbanization

Proactive planning efforts at the local level are needed to assure that urbanization is done in a manner that maintains water quality. These planning efforts will need to find a balance between water quality protection, natural resource management, and economic growth. Managing population growth requires planning for the needs of increased population, as well as developing and enforcing environmental protection measures. These actions are critical to water quality management and the quality of life for the residents of the basin. Public education is also needed in the Watauga River basin so that citizens can learn and understand the value of urban planning and stormwater management.

Streams in areas adjacent to high growth areas of the basin are at a high risk of loosing healthy aquatic communities. These biological communities are important to maintaining the ecological integrity in the Watauga River basin. Unimpacted streams are important sources of benthic macroinvertebrates and fish for reestablishment of biological communities in nearby streams that are recovering from past impacts or are being restored.

To prevent further impairment to aquatic life in streams in urbanizing watersheds local governments should:

(1) Identify waters that are threatened by construction activities.
(2) Protect existing riparian habitat along streams.
(3) Implement stormwater BMPs during and after construction.
(4) Develop land use plans that minimize disturbance in sensitive areas of watersheds.
(5) Minimize impervious surfaces including roads and parking lots.

(6) Develop public outreach programs to educate citizens about stormwater runoff.
(7) Enact a Stormwater Control Ordinance. EPA offers a model ordinance at: http://www.epa.gov/nps/ordinance/stormwater.htm

For more detailed information regarding recommendations for new development found in the text box, refer to EPA's website at www.epa.gov/owow/watershed/wacademy/acad2000/protection, the Center for Watershed Protection website at www.cwp.org, and the Low Impact Development Center website at www.lowimpactdevelopment.org. For an example of local community planning effort to reduce stormwater runoff, visit http://www.charmeck.org/Home.htm. For more information on stormwater programs across the state, refer to Chapter 5.

Planning Recommendations for New Development

- Minimize number and width of residential streets.
- Minimize size of parking areas (angled parking & narrower slots).
- Place sidewalks on only one side of residential streets.
- Minimize culvert pipe and hardened stormwater conveyances.
- Vegetate road right-of-ways, parking lot islands and highway dividers to increase infiltration.
- Plant and protect natural buffer zones along streams and tributaries.

4.5 The Role of Homeowners and Landowners

4.5.1 Ten Simple Steps to Reduce Runoff and Pollution from Individual Homes

(1) To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns.
(2) Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose.
(3) Instead of disposing of yard waste, use the materials to start a compost pile.
(4) Learn to use Integrated Pest Management (IPM) in the garden and on the lawn to reduce dependence on harmful pesticides.
(5) Pick up after pets.
(6) Use, store, and dispose of chemicals properly.
(7) Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed.
(8) Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that do not generate runoff.
(9) Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.
(10) Support local government watershed planning efforts and ordinance development.

Chapter 5
Stormwater and Wastewater Programs

5.1 Federal and State Stormwater Programs

The goal of the DWQ stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state via stormwater runoff. These programs try to accomplish this goal by controlling the source(s) of pollutants. These programs include NPDES Phase I and II regulations, HQW/ORW stormwater requirements, and requirements associated with the Water Supply Watershed Program. Currently, there are six general stormwater permits listed for the Watauga River basin (Appendix VI). Phase I or II regulations are not applicable; however, there are a few local governments and/or counties that are affected by other water quality protection programs. Those affected governments and/or counties are listed in Table 6.

5.1.1 NPDES Phase I

Phase I of the EPA stormwater program started with Amendments to the Clean Water Act (CWA) in 1990. Phase I required NPDES permit coverage to address stormwater runoff from medium and large stormwater sewer systems serving populations of 100,000 or more people. There are no NPDES Phase I stormwater permits issued in the Watauga River basin.

Phase I also had requirements for ten categories of industrial sources to be covered under stormwater permits. Industrial activities which require permitting are defined in categories ranging from sawmills and landfills to manufacturing plants and hazardous waste treatment, storage or disposal facilities. Construction sites disturbing greater than five acres are also required to obtain an NPDES stormwater permit under Phase I of the EPA stormwater program.

There were six general stormwater permits issued in this basin under Phase I (Appendix VI). Three of the permitted facilities discharge to Laurel Fork [AU#8-10], and one has been issued a notice of violation (NOV). More information related to the stormwater permits in the Laurel Fork watershed can be found in Section 1.4.2.

5.1.2 NPDES Phase II

The Phase II stormwater program is an extension of the Phase I program. Phase II provides permit coverage for smaller municipalities and includes construction activities down to one acre. The local governments permitted under Phase II will be required to develop and implement a comprehensive stormwater management program that includes six minimum measures:

(1) Public education and outreach on stormwater impacts.
(2) Public involvement/participation.
(3) Illicit discharge detection and elimination.
(4) Construction site stormwater runoff control.
(5) Post-construction stormwater management for new development and redevelopment.
(6) Pollution prevention/good housekeeping for municipal operations.

Construction sites greater than one acre will also be required to obtain an NPDES stormwater permit under Phase II of the EPA stormwater program in addition to erosion and sedimentation control approvals.

Those municipalities and counties required to obtain a NPDES stormwater permit under the Phase II rules are identified using 1990 US Census Designated Urban Areas and the results of the 2000 US Census. Currently, there are no municipalities or counties identified as an urban area in the Watauga River basin.

2007 Recommendations
Even though none of the municipalities were identified as federally designated urban areas, DWQ recommends that the local governments and county officials develop stormwater management programs that go beyond the six minimum measures listed for Phase II rules. Implementation of stormwater programs should help reduce future impacts to streams in the basin. To the extent possible, local governments should identify sites for preservation or restoration. DWQ and other NCDENR agencies will continue to provide information on funding sources and technical assistance to support local government and county stormwater programs.

5.1.3 State Stormwater Programs – Sensitive Waters

The State Stormwater Management Program was established in the late 1980s under the authority of the North Carolina Environmental Management Commission (EMC) and North Carolina General Statute 143-214.7. This program (Administrative Code 15A NCAC 2H .1000) affects development activities that require either (1) an Erosion and Sediment Control Plan (for disturbances of one or more acres) or (2) a CAMA major permit within one of the 20 coastal counties and/or development draining to Outstanding Resource Waters (ORW) or High Quality Waters (HQW). The State Stormwater Management Program requires developments to protect these sensitive waters by maintaining a low density of impervious surfaces, maintaining vegetative buffers and transporting runoff through vegetative conveyances. Low-density development thresholds vary from 12 to 30 percent built-upon area (impervious surface) depending on the classification of the receiving stream. If low-density design criteria cannot be met, then high density development requires the installation of structural best management practices (BMPs) to collect and treat stormwater runoff from the project. High-density BMPs must control the runoff from the 1 or 1.5-inch storm event (depending on the receiving stream classification) and remove 85 percent of the total suspended solids.

Table 6 shows the counties in the Watauga River basin where permits may be required under the state stormwater management program under the state stormwater rules. All development requiring an Erosion and Sediment Control Plan (for disturbances of one or more acres) must obtain a stormwater permit.

2007 Recommendations
DWQ will continue implementing the state stormwater program with the other NCDENR agencies and local governments. Local governments should develop local land use plans that minimize impervious surfaces in sensitive areas. To the extent possible, communities should integrate state stormwater program requirements with other stormwater programs in order to be

more efficient and gain the most water quality benefits for protection of public health and aquatic life.

Table 6 Communities in the Watauga River Basin Subject to Stormwater and/or Water Supply Watershed Stormwater Requirements

Local Government	State Stormwater Program HQW/ORW	Water Supply Watershed Stormwater Requirements
Municipalities		
Banner Elk		
Beech Mountain		
Boone		**X**
Elk Park		
Seven Devils		
Sugar Mountain		
Counties		
Avery		
Watauga	**X**	**X**

5.1.4 Water Supply Watershed Stormwater Rules

The purpose of the Water Supply Watershed Protection Program is to provide a proactive drinking water supply protection program for communities. Local governments administer the program based on state minimum requirements. There are restrictions on wastewater discharges, development, landfills and residual application sites to control the impacts of point and nonpoint sources of pollution. The program attempts to minimize the impacts of stormwater runoff by utilizing low density development or stormwater treatment in high density areas.

2007Recommendations

The Town of Beech Mountain in the Watauga River basin has EMC approved water supply watershed protection ordinances. DWQ recommends continued implementation of local water supply watershed protection ordinances to ensure safe and economical treatment of drinking water. To the extent possible, communities should also integrate water supply watershed protection ordinances with other stormwater programs in order to be more efficient and gain the most water quality benefits for both drinking water and aquatic life.

5.2 Federal and State Wastewater Programs

5.2.1 NPDES Wastewater Discharge Permit Summary

The primary pollutants associated with point source discharges are:

- oxygen-consuming wastes
- nutrients
- sediments
- color
- toxic substances including chlorine, ammonia and metals.

Discharges that enter surface waters through a pipe, ditch or other well-defined point of discharge are broadly referred to as point sources. Wastewater point source discharges include municipal (city and county) and industrial wastewater treatment plants and small domestic wastewater treatment systems serving schools, commercial offices, residential subdivisions and individual homes. Stormwater point source discharges include stormwater collection systems for municipalities and stormwater discharges associated with certain industrial activities. Point source dischargers in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit. Discharge permits are issued under the NPDES program, which is delegated to DWQ by the Environmental Protection Agency (EPA).

Types of Wastewater Discharges

Major Facilities: Wastewater treatment plants with flows ≥1 MGD (million gallons per day); and some industrial facilities (depending on flow and potential impacts to public health and water quality).

Minor Facilities: Facilities not defined as Major.

100% Domestic Waste: Facilities that only treat domestic-type waste (from toilets, sinks, washers).

Municipal Facilities: Public facilities that serve a municipality. Can treat waste from homes and industries.

Nonmunicipal Facilities: Non-public facilities that provide treatment for domestic, industrial or commercial wastewater. This category includes wastewater from industrial processes such as textiles, mining, seafood processing, glass-making and power generation, and other facilities such as schools, subdivisions, nursing homes, groundwater remediation projects, water treatment plants and non-process industrial wastewater.

Currently, there are 29 permitted wastewater discharges in the Watauga River basin. Table 7 provides summary information (by type and subbasin). The types of dischargers listed in the table are described in the inset box (right). Facilities are mapped in the subbasin chapter, and a complete listing of permitted facilities is included in Appendix VI.

The majority of NPDES permitted wastewater flow is from 24 small package wastewater treatment plants (WWTP). Nonmunicipal discharger contributes only 0.26 percent of the total wastewater flow into the Watauga River basin. Facilities, large or small, where recent data show problems with a discharge are discussed in the subbasin chapter (Chapter 1). This includes the Grassy Gap WWTP (Section 1.4.7), owned and managed by the Town of Beech Mountain.

Table 7 Summary of NPDES Dischargers and Permitted Flows for the Watauga River Basin (April 2006)

Facility Categories	Subbasin 04-02-01
Total Facilities*	29
Total Permitted Flow (MGD)	3.92
Facilities by Type	
100% Domestic Waste	24
Total Permitted Flow (MGD)	2.73
Municipal Facilities	4
Total Permitted Flow (MGD)	1.18
Nonmunicipal Facilities	1
Total Permitted Flow (MGD)	0.01

* Minor Facilities

5.2.2 Septic Systems and Straight Piping

In the Watauga River basin, wastewater from many households is not treated at wastewater treatment plants. Instead, it is treated on-site through the use of permitted septic systems. Wastewater from some of these homes illegally discharges directly to streams through what is known as a "straight pipe". In other cases, wastewater from failing septic systems makes its way to streams or contaminates groundwater. Straight piping and failing septic systems are illegal discharges of wastewater into the waters of the State.

With on-site septic systems, the septic tank unit treats some wastes, and the drainfield associated with the septic tank provides further treatment and filtration of the pollutants and pathogens found in wastewater. A septic system that is operating properly does not discharge untreated wastewater to streams and lakes or to the ground's surface where it can run into nearby surface waters. Septic systems are a safe and effective long-term method for treating wastewater if they are sited, sized and maintained properly. If the tank or drainfield are improperly located or constructed, or the systems are not maintained, nearby wells and surface waters may become contaminated, causing potential risks to human health. Septic tanks must be properly installed and maintained to ensure they function properly over the life of the system. Information about the proper installation and maintenance of septic tanks can be obtained by calling the environmental health sections of the local county health departments. See Appendix VIII for contact information.

The discharge of untreated or partially treated sewage can be extremely harmful to humans and the aquatic environment. Pollutants from illegally discharged household wastewater contain chemical nutrients, disease pathogens and endocrine disrupting chemicals. Fecal coliform bacteria levels were not exceeded for primary recreation at any of the ambient monitoring stations in the Watauga River basin; however, smaller streams not evaluated through the ambient monitoring program may contain a higher concentration of bacteria and other pollutants. The

economies of the counties in this basin are highly dependent upon river recreation, especially from tourists and seasonal residents, and these waters should be protected from straight pipes and/or failing septic systems.

In order to protect human health and maintain water quality, the NC Wastewater Discharge Elimination (WaDE) Program is actively helping to identify and remove straight pipes (and failing septic systems) in western North Carolina. The program uses door-to-door surveys to locate straight pipes and failing septic systems and offers deferred loans or grants to assist homeowners in eliminating straight pipes and repairing septic systems. In November 2005, the WaDE Program was awarded a $1.5 million grant from the North Carolina Clean Water Management Trust Fund (CWMTF) to continue its straight-pipe and failing septic system survey and repair program through April 2009. The new agreement supports survey and repair work in 22 western North Carolina counties, including several that were previously excluded from WaDE efforts. These include Ashe, Avery, Alleghany, Jackson, Madison, Mitchell, and Yancey Counties. Areas normally selected for surveys are public water supply and recreational watersheds, as well as streams targeted by DWQ or the Ecosystem Enhancement Program (EEP).

WaDE will utilize the CWMTF monies to eliminate straight-pipes and failing septic systems across the river basins of western North Carolina following the established and improved survey/repair model. Staffing developments within the statewide system that governs the issuance of septic repair permits should produce a higher rate of repairs than has been experienced in the past. Through these developments, more Registered Sanitarians—those responsible for septic system repair permits—should be available to accomplish the needed corrections.

For more information on the WaDE Program, contact the DENR On-Site Wastewater Section (OSWW), NC Division of Environmental Health, toll free at 1-866-223-5718 or visit their website at http://www.deh.enr.state.nc.us/osww_new//WaDE.htm .

2007 Recommendations

DWQ supports the efforts of the WaDE Program and will assist in identifying potential watersheds for straight pipes and failing septic system surveys. Additional monitoring for fecal coliform bacteria is also recommended in those watershed identify to have straight pipes or failing septic systems. Precautions should be taken by local septic system permitting authorities to ensure that new systems are sited and constructed properly and that an adequate repair area is also available. Educational information should also be provided to new septic system owners regarding the maintenance of these systems over time.

DWQ has developed a booklet that discusses actions individuals can take to reduce stormwater runoff and improve stormwater quality entitled *Improving Water Quality In Your Own Backyard*. The publication includes a discussion about septic system maintenance and offers other sources of information. Contact DWQ for a free copy of the booklet or visit the DWQ website to download the document (www.ncwaterquality.org/Wateryouknow.htm). The following website also offers good information in three easy to follow steps: http://www.wsg.washington.edu/outreach/mas/water_quality/septicsense/septicmain.html.

Chapter 6
Agriculture and Water Quality

6.1 Animal Operations

There are no registered animal operations in the Watauga River basin.

6.2 Impacted Streams in Agricultural Areas

In the Watauga River basin, the majority of agricultural land is used for pasture, but there are a variety of specialty crop farms throughout the river basin, including Christmas tree farms. Impacts to streams from agricultural activities can include excessive nutrient loading, pesticide and herbicide contamination, bacterial contamination and sedimentation.

Based on the most recent information from the USDA Natural Resources Conservation Service (NRCS) National Resources Inventory (NRI), agricultural land use in the Watauga River basin has decreased. Cultivated and uncultivated cropland decreased by 100 percent (1,000 acres) and 33.3 percent (1,200 acres), respectively. Pasture use decreased by 0.4 percent (100 acres). Data also shows that urban and built-up areas increased by almost 218.9 percent (8,100 acres) throughout the Watauga River basin (USDA-NRCS, 2001). Refer to Appendix III for more information related to land use changes in the Watauga River basin.

2007 Recommendations

DWQ will work with the local Soil and Water Conservation Districts (SWCD) to identify streams where agricultural land use may be impacting water quality and aquatic habitat. Local SWCD and NRCS staff should investigate these streams to assess agricultural impacts and recommend best management practices (BMPs) to reduce those impacts. DWQ recommends that funding and technical support for agricultural BMPs continue. Agricultural nonpoint source agency contact information can be found in Appendix VIII.

6.3 Agricultural Best Management Practices and Funding Opportunities

6.3.1 USDA – NRCS Environmental Quality Improvement Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides assistance to farmers and ranchers who face threats to soil, water, air, and related natural resources on their land. Through EQIP, the Natural Resources Conservation Service (NRCS) provides assistance to agricultural producers in a manner that will promote agricultural production and environmental quality as compatible goals, optimize environmental benefits, and help farmers and ranchers meet federal, state, tribal, and local environmental requirements. The 2002 Farm Bill reauthorized national EQIP funding at $6.16 billion over the six-year period of FY 2002 through FY 2007. Program priorities are as follows:

- Reduction of nonpoint source pollution including nutrients, sediment, pesticides, and excess salinity in impaired watersheds consistent with TMDLs where available; reduction of groundwater contamination; reduction of point source pollution including contamination from confined animal feeding operations.
- Conservation of ground and surface water resources.
- Reduction of emissions including particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards.
- Reduction in soil erosion and sedimentation from unacceptable levels on agricultural land.
- Promotion of at-risk species habitat conservation.

EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practice and a maximum term of ten years. These contracts provide incentive payments and cost-shares to implement conservation practices. Persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program. EQIP activities are carried out according to an environmental quality incentives program plan of operations developed in conjunction with the producer that identifies the appropriate conservation practice or practices to address the resource concerns. The practices are subject to NRCS technical standards adapted for local conditions. The local conservation district approves the plan.

North Carolina EQIP Funding 2000-2005

2000:	$1.1 Million
2001:	$3.5 Million
2002:	$7.1 Million
2003:	$10.0 Million
2004:	$13.2 Million
2005:	$14.3 Million

EQIP may cost-share up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. However, limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent. Farmers and ranchers may elect to use a certified third-party provider for technical assistance. An individual or entity may not receive, directly or indirectly, cost-share or incentive payments that, in the aggregate, exceed $450,000 for all EQIP contracts entered during the term of the Farm Bill.

NRCS district contacts for the Watauga River basin are provided in Appendix VIII, and EQIP signup information can be found on NRCS website at http://www.nc.nrcs.usda.gov/programs/EQIP/index.html.

6.3.2 NC Agriculture Cost Share Program

The NC Agricultural Cost Share Program (NCACSP) was established in 1984 to help reduce agricultural nonpoint runoff into the state's waters. The program helps owners and renters of established agricultural operations improve their on-farm management by using best management practices (BMPs). These BMPs include vegetative, structural or management

systems that can improve the efficiency of farming operations while reducing the potential for surface and groundwater pollution. The NCACSP is implemented by the Division of Soil and Water (DSWC), which divides the approved BMPs into five main purposes or categories.

- *Erosion Reduction/Nutrient Loss Reduction in Fields*
  Erosion/nutrient management measures include planned systems for reducing soil erosion and nutrient runoff from cropland into streams. Practices include: critical area planting, cropland conversion, water diversion, long-term no-till, pastureland conversion, sod-based rotation, stripcropping, terraces, and Christmas tree conservation cover.

- *Sediment/Nutrient Delivery Reduction from Fields*
  Sediment/nutrient management measures include planned systems that prevent sediment and nutrient runoff from fields into streams. Practices include: field borders, filter strips, grassed waterways, nutrient management strategies, riparian buffers, water control structures, streambank stabilization, and road repair/stabilization.

- *Stream Protection from Animals*
  Stream protection management measures are planned systems for protecting streams and streambanks. Such measures eliminate livestock access to streams by providing an alternate watering source away from the stream itself. Other benefits include: reduced soil erosion, sedimentation, pathogen contamination and pollution from dissolved, particulate, and sediment-attached substances. Practices include: heavy use area protection, livestock exclusion (i.e., fencing), spring development, stream crossings, trough or watering tanks, wells, and livestock feeding areas.

- *Proper Animal Waste Management*
  A waste management system is a planned system in which all necessary components are installed for managed liquid and solid waste to prevent or minimize degradation of soil and water resources. Practices include: animal waste lagoon closures, constructed wetlands, controlled livestock lounging area, dry manure stacks, heavy use area protection, insect and odor control, stormwater management, waste storage ponds/lagoons, compost, and waste application system.

- *Agricultural Chemical (agrichemical) Pollution Prevention*
  Agrichemical pollution prevention measures involve a planned system to prevent chemical runoff to streams. Practices include: agrichemical handling facilities and fertigation/ chemigation back flow prevention systems.

The NCACSP is a voluntary program that reimburses farmers up to 75% of the cost of installing an approved BMP. The cost share funds are paid to the farmer once the planned BMP is completed, inspected and certified to be installed according to NCACSP standards. The annual statewide budget for BMP cost sharing is approximately $6.9 million. During this assessment period, $87,029 was provided for ag cost share BMPs in the Watauga River basin. Table 8 summaries the cost and total BMPs implemented (i.e., acres, units and linear feet) throughout the Watauga River basin. Specific project information can be found in the subbasin chapter (Chapter 1).

Local Soil and Water Conservation District (SWCD) contacts for the Watauga River basin are included in Appendix VIII. BMP definitions and DSWC contact information can be found online at www.enr.state.nc.us/DSWC/pages/agcostshareprogram.html.

Table 8 Summary of NCACSP projects in the Watauga River Basin (1999 to 2004)

Purpose of BMP	Subbasin 04-02-01	
	Total Implemented	**Cost**
Erosion Reduction/Nutrient Loss	9.40 acres	$863
Reduction in Fields	1200 ft.	$11,023
Sediment/Nutrient Delivery	1 acre	$224
Reduction from Fields	1 unit	$646
Stream Protection from	38 units	$55,006
Animals	14009 ft.	$19,267
Total Costs		$87,029
Benefits	**Subbasin 04-02-01**	
Total Soil Saved (tons)	1,353	
Total Nitrogen (N) Saved (lb.)	2,216	
Total Phosphorus (P) Saved (lb.)	1,770	
Total Waste-N Saved (lb.)	2,000	
Total Waste-P Saved (lb.)	180	

* The North Carolina Agricultural Nutrient Assessment Tool (NCANAT) contains two field-scale assessment tools: the Nitrogen Loss Estimation Worksheet (NLEW) and the Phosphorus Loss Assessment Tool (PLAT). NCANAT is a product of the cooperative effort between the NC State University, NC Department of Agriculture & Consumer Services, USDA-NRCS and the NCDENR. The tool consists of a function that allows comparisons to be made before and after BMPs are installed. Gains and losses of nitrogen, phosphorus and sediment due to BMP implementation can be computed. The DSWC has adopted this program to calculate these losses for the NCACSP reporting requirements.

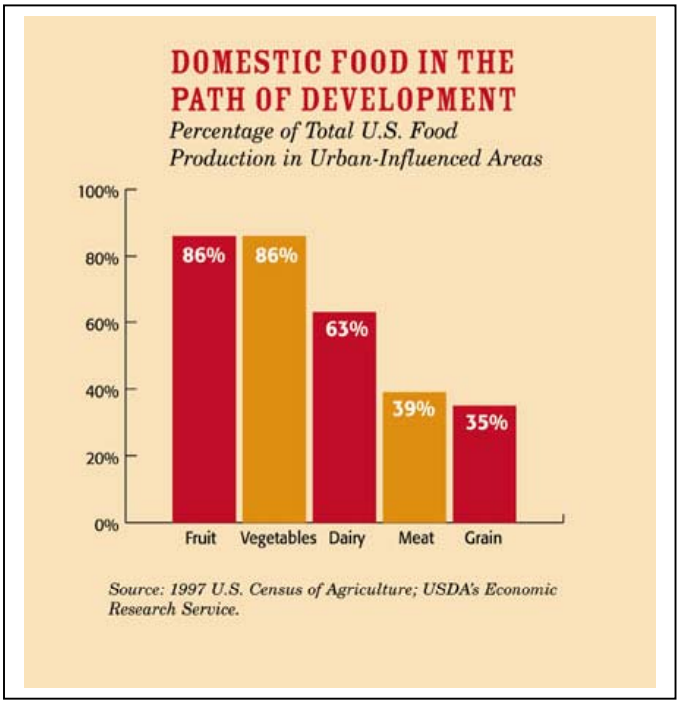
6.4 Working Lands and Conservation Benefits

Working Lands are those used for agriculture, forestry or other natural resource industries. Well-managed working lands provide important non-market goods and services. For example, farms, ranches and forestlands provide food and cover for wildlife, help control flooding, protect wetlands and watersheds, and maintain air quality. They can absorb and filter wastewater, runoff and provide groundwater recharge.

Rapid urbanization is forcing the conversion of working lands to developed land at an astonishing rate in North Carolina. From1992-1997, over 170,000 acres of agricultural land was converted to developed land. That was the 12th highest rate in the nation. The figures for Prime Farmland, the best land for growing crops, are even more disturbing. North Carolina is losing prime farmland at the fourth fastest rate in the nation (USDA, 2001). The 1997 U.S. Census of Agriculture shows that a large percentage of cropland is in urban-influenced areas, making them prime targets for development. It is well established that developed land negatively impacts water quality (Section 4.1). Therefore, preserving North Carolina's working lands should be a priority.

The value of specific working lands can be calculated for any watershed by performing a Cost of Community Services (COCS) study. COCS studies are a case study approach used to determine a community's public service costs versus revenues based on current land use. Their particular niche is to evaluate the overall contribution of agricultural and other open lands on equal ground with residential, commercial and industrial development.

