PASQUOTANK RIVER BASINWIDE WATER QUALITY PLAN

July 2002

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This document was approved and endorsed by the NC Environmental Management Commission on July 11, 2002 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 Pasquotank River basin. This plan is the first five-year update to the Pasquotank River Basinwide Water Quality Management Plan approved by the NC Environmental Management Commission in September 1997.

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ADDENDUM: Corrections for the 2002 Pasquotank River Basinwide Water Quality Plan

December 2003

The *2000 303(d) List* and the *1997 Pasquotank River Basinwide Water Quality Plan* show 1,125 acres (page 29 of the list) and 11.8 miles (page 27 of the list) of the Little River as Impaired (Partially Supporting) based on Division of Environmental Health (DEH) growing area classifications and closures of shellfish harvesting areas. At that time, neither the Division of Water Quality (DWQ) nor DEH had an exact means of delineating acreage.

Since that time, DWQ has been able to develop a means of delineating acreage for the DEH growing areas. Therefore, the *North Carolina Water Quality Assessment and Impaired Waters List (2002 Integrated 305(b) and 303(d) Report)* correctly list the delineated acres as 512 acres and 11.8 miles (page 57 of the report). These waters will remain on the Integrated List until a TMDL or management strategy is completed, or until the DEH classification is upgraded due to water quality improvements.

The *2002 Pasquotank River Basinwide Water Quality Plan* notes that the Little River is Not Rated based on a Not Rated bioclassification (page 95), and only reported the 11.8 miles as Impaired and did not report the acreage. The basinwide plan should have also reported the 512 acres as Impaired. The *2002 Pasquotank River Basinwide Water Quality Plan* and the *North Carolina Water Quality Assessment and Impaired Waters List (2002 Integrated 305(b) and 303(d) Report)* should have reported the same acres and miles as Impaired.

In addition, Buzzard Bay and Colington Creek (Section B, Chapter 6, Part 6.5, page 114 of the *2002 Pasquotank River Basinwide Water Quality Plan*) are incorrectly noted in the wrong subbasin chapter. These waters should be discussed in Section B, Chapter 7, Part 7.5.

Future Pasquotank River Basinwide Water Quality Plans will note these errors and make corrections.

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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 seventeen major river basins in the state. Each basinwide plan is revised at five-year intervals. While these plans are prepared by the DWQ, their implementation and the protection of water quality entails the coordinated efforts of many agencies, local governments and stakeholders in the state. The first basinwide plan for the Pasquotank River basin was completed in 1997.

This draft document is the first five-year update of the *Pasquotank River Basinwide Water Quality Plan*. 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 plan with more detailed information specific to the Pasquotank River basin. A greater emphasis was placed on identifying causes and sources of pollution for individual streams in order to facilitate local restoration efforts.

DWQ considered comments from two public workshops held in the basin and subsequent discussions with local resource agency staff and citizens during draft plan development. This input will help guide continuing DWQ activities in the basin.

Goals of the Basinwide Approach

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;
- protect unimpaired waters while allowing for reasonable economic growth;
- develop appropriate management strategies to protect and restore water quality;
- assure equitable distribution of waste assimilative capacity for dischargers; and
- improve public awareness and involvement in the management of the state's surface waters.

Pasquotank River Basin Overview

The Pasquotank River basin encompasses 3,635 square miles of low-lying lands and vast open waters, including Albemarle Sound, in the state's northeast outer coastal plain. The basin includes all or portions of Camden, Chowan, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties. The basin also contains numerous small watersheds that drain into Albemarle, Currituck, Croatan, Roanoke and Pamlico Sounds.

A small portion of the Pasquotank River basin is located in Virginia, managed by Virginia as the Chowan River and Dismal Swamp basin. The portion of the basin managed by Virginia covers

4,061 square miles of the Chowan River and Pasquotank River basin's headwaters, covering approximately 145 miles in length and varying from 10 to 50 miles in width (Virginia, 2000).

The Pasquotank River basin is part of the Albemarle-Pamlico Estuarine system, the second largest estuarine system in the United States. In 1987, this estuarine system became part of the Environmental Protection Agency National Estuary Program and was the subject of a major study known as the Albemarle-Pamlico Estuarine Study.

Population of the basin, based on 1990 census data, was estimated to be 97,215. The 2000 population was estimated at 118,913. This change in population over the ten-year period results in a 22 percent increase in population. In 1998, population among the municipalities ranged from 278 in Creswell to 17,188 in Elizabeth City. The overall population density of the basin is 46 persons per square mile compared to an estimated statewide average of 139 persons per square mile. The greatest population and density are concentrated in the coastal area of the basin.

The land comprising the Pasquotank River basin is dominated by open water. Forty-one percent of the land use in the basin is water with another 38 percent characterized as forest/wetlands. Important natural resources in the basin include wetlands, anadromous fish spawning areas, National Seashore and National Wildlife Refuges. Most of the water used in the basin comes from surface water and groundwater sources, but the vast majority comes from groundwater sources.

Assessment of Water Quality in the Pasquotank River Basin

Surface waters are classified according to their best intended uses. Determining how well a water supports its designated uses (use support status) is an important method of interpreting water quality data and assessing water quality. Waters are rated fully supporting (FS), partially supporting (PS) or not supporting (NS). The terms refer to whether the classified uses of the water (i.e., aquatic life protection, recreation and water supply) are being met. For example, waters classified for aquatic life protection and secondary recreation (Class C for freshwater and SC for saltwater) are rated FS 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 PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR).

Beginning in 2000 with the Roanoke River basin, an approach to assess ecosystem health and human health risk is being initiated via the development of use support ratings for each of six use support categories: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. Each of these categories relates to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use categories. For many waters, a use category will not be applicable (NA) to the best use classification of that water (e.g., drinking water supply is not the best use of a Class C water). This method of determining use support differs from that done prior to 2000; in that, there is no longer an *overall* use support rating for a water.

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 (474.1), estuarine acres (918,223.6), freshwater acres (22,770.2), and coastal miles (110.6) in the Pasquotank River basin. A basinwide summary of current aquatic life/secondary recreation use support ratings is presented in Table 1.

Approximately 29 percent of stream miles (135.6. mi.), 69 percent of estuarine acres (639,207.2 acres) and 94 percent of freshwater acres (15,938.3 acres) were monitored for the protection of aquatic life and secondary recreation by DWQ during this basinwide planning cycle. The 110.6 miles of Atlantic coastline are not currently monitored by DWQ to assess the aquatic life/secondary recreation use support category. There was no impairment in this use support category in the basin during this planning cycle.

Many of the not rated streams in the Pasquotank River basin are swamp streams. DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to swamp streams (as is currently done for other streams and rivers across the state). However, validation of the swamp criteria will require collecting data for several years from swamp stream reference sites. The criteria will remain in draft form until DWQ is better able to evaluate such things as: year-to-year variation at reference swamp sites, effects of flow interruption, variation among reference swamp sites, and the effect of small changes in pH on the benthos community. Other factors, such as whether the habitat evaluation can be improved and the role fisheries data should play in the evaluation, must also be resolved.

Table 1 Aquatic Life/Secondary Recreation Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Aquatic Life/Secondary Recreation Use Support Ratings	Monitored, Evaluated and Not Rated Streams*			Monitored Streams Only**	
	Miles or Acres	%		Miles or Acres	%
Fully Supporting	**629,196.7 estuarine ac**	**68.1%**		**629,196.7 estuarine ac**	**98.4%**
Impaired	**0**	**0%**		**0**	**0%**
Partially Supporting	*0*	*0%*		*0*	*0%*
Not Supporting	*0*	*0%*		*0*	*0%*
Not Rated	**474.1 mi** **22,770.2 fresh ac** **289,026.9 estuarine ac** **110.6 coastal mi**	**100%** **100%** **31.5%** **100.0%**		**135.6 mi** **15,938.3 fresh ac** **10,010.5 estuarine ac**	**100%** **100%** **1.6%**

* = Percent based on total of all waters, both monitored and evaluated. ** = Percent based on total of all monitored waters.

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. One hundred percent of Atlantic coastline (110.6 miles) in the Pasquotank River basin was monitored for the fish consumption use support category during this basinwide cycle. No stream miles were monitored for fish consumption use support. Fish consumption use support ratings are based on fish consumption advisories issued by the NC Department of Health and Human Services (NCDHHS). Currently, there is a regional advisory limiting consumption of shark, swordfish, king mackerel, tilefish, as well as, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack) for elevated levels of methylmercury. Because of this advisory, all waters south and east of Interstate 85 are considered partially supporting the fish consumption use. A basinwide summary of current fish consumption use support ratings is presented in Table 2.

Table 2 Fish Consumption Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Fish Consumption Use Support Ratings	**Monitored, Evaluated and Not Rated Streams***			**Monitored Streams Only****	
	Miles or Acres	**%**		**Miles or Acres**	**%**
Fully Supporting	**0**	**0%**		**0**	**0%**
Impaired					
Partially Supporting	*474.1 mi 22,770.2 fresh ac 918,223.6 estuarine ac 110.6 coastal mi*	*100%*		*110.6 coastal mi*	*100%*
Not Supporting	*0*	*0%*		*0*	*0%*
Not Rated	**0**	**0%**		**0**	**0%**

* = Percent based on total of all streams, both monitored and evaluated.

** = Percent based on total of all monitored streams.

Primary Recreation

There are 707,455.2 estuarine acres, 110.6 coastal miles, 15,938.3 freshwaters acres and 25.1 freshwater miles currently classified for primary recreation in the Pasquotank River basin. The Division of Environmental Health Shellfish Sanitation and Recreational Water Quality Section monitors primary recreation on both the estuarine and coastal shorelines. During the last two years, all monitored sites are fully supporting the primary recreation use. However, one site at the Villas Condominiums, Inc. did not support primary recreation due to an ongoing swimming closure advisory in accordance to rule which has been in effect more than two years. However, DEH does not monitor this site. A basinwide summary of current primary recreation use support ratings is presented in Table 3.

Table 3 Primary Recreation Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Primary Recreation Use Support Ratings	Monitored, Evaluated and Not Rated Streams*			Monitored Streams Only**	
	Miles or Acres	%		Miles or Acres	%
Fully Supporting	651,469.1 estuarine ac 110.6 coastal mi	92.1% estuarine ac 100% coastal mi		651,469.1 estuarine ac 110.6 coastal mi	99.9% estuarine ac 100% coastal mi
Impaired	**21.4 estuarine ac**	**<1% estuarine ac**		**21.4 estuarine ac**	**<1% estuarine ac**
Partially Supporting	*0*	*0%*		*0*	*0%*
Not Supporting	21.4 estuarine ac	<1% estuarine ac		21.4 estuarine ac	<1% estuarine ac
Not Rated	*55,964.7 estuarine ac* *25.1 miles* *15,938.3 fresh ac*	**7.9% estuarine ac** **100% fresh ac**		*15,938.3 fresh ac*	**100**
TOTAL	*707,455.0 estuarine ac* *110.6 coastal mi* *25.1 miles* *15,938 fresh ac*			**651,490.5 estuarine ac** **15,938 fresh ac** **110.6 Coastal Miles**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Shellfish Harvesting

In the Pasquotank River basin, there are 395,371.3 estuarine acres which have shellfish harvesting (Class SA) identified by the state as its best use. All were monitored during the past five years by DEH Shellfish Sanitation. A basinwide summary of current shellfish harvest use support ratings is presented in Table 4.

The Pasquotank River basin contains many Prohibited shellfish harvesting areas, which are now given a use support rating of not supporting (NS) shellfish harvesting based on the DEH designation. This use support rating differs significantly from the historical use support ratings of partially supporting (PS) for Prohibited shellfish harvesting areas. Changes that are related to water quality or DEH SS growing area reclassifications are explained in detail in the subbasin chapters of Section B.

Table 4 Shellfish Harvest Use Support Summary Information for Waters in the Pasquotank River Basin (1995-2000)

Shellfish Harvest Use Support Ratings	Monitored Streams	
	Acres	%
Fully Supporting	**390,338.0**	**98.7%**
Impaired	**5,033.3**	**1.3%**
Partially Supporting	*0*	*0%*
Not Supporting	*5,033.3*	*1.3*
Not Rated	**0**	**0**
Total	**395,371.3**	**100%**

Water Supply

There are 30.3 stream miles and 23.8 freshwater acres currently classified for water supply in the Pasquotank River basin. All are considered fully supporting on an evaluated basis, based on information provided by the regional water treatment plant consultant. Local water treatment plant operators monitored all during the past five years.

Use Support Summary

There are no impaired waters in the aquatic life/secondary recreation use support category and one impaired water in the primary recreation use support category. All waters are considered impaired for the fish consumption use support category due to a regional fish consumption advisory for shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack) bowfin and king mackerel. There are 5,033.3 estuarine acres impaired for the shellfish harvesting use support category. All water supply watershed waters are fully supporting their uses in the basin. Descriptions of impaired segments, as well as problem parameters, are outlined in Appendix III. Management strategies for each water are discussed in detail in the appropriate subbasin chapter.

Section A

General Basinwide Information

Chapter 1 -
Introduction to Basinwide Water Quality Planning

1.1 What is Basinwide Water Quality Planning?

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 seventeen major river basins in the state, as shown in Figure A-1 and Table A-1. Preparation of an individual basinwide water quality plan is a five-year process, which is broken down into three major phases as presented in Table A-2. While these plans are prepared by the Division of Water Quality, their implementation and the protection of water quality entails the coordinated efforts of many agencies, local governments and stakeholder groups in the state. The first cycle of plans was completed in 1998, but each plan is updated at five-year intervals.

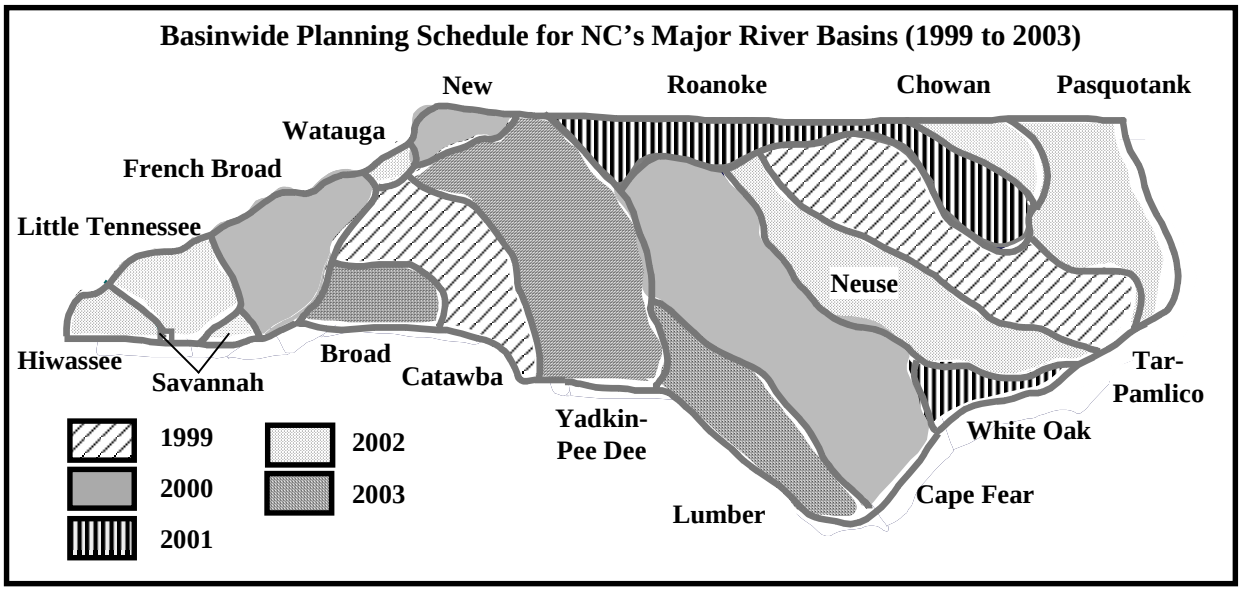

Figure A-1 Basinwide Planning Schedule (1999 to 2003)

1.2 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 while allowing for reasonable economic growth;
- develop appropriate management strategies to protect and restore water quality;
- assure equitable distribution of waste assimilative capacity for dischargers; and
- improve public awareness and involvement in the management of the state's surface waters.

Table A-1 Schedule for Second Cycle of Basinwide Planning (1998 to 2003)

Basin	DWQ Biological Data Collection	River Basin Public Workshops	Public Mtgs. and Draft Out For Review	Final Plan Receives EMC Approval	Begin NPDES Permit Issuance
Neuse	Summer 2000	6/2001	5/2002	7/2002	1/2003
Lumber	Summer 2001	12/2002	9/2003	12/2003	7/2004
Tar-Pamlico	Summer 97	6/1998	4/1999	7/1999	1/2000
Catawba	Summer 97	2/1999	10/1999	12/1999	3/2000
French Broad	Summer 97	5/1999	2/2000	5/2000	8/2000
New	Summer 98	6/1999	4/2000	7/2000	11/2000
Cape Fear	Summer 98	7/1999	4/2000	7/2000	12/2000
Roanoke	Summer 99	4/2000	2/2001	7/2001	1/2002
White Oak	Summer 99	10/2000	7/2001	9/2001	6/2002
Savannah	Summer 99	10/2000	12/2001	3/2002	8/2002
Watauga	Summer 99	10/2000	12/2001	2/2002	9/2002
Little Tennessee	Summer 99	3/2001	12/2001	4/2002	10/2002
Hiwassee	Summer 99	10/2000	12/2001	3/2002	8/2002
Chowan	Summer 2000	3/2001	5/2002	7/2002	11/2002
Pasquotank	**Summer 2000**	**3/2001**	**5/2002**	**7/2002**	**12/2002**
Broad	Summer 2000	11/2001	11/2002	2/2003	7/2003
Yadkin Pee-Dee	Summer 2001	4/2002	12/2002	3/2003	9/2003

Note: A basinwide plan was completed for all 17 basins during the first cycle (1993 to 1998).

Table A-2 Five-Year 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 Public Workshops**	• Gather and analyze data from sampling activities • Develop use support ratings • Conduct special studies and other water quality sampling activities • Conduct public workshops to establish goals and objectives and identify and prioritize issues for the next basin cycle • Develop preliminary pollution control strategies • Coordinate with local stakeholders and other 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 at public meetings • Revise plan after public review period • 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

1.3 Major Components of the Basinwide Plan

The second round of basinwide plans uses a different format from the earlier basinwide plans. Each plan is subdivided into three major sections. The intent of the format change is to make the plans easier to read and understand, but still comprehensive in content.

Section A: Basinwide Information

- Introduces the basinwide planning approach used by the state.
- Provides an overview of the river basin including: hydrology, land use, local government jurisdictions, population and growth trends, natural resources, wastewater discharges, animal operations and water usage.
- Presents general water quality information including summaries of water quality monitoring programs and use support ratings in the basin.

Section B: Subbasin Information

- Summarizes recommendations from first basin plan, achievements made, what wasn't achieved and why, current priority issues and concerns, and goals and recommendations for the next five years by subbasin.

Section C: Current and Future Initiatives

- Presents current and future water quality initiatives by federal, state and local agencies, and corporate, citizen and academic efforts.
- Describes DWQ goals and initiatives beyond the five-year planning cycle for the basin.

1.4 Benefits of Basinwide Water Quality Planning

Several benefits of basinwide planning and management to water quality include:

- *Improved efficiency*. The state's efforts and resources are focused on one river basin at a time.
- *Increased effectiveness*. The basinwide approach is in agreement with basic ecological principles.
- *Better consistency and equitability*. By clearly defining the program's long-term goals and objectives, basinwide plans encourage *consistent* decision-making on permits and water quality improvement strategies.
- *Increased public participation in the state's water quality protection programs*. The basinwide plans are an educational tool for increasing public involvement and awareness about water quality issues.
- *Increased integration of point and nonpoint source pollution assessment and controls*. Once waste loadings from both point and nonpoint sources are established, management strategies can be developed to ensure compliance with water quality standards.

1.5 How to Get Involved

To assure that basinwide plans are accurately written and effectively implemented, it is important for local citizens and other stakeholders to participate in the planning process. DWQ offers three opportunities for the public to participate in the process:

- Public Workshops: Held prior to writing the basinwide plans. DWQ staff present information about basinwide planning and the water quality of the basin. Participants then break into smaller groups where they can ask questions, share their concerns, and discuss potential solutions to water quality issues in the basin.
- Public Meetings: Held after the draft basinwide plan has been approved by the Water Quality Committee of the Environmental Management Commission. DWQ staff present more detailed information about the draft basinwide plan and its major recommendations. Then, the public is invited to comment and ask questions.
- Public Comment Period: Held after the draft plan has been approved by the Water Quality Committee of the Environmental Management Commission. The comment period is at least thirty days in length from the date of the first public meeting.

Citizens seeking involvement in efforts to restore and protect water quality can call the DWQ Planning Branch at (919) 733-5083 and ask to speak to the basin planner for your river basin.

1.6 Other References

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

- *Pasquotank River Basinwide Assessment Report*. January 2002. This technical report presents the physical, chemical and biological data in the Pasquotank River basin. 131 pp.
- *Pasquotank River Basinwide Water Quality Management Plan*. September 1997. This first basinwide plan for the Pasquotank River basin presents water quality data, information and recommended management strategies for the first five-year cycle.
- *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. 156 pp.
- *NC Basinwide Wetlands and Riparian Restoration Plan for the Pasquotank River Basin.* August 1998. DWQ NC Wetlands Restoration Program. Raleigh, NC.
- *North Carolina's Basinwide Approach to Water Quality Management: Program Description*. Creager, C.S. and J.P. Baker. 1991. DWQ Water Quality Section. Raleigh, NC.
- NC Division of Water Quality Basinwide Planning Website http://h2o.enr.state.nc.us. Click on Water Quality Section and then, under Programs, click on Basinwide Planning Program.
- NC Division of Water Quality Environmental Sciences Branch Website http://esb.ehnr.state.nc.us/BAU.html.

Anyone interested in receiving these documents can contact the DWQ Planning Branch at (919) 733-5083 or by internet: http://h2o.enr.state.nc.us/basinwide/.

1.7 Division of Water Quality Functions and Locations

The major activities coordinated by DWQ through basinwide planning are listed in Figure A-2. Information on the location, address and phone numbers for each Branch and Regional Office are also shown in Figure A-2 and Figure A-3. Additional information can be found on the Division of Water Quality website at http://h2o.enr.state.nc.us/.

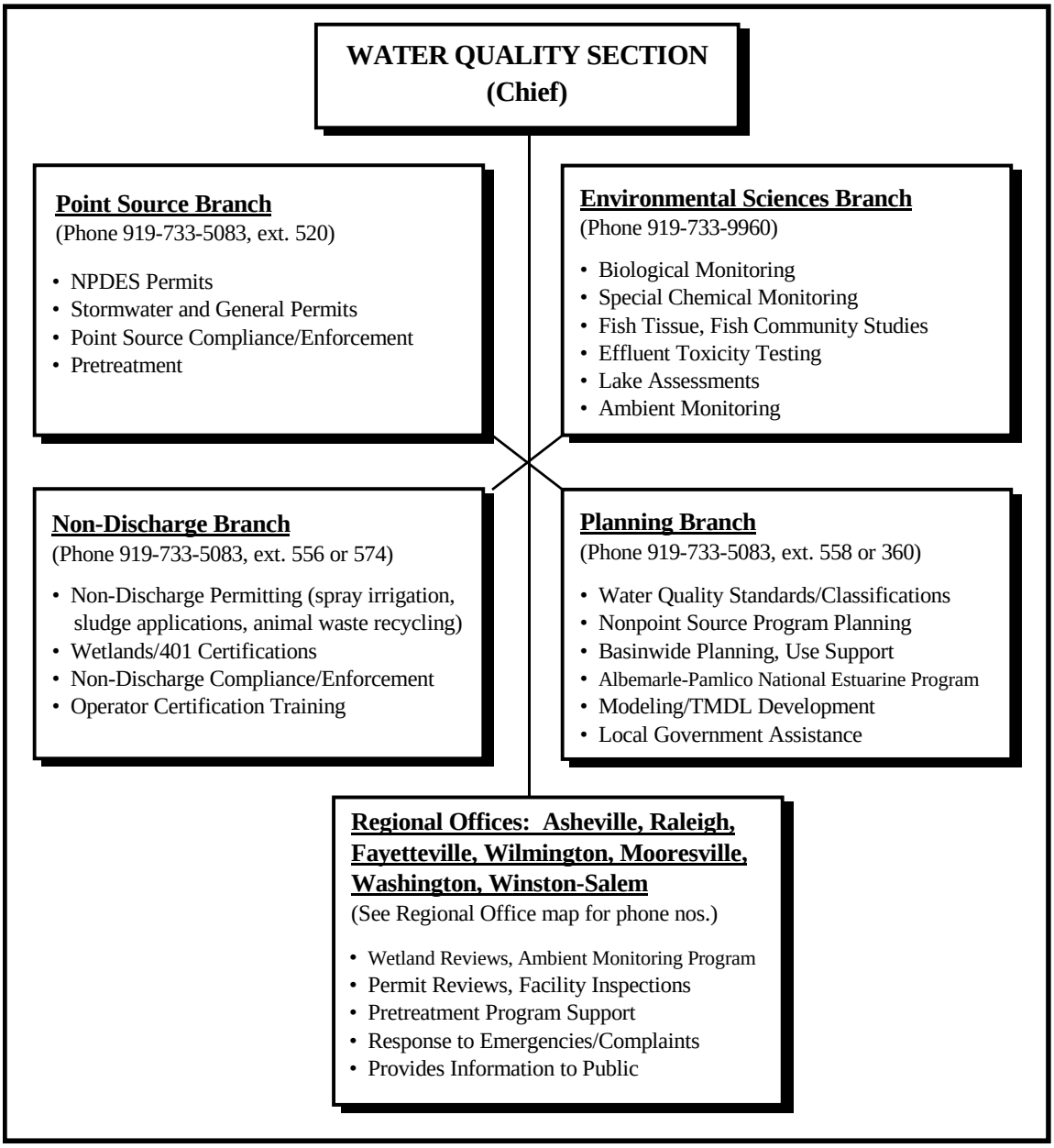

Figure A-2 Water Quality Section Organization Structure

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Figure A-3 Division of Water Quality Regional Offices

Chapter 2 -
Basin Overview

2.1 General Overview

The Pasquotank River basin encompasses 3,635 square miles of low-lying lands and vast open waters, including Albemarle Sound, in the state's northeast outer coastal plain (Figure A-4). It includes all or portions of Camden, Chowan, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties. It contains numerous small watersheds that drain into Albemarle, Currituck, Croatan, Roanoke and Pamlico Sounds.

Pasquotank River Basin Statistics

Total Area: 3,635 mi^2
Stream Miles: 474.1
Estuary Acres: 918,223.6
Freshwater Acres: 22,770.2
Coast Miles: 110.6
No. of Counties: 10
No. of Municipalities: 11
No. of Subbasins: 7
Population (2000): 118,912 *
Estimated Pop. (2020): 151,192 *
% Increase (2000-2020): 27 %
Pop. Density (1990): 46 persons/sq. mi.

* Based on % of county land area estimated to be within the basin.

A small portion of the Pasquotank River basin is located in Virginia, managed by Virginia as the Chowan River and Dismal Swamp basin (Figure A-5). The portion of the basin managed by Virginia covers 4,061 square miles of the Chowan River and Pasquotank River basin's headwaters. The basin is approximately 145 miles in length and varies from 10 to 50 miles in width. The basin is mostly rural with approximately 64 percent of its land covered by forest, 28 percent cropland and pasture, and about 6 percent urban areas (Hill, 2000). The Albemarle Sound is a large fresh to brackish estuarine system with major tributaries including the Pasquotank, Roanoke, North, Little and Perquimans Rivers on the north side. On the south portion of the sound, the Scuppernong and Alligator Rivers drain into the estuary. Salinities in the sound are low due to dilution from the large inflow of freshwater from the Pasquotank and Roanoke Rivers relative to the sound's volume.

Major tributaries on the northwestern side of the Albemarle Sound include the Perquimans, Little and Pasquotank Rivers. The Perquimans River originates in the Great Dismal Swamp, takes flow from a system of drainage canals, and flows southeast into the sound. East of the Perquimans River lies the Little River, a slow-flowing coastal stream that flows along the border of Perquimans and Pasquotank counties. The Pasquotank River flows along the border of Pasquotank and Camden counties, originating as freshwater above Elizabeth City. As it drains southeast toward the Albemarle Sound, the river becomes brackish and tidally influenced.

On the southeastern side of the Albemarle Sound are the Alligator and Scuppernong Rivers. The Alligator River is a large blackwater river, designated as Outstanding Resource Waters. It is remote from any urban areas and is bordered by wooded swamps and pocosins. The river's outstanding resource is its function as a major spawning area for anadromous fish (those species that migrate from freshwater to saltwater back to freshwater during their life cycles), including

Figure A4 General Map of the Pasquotank River Basin

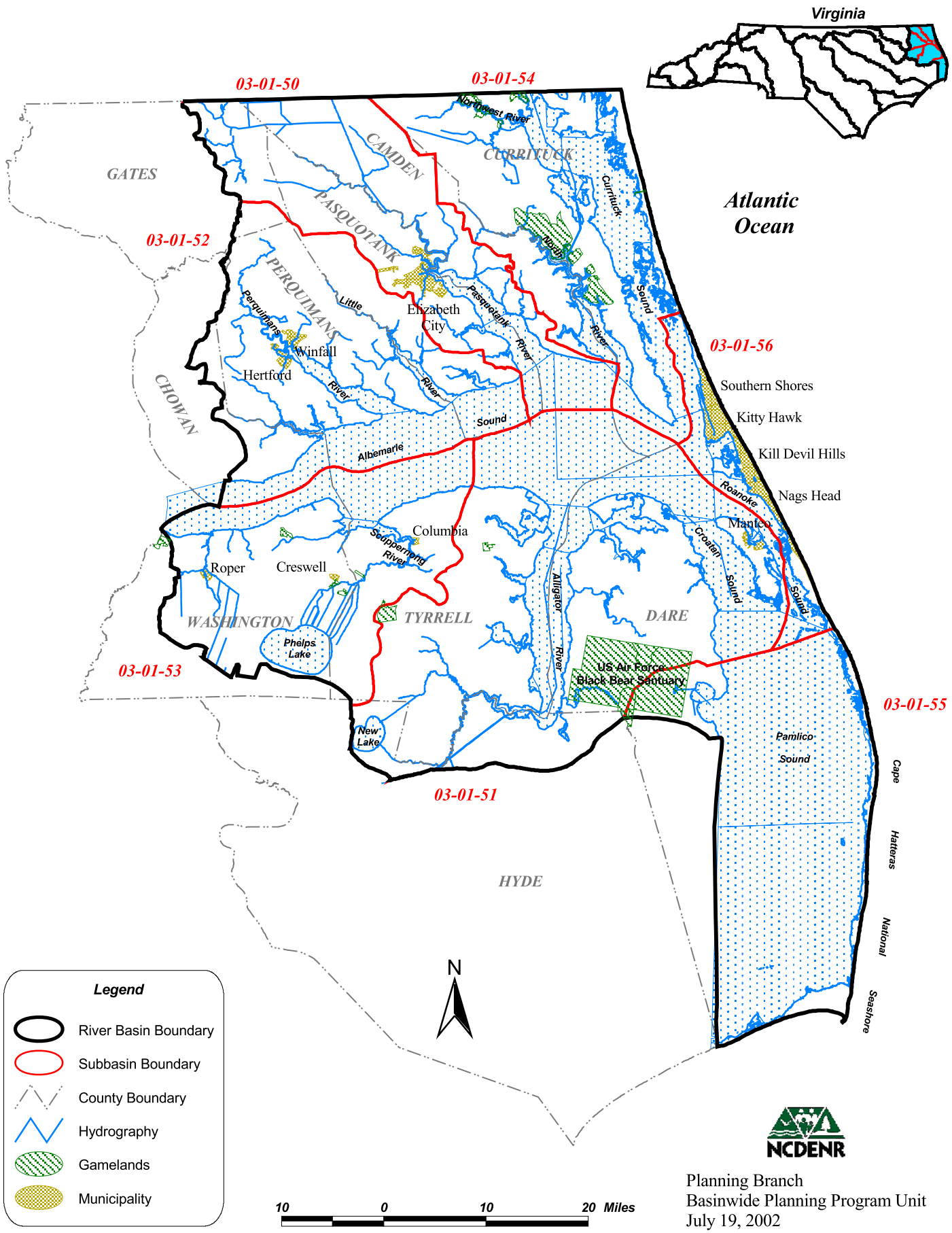
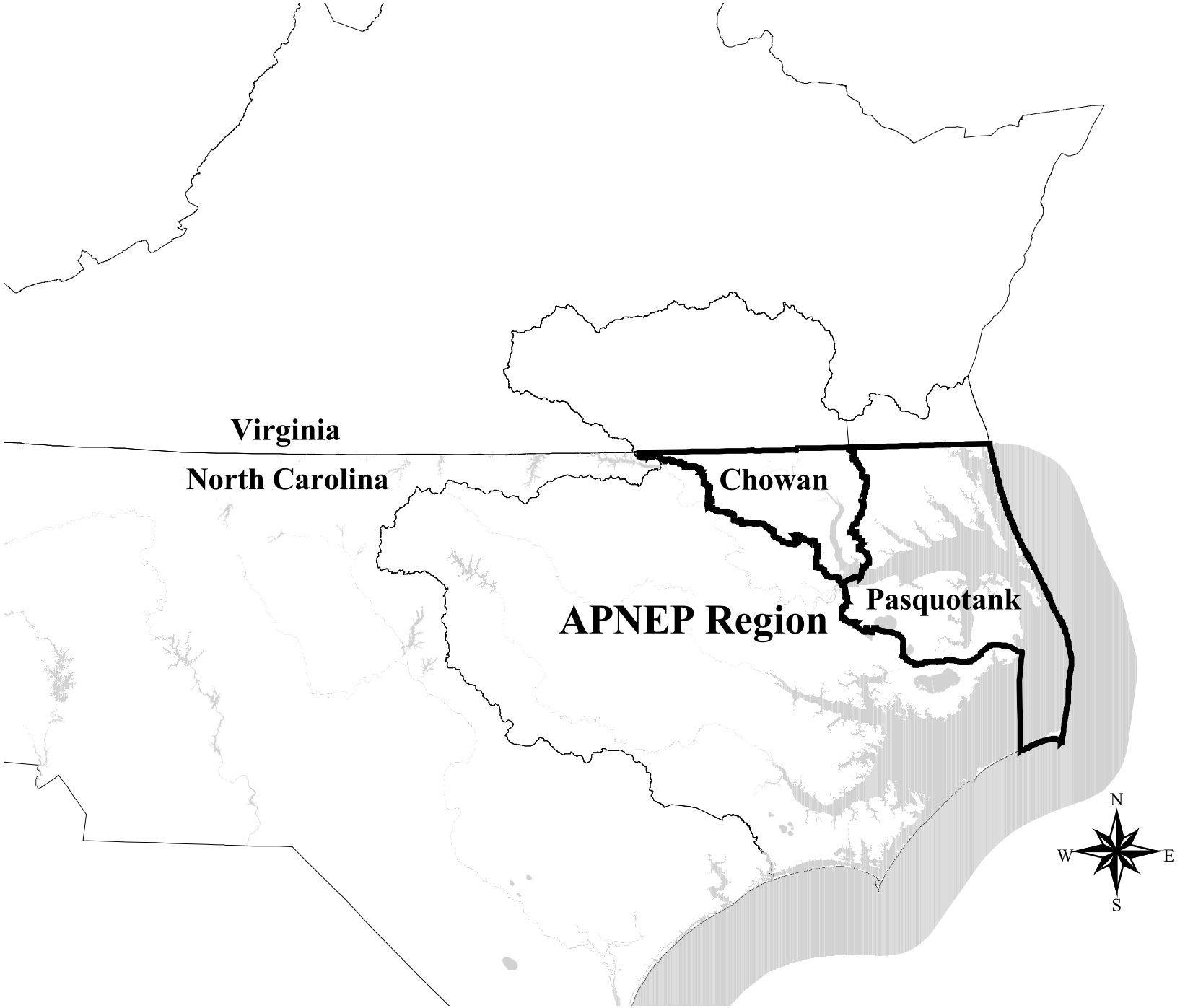


Figure A-5 Virginia Portion of Chowan and Pasquotank River Basins



river herring (alewife and blueback herring), and the river's inclusion as a National Wildlife Refuge. The Pasquotank River basin also contains several lakes including Lake Phelps, the second largest natural lake in the state.

Northeast of the Albemarle Sound lies Currituck Sound, a shallow, fresh to brackish estuary influenced greatly by wind movement. Historically, Currituck Sound supported a waterfowl hunting industry and largemouth bass fishery, both of which have declined due to habitat changes. Serving as part of the Atlantic Flyway for migratory waterfowl, the Currituck Sound offers habitat to thousands of wintering ducks, geese and swans. Inputs to the Currituck Sound come from the Northwest River and numerous canals originating in the Great Dismal Swamp.

South of Currituck Sound, the Pasquotank River basin contains waters along the Outer Banks including Roanoke Sound, Croatan Sound and Pamlico Sound from Oregon Inlet to Hatteras Inlet. These waters are predominantly estuarine with the exception of a few small lakes in the maritime forest of the outer banks. Much of the area is adjacent to the Cape Hatteras National Seashore and Pea Island National Wildlife Refuge.

Water quality is generally good in the Pasquotank River basin. The basin contains a mixture of each type of primary classification possible in North Carolina ranging from Class B, C, SB, SC to SA (see Section A, Chapter 3). In addition to the diversity of primary water quality classifications, many waters are designated as Outstanding Resource Waters such as Lake Phelps, the Alligator River, Swan Creek Lake and many others. Other supplemental classifications in the basin include High Quality Waters, Water Supply Watersheds and Swamp Waters.

Population of the basin, based on 1990 census data, was estimated to be 97,215. The 2000 population was estimated at 118,912. The projected change in population between 2000 and 2020 shows a 27 percent increase in population. In 1998, population among the municipalities ranged from 278 in Creswell to 17,188 in Elizabeth City. The overall population density of the basin is 46 persons per square mile compared to an estimated statewide average of 139 persons per square mile. The greatest population and density are concentrated in the coastal area of the basin.

The Pasquotank River basin is part of the Albemarle-Pamlico Estuarine system, the second largest estuarine system in the United States. In 1987, this estuarine system became part of the Environmental Protection Agency National Estuary Program and was the subject of a major study known as the Albemarle-Pamlico Estuarine Study (refer to Section C, Chapter 2).

The land comprising the Pasquotank River basin is dominated by open water. Forty-one percent of the land use in the basin is water with another 38 percent characterized as forest/wetlands. Important natural resources in the basin include wetlands, anadromous fish spawning areas, National Seashore and National Wildlife Refuges. Most of the water used in the basin comes from surface water and groundwater sources, but the vast majority comes from groundwater sources.

2.2 Local Governments and Planning Jurisdictions in the Basin

The basin encompasses all or part of the following ten counties and 11 municipalities (Table A-3). All local governments fall within the Region R Council of Governments overseen by the Albemarle Regional Planning and Development Commission located in Hertford.

Table A-3 Local Governments and Planning Units within the Pasquotank River Basin

County	Municipalities
Camden	Elizabeth City *
Chowan	None
Currituck	None
Dare	Kill Devil Hills Kitty Hawk Manteo Nags Head Southern Shores
Gates	None
Hyde	None
Pasquotank	Elizabeth City *
Perquimans	Hertford Winfall
Tyrrell	Columbia
Washington	Creswell Roper

* Located in more than one county

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%) is located in that basin, unless a municipality is located in that county.

2.3 Surface Water Hydrology

Most federal government agencies, including the US Geological Survey and the Natural Resources Conservation Service (NRCS), use a system of defining watersheds that is different from that used by the Division of Water Quality (DWQ) and many other state agencies in North Carolina. Under the federal system, the Pasquotank River basin is made up of one hydrologic area referred to as a hydrologic unit. DWQ has a two-tiered system in which the state is divided into 17 major river basins with each basin further subdivided into subbasins. Table A-4 compares the two systems. The Pasquotank River basin is subdivided by DWQ into seven subbasins that correspond with the watershed of the Albemarle Sound (shown on Figure A-4). Maps of each subbasin are included in Section B of this plan.

Table A-4 Hydrologic Subdivisions in the Pasquotank River Basin

Watershed Name and Major Tributaries	USGS 8-digit Hydrologic Units	DWQ 6-digit Subbasin Codes
Albemarle Sound	03010205	
Pasquotank River		03-01-50
Alligator River and Croatan Sound		03-01-51
Perquimans, Little and Yeopim Rivers		03-01-52
Scuppernong River and Phelps Lake		03-01-53
Currituck Sound and North River		03-01-54
Roanoke Sound and surrounding areas		03-01-56

Note: Pasquotank River subbasin 03-01-55 is contained in hydrologic unit 03020105, and it is not included in the above table. The hydrologic unit 03020105 is discussed in the Tar-Pamlico River Basin Water Quality Plan.

Hydrologic Features

In this basin, 465 miles of freshwater streams drain 3,635 square miles of low-lying lands and vast open waters. The average drainage area per stream mile is 0.13 square mile, the lowest drainage density per stream mile in the state. In comparison, the largest river basin in the state, the Cape Fear, drains 1.5 square miles per stream mile. In the Cape Fear, there are fewer streams draining much larger portions of land as compared to the Pasquotank. Areas with low drainage density are associated with low flood peaks, low sediment production, relatively high suitability for traditional agriculture.

The basin lies in the Coastal Plain Physiographic Region. The geology of this area consists of alternating layers of sand, silt, clay and limestone. In this portion of the basin, the land is relatively flat. The slope dips downward at a rate of only a few feet per mile. A smaller number of streams drain a large area of land on the Coastal Plain. In addition to low drainage density, the lower portion of the basin also has the lowest potential for sustaining base flow in streams. The low flow frequency, measured by a 7Q10 (annual minimum 7-day consecutive low flow, which on average, will be exceeded 9 out of 10 years) flow calculation, is zero for all but the largest drainages. This very low flow over the warmest months of the year limits streams' ability to maintain high dissolved oxygen levels (increased temperature depletes dissolved oxygen while decreased velocity inhibits reaeration). The capacity for assimilating oxygen-consuming wastes is also limited under these conditions.

2.4 Land Cover

Land cover information in this section is from the most recent National Resources Inventory (NRI), as developed by the Natural Resources Conservation Service (USDA, updated June 2001). The National Resources Inventory (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 published for the 1982, 1987 and 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."*

Table A-5 summarizes acreage and percentage of land cover from the 1997 NRI for the North Carolina portion of the basin, as defined by the USGS 8-digit hydrologic units, and compares the coverages to 1982 land cover. Land cover in the basin, as presented in Table A-5, is dominated by open waters, characterized as "Other" which covers approximately 37.9 percent of the land area. Forest and federal lands combined cover approximately 37.1 percent. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 21.6 percent. Only 3.3 percent of the land area is developed. Table A-6 describes the land cover types.

Table A-5 Land Cover in the Pasquotank River Basin by Major Watersheds - 1982 vs. 1997 (Source: USDA-NRCS, NRI, updated June 2001)

	MAJOR WATERSHED AREAS *						
	Albemarle Sound Watershed		1997 TOTALS		1982 TOTALS		% change since 1982
LAND COVER	Acres (1000s)	%	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	
Cult. Crop	437.1	21.3	437.1	21.3	493.2	24.0	-11.4
Uncult. Crop	0.1	0.0	0.1	0.0	0.0	0.0	10.0
Pasture	6.7	0.3	6.7	0.3	3.9	0.2	71.8
Forest	491.7	23.9	491.7	23.9	668.7	32.5	-26.5
Urban & Built-Up	68.7	3.3	68.7	3.3	36.9	1.8	86.2
Federal	271.8	13.2	271.8	13.2	69.1	3.4	293.3
Other	779.5	37.9	779.5	37.9	783.8	38.1	-0.5
Totals	2055.6	100.0	2055.6	100.0	2055.6	100.0	
% of Total Basin		100.0		100.0			
SUBBASINS	03-01-50 to 03-01-54 03-01-56 **						
8-Digit Hydraulic Units	03010205						

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

** Pasquotank River subbasin 03-01-55 is contained in hydrologic unit 03020105.
It is not currently feasible to estimate the land use in the Pasquotank portion of hyrdologic unit 03020105 to include above.
The hydrologic unit 03020105 is discussed in the Tar-Pamlico River Basin Water Quality Plan.
A small portion of Chowan River subbasin 03-01-04 is contained in hydrologic unit 03010205.
The hydrologic unit 03010205 is discussed in the Pasquotank River Basin Water Quality Plan.

Table A-6 Description of Land Cover Types (Source: USDA-NRCS, NRI, updated June 2001)

Land Cover Type	Land Cover 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	Forage plants for livestock grazing, including 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; must be at least 1,000 feet wide.
Urban and Built-up Land	Includes airports, playgrounds with permanent structures, cemeteries, public administration sites, commercial sites, railroad yards, construction sites, residences, golf courses, sanitary landfills, industrial sites, sewage treatment plants, institutional sites, water control structure spillways and parking lots. 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 in size and streams less than one-half mile wide. *Census Water*: Large waterbodies consisting of lakes and estuaries greater than 40 acres and rivers greater than one-half mile in width. *Minor Land*: Lands not in one of the other categories.

Comparisons of land cover between 1982 and 1997 (Figure A-6) show decreases in cultivated croplands and forest. Over the 10-year period, substantial increases were experienced in the pasture, urban and federal categories.

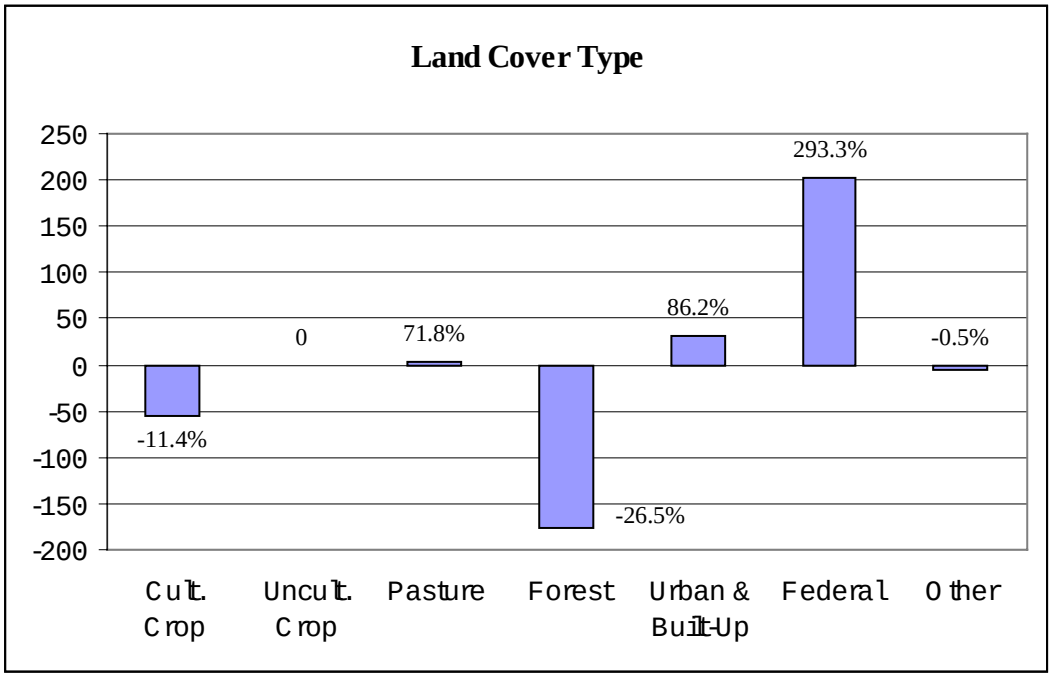


Figure A-6 Land Cover Changes from 1982 to 1997 for the Pasquotank River Basin (Source: USDA-NRCS, NRI, updated June 2001)

The most recent land cover information for the Pasquotank River basin is based on satellite imagery collected from the North Carolina Corporate Geographic Database. The state's Center for Geographic Information and Analysis (CGIA) developed statewide land cover information based on this 1993-1995 satellite imagery. The land cover data are divided into 24 categories. For the purposes of this report, those categories have been condensed into five broader categories as described in Table A-7. An important distinction between this land cover dataset and that of the NRI is that there is no actual groundtruthing of the satellite-generated data.

Table A-7 Description of Major CGIA Land Cover Categories

Land Cover Type	Land Cover Description
Urban	Greater than 50% coverage by synthetic land cover (built-upon area) and municipal areas.
Cultivated	Areas that are covered by crops that are cultivated in a distinguishable pattern (such as rows).
Pasture/Managed Herbaceous	Areas used for the production of grass and other forage crops and other 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 all kinds of forested areas (such as needleleaf evergreens, conifers, deciduous hardwoods).
Water	Areas of open surface water, areas of exposed rock, and areas of sand or silt adjacent to tidal waters and lakes.

Unfortunately, due to differences in the system of categorizing various land cover classes, it is not possible to establish trends in land cover changes by comparing this data set to previously attained land cover data. However, it is anticipated that comparisons will be possible with future satellite data since a strong consensus-based effort was made to develop the classification system that was used with the 1996 data. Satellite imagery from a 1998 fly-over is available; however, it is not in a format conducive for analysis. DWQ is collaborating with CGIA to make this data available for future analysis in the next basin plan update.

Figure A-7 provides an illustration of the relative amount of land area that falls into each major cover type for the Pasquotank River basin. Section B of this plan provides land cover data specific to each subbasin.

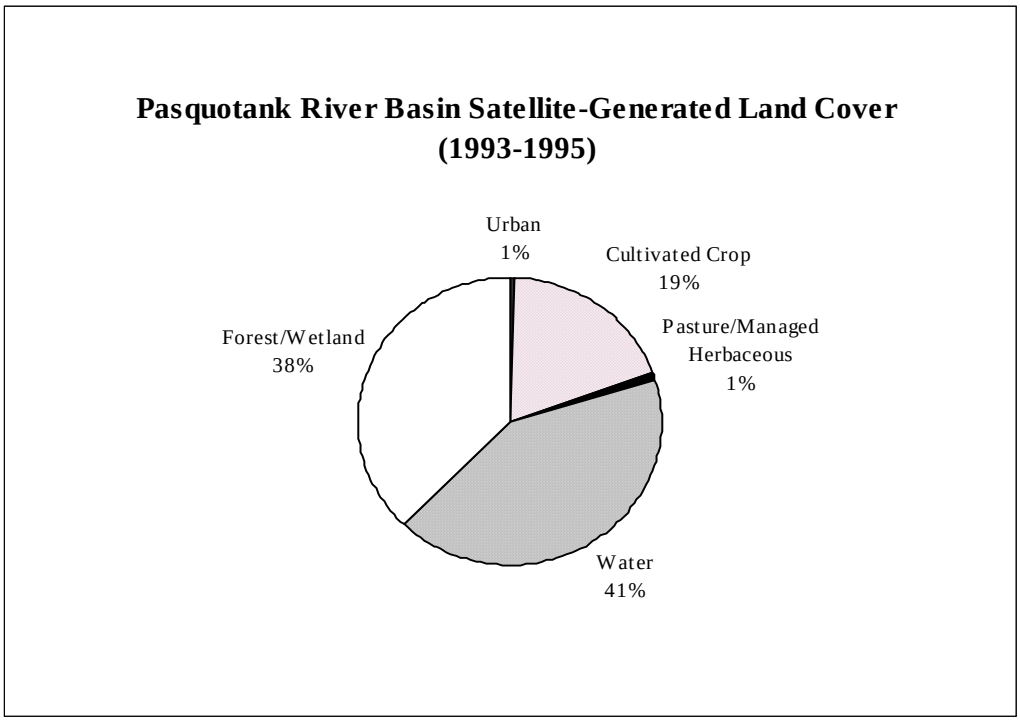


Figure A-7 Percentages within Major CGIA Land Cover Categories in the Pasquotank River Basin

2.5 Population and Growth Trends

Population

The Pasquotank River basin has an estimated population of 118,913 based on 2000 census data. Table A-8 presents census data for 1970, 1980 and 1990 for each of the subbasins. It also includes population densities (persons/square mile) based on the *land area* (excludes open water) for each subbasin. Approximately one-third of the basin's population is located in subbasin 03-01-50, which includes Elizabeth City. Subbasin 03-01-56, which includes the Outer Banks' municipalities of Nags Head, Kitty Hawk and Kill Devil Hills, has a population density of 305

persons/square mile, making it the most densely populated land area in the Pasquotank River basin.

Table A-8 Pasquotank River Subbasin Population, Densities (1970, 1980 and 1990) and Land Area Summaries

	POPULATION [1] (Number of Persons)			POPULATION DENSITY [2] (Persons/Square Mile)			LAND AND WATER AREAS [3]			
							Total Land and Water Area		Water Area	Land Area
SUBBASIN	1970	1980	1990	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-01-50	28,271	29,867	31,369	72	77	80	291,066	455	64	390
03-01-51	5,287	6,220	9,240	9	11	16	625,919	978	410	568
03-01-52	13,603	15,217	18,399	34	38	46	346,203	541	142	399
03-01-53	8,190	8,782	8,836	24	26	26	304,012	475	139	336
03-01-54	8,320	12,525	14,653	27	41	48	322,062	503	199	304
03-01-55	1,763	3,801	3,436	18	40	36	367,331	574	478	96
03-01-56	1,524	4,807	11,282	41	130	305	70,010	109	72	37
TOTALS	**66,958**	**81,219**	**97,215**	**31**	**38**	**46**	**2,326,603**	**3,635**	**1,504**	**2,130**

[1] Population estimated based on US Census data and percentage of census block that falls within the subbasin.

[2] Population density based on land area only. Large wetlands (swamps) not included in area used to calculate density.

[3] Information generated by the NC Center for Geographic Information Analysis.

In using these data, it should be noted that some of the population figures are estimates because the census block group boundaries do not generally coincide with subbasin boundaries. The census data are collected within boundaries such as counties and municipalities. By contrast, the subbasin lines are drawn along natural drainage divides separating watersheds. Therefore, where a census block group straddles a subbasin line, an estimate is made on the percentage of the population that is located in the subbasin. This is done by simply determining the percentage of the census block group area located in the subbasin and then taking that same percentage of the total census block group population and assigning it the subbasin. Use of this method necessitates assuming that population density is evenly distributed throughout a census block group, which is not always the case. However, the level of error associated with this method is not expected to be significant for the purposes of this document. It is also important to note that the census block groups change every ten years, so comparisons between years must be considered approximate.

Growth Trends

Basinwide, the percentage increase in population from 1980 to 1990 was 16.4 percent, exceeding the statewide increase of 12.7 percent over the same 10-year period. The projected population figures indicate that the majority of the basin is expected to continue to grow at significant rates. The highest levels of growth are expected on the Outer Banks.

