

# **Appendix I**

## **DWQ Water Quality Monitoring Programs in the Pasquotank River Basin**



## DWQ Water Quality Monitoring Programs in the Pasquotank River Basin

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

### DWQ monitoring programs for the Pasquotank River Basin include:

- Benthic Macroinvertebrates
- Fish Assessments
- Lakes and Reservoirs
- Aquatic Toxicity Monitoring
- Ambient Monitoring System

### Overview of Benthic Macroinvertebrate Monitoring

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

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

There were 11 benthic samples collected during this assessment period. The following table lists the total bioclassifications (by subbasin) for all benthos sites in the Pasquotank River basin. For detailed information regarding the samples collected during this assessment period, refer to the table that follows the next section.

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

Subbasin	Bioclassifications						Swamp Streams Bioclass.			Total
	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Natural	Moderate	Severe Stress	
03-01-50				1				3		4
03-01-52				1				3		4
03-01-53					1				1	2
03-01-54								1		1

Assessing Benthic Macroinvertebrate Communities in the Northeastern Coastal Plain

There are three types of streams in the Pasquotank River basin, in which biological criteria can be assessed and bioclassifications are assigned. Streams referred to as Coastal A have continuous flow throughout the year, Coastal B streams are deep non-wadeable rivers with minimal flow throughout the year and swamp streams typically only have flow between February to March.

The Biological Assessment Unit defines swamp streams, as those streams that are within the coastal plain ecoregion and that normally have no visible flow during a part of the year. This low flow period usually occurs during the summer, but flowing water should be present in swamp streams during the winter. Sampling during winter, high flow periods provides the best opportunity for detecting differences in communities from what is natural, and only winter (February to early March) benthos data can be used when evaluating swamp streams. The swamp stream must have visible flow in this winter period, with flow comparable to a coastal plain stream that would have acceptable flow for sampling in summer.

The Biological Assessment Unit has limited data on Coastal B, thus, draft criteria have been developed based only on EPT taxa richness. However, biotic index values and total taxa richness values were also evaluated for between year and among site comparisons. These criteria will continue to be evaluated and any bioclassifications derived from them should be considered tentative and not used for use support decisions. Three Coastal B waterbody segments were Not Rated during this assessment period because of the draft Coastal B criteria.

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

Benthic macroinvertebrate basinwide monitoring data collected in the Pasquotank River basin, 2000-2005.

Subbasin/ Waterbody	Map ID	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	BioClass
<b>03-01-50</b>										
<b>Pasquotank R</b>	MB4	SR 1361	Pasquotank	30-3-(1)	2/22/2005	30	2	7.56	6.40	Moderate
					3/6/2002	29	1	7.19	---	Not Rated
					8/3/2000	27	0	8.28	---	Not Rated
<b>Newland Drainage Canal</b>	MB2	SR 1363	Pasquotank	30-3-1.5	2/22/2005	44	2	7.77	6.73	Moderate
					3/6/2002	26	2	7.13	7.10	Moderate
<b>Pasquotank R</b>	MB3	Goat Island	Pasquotank	30-3-(3)	8/24/2005	52	4	7.79	7.20	Fair
					8/2/2000	31	4	8.09	6.83	Not Rated
<b>Sawyers Cr</b>	MB5	SR 1200	Camden	30-3-6	3/7/2002	29	0	6.89	---	Not Rated
					2/18/2000	27	0	7.55	---	Natural
<b>Areneuse Cr</b>	MB1	NC 343	Camden	30-3-13-(1)	2/23/2005	36	1	7.98	9.80	Moderate

