

## North Carolina's Basinwide Approach to Water Quality Management

Basinwide water quality planning is a nonregulatory 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. Each basinwide plan is revised at five-year intervals. While these plans are prepared by the DWQ, the implementation and the protection of water quality entails coordinated efforts of many agencies, local governments and stakeholders in the state.

The goals of DWQ's basinwide program are to:

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

DWQ accomplishes these goals through the following objectives:

- Evaluate cumulative effects of pollution,
- Assure equitable distribution of waste assimilative capacity for dischargers,
- Regulate point and nonpoint source pollution where other approaches were unsuccessful,
- Improve public awareness and involvement, and
- Collaborate with other agencies to develop appropriate management strategies to protect and restore water quality. This includes providing agencies information related to financial and funding opportunities.

This document is the third edition of the *Chowan River Basinwide Water Quality Plan* updated on a five-year cycle. The first basinwide plan for the Chowan River basin was completed in 1997 and the second in 2002. The format of this plan was revised in response to comments received during the first planning cycle. DWQ replaced much of the general information in the first two plans with more detailed information specific to the Chowan 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 local restoration efforts.

### Chowan River Basin Overview

The Chowan River basin is located in the northeastern coastal plain of North Carolina and southeastern Virginia (Figure *i*). The North Carolina portion includes all or part of Northampton, Hertford, Gates, Bertie and Chowan counties (Figure *ii*). The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers, and its streams flow southeastward towards the Albemarle Sound. Approximately 75 percent (4,061 square miles) of the river's watershed lies within the Virginia border.

The Chowan River basin in North Carolina is composed of two major drainages: Chowan River and Meherrin River. The Chowan River basin is part of the Albemarle-Pamlico Estuarine system, the second largest estuarine system in the United States. All of the waters in the basin are designated as Nutrient Sensitive Waters. Many waterbodies in this basin are transitional in

nature (i.e., from Coastal A to Swamp) making water quality monitoring difficult. Some creeks and rivers flushing rates are influenced by tides and wind, while others receive swamp drainage. There are four waterbody segments that were not rated because DWQ criteria for Coastal B waters have not been finalized. Overall, water quality in the Chowan River basin is generally good.

Information presented in this basinwide water quality plan is based on information collected from September 2000 to July 2007 to describe water quality conditions and issues in each of the four subbasins. Specific water quality assessments were based on biological, chemical and physical monitoring data collected between September 2000 and August 2005. A discussion of conditions reflecting whether specific waterbodies support their best-intended use and maps of each subbasin are included in each subbasin chapter.

**Subbasin 03-01-01**

The upper Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers. Major tributaries to the Chowan River in this subbasin include the Wiccacon River and Ahoskie Creek, both having land use activities influencing poor water quality conditions. The lower portion of the Wiccacon River is the only Impaired waterbody for aquatic life in the Chowan River basin. Portions of Merchants Millpond State Park and Chowan Swamp State Natural Area are also located in this subbasin. Merchants Millpond supports a diverse assemblage of aquatic plants including several rare species. The largest municipalities in this subbasin include Ahoskie, Aulander, and Winton. Surface water classifications and the amount of miles in subbasin 03-01-01 are listed in Table *i*. Chapter 1 presents specific water quality information for each monitored waterbody in the subbasin.

Table *i* Subbasin 03-01-01 DWQ Classifications

DWQ Classification	Freshwater Miles
B; NSW	39.8
C; NSW	376.5
C = Aquatic life propagation/protection and secondary recreation B = Primary recreation and Class C uses. NSW = <i>Nutrient Sensitive Waters</i> : Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.	

**Subbasin 03-01-02**

Subbasin 03-01-02 contains 494 square miles of the Meherrin River and its tributaries, but much of the river’s catchment is in Virginia. Major tributaries to the Meherrin River include Potecasi and Kirbys Creeks. Aquatic habitats include streams that have been channelized and/or swamp areas that cease to flow during dry periods and are expected to have very low dissolved oxygen levels during low-flow periods. Significant natural heritage areas are located within the watershed, including the Meherrin River Swamp and Meherrin River Slopes and Swamp. The largest municipalities in this subbasin include Murfreesboro and Rich Square. Surface water classifications and the amount of miles in subbasin 03-01-02 are listed in Table *ii*. Chapter 2 presents specific water quality information for each monitored waterbody in the subbasin.