Table A-9 presents population data for municipalities that are located wholly or partially within the basin. The table indicates that Kitty Hawk is currently the fastest growing municipality in the basin with an increase in population of 54.4 percent from 1990 to 2000. Population in Elizabeth City, Kill Devil Hills, Nags Head, Southern Shores and Winfall also increased over the same 10-year period from between 10.6 and 52.1 percent. Population growth in the majority of municipalities in the basin slowed considerably after 1990. For instance, between 1980 and 1990, Kill Devil Hills, Kitty Hawk and Southern Shores increased by over 125 percent each, slowing down to 54.4 percent between 1990 and 2000. This information was obtained from the Office of State Planning (April and May 2001).

Table A-9 Population (1980, 1990, 2000) and Percent Change for Municipalities Located Wholly or Partly in the Pasquotank River Basin

Municipality	County	Apr-80	Apr-90	April 2000	% Change (1980-1990)	% Change (1990-2000)
Columbia	Tyrrell	758	836	819	10.3	-2.0
Creswell	Washington	426	361	278	-15.3	-23.0
Elizabeth City	Camden, Pasquotank	14,007	14,292	17,188	2.0	20.3
Hertford	Perquimans	1,941	2,244	2,070	15.6	-7.8
Kill Devil Hills	Dare	1,671	4,238	5,897	153.6	39.1
Kitty Hawk	Dare	849	1,937	2,991	128.2	54.4
Manteo	Dare	902	991	1,052	9.9	6.2
Nags Head	Dare	1,020	1,838	2,700	80.2	46.9
Roper	Washington	795	669	613	-15.8	-8.4
Southern Shores	Dare	520	1,447	2,201	178.3	52.1
Winfall	Perquimans	634	501	554	-21.0	10.6

* The numbers reported reflect municipality population. All of the municipalities are completely contained within the basin.

Table A-10 shows the projected population and change in growth between 1990 and 2020 for counties that are wholly or partly contained within the basin. Since river basin boundaries do not usually coincide with county boundaries, these numbers are not directly applicable to the Pasquotank River basin. Even though 100 percent of Camden, Currituck, Pasquotank, Perquimans and Tyrrell counties are contained within the basin, only nine percent of Hyde County is encompassed.

Table A-10 Past, Projected and Change in Population (1990, 2000, 2020) by County

County	% of County in Basin *	1990	2000	Estimated Population 2020	Estimated Pop Change 1990-2000	Estimated Pop Change 2000-2020
Camden	100	5,904	6,885	8,794	981	1,909
Chowan	33	13,506	14,526	16,026	1,020	1,500
Currituck	100	13,736	18,190	27,060	4,454	8,870
Dare	89	22,746	29,967	44,061	7,221	14,094
Gates	20	9,305	10,516	12,869	1,211	2,353
Hyde	9	5,411	5,826	6,310	415	484
Pasquotank	100	31,298	34,897	41,567	3,599	6,670
Perquimans	100	10,447	11,368	12,873	921	1,505
Tyrrell	100	3,856	4,149	4,534	293	385
Washington	68	13,997	13,723	12,823	-274	-900
Total		**130,206**	**150,047**	**186,917**	**19,841**	**36,870**

* Source: North Carolina Center for Geographic Information and Analysis

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

For more information on past, current and projected population estimates, contact the Office of State Planning at (919) 733-4131 or visit their website at http://www.ospl.state.nc.us/demog/.

2.6 Natural Resources

2.6.1 Public Lands in the Pasquotank River Basin

The Pasquotank River basin contains multiple diverse public lands including several National Wildlife Refuges, National Estuarine Research Reserves, state parks, preserves and a National Seashore. Figure A-8 shows public lands and significant natural heritage areas in the basin.

2.6.2 Ecological Significance of the Pasquotank River Basin

The Pasquotank River basin has a large number of significant natural areas and rare species, many with coastal affinities. For instance, six of the seven federally listed threatened and endangered aquatic species are predominantly marine species -- the American Alligator being the exception -- although the Shortnose Sturgeon is anadromous, spending some stages of its life in freshwater rivers. The Pasquotank River basin contains some extensive conservation lands, which correspond to a number of expansive natural features (swamps, marshes, pocosins, etc.). The Natural Heritage Program inventories areas for natural diversity and catalogs rare plant and animal species and natural communities.

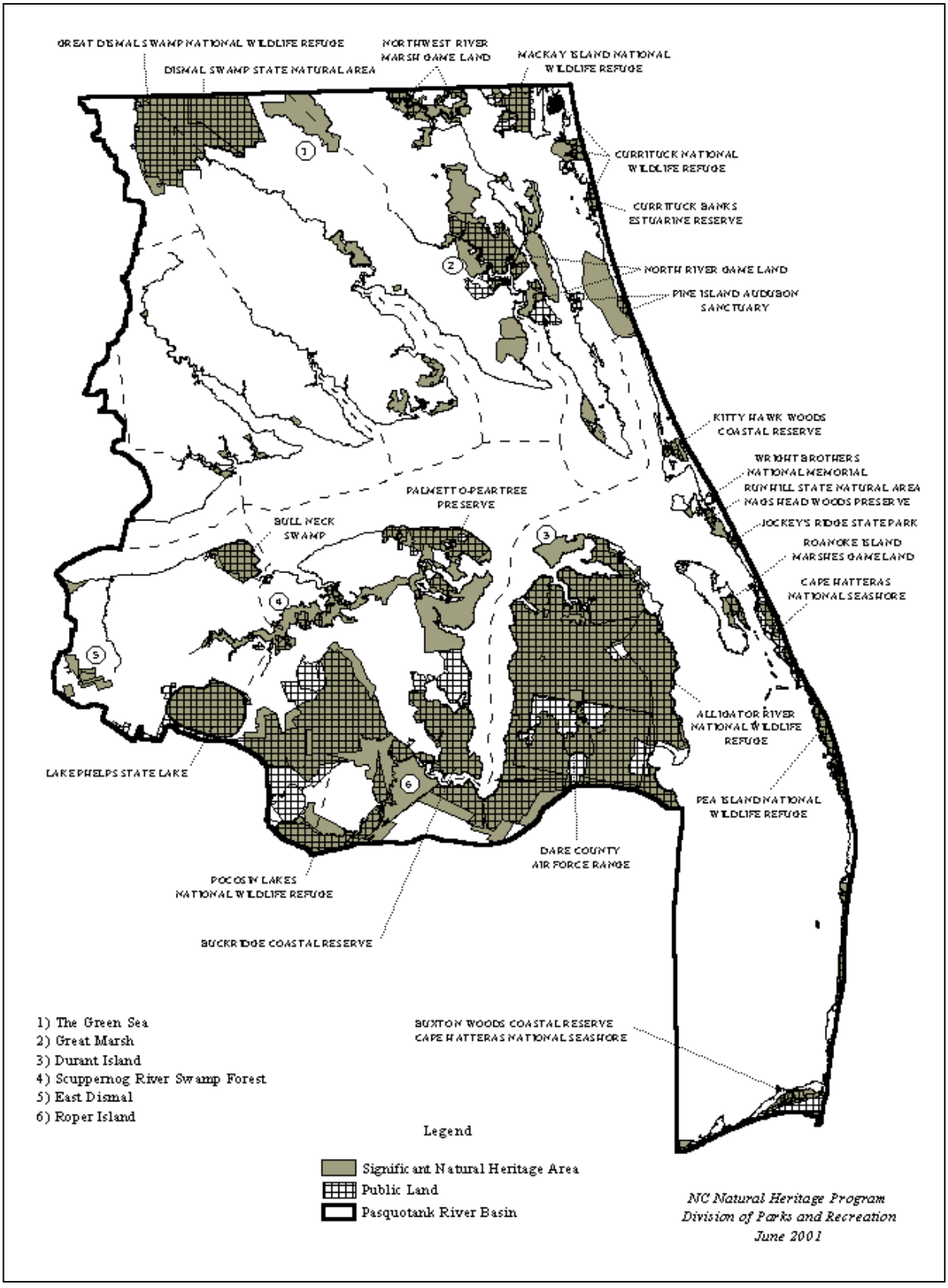


Figure A-8 Public Lands and Significant Natural Heritage Areas in the Pasquotank River Basin

Wetland Communities in the Pasquotank River Basin

The Pasquotank River basin constitutes a significant portion of the North Carolina Coastal Plain known as the Embayed Region. This name refers to the prominence of drowned river valleys that form the large sounds and many bays. The land in the Embayed Region is universally low and flat, and most is poorly drained. This region contains the largest acreage and proportion of wetlands in the state. The Pasquotank River basin has many types of wetland communities. Vast peatlands occupy the centers of peninsulas between the drowned rivers. On the fringes of the peatlands are flat mineral soil wetlands that are kept saturated primarily by rainfall and sheet flow. Additional large areas of organic and mineral soil swamps and marshes lie adjacent to the sounds and tidally influenced rivers.

Freshwater Tidal Wetlands

Freshwater tidal wetlands are an important component of the landscape in the Pasquotank River basin, especially along Currituck Sound and the North and Northwest Rivers. Along the Albemarle Sound, the land-water interface is characterized by Tidal Cypress-Gum Swamp communities.

Nonriverine Wetlands

Nonriverine wetland communities in the Pasquotank River basin include Nonriverine Swamp Forest, Nonriverine Wet Hardwood Forest, High Pocosin, Low Pocosin, Pond Pine Woodland, Peatland Atlantic White Cedar Forest and Bay Forest. Both the Dismal Swamp and the Dare County mainland contain extensive Nonriverine Swamp Forest and also support patches of Atlantic White Cedar, Pocosin and Pond Pine Woodland. The extent of the natural areas in both the Dismal Swamp and the Dare mainland allows for the natural 'shifting mosaic' pattern of these wet peatland communities. The Nonriverine Wet Hardwood Forest community, which is dominated by oaks, is not part of the 'shifting mosaic' pattern, being associated more with mineral soils than organic soils and peatlands. The high productivity of the Nonriverine Wet Hardwood wetland community soils when cleared for agriculture has led to a drastic decline in the acreage of this community type across the state.

Natural Lake Shoreline Wetlands

Natural Lake Shoreline is a wetland community type composed of the vegetated shoreline zone of large natural lakes. The vegetation may include herbs, shrub thickets, Cypress-Gum Swamps or various bottomland species. The Natural Lake Shoreline of Phelps Lake in Washington County is a high quality example of this wetland community type that is protected within Pettigrew State Park.

Nontidal Coastal Fringe Wetlands

Nontidal coastal fringe wetlands occur primarily on the outer banks. Wetland communities on the Outer Banks include Maritime Swamp Forest and Maritime Shrub Swamp, examples of which are protected at Nag's Head Woods; Maritime Wet Grassland, an example is found in the

Pine Island Audubon Sanctuary in Currituck County; and Interdune Pond, an example is found along the Cape Hatteras National Seashore.

2.6.3 Significant Natural Heritage Areas

The North Carolina Natural Heritage Program (NHP) compiles the list of Significant Natural Heritage Areas. The list is based on the program's inventory of natural diversity in the state. Natural areas are evaluated on the basis of the occurrences of rare plant and animal species, rare or high quality natural communities, and geologic features. The global and statewide rarity of these elements and the quality of their occurrence at a site relative to other occurrences determine a site's significance rating. The sites included on this list are the best representatives of the natural diversity of the state, and therefore, have priority for protection. Inclusion on the list does not imply that any protection or public access exists.

Figure A-8 shows the Significant Natural Heritage Areas (SNHA) in the Pasquotank River basin. Certain sites that contribute to the maintenance of water quality in the Pasquotank River basin are highlighted below.

Currituck Sound Significant Natural Heritage Areas

The Currituck Sound region includes the Northwest River, North Landing River and Currituck Banks. Many of the Significant Natural Heritage Areas in Currituck Sound are Tidal Freshwater Marsh and Nonriverine Swamp Forest/Nonriverine Wet Hardwood Forest communities surrounding the estuarine shoreline and drowned river mouths. Several of the sites in this region are extensive, such as Great Marsh (6,037 acres), Pine Island/Currituck Club Natural Area (11,709 acres), and Buckskin Creek/Great Swamp (5,044 acres). These high quality natural areas provide water quality benefits as well as outstanding wildlife habitat.

North River Significant Natural Heritage Areas

Significant Natural Heritage Areas in the North River are characterized by vast, high quality Tidal Freshwater Marshes and Cypress-Gum Swamps, as well as nonriverine wetland communities of Swamp Forest and Atlantic White Cedar. However, only a small fraction of the area is protected.

Great Dismal Swamp Significant Natural Heritage Areas

The combined acreage of the Dismal Swamp State Natural Area and the Great Dismal Swamp National Wildlife Refuge is over 41,000 acres. This vast area extends into Virginia and consists mostly of Nonriverine Swamp Forest, High Pocosin, Atlantic White Cedar and other associated nonriverine wetland communities. Together with the Green Sea, a 9,592-acre natural area to the east, the Great Dismal Swamp provides habitat for rare plant and animal species and is home to wildlife such as black bear that require large undeveloped areas for survival. Sizeable portions of the Dismal Swamp State Natural Area and the National Wildlife Refuge are Registered Natural Heritage Areas, yet drainage of adjacent lands has significantly affected the hydrology of these areas.

Albemarle Sound Significant Natural Heritage Areas

The Significant Natural Heritage Areas that border Albemarle Sound are areas of high quality Tidal Freshwater Marsh, Nonriverine Swamp Forest, Maritime Forests and important Nonriverine Wet Hardwood Forests. These areas, though scattered, serve important roles as natural vegetated buffers for Albemarle Sound, in addition to providing habitat for wildlife.

East Dismal Swamp Significant Natural Heritage Areas

East Dismal Swamp is a 3,868-acre remnant of a Nonriverine Swamp Forest that once stretched over 100,000 acres in Washington and Beaufort counties. Certain old-growth forest characteristics of the East Dismal Swamp make it an attractive stop over for neotropical migrant birds. When protected, the East Dismal Swamp will contribute to the overall ecosystem function of natural areas in the region.

Scuppernong River/Lake Phelps Significant Natural Heritage Areas

Emptying into Albemarle Sound, the Scuppernong River drains northern Washington and Tyrrell counties. The high quality communities bordering the river comprise over 14,000 acres and include Coastal Plain Small Stream Swamp (Blackwater Subtype), Cypress--Gum Swamp (Blackwater Subtype), Atlantic White Cedar and Nonriverine Swamp Forest. Lake Phelps, one of the Coastal Plain's few natural lakes, drains into the Scuppernong River via canals. Lake Phelps is noteworthy for its unique shoreline community.

Alligator River, Dare/Tyrrell/Northern Hyde Counties Significant Natural Heritage Areas

This large area is made up of extensive peatlands on either side of Alligator River. This region has the greatest extent of peatland communities in North Carolina, and probably in the whole eastern United States. Nonriverine communities -- Swamp Forests, Pocosins, Pond Pine Woodland, Atlantic White Cedar Forests -- dominate the landscape here, although they are quite rare outside the Pasquotank River basin. Some areas along the shores of the Albemarle Sound and the Alligator River support marshes and Tidal Cypress--Gum Swamps. Much of the land in this region is publicly owned. Protection of Roper Island, Buck Island Bay Forest and Alligator River/Swan Creek Swamp Forest in southern Tyrrell and northern Hyde counties could add significantly to the ecological integrity of the area by acting as a link between protected natural areas on either side of Alligator River.

Coastal Region Significant Natural Heritage Areas

The Coastal Region includes the barrier islands and peninsulas, along with their associated marshes. These narrow ridges of land are among the most dynamic environments in the state, subject to reworking by erosion and overwash by storms as well as the more regular effects of tides, surf, salt spray and wind. Significant Natural Heritage Areas in the coastal region of the Pasquotank River basin include communities of Maritime Grassland, Maritime Forest, Sand Flats and Salt Marshes. Protection exists for portions of several of these sites, such as Buxton Woods, Jockey's Ridge State Park, Pea Island National Wildlife Refuge, Nags Head Woods and

part of Kitty Hawk Woods. Because of the extreme rarity of these barrier island communities, protection should be a priority for the unprotected Significant Natural Heritage Areas.

2.6.4 Rare and Threatened Aquatic Species in the Pasquotank River Basin

The following information on rare aquatic and wetland-dwelling species (Table A-11) was obtained from the Division of Parks and Recreation, NC Natural Heritage Program.

Table A-11 Rare and Threatened Aquatic Species in the Pasquotank River Basin (as of June 2001)

Major Taxon	Common Name	Scientific Name	State Status	Federal Status
fish	Shortnose Sturgeon	*Acipenser brevirostrum*	E	E
reptile	American Alligator	*Alligator mississippiensis*	T	T(S/A)
reptile	Loggerhead	*Caretta caretta*	T	T
reptile	Green Turtle	*Chelonia mydas*	T	T
reptile	Hawksbill	*Eretmochelys imbricata*	E	E
fish	Lyre Goby	*Evorthodus lyricus*	SR	
fish	Waccamaw Killifish	*Fundulus waccamensis*	SC	FSC
reptile	Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	SC	FSC
mammal	Manatee	*Trichechus manatus*	E	E

Rare Species Listing Criteria

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

While there are other rare mammals in the Pasquotank River basin, the manatee is the only rare aquatic mammal. A migratory animal that typically lives in the warmer waters of Florida and other Gulf states, manatees occasionally inhabit North Carolina's inlets, estuaries and rivers from June to October. Manatees rest near the surface of the water, which makes them vulnerable to motor boats and propellers.

The shortnose sturgeon is a large, anadromous fish that once was common in North Carolina waterways. The shortnose sturgeon may live for up to 30 years and inhabits the lower sections of larger rivers and estuaries along the Atlantic coast. The fish moves from the ocean and estuaries into freshwater rivers to spawn between February and May. Juveniles may remain upriver for up to five years after birth before migrating to the ocean. The species has suffered from excessive harvesting and habitat degradation and is now in danger of extinction. Current distribution is not

well known, and the shortnose sturgeon has not been reported from the Pasquotank River basin for more than 20 years.

Several rare reptiles are found in the Pasquotank River basin. Three species of sea turtles have been identified in the basin: the Loggerhead Turtle, the Green Turtle and the Hawksbill Turtle. A fourth turtle, the Northern Diamondback Terrapin, is basically restricted to estuarine situations and lives in coastal marshes, tidal flats, coves, estuaries and lagoons behind barrier beaches. It is intolerant of long-term exposure to freshwater or 100 percent seawater. The American alligator lives in slow-moving coastal rivers, canals, lakes, marshes and estuaries. The American alligator has recovered from the low populations of the past century and is no longer biologically threatened or endangered under the Endangered Species Act. However, it retains the federally threatened status due to its similarity of appearance to other rare crocodilians, and commercial hunting and trade are regulated.

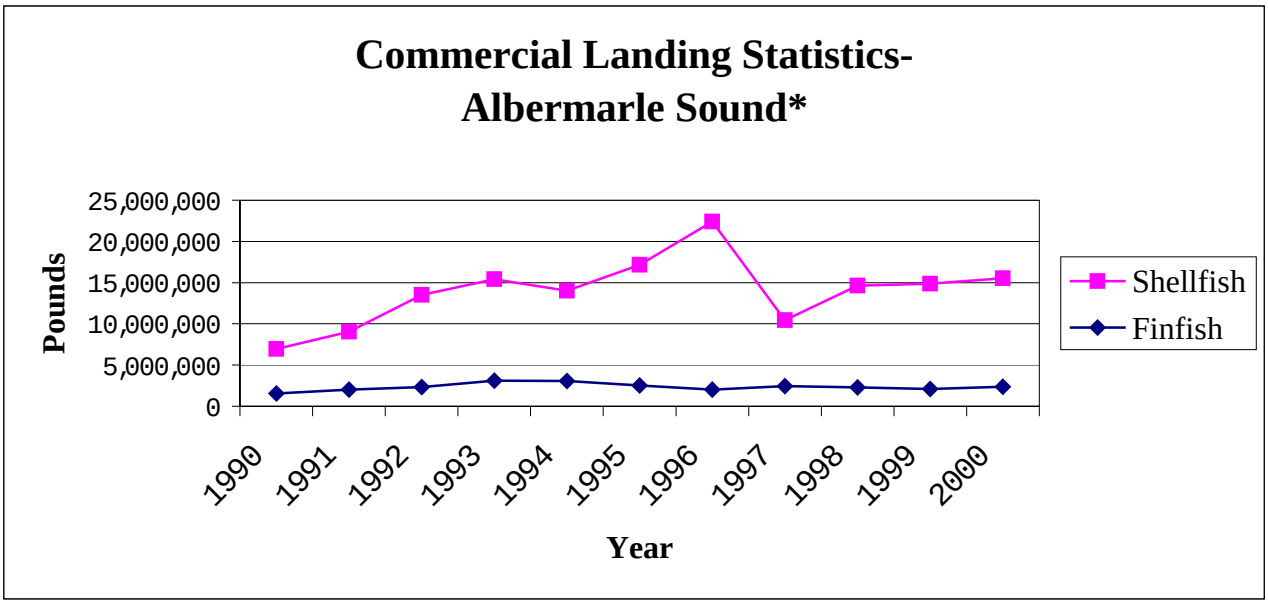
Two rare fishes currently occur in the Pasquotank River basin. The lyre goby, so named for the lyre-shaped marking on its caudal fin, is a small fish limited to coastal areas in North Carolina. It is found in the Cape Fear River estuary, tidepools at Wrightsville Beach, and Bogue and Pamlico Sounds. It prefers shallow, muddy tidepools dominated by smooth cordgrass. Human impacts to smooth cordgrass marshes place constant pressures on the natural habitat of the lyre goby. The second rare fish is the Waccamaw Killifish, endemic to North Carolina. The main population occurs in Lake Waccamaw in Columbus County, but a distinct population also occurs in Phelps Lake in Washington County.

For more information on the Division of Parks and Recreation's NC Natural Heritage Program, contact (919) 715-8702. Information is also available on-line at http://ils.unc.edu/parkproject/nhp/index.html.

2.6.5 Fisheries Resources

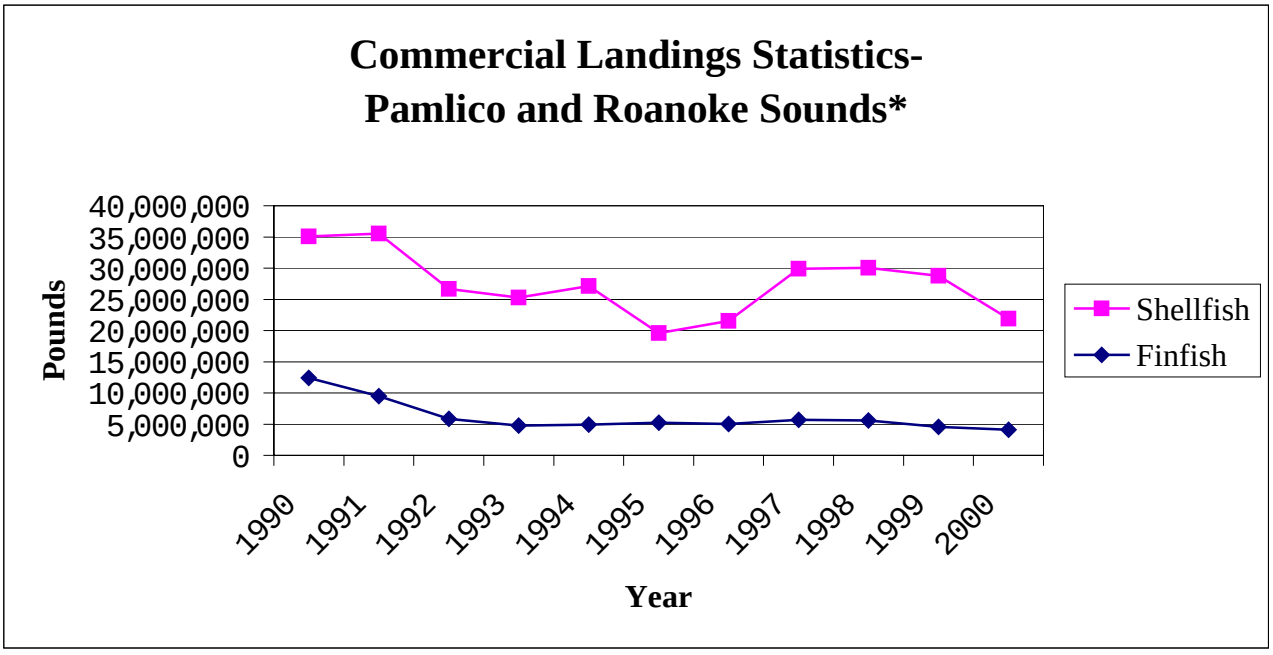
The waters of the Pasquotank River basin are an important habitat for several anadromous fish species. Anadromous species found in the area include blueback herring, alewife, hickory shad, American shad, Atlantic sturgeon and striped bass. Blueback herring and alewife are commonly referred to as 'river herring'.

In an effort to examine the status of the populations in the Pasquotank River basin, Figures A-9 and A-10 provide landing statistics (NCDENR-DMF, 2000). Commercial landings measure the number of pounds of fish caught. The value is an indicator of the direct income generated from the landings. The North Carolina Division of Marine Fisheries (DMF) also conducts stock status reports of important commercial fisheries in the state. River herring in Albemarle Sound is reported as overfished. This was evidenced by a reduced number of age classes in harvest, low juvenile production and a fewer number of repeat spawners. Atlantic sturgeon is listed as overfished as well due to low landings since 1960. The Albemarle-Roanoke Striped Bass community is listed as viable. American shad's status is unknown due to a lack of a current sampling program.



* A portion of the Albemarle Sound landing data may include landing statistics which coincide with DWQ's Roanoke or Chowan River basins. Includes blue crab.

Figure A-9 Commercial Landing Statistics - Albemarle Sound



* A portion of the Pamlico Sound landing data may include landing statistics which coincide with DWQ's Tar Pamlico or Neuse River basins. Includes blue crab.

Figure A-10 Commercial Landing Statistics - Pamlico and Roanoke Sounds

2.7 Permitted Wastewater and Stormwater Discharge Facilities

Discharges that enter surface waters through a pipe, ditch or other well-defined point 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 that serve populations greater than 100,000 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. The Environmental Protection Agency issues discharge permits under the NPDES program, which is delegated to DWQ.

The primary pollutants associated with point source discharges are:

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

2.7.1 Wastewater Discharges in the Pasquotank River Basin

Type of Wastewater Discharge

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

Minor Facilities: Any facilities not meeting the definition of Major.

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

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

Nonmunicipal: 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.

There are 34 permitted discharges in the Pasquotank River basin. Table A-12 provides summary information (numbers of facilities and permitted flows) regarding the discharges by types and subbasin. More detailed information regarding the dischargers characterized in the table is provided in Appendix I.

Figure A-11 shows the location of major and minor permitted wastewater discharges within the basin. The number of triangles on the map depicting major discharges does not correspond exactly to the number of major facilities listed in Table A-12, because some major facilities have more than one discharge location (outfall). Each outfall received its own triangle on Figure A-11.

Table A-12 Summary of NPDES Dischargers and Permitted Flows for the Pasquotank River Basin

	Subbasin							
Facility Categories	**03-01-50**	**03-01-51**	**03-01-52**	**03-01-53**	**03-01-54**	**03-01-55**	**03-01-56**	**TOTAL**
Total Facilities	7	6	5	7	2	6	1	34
Total Permitted Flow (MGD)	4.507	0.7	0.472	0.455	0.07	2.31	0.06	8.574
Major Discharges	1	1	0	0	0	0	0	2
Total Permitted Flow (MGD)	4.5	0.6	0.0	0.0	0.0	0.0	0.0	5.1
Minor Discharges	6	5	5	7	2	6	1	32
Total Permitted Flow (MGD)	0.007	0.1	0.472	0.455	0.07	2.31	0.06	3.474
100% Domestic Waste	1	1	1	4	0	1	1	9
Total Permitted Flow (MGD)	0.007	0.6	0.4	0.455	0.0	0.06	0.06	1.582
Municipal Facilities	1	1	1	3	0	1	0	7
Total Permitted Flow (MGD)	4.5	0.6	0.4	0.449	0.0	0.06	0.0	6.009
Nonmunicipal Facilities	6	5	4	4	2	5	1	27
Total Permitted Flow (MGD)	0.007	0.1	0.072	0.006	0.07	2.25	0.06	2.565

2.7.2 Stormwater Discharges in the Pasquotank River Basin

Amendments were made to the Clean Water Act in 1990 and, most recently in 1999, pertaining to permit requirements for stormwater discharges associated with industrial activities and storm sewer systems. DWQ administers these regulations in North Carolina through the state stormwater program. The goal of the DWQ stormwater discharge permitting regulations is to prevent pollution via stormwater runoff by controlling the source(s) of pollutants.

The municipal permitting requirements are designed to lead into the formation of comprehensive stormwater management programs for municipal areas. Elizabeth City is the only local government in the Pasquotank River basin large enough to require a stormwater discharge permit under Phase II requirements. North Carolina is developing further guidelines that may result in additional municipalities designated as Phase II areas.

EPA Stormwater Rules

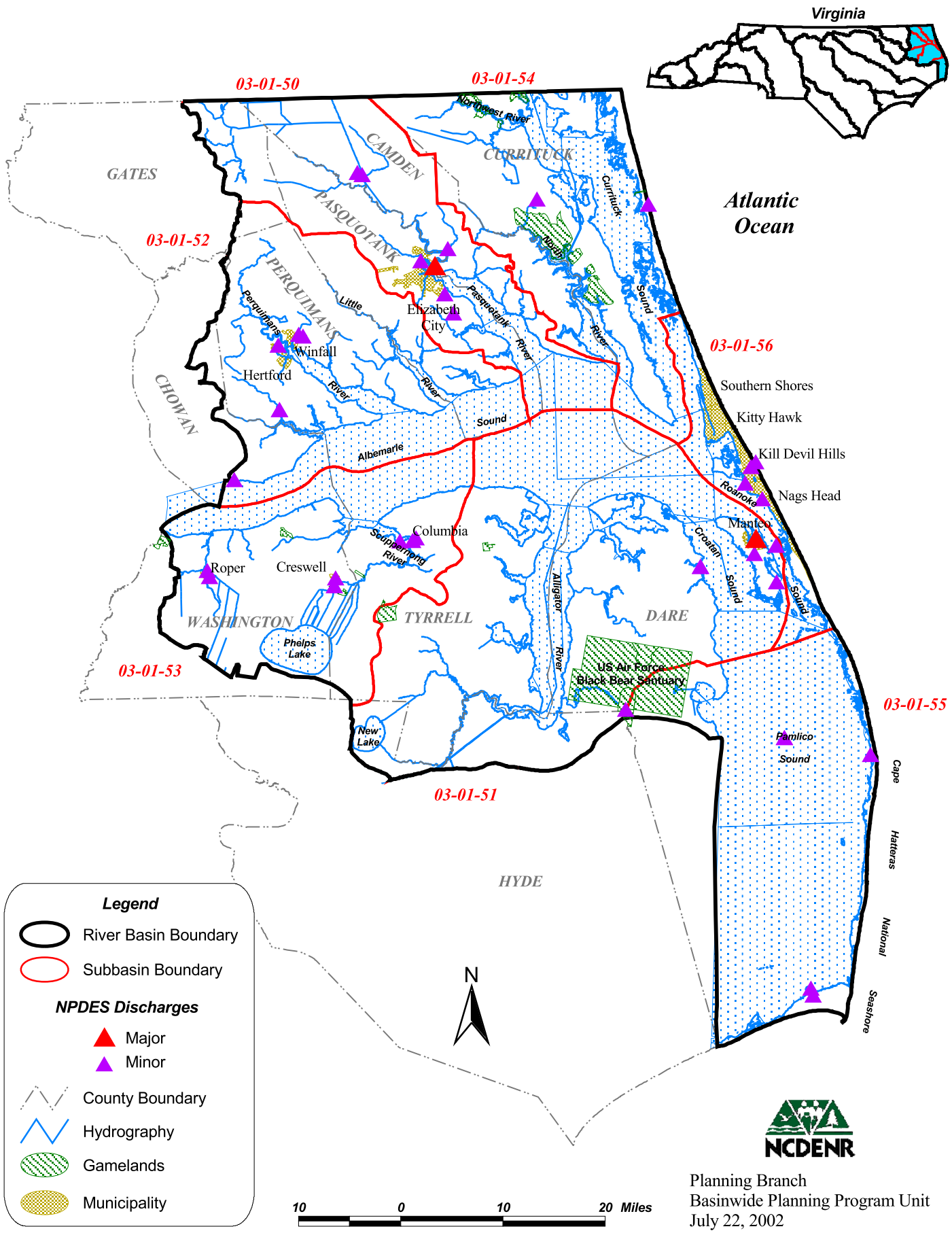
Phase I – December 1990

- Requires a NPDES permit for municipal separate storm sewer systems (MS4s) serving populations of 100,000 or more.
- Requires a NPDES stormwater permit for ten categories of industry.
- Requires a NPDES stormwater permit for construction sites that are 5 acres or more.

Phase II – November 1999

- Requires a NPDES permit for some municipal storm sewer systems serving populations under 100,000, located in urbanized areas.
- Provides a "no stormwater exposure" exemption to industrial facilities covered under Phase I.
- Requires a NPDES stormwater permit for construction sites that are 1-5 acres.

Figure A-11 NPDES Discharges in the Pasquotank River Basin



Industrial activities that require permitting are defined in categories ranging from sawmills and landfills to manufacturing plants and hazardous waste treatment, storage or disposal facilities. Stormwater permits are granted in the form of general permits (which cover a wide variety of more common activities) or individual permits. Excluding construction stormwater general permits, there are 51 general stormwater permits active within the basin. Two individual stormwater permits are currently held: South Atlantic Wood Preserving and Universal Forest Products Eastern Division, Inc.

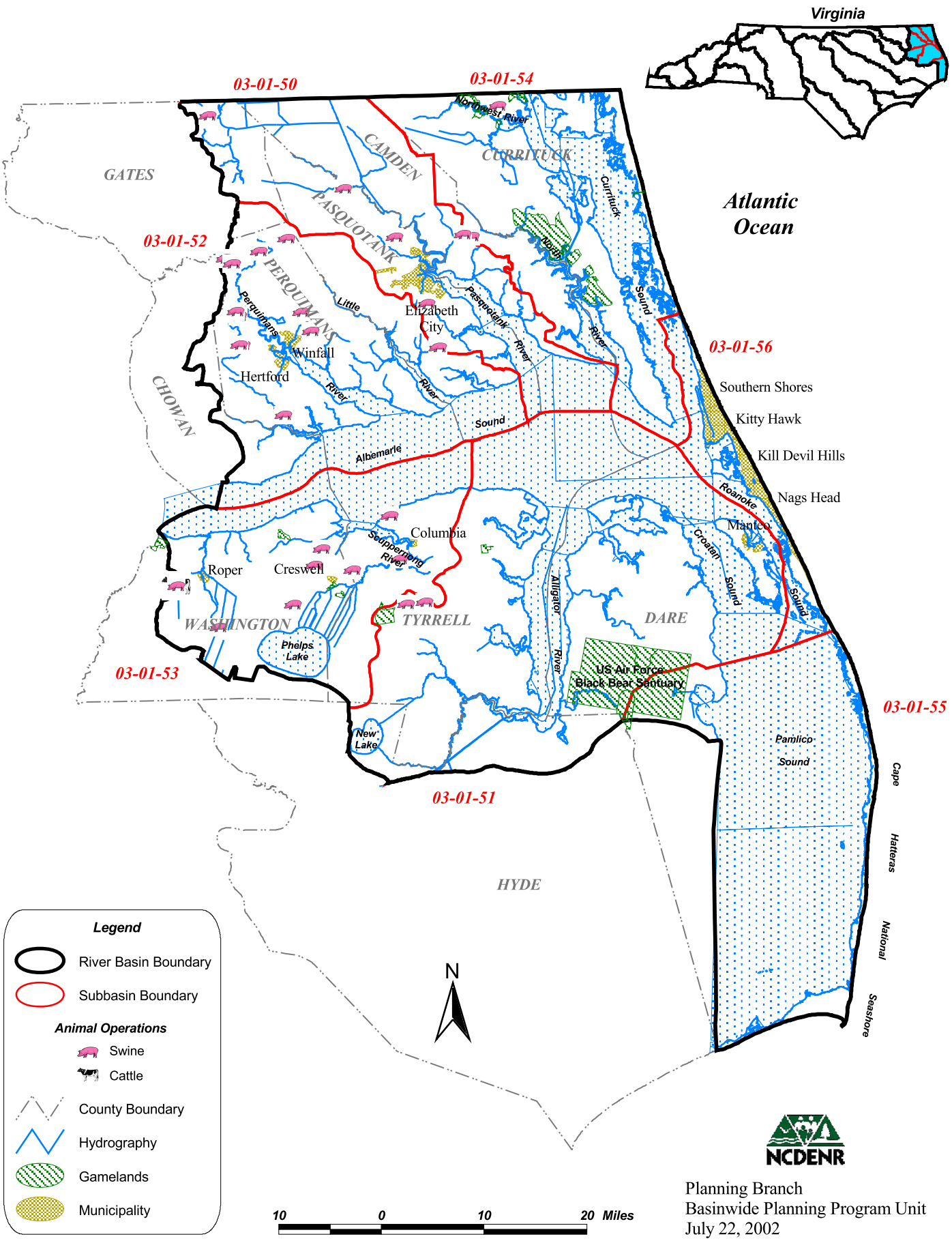
The primary concern with runoff from industrial facilities is the contamination of stormwater from contact with exposed materials. Poor housekeeping can lead to significant contributions of sediment and other water quality pollutants. To address these issues, each NPDES stormwater permitted facility must develop a Stormwater Pollution Prevention Plan (SPPP) that addresses the facility's potential impacts on water quality. Facilities identified as having significant potential to impact water quality are also required to conduct analytical monitoring to characterize pollutants in stormwater discharges under individual NPDES stormwater permits.

The state stormwater management rules (15A NCAC 2H .1000) regulate development activities in 20 coastal counties and on land statewide that drains to Outstanding Resource Waters (ORW) and/or High Quality Waters (HQW). Under this program, development is permitted as either low density or high density. Low density limits the impervious, or built upon, area and allows natural infiltration and attenuation of stormwater runoff. High density requires installation and maintenance of a structural best management practice to control and treat stormwater runoff from the site. Surface waters in the Pasquotank River basin classified as ORW or HQW are presented in Section A, Part 3.2 on Figure A-13.

2.8 Animal Operations

In 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H.0217) establishing procedures for managing and reusing animal wastes from intensive livestock operations. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve animal populations of at least the following size: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds (chickens and turkeys) with a liquid waste system. Figure A-12 displays locations of animal operations in the Pasquotank River basin. Within the past five years there have been several additional pieces of legislation enacted that affect animal operations in North Carolina and the Pasquotank River basin.

Figure A-12 Registered Animal Operations in the Pasquotank River Basin



Key Animal Operation Legislation (1995-2000)

1995 – Senate Bill 974 requires owners of swine facilities with 250 or more animals to hire a certified operator. Operators are required to attend a six-hour training course and pass an examination for certification. Senate Bill 1080 established buffer requirements for swine houses, lagoons and land application areas for farms sited after October 1, 1995.

1996 – Senate Bill 1217 required all facilities (above threshold populations) to obtain coverage under a general permit, beginning in January 1997, for all new and expanding facilities. DWQ was directed to conduct annual inspections of all animal waste management facilities. Poultry facilities with 30,000+ birds and a liquid waste management system were required to hire a certified operator by January 1997 and facilities with dry litter animal waste management systems were required to develop an animal waste management plan by January 1998. The plan must address three specific items: 1) periodic testing of soils where waste is applied; 2) development of waste utilization plans; and 3) completion and maintenance of records on-site for three years. Additionally, anyone wishing to construct a new, or expand an existing, swine farm must notify all adjoining property owners.

1997 – House Bill 515 placed a moratorium on new or existing swine farm operations and allows counties to adopt zoning ordinances for swine farms with a design capacity of 600,000 pounds (SSLW) or more. In addition, owners of potential new and expanding operations are required to notify the county (manager or chair of commission) and local health department, as well as adjoining landowners. NCDENR was required to develop and adopt economically feasible odor control standards by March 1, 1999.

1998 – House Bill 1480 extended the moratorium on construction or expansion of swine farms. The bill also requires owners of swine operations to register with DWQ any contractual relationship with an integrator.

1999 – House Bill 1160 extended (again) the moratorium on new construction or expansion of swine farms, required NCDENR to develop an inventory of inactive lagoons, and requires owners/operators of an animal waste treatment system to notify the public in the event of a discharge to surface waters of the state of 1,000 gallons or more of untreated wastewater.

2000 Attorney General Easley reached a landmark agreement with Smithfield Foods, Inc. to phase out hog lagoons and implement new technologies that will substantially reduce pollutants from hog farms. The agreement commits Smithfield to phase out all anaerobic lagoon systems on 276 company-owned farms. Legislation will be required to phase out the remaining systems statewide within a 5-year period (State of Environment Report, 2000).

Table A-13 summarizes, by subbasin, the number of registered livestock operations, total number of animals, total acres in operation and total steady state live weight as of March 2001. These numbers reflect only operations required by law to be registered, and therefore, do not represent the total number of animals in each subbasin.

Since 1997, many facilities have become inactive, though inactive facilities may continue to be certified and registered with the state. Some likely causes for the inactivity may include financial difficulties, the state moratorium, or a request by the facility for state buyout to close the lagoons. Therefore, Table A-13 may overestimate the number of registered animal operations that still actively raise livestock in the basin.

Table A-13 Registered Animal Operations in the Pasquotank River Basin (as of March 16, 2001)

Subbasin	Cattle			Poultry			Swine		
	No. of Facilities	No. of Animals	Total Steady State Live Weight	No. of Facilities	No. of Animals	Total Steady State Live Weight	No. of Facilities	No. of Animals	Total Steady State Live Weight
03-01-50	0	0	0	0	0	0	4	5,455	634,940
03-01-51	0	0	0	0	0	0	2	25,350	3,583,050
03-01-52	0	0	0	0	0	0	11	14,803	1,779,191
03-01-53	1	120	96,000	0	0	0	8	15,241	2,196,085
03-01-54	0	0	0	0	0	0	3	23,978	3,463,611
03-01-55	0	0	0	0	0	0	0	0	0
03-01-56	0	0	0	0	0	0	0	0	0
Totals	1	120	96,000	0	0	0	28	84,827	11,656,877

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

The NC Department of Agriculture provided information on animal capacity by subbasin (Table A-14). A negligible percentage of the state's total capacity for swine, dairy and poultry is found in the Pasquotank River basin. Overall, the poultry and swine capacity increased from 1994 to 1998; whereas, the dairy capacity decreased over the same time period.

Table A-14 Estimated Populations of Swine, Dairy and Poultry (1994 and 1998) in the Pasquotank River Basin

Subbasin	Total Swine Capacity		Swine Change	Total Dairy Capacity		Dairy Change	Poultry Capacity		Poultry Change
	1998	1994	94-98 (%)	1998	1994	94-98 (%)	1998	1994	94-98 (%)
03-01-50	15,864	13,889	14	0	0	0	746,500	694,000	8
03-01-51	12,902	1,157	1015	0	1	-100	3,406,420	0	34,064
03-01-52	20,672	28,660	-28	0	0	0	1,375,000	1,610,000	15
03-01-53	86,810	49,313	76	0	0	0	943,100	817,400	15
03-01-54	21,580	14,445	49	0	0	0	175	50	250
03-01-55	13	13	0	0	0	0	0	0	0
03-01-56	0	0	0	0	0	0	0	0	0
TOTALS	157,841	107,477	47	0	1	-100	6,471,195	3,121,450	107
% of State Total	<1	2	---	0	<1	---	3	2	---

2.9 Water Use

2.9.1 Local Water Supply Planning

The North Carolina General Assembly has mandated a local and state water supply planning process under North Carolina General Statute 143-355(l) and (m) to assure that communities have an adequate supply of 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. LWSPs were submitted by 20 public water systems to the Division of Water Resources.

There are six countywide systems and one regional water supply system in the area. Total water use in the basin in 1997 was 18.4 MGD consisting of 35 percent residential use, 11 percent non-residential, and 20 percent unaccounted for use (NCDENR-DWR, 2001). By the year 2020, the area expects to see a 59 percent increase in water demand over the 1997 levels. In addition, 10 out of the 20 systems submitting LWSPs in 1997 indicated that their peak demands would exceed their water treatment capacity by 2010 (NCDENR-DWR, 2001). An additional 6.6 MGD of water is necessary to ensure that the projected 2010 demands do not exceed 80 percent of the available water in the area. In addition to treatment concerns, water quantity concerns are paramount in the region. Nine out of the 20 LWSP systems indicated that their average daily use currently exceeds 80 percent of their available supply, and nine systems predict that demand levels will exceed 80 percent of their available supply by 2020.

Based on 1995 USGS estimates, nonmunicipal users account for 272 MGD in the following areas: irrigation (57 percent), livestock (20 percent), domestic (20 percent), industrial (2 percent) and commercial (1 percent) uses rely on self-supplied water (NCDENR-DWR, 2001). DWR recommended that those systems with "Demand as Percent of Supply" above 80 percent to actively manage demand and pursue additional supplies (NCDENR-DWR, 2001).

More information is available for these and other systems across the state that submitted a LWSP from the Division of Water Resources Website at www.dwr.ehnr.state.nc.us/home.htm.

Table A-15 Water Use and Population for Water Systems in the Pasquotank River Basin

Population and Water Use for Water Systems in the Albemarle Sound Basin							
		Year-Round Service Population		Average Daily Demand (MGD)		Demand as % of Supply	
County	**System**	**1997**	**2010**	**1997**	**2010**	**1997**	**2010**
Camden	South Camden WSD	1585	2760	0.154	0.437	103	291
	South Mills	4520	5573	0.255	0.515	62	88
Currituck	Currituck County (mainland)	8791	11001	0.597	0.689	70	76
Dare	Cape Hatteras	7037	11020	1.172	1.837	184	90
	Dare County RWS	7764	10538	11.971	14.456	77	90
	Dare County RWS-RO Plant	2085	2830	0.185	0.259	29	40
	Kill Devil Hills	5136	7265	1.565	2.214	52	74
	Manteo	1200	1700	0.192	0.306	27	44
	Nags Head	2113	2995	2.692	3.272	77	93
	Stumpy Point WSD	0	412	0	0.038	0	21
Hyde	Ocracoke SD	720	740	0.438	0.539	61	67
Pasquotank	Elizabeth City	16921	19172	4.71	5.14	298	144
	Pasquotank county	14229	18876	1.85	2.25	92	93
Perquimans	Perquimans County	6469	7000	0.596	0.68	86	98
	Hertford	2333	2434	0.231	0.478	92	91
	Winfall	520	560	0.051	0.063	86	107
Tyrrell	Columbia	980	1020	0.124	0.127	35	36
	Tyrrell County	2517	3150	0.214	0.267	55	69
Washington	Creswell	500	500	0.161	0.069	107	46
	Roper	643	703	0.247	0.256	86	89

2.9.2 Capacity Use Areas

When the long-term sustainability of groundwater resources is threatened or when an area requires coordination to protect the public interest, the EMC can designate an area as a Capacity Use Area (CUA) (NCDENR-DWR, 2001). In 1976, the state exercised its authority by designating CUA #1 to extend radially from Beaufort County north to the Albemarle Sound. The CUA #1 affects portions of the Pasquotank River basin, specifically parts of Washington, Hyde and Tyrrell counties. In the operation of a phosphate mining facility near Aurora, a cone of depression began to form in the Castle Hayne aquifer, affecting groundwater levels several counties away. Since the 1976 designation of the CUA, water use appears to be at sustainable levels (NCDENR-DWR, 2001). Water use by many existing and new permittees has increased; however, the high recharge to the aquifer with decreased pumping at the phosphate mine has lessened the overall water use impacts. DWR has begun a monitoring well network and to develop a model to assess cumulative impacts of multiple water withdrawals within CUA #1.

In 1998, DWR data indicated that declines in the Black Creek and upper Cape Fear aquifers of the Central Coastal Plain increased faster than predicted, resulting in a demand that has exceeded the safe yield of these aquifers (WRRI, 2001). Given the situation, DWR was concerned that the dewatering could result in serious impairment to the aquifer and ultimately to groundwater quality. In response, DWR developed a three-part program to address the issue: 1) expanding and rehabilitating groundwater level monitoring; 2) assisting local governments to develop sustainable water supply plans; and 3) establishing a Central Coastal Plain Capacity Use Area (CCPCUA) to coordinate the usage of water in the most critical areas. The CCPCUA involves 15 counties, including Washington, that fall within the Pasquotank River basin. DWR presented draft rules in 1999, hosted a collaborative stakeholder process in 2000, and is working toward finalizing the rules in 2002.

2.9.3 Water Withdrawals and Interbasin Transfers

Prior to 1999, North Carolina General Statute 143-215.22H only required water users to register their water withdrawals and transfers with DWR if the amount was one million gallons or more of surface water or groundwater per day. Beginning in 1999, withdrawals and transfers greater than 100,000 gallons per day must be registered with DWR. In addition, transfers of 2 MGD or more require a certification from the Environmental Management Commission, according to G.S. 143-215.22I. The river basin boundaries that apply to these requirements are designated on a map entitled *Major River Basins and Sub-Basins in North Carolina* and filed in the Office of the Secretary of State.

Six of the registered agricultural water users irrigate, with the largest irrigation requiring an average of 49 MGD in 1997 (Table A-16). Seven of the total nine agricultural users are permitted through the CUA #1 program. In the nonagricultural sector, there is one industrial user and five private water supply systems with registered withdrawals.

Table A-16 Registered Water Withdrawls for 1999 in the North Carolina Portion of the Pasquotank River Basin

Purpose of Withdrawal	Number of Facilities	Withdrawl Amount (MGD)	Percentage of Total Withdrawal
Agricultural	9	57.6	98.9
Nonagricultural	6	0.62	1.1
Total	15	58.2	----

Though interbasin transfers occur in the state, no surface water transfers affect this basin (NCDENR-DWR, 2001). All local water systems are required to report existing and anticipated interbasin transfers as part of the local water supply planning process. This information will be available for future updates of this basinwide water quality plan and will allow for cumulative impact assessments.

Chapter 3 -
Summary of Water Quality Information for the Pasquotank River Basin

3.1 General Sources of Pollution

Human activities can negatively impact surface water quality, even when the activity is far removed from the waterbody. With proper management of wastes and land use activities, these impacts can be minimized. 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

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

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

Unlike point sources of 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. While nonpoint source pollution control often relies on voluntary actions, the state has many programs designed to reduce nonpoint source pollution.

Every person living in or visiting a watershed contributes to impacts on water quality. Therefore, each individual should be aware of these contributions and take actions to reduce them.

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.

3.2 Description of Surface Water Classifications and Standards

3.2.1 Program Overview

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, and the protection of unique and special pristine waters with outstanding resource values.

3.2.2 Surface Water Classifications

All surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water (Table A-17). 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. For example, a stream might have a C Sw classification, where C is the primary classification followed by the Sw (Swamp) supplemental classification. A full description of the state's primary and supplemental classifications is available in the document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina*. Information on this subject is also available at DWQ's website at http://h2o.enr.state.nc.us/wqhome.html.

Table A-17 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 uses.
SA	Waters classified for commercial shellfish harvesting.
WS	*Water Supply watershed*. There are five WS classes ranging from WS-I through WS-V. WS classifications are assigned to watersheds based on land use characteristics of the area. Each water supply classification has a set of management strategies to protect the surface water supply. WS-I provides the highest level of protection and WS-IV provides the least protection. A Critical Area (CA) designation is also listed for watershed areas within a half-mile and draining to the water supply intake or reservoir where an intake is located.
SUPPLEMENTAL CLASSIFICATIONS	
Class	**Best Uses**
Sw	*Swamp Waters*: Recognizes waters that will naturally be more acidic (have lower pH values) and have 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 possessing special qualities including excellent water quality, Native or Special Native Trout Waters, Critical Habitat areas, or WS-I and WS-II water supplies.
ORW	*Outstanding Resource Waters*: Unique and special surface waters that are unimpacted by pollution and have some outstanding resource values.
NSW	*Nutrient Sensitive Waters*: Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.

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

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 a 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 standards for C waters establish the basic protection level for all state surface waters. With the exception of swamp waters, all of the other primary and supplemental classifications have more stringent standards than for C, 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. These waters may be designated as HQW or ORW.

High Quality Waters

Special HQW protection management strategies are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new wastewater discharge facilities and facilities which expand beyond their currently permitted loadings must address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume and toxic substances.

Criteria for HQW Classification

- Waters rated as Excellent based on DWQ's chemical and biological sampling.
- Streams designated as native and special native trout waters or primary nursery areas by the Wildlife Resources Commission (WRC).
- Waters designated as primary nursery areas by the Division of Marine Fisheries.
- Critical habitat areas designated by the Wildlife Resources Commission or the Department of Agriculture.
- Waters classified by DWQ as WS-I, WS-II and SA are HQW by definition, but these waters are not specifically assigned the HQW classification because the standards for WS-I, WS-II and SA waters are at least as stringent as those for waters classified HQW.

For nonpoint source pollution, development activities which require a Sedimentation and Erosion Control Plan in accordance with rules established by the NC Sedimentation Control Commission or approved local erosion and sedimentation control program, and which drain to and are within one mile of HQWs, are required to control runoff from the development using either a low density or high density option. Section A, Part 2.7.2 describes these stormwater controls in more detail. In addition, the Division of Land Resources requires more stringent sedimentation controls for land-disturbing projects within one mile and draining to HQWs.

Outstanding Resource Waters

A small percentage of North Carolina's surface waters have excellent water quality (rated based on biological and chemical sampling as with HQWs) and an associated outstanding resource designation. The requirements for ORW waters are more stringent than those for HQWs.

The ORW rule defines outstanding resource values as including one or more of the following:

- 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;
- being within a state or national park or forest; or
- having special ecological or scientific significance.

Special protection measures that apply to North Carolina ORWs are set forth in 15A NCAC 2B .0225. At a minimum, no new discharges or expansions are permitted, and stormwater controls for most new developments are required. In some cases, the unique characteristics of the waters and resources that are to be protected require that a customized ORW management strategy be developed. Many streams in the Pasquotank River basin fall under such a management strategy that is discussed in greater detail below.

Water Supply Watersheds

The purpose of the Water Supply Watershed Protection Program is to provide an opportunity for communities to work with the state to strengthen protection of their water supplies. There are five water supply classifications (WS-I to WS-V) that are defined according to the amount and types of permitted point source discharges, as well as requirements to control nonpoint sources of pollution (Table A-17). Watersheds draining to waters classified WS carry some restrictions on point source discharges and on many land use activities including urban development, agriculture, forestry and highway sediment control. Minimum requirements for WS-I to WS-IV include a 30-foot undisturbed vegetated buffer. The WS-I and WS-II classifications are HQW by definition because requirements for these levels of water supply protection are at least as stringent as for HQWs.

