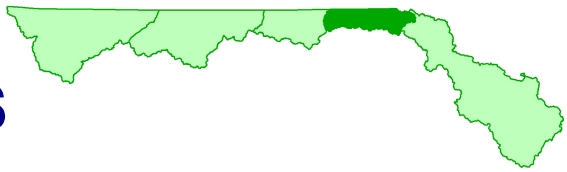
CHAPTER 4

ROANOKE RAPIDS SUBBASIN



HUC 03010106

Includes: Newmans Creek, Smith Creek, Sixpound Creek, Lake Gaston & Roanoke Rapids Lake

SUBBASIN WATER QUALITY OVERVIEW

The Roanoke Rapids Subbasin is the second eastern most subbasin and runs along the North Carolina/Virginia state line. The subbasin contains two Impaired streams: Newmans Creek is Impaired for biological integrity; and Smith Creek are Impaired for low DO and the upper and lower segments are Impaired for biological integrity.

During this assessment cycle (2004-2009), the subbasin experienced a moderate drought in 2005 and 2006 as well as a prolonged drought between 2007 and 2008. Monitoring the biological community during this time did not indicate much change between cycles. There were no major ambient monitoring violations; however, there is a general downward long term pattern in pH levels and a few spikes in turbidity and fecal coliform bacteria levels were measured.

The John H. Kerr Dan and Reservoir Section 216 Feasibility Study project is partially located in this subbasin. The project area also includes HUCs 03010102 and 03010107. The study has focused on examining the feasibility of addressing downstream environmental resource concerns in the Lower Roanoke River drainage area through changes in operations or structures at the John H. Kerr Dam and Reservoir. Along with USACE, the non-federal cost sharing partners for this study are Virginia, and North Carolina. The process includes forming diverse workgroups, conducting a wide range of studies and developing a plan of recommendations. The project is currently completing phase 2 and beginning phase 3, the final phase. A more detailed description of the project is found in the Additional Study section in Chapter 3.

SUBBASIN AT A GLANCE

COUNTIES:

Warren, Halifax & Northampton

MUNICIPALITIES:

Littleton, Macon & Norlina

ECOREGIONS:

North Outer Piedmont & Rolling Coastal Plain

PERMITTED FACILITIES:

NPDES Dischargers:	1
Major	0
Minor	0
General	1
NPDES Non-Dischargers:	1
Stormwater:	7
General	7
Individual	0
Animal Operations:	16