Table *ii* Subbasin 03-01-02 DWQ Classifications

DWQ Classification	Freshwater Miles
B; NSW	13.6
C; NSW	272.9
C = Aquatic life propagation/protection and secondary recreation B = Primary recreation and Class C uses. NSW = <i>Nutrient Sensitive Waters</i> : Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.	

### Subbasin 03-01-03

This subbasin contains the middle section of the Chowan River, below Bennetts Creek (Merchants Millpond) and above Rockyhock Creek and includes the Indian Creek and Catherine Creek tributaries. Tidal Cypress-Gum Swamp, a designated significant natural heritage area, is found along much of the shoreline of the Chowan River and represents an important wetland ecosystem within the Chowan River basin. Land use is mainly forested wetlands and agricultural cropland. The largest municipality in the subbasin is Colerain, which has experienced an overall net population decline since 1990. Surface water classifications and the amount of miles in subbasin 03-01-03 are listed in Table *iii*. Chapter 3 presents specific water quality information for each monitored waterbody in the subbasin.

Table *iii* Subbasin 03-01-03 DWQ Classifications

DWQ Classification	Freshwater Miles
B; NSW	27.0
C; NSW	4.2

C = Aquatic life propagation/protection and secondary recreation  
B = Primary recreation and Class C uses.  
NSW = *Nutrient Sensitive Waters*: Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.

### Subbasin 03-01-04

Subbasin 03-01-04 contains the lower Chowan River and small tributaries including Salmon Creek, Edenton Bay and Pembroke Creek. It also includes a small northwest portion of the Albemarle Sound. Edenton is the largest municipality in the subbasin. This region of the Chowan River basin is experiencing growth and development with proposed upscale housing communities, golf courses and marinas. With this growth along the inland waterways, many channels to the Chowan River are losing their riparian buffers and consequently water quality is in jeopardy. Within this subbasin, a portion of the Albemarle Sound to the mouth of the Chowan River is Impaired in the fish consumption category because of a dioxin advisory for these waters. Surface water classifications and the amount of miles and acres in subbasin 03-01-04 are listed in Table *iv*. Chapter 4 presents specific water quality information for each monitored waterbody in the subbasin.

Table *iv* Subbasin 03-01-04 DWQ Classifications by Miles and Acres

DWQ Classification	Freshwater Miles	Freshwater Acres
B; NSW	25.1	15,600.4
C; NSW	50.8	1,370.3

C = Aquatic life propagation/protection and secondary recreation  
B = Primary recreation and Class C uses.  
NSW = *Nutrient Sensitive Waters*: Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.

## **Waterbody Classifications and Use Support Assessment of Water Quality**

Surface waters are classified according to their best-intended uses. Determining how well a waterbody supports its designated uses (use support rating) is an important method of interpreting water quality data to assess water quality. The terms Impaired and Supporting refer to whether the classified uses (e.g., aquatic life protection, recreation, shellfish harvesting, and fish consumption) of the water are being met. For example, waters classified for aquatic life protection and secondary recreation (Class C for freshwater) are rated Supporting if data used to determine use support did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as Impaired. A single waterbody could have more than one use support rating corresponding to one or more of the multiple use support categories. Use support assessments based on surface water classifications form the foundation of this basinwide plan. Chapter 5 presents more information about surface water classifications.

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/](http://www.ncwaterquality.org/csu/)).

Use support methodology has changed significantly since the 2002 revision of the *Chowan 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). 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 are being met. Detailed information on use support methodology is provided in Appendix II.

### **Aquatic Life/Secondary Recreation**

The aquatic life/secondary recreation use support category is applied to all waters in North Carolina. Therefore, this category is applied to the total number of stream miles (810 mi.) in the Chowan River basin. A basinwide summary of current aquatic life/secondary recreation use support ratings is presented in Table v.

Approximately 33 percent of stream miles (268 mi.) were monitored for the protection of aquatic life and secondary recreation by DWQ during this basinwide planning cycle. Impaired waters account for 2.8 percent of the total stream miles and 8.4 percent of monitored stream miles. Over 22 miles of the Wiccacon River are Impaired for aquatic life due to a Fair bioclassification as described in Chapter 1.

Table v Aquatic Life/Secondary Recreation Use Support Summary Information

Aquatic Life/Secondary Recreation Use Support Ratings	Monitored Streams Only*	
	Miles	%
<b>Supporting</b>	143.4	53.5%
<b>Impaired</b>	22.5	8.4%
<b>Not Rated</b>	102.1	38%
<b>Total</b>	268	-----

\* = Percent based on total of all monitored waters.