As of January 2002, 83 COCS studies conducted in 19 states found that tax and other revenues collected from farm, ranch and forest landowners more than covered the public service costs these lands incur. COCS studies show that on average, residential development generates significant tax revenue but requires costly public services that typically are subsidized by revenues from commercial and industrial land uses. The special contribution of COCS studies is that they show that farm, ranch, and forestlands are important commercial land uses that help balance community budgets. Working lands are not just vacant land waiting to be developed (Freedgood et *al*., 2002)

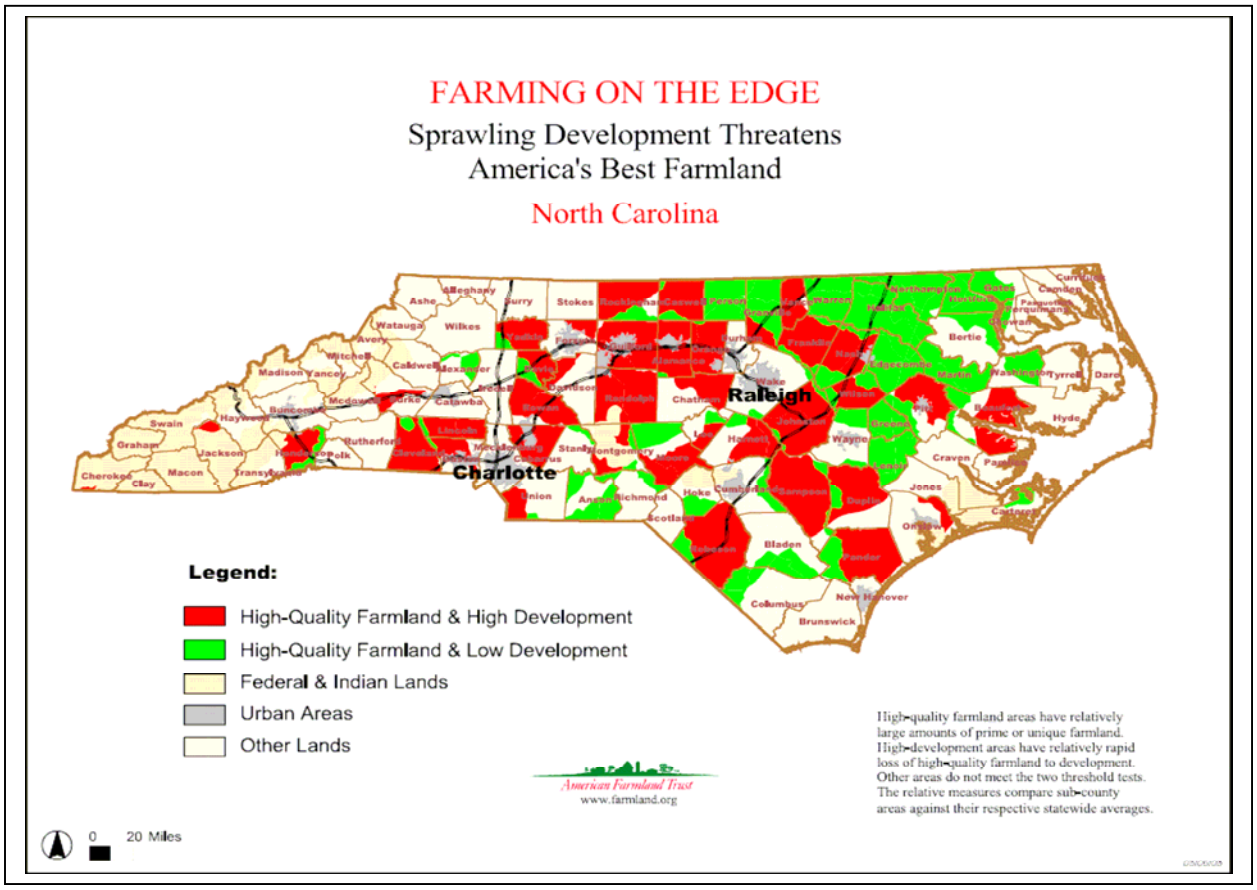


A recent analysis of the fiscal impact of different land uses in Macon County, North Carolina demonstrates the cost-saving benefits to the county of maintaining farmland and open space. Using county budget data and tax data from fiscal year 2000, the study indicates that typical residential and commercial properties cost the county budget by demanding more in tax-supported services than they contribute in property tax revenues. Such services include schools, roads, water and sewer lines, fire and police protection, and social and administrative services. On the other hand, the typical farmland/open-space parcel contributed more property tax to the county budget than it demanded in expenditures for county services. Analyzing a scenario of a 30-acre parcel of farmland/open-space, the study estimated that the county budget would gain $290 if the land remained as farmland, but would lose a net $532 if converted to ten 3-acre lots with houses on them (Jones and Kask, 2001).

The opportunities for private landowners to protect working lands are growing. North Carolina cities and counties have now begun to use the new set of farmland protection tools authorized by the General Assembly in 2005 through Session Law 2005-390. Along with an expanded definition of agriculture and a revamped Agricultural Development and Farmland Preservation Trust Fund, this legislation authorized a new category for localities to promote the stability of their agricultural sectors. Counties and municipalities now have the authority to create an Enhanced Voluntary Agricultural District (EVAD) option, which offers an increased set of incentives for landowners to restrict development over a ten-year period. Polk County in the mountains and Wentworth in the Piedmont are amongst the first jurisdictions in the state to utilize this new tool, with the recent adoption of local EVAD ordinances. Landowners interested

in working land protection should contact their local land trust; NRCS field representative, or Soil and Water Conservation District. The Farmland Information Center is also an excellent online resource http://www.farmlandinfo.org/. Local government officials interested in the value of working land conservation should visit the Land Trust Alliance's Economic Benefits of Open Space Protection webpage http://www.lta.org/resources/economic_benefits.htm.

Figure 10 North Carolina's High Quality Farmland and High Development Areas



Chapter 7
Forestry in the Watauga River Basin

7.1 Forestland Ownership and Resources

In the Watauga River basin, approximately 92 percent of the forestland is privately owned with the remaining eight percent owned by the State Parks System (Brown, 2004). There are no state forests, education state forests or significant national forestlands in the Watauga River basin.

7.1.1 Forest Management

From September 1999 to August 2004, nearly 130 acres of land were established or regenerated with forest trees across the Watauga River basin. During this same time period, the Division of Forest Resources (DFR) provided 120 individual forest plans for landowners that encompassed over 4,700 acres in the basin.

7.1.2 Christmas Tree Production

It should be noted that the Division of Forest Resources does not oversee regulations relating to land clearing for Christmas tree production nor the associated best management practices (BMPs) for tree farming operations. These activities are deemed to be an agricultural/horticultural practice, and therefore come under the oversight of the NC Department of Agriculture & Consumer Services (NCA&CS) and their recommended agriculture BMPs. The NC Cooperative Extension Service through NC State University has developed extensive guidelines and recommendations for Christmas tree operations. This material is available on the website www.ces.ncsu.edu/fletcher/programs/xmas/index.html. Section 1.5.2 contains more information related to Christmas tree BMPs.

7.2 Forestry Water Quality Regulations in North Carolina

7.2.1 Forest Practice Guidelines (FPG) for Water Quality

Forestry operations in North Carolina are subject to regulation under the Sedimentation Pollution Control Act of 1973 (General Statute Chapter 113A Article 4 referred to as "SPCA") and its amendments. Forestry operations may be exempt from the permit and plan requirements of the SPCA if the operations meet the compliance standards outlined in the *Forest Practices Guidelines (FPGs) Related to Water Quality* (Administrative Code 15A NCAC 1I .0101 - .0209) and General Statutes regarding stream obstruction (General Statutes 77-13 and 77-14).

DFR is delegated the authority to monitor and evaluate forestry operations for compliance with the aforementioned laws and/or rules. In addition, the DFR works to resolve identified FPG compliance questions brought to its attention through citizen complaints. Violations of the FPG performance standards that cannot be resolved by the DFR are referred to the appropriate State agency for enforcement action. During the five-year assessment period, DFR conducted 73 FPG

inspections of forestry-related activities in the basin; approximately 73 percent of the sites inspected were in compliance with the FPGs.

7.2.2 Water Quality Foresters

Water quality issues related to forestry in the Watauga River basin are predominantly handled by a Water Quality Forester based in the DFR's Lenoir District Office. DFR currently has a Water Quality Forester located in ten of its thirteen Districts across the State. Assistant District Foresters or Service Foresters handle water quality issues in the remaining Districts, along with other forest management and fire control responsibilities. Water Quality Foresters conduct FPG inspections, survey BMP implementation, develop pre-harvest plans, and provide training opportunities for landowners, loggers, and the public regarding water quality issues related to forestry. Contact information for each district and/or county can be found on the website www.dfr.state.nc.us and in Appendix VIII.

7.2.3 Forestry Best Management Practices (BMPs) and Water Quality

Implementing Forestry Best Management Practices (BMPs) is strongly encouraged by DFR in order to efficiently and effectively protect the water resources of North Carolina. During this assessment period, DFR recorded 79 instances across 3,000 acres in which BMPs were either noted in use or had been recommended. The Forestry BMP Manual describes recommended techniques that should be used to help comply with the State's forestry laws and help protect water quality. This manual is currently undergoing its first revision since adoption in 1989. This revision, led by the DENR appointed Technical Advisory Committee (TAC) has undertaken four years of effort.

To further assess BMPs, DFR conducted a detailed, statewide BMP Implementation Survey (March 2000 through March 2003) to evaluate forestry BMPs on active harvest operations. This survey, and future surveys, will serve as a basis for focused efforts in the forestry community to address water quality concerns through better and more effective BMP implementation and training. The survey did not capture any harvest sites within the Watauga River basin; however, of those survey sites taken statewide, the problems most often cited relate to stream crossings, skid trails and site rehabilitation.

Among the BMP's promoted for timber harvesting is the use of bridgemats for establishing temporary stream crossings. DFR's Bridgemat Loan and Education Program is an education and protection project which promotes the benefits of using portable bridges for stream crossings, in lieu of using other techniques such as culverts or hard-surface crossings, both of which have a greater potential to result in stream sedimentation. Bridgemats have been available for use in the basin for nearly nine years, and are available upon request from the Lenoir District Water Quality Forester. In 2003, three new steel bridgemats were assigned to the Lenoir District to replace older worn out wooden timber mats. In 2005, due to the high demand for this program, a second set of new wooden timber bridgemats was also assigned to the Lenoir District. In both cases, Environmental Protection Agency (EPA) Section 319 grant funds allowed DFR to implement and support this successful program. More information about using bridgemats and the BMP survey is available on the "Water Quality" section of the DFR website www.dfr.state.nc.us.

7.2.4 Forestry Accomplishments

Since the previous basinwide plan was produced, DFR accomplished the following tasks in an ongoing effort to improve compliance with forest regulations and, in turn, minimize nonpoint source (NPS) pollution from forestry activities:

- Replaced worn-out wood timber bridgemats in the Lenoir District with new steel and wood mats available for use throughout the basin.
- Established a Forestry NPS Unit that develops and oversees projects throughout the state that involves protection, restoration and education on forestry NPS issues.
- Revised and produced 10,000 copies of a pocket field guide outlining the requirements of the FPGs and suggested BMPs.
- Created and published 15,000 copies of a new brochure "Call Before You Cut" for landowners promoting pre-harvest planning to ensure water quality issues are addressed prior to undertaking timber harvesting.
- Continued to assist with workshops in cooperation with the NC Forestry Association's "ProLogger" logger training program.

DFR continues its efforts to protect water quality through various protection, restoration, and education projects. This includes research projects, on-site demonstrations, and integration of NPS topics through DFRs network of Educational State Forests and State Forests. Progress reports and summaries are posted in the 'Water Quality' section of DFRs website www.dfr.state.nc.us as they are completed.

Chapter 8
Water Resources

8.1 River Basin Hydrologic Units

Under the federal system, the Watauga River basin is made up of hydrologic areas referred to as cataloging units (USGS 8-digit hydrologic units). Cataloging units are further divided into smaller watershed units (14-digit hydrologic units or local watersheds) that are used for smaller scale planning like that done by the Ecosystem Enhancement Program (EEP)(Chapter 10). There are six local watershed units in the basin, all of which are listed in Table 9. A map identifying the hydrologic units and subbasins can be found in Appendix I.

Table 9 Hydrologic Subdivisions in the Watauga River Basin

Watershed Name and Major Tributaries	DWQ Subbasin 6-Digit Codes	USGS 8-Digit Hydrologic Units	USGS 14-Digit Hydrologic Units Local Watersheds*
Watauga River	04-02-01	06010103	010010, 010020, 010030, 010040
Boone Fork			
Laurel Fork			
Cove Creek			
Beaverdam Creek			
Laurel Creek			
Beech Creek			
Elk River			020010, 100010
Cranberry Creek			

* Numbers from the 8-digit and 14-digit column make the full 14-digit HU.

8.2 Minimum Streamflow

Conditions may be placed on dam operations specifying mandatory minimum releases in order to maintain adequate quantity and quality of water in the length of a stream affected by an impoundment. One of the purposes of the Dam Safety Law is to ensure maintenance of minimum streamflows below dams. The Division of Water Resources (DWR), in conjunction with the Wildlife Resources Commission (WRC), recommends conditions related to release of flows to satisfy minimum instream flow requirements. The Division of Land Resources (DLR) issues the permits.

Under the authority of the Federal Power Act, the Federal Energy Regulatory Commission (FERC) licenses all non-federal dams located on the navigable waters in the United States that produce hydropower for the purposes of interstate commerce. The license may include requirements for flows from the project for designated in-stream or off-stream uses.

Under the authority of Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (USACE) issues permits for the discharge of fill material into navigable waters. The permit may include requirements for flows for designated in-stream or off-stream uses. A 404 permit will not only apply to dams under state and federal regulatory authorities mentioned above, but will also cover structures that are not under their authority, such as weirs, diversions, and small dams. Table 10 presents minimum streamflow projects in the Watauga River basin. It should be noted that this is not necessarily a complete list of minimum streamflow requirements in the basin. Absence from this list should not be interpreted as relief from fulfilling existing permit flow requirements.

Table 10 Minimum Streamflow Projects in the Watauga River Basin

Name	Location	Waterbody	Drainage Area (sq. mi.)	Min. Release (cu.ft/sec)
Hydroelectric Dams				
Ward Mill Dam		Watauga River	92.6	None[a]
Impoundment Dams/Weirs				
Beech Mountain Reservoir	Beech Mountain	Buckeye Creek	3.4	1.5 (January-September) 2.8[b] (October-December)

[a] Even though there is no minimum flow, the project must operate in a run-of-river mode (i.e., instantaneous inflow equals instantaneous outflow). Note: A noncompliant project can noticeably alter the streamflow.

[b] A higher minimum flow is required from October to December due to brook trout spawning season.

8.3 Interbasin Transfers

In addition to water withdrawals (discussed above), water users in North Carolina are also required to register surface water transfers with DWR if the amount is 100,000 gallons per day or more. Also, persons wishing to transfer more than the minimum transfer quantity allowed by the Interbasin Transfer (IBT) law (usually 2.0 MGD), must first obtain a certificate from the Environmental Management Commission (General Statute 143-215.22I). The river basin boundaries that apply to these requirements are designated on a map entitled *Major River Basins and Subbasins in North Carolina*, on file in the Office of the Secretary of State, and included as part General Statute 143-215.22G of the law. These boundaries differ slightly from the 17 major river basins delineated by DWQ.

In determining whether a certificate should be issued, the state must determine that the overall benefits of a transfer must outweigh the potential impacts. Factors used to determine whether a certificate should be issued include:

- Necessity, reasonableness and beneficial effects of the transfer;
- Detrimental effects on the source and receiving basins, including effects on water supply needs, wastewater assimilation, water quality, fish and wildlife habitat, hydroelectric power generation, navigation and recreation;
- Cumulative effect of existing transfers or water uses in the source basin;

- Reasonable alternatives to the proposed transfer; and
- Any other factors and/or circumstances necessary to evaluate the transfer request.

A provision of the IBT law requires that an environmental assessment or environmental impact statement be prepared in accordance with the State Environmental Policy Act (SEPA) as supporting documentation for a transfer petition.

Currently, the only potential transfer involving the Watauga River basin is the Town of Boone. Based on information from 2002 Local Water Supply Plans, the town withdraws water from the New River basin and serves some customers in the Watauga River basin. The transfer amount due to consumptive losses (irrigation, septic, etc.) is unknown, but most likely small.

8.4 Local Water Supply Planning

The North Carolina General Assembly mandated a local and state water supply planning process in 1989 to assure that communities have an adequate supply of potable water for future needs. Under this statute, all units of local government that provide, or plan to provide, public water supply service are required to prepare a Local Water Supply Plan (LWSP) and to update that plan at least every five years. The information presented in a LWSP is an assessment of a water system's present and future water needs and its ability to meet those needs.

Table 11 shows the water use and the service population for water systems that use water from the Watauga River Basin and submit a Local Water Supply Plan to DWR. Except where noted, the data is from the systems' 2002 LWSP.

Table 11 Water Use and Population Served for Local Water Supply Plans in the Watauga River Basin

County	System	Average Daily Demand (MGD)		Population Served	
		2002	2020	2002	2020
Avery	Banner Elk	0.183	0.135	854	1023
Avery	Elk Park	0.138	0.140	497	607
Watauga	Seven Devils (1997 Data)	0.130	0.174	135	184
Watauga	Beech Mountain	0.293	0.234	310	370
Watauga	Mill Ridge Property Owners Association	0.032	0.036	132	200
	Totals	0.776	0.719	1928	2384

Ski Beech (Avery County) is the only registered surface water user in the Watauga River basin. In 2004, Ski Beech pumped an average of one million gallons per day for 25 days.

8.5 Water Quality Issues Related to Drought

Water quality problems associated with rainfall events usually involve degradation of aquatic habitats because the high flows may carry increased loadings of substances like metals, oils, herbicides, pesticides, sand, clay, organic material, bacteria and nutrients. These substances can be toxic to aquatic life (fish and insects) or may result in oxygen depletion or sedimentation.

During drought conditions, these pollutants become more concentrated in streams due to reduced flow. Summer months are generally the most critical months for water quality. Dissolved oxygen is naturally lower due to higher temperatures, algae grow more due to longer periods of sunlight, and streamflows are reduced. In a long-term drought, these problems can be greatly exacerbated and the potential for water quality problems to become catastrophic is increased. This section discusses water quality problems that can be expected during low flow conditions.

The frequency of acute impacts due to nonpoint source pollution (runoff) is actually minimized during drought conditions. However, when rain events do occur, pollutants that have been collecting on the land surface are quickly delivered to streams. When streamflows are well below normal, this polluted runoff becomes a larger percentage of the water flowing in the stream. Point sources may also have water quality impacts during drought conditions even though permit limits are being met. Facilities that discharge wastewater have permit limits that are based on the historic low flow conditions. During droughts these wastewater discharges make up a larger percentage of the water flowing in streams than normal and might contribute to lowered dissolved oxygen concentrations and increased levels of other pollutants.

As streamflows decrease, there is less habitat available for aquatic insects and fish, particularly around lake shorelines. There is also less water available for irrigation and for water supplies. The dry conditions and increased removal of water for these uses further increases strain on the resource. With less habitat, naturally lower dissolved oxygen levels and higher water temperatures, the potential for large kills of fish and aquatic insects is very high. These conditions may stress the fish to the point where they become more susceptible to disease and where stresses that normally would not harm them result in mortality.

These are also areas where longer retention times due to decreased flows allow algae to take full advantage of the nutrients present resulting in algal blooms. During the daylight hours, algae greatly increase the amount of dissolved oxygen in the water, but at night, algal respiration and die off can cause dissolved oxygen levels to drop low enough to cause fish kills. Besides increasing the frequency of fish kills, algae blooms can also cause difficulty in water treatment resulting in taste and odor problems in finished drinking water.

8.6 Source Water Assessment of Public Water Supplies

8.6.1 Introduction

The Federal Safe Drinking Water Act (SDWA) Amendments of 1996 emphasize pollution prevention as an important strategy for the protection of ground and surface water resources. This new focus promotes the prevention of drinking water contamination as a cost-effective means to provide reliable, long-term and safe drinking water sources for public water supply (PWS) systems. In order to determine the susceptibility of public water supply sources to contamination, the amendments also required that all states establish a Source Water Assessment Program (SWAP). Specifically, Section 1453 of the SDWA Amendments require that states develop and implement a SWAP to:

- Delineate source water assessment areas;
- Inventory potential contaminants in these areas; and

- Determine the susceptibility of each public water supply to contamination.

In North Carolina, the agency responsible for the SWAP is the Public Water Supply (PWS) Section of the DENR Division of Environmental Health (DEH). The PWS Section received approval from the EPA for their SWAP Plan in November 1999. The SWAP Plan, entitled *North Carolina's Source Water Assessment Program Plan*, fully describes the methods and procedures used to delineate and assess the susceptibility of more than 9,000 wells and approximately 207 surface water intakes. To review the SWAP Plan, visit the PWS website at http://www.deh.enr.state.nc.us/pws/index.htm.

8.6.2 Delineation of Source Water Assessment Areas

The SWAP Plan builds upon existing protection programs for ground and surface water resources. These include the state's Wellhead Protection Program and the Water Supply Watershed Protection Program.

Wellhead Protection (WHP) Program
North Carolinians withdraw more than 88 million gallons of groundwater per day from more than 9,000 water supply wells across the state. In 1986, Congress passed Amendments to the SDWA requiring states to develop wellhead protection programs that reduce the threat to the quality of groundwater used for drinking water by identifying and managing recharge areas to specific wells or wellfields.

Defining a wellhead protection area (WHPA) is one of the most critical components of wellhead protection. A WHPA is defined as "the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The SWAP uses the methods described in the state's approved WHP Program to delineate source water assessment areas for all public water supply wells. More information related to North Carolina's WHP Program can be found at http://www.deh.enr.state.nc.us/pws/swap.

Water Supply Watershed Protection (WSWP) Program
DWQ is responsible for managing the standards and classifications of all water supply watersheds. In 1992, the WSWP Rules were adopted by the EMC and require all local governments that have land use jurisdiction within water supply watersheds adopt and implement water supply watershed protection ordinances, maps and management plans. SWAP uses the established water supply watershed boundaries and methods established by the WSWP program as a basis to delineate source water assessment areas for all public water surface water intakes. Additional information regarding the WSWP Program can be found at www.ncwaterquality.org/wswp/index.html.

8.6.3 Susceptibility Determination – North Carolina's Overall Approach

The SWAP Plan contains a detailed description of the methods used to assess the susceptibility of each PWS intake in North Carolina. The following is a brief summary of the susceptibility determination approach.

Overall Susceptibility Rating
The overall susceptibility determination rates the potential for a drinking water source to become contaminated. The overall susceptibility rating for each PWS intake is based on two key components: a contaminant rating and an inherent vulnerability rating. For a PWS to be determined "susceptible", a potential contaminant source must be present and the existing conditions of the PWS intake location must be such that a water supply could become contaminated. The determination of susceptibility for each PWS intake is based on combining the results of the inherent vulnerability rating and the contaminant rating for each intake. Once combined, a PWS is given a susceptibility rating of higher, moderate or lower (H, M or L).

Inherent Vulnerability Rating
Inherent vulnerability refers to the physical characteristics and existing conditions of the watershed or aquifer. The inherent vulnerability rating of groundwater intakes is determined based on an evaluation of aquifer characteristics, unsaturated zone characteristics and well integrity and construction characteristics. The inherent vulnerability rating of surface water intakes is determined based on an evaluation of the watershed classification (WSWP Rules), intake location, raw water quality data (i.e., turbidity and total coliform) and watershed characteristics (i.e., average annual precipitation, land slope, land use, land cover, groundwater contribution).

Contaminant Rating
The contaminant rating is based on an evaluation of the density of potential contaminant sources (PCSs), their relative risk potential to cause contamination, and their proximity to the water supply intake within the delineated assessment area.

Inventory of Potential Contaminant Sources (PCSs)
In order to inventory PCSs, the SWAP conducted a review of relevant, available sources of existing data at federal, state and local levels. The SWAP selected sixteen statewide databases that were attainable and contained usable geographic information related to PCSs.

8.6.4 Source Water Protection

The PWS Section believes that the information from the source water assessments will become the basis for future initiatives and priorities for public drinking water source water protection (SWP) activities. The PWS Section encourages all PWS system owners to implement efforts to manage identified sources of contamination and to reduce or eliminate the potential threat to drinking water supplies through locally implemented programs

To encourage and support local SWP, the state offers PWS system owners assistance with local SWP as well as materials such as:

- Fact sheets outlining sources of funding and other resources for local SWP efforts.
- Success stories describing local SWP efforts in North Carolina.
- Guidance about how to incorporate SWAP and SWP information in Consumer Confidence Reports (CCRs).

Information related to SWP can be found at http://www.deh.enr.state.nc.us/pws/swap.

8.6.5 Public Water Supply Susceptibility Determinations in the Watauga River Basin

In April 2004, the PWS Section completed source water assessments for all drinking water sources and generated reports for the PWS systems using these sources. A second round of assessments were completed in April 2005. The results of the assessments can be viewed in two different ways, either through the interactive ArcIMS mapping tool or compiled in a written report for each PWS system. To access the ArcIMS mapping tool, simply click on the "NC SWAP Info" icon on the PWS web page (http://www.deh.enr.state.nc.us/pws/swap). To view a report, select the PWS System of interest by clicking on the "SWAP Reports" icon.

In the Watauga River Basin, 140 public water supply sources were identified. Two are surface water sources, three are groundwater sources under the influence of surface water and 135 are groundwater sources. Of the135 groundwater sources, one has a Higher susceptibility rating and 134 have a Moderate susceptibility rating. Table 12 identifies the two surface water sources, the three groundwater water sources under the influence of surface water and their overall susceptibility ratings. It is important to note that a susceptibility rating of Higher *does not* imply poor water quality. Susceptibility is an indication of a water supply's *potential* to become contaminated by the identified PCSs within the assessment area.