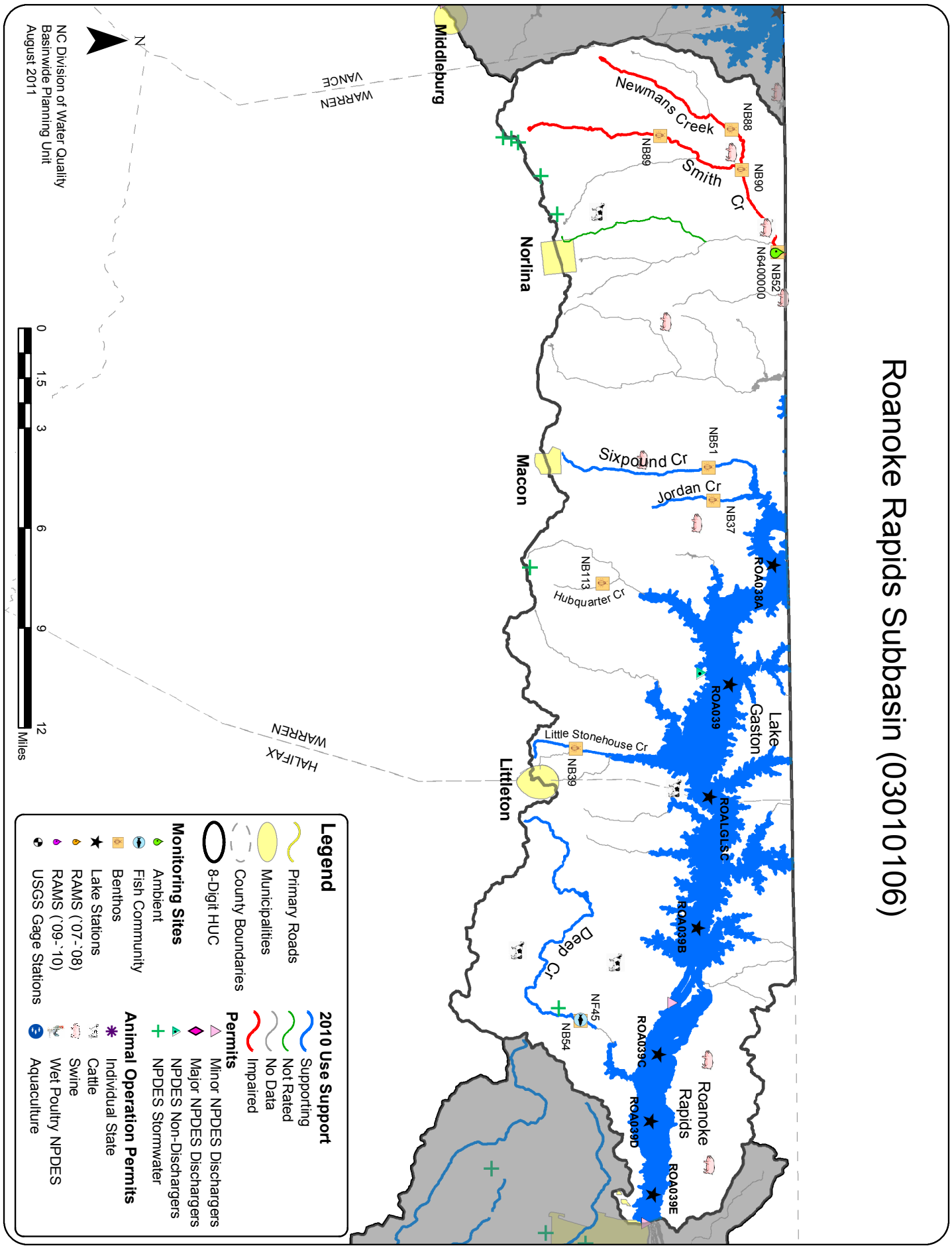
POPULATION:

2010 Census	13,846

2006 LAND COVER:

Open Water	10.3%
Developed	6.7%
Forest	57.5%
Agriculture	14.9%
Wetlands	2.7%
Barren Land	0.1%
Shrub/Grassland	7.8%

Figure 4-1: Roanoke Rapids Subbasin (03010106)



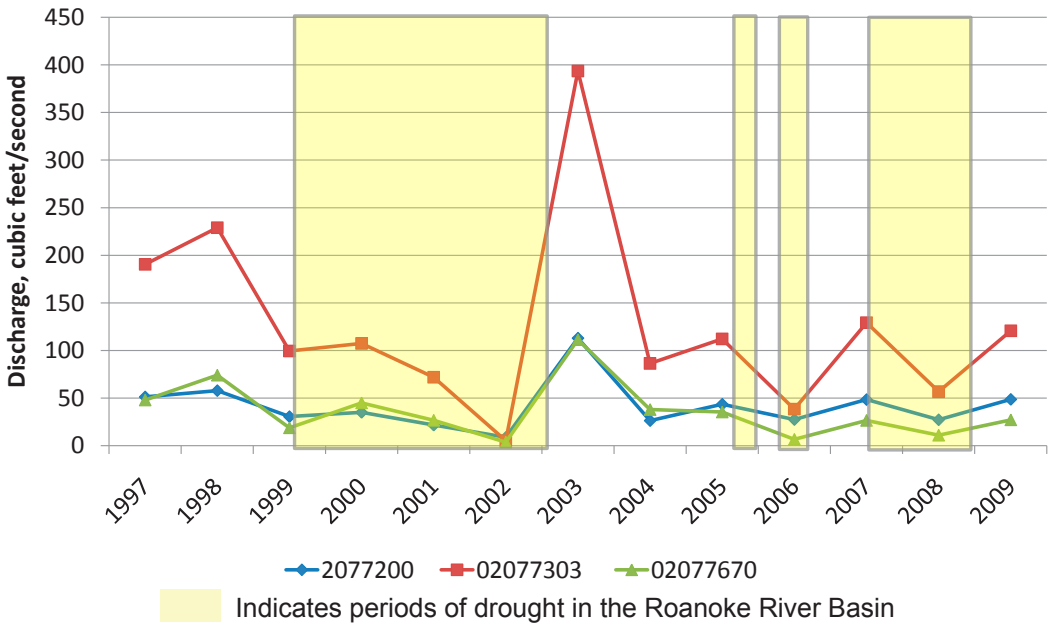
Water Quality Data Summary for this Subbasin

Monitoring stream flow, aquatic biology and chemical/physical parameters is a large part of the basinwide planning process. More detailed information about DWQ monitoring and the effects each parameter has on water quality is discussed in Chapters 2 and 3 of the Supplemental Guide to North Carolina's Basinwide Planning document.