Class SA Waters

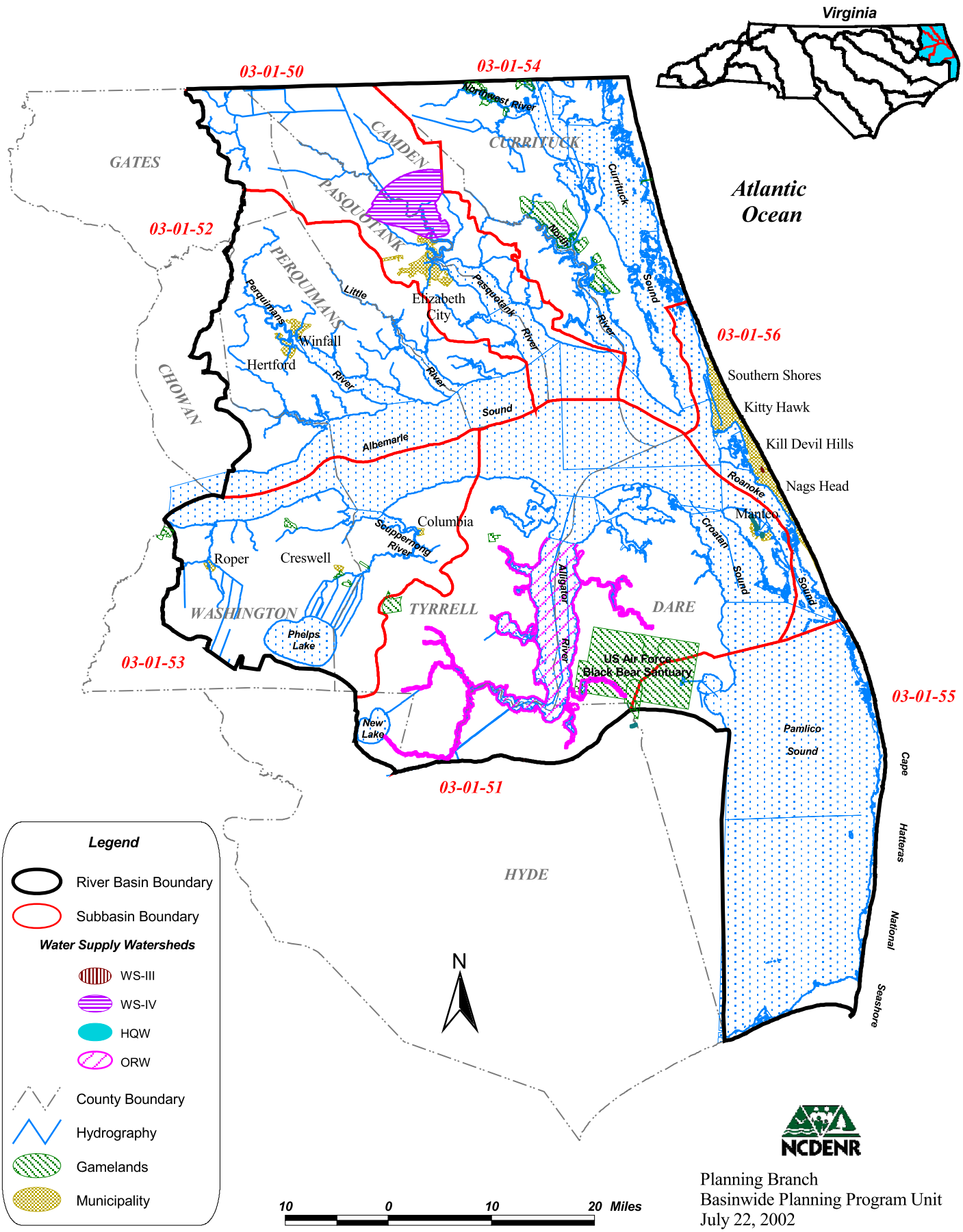
The best uses of Class SA waters are for shellfishing for market purposes and any other usage specified by the "SB" or "SC" classification. Fecal coliform bacteria in Class SA waters shall meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services. Domestic wastewater dishcharges are not allowed, and there are provisions for stormwater controls. Refer to 15A NCAC 2B .0221 for specifics on water quality standards in Class SA waters.

3.2.3 Classifications and Standards in the Pasquotank River Basin

Waters of the Pasquotank River basin have a variety of surface water quality classifications applied to them including each of the primary classifications possible and all but two of the secondary classifications (NSW and Tr). Water supply watersheds (WS-I and WS- II) and SA waters are also, by definition, HQWs. For a view of the variety of water supply watersheds, Outstanding Resource Waters and High Quality Waters, see Figure A-13.

The majority of the waters in the Pasquotank River basin were classified in the 1960s and 1970s. Some waters have undergone reclassification based on new information or public comment. Some of the recent reclassifications since the last basin plan include the following:

Figure A-13 Water Supply Watersheds, High Quality Waters and Outstanding Resource Waters in the Pasquotank River Basin



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Basinwide Planning Program Unit
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- August 2000, Phelps Lake (B Sw ORW) was reclassified as an Outstanding Resource Water.
- August 1998, a portion of Turners Cut from a point 1.2 miles upstream of its mouth to Pasquotank River was designated as WS-IV Sw. The Pasquotank River from a point 1.7 miles upstream of its mouth to Turners Cut to a point 0.6 mile upstream of the Pasquotank County SR 1368 extension was reclassified in 1998 to WS-IV Sw. In addition, Turners Cut from the Dismal Swamp Canal to a point 1.2 miles upstream of the mouth was reclassified to C Sw.
- August 1998, Joyce Creek was reclassified from its source to the Dismal Swamp Canal as C Sw.
- August 1998, the Dismal Swamp Canal from the northern state border to the Pasquotank River was reclassified to C Sw.

Pending Reclassifications in the Pasquotank River Basin

Table A-18 Pending Reclassifications in the Pasquotank River Basin

Waterbody	County	Current Classification	Proposed Classification
Broad Creek	Camden	SC	SC HQW
Deep Creek	Currituck	SC	SC HQW
East Lake	Dare	SC Sw	SC Sw HQW
Jean Guite Creek	Dare	SC Sw	SC Sw HQW
Little Alligator River	Tyrrell	SC Sw	SC Sw HQW
Lutz Creek	Currituck	SC	SC HQW
Tull Creek and Bay	Currituck	B Sw, C Sw	B Sw HQW, C Sw HQW

The areas above were designated as inland primary nursery areas (PNAs) by the NC Wildlife Resources Commission (Table A-18). Coastal primary nursery areas are automatically eligible for HQW status; however, the rule does not currently apply to inland PNAs. Each water would have to go through the reclassification process individually.

In October 2000, DWQ conducted a special study on Kendrick Creek in Washington County. Their study noted that even though Kendrick Creek is classified as SC to the US 64 bridge, analysis of monitoring data would place the SC line much closer to the Albemarle Sound.

Shallowbag Bag, currently rated SC, contains Manteo's Wastewater Treatment Plant discharge as well as swimming areas. The area is also surrounded by SA waters in nearby Roanoke Sound. The Division of Environmental Health also collects swimming area sampling data for four sites in the Currituck Sound, all of which are situated in Class SB waters. SC waters are not designated specifically for primary recreation such as swimming; therefore, the waters should undergo reclassification to SB waters.

2002 Recommendations

DWQ will pursue reclassification of the NC Wildlife Resource Commission's inland PNAs, Kendrick Creek and Shallowbag Bay during this five-year basin cycle. DWQ will communicate with the Environmental Management Commission regarding the status of the reclassification during its multiyear process.

Classification and standards for the entire basin can be found in a separate document entitled *Classifications and Water Quality Standards Assigned to the Waters of the Pasquotank River Basin*. This document may be obtained by calling the Planning Branch of DWQ at (919) 733-5083 or accessed through the DWQ Water Quality Section website at http://h2o.enr.state.nc.us/wqhome.html.

3.3 DWQ Water Quality Monitoring Programs in the Pasquotank River Basin

The Environmental Sciences Branch of DWQ collects 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 Pasquotank River basin for that program. A more complete discussion of DWQ monitoring within the basin can be found in the *Pasquotank River Basinwide Assessment Report* (NCDENR-DWQ, 2001). For further information on DWQ's biological sampling methods, refer to Appendix III.

DWQ monitoring programs for the Pasquotank River basin include:

- Benthic Macroinvertebrates (Section 3.3.1)
- Fish Assessments (Section 3.3.2)
- Aquatic Toxicity Monitoring (Section 3.3.3)
- Lake Assessment (Section 3.3.4)
- Ambient Monitoring System (Section 3.3.5)

3.3.1 Benthic Macroinvertebrates

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily 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 more than one year, the effects of short-term pollution (such as a spill) will generally not be overcome until the following generation appears, even though a toxic substance may be carried away fairly quickly. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign a bioclassification rating to each benthic sample based on the number of different species present in the pollution intolerant groups of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies); commonly referred to as EPTs. Unique criteria have been developed for each of three ecoregions (mountains, piedmont and coastal plain) within North Carolina. These ratings fall into five categories ranging from Poor to Excellent.

Overview of Benthic Macroinvertebrate Data

Appendix II lists all the benthic macroinvertebrate collections in the Pasquotank River basin between 1983 and 2000, giving site location, collection date, taxa richness, biotic index values and bioclassifications. Benthic macroinvertebrates have been collected at 46 sites in the Pasquotank River basin since 1983. For the 2000 collections, no sites were given bioclassifications (see Section A, Chapter 4 for further details). Table A-19 lists the most recent

ratings since 1983 (by subbasin) for all benthic macroinvertebrate sites in the Pasquotank River basin.

Table A-19 Summary of Bioclassifications for All Freshwater Benthic Macroinvertebrate Sites (using the most recent sample for each site) in the Pasquotank River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
03-01-50	0	0	0	0	0	5	5
03-01-51	0	0	0	0	0	10	10
03-01-52	0	0	0	0	0	6	6
03-01-53	0	0	0	0	0	6	6
03-01-54	0	0	0	0	0	0	0
03-01-55	0	0	0	0	0	0	0
03-01-56	0	0	0	0	0	0	0
Total (#)	**0**	**0**	**0**	**0**	**0**	**27**	**27**
Total (%)	**0%**	**0%**	**0%**	**0%**	**0%**	**100%**	**----**

3.3.2 Fish Assessments

Overview of Fish Assessment

During 2000, DWQ did not sample any fish community sites. Typically, DWQ uses the North Carolina Index of Biotic Integrity (NCIBI) as a tool for fish assessments. Since 1995, DWQ has not conducted any fish tissue surveys in the Pasquotank River basin. However, there are currently fish consumption advisories in the Pasquotank River basin. Refer to page 68 for more information on fish consumption advisories.

Significant mercury contamination was identified in areas such as Lake Phelps where over 50 percent of the fish sampled prior to 1996 contained levels above human health standards. Lake Phelps is unique because it possesses a minimal drainage area, receives most of its hydrologic input from the atmosphere, and represents a minimally impacted system. Research indicates that atmospheric mercury deposition is a significant source for the observed mercury levels (USEPA, 1997).

Pasquotank River Basin Fish Kills

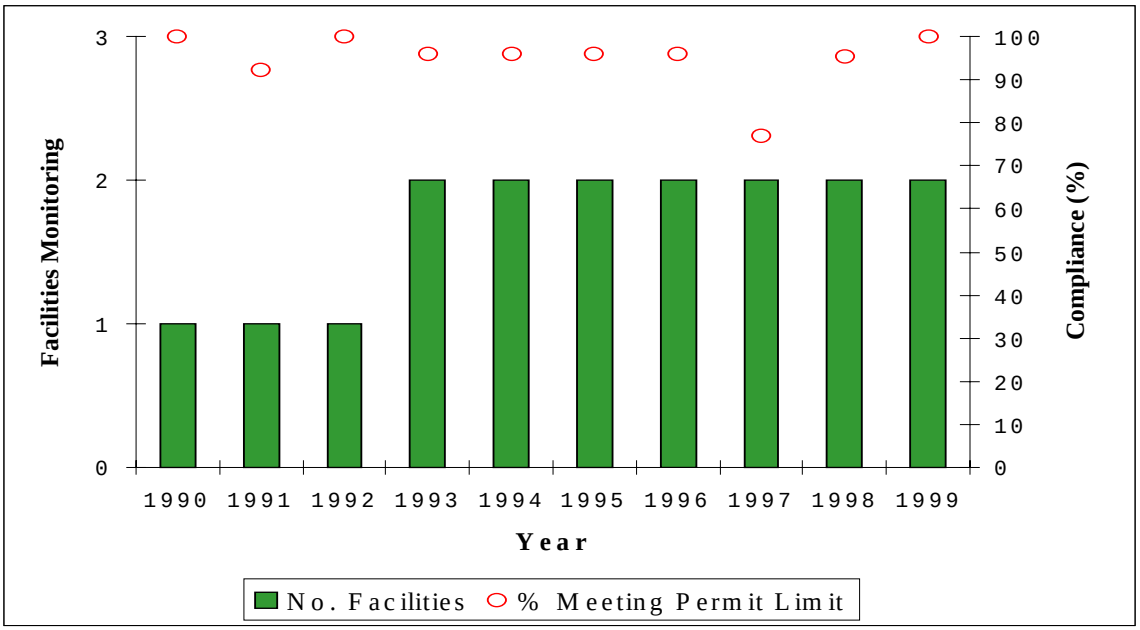
DWQ has systematically monitored and reported on fish kill events across the state since 1996. Field reports since 1996 have generally shown light fish kill activity (ten or less events) in the Chowan River and Pasquotank River basins each year (NCDENR-DWQ, 1999a). These basins generally exhibited fewer conditions that have given rise to frequent kill activity in other coastal areas. Such conditions include eutrophication, stratification and associated hypoxia, especially along the shallow, poorly flushed waterbodies. The Pasquotank River basin has not experienced hurricane related fish kills in recent years as compared with the more southern areas such as the

Neuse River and Cape Fear River basins. One fish kill associated with mild blooms of nontoxic dinoflagellates was investigated during August 1999.

3.3.3 Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory.

The Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge. A summary of compliance for the Pasquotank River basin from 1989 through 1999 is presented in Figure A-14 below. Problems associated with noncompliance in 1997 and 1998 are discussed in Section B in appropriate subbasin chapters.



These numbers were calculated by determining whether a facility was meeting its ultimate permit limit during the given time period, regardless of any SOCs in force.

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

Figure A-14 Summary of Compliance with Aquatic Toxicity Tests in the Pasquotank River Basin

3.3.4 Lake Assessment

Lake Phelps is the second largest natural lake in North Carolina. This shallow and acidic lake (pH<5) is located at a higher elevation than the surrounding land, so most of the recharge to the lake comes from precipitation. Lake Phelps was the only lake monitored in the Pasquotank River basin as part of the lake assessment program. Lake Phelps was sampled three times during the summer of 2000.

In January 2001, DWQ discovered quality assurance issues with chlorophyll *a* laboratory analyses for samples from 1996 through February 2001. DWQ tracking efforts have identified several different quality assurance issues. In some circumstances, laboratory data for chlorophyll *a* will require recalculation efforts. In other cases, chlorophyll *a* data cannot be recovered from the laboratory methods that were utilized. For lakes that were monitored as part of this time period, all previously reported chlorophyll *a* laboratory analyses have been withheld pending a sufficient quality assurance evaluation and/or recalculation of chlorophyll *a* values. As a result, there are no North Carolina Trophic State Index (NCTSI) values available for this time period.

3.3.5 Ambient Monitoring System Program

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine stations strategically located for the collections of physical and chemical water quality data. North Carolina has over 400 monitoring stations statewide, including 12 stations in the Pasquotank River basin (Table A-20). Locations of the Pasquotank River basin ambient stations are presented in subbasin chapters of Section B.

Table A-20 Ambient Monitoring System Stations within the Pasquotank River Basin

Subbasin/ Station	Location	County	Classification*
03-01-50			
M2750000	Pasquotank River at Elizabeth City	Pasquotank	SB
03-01-51			
M7175000	Alligator River at US 64 near Alligator	Tyrrell	SC SW ORW
M390000C	Albemarle Sound near Frog Island mid channel	Tyrrell	SB
M390000S	Albemarle Sound near Frog Island south shore	Tyrrell	SB
03-01-52			
M3500000	Little River at US 17 at Woodville	Perquimans	C SW
M390000N	Albemarle Sound near Frog Island north shore	Pasquotank	SB
M5000000	Perquimans River at SR 1336 at Hertford	Perquimans	SC
M610000N	Albemarle Sound between Harvey Point and Mill Point north shore	Perquimans	SB
03-01-53			
M698000C	Scuppernong River at SR 1105 near Columbia	Tyrrell	C SW
M6920000	Kendrick Creek at SR1300 at Mackeys	Washington	SC
M610000C	Albemarle Sound between Harvey Point and Mill Point mid channel	Tyrrell	SB
M610000S	Albemarle Sound between Harvey Point and Mill Point south shore	Tyrrell	SB

***** An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-17).

3.4 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. Data and information indicating possible water quality problems are investigated further. Both quantitative and qualitative information are accepted during the solicitation period. 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 303(d) list. Methodology for soliciting and evaluating outside data is presented in *North Carolina's 2000 § 303(d) List* (NCDENR-DWQ, October 2000). The next data solicitation period for the Pasquotank River is planned for 2004.

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.

DWQ solicited data from other water sampling programs conducted in the Pasquotank River basin; however, no data meet quality and accessibility requirements considered necessary for use support assessments, 303(d) list, or adjustment of biological and chemical monitoring sites.

3.4.1 Division of Environmental Health Shellfish Sanitation and Recreational Water Quality Section

The Shellfish Sanitation and Recreational Water Quality Section of the Division of Environmental Health is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption and inspection and certification of shellfish and crustacea processing plants. The section also administers the recreational beach monitoring program and posts advisories, under the guidance of the State Health Director, for those waters not suitable for bodily contact activities.

The Shellfish Sanitation Program is conducted in accordance with the guidelines set by the Interstate Shellfish Sanitation Conference (ISSC) contained in the *National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish Model Ordinance*. The NSSP is administered by the US Food and Drug Administration (FDA). Classifications of coastal waters for shellfish harvesting are done by means of a Sanitary Survey which includes: a shoreline survey of sources of pollution, a hydrographic and meteorological survey, and a bacteriological survey of growing waters. Sanitary Surveys are conducted of all potential shellfish growing areas in coastal North Carolina, and recommendations are made to the Division of Marine Fisheries of which areas should be closed for shellfish harvesting.

The Recreational Beach Monitoring Program determines the quality of coastal waters and beaches for suitability for bodily contact activities. Shoreline surveys of potential sources of pollution that could affect the area are also conducted. Swimming advisories are posted when bacteriological standards are exceeded or point source discharges are found.

Water samples are collected and analyzed for fecal coliform bacteria from numerous sampling stations located throughout the coastal area for both the shellfish and recreational programs. The recreational monitoring program also tests waters for *Escherichia coli*.

3.4.2 Virginia's Water Quality Monitoring

Virginia reported the following percentages of waters in the Chowan River and Dismal Swamp basin as impaired in its 2000 305(b) report: aquatic life (88.02 miles partially supporting, 647.89 miles not supporting, 0.12 estuary miles not supporting); and swimming (235.09 miles partially supporting, 49.86 miles not supporting, 0.12 estuary miles partially supporting). The various causes associated with the impairment include bethic macroinvertebrate population impacts, pH, organic enrichment/low DO and pathogen indicators. Potential sources of pollutants listed are industrial point sources, agriculture, hydromodification, urban runoff/storm sewers, natural sources and sources unknown (Virginia, 2000).

Virginia needs to develop 648 TMDLs on 600 impaired waters in the state. Several TMDLs in the Chowan River and Dismal Swamp basin are slated for completion in 2006 including: Roses Creek (benthic macroinvertebrate community issues, fecal coliform and unknown causes); Hurricane Branch UT (benthic macroinvertebrate community issues); West Neck Creek (fecal coliform); and Nawney Creek (fecal coliform).

For more information, visit the Virginia Department of Environmental Quality's webpage at http://www.deq.state.va.us/tmdl/10yrsch.html.

3.5 Use Support Summary

3.5.1 Introduction to Use Support

Waters are classified according to their best-intended uses. Determining how well a water supports its uses (*use support* status) is an important method of interpreting water quality data and assessing water quality. Surface waters are rated *fully supporting* (FS), *partially supporting* (PS) or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and recreation) are being met.

For example, waters classified for fishing and secondary contact recreation (Class C for freshwater) are rated as fully 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 PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR).

Use support ratings for streams and lakes:

- *Fully Supporting (FS)*
- *Partially Supporting (PS)*
- *Not Supporting (NS)*
- *Not Rated (NR)*

Categories for impaired waters:

- *Partially Supporting*
- *Not Supporting*

Historically, the non-impaired category was subdivided into fully supporting and fully supporting but threatened (ST). ST was used to identify waters that were fully supporting but had some notable water quality concerns and could represent constant, degrading or improving conditions. North Carolina's past use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that demonstrate declining water quality (EPA Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305(b) Reports] and Electronic Updates, 1997). Given the difference between the EPA and North Carolina definitions of ST and the resulting confusion that arises from this difference, North Carolina no longer subdivides the non-impaired category. However, these waters and the specific water quality concerns remain identified in the subbasin chapters in Section B so that data, management and the need to address the identified concerns are not lost.

Beginning in 2000 with the Roanoke River basin, an approach to assess ecosystem health and human health risk is applied to use support categories. Six categories are used to assess this approach: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. Each of these categories relates to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use support categories, as shown in Table A-28. For many waters, a use support category will not be applicable (NA) to the best use classification of that water (e.g., drinking water supply is not the best use of a Class C water). This method of determining use support differs from that done prior to 2000; in that, there is no longer an *overall* use support rating for a water. For more detailed information regarding use support methodology, refer to Appendix III.

3.5.2 Comparison of Use Support Ratings to Streams on the Section 303(d) List

Section 303(d) of the Clean Water Act requires states to identify waters not meeting standards. EPA must then provide review and approval of the listed waters. A list of waters not meeting standards is submitted to EPA biennially. Waters placed on this list, termed the 303(d) list, require the establishment of total maximum daily loads (TMDLs) intended to guide the restoration of water quality. See Appendix IV for a description of 303(d) listing methodology.

Waters are placed on North Carolina's 303(d) list primarily due to a partially or not supporting use support rating. These use support ratings are based on biological and chemical data. When the state water quality standard is exceeded, then this constituent is listed as the problem

parameter. TMDLs must be developed for problem parameters on the 303(d) list. Other strategies may be implemented to restore water quality; however, the waterbody must remain on the 303(d) list until improvement has been realized based on either biological ratings or water quality standards.

Use support ratings and accompanying data are updated as the basinwide plans are revised. In some cases, the new data will demonstrate water quality improvement and waters may receive a better use support rating. These waters may be removed from the 303(d) list since water quality improvement has been attained. In other cases, the new data will show a stable or decreasing trend in overall water quality resulting in the same, or lower, use support rating. Attention remains focused on these waters until water quality standards are being met. Swamp waters may have been on previous impaired waters lists due to depressed dissolved oxygen and/or pH levels. These waters will remain on the impaired waters list until swamp studies, biological and chemical, have been completed and use support has been reassessed. Thus, some inconsistencies remain between the 303(d) list and the Pasquotank Basinwide Water Quality Plan.

3.5.3 Use Support Ratings for the Pasquotank River Basin

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 (474.1), estuarine acres (918,223.6), freshwater acres (22,770.2), and coastal miles (110.6) in the Pasquotank River basin. Table A-21 presents use support ratings by subbasin for both monitored and evaluated waters in the aquatic life/secondary recreation category. A basinwide summary of current aquatic life/secondary recreation use support ratings is presented in Table A-22.

Approximately 29 percent of stream miles (135.6. mi.), 69 percent of estuarine acres (639,207.2 acres), and 94 percent of freshwater acres (15,938.3 acres) were monitored for the protection of aquatic life and secondary recreation by DWQ during this basinwide planning cycle. The 110.6 miles of Atlantic coastline are not currently monitored by DWQ to assess the aquatic life/secondary recreation use support category. There was no impairment in this use support category in the basin during this planning cycle.

Table A-21 Aquatic Life/Secondary Recreation Use Support Ratings for Monitored, Evaluated and Not Rated Waters Listed by Subbasin in Miles and Acres (1995-2000)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-01-50	28,665.8 estuarine ac	0	0	132.4 mi 23,208.9 estuarine ac	132.4 mi 51,874.7 estuarine ac
03-01-51	124,679 estuarine ac	0	0	70.0 mi 5,747.4 fresh ac 109,828.1 estuarine ac	70.0 mi 5,747.4 fresh ac 234,507.1 estuarine ac
03-01-52	72,795.5 estuarine ac	0	0	88.6 mi 18,924.6 estuarine ac	88.6 mi 91,720.1 estuarine ac
03-01-53	63,433.2 estuarine ac	0	0	113.2 mi 15,938.5 fresh ac 3,653.3 estuarine ac	113.2 mi 15,938.5 fresh ac 67,086.5 estuarine ac
03-01-54	11,049.3 estuarine ac	0	0	69.9 mi 942.9 fresh ac 113,560 estuarine ac 22.6 coastal mi	69.9 mi 942.9 fresh ac 124,609.3 estuarine ac 22.6 coastal mi
03-01-55	316,110.7 estuarine ac	0	0	117.6 fresh ac 4,022.0 estuarine ac 53.8 coastal mi	117.6 fresh ac 320,132.7 estuarine ac 53.8 coastal mi
03-01-56	12,463.2 estuarine ac	0	0	23.8 fresh ac 15,830.2 estuarine ac 34.2 coastal mi	23.8 fresh ac 28,293.5 estuarine ac 34.2 coastal mi
Total	**629,196.7 estuarine ac**	**0**	**0**	**474.1 mi 22,770.2 fresh ac 289,026.9 estuarine ac 110.6 coastal mi**	**474.1 mi 22,770.2 fresh ac 918,223.6 estuarine ac 110.6 coastal mi**
Percent estuarine acres	68.1%	0%	0%	31.5% estuarine ac*	100%

* = Coastal miles, freshwater miles and freshwater acres are 100 percent not rated.

Table A-22 Aquatic Life/Secondary Recreation Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Aquatic Life/Secondary Recreation Use Support Ratings	Monitored, Evaluated and Not Rated Streams*		Monitored Streams Only**	
	Miles or Acres	%	Miles or Acres	%
Fully Supporting	**629,196.7 estuarine ac**	**68.1%**	**629,196.7 estuarine ac**	**98.4%**
Impaired	**0**	**0%**	**0**	**0%**
Partially Supporting	*0*	*0%*	*0*	*0%*
Not Supporting	*0*	*0%*	*0*	*0%*
Not Rated	**474.1 mi 22,770.2 fresh ac 289,026.9 estuarine ac 110.6 coastal mi**	**100% 100% 31.5% 100%**	**135.6 mi 15,938.3 fresh ac 10,010.5 estuarine ac**	**100% 100% 1.6%**
Total	**474.1 mi 22,770.2 fresh ac 918,223.6 estuarine ac 110.6 coastal mi**		**135.6 mi 15,938.3 fresh ac 639,207.2 estuarine ac**	

* = Percent based on total of all waters, both monitored and evaluated. ** = Percent based on total of all monitored waters.

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. One hundred percent of Atlantic coastline (110.6 miles) in the Pasquotank River basin was monitored for the fish consumption use support category during this basinwide cycle. No stream miles were monitored for fish consumption use support. Fish consumption use support ratings are based on fish consumption advisories issued by the NC Department of Health and Human Services (NCDHHS). Currently, there is a regional advisory limiting consumption of shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack) due to elevated methlymercury levels. Because of this advisory, all waters south and east of Interstate 85 are considered partially supporting the fish consumption use. Refer to page 68 for more information on fish consumption advisories.

Table A-23 presents use support ratings by subbasin for monitored streams in the fish consumption use support category. A basinwide summary of current fish consumption use support ratings is presented in Table A-24.

Table A-23 Fish Consumption Use Support Ratings for Monitored Waters Listed by Subbasin (1995-2000)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-01-50	0	0	0	0	0
03-01-51	0	0	0	0	0
03-01-52	0	0	0	0	0
03-01-53	0	0	0	0	0
03-01-54	0	22.6 coastal mi	0	0	22.6 coastal mi
03-01-55	0	53.8 coastal mi	0	0	53.8 coastal mi
03-01-56	0	34.2 coastal mi	0	0	34.2 coastal mi
Total	**0**	110.6 coastal mi	**0**	**0**	110.6 coastal mi
Percent	**0%**	**100%**	**0%**	**0%**	--

Table A-24 Fish Consumption Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Fish Consumption Use Support Ratings	Monitored, Evaluated and Not Rated Streams*			Monitored Streams Only**	
	Miles or Acres	%		Miles or Acres	%
Fully Supporting	**0**	**0%**		**0**	**0%**
Impaired					
Partially Supporting	*474.1 mi 22,770.2 fresh ac 918,223.6 estuarine ac 110.6 coastal mi*	*100%*		*110.6 coastal mi*	*100%*
Not Supporting	*0*	*0%*		*0*	*0%*
Not Rated	**0**	**0%**		**0**	**0%**

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Primary Recreation

There are 707,455.2 estuarine acres, 110.6 coastal miles, 15,938.3 freshwaters acres and 25.1 freshwater miles currently classified for primary recreation in the Pasquotank River basin. The Division of Environmental Health Shellfish Sanitation and Recreational Water Quality Section monitors primary recreation on both the estuarine and coastal shorelines. During the last two years, all monitored sites are fully supporting the primary recreation use. However, one site at the Villas Condominiums, Inc. did not support primary recreation due to an ongoing swimming closure advisory in accordance to rule which has been in effect more than two years. However,

DEH does not monitor this site. Table A-25 presents use support ratings by subbasin for monitored streams in the primary recreation use support category. A basinwide summary of current primary recreation use support ratings is presented in Table A-26.

Table A-25 Primary Recreation Use Support Ratings for Monitored Waters Listed by Subbasin (1995-2000)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-01-50	37,851.5 estuarine ac	0	0	93.3 estuarine ac	37,944.8 estuarine ac
03-01-51	149,130.1 estuarine ac	0	0	13,004.7 estuarine ac	162,134.8 estuarine ac
03-01-52	72,795.5 estuarine ac	0	0	9,840.3 estuarine ac	82,635.8 estuarine ac
03-01-53	63,433.2 estuarine ac	0	0	1,839.4 estuarine ac 15,938.3 fresh ac	65,272.6 estuarine ac 15,938.3 fresh ac
03-01-54	22.6 coastal mi	0	0	25.1 miles 11,049.3 estuarine ac	25.1 miles 11,049.3 estuarine ac 22.6 coastal mi
03-01-55	315,407.0 estuarine ac 53.8 coastal mi			4,725.8 estuarine ac	320,132.8 estuarine ac 53.8 coastal mi
03-01-56	12,851.8 estuarine ac 34.2 coastal mi	0	21.4 estuarine ac	15,411.9 estuarine ac	28,258.1 estuarine ac 34.2 coastal mile
Total	**651,469.10 estuarine ac 110.6 coastal mi**	**0**	**21.4 estuarine ac**	**55,964.7 estuarine ac 25.1 miles 15,938 fresh ac**	**707,455.2 estuarine ac 110.6 coastal mi 25.1 miles 15,938.3 fresh ac**
Percent	**92.1% estuarine ac 100% coastal mi**	**0%**	**<1% estuarine ac**	**7.9% estuarine ac 100% fresh ac**	

Table A-26 Primary Recreation Use Support Summary Information for Waters in the Pasquotank River Basin (2000)

Primary Recreation Use Support Ratings	Monitored, Evaluated and Not Rated Streams*			Monitored Streams Only**	
	Miles or Acres	%		Miles or Acres	%
Fully Supporting	651,469.1 estuarine ac 110.6 coastal mi	92.1% estuarine ac 100% coastal mi		651,469.1 estuarine ac 110.6 coastal mi	99.9% estuarine ac 100% coastal mi
Impaired	**21.4 estuarine ac**	**<1% estuarine ac**		**21.4 estuarine ac**	**<1% estuarine ac**
Partially Supporting	*0*	*0%*		*0*	*0%*
Not Supporting	21.4 estuarine ac	<1% estuarine ac		21.4 estuarine ac	<1% estuarine ac
Not Rated	*55,964.7 estuarine ac* *25.1 miles* *15,938.3 fresh ac*	**7.9% estuarine ac** **100% fresh ac**		*15,938.3 fresh ac*	
TOTAL	*707,455.2 estuarine ac* *110.6 coastal mi* *25.1 miles* *15,938 fresh ac*			**651,469.1 estuarine ac** **15,938 fresh ac** **110.6 coastal miles**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Shellfish Harvesting

In the Pasqutoank River basin, there are 395,371.3 estuarine acres which have shellfish harvesting (Class SA) identified by the state as its best use. All were monitored during the past five years by DEH Shellfish Sanitation. Table A-27 presents use support ratings by subbasin for monitored streams in the shellfish harvesting use support category. A basinwide summary of current shellfish harvest use support ratings is presented in Table A-28. For more information on shellfish harvesting issues, refer to Section 4.2.

Table A-27 Shellfish Harvesting Use Support Ratings for Monitored Waters Listed by Subbasin (1995-2000) in Acres

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-01-51	52,791.3 ac.	0	1,959.3 ac	0	54,750.6 ac
03-01-55	318,771.7 ac	0	1,361.1 ac	0	320,132.8 ac
03-01-56	18,775.0 ac	0	1,712.9	0	20,487.9
Total	**390,338.0 ac**		**5,033.3 ac**	**0**	**395,371.3 ac**
Percent	**98.7%**	**0%**	**1.3%**	**0%**	**100%**

Table A-28 Shellfish Harvest Use Support Summary Information for Waters in the Pasquotank River Basin (1995-2000)

Shellfish Harvest Use Support Ratings	Monitored Streams	
	Acres	%
Fully Supporting	**390,338.0**	**98.7%**
Impaired	**5,033.3**	**1.3%**
Partially Supporting	*0*	*0%*
Not Supporting	*5,033.3*	*1.3*
Not Rated	**0**	**0**
Total	**395,371.3**	**100%**

Water Supply

There are 30.3 stream miles and 23.8 freshwater acres currently classified for water supply in the Pasquotank River basin. All are considered fully supporting on an evaluated basis, based on information provided by the regional water treatment plant consultant. Local water treatment plant operators monitored all during the past five years.

Use Support Summary

There are no impaired waters in the aquatic life/secondary recreation use support category and one impaired water in the primary recreation use support category. All waters are considered impaired for the fish consumption use support category due to a regional fish consumption advisory for bowfin, largemouth bass, chain pickerel and king mackerel. Although no stream miles were monitored for this category, the Atlantic Ocean was monitored to assess this category. There are 5,033.3 estuarine acres impaired for the shellfish harvesting use support category. All water supply watershed waters are fully supporting their uses in the basin. Descriptions of impaired segments, as well as problem parameters, are outlined in Appendix III. Management strategies for each water are discussed in detail in the appropriate subbasin chapter.

Color maps showing current use support ratings for the Pasquotank River basin are presented in Figure A-15. Since no waters in the basin were sampled for fish tissue, there are no waters colored for fish consumption impairment on the maps. When use support ratings have been assigned to more than one category for a particular water, the rating that represents the most severe impairment is shown on the map.

INSERT

Figure A-15 Use Support Map for the Pasquotank River Basin

Chapter 4 -
Water Quality Issues Related to the Entire Pasquotank River Basin

4.1 Overview

The 1997 Pasquotank River Basinwide Water Quality Management Plan included several recommendations to address water quality issues in the basin. Most of these recommendations were for specific stream segments, and they are discussed separately in the individual subbasin chapters in Section B. This chapter discusses water quality issues that relate to the entire Pasquotank River basin. Habitat degradation, including loss of riparian vegetation and channelization and erosion, is the main water quality issue in the basin.

4.2 Shellfish Harvest Issues

Water polluted by human or animal wastes can harbor numerous pathogens that may threaten human health. This is of particular concern in waters where shellfish are harvested for human consumption. Because of the tendency of clams and oysters to concentrate the material they filter from the water column, shellfish can potentially become too contaminated for safe consumption by humans, even when fecal coliform concentrations are relatively low. Therefore, while water quality may be safe enough for swimming, fishing or other forms of recreation, the waters may be closed to shellfish harvesting and require both corrective and preventive action.

Since routine tests for individual pathogens are not practical, fecal coliform bacteria are widely used as an indicator of the potential presence of disease-causing microorganisms. Fecal coliform bacteria are typically associated with the intestinal tract of warm-blooded animals, and their number is generally assumed to be correlated with the number of pathogens in a water sample. They enter surface waters from a number of sources including urban stormwater, agricultural runoff, improperly designed or managed animal waste facilities, failing on-site wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, and wild or domestic animal waste.

There are 395,371.3 acres of shellfish harvesting waters (Class SA) in the Pasquotank River basin. There are 5,033.3 (1.3%) acres currently rated as impaired in the shellfish harvesting use support category. Many of the impaired waters are in areas that have a high value shellfish resource. The following sections describe programs that monitor shellfish harvesting waters, methods for determining use support in class SA waters, and recommendations for addressing impairment class SA waters.

4.2.1 Division of Environmental Health Shellfish Sanitation (DEH SS)

The Division of Environmental Health Shellfish Sanitation (DEH SS) is the agency responsible for monitoring shellfish and shellfish harvesting waters in North Carolina to evaluate the risk to

public health from consuming shellfish meats. DEH SS monitors all coastal waters that have the potential to support shellfish. Table A-29 and the following paragraphs describe DEH SS growing area classifications. In the Pasquotank River basin, there are approximately 917,348 acres of estuarine waters (SC, SB and SA) monitored by DEH SS. Waters are closed to shellfish harvest because of contamination by fecal coliform bacteria.

Table A-29 DEH Shellfish Sanitation Growing Area Classifications

DEH Classification	DEH Criteria
Approved	The median fecal coliform Most Probable Number (MPN) or geometric mean MPN of water shall not exceed 14 per 100 milliliters, and the estimated 90th percentile shall not exceed an MPN of 43 per 100 milliliters for a five tube decimal dilution test.
Conditionally Approved-Open	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.
Conditionally Approved-Closed	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.
Restricted	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	No Sanitary Survey; point source discharges; marinas; data does not meet criteria for Approved, Conditionally Approved or Restricted Classification.

Approved

There are 390,338.0 acres of shellfish harvesting (Class SA) waters that are classified as approved by DEH Shellfish Sanitation in the Pasquotank River basin. These areas are always open to shellfishing harvesting and close only after rare heavy rainfall events such as hurricanes.

Conditionally Approved Shellfish Areas

As of 2001, there were no Conditionally Approved-Open or Conditionally Approved-Closed shellfish harvesting waters in the Pasquotank River basin.

Prohibited/Restricted Shellfish Harvest Areas

There are 5,033.3 acres of shellfish harvesting (Class SA) waters that are prohibited or restricted for shellfish harvesting in the Pasquotank River basin. Most of these areas receive runoff that consistently results in fecal coliform bacteria levels above the state standard. As noted above, the sources of fecal coliform bacteria may be many. DEH Shellfish Sanitation shoreline surveys attempt to identify possible sources. In many areas, the contamination may be from several different sources at different times of the year including, but not limited to, adjacent development and marinas.

4.2.2 Changes in Shellfish Harvesting Use Support Assessment

The 1997 Pasquotank River basin use support assessment rated Approved waters as fully supporting (FS), Conditionally Approved waters as fully supporting but threatened (ST), and Prohibited waters as partially supporting (PS). As described in Section A, Part 3.4, the ST subcategory of fully supporting is no longer used. In the 1997 assessment, there were 862,813 acres rated fully supporting and 5,987 acres rated partially supporting. Of the impaired acres, 1,125 are in Class SC waters which are not designated for shellfish harvesting through the DWQ surface water classification system. In the 1997 basin plan, acres were reported by the 20 DEH SS growing areas (e.g., Roanoke Sound H1 - 1,950 partially supporting acres).

Interim Frequency of Closures Based Method

DWQ and DEH SS are developing the database and expertise necessary to assess shellfish harvesting use support using a frequency of closure based approach. This database will allow DWQ to better assess the extent and duration of closures in Class SA waters. These tools are not available for use support determinations in Class SA waters for the 2001 Pasquotank River basin assessment. DWQ believed it important to identify frequency of closures in Conditionally Approved-Open waters, so an interim methodology was used based on existing databases and GIS shapefiles. Since there are no Conditionally Approved waters in the basin, there is no resultant impact on use support determinations for this designation during this five-year basinwide cycle. There will likely be changes in reported acreages in future assessments using the permanent methods and tools that define areas and closure frequency.

The Pasquotank River basin contains many Prohibited shellfish harvesting areas, which are now given a use suppoprt rating of not supporting (NS) shellfish harvesting based on the DEH designation. This use support rating differs significantly from the historical use support ratings of partially supporting (PS) for Prohibited shellfish harvesting areas. Changes that are related to water quality or DEH SS growing area reclassifications are explained in detail in the subbasin chapters of Section B. Refer to Appendix III and the subbasin chapters in Section B for more specific information on individual waters.

4.2.3 Recommendations for Addressing Impaired Shellfish Harvest Waters

Fecal coliform bacteria are the primary pollutant that causes closures in shellfish harvesting waters. Fecal coliform bacteria are relatively short lived in saltwater. Many of the impacted waters are where freshwater flows from the land into shellfish harvesting areas. Larger waters are impacted from the cumulative effect of freshwater runoff transporting bacterial contaminants farther out into the estuary. The runoff increases with increasing development (impervious surface). Research over the past 15 years consistently demonstrates a strong correlation between the imperviousness of a drainage basin and the health of its receiving waters (Arnold and Gibbons, 1996). Mallin et al. (2000) showed that with increasing impervious surfaces there is an increase in fecal coliform delivery to estuarine waters. Larger waters are being impacted from the cumulative effect of freshwater runoff from increasing upstream development, which in turn is transporting bacterial contaminants farther out into the estuary. Restoration strategies that address the source and transport of bacterial contamination are more appropriate than developing

complicated models, because of the complex hydrology of coastal waters and the life-cycle of fecal coliform bacteria.

A study by Duke University Marine Labs (Reilly and Kirby-Smith, 1999) developed recommendations to restore impaired shellfish harvesting waters that included controlling the sources of fecal coliform bacteria and slowing the movement of fecal coliform bacteria from source to receiving waters.

North Carolina Blue Ribbon Advisory Council on Oysters

The NC Blue Ribbon Advisory Council on Oysters (NCBRACO) issued its final *Report on Studies and Recommendations* in October 1995. In the report, the council "reaches the inescapable conclusion that oyster harvests have declined sufficiently in North Carolina to justify bold new action and to require initiation of that action immediately."

The council's report along with a report from the Council's Public Bottom Production Committee makes a series of specific water quality recommendations (NC Blue Ribbon Advisory Council on Oysters, 1995). The objective of these recommendations is to "restore and protect coastal water quality to create an environment suitable for oysters that are safe for human consumption." These recommendations include, but are not limited to:

- Institution of regulatory mechanisms for control of NPS runoff, particularly fecal coliform bacteria and nutrients.
- Mandatory 100-foot buffers along all SA waters.
- Reducing the allowable built-upon area for low density development.
- Promote and fund research on oyster reefs that documents their positive impact on water quality.
- Urge the Marine Fisheries and Environmental Management Commissions to work together to establish and implement a "Use Restoration Waters" classification in order to restore closed shellfish beds.
- DEHNR should "augment its basinwide management plans to include mechanisms for controlling both point and nonpoint source nutrient additions" and "develop and fund a coastal water quality monitoring system capable of measuring oxygen levels in bottom waters in historically important shellfish grounds."
- Work with the NCDOT to reverse past road construction activity that has adversely affected oyster beds through restrictions on normal water flow.

The following sets of recommendations address or start to address some of the recommendations from the Blue Ribbon Advisory Panel listed above. The NCDENR agencies will first work to identify and quantify the extent and duration of shellfish harvest area closures. Then through education and involvement in land use plan review help, local governments identify these closed areas. The various agencies will work together with local governments to reduce frequency and duration of closures.

Recommendations for NCDENR Agencies to Address Impairment in Class SA Waters

Better Identification of Growing Areas and Database Development

To better identify impairment of shellfish waters, DWQ, DEH SS, DCM and DMF are developing the tools necessary to use a frequency of closures based assessment of Class SA waters as described above. DWQ, DEH SS and DMF have received funding from the NC Coastal Nonpoint Source Program (described below) to georeference growing areas and monitoring sites and develop a new tracking database. Shellfish harvesting use support assessments will be completed for the next assessment period using these tools. The tools will also help:

- identify waters where bacterial contamination is increasing or decreasing with changes in land use;
- provide a means to share this information with the public and local governments; and
- identify areas where best management practices and restoration projects are needed, as well as providing a means of evaluating the implementation of these projects.

Continued Enforcement of DWQ ORW Program

In addition to the stringent water quality standards for Class SA waters, DWQ also has the supplemental classification of ORW (Outstanding Resource Waters). In the Pasquotank River basin there are no SA ORW waters. There are 17,043.7 freshwater acres, 51.3 miles and 43,154.6 estuarine acres of ORW waters. The largest areas are Phelps Lake and the Alligator River. All these waters are currently not rated. DWQ will continue to implement this program.

Reclassification of Waters to Identify Shellfish Harvesting Uses

DWQ, DMF and DEH SS may pursue the reclassification of some segments that are currently classified as SC waters. DWQ, DMF and DEH SS will continue to pursue reclassifications to Class SA of areas that are approved for shellfish harvesting.

Developing Coastal Habitat Protection Plans

DMF is in the process of developing Coastal Habitat Protection Plans (CHPP) with DWQ and DCM. These plans will identify existing and potential threats to habitats important to coastal fisheries and recommend actions to restore and protect them. The plans will also provide a framework for adoption of rules to protect habitats vital to coastal fisheries. The plans will help to assure consistent actions among the Coastal Resources Commission (CRC), Environmental Management Commission (EMC) and the Marine Fisheries Commission (MFC). For more information on these plans, contact the Habitat Protection Section at (252) 726-7021 or visit the CHPP website at http://www.ncfisheries.net/habitat/chpp1.htm.

Oyster and Clam Fisheries Management Plans Recommendations

The major recommendations of the most recent oyster and clam fisheries management plans include increasing use of existing authority to reverse trends in shellfish closures and to restore

conditionally approved-open areas. For more information on these plans, contact the Division of Marine Fisheries at (252) 726-7021 or visit the website at http://www.ncfisheries.net/.htm.

North Carolina Coastal Nonpoint Source Program (Section 6217)

Section 6217 of the Federal 1990 Coastal Zone Act Reauthorization Amendments (CZARA) requires every state participating in the Coastal Zone Management Act program to develop a Coastal Nonpoint Pollution Control Program (CNPCP). The purpose of this requirement, as stated in the Act, is to "strengthen the links between Federal and State coastal zone management and water quality management programs and to enhance State and local efforts to manage land use activities that degrade coastal waters and coastal habitats." To accomplish these goals, the federal agencies established 56 Management Measures that are to be used by each state to address the following nonpoint source pollution categories:

- *Agricultural Sources*
- *Forestry*
- *Urban Areas* (urban runoff; construction activities; existing development; on-site disposal systems; pollution prevention; and roads, highways and bridges)
- *Marinas and Recreational Boating* (siting and design; and marina and boat operation/maintenance)
- *Hydrologic Modification* (channelization and channel modification; dams; and streambank and shoreline erosion)
- *Wetlands, Riparian Areas and Vegetated Treatment Systems*

At the federal level, the CNPCP is administered jointly by the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA). Within North Carolina, the state program, referred to as the Coastal Nonpoint Source Program (CNPSP), is administered by DWQ and the DCM. The state program currently has one full-time staff person located in the Nonpoint Source Planning Unit of DWQ.

The core of the state's CNPSP will be increased through communication and coordination between DWQ and key state agencies that have regulatory responsibilities for controlling nonpoint sources of pollution. This increased dialogue will be facilitated in part by the state's CNPSP Coordinator and will allow for identification of gaps, duplications, inadequacies or inefficiency of existing programs and policies. Responsibilities of the state program coordinator will include participation in the NPS Workgroup to represent coastal water quality interests. The workgroup is involved with the continual refinement of the 319 Grant Program and development of North Carolina's 2001 NPS Management Program Update. The CNPSP Coordinator will also participate in the development and implementation of the basinwide management plans for the coastal draining rivers; serve as a liaison between DWQ and DCM; and participate in the development of nonpoint source educational materials. For more information about this program, contact the Coastal Nonpoint Source Program Coordinator at (919) 733-5083 or visit http://h2o.enr.state.nc.us/nps/czara.htm.

Implementation of Coastal Resources Commission 30-Foot Buffer Rules

In November 1999, the Coastal Resources Commission (CRC) enacted rules designed to protect coastal waters. The rules require a 30-foot buffer for new development along coastal shorelines in the 20 CAMA counties. The new rules became effective in August 2000. Visit http://dcm2.enr.state.nc.us/ for more information on these rules.

Land Use Planning

A Land Use Plan Review Team authorized by the CRC has recommended better implementation of land use plans and involvement of local governments in the basinwide planning process. In 1998, the CRC suspended the Coastal Area Management Act land use plan updates in order to review and improve the program. Seeking input from local stakeholders, DCM convened a group of external experts, the Land Use Plan Review Team, representing different interests in coastal North Carolina. In September 2000, the team provided the CRC with a set of recommendations to restructure the existing land use planning program. Since land use plans affect permit decisions, growth patterns and community visions, any revisions to the process can potentially have widespread impact to coastal decision-making and inevitably water quality. Therefore, DWQ will play an active role in land use planning discussions, especially with respect to water quality concerns.

The team developed several recommendations, some of which directly impact DWQ. DWQ provided feedback during the development of these recommendations, actively seeks to improve existing communication links with DCM, and continues to stay abreast of events as the recommendations evolve into implementation.

The new coastal land use planning guidelines under consideration by the CRC stress the importance of healthy water. From the requirements of the pre-planning scoping process to the elements of local plans, the new guidelines will ask local governments to do more to protect water quality. One of the goals of the proposed guidelines is to maintain, protect and, where possible, enhance water quality in all coastal wetlands, rivers, streams and estuaries. That effort begins at the local level. The guidelines will require local governments to adopt policies to ensure that coastal water quality is improved or maintained. Chief among these policies are those that prevent or control stormwater discharges, as it is a leading cause of water quality problems along the coast. Local policies, such as impervious surface limits, vegetated riparian buffer creation and wetlands protection, can help lessen the negative impacts of stormwater runoff on coastal waters. The guidelines also will require local governments to develop policies and land use categories that protect open shellfish waters and restore closed or conditionally approved shellfish waters. The Coastal Resources Commission anticipates the revision and adoption of new land use planning rules to go into effect by August 2002.

A detailed summary of the Land Use Plan Review Team recommendations is available through the DCM website at http://dcm2.enr.state.nc.us/. DWQ continues to support these team suggestions, including:

- Development of a "how to" manual to assist local governments in developing high quality land use plans.

- Involvement of coastal local governments in state basinwide planning and seeking application of a land use planning requirement in all areas of coastal river basins are strongly encouraged.
- Strengthen the ties between basinwide planning for water quality and CAMA land use plans, especially focusing on participation in basinwide planning. The team also recommends that the CRC coordinate with the Environmental Management Commission to expand the role of local government and local land use plans in the basinwide water quality planning process. Three specific steps are recommended:
    - ► The database and strategies contained in the basinwide plans should be loosely tailored to the requirements for land use plans.
    - ► The EMC should incorporate local land use policies in basinwide plans.
    - ► Local governments should be encouraged by the CRC to participate in the scoping process for basinwide plans.
- Measures to encourage greater intergovernmental coordination in the development of land use plans.

DWQ will review local land use plans with DCM for communities in the Pasquotank River basin to help identify impaired or impacted shellfish harvesting waters and make recommendations to reduce future increases in bacterial contamination related to development and land use changes. DWQ will also support local government and community group endeavors to protect and improve shellfish harvesting waters. This will include providing educational opportunities to increase the understanding of technical issues, as well as assisting with identifying funds for restoration and protection projects.

For more information on the CAMA land use process, contact a DCM land use planner at (252) 808-2808 or visit the program on-line at http://dcm2.enr.state.us/.

Recommendations for Local Governments, Community Groups and Pasquotank River Basin Citizens to Address Impairment in Class SA Waters

Because of limited resources and authority, the various state agencies listed above cannot completely address impairment in shellfish harvesting waters. Shellfish harvesting is a potentially stable and sustainable economic resource for coastal areas and for the state. The state agencies can help to reduce temporary closures, restore areas that are permanently closed, and help in managing a healthy shellfish harvesting industry through existing regulations and authorities. Local governments, community groups and citizens have more local knowledge and are directly affected by a degraded coastal environment, and therefore, have a responsibility for protecting and restoring shellfish harvesting in coastal waters.

Local Governments

Local governments should consider water quality impacts in all aspects of government operations. Land use planning should discourage development in wetlands and areas draining to sensitive coastal areas. Land use plans should incorporate preservation and limited development of land adjacent to approved shellfish harvesting areas. Best management practices should be implemented during all land-disturbing activities to reduce runoff and delivery of bacterial contaminants to shellfish harvesting waters. Local governments with jurisdictions around the

large areas of conditionally approved-open waters should work together and with the NCDENR agencies to develop strategies for reducing sources and delivery of bacterial contaminants to these waters in an effort to reduce the extent and duration of temporary closures. A long-term strategy should be put in place to eventually restore shellfish harvesting to prohibited areas where human activities have caused these closures.

Community Groups

Environmental groups, community organizations and fisherman groups should make efforts to address coastal water quality issues by becoming involved. Attendance and participation in DWQ's Basinwide Planning Program, The Coastal Habitat Protection Planning Program, City Council meetings, County Commissioner and Planning Board meetings will be essential in addressing coastal water quality issues.

Marina Operators

Many marina areas on the coast are closed to shellfish harvesting. Marina operators should enroll in programs like the Clean Marinas Program to minimize impacts of these activities on coastal water quality. For more information on this program, visit the NC Marine Trade Association's webpage at http://www.ncmta.com/ or call (910) 962-3351.

4.3 Biological Monitoring Issues

DWQ strives to properly evaluate the health of biological communities throughout the state. Swamp stream systems, nonwadeable waters and coldwater fisheries have presented unique challenges. This section discusses some of these challenges. Refer to Appendix III for further information.

4.3.1 Draft Criteria for Assessing Benthic Macroinvertebrates in Swamp Streams

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria must be used to assess the condition of water quality in these systems. Swamp streams are characterized by seasonally interrupted flows, lower dissolved oxygen and sometimes, lower pH. Sometimes they also have very complex braided channels and dark-colored water. Since 1995, benthic macroinvertebrates swamp sampling methods have been used at over 100 sites in the coastal plain of North Carolina, including more than 20 reference sites. In 1999, 10 sites on swamp streams in the Pasquotank River basin were sampled by DWQ as well. Preliminary investigations indicate that there are at least five unique swamp ecoregions in the NC coastal plain, and each of these may require different biocriteria. The lowest "natural" diversity has been found in low-gradient streams (especially in the outer coastal plain) and in areas with poorly drained soils.

DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams (as is currently done for other streams and rivers across the state). However, validation of the swamp criteria will require collecting data for several years from swamp stream reference sites. The criteria will remain in draft form until DWQ is better able to evaluate such things as: year-to-year variation at reference swamp sites, effects of flow

interruption, variation among reference swamp sites, and the effect of small changes in pH on the benthos community. Other factors, such as whether the habitat evaluation can be improved and the role fisheries data should play in the evaluation, must also be resolved. While it may be difficult to assign use support ratings to these swamp streams, these data can be used to evaluate changes in a particular stream between dates or to evaluate effects of different land uses on water quality within a relatively uniform ecoregion.

4.3.2 Draft Criteria for Assessing Fish Communities

In the past, fish communities in some streams were sampled by DWQ, and scores were assigned using the North Carolina Index of Biotic Integrity (NCIBI). The NCIBI uses a cumulative assessment of twelve 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.

However, during the late 1990s, application of the NCIBI was restricted to wadeable streams that can be sampled by a crew of 2-4 persons using backpack electrofishers and following the DWQ Standard Operating Procedures (NCDEHNR, 1997). Work began in 1998 to develop a fish community boat sampling method that could be used in nonwadeable coastal plain streams. Plans are to sample 10-15 reference sites with the boat method once it is finalized. As with the benthos in swamp streams, several years of reference site data will be needed before criteria can be developed with confidence to evaluate the biological integrity of large streams and rivers using the fish community.

4.4 Fish Consumption Advisories

The NC Department of Health and Human Services (NCDHHS) has developed guidelines to advise people to what fish are safe to eat. DWQ considers uses of waters with a consumption advisory for one or more species of fish to be impaired. Elevated methylmercury levels have been found in shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack). As of April 2002, these fish are under an advisory.

4.4.1 Mercury Related Fish Consumption Advisories

The presence and accumulation of mercury in North Carolina's aquatic environment is 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 into biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway of mercury in the environment is through the atmosphere. Mercury that has been emitted from industrial and municipal stacks into the ambient air can circulate across 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 levels in fish.

The NC Department of Health and Human Services issues fish consumption advisories for those fish species which have median and/or average methylmercury levels of 0.4 mg/kg or greater. These fish include shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack) caught in North Carolina waters south and east of Interstate 85. As a result of these advisories, DWQ considers all waters in the Pasquotank River basin to be partially supporting the fish consumption use support category. Refer to Appendix III for more information regarding use support ratings and assessment methodology.

Specific Fish Consumption Advisories

Lake Phelps: Due to higher than normal levels of mercury in Phelps Lake, NCDHHS posted a limited consumption advisory in June 1996. Consumption of bass and blackfish should be limited to no more than two meals per person per month, and women of childbearing age and children should eat no bass or blackfish.

Fish is an excellent source of protein and other nutrients. However, several varieties of saltwater and NC freshwater fish may contain high levels of mercury, which may pose a risk to human health. These guidelines will help you make healthy food choices.

Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women and Children under 15:

- **Do not eat** shark, swordfish, tilefish or king mackerel; or blackfish (bowfin), largemouth bass or jack fish (chain pickerel) caught in North Carolina waters south and east of Interstate 85. These fish are all high in mercury.
- **Eat up to two meals* per week of other fish.**

Other Women, Men and Children 15 years and older:

- **Eat no more than one meal* per week** of shark, swordfish, tilefish or king mackerel; or blackfish (bowfin), largemouth bass or jack fish (chain pickerel) caught in North Carolina waters south and east of Interstate 85. These fish are all high in mercury.
- **Eat up to four meals* per week of other fish.**

* A "meal" is 6 ounces of cooked fish for adults and children 15 years and older, and 2 ounces of cooked fish for younger children.

4.4.2 Dioxin Related Fish Consumption Advisories

Dioxin contamination is found worldwide, including a portion of the Albemarle Sound westward of Bull Bay and Harvey Point to the Roanoke River. Dioxin is typically generated through high temperature combustion processes, chemical bleaching of pulp, and through the production of chlorinated phenols and their derivatives. Dioxins can bioaccumulate in animal tissues, creating human health concerns such as reproductive impairment, carcinogencity and even death. Dioxin binds tightly with sediment, food particles and organic matter in the water column, thus, leaving only low concentrations dissolved in the water column.

Due to dioxin's bioaccumulation properties, the Department of Health and Human Services (NCDHHS) recommends that in fish advisory areas fish consumption should be limited to two meals per person per month. Children and pregnant or nursing women should not consume any fish from the Albemarle Sound. Consumption of herring, shellfish and shad (including roe) is not considered a health risk.

Specific Fish Consumption Advisories

Albemarle Sound: Dioxin has prompted an advisory since March 2001 in the Albemarle Sound from Bull Bay to Harvey Point, west to the mouth of the Roanoke River and north to the mouth of the Chowan River at the US Highway 17 Bridge. Weyerhaeuser Company, located at the mouth of Welch Creek in the Roanoke River basin, previously discharged directly to the creek. During the 1980s, officials recognized that dioxin, a carcinogenic by-product of the chlorine bleaching process, was accumulating in fish tissue. In 1988, Weyerhaeuser made improvements and relocated the discharge to the Roanoke River. Weyerhaeuser is required by DWQ to provide extensive monitoring in the Roanoke River from Williamston down the Roanoke and out into the Albemarle Sound as far as Bull Bay. Data recently collected by Weyerhaeuser Company indicate a decline in dioxin concentrations. In October 2001, the advisory was partially lifted for game fish. However, an advisory remains in place for bottom-dwelling fish such as carp and catfish.

For more information regarding fish consumption advisories, visit the NC Department of Health and Human Services website at http://www.schs.state.nc.us/epi/fish/current.html or call (919) 733-3816.

4.4.3 2002 Recommendations

DWQ, in cooperation with Weyerhaeuser Company, will continue to monitor for dioxin contamination and will work closely with the Department of Health and Human Service's Division of Public Health to lift the advisory when there is no longer a risk to human health from consumption of fish.

DWQ Mercury Workgroup

DWQ is committed to characterizing methylmercury exposure levels and determining if NPDES sources need to be controlled. DWQ formed an internal Mercury Workgroup to improve communication which directly affect mercury issues (i.e., Pretreatment, Environmental Sciences, Basinwide and Estuary Planning, etc.). The workgroup meets as needed to share information and determine next steps in addressing mercury issues associated with the aquatic environment.

Improved Ambient Sampling Techniques

DWQ aims to stay abreast of new technology and sampling techniques to ensure that water quality data are accurate, precise and of highest value. In 2000, DWQ started training water quality sampling staff on the new EPA Method 1631 technique. Current monitoring using a higher detection limit (EPA Method 245.1) has consistently yielded non-detected values, and DWQ aims to use the 1631 method to allow detection levels three orders of magnitude lower than EPA Method 245.1.

Regional Mercury Study

In an effort to better manage state waters that may have methylmercury issues, DWQ initiated a study through EPA 104(b)(3) funds. The study aims to provide information that may be used in water quality standard and TMDL development. The study goals include:

- determining levels of ambient mercury in the surface water system;
- estimating site-specific total mercury: methylmercury translators to evaluate water quality criteria;
- develop site-specific water to fish bioaccumulation factors; and
- determine levels of mercury in treatment plant effluent.

DWQ aims to complete this study in 2003, and results will be available to the public. For more information, contact the DWQ Planning Branch Modeling/TMDL Supervisor at (919) 733-5083.

DWQ will continue to host an internal workgroup to stay abreast of current mercury issues. The public has voiced concerns that DWQ should be working on the ecological components and consequences of mercury bioavailability to biota in these areas and the biogeochemical cycling and production of methylmercury from associated wetlands along these streams. Though the workgroup does not have a mandate to conduct research into mercury, the workgroup will better communicate its purpose and accomplishments to the public through periodic updates on the DWQ website.

DWQ will also provide interested members of the public with an overview of the new ambient monitoring sampling technique to gather feedback and insights on how DWQ can best accomplish its data collecting goals.

DWQ will continue to monitor concentrations of various contaminants in fish tissue across the state and will work to identify and reduce wastewater contributions of mercury to surface waters. The Division of Air Quality (DAQ) evaluates mercury levels in rainwater on a regular basis through the EPA Mercury Deposition Network. EPA continues to focus on nationwide mercury reductions from stack emissions and through pollution prevention efforts. Pollution prevention efforts are being investigated on a state and federal level to reduce mercury emissions.

4.5 Wetland Loss

4.5.1 Introduction

Wetlands provide a variety of benefits to society and are very important in watershed planning because of the functions they perform. Wetlands provide important protection for flood prevention to protect property values; streambank stabilization to prevent erosion and downstream sedimentation; water purification and pollutant removal (especially for nitrogen and phosphorus); habitat for aquatic life and wildlife and endangered species protection. These values vary greatly with wetland type. Wetlands adjacent to intermittent and permanent streams are most important to protecting water quality in those streams, as well as downstream lakes and estuaries. However, wetlands located away from streams also have important water storage

capacity and pollutant removal potential. Section A, Part 2.6 contains more specific information on the ecological significance of wetlands in the Pasquotank River basin.

4.5.2 Physical Impacts to Wetlands and Streams

DWQ has issued approvals for wetland filling activities since the mid-1980s; however, in 1989, the Environmental Management Commission directed DWQ to begin reviewing wetland fill and stream alteration activities using a review sequence of (1) avoidance, (2) minimization, and (3) mitigation of wetland impacts. Rules finalized in 1996 required that wetland values, such as whether or not the wetland is providing significant uses or whether the filling activity would remove or degrade those uses, be considered. The rules also specify wetland and stream mitigation ratios and type and location of projects to make the mitigation process more predictable and manageable for the regulated community. DWQ's emphasis continues to be on water quality and the essential role that wetlands play in maintaining water quality. The issuance of a 401 Water Quality Certification by DWQ is required before the US Army Corps of Engineers can issue a Section 404 Permit authorizing the fill or alteration of wetlands and/or streams in North Carolina.

Despite efforts to protect and restore wetland and stream functions on the part of DWQ and many other agencies and organizations in North Carolina, there is still an annual net loss of wetlands and streams statewide. DWQ and Division of Land Resources (DLR) regulate construction activities near streams and wetlands. These regulatory programs ensure that construction projects cause minimal damage to these resources and that unavoidable impacts are addressed through mitigation projects. Restoration projects are also funded through the Wetland Restoration Program (WRP), Section 319 Program, Clean Water Management Trust Fund, and Division of Water Resources Grant Program that can help offset stream and wetland impacts (NCDENR-DWQ-WRP, 1998).

DWQ tracks wetland and stream losses that are authorized through the issuance of a 401 Water Quality Certification. In addition to the permitted wetland and stream impacts that are tracked by DWQ, an unknown amount of permanent wetland and stream losses also occurs. Projects that affect less than one-third of an acre of wetland or less than 150 linear feet of stream are not required to receive written confirmation from DWQ, and therefore, might not be reported. The magnitude of unauthorized impacts to wetlands and streams is not known.

In June 1998, a federal court declared that the US Army Corps of Engineers' Tulloch Rule, which prohibited the ditching and draining of wetlands, was illegal. As a result, during FY 1999-2000, approximately 9,220 acres of wetlands on about 80 sites (mostly in southeastern NC) were ditched and drained. This activity stopped in March 1999 when DWQ began to enforce its wetland standards. DWQ, EPA and DLR have spent an extensive amount of time visiting each of these sites to check for compliance with environmental rules. Most of these wetlands were slated to be restored by December 2000.

Over the past six years (1995-2000), DWQ issued permits for approximately 369.62 acres of wetland fill activities and alteration activities in the Pasquotank River basin (Table A-30). One of the largest impacts occurred in the Pasquotank River subbasin which includes Currituck Sound and the North River subbasin (subbasin 03-01-54) involving 242.63 acres of permitted

wetland impacts. Overall, there have 4,790.63 acres of wetlands mitigated than impacted in the basin.

Table A-30 Permitted Wetland Impacts Activities (in Acres) by Subbasin and Year

Subbasin Number	1995	1996	1997	1998	1999	2000	Total
03-01-50	1.25	2.59	10.56	1.57	0.51	0.5	**16.98**
03-01-51	0.53	1.04	0.26	40.35	10.74	1.44	**54.36**
03-01-52	28.73	5.09	1.05	0.07	1.02	1.41	**37.37**
03-01-53	0.67	0	0.33	0	0.6	0.06	**1.66**
03-01-54	242.63	1.72	1.23	1.32	0.74	1.44	**249.08**
03-01-55	0.62	1.34	3.05	1.67	1.42	1.62	**9.72**
03-01-56	0.16	0	0.14	0.01	0.01	0.13	**0.45**
Total Acres	**274.59**	**11.78**	**16.62**	**44.99**	**15.04**	**6.60**	**369.62**

Table A-31 Permitted Wetland Mitigation Activities (in Acres) by Subbasin and Year

Subbasin Number	1995	1996	1997	1998	1999	2000	Total
03-01-50	0.5	0	20.6	0	0	0	**21.1**
03-01-51	0	4000	0	42.9	0	0	**4,042.9**
03-01-52	0	0	0	0	0	0.25	**0.25**
03-01-53	640	0	0	0	0	0	**640**
03-01-54	74.74	0	0.2	0	0	0	**74.94**
03-01-55	0	0	11.44	0	0	0	**11.44**
03-01-56	0	0	0	0	0	0	**0**
Total Acres	**715.24**	**4,000**	**32.24**	**42.9**	**0**	**0.25**	**4,790.63**

4.5.3 2002 Recommendations

Through protecting wetlands, local decision-makers can reduce the likelihood of nonpoint source contamination of surface waters. DWQ recommends that local governments consider the value of wetlands and include protection of wetlands in land use plans. DWQ will provide funding source information upon request to local governments for opportunities to restore, enhance or create wetlands.

4.6 Effects of Hurricanes on Water Quality

The Pasquotank River basin in North Carolina is periodically subjected to hurricanes and tropical storms. Aquatic ecosystems and water quality can, and do, recover from the wind damage and

extensive flooding that result from these storms. However, human activities in hurricane-prone areas can greatly increase the extent and severity of water quality and ecosystem impacts, as well as the system's recovery time.

In September 1999, Hurricane Floyd made landfall in North Carolina, only a few days after Hurricane/Tropical Storm Dennis made two passes across the eastern part of the state. Flooding in eastern North Carolina was higher and more extensive than any ever recorded. Many towns and homes were completely flooded, bridges and buildings were washed downstream, animal waste lagoons breached, and wastewater treatment plants were inundated. Floyd resulted in more fatalities than any hurricane since 1972 and thousands were left homeless (Bales, 2000). In terms of water quality impacts, DWQ scientists note that the Pasquotank River basin did not experience hurricane-related fish kills in recent years as compared with the more southern areas such as the Neuse River and Cape Fear River basins (NCDENR-DWQ, 1999).

4.6.1 Contaminants

Floods can transport large amounts of materials from the land into surface waters, inundate areas that are contaminated with various substances, flood wastewater treatment facilities that may be located in or near the floodplain, and result in the failure of animal waste lagoons. The large volume of water transported during Hurricane Floyd demonstrated that flooding could result in the transport of a large mass of pollutants through watersheds and into the estuaries of eastern North Carolina. Pollutants that can be carried into waters during large floods include excess nutrients (nitrogen, phosphorus and organic carbon), bacteria and other pathogens, pesticides and fuels, and sediment. As a result of contamination by these pollutants, dissolved oxygen can be depleted, causing stress (or death) to fish and other aquatic life. Salt concentrations in the estuaries can also be affected by the large volume of freshwater flowing into the system within a short period of time.

4.6.2 De-Snagging

The Natural Resources Conservation Services' (NRCS) Emergency Watershed Protection (EWP) is responsible for emergency de-snagging (removal of piles of woody debris from stream and river channels) activities. The EWP program is intended to respond to watersheds impacted by natural disasters such as hurricanes, floods and fire. The purpose of the program is to restore watershed functions to predisaster conditions. Areas selected for debris removal are based on the amount and location of debris and the increased risk of flooding to improved property (including cropland), or public safety (primarily roads and bridges). Location maps and a description of all proposed work is sent to appropriate federal and state agencies for review and comment prior to contracting the work. The programs' intent is to consider environmental concerns.

The activity of debris removal is of great interest to DWQ as the excessive removal of debris can impact the aquatic habitat and aquatic life within a stream reach. The decision to remove debris is made by considering topography, proximity of improved property subject to damage, location of culverts, bridges and other restrictions, comparison of costs and benefits, and potential environmental impacts. NRCS, along with other state and federal agencies, is in the process of developing guidelines for debris removal that will improve the decision-making process with regard to eligibility and damage thresholds, as well as improving the standards and specifications

for removing woody debris in a manner that leaves enough to provide suitable habitat. Debris removal under EWP is not intended to remove all debris from stream channels, only that which causes or may cause an increased risk of flooding or streambank erosion.

Woody debris is the predominant habitat for benthic macroinvertebrates in larger, slower-moving coastal stream and wetland systems. Therefore, removal of these snags removes the habitat available for aquatic life. If care is not taken in properly removing woody debris, the streambanks and streambed can be altered as well as causing moderate to severe habitat degradation.

4.6.3 2002 Recommendations

DWQ is aware of the need to remove obstructions to water flow, including snags, near bridges or other structures in emergency situations because of safety concerns, to reduce economic loss in the event of natural disasters, and to reduce the risk of flooding. NRCS has recently adopted an Interagency Coordination and Implementation Plan for the EWP program that allows for a direct and ongoing role for several agencies to play in the implementation process. The method in which snags are removed, the amount of debris that is removed, and the sites selected should all be chosen following a thorough review by the various agencies responsible for the implementation of the EWP program. Local governments that receive additional funding for this type of activity should also implement the same management strategies as outlined in the EWP implementation plan to reduce impacts to water quality, aquatic habitat and aquatic life.

4.7 Aquaculture

North Carolina has a growing aquaculture industry. The industry is considered an agricultural venture in the state. Aquaculture is the business of farming aquatic plants and animals. In North Carolina, farmers grow trout, catfish, hybrid striped bass, crawfish, ornamental fish, baitfish, clams and oysters. The NC Department of Agriculture is the lead agency for aquaculture, and it considers North Carolina one of the most aquaculture-friendly states in the US (http://www.agr.state.nc.us/fooddist/aquacult/general.html). Given the state's promotion of the industry, the state should expect to see an increase in production in the upcoming years.

DWQ has concerns about the amount of fish tissue that is produced by each facility, specifically regarding the tracking mechanisms in place. DWQ also has concerns about the potential discharge of high salinity waters into adjacent SA waters and primary nursery areas.

4.7.1 2002 Recommendations

DWQ will develop a workgroup to look at the potential impacts of aquaculture on surface and groundwater quality. DWQ will generate a strategic plan for addressing aquaculture facilities, and DWQ will share the information with the public through its website.

4.8 Water Control Structures

Due to the high groundwater table in eastern North Carolina, agriculturalists tend to alter the local hydrology in an effort to maximize their crop. This alteration can take the form of channelizations and water control structures.

In addition, there are a multitude of stormwater discharges into the Atlantic Ocean. These discharges can affect public health, and thus, swimming use support.

4.8.1 2002 Recommendations

DWQ has begun discussions with Weyerhaeuser in southeast North Carolina. DWQ will facilitate an information exchange between major landholders in the basin that currently use or may use water control structures in the future. This information exchange will hopefully lead to better technology transfer between large landholders, ultimately improving the local water quality around the large plats of land.

DEH is currently mapping the geographic location of stormwater drains in the coastal area. DEH is sharing this information with DWQ. Both Divisions will discuss effective use support methodology to ensure that current and proposed stormwater discharges minimize their impairment of surface waters in the Pasquotank River basin.

4.9 Growth Management

Urbanization often has greater hydrologic effects than any other land use, as native watershed vegetation is replaced with impervious surfaces in the form of paved roads, buildings, parking lots, and residential homes and yards. Urbanization results in increased surface runoff and correspondingly earlier and higher peak flows after storms. Flooding frequency is also increased. These effects are compounded when small streams are channelized (straightened) or piped and storm sewer systems are installed to increase transport of drainage waters downstream. Bank scour from these frequent high flow events tends to enlarge urban streams and increases suspended sediment. Scouring also destroys the variety of habitat in streams leading to degradation of benthic macroinvertebrate populations and loss of fisheries (EPA, 1999).

The population in the Pasquotank River basin is expected to increase significantly along the coastline by 2020. Most of the growth will be on the coast and around existing urban areas. As populations expand, so do developed areas. Some local governments have prioritized water quality planning. However, proactive planning efforts at the local level are needed across the entire basin in order to assure that development is done in a manner that minimizes impacts to water quality.

Urban runoff also carries a wide variety of contaminants to streams including oil and grease from roads and parking lots, street litter, bacterial contaminates and pollutants from the atmosphere. Generally, there are a larger number of point source discharges in urban areas. Cumulative impacts from habitat alterations, point and nonpoint source pollution can cause severe impairment to urban streams.

The presence of intact riparian buffers and/or wetlands in urban areas can lessen these impacts, and restoration of these watershed features should be considered where feasible; however, the amount of impervious cover should be limited as much as possible. Wide streets, huge cul-de-sacs, long driveways and sidewalks lining both sides of the street are all features of urban development that create excess impervious cover and consume natural areas.

Public education is needed in the Pasquotank River basin in order for citizens to understand the value of urban planning and stormwater management. Action should be taken by county governments and municipalities to plan for new development in urban and rural areas. 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.

Proactive planning efforts at the local level are needed to assure that development 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. Growth management requires planning for the needs of future population increases, 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.

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.

4.9.1 Stormwater Programs

In addition to the current NPDES stormwater permitting, DWQ is developing a permitting and program strategy to address the EPA proposed Phase II stormwater permitting program requirements. The Phase II program will be directed towards smaller municipalities and construction sites. At present, Phase II requirements will be handled with existing state staff. Elizabeth City will fall within the Phase II requirements. For more information on the state NPDES stormwater program, contact the Stormwater and General Permits Unit at (919) 733-5083.

DWQ administers a number of programs aimed at controlling stormwater runoff in the Pasquotank River basin. These include: 1) in the "coastal" counties as defined by the Coastal Area Management Act (CAMA); 2) NPDES stormwater permit requirements for industrial activities and municipalities; and 3) NPDES stormwater permit requirements for construction or land development activities on one acre of land or more. For more detailed information on current and proposed stormwater rules, refer to Section 2.7.

4.10 Priority Issues for the Next Five Years

4.10.1 Introduction

Clean water is crucial to the health, economic and ecological well-being of the state. Tourism, water supplies, recreation and a high quality of life for residents are dependent on the water resources within any given river basin. Water quality problems are varied and complex. Inevitably, water quality impairment is due to human activities within the watershed. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge. Looking to the future, water quality in this basin will depend on the manner in which growth and development occur.

The long-range mission of basinwide management is to provide a means of addressing the complex problem of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Pasquotank River basin's surface waters. In striving towards its mission, DWQ's highest priority near-term goals are to:

- identify and restore impaired waters in the basin;
- identify and protect high value resource waters and biological communities of special importance; and
- protect unimpaired waters while allowing for reasonable economic growth.

4.10.2 Strategies for Restoring and Protecting Impaired Waters

Impaired waters are those waters identified in Section A, Chapter 3 as partially supporting (PS) or not supporting (NS) their designated uses based on DWQ monitoring data. These waters are summarized by subbasin in Table A-25. The impaired waters are also discussed individually in the subbasin chapters in Section B.

These waters are impaired, at least in part, due to nonpoint sources (NPS) of pollution. The tasks of identifying NPS pollution and developing management strategies for these impaired waters are resource intensive. Accomplishing these tasks is overwhelming, given the current limited resources of state and local governments. Therefore, only limited progress towards restoring NPS impaired waters can be expected during this five-year cycle unless substantial resources address NPS problems.

DWQ plans to further evaluate the impaired waters in the Pasquotank River basin in conjunction with other NPS agencies and develop management strategies for a portion of these impaired waters for the next Pasquotank River Basinwide Water Quality Plan, in accordance with the requirements of Section 303(d) (see Part 4.10.3 below).

4.10.3 Addressing Waters on the State's 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 priority. The waters in the Pasquotank River basin that are on this list are

presented in the individual subbasin descriptions in Section B. For information on listing requirements and approaches, refer to Appendix IV.

Section 303(d) of the federal Clean Water Act requires states to develop a 303(d) 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. In the last few years, the TMDL program has received a great deal of attention as the result of a number of lawsuits filed across the country against EPA. These lawsuits argue that TMDLs have not adequately been developed for specific impaired waters. As a result of these lawsuits, EPA issued a guidance memorandum in August 1997 that called for states to develop schedules for developing TMDLs for all waters on the 303(d) list. The schedules for TMDL development, according to this EPA memo, are to span 8-13 years.

There are approximately 2,387 impaired stream miles on the 303(d) list in NC. The rigorous and demanding task of developing TMDLs for each of these waters during an 8 to 13-year time frame will require the focus of much of the water quality program's resources. Therefore, it will be a priority for North Carolina's water quality programs over the next several years to develop TMDLs for 303(d) listed waters.

Section B

Water Quality Data
and
Information by Subbasin

Chapter 1 –
Pasquotank River Subbasin 03-01-50
Includes Pasquotank River and Tributaries

1.1 Water Quality Overview

Subbasin 03-01-50 at a Glance

Land and Water

Total area:	454 mi^2
Land area:	390 mi^2
Water area:	64 mi^2

Population Statistics

1990 Est. pop.:	31,369 people
Pop. density:	80 persons / mi^2

Land Cover (%)

Forest / Wetland:	46%
Surface Water:	18%
Urban:	<1%
Cultivated Crop:	34%
Pasture / Managed Herbaceous:	1%

This subbasin consists of the Pasquotank River and its tributaries in Camden, Pasquotank and Gates counties. The headwaters of the Pasquotank River include freshwater in the Great Dismal Swamp. Southward, a significant portion of the waters in this subbasin is brackish estuarine, including Albemarle Sound and the Pasquotank River below Elizabeth City. A map of this subbasin including water quality sampling locations is presented as Figure B-1.

DWQ conducted ambient and benthic macroinvertebrate sampling in this subbasin. Bioclassifications for these sample locations are presented in Table B-1. Use support ratings are summarized in Table B-2. Refer to Appendix III for a complete listing of monitored waters and use support methods.

This subbasin includes the Great Dismal Swamp Wildlife Refuge and portions of the Great Marsh. In addition, the subbasin has Significant Natural Heritage Areas near the mouth of the Pasquotank River.

There are seven permitted dischargers in the subbasin. The Elizabeth City WWTP is the only major discharge, which discharges into the Pasquotank River. Also, there are 15 general permits. Two facilities: the Elizabeth City Wastewater Treatment Plant and the US Coast Guard are required under permit to perform whole effluent toxicity testing in the subbasin. The Elizabeth City WWTP experienced problems during 1997, and the causes of their toxicity testing failures are not clear. Since September of 1997, the facility has not failed a test. There is one individual stormwater permit issued in the subbasin for Universal Forest Products Eastern Division, Inc.

Benthic macroinvertebrate data have been collected at five sites since the fall of 1995. However, these data are not rated, and therefore, offer little indication of the water quality status of the Pasquotank River basin.

Figure B-1 Pasquotank River Subbasin 03-01-50

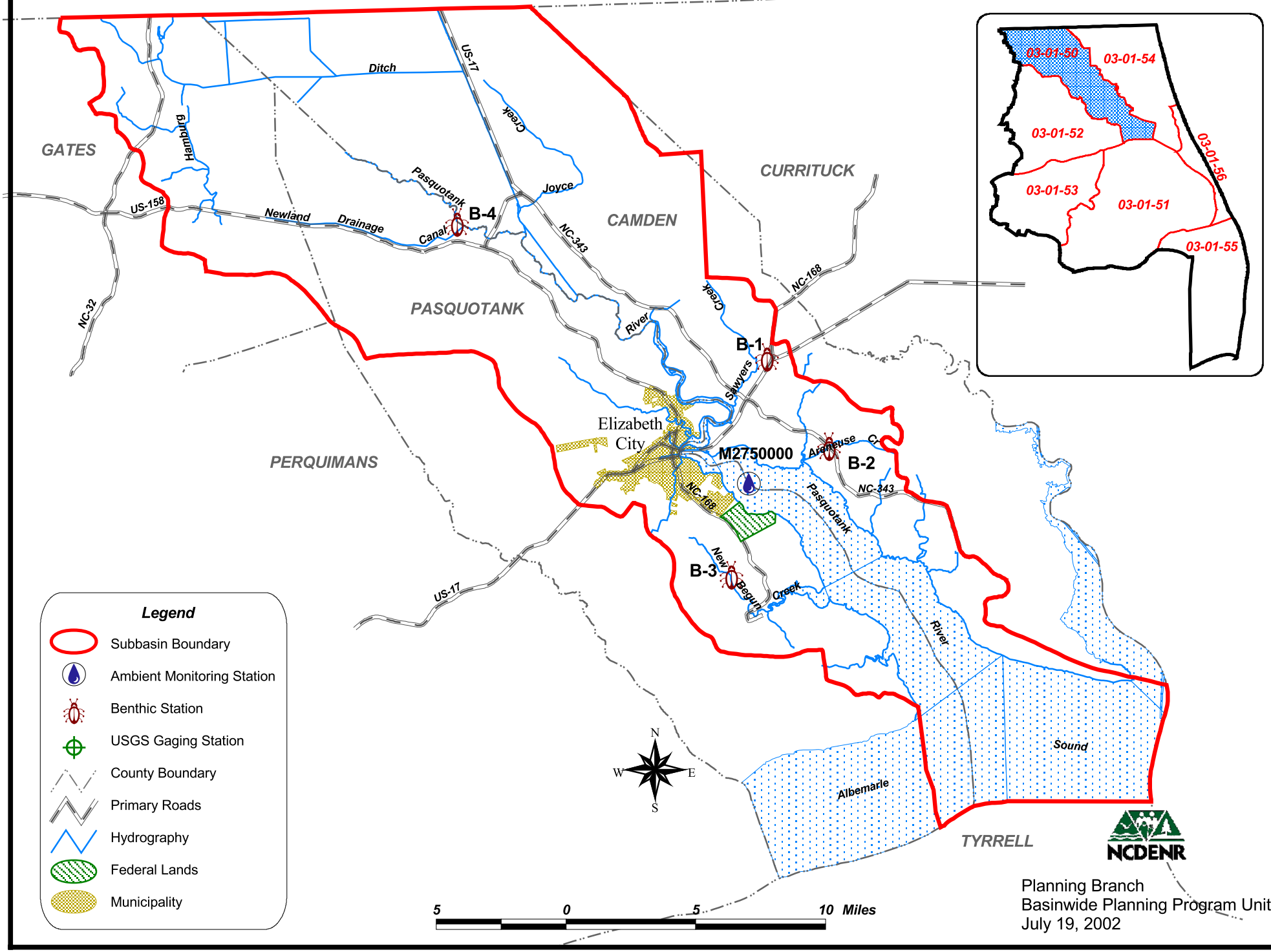


Table B-1 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (2000) for Pasquotank River Subbasin 03-01-50

Site(s)	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
Freshwater				
B-4	Pasquotank River	Pasquotank	End of SR 1361	Not Rated
B-5	Pasquotank River	Pasquotank	Goat Island	Not Rated
B-1	Sawyers Creek	Camden	SR 1200	Not Rated
B-2	Areneuse Creek	Camden	NC 343	Not Rated
B-3	Newbegun	Camden	SR 1132	Not Rated
Ambient Monitoring				***Problem Parameters***
M2750000	Pasquotank River	Pasquotank	at Elizabeth City	pH

* Refer to Section A, Part 3.3 for more information on fish community and benthic macroinvertebrate bioclassifications.

Table B-2 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Freshwater Streams (Miles) in Pasquotank River Subbasin 03-01-50

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	28,665.8 estuarine ac	0	0	132.4 mi 23,208.9 estuarine ac	132.4 mi 51,874.7 estuarine ac
Primary Recreation	37,851.5 estuarine ac			93.3 estuarine ac	37,944.8 estuarine ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, January 2002), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

1.2 Status and Recommendations for Previously Impaired Waters

The 1997 Pasquotank River Basinwide Plan identified no impaired stream segments in this subbasin.

1.3 Status and Recommendations for Newly Impaired Waters

The four benthic monitoring sites in this subbasin are currently not rated because criteria for assigning bioclassifications to swamp streams are still in draft form (page 67). There are no other newly impaired waters in this subbasin.

1.4 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

1.4.1 Pasquotank River

Current Status

The Pasquotank River is currently not rated. There are indications that urban stormwater runoff may be adversely affecting water quality in the Pasquotank River near Elizabeth City. Elizabeth City operates a wastewater treatment plant, and its influent chamber has experienced chronic overflows to Knobbs Creek. DWQ believes that the overflows do not warrant a Special Order by Consent (SOC) at the present time. Instead, DWQ believes that the facility has maintenance issues with insufficient operational oversight.

2002 Recommendations

As of March 2002, DWQ believes the situation has been rectified regarding the wastewater treatment plant's influent chamber. DWQ has appreciated Elizabeth City's efforts in keeping the state abreast of the city's efforts to correct this problem. Elizabeth City will be required to apply for a NPDES Phase II stormwater permit by March 2003. DWQ is currently developing rules to implement Phase II.

Water Supply Watersheds

Elizabeth City informed DWQ's Water Supply Protection Program that they might permanently stop using their water supply intake. As of April 2002, a decision was not finalized regarding this issue.

2002 Recommendations

DWQ recommends that Elizabeth City decide whether they wish to use the Pasquotank River as a raw water supply source. If Elizabeth City decides not to use the Pasquotank River as a raw drinking water supply source, then the river could be reclassified for non-water supply use. In order for DWQ to consider the reclassification, a request for the reclassification must be submitted to DWQ. As of April 2002, DWQ has not received any requests from Elizabeth City. Until then, Elizabeth City, Pasquotank County and Camden County are required to implement water supply watershed protection ordinances that meet or exceed the state's rules.

1.4.2 Albermarle Sound

Current Status
Albemarle Sound is currently not rated. Small areas of the sound may be adversely affected by increased development in this subbasin. A new golf community, *Fortune Bay*, is proposed for 606 acres at Currituck Point. The facility will affect 400 acres of wetlands, and it proposes to discharge into SB waters of the Albemarle Sound.

2002 Recommendations
DWQ recommends that Fortune Bay reuse high quality water at its facility to limit the amount of discharge into SB waters.

1.4.3 Areneuse Creek

Current Status
Areneuse Creek is currently not rated. The DWQ Regional Office indicated that there have been numerous algal blooms near the canals of Areneuse Creek. Potential contributing sources to the algal bloom may include increased local development.

2002 Recommendations
DWQ will continue to monitor Areneuse Creek to evaluate potential impacts of algal blooms.

Chapter 2 -
Pasquotank River Subbasin 03-01-51
Includes the Alligator River, Croatan Sound and a portion of Albemarle Sound Watershed

2.1 Water Quality Overview

Subbasin 03-01-51 at a Glance

Land and Water

Total area:	978 mi^2
Land area:	568 mi^2
Water area:	410 mi^2

Population Statistics

1990 Est. pop.:	9,240 people
Pop. density:	16 persons / mi^2

Land Cover (%)

Forest / Wetland:	53
Surface Water:	39
Urban:	<1
Cultivated Crop:	8
Pasture / Managed Herbaceous:	<1

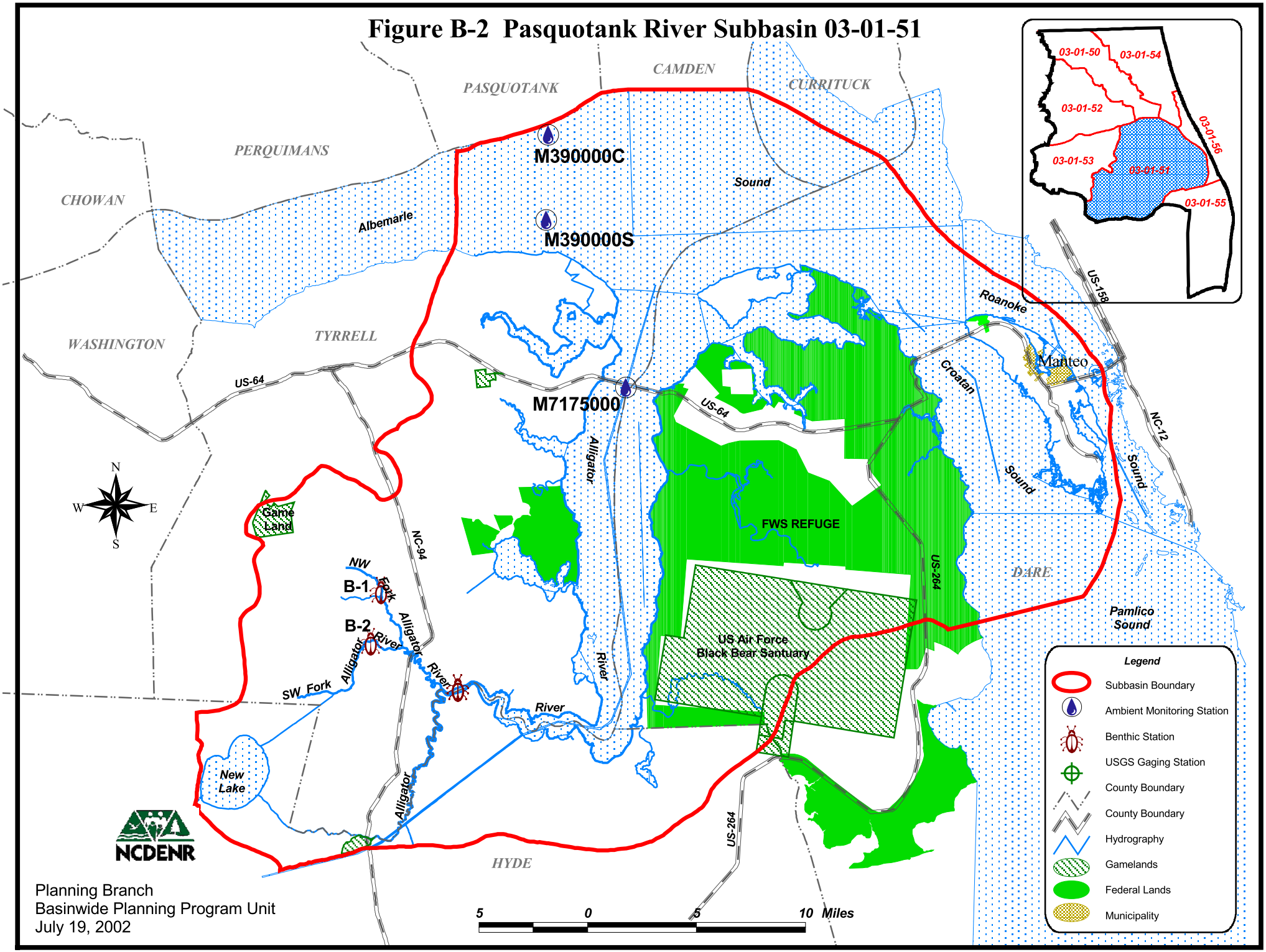
This subbasin consists of the Alligator River and its tributaries, Alligator (New) Lake, part of Albemarle Sound, Croatan Sound, Roanoke Island, and part of Roanoke Sound in Dare, Tyrrell and Hyde counties. Most waters in this subbasin are brackish estuarine, including Albemarle, Croatan and Roanoke Sounds, and the Alligator River to the Intracoastal Waterway (ICWW). A map of this subbasin including water quality sampling locations is presented as Figure B-2.

The Alligator River upstream of US 64 and all of its natural tributaries (not canals, Alligator Lake or ICWW) are classified as Outstanding Resource Waters. Two tributaries to Shallowbag Bay (upper Scarboro Creek and Doughs Creek) are classified as High Quality Waters based on their designations by the Marine Fisheries Commission as primary nursery areas.

DWQ conducted benthic macroinvertebrate, phytoplankton and ambient sampling in this subbasin. Biological ratings for these sample locations are presented in Table B-3. Table B-4 summarizes use support ratings in subbasin 03-01-51. Refer to Appendix III for a complete listing of monitored waters and for more information on use support ratings.

This subbasin contains a mixture of public lands and Significant Natural Heritage Areas including Roper Island, Durant Island, Pocosin Lakes National Wildlife Reserve, the Alligator River National Wildlife Refuge and the Preyer Reserve. Roanoke Island, with the towns of Manteo and Wanchese, is the most developed area in this subbasin. This subbasin contains the lowest population density (16 persons/square mile) in the entire Pasquotank River basin. The basinwide average is 46 persons/square mile.

Figure B-2 Pasquotank River Subbasin 03-01-51



Planning Branch
Basinwide Planning Program Unit
July 19, 2002

Table B-3 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (2000) for Pasquotank River Subbasin 03-01-51

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
Freshwater, Swamp				
B-1	NW Fork Alligator River	Tyrrell	Canoe Trail Mile 4	Not Rated
B-2	SW Fork Alligator River	Tyrrell	Canoe Trail Mile 2	Not Rated
Ambient Monitoring				***Problem Parameters***
M7175000	Alligator River	Tyrrell	at US 64 near Alligator	pH
M390000C	Albemarle Sound	Tyrrell	near Frog Island mid channel	None observed
M390000S	Albemarle Sound	Tyrrell	near Frog Island south shore	None observed

* Refer to Section A, Part 3.3 for more information on fish community and benthic macroinvertebrate bioclassifications.

Table B-4 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Freshwater Streams (Miles) in Pasquotank River Subbasin 03-01-51

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	124,679.0 estuarine ac	0	0	70.0 mi 5,747.4 fresh ac 109,828.1 estuarine ac	70.0 mi 5747.4 fresh ac 234,507.1 estuarine ac
Primary Recreation	149,130.1 estuarine ac	0	0	13,004.7 estuarine ac	162,134.8 estuarine ac
Shellfish Harvest	52,791.3 estuarine ac		1,959.3 estuarine ac	0	54,750.6 estuarine ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

There are six permitted dischargers in the subbasin. The Town of Manteo's Wastewater Treatment Plant is the only major discharge, which discharges into Shallowbag Bay. The Manteo plant is the only facility required to perform whole effluent toxicity testing in the subbasin. Before 2000, the plant met their permit limit or met a target monitoring value, and it only failed to meet its permit limit or target value three times. In 2000, the facility had no toxicity testing failures. There are no permitted individual stormwater permits issued in the subbasin, but there are five general permits.

Benthos were collected at two freshwater sites and no estuarine sites within this subbasin; however, these data are not rated; and therefore, they currently offer little indication of the water quality status of the Pasquotank River basin (Table B-3). For more information, refer to Section A, Chapter 4.

Although the benthos sampling sites were not rated, the field visits relay information crucial to water quality determinations. The upper reaches of the Alligator River were found to have elevated nitrogen concentrations, low pH and low dissolved oxygen concentrations. The low pH values suggested that much of the oxygen problem was related to drainage from Hollow Ground Swamp, but possible effects from agricultural runoff around New Lake could not be ruled out. Some of the tributary streams in Dare County were sampled in 1999 and 2000, and the sampling indicated that the ditches and canals had a limited macroinvertebrate fauna, were dominated by pollution tolerant species, and displayed low DO.

The Northwest Fork of the Alligator River had a low dissolved oxygen and low pH, indicative of natural conditions. The Southwest Fork of the Alligator River had a higher conductance, less macrophytes, and more filamentous algae than the Northwest Fork, indicating a greater enrichment at this site.

During the last five years, phytoplankton monitoring has been confined to a single station in Albemarle Sound near Frog Island. A series of tropical storms in 1999 led to increased phytoplankton biovolumes in August and September. Though the total phosphorous and inorganic and organic nitrogen measurements recorded during the sampling period did not change much, the phytoplankton biovolume fluctuated at the Frog Island sampling site.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, January 2002), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

2.2 Status and Recommendations for Previously Impaired Waters

The 1997 Pasquotank River Basinwide Plan identified no impaired stream segments in this subbasin.

2.3 Status and Recommendations for Newly Impaired Waters

No additional stream segments were rated as impaired in this subbasin based on recent DWQ monitoring (1995-2000). Class SA waters are discussed below in Section 2.4.

2.4 Impaired Class SA Waters

There are 54,750.6 acres of Class SA waters in this subbasin that were assessed in the shellfish harvesting use support category. In this subbasin, 1,959.3 (3.6%) are considered impaired for the shellfish harvesting use support category. Refer to Figure B-3 to identify locations of DEH SS growing areas and growing area classifications. The larger water areas in this subbasin are described below with reference to DEH SS growing areas. The problem parameter for all waters listed below is fecal coliform bacteria contamination. Refer to page 61 for recommendations to address impairment in Class SA waters.

The differences in acreage estimates between basinwide cycles are not necessarily related to changes in water quality, but to different methods of estimating acreage and changes in use support methodology. For more information on changes in use support methodology, refer to Appendix III and page 59. For a complete listing of monitored Class SA waters, refer to Appendix III.

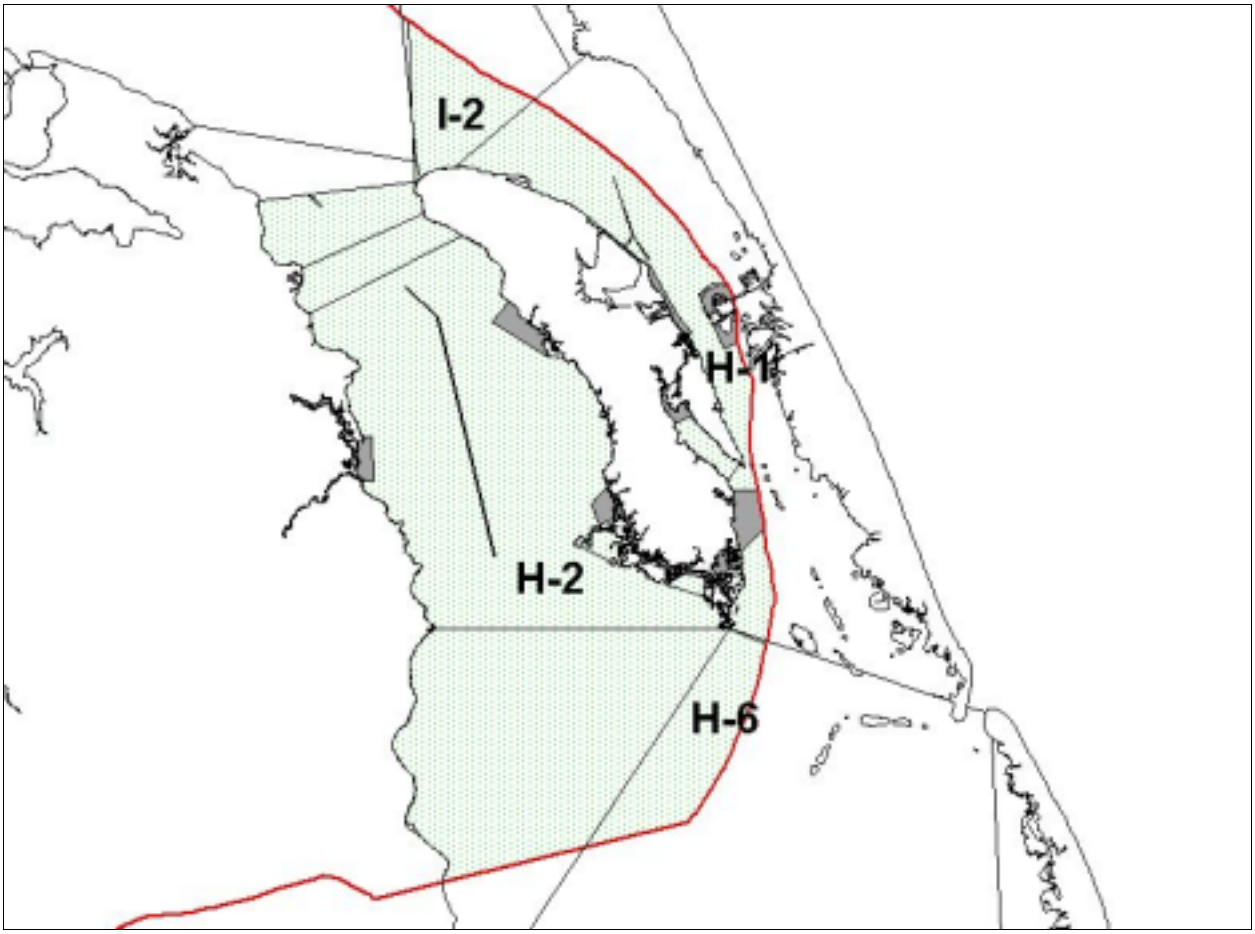


Figure B-3 DEH Shellfish Growing Area Classifications in SA Waters of Subbasin 03-01-51

West Shore of Roanoke Sound (Area H-1)

DEH Growing Area H-1 contains the waters of the Roanoke Sound. Class SA waters currently prohibited for commercial shellfish harvesting include portions of The Cut Through, Broad Creek, Roanoke Sound, Sand Beach Creek and John's Creek. Contamination sources included nonpoint source pollution from adjacent land uses. Little change in water quality occurred throughout the area between 1993-1999 (NCDENR-DEH, H1).

The Wanchese Harbor Project is permitted for discharge into Mill Creek (SC). DWQ has concerns about the potential impacts of the project on adjacent SA waters of Roanoke Sound once the facility is operational. These waters are currently prohibited to shellfish harvesting.

A proposed marina is seeking a permit near Wanchese on the eastern side of Roanoke Island in the Roanoke Sound. The facility would close 250 acres of SA waters in accordance with rule. This area is currently a commercially productive, open area with shellfish leases and potential water quality impacts could result due to the associated development. The project received a Finding of No Significant Impact (FONSI) when reviewed under the National Environmental Policy Act Environmental Assessment process.

2002 Recommendations
DWQ will review the Wanchese Harbor Project's discharge permits to include fecal coliform monitoring requirements in the SA waters at the mouth of Mill Creek. DWQ, DEH and the permittees will discuss monitoring locations, frequency and parameters. DWQ recommends that the applicant develop an Environmental Impact Statement given the closure of SA waters to commercial shellfish harvest uses.

Croatan Sound (Area H-2)

Waters currently prohibited for commercial shellfish harvesting include portions of Manns Harbor, Spencer Creek, Callaghan Creek and a couple of large areas in Croatan Sound. Contamination sources included nonpoint source pollution from adjacent land uses. Little change in water quality occurred throughout the area between 1990-1998 (NCDENR-DEH, H2).

2.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

2.5.1 Shallowbag Bay

Current Status
Shallowbag Bay is currently not rated. In 1986, DWQ received a request from the Town of Manteo for reclassification of Shallowbag Bay from SC to SB waters. In 1988, the town requested that Shallowbag Bay be reclassified from Class SC to Class SA waters. In 1990, DWQ informed the Town of Manteo that a reclassification to Class SA was not possible due to the existing wastewater treatment plant discharge into the bay. The Town of Manteo completed building a new plant and dismantled the old plant several years ago. DEH Recreational Water Quality Monitoring Program has not posted closures in Shallowbag Bay. Shallowbag Bay is currently prohibited to shellfish harvesting.

Shallowbag Bay experienced a dredge spill in a tidal creek near Wanchese. The state continues to clean up the spoils. Some of the material was placed on a local beach; however, the particle size is not appropriate for the beach.

2002 Recommendations

DWQ will discuss reclassification of Shallowbag Bay from SC waters to SB waters with the Town of Manteo.

DWQ recommends that dredge spoil analysis consider the full range of particle sizes within potential spoils rather than focusing on the average particle size within the spoil. Projects designed for the average particle size of the dredge spoil can negatively impact local water quality.

2.5.2 Callaghan Creek

In December 1998, the DWQ Regional Office requested a study involving fire response efforts at the Dare County landfill located in subbasin 03-01-51. Construction materials in the landfill had caught fire and burned for several weeks in the fall of 1998, requiring a great deal of water to address the fire. The regional office was interested in determining the effects of any runoff from the fire into waters of the state. Manns Harbor Fire Department built a berm around the burning portion of the landfill, flooded it with 0.5-1 m of water, and then, pushed portions of the burning pile through the water and into a new, extinguished pile. On one or two occasions, the berm was breached to let some water out, but minimal water was thought to have escaped into the adjacent canal system. Water in this canal could possibly flow into a nearby field and around the dikes, potentially affecting Callaghan Creek.

DWQ conducted an on-site assessment and collected water samples for toxicity testing, chemical sampling and macroinvertebrate sampling. Only two of the sites tested for toxicity failed their tests: Station 1 inside the burning landfill; and the reference site, Station 8. Since these two sites had the highest salinity, it is possible that salt is a major factor causing the toxicity. However, the extremely high metal levels inside the berm were also having an impact at Station 1. These metals included Silver, Selenium, Copper, Zinc, Arsenic, Aluminum, Lead, Manganese and Iron.

Phenol and methyl phenol were the only semi-volatile compounds released by the fire. Elevated levels of most of these parameters appeared to be confined to Dare County property; however, there is a chance that continued operation of the firewater pump could spread the contaminants to a larger area. Periodic sampling may be required to verify that significant levels of metals are not leaving the property.

There are some impacts to the macroinvertebrate community by runoff from the landfill fire, but these appear to have been confined to waters nearest the landfill. Appropriate disposal options for water inside the berm need to be considered.

2002 Recommendations

In response to the special study conducted at the Dare County Landfill in December 1998, DWQ will conduct a follow-up study on Callaghan Creek to determine if the fire response effects were contained and diminished. In addition, DWQ Washington Regional Staff will work with Dare County and the Landfill Managers to generate appropriate disposal options for water inside the berm as well as a fire response plan.

Chapter 3 -
Pasquotank River Subbasin 03-01-52
Includes Perquimans River, Little River and Tributaries

3.1 Water Quality Overview

Subbasin 03-01-52 at a Glance

Land and Water

Total area:	541 mi^2
Land area:	399 mi^2
Water area:	142 mi^2

Population Statistics

1990 Est. pop.:	18,399 people
Pop. density:	46 persons / mi^2

Land Cover (%)

Forest / Wetland:	32
Surface Water:	28
Urban:	<1
Cultivated Crop:	39
Pasture / Managed Herbaceous:	1

This Pasquotank River subbasin consists of the northwestern edge of Albemarle Sound and the rivers that empty to it. The largest of these rivers are the Little River and the Perquimans River. The Perquimans River originates in the Great Dismal Swamp and flows south before emptying into Albemarle Sound. A map including water quality sampling locations is presented as Figure B-4. The largest town in this subbasin is Hertford.

DWQ conducted benthic macroinvertebrate and ambient water quality sampling in this subbasin. Biological ratings for these sample locations are presented in Table B-5. Use support ratings are summarized in Table B-6. Refer to Appendix II for a complete listing of monitored waters and Appendix III for use support ratings. There are few indications of water quality problems in the subbasin.

A small portion of the land area near the mouths of the Yeopim, Perquimans and Little River is designated as Significant Natural Heritage Areas.

There are five permitted dischargers in the subbasin; none of which are major permit holders. Four general permits are currently issued in the basin. No facilities are required under permit to perform whole effluent toxicity testing in the subbasin. There is only one facility with a NPDES individual stormwater permit issued in the subbasin, South Atlantic Wood Preserving, discharging into the Little River.