Table 12 SWAP Results for Surface Water Sources and Groundwater Sources Influenced by Surface Water in the Watauga River Basin

PWS ID Number	Inherent Vulnerability Rating	Contaminant Rating	Overall Susceptibility Rating	Name of Surface Water Source	PWS Name
0195104	M	L	M	Buckeye Creek	Town of Beech Mountain
0195104	M	L	M	Pond Creek	Town of Beech Mountain
0106015	H	L	M	Well #4	Town of Banner Elk
0195103	H	M	H	Well #1	Foscoe Valley MHP #1
0195132	H	L	M	Well #1	Flintlock Campground

Chapter 9
Natural Resources

9.1 Ecological Significance of the Watauga River Basin

Unusual wetlands, topography, and the unique geology of the amphibolite bluffs on the eastern edge of the basin give the Watauga River basin a vital role in supporting the native biological diversity of the North Carolina mountains. Although small in area proportional to the total area of the state, the Watauga River basin contains a number of significant areas of natural heritage including portions of two of the most significant sites in the Southern Appalachian Mountain range – Grandfather Mountain and the Roan Mountain Massif. Both names are recognized well beyond the North Carolina State line, and both areas contain numerous rare plant and animals species, as well as outstanding natural communities.

9.2 Rare Aquatic and Wetland-Dwelling Animal Species

Table 13 lists the rare animal species associated with the aquatic and wetland habitats in the Watauga River basin. Three of these species – the hellbender, green floater and banded sculpin – are discussed in more detail in the following paragraphs. For information on any of the species listed in Table 13, visit the NC Natural Heritage Program (NHP) website www.ncnhp.org.

Table 13 List of Rare Animals Associated with Aquatic and Wetland Habitats in the Watauga River Basin

Scientific Name	Common Name	Major Group	State Status	Federal Status
Cottus carolinae	Banded sculpin	Fish	T	
Lasmigona subviridis	Green Floater	Mollusk	E	FSC
Drunella longicornis	Mayfly	Insect	SR	
Bolotoperla rossi	Stonefly	Insect	SR	
Palaeagapetus celsus	Caddisfly	Insect	SR	
Cryptobranchus alleganiensis	Hellbender	Amphibian	SC	FSC
Eurycea longicauda	Longtail Salamander	Amphibian	SC	
Glyptemys muhlenbergii	Bog Turtle	Reptile	T	T(S/A)

Rare Species Listing Criteria

E = Endangered (those species in danger of becoming extinct)
T = Threatened (considered likely to become endangered within the foreseeable future)
SR = Significantly Rare (those whose numbers are small and whose populations need monitoring)
SC = Species of Special Concern
FSC = Federal Species of Concern (those under consideration for listing under the Federal Endangered Species Act)
T(S/A) = Threatened due to similarity of appearance

The hellbender is a long-lived salamander that inhabits large streams with cool, clean and fast-moving water. Because they are sensitive to stream pollution, siltation and damming, hellbenders serve as good indicators of water quality. Urban development and associated habitat degradation have reduced hellbender populations in North Carolina. Forested riparian buffers can reduce pollution and siltation of streams and improve hellbender habitat.

The green floater is an endangered mussel that lives in smaller, slow-moving streams. Once common in the Neuse and Cape Fear River basins, populations have declined due to water quality degradation. Clean, high quality waters can help protect the green floater mussel populations in the Watauga River basin.

The entire range of the banded sculpin is limited to far western Virginia and North Carolina. These fish are typical of clean, clear streams with well-oxygenated, cool water. Sculpins prefer streams with rock or gravel bottoms, and an abundance of rocks where they can find aquatic insects, small fish and vegetation.

9.3 Significant Natural Heritage Areas and Aquatic Habitats in the Watauga River Basin

The NC Natural Heritage Program (NHP) compiles a list of Significant Natural Heritage Areas as required by the Nature Preserves Act. The list is based on the program's inventory of natural diversity in the state. Natural areas are evaluated based on the number and quality occurrences of rare plant and animal species, rare or high-quality natural communities, and special animal habitats. The global and statewide rarity of these elements and their quality at a site is compared with other occurrences to determine a site's significance. Sites included on this list are the best representatives of the natural diversity of the state, and therefore, have priority for protection. Inclusion on the list does not imply that any protection or public access to the site exists.

The NHP has identified more than 20 individual natural heritage areas in the Watauga River basin. These are shown in Figure 11. A few are described briefly below and include significant aquatic habitats. In identifying the significant aquatic habitats in North Carolina, the NHP collaborates with other agencies and organizations. These habitat areas often include stream segments or other bodies of water that contain significant natural resources, such as a large diversity of rare aquatic animal species. The impact from lands adjacent to and upstream of these stream reaches determines their water quality and the viability of the aquatic species found there.

The Watauga River basin contains two significant aquatic habitat areas: Boone Fork and the Watauga River. Boone Fork Aquatic Habitat is considered regionally significant as habitat for rare aquatic species, including the caddisfly *Palaeagapetus celsus*, as well as an excellent community of native benthic species. The Watauga River Aquatic Habitat is also considered regionally significant, and provides habitat for hellbenders, green floaters, and the stonefly *Bolotoperla rossi.* The longtail salamander was historically known in this section of the Watauga River but has not been observed here in decades.

Outside of lotic, or flowing waters, the Watauga River basin also contains high-quality Southern Appalachian Mountain Bogs. Mountain bogs are saturated with water most of the year, and may

have thick layers of sphagnum moss underlain by peat. Most mountain bogs are acidic. These areas, in which water enters the system faster than it leaves, form on flat, stream-bordered glades. Although these bogs are often small and do not make up a significant portion of the landscape, they support many rare plants and animals, including bog turtles (*Glyptemis muhlenbergii*).

Beech Creek Bog is an outstanding example of a mountain bog. The Julian Price Park also contains three examples of Southern Appalachian Mountain Bogs along the Blue Ridge Parkway. Some mountain bogs likely date back to the last ice age – almost 11,000 years ago. Bogs provide food and shelter for wildlife, as well as aid in flood control and act as natural water purification systems. Even small bogs, most of which are located on the headwaters of trout streams, contribute to the productivity and high water quality needed by the fish downstream.

Significant upland sites and mountain ranges also contribute to the maintenance of water quality in the Watauga River basin. Hanging Rock Mountain is considered nationally significant and noted for the excellent examples of natural communities at its peak, including several rare plant species. Two other sites – Snake Mountain and Potato Hill Bog and Seeps/Rich Mountain Bald – are composed of amphibolite, a mineral-rich granite that neutralizes the natural soil acidity. It also contains higher levels of plant nutrients, affecting plant growth and community composition.

Even though only part of Grandfather Mountain lies within the Watauga basin, it warrants special mention. Grandfather Mountain contains one of the largest clusters of rare plants, animals, and natural communities in the Southern Appalachians, and is one of the most significant sites in Eastern North America. One of the highest mountains in the Blue Ridge escarpment at 5,964 feet, Grandfather Mountain drops to 3,200 feet in the Watauga River valley. Although, popular for its rugged bluffs and scenic vistas, biologists are especially enthusiastic about Grandfather Mountain because it contains extensive and well-developed natural communities, and numerous rare, threatened and endangered species.

The Roan Mountain Massif, like other upland sites, straddles the Watauga basin. Only a small portion of the Roan Mountain Massif lies in the watershed, but even this portion contains a number of rare species of plant, animal and natural communities, including a Southern Appalachian Mountain Bog.

There are a number of upland, riparian and wetland Significant Natural Heritage Areas not listed here that contribute to the water quality in the Watauga River basin. Contact the NHP to obtain more information about these natural areas, or visit the NHP website http://www.ncnhp.org/.

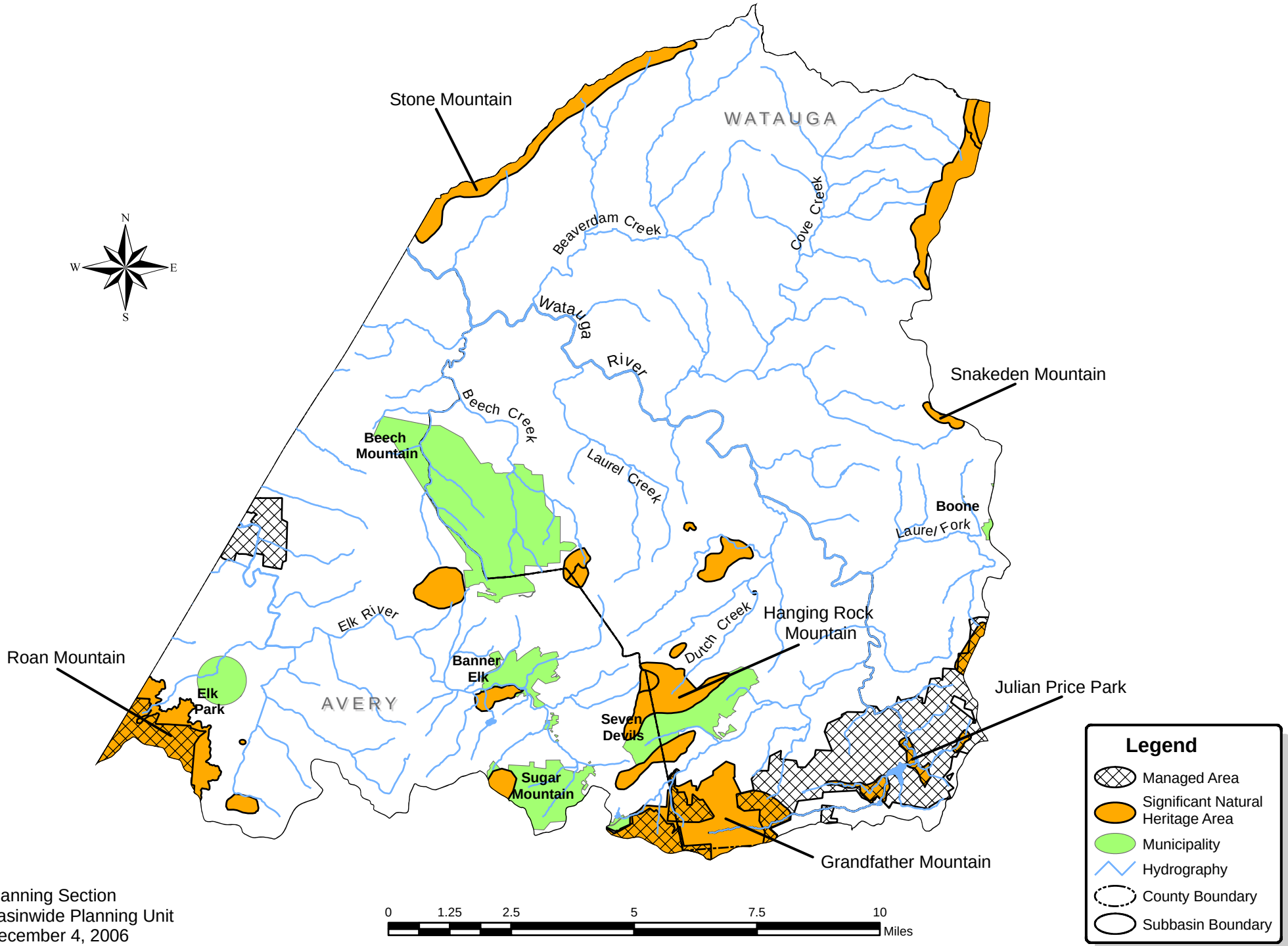
9.4 Conservation Lands – Public and Private

Public conservation lands in the Watauga River basin are also shown in Figure 11. The basin contains significant public lands, both in terms of area and ecological value. Roan Mountain and wetlands in the Julian Price Park are managed by the National Park Service (Blue Ridge Parkway) and the U.S. Forest Service (USFS). The North Carolina Division of Parks and Recreation owns and manages a significant portion of the Beech Creek Bog, a significant aquatic habitat area (Section 9.3). Portions of Potato Hill Bog and Seeps/Rich Mountain Bald are also owned by the State of North Carolina under the Plant Conservation Program in the Department

of Agriculture. Appalachian State University (ASU) conducts research and assists with natural resources management in the Potato Hill Bog and Seeps/Rich Mountain Bald. Beech Creek Bog, Potato Hill Bog and Seeps/Rich Mountain Bald are all significant natural heritage areas and considered nationally significant.

Much of the basin is privately owned, and a number of significant natural heritage areas lie outside public ownership. While many landowners want to protect the natural character of the land, some of these ecosystems remain threatened. Grandfather Mountain is one of the earliest examples of how private land can be permanently protected through conservation easements. A conservation easement is a voluntary, binding agreement entered into by landowners wishing to protect natural features of their land while retaining ownership and use. A conservation easement can often provide estate tax or North Carolina income tax advantages to landowners, depending on the situation, along with the satisfaction of knowing that the land is being preserved for the future. In the case of Grandfather Mountain, The Nature Conservancy holds the conservation easement. The Nature Conservancy also holds a conservation easement on Hanging Rock Mountain. Land trusts, such as the High Country Conservancy and Blue Ridge Rural Land Trust (BRRLT) have also been active conserving natural areas, and consequently water quality, around Valle Mountain (Dutch Creek watershed) and the Watauga River. Funding has also been provided by the Clean Water Management Trust Fund (CWMTF). For more information on conservation easements, visit the land trust website http://www.ctnc.org/ltmap.htm.

Figure 11 Managed Lands and Significant Natural Heritage Area



Planning Section
Basinwide Planning Unit
December 4, 2006

Chapter 10
Water Quality Initiatives

10.1 The Importance of Local Initiatives

As the Basinwide Planning Program completes its third cycle of plan development, there are many efforts being undertaken at the local level to improve water quality. Information about local efforts in a particular watershed or subbasin is included in the subbasin chapter (Chapter 1). DWQ encourages local agencies and organizations to learn about and become active in their local watersheds.

In an effort to provide water quality information and gain input from local resource agency staff and local officials, DWQ held a roundtable in Boone (November 2005). The purpose of the roundtable was to inform local resource agency staff, officials and watershed groups of water quality concerns in the Watauga River basin and to seek input prior to writing the basinwide water quality plan. Participants provided comments on specific waters throughout the basin and generalized issues related to urbanization and land use changes, streamside management, enforcement, permitting, monitoring, water quantity, funding sources, and local initiatives.

An important benefit of local initiatives is that local people make decisions that affect change in their own communities. Local initiatives can overcome a variety of limitations including: state government budgets, staff resources, lack of regulations for nonpoint sources, the rulemaking process and many others. Multiple local organizations and agencies are able to combine professional expertise in a watershed. This allows groups to holistically understand the challenges and opportunities of different water quality efforts. Involving a wide array of people in water quality projects also brings together a range of knowledge and interests, and encourages others to become involved and invested in these projects. By working in coordination across jurisdictions and agency lines, more funding opportunities are available, and it is easier to generate necessary matching or leveraging funds. This will potentially allow local entities to do more work and be involved in more activities because their funding sources are diversified. The most important aspect of these local endeavors is that the more localized the project, the better the chances for success.

The collaboration of these local efforts are key to water quality improvements. There are good examples of local agencies and groups using these cooperative strategies throughout the state. A few of the local organizations are highlighted in Table 14. Specific projects are described in the subbasin chapter (Chapter 1). Nonpoint source program descriptions, Soil and Water Conservation Districts (SWCD), NC Cooperative Extension Service and USDA Natural Resources Conservation Service (NRCS) contact information can be found in Appendix VIII.

DWQ applauds the foresight and proactive response to potential water quality problems in the watersheds identified in the subbasin chapter (Chapter 1). Federal and State government agencies are interested in assisting local governments and citizen groups in developing their water quality management programs. The distribution of several grantors is discussed below (Sections 10.2 and 10.3).

Table 14 Local and Regional Water Quality Initiatives

Watauga River Conservation Partners (WRCP)
Banner Elk, North Carolina

WRCP is a nonprofit membership organization that works in partnership with the Western North Carolina Alliance (WNCA), NC Cooperative Extension Service and the Tennessee Valley Authority (TVA) to provide education activities for local public schools and the general public, monitor compliance with environmental laws, and monitor stream health. WRCP works to support conservation groups and protect, preserve and restore the Watauga River and its tributaries. For more information about WRCP, contact:

Richard Demott	Phone: (828) 963-8682 Email: watauga@wnca.org	http://www.wnca.org

Accomplishments/Projects:

- Riverfest is an annual event to increase public understanding of the condition of and the risks facing the Watauga River. The festival also serves as a catalyst for community activism to protect water quality and quality of life throughout the area.
- WRCP has been influential in shaping local policy and improving local conditions by working with land use planning boards and community councils.

Watauga County
Boone, North Carolina

Watauga County administers an Erosion Control Ordinance that exceeds those required by the NC Sedimentation Pollution Control Act (SPCA). The local program requires a sediment and erosion control permit for all projects that disturb more than 0.5 acres or more. SPCA requires a permit for one acre or more of disturbed land. In addition to the Local Program, a Zoning Ordinance is administered in the Foscoe and Grandfather Mountain Communities. The ordinance requires a 50-foot vegetated corridor along the Watauga River mainstem and along Boone Fork and a 40-foot vegetated corridor along all perennial streams as denoted as solid blue lines on USGS topographic maps. For more information contact:

Randy Woodrow Property Development Coordinator	Phone: (828) 265-8043 Email: randy.woodrow@ncmail.net	www.wataugacounty.org

Town of Boone
Boone, North Carolina

The majority of the Town of Boone drains into the South Fork New River in the New River basin. With the increase of commercial and residential properties however, the Town now extends into the Watauga River basin. The Town administers a local Sediment and Erosion Control program that requires that all projects (regardless of land area disturbed) implement measures to prevent the movement of sediment off-site or into a waterbody. The town has also adopted specific grading regulations to control erosion on steep slopes. More information about grading and soil erosion and sediment control can be found in the Unified Development Ordinance (UDO) (www.townofboone.net/departments/development/index.html).

James Perry Environmental Planner	Phone: (828) 262-4540 Email: james.perry@townofboone.net	www.townofboone.net

Southern Appalachian Man and Biosphere (SAMAB) Program
Southern Appalachian Volunteer Environmental Monitoring (SAVEM) Program
Knoxville, Tennessee

SAMAB promotes environmental health and sustainable development of natural, cultural and economic resources in the Southern Appalachians. It encourages community-based solutions to critical regional issues through cooperation among partners, information gathering and sharing, integrated assessments and demonstration projects. SAMAB relies on volunteers to collect water samples for chemical and biological monitoring along the Appalachian Trail and in several of the National Forests. In the Watauga River basin, SAVEM trains volunteers to collect water samples for chemical analysis. Volunteers are also trained to identify habitat characteristics as well as identify and count benthic macroinvertebrates. For more information about SAMAB and the Volunteer Environmental Monitoring Program, contact:

Andy Brown	Phone: (828) 253-6856	www.samab.org
SAVEM Program Coordinator	Email: andy@equinoxenvironmental.com	

Accomplishments/Projects:

- Information gathered by SAMAB is used by both public and private entities for planning, protection and conservation throughout the states of Virginia, North Carolina, Tennessee and Georgia.

Blue Ridge Rural Land Trust (BRRLT)
Boone, North Carolina

The BRRLT is a non-profit land trust serving a seven county area of western North Carolina. The mission of BRRLT is to preserve rural communities and culture in northwestern North Carolina through the preservation of the land resources upon which they depend. For more information on BRRLT and their most recent projects, contact:

James Coman, III	Phone: (336) 359-2909	www.brrlt.org
Executive Director	Email: hillshepherd@skybest.com	

Accomplishments/Projects:

- BRRLT participated in the designation of Beech Creek Bog as a State Natural Area. It is the largest Southern Appalachian bog and contains several endangered and threatened plant and animal species.
- BRRLT has acquired several conservation easements throughout Watauga County, many of which are significant contributions to the protection of water quality.

10.2 Federal Initiatives

10.2.1 Clean Water Act – Section 319 Program

Section 319 of the Clean Water Act provides grant money for nonpoint source demonstration and restoration projects. Through annual base funding, there is approximately $1 million available for demonstration and education projects across the state. An additional $2 million is available annually through incremental funds for restoration projects. All projects must provide nonfederal matching funds of at least 40% of the project's total costs. Project proposals are reviewed and selected by the North Carolina Nonpoint Source Workgroup made up of state and federal agencies involved in regulation or research associated with nonpoint source pollution

(NPS). Information on the North Carolina Section 319 Grant Program and the application process is available online at www.ncwaterquality.org/nps/application_process.htm.

During this assessment period, one project in the Watauga River basin was funded through Section 319 base funding. The project will focus on water quality education and the implementation of best management practices (BMPs) on urban and non-urban lands (i.e., forests, Christmas tree farms, pasturelands and row crops). The education component will focus on water quality protection, BMPs for various land uses and pollution prevention. North Carolina State University (NCSU) will work with local resource agency staff and the NC Cooperative Extension Service to educate and work with school children, landowners and community leaders throughout the Watauga River Basin to change behaviors and attitudes related to water quality. The project comes at a time when the high quality waters of the river are being threatened by an increasing amount of nonpoint source runoff and sedimentation from rapidly expanding residential and recreational (i.e., resorts, golf courses) developments. Previous local educational programs and monitoring efforts have been successful and this project will allow for that continued effort. Descriptions of projects and general Section 319 Program information are available at www.ncwaterquality.org/nps/Section_319_Grant_Program.htm.

10.3 State Initiatives

10.3.1 North Carolina Ecosystem Enhancement Program (NCEEP)

The North Carolina Ecosystem Enhancement Program (NCEEP) is responsible for providing ecologically effective compensatory mitigation in advance of permitted impacts associated with road projects and other development activities. The fundamental mission of the program is to restore, enhance and protect key watershed functions in the 17 river basins across the state. This is accomplished through the implementation of wetland, stream and riparian buffer projects within selected local watersheds. The vital watershed functions that NCEEP seeks to restore and protect include water quality, floodwater conveyance and storage, fisheries and wildlife habitat. NCEEP is not a grant program, but can implement its restoration projects cooperatively with other state or federal programs such as Section 319 (Section 10.2.1). Combining NCEEP-funded restoration or preservation projects with Section 319 or other local watershed initiatives (i.e., those funded through the Clean Water Management Trust Fund or local/regional Land Trusts) increases the potential to improve the water quality, hydrologic and habitat functions within selected watersheds.

The selection of optimal sites for NCEEP mitigation projects is founded on a basinwide and local watershed planning approach, which results, respectively, in the development of *River Basin Restoration Priorities* and *Local Watershed Plans*.

In developing *River Basin Restoration Priorities (RBRP)*, NCEEP identifies local watersheds (14-digit Hydrologic Units) with the greatest need and opportunity for restoration, enhancement or preservation projects. These high-priority watersheds are called targeted local watersheds (*TLW*s). Targeted local watersheds are identified, in part, using information compiled by DWQ's programmatic activities (i.e, Basinwide Assessment Reports and Basinwide Water Quality Plans). Local factors considered in the selection of *TLW*s include:

- Water quality impairment;
- Habitat degradation;
- The presence of critical habitat or significant natural heritage areas;
- The presence of water supply watersheds or other high-quality waters;
- The status of riparian buffers;
- Estimates of impervious cover and existing or planned transportation projects; and
- The opportunity for local government partnerships.

Recommendations from local resource agency professionals and the presence of existing or planned watershed projects are given significant weight in the selection of *TLW*s.

*TLW*s represent those areas where NCEEP resources can be focused for maximum benefit to local watershed functions. *TLW*s are therefore given priority by NCEEP for the implementation of new stream and wetland restoration/enhancement projects (and/or for the acquisition of preservation easements), providing that willing landowners are available for such projects.

The 2002 *Watershed Restoration Plan* for the Watauga River basin can be found on the NCEEP website http://www.nceep.net/services/restplans/watershedplans.html. NCEEP is currently updating their selections of *TLW*s within the Watauga basin. Table 15 provides a summary of proposed *TLW*s for the Watauga Basin as of August 2006. NCEEP is seeking comments from local resource professionals regarding these selections. To provide comments on these proposed *TLW*s, please contact the lead watershed planner for the Watauga River Basin. Contact information can be found in Appendix VIII.

NCEEP *Local Watershed Plans (LWPs)* are usually developed within *TLW*s identified in the *RBRPs*. Through the local watershed planning process, NCEEP conducts watershed characterization and field assessment tasks to identify critical stressors in local watersheds. The NCEEP planners and their consultants coordinate with local resource professionals and local governments to identify optimal watershed projects and management strategies to address the major functional stressors identified. The *LWP*s prioritize restoration/enhancement projects, preservation sites, and best management practices (BMP) projects that will provide water quality improvement, habitat protection and other environmental benefits to the local watershed.

Currently, there are no NCEEP funded *LWP*s in the Watauga River basin; however, it is possible that such an effort will be undertaken in the future. Decisions regarding the possible need for new *LWP* initiatives within a given basin are made annually by NCEEP planners. These decisions are based primarily on the quantity and type of compensatory mitigation projects the Program is required to implement in future years, as well as the opportunity for local partnerships within selected 14-digit hydrologic units within the basin.

10.3.1.1 NCEEP Projects in the Watauga River Basin

To date, NCEEP has implemented one stream mitigation project in the Watauga River basin. Located on Hanging Rock Creek [AU# 8-22-5], the project consisted of approximately 2,800 feet of stream restoration and 1,000 feet of stream enhancement. Hanging Rock Creek is a tributary to the Elk River, just outside the Town of Banner Elk. The NCEEP project is in the third year of post-construction monitoring.

Table 15 Proposed Targeted Local Watersheds in the Watauga River Basin

Name of Watershed [major streams]	14-digit HU Code	Rationale for Selection as TLW for NCEEP Projects
Watauga River headwaters, including Boone Fork, Dutch Creek and Laurel Fork	06010103 010010	Habitat degradation & water quality threats associated with increasing development pressures, impervious surfaces, stormwater runoff from industry/mining, impoundments (ponds/lakes), sediment inputs and degraded riparian zones; presence of one or more stream restoration projects; natural heritage element occurrences and significant natural heritage areas; HQW, ORW and designated Trout waters
Cove Creek and tributaries, including Vanderpool Creek	06010103 010020	Habitat degradation & water quality threats associated with agricultural land uses (primarily pasture; some tree farms), unrestricted livestock access to streams, increasing residential uses, narrow or degraded riparian zones, streambank instability, nutrient inputs and sedimentation; existing stream & wetlands restoration project; numerous candidate sites for additional stream restoration projects
Beaverdam and Little Beaverdam Creeks	06010103 010040	Impaired water quality [proposed 303(d) listing for Beaverdam Crk] and degraded habitat; stressors include mixed residential and agricultural land uses, degraded or absent riparian zones, cattle access to streams; numerous candidate sites for stream restoration projects; designated Trout waters
Elk River and headwater tributaries, including Cranberry Creek	06010103 020010	Habitat degradation & water quality threats from increasing development, impervious surfaces, agriculture, direct cattle access, nutrient inputs, septic systems and possible straight-pipe discharges, sediment inputs; designated Trout waters; stormwater BMPs & greenway in Banner Elk; existing NCEEP stream project (Hanging Rock Creek)

For additional information about NCEEP's Project Implementation efforts, visit: www.nceep.net/services/implementation/project_implementation.htm. For additional information about NCEEP in general, including its various program activities and products, visit www.nceep.net/.