### **Primary Recreation**

There are 105.5 miles currently classified for primary recreation (Class B) and 704.4 miles classified for secondary recreation (Class C) in the Chowan River basin. Approximately 14 percent of stream miles (810 mi.) were monitored for recreational uses by DWQ during this basinwide planning cycle. Of the 73.4 monitored stream miles for primary recreation, all are Supporting.

### **Fish Consumption**

Like the aquatic life/secondary recreation use support category, the fish consumption use support category is also applied to all waters in the state. Approximately one percent of stream miles in the Chowan River basin were monitored for the fish consumption use support category during

this basinwide cycle. Fish consumption use support ratings are based on fish consumption advice and advisories issued by the NC Department of Health and Human Services (NCDHHS). Currently, there is a statewide advice limiting consumption of several fish species, due to the potential for elevated methylmercury levels; see the DHHS website for more information (<http://www.epi.state.nc.us/epi/fish/>). Because of this advice, all waters are considered Impaired for the fish consumption category on an evaluated basis.

Currently, 7.8 miles of the Chowan River and 15,600 acres of the Albemarle Sound are Impaired due to a dioxin fish consumption advisory by DHHS. The dioxin advisory recommends that women of childbearing age and children should not eat catfish and carp and others should limit their consumption of these bottom feeder fish species.

### **Water Quality Standards and Classifications**

All waters in the basin have the supplemental classification of Nutrient Sensitive Water (NSW). In response to this classification, nitrogen and phosphorus reductions have resulted in water quality improvements with the implementation of agricultural best management practices, the conversion of many wastewater treatment plants to land application systems, and the implementation of more stringent permit limits for nutrients. Water quality standards and classifications are discussed in Chapter 5.

### **Water Quality Stressors and Sources**

DWQ identifies the stressors of water quality impact as specifically as possible depending on the amount of information available in a watershed. Most often, the source of the stressor is based on predominant land use in the watershed. In the Chowan River basin, agriculture and runoff from WWTP land application sites were identified as possible sources of stressors to biological (benthic and fish) communities or where water quality standards have been violated. In the fish consumption category, mercury and dioxin are the noted stressors. However, unknown sources of stressors impact many waterbodies. The accumulation of multiple stressors leads to water quality degradation. In some way, every resident, tourist, landowner, industry and municipality in the basin impacts water quality. Therefore, it is important that all stakeholders play a role in management strategies designed to protect and restore water quality in the Chowan River basin. More information about water quality stressors and sources can be found in Chapter 6.

### **Impacts from Stormwater Runoff**

Stormwater runoff is a primary carrier of nonpoint source pollution in both urbanized and rural areas. Stormwater runoff is a particular concern in the agricultural based Chowan River basin. Previous hydrologic alterations of the landscape have ditched and channelized the land to improve drainage. Stormwater currently moves quickly off the land bypassing swamps and enters directly into creeks and rivers untreated. The impact of stormwater runoff is also 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, curb and gutter systems into nearby waterbodies.

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. Currently, there are 23 individual stormwater permit listed for the Chowan River basin. Chapter 7 contains more information federal and state stormwater programs.

## **Wastewater Management**

In the Chowan River basin, wastewater is treated by wastewater treatment plants, non-discharge systems and on-site septic systems. 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 and industrial wastewater treatment plants and small domestic wastewater treatment systems serving schools, commercial offices, residential subdivisions and individual homes. Dischargers in North Carolina must apply for and obtain a NPDES permit. Because of the nutrient sensitivity of the waters in this basin, dischargers are permitted with set nitrogen and phosphorus limits at 3 and 1 mg/l, respectively. Currently, there are 10 permitted wastewater dischargers in the Chowan River basin.

Many municipalities, residential developments, and commercial/industrial operations located in northeastern North Carolina utilize wastewater treatment systems that dispose of the wastewater through land application methods. Such systems are referred to as non-discharge systems, as there is no direct discharge to surface water of the state. A large concentration of non-discharge systems are located within the Chowan basin. Although non-discharge systems should not present high potentials for surface water impacts, some systems within the Chowan basins have problems that may result in impaired surface water quality. In the Chowan River basin, 21 non-discharge (non-agricultural) permits have been issued. Some of these facilities have problems due to direct discharges resulting from storm events, run-off, or continued inability to comply with permit conditions.