					3/6/2002	16	0	7.88	---	Not Rated
					2/18/2000	22	0	7.82	---	Moderate
Newbegun Cr		SR 1132	Camden	30-3-16-(1)	2/23/2000	20	0	8.59	---	Moderate
<b>03-01-51</b>										
NW Fk Alligator R		Canoe Trail Mile 4	Tyrrell	30-16-8	3/1/2000	13	0	8.19	---	Not Rated
SW Fk Alligator R		Canoe Trail Mile 2	Tyrrell	30-16-8-2	3/1/2000	14	0	7.19	---	Not Rated
UT Billys Ditch		off US-64 E of FWS ofc	Dare		10/10/2000	33	2	8.42	6.67	Not Rated
UT Billys Ditch		off US 64 nr landfill	Dare		10/10/2000	43	2	8.05	7.98	Not Rated
UT Callaghan Cr		ditch off Cub Rd	Dare		10/10/2000	37	2	8.87	5.46	Not Rated
UT Callaghan Cr		ditch off Long Curve Rd	Dare		10/10/2000	31	0	8.78	---	Not Rated
<b>03-01-52</b>										
<b>Little R</b>	MB7	SR 1221	Perquimans	30-5-(1)	2/23/2005	40	1	8.35	6.40	Moderate
					2/11/2000	24	0	7.95	---	Moderate
Perquimans R		SR 1204	Perquimans	30-6-(1)	2/22/2000	26	0	7.54	---	Moderate
<b>Perquimans R</b>	MB8	NC 37	Perquimans	30-6-(1)	2/22/2005	25	0	7.53	---	Moderate
<b>Perquimans R</b>	MB12	above Hertford	Perquimans	30-6-(1)	8/23/2005	41	4	7.91	6.80	Fair
					8/2/2000	45	4	8.04	6.91	Not Rated
<b>Burnt Mill Cr</b>	MB6	NC 37	Chowan	30-8-1	2/21/2005	54	0	7.91	---	Moderate
					2/22/2000	37	0	7.92	---	Moderate
<b>03-01-53</b>										
Kendrick Cr		US 64	Washington	30-9-(1)	10/26/2000	35	0	7.60	---	Not Rated
<b>Main Canal</b>	MB9	SR 1180	Washington	30-9-4	2/21/2005	33	1	8.34	6.20	Severe
					2/23/2000	31	1	8.62	9.80	Severe
Deep Cr		SR 1302	Washington	30-14-2	2/23/2000	28	1	7.06	6.40	Natural
Scuppernong R		SR 1155	Washington	30-14-4-(1)	8/3/2000	49	2	8.14	6.06	Poor
<b>Scuppernong R</b>	MB10	SR 1105	Tyrrell	30-14-4-(1)	8/25/2005	59	2	8.27	7.62	Poor
<b>03-01-54</b>										
<b>UT Cowells Cr</b>	MB11	NC 34	Currituck		2/24/2005	36	1	8.02	9.80	Moderate

## Overview of Fish Tissue Assessment

Because fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Since 1991, fish tissue surveys have been conducted as part of the Basinwide Assessment Program. Fish tissues were sampled for metals and organic contaminants throughout the year's scheduled basins with the intent of assessing as many waterbodies as possible. While this included efforts to assess suspected "trouble spots" in a basin, significant time and resources were spent in gathering data from areas where few fish tissue contaminants were historically detected. Review of data after the first round of basin assessments were completed revealed that,

except for mercury, there were no widespread fish contaminant issues in the state that warranted basinwide-style investigations.

In 1999, the scope of fish tissue surveys were revised and shifted from basinwide assessments to areas where contaminants exist or are suspected. This shift has resulted in less basinwide coverage, but has focused resources on known contaminant issues within a basin.

All fish samples were collected according to standard operating procedures (NCDENR 2001). Analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem. The Division conducted fish tissue surveys at three stations within the Pasquotank Basin during 2003 and 2004. These surveys were conducted as part of statewide fish tissue mercury assessments. All fish samples were analyzed for concentrations of total mercury (wet weight, ppm).

Eighty-nine fish tissue samples were collected from three stations in the Pasquotank basin during 2003 and 2004 and analyzed for mercury contamination. The samples included largemouth bass, yellow perch, sunfish and catfish. Results from the period show 48 of 89 samples collected contained mercury concentrations exceeding the state criteria of 0.4 ppm.

Fish samples and results exceeding NC criteria in Subbasin 53 in the Pasquotank River basin.				
Description	Years Sampled	Species	Number Samples	Samples exceeding NC Hg criteria (0.4 ppm)
Kendricks Creek	2003	Bass, Sunfish, Catfish, Pickerel, Yellow Perch	23	7
Lake Phelps	2003, 2004	Bass, Sunfish, Catfish, Yellow Perch	59	39
Scuppernong River	2004	Bass, Sunfish	7	2

### **Fish Kill Assessment**

DWQ has systematically monitored and reported fish kill events across the state since 1996. From 2000 to 2005, field investigators reported eleven kill events in the Pasquotank River basin. Low dissolved oxygen, high water temperatures and possible chemical contamination may have contributed to these fish kill events. Annual fish kill reports can be found at DWQ's Environmental Sciences website <http://h2o.enr.state.nc.us/esb/Fishkill/fishkillmain.htm>.

### **Overview of Lakes Assessment**

Phelps Lake was the only lake sampled between October 1, 2001 and September 30, 2005. The lake was sampled four times in 2005 for chlorophyll a, pH, dissolved oxygen, water temperature, turbidity and metals and eight times as part of a low-level mercury study from November 2002 through September 2006. Except for one sample with mercury exceeding state standards, all water quality standards were met.

## Overview of 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 (WET) by their NPDES permit or by administrative letter. Other facilities may also be tested by DWQ's Aquatic Toxicology Unit (ATU). Per Section 106 of the Clean Water Act, the ATU is required to test at least 10 percent of the major discharging facilities over the course of the federal fiscal year (FFY). However, it is ATU's target to test 20 percent of the major dischargers in the FFY. This means that each major facility would get evaluated over the course of their five-year permit. There are no requirements or targets for minor dischargers.