Stream Flow

The basin experienced prolonged droughts from 1998-2002 and again from 2007-2008, with moderate droughts in 2005 and 2006 (Figure 4-2). More detail about flows in the Roanoke River Basin can be found in the 2010 Roanoke River Basinwide Assessment Report produced by DWQ-Environmental Science Section.

Figure 4-2: Yearly Flow Rates (cfs) of the USGS Gage Stations in the Roanoke Rapids Subbasin Between 1997 & 2009



From Left to Right:

- 2077200: Hyco Creek (Leasburg)
- 2077303: Hyco River (McGehees)
- 2077670: Mayo Creek (Bethel Hill)

Biological Data

Biological samples were collected during the spring and summer months of 2009 by the DWQ-Environmental Sciences Section as part of the five year basinwide sampling cycle, in addition to special studies. Overall, 6 biological sampling sites were monitored within the Roanoke Rapids Subbasin. The ratings for each of the sampling stations can be seen in Appendix 4-B.

Benthic Macroinvertebrate Sampling

Each benthic station monitored during the current cycle is shown in Figure 4-4 and color coded based on the current rating. Each of the sites are discussed in more detail in the watershed section below. Figure 4-5 is a comparison of benthic site ratings sampled during the last two basinwide cycles to indicate if there are any overall shifts in ratings. Benthic ratings from this cycle are similar to those received during the previous cycle indicating a stable community.

Benthic Sampling Summary

Total Stations Monitored	5
Total Samples Taken	6
Number of New Stations	3

Figure 4-3: Benthic Stations Color Coded by Current Rating in the Roanoke Rapids Subbasin

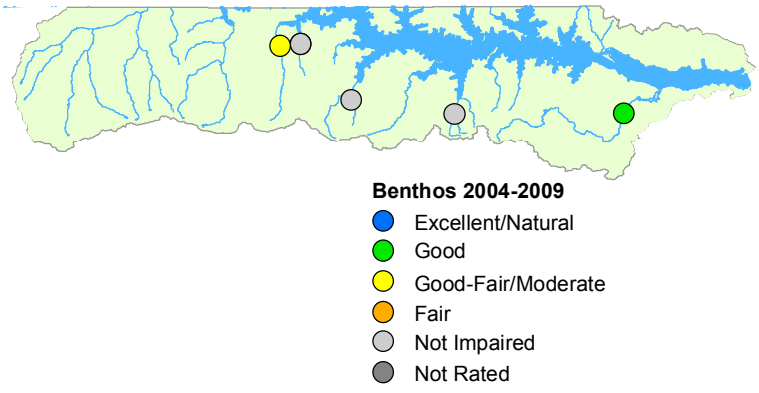


Figure 4-4: Current Benthic Site Ratings

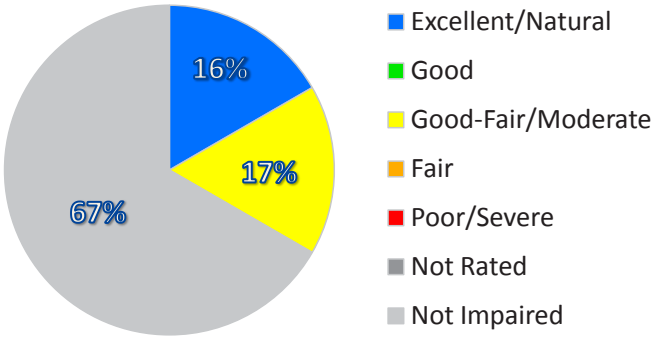
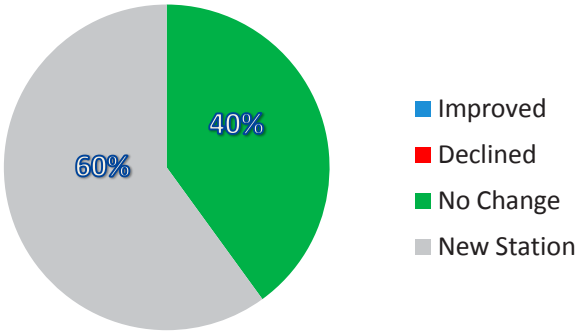