Within the Chowan basin, it is important to note that there is a direct connection between groundwater and surface water in many places. Drainage ditches and canals are widespread in northeastern NC and function as a direct pathway for groundwater that may be impacted from nutrients and coliform bacteria, especially in rural areas where agriculture is widespread, to enter into the surface water system. In other cases, surface water bodies, directly border areas where groundwater quality may be impaired. In many areas, the time it takes for groundwater to move into the surface water system is brief. Although groundwater quality at non-discharge facilities may be compliant with groundwater quality standards, groundwater flux moving into the surface water system has the ability to transport contaminants into surface water bodies and add to total mass loadings. It is recommended that research be conducted to better establish and understand the relationship between groundwater and surface water in eastern North Carolina. Such understanding would provide for more accurate assessment of surface water impairments resulting from groundwater discharges and enable the state to make sound permitting judgments and recommendations to better protect water quality in general.

On-site septic systems are common throughout the Chowan River basin. However, soil conditions in the basin may limit the functionality of the septic system treatment allowing untreated effluent to reach surface waters. Precautions should be taken by local septic system permitting authorities to ensure that failing systems are repaired, older systems are updated and new systems are sited and constructed properly allowing an adequate repair area.

Chapter 7 provides more information on wastewater permitting regulations.

## **Population, Land Use Changes and Natural Resources**

Based on the 2000 Census, the overall population of the Chowan River basin is 61,153, with approximately 44-persons/square mile. Although this is a decrease from the 1990 census of 62,474 people, population growth and development is expanding inward from the rapidly developing coastal areas. Two of the five counties in the basin are expected to experience growth rates in excess of ten percent by 2020. As the counties in the Chowan River basin continue to grow along the inner waterways there will likely be a loss of natural areas and an increase in the amount of impervious surface associated with new homes and businesses.

Based on 1997 National Resources Inventory data, land cover in the basin is dominated by forestland that covers approximately 54.9 percent of the land area. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 32.8 percent. This ten-year-old data reflects only 2.8 percent of the land area as being developed. To more accurately describe land cover and land use changes updated data is needed. Approximately 86 percent of forestland in the Chowan River basin is privately owned, 12 percent is owned by forest industry and the rest is publicly owned. A small percentage (1.2 percent) of the Chowan River basin is publicly owned conservation land. More information on population, land use and natural resources in the Chowan River basin is found in Chapter 8.

### **Public Water Supply**

In the Chowan River basin, 75 public water supply sources were identified, all of which are groundwater wells. Of the 75 groundwater sources, 4 of them have a Higher, 29 have a Moderate and 42 have a Lower susceptibility rating. 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 potential contaminant sources within the assessment area. More information on water supply resources in the Chowan River basin is found in Chapter 8.

### **Ecological Significance of the Chowan River Basin**

Approximately 100 stream miles of the Chowan River are considered an Aquatic Significant Natural Heritage Area by the North Carolina Natural Heritage Program. The Chowan River receives this designation because of the diversity of its freshwater mussel populations, many of which are rare and vulnerable. The Chowan River and its tributaries provide critical habitat for some anadromous fish species and is known for some of the best fishing in the state, with largemouth bass, bluegill, chain pickerel, black crappie, and perch being some of the most sought after species. Recent harvest restrictions were enacted on the river herring fishery due to the declining stock, which may be associated with water quality conditions. The Chowan and Meherrin Rivers still reflect the rural character of the basin where priority conservation activities should include the establishment of buffer strips and conservation easements and continued refinement and monitoring of BMPs on lands used primarily for agriculture and silviculture. These activities are also needed for industrial and residential developments. More information on natural resources in the Chowan River basin is found in Chapter 8.

## **Agriculture and Water Quality**

There are 101 animal operations in the Chowan River basin. Excess nutrient loading, pesticide and/or herbicide contamination, bacterial contamination, and sedimentation are often associated with agricultural activities, and all can impact water quality. In the Chowan River basin, significant efforts have been made to reduce nitrogen and phosphorus loads originating from agricultural land uses through the implementation of best management practices (BMPs). Additional efforts are needed to redesign drainage from agricultural fields to help filter runoff. During this five-year assessment period, the North Carolina Agricultural Cost Share Program (NCACSP) funded BMPs totaling more than \$2,400,000 throughout the Chowan River basin. Chapter 9 provides information related to agricultural activities in the Chowan River basin and also identifies funding opportunities for BMPs.