Benthic macroinvertebrates have been collected at four freshwater sites within this subbasin; however, these data are not rated; and therefore, they currently offer little indication of the water quality status of the Pasquotank River basin.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, January 2002), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

Figure B-4 Pasquotank River Subbasin 03-01-52

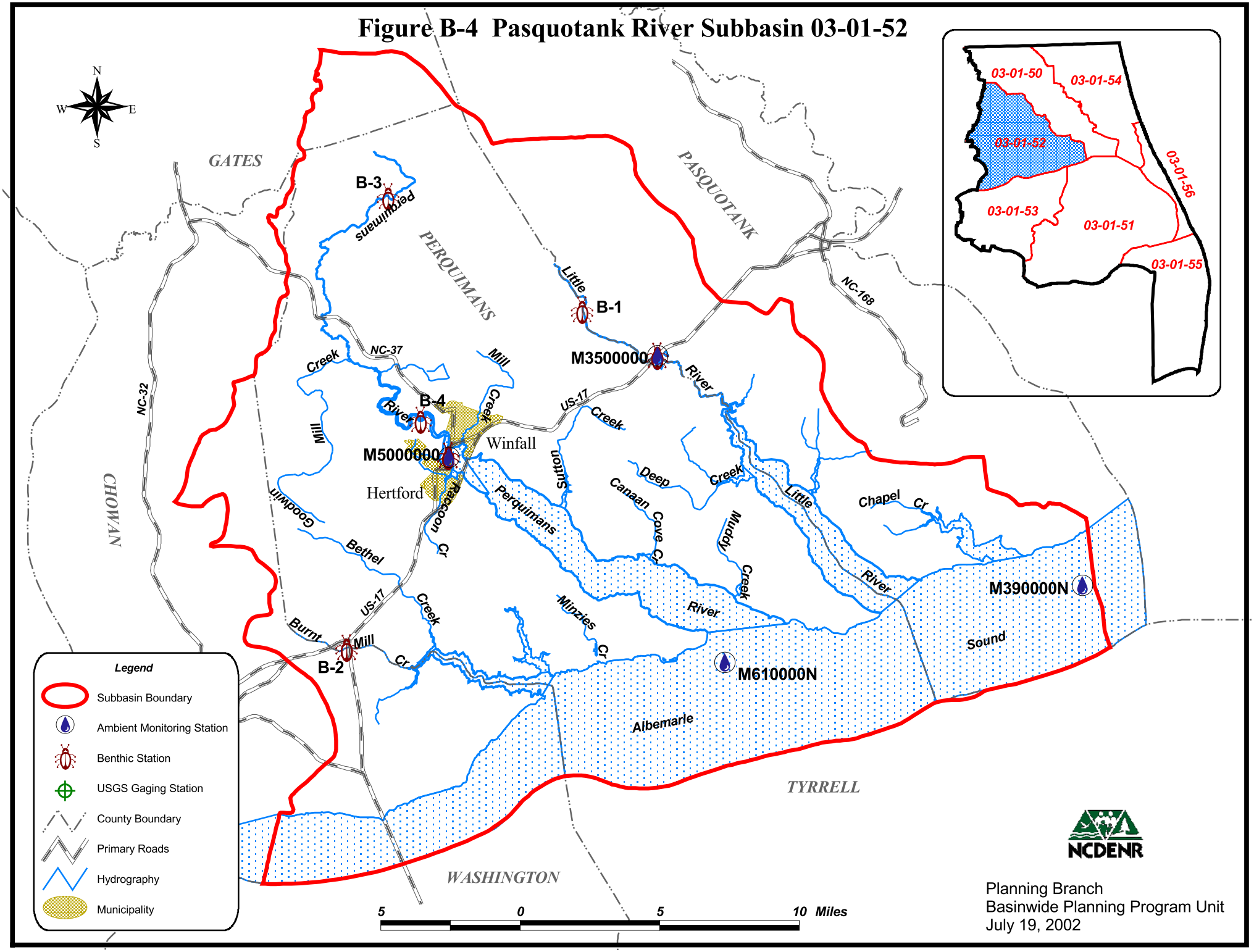


Table B-5 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (2000) for Pasquotank River Subbasin 03-01-52

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
Freshwater				
B-1	Little River	Perquimans	SR 1221	Not Rated
B-2	Burnt Mill Creek	Chowan & Perquimans	NC 37	Not Rated
B-3	Perquimans River	Perquimans	SR 1111	Not Rated
B-4	Perquimans River	Perquimans	2 miles above Hertford	Not Rated
Ambient Monitoring				***Problem Parameters***
M3500000	Little River at US 17	Perquimans	at Woodville	DO and pH
M390000N	Albemarle Sound	Pasquotank	near Frog Island north shore	None observed
M5000000	Perquimans River	Perquimans	at SR 1336 at Hertford	pH
M610000N	Albemarle Sound	Perquimans	between Harvey Point and Mill Point north shore	None observed

* Refer to Section A, Part 3.3 for more information on fish community and benthic macroinvertebrate bioclassifications.

Table B-6 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Freshwater Streams (Miles) in Pasquotank River Subbasin 03-01-52

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	72,795.5 estuarine ac	0	0	88.6 mi 18,924.6 estuarine ac	88.6 mi 91,720.1 estuarine ac
Primary Recreation	72,795.5 estuarine ac	0	0	9,840.3 estuarine ac	82,635.8 estuarine ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

3.2 Status and Recommendations for Previously Impaired Waters

The 1997 Pasquotank River Basinwide Plan identified two segments as impaired in this subbasin (Little River and Burnt Mill Creek). This section reviews use support and recommendations detailed in the 1997 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for these stream segments.

3.2.1 **Little River** (11.8 miles from source to mouth of Halls Creek)

1997 Recommendations
This segment of the Little River was partially supporting because of low dissolved oxygen (DO) levels. Potential sources included land development, nonirrigated crop production, off-farm animal holding/management area and on-site wastewater systems (septic systems). Swamp conditions combined with agricultural runoff were thought to be contributing to the low dissolved oxygen.

Status of Progress
The Nonpoint Source Team chose against focusing on Little River and instead focused on broader issues that could impact the entire basin.

The Little River is currently not rated, but there are indications that agricultural land uses may be contributing to observed algal growths and low dissolved oxygen.

2002 Recommendations
DWQ will determine if the low dissolved oxygen in the Little River is due to natural conditions or other inputs. DWQ will continue to develop biocriteria to better assess use support in waters with swamp characteristics. Land adjacent to Little River is expected to undergo development in the near future. Special attention should be placed on development impacts to local primary nursery areas. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Refer to Section 4.11 for more information about minimizing impacts to water quality from development.

3.2.2 **Burnt Mill Creek** (3.5 miles from source to Yeopim River)

1997 Recommendations
Burnt Mill Creek was not supporting from its source to Yeopim River. DWQ recommended monitoring the waterbody.

Status of Progress
The creek is currently not rated and is no longer considered impaired. DWQ collected new biological information suggesting the previous bioclassification was inappropriate.

2002 Recommendations
DWQ will continue to develop biocriteria to better assess use support in waters with swamp characteristics.

3.3 Status and Recommendations for Newly Impaired Waters

The four benthic monitoring sites in this subbasin are currently not rated because criteria for assigning bioclassifications to swamp streams are still in draft (page 67). No additional stream segments were rated as impaired in this subbasin based on recent DWQ monitoring (1995-2000).

3.4 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or are not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

3.4.1 Mill Creek

Current Status
Mill Creek is currently not rated. The Perquimans County Water Treatment Plant #2 discharges effluent into an unnamed tributary to Mill Creek that leads to the Pasquotank River. The facility exceeded its permit limits by greater than 40 percent for total suspended solids over the course of two or more months during quarterly review periods in 1999 and 2000.

2002 Recommendations
The Perquimans County Water Treatment Plant #2 has been under a Special Order of Consent and has constructed a treatment facility to treat the total suspended solids problem. DWQ will continue to monitor the treatment facility.

Current Status
The Town of Winfall's Water Treatment Plant discharges to Mill Creek. The facility exceeded its permit limits by greater than 40 percent for total suspended solids over the course of two or more months during quarter review periods in 1998 and 1999.

2002 Recommendations
The Town of Winfall is under a Special Order of Consent (SOC) which requires them to meet the required permit limits by November 2003. DWQ will continue to work with Winfall to make the requirements of the SOC.

3.4.2 Bethel Creek

Current Status
Bethel Creek is currently not rated. Perquimans County exceeded its permit limits at its Water Treatment Plant (#1/Bethel) that discharges to Bethel Creek. The facility exceeded its permit limits by greater than 40 percent for total suspended solids over the course of two or more months during quarterly review periods in 1999.

2002 Recommendations
The Perquimans County Water Treatment Plant #1 has been under a Special Order of Consent and has constructed a treatment facility to treat the total suspended solids problem. DWQ will continue to monitor the treatment facility.

3.4.3 Perquimans River

Current Status

Perquimans River is currently not rated. The Town of Hertford has been experiencing some problems with their wastewater treatment plant. DWQ's Washington Regional Office has met with Hertford to discuss the current situation and to identify some solutions.

2002 Recommendations

DWQ will continue to provide technical assistance to the facilities to ensure that the facilities do not exceed their effluent permit limits. Because of the multiple number of facility violations in the subbasin, DWQ's Environmental Sciences Branch will determine whether or not a biological survey is appropriate.

Chapter 4 -
Pasquotank River Subbasin 03-01-53
Includes Scuppernong River and tributaries and Phelps Lake

4.1 Water Quality Overview

Subbasin 03-01-53 at a Glance

Land and Water

Total area:	475 mi^2
Land area:	336 mi^2
Water area:	139 mi^2

Population Statistics

1990 Est. pop.:	8,836 people
Pop. density:	26 persons / mi^2

Land Cover (%)

Forest / Wetland:	41
Surface Water:	28
Urban:	<1
Cultivated Crop:	30
Pasture / Managed Herbaceous:	<1

The Scuppernong River, which drains to Albemarle Sound, is the largest river system in this subbasin. The largest town is Roper. A map including water quality sampling locations is presented as Figure B-5.

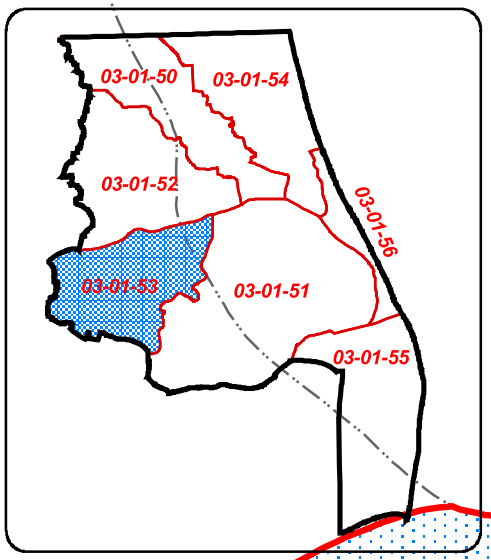
DWQ collects both ambient and benthic macroinvertebrate samples from this subbasin. Biological ratings for these sample locations are presented in Table B-7. Table B-8 summarizes use support ratings for subbasin 03-01-53. Refer to Appendix III for a complete listing of monitored waters and use support ratings.

This subbasin contains a diversity of public lands and Significant Natural Heritage Areas, including Lake Phelps State Park, Bull Neck Swamp, East Dismal and the Scuppernong River Swamp Forest.

There are seven permitted dischargers in the subbasin; all of which are minor NPDES permits. Columbia, Roper and Creswell hold wastewater treatment plant permits in the subbasin. Eight general stormwater permits are also held in the basin. No facilities are required under permit to perform whole effluent toxicity testing in the subbasin.

Benthic macroinvertebrates have been collected at four sites within this subbasin; however, these data are not rated; and therefore, they currently offer little indication of the water quality status of the Pasquotank River basin.

Figure B-5 Pasquotank River Subbasin 03-01-53



PASQUOTANK
PERQUIMANS
CHOWAN
Sound
Albemarle
BERTIE
Deep
Creek
B-2
Columbia
US-64
NC-308
Kendrick
River
US-64
NC-94
TYRRELL
US-64
Roper
Creswell
B-3
Scuppernong
B-1
Creek
Phelps Lake
WASHINGTON
HYDE

N
W
E
S

Legend

- Subbasin Boundary
- Ambient Monitoring Station
- Benthic Station
- Benthic Station
- County Boundary
- Primary Roads
- Hydrography
- Gamelands
- Municipality

5 0 5 10 Miles

NCDENR

Planning Branch
Basinwide Planning Program Unit
July 19, 2002

Table B-7 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (2000) for Pasquotank River Subbasin 03-01-53

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
Freshwater				
SB	Kendrick Creek	Washington	US 64	Not Rated
B-1	Mail Canal	Washington	SR 1180	Not Rated
B-2	Deep Creek	Washington	SR 1302	Not Rated
B-3	Scuppernong River	Washington	SR 1155	Not Rated
Ambient Monitoring				***Problem Parameter***
M6920000	Kendrick Creek	Washington	at SR1300 at Mackeys	DO
M698000C	Scuppernong River	Tyrrell	at SR 1105 near Columbia	DO
M610000C	Albemarle Sound	Tyrrell	between Harvey Point and Mill Point mid channel	None observed
M610000N	Albemarle Sound	Tyrrell	between Harvey Point and Mill Point south shore	None observed

* Refer to Section A, Part 3.3 for more information on fish community and benthic macroinvertebrate bioclassifications.

Table B-8 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Streams in Pasquotank River Subbasin 03-01-53

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	63,433.2 estuarine ac	0	0	113.2 mi 15,938.3 fresh ac 3,653.3 estuarine ac	113.2 mi 15,938.3 fresh ac 67,086.5 estuarine ac
Primary Recreation	63,433.2 estuarine ac	0	0	1,839.4 estuarine ac 15,938.3 fresh ac	65,272.6 estuarine ac 15,938.3 fresh ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, December 2001), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

4.2 Status and Recommendations for Previously Impaired Waters

The 1997 Pasquotank River Basinwide Plan identified three segments of subbasin 03-01-53 as impaired in this subbasin. This section reviews use support and recommendations detailed in the 1997 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for these stream segments.

4.2.1 **Scuppernong River** (15.2 miles from source to mouth of Riders Creek)

1997 Recommendations
The upper Scuppernong River was rated partially supporting, likely due to agriculture and animal operations and possibly Creswell WWTP. The 1997 basin plan recommended that the NPS team consider targeting their efforts to this area.

Status of Progress
The Scuppernong River is currently not rated. The Nonpoint Source Team chose against focusing on the Scuppernong River as its main water quality segment of concern. Instead, the Nonpoint Source Team focused on broader issues that could impact the entire basin.

Tyrrell County's Water Treatment Plant near Columbia discharges into Rider's Creek. The Washington Regional Office indicated that the facility had previously not been permitted. As of 2002, the facility had been issued a NPDES permit.

2002 Recommendations
DWQ determined that it is likely that the pH and dissolved oxygen values are due to natural conditions. DWQ will determine whether the ambient conditions are due to natural conditions. Though the river was not considered impaired during the 1995-2000 basinwide cycle, the Scuppernong River remains an issue of concern, and DWQ should encourage more funding, research and emphasis on the watershed.

DWQ will continue to monitor Tyrrell County Water Treatment Plant and work towards relocating the facility's discharge.

4.2.2 **Kendrick Creek and Main Canal** (13.2 miles from source to Hwy. 64 at Roper)

1997 Recommendations
Kendrick Creek and Main Canal were rated partially supporting, likely due to agriculture and animal operations. The 1997 basin plan recommended that the NPS team consider targeting their efforts to this area.

Status of Progress
Kendrick Creek is currently not rated. The Nonpoint Source Team chose against focusing on Kendrick Creek as its main water quality segment of concern. Instead, the Nonpoint Source Team focused on broader issues that could impact the entire basin.

DWQ conducted a special study in Washington County specifically in response to planning efforts to build a water treatment facility in the Town of Roper. The facility would include a brine effluent that could be discharged into Kendrick Creek at US 64 in Roper. The DWQ Regional Office requested a survey to determine if there is a freshwater benthic community in that part of the stream that would be negatively impacted by an input of salt. All of the 36 macroinvertebrate taxa collected were freshwater taxa, and the stream appeared to be very stressed. Staff also noted that even though SC waters in Kendrick Creek are classified as such to the US 64 bridge, analysis of monitoring data suggest that saline influence is much closer to the Albemarle Sound.

Weyerhaeuser Company has participated in a cooperative watershed study in the Kendrick Creek (Lebo et al., 2000) drainage basin with NC State University since 1996. Weyerhaeuser scientists conducted a water quality and biological assessment of the condition of the creek from its headwaters at the Parker Tract to Albemarle Sound. The study characterized water quality and the biological conditions of the creek in addition to identifying, where possible, the factors contributing to the observed water quality. Information on the report can be obtained by contacting Weyerhaeuser at (252) 633-7511.

2002 Recommendations
Though the 1995-2000 basinwide cycle does not rate Kendrick's Creek as impaired, DWQ still considers Kendrick Creek an issue of concern. DWQ should encourage more funding, research and emphasis on the watershed. DWQ determined that it is likely that the pH and dissolved oxygen values are due to natural conditions, because the river segment is located in a swampy area. DWQ will determine whether the ambient conditions are due to natural conditions.

4.3 Status and Recommendations for Newly Impaired Waters

The four benthic monitoring sites in this subbasin are currently not rated because criteria for assigning bioclassifications to swamp streams are still in draft form (page 67). No additional stream segments were rated as impaired in this subbasin based on recent DWQ monitoring (1995-2000).

4.4 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or are not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

4.4.1 Phelps Lake

Current Status
Phelps Lake is currently not rated. Lake Phelps, North Carolina's second largest natural lake, is located within a vast peninsula between the Albemarle Sound to the north and the Pamlico River

to the south. This peninsula contains numerous low-lying swampy areas underlain by thick organic muck and relatively well-drained areas with fertile mineral and organic soils. Much of this area has been cleared of vegetation, drained and put into large scale agricultural use.

The lake is owned by the State of North Carolina as part of Pettigrew State Park. This lake is principally recharged by natural precipitation with a small fraction of the water coming from underground aquifers. Because of its shallow depth, the lake is wind mixed and rarely stratifies. The waters are acidic, which is typical of coastal plain lakes, but unlike other coastal plain lakes, the water is not colored.

Lake Phelps is used primarily for boating and fishing. It has also been used as a source of water for fighting peat fires. The lake also provides habitat for the endemic Waccamaw killifish and for the leafless watermilfoil (*Myriophyllum tenellum*), an aquatic macrophyte not previously found south of New Jersey.

In August 2000, Lake Phelps was reclassified from C Swamp Water (Sw) to B Sw ORW (Outstanding Resource Water). The lake was not rated during the 1995-2000 basinwide planning cycle.

2002 Recommendations
DWQ will continue to monitor Phelps Lake.

Chapter 5 -
Pasquotank River Subbasin 03-01-54
Includes Currituck Sound and the North River

5.1 Water Quality Overview

Subbasin 03-01-54 at a Glance

Land and Water

Total area:	503 mi^2
Land area:	304 mi^2
Water area:	199 mi^2

Population Statistics

1990 Est. pop.:	14,653 people
Pop. density:	48 persons / mi^2

Land Cover (%)

Forest / Wetland:	39
Surface Water:	39
Urban:	<1
Cultivated Crop:	20
Pasture / Managed Herbaceous:	<1

This subbasin consists of Currituck Sound and the North River and its tributaries in Currituck and Camden counties. A map including water quality sampling locations is presented as Figure B-6.

DWQ did not conduct benthic macroinvertebrate, fish community, fish tissue or ambient sampling in this subbasin. Therefore, there is currently little information on water quality status in subbasin 03-01-54. DWQ relies on information from the Division of Environmental Health, local water treatment plant operators, and county health departments for this subbasin. Use support ratings are presented in Table B-9.

This subbasin contains multiple public lands and Significant Natural Heritage Areas including several National Wildlife Refuges, the Currituck Banks National Estuarine Research Reserve, Northwest River Marsh Game Land, North River Game Land and portions of the Great Marsh.

A portion of this subbasin is located on the Outer Banks, an area of high growth potential. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin.

There are two permitted NPDES dischargers in the subbasin: Currituck County Water Treatment Plant and Corolla North Utilities. Both facilities hold minor permits. No facilities are required under permit to perform whole effluent toxicity testing in the subbasin. There are no NPDES individual stormwater permits issued in the subbasin; however, there are 11 general stormwater permits issued.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, December 2001), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

Figure B-6 Pasquotank River Subbasin 03-01-54

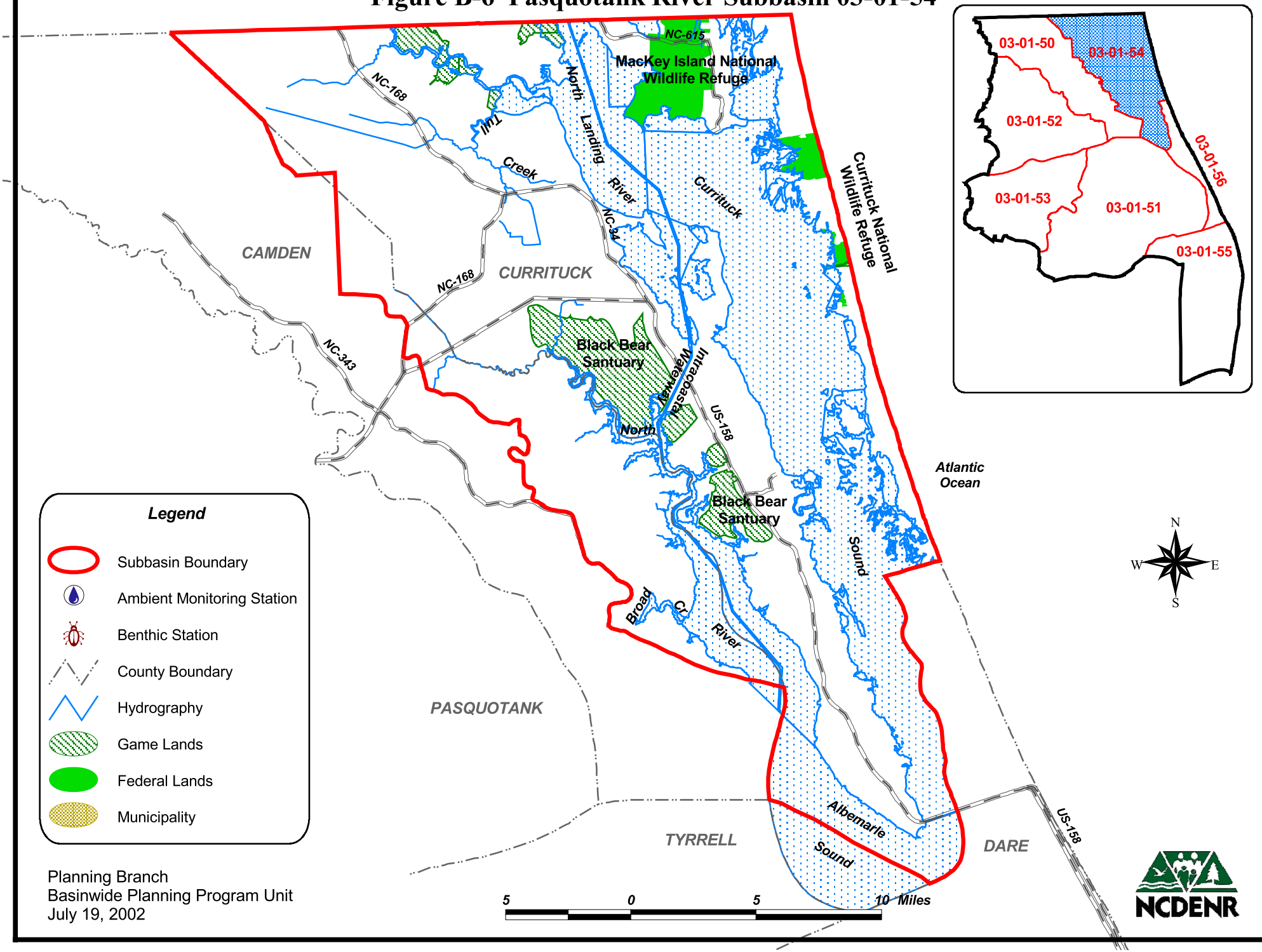


Table B-9 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Streams (Miles) in Pasquotank River Subbasin 03-01-54

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	11,049.3 estuarine ac	0	0	69.9 mi 942.9 fresh ac 113,560.0 estuarine ac 22.6 coastal mi	69.9 mi 942.9 fresh ac 124,609.3 estuarine ac 22.6 coastal mi
Fish Consumption[3]	0	22.6 coastal mi	0	0	22.6 coastal mi
Primary Recreation	22.6 coastal mi	0	0	25.1 mi 11,049.3 estuarine ac	25.1 mi 11,049.3 estuarine ac 22.6 coastal mi

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

5.2 Status and Recommendations for Previously Impaired Waters

The 1997 Pasquotank River Basinwide Plan did not identify any segments in this subbasin as impaired.

5.3 Status and Recommendations for Newly Impaired Waters

There are 22.6 Atlantic coastal miles which are partially supporting that were monitored for fish consumption. All waters in this subbasin are currently partially supporting (PS) on an evaluated basis in the fish consumption use support category because of a regional fish consumption advisory for shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack). Refer to page 68 for more information on this issue.

5.4 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or are not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

This subbasin has the potential to undergo a great population increase due to its proximity to Virginia and growing municipalities in the North Carolina portion of the basin. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of

environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section 4.11 for more information about minimizing impacts to water quality from development.

5.4.2 Guinea Mill Run

Current Status
Guinea Mill Run is currently not rated. Orchard Park in Moyock has had challenges with insufficient infiltration of their wastewater treatment plant's spray irrigation. The facility is in continual violation; however, little effort by the facility is underway to correct the problem.

2002 Recommendations
DWQ's Regional Office has made several consultations to the facility; however, the owners have made insufficient progress on the violations. DWQ will issue a substantial fine to the facility coupled with a meeting to discuss potential state-based funding to remedy the situation.

5.4.3 Currituck Sound

1997 Recommendations
Part of Currituck Sound was experiencing mild algal blooms. DWQ stated that it would continue to monitor the character, frequency and duration of the blooms to determine whether or not they were becoming more severe.

In addition, DWQ recommended that the NPS team should consider any actions that could be taken to reduce the amount of nutrients entering the sound.

Status of Progress
Currituck Sound is currently not rated. In the 1999 Environmental Sciences Branch Algal Assessment, there were no reports of algal blooms in Currituck Sound.

2002 Recommendations
DWQ will continue to monitor the frequency and duration of algal blooms in Currituck Sound. Where necessary, DWQ will use the assistance of the other scientific staff such as Rapid Response Teams to assist in determining the cause of the algal blooms. Upon notification of an algal bloom in the vicinity, DWQ will continue to immediately provide the information to the public.

DWQ should collaborate with the National Oceanic and Atmospheric Administration's Submerged Aquatic Vegetation Research efforts to monitor the status of the submerged aquatic vegetation in the area. Where feasible, DWQ should allocate funding and technical assistance toward the initiative.

DWQ will continue to provide information to the US Army Corps in their efforts to undertake a Scoping Study of Currituck Sound. Pending budget flexibility, DWQ will allocate funding towards future collaboration efforts with the US Army Corps.

Chapter 6 -
Pasquotank River Subbasin 03-01-55
Includes Northeastern Pamlico Sound

6.1 Water Quality Overview

Subbasin 03-01-55 at a Glance

Land and Water

Total area:	574 mi^2
Land area:	96 mi^2
Water area:	478 mi^2

Population Statistics

1990 Est. pop.:	3,436 people
Pop. density:	36 persons / mi^2

Land Cover (%)

Forest / Wetland:	11
Surface Water:	89
Urban:	<1
Cultivated Crop:	<1
Pasture / Managed Herbaceous:	<1

This subbasin consists of Pamlico Sound from Oregon Inlet to Hatteras Inlet and the Outer Banks in Dare County. It also includes Black Lake and Stumpy Point Bay. The majority of the subbasin consists of the SA waters of the Pamlico Sound. In the northwestern portion of the basin, several freshwater swampy systems can be found. The largest municipalities in the basin include Rodanthe and Avon. A map including water quality sampling locations is presented as Figure B-7.

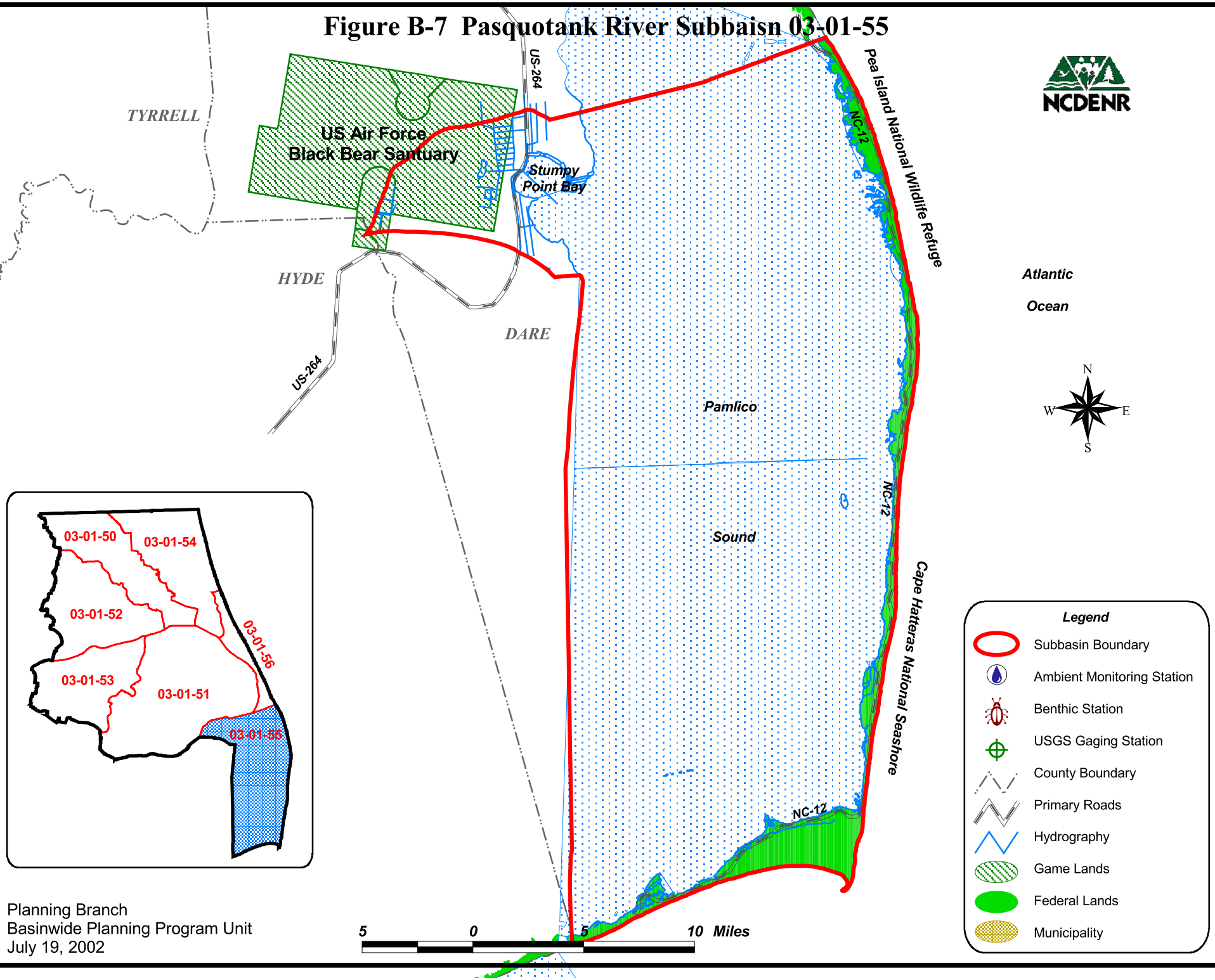
DWQ did not collect benthic macroinvertebrate, fish community, fish tissue or ambient water quality sampling in this basin. Therefore, there is currently little DWQ scientific information on water quality status in this subbasin. DWQ relies on information from the Division of Environmental Health, local water treatment plant operators, and county health departments for this subbasin. Use support ratings are presented in Table B-10.

The Pea Island National Wildlife Refuge and Cape Hatteras National Seashore predominate the public lands and Significant Natural Heritage Areas in the subbasin.

Six facilities in the subbasin hold NPDES minor permits. Five of the six facilities are nonmunicipal. Several facilities are required to conduct whole effluent toxicity testing as a condition of their permit. Of these facilities, Dare County's Reverse Osmosis facility (No. 001) had 18 passes and four fails before 2000. During 2000, the facility had three passes and no failures. The Dare County Reverse Osmosis facility (No. 002) had 36 passes and 14 fails before 2000. During 2000, the facility had three passes and four failures. No individual stormwater permits exist in the subbasin; however, there are six general stormwater permits.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, January 2002), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

Figure B-7 Pasquotank River Subbaisn 03-01-55



Planning Branch
Basinwide Planning Program Unit
July 19, 2002

Table B-10 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Streams (Miles) in Pasquotank River Subbasin 03-01-55

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	316,110.70 estuarine ac	0	0	53.8 coastal mi 117.6 fresh ac 4,022.0 estuarine ac	53.8 coastal mi 117.6 fresh ac 320,132.7 estuarine ac
Fish Consumption[3]	0	53.8 coastal mi	0	0	53.8 coastal mi
Primary Recreation	53.8 coastal mi 315,407.0 estuarine ac	0	0	4,725.8 estuarine ac	53.8 coastal mi 320,132.8 estuarine ac
Shellfish Harvest	318,771.7 estuarine ac	0	1,361.1 estuarine ac	0	320,132.8 estuarine ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

6.2 Status and Recommendations for Previously Impaired Waters

Previously impaired Class SA waters are discussed in Section 6.4 below. There were no other waters identified as impaired in the 1997 plan.

6.3 Status and Recommendations for Newly Impaired Waters

There are 53.8 Atlantic coastal miles which are partially supporting that were monitored for fish consumption. All waters in this subbasin are currently partially supporting (PS) on an evaluated basis for the fish consumption use support category because of a regional fish consumption advisory for shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack). Refer to page 68 for more information on this issue. There are other newly impaired shellfish waters in this subbasin. Class SA waters are discussed below in Section 6.4.

6.4 Impaired Class SA Waters

There are 320,132.8 acres of Class SA waters in this subbasin that were assessed in the shellfish harvesting use support category. In this subbasin, 1,361.1(4.21%) are considered impaired for the shellfish harvesting use support category. Refer to Figures B-8 and B-9 to identify locations of DEH SS growing areas and growing area classifications. The larger water areas in this subbasin are described below with reference to DEH SS growing areas. The problem parameter for all waters listed below is fecal coliform bacteria contamination. Refer to page 61 for recommendations to address impairment in Class SA waters.

The differences in acreage estimates between basinwide cycles are not necessarily related to changes in water quality, but to different methods of estimating acreage and changes in use support methodology. For more information on changes in use support methodology, refer to Appendix III and page 59. For a complete listing of monitored Class SA waters refer to Appendix III.

Subbasin 03-01-55 contains portions of four DEH growing areas: H3, H4, H5 and H6 (Figures B-8 and B-9).

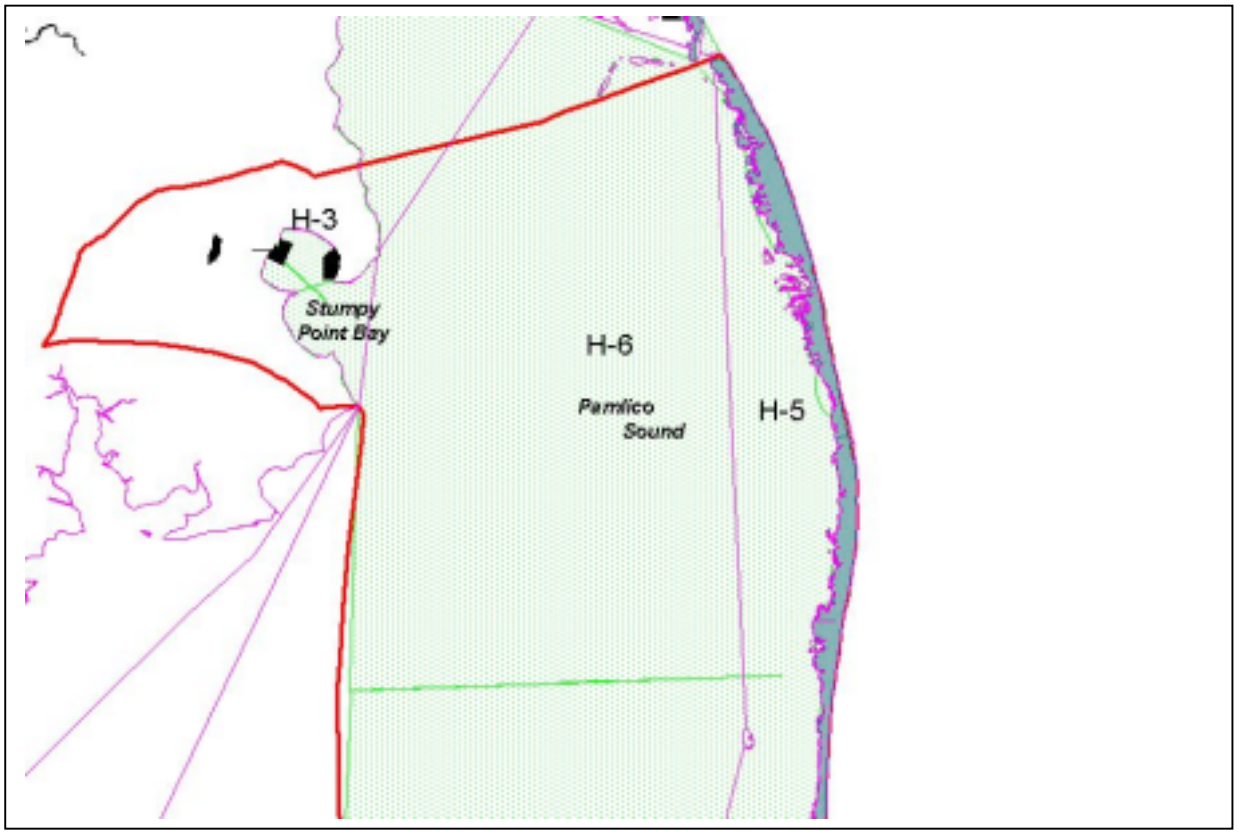


Figure B-8 Northern DEH Shellfish Growing Area Classifications in SA Waters of Subbasin 03-01-55

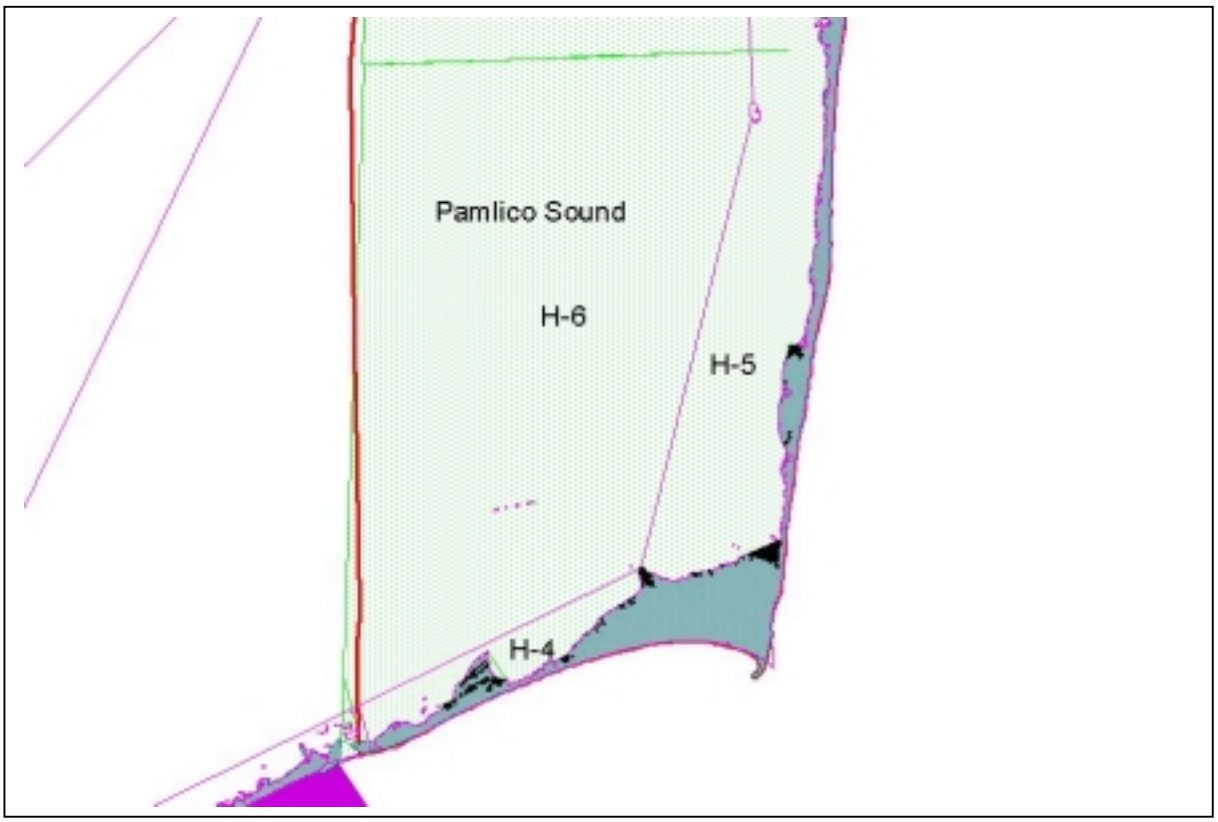


Figure B-9 Southern DEH Shellfish Growing Area Classifications in SA Waters of Subbasin 03-01-55

Stumpy Point (DEH Area H-3)

The majority of the area is approved for commercial shellfish harvesting, and most waters are fully supporting. There are several areas closed, including an area surrounding Lake Worth and an area at the southeastern most section of Stumpy Point Bay. Potential sources of pollution include straight pipes, wildlife and nonpoint source runoff (NCDENR-DEH, H3).

Hatteras Area (DEH Area H-4)

The majority of the area is approved for commercial shellfish harvesting, and most waters are fully supporting. There are several areas closed, including several sections of Pamlico Sound which house boating facilities. All canals along the shoreline are closed to shellfish harvesting. Potential sources of pollution include nonpoint source runoff, illicit solid waste disposal in "The Slash" and nearby development (NCDENR-DEH, H4).

Outer Banks (DEH Area H-5)

All of DEH Area H-5 is located within this subbasin. Some of the areas that are prohibited to commercial shellfishing include Cape Creek, portions of Pamlico Sound, Askins Creek, Peters

Ditch and Mill Creek. Bacteriological data for Area H-5 indicated further deterioration in water quality in the Mill Creek section; however, DEH noted that the approved classification of the area is adequate at the current time (NCDENR-DEH, H5). Potential sources of pollution include nonpoint source pollution from failing/overused septic systems, stormwater runoff, local wildlife and nearby residential developments (NCDENR-DEH, H3).

6.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or are not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

6.5.1 Buzzard Bay

Current Status
Buzzard Bay is currently not rated. The Town of Kill Devil Hill's Wastewater Treatment Plant which discharges into Buzzard Bay exceeded its fecal coliform limits by greater than 40 percent over the third and fourth quarters of 1999. The facility was designed under capacity; however, the facility has made efforts to increase treatment levels and change to a non-discharge method.

2002 Recommendations
DWQ will provide technical consultation to the town to determine the severity and cause of the fecal coliform permit exceedences.

6.5.2 Colington Creek

Current Status
Colington Creek is currently not rated. The Outer Banks Beach Club, a non-discharge facility, currently lacks sufficient maintenance. The operation is undergoing a change of management.

2002 Recommendations
DWQ will make site consultations to provide technical information to the owners about the history and current condition of the facility with respect to its impact to local surface water.

6.5.3 Pamlico Sound

Current Status
Pamlico Sound is currently fully supporting. The Buxton Water Treatment Plant, a non-discharge facility, has had an ongoing challenge with solids in their holding pond. DWQ will conduct site consultations to determine long-term solutions to remedy the situation.

2002 Recommendations
DWQ will provide both technical and financial information to the facility operators to assist them in their strategic planning.

Chapter 7 -
Pasquotank River Subbasin 03-01-56
Includes Roanoke Sound and small portions of Albemarle and Currituck Sounds

7.1 Water Quality Overview

Subbasin 03-01-56 at a Glance

Land and Water

Total area:	109 mi^2
Land area:	37 mi^2
Water area:	72 mi^2

Population Statistics

1990 Est. pop.:	11,282 people
Pop. density:	305 persons / mi^2

Land Cover (%)

Forest / Wetland:	22
Surface Water:	70
Urban:	7
Cultivated Crop:	<1
Pasture / Managed Herbaceous:	2

This subbasin consists of the lower portion of Currituck Sound, outer Albemarle Sound, Kitty Hawk Bay and eastern Roanoke Sound in Dare County. A map including water quality sampling locations is presented as Figure B-10.

DWQ did not collect benthic macroinvertebrate, fish community, fish tissue or ambient water quality data in this subbasin. Water quality use support determinations are based on fish consumption advisories, DEH sanitary surveys, water treatment plant operator reports, and recreational waters testing. Use support ratings are presented in Table B-11.

Several public lands and Significant Natural Heritage Areas occur in this subbasin, including Jockey's Ridge State Park, Nags Head Woods Preserve, Run Hill State Natural Area, Wright Brothers National Memorial, and Kitty Hawk Woods Coastal Reserve.

The cities with the highest populations in the basin include Kill Devil Hills and Nags Head. This subbasin contains the highest population density (305 persons/square mile) in the entire Pasquotank River basin with the second highest density falling far behind at 80 persons/square mile. This subbasin has also undergone the highest rate of population density growth over the 1980-1990 period, growing from 130 persons/square mile to 305 persons/square mile.

Only one facility holds a NPDES minor permit in the subbasin: Villas Association, Inc. The facility is nonmunicipal and discharges using an on-site land application method. No facilities are required under permit to perform whole effluent toxicity testing in the subbasin. There are no individual NPDES stormwater permits issued in the basin; however, there are two general stormwater permits issued.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report-Pasquotank River Basin* (NCDENR-DWQ, January 2002), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.ncu.us/bar.html or by calling (919) 733-9960.

Figure B-10 Pasquotank River Subbasin 03-01-56

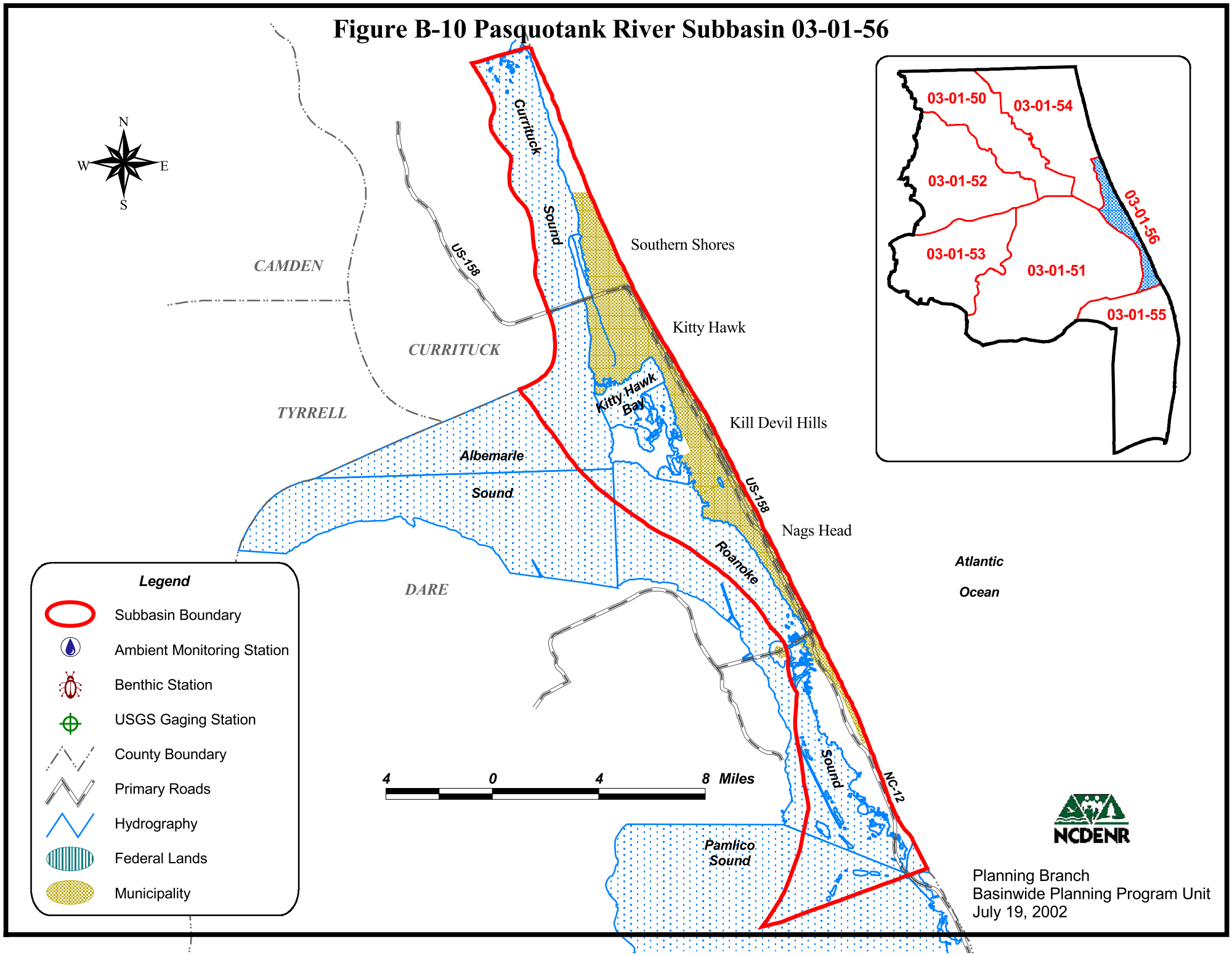


Table B-11 Use Support Ratings Summary (2000) for Monitored and Evaluated[2] Streams (Miles) in Pasquotank River Subbasin 03-01-56

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation[2]	12,463.2 estuarine ac	0	0	15,830.2 estuarine ac 23.8 fresh ac 34.2 coastal mi	28,293.5 estuarine mi 23.8 fresh ac 34.2 coastal mi
Fish Consumption[3]	0	34.2 coastal mi	0	0	34.2 coastal mi
Primary Recreation	12,851.8 estuarine ac 34.2 coastal mi	0	21.4 estuarine ac	15,411.9 estuarine ac	28,285.1 estuarine ac 34.2 coastal mi
Shellfish Harvesting	18,775.0 estuarine ac	0	1,712.9 estuarine ac	0	20,487.9 estuarine ac

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a regional fish consumption advisory. Refer to Section A, Part 4.3 for further information.

7.2 Status and Recommendations for Previously Impaired Waters

Previously impaired Class SA waters are discussed in Section 7.4 below. There were no other waters identified as impaired in the 1997 plan.

7.3 Status and Recommendations for Newly Impaired Waters

There are 34.2 Atlantic coastal miles which are partially supporting that were monitored for fish consumption. All waters in this subbasin are currently partially supporting (PS) on an evaluated basis for the fish consumption use support category because of a regional fish consumption advisory for shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin (or blackfish), and chain pickerel (or jack). There are other newly impaired shellfish waters in this subbasin. Class SA waters are discussed below in Section 7.4.

7.3.1 **Roanoke Sound** (Waters surround Villas Association, Inc. Outfall)

Current Status

This portion of Roanoke Sound (21.4 estuarine acres) is currently not supporting primary recreation. DEH Recreational Water Quality issued a swimming advisory for a portion of Roanoke Sound centered around the Villas Association, Inc. direct discharge. The advisory closure due to rule had been posted since 1998. Villas Association, Inc. exceeded its ammonia limits by over 40 percent over the last quarter of 1998 and the first quarter of 1999. The association did not exceed ammonia limits in 2000. In 2002, the Villas Association received a non-discharge permit to eliminate the direct discharge to Roanoke Sound. The facility is utilizing a land application method on-site of the Villas property.

2002 Recommendations

DWQ will continue to work with DEH to monitor the Roanoke Sound's swimming uses.

7.4 Impaired Class SA Waters

There are 20,487.9 acres of Class SA waters in this subbasin that were assessed in the shellfish harvesting use support category. In this subbasin, 1,712.9 acres (8.4%) are considered impaired for the shellfish harvesting use support category. Refer to Figure B-11 to identify locations of DEH SS growing areas and growing area classifications. The larger water areas in this subbasin are described below with reference to DEH SS growing areas. The problem parameter for all waters listed below is fecal coliform bacteria contamination. Refer to page 61 for recommendations to address impairment in Class SA waters.

The differences in acreage estimates between basinwide cycles are not necessarily related to changes in water quality, but to different methods of estimating acreage and changes in use support methodology. For more information on changes in use support methodology, refer to Appendix III and page 59. For a complete listing of monitored Class SA waters, refer to Appendix III.

Subbasin 03-01-56 contains portions of three DEH Growing Areas: H1, H6 and I2 (Figure B-11).