10.3.2 Clean Water Management Trust Fund

The CWMTF offers approximately $40 million annually in grants for projects within the broadly focused areas of restoring and protecting state surface waters and establishing a network of riparian buffers and greenways. In the Watauga River basin, 17 projects have been funded for a total of $7,562,928 (Table 16). For more information on the CWMTF or these grants, call (252) 830-3222 or visit the website at www.cwmtf.net.

Table 16 Projects in the Watauga River Basin Funded by the Clean Water Management Trust Fund

Project Number	Application Name	Proposed Project Description	Amount Funded
1997A-076	NCSU Cooperative Extension Service - Acq/Restoration/Stormwater-Watauga River	Restore up to 1.6 miles of degraded streams, protect 10-acre wetland, restore 40-acre wetland, provide education to landowners.	$394,103
1999B-402	Blue Ridge RC&D - Restoration & Stormwater/Watauga River	Restore 10,000 ft of streambank and restore 6 acres of wetlands. Build constructed wetland to treat 65-acre watershed. Monitor results for stream restoration and stormwater component.	$880,000
2000M-003	Blue Ridge Rural Land Trust - Beech Ck Bog Acq Minigrant	Minigrant to pay for preacquisition costs for land that borders Beech Creek Bog.	$25,000
2001B-002	Blue Ridge Rural Land Trust - Acquisition/ Watauga R and tributaries	Provide funds to cover transactional and stewardship costs on four donated conservation easements to protect 240 acres along the Beech and Cove Creeks.	$124,900
2002A-017	Nature Conservancy - Acq/ Boone Fork Cr.	Acquire a permanent conservation easement on 720 acres on Grandfather Mountain along Boone Fork Creek. Grandfather Mountain, Inc to donate a minimum of 206 acres on adjacent property in the Green Creek watershed. Would protect a total of 925 acres.	$3,350,000
2002A-601	Region D COG - Watauga/Wilkes Straight Pipe Elimination	Eliminate up to 125 straight pipe systems in Watauga and Wilkes Counties in the headwaters of the Watauga, New, and Yadkin River Basins. Install septic tank systems in homes without systems and upgrade failing drain fields.	$338,000
2002B-408	Watauga Soil & Water Conservation District - Restoration/Agricultural BMPs	Install livestock exclusion systems, including fencing, critical area stabilization, riparian plantings and alternate watering facilities, in various locations in the Watauga, New and Yadkin River Basins.	$38,000
2003A-015	High Country Conservancy - Acq./ Valle Crucis, Craborchard Creek	Purchase permanent conservation easements on 227 acres along Craborchard, Pigeonroost and Dutch Creeks.	$706,000
2004B-025	Nature Conservancy - Acq/ Grandfather Mountain, Profile Trail	Minigrant to pay for pre-acquisition costs associated with the purchase of a permanent conservation easement on 73 acres, including 26 riparian acres, along Shanley Spring Branch and the Watauga River.	$712,000
2004B-404	Valle Crucis Park, Inc. - Rest/ Watauga Park Greenway Restoration	Design, permit and construct a stream stabilization project on 400 feet of the Watauga River in the Valley Crucis Park. Establish 50 ft permanent conservation easements on streambanks. Excessive erosion occurred from Hurricanes Ivan and Frances.	$107,000

2004D-006	Blue Ridge Rural Land Trust - Donated Minigrant/ Dishman Tract, Watauga River	Minigrant to pay for transactional costs for a donated permanent conservation easement on 50 acres along the Watauga River.	$25,000
2004D-014	High Country Conservancy - Donated Minigrant, Cooper Tract	Minigrant to pay for transactional costs for a donated permanent conservation easement on 22 acres along Dutch Creek and the Watauga River.	$12,925
2005A-401	NCSU Cooperative Extension Service- Rest/ Watauga Restoration, Cove & Dutch Creeks; Elk River	Design, permit and construct a natural channel stream restoration project on 1,800 LF of the Watauga River, 1,300 LF of Cove Creek and 900 LF of the Elk River.	$561,000
2005B-046	Southern Appalachian Highlands Conservancy - Acq/ Roan Mountain Tract, Elk River	Protect through fee simple purchase 97 acres, including 41 riparian acres, along Cranberry Creek. Tract is within the Nationally Significant Roan Mountain Massif Natural Heritage Area, adjacent to Pisgah Natl Forest, & upstream of another protected tract.	$214,000
2005D-016	Blue Ridge Rural land Trust - Thornton Farm Tract, Cove Creek	Minigrant to pay for transactional costs for a donated conservation easement on 70 acres of the Thornton farm on North Fork Cove Creek	$25,000
2005M-001	Blue Ridge Rural Land Trust - Mini - Teeter- Beech Creek Project	Minigrant to pay for pre-acquisition and transactional costs associated with the donation of conservation easements on 170 acres along Beech Creek. Easements would be on the Teeter tract and 12 other tracts.	$25,000
2005M-004	Conservation Trust for North Carolina - Mini/ Lankford Tract, Boone Fork Creek	Minigrant to pay for pre-acquisition costs associated with the fee simple purchase of the 22.7 acre Lankford tract along Boone Fork Creek as it travels from Grandfather Mountain to Julian Price Lake.	$25,000
		Total Funded	$7,562,928

Notes:

(1) The entire Watauga River basin is within the CWMTF's Western Piedmont Region.
(2) The total funded amount excludes funded projects that were subsequently withdrawn by the applicant.
(3) Several regional and statewide projects were funded in areas that include the Watauga River basin. These projects include various riparian corridor planning projects and straight pipe/septic system discharge elimination programs.

10.3.3 NC Construction Grants and Loans Programs

The NC Construction Grants and Loans (CG&L) Section provides grants and loans to local government agencies for the construction, upgrade and expansion of wastewater collection and treatment systems. As a financial resource, the section administers five major programs that assist local governments. Of these, two are federally funded programs administered by the state: the Clean Water State Revolving Fund (SRF) Program and the State and Tribal Assistance Grants (STAG). The STAG is a direct congressional appropriations for a specific "special needs" project within the State of North Carolina. The High Unit Cost Grant (SRG) Program, the State Emergency Loan (SEL) Program and the State Revolving Loan (SRL) Program are

state funded programs, with the latter two being below market revolving loan money. In the Watauga River basin, one facility received over $1.2 million in grants and loans from CG&L (Table 17).

As a technical resource, CG&L in conjunction with the Environmental Protection Agency (EPA) has initiated the Municipal Compliance Initiative Program. It is a free technical assistance program to identify wastewater treatment facilities that are declining but not yet out of compliance. A team of engineers, operations experts and managers from the section work with local officials to analyze the facility's design and operation. For more information, visit the CG&L website www.nccgl.net.

Table 17 Projects Supported by the NC Construction Grants and Loans Section in the Watauga River Basin

Program	Applicant[1]	Offer Date	Project Description	Loan/Grant Offered
SRF[2]	Beech Mountain	08/29/2005	WWTP Upgrade	$ 1,229,100

1 Projects/Applicants on this list are either funded or funding is expected (i.e., offer not yet made).
2 Clean Water State Revolving Fund (SRF) Program

10.3.4 Clean Water Bonds – NC Rural Center

Outdated wastewater collection systems, some more than 70 years old, allow millions of gallons of untreated or partially treated wastewater to spill into the state's rivers and streams. The NC Rural Economic Development Center, Inc. (Rural Center) has taken the lead role in designing public policy initiatives to assist rural communities in developing and expanding local water and sewer infrastructure. The Rural Center is a private, nonprofit organization. The Rural Center's mission is to develop sound, economic strategies that improve the quality of life in North Carolina, while focusing on people with low to moderate incomes and communities with limited resources.

To support local economic growth and ensure a reliable supply of clean water, the Rural Center administers three Water and Sewer Grant Programs to help rural communities develop water and sewer systems. The *Supplemental Grants Program* allows local governments and qualified nonprofit corporations to improve local water and sewer systems by addressing critical needs for public health, environmental protection and/or economic development. The maximum grant amount is $400,000 and must be used to match other project funds. The *Capacity Building Grants Program* provides funding for local governments to undertake planning efforts to support strategic investment in water and sewer facilities. Projects typically include preliminary engineering reports, master water/sewer plans, capital improvement plans, feasibility studies, and rate studies. The maximum grant amount is $400,000. The *Unsewered Communities Grants Program* funds the planning and construction of new central, publicly owned sewer systems. This grant is designed to cover 90 percent of the total cost of a project, not to exceed $3 million. Qualifying communities for this program must not be served by an existing wastewater collection or treatment system. For each grant program, priority is given to projects from economically distressed counties of the state as determined by the NC Department of Commerce (www.nccommerce.com).

The water and sewer grants listed above are made possible through appropriations from the NC General Assembly and through proceeds from the Clean Water Bonds. In 1998, North Carolina voters approved an $800 million clean water bond referendum that provided $330 million to state grants to help local governments repair and improve water supply systems and wastewater collection and treatment. The grants also address water conservation and water reuse projects. Another $300 million was made available as clean water loans.

Since the program's beginning, the Rural Center has awarded nearly 500 communities and counties more than $64 million to plan, install, expand, and improve their water and sewer systems. As a result, these communities have served new residential and business customers, created and preserved thousands of jobs, and leveraged millions of dollars in other water and sewer funds. Table 18 lists the grants that were awarded in the Watauga River basin between 1999 and 2005. For more information on the Water and Sewer Grants administered by the Rural Center visit www.ncruralcenter.org/grants/water.htm.

Table 18 Clean Water Bonds Awarded in the Watauga River Basin

County	Recipient	Grant Amount	Grant	Year Awarded
Avery	Town of Elk Park	$25,572	Capacity	August 2002
Avery, Watauga	Town of Beech Mountain	$40,000	Capacity	February 2001
Avery	Town of Banner Elk	$20,000	Capacity	April 2000
Avery	Town of Banner Elk	$15,750	Capacity	December 1999

References

Allen, J., and K.S. Lu. 200. *Modeling and Predicting Future Urban Growth in the Charleston Area*. Strom Thurmond Institute, Clemson University, Clemson, South Carolina. 24 Sept. 2001. http://www.charleston.net/org/greenbelt/method.html

Beach, D. 2002. Coastal Sprawl: *The Effects of Urban Design on Aquatic Ecosystems in the United States*. Pew Oceans Commission, Arlington, Virgina.

Brown, M.J. January 2004. *Forest Statistics for North Carolina, 2002*. Southern Research Station Resource Bulletin SRS-088. Raleigh, NC.

CALFED Bay-Delta Program. 1999. *Monitoring, Research, and Assessment Components for Benthic Macroinvertebrate Communities*. Sacramento, CA. http://www.calwater.ca.gov/programs/science/cmarp/a7a13.html

Cohn-Lee, R.G., and D.M. Cameron. 1992. *Urban Stormwater Runoff Contamination of the Chesapeake Bay: Sources and Mitigation*. The Environmental Professional. 14:10-27.

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

Environmental Protection Agency (EPA). Feb. 2003. *Protecting Water Quality From Urban Runoff*. United States Environmental Protection Agency, Washington, D.C. EPA 841-F-03-003. www.epa.gov/nps

___. April 1995. *Cleaner Water Through Conservation.* United States Environmental Protection Agency, Washington, D.C. EPA 841-B-95-002

Erman, N.A. 1996. *Status of Aquatic Invertebrates in: Sierra Nevada Ecosystem Project: Final Report to Congress, Vol II, Assessments and Scientific Basis for Management Options*. University of California. Davis Centers for Water and Wildland Resources.

Freedgood, J., Lori Tanner, Carl Mailler, Andy Andrews, Mellisa Adams. *Cost of Community Services Studies: Making the Case for Conservation*; Northampton, MA: American Farmland Trust; AFT Publication; page(s) iv, 78; 2002; National; Reports and Studies

Galli, J. 1991. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments, Maryland Department of Environment, Washington, D.C..

Griffith, G.E., J.M. Omernik, J.A. Comstock, M.P. Schafele, W.H. McNab, D.R. Lenat, T.F. MacPherson, J.B Glover, and N.B. Shelburne. 2002. *Ecoregions of North Carolina and*

South Carolina (color poster with map, descriptive text, summary tables, and photographs). U. S. Geological Survey: Reston, VA. (Map Scale 1:1,500,000).

Haupt, M., J. Jurek, L. Hobbs, J. Guidry, C. Smith and R. Ferrell. 2002. *A Preliminary Analysis of Stream Restoration Costs in the North Carolina Wetlands Restoration Program*. Paper presented at the conference *Setting the Agenda for Water Resources Research*. April 9, 2002. Raleigh, NC.

Howell, J.M., M.S. Coyne and P.L. Cornelius. 1996. *Effect of Sediment Particle Size and Temperature on Fecal Bacteria Mortality Rates and the Fecal Coliform/Fecal Streptococci Ratio*. J Environ Qual. 21:1216-1220.

Jones, J.L. and S.B. Kask. 2001. *The fiscal impact of alternative land uses in Macon County*. Land Trust for the Little Tennessee, Franklin, NC.

Kauffman, G.J., and T. Brant. *The Role of Impervious Cover as a Watershed-based Zoning Tool to Protect water Quality in the Christina River Basin of Delaware, Pennsylvania, and Maryland*. University of Delaware, Institute for Public Administration, Water Resources Agency. 2000.

Line, D.E. and G.D. Jennings. 2002. *Long Creek Watershed Nonpoint source Water Quality Monitoring Project – Final Report*. North Carolina State University: Raleigh, NC. Report available online: www.bae.ncsu.edu/bae/programs/extension/wqg/section319/319_LongCreek/index.htm.

McGarvey, Daniel J. 1996. *Stream Channelization*. Bibliography of Environmental Literature. Wittenberg University. Environmental Geology. Springfield, Ohio.

Meyer, J.M., L.A. Kaplan, D. Newbold, D.L. Strayer, C.J. Woltemade, J.B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M.C. Watzin and P.H. Zedler. September 2003. *Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands.* American Rivers and Sierra Club. Washington, D.C.

National Atlas of the United States, April 28, 2006, Raw Data: Boundaries, Map References, Transportation and Water, NationalAtlas.gov, United States Department of Interior.

North Carolina Department of Environment and Natural Resources (NCDENR). Division of Land Resources (DLR). Land Quality Section. July-September 1999. *Sediments: Newsletter of the North Carolina Sediment Control Commission.* Vol. 6 No. 3. Raleigh, NC. http://www.dlr.enr.state.nc.us/.

____. DLR. Land Quality Section. 1998. *What is Erosion and Sedimentation?* Raleigh, NC.

____. DLR. Center for Geographic Information Analysis. 1997. Raleigh, NC.

____. Division of Water Quality (DWQ). August 2004. *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina*. North Carolina Administrative Code 15A NCA 2B .0220. Raleigh, NC.

____. DWQ. August 1, 2004. *Administrative Code Section: 15A NCAC 2B .0100, Procedures for Assignment of Water Quality Standards 15A NCAC 2B .0200, Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of NC 15A NCAC 2B .0300, Assignment of Stream Classification*. Environmental Management Commission. Raleigh, NC.

____. DWQ. December 1, 1995. *Administrative Code Section: 15A NCAC 2H .1000 Stormwater Management. Environmental Management Commission*. Raleigh, NC.

____. DWQ. February 2004. *Buffers for Clean Water*. Raleigh, NC.

____. DWQ. Environmental Sciences Section (ESS). Biological Assessment Unit (BAU). April 2005. *Basinwide Assessment Report: Watauga River Basin*. Raleigh, NC.

____. DWQ. ESS. BAU. April 2005. *Post-Hurricanes Frances, Ivan and Jeanne Biological Monitoring (French Broad and Watauga River Basins): Biological Sampling (November-December 2004)*. Raleigh, NC.

____. DWQ. ESS. BAU. February 2005. *Special Sampling: Watauga River Basin, Watauga County (August 2004)*. Raleigh, NC.

North Carolina Department of Environment, Health and Natural Resources (NCDEHNR). Division of Forest Resources (DFR). January 1990. *Forest Practices Guidelines Related to Water Quality*. North Carolina Administrative Code 15A G.S. 77-13 and 77-14. Raleigh, NC.

North Carolina Department of Natural Resources and Community Development (NRCD). Division of Forest Resources (DFR). September 1989. *Forestry Best Management Practices Manual*. Raleigh, NC. www.dfr.state.nc.us.

Patch, S.C., M.J. Westphal, T.Pandolfo, E. Cates and K.P. Messier. February 2006. *Long-Term Analysis of Water Quality Trends in the Nolichucky and Watauga River Watersheds: Year Two*. Volunteer Water Information Network (VWIN), University of North Carolina at Asheville (UNCA), Environmental Quality Institute (EQI). Technical Report #06-156.

Orr, D.M., Jr. and A.W. Stuart. 2000. *The North Carolina Atlas*. The University of North Carolina Press. Chapel Hill, NC.

Raphals, P. 2001. *Restructured Rivers: Hydropower in the Era of Competitive Markets*. Berkeley: International Rivers Network.

Roell, Michael J. June 1999. *Sand and Gravel Mining in Missouri Stream Systems: Aquatic Resource Effects and Management Alternatives*. Missouri Department of Conservation. Conservation Research Center. Columbia, MO.

Schillinger, J.E. and J.J. Gannon. 1985. *Bacterial Adsorption and Suspended Particles in Urban Stormwater*. Journal WPCF. 57:384-389.

Sherer, B.M., J.R. Miner, J.A. Moore and J.C. Buckhouse. 1992. *Indicator Bacterial Survival in Stream Sediments*. J Environ Qual. 21:591-595.

Schueler, T.R. 1995. *Site Planning for Urban Stream Protection.* Metropolitan Washington Council of Governments: Washington D.C.

Schueler, T.R. 1992. *Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government*. Watershed Restoration Sourcebook. Publication #92701 of the Metropolitan Washington Council of Governments, edited by P. Kumble and T. Schueler.

Schueler, T., and H.K. Holland. 2000. *The Practice of Watershed Protection.* Center for Watershed Protection, Ellicott City, Maryland.

US Department of Agriculture (USDA). Natural Resources Conservation Service (NRCS). North Carolina State Office. June 2001. *1997 National Resources Inventory*. Raleigh, NC.

US Environmental Protection Agency (EPA). 1999. Watershed Academy Website: http://www.epa.gov/OWOW/watershed/wacademy/.

Watershed Education for Communities and Local Officials (WECO). 2003. *Nonpoint Source Pollution Prevention and Control Through Land Use Planning and Management: An Introduction & Resource Guide for Protection Coastal North Carolina Waters*. Prepared by Jason Jolley. North Carolina State University (NCSU): Raleigh, NC.

Weinkam, C., R. Shea, C. Shea, C. Lein and D. Harper. October 2001. *Urban Stream Restoration Programs of Two Counties in the Baltimore-Washington DC Area*. Paper presented at the *Fourth Annual North Carolina Stream Restoration Conference, Stream Repair and Restoration: A Focus on the Urban Environment*. Raleigh, NC.

Yaggi, M.A. and W. Wegner. 2002. *Steep Slope Development and How It Effects the Environment*. Concerned Citizens of Southeast; Brewster, NY.

Appendix I

Population and Growth Trends in the Watauga River Basin

Population and Growth Trends

Below are three different ways of presenting population data for the Watauga River basin. The data for the entire river basin allow for the 2000 population data to be shown across subbasins. Population data presented by county allow for analysis of projected growth trends in the basin based on information from the Office of State Planning (May, 2006). Data presented by municipality summarizes information on past growth of large urban areas in the basin. While the three different sets of information cannot be directly compared, general conclusions are apparent by evaluating the information. Counties with the highest expected growth are associated with the largest municipal areas and the most densely populated subbasins in the basin.

Basin Population and Population Density

Information on population density at a watershed scale is useful in determining what streams are likely to have the most impacts as a result of population growth. This information is also useful in identifying stream segments that have good opportunities for preservation or restoration activities. This information is presented to estimate population and population density by each subbasin and for the entire basin. It is assumed that county populations are distributed evenly throughout each county; therefore, subbasins that are within counties with large urban areas may overestimate the actual population in that portion of the basin. The overall population of the basin based on 2000 Census data is 23,675, with approximately 115 persons/square mile. (See the map of hydrologic units and population density.) The overall population and persons/square mile is estimated based on the percent of the county land area that is partially or entirely within the basin.

County Population and Growth Trends

The following table shows the projected population for 2020 and the change in growth between 1990 and 2000 for counties that are partially or entirely contained within the basin. Since river basin boundaries do not coincide with county boundaries, these numbers are not directly applicable to the Watauga River basin. This information is intended to present an estimate of expected population growth in counties that have some land area in the Watauga River basin. For more information on past, current and projected population estimates, contact the Office of State Planning (919) 733-4131 or visit their website at http://demog.state.nc.us.

County	Percent of County in Basin ♦	County Population 1990	County Population 2000	Estimated % Growth 1990-2000	Estimated Population 2020	Estimated % Growth 2000-2020
Avery	26	14,867	17,167	13.4	20,503	16.3
Watauga	45	36,952	42,693	13.4	46,060	7.3
Subtotals		51,819	59,860	13.4	66,563	10.1

Source: North Carolina Center for Geographic Information and Analysis (CGIA), 1997.

Note: The numbers reported reflect county population; however, these counties are not entirely within the basin. The intent is to demonstrate growth for counties located wholly or partially within the basin.

Municipal Population and Growth Trends

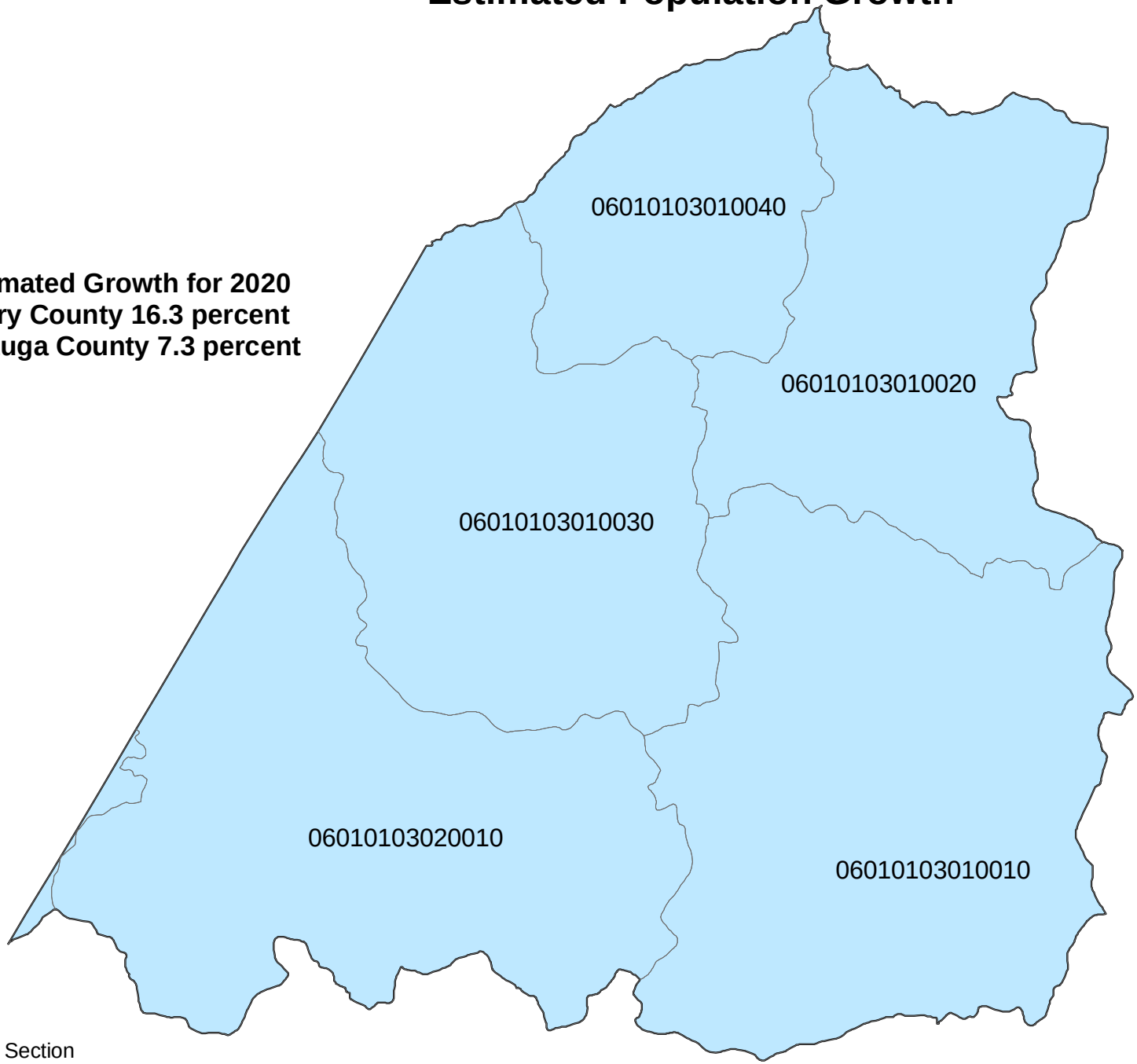
The table below presents population data from Office of State Planning for municipalities located partially or entirely in the basin. These data represent six municipalities in the basin.