Figure 4-5: Change in Benthic Site Ratings



Fish Community Sampling

Each fish community station monitored during the current cycle is shown in Figure 4-6 and color coded based on the current rating. The site is discussed in more detail in the watershed section below. Figure 4-7 shows the percentages of each rating given during this sampling cycle within this subbasin. Figure 4-8 is a comparison of fish community site ratings sampled during the last two cycles to determine if there are any overall watershed shifts in ratings. Overall, the community at this site is stable.

Fish Com. Sampling Summary

Total Stations Monitored	1
Total Samples Taken	2
Number of New Stations	0

Figure 4-6: Fish Community Stations Color Coded by Current Rating in the Roanoke Rapids Subbasin

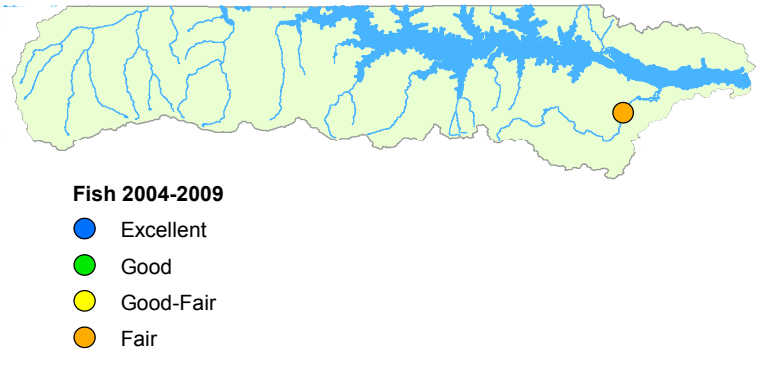


Figure 4-7: Current Fish Comm Site Ratings

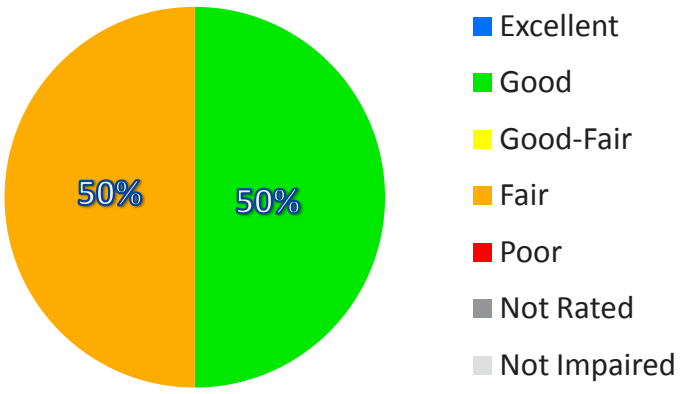
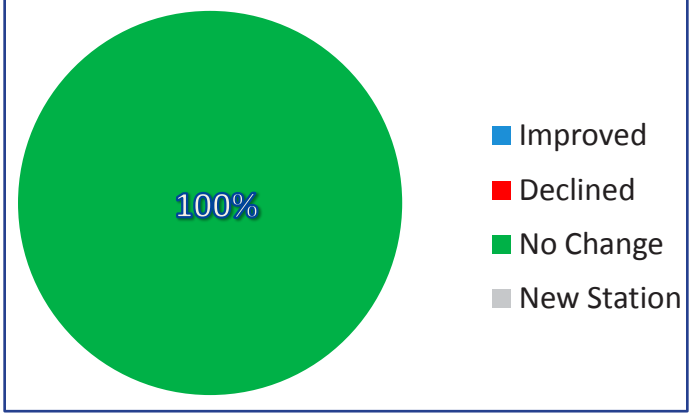


Figure 4-8: Change in Fish Comm Site Ratings



For more information about biological data in this subbasin, see the 2010 Roanoke River Basinwide Assessment Report. Detailed data sheets for each sampling site can be found in Appendix 4-B.