## **Land Use Planning and Sea Level Rise**

The Coastal Area Management Act (CAMA) requires each of the 20 coastal counties to have a local land use plan in accordance with guidelines established by the Coastal Resources Commission (CRC). A land use plan is a collection of policies, maps, and implementation actions that serves as a community's blueprint for growth. The management goal for water quality is to maintain, protect, and where possible enhance water quality in all coastal wetlands, rivers, streams and estuaries. The CRC's planning objective is for communities to adopt policies for coastal waters within the planning jurisdiction to help ensure that water quality is maintained if not impaired and improved if impaired. Local communities are required to devise policies that help prevent or control nonpoint source discharges (sewage and stormwater) through strategies such as impervious surface limits, vegetated riparian buffers, maintenance of natural areas, natural area buffers, and wetland protection. In the Chowan River basin, Gates County has completed their land use plan and Bertie, Chowan and Hertford Counties are in the process. Chapter 10 presents specific information regarding land use plans in communities of the Chowan River basin.

Sea level rise has the potential to dramatically alter North Carolina's coast and estuary systems. Coastal infrastructure, residential properties and industry are threatened and water quality conditions will change. Research is being conducted by several universities in North Carolina to predict changes in our environmental and economic resources. Links to resources about sea level rise are provided in Chapter 10.

## **Water Quality Management Strategies**

The N.C. Divisions of Water Quality, Coastal Management, Land Resources, Marine Fisheries, Soil and Water Conservation, Parks and Recreation and Environmental Health are responsible for many natural resource use activities and policies including stormwater management, development permits, erosion control programs, agriculture and land preservation, and recreation monitoring. Additional state programs and many interagency and local group partnerships work together to protect the resources found in the Chowan River basin. The Albemarle-Pamlico National Estuary Program (APNEP) has supported a number of research, restoration, and demonstration projects. Recently, in the Chowan River basin, the APNEP funded a Chowan River Riparian Shoreline Assessment, environmental education projects and projects designed to mitigate the effects of stormwater runoff and pollution. Over \$20,000,000 in Clean Water Management Trust Funds, and over \$270,000 in Section 319 Nonpoint Source Grants have been

allocated for projects in the Chowan River basin. Chapter 10 presents more information local initiative and state programs and strategies to preserve and protect water quality.

### **Restoring Impaired Waters**

The long-range mission of basinwide planning is to provide a means of addressing the complex problem of planning for increased development and economic growth while maintaining, protecting and enhancing water quality and intended uses of the Chowan River basin's surface waters. Within this basinwide plan, DWQ presents management strategies and recommendations for those waters rated Impaired or that exhibit some notable water quality problems. There are eight waterbody segments consisting of 135 miles in the Chowan River basin that are on the draft 2006 303(d) list of impaired waters. 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. The waters in the Chowan River basin that are on this list are discussed in the individual subbasin chapters. 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. More information on the TMDL process is found in Chapter 11.

### **Challenges and Recommendations for Achieving Water Quality Improvements**

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 Chowan 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:

- 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, and
- Develop and enforce local erosion control ordinances.

***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.

Without proactive land use planning initiatives and local water quality strategies, population growth and development in the basin increases the risk of waterbody impairment. Balancing economic growth and water quality protection will continue to be an immense challenge. 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.