Municipality	County	April 1980	April 1990	April 2000	Percent Change (1980-1990)	Percent Change (1990-2000)
Banner Elk	Avery	1,087	933	811	-14.2	-13.1
Beech Mountain	Avery, Watauga	190	239	310	25.8	29.7
Boone•	Watauga	10,191	12,949	13,472	27.1	4.0
Elk Park	Avery	535	486	459	-9.2	-5.6
Seven Devils	Avery, Watauga	54	117	129	116.7	10.3
Sugar Mountain	Avery	188	132	226	-29.8	71.2

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

14-Digit Hydrologic Units in the Watauga River Basin and Estimated Population Growth

Estimated Growth for 2020
Avery County 16.3 percent
Watauga County 7.3 percent



Planning Section
Basinwide Planning Unit
September 28, 2006

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Miles

Legend
14-Digit Hydrologic Unit
Estimated Growth Area

Appendix II

Local Governments and Planning Jurisdictions in the Watauga River Basin

Local Governments and Planning Jurisdictions in the Basin

The Watauga River basin encompasses all or portions of two counties and six municipalities. The following table provides a listing of these local governments, along with the regional planning jurisdiction (Council of Governments). Two municipalities are located in more than one county. Two municipalities are located in more than one major river basin.

County	Region	Municipalities
Avery	D	Banner Elk, Beech Mountain*, Elk Park, Seven Devils*, Sugar Mountain♦
Watauga	D	Beech Mountain*, Boone♦, Seven Devils*

* Located in more than one county.

♦ Located in more than one major river basin.

Note: Counties adjacent to and sharing a border with a river basin are not included as part of that basin if only a trace amount of the county (<2 percent) is located in that basin, unless a municipality is located in that county.

Region	Name	Location
D	Council of Governments	Boone

Appendix III

Land Cover
in the
Watauga River Basin

Land Cover

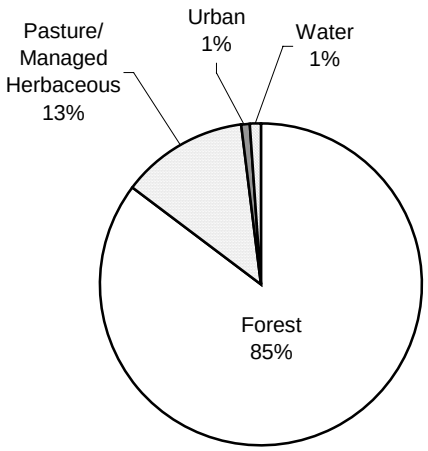
Land cover can be an important way to evaluate the effects of land use changes on water quality. Unfortunately, the tools and database to do this on a watershed scale are not available. The information below describes two different ways of presenting land cover in the Watauga River basin.

The state's Center for Geographic Information and Analysis (CGIA) land cover information is useful in providing a snapshot of land cover in the basin from 1993 to 1995. This information is also available in a GIS format so it can be manipulated to present amounts of the different land covers by subbasin or at the watershed scale. The Natural Resources Inventory (NRI) land cover information is presented only at a larger scale (8-digit hydrologic unit), but the collection methods allow for between year comparisons. The two datasets cannot be compared to evaluate land cover data. This information is presented to provide a picture of the different land covers and some idea of change in land cover over time. In the future, it is hoped that land cover information like the GIS formatted dataset will be developed to make more meaningful assessments of the effects of land use changes on water quality. This dataset would also be useful in providing reliable and small-scale information on land cover changes that can be used in water quality monitoring, modeling and restoration efforts.

CGIA Land Cover

The North Carolina Corporate Geographic Database contains land cover information for the Watauga River basin based on satellite imagery from 1993-1995. CGIA developed 24 categories of statewide land cover information. For the purposes of this report, those categories have been condensed into five broader categories as described in the following table. The chart provides an illustration of the relative amount of land area that falls into each major land cover type. Cultivated cropland is not identified as one of the land cover types in the Watauga River basin.

Land Cover Type	Land Cover Description
Urban	Greater than 50 percent coverage by synthetic land cover (built-upon area) and municipal areas.
Cultivated Cropland	Areas that are covered by crops that are cultivated in a distinguishable pattern.
Pasture/Managed Herbaceous	Areas used for the production of grass and other forage crops and managed areas such as golf courses and cemeteries. Also includes upland herbaceous areas not characteristic of riverine and estuarine environments.
Forest/Wetland	Includes salt and freshwater marshes, hardwood swamps, shrublands and forested areas (i.e., needleleaf evergreens, deciduous hardwoods).
Water	Areas of open surface water, areas of exposed rock and areas of sand or silt adjacent to tidal waters and lakes.



NRI Land Cover Trends

Land cover information in this section is from the most current National Resources Inventory (NRI), as developed by the Natural Resources Conservation Service (USDA, updated June 2001). The NRI is a statistically based longitudinal survey that has been designed and implemented to assess conditions and trends of soil, water and related resources on the Nation's nonfederal rural lands. The NRI provides results that are nationally and temporally consistent for four points in time -- 1982, 1987, 1992 and 1997.

In general, NRI protocols and definitions remain fixed for each inventory year. However, part of the inventory process is that the previously recorded data are carefully reviewed as determinations are made for the new inventory year. For those cases where a protocol or definition needs to be modified, all historical data must be edited and reviewed on a point-by-point basis to make sure that data for all years are consistent and properly calibrated. The following excerpt from the *Summary Report: 1997 National Resources Inventory* provides guidance for use and interpretation of current NRI data.

> The 1997 NRI database has been designed for use in detecting significant changes in resource conditions relative to the years 1982, 1987, 1992 and 1997. All comparisons for two points in time should be made using the new 1997 NRI database. Comparisons made using data previously published for the 1982, 1987 or 1992 NRI may provide erroneous results because of changes in statistical estimation protocols, and because all data collected prior to 1997 were simultaneously reviewed (edited) as 1997 NRI data were collected.

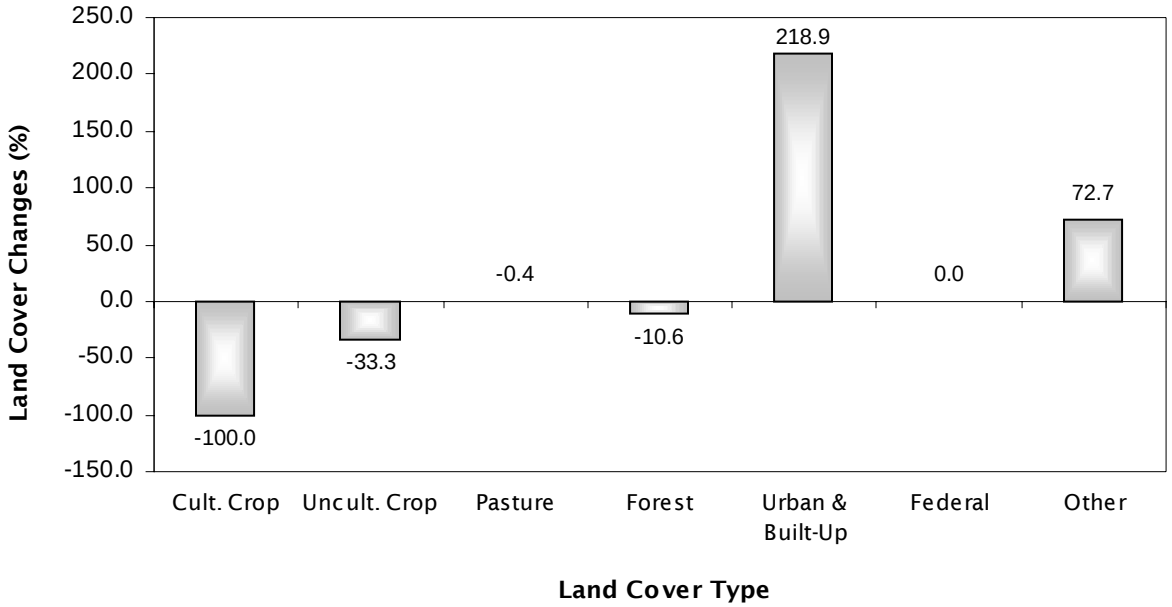
The following table summarizes acreage and percentage of land cover from the 1997 NRI for the major watersheds within the basin, as defined by the USGS 8-digit hydrologic units, and compares the land cover to 1982 land cover. Definitions of the different land cover types are also presented.

LAND COVER	MAJOR WATERSHED AREAS						
	Watauga Watershed		1997 TOTALS		1982 TOTALS		% Change Since 1982
	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	
Cult. Crop	0.0	0.0	0.0	0.0	2.0	1.6	-100.0
Uncult. Crop	2.4	1.9	2.4	1.9	3.6	2.8	-33.3
Pasture	25.9	20.0	25.9	20.0	26.0	20.3	-0.4
Forest	67.8	53.0	67.8	53.0	75.8	59.2	-10.6
Urban & Built-Up	11.8	9.2	11.8	9.2	3.7	2.9	218.9
Federal	12.5	9.8	12.5	9.8	12.5	9.8	0.0
Other	7.6	5.9	7.6	5.9	4.4	3.4	72.7
Totals	128.0	100	128.0	100	128.0	100	
% of Total Basin		100		100			
SUBBASINS	04-02-01						
8-Digit Hydraulic Units	06010103						

Type	Description
Cultivated Cropland	Harvestable crops including row crops, small-grain and hay crops, nursery and orchard crops, and other specialty crops.
Uncultivated Cropland	Summer fallow or other cropland not planted.
Pastureland	Includes land that has a vegetative cover of grasses, legumes and/or forbs, regardless of whether or not it is being grazed by livestock.
Forestland	At least 10 percent stocked (a canopy cover of leaves and branches of 25 percent or greater) by single-stemmed trees of any size, which will be at least 4 meters at maturity, and land bearing evidence of natural regeneration of tree cover. The minimum area for classification of forestland is 1 acre, and the area must be at least 1,000 feet wide.
Urban and Built-up Areas	Includes airports, playgrounds with permanent structures, cemeteries, public administration sites, commercial sites, railroad yards, construction sites, residences, golf courses, sanitary landfills, industrial sites, sewage treatment plants, institutional sites, water control structure spillways and parking lots. Includes highways, railroads and other transportation facilities if surrounded by other urban and built-up areas. Tracts of less than 10 acres that are completely surrounded by urban and built-up lands.
Other	*Rural Transportation*: Consists of all highways, roads, railroads and associated rights-of-way outside urban and built-up areas, private roads to farmsteads, logging roads and other private roads (but not field lanes). *Small Water Areas*: Waterbodies less than 40 acres; streams less than 0.5 mile wide. *Census Water*: Large waterbodies consisting of lakes and estuaries greater than 40 acres and rivers greater than 0.5 mile in width. *Minor Land*: Lands that do not fall into one of the other categories.

Source: USDA, Soil Conservation Service - 1982 and 1997 NRI

Between 1982 and 1997, urban and built-up land cover increased by nearly 8,100 acres (218.9 percent). Uncultivated cropland decreased by over 1,200 acres (-33.3 percent). Pastureland also decreased by 100 acres (-0.4 percent). Forest cover decreased by nearly 8,000 acres (-10.6 percent), and cultivated cropland cover decreased by almost 2,000 acres (-100.0 percent). Most land cover change is accounted for in the areas surrounding the local municipalities in the Watauga River basin. Below is a graph that presents percent land cover change (1982 to 1997).



Source: USDA-NRCS, NRI, updated June 2001

Appendix IV

DWQ Water Quality Monitoring Programs in the Watauga River Basin

DWQ Water Quality Monitoring Programs in the Watauga River Basin

Staff in the Environmental Sciences Section (ESS) and Regional Offices of DWQ collect a variety of biological, chemical and physical data. The following discussion contains a brief introduction to each program, followed by a summary of water quality data in the Watauga River basin for that program. For more detailed information on sampling and assessment of streams in this basin, refer to the *Basinwide Assessment Report* for the Watauga River basin, available on the ESS website http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

DWQ monitoring programs for the Watauga River Basin include:

- Benthic Macroinvertebrates
- Fish Community Assessments
- Aquatic Toxicity Monitoring
- Ambient Monitoring System

Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since macroinvertebrates have life cycles of six months to over one year, the effects of short-term pollution (i.e., chemical spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign a bioclassification to each benthic sample based on the number of different species present in the pollution intolerant groups of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), commonly referred to as EPT. A Biotic Index (BI) value gives an indication of overall community pollution tolerance. Different benthic macroinvertebrate criteria have been developed for different ecoregions (i.e., mountains, piedmont, coastal plain and swamp) within North Carolina and bioclassifications fall into five categories: Excellent, Good, Good-Fair, Fair and Poor.

Overview of Benthic Macroinvertebrate Data

There were 15 benthic sites sampled during this assessment period. The following table lists the total bioclassifications (by subbasin) for all benthos sites in the Watauga River basin. Benthos sampling may slightly overestimate the proportion of Fair and Poor sites, as DWQ special studies often have the greatest sampling intensity (number of sites/stream) in areas where it is believed that water quality problems exist.

Summary of Bioclassifications for All Freshwater Benthic Macroinvertebrate Sites (using the most recent rating for each site) Sampled in the Watauga River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Not Impaired	Total
04-02-01	7	5	2	0	0	0	1	15
Total (%)	**47**	**33**	**13**	**0**	**0**	**0**	**7**	**100**

For more detailed information and the history of sampling in the Watauga River basin, refer to the following table.

Benthic Macroinvertebrate Data Collected in the Watauga River Basin (1999-2004). Current basinwide sites are in bold font.

Waterbody	Location	County	Index No.	Date	Total Species	EPT	BI	EPT BI	Bioclassification
Watauga R	SR 1594	Watauga	8-(1)	8/16/04	-----	43	-----	2.53	Excellent
Watauga R	SR1580	Watauga	8-(1)	8/18/04	-----	32	-----	3.33	Good
				7/13/99	-----	25	-----	3.90	Good-Fair
Watauga R	NC 105	Watauga	8-(1)	8/18/04	106	55	4.01	3.27	Excellent
				7/14/99	88	42	3.91	3.38	Excellent
Boone Fk	SR 1561	Watauga	8-7	8/18/04	75	46	2.95	1.76	Excellent
				7/13/99	72	39	2.54	1.62	Excellent
Boone Fk	Off SR 1558	Watauga	8-7	8/18/04	-----	39	-----	3.30	Excellent
				7/12/99	-----	32	-----	2.84	Good
Laurel Fk	SR 1552	Watauga	8-10	8/18/04	58	34	2.88	2.37	Not Impaired
Laurel Fk	SR 1111	Watauga	8-10	8/18/04	-----	26	-----	2.91	Good-Fair
				7/13/99	-----	27	-----	3.28	Good-Fair
Cove Cr	SR 1149	Watauga	8-15	8/17/04	-----	34	-----	3.64	Good
				7/13/99	-----	32	-----	3.35	Good
Watauga R	SR 1121	Watauga	8-(16)	8/17/04	100	47	4.46	3.67	Excellent
				7/15/99	81	38	4.27	3.48	Good
Watauga R	SR 1200	Watauga	8-(16)	8/17/04	110	45	4.33	3.18	Excellent
				7/15/99	94	50	3.89	3.22	Excellent
Laurel Cr	SR 1123	Watauga	8-17	8/17/04	-----	35	-----	2.33	Good
				7/15/99	-----	31	-----	2.60	Good
Beaverdam Cr	SR 1202	Watauga	8-19	8/17/04	-----	30	-----	2.57	Good
				7/13/99	-----	37	-----	3.17	Good
Beech Cr	US 321	Watauga	8-20	8/17/04	-----	41	-----	2.01	Excellent
				7/15/99	-----	38	-----	2.51	Excellent
Elk R	Off NC 184	Avery	8-22-(3)	8/16/04	71	24	5.37	4.11	Good-Fair
				7/14/99	102	44	4.38	3.58	Good
Elk R	SR 1305	Avery	8-22-(14.5)	8/16/04	103	43	4.33	3.17	Good
				7/14/99	88	44	3.86	3.09	Excellent

Assessing Benthic Macroinvertebrate Communities in Small Streams

The benthic macroinvertebrate community of small streams is naturally less diverse than the streams used to develop the current criteria for flowing freshwater streams. The benthic macroinvertebrate database is being evaluated, and a study to systematically look at small reference streams in different ecoregions is being developed with the goal of finding a way to evaluate water quality conditions in such small streams.

Presently, a designation of Not Impaired may be used for flowing waters that are too small to be assigned a bioclassification (less than 4 meters in width) but meet the criteria for a Good-Fair or higher bioclassification using the standard qualitative and EPT criteria. This designation will translate into a use support rating of Supporting. However, DWQ will use the monitoring information from small streams to identify potential impacts to small streams even in cases when a use support rating cannot be assigned.

DWQ will use this monitoring information to identify potential impacts to these waters even though a use support rating is not assigned. DWQ will continue to develop criteria to assess water quality in small streams.

Fish Community Assessments

All of the fish community sites in this subbasin were sampled by DWQ for the first time in 2004. The 2004 basinwide assessment will therefore serve as a baseline for fish communities sampled during the 2009 basinwide assessment period. The North Carolina Index of Biotic Integrity (NCIBI) is used to assess biological integrity. The NCIBI uses a cumulative assessment of ten parameters or metrics. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score.

Overview of Fish Community Data

There were 10 fish sites sampled in the Watauga River basin during this assessment period. The following table lists the most recent ratings (by subbasin) for all fish community sites.

Summary of NCIBI Categories for All Freshwater Fish Community Sites (using the most recent rating for each site) Sampled in the Watauga River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
04-02-01	0	1	3	0	1	5	10
Total (%)	**0**	**10**	**30**	**0**	**10**	**50**	**100**

For detailed information regarding the fish samples collected during this assessment period, refer to the following table.

Fish Community Data Collected in the Watauga River Basin (2004)

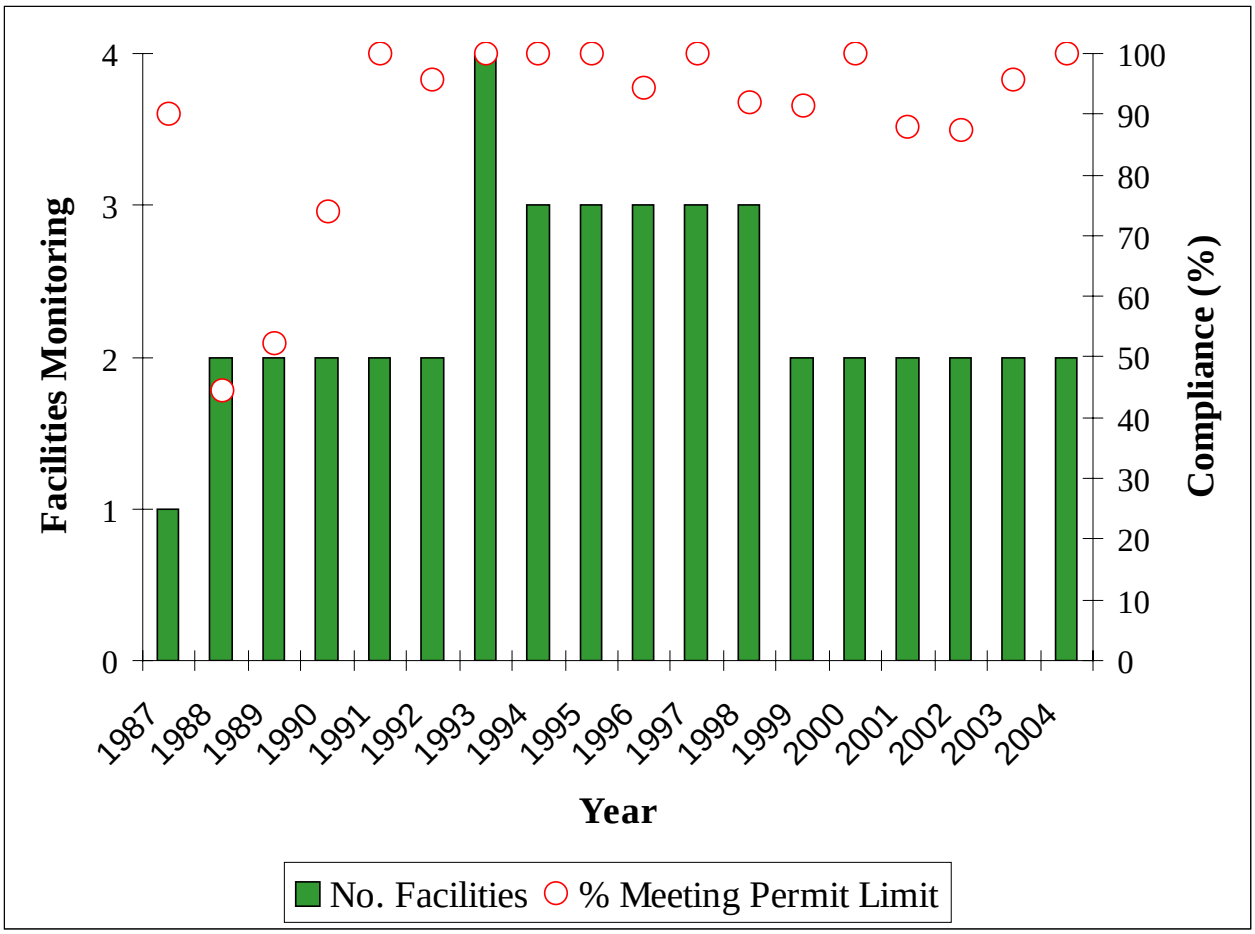
Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Bioclassification
Watauga R	off SR 1557	Watauga	8-(1)	05/06/04	44	Good-Fair
Boone Fk	off SR 1558	Watauga	8-7	05/06/04	50	Good
Laurel Fk	SR 1111	Watauga	8-10	05/05/04	---	Not Rated
Dutch Cr	SR 1112/NC 194	Watauga	8-12-(1.5)	05/05/04	46	Good-Fair
Cove Cr	SR 1149	Watauga	8-15	05/05/04	40	Good-Fair
				12/02/04	34	Fair
Laurel Cr	SR 1123	Watauga	8-17	05/04/04	---	Not Rated
Beaverdam Cr	SR 1202	Watauga	8-19	05/04/04	26	Poor
Beech Cr	off SR 1312	Avery	8-20	05/04/04	---	Not Rated
Elk R	SR 1326	Avery	8-22-(14.5)	05/03/04	---	Not Rated
Cranberry Cr	NC 194	Avery	8-22-16	05/03/04	---	Not Rated

Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of permitted discharges to sensitive aquatic species (i.e., fathead minnows and/or water fleas, *Ceriodaphnia dubia*). Results of these tests have been shown by several researchers to be predictive of point source discharge effects on receiving stream populations. Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit or by administrative letter. The Aquatic Toxicology Unit (ATU) may also test other facilities. Per Section 106 of the Clean Water Act, the ATU is required to test at least 10 percent of the major discharging facilities over the course of the federal fiscal year (FFY). However, it is ATU's target to test 20 percent of the major dischargers in the FFY. This means that each major facility would be evaluated over the course of their five-year permit. There are no requirements or targets for minor dischargers.

In addition, the ATU maintains a compliance summary for all facilities required to perform tests and provides monthly updates 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.

Two NPDES permits in the Watauga River basin currently require WET testing. Both facility permits have a WET limit. The number of facilities required to monitor WET has increased steadily since 1987, the first year that WET limits were written into permits in North Carolina. The compliance rate has risen as well. Since 1996, the compliance rate has stabilized at approximately 90 percent. The following graph summaries WET monitoring compliance in the Watauga River basin from 1987 to 2004. Facilities with toxicity problems during the most recent two-year review period are discussed in the subbasin chapter (Chapter 1).



NPDES facility WET compliance in the Watauga River basin (1987-2004). The compliance values were calculated by determining whether facilities with WET limits were meeting their ultimate permit limits during the given time period, regardless of any Special Orders of Consent (SOC) in force.

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. North Carolina has more than 378 water chemistry monitoring stations statewide, including 4 stations in the Watauga River basin. Between 23 and 32 parameters are collected monthly at each station. The locations of these stations are listed in the following table and shown on the subbasin map (Chapter 1). Notable ambient water quality parameters are discussed in the subbasin chapter (Chapter 1). Refer to the *2005 Watauga River Basinwide Assessment Report* (http://www.esb.enr.state.nc.us/bar.html) for a more detailed analysis of ambient water quality monitoring data.

Ambient Monitoring Stations in the Watauga River Basin

Station Number	STORET Number	Waterbody/ Location	County	Class
LA1	L1700000	Watauga River SR1557 nr Shulls Mill	Watauga	B Tr HQW
LA2	L2000000	Watauga River NC105 nr Shulls Mill	Watauga	B Tr HQW
LA3	L2350000	Watauga River SR1114 nr Valle Crucis	Watauga	B Tr HQW
LA4	L4700000	Watauga River SR1121 nr Sugar Grove	Watauga	B Tr HQW

Appendix V

Other Water Quality Data in the Watauga River Basin

Other Water Quality Research

North Carolina actively solicits "existing and readily available" data and information for each basin as part of the basinwide planning process. Data meeting DWQ quality assurance objectives are used in making use support determinations. When resources allow, data and information indicating possible water quality problems are investigated further. Both quantitative and qualitative information are accepted during the solicitation period.

DWQ data solicitation includes the following:

- Information, letters and photographs regarding the uses of surface waters for boating, drinking water, swimming, aesthetics and fishing.
- Raw data submitted electronically and accompanied by documentation of quality assurance methods used to collect and analyze the samples. Maps showing sampling locations must also be included.
- Summary reports and memos, including distribution statistics and accompanied by documentation of quality assurance methods used to collect and analyze the data.

Contact information must accompany all data and information submitted.

High levels of confidence must be present in order for outside quantitative information to carry the same weight as information collected from within DWQ. This is particularly the case when considering waters for the Impaired categories in the Integrated Report and 303(d) list. Methodology for soliciting and evaluating outside data is presented in *North Carolina's 2002 Integrated Report*, which is available on-line http://h2o.enr.state.nc.us/tmdl/Docs_303/2002/2002 Integrated Rept.pdf. The next data solicitation period for the Watauga River basin is scheduled for fall 2008.

Any data submitted to DWQ from other water sampling programs conducted in the Watauga River basin have been reviewed. Data that meet quality and accessibility requirements were considered for use support assessments and the 303(d) list. These data are also used by DWQ to adjust the location of biological and chemical monitoring sites. In particular, DWQ has reviewed and considered information developed through the Volunteer Water Information Network (VWIN) as managed by the University of North Carolina – Asheville (UNCA) Environmental Quality Institute (EQI). Other programs or research that developed data or information are presented in individual subbasin chapters.