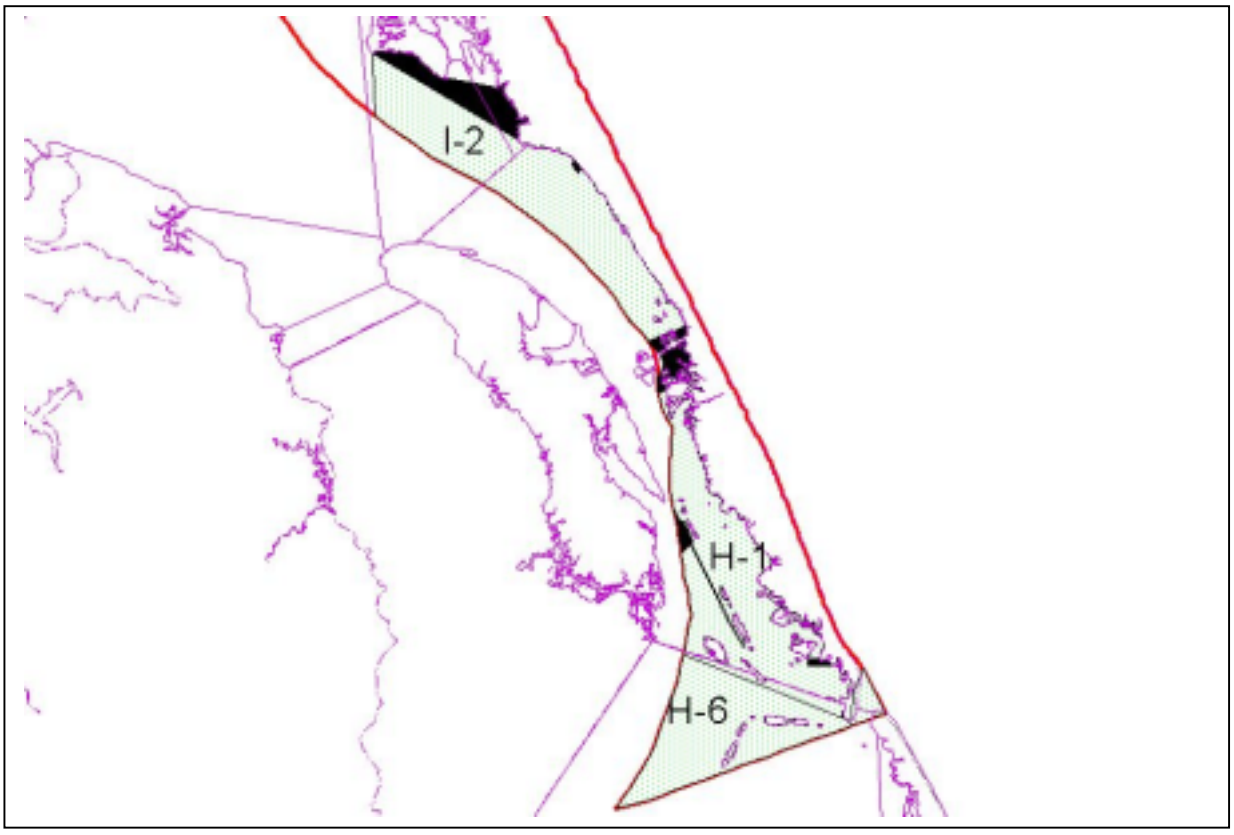


Figure B-11 DEH Shellfish Growing Area Classifications in SA Waters of Subbasin 03-01-56

Eastern Shore of Roanoke Sound (Area H-1)

DEH Growing Area H-1 contains the waters of the Roanoke Sound. The DEH growing area overlaps several subbasins, and DWQ has improved its reporting methodology to provide area closure information by subbasin. Waters currently prohibited for commercial shellfish harvesting include portions of Roanoke Sound, Pond Island and Rockhall Creek. Contamination sources included nonpoint source pollution from adjacent land uses. Analysis of the bacteriological data for the DEH Growing area indicated that little change in water quality occurred throughout the area during 1993-1999 (NCDENR-DEH, H1).

7.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses or are not rated based on recent DWQ monitoring; however, these data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

This subbasin has undergone a great increase in population between 1980-1990. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section 4.11 for more information about minimizing impacts to water quality from development.

Section C

Current and Future Water Quality Initiatives

Chapter 1 -
Current Water Quality Initiatives

1.1 Workshop Summaries

Two workshops were held in the Pasquotank River basin in March 2001. The Albemarle-Pamlico National Estuary Program's Pasquotank Regional Council and the NC Cooperative Extension Service cosponsored the workshops. There were 55 people in attendance representing a wide variety of interests (Figure C-1).

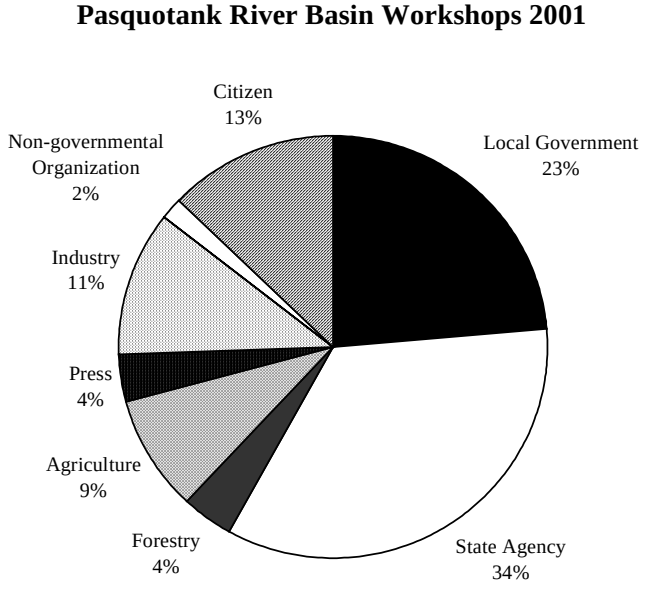


Figure C-1 Pasquotank River Basin Water Quality Workshop Participants

DWQ staff gave presentations about basinwide planning and an overview of recommendations in the 1997 plan and what has been accomplished since. Representatives from several local initiatives spoke, including the Wetlands Restoration Program, Virginia's Southern Watershed Assessment Program, the Albemarle-Pamlico Citizen's Water Quality Monitoring Program, and the Albemarle-Pamlico National Estuary Program's Pasquotank Regional Council. In addition to the spoken presentations, several local initiatives shared information about their programs through written materials. Workshop attendees were asked to discuss the following questions in small groups:

1) *What are the main threats to water quality in the basin?*
2) *Where are the problem areas or waters? And what recommendations do you have for addressing these problem areas/waters?*
3) *Who should address the problems? (i.e., local agencies, organizations, etc.)*

The discussion on these questions was very productive. Comments and responses were recorded. A general summary providing common ideas and viewpoints expressed by more than one group is presented below. DWQ considered these comments while drafting the revised Pasquotank River Basinwide Water Quality Plan and will continue to use these comments to guide water quality activities in the Pasquotank River basin. Detailed workshop notes are included as Appendix V.

Important Issues Basinwide

The most frequently cited concerns about water quality as identified by workshop participants are presented in Table C-1.

Table C-1 Basinwide Concerns Commented by Workshop Participants

Issue	Recommendation	Responsible Parties
♦ Septic system management	♦ Promote decentralized wastewater management ♦ Educate about effective treatment ♦ Improve water quality testing ♦ Mandate particular systems on a case-by-case basis	♦ Nags Head Model ♦ Roper facility ♦ North Carolina Coop. Extension Service (CES)
♦ Submerged aquatic vegetation loss	♦ Increase automated monitoring through the Knotts Island Ferry ♦ Extend UNC/Duke's study to the northeast ♦ Analyze data taking into account wind, flow, salinity ♦ Monitor more ♦ Conduct an assessment of where we need to go in terms of future science needs ♦ Ensure regulations have enforcement teeth	♦ Ferry system ♦ State ♦ Trained citizens ♦ Public ♦ DWQ
♦ Growth and development	♦ Integrate DWQ basin planning into CAMA (i.e., water/land use plan) ♦ Manage effectively ♦ Mandate smart growth approach which prevents environmental degradation ♦ Ensure funding for mandates ♦ Identify and protect critical areas ♦ Restrict uses in critical areas ♦ Promote acquisition ♦ Institute build-out restriction (i.e., short-term and long-term)	♦ DMF Coastal Habitat Protection Plans ♦ Nature Conservancy ♦ CAMA ♦ Local governments ♦ Federal government
♦ Erosion	♦ Implement buffers	♦
♦ Agriculture/Urban nonpoint surface runoff	♦ Monitor ♦ Acquire background information ♦ Educate the public	♦ DWQ
♦ Research	♦ Conduct more education and research	♦ DWQ ♦ CES ♦ Universities

♦ BMPs (agriculture) (i.e., water control structures, sediment control and denitrification)	♦ Use the systems the right way ♦ Educate ♦ Build in flexibility	♦ NRCS ♦ CES
♦ Boating waste (i.e., petroleum concentration)	♦ Enforce rules and regulations ♦ Advertise pumpout/disposal facilities available ♦ Increase education	♦ Coast Guard ♦ Fish and Wildlife Services ♦ Marinas
♦ Salt wedge stratification and associated problems	♦	♦
♦ Public Outreach	♦ Publish information on a periodic basis ♦ Use Nags Head's program as example	♦ Local, state and county government
♦ Wetland Loss	♦ Preserve wetlands	♦ US Army Corps of Engineers ♦ Division of Coastal Management ♦ NC DWQ
♦ Enforcement	♦ Adequately staff the state employees ♦ Evaluate existing regulations and get ineffective ones out before making new ones ♦ Ensure better coordination of activities	♦ NCDENR ♦ US Army Corp of Engineers ♦ Federal agencies ♦ General Assembly ♦ Governor

Please refer to Section A, Chapter 4 for discussion of some of these issues. All groups commented that development and wastewater treatment concerns were major threats to water quality in the Pasquotank River basin.

1.2 Federal Initiatives

1.2.1 Clean Water Act – Section 319 Program

Section 319 of the Clean Water Act provides grant money for nonpoint source demonstration projects. Approximately $1 million is available annually for demonstration and education projects across the state. 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.

Pasquotank Nonpoint Source Team

A water quality project was funded through the Section 319(h) grant in 1998. The Pasquotank Nonpoint Source (NPS) Team led the project. The objectives of the project include evaluating homeowners' attitudes about nonpoint source (NPS) pollution issues regarding on-site wastewater and management of on-site wastewater systems in order to develop recommendations for improving on-site wastewater system maintenance, understanding and performance; and demonstrating the effectiveness of an advanced on-site wastewater treatment systems for coliform and nutrient reduction. The team hopes to improve educational opportunities regarding operation and maintenance of on-site wastewater systems.

Information on the Section 319 program, including application deadlines and requests for proposals, are available by calling the DWQ Planning Branch Nonpoint Source Planning Unit at (919) 733-5083 or visit the program's website at http://h2o.enr.state.nc.us/nps/bigpic.htm.

1.2.2 US Army Corps of Engineers Projects

The US Army Corps of Engineers is active in the Pasquotank River basin with multiple projects ranging from dredging to environmental assessments.

Currituck Sound Environmental Study

The US Army Corps of Engineers, Wilmington District, is beginning a reconnaissance study to identify the environmental needs for Currituck Sound. This study will consider both nonstructural and structural measures to address environmental quality improvements. For more information, contact Ms. Lias Hetherman, Project Manager, at (910) 251-4831.

Wanchese Marsh Creation and Protection

The proposed plan involves the construction of estuarine creek and marsh habitat using dredged material from maintenance of the Manteo-Oregon Inlet Channel and Side Channel to Wanchese, a portion of the Manteo (Shallowbag) Bay project and enhancing the area by the application of oyster shells to serve as habitat for other oysters. This project will restore or enhance about eight acres of estuarine creek and marsh habitat and protect two acres of adjacent marsh currently threatened by erosion providing a total of ten acres of valuable estuarine marsh habitat that will be enhanced, restored or protected by this project. For more information, contact Mr. Chuck Wilson, US Army Engineer District at (910) 251-4746.

Roanoke Island Festival Park Marsh Restoration

The Roanoke Island Festival Park is located on Ice Plant Island adjacent to Manteo. The Roanoke Island Festival Park is connected to Manteo via a bridge, which crosses Dough's Creek. Dough's Creek is located on Shallowbag Bay, off Roanoke Sound. The proposed project will protect about two acres of existing coastal marsh and wooded wetlands, restore about one acre of shallow water area by restoration of marsh, sea grass and oyster habitat, and enhance about one acre of estuarine habitat by development of oyster reef. For more information, contact Chuck Wilson, US Army Engineer District at (910) 251-4746.

Oregon Inlet Study

In order to improve navigation in the Oregon Inlet for commercial fishing interests, the USACE is undertaking the Oregon Inlet Study. As part of the study, the USACE is preparing the Final Supplement III to the Federal Environmental Impact Statement. To date, no accomplishments have been achieved, but the USACE is working towards placing jetties at the Oregon Inlet. For more information, contact William Adams, US Army Engineer District at (910) 251-4748.

Walter Slough Study

Walter Slough is an existing channel located just north of Oregon Inlet in Dare County. Walter Slough is the only access to the sound and ocean from the Oregon Inlet Fishing Center (OIFC). Walter Slough runs 1.5 miles in an east-west direction and connects to Oregon Inlet Channel. Walter Slough has been maintained periodically using combinations of local, state and United States Coast Guard (USCG) funds. The USACE initiated this study in response to a resolution adopted by the Dare County Board of Commissioners requesting a study to determine if a federal navigation channel can be economically justified, constructed and maintained. Contact Bob Finch, US Army Engineer District at (910) 251-4776 for more information.

PAST PROJECTS 1995-2000

Joyce Creek

This project was authorized in March 1967 and provides for excavated channel improvements beginning at the mouth of Joyce Creek in Camden County, and extending upstream along Joyce Creek and Mill Run to County Road 1232, and along Cypress Run to County Road 1233, a total distance of 9.5 miles, with bottom widths ranging from 10 feet to 40 feet.

Manteo (Shallowbag) Bay, North Carolina

The authorized project provides for a channel 14 feet deep and 400 feet wide from the Atlantic Ocean through Oregon Inlet with connecting 12-foot channels, 100 feet wide, to Pamlico Sound, Manteo and Wanchese; and a channel 6 feet deep and 100 feet wide connecting the Manteo-Oregon Inlet Channel with Albemarle Sound. A newly authorized modification provides for stabilization of Oregon Inlet with a dual rubble-mound jetty system, including means for sand transfer to the down drift beach; a channel through the ocean bar at Oregon Inlet; a channel from the gorge in Oregon Inlet to and through Roanoke Sound to and including a 15-acre basin of the same depth at Wanchese; and a channel from the 12-foot-deep channel in Manteo (Shallowbag) Bay through Roanoke and Albemarle Sounds to deep water near the northern end of Croatan Sound. Manteo (Shallowbag) Bay was most recently dredged in 2001 and is dredged every one to two years. For more information, contact Dan Small, US Army Engineer District at (910) 251-4730.

Avon Harbor

The authorized project provides for a direct channel 6 feet deep, 100 feet wide and 3.5 miles long from the depth in Pamlico Sound southeast to a basin of the same depth, 100 feet wide and 300 feet long at Avon. For more information, contact Marie Hefferon, US Army Engineer District at (910) 251-4730.

Channel From Pamlico Sound To Rodanthe

The channel maintenance will involve the waterway from Pamlico Sound to a basin at Rodanthe. Anticipated construction costs will be $42,029. The channel was last dredged in 2000 and is

scheduled to be dredged every 30 years. For more information, contact Marie Hefferon, US Army Engineer District at (910) 251-4730.

Rollinson Channel

The Rollinson Channel, located about 3.5 miles northeast of Hatteras Inlet, was last dredged in 2000 and is scheduled to be dredged every two years. The authorized project provides for a channel about 5.1 miles long from deep water in Pamlico Sound to and including a basin of the same depth at Hatteras; a rubble-mound breakwater on each side of the channel at the entrance to the basin; and a channel from that depth in Hatteras Inlet gorge to Rollinson Channel, in the vicinity of the basin at Hatteras. For more information, contact Marie Hefferon, US Army Engineer District at (910) 251-4730.

Dare County Beaches (Bodie Island Portion); Dare County

The US Army Corps of Engineers, Wilmington District, has investigated opportunities to increase storm protection and control beach erosion in the study area. Alternatives include a nonstructural plan, dunes and/or berms of various dimensions, and no-action. The potential impacts associated with beach nourishment within the study area are primarily from the excavation of fill material and the placement of this material on the beach. Impacts will be reduced by use of beach compatible sandy material and avoidance of borrow sites that contain hardbottom or significant cultural resources. Disposal operations will begin as soon as practical after the previous sea turtle nesting season (ending November 15) and continue until construction of a given segment is complete (about 8-12 months). There is no time of year when dredging and beach disposal would avoid all significant resources in the project area. While the initial construction schedule does not avoid all significant resources, the proposed phased construction and efforts to start a given phase as soon as practical after November 15 will cause much of the work to occur during colder, less biologically productive, months. Periodic nourishment (maintenance) will occur between November 16 and April 30 to the degree practical. As agreed in previous protocol developed with USFWS, a sea turtle nest-monitoring program will be implemented by the Corps during initial construction or periodic nourishment if dredging and disposal occur during sea turtle nesting season. Construction of this plan is considered to be economically and environmentally feasible. For more information, contact Chuck Wilson, US Army Engineer District at (910) 251-4746.

1.2.3 US Fish and Wildlife Service

Based on a 1997 mandate by Congress under the National Wildlife Program Improvement Act, the US Fish and Wildlife Service is actively developing Comprehensive Conservation Plans for each of its National Wildlife Refuges (NWR) by 2012. This effort will affect several refuges in the Pasquotank River basin: Alligator River NWR, Currituck NWR, Mackay Island NWR, Pea Island NWR and Pocosin Lakes NWR. The planning process involves a public input component in an effort to:

- Provide a clear statement of direction for management of the refuge.
- Provide refuge neighbors, visitors, the public and government officials with an understanding of service refuge management actions on and around the refuge.

- Ensure that the US Fish and Wildlife Service management actions are consistent with the mandates of the National Wildlife Refuge System.
- Ensure that the management of the refuge considers federal, state and county plans.
- Provide long-term guidance and continuity in refuge management.
- Provide the basis for developing budget requests.

The Pasquotank River basin is incorporated into the Roanoke-Tar-Neuse-Cape Fear Ecosystem management unit that contains a 40,000-square mile area in southeastern Virginia and eastern North Carolina, extending from the piedmont to the Atlantic Coast. The management unit contains 59 federally listed endangered and threatened species and over a half million overwintering ducks, swans and geese; totally almost 400 species of birds. In addition, the unit contains the highest black bear population along the mid-Atlantic coast. Some common environmental challenges in the area include habitat loss, fragmentation, cowbird nest predation, construction, clearing for agriculture and industrial activity. In an effort to address these concerns, the USFWS began in the 1990s to delineate land protection needs; consider ecosystem management factors; and expand its refuge boundaries through partnerships, easements and donations.

For more information, contact Bob Glennon or D.A. Brown at (252) 482-2364 or by email d_a_brown@fws.gov or view the program at rtncf-rci.ral.r4.fws.gov.

1.3 State Initiatives

1.3.1 NC Agriculture Cost Share Program

The North Carolina Agriculture Cost Share Program was established in 1984 to help reduce the sources of agricultural nonpoint source pollution to 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 water and groundwater pollution. The Agriculture Cost Share Program is a voluntary program that reimburses farmers up to 75 percent of the cost of installing an approved BMP. The cost share funds are paid to the farmer once the planned control measures and technical specifications are completed. The annual statewide budget for BMP cost sharing is approximately 6.9 million.

Figure B-2 provides a summary of cost share dollars spent in the Pasquotank River basin between 1995 and 2000. Some of the county lines cross multiple river basins; therefore, some of the expenditures in Gates, Chowan, Washington and Dare may be due to projects in the Chowan, Roanoke or Tar-Pamlico River basins.

For more information about the NC Agriculture Cost Share Program, contact the Division of Soil and Water Conservation at (919) 733-2302.

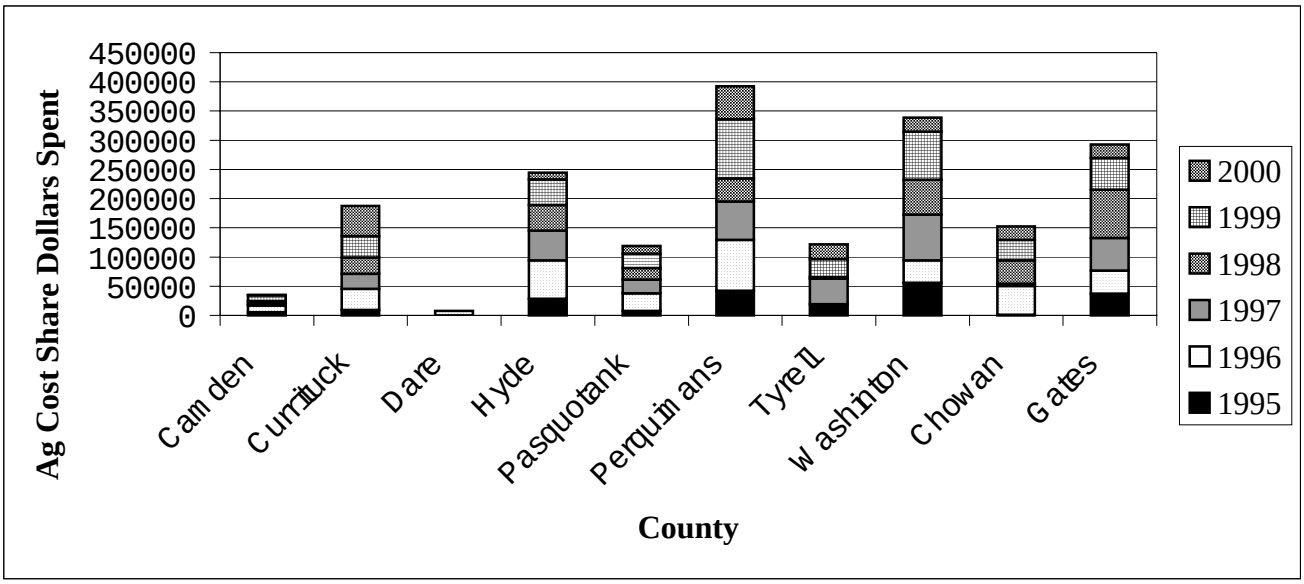


Figure C-2 Agriculture Cost Share Program Dollars Expended (1995-2000) in Counties in the Pasquotank River Basin (Source: NC Division of Soil and Water Conservation, 2001)

1.3.2 Emily and Richardson Preyer-Buckridge Coastal Reserve

The NC Division of Coastal Management acquired the 18,648-acre Preyer-Buckridge Coastal Reserve in June 1999 with funding from the NC Clean Water Management Trust Fund, the NC Natural Heritage Trust Fund, and the US Fish and Wildlife Service's Coastal Wetlands Conservation Grant Program. Additional funding was allocated for restoration of the site's hydrology and the natural communities that have been altered by historical logging activities. The reserve lies along the western shore of the Alligator River in the Pasquotank River basin (HUC 03010205 subbasin 03-01-51). Specific objectives for the Preyer-Buckridge Coastal Reserve are to:

1) Restore the natural hydrology and rare vegetative communities, including peatland Atlantic white cedar, pond pine woodland, nonriverine swamp forest and tidal cypress-gum swamp.
2) Protect the outstanding water quality of the Alligator River and its tributaries.
3) Improve water quality in the coastal area by preserving and restoring functioning wetlands.
4) Ensure the protection of aquatic and terrestrial habitat at a watershed level.
5) Foster environmental education partnerships with other agencies and organizations.

The Division has completed an environmental assessment for the proposed restoration work and is currently preparing a natural resource management and restoration plan for the reserve. An advisory group consisting of federal and state agency representatives, university researchers and private consultants has been formed to guide the restoration planning process. A natural resource inventory and assessment is underway. In addition, the NC Geodetic Survey has installed a network of elevation benchmarks. Also, dependent on funding, the US Geological Survey will undertake a two-year study to assess the site's hydrology and derive a hydrological model and water budget for the reserve. The USGS will also perform water quality testing in the reserve's

canals. Based on the results of hydrological data collection and analysis, a variety of restoration techniques may be employed with an emphasis on hydrological restoration.

For additional information, visit the DCM website at http://www.ncnerr.org/pubsiteinfo/siteinfo/buckridge/buck_ridge.htm.

1.3.3 NC Division of Water Quality and NC Division of Coastal Management Collaboration

North Carolina's Division of Coastal Management (DCM) and the Division of Water Quality (DWQ) share similar goals regarding water quality, and each program recognizes the value of enhanced coordination in accomplishing program missions. In an effort to enhance coordination, the two programs have agreed to work towards many improved collaborative efforts. Collaboration is intended to increase collaboration through periodic updates, increased review of each other's work products, and joint efforts to provide guidance and technical support between local land use planning programs and basinwide water quality planning.

Some of agreements include the following:

- DCM will provide written annual updates to DWQ on all types of permit activities occurring in the coastal region when the CAMA Permitted Activities Database is operational. Until that time, DCM will provide file access to any DWQ staff to compile the data themselves. This information will inform DWQ of potential impending cumulative effects of permits issued through CAMA.
- DWQ will periodically contact DCM district offices to relay information and gain feedback about the development or implementation of basinwide water quality plans.
- DWQ will discuss the draft basinwide water quality plan with DCM during the public review phase before soliciting the EMC's endorsement.
- DWQ will provide water quality use support methodology updates to DCM staff.
- DCM and DWQ to discuss the information provided to local land use planners (i.e., data packet, water quality designation information, etc.) on an annual basis.
- DCM to update DWQ periodically on local land use plan certifications.
- DCM to update DWQ on incremental reviews of local land use plan implementation pending recent regulation amendments.
- DCM and the CRC should encourage local governments to participate in the Basinwide Planning Program throughout its planning cycle. DCM will share local governments' contact information with DWQ and distribute DWQ programmatic information. DCM staff will also attend basinwide planning workshops and public meetings to the extent they can.
- DCM will provide a list to DWQ of each local government updating its land use plan at least annually. DWQ will provide each local government updating its plan a summary of the applicable water quality and basinwide plan information contained within that local government's jurisdiction. DWQ will provide the information based on the DWQ basinwide planning scale.
- DWQ will incorporate or at least acknowledge applicable local policies contained in certified local land use plans in the development of the respective basinwide plans. In Section C of the basinwide plans, DWQ will identify those local governments that have developed or implemented programs directed toward water quality restoration or protection.

- DWQ will review all draft local land use plans, provide comments to DCM within 30 days identifying potential problem areas, make suggestions for improvements, and identify violations or potential violations of water quality regulations.
- DCM will update DWQ periodically on the status of permitting analysis/cumulative and secondary impacts assessment. DCM and DWQ will work cooperatively to determine the Permitted Activities database query needs. Once the permit tracking system is operational, DCM will provide access for DWQ to conduct queries.
- DCM and DWQ will discuss the information provided in the *Reviewer's Guide for the Consideration of Cumulative and Secondary Impacts of Proposed Development in NEPA/SEPA Documents* specifically related to coastal water quality.
- DCM and DWQ to discuss DCM's guidelines for assessing and mitigating cumulative and secondary impacts during the CAMA permitting process.

For more information, contact the DWQ Planning Branch at (919) 733-5083.

1.3.4 NC Wetlands Restoration Program

The North Carolina Wetlands Restoration Program (NCWRP) is a nonregulatory program responsible for implementing wetland, stream and riparian buffer restoration projects throughout the state. The focus of the program is to improve water quality, flood prevention, fisheries and wildlife habitat, and recreational opportunities. The NCWRP is not a grant program. Instead, the program funds wetland, stream and riparian area projects directly through the Wetlands Restoration Fund.

Restoration projects are targeted through the use and development of the Watershed Restoration Plans for each of the state's 17 major river basins. These plans were developed, in part, using information compiled in DWQ's Basinwide Water Quality Plans. The Watershed Restoration Plans, previously known as the Basinwide Wetlands and Riparian Restoration Plans, are updated every five years on the same schedule as DWQ's Basinwide Water Quality Plans. This year marks the first update cycle of Watershed Restoration Plan for the Pasquotank River basin.

The NCWRP can perform restoration projects cooperatively with other state or federal programs or environmental groups. For example, the NCWRP's efforts can complement projects funded through the Section 319 Program. Integrating wetlands, stream or riparian area restoration components with 319 funded or proposed projects will often improve the overall water quality benefits of the project. The NCWRP actively seeks landowners within the Pasquotank River basin that have restorable wetland, riparian and stream sites.

Table C-2 lists the NCWRP's targeted Local Watersheds [stream names and 14-digit HU codes] in the Pasquotank River basin. This table indicates the pertinent factors that led to the selection of each Targeted Local Watershed. The Targeted Local Watersheds are selected on the basis of available data indicating the need and opportunity for local stream and wetlands restoration projects. Factors such as water quality problems, degraded aquatic habitat, cleared riparian buffers, significant natural areas or species, and increasing development pressures in the watershed are weighted heavily in determining these priority watersheds. Also, the presence of existing or planned water quality or habitat restoration projects in the same local watershed can be a significant factor in the choice of these watersheds. In some cases, NCWRP has used the

water quality information alone (e.g., use impairment, potential increases in nonpoint source pollution) to support the selection of a specific Targeted Local Watershed.

Table C-2 Wetlands Restoration Program Targeted Local Watersheds (2000)

Subbasin	Targeted Local Watershed Name(s)	14 Digit Hydrologic Unit
03-01-50	Folly Swamp	03010205010010
03-01-50	Pasquotank River	03010205010020
03-01-50	Sawyer's Creek	03010205040010
03-01-50	Knobs/Areneuse	03010205050010
03-01-51	Alligator River	03010205190010
03-01-52	Little River	03010205070010
03-01-54	Tull Creek/Buckskin Creek	03010205020010

* The numbers listed are the last five digits of the 14-digit Hydrologic Unit (HU) for each Local Watershed.

The NCWRP is also working to develop comprehensive Local Watershed Restoration Plans for Folly Swamp, Pasquotank River, Sawyer's Creek, and Knobs/Areneuse Creek from the Targeted Local Watersheds in subbasin 03-01-50. These more locally-based plans will identify wetland areas, contiguous reaches of stream, and contiguous strips of buffer vegetation that, once restored, will provide significant water quality and other environmental benefits to watersheds. The NCWRP will coordinate with local community groups, local governments and others to develop and implement these plans. Further details about these watersheds are provided in the appropriate subbasin chapter in Section B.

For more information about participating in the NCWRP, please visit the website at http://h2o.enr.state.nc.us/, then click on Wetlands Restoration Program or call (919) 733-5208.

1.3.5 Clean Water Management Trust Fund

The Clean Water Management Trust Fund 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 Pasquotank River basin, 11 projects have been funded since 1997 for a total of $8,326,638. The largest amount of funding ($3,858,500) was for acquisition purpose, conducted by the NC Division of Coastal Management. Table C-3 outlines the projects.

Table C-3 Projects in the Pasquotank River Basin Funded by the Clean Water Management Trust Fund (as of April 2001)

Project	Project Lead	Amount Funded
Restoration	Currituck County	$354,610
Buffer Acquisition	Dare County	$623,000
	NC Division of Coastal Management	$3,858,500
	NC Wildlife Resources Commission-Harrison Tract	$534,360
	NC Wildlife Resources Commission-Hassell	$169,000
	NC Wildlife Resources Commission-Midgett March	$620,000
	NC Wildlife Resources Commission-Tice	$250,000
Restoration	Pasquotank County	$413,600
Greenway Acquisition	Roanoke Island	$1,200,000
Wastewater	Roanoke Villas Clean Water Foundation	$245,568
Restoration	Roper	$60,000

For more information on the CWMTF or these grants, call (252) 830-3222 or www.cwmtf.net.

1.3.6 Virginia's Southern Watershed Area Management Program

The Southern Watershed Area Management Program (SWAMP) is a joint venture involving the cities of Chesapeake and Virginia Beach, Virginia; the Hampton Roads Planning District Commission (HRPDC); and the Virginia Coastal Program. SWAMP is intended to protect the natural resources, sensitive lands and water supplies in the Southern Watershed Area (SWA) through management of competing uses and collaboration of local, state and federal agencies working in the SWA.

The SWA is bounded by the Atlantic Ocean to the east, the Great Dismal Swamp to the west, and the State of North Carolina to the south. The SWA covers approximately 325 square miles and contains the sub-watersheds of the Northwest River, the North Landing River and Back Bay.

SWAMP has progressed through several phases. Phase I was largely concerned with the creation of a shared Mission Statement, Goals and Objectives for the SWA, and the development of a Memorandum of Agreement (MOA) between the two cities. The MOA acknowledges the goals and objectives and establishes a policy of attempting to coordinate planning initiatives between the two cities. Research activities accomplished under Phase I include collection of water quality data and initiation of a survey of agencies and organizations working in the SWA. Phase II involved the completion of the agency survey and analysis of the water quality monitoring network in the SWA.

Phase III marked a major transformation in the project. Funding was obtained from the National Oceanic and Atmospheric Administration, through the Virginia Coastal Program, to implement a

Special Area Management Plan (SAMP). A SAMP is intended to foster improved coordination between local, state and federal governmental agencies and other stakeholders that impact a designated coastal area.

Several major planning and technical studies of the SWA are nearing completion. The studies include a Strategic Plan for Agriculture, a Conservation Plan, a Rural Area Preservation Plan and a Mitigation Strategy. This information will be synthesized into a set of policy options for the cities of Chesapeake and Virginia Beach. In addition, MOAs on wetland mitigation, waterway use conflict management and conservation issues will be developed. The MOAs are intended to better integrate management efforts by local, state and federal agencies. The first of the MOAs, dealing with water use conflicts on the North Landing River, will be signed on April 30, 2001.

For additional information regarding SWAMP, contact the Hampton Roads Planning District Commission by calling (757) 420-8300.

1.3.7 Coastal Nonpoint Pollution Control Program

The goal of the CNPCP is to strengthen the links between federal and state coastal zone management and water quality management programs and to enhance state and local efforts to manage land use activities that degrade coastal waters and habitats. As required by the federal mandate, the CNPCP must implement, where necessary, the management measures identified by the federal agencies that address various sources of nonpoint source pollution.

Detailed descriptions of the management measures, where they are intended to be applied, their effectiveness, and their costs can be found in EPA's *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* at the following website at http://www.epa.gov/owow/nps/MMGI/.

Overview

The North Carolina Coastal Nonpoint Pollution Control Program (CNPCP) is a federally mandated program that is administered jointly by the NC Department of Environment and Natural Resource's Division of Water Quality and Division of Coastal Management. The National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) administer the Program jointly at the federal level. North Carolina is currently seeking final approval of its program from NOAA and EPA.

The CNPCP will develop a 15-year strategy to ensure implementation of the applicable management measures to protect and restore water quality. The immediate and primary focuses of the program will be on improving and protecting the quality of shellfishing waters; increasing the awareness of coastal nonpoint source related issues in the state; and providing resources that enable the improvement of the water quality component of DCM's Local Land Use Plans.

For additional information on the program, contact the DWQ Planning Branch NPS Planning Unit at (919) 733-5083.

1.3.8 Coastal Habitat Protection Plans

The North Carolina Fisheries Reform Act of 1997 requires the North Carolina Department of Environment and Natural Resources to prepare Coastal Habitat Protection Plans (CHPPs) for the

"long-term enhancement of coastal fisheries associated with each coastal habitat…." The plans describe the fisheries, fishery habitats and water quality affecting coastal fisheries stocks in the eight river basins that drain to the coast of North Carolina. Although staff of the Division of Marine Fisheries (DMF) is responsible for actually writing the plans, DWQ and the Wildlife Resources Commission, as well as the Divisions of Coastal Management (DCM) and Environmental Health (DEH), are heavily involved in the program. The Environmental Management, Coastal Resources and Marine Fisheries Commissions review and approve the plans, and those commissions are responsible for any new rules necessary for implementation of the plans.

The plans are organized by geographic area, with 11 management units, including the Roanoke River basin, that generally correspond with the DWQ Basinwide Planning Program units. A general Source Document includes regional and summary information. The management unit plans are specific to their areas, including detailed information and specific recommendations addressing conservation; habitat protection and enhancement; water quality improvement; research and monitoring; and administrative actions. A complete plan includes both the Source Document and the management unit plan. The first two area plans are underway in 2001. CHPPs that would affect the DWQ Pasquotank River basin management unit would include the Albemarle CHPP, Coastal Ocean CHPP and the Pamlico CHPP. All CHPPs are scheduled to be finalized by July 2003, then reviewed and updated every five years.

For additional information about CHPPs, call 1-800-682-2632 (in NC) or visit the program's website at http://www.ncfisheries.net/habitat/chpp1.htm.

1.3.9 North Carolina Sea Grant College Program

North Carolina Sea Grant's program priorities focus on three main areas: Economic Leadership; Coastal Ecosystem Health and Public Safety; and Education and Human Resources. Coastal Ecosystem Health and Public Safety reflects the transfer of research and technology to protect and enhance coastal habitats and provide safety for inhabitants. As many coastal counties see record growth, the following issues have moved to the forefront: water quality, sustainable development, coastal hazards, and habitat protection and restoration.

Some of the priority research and outreach goals include:

- Developing the capability to predict where and when phytoplankton blooms and hypoxic/anoxic conditions will occur, which is important for determining ecosystem response to these events.
- Determining ecosystem responses to various levels of nutrient controls.
- Quantifying the interrelationships between land-use activities, hydrologic processes and the ecological response of receiving waters in coastal and upland zones.
- Developing techniques to identify, characterize and understand nonpoint sources of nutrients, toxins and other contaminants.

Sea Grant has worked with local shoreline owners to develop and demonstrate erosion control techniques that combine planted or existing marsh grasses with small structures call sills or breakwaters in areas where neither method would be successful if used alone. Some of these

areas include sites in Currituck Sound, Duke, Aydlette and Camden Point on Albemarle Sound. By establishing a new marsh or preventing erosion of an existing marsh, the small structures create or maintain fringing marshes along areas that would otherwise be eroding upland areas. The method reduces sediment and nutrient erosion inputs that would otherwise be added to the rivers and sounds. The method enlarges or stabilizes the width of existing vegetative buffers and their water quality benefits while creating or maintaining an enhanced biological habitat of the marsh compared to less productive eroding beaches.

For additional information about NC Sea Grant or help with shoreline erosion options, contact Spencer Rogers (919) 962-2491 or by email rogerssp@uncwil.edu. If you need help with water quality issues, contact Barbara Doll, Water Quality Specialist, at (919) 515-5287 or by email barbara_doll@ncsu.edu.

1.3.10 Albemarle-Pamlico National Estuary Program

The Albemarle-Pamlico National Estuary Program (APNEP), formerly known as the Albemarle-Pamlico Estuarine Study (APES), was among the first National Estuary Programs established by the EPA in 1987. The mission of the APNEP is to identify, restore and protect the significant resources of the Albemarle-Pamlico estuarine ecosystem. Unlike traditional regulatory approaches to environmental protection, the APNEP is a cooperative effort jointly sponsored by NCDENR and the EPA that targets a broad range of issues and engages local communities in the process.

The program focuses not just on improving water quality in the region's estuaries, but on maintaining the integrity of the whole system - its chemical, physical and biological properties, as well as its economic, recreational and aesthetic values. Important components of the APNEP are the consideration of water quality, fisheries resources, land and water habitats, and the interaction of humans with the natural resources of the estuarine system. The APNEP is designed to encourage local communities to take responsibility for managing the resources in their respective jurisdictions.

Comprehensive Conservation and Management Plan

Since 1987, research generated by the APNEP has been instrumental to the development of a Comprehensive Conservation and Management Plan (CCMP). This plan is composed of recommendations for management strategies that address concerns in the Albemarle-Pamlico Sounds region and to protect the system's estuarine resources.

During the development of the CCMP, the APNEP was guided by a 95-member Management Conference that represented diverse interests. Four committees were responsible for identifying problems in the estuarine system, generating research where gaps in knowledge existed, increasing public awareness of environmental issues, and finding solutions to address those issues. As a result of these efforts, more is known about the Albemarle-Pamlico estuarine system than ever before.

One of the recommendations of the CCMP was to develop regional councils in each of the five major river basins of the Albemarle-Pamlico watershed for the purpose of fostering public input into the APNEP program. In 1995, an Executive Order was issued by the Governor of North Carolina calling for the creation of these regional councils. The Pasquotank River Basin Regional Council is highlighted below.

Currently, the APNEP is administered and staffed by DWQ; however, staff works closely with the EPA's Office of Water to implement the many objectives and key management actions contained in the APNEP's CCMP.

CCMP Development Involved Diverse Interests Including:

- Federal and state government
- University researchers
- Environmental groups
- Agriculture representatives
- Forestry interests
- Industry representatives
- Developers
- Fishers
- Local elected officials

Pasquotank River Basin Regional Council

Each regional council is comprised of elected and appointed county and municipal officials, representatives from agriculture, silviculture, commercial and recreational fishing, conservation, environmental science, business/industry and tourism groups. Each council is charged with identifying and implementing a project that utilizes innovative or unique management strategies to address a priority watershed problem. Regional councils provide a form for public, special interest and local government involvement in the APNEP.

The Pasquotank River Basin Regional Council (PRBRC) has been active, meeting approximately four times per year. Highlights of accomplishments thus far include:

- Securing congressional funding ($100,000) for the Army Corps of Engineers to conduct a comprehensive study of Currituck Sound.
- Touring the Tidewater On-Site Wastewater Demonstration Center at the Vernon James Research Center in Plymouth to view current research/demonstration of alternative septic systems.
- Conducting a demonstration project with the Albemarle RC&D regarding constructed wetlands.
- Hosting discussions regarding sustainable development in response to ever-increasing population pressures being applied to communities along the Outer Banks.
- Learning about the USFWS's development of comprehensive conservation and management plans for each of the wildlife refuges in North Carolina and Virginia.
- Co-sponsoring public workshops conducted by DWQ regarding development of the 2002 Pasquotank River Basinwide Water Quality Plan.
- Linking with Noah Hill (APNEP/VADCR liaison) regarding Virginia's Watershed Roundtables, SWAMP (Southern Watersheds Area Management Plan), draft MOA between NCDENR and VADCR, Virginia's Adopt-A-Stream Program and Riverkeeper efforts in the Blackwater and Nottoway Rivers.

Interstate Collaboration Efforts

North Carolina and Virginia have jointly funded a Watershed Field Coordinator position to facility discussions regarding the Albemarle, Chowan and Coastal Watersheds. The term position aims to accomplish:

- Facilitate and foster coordination and communication between Virginia's Watershed Roundtables and NC's River Basin Regional Councils.
- Compile information from local jurisdictions that will aid in the Albemarle-Pamlico National Estuary Program's Comprehensive Conservation and Management Plan's work plans, targeting and monitoring of progress.
- Assist in preparing regionally targeted fact sheets, news releases and other articles for publishing purposes.
- Assist with event planning and facilitation.

For more information on the Watershed Field Coordinator's activities, call (757) 925-2468.

For more information on the Albemarle-Pamlico National Estuary Program, call (919) 733-5083, ext. 585 or visit the program's website at http://h2o.enr.state.nc.us/nep/.

1.4 Local Initiatives

1.4.1 NC Cooperative Extension Service

In an effort to improve the information flow in the Pasquotank River basin, the NC Cooperative Extension Service's local area specialized agent in water quality acquired Section 319 funding. The funding is used to develop and circulate a periodic newsletter entitled *River and Sound Advice: News about the Chowan and Pasquotank River Basins*. For more information, contact Marjorie Rayburn at (252) 357-1400 or by email Marjorie_Rayburn@ncsu.edu.

1.4.2 Town of Nags Head Septic Health Initiative

In the fall of 2000, the Town of Nags Head began a Septic Health Initiative Program designed to develop strategies and programs to improve the performance of septic systems in the town. Failing or poorly maintained septic systems can adversely impact water quality in the sounds and ocean surrounding the town. The programs developed were the result of several years of work from the Town of Nags Head Septic Health Committee.

The Septic Health Committee, established in 1997, is composed of a cross-section of town citizens sharing a deep concern for the protection of water quality within and around the town. The Septic Health Committee developed, and the Board of Commissioners approved, a series of programs designed to improve the performance of septic systems while gathering information about septic systems in the town.

Guiding the development of the Septic Health Initiative were the goals of the Septic Health Committee and a companion goal in the town's Land and Water Use Plan. The Goal of the

Septic Health Initiative is to reduce the need for central sewage and improve the quality of the town's surface water and groundwater by improving the performance of individual septic systems used to dispose of wastewater throughout the town.

The Town of Nags Head is to provide an economic and environmentally sensitive means of sewage treatment and disposal which maintains or improves the quality of the town's surface waters and groundwater and maintain low density development. The Septic Health Initiative has four separate but interrelated programs: Septic Tank Pumping Program; Water Quality Monitoring Program; an Education Program; and a Decentralized Wastewater Master Plan.

Septic Tank Pumping and Inspection Program

This program is designed to encourage homeowners through incentives and educational resources to have their septic systems inspected and pumped on a regular basis. The inspection data collected during the pumping process will be used to develop a Decentralized Wastewater Management Plan.

Water Quality Monitoring Program

In order to measure the effectiveness of the town's septic health initiative, the town is monitoring 31 groundwater and surface water sites throughout the town to identify any problems associated with septic systems.

Education Program

Aimed at homeowners, guests and school children, the education program is designed to increase awareness about water quality and the importance of proper operation and maintenance of septic systems.

Decentralized Wastewater Management Plan

The long-term goal of the Septic Health Initiative is to develop a plan that will allow the continued use of on-site systems in the town without impacts on water quality. The information currently being collected in the Septic Tank Pumping and Inspection Program and the Water Quality Monitoring Program will be used to develop this plan. The Decentralized Wastewater Management Plan will provide a long-term strategy for the protection of water quality while at the same time allowing the continued use of on-site systems.

Program objectives include the following:

- Providing incentives for the pumping and inspections for non-state regulated systems. The department goal is to have 500 tanks pumped this year.
- Testing and analyzing groundwater and surface waters from 31 sites.
- Developing a "protocol" for the release of water quality data.
- Developing educational materials directed towards elementary school children.
- Analyzing water quality and inspection data and develop strategies to address any problems that may be found.

- Developing the necessary databases (inspection reports, existing permits, land and water use data, etc.) needed for the development of an effective management program.
- Distributing to homeowners and rental agencies educational material (vinyl decals, bathroom door hangers and brochures). Revise and "refresh" the program and materials as well as develop new ideas for promoting the program.
- Beginning the development of a Decentralized Wastewater Management Plan to assure optimum operation and maintenance of on-site septic systems.
- Promoting the program by: continued press releases, interviews, participation at conferences and seminars, town newsletter articles, participation at civic groups, government informational channel, etc.
- Applying for state and federal grants as the opportunity arises.
- Promote and inform citizens about the Septic Health Initiative loan program for the repair of failed or failing septic systems.

As of April 2001, this initiative has assisted 200 property owners in Nags Head with the inspection and pumping program. Our water quality data results are available for public viewing on the town website, and our educational material is being distributed to many groups, associations and individuals. The Town of Nags Head intends for this initiative to run approximately 4-5 years.

For additional information on any part of Septic Health Initiative, please call The Town of Nags Head Septic Health Coordinator at (252) 441-5508 or visit the website at http://www.townofnagshead.net.

1.4.3 Dare County Surface Water Quality Monitoring Program

The Dare County Health Department works with NC Shellfish Sanitation in coordinating the surface water quality program in Dare County. At this time, there are 49 sites sampled within the county. The samples are analyzed one time per month for total phosphates, nitrates and nitrites. Fecal coliform and E. coli are tested one time per week from Memorial Day to Labor Day, and less frequently during the 'off' season.

The county works with DEH Shellfish Sanitation in the posting of advisories for high bacterial content at these sites. When an advisory must be posted, the Dare County Health Department handles the notification of county and town officials, any business that may be affected, and the public through the internet and radio. DEH Shellfish Sanitation posts the sign.

To view bacterial data on-line, go to www.co.dare.nc.us/Health, click on water monitoring, along with current advisories and information about how the program works. For more information on the program, call the Dare County Health Department at (252) 475-1096 or visit the program on the web at http://www.co.dare.nc.us/health/WaterMon/index.htm.

1.4.4 Keep Pasquotank Beautiful/Recycling; Pasquotank County

One of the projects that Pasquotank County's Keep Pasquotank Beautiful campaign has considered involves storm drain marking. This effort has historically been done in the local area; however, the recycling program hopes to gain additional exposure. For example, several of the

program's affiliate municipalities have found that a reflective plate with the "do not dump" message and a visual reminder that storm drains flow directly into the Pasquotank River is much more effective. The program is conducting cost research with the NC Department of Corrections and local municipalities to determine cost and number of signs needed. In addition, the program is actively seeking funding for the initiative. For further information, contact the coordinator at (252) 335-4105.

1.4.5 North Carolina Coastal Federation

The North Carolina Coastal Federation (NCCF) is the state's largest nonprofit organization working to restore and protect the coast. Formed in 1982, the NCCF has grown to serve more than 5,000 members and 200 member groups. The NCCF focuses on three main areas of work including habitat restoration and protection, environmental education, and the encouragement of sound environmental programs and their enforcement.

ShoreKeeper Projects

The NCCF ShoreKeeper projects are examples of ways citizens can restore and protect water quality and coastal resources. Naturally green shorelines act as "buffers" and can consist of native trees, shrubs, grasses, wetland plants or any combination. NCCF has performed several ShoreKeeper erosion control consultations in the Dare County area and offers expertise and guidance to citizens interested in this method of shoreline stabilization.

Ice Plant Island Shoreline Restoration

The Corps of Engineers, working cooperatively with the NCCF, staff from the Roanoke Island Festival Park, and various state and federal agencies, has developed draft design plans for a shoreline restoration project. In recent years, about 1,500 feet of Ice Plant Island's southern and eastern shorelines have experienced severe erosion, primarily due to increased boat wakes in the area. An estimated 100 feet of shoreline was lost in the last ten years. The conceptual approach for this site involves the construction of a low profile stone sill channelward of the eroding marsh and the reestablishment of a coastal marsh fringe landward of the sill. In addition to restoration of the coastal marsh, the proposed design includes enhancement of both oyster habitat and seagrass beds. The proposed sill and resource/habitat enhancement areas will be implemented along approximately 900 feet of shoreline; the remaining eroding shoreline (east facing) will be stabilized with a standard stone revetment adjacent to the existing marsh and upland. The project, as designed, will restore coastal marsh, oyster habitat and seagrass beds, in addition to halting erosion and preventing further loss of the remaining marsh fringe. The stone sill will remain open at regularly spaced drop down areas to ensure fish passage to the protected marsh, and the stone itself provides habitat for fauna utilizing the nearshore zone. Restoration and protection of the marsh fringe along Ice Plant Island is essential to maintaining the fish habitats of this area, and Dough's Creek is designated by the Department of Environment and Natural Resources as a Primary Nursery Area, and the area also serves as an important habitat for shellfish. The Corps of Engineers has proposed project construction during the winter 2001/2002, with completion of the seagrass and marsh plantings scheduled for April/May 2002.

CoastKeepers

NCCF was approved by the Water Keeper Alliance in November 2000 to license three CoastKeepers. The federation is the only organization to be licensed to cover the state's entire coast. The first of the three CoastKeepers, Cape Fear CoastKeeper, was hired to cover the coastal areas from Camp Lejeune to Calabash. NCCF's next goal is to establish CoastKeepers at the ocean headquarters and then along the Outer Banks. NCCF aims to have the Cape Lookout CoastKeeper by the end of 2001 and the Cape Hatteras CoastKeeper in 2002.

Educational Programs

NCCF's Education Program's mission is to provide educational experiences and resources that will produce an understanding and appreciation of coastal areas, motivating participants to make informed decisions and become active stewards. The Education's Program includes field trips, teacher workshops, classroom curriculum, action projects and much more. All students and teachers will find a hands-on way to connect to North Carolina's coast. Field trip sites in the Pasquotank River basin include Currituck Sound, Dare County and Hyde County (Alligator River). Each month NCCF offers a day-long coastal canoe trip to a different location. NCCF also offers a Coastal Canoe trip at the Alligator River National Refuge once or twice a year.

For more information, call NCCF at (252) 393-8185 or visit the website at http://www.nccf.

1.4.6 Citizens' Water Quality Monitoring Program

The Albemarle-Pamlico National Estuary Program's (APNEP) Citizens' Water Quality Monitoring Program (CWQMP) is a network of private citizens who monitor ambient, surface water quality in the Albemarle-Pamlico Estuary and its tributaries. This program began as an initiative by the Pamlico-Tar River Foundation, to protect, preserve and promote the quality of the Tar-Pamlico River and its watershed. In 1991, the CWQMP was expanded under the Albemarle-Pamlico National Estuary Program to include all waters located within the Albemarle-Pamlico Watershed basin.

The CWQMP focuses upon three areas of activity: 1) baseline monitoring; 2) targeted monitoring and surveys; and 3) water quality education. Program participants receive support in many forms: water quality education and training, equipment and supplies, data management and analysis, and network opportunities.

Participants in the CWQMP primarily monitor "vital signs" of the estuary. Specifically, volunteers monitor dissolved oxygen, pH, salinity, air and water temperatures, and turbidity to gauge the general health or quality of water in the estuary. Using basic, but accurate water quality test kits, citizen volunteers analyze water samples, observe qualitative factors such as weather conditions and other visual indicators, and record their results. All data collected are forwarded to the program office where staff compiles the information and enters the data into report form for citizen and government agency use. Often, these monitoring efforts serve as useful supplements to existing governmental activities.

For additional information, please contact the CWQMP by calling (252) 328-1747 or by visiting the APNEP website at http://h2o.enr.state.nc.us/nep/.

1.4.7 North Carolina Coastal Land Trust

The North Carolina Coastal Land Trust and its contractors are currently developing a conservation planning document, *Riparian Corridor Conservation*. The document is designed for the Pasquotank River riparian zone. The document will be completed and submitted to the Conservation Trust of North Carolina and the Clean Water Management Trust Fund by December 2001. The area of concern for this document is the nontidal, riparian zone of the Pasquotank River and its major tributaries between the southern boundary of the Great Dismal Swamp National Wildlife Refuge and Elizabeth City, a distance of approximately 20 miles.

The document will contain three main sections. The first section will be a summary of available water quality and quantity information and features of the watershed that may affect water quality and quantity. This will include summaries of stream classifications, state and federal water quality monitoring efforts, state Natural Heritage areas and other protected lands, demographic information, land uses and potential threats to water quality. The second section will be a compilation and summary of conservation strategies available to landowners and land managers that target water quality and quantity protection. Specifically, this section will include a summary of state and federal programs that promote the protection of riparian buffers along the main stem of the Pasquotank River and its tributaries. The third section will be an action plan specifying ways to implement water quality and quantity protection strategies on parcels that received high priority rankings as well as outreach and education strategies in the watershed in general. An integral part of this section will be a "Prioritization Strategy" which will identify key parcels of land that, if protected, would serve to maintain or enhance water quality for the river basin.

Funding for this document has been provided by a grant from the North Carolina Clean Water Management Trust Fund through the Conservation Trust of North Carolina.

The Land Trust acquired four acres overlooking the Pasquotank River in Pasquotank County. The property is located north of Elizabeth City, including a cypress-gum swamp along the river. In addition, the NC Coastal Land Trust acquired funding to work on other projects in the region (Coast Lines, 2001).

1.4.8 The Town of Winfall

The Winfall Water Quality Demonstration Project is intended to demonstrate the effectiveness of a constructed wetland in treating backwash water from a municipal water treatment plant and stormwater runoff.

The site is located within the Town of Winfall adjacent to the Winfall Town Offices and an elementary school. Begun in July 2001, the constructed wetland portion of the project is completed. In addition to approval from the Town of Winfall, this project also required approval from the US Army Corps of Engineers and the NC Division of Water Quality. Wetland construction combined bioengineering methodology with the planting of specific aquatic plants.

Development of an educational brochure, as well as the construction of a boardwalk leading to an outdoor classroom platform in the middle of the wetland, are almost complete.

The project is a cooperative effort between the Albemarle Resource Conservation and Development Council, the Albemarle Pamlico National Estuary Program Pasquotank River Basin Regional Council, the Town of Winfall, the Perquimans Soil and Water Conservation District, the National Resource Conservation Service, Wooten Engineering, Royster Clark, Inc., and the USEPA.

Chapter 2 -
Future Water Quality Initiatives

2.1 Overall DWQ Goals for the Future

The long-term goal of basinwide management is to protect the water quality standards and uses of the surface waters in the state while accommodating reasonable economic growth. Attainment of these goals and objectives will require determined, widespread public support; the combined cooperation of state, local and federal agencies, agriculture, forestry, industry and development interests; and considerable financial expenditure on the part of all involved. With this needed support and cooperation, DWQ believes that these goals are attainable through the basinwide water quality management approach.