Ambient Data

The ambient data are used to develop use support ratings every two years, which are then reported to the EPA via the Integrated Report (IR). The IR is a collection of all monitored waterbodies in North Carolina and their water quality ratings. The most current IR is the 2010 version and is based on data collected between 2004 and 2008. The ambient data reported in this basin plan were collected between 2005 and 2009 and will be used for the 2012 IR. If a waterbody receives an Impaired rating, it is then placed on the 303(d) Impaired Waters List. The Roanoke River Basin portion of the 2010 IR can be found in Appendix 4-A and the full 2010 IR can be found on the Modeling & TMDL Unit's website.

Four Ambient Monitoring System (AMS) stations are located in the Roanoke Rapids subbasin (see Figure 4-1 for the station locations). During the current sampling cycle (January 2005 and December 2009), samples were collected for all parameters on a monthly basis except metals, which were sampled quarterly until May 2007 when metals sampling was suspended. For more information about the ambient monitoring, parameters, how data are used for use support assessment and other information, see Chapter 2 of the Supplemental Guide to North Carolina's Basinwide Planning.

Long Term Ambient Monitoring

The following discussion of ambient monitoring parameters of concern include graphs showing the median and mean concentration values for each ambient station in this subbasin by specific parameter over a 13 year period (1997-2009). The geometric mean is a type of mean or average, which indicates the central tendency or typical value of a set of numbers. The graphs are not intended to provide statistically significant trend information, but rather an idea of how changes in land use or climate conditions can affect parameter readings over the long term. The difference between median and mean results indicate the presence of outliers in the data set. Box and whisker plots of individual ambient stations were completed by parameter for data between 2005 and 2009 by DWQ's Environmental Sciences Section (ESS) and can be found in the Roanoke River Basin Ambient Monitoring System Report.

pH

Figure 4-10 shows the mean and median pH levels for all samples taken over the course of 13 years in the Roanoke Rapids Subbasin. The pH pattern seen during this time period is a steady decrease until 2009 when it jumps back up a bit. This pattern is seen in other parts of the southwestern portion of the state. Possible causes of the increasing levels in this subbasin could be atmospheric deposition, groundwater influences or precipitation influences. However, the exact reason is unknown at this time. Site N6400000 exceeded the low pH standard of 6.0 in 9.6% of samples as indicated by the orange dot in Figure 4-9.

Proper riparian buffers throughout the subbasin could reduce the impact of stormwater runoff, which can include nutrients from farm or lawn fertilizers, as well as impacts from acid rain. Trees within riparian buffers are also beneficial for shading streams and reducing water temperatures. It is recommended to continue monitoring pH levels within the subbasin and investigate possible causes.

Figure 4-9: Percentage of Samples Exceeding the pH Standards (2005-2009)

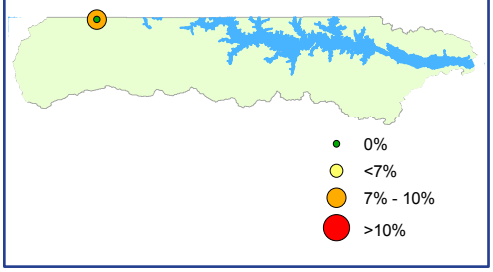
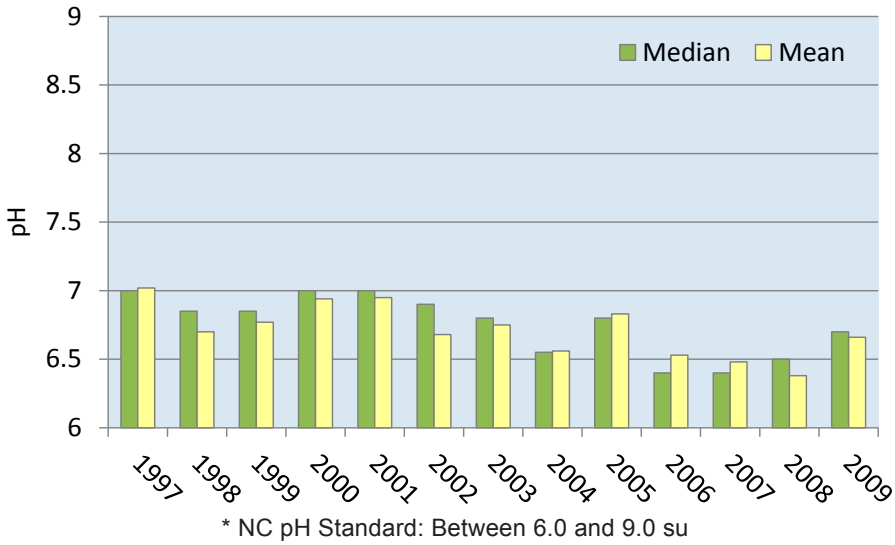