For VWIN, each county with monitoring stations has a coordinator to organize and train volunteers and to ensure that all stations are monitored monthly. The NC Cooperative Extension Service (CES), the Appalachian Trail Conservancy, and Equinox Environmental Consultation & Design coordinate monitoring in the Watauga River basin. Southern Appalachian Man and the Biosphere (SAMAB), the National Forest Foundation, and the Appalachian Trail Park Office initiated watershed monitoring. The Blue Ridge Resource Conservation & Development Council and the NC CES provide funding. The information obtained through VWIN provides an overall view of water quality conditions and changes over time.

In the Watauga River basin, VWIN monitors 11 sites, which are listed in the following table. These sites generally agree with DWQ ambient monitoring data but were not used in use support assessments. VWIN has collected two years of monthly data for most sites. Parameters monitored include major nutrients, turbidity, suspended solids, pH, alkalinity, conductivity and heavy metals such as zinc, copper and lead.

County	Stream Name	Sampling Location
Avery	Elk River	Near Appalachian Trail and Elk River Falls
	Elk River	Downstream from Lees McRae
	Spring to UT	Spring to Unnamed Tributary on the Appalachian Trail at Doll Flats
Watauga	Watauga River	NC-TN State Line
	Watauga River	Gauging station upstream from Cove Creek
	Watauga River	Hwy 105/Appalachian Angler
	Cove Creek	Near confluence with the Watauga River
	Laurel Fork	Flintlock Campground
	Dutch Creek	Valle Crucis Elementary School
	Brushy Fork	Corner of Hwy 421/321
	Boone Fork	Downstream from Price Lake

Appendix VI

NPDES Discharges
and
Stormwater Permits

NPDES Dischargers in the Watauga River Basin (2006)

Permit	Owner	Facility	County	Region	Type	Class	Flow	Subbasin	Receiving Stream
NC0022730	Town of Beech Mountain	Grassy Gap Creek WWTP	Watauga	Winston-Salem	Municipal	Minor	80000	04-02-01	Grassy Gap Creek (Grassy Gap Branch)
NC0022900	Carolina Water Service Inc Of NC	Sugar Mountain WWTP	Avery	Asheville	100% Domestic	Minor	1000000	04-02-01	Flattop Creek
NC0030473	Mill Ridge Property Owners Association	Mill Ridge Development WWTP	Watauga	Winston-Salem	100% Domestic	Minor	52000	04-02-01	Watauga River
NC0032115	Town of Banner Elk	Banner Elk WWTP	Avery	Asheville	Municipal	Minor	600000	04-02-01	Elk River (Mill Pond)
NC0032123	Carolina Water Service Inc Of NC	Hound Ears WWTP	Watauga	Winston-Salem	100% Domestic	Minor	140000	04-02-01	Watauga River
NC0032166	Appalachian State University	Camp Broadstone WWTP	Watauga	Winston-Salem	100% Domestic	Minor	7500	04-02-01	Watauga River
NC0032182	Sunset Apartments	Sunset Apartments	Watauga	Winston-Salem	100% Domestic	Minor	3300	04-02-01	Brushy Fork
NC0032191	Hebron Colony Ministries Inc	Hebron Colony & Grace Home WWTP	Watauga	Winston-Salem	100% Domestic	Minor	4000	04-02-01	Watauga River
NC0032212	Water Quality Services	Yonahlossee WWTP	Watauga	Winston-Salem	100% Domestic	Minor	150000	04-02-01	Lance Creek
NC0033448	MS & SR Enterprises, LLC	Country House Village WWTP	Watauga	Winston-Salem	100% Domestic	Minor	5000	04-02-01	Valley Creek
NC0035149	Seven Devils Resort	Seven Devils Resort	Watauga	Winston-Salem	100% Domestic	Minor	120000	04-02-01	Unnamed Tributary to Watauga River
NC0036242	Sofield's Children LTD Partnership DBA Sofield Properties	Woodland Hills Apartments WWTP	Watauga	Winston-Salem	100% Domestic	Minor	6700	04-02-01	Brushy Fork
NC0038041	PSI Properties Inc	Laurel Seasons WWTP	Watauga	Winston-Salem	Industrial Process & Commercial	Minor	14500	04-02-01	Laurel Fork
NC0042358	Adams Apple Racquet Club	Adams Apple Condominiums	Avery	Asheville	100% Domestic	Minor	20000	04-02-01	Watauga River
NC0049174	Smoketree Lodge	Smoketree Lodge	Watauga	Winston-Salem	100% Domestic	Minor	10000	04-02-01	Watauga River
NC0050610	Water Quality Services	The Ponds WWTP	Watauga	Winston-Salem	100% Domestic	Minor	76000	04-02-01	Watauga River
NC0058378	Elk River Utility Inc	Elk River WWTP	Avery	Asheville	100% Domestic	Minor	80000	04-02-01	Elk River (Mill Pond)

NPDES Dischargers in the Watauga River Basin (2006)

Permit	Owner	Facility	County	Region	Type	Class	Flow	Subbasin	Receiving Stream
NC0058891	Hawksnest Utilities	Valley Creek WWTP	Watauga	Winston-Salem	100% Domestic	Minor	900000	04-02-01	Valley Creek
NC0061425	Water Quality Services	Willow Valley Resort WWTP	Watauga	Winston-Salem	100% Domestic	Minor	30000	04-02-01	Laurel Fork
NC0062961	RCS Properties	Tynecastle WWTP	Avery	Asheville	100% Domestic	Minor	40000	04-02-01	Watauga River
NC0065617	Hidden Valley Inc	Hidden Valley Incorporated	Watauga	Winston-Salem	100% Domestic	Minor	20000	04-02-01	Watauga River
NC0066991	Watauga County Board of Education	Bethel Elementary School	Watauga	Winston-Salem	100% Domestic	Minor	6500	04-02-01	Beaverdam Creek
NC0067008	Watauga County Commission	Old Cove Creek School	Watauga	Winston-Salem	100% Domestic	Minor	10000	04-02-01	Cove Creek
NC0067024	Watauga County Board of Education	Valle Crucis Elementary School	Watauga	Winston-Salem	100% Domestic	Minor	6500	04-02-01	Dutch Creek
NC0069761	Town of Beech Mountain	Pond Creek WWTP	Watauga	Winston-Salem	Municipal	Minor	400000	04-02-01	Pond Creek
NC0070408	Clevon Woods Association	Art Plaza WWTP	Watauga	Winston-Salem	100% Domestic	Minor	35000	04-02-01	Watauga River
NC0072559	Valle Landing Property Owners Association Inc	Valle Landing Shopping Center WWTP	Watauga	Winston-Salem	100% Domestic	Minor	3500	04-02-01	Dutch Creek
NC0079561	Town of Elk Park	Elk Park WWTP	Avery	Asheville	Municipal	Minor	100000	04-02-01	Little Elk Creek
NC0088099	Town of Beech Mountain	Buckeye Lake WTP	Watauga	Winston-Salem	Water Treatment Plant	Minor	not limited	04-02-01	Buckeye Creek

COC Number	Facility Name	Receiving Stream	Subbasin	County
NCG020251	Vulcan Construction Materials-Boone Quarry	Laurel Fork	04-02-01	Watauga
NCG140101	Chandler Concrete - Boone	Laurel Fork	04-02-01	Watauga
NCG140259	R H Loven Co Incorporated	Upper Laurel Fork	04-02-01	Watauga
NCG160039	Maymead Materials Inc	Laurel Fork	04-02-01	Watauga
NCG160141	Maymead Materials Inc - Boone	Upper Laurel Fork	04-02-01	Watauga
NCG180192	Charleston Forge	Laurel Creek	04-02-01	Watauga

Appendix VII

303(d) Listing
and
Reporting Methodology

Integrated 305(b) and 303(d) Report Summary

The *North Carolina Water Quality Assessment and Impaired Waters List* is an integrated report that includes both the 305(b) and 303(d) reports of previous years. The *305(b) Report* is compiled biennially to update the assessment of water quality in North Carolina and to meet the Section 305(b) reporting requirement of the Clean Water Act. The 305(b) reports present how well waters support designated uses (e.g., swimming, aquatic life support, water supply), as well as likely causes (e.g., sediment, nutrients) and potential sources of impairment. The term "Use Support" refers to the process mandated by 305(b). The *303(d) List* is a comprehensive public accounting of all Impaired waterbodies that is derived from the 305(b) Report/Use Support. An Impaired waterbody is one that does not meet water quality uses, such as water supply, fishing or propagation of aquatic life. Best professional judgement along with numeric and narrative standards criteria and anti-degradation requirements defined in 40 CFR 131 is considered when evaluating the ability of a waterbody to serve its uses.

Section 303(d) of the federal Clean Water Act (CWA) which Congress enacted in 1972 required States, Territories and authorized Tribes to identify and establish a priority ranking for waterbodies for which technology-based effluent limitations required by Section 301 are not stringent enough to attain and maintain applicable water quality standards, establish total maximum daily loads (TMDLs) for the pollutants causing impairment in those waterbodies, and submit, from time to time, the list of Impaired waterbodies and TMDLs to the US Environmental Protection Agency (EPA). Current federal rules require states to submit 303(d) lists biennially, by April 1st of every even numbered year. EPA is required to approve or disapprove the state-developed 303(d) list within 30 days. For each water quality limited segment Impaired by a pollutant and identified in the 303(d) list, a Total Maximum Daily Load (TMDL) must be developed. TMDLs are not required for waters Impaired by pollution.

The Integrated Report includes descriptions of monitoring programs, the use support methodology, and the Impaired waters list. New guidance from EPA places all waterbody assessment units into one unique assessment category (EPA, 2001b). Although EPA specifies five unique assessment categories, North Carolina elects to use seven categories. Each category is described in detail below:

Category 1: Attaining the water quality standard and no use is threatened. This category consists of those waterbody assessment units where all applicable use support categories are rated " Supporting". Data and information are available to support a determination that the water quality standards are attained and no use is threatened. Future monitoring data will be used to determine if the water quality standard continues to be attained.

Category 2: Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened. This category consists of those waterbody assessment units where at least one of the applicable use support categories are rated " Supporting" and the other use support categories are rated "Not Rated" or "No Data". Also included in this category are waters where at least one of the applicable use support categories, except Fish Consumption, are rated "Supporting"; the remaining applicable use support categories, except Fish Consumption, are rated "Not Rated"; and the Fish Consumption category is rated "Impaired-Evaluated". Data and information are available to support a determination that some, but not all, uses are attained. Attainment status of the remaining uses is unknown because there are insufficient or no data or information.

Future monitoring data will be used to determine if the uses previously found to be in attainment remain in attainment, and to determine the attainment status of those uses for which data and information were previously insufficient to make a determination.

Category 3: Insufficient or no data and information to determine if any designated use is attained. This category consists of those waterbody assessment units where all applicable use support categories, except Fish Consumption, are rated "Not Rated", and the Fish Consumption category is rated "Impaired-Evaluated". Measured data or information to support an attainment determination for any use are not available. Supplementary data and information, or future monitoring, will be required to assess the attainment status.

Category 4: Impaired or threatened for one or more designated uses but does not require the development of a TMDL. This category contains three distinct sub-categories:

Category 4a: TMDL has been completed. This category consists of those waterbody assessment units for which EPA has approved or established a TMDL and water quality standards have not yet been achieved. Monitoring data will be considered before moving an assessment unit from Category 4a to Categories 1 or 2.

Category 4b: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. This category consists of those waterbody assessment units for which TMDLs will not be attempted because other required regulatory controls (e.g., NPDES permit limits, Stormwater Program rules, etc.) are expected to attain water quality standards within a reasonable amount of time. Future monitoring will be used to verify that the water quality standard is attained as expected.

Category 4c: Impairment is not caused by a pollutant. This category consists of assessment units that are Impaired by pollution, not by a pollutant. EPA defines pollution as "The man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of the water." EPA staff have verbally stated that this category is intended to be used for impairments related to water control structures (i.e., dams). Future monitoring will be used to confirm that there continues to be an absence of pollutant-caused impairment and to support water quality management actions necessary to address the cause(s) of the impairment.

Category 5: Impaired for one or more designated uses by a pollutant(s) and requires a TMDL. This category consists of those waterbody assessment units that are Impaired by a pollutant and the proper technical conditions exist to develop TMDLs. As defined by the EPA, the term pollutant means "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into the water." When more than one pollutant is associated with the impairment of a single waterbody assessment unit in this category, the assessment unit will remain in Category 5 until TMDLs for all listed pollutants have been completed and approved by the EPA.

Category 6: Impaired based on biological data. This category consists of waterbody assessment units historically referred to as "Biologically Impaired" waterbodies; these assessment units have no identified cause(s) of impairment although aquatic life impacts have

been documented. The waterbody assessment unit will remain in Category 6 until TMDLs have been completed and approved by the EPA.

Category 7: Impaired, but the proper technical conditions do not yet exist to develop a TMDL. As described in the Federal Register, "proper technical conditions" refer to the availability of the analytical methods, modeling techniques and data base necessary to develop a technically defensible TMDL. These elements will vary in their level of sophistication depending on the nature of the pollutant and characteristics of the segment in question" (43 FR 60662, December 28, 1978). These are assessment units that would otherwise be in Category 5 of the integrated list. As previously noted, EPA has recognized that in some specific situations the data, analyses or models are not available to establish a TMDL. North Carolina seeks EPA technical guidance in developing technically defensible TMDLs for these waters. Open water and ocean hydrology fecal coliform Impaired shellfishing waters are included in this category.

For this integrated list, Categories 1 and 2 are considered fully supporting any assessed uses. This portion of the integrated list is extensive (thousands of segments); thus, a printed copy is not provided. A table of waters on Categories 1 through 3 is available for downloading on the DWQ website (http://h2o.enr.state.nc.us/tmdl/General_303d.htm). *Categories 5, 6 and 7 constitute the 2004 North Carolina 303(d) List for the State of North Carolina.*

Removing Waters from the 303(d) List

In general, waters will move from Categories 5, 6 or 7 when data show that uses are fully supported or when a TMDL has been approved by EPA. In some cases, mistakes have been discovered in the original listing decision and the mistakes are being corrected. Waters appearing on the previously approved Impaired waters list will be moved to Categories 1, 2, 3 or 4 under the following circumstances:

- An updated 305(b) use support rating of Supporting, as described in the basinwide management plans.
- Applicable water quality standards are being met (i.e., no longer Impaired for a given pollutant) as described in either basinwide management plans or in technical memoranda.
- The basis for putting the water on the list is determined to be invalid (i.e., was mistakenly identified as Impaired in accordance with 40 CFR 130.7(b)(6)(iv) and/or *National Clarifying Guidance for State and Territory 1998 Section 303(d) Listing Decisions*. Robert Wayland, III, Director. Office of Wetlands, Oceans and Watersheds. Aug 27, 1997).
- A water quality variance has been issued for a specific standard (e.g., chloride).
- Removal of fish consumption advisories or modification of fish eating advice.
- Typographic listing mistakes (i.e., the wrong water was identified).
- EPA has approved a TMDL.

Scheduling TMDLs

Category 5 waters, those for which a TMDL is needed, are at many different stages on the path to an approved TMDL. Some require additional data collection to adequately define the problem in TMDL terms. Some require more outreach to increase stakeholder involvement. Others need to have a technical strategy budgeted, funded and scheduled. Some are ready for EPA submittal.

North Carolina has prioritized TMDL development for waters Impaired due to bacteria or turbidity. The approach of prioritizing TMDL development based on pollutant has been successfully used in other states. Limited resources are used more effectively with a focus on a particular pollutant. Waters Impaired by other pollutants (i.e., not bacteria) are not excluded from the schedule. However, the majority of waters prioritized for the next few years are associated with bacterial contamination. Compliance with TMDL development schedules provided in the Integrated Report depends upon DWQ and EPA resources.

North Carolina uses biological data to place the majority of waterbody assessment units on the 303(d) list. Additional consideration and data collection are necessary if the establishment of a TMDL for waters on Category 6 is to be expected. It is important to understand that the identification of waters in Category 6 does not mean that they are low priority waters. The assessment of these waters is a high priority for the State of North Carolina. However, it may take significant resources and time to determine the environmental stressors and potentially a cause of impairment. Assigning waters to Category 6 is a declaration of the need for more data and time to adequately define the problems and whether pollution, pollutants or a combination affects waters.

According to EPA guidance (EPA 2004), prioritization of waterbody assessment units for TMDLs need not be reflected in a "high, medium or low" manner. Instead, prioritization can be reflected in the TMDL development schedule. Generally, North Carolina attempts to develop TMDLs within 10 years of the original pollutant listing. Other information for each assessment unit is also utilized to determine the priority in the TMDL development schedule. This information includes the following:

- Year listed. Assessment units that have been on the 303(d) list for the longest period of time will receive priority for TMDL development and/or stressor studies.
- Reason for listing. (Applicable to Category 5 AUs only) AUs with an impairment due to a standard violation will be prioritized based on which standard was violated. Standard violations due to bacteria or turbidity currently receive priority for TMDL development.
- Classification. AUs classified for primary recreation (Class B), water supply (Class WS-I through WS-V), trout (Tr), high quality waters (HQW), and outstanding resource waters (ORW) will continue to receive a higher priority for TMDL development and/or stressor studies.
- Basinwide Planning Schedule. (Applicable to Category 6 AUs only). The basinwide schedule is utilized to establish priority for stressor studies.

Revising TMDLs

Current federal regulations do not specify when TMDLs should be revised. However, there are several circumstances under which it would seem prudent to revisit existing TMDLs. The TMDL analysis of targets and allocations is based upon the existing water quality standards, hydrology, water quality data (chemical and biological), and existing, active NPDES wastewater discharges. Conditions related to any of these factors could be used to justify a TMDL revision. Specific conditions that the Division will consider prior to revising an existing, approved TMDL include the following:

- A TMDL has been fully implemented and the water quality standards continue to be violated. If a TMDL has been implemented and water quality data indicate no improvement or a decline in overall water quality, the basis for the TMDL reduction or the allocation may need to be revised;
- A change of a water quality standard (e.g., fecal coliform to Echerichia coli). The Division will prioritize review of existing TMDLs and data to determine if a revision to TMDLs will be required;
- The addition or removal of hydraulic structures to a waterbody (e.g., dams). Substantial changes to waterbody hydrology and hydraulics have the potential to change many aspects of target setting, including the water quality standard upon which the TMDL was developed, the water quality data, and the water quality modeling;
- Incorrect assumptions were used to derive the TMDL allocations. This would include errors in calculations and omission of a permitted discharge.

Should a TMDL be revised due to needed changes in TMDL targets, the entire TMDL would be revised. This includes the TMDL target, source assessment, and load and wasteload allocations. However, the Division may elect to revise only specific portions of the TMDL. For example, changes may be justifiable to the load and wasteload allocation portions of a TMDL due to incorrect calculations or inequities. In these cases, revisions to the TMDL allocations would not necessarily include a revision of TMDL targets.

Appendix VIII

Watauga River Basin
Nonpoint Source Program
Description and Contacts

Agriculture

USDA Natural Resources Conservation Service:

Part of the U.S. Department of Agriculture (USDA), formerly the Soil Conservation Service. Technical specialists certify waste management plans for animal operations; provide certification training for swine waste applicators; work with landowners on private lands to conserve natural resources, helping farmers and ranchers develop conservation systems unique to their land and needs; administer several federal agricultural cost share and incentive programs; provide assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conduct soil surveys; offer planning assistance for local landowners to install best management practices; and offer farmers technical assistance on wetlands identification. www.nc.nrcs.usda.gov/

County	Contact Person	Phone	Address
Area 1 Conservationist	Carol S. Litchfield	828-456-6341	589 Raccoon Road, Suite 246, Waynesville NC 28786
Avery	Jane Shaw	828-733-2291	146 West B Street, Newland NC 28657
Watauga	Jane Shaw	828-264-0842	971 West King Street, Boone NC 28607

Soil and Water Conservation Districts:

Boards and staff under the administration of the NC Soil and Water Conservation Commission (SWCC). Districts are responsible for: administering the *Agricultural Cost Share Program for Nonpoint Source Pollution Control* at the county level; identifying areas needing soil and/or water conservation treatment; allocating cost share resources; signing cost share contracts with landowners; providing technical assistance for the planning and implementation of BMPs; and encouraging the use of appropriate BMPs to protect water quality.

Avery County SWCD		828-733-2291	146 West B Street, Newland NC 28657
Watauga County SWCD		828-264-3943	971 West King Street, Boone NC 28607

Division of Soil and Water Conservation:

State agency that administers the *Agricultural Cost Share Program for Nonpoint Source Pollution Control* (ACSP). Allocates ACSP funds to the Soil and Water Conservation Districts, provides administrative and technical assistance related to soil science and engineering. Distributes Wetlands Inventory maps for a small fee. www.enr.state.nc.us/DSWC/

Central Office	David B. Williams	919-733-2302	512 N Salisbury Street, Raleigh NC 27604
Asheville Region **	Davis Ferguson Area Coordinator	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778
Winston-Salem Region *	Michelle Lovejoy Area Coordinator	336-771-4600	585 Waughtown Street, Winston-Salem NC 27107

NCDA&CS Regional Agronomists:

The NC Department of Agriculture & Consumer Services (NCDA&CS) technical specialists: certify waste management plans for animal operations; provide certification training for swine waste applicators; track, monitor, and account for use of nutrients on agricultural lands; operate the state *Pesticide Disposal Program*, and enforce the state pesticide handling and application laws with farmers. www.ncagr.com/

Central Office	J. Kent Messick	919-733-2655	4300 Reedy Creek Road, Raleigh NC 27607
Region 12	Lynn Howard	828-373-9982	604 Pine Mountain Road, Hudson NC 28638

Education

NC Cooperative Extension Service:

Provides practical, research-based information and programs to help individuals, families, farms, businesses and communities. www.ces.nscu.edu

Avery		828-733-8270	805 Cranberry Street, Newland NC 28657
Watauga		828-264-3061	971 West King Street, Boone NC 28607

Forestry

DENR Division of Forest Resources:

Develop, protect, and manage the multiple resources of North Carolina's forests through professional stewardship, enhancing the quality of our citizens while ensuring the continuity of these vital resources. www.dfr.state.nc.us

Lenoir District Office (DFR District 2)	Water Quality Forester	828-757-5611	1543 Wilkesboro Blvd. NE, Lenoir NC 28645-8215
Region III Mountains	Regional Forester or Asst. Regional Forester	828-251-6509	14 Gaston Mountain Road, Asheville NC 28806-9101
Raleigh Central Office (Statewide)	Forest Hydrologist, NPS Unit	919-733-2162 ext. 206	1616 Mail Service Center, Raleigh NC 27699-1616
Griffiths Forestry Center (Statewide)	Water Quality & Wetlands Forester	919-553-6178 ext. 230	2411 Old U.S. Hwy 70 West, Clayton NC 27250

Construction/Mining

DENR Division of Land Resources:

Administers the NC Erosion and Sedimentation Control Program for construction and mining operations. Conducts land surveys and studies, produces maps, and protects the state's land and mineral resources. www.dlr.enr.state.nc.us

Central Office	Floyd Williams	919-733-4574	512 North Salisbury Street, Raleigh NC 27626
Asheville Region **	Janet Boyer	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778
Winston-Salem Region *	Matt Gantt	336-771-4600	585 Waughtown Street, Winston-Salem NC 27107

Local Erosion and Sedimentation Control Ordinances:

Several local governments in the basin have qualified to administer their own erosion and sedimentation control ordinances. For a listing of the most recently approved local programs visit www.dlr.enr.state.nc.us/pages/sedimentlocalprograms.html

Avery County	Garry Benfield	828-733-8204	200 Montezuma Street, Newland NC 28657
Watauga County	Randy Woodrow	828-265-8043	842 West King Street, Boone NC 28607
Town of Beech Mountain	Keith Cook	828-387-4236	403 Beech Mountain Parkway, Beech Mountain NC 28604
Town of Boone	James Perry	828-262-4540	1510 Blowing Rock Road, Boone NC 28607

General Water Quality

DENR DWQ Planning Section:

Coordinate the numerous nonpoint source programs carried out by many agencies; coordinate the Neuse and Tar-Pamlico River Nutrient Sensitive Waters Strategies; administer the Section 319 grants program statewide; conduct stormwater permitting; model water quality; conduct water quality monitoring; perform wetlands permitting; conduct animal operation permitting and enforcement; and conduct water quality classifications and standards activities. http://h2o.enr.state.nc.us/pb/index.html

Planning Section Chief	Alan Clark	919-733-5083 x 570	1617 Mail Service Center, Raleigh NC 27699
NPS Planning	Rich Gannon	919-733-5083 x 356	1617 Mail Service Center, Raleigh NC 27699
Modeling/TMDL	Michelle Woolfolk	919-733-5083 x 505	1617 Mail Service Center, Raleigh NC 27699
Classifications and Standards	Jeff Manning	919-733-5083 x 579	1617 Mail Service Center, Raleigh NC 27699
Basinwide Planning	Darlene Kucken	919-733-5083 x 354	1617 Mail Service Center, Raleigh NC 27699
Groundwater Planning	Carl Bailey	919-733-5083 x 522	1617 Mail Service Center, Raleigh NC 27699

DWQ Regional Offices:

Conduct permitting and enforcement field work on point sources, stormwater, wetlands and animal operations; conduct enforcement on water quality violations of any kind; and perform ambient water quality monitoring. http://www.enr.state.nc.us/html/regionaloffices.html

Asheville Region **	Roger Edwards	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778
Winston-Salem Region *	Steve Tedder	336-771-4600	585 Waughton Street, Winston-Salem NC 27107

NC Wildlife Resources Commission:

To manage, restore, develop, cultivate, conserve, protect and regulate the wildlife resources of the state, and to administer the laws enacted by the General Assembly relating to game, game and non-game freshwater fishes, and other wildlife resources in a sound, constructive, comprehensive, continuing and economical manner. www.ncwildlife.org

Central Office	Wildlife Management	919-707-0050	1722 Mail Service Center, Raleigh NC 27699

U.S. Army Corps of Engineers:

Responsible for: investigating, developing and maintaining the nation's water and related environmental resources; constructing and operating projects for navigation, flood control, major drainage, shore and beach restoration and protection; hydropower development; water supply; water quality control, fish and wildlife conservation and enhancement, and outdoor recreation; responding to emergency relief activities directed by other federal agencies; and administering laws for the protection and preservation of navigable waters, emergency flood control and shore protection. Responsible for wetlands and 404 Federal Permits. www.usace.army.mil

Asheville Field Office	Robert Johnson	828-271-7980	151 Patton Ave, Room 208, Asheville NC 28801

Solid Waste			
DENR Division of Waste Management: Management of solid waste in a way that protects public health and the environment. The Division includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors Program. http://wastenot.enr.state.nc.us			
Central Office	Brad Atkinson	919-508-8409	401 Oberlin Road, Suite 150, Raleigh NC 27605
Asheville Region **	Jan Anderson	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778
Winston-Salem Region *	Cindy Rintoul	336-771-4600	585 Waughton Street, Winston-Salem NC 27107
On-Site Wastewater Treatment			
Division of Environmental Health and County Health Departments: Safeguard life, promote human health, and protect the environment through the practice of modern environmental health science, the use of technology, rules, public education, and above all, dedication to the public trust. Services include: training of and delegation of authority to local environmental health specialists concerning on-site wastewater; engineering review of plans and specifications for wastewater systems 3,000 gallons or larger and industrial process wastewater systems designed to discharge below the ground surface; and technical assistance to local health departments, other state agencies, and industry on soil suitability and other site considerations for on-site wastewater systems. www.deh.enr.state.nc.us			
Central Office	Andy Adams	919-715-3274	2728 Capital Boulevard, Raleigh NC 27604
Asheville Region **	Joe Lynn	828-397-5152	2090 U.S. Highway 70, Swannanoa NC 28778
Winston-Salem Region *	Kevin Neal	336-462-0052	585 Waughton Street, Winston-Salem NC 27107
County	**Primary Contact**	**Phone**	**Address**
Avery (Toe River District)	Tom Singleton Health Director	828-733-6031	861 Greenwood Rd., Spruce Pine NC 28777
Watauga (Appalachian District)	Danny Staley Health Director	828-264-4995	126 Poplar Grove Connector, Boone NC 28607

* **DENR Winston-Salem Regional Office covers the following counties:** Alamance, Alleghany, Ashe, Caswell, Davidson, Davie, Forsyth, Guilford, Randolph, Rockingham, Stokes, Surry, Watauga, Wilkes and Yadkin.