In addition to these efforts, DWQ will continue to pursue several programmatic initiatives intended to protect or restore water quality across the state. These include NPDES Program Initiatives, better coordination of basinwide planning, use restoration waters program for nonpoint source pollution, and improving database management and use of GIS capabilities. Summaries of these initiatives are outlined below.

NPDES Program Initiatives

In the next five years, DWQ will continue to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes discharged to municipal wastewater treatment plants so as to reduce effluent toxicity;
- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or use of alternative disinfection methods for new or expanding facilities;
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for enlargement well before they reach capacity.

Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling by-products of the treatment process (including reuse of nonpotable treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

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

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

2.2 Coordination with Other Agencies

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

DWQ would like to work more closely with the conservation districts in each county of the Pasquotank River basin to identify nonpoint sources of pollution, develop land use and land cover data, and to develop water quality management strategies for impaired watersheds within the Pasquotank River basin.

DWQ is also working with DEH Shellfish Sanitation to develop databases and other tools to better identify impairment in shellfish harvesting waters. Refer to Section 3.4.1 for more information on this process.

Division of Soil and Water Conservation and Division of Water Quality are working together to better identify causes and sources of impairment in rural streams. The two agencies will be working together to target those streams that are impaired and where implementation of best management practices would improve water quality. Refer to Section C, Chapter 2 for more information on the Agricultural Cost Share Program.

DWQ and DCM are working to ensure that local governments consider water quality impacts in their land use plan. Refer to Section C, Chapter 2 for more information.

Use Restoration Waters (URW) Program for Nonpoint Source Impairment

DWQ has developed a conceptual strategy to manage watersheds with nonpoint source impairments as determined through the use support designations. In July 1998, the state Environmental Management Commission approved the Use Restoration Waters (URW) Program concept which will target all NPS impaired waters in the state using a two-part approach. The program will catalyze voluntary efforts by stakeholder groups in impaired watersheds to restore those waters by providing various incentives and other support. For locations where local groups choose not to take responsibility for restoring their impairments, the program will consider the option of developing a set of mandatory requirements for NPS pollution categories.

This URW concept offers local governments an opportunity to implement site-specific projects at the local level as an incentive ("the carrot"). If the EMC is not satisfied with the progress made

towards use restoration by local committees, impairment based rules will become mandatory in those watersheds ("the stick").

These mandatory requirements may not be tailored to specific watersheds but may apply more generically across the state or region. The form of the URW program will be strongly influenced by the year-long stakeholder input process.

With more than 400 impaired watersheds or stream segments in the state, it is not realistic for DWQ to attempt to develop watershed specific restoration strategies for nonpoint source pollution. By involving the stakeholders in these watersheds, we believe we can catalyze large-scale restoration of impaired waters. We anticipate that one of the major implementation challenges of this new program will be educating public officials and stakeholders at the local level as to the nature and solutions to their impairments. To address this challenge, the state plans to develop a GIS-based program to help present information at a scale that is useful to local land management officials. Other incentives that the state might provide include seed grants and technical assistance, as well as retaining the authority to mandate regulations on stakeholders who are not willing to participate.

In cases where incentives and support do not result in effective watershed restoration strategies, mandatory impairment source management requirements would be implemented in the watershed. This is not the state's preferred alternative, as it would add to state monitoring and enforcement workload. However, in areas where it is necessary, DWQ plans to implement such requirements. In the management area, DWQ would be assisted by regulatory staff from the Divisions of Environmental Health and Land Resources and to insure compliance.

For more information on the Use Restoration Waters Program, contact the DWQ Planning Branch's Nonpoint Source Unit at (919) 733-5083.

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

DWQ is in the process of centralizing and improving its computer data management systems. Most of its water quality program data (including permitted dischargers, waste limits, compliance information, water quality data, stream classifications, etc.) will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Some of this information is also being submitted into the NC Geographic Data Clearinghouse (Center for Geographic Information and Analysis or CGIA). As this and other information (including land use data from satellite or air photo interpretation) are made available to the GIS system, the potential to graphically display the results of water quality data analysis will be tremendous.

Additional Research and Monitoring Needs

DWQ staff have identified some additional research needs that would be useful for assessing, protecting and restoring the water quality of the Pasquotank River basin. The following list is not inclusive. Rather, it is meant to stimulate ideas for obtaining more information to better address water quality problems in the basin. With the newly available funding programs (Clean Water Management Trust Fund and Wetlands Restoration Program) and the existing Section 319

grant program, it may be desirable for grant applicants to focus proposals on the following issues:

- *Nonpoint sources of pollution*. Identifying nonpoint sources of pollution and developing management strategies for impaired waters, given the current limited resources available, are an overwhelming task. Therefore, only limited progress towards restoring NPS impaired waters can be expected unless substantial resources are put towards solving NPS problems.
- *Swamp Waters Study*. Increasing population in these areas will demand more water and generate more wastewater. In addition, conversion of land from forests and farms will increase impervious surfaces producing higher than natural streamflows and cause erosion. Streams in these areas will likely remain (or become) impaired unless this growth is planned for and managed properly.
- *Cost Effective BMPs*. The state has provided a great deal of funding to the Pasquotank agriculture sector to share information on best management practices that protect and restore water quality while at the same time ensuring appropriate harvest yields.
- *Urban planning*. Increasing population in these areas will demand more water and generate more wastewater. In addition, conversion of land from forests and farms will increase impervious surfaces producing higher than natural streamflows and cause erosion. Streams and estuarine waters in these areas will likely remain (or become) impaired unless this growth is planned for and managed properly.

2.3 DWQ Compliance and Enforcement Policy Revisions

NCDENR began implementing a new two-stage compliance and enforcement policy in 1997. Both stages of the revised policy are in effect as of July 1, 1999. The five major elements of the policy are intended to provide a comprehensive route to strengthen enforcement and heighten compliance for all dischargers and nonpoint sources of water pollution in North Carolina. The five major components of the policy are to:

1. Foster compliance through pollution prevention, technical assistance and training, reevaluate existing grant and loan funding priority criteria, and develop recognition and incentive programs.
2. Enhance enforcement through increased penalties, penalties for sewer collection systems, reduced thresholds for noncompliance, and delegation of civil penalty assessment authority to the DWQ regional office supervisors.
3. Focus on chronic and willful violators through increased use of moratoriums on expanding and additional connections, expansion of notification to the public of violators, clarification of process of determining "noncompliance", and initiation of discussion with stakeholders on possible legislative actions.
4. Assure improvement in compliance and enforcement through development of accountability measures.
5. Find and use all available resources for compliance needs with local, state and nonprofit groups.

NCDENR is also in the process of conducting an assessment of its enforcement programs. The goal of the assessment is to identify potential areas for improvement in NCDENR's efforts to

enforce environmental laws and ultimately improve compliance. This effort got underway in July 1999 with two focus group meetings. If you would like to see the Scope of Work for the enforcement assessment, see NCDENR's web page at http://www.enr.state.nc.us/novs/scope.htm/.

2.4 Non-Discharge Permits

Non-discharge (land application) has the potential to affect adjacent surface waters if not properly designed and maintained. There are currently no protocols regarding water balance calculations to attach to permit applications. Therefore, there is a need for DWQ to look into the issue, hence the Water Balance Group. Per recent regulations, DWQ needs to decide what parameters need to be addressed in hydrologic evaluations as a means of ascertaining impacts to local surface waters.

Hydrological studies will need to look at nutrient load by conducting a nutrient impacts study for surrounding surface waters. There is no comparable analysis required for BOD since there are no standards for BOD. There are no numeric standards for nutrients, but DWQ works with a sensitivity level. Some of the criteria that are considered in the water balance calculations include: rain, evapotranspiration, drainage (varies seasonally), spray irrigation (what you want to spray based on design capacity), spray available (soil assimilative capacity), and storage (what you cannot spray).

In order to conduct an effective analysis, DWQ may need to gather 12 months or more of data. An effective analysis will also require a great deal of field surveying. Since the effort will be field intensive, it will probably take longer for a permit application to evolve and get approved.

2.5 Coordination within DWQ

As a large governmental Division, DWQ has challenges regarding communication across its many programs. In an effort to improve facility construction, maintenance and permitting, DWQ will work towards holding periodic discussions with appropriate staff and other agency personnel during multiple stages of the facility permitting process: grant review, facility permitting, and upon notice of violation. The DWQ Basinwide Planning Program will coordinate these discussions

The DWQ Basinwide and Estuary Planning Unit has initiated periodic meetings with the DWQ Nonpoint Source Unit to ensure more efficient and timely communication exchanges as well as implementation oversight of basinwide water quality plan recommendations.

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Appendix I

NPDES Dischargers
and
Individual Stormwater Permits
in the
Pasquotank River Basin

NPDES Dischargers in the Pasquotank River Basin (as of March 5, 2001)

Permit	Facility	County	Region	Type		D1	D2	D3	D4	D5	Qw	Subbasin	Receiving Stream
NC0007978	South Mills Water Association, Inc.	Camden	Washington	Minor	Non-Municipal	22					not limited	03-01-50	Dismal Swamp Canal
NC0025011	Elizabeth City (City) - WWTP	Pasquotank	Washington	Major	Municipal	1	56				4.5	03-01-50	Pasquotank River
NC0036447	Elizabeth City WTP	Pasquotank	Washington	Minor	Non-Municipal	22					not limited	03-01-50	Knobbs Creek
NC0037214	Camden County BOE - Grandy Primary	Camden	Washington	Minor	Non-Municipal	3					0.007	03-01-50	Sawyers Creek
NC0043583	Pasquotank Co WTP	Pasquotank	Washington	Minor	Non-Municipal	22					not limited	03-01-50	UT New Begun Creek
NC0085430	Sprint Carolina Telephone	Camden	Washington	Minor	Non-Municipal	66					not limited	03-01-50	Great Dismal Swamp
NC0086681	Camden County WTP	Camden	Washington	Minor	Non-Municipal	22					not limited	03-01-50	Pasquotank River
NC0001732	Daniels Seafood (Nags Head)	Dare	Washington	Minor	Non-Municipal	25	30				not limited	03-01-51	Roanoke Sound
NC0035670	Dare County - Skyco Regional WTP	Dare	Washington	Minor	Non-Municipal	22					0.05	03-01-51	UT Croatan Sound
NC0041386	DCOM - Wanchese Harbor Project	Dare	Washington	Minor	Non-Municipal	2	25				0.025	03-01-51	Mill Creek
NC0048151	Etheridge Seafood Company	Dare	Washington	Minor	Non-Municipal	25	30				0.025	03-01-51	Mill Creek
NC0056065	NCDOT - Marine Maintenance	Dare	Washington	Minor	Non-Municipal	37	22				not limited	03-01-51	UT Spencers Creek
NC0079057	Manteo, Town - WWTP	Dare	Washington	Major	Municipal	1					0.6	03-01-51	Shallowbag Bay
NC0021849	Hertford, Town - WWTP	Perquimans	Washington	Minor	Municipal	1					0.4	03-01-52	Perquimans River
NC0051373	Perquimans County WTP #2	Perquimans	Washington	Minor	Non-Municipal	22					not limited	03-01-52	UT Mill Creek
NC0068861	Perquimans Co. WTP #1 / Bethel	Perquimans	Washington	Minor	Non-Municipal	22					not limited	03-01-52	Bethel Creek
NC0081850	Winfall, Town - WTP	Perquimans	Washington	Minor	Non-Municipal	22					not limited	03-01-52	Mill Creek
NC0085961	Edenton Auxiliary Naval Station - Midway	Chowan	Washington	Minor	Non-Municipal	66					0.072	03-01-52	UT Albermarle Sound
NC0007510	Columbia, Town - WTP	Tyrrell	Washington	Minor	Non-Municipal	22					not limited	03-01-53	UT Scuppernong River
NC0020443	Columbia, Town - WWTP	Tyrrell	Washington	Minor	Municipal	1					0.3	03-01-53	Scuppernong River
NC0027600	Creswell, Town - WTP	Washington	Washington	Minor	Non-Municipal	22					not limited	03-01-53	UT Scuppernong River
NC0031925	Roper, Town - WTP	Washington	Washington	Minor	Non-Municipal	22					not limited	03-01-53	UT Main Canal
NC0036315	Roper, Town - WWTP	Washington	Washington	Minor	Municipal	1					0.085	03-01-53	Main Canal - Kendricks Creek

NPDES Dischargers in the Pasquotank River Basin (as of March 5, 2001)

Permit	Facility	County	Region	Type	D1	D2	D3	D4	D5	Qw	Subbasin	Receiving Stream
NC0048861	Creswell, Town - WWTP	Washington	Washington	Minor Municipal	1					0.064	03-01-53	Scuppernong River
NC0085081	Dalton House Motel / Restaurant	Tyrrell	Washington	Minor Non-Municipal	13	10	4			0.006	03-01-53	Scuppernong River
NC0072150	Currituck County WTP	Currituck	Washington	Minor Non-Municipal	22					not limited	03-01-54	UT East Creek
NC0077984	Corolla North Utilities	Currituck	Washington	Minor Non-Municipal	22					0.07	03-01-54	Atlantic Ocean
NC0025313	Kill Devil Hills, Town - WWTP	Dare	Washington	Minor Municipal	1					0.06	03-01-55	Buzzard Bay
NC0033103	Dare County Cape Hatteras Water System	Dare	Washington	Minor Non-Municipal	22					not limited	03-01-55	Peter's Ditch
NC0041530	Ocracoke Sanitary District - Hyde WTP	Hyde	Washington	Minor Non-Municipal	22					0.45	03-01-55	Pamlico Sound
NC0070157	Dare County - Reverse Osmosis	Dare	Washington	Minor Non-Municipal	21					not limited	03-01-55	Ditch To Atlantic Ocean
NC0083909	Dare County Regional Water System	Dare	Washington	Minor Non-Municipal	22					not limited	03-01-55	Blackmar Gut
NC0085707	Dare County Cape Hatteras Water System	Dare	Washington	Minor Non-Municipal	22					1.8	03-01-55	Pamlico Sound
NC0023027	Villas Association, Inc.	Dare	Washington	Minor Non-Municipal	6					0.06	03-01-56	Roanoke Sound

List of Discharger Codes

1	Domestic	Municipal
2	Domestic	Industrial / Commercial
3	Domestic	Schools
4	Domestic	Single Family Residence
6	Domestic	Condominiums
10	Domestic	Restaurants
13	Domestic	Lodging (hotels, motels, guest houses, campgrounds, rest areas, etc.)
21	Water plants (Surface water)	
22	Water plants and Water conditioning (Groundwater)	
25	Seafood and Fish processing	
30	Seafood or Fish packing	
37	Oil separator	
56	Metal plating	
66	Groundwater remediation	

NPDES Individual Stormwater Permits in the Pasquotank River Basin (as of April 5, 2001)

Permit #	Facility Name	Receiving Stream	Subbasin	County
NCS000336	Universal Forest Products Eastern Div, Inc.	Knobbs Creek	03-01-50	Pasquotank
NCS000008	South Atlantic Wood Preserving	Little River	03-01-52	Pasquotank

Appendix II

Water Quality Data Collected by DWQ

- **Benthic Macroinvertebrate Collections**
- **Fish Community Assessments**

Benthic Macroinvertebrate Sampling Methods and Criteria

Freshwater Wadeable and Flowing Waters

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two sampling procedures. The NC Division of Water Quality's standard qualitative sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs (NCDEHNR, 1997). The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1-2 specimens), Common (3-9 specimens), or Abundant (≥10 specimens).

Several data-analysis summaries (metrics) can be produced from standard qualitative samples to detect water quality problems (Table A-II-1).

Table A-II-1 Benthos Classification Criteria for Freshwater Wadeable and Flowing Water Systems in the Coastal Plain Ecoregion

Metric	Sample Type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 27
		Good	21 - 27
		Good-Fair	14 - 20
		Fair	7 - 13
		Poor	0 - 6
	4-sample EPT	Excellent	> 23
		Good	18 - 23
		Good-Fair	12 - 17
		Fair	6 –11
		Poor	0 - 5
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 5.47
		Good	5.47 - 6.05
		Good-Fair	6.06 - 6.72
		Fair	6.73 - 7.73
		Poor	> 7.73

These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with DWQ criteria to assign water quality ratings (bioclassifications). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings also are based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI).

Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality ratings assigned with the biotic index numbers are combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for coastal plain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value is used to determine the final site rating.

Benthic macroinvertebrates can also be collected using an EPT sampling procedure. Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections. Only EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

Both EPT taxa richness and biotic index values also can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT taxa richness can be adjusted by subtracting out winter/spring Plecoptera or other adjustment based on resampling of summer site. The biotic index values also are seasonally adjusted for samples outside the summer season.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Boat Sampling and Coastal B Criteria

Coastal B rivers are defined as waters in the coastal plain that are deep (nonwadeable) with little or no visible current under normal or low flow conditions and that have freshwater. Other characteristics may include open canopy, low pH and low dissolved oxygen. These waters require a boat for sampling. These are usually large coastal plain rivers, including the lower sections of the Alligator, Chowan, Meherrin, Neuse, Pasquotank, Perquimans, Roanoke, Tar, South, Black, Waccamaw, Wiccacon, Northeast Cape Fear and Cape Fear Rivers. In such habitats, petite Ponar dredge sampling replaces kick-net samples, but all other standard qualitative collections techniques are still useable.

The standard boat method still aims at a total of 10 composite samples per site:

- Dredges - 3 composite samples using a petite Ponar.
- Sweeps - 3 samples collected from bank habitats, sampling as much of the edge habitat as possible, including aquatic macrophytes, roots and areas of debris.
- Leaf packs/Debris wash - 1 composite sample of leaves and other large particulate organic matter are to be rinsed in a wash bucket.
- Epifaunal collections - 2 composite samples of macrophytes and well-colonized logs (both in the current and along the shore.
- Visuals - should cover macrophytes, logs along the shore, and especially logs in the current.

The Biological Assessment Unit has limited data on Coastal B rivers and has had a difficult time gathering more data. Criteria have been developed based only on EPT taxa richness (Table A-II-2), although using biotic index values and total taxa richness values were also evaluated. The

criteria that are presented here will continue to be evaluated, and any bioclassifications derived from them should be considered tentative and not used for use support decisions.

Table A-II-2 Benthos Classification Criteria for Freshwater Nonwadeable, Coastal B Systems in the Coastal Plain Ecoregion

Bioclassification	EPT S
Excellent	> 11
Good	9 - 11
Good-Fair	6 - 8
Fair	3 - 5
Poor	> 3

Estuaries

Shallow (<1.5 m) estuarine waters are sampled using a D-frame dip net with a 600-700 μm mesh bag. All available subtidal benthic habitats were swept for a total of ten minutes. Some elutriation of the sample usually took place in the field to reduce sample volume, then the sample was preserved in 10% formalin with rose bengal added as a tissue stain.

At the laboratory, macroinvertebrates were separated from the sediment by visual examination. Macroinvertebrates were identified to the lowest practical taxonomic level, usually species. Abundance was recorded semi-quantitatively, with only a general indication of a taxon's abundance: Rare = 1 - 2; Common = 3 - 9; Abundant = 10 - 29; Very Abundant = 30 - 99; and Dominant >100. No more than 100 individuals of any taxon were counted since the presence of a greater number of individuals of a particular taxa at a site was no more informative, but much more costly to enumerate.

A biotic index is calculated from the individual taxon's sensitivity values (ranging from 1 to 5) and weighted for abundance using a formula commonly used in calculating freshwater biotic indices (Chutter, 1972; Hilsenhoff, 1977; Lenat, 1993):

$$BI = (\sum SV_i * N_i)/\text{Total N}$$

where SV_i is the sensitivity value of the i^{th} taxa; N_i is the abundance of the i^{th} taxa; and Total N is the number of individuals in the sample. A high Estuarine Biotic Index (EBI) value indicates many intolerant taxa and good water quality at a location, while a low EBI is indicative of stressed conditions.

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Hilsenhoff, W. L. 1977. *Use of Arthropods to Evaluate Water Quality in Streams*. Wisconsin Department of Natural Resources. Technical Bulletin No. 100.

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Flow Measurement

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. Some between-year changes in the macroinvertebrates, however, may be due largely to changes in flow. High flow years magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability and reduced periphyton. Low flow years may accentuate the effect of point source dischargers by providing less dilution of wastes.

For these reasons, all between-year changes in the biological communities are considered in light of flow conditions (high, low or normal) for one month prior to the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term mean flows. High flow is defined as a mean flow >140% of the long-term mean for that time period, usually July or August. Low flow is defined as a mean flow <60% of the long-term mean, while normal flow is 60-140% of the mean. While broad scale regional patterns are often observed, there may be large geographical variation within the state, and large variation within a single summer period.

Habitat Evaluation

The NC DWQ has developed a habitat assessment form to better evaluate the physical habitat of a stream. The habitat score has a potential range of 1-100, based on evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

Table A-II-3 Benthic Macroinvertebrate Data Collected in the Pasquotank River Basin, 1983-1999 (Basinwide monitoring sites are in bold.)

Subbasin/ Waterbody	Location	County	Index No.	Date	S	EPT S	BI (EBI)	EPT BI	BioClass
03-01-50									
Freshwater									
Pasquotank R	End of SR 1361	Pasquotank	30-3-(1)	08/03/00	27	0	8.27	---	Not Rated
Pasquotank R	Goat Island	Pasquotank	30-3-(3)	08/02/00	31	4	8.09	6.83	Not Rated
Sawyers Cr	SR 1200	Camden	30-3-6	02/18/00	27	0	7.65	---	Not Rated
Areneuse Cr	NC 343	Camden	30-3-13-(1)	02/18/00	22	0	7.88	---	Not Rated
Newbegun Cr	SR 1132	Camden	30-3-16-(1)	02/23/00	20	0	8.60		Not Rated
Estuarine									
Albemarle Sound	Frog Island	Pasquotank	30	07/14/83	26	4	2.0	3.97	Not Rated
Pasquotank R	US 158	Pasquotank	30-3-(7)	08/08/95	17	1	1.9		Not Rated
				07/18/85	16	0	2.1	---	Not Rated
				07/19/83	35	1	1.7	---	Not Rated
Newbegun Cr	near mouth	Pasquotank	30-3-16-(2)	06/26/95	21	1	2.3	---	Not Rated
03-01-51									
Freshwater									
Alligator R	near Gum Neck	Tyrrell	30-16-(7)	08/07/95	22	2	8.27	6.32	Not Rated
				07/17/85	26	3	7.92	4.64	Not Rated
				07/24/84	35	4	7.72	5.19	Not Rated
				06/22/83	31	4	7.80	4.69	Not Rated
NW Fk Alligator R	Canoe trail mile 4	Tyrrell	30-16-8	03/01/00	13	0	8.20	---	Not Rated
SW Fk Alligator R	Canoe trail mile 2	Tyrrell	30-16-8-2	03/01/00	14	0	7.19	---	Not Rated
UT Billys Ditch	Off US 64, near landfill	Dare	30-16-23-2-2-1	10/10/00	43	2	8.04	7.97	Not Rated
UT Billys Ditch	Off US 64, east of NWR (Reference)	Dare	30-16-23-2-2-1	10/10/00	33	2	8.42	6.67	Not Rated
UT Hooker Gut	Off US 64, #8	Dare	30-16-23-2-2	01/06/99	24	2	8.81	9.26	Not Rated
Callaghan Cr	At bend	Dare	30-20-4	06/27/95	23	0	8.21	---	
UT Callaghan Cr	Below landfill, #3	Dare	30-20-4	01/06/99	2	0	9.25	---	Not Rated
UT Callaghan Cr	Ditch off Cub Rd, #2A	Dare	30-20-4	10/10/00	37	2	8.86	5.45	Not Rated
UT Callaghan Cr	Bear Rd Ditch below Cub Rd Ditch, #6	Dare	30-20-4	01/06/99	31	2	8.42	7.63	Not Rated
Estuarine									
Alligator R	US 64	Dare	30-16-(21.5)	06/28/95	13	---	2.4	---	Not Rated
Croatan Sound	Mann's Harbor	Dare	30-20-(2)	06/27/95	25	---	2.1	---	Not Rated
				07/17/85	16	---	1.8	---	Not Rated
Spencer Cr	Across from Ferry	Dare	30-20-3	06/27/95	19	---	2.1	---	Not Rated
			30-20-4	10/10/00	31	0	8.77	---	Not Rated
Shallowbag Bay	Along shore near outfall	Dare	30-21-3	06/26/95	15	---	1.8	---	Not Rated
Broad Cr	North side, near point	Dare	30-21-7	06/27/95	35	---	2.0	---	Not Rated
Mill Cr	Wanchese Harbor	Dare	30-21-8	06/27/95	18	---	2.1	---	Not Rated
03-01-52									
Freshwater									
Little R	SR 1221	Perquimans	30-5-(1)	02/11/00	24	0	7.95	---	Not Rated
Little R	US 17	Perquimans	30-5-(1)	07/18/85	44	2	8.48	7.22	Not Rated
				08/18/83	46	2	8.54	7.22	Not Rated
Burnt Mill Cr	NC 37	Chowan	30-8-1	02/22/00	37	0	7.90	---	Not Rated
				02/27/95	41	2	7.69	8.81	Not Rated
Perquimans R	SR 1111	Perquimans	30-6-(1)	02/22/00	26	0	7.56		Not Rated

Subbasin/ Waterbody	Location	County	Index No.	Date	S	EPT S	BI (EBI)	EPT BI	BioClass
03-01-52									
Perquimans R	2 miles above Hertford	Perquimans	30-6-(1)	08/02/00	44	4	8.03	6.01	Not Rated
	US 17	Perquimans	30-6-(3)	08/08/95	41	6	7.23	3.46	Not Rated
				07/11/90	49	8	7.71	6.01	Not Rated
				07/12/88	42	5	7.66	6.20	Not Rated
				07/09/86	36	5	7.72	4.81	Not Rated
				07/18/85	38	6	7.65	5.65	Not Rated
				07/20/83	36	4	8.07	4.72	Not Rated
Estuarine									
Little R	At Hobbs Landing	Pasquotank	30-5-(2)	06/26/95	28	1	2.3	---	Not Rated
03-01-53									
Kendricks Cr	US 64	Washington	30-9-(1)	10/26/00	36	0	7.60	---	Not Rated
Kendricks Cr	NC 308, near Mackeys	Washington	30-9-(2)	07/16/84	55	4	7.97	6.76	Not Rated
		Washington		06/21/83	42	3	8.46	7.31	Not Rated
Main Canal	SR 1180	Washington	30-9-4	02/23/00	31	1	8.63	9.84	Not Rated
		Washington		02/27/95	31	2	7.07	8.02	Not Rated
Deep Cr	SR 1302	Washington	30-14-2	02/23/00	28	1	7.06	6.37	Not Rated
Scuppernong R	SR 1155	Washington	30-14-4-(1)	08/03/00	49	2	8.13	6.06	Not Rated
Scuppernong R	SR 1105	Tyrrell	30-14-4-(1)	08/07/95	46	3	7.66	7.74	Not Rated
				06/21/83	46	1	8.37	5.77	Not Rated
03-01-54									
Estuarine									
Currituck Sound	Off Mackey Island	Currituck	30-1	07/19/93	13	---	3.0	---	Not Rated
Currituck Sound	Knotts Island	Currituck	30-1	06/19/95	27	2	2.0	4.67	Not Rated
				07/19/93	26	4	2.7	2.31	Not Rated
Currituck Sound	Near Estuarine Reserve	Currituck	30-1	06/20/95	29	2	2.2	2.29	Not Rated
				07/20/93	32	2	2.5	1.38	Not Rated
Currituck Sound	South of Corolla	Currituck	30-1	06/20/95	31	3	1.8	3.67	Not Rated
Currituck Sound	Off Aydlett	Currituck	30-1	06/20/95	28	1	2.2	3.50	Not Rated
Currituck Sound	Poplar Landing	Currituck	30-1	07/20/93	31	4	2.4	7.24	Not Rated
North R	East side near mouth	Currituck	30-2	06/26/95	27	2	2.1	7.21	Not Rated
03-01-55									
Estuarine									
Pamlico Sound	Near Pea Island	Dare	30-22	06/27/95	76	---	2.8	---	Not Rated
03-01-56									
Estuarine									
Currituck Sound	US 158	Currituck	30-1	06/20/95	28	---	2.3	---	Not Rated
				07/20/93	29	---	2.7	---	Not Rated

Appendix III

Use Support Methodology
and
Use Support Ratings

Multiple-Category Use Support Methods

DRAFT December 11, 2001

A. Introduction to Use Support

Surface waters are classified according to their best intended uses. Determining how well a waterbody supports its uses (*use support* status) is an important method of interpreting water quality data and assessing water quality.

Surface waters are rated *fully supporting* (FS), *partially supporting* (PS) or *not supporting* (NS). The ratings refer to whether the classified uses of the water (i.e., aquatic life protection, primary recreation and water supply) are being met. For example, waters classified for fishing, aquatic life protection and secondary recreation (Class C for freshwater or SC for saltwater) are rated FS if data used to determine use support meet certain criteria. However, if these criteria were not met, then the waters would be rated as PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR). More specific methods are presented in Part C of this appendix.

Historically, the non-impaired category was subdivided into fully supporting and fully supporting but threatened (ST). ST was used to identify waters that were fully supporting but had some notable water quality concerns and could represent constant, degrading or improving conditions. North Carolina's past use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that demonstrate declining water quality (EPA Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305(b) Reports] and Electronic Updates, 1997). Given the difference between the EPA and North Carolina definitions of ST and the resulting confusion that arises from this difference, North Carolina no longer subdivides the non-impaired category. However, these waters and the specific water quality concerns remain identified in the basin plans so that data, management and the need to address the identified concerns are not lost.

B. Interpretation of Data and Information

Data used in the use support assessments include biological data, chemical/physical data, lakes assessment data, fish consumption advisories from the NC Department of Health and Human Services, and swimming advisories and shellfish sanitation growing area classification from the NC Division of Environmental Health (as appropriate). Available land cover and land use information is also used, along with annual water supply reports from regional water treatment plant consultants.

Although there is a general procedure for analyzing the data and information for determining use support ratings, each waterbody is reviewed individually, and best professional judgment is applied during these determinations. Assessments are made on either a monitored (M) or evaluated (E) basis depending on the level of information available. Refer to Part E for more information on the basis of assessments.

When interpreting the use support ratings, it is important to understand its associated limitations and degree of uncertainty. The assessments are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Rather, the intent of use support assessments is to gain an overall picture of water quality, to describe how well surface waters support the uses for which they were classified, and to document the potential contribution made by different pollution sources.

C. Assessment Methodology

Use Support Categories and Uses

Beginning in 2000 with the *Roanoke River Basinwide Water Quality Plan*, DWQ assesses ecosystem health and human health risk through the development of use support ratings for six categories: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. These categories are tied to the uses associated with the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the six use support categories, as shown in the table below. For many waters, a use support category will not be applicable (N/A) to the use 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*.

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

Many types of information are used to determine use support ratings and to identify causes and sources of use support impairment. A use support data file is maintained for each of the 17 river basins. All existing data pertaining to a stream segment for each applicable use support category are entered into its record and can include, but is not limited to, use support ratings, basis of assessment, biological data, ambient monitoring data, problem parameters and potential sources. The following describes the data and methodologies used to make use support assessments for the surface water classifications (described in Section A, Chapter 3 of each basin plan) using the six use support categories. These methods will continue to be refined, as additional information becomes available.

Basis of Assessment

FS ratings are extrapolated up tributaries from monitored streams when no problematic dischargers or change in land use/cover are identified. The FS rating 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 parameters or sources (except general NPS) are not applied to unmonitored tributaries. PS or NS ratings are not extrapolated to unmonitored tributaries. Refer to Part E for more information.

Problem Parameters

Where an ambient parameter is identified as a potential concern, the parameter is listed in the DWQ database and use support summary table. Where habitat degradation is identified by DWQ biologists based on site visits, it is listed and attempts are made to identify the type of habitat degradation (e.g., sedimentation, loss of woody habitat, loss of pools, loss of riffles, channelization, lack of riparian vegetation, streambed scour and bank erosion). Habitat evaluation methods are being developed to better identify specific types of habitat degradation.

Potential Sources

General nonpoint sources (NPS) and point sources (PS) of pollution are identified where there is sufficient information.

Aquatic Life and Secondary Recreation Use Support

The aquatic life and secondary recreation use support category is an ecosystem approach to assess whether aquatic life (benthic macroinvertebrates and fish) can live and reproduce in the waters of the state and whether waters support secondary recreation (i.e., wading, boating and minimal human body contact with water). This category is applied to all waters of the state. Biological data, ambient monitoring data and NPDES discharger data are all considered in assessing the aquatic life and secondary recreation use support category. The following is a description of each data type and methods used to assess how well a water is meeting the criteria for aquatic life protection and secondary recreation.

Biological Data

There are two main types of biological data: benthic marcoinvertebrate and fish community. Where recent data for both benthic macroinvertebrates and fish communities are available, both are evaluated in assessing use support. It is important to note that where both ambient monitoring data and biological data are available, biological data are given greater weight.

In special situations, where there are currently insufficient biological data available, the basinwide planner will make a request of the DWQ Environmental Sciences Branch to determine whether a biological survey is appropriate. If a biological survey is appropriate, the use support rating will be determined by the bioclassification resulting from the survey. If a biological survey is not appropriate, then the stream will be not rated.

Benthic Macroinvertebrate Bioclassifications

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent 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 collection. The benthic macroinvertebrate bioclassifications are translated into use support ratings according to the following scheme:

Bioclassification	Use Support Rating
Excellent	Fully Supporting (FS)
Good	Fully Supporting (FS)
Good-Fair	Fully Supporting (FS)
Fair	Partially Supporting (PS)
Poor	Not Supporting (NS)

Due to the increased emphasis placed on Fair or Poor bioclassifications and the borderline nature of some bioclassification scores, sites should be resampled within 12-24 months after a Fair rating is obtained in 1999 and beyond, if this Fair rating will result in a lower use support rating or if data are from a site never sampled before. This resampling will be done to validate the Fair bioclassification. Such sites will not be given a use support rating until the second sample is obtained. The table below shows how a final use support rating is obtained for sites that are resampled.

New Benthic Macroinvertebrate Classifications (1999 and Beyond) and Data Causing a Decline in Use Support Ratings

Pre-1999 Bioclassification	1st sample Bioclassification	Draft Use Support Rating	2nd sample Bioclassification	Final Use Support Rating
N/A	Fair	NR; resample	Good-Fair, Good or Excellent	FS
N/A	Fair	NR; resample	Fair	PS
N/A	Fair	NR; resample	Poor	NS
N/A	Poor	NS	N/A	NS
Good-Fair, Good or Excellent	Fair	NR; resample	Good-Fair, Good or Excellent	FS
Good-Fair, Good or Excellent	Fair	NR; resample	Fair	PS
Good-Fair, Good or Excellent	Fair	NR; resample	Poor	NS
Good-Fair, Good or Excellent	Poor	NS	N/A	NS

N/A – Not Applicable NR = Not Rated

The use of benthic macroinvertebrate data can be limited in some waters. The accumulation of swamp stream data over nearly a decade suggests that not all swamp streams support similar fauna. The development of swamp stream criteria is complex, and one set of criteria is not

appropriate for all swamp streams. Benthic macroinvertebrate data will not be used in waters characterized or classified by DWQ as swamp waters until the bioclassification criteria for these waters can be used with confidence. Benthic macroinvertebrate data are also not used to develop use support ratings for estuarine waters. Until bioclassification criteria for swamp and estuarine waters are developed, a designation of Not Rated (NR) will be used, and these waters will be listed as NR for aquatic life and secondary recreation use support assessments.

Benthic macroinvertebrate data are used to provide bioclassifications for high elevation trout streams. The benthic macroinvertebrate data, while not a direct measure of the trout population, are a robust measure of stream integrity. Loss of canopy, increase in stream temperature, increased nutrients, toxicity and increased sedimentation will affect the benthic macroinvertebrate and fish communities. For these reasons, the benthic macroinvertebrate bioclassifications provide a valuable assessment of the integrity of trout waters.

A designation of Not Impaired (NI) 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 FS.

Fish Community Bioclassification

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. The NCIBI is translated into use support ratings according to the following scheme:

NCIBI	Use Support Rating
Excellent	Fully Supporting (FS)
Good	Fully Supporting (FS)
Good-Fair	Fully Supporting (FS)
Fair	Partially Supporting (PS)
Poor	Not Supporting (NS)

The NCIBI was recently revised by DWQ (NCDENR, 2001b). Currently, the focus of using and applying the NCIBI is restricted to wadeable streams that can be sampled by a crew of four persons. Infrequently, larger wadeable streams can be sampled if there is a crew of six persons. 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-Pamilco, 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 the "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, NC, except for the south and southwest portions of Johnston County and the 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, NC, 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 non-wadeable and large streams and rivers throughout the state.

Due to the increased emphasis placed on Fair or Poor bioclassifications and the borderline nature of some bioclassification scores, sites should be resampled within 12-24 months after a Fair rating is obtained in 1999 and beyond, if this Fair rating will result in a lower use support rating or if data are from a site never sampled before. This resampling will be done to validate the Fair bioclassification. Such sites will not be given a use support rating until the second sample is obtained. The table below shows how a final use support rating is obtained for sites that are resampled.

New Fish Community Classifications (1999 and Beyond) and Data Causing a Decline in Use Support Ratings				
Pre-1999 Bioclassification	**1st sample Bioclassification**	**Draft Use Support Rating**	**2nd sample Bioclassification**	**Final Use Support Rating**
N/A	Fair	NR; resample	Good-Fair, Good or Excellent	FS
N/A	Fair	NR; resample	Fair	PS
N/A	Fair	NR; resample	Poor	NS
N/A	Poor	NS	N/A	NS
Good-Fair, Good or Excellent	Fair	NR; resample	Good-Fair, Good or Excellent	FS
Good-Fair, Good or Excellent	Fair	NR; resample	Fair	PS
Good-Fair, Good or Excellent	Fair	NR; resample	Poor	NS
Good-Fair, Good or Excellent	Poor	NS	N/A	NS

N/A – Not Applicable NR = Not Rated

Ambient Monitoring Data

Chemical/physical water quality data are collected through the DWQ Ambient Monitoring System. These data are downloaded from the ambient database, the Surface Water Information Management System, for analysis. Total number of samples and percent of samples exceeding the NC water quality standards are evaluated for the development of use support ratings along with other data or alone when other data are not available. Where both ambient data and biological data are available, biological data are given greater weight.

When reviewing ambient data, a five-year window that ends on August 31 of the year of biological sampling is used. For example, if biological data are collected in a basin in 2000, then the five-year window for the ambient data would be September 1, 1995 to August 31, 2000. Selected ambient parameters are used to assess aquatic life/secondary recreation use support. These parameters include ammonia, dissolved oxygen, pH, chloride, arsenic, cadmium, chromium, nickel and lead. These parameters are measured against standards for a minimum of ten samples as follows:

Standards Violation	Rating
Criterion exceeded ≤10%	Fully Supporting (FS)
Criterion exceeded 11-25%	Partially Supporting (PS)
Criterion exceeded >25%	Not Supporting (NS)

Data for copper, iron and zinc are not used according to the scheme outlined above. These metals have action level standards because they are generally not bioaccumulative and have variable toxicity to aquatic life depending on chemical form, solubility and stream characteristics. In order for an action level standard to be violated, there must be a toxicological

test that documents an impact on a sensitive aquatic organism. The action level standard is used to screen waters for potential problems with copper, iron and zinc.

Metals data for copper and iron are screened at the 85th percentile of five years of ambient data ending on August 31 of the year of biological sampling. Sites, other than estuarine and swamp waters, with an 85th percentile of ≥20 µg/l of copper and/or ≥2000 µg/l of iron are identified and flagged for instream chronic toxicity testing by DWQ. Chronic toxicity testing in estuarine and swamp waters is not ecologically meaningful. Criteria are still being developed for zinc. If a stream does not have biological data that would deem a FS rating, then the stream can be rated PS or NS for aquatic life if instream chronic toxicity is found. Criteria for evaluating instream chronic toxicity are three chronic pass/fail tests over three months using *Ceriodaphnia*. Three fails result in a NS rating, and two fails result in a PS rating.

It is important to note that some waters may exhibit characteristics outside the numerical standards due to natural conditions (e.g., many swamp waters are characterized by low pH and dissolved oxygen). These natural conditions do not constitute a violation of water quality standards.

NPDES Discharger Data

Aquatic Toxicity Data

For facilities that perform Whole Effluent Toxicity (WET) tests according to state NPDES discharge permit requirements, a review of the results of a five-year window that ends on August 31 of the year of biological sampling is used. For example, if biological data are collected in a basin in 2000, then the five-year window for aquatic toxicity data would be September 1, 1995 to August 31, 2000. If a stream with a WET test facility has not been sampled for instream chronic toxicity, biological community data, or has no ambient data, and that facility has failed three or more WET tests in the most recent two years, the stream is not rated. If failures continue, DWQ will work with the facility to correct the failures and assess stream impacts before the next basin sampling cycle begins with either a biological survey or instream chronic toxicity testing, if possible.

Discharge Effluent Data

NPDES effluent data are reviewed by analyzing monthly averages of water quality parameters over a two-year period of data ending on August 31 of the year of biological sampling. Prior to May 31, 2000, facilities were screened for criterion 40 percent in excess of state water quality standards for conventional pollutant limitations or 20 percent in excess of state water quality standards for toxic pollutants for two or more months during two consecutive quarters, or chronic violations of either conventional or toxic pollutant limitations for four or more months during two consecutive quarters.

After May 31, 2000, facilities are screened for criterion 20 percent in excess of state water quality standards for both conventional and toxic pollutants for two or more months during two consecutive quarters, or chronic violations of either conventional or toxic pollutant limitations for four or more months during two consecutive quarters. Streams with discharges that are in excess of permit limits will not be rated if no biological or ambient monitoring data are available.

Therefore, streams will not be rated PS or NS based on effluent data alone. Appropriate DWQ staff will be given a list of these facilities for follow-up.

Fish Consumption Use Support

The fish consumption use support category is a human health approach to assess whether humans can safely consume fish from a water. This use support category is applied to all waters of the state. The use support rating is assigned using fish consumption advisories issued by the NC Department of Health and Human Services.

If a limited fish consumption advisory is posted at the time of use support assessment, the water is rated PS. If a no consumption advisory is posted at the time of use support assessment, the water is rated NS.

In order to separate this from other fish consumption advisories and to identify fish populations with high levels of mercury, only waters with fish tissue monitoring data are presented on the use support maps and in the use support summary tables of the basin plans. A review of the present methods for assessing the fish consumption use support category is being conducted, and methods may be modified in the future.

Primary Recreation Use Support

In addition to the use support categories applicable to Class C and SC waters, the primary recreation use support category will be assessed for all Class B, Class SA and Class SB waters where data are available. This use support category is a human health approach to assess whether waters support primary recreation activities such as swimming, water-skiing, skin diving, and similar uses involving human body contact in an organized or frequent basis. The use support rating is based on swimming advisories issued by local health departments and by the NC Division of Environmental Health (DEH) beach monitoring program.

Freshwaters

Each January, the geometric mean for ambient stations in Class B waters for the previous sampling year is obtained, and a screen is conducted for waters with geometric means greater than 200 colonies per 100 ml. If the geometric mean is greater than 200 colonies per 100 ml during the previous year, fecal coliform bacteria are noted as a problem parameter, and a request is made of the DWQ regional office to sample this water 5 times within 30 days in June during non-runoff events, if possible. If this data, as required to assess the NC standard, indicate a geometric mean greater than 200 colonies per 100 ml, then the data are sent to DEH for consideration of posting swimming advisories. The DWQ regional office should continue to sample the stream 5 times within 30 days during the months of July and August and send the data to DEH.

When reviewing fecal coliform data and swimming advisories, a five-year window that ends on August 31 of the year of biological sampling is used. For example, if biological data are collected in a basin in 2000, then the five-year window for the fecal coliform data and swimming advisories would be September 1, 1995 to August 31, 2000. Monitored Class B waters are rated FS if the geometric mean over the five-year window is less than or equal to 200 colonies per 100

ml. If a water was posted with an advisory for at least two months within the five-year window, it is rated as PS unless DEH staff believes that the cause of elevated fecal bacteria is not persistent. Those waters posted as "Do Not Swim" for more than two months in the five-year window are rated NS. Class B waters without fecal coliform data or swimming advisories are not rated.

DWQ attempts to determine if there are any inland swimming areas monitored by county or local health departments. County or local health departments are asked to list those waters with swimming advisories posted for at least two months in the previous five years (ending on August 31 of the year of biological sampling).

Estuarine waters

Each January, the geometric mean for ambient stations in Class SB and SA waters for the previous sampling year is obtained, and a screen is conducted for waters with geometric means greater than 200 colonies per 100 ml. If the geometric mean is greater than 200 colonies per 100 ml during the previous year, fecal coliform bacteria are noted as a problem parameter, and a request is made of the DWQ regional office to sample this water 5 times within 30 days in June during non-runoff events, if possible. If this data, as required to assess the NC standard, indicate a geometric mean greater than 200 colonies per 100 ml, then the data are sent to DEH for consideration of posting swimming advisories. The DWQ regional office should continue to sample the stream 5 times within 30 days during the months of July and August and send the data to DEH.

DEH fecal coliform data are used to assess estuarine (SA and SB) waters. Each January, DEH submits a letter to DWQ stating which coastal waters were posted with an advisory reporting an increased risk from swimming during the prior year. When reviewing DEH fecal coliform data and swimming advisories, a five-year window that ends on August 31 of the year of biological sampling is used. For example, if biological data are collected in a basin in 2000, then the five-year window for the DEH fecal coliform data and swimming advisories would be September 1, 1995 to August 31, 2000. If a water was posted with an advisory for at least two months within the five-year window, it is rated as PS unless DEH staff believes that the cause of elevated fecal bacteria is not persistent. Those waters posted as "Do Not Swim" for more than two months in the five-year window are rated NS. If DEH has no data on a water, that water will not be rated.

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 determine use support ratings for shellfish waters and to determine causes and sources of impairment for these waters.

Department 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 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 fecal coliform 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.
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.
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 does not meet criteria for Approved, Conditionally Approved or Restricted Classification.

Assigning Use Support Ratings to Shellfish Harvesting Waters (Class SA)

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. Thus, the DWQ Class SA waters must be separated out and rated for shellfish harvesting use support. The acreage of FS, PS and NS waters are calculated using GIS showing DWQ and DEH classifications as attribute information. However, 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 NS.

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 those areas that DWQ Class SA (shellfish harvesting waters). This will result in a difference of acreage between DEH areas classified as CAC, PRO, RES and DWQ waters rated as PS or NS. 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 assessed and rated PS.

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 procedure 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 use support using a frequency of closures-based approach. This database will allow DWQ to better assess the extent and duration of closures in Class SA waters. These tools will not be available for use support determinations in Class SA waters for the 2001 White Oak, 2002 Neuse and 2003 Lumber River basin use support assessments. DWQ believes it is important to identify frequency of closures in these waters, so an interim methodology will be used based on existing databases and GIS shapefiles. There will likely be changes in reported acreages in future assessments using the permanent methods and tools that result from this project. DWQ and DEH hope to have these tools fully developed for using the frequency of closure-based methods for the 2005 Cape Fear River use support assessment and basin plan.

Interim Frequency of Closure-Based Assessment Methodology

The interim method will be 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.

Interim Frequency of Closure-Based Use Support Ratings

Percent of Time Closed within Basin Data Window	DEH Growing Area Classification	DWQ Use Support Rating
N/A	Approved*	FS
Closed ≤10% of data window	Portion of CAO closed ≤10%	FS
Closed >10% to ≤25% of data window	Portion of CAO closed >10% to ≤25% of data window	PS
Closed >25% of data window	Portion of CAO closed >25% of data window	NS
N/A	CAC and P/R**	NS

* 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 will work with DEH to determine the number of days and acreages that CAO Class SA waters were closed to shellfish harvesting during a five-year window of data that ends on August 31 of the year of biological sampling. For example, if biological data are collected in a basin in 2000, then the five-year window for closure data would be September 1, 1995 to August 31, 2000. For each growing area with CAO Class SA waters, DEH and DWQ staff will define subareas within the CAO area that were opened and closed at the same time. The number of days these CAO areas were closed will be 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 pre-emptive closures because of named storms is not counted. For example, all waters in growing area E-9 were pre-emptively 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 10 days after the APP waters were reopened.

Proposed Permanent Frequency of Closure-Based Assessment Methodology

Over the next few years DWQ, DEH, Division of Coastal Management (DCM) and Division of Marine Fisheries (DMF) will be engaged in developing a fully functionally database with related 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. DWQ proposes to use information generated by these new tools to do frequency of closure-based shellfish harvesting use support assessments in Class SA waters, starting with the 2005 Cape Fear River basin use support assessment.

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 named storms. The percent of the five-year data window that individual Class SA waters are closed will be used to make use support determinations for areas that are classified by DEH as CAO. PRO, RES and CAC areas will be rated NS and CAO areas will be rated FS, PS or NS based on the methodology outlined above in the interim methods. Growing areas that have been reclassified by DEH during the data window from a lower classification to APP will be rated Supporting. Areas that are reclassified from APP to CAO during the data window will be rated as described above in the interim methods, taking into account the total days closed during the data window, including when the area was classified as APP.

Water Supply Use Support

This use support category is used to assess all Class WS waters and is a human health approach to assess whether a water can be used for water supply purposes. Many drinking water supplies in NC are drawn from human-made reservoirs that often have multiple uses.

Water supply use support is assessed using information from the seven regional water treatment plant (WTP) consultants. Each January, the WTP consultants 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 for the WTP, and the reason for the closure or switch.

The WTP consultants' spreadsheets are reviewed 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. In general, North Carolina's surface water supplies are currently rated FS. Specific criteria for rating waters PS and NS are yet to be determined.

Other Uses: All Waters in the State

This category of use will be assessed infrequently but could be applied to any water in the state. Examples of uses that could fall into this category are aesthetics and industrial and agricultural water supply. This category allows for the assessment of any use that is not considered for

aquatic life and secondary recreation, primary recreation, fish consumption, shellfish harvesting or water supply.

D. 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 60 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 2000 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 problem parameters. 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

E. Monitored vs. Evaluated

Assessments are made on either a monitored (M) or evaluated (E) basis depending on the level of information available. Because a monitored rating is based on the most recent five-year window and site-specific data, it is treated with more confidence than an evaluated rating.

FS ratings are extrapolated up tributaries to monitored streams where there are no dischargers with permit violations or changes in land use/cover. Problem parameters or sources (except general NPS) are not applied to unmonitored tributaries. PS or NS are not applied to unmonitored tributaries. Refer to the following summary for the basis of assigning use support ratings.

Summary of Basis for Assigning Use Support Ratings to Freshwater Streams		
Overall Basis	**Specific Basis**	**Description**
Monitored	Monitored (M)	Monitored stream segments[a] with data[b] ≤5[c] years old.
	Monitored/Evaluated (ME)	Stream segment[a] is unmonitored, but is assigned a use support rating based on another segment of same stream for which data[b] ≤5[c] years old are available.
Evaluated	Evaluated (E)	Unmonitored streams that are direct or indirect tributaries to monitored stream segments rated FS. Must share similar land use to the monitored stream segment.
Not Rated	Not Rated (NR)	Insufficient or no data available to determine use support. Includes unmonitored streams that are direct or indirect tributaries to stream segments rated PS or NS.

a) A stream segment is a stream, or a portion thereof, listed in the Classifications and Water Quality Standards for a river basin. Each segment is assigned a unique identification number (index number).
b) Major data sources include benthic macroinvertebrate and fish community bioclassifications and chemical/physical monitoring data.
c) From the year that basin monitoring was done.

F. Nutrient Enrichment Issues

One of the main causes of impacts to lakes is nutrient enrichment, or eutrophication. Several water quality variables help to describe the level of eutrophication. These include pH, chlorophyll *a*, dissolved oxygen, phosphorus, nitrogen, turbidity, total dissolved gases and other quantitative indicators, some of which have specific water quality standards. It is generally agreed that excessive amounts of nitrogen and phosphorus are the principal culprits in eutrophication related use impairment. These variables are important concerns; however, climate, hydrology and biological response factors (chlorophyll, phytoplankton, fish kills, etc.) are also essential to evaluate because they may control the frequency of episodes related to potential use impairment. In addition, many of North Carolina's lakes are human-made reservoirs that do not mimic natural systems.

Violations of water quality standards in lakes or estuaries are not equated with use impairment unless uses are not met. DWQ does not determine eutrophication related use impairment with the quantitative assessment of an individual water quality variable (i.e., chlorophyll *a*). Likewise, DWQ does not depend on a fixed index composed of several water quality variables, which does not have the flexibility to adapt to numerous hydrological situations, to determine use impairment. Instead, the weight of evidence approach is used to determine use support in lakes. This approach can be flexibly applied depending on the amount and quality of available information. The approach uses the following sources of information:

- multiple quantitative water quality variables (e.g., dissolved oxygen, chlorophyll *a*)
- third party reports
- analysis of water quality or aesthetic complaints, and taste and odor observations
- algal bloom reports
- macrophyte observations
- fish kill reports

- frequency of noxious algal activity
- reports/observations of the NC Wildlife Resources Commission, lake associations and water treatment plant operators

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_____. BAU. 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*.

_____. BAU. 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. North Carolina Department of Environment and Natural Resources. Raleigh, NC.