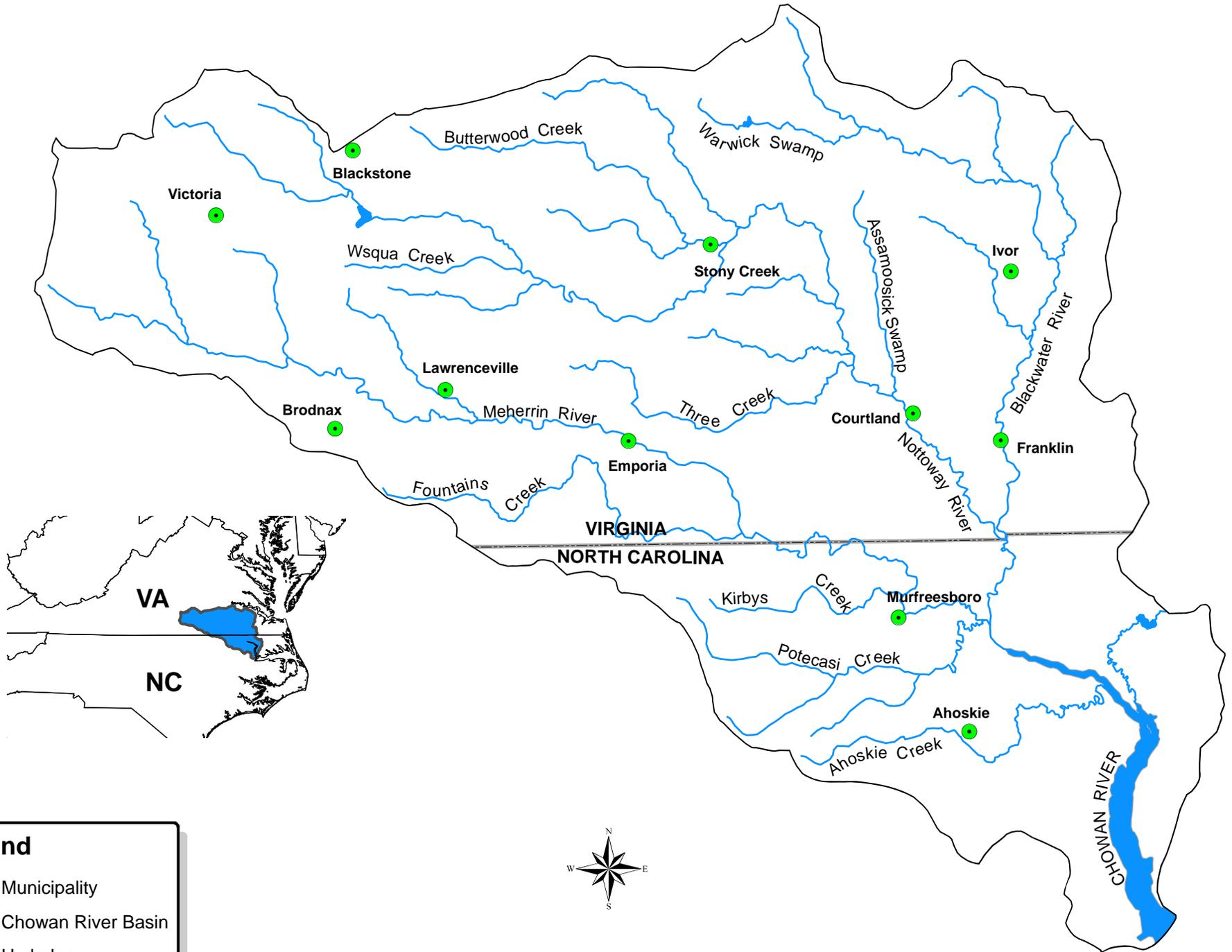
### **General Recommendations for the Chowan River Basin**

Recent water quality data indicates water quality has improved in the Chowan River since the algal bloom events of the 1970's. However, maintenance and continual improvements in water quality are dependent on proactive planning. The following recommendations are compiled

from natural resource agencies and stakeholders working and/or living within the Chowan River basin:

- Conduct additional research to understand possible surface-ground water interactions and possible water quality issues associated with non-discharge wastewater disposal.
- Continue efforts to focus on proper training of facility operators to address non-compliance issues associated with permitted facilities, both non-discharge and discharge, often associated with operator mismanagement.
- Protect human health and maintain water quality by repairing failing septic systems, update older systems, and eliminate straight pipes. Additional monitoring of fecal coliform bacteria throughout tributary watersheds will aid in identifying where straight pipes and failing septic systems are problems. Septic system maintenance outreach is needed in rural areas dependent on on-site wastewater disposal.
- Develop stormwater management programs for new development and to retrofit existing development.
- Develop additional outreach opportunities to incorporate smart growth technologies or low impact development techniques for municipal planners to incorporate into land use plans.
- Establish riparian buffers, as needed throughout the basin, both in residential and agricultural land use areas.
- Reestablish natural drainage and associated wetlands to reduce stormwater runoff, assist with flood control and improve water quality.
- Support the development and implementation of best management practices (BMPs) to help reduce nonpoint source pollution. Monitoring of these BMPs should also be required to improve maintenance, design and functionality. BMPs applicable in residential areas need to be encouraged through public education campaigns.
- Support the implementation of the Coastal Habitat Protection Plan at all levels of government and amongst citizens.
- Continue collaborative efforts between natural resource agencies within North Carolina and Virginia to improve adaptive management and policies on a watershed ecosystem scale.

# Figure i General Map of the Entire Chowan River Basin



**Legend**

- Municipality
- Chowan River Basin
- ~ Hydrology
- State Boundary



# Figure ii General Map of the Chowan River Basin in North Carolina