** **DENR Asheville Regional Office covers the following counties:** Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Swain, Transylvania and Yancey

Appendix IX

Use Support Methodology

Introduction to Use Support

All surface waters of the state are assigned a classification appropriate to the best-intended uses of that water. Waters are assessed to determine how well they are meeting the classified or best-intended uses. The assessment results in a use support rating for the use categories that apply to that water.

Use Support Categories

Beginning in 2000 with the *Roanoke River Basinwide Water Quality Plan*, DWQ assesses ecosystem health and human health risk through the use of five use support categories: aquatic life, recreation, fish consumption, water supply, and shellfish harvesting. These categories are tied to the uses associated with the primary classifications applied to NC rivers and streams. Waters are Supporting if data and information used to assign a use support rating meet the criteria for that use category. If these criteria are not met, then the waters are Impaired. Waters with inconclusive data and information are Not Rated. Waters where no data or information are available to make an assessment are No Data. The table below specifies which use support categories apply to which primary classifications.

A single body of water may have more than one use support rating corresponding to one or more of the use support categories, as shown in the following table. For many waters, a use support category will not be applicable (N/A) to the classification of that water (e.g., shellfish harvesting is only applied to Class SA waters). A full description of the classifications is available in the DWQ document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina* (15A NCAC 2b .0100 and .0200). Information can also be found within each basin plan and at http://h2o.enr.state.nc.us/csu/.

Use Support Categories

Primary Classification	Ecosystem Approach	Human Health Approach			
	Aquatic Life	Fish Consumption	Recreation	Water Supply	Shellfish Harvesting
C	X	X	X	N/A	N/A
SC	X	X	X	N/A	N/A
B	X	X	X	N/A	N/A
SB	X	X	X	N/A	N/A
SA	X	X	X	N/A	X
WS I – WS IV	X	X	X	X	N/A

Assessment Period

Data and information are used to assess water quality and assign use support ratings using a five-year data window that ends on August 31 of the year of basinwide biological sampling. For example, if biological data are collected in a basin in 2004, then the five-year data window for

use support assessments would be September 1, 1999 to August 31, 2004. There are occasionally some exceptions to this data window, especially when follow up monitoring is needed to make decisions on samples collected in the last year of the assessment period.

Data and information for assessing water quality and assigning use support ratings for lakes uses a data window of October 1 to September 30. Any data collected by DWQ during the five-year data window that ends on September 30 of the year of biological sampling will be used to develop a Weight-of-Evidence approach to lakes assessment. Refer to page 16 of this appendix for more information.

Assessment Units

DWQ identifies waters by index numbers and assessment unit numbers (AU). The AU is used to track defined stream segments or waterbodies in the water quality assessment database, for the 303(d) Impaired waters list, and in the various tables in basin plans and other water quality documents. The AU is a subset of the DWQ index number (classification identification number). A letter attached to the end of the AU indicates that the AU is smaller than the DWQ index segment. No letter indicates that the AU and the DWQ index segment are the same.

Interpretation of Data and Information

It is important to understand the associated limitations and degree of uncertainty when interpreting use support ratings. Although these use support methods are based on data analysis and other information, some best professional judgment is applied during these assessments. Use support ratings are intended to provide an assessment of water quality using a five-year data window, to describe how well surface waters support their classified uses, and to document the potential stressors contributing to water quality degradation and the sources of these contributions.

Use support methods continue to improve over time, and the information and technology used to make use support determinations also continue to become more accurate and comprehensive. These improvements sometimes make it difficult to make generalizations comparing water quality between basin plans. However, technology and methods improvements result in more scientifically sound use support assessments.

Assessment Methodology

Introduction

Many types of data and information are used to determine use support ratings and to identify stressors and sources of water quality degradation. All existing data pertaining to a stream segment for each applicable use support category are entered into a use support database. Assessments and data entries may include use support ratings for each of the five use support categories, basis of assessment, stressors and potential sources, biological, chemical/physical (ambient monitoring), and lakes assessment data, fish consumption advisories from the NC Department of Health and Human Services, swimming advisories and shellfish sanitation growing area classifications from the NC Division of Environmental Health, and available land

cover and land use information. The following describes the data and methodologies used to conduct use support assessments. These methods will continue to be refined as additional information and technology become available.

Basis of Assessment

Assessments are made on an overall basis of either monitored (M) or evaluated (E), depending on the level of information available. A monitored rating is based on the most recent five-year data window and site-specific data and is therefore treated with more confidence than an evaluated rating. Evaluated ratings are used when there are no site-specific data.

Rating Basis	Use Support Category	Assessment Applicability*
S/M	AL	Biological community data or ambient water quality parameters do not exceed criteria in AU during assessment period. Biological and ambient data are independently applied.
S/M	REC	Ambient fecal coliform bacteria levels do not exceed criteria in AU or AU with DEH sites is posted with advisories for 61 days or less during assessment period.
S/M	SH	AU is a DEH Approved shellfish growing area.
I/M	AL	Biological community data or ambient water quality parameters exceed criteria in AU during assessment period. Biological and ambient data are independently applied.
I/M	REC	Ambient fecal coliform bacteria levels exceeds criteria in AU or AU with DEH sites is posted with advisories for more than 61 days during assessment period.
I/M	FC	DHHS has established a site-specific advisory for fish consumption and fish tissue data are available.
I/M	SH	AU is a DEH Conditionally-Approved, Prohibited or Restricted shellfish growing area.
NR/M	AL	Biological community is Not Rated or inconclusive, or ambient water quality parameters are inconclusive or there are less than 10 samples in AU during assessment period. Biological and ambient data are independently applied.
NR/M	REC	Ambient fecal bacteria parameter exceeds annual screening criteria, but does not exceed assessment criteria of five samples in 30 days in AU during assessment period.
NR/M	FC	AU does not have site-specific advisory and is not under a mercury advice or drains to areas within a mercury advice; fish tissue data available.
S/E	AL	AU is a tributary to a S/M AU and land use is similar between AUs.
S/E	WS	AU is classified as WS, and DEH report notes no significant closures at time of assessment.
I/E	FC	AU is in basin under a mercury advice or drains to areas within a mercury advice. AU has a site-specific advisory and there is no fish tissue data available.
NR/E	AL	AU is tributary to I/M AU, or AU is in watershed with intensive and changing land use, or other information suggests negative water quality impacts to AU. Discharger in AU has noncompliance permit violations or has failed three or more WET tests during the last two years of the assessment period.
NR/E	REC	Discharger has noncompliance permit violations of fecal bacteria parameter during last two years of assessment period.
NR/E	FC	AU does not have site-specific advisory and is not under a mercury advice or drains to areas within a mercury advice, or has no fish tissue data.
ND	AL, REC, SH	No data available in AU during assessment period.

Note: S/M = Supporting/Monitored I/M = Impaired/Monitored NR/M = Not Rated/Monitored
S/E = Supporting/Evaluated I/E = Impaired/Evaluated NR/E = Not Rated/Evaluated
ND = No Data
AL = Aquatic Life REC = Recreation FC = Fish Consumption
SH = Shellfish Harvesting WS = Water Supply
AU = Assessment Unit WET = Whole Effluent Toxicity
DEH = Division of Environmental Health
DHHS = Department of Health and Human Services
* = for lakes assessments, see page 16

Supporting ratings are extrapolated up tributaries from monitored streams when there are no problematic dischargers with permit violations or changes in land use/cover. Supporting ratings may also be applied to unmonitored tributaries where there is little land disturbance (e.g., national forests and wildlife refuges, wilderness areas or state natural areas). Problem stressors or sources are not generally applied to unmonitored tributaries. Impaired ratings are not extrapolated to unmonitored tributaries.

Stressors

Biological and ambient samplings are useful tools to assess water quality. However, biological sampling does not typically identify the causes of impairment, and ambient sampling does not always link water quality standards to a biological response. Linking the causes of impairment and the biological response are a complex process (USEPA, 2000) that begins with an evaluation of physical, chemical or biological entities that can induce an adverse biological response. These entities are referred to as stressors. A stressor may have a measurable impact to aquatic health. Not all streams will have a primary stressor or cause of impairment. A single stressor may not be sufficient to cause impairment, but the accumulation of several stressors may result in impairment. In either case, impairment is likely to continue if the stressor or the various cumulative stressors are not addressed. Use support assessments evaluate the available information related to potential stressors impacting water quality.

A stressor identification process may be initiated after a stream appears on the 303(d) list in order to address streams that are Impaired based on biological data. Intensive studies are required to summarize and evaluate potential stressors to determine if there is evidence that a particular stressor plays a substantial role in causing the biological impacts. Intensive studies consider lines of evidence that include benthic macroinvertebrate and fish community data, habitat and riparian area assessment, chemistry and toxicity data, and information on watershed history, current watershed activities and land uses, and pollutant sources. These studies result in decisions regarding the probable stressors contributing to or causing impairment. The intensity of a stressor study may be limited due to a lack of resources. In these cases, it may still be appropriate to include stressors in use support assessments, but to also note where additional information is needed in order to evaluate other stressors.

Where an ambient parameter is identified as a potential concern, the parameter is noted in the DWQ database and use support summary table. Where habitat degradation is identified as a stressor, DWQ and others attempt to identify the type of habitat degradation (e.g., sedimentation, loss of woody habitat, loss of pools or riffles, channelization, lack of riparian vegetation, streambed scour and bank erosion).

Aquatic Life Category

The aquatic life category is an ecosystem approach to assessing the biological integrity of all surface waters of the state. The biological community data and ambient water quality data are used in making assessments in this category. These represent the most important monitoring data for making water quality assessments in the aquatic life category. Evaluation information such as compliance and whole effluent toxicity information from NPDES dischargers, land cover, and other more anecdotal information are also used to identify potential problems and to refine assessments based on the monitoring data. The following is a description of each monitoring data type and the criteria used in assigning use support ratings. Criteria used to evaluate the other information and assign use support ratings are also described. Refer to page 14 for lakes and reservoir assessment methods as applied in the aquatic life category.

Biological Data

Benthic macroinvertebrate (aquatic insects) community and fish community samples are the best way to assess the biological integrity of most waterbodies. Unfortunately, these community measures cannot be applied to every stream size and are further limited by geographic region. These community measures are designed to detect current water quality and water quality changes that may be occurring in the watershed. However, they are only directly applied to the assessment unit where the sample was collected.

Where recent data for both benthic macroinvertebrates and fish communities are available, both are assessed for use support ratings. When the data from multiple biological data types are gathered, each data type is assessed independently. Biological monitoring is typically assessed independent of ambient monitoring data and either may be used to assign a use support rating for an assessment unit.

Benthic Macroinvertebrate Criteria

Criteria have been developed to assign bioclassifications to most benthic macroinvertebrate samples based on the number of taxa present in the pollution intolerant aquatic insect groups of *Ephemeroptera, Plecoptera* and *Trichoptera* (EPTs); and the Biotic Index (BI), which summarizes tolerance data for all taxa in each sample. Because these data represent water quality conditions with a high degree of confidence, use support ratings using these data are considered monitored.

If a Fair macroinvertebrate bioclassification is obtained under conditions (such as drought or flood conditions, recent spills, etc.) that may not represent normal conditions or is borderline Fair (almost Good-Fair), a second sample should be taken within 12-24 months to validate the Fair bioclassification. Such sites will be Not Rated until the second sample is obtained.

Use support ratings are assigned to assessment units using benthic macroinvertebrate bioclassifications as follows.

Waterbody Sample Type or Criteria	Benthic Bioclassification	Use Support Rating
Mountain, piedmont, coastal A[3]	Excellent	Supporting
Mountain, piedmont, coastal A[3]	Good	Supporting
Swamp[1]	Natural	Supporting
Mountain, piedmont, coastal A	Good-Fair	Supporting
Smaller than criteria but Good-Fair[2]	Not Impaired	Supporting
Swamp[1]	Moderate Stress	Supporting
Mountain, piedmont, coastal A[3]	Fair	Impaired
Swamp[1]	Severe Stress	Impaired
Mountain, piedmont, coastal A[3]	Poor	Impaired
Criteria not appropriate to assign bioclassification	Not Rated	Not Rated

1 Swamp streams for benthos sampling are defined as streams in the coastal plain that have no visible flow for a part of the year, but do have flow during the February to early March benthic index period.

2 This designation may be used for flowing waters that are too small to be assigned a bioclassification (less than three square miles drainage area), but have a Good-Fair or higher bioclassification using the standard qualitative and EPT criteria.

3 Coastal A streams are those located in the coastal plain that have flow year round and are wadeable.

Fish Community Criteria

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 NCIBI incorporates information about species richness and composition, indicator species, trophic function, abundance and condition, and reproductive function. Because these data represent water quality conditions with a high degree of confidence, use support ratings using these data are considered monitored. Use support ratings are assigned to assessment units using the NCIBI bioclassifications as follows:

NCIBI	Use Support Rating
Excellent	Supporting
Good	Supporting
Good-Fair	Supporting
Fair	Impaired
Poor	Impaired

The NCIBI was recently revised (NCDENR, 2001), and the bioclassifications and criteria have also been recalibrated against regional reference site data (NCDENR, 2000a, 2000b and 2001a). NCIBI criteria are applicable only to wadeable streams in the following river basins: Broad, Catawba, Savannah, Yadkin-Pee Dee, Cape Fear, Neuse, Roanoke, Tar-Pamlico, French Broad, Hiwassee, Little Tennessee, New and Watauga. Additionally, the NCIBI criteria are only applicable to streams in the piedmont portion of the Cape Fear, Neuse, Roanoke and Tar-Pamlico River basins. The definition of "piedmont" for these four river basins is based upon a map of North Carolina watersheds (Fels, 1997). Specifically:

- In the Cape Fear River basin -- all waters except for those draining the Sandhills in Moore, Lee and Harnett counties, and the entire basin upstream of Lillington, NC.
- In the Neuse River basin -- the entire basin above Smithfield and Wilson, except for the south and southwest portions of Johnston County and eastern two-thirds of Wilson County.
- In the Roanoke River basin -- the entire basin in North Carolina upstream of Roanoke Rapids, NC and a small area between Roanoke Rapids and Halifax, NC.
- In the Tar-Pamlico River basin -- the entire basin above Rocky Mount, except for the lower southeastern one-half of Halifax County and the extreme eastern portion of Nash County.

NCIBI criteria have not been developed for:

- Streams in the Broad, Catawba, Yadkin-Pee Dee, Savannah, French Broad, Hiwassee, Little Tennessee, New and Watauga River basins which are characterized as wadeable first to third order streams with small watersheds, naturally low fish species diversity, coldwater temperatures, and high gradient plunge-pool flows. Such streams are typically thought of as "Southern Appalachian Trout Streams".
- Wadeable streams in the Sandhills ecoregion of the Cape Fear, Lumber and Yadkin-Pee Dee River basins.
- Wadeable streams and swamps in the coastal plain region of the Cape Fear, Chowan, Lumber, Neuse, Pasquotank, Roanoke, Tar-Pamlico and White Oak River basins.
- All nonwadeable and large streams and rivers throughout the state.

Ambient Water Quality Monitoring Criteria

Chemical/physical water quality data are collected through the DWQ Ambient Monitoring Program statewide and NPDES discharger coalitions in some basins. All samples collected (usually monthly) during the five-year assessment period are used to assign a use support rating. Ambient water quality data are not direct measures of biological integrity, but the chemical/physical parameters collected can provide an indication of conditions that may be impacting aquatic life. Because these data represent water quality conditions with a high degree of confidence, use support ratings assigned using these data are considered monitored. Where both ambient data and biological data are available, each data type is assessed independently.

The parameters used to assess water quality in the aquatic life category include dissolved oxygen, pH, chlorophyll *a* and turbidity. Criteria for assigning use support ratings to assessment units with ambient water quality data of a minimum of ten samples are as follows:

Ratings Criteria	Rating
Numerical standard exceeded in ≤10% of samples	Supporting
Numerical standard exceeded in >10% of samples	Impaired
Less than 10 samples collected	Not Rated
DO and pH standard exceeded in swamp streams	Not Rated

Some standards are written with more specific criteria than others and these specific criteria are used to assess use support. For example, the DO standard for Class C waters is a daily average of 5 mg/l and an instantaneous value of 4 mg/l. Because DWQ does not collect daily DO levels at the ambient stations, the instantaneous value is used for assessment criteria. In areas with

continous monitoring, the daily average of 5 mg/l will also be assessed. In addition, pH has a standard of not less than 6 and not greater than 9; each level is assessed. To assess the fecal coliform bacteria standard, five samples must be collected within a 30 day period (see Recreation Category for more information).

Multiple Monitoring Sites

There are assessment units with more than one type of monitoring data. When the data from multiple biological data types are gathered, each data type is assessed independently. Biological monitoring is typically assessed independent of ambient monitoring data and either may be used to assign a use support rating for an assessment unit. Monitoring data are always used over the evaluation information; however, evaluation information can be used to lengthen or shorten monitored assessment units and to assign use support ratings on an evaluated basis to non-monitored assessment units.

NPDES Wastewater Whole Effluent Toxicity (WET) Information

Whole Effluent Toxicity (WET) tests are required for all major NPDES discharge permit holders, as well as those minor NPDES dischargers with complex effluent (defined as not being of 100 percent domestic waste). WET tests are evaluated to determine if the discharge could be having negative water quality impacts. If a stream with a WET test facility has not been sampled for instream chronic toxicity, biological community data or has no ambient water quality data, and that facility has failed three or more WET tests in the last two years of the assessment period, the assessment unit is Not Rated. Because this information is not a direct measure of water quality and the confidence is not as high as for monitoring data, this use support rating is considered evaluated rather than monitored. Problems associated with WET test failures are addressed through NPDES permits.

NPDES Discharger Daily Monitoring Report (DMR) Information

NPDES effluent data monthly averages of water quality parameters are screened for the last two years of the assessment period. If facilities exceed the effluent limits by 20 percent for two or more months during two consecutive quarters, or have chronic exceedances of permit limits for four or more months during two consecutive quarters, then the assessment unit is Not Rated if no biological or ambient monitoring data are available. Because discharger effluent data is not a direct measure of water quality and data confidence is not as high as for stream monitoring data, the assessment units are considered evaluated rather than monitored. If biological or ambient data are available, that data will be used to develop a use support rating for appropriate stream segments.

Fish Consumption Category

The fish consumption category is a human health approach to assess whether humans can safely consume fish from a waterbody. This category is applied to all waters of the state. The use support rating is assigned using fish consumption advisories or advice as issued by the NC Department of Health and Human Services (DHHS). The fish consumption category is different from other categories in that assessments are based on the existence of a DHHS fish consumption advice or advisory at the time of use support assessment. The advice and

advisories are based on DHHS epidemiological studies and on DWQ fish tissue data. DWQ fish tissue data are used to inform DHHS of potential fish tissue toxicity. DHHS is responsible for proclaiming a fish tissue advisory or advice for any waterbody. Fish tissue monitoring data are not used directly for assigning a use support rating in this category.

If a site-specific fish consumption advisory is posted at the time of assessment, the water is Impaired on either a monitored or evaluated basis dependent upon the availability of monitoring data. The DHHS has developed statewide fish consumption advice for certain fish species shown to have elevated levels of mercury in their tissue. All waters of the state are therefore Impaired/Evaluated in the fish consumption category.

Recreation Category

This human health related category evaluates waters for the support of primary recreation activities such as swimming, water-skiing, skin diving, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. Waters of the state designated for these uses are classified as Class B, SB and SA. This category also evaluates waters used for secondary recreation activities such as wading, boating, and other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized or incidental basis. These waters are classified as Class C, SC and WS.

The use support ratings applied to this category are currently based on the state's fecal coliform bacteria water quality standard where ambient monitoring data are available or on the duration of local or state health agencies posted swimming advisories. Use support ratings for the recreation category may be based on other bacteriological indicators and standards in the future.

DWQ conducts monthly ambient water quality monitoring that includes fecal coliform bacteria testing. The Division of Environmental Health (DEH) tests coastal recreation waters (beaches) for bacteria levels to assess the relative safety of these waters for swimming. If an area has elevated bacteria levels, health officials will advise that people not swim in the area by posting a swimming advisory and by notifying the local media and county health department.

The North Carolina fecal coliform bacteria standard for freshwater is: 1) not to exceed the geometric mean of 200 colonies per 100 ml of at least five samples over a 30-day period; and 2) not to exceed 400 colonies per 100 ml in more than 20 percent of the samples during the same period. The AU being assessed for the five-year data window is Supporting in the recreation category if neither number (1) nor (2) of the standard are exceeded. The AU being assessed is Impaired in the recreation category if either number (1) or (2) is exceeded. Waters without sufficient fecal coliform bacteria data (five samples within 30 days) are Not Rated, and waters with no data are noted as having No Data.

Assessing the water quality standard requires significant sampling efforts beyond the monthly ambient monitoring sampling and must include at least five samples over a 30-day period. Decades of monitoring have demonstrated that bacteria concentrations may fluctuate widely in surface waters over a period of time. Thus, multiple samples over a 30-day period are needed to evaluate waters against the North Carolina water quality standard for recreational use support.

Waters classified as Class SA, SB and B are targeted for this intensive sampling effort due to the greater potential for human body contact.

Waters with beach monitoring sites will be Impaired if the area is posted with an advisory for greater than 61 days of the assessment period. Waters with beach monitoring sites with advisories posted less than 61 days will be Supporting. Other information can be used to Not Rate unmonitored waters.

DWQ Ambient Monitoring Fecal Coliform Bacteria Screening Criteria

As with other information sources, all available information and data are evaluated for the recreation category using the assessment period. However, DWQ conducts an annual screening of DWQ ambient fecal coliform bacteria data to assess the need for additional monitoring or immediate action by local or state health agencies to protect public health.

Each March, DWQ staff will review bacteria data collections from ambient monitoring stations statewide for the previous sampling year. Locations with annual geometric means greater than 200 colonies per 100 ml, or when more than 20 percent of the samples are greater than 400 colonies per 100 ml, are identified for potential follow-up monitoring conducted five times within 30 days as specified by the state fecal coliform bacteria standard. If bacteria concentrations exceed either portion of the state standard, the data are sent to DEH and the local county health director to determine the need for posting swimming advisories. DWQ regional offices will also be notified.

Due to limited resources and the higher risk to human health, Class B, SB and SA waters will be given monitoring priority for an additional five times within 30 days sampling. Follow-up water quality sampling for Class C waters will be performed as resources permit. Any waters on the 303(d) list of Impaired waters for fecal coliform will receive a low priority for additional monitoring because these waters will be further assessed for TMDL development.

DWQ attempts to determine if there are any swimming areas monitored by state, county or local health departments or by DEH. Each January, DEH, county or local health departments are asked to list those waters which were posted with swimming advisories in the previous year.

Shellfish Harvesting Use Support

The shellfish harvesting use support category is a human health approach to assess whether shellfish can be commercially harvested and is therefore applied only to Class SA waters. The following data sources are used to assign use support ratings for shellfish waters.

Division of Environmental Health (DEH) Shellfish Sanitation Surveys

DEH is required to classify all shellfish growing areas as to their suitability for shellfish harvesting. Estuarine waters are delineated according to DEH shellfish management areas (e.g., Outer Banks, Area H-5) which include Class SA, SB and SC waters. DEH samples growing areas regularly and reevaluates the areas by conducting shellfish sanitation shoreline surveys every three years to determine if their classification is still applicable. DEH classifications may be changed after the most recent sanitary survey. Classifications are based on DEH bacteria

sampling, locations of pollution sources, and the availability of the shellfish resource. Growing waters are classified as follows.