_____. BAU. 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*.

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-50. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-50	0.00	28,665.80		FS	ME			
Pasquotank River	From source to a point 1.7 mile upstream of mouth of Turners Cut	03-01-50	15.92	0.00		NR	M			
Pasquotank River	From a point 1.7 mile upstream of mouth to Turners Cut to a point 0.6 mile upstream of Pasquotank County SR 1368 extension	03-01-50	10.77	0.00		NR	M			
Pasquotank River	From a point 0.6 mile upstream of Pasquotank County SR 1368 extension to Elizabeth City water supply intake	03-01-50	0.65	0.00		NR	M			
Sawyers Creek	From source to Pasquotank River	03-01-50	6.69	0.00		NR	M			
Areneuse Creek	From source to N.C. Highway # 343	03-01-50	2.88	0.00		NR	M			
New Begun Creek	From source to mouth of Wilson Creek	03-01-50	5.14	0.00		NR	M			

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-51. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-51	0.00	106,623.00		FS	M			
Northwest Fork Alligator River	From source to Alligator River	03-01-51	12.05	0.00		NR	M			
Southwest Fork Alligator River	From source to Northwest Fork Alligator River	03-01-51	9.31	0.00		NR	M			
Hooker Gut	From source to South Lake	03-01-51	0.00	126.63		NR	M			
Billys Ditch	From source to Hooker Gut	03-01-51	0.20	0.00		NR	M			
Callaghan Creek	From source to Croatan Sound	03-01-51	0.00	24.80		NR	M			
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-51.	03-01-51	0.00	18,056.00		FS	ME			
New Lake	Entire Lake	03-01-51	0.0	0.0	4,980.6	NR				

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
Swan Creek (Swan Creek Lake)	From source to Alligator River	03-01-51	0.0	0.0	424.1	NR				
Whipping Creek (Whipping Creek Lake)	From source to Alligator River	03-01-51	0.0	0.0	284.0	NR				
Sandy Ridge Gut (Sawyer Lake)	From source to Milltail Creek	03-01-51	0.0	0.0	58.7	NR				
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-52. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-52	0.00	72,795.50		FS	M			
Little River	From source to Halls Creek	03-01-52	10.68	0.00		NR	M			
Perquimans River	From source to Norfolk-Southern Railroad Bridge	03-01-52	24.13	0.00		NR	M			
Perquimans River	From a line across the River from Barrow Point to Ferry Point to Albemarle Sound	03-01-52	0.00	9,840.28		NR	M			
Burnt Mill Creek	From source to Yeopim River	03-01-52	5.20	0.00		NR	M			

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-53. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-53	0.00	63,433.20		FS	M			
Kendrick Creek (Mackeys Creek)	From source to U.S. Hwy. 64 at Roper	03-01-53	6.21	10.88		NR	M			
Main Canal	From source to Kendrick Creek	03-01-53	4.39	0.00		NR	M			
Deep Creek	From source to Bull Bay	03-01-53	7.79	8.63		NR	M			
Scuppernong River	From source to mouth of Riders Creek (First Creek)	03-01-53	13.62	295.47		NR	M			
Phelps Lake	Entire Lake	03-01-53	0.00		15,938.29	NR	M			

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-54. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-54	0.00	11,049.30		FS	ME			
Tull Bay	Entire Bay	03-01-54	0.0	0.0	942.9	NR				
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area: All waters south of a line bginning at a point on the shore north of Buxton at 35 degrees 16’ 44" N- 75 degrees 31’ 05" W, thence in awesterly direction through Bald Point to a point on the Buxton shorelin at 35 degrees 16’ 24" N- 75 degrees 32’ 12" W, thence westerly along the shoreline crossing the entrace to all creeks, canals and tributaries to a point on shore east of Brooks Point	03-01-55	0.00	171.80		FS	ME			

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area: all creeks, canals, and tributaries along Hatteras Island between Brooks Point to west mouth of Joe Saur Creek.	03-01-55	0.00	472.90		FS	ME			
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area at the mouth of Askins Creek	03-01-55	0.00	0.70		FS	ME			
Pamlico Sound	The waters of the Pamlico Sound which include the DEH closed area with mouth 1.17 miles southwest of Durant Point.	03-01-55	0.00	13.71		FS	ME			
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area at the mouth of Mill Creek. This includes all waters south of a line from Big Island to the Outer Banks and all waters east of line from Big Island to Gibbs Point.	03-01-55	0.00	28.83		FS	ME			
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area of a boundary begnning at a point on land west of the Hatteras Ferry Landing at 35 degrees 12’ 30" N- 75 degrees 42’ 24" W, thence to a point in the ferry channel at 35 degrees 12’ 37" N-75 degrees 42’ 26" W to the mouth of Austin Creek	03-01-55	0.00	12.65		FS	ME			
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-55 except DEH closure areas 30-22b through 30-22j.	03-01-55	0.00	315,407.00		FS	ME			

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area with mouth 321 meters east of east mouth of Austin Creek	03-01-55	0.00	3.13		FS	ME			
Back Lake	Entire Lake and connecting canal to Stumpy Point Bay	03-01-55	0.0	0.0	117.6	NR				
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-56. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River). Those waters in subbasin 03-01-56.	03-01-56	0.00	7,797.20		FS	ME			
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-56	03-01-56	0.00	4,666.00		FS	ME			
Fresh Water Lake at Kill Devil Hills	Entire Lake	03-01-56	0.0	0.0	23.8	NR				

Name	Description	Subbasin	Miles	Estuarine Acres	Freshwater Acres	Rating	Basis	Problem Parameter	Potential Source	Major Source
NOTES										
*"Ag" denotes agriculture, which could include row crops and animal operations. Where "cattle" is noted, cattle were observed on site at the time of sampling										
or the watershed hosts many cattle farms.										
"Rating" = Use Support Rating										
"Basis"=Rating basis										
"Habitat degradation" is 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 stream bed scour.										
"Non-urban develop" is residential and/or commercial develop outside urban areas.										
"Rural runoff" is non-point source runoff from rural areas, including that from low density residential and commercial areas.										
ABBREVIATION KEY		nut = high nutrient levels								
P = Point Source Pollution (Major source)		turb = turbidity								
NP = Non-point Source Pollution		fecal = fecal coliform bacteria								
M = Monitored		sed = sediment								
ME= Monitored evaluated		ab = above								
FS= Fully Supporting		nr = near								
PS= Partially Supporting		be = below								
NS= Not Supporting		APP= Approved								
NR= Not Rated		PRO= Prohibited								

Name	Description	Subbasin	Coastline mi	Miles	Estuarine Acres	Freshwater Acres	Rating
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-50. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-50	0	0.0	28,665.8	0.0	FS
Pasquotank River	From a line across River from Hospital Point to Cobb Point to a line across River from Miller Point to Pool Point	03-01-50	0	0.0	9,185.7	0.0	FS
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-51. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River).	03-01-51	0	0.0	106,623.0	0.0	FS
Croatan Sound	From Northwest Point on Roanoke Island following a line west to Reeds Point on the Dare County mainland to a line running from a point of land just below Long Wretch Creek on Dare County mainland to the Southern tip of Smith Island south of Roanoke Island excluding DEH closure areas	03-01-51	0	0.0	24,451.1	0.0	FS
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-51.	03-01-51	0	0.0	18,056.0	0.0	FS

Name	Description	Subbasin	Coastline mi	Miles	Estuarine Acres	Freshwater Acres	Rating
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-52. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River)	03-01-52	0	0.0	72,795.5	0.0	FS
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-53. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River))	03-01-53	0	0.0	63,433.2	0.0	FS
Phelps Lake	Entire Lake	03-01-53	0	0.0	0.0	15,938.3	NR
Atlantic Ocean	The waters of the Atlantic Ocean contiguous to that portion of Pasquotank River Basin that extends from the North Carolina-Virginia State Line to the northeast tip of Ocracoke Island	03-01-54	22.6	0.0	0.0	0.0	FS
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-55 except DEH closure areas 30-22b through 30-22j.	03-01-55	0	0.0	315,407.0	0.0	FS
Atlantic Ocean	The waters of the Atlantic Ocean contiguous to that portion of Pasquotank River Basin that extends from the North Carolina-Virginia State Line to the northeast tip of Ocracoke Island	03-01-55	53.8	0.0	0.0	0.0	FS

Name	Description	Subbasin	Coastline mi	Miles	Estuarine Acres	Freshwater Acres	Rating
ALBEMARLE SOUND	Portion of Albemarle Sound in subbasin 03-01-56. Waters of Albemarle Sound (All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River) Those waters in subbasin 03-01-56	03-01-56	0	0.0	7,797.2	0.0	FS
Roanoke Sound	DEH closed area east of Pond Island adjacent ot HWY 264 bridge	03-01-56	0	0.0	388.6	0.0	FS
Roanoke Sound	The waters of Roanoke sound which include those waters around the Villa Condominium STP Outfall beginning at a point 35 degrees 57’ 54" N- 75 degrees 38’ 46" W, thence 200 yards in a southwesterly direction to a point in the sound at 35 degrees 57’ 48" N- 75 degrees 38’ 50" W, thence 400 yards in a southesterly direction to a point in the sound at 35 degrees 57’ 38" N- 75 degrees 38’ 39" W, thence in a northeasterly direction to a point on shore at 35 degrees 57’ 45" N- 75 degrees 38’ 36" W.	03-01-56	0	0.0	21.4	0.0	NS
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-56	03-01-56	0	0.0	4,666.0	0.0	FS
Atlantic Ocean	The waters of the Atlantic Ocean contiguous to that portion of Pasquotank River Basin that extends from the North Carolina-Virginia State Line to the northeast tip of Ocracoke Island	03-01-56	34.2	0.0	0.0	0.0	FS

Name	Description	Subbasin	Coastline mi	Miles	Estuarine Acres	Freshwater Acres	Rating
NOTES							
*"Ag" denotes agriculture, which could include row crops and animal operations. Where "cattle" is noted, cattle were observed on site at the time of sampling							
or the watershed hosts many cattle farms.							
"Rating" = Use Support Rating							
"Basis"=Rating basis							
"Habitat degradation" is 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 stream bed scour.							
"Non-urban develop" is residential and/or commercial develop outside urban areas.							
"Rural runoff" is non-point source runoff from rural areas, including that from low density residential and commercial areas.							
ABBREVIATION KEY		nut = high nutrient levels					
P = Point Source Pollution (Major source)		turb = turbidity					
NP = Non-point Source Pollution		fecal = fecal coliform bacteria					
M = Monitored		sed = sediment					
ME= Monitored evaluated		ab = above					
FS= Fully Supporting		nr = near					
PS= Partially Supporting		be = below					
NS= Not Supporting		APP= Approved					
NR= Not Rated		PRO= Prohibited					

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Croatan Sound	The waters of Croatan Sound which include all waters on the North whore of Baum Creek to a straight line to Fl. Beacon number 2 at 35 degrees 50’ 27" n-75 degrees 40’ 06" W, thence in a straight line tto a point on an island at 35 degrees 50’ 05" N- 75 degrees 39’ 56" W, , thence in a straight line to a point on the shore at 35 degrees 50’ 16"-75 degees 39’ 26" W; to include all crreks and tributaries within the boundary except Oyster Creek. DEH closed area Croatan Sound 5-b.	03-01-51	146.1	NS	M	PRO
Croatan Sound	The waters of Croatan Sound which include all waters within a line beginning at a point on the shore at 35 degrees 53’ 56" N- 75 degrees 41’ 36" W, thence WSW 800 yards to a point in the sound at 35 degrees 53’ 38" N- 75 degrees 41’ 53 W, thence 1975 yards to a point on Sand Point at 35 degrees 53’ 03" N- 75 degrees 40’ 54" W. DEH closed area Croatan Sound 5-a.	03-01-51	280.1	NS	M	PRO
Croatan Sound	The waters of Croatan Sound enclosed in a line beginning at a point near north shore of Spencer Creek at 35 degrees 51’ 45" N- 75 degrees 44’ 53" W; and thence 250 yeards in an easterly direction to a point at 35 degrees 51’ 45" n- 75 degrees 44’ 43" west, thence south 1500 yards to a point 35 degrees 50’ 58" N- 75 degrees 44’ 43" W; thence 250 yards west to a poin on shore at 35 degrees 50’ 58" N- 75 degrees 44’ 53" W. DEH closed area Croatan Sound 5-c	03-01-51	160.2	NS	M	PRO
Croatan Sound	The waters of Croatan sound which include all waters below Oyster Creek southeast to Cut Through. DEH closed area Croatan Sound 5-e	03-01-51	78.1	NS	M	PRO
Croatan Sound	From Northwest Point on Roanoke Island following a line west to Reeds Point on the Dare County mainland to a line running from a point of land just below Long Wretch Creek on Dare County mainland to the Southern tip of Smith Island south of Roanoke Island excluding DEH closure areas	03-01-51	24,451.1	FS	M	APP
Croatan Sound	DEH Closure Area at Mann’s Harbor	03-01-51	16.4	NS	M	PRO
Spencer Creek	From source to Croatan Sound	03-01-51	86.8	NS	M	PRO
Callaghan Creek	From source to Croatan Sound	03-01-51	24.8	NS	M	PRO
Baum Creek	From source to Croatan Sound	03-01-51	10.8	NS	M	PRO
Oyster Creek	From source to Croatan Sound	03-01-51	62.8	NS	M	PRO
Cedar Bush Bay	Entire Bay	03-01-51	207.8	FS	M	APP

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Cut Through	From DEH closure line to Croatan Sound	03-01-51	183.1	FS	M	APP
Cut Through	From Roanoke Sound to DEH closure line	03-01-51	124.0	NS	M	PRO
Hog I Creek	Entire Creek	03-01-51	15.4	FS	M	APP
Long Wretch Creek	From source to Croatan Sound	03-01-51	1.7	FS	M	APP
Smith Creek	Entire Creek	03-01-51	3.3	FS	M	APP
Roanoke Sound	DEH closed area west of Pond Island in subbasin 03-01-51	03-01-51	105.3	NS	M	PRO
Roanoke Sound	DEH closed area on east side of Roanoke Island extending from mouth of Shallowbag Bay to Johns Creek along the shoreline	03-01-51	136.0	NS	M	PRO
Roanoke Sound	DEH closed area adjacent to Mill Landing on east side of Roanoke Island	03-01-51	386.3	NS	M	PRO
Roanoke Sound	Those waters in subbasin 03-01-51in the western portion of Roanoke Sound, from a line running from Northwest Point on Roanoke Island northward to Rhodoms Point on Colington Island, thence a line running eastward through Wright Memorial Monument, to a line running from the southern tip of Smith Island south of Roanoke Island to southern tip of Bodie Island at North Point excluding three DEH closure areas	03-01-51	9,289.7	FS	M	APP
Pond Island	The waters surrounding the Island within 1,000 feet from shore within subbasin 03-01-51	03-01-51	167.2	NS	M	PRO
Johns Creek	From source to Roanoke Sound	03-01-51	10.7	NS	M	PRO
Sand Beach Creek	From source to Johns Creek	03-01-51	38.7	NS	M	PRO
Rockhall Creek	Entire Creek	03-01-51	5.8	NS	M	PRO
Broad Creek	From source to Roanoke Sound except closed area	03-01-51	499.0	FS	M	APP
Broad Creek	DEH closed area	03-01-51	119.2	NS	M	PRO
Oyster Creek	Entire Creek	03-01-51	84.2	FS	M	APP
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-51.	03-01-51	18,056.0	FS	M	APP

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area: All waters south of a line bginning at a point on the shore north of Buxton at 35 degrees 16’ 44" N- 75 degrees 31’ 05" W, thence in awesterly direction through Bald Point to a point on the Buxton shorelin at 35 degrees 16’ 24" N- 75 degrees 32’ 12" W, thence westerly along the shoreline crossing the entrace to all creeks, canals and tributaries to a point on shore east of Brooks Point	03-01-55	171.8	NS	M	PRO
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area: all creeks, canals, and tributaries along Hatteras Island between Brooks Point to west mouth of Joe Saur Creek.	03-01-55	472.9	NS	M	PRO
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area at the mouth of Askins Creek	03-01-55	0.7	NS	M	PRO
Pamlico Sound	The waters of the Pamlico Sound which include the DEH closed area with mouth 1.17 miles southwest of Durant Point.	03-01-55	13.7	NS	M	PRO
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area at the mouth of Mill Creek. This includes all waters south of a line from Big Island to the Outer Banks and all waters east of line from Big Island to Gibbs Point.	03-01-55	28.8	NS	M	PRO
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area of a boundary begnning at a point on land west of the Hatteras Ferry Landing at 35 degrees 12’ 30" N- 75 degrees 42’ 24" W, thence to a point in the ferry channel at 35 degrees 12’ 37" N-75 degrees 42’ 26" W to the mouth of Austin Creek	03-01-55	12.6	NS	M	PRO
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-55 except DEH closure areas 30-22b through 30-22j.	03-01-55	315,407.0	FS	M	APP
Pamlico Sound	The waters of Pamlico Sound which include the DEH closed area with mouth 321 meters east of east mouth of Austin Creek	03-01-55	3.1	NS	M	PRO
Oregon Inlet	Entire Inlet	03-01-55	626.7	FS	M	APP
Eagle Nest Bay	Entire Bay	03-01-55	0.0	NS	M	PRO
Goat Island Bay	Entire Bay	03-01-55	40.8	FS	M	APP
The Trench	From source to Pamlico Sound	03-01-55	51.5	FS	M	APP

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Pea Island Creek	Entire Creek	03-01-55	4.6	FS	M	APP
Pea Island Bay	Entire Bay	03-01-55	18.3	FS	M	APP
Terrapin Creek Bay	Entire Bay	03-01-55	163.7	FS	M	APP
Terrapin Creek	From source to Terrapin Creek Bay	03-01-55	2.8	FS	M	APP
Stumpy Point Bay	Entire Bay except DEH area closures	03-01-55	1,704.1	FS	M	APP
Stumpy Point Bay	All those waters bounded by a line beginning at a point 35 degrees 41’ 55" N-75 degrees 46’ 09" W, thence in a southeasterly direction to a point 400 yards offshore at 35 degrees 41’ 46" N- 75 degrees 45’ 54" W, thence in a southwesterly direction in a straight line through . Beacon 10 to a point at 35 degrees 41’ 28"N-75 degrees 46’ 20" W, thence in a northwesterly direction to a point on the mainland at 35 degrees 41’ 38" N- 75 degrees 46’ 32" W: to include all of the Lake Worth drainage canal.	03-01-55	185.8	NS	M	PRO
Stumpy Point Bay	All those waters within an area bounded by a line beginning at a point on the east shore at 35 degrees 41’ 44" N- 75 degrees 44’ 18" W, thence to a point in the bay at 35 degrees 41’ 28" N- 75 degrees 44’ 45" W, thence to a point in the bay at 35 degrees 40’ 56" N- 75 degrees 44’ 45" W, thence to Drain Point at 35 degrees 40’ 58" N- 75 degrees 44’ 28" W, thence in a northerly direction along the shoreline back to the point of beginning.	03-01-55	245.5	NS	M	PRO
Beach Slue	Entire area of Beach Slue	03-01-55	76.9	NS	M	PRO
Wreck Creek	Entire Creek	03-01-55	43.5	FS	M	APP
Round Hammock Bay	Entire Bay	03-01-55	276.4	FS	M	APP
Pauls Ditch	From source to Pamlico Sound	03-01-55	6.9	FS	M	APP
Blackmar Gut	From source to Pamlico Sound	03-01-55	4.6	FS	M	APP
North Drain	From source to Pamlico Sound	03-01-55	2.0	FS	M	APP
Midgett Cove	From source to Pamlico Sound	03-01-55	36.4	FS	M	APP
Clarks Bay	Entire Bay	03-01-55	19.8	FS	M	APP
No Ache Bay	Entire Bay	03-01-55	38.1	FS	M	APP
Gull Island Bay	Entire Bay	03-01-55	16.5	FS	M	APP
Phipps Cove	From source to Pamlico Sound	03-01-55	5.8	FS	M	APP
The Drain	From source to Pamlico Sound	03-01-55	1.4	FS	M	APP
Spencer Creek	From source to Pamlico Sound	03-01-55	4.4	FS	M	APP

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Mill Creek	From source to Pamlico Sound	03-01-55	16.2	NS	M	PRO
Peters Ditch	From source to Pamlico Sound	03-01-55	2.4	NS	M	PRO
Askins Creek	From source to Pamlico Sound	03-01-55	4.9	NS	M	PRO
Boat Creek	From source to Pamlico Sound	03-01-55	1.9	FS	M	APP
Long Point Creek	From source to Pamlico Sound	03-01-55	6.3	FS	M	APP
Cape Creek	From source to Pamlico Sound	03-01-55	15.8	NS	M	PRO
Brooks Creek	From source to Pamlico Sound	03-01-55	24.8	NS	M	PRO
Joe Saur Creek	From source to Pamlico Sound	03-01-55	17.9	NS	M	PRO
Sandy Bay	DEH Closure Area	03-01-55	28.4	NS	M	PRO
Sandy Bay	Entire Bay excluding DEH closure Area	03-01-55	132.9	FS	M	APP
The Slash	From source to Sandy Bay	03-01-55	30.9	NS	M	PRO
Duck Ponds and Isaac Pon	Entire ponds and connecting streams to The Slash	03-01-55	10.3	FS	M	APP
Austin Creek (Clubhouse	From source to Pamlico Sound	03-01-55	7.9	NS	M	PRO
Goose Creek	From source to Pamlico Sound	03-01-55	1.7	FS	M	APP
Hatteras Inlet	Entire Inlet	03-01-55	143.1	FS	M	APP
Roanoke Sound	Those waters in 03-01-56 in the eastern portion of Roanoke Sound, from a line running from Northwest Point on Roanoke Island northward to Rhodoms Point on Colington Island, thence a line running eastward through Wright Memorial Monument, to a line running from the southern tip of Smith Island south of Roanoke Island to southern tip of Bodie Island at North Point except DEH closure areas; those waters in subbasin 03-01-56	03-01-56	14,053.5	FS	M	APP
Roanoke Sound	DEH closed area east of Pond Island adjacent ot HWY 264 bridge	03-01-56	388.6	NS	M	PRO
Roanoke Sound	DEH closed area northeast of a line from Rhodams Point to Mann Point including Buzzard bay	03-01-56	1,142.4	NS	M	PRO
Roanoke Sound	DEH closed area in southern portion of Roanoke Sound adjacent to Big Tim Island	03-01-56	34.3	NS	M	PRO
Roanoke Sound	DEH closed area adjacent to Mill Landing in subbasin 03-01-56	03-01-56	88.4	NS	M	PRO

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
Roanoke Sound	The waters of Roanoke sound which include those waters around the Villa Condominium STP Outfall beginning at a point 35 degrees 57’ 54" N- 75 degrees 38’ 46" W, thence 200 yards in a southwesterly direction to a point in the sound at 35 degrees 57’ 48" N- 75 degrees 38’ 50" W, thence 400 yards in a southesterly direction to a point in the sound at 35 degrees 57’ 38" N- 75 degrees 38’ 39" W, thence in a northeasterly direction to a point on shore at 35 degrees 57’ 45" N- 75 degrees 38’ 36" W.	03-01-56	21.4	NS	M	PRO
Pond Island	The waters surrounding the Island within 1,000 feet from shore within subbasin 03-01-56	03-01-56	37.8	NS	M	PRO
Georges Creek	From source to Roanoke Sound	03-01-56	3.0	FS	M	APP
Lighthouse Bay	Entire Bay	03-01-56	19.3	FS	M	APP
Blossie Creek	Entire Creek	03-01-56	33.3	FS	M	APP
Pamlico Sound	Portion of Pamlico Sound (from Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island) in subbasin 03-01-56	03-01-56	4,666.0	FS	M	APP

Name	Description	Subbasin	Estuarine Acres	Rating	Basis	DEH Class
NOTES						
*"Ag" denotes agriculture, which could include row crops and animal operations. Where "cattle" is noted, cattle were observed on site at the time of sampling						
or the watershed hosts many cattle farms.						
"Rating" = Use Support Rating						
"Basis"=Rating basis						
"Habitat degradation" is 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 stream bed scour.						
"Non-urban develop" is residential and/or commercial develop outside urban areas.						
"Rural runoff" is non-point source runoff from rural areas, including that from low density residential and commercial areas.						
ABBREVIATION KEY		nut = high nutrient levels				
P = Point Source Pollution (Major source)		turb = turbidity				
NP = Non-point Source Pollution		fecal = fecal coliform bacteria				
M = Monitored		sed = sediment				
ME= Monitored evaluated		ab = above				
FS= Fully Supporting		nr = near				
PS= Partially Supporting		be = below				
NS= Not Supporting		APP= Approved				
NR= Not Rated		PRO= Prohibited				

Appendix IV

303(d) Listing
and
Reporting Methodology

303(d) LISTING AND REPORTING REQUIREMENTS

What is the 303(d) List?

Section 303(d) of the Clean Water Act (CWA) requires states to develop a comprehensive public accounting of all impaired waters. North Carolina's list of impaired waters must be submitted to EPA by April 1 of every even year (40 CFR 130.7). The list includes waters impaired by pollutants, such as nitrogen, phosphorus and fecal coliform bacteria, and by pollution, such as hydromodification and habitat degradation. The source of impairment might be from point sources, nonpoint sources or atmospheric deposition. Some sources of impairment exist across state lines. North Carolina lists impaired waters regardless of whether the pollutant or source of pollution is known and whether the pollutant/pollution source(s) can be legally controlled or acted upon by the State of North Carolina. More complete information can be obtained from *North Carolina's 2000 303(d) List* (http://h2o.enr.state.nc.us/mtu/), which can be obtained by calling the Planning Branch of DWQ at (919) 733-5083.

303(d) List Development

Generally, there are three steps to preparing North Carolina's 303(d) list. They are: 1) gathering information about the quality of North Carolina's waters; 2) screening those waters to determine if any are impaired and should be listed; and 3) prioritizing listed waters for TMDL development. The following subsections describe each of these steps in more detail.

Sources of Information

North Carolina considers all practical existing and readily available data and information in preparing the 303(d) list. Sources solicited for "existing and readily available data and information" include, but are not limited to the following:

- The previous 303(d) list.
- Basinwide Water Quality Plans and Assessment Reports.
- 305(b) reports.
- 319 nonpoint source pollution assessments.
- Waters where specific fish or shellfish consumption bans and/or advisories are currently in effect.
- Waters for which effluent toxicity test results indicate possible or actual excursions of state water quality standards.
- Waters identified by the state as impaired in its most recent Clean Lakes Assessment.
- Drinking water source water assessments under the Safe Drinking Water Act.
- Trend analyses and predictive models used for determining numeric and narrative water quality standard compliance.
- Data, information and water quality problems reported from local, state or federal agencies, Tribal governments, members of the public and academic institutions.

Listing Criteria

Waters whose use support ratings were not supporting (NS) or partially supporting (PS) based on monitored information in the 305(b) report are considered as initial candidates for the 303(d) list. Waters that were listed on the previously approved 303(d) list are evaluated and automatically included if the use support rating was NS, PS or not rated (NR).

Guidance from EPA on developing the 1998 303(d) lists indicates that impaired waters without an identifiable problem parameter should not be included on the 303(d) list. However, DWQ feels that waters listed in the 305(b) report as impaired for biological reasons, where problem parameters have not been identified, should remain on the 303(d) list. The Clean Water Act states that chemical, physical and biological characteristics of waters shall be restored. The absence of an identified cause of impairment does not mean that the water should not receive attention. Instead, DWQ should resample or initiate more intensive studies to determine why the water is impaired. Thus, biologically impaired waters without an identified cause of impairment are on the 2000 303(d) list.

Assigning Priority

North Carolina has developed a TMDL priority ranking scheme that reflects the relative value and benefits that a water provides to the state. The priority ranking system is designed to take into account the severity of the impairment, especially when threats to human health, endangered species or the designated uses of the water are present.

A priority of High, Medium or Low has been assigned to all waters on Parts 1, 4, 5 and 6 of the list (the following section describes these parts in more detail). A high priority is assigned to all waters that are classified as water supplies. A high priority is also automatically assigned to all waters harboring species listed as endangered or threatened under the federal Endangered Species Act (ESA). A medium priority has minimally been assigned to waters harboring state listed endangered and threatened species. As a way of addressing anti-degradation concerns, classified Outstanding Resource Waters and High Quality Waters start at the medium priority. The remaining waters on the list are prioritized according to severity of the impairment.

New Format of the List

North Carolina has begun to make the structural changes prescribed in EPA's July 13, 2000 final TMDL rule. The *2000 303(d) List* reflects many of these changes. EPA's final rule will likely eventually require 303(d) lists to be divided into four sections. North Carolina's 2000 list has been divided into six parts and reflects comments made on the proposed rules by North Carolina and other states. This six-part format meets the requirements of existing rules, and future lists will meet requirements of revised federal rules (when implemented). A summary of each part of the list is provided below. A more detailed discussion is found in the preface to the actual list document.

Part 1 - Waters impaired by a *pollutant* as defined by 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." TMDLs will be submitted for all water/pollutant combinations listed in Part 1.

Part 2 - Waters 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" in the CWA section 502(19). EPA believes that in situations where the impairment is not caused by a *pollutant*, a TMDL is generally not the appropriate solution to the problem. In keeping with the principle that the 303(d) list is an

accounting of all impaired waters; however, these types of waters will remain on Part 2 of the list until water quality uses and standards are attained by some other means.

Part 3 - Waters for which EPA has approved or established a TMDL and water quality standards have not yet been attained.
Monitoring data will be considered when evaluating Part 3 waters for potential delisting. Waters will be moved to Part 1 of the list if updated information and data demonstrate that the approved TMDL is inadequate.

Part 4 - Waters for which TMDLs are not required.
Other required regulatory controls (e.g., NPDES permit limits, Phase I Federal Stormwater Permits, etc.) are expected to attain water quality standards by the next regularly scheduled listing cycle.

Part 5 - Biologically impaired waters with no identified cause of impairment.
Roughly half of the waters on North Carolina's 303(d) list appear on Part 5. Identification of the cause(s) of impairment will precede movement of these waters to Parts 1 and 2 of the list. EPA recognized that in specific situations the data are not available to establish a TMDL, and that these specific waters might be better placed on a separate part of the 2000 303(d) list (64 FR, 46025). Data collection and analysis will be performed in an attempt to determine a cause of impairment. North Carolina's proposed plan for managing biologically impaired waters can be found in the preface to Part 5 of the list.

Part 6 – The *proper technical conditions* do not yet exist to develop a TMDL.
"*Proper technical conditions* refers 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). These are waters that would otherwise be on Part 1 of the list. In the proposed TMDL regulations, EPA again recognized that in some specific situations the data, analyses or models are not available to establish a TMDL, and that these specific waters might be better off on a separate part of the 2000 303(d) list (64 FR, 46025). North Carolina seeks EPA technical guidance in developing technically defensible TMDLs for these waters. DWQ has included fecal impaired shellfish waters on this part of the list. North Carolina's approach to managing shellfish waters impaired because of fecal coliform violations is outlined in the preface to Part 6 of the list.

Scheduling TMDLs

North Carolina will submit TMDLs for each water within 13 years of its first listing, starting with the EPA-approved 1998 303(d) list. TMDLs for waters first listed in 1998 or earlier will be developed by 2011. As a general rule, TMDLs will be addressed according to highest priority in accordance with the rotating basinwide planning approach. Due to the wide range of complexities encountered in TMDL development, TMDLs will not necessarily be submitted to EPA in order of priority.

TMDLs on Part 1 of the 303(d) list 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 and "buy-in". Others

need to have a technical strategy budgeted and scheduled. Some are almost ready for submittal to EPA for approval. As the current regulations require, North Carolina has listed waters targeted for TMDL development within the next two years.

North Carolina has used "biological impairment" to place the majority of waters on the 303(d) list. Additional consideration and data collection are necessary if the establishment of a TMDL for waters on Part 5 is to be expected. It is important to understand that the identification of waters on Part 5 of the list does not mean that they are low priority waters. The problem parameter identification (PPI) approach is a high priority for the State of North Carolina. However, it should be noted that it may take significant resources and time to determine the cause of impairment. The PPI approach is also a declaration of need for more data and more time to adequately define the problems and whether they are affected by *pollution, pollutants* or a combination.

North Carolina believes it to be both practical and honest to schedule TMDL development for only those waters where we have some information about the cause of impairment. Scheduling TMDLs for waters that may not be impaired by a *pollutant* is misleading and counterproductive.

Delisting Waters

North Carolina relies heavily on the existing 305(b) reporting methodology to complete the 303(d) process. In general, waters will be removed from the 303(d) list when data show that a water is fully supporting its uses. In some cases, mistakes have been discovered in the original listing decision and the mistakes are being corrected. Waters appearing on the previously approved 303(d) list will be removed from the 303(d) lists under the following circumstances:

- An updated 305(b) use support rating of fully supporting.
- Applicable water quality standards are being met (i.e., no longer impaired for a given *pollutant*).
- 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.
- Typographic listing mistakes (i.e., the wrong water was identified).

Appendix V

Pasquotank River Basin Workshop Summaries

PASQUOTANK RIVER BASIN WORKSHOPS

South Pasquotank Workshop
Manteo, North Carolina
March 26, 2001

These questions were purposed to the participants:

Discussion Question 1: WHAT ARE THE MAIN ISSUES TO WATER QUALITY IN THE PASQUOTANK RIVER BASIN?

Discussion Question 2: WHERE ARE THE PROBLEM AREAS OR WATERS AND WHAT RECOMMENDATIONS DO YOU HAVE FOR ADDRESSING THESE PROBLEMS/WATERS?

Discussion Question 3: WHO SHOULD BE INVOLVED IN ADDRESSING THE PROBLEMS (i.e., local agencies or organizations)?

ISSUES	WHERE	RECOMMENDATIONS	WHO	WHERE DWQ ADDRESSES IN PLAN
♦ Septic system management	♦ Basinwide ♦ Dare County beaches due to high residential density	♦ Promote decentralized wastewater management ♦ Educate about effective treatment ♦ Improve water quality testing ♦ Mandate particular systems on a case-by-case basis	♦ Nags Head Model ♦ Roper facility ♦ North Carolina Cooperative Extension Service (NCES)	
♦ Lack of wastewater treatment ♦ Failing systems	♦ Nags Head	♦ Promote treatment alternatives ♦ Conduct inspection and monitoring effectively ♦ Eliminate regulatory restrictions to alternative technologies	♦	

♦ Submerged aquatic vegetation loss ♦ Turbidity concerns ♦ Lack of information ♦ Aquatic growth ♦ Salinity changes	♦ Currituck Sound ♦ Northern Little River ♦ Basinwide	♦ Increase automated monitoring through the Knotts Island Ferry ♦ Extend UNC/Duke's study to the northeast ♦ Analyze data taking into account wind, flow, salinity ♦ Monitor more ♦ Conduct an assessment of where we need to go in terms of future science needs ♦ Ensure regulations have enforcement teeth	♦ Ferry system ♦ State ♦ Trained citizens ♦ Public ♦ DWQ	
♦ Growth and development	♦ Elizabeth City ♦ Basinwide ♦ Outer Banks ♦ N. Pasquotank County ♦ Camden County ♦ Currituck County	♦ Integrate DWQ basin planning into CAMA (i.e., water/land use plan) ♦ Manage effectively ♦ Limit growth with a date for full build out ♦ Mandate smart growth approach which prevents environmental degradation ♦ Ensure funding for mandates ♦ Identify and protect critical areas ♦ Restrict uses in critical areas ♦ Promote acquisition ♦ Institute build-out restriction (i.e., short-term and long-term) ♦ Serve as role model for other locations ♦ Institute build-out capacity or limits	♦ DMF Coastal Habitat Protection Plans ♦ Nature Conservancy ♦ CAMA ♦ Local governments ♦ Federal government	

PASQUOTANK RIVER BASIN WORKSHOPS

North Pasquotank Workshop
Elizabeth City, North Carolina
March 27, 2001

These questions were purposed to the participants:

Discussion Question 1: WHAT ARE THE MAIN ISSUES TO WATER QUALITY IN THE PASQUOTANK RIVER BASIN?

Discussion Question 2: WHERE ARE THE PROBLEM AREAS OR WATERS AND WHAT RECOMMENDATIONS DO YOU HAVE FOR ADDRESSING THESE PROBLEMS/WATERS?

Discussion Question 3: WHO SHOULD BE INVOLVED IN ADDRESSING THE PROBLEMS (i.e., local agencies or organizations)?

ISSUES	WHERE	RECOMMENDATIONS	WHO	WHERE DWQ ADDRESSES IN PLAN
♦ Pollutants (i.e., mercury, dioxin, etc.)	♦ Lake Phelps ♦ Other areas	♦ Understand their source – is it natural/man made? ♦ Set acceptable standards ♦ Monitor	♦ DWQ	
♦ Drinking water Trihalomethanes	♦ Elizabeth City ♦ Other areas	♦ Use ammonia in water treatment ♦ Monitor	♦ Municipal water systems	
♦ Erosion	♦ Basinwide	♦ Implement buffers	♦	
♦ Sewer pipe breakage/leaks	♦ Elizabeth City	♦ Monitor ♦ Conduct enforcement actions ♦ Upgrade	♦ Elizabeth City ♦ Grants	
♦ Septic systems ♦ Site differences ♦ Politics ♦ Different standards	♦ Dare/Tyrrell counties	♦ Ensure proper maintenance and education ♦ Allow flexibility in siting (monitoring)	♦ NCES ♦ Health department	
♦ Organic loading	♦	♦	♦	

♦ Agriculture/Urban nonpoint surface runoff	♦ Basinwide	♦ Monitor ♦ Acquire background information ♦ Conduct education	♦ DWQ	
♦ Concerns regarding status of watershed (need more information)	♦ Basinwide	♦ Conduct more education and research	♦ DWQ ♦ NCES ♦ Universities	
♦ Work on major problems first	♦ Basinwide	♦ Conduct science ♦ Research ♦ Monitor	♦ All agencies	
♦ Enforce present regulations and provide assistance (i.e., be flexible!)	♦ Basinwide	♦ Use science	♦	
♦ BMPs (agriculture) (i.e., water control structures, sediment control and denitrification)	♦ Basinwide	♦ Use the systems the right way ♦ Educate ♦ Build in flexibility	♦ NRCS ♦ NCES	
♦ Continue forest BMPs	♦ Basinwide	♦ Monitor concerns in "critical areas"	♦	
♦ Industry potential impact	♦ Rural areas	♦ Plan ahead ♦ Consider type of industry when permitting	♦ County planner ♦ Economic development groups	
♦ Boating waste (i.e., petroleum concentration)	♦ Around marinas	♦ Enforce rules and regulations ♦ Advertise pumpout/disposal facilities available ♦ Increase education	♦ Coast Guard ♦ Fish and Wildlife Services ♦ Marinas	
♦ Salt intrusion	♦ Northwest River ♦ Currituck Sound ♦ Pasquotank River ♦ Perquimans River	♦ Monitor	♦ DWQ	
♦ Salt wedge stratification and associated problems	♦	♦	♦	
♦ Impact of 4-lane Highway 64 (i.e., development)	♦ Washington County ♦ Tyrrell County ♦ Dare County	♦ Plan and zone appropriately ♦ Conduct an environmental study through "Smart Growth" initiative	♦ County planners	
♦ Develop wastewater runoff	♦ Close to and along Virginia border	♦ Direct development to protect resources through zoning/ordinances	♦ County/city	
♦ Public does not know or is not made aware of water quality (specifically recreational use impairment)	♦ Basinwide	♦ Publish information on a periodic basis ♦ Use Nags Head's program as example	♦ Local government ♦ State government ♦ County government	
♦ Water use/consumption	♦ Future growth in Elizabeth City area ♦ Southern portions of counties/waterfront development	♦ Protect resources through development options ♦ Conduct a comprehensive assessment to protect resources (i.e., look at cumulative impacts)	♦	
♦ Waterfront development ♦ Subdivisions are allowed to a point where wetlands fill is allowed (current regulations)	♦	♦	♦	
♦ Growth development ♦ USDA is piping the area	♦ Pasquotank County ♦ Hwy 17 corridor	♦ Reevaluate population projections ♦ Reevaluate seasonal flux	♦ DWQ ♦ NCES	

	♦ Little River ♦ Currituck County ♦ Dare County ♦ Virginia	♦ Educate that agricultural lands could provide service for urban waste ♦ Allow clustering for residential development to allow open space: promote concept and offer incentives	♦ Health department ♦ Local governments ♦ USDA	
♦ Loss of wetlands (quantity and quantity)	♦	♦ Preserve wetlands	♦ US Army Corps of Engineers ♦ Division of Coastal Management ♦ NC DWQ	
♦ Point source pollution (i.e., untreated waste discharged)	♦ Elizabeth City ♦ Discharge to Pasquotank River	♦ Use wetlands for treating waste	♦ DWQ	
♦ Accidental/illegal discharge events	♦ Pasquotank River	♦ Provide information/education on operations and maintenance ♦ Ensure effective planning for capacity needs	♦	
♦ Lack of state employees to enforce existing regulations (i.e., erosion/sediment control, wastewater treatment oversight)	♦ Basinwide ♦ State	♦ Adequately staff the state employees ♦ Evaluate existing regulations and get ineffective ones out before making new ones ♦ Ensure better coordination of activities	♦ DENR ♦ US Army Corp of Engineers ♦ Federal agencies ♦ General Assembly ♦ Governor	
♦ Groundwater ♦ Overuse of drinking water ♦ Deplete acquifer	♦	♦	♦	
♦ Direct disturbance of contaminated sediments in rivers due to lack of adequate review in the permitting process	♦	♦	♦	
♦ Discharges to surface waters from water treatment plants ♦ Inadequate planning for dischargers ♦ Incorrect surface water classifications ♦ Concerns about discharge constituents ♦ Adjacent waterbody becomes impacted ♦ High salinity discharges ♦ Negative impact on local vegetation ♦ Inadequate impact studies by consultants (especially cumulative and long-term) ♦ Existing loopholes due to incorrect classification ♦ Inadequate review of permit applications (by state)	♦ Roper ♦ Camden County ♦ Dare County ♦ Tyrrell County ♦ Kendricks Creek	♦ Research suitable discharge sites ♦ Address classifications of adjacent waterbodies – are they right? ♦ Evaluate where discharge should go ♦ Review recent scientific studies ♦ Determine if issue is more widespread than we are aware ♦ Staff state agencies adequately ♦ Close reclassification loopholes ♦ Conduct adequate assessments using current flow data and water quality data	♦ DWQ ♦ Consultants ♦ Division of Marine Fisheries ♦ Wildlife Resources Commission ♦ NCSU ♦ Weyerhaeuser ♦ General Assembly ♦ Governor ♦ Division of Water Resources	
♦ Are the waters around the Avon area polluted – is it safe to fish there?	♦	♦	♦	
♦ Nutrient enrichment	♦	♦	♦	
♦ Water quality effects on submerged aquatic	♦ Currituck Sound	♦	♦	

vegetation in Currituck Sound and Back Bay	♦ Back Bay			

Appendix VI

Pasquotank River Basin Nonpoint Source Program Description and Contacts

Statewide Nonpoint Source Management Program Description

The North Carolina Nonpoint Source Management Program consists of a broad framework of federal, state and local resource and land management agencies. More than 2,000 individuals administer programs that are directly related to nonpoint source pollution management within the state. A range of responsibilities have been delegated to county or municipal programs including the authority to inspect and permit land clearing projects or septic system performance. In the field of agriculture, a well established network of state and federal agricultural conservationists provide technical assistance and program support to individual farmers.

Staff in the DWQ Water Quality Section's Planning Branch lead the Nonpoint Source Management Program, working with various agencies to insure that program goals are incorporated into individual agencies' management plans. The goals include:

1. Coordinate implementation of state and federal initiatives addressing watershed protection and restoration.
2. Continue to target geographic areas and waterbodies for protection based upon best available information.
3. Strengthen and improve existing nonpoint source management programs.
4. Develop new programs that control nonpoint sources of pollution not addressed by existing programs.
5. Integrate the NPS Program with other state programs and management studies (e.g., Albemarle-Pamlico National Estuary Program).
6. Monitor the effectiveness of BMPs and management strategies, both for surface and groundwater quality.

Coordination between state agencies is achieved through reports in the *North Carolina Nonpoint Source Management Program Update*. Reports are intended to keep the program document current and develop a comprehensive assessment identifying the needs of each agency to meet the state nonpoint source program goals. Annual reports are developed to describe individual program priorities, accomplishments, significant challenges, issues yet to be addressed, and resource needs. A copy of the latest Annual Report (FY2000) is available online at http://h2o.enr.state.nc.us/nps/nps_mp.htm.

The nature of nonpoint source pollution is such that involvement at the local level is imperative. Basinwide water quality plans identify watersheds that are impaired by nonpoint sources of pollution. Identification, status reports and recommendations are intended to provide the best available information to local groups and agencies interested in improving water quality. The plans also make available information regarding federal, state and local water quality initiatives aimed at reducing or preventing nonpoint source pollution.

The following table is a comprehensive guide to contacts within the state's Nonpoint Source Management Program. For more information, contact Alan Clark at (919) 733-5083 ext. 570. Most employees of the Department of Environment and Natural Resources, including Division of Water Quality, Division of Land Resources and the Division of Forest Resources, can be reached by email using the following formula: firstname.lastname@ncmail.net.

Agriculture

USDA Natural Resources Conservation Service:

Formerly the Soil Conservation Service; provides technical specialist for certifying waste management plans; certified trainers for swine applicators training sessions works with landowners on private lands to conserve natural resources helping farmers and ranchers develop conservation systems uniquely suited to their land and individual ways of doing business; provides assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conducts site evaluations and soil surveys; administers the Wetlands Reserve Program; offers planning assistance for local landowners for installing best management practices; offers technical assistance for the determination of wetlands on agricultural lands.

Camden County	R. Dwane Hinson	(252) 482-4127	730 North Granville Street, Edenton, NC 27932
Chowan County	R. Dwane Hinson	(252) 482-4127	730 North Granville Street, Edenton, NC 27932
Currituck County	R. Dwane Hinson	(252) 482-4127	730 North Granville Street, Edenton, NC 27932
Dare County	Rufus W. Croom	(252) 793-4561	128 E. Water Street, Suite 202, Plymouth, NC 27962
Gates County	W. Paul Boone	(252) 358-7846	P.O. Box 265, Winton, NC 27986-0265
Hyde County	Rufus W. Croom	(252) 793-4561	128 E. Water Street, Suite 202, Plymouth, NC 27962
Pasquotank County	R. Dwane Hinson	(252) 482-4127	730 North Granville Street, Edenton, NC 27932
Perquiman County	R. Dwane Hinson	(252) 482-4127	730 North Granville Street, Edenton, NC 27932
Tyrrell County	Sandra W. Merritt	(252) 441-1345	2601 N. Croatan Hwy, Kill Devil Hill, NC 27949
Washington County	Rufus W. Croom	(252) 793-4561	128 East Water St., Suite 202, Plymouth, NC 27845

Soil & Water Conservation Districts:

The local Soil and Water Conservation District Boards function under the administration of the North Carolina Soil and Water Conservation Commission (SWCC). The districts are responsible for administer the Agricultural Cost Share Program, identifying treatment areas, allocating resources, signing contractual agreements with landowners, providing technical assistance for the planning and implementation of BMPs and generally encouraging the use of appropriate BMPs to protect water quality

Camden County	Randolph Keaton	(252) 771-5400	188 Old Swamp Rd., South Mills, NC 27976
Chowan County	Louis S. Nixon	(252) 221-8578	3007 Rocky Hock Road, Edenton, NC 27932
Currituck County	Manly M. West	(252) 232-2706	Rt. 2, Box 139, Moyock, NC 27958
Dare County	Larry Bray	(252) 261-2769	PO Box 1578, Kill Devil Hills, NC 27948
Gates County	Rick Morgan	(252) 465-4122	Route 1, Box 50, Corapeake, NC 27926
Hyde County	David O'Neal, Sr.	(252) 926-5721	7453 Turnpike Road, Swan Quarter, NC 27885
Pasquotank County	Stephen Harris	(252) 335-1306	139 Hunters Trail, West, Elizabeth City, NC 27909
Perquiman County	Elmer Lassiter	(252) 297-2640	Rt.1, Box 239, Belvidere, NC 27919
Tyrrell County	Roy Smith	(252) 796-3891	Rt.1, Box 219, Columbia, NC 27925
Washington County	Paul Lilly	(252) 793-2088	312 Hampton Drive, Plymouth, NC 27962

Division of Soil and Water Conservation:

Provides administrative and technical assistance to the Soil & Water Conservation Districts in areas pertaining to soil science and engineering; distributes Wetlands Inventory maps for a small fee. Administers the Agriculture Cost Share Program (ACSP).

Central Office	David Williams	(919) 715-6103	512 N. Salisbury St., Raleigh, NC 27604-1148
Region V	George Stewart	(252) 946-6481	943 Washington Square Mall, Washington, NC 27889

Agriculture

NCDA Regional Agronomists:

Provides technical specialists for certifying waste management plans. Provides certified trainers for animal waste applicators training sessions. Tracks, monitors, and accounts for use of nutrients on agricultural lands. Identifies and evaluates the use of nutrient management plans.

Central Office	Kent Messick	(919) 733-2655	4300 Reedy Creek Road, Raleigh, NC 27607-6465
Regional Office	Wayne Nixon	(252) 426-7210	286 Bagley Swamp Road, Hertford, NC 27944

Education

NC Cooperative Extension Service:

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

Camden County	Freddie O'Neal	(252) 338-0171	P.O. Box 129, Camden, NC 27921
Chowan County	J. Michael Williams	(252) 482-8431	P.O. Box 1030, Edenton, NC 27932
Currituck County	M. Rodney Sawyer, Jr.	(252) 232-2261	153 Courthouse Road, Currituck, NC 27932
Dare County	Ann B. Ward	(252) 473-1101	Adm. Bldg., Manteo, NC 27954
Gates County	Marjorie Rayburn	(252) 357-1400	P.O. Box 46, Gatesville, NC 27938
Hyde County	Jean Balance	(252) 926-3201	P.O. Box 219, Swan Quarter, NC 27885
Pasquotank County	Travis Burke	(252) 338-3954	P.O. Box 1608, Elizabeth City, NC 27909
Perquiman County	Lewis W. Smith	(252) 426-5428	Cp. Office Bldg., Hertford, NC 27944
Tyrrell County	Richard Rhodes	(252) 796-1581	Agr. Bldg., Box 208, Columbia, NC 27962
Washington County	Richard Rhodes	(252) 793-2163	128 East Water Street, Plymouth, NC 27962

Forestry

Division of Forest Resources:

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

Central Office	Moreland Gueth	(919) 733-2162 ext. 255	P.O. Box 29581, Raleigh, NC 27626-0581

Fish and Wildlife Resources

Division of Marine Fisheries

The North Carolina Division of Marine Fisheries (DMF) is responsible for stewardship of the state's marine and estuarine resources. The DMF's jurisdiction encompasses all coastal waters and extends to 3 miles offshore. Agency policies are established by the 17-member Marine Fisheries Commission and the Secretary of the Department of Environment, Health and Natural Resources.

Central Office	Jenny Hardy	(252) 726-7021	3441 Arendell St., Morehead City, NC 28557
Elizabeth City Office	Sara Winslow	(252) 264-3911	1367 US HWY 17, Elizabeth City, NC 27909

Fish and Wildlife Resources

Wildlife Resources Commission:

To manage, restore, develop, cultivate, conserve, protect, and regulate the wildlife resources of the State, and to administer the laws relating to game, game and freshwater fishes, and other wildlife resources enacted by the General Assembly to the end that there may be provided a sound, constructive, comprehensive, continuing, and economical game, game fish, and wildlife program.

Central Office	Frank McBride	(252) 528-9886	P.O. Box 118, Northside, NC 27564

General Water Quality

DWQ Water Quality Section:

Control of water pollution from point sources such as municipal and industrial wastewater discharges, and from nonpoint sources that originate from agricultural drainage, urban runoff, land clearing, construction, mining, forestry, septic tanks and land application of waste; issues permits for both discharging and on-site wastewater treatment systems, conducts compliance inspections, operates an ambient water quality monitoring program, and performs a wide variety of special studies on activities affecting water quality; administers the 319 projects statewide.

Central Office	Lin Xu	(919) 733-5083	DWQ - Planning Branch, 1617 Mail Service Center, Raleigh, NC 27609-1617
Washington Region	Jim Mulligan	(252) 946-6481	943 Washington Square Mall, Washington, NC 27889

US Army Corps of Engineers:

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

Wilmington District	Keith Harris	(910) 251-4631	P.O. Box 1890, Wilmington, NC 28402-1890

DWQ Groundwater Section:

Groundwater classifications and standards, enforcement of groundwater quality protection standards and cleanup requirements, review of permits for wastes discharged to groundwater, issuance of well construction permits, underground injection control, administration of the underground storage tank (UST) program (including the UST Trust Funds), well head protection program development, and ambient groundwater monitoring.

Central Office	Carl Bailey	(919) 715-6169	2728 Capital Blvd., Raleigh, NC 27604
Washington Region	David Lekson	(252) 946-6481	107 Union Drive, Suite 202, Washington, NC 27889

General Water Quality

DENR Division of Coastal Management:

Responsible for carrying out the provisions of the North Carolina Coastal Area Management Act (CAMA); processes major development permits, review all dredge and fill permit applications, and determines consistency of state and federal grants and projects with the North Carolina Coastal Management Program; prepares guidelines for a local land use planning program in twenty coastal counties; administers grants to local government for planning, permitting and beach access programs; and acquires and manages coastal and estuarine reserves as natural areas for research, education and preservation.

Central Office	Donna Moffitt	(919) 733-2293	1638 Mail Service Center, Raleigh, NC 27699-1638
Washington Office	Terry Moore	(252) 946-6481	943 Washington Square Mall, Washington, NC 27889
Elizabeth City Office	Ted Sampson	(252) 264-3723	1367 US Hwy. 17, Elizabeth City, NC 27909

Construction/Mining

DENR Division of Land Resources:

Conducts land surveys and studies, produces maps, and protects the state's land and mineral resources. Administers the NC Sedimentation and Erosion Control Program.

Central Office	Mel Nevills	(919) 733-4574	512 N. Salisbury St., Raleigh, NC 27626
Washington Region Office	Pat McLain	(252) 946-6481	943 Washington Square Mall., Washington, NC 27889

Solid Waste

DEH Solid Waste Management:

Management of solid waste in a way that protects public health and the environment. The District includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors program.

Raleigh Regional Office	Ben Barns	(919) 571-4700	3800 Barrett Drive, Raleigh, NC 27609
Washington Regional Office	Chuck Boyette	(252) 946-6481 ext. 307	943 Washington Square Mall, Washington, NC 27889

On-Site Wastewater Treatment

Division of Environmental Health:

Safeguards life, promotes human health, and protects 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
- Technical assistance to local health departments, other state agencies, and industry on soil suitability and other site considerations for on-site wastewater systems.

Central Office - DEH	Steve Steinbeck	(919) 715-3273	2728 Capital Blvd., Raleigh, NC 27604
Camden County	Walker Rayburn, Jr.	(252) 338-4490	PO Box 72, Camden, NC 27921
Chowan County	Walker Rayburn, Jr.	(252) 482-6019	PO Box 72, Camden, NC 27921
Currituck County	Joe Hobbs	(252) 232-2271	PO Box 26, Currituck, NC 27929
Dare County	Mavin F. (Fred) Parker	(252) 441-2143	PO Box 1000, Manteo, NC 27954
Gates County	Daniel R. McDougald	(252) 358-7833	29 Medical Center Road, Gates, NC 27937
Hyde County	Hubert H. Watson	(252) 926-3561	PO Box 100, Swan Quarter, NC 27885
Pasquotank County	Walker Rayburn, Jr.	(252) 338-4490	PO Box 189, Elizabeth City, NC 27907-0189
Perquiman County	Walker Rayburn, Jr.	(252) 426-2111	103 Charles St., Hertford, NC 27944
Tyrrell County	Robert Martin	(252) 792-7811	PO Box 238, Columbia, NC 27892
Washington County	Robert Martin	(252) 793-3023	198 NC Hwy 45 North, Plymouth, NC 27962

Note: The DWQ, DLR and Division of Solid Waste Management Washington Regional Offices serve Bertie, Chowan, Currituck, Camden, Dare, Gates, Hertford, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties.

The Division of Coastal Management (DCM) Elizabeth City Field Office serves Currituck, Camden, Chowan, Gates, Pasquotank, Perquimans and Dare counties.

The DCM Washington Field Office serves Bertie, Hertford, Hyde, Tyrrell and Washington counties.

Appendix VII

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).
conductivitiy	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.
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.
effluent	The treated liquid discharged from a wastewater treatment plant.
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*).
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.