The ATU maintains a compliance summary for all facilities required to perform tests and provides monthly updates of this information to regional offices and DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

Sixteen NPDES permits in the Pasquotank River basin currently require WET testing. Two of these facilities have a WET limit, while fourteen require monitoring without a limit; all of these facilities are drinking water treatment plants discharging filter backwash or reverse osmosis reject water. Across the state, the number of facilities required to perform WET has increased steadily since 1987, the first year that WET limits were written into permits in North Carolina. Consequently, compliance rates have also risen. Since 1996, the compliance rate has stabilized at approximately 90 percent.

## Overview of Ambient Monitoring System

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 more than 378 water chemistry monitoring stations statewide, including 12 stations in the Pasquotank River basin. Between 23 and 32 parameters are collected monthly at each station. In the Pasquotank River basin, five ambient parameters exceeded state water quality parameters including: copper, iron, nickel, pH, and dissolved oxygen. The locations of these stations are shown on individual subbasin maps. Notable ambient water quality parameters are discussed in the subbasin chapters. Refer to *2006 Pasquotank River Basinwide Assessment Report* at <http://www.esb.enr.state.nc.us/bar.html> for more detailed analysis of ambient water quality monitoring data.

Specific information on water quality standards and action levels can be found in 15A NCAC 2B.0200 (August 1, 2004) available at <http://h2o.enr.state.nc.us/csu/swstdsfaq.html>.

### Water Quality Parameters

#### Dissolved Oxygen

Dissolved oxygen (DO) is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality

standards for dissolved oxygen vary depending on the classification of the body of water but generally results less than 4.0 mg/L can be problematic. Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, although patterns of low dissolved oxygen can occur naturally in and near swamp waters, in estuarine waters under salt wedge conditions, or during droughts.

### pH

The pH of natural waters can vary throughout the state. Low values ( $\ll 7.0$  s.u.) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values ( $\gg 7.0$  s.u.) may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. to warrant attention; whereas in salt waters pH values less than 6.8 or greater than 8.5 warrant attention.

### Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times. Tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity.

### Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as “nutrients.” Nitrogen compounds include ammonia-nitrogen ( $\text{NH}_3\text{-N}$ ), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen ( $\text{NO}_2+\text{NO}_3\text{-N}$ ). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the excessive growth of algae (algal blooms) and other plants may be accelerated. In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form  $\text{NH}_4\text{OH}$ , a form toxic to fish and other aquatic organisms.

### Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all sites in the Pasquotank River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (August 1, 2005) is applicable:

*"Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method."*

### Metals

A number of metals are essential micronutrients for the support of aquatic life. However, there are threshold concentrations over which metals can be toxic. DWQ monitors total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, manganese (Water Supply waters only), nickel, and zinc. Aluminum and iron are commonly found in North Carolina soils, therefore high aluminum and iron concentrations are typically correlated with high turbidity.

### Conductivity

Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values reported over a period of time indicate the relative presence of ions in water. North Carolina freshwater streams have a natural conductance range of 17-65 µmhos/cm, however (USGS 1992).

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity. However, water bodies that contain saltwater will also have high conductivities. Therefore those wishing to use conductivity as an indicator for problems must first account for salinity.

### Locations of DWQ Monitoring stations in the Pasquotank River Basin, 2000 - 2005.

Subbasin/ Station ID	Map ID	Location	Class
<b>50</b>		<b>Pasquotank River and Northeast Albemarle Sound</b>	
M2750000	MA1	Pasquotank River at Elizabeth City	SB
M390000N	MA4	Albemarle Sound near Frog Island North Shore	SB
<b>51</b>		<b>Alligator River and Southeast Albemarle Sound</b>	
M7175000	MA12	Alligator River at US 64 near Alligator	SC Sw ORW
M390000S	MA5	Albemarle Sound near Frog Island South Shore	SB
M390000C	MA3	Albemarle Sound near Frog Island Mid Channel	SB
<b>52</b>		<b>Little River, Perquimans River, and Central Albemarle Sound</b>	
M3500000	MA2	Little River at SR 1367 at Woodville	C Sw
M5000000	MA6	Perquimans River at SR 1336 at Hertford	SC
M610000N	MA8	Albemarle Sound btwn Harvey Point and Mill Point N Shore	SB
<b>53</b>		<b>Scuppernong River, Kendrick Creek, and Southwest Albemarle Sound</b>	
M6920000	MA10	Kendrick Creek at SR 1300 at Mackeys	SC
M6980000	MA11	Scuppernong River at SR 1105 near Columbia	C Sw
M610000S	MA9	Albemarle Sound btwn Harvey Point and Mill Point S Shore	SB
M610000C	MA7	Albemarle Sound btwn Harvey Point and Mill Point Mid Channel	SB