Figure 4-10: Summarized pH Values for All Data Collected at Ambient Sampling Stations in HUC 03010106



* NC pH Standard: Between 6.0 and 9.0 su

Turbidity

The AMS station in the Roanoke Rapids subbasin exceeded the state's turbidity standard in 6 percent of samples, as seen in Figure 4-11 indicated by the yellow dot. Possible sources of the elevated turbidity levels are discussed in the 10-digit watershed section. Figure 4-12 shows the mean and median turbidity levels for all samples taken over the course of 13 years in the Roanoke Rapids subbasin. The yearly averages are well below the state standard of 50 NTUs.

While some erosion is a natural phenomenon, human land use practices may accelerate the process to unhealthy levels for aquatic life. Construction sites, mining operations, agricultural operations, logging operations and excessive stormwater flow off impervious surfaces are all potential sources. Turbidity exceedances demonstrate the importance of **protecting and conserving stream buffers and natural areas**.

Figure 4-11: Percentage of Samples Exceeding the Turbidity Standard (2005-2009)

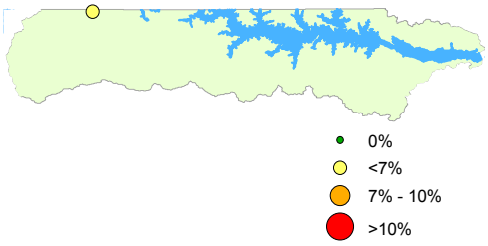
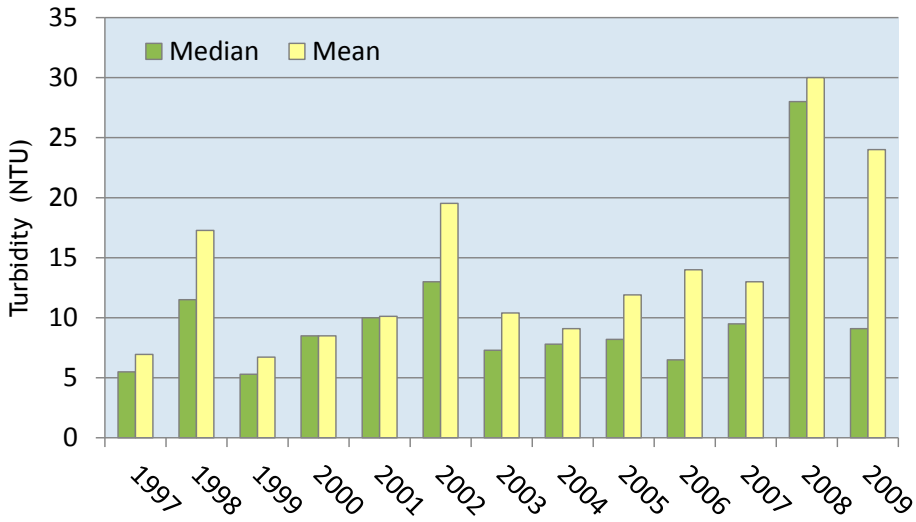


Figure 4-12: Summarized Turbidity Values for All Data Collected at Ambient Sampling Stations in HUC 03010106



* NC Turbidity Standard: 50 NUT

Dissolved Oxygen

As seen in Figure 4-13, the AMS site exceeded the DO standard in 22% of samples during this monitoring cycle. Figure 4-14 shows the mean and median of DO levels for all samples taken over the course of 13 years in the Roanoke Rapids subbasin. These averages are well within the normal DO range.

Figure 4-13: Percentage of Samples Exceeding the DO Standard (2005-2009)

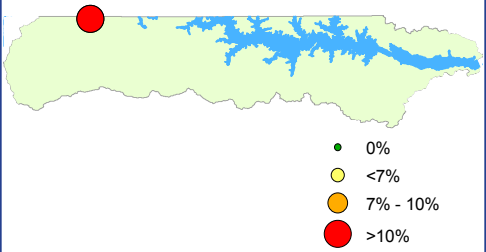