DEH Classification	DEH Criteria
Approved (APP)	**Fecal Coliform Standard for Systematic Random Sampling:** The median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of the water shall not exceed 14 per 100 milliliters (ml), and the estimated 90th percentile shall not exceed an MPN of 43 MPN per 100 ml for a 5-tube decimal dilution test. **Fecal Coliform Standard for Adverse Pollution Conditions Sampling:** The median fecal coliform or geometric mean MPN of the water shall not exceed 14 per 100 ml, and not more than 10 percent of the samples shall exceed 43 MPN per 100 ml for a 5-tube decimal dilution test.
Conditionally Approved-Open (CAO)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be open more frequently than closed.
Conditionally Approved-Closed (CAC)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be closed more frequently than open.
Restricted (RES)	Sanitary Survey indicates limited degree of pollution, and the area is not contaminated to the extent that consumption of shellfish could be hazardous after controlled depuration or relaying.
Prohibited (PRO)	No Sanitary Survey; point source discharges; marinas; data do not meet criteria for Approved, Conditionally Approved or Restricted Classification.

Assigning Use Support Ratings to Shellfish Harvesting Waters (Class SA)

DWQ use support ratings may be assigned to separate segments within DEH management areas. In assessing use support, the DEH classifications and management strategies are only applicable to DWQ Class SA (shellfish harvesting) waters. It is important to note that DEH classifies all actual and potential growing areas (which includes all saltwater and brackish water areas) for their suitability for shellfish harvesting. This will result in a difference of acreage between DEH areas classified as CAC, PRO and RES, and DWQ waters rated as Impaired. For example, if DEH classifies a 20-acre area CAC, but only 10 acres are Class SA, only those 10 acres of Class SA waters are rated as Impaired.

The DEH "Closed" polygon coverage includes CAC, RES and PRO classifications, and it is not currently possible to separate out the PRO from the RES areas. Therefore, these areas are a combined polygon coverage, and DWQ rates these waters as Impaired.

Sources of fecal coliform bacteria are more difficult to separate out for Class SA areas. DEH describes the potential sources in the sanitary surveys, but they do not describe specific areas affected by these sources. Therefore, in the past, DEH identified the same sources for all Class SA sections of an entire management area (e.g., urban runoff and septic systems). Until a better way to pinpoint sources is developed, this information will continue to be used. A point source discharge is only listed as a potential source when NPDES permit limits are exceeded.

DWQ and DEH are developing the database and expertise necessary to assess shellfish harvesting frequency of closures. In the interim, DWQ has been identifying the frequency of closures in Class SA waters using an interim methodology (see below) based on existing databases and GIS shapefiles. There will be changes in reported acreages in future assessments using the permanent methods and tools that result from this project.

Past Interim Frequency of Closure-Based Assessment Methodology

The interim method was used for the 2001 White Oak, 2002 Neuse and 2003 Lumber River basin use support assessments. Shellfish harvesting use support ratings for Class SA waters using the interim methodology are summarized below.

Percent of Time Closed within Basin Data Window	DEH Growing Area Classification	DWQ Use Support Rating
N/A	Approved*	Supporting
Closed ≤10% of data window	Portion of CAO closed ≤10% of data window	Supporting
Closed >10% of the data window	Portion of CAO closed >10% of data window	Impaired
N/A	CAC and PRO/RES**	Impaired

* Approved waters are closed only during extreme meteorological events (hurricanes).

** CAC and P/R waters are rarely opened to shellfish harvesting.

For CAO areas, DWQ worked with DEH to determine the number of days and acreages that CAO Class SA waters were closed to shellfish harvesting during the assessment period. For each growing area with CAO Class SA waters, DEH and DWQ defined subareas within the CAO area that were opened and closed at the same time. The number of days these CAO areas were closed was determined using DEH proclamation summary sheets and the original proclamations.

The number of days that APP areas in the growing area were closed due to preemptive closures because of named storms was not counted. For example, all waters in growing area E-9 were preemptively closed for Hurricane Fran on September 5, 1996. APP waters were reopened September 20, 1996. Nelson Bay (CAO) was reopened September 30, 1996. This area was considered closed for ten days after the APP waters were reopened.

Current Assessment Methodology

Use support assessment is now conducted such that only the DEH classification will be used to assign a use support rating. By definition, CAO areas are areas that DEH has determined do not, or likely do not, meet water quality standards and these areas will be rated Impaired, along with CAC and PRO/RES areas. Only APP areas will be rated Supporting.

Growing areas that have been reclassified by DEH during the assessment period from a lower classification to APP will be rated Supporting. Areas that are reclassified from APP to any other classification during the assessment period will be rated Impaired.

Over the next few years, DWQ, DEH, Division of Coastal Management (DCM) and Division of Marine Fisheries (DMF) will be engaged in developing a database with georeferenced (GIS)

shellfish harvesting areas. The new database and GIS tools will be valuable for the above agencies to continue to work together to better serve the public. Using the new database with georeferenced areas and monitoring sites, DEH will be able to report the number of days each area was closed excluding closures related to large or named storms.

Water Supply Use Support

This human health related use support category is used to assess all Class WS waters for the ability of water suppliers to provide potable drinking water. Water quality standards established for drinking water apply to water delivered to consumers after it has been treated to remove potential contaminants that may pose risks to human health. Ambient standards established by states under the Clean Water Act are not intended to ensure that water is drinkable without treatment. Modern water treatment technologies are required to purify raw water to meet drinking water standards as established by the North Carolina Division of Environmental Health.

Water supply use support is assessed by DWQ using information from the seven DEH regional water treatment plant consultant staff. Each January, the DEH staff consultants are asked to submit a spreadsheet listing closures and water intake switch-overs for all water treatment plants in their region. This spreadsheet describes the length and time of the event, contact information, and the reason for the closure or switch.

The spreadsheets are reviewed by DWQ staff to determine if any closures/switches were due to water quality concerns. Those closures/switches due to water quantity problems and reservoir turnovers are not considered for use support. The frequency and duration of closures/switches due to water quality concerns are considered when assessing use support. Using these criteria, North Carolina's surface water supplies are currently rated Supporting on an Evaluated basis. Specific criteria for rating waters Impaired are to be determined on a case-by-case basis.

Use of Outside Data

DWQ actively solicits outside data and information in the year before biological sampling in a particular basin. The solicitation allows approximately 90 days for data to be submitted. Data from sources outside DWQ are screened for data quality and quantity. If data are of sufficient quality and quantity, they may be incorporated into use support assessments. A minimum of ten samples for more than a one-year period is needed to be considered for use support assessments.

The way the solicited data are used depends on the degree of quality assurance and quality control of the collection and analysis of the data as detailed in the 303(d) report and shown in the table below. Level 1 data can be use with the same confidence as DWQ data to determine use support ratings. Level 2 or Level 3 data may be used to help identify causes of pollution and stressors. They may also be used to limit the extrapolation of use support ratings up or down a stream segment from a DWQ monitoring location. Where outside data indicate a potential problem, DWQ evaluates the existing DWQ biological and ambient monitoring site locations for adjustment as appropriate.

Criteria Levels for Use of Outside Data in Use Support Assessments			
Criteria	**Level 1**	**Level 2**	**Level 3**
Monitoring frequency of at least 10 samples for more than a one-year period	Yes	Yes/No	No
Monitoring locations appropriately sited and mapped	Yes	Yes	No
State certified laboratory used for analysis according to 15A NCAC 2B .0103	Yes	Yes/No	No
Quality assurance plan available describing sample collection and handling	Yes, rigorous scrutiny	Yes/No	No

Lakes and Reservoir Use Assessment

Like streams, lakes are classified for a variety of uses. All lakes monitored as part of North Carolina's Ambient Lakes Monitoring Program carry the Class C (aquatic life) classification, and most are classified Class B and SB (recreation) and WS-I through WS-V (water supply). The surface water quality numeric standard specifically associated with recreation is fecal coliform. For water supplies, there are 29 numeric standards based on consumption of water and fish. Narrative standards for Class B and Class WS waters include aesthetics such as no odors and no untreated wastes. There are other numeric standards that also apply to lakes for the protection of aquatic life and human health. These standards also apply to all other waters of the state and are listed under the Class C rules. One of the major problems associated with lakes and reservoirs is increasing eutrophication related to nutrient inputs. Several water quality parameters help to describe the level of eutrophication.

For nutrient enrichment, one of the main causes of impacts to lakes and reservoirs, a more holistic or weight of evidence approach is necessary since nutrient impacts are not always reflected by the parameters sampled. For instance, some lakes have taste and odor problems associated with particular algal species, yet these lakes do not have chlorophyll *a* concentrations above 40 µg/l frequently enough to impair them based on the standard. In addition, each reservoir possesses unique traits (watershed area, volume, depth, retention time, etc.) that dramatically influence its water quality, but that cannot be evaluated through standards comparisons. In such waterbodies, aquatic life may be Impaired even though a particular indicator is below the standard. Where exceedances of surface water quality standards are not sufficient to evaluate a lake or reservoir, the weight of evidence approach can take into consideration indicators and parameters not in the standards to allow a more sound and robust determination of water quality.

The weight of evidence approach uses the following sources of information to determine the eutrophication (nutrient enrichment) level as a means of assessing lake use support in the aquatic life category:

- Quantitative water quality parameters - dissolved oxygen, chlorophyll *a*, pH, etc.
- Algal bloom reports
- Fish kill reports

- Hydrologic and hydraulic characteristics – watershed size, lake volume, retention time, volume loss, etc.
- Third party reports – citizens, water treatment plant operators, state agencies, etc.
    - Taste and odor
    - Sheens
    - Odd colors
    - Other aesthetic and safety considerations

In implementing the weight of evidence approach for eutrophication, more consideration is given to parameters that have water quality standards (see table). Each parameter is assessed for percent exceedance of the state standard. Parameters with sufficient (ten or more observations), quality-assured observations are compared to surface water quality standards. When standards are exceeded in more than 10 percent of the assessment period, portions or all of the waterbody are rated Impaired.

However, in many cases, the standards based approach is incapable of characterizing the overall health of a reservoir. The eutrophication-related parameters and water quality indicators without numeric standards are reviewed based on interpretation of the narrative standards in 15A NCAC 2B .0211(2) and (3).

A modification to lake use assessment is the evaluation and rating of a lake or reservoir by assessment units (AUs). Each lake or reservoir may have one or more AU based on the classification segments (DWQ index numbers). Each sampling date is considered one sample. Multiple sampling locations within one AU are considered one sample. A minimum of ten samples is needed to assess use support for any AU. Each AU with documented problems (sufficient data, ambient data above standards, and supporting public data) will be rated as Impaired while the other portions are rated as Supporting or Not Rated. The following table lists the information considered during a lake/reservoir use assessment, as well as the criteria used to evaluate that information.

Lake/Reservoir Weight of Evidence Use Assessment for Aquatic Life Category	
Assessment Type	**Criteria**
EUTROPHICATION	
Water Quality Standards (a minimum of 10 samples is required for use support assessment)	
Chl *a*	Above standard in >10% of samples.
DO	Below or above standard in >10% of samples.
pH	Below or above standard in >10% of samples.
Turbidity	Above standard in >10% of samples.
% Total Dissolved Gases	Above standard in >10% of samples.
Temperature	Minor and infrequent excursions of temperature standards due to anthropogenic activity. No impairment of species evident.
Metals (excluding copper, iron and zinc)	Above standard in >10% of samples.
Other Data	
% Saturation DO	>10% of samples above >120%
Algae	Blooms during 2 or more sampling events in 1 year with historic blooms.
Fish	Kills related to eutrophication.
Chemically/ Biologically Treated	For algal or macrophyte control - either chemicals or biologically by fish, etc.
Aesthetics Complaints	Documented sheens, discoloration, etc. - written complaint and follow-up by a state agency.
Trophic Status Index (TSI)	Increase of 2 trophic levels from one 5-year period to next.
Historic DWQ Data	Conclusions from other reports and previous use support assessments.
AGPT	Algal Growth Potential Test ≥5 mg/L
Macrophytes	Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat; clogging intakes.
Taste and Odor	Public complaints; Potential based on algal spp
Sediments	Clogging intakes - dredging program necessary.

References

Fels, J. 1997. *North Carolina Watersheds Map*. North Carolina State University Cooperative Extension Service. Raleigh, NC.

North Carolina Department of Environment and Natural Resources (NCDENR). 2000a. *Fish Community Metric Re-Calibration and Biocriteria Development for the Inner Piedmont, Foothills, and Eastern Mountains (Broad, Catawba, Savannah, and Yadkin River Basins)*. September 22, 2000. Biological Assessment Unit. Environmental Sciences Branch. Water Quality Section. Division of Water Quality. Raleigh, NC.

____. 2000b. *Fish Community Metric Re-Calibration and Biocriteria Development for the Outer Piedmont (Cape Fear, Neuse, Roanoke and Tar River Basins)*. October 17, 2000. *Ibid*.

____. 2001a. *Standard Operating Procedure*. *Biological Monitoring*. *Stream Fish Community Assessment and Fish Tissue*. Biological Assessment Unit. Environmental Sciences Branch. Water Quality Section. Division of Water Quality. Raleigh, NC.

____. 2001b. *Fish Community Metric Re-Calibration and Biocriteria Development for the Western and Northern Mountains (French Broad, Hiwassee, Little Tennessee, New and Watauga River Basins)*. January 05, 2001. *Ibid*.

USEPA. 2000. *Stressor Identification Guidance Document*. EPA/822/B-00/025. Office of Water. Washington, DC.

Appendix X

Glossary
of
Terms and Acronyms

Glossary

§	Section.
30Q2	The minimum average flow for a period of 30 days that has an average recurrence of one in two years.
7Q10	The annual minimum 7-day consecutive low flow, which on average will be exceeded in 9 out of 10 years.
B (Class B)	Class B Water Quality Classification. This classification denotes freshwaters protected for primary recreation and other uses suitable for Class C. Primary recreational activities include frequent and/or organized swimming and other human contact such as skin diving and water skiing.
basin	The watershed of a major river system. There are 17 major river basins in North Carolina.
benthic macroinvertebrates	Aquatic organisms, visible to the naked eye (macro) and lacking a backbone (invertebrate), that live in or on the bottom of rivers and streams (benthic). Examples include, but are not limited to, aquatic insect larvae, mollusks and various types of worms. Some of these organisms, especially aquatic insect larvae, are used to assess water quality. See EPT index and bioclassification for more information.
benthos	A term for bottom-dwelling aquatic organisms.
best management practices	Techniques that are determined to be currently effective, practical means of preventing or reducing pollutants from point and nonpoint sources, in order to protect water quality. BMPs include, but are not limited to: structural and nonstructural controls, operation and maintenance procedures, and other practices. Often, BMPs are applied as system of practices and not just one at a time.
bioclassification	A rating of water quality based on the outcome of benthic macroinvertebrate sampling of a stream. There are five levels: Poor, Fair, Good-Fair, Good and Excellent.
BMPs	See *best management practices*.
BOD	Biochemical Oxygen Demand. A measure of the amount of oxygen consumed by the decomposition of biological matter or chemical reactions in the water column. Most NPDES discharge permits include a limit on the amount of BOD that may be discharged.
C (Class C)	Class C Water Quality Classification. This classification denotes freshwaters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, and others uses.
channelization	The physical alteration of streams and rivers by widening, deepening or straightening of the channel, large-scale removal of natural obstructions, and/or lining the bed or banks with rock or other resistant materials.
chlorophyll *a*	A chemical constituent in plants that gives them their green color. High levels of chlorophyll *a* in a waterbody, most often in a pond, lake or estuary, usually indicate a large amount of algae resulting from nutrient overenrichment or eutrophication.
coastal counties	Twenty counties in eastern NC subject to requirements of the Coastal Area Management Act (CAMA). They include: Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hertford, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell and Washington.
Coastal Plain	One of three major physiographic regions in North Carolina. Encompasses the eastern two-fifths of state east of the *fall line* (approximated by Interstate I-95).
conductivity	A measure of the ability of water to conduct an electrical current. It is dependent on the concentration of dissolved ions such as sodium, chloride, nitrates, phosphates and metals in solution. Levels too high or too low may limit an organism's survival, growth and reproduction.
degradation	The lowering of the physical, chemical or biological quality of a waterbody caused by pollution or other sources of stress.
DENR	Department of Environment and Natural Resources.

DO	Dissolved oxygen.
drainage area	An alternate name for a watershed.
DWQ	North Carolina Division of Water Quality, an agency of DENR.
dystrophic	Naturally acidic (low pH), "black-water" lakes which are rich in organic matter. Dystrophic lakes usually have low productivity because most fish and aquatic plants are stressed by low pH water. In North Carolina, dystrophic lakes are scattered throughout the Coastal Plain and Sandhills regions and are often located in marshy areas or overlying peat deposits. NCTSI scores are not appropriate for evaluating dystrophic lakes.
EEP	Ecosystem Enhancement Program (EEP)
effluent	The treated liquid discharged from a wastewater treatment plant.
embeddedness	A measure of the amount of surface area of the large particles (i.e., boulders, cobble, gravel) that are buried in the fine sediments (i.e., sand and silt) of a stream bottom.
EMC	Environmental Management Commission.
EPA	United States Environmental Protection Agency.
EPT Index	This index is used to judge water quality based on the abundance and variety of three orders of pollution sensitive aquatic insect larvae: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).
eutrophic	Elevated biological productivity related to an abundance of available nutrients. Eutrophic lakes may be so productive that the potential for water quality problems such as algal blooms, nuisance aquatic plant growth and fish kills may occur.
eutrophication	The process of physical, chemical or biological changes in a lake associated with nutrient, organic matter and silt enrichment of a waterbody. The corresponding excessive algal growth can deplete dissolved oxygen and threaten certain forms of aquatic life, cause unsightly scums on the water surface and result in taste and odor problems.
fall line	A geologic landscape feature that defines the line between the piedmont and coastal plain regions. It is most evident as the last set of small rapids or rock outcroppings that occur on rivers flowing from the piedmont to the coast.
FS	Fully supporting. A rating given to a waterbody that fully supports its designated uses and generally has good or excellent water quality.
GIS	Geographic Information System. An organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information.
habitat degradation	Identified where there is a notable reduction in habitat diversity or change in habitat quality. This term includes sedimentation, bank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, loss of woody habitat, and streambed scour.
headwaters	Small streams that converge to form a larger stream in a watershed.
HQW	High Quality Waters. A supplemental surface water classification.
HU	Hydrologic unit. See definition below.
Hydrilla	The genus name of an aquatic plant - often considered an aquatic weed.
hydrologic unit	A watershed area defined by a national uniform hydrologic unit system that is sponsored by the Water Resources Council. This system divides the country into 21 regions, 222 subregions, 352 accounting units and 2,149 cataloging units. A hierarchical code consisting of two digits for each of the above four levels combined to form an eight-digit hydrologic unit (cataloging unit). An eight-digit hydrologic unit generally covers an average of 975 square miles. There are 54 eight-digit hydrologic (or cataloging) units in North Carolina. These units have been further subdivided into eleven and fourteen-digit units.
hypereutrophic	Extremely elevated biological productivity related to excessive nutrient availability. Hypereutrophic lakes exhibit frequent algal blooms, episodes of low dissolved oxygen or periods when no oxygen is present in the water, fish kills and excessive aquatic plant growth.

impaired	Term that applies to a waterbody that has a use support rating of partially supporting (PS) or not supporting (NS) its uses.
impervious	Incapable of being penetrated by water; non-porous.
kg	Kilograms. To change kilograms to pounds multiply by 2.2046.
lbs	Pounds. To change pounds to kilograms multiply by 0.4536.
loading	Mass rate of addition of pollutants to a waterbody (e.g., kg/yr)
macroinvertebrates	Animals large enough to be seen by the naked eye (macro) and lacking backbones (invertebrate).
macrophyte	An aquatic plant large enough to be seen by the naked eye.
mesotrophic	Moderate biological productivity related to intermediate concentrations of available nutrients. Mesotrophic lakes show little, if any, signs of water quality degradation while supporting a good diversity of aquatic life.
MGD	Million gallons per day.
mg/l	Milligrams per liter (approximately 0.00013 oz/gal).
NCIBI	North Carolina Index of Biotic Integrity. A measure of the community health of a population of fish in a given waterbody.
NH_3-N	Ammonia nitrogen.
nonpoint source	A source of water pollution generally associated with rainfall runoff or snowmelt. The quality and rate of runoff of NPS pollution is strongly dependent on the type of land cover and land use from which the rainfall runoff flows. For example, rainfall runoff from forested lands will generally contain much less pollution and runoff more slowly than runoff from urban lands.
NPDES	National Pollutant Discharge Elimination System.
NPS	Nonpoint source.
NR	Not rated. A waterbody that is not rated for use support due to insufficient data.
NS	Not supporting. A rating given to a waterbody that does not support its designated uses and has poor water quality and severe water quality problems. Both PS and NS are called impaired.
NSW	Nutrient Sensitive Waters. A supplemental surface water classification intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation. Waters classified as NSW include the Neuse, Tar-Pamlico and Chowan River basins; the New River watershed in the White Oak basin; and the watershed of B. Everett Jordan Reservoir (including the entire Haw River watershed).
NTU	Nephelometric Turbidity Units. The units used to quantify turbidity using a turbidimeter. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions.
oligotrophic	Low biological productivity related to very low concentrations of available nutrients. Oligotrophic lakes in North Carolina are generally found in the mountain region or in undisturbed (natural) watersheds and have very good water quality.
ORW	Outstanding Resource Waters. A supplemental surface water classification intended to protect unique and special resource waters having excellent water quality and being of exceptional state or national ecological or recreational significance. No new or expanded wastewater treatment plants are allowed, and there are associated stormwater runoff controls enforced by DWQ.
pH	A measure of the concentration of free hydrogen ions on a scale ranging from 0 to 14. Values below 7 and approaching 0 indicate increasing acidity, whereas values above 7 and approaching 14 indicate a more basic solution.
phytoplankton	Aquatic microscopic plant life, such as algae, that are common in ponds, lakes, rivers and estuaries.

Piedmont	One of three major physiographic regions in the state. Encompasses most of central North Carolina from the Coastal Plain region (near I-95) to the eastern slope of the Blue Ridge Mountains region.
PS	Partially supporting. A rating given to a waterbody that only partially supports its designated uses and has fair water quality and severe water quality problems. Both PS and NS are called impaired.
riparian zone	Vegetated corridor immediately adjacent to a stream or river. See also SMZ.
river basin	The watershed of a major river system. North Carolina is divided into 17 major river basins: Broad, Cape Fear, Catawba, Chowan, French Broad, Hiwassee, Little Tennessee, Lumber, Neuse, New, Pasquotank, Roanoke, Savannah, Tar-Pamlico, Watauga, White Oak and Yadkin River basins.
river system	The main body of a river, its tributary streams and surface water impoundments.
runoff	Rainfall that does not evaporate or infiltrate the ground, but instead flows across land and into waterbodies.
SA	Class SA Water Classification. This classification denotes saltwaters that have sufficient water quality to support commercial shellfish harvesting.
SB	Class SB Water Classification. This classification denotes saltwaters with sufficient water quality for frequent and/or organized swimming or other human contact.
SC	Class SC Water Classification. This classification denotes saltwaters with sufficient water quality to support secondary recreation and aquatic life propagation and survival.
sedimentation	The sinking and deposition of waterborne particles (e.g., eroded soil, algae and dead organisms).
silviculture	Care and cultivation of forest trees; forestry.
SOC	Special Order by Consent. An agreement between the Environmental Management Commission and a permitted discharger found responsible for causing or contributing to surface water pollution. The SOC stipulates actions to be taken to alleviate the pollution within a defined time. The SOC typically includes relaxation of permit limits for particular parameters, while the facility completes the prescribed actions. SOCs are only issued to facilities where the cause of pollution is not operational in nature (i.e., physical changes to the wastewater treatment plant are necessary to achieve compliance).
streamside management zone (SMZ)	The area left along streams to protect streams from sediment and other pollutants, protect streambeds, and provide shade and woody debris for aquatic organisms.
subbasin	A designated subunit or subwatershed area of a major river basin. Subbasins typically encompass the watersheds of significant streams or lakes within a river basin. Every river basin is subdivided into subbasins ranging from one subbasin in the Watauga River basin to 24 subbasins in the Cape Fear River basin. There are 133 subbasins statewide. These subbasins are not a part of the national uniform hydrologic unit system that is sponsored by the Water Resources Council (see *hydrologic unit*).
substrate	A surface on which an organism grows or is attached.
Sw	Swamp Waters. A supplemental surface water classification denoting waters that have naturally occurring low pH, low dissolved oxygen and low velocities. These waters are common in the Coastal Plain and are often naturally discolored giving rise to their nickname of “blackwater” streams.
TMDL	Total maximum daily load. The amount of a given pollutant that a waterbody can assimilate and maintain its uses and water quality standards.
TN	Total nitrogen.
TP	Total phosphorus.
tributary	A stream that flows into a larger stream, river or other waterbody.
trophic classification	Trophic classification is a relative description of a lake's biological productivity, which is the ability of the lake to support algal growth, fish populations and aquatic plants. The

	productivity of a lake is determined by a number of chemical and physical characteristics, including the availability of essential plant nutrients (nitrogen and phosphorus), algal growth and the depth of light penetration. Lakes are classified according to productivity: unproductive lakes are termed "oligotrophic"; moderately productive lakes are termed "mesotrophic"; and very productive lakes are termed "eutrophic".
TSS	Total Suspended Solids.
turbidity	An expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through a sample. All particles in the water that may scatter or absorb light are measured during this procedure. Suspended sediment, aquatic organisms and organic particles such as pieces of leaves contribute to instream turbidity.
UT	Unnamed tributary.
watershed	The region, or land area, draining into a body of water (such as a creek, stream, river, pond, lake, bay or sound). A watershed may vary in size from several acres for a small stream or pond to thousands of square miles for a major river system. The watershed of a major river system is referred to as a basin or river basin.
WET	Whole effluent toxicity. The aggregate toxic effect of a wastewater measured directly by an aquatic toxicity test.
WS	Class WS Water Supply Water Classification. This classification denotes freshwaters used as sources of water supply. There are five WS categories. These range from WS-I, which provides the highest level of protection, to WS-V, which provides no categorical restrictions on watershed development or wastewater discharges like WS-I through WS-IV.
WWTP	Wastewater treatment plant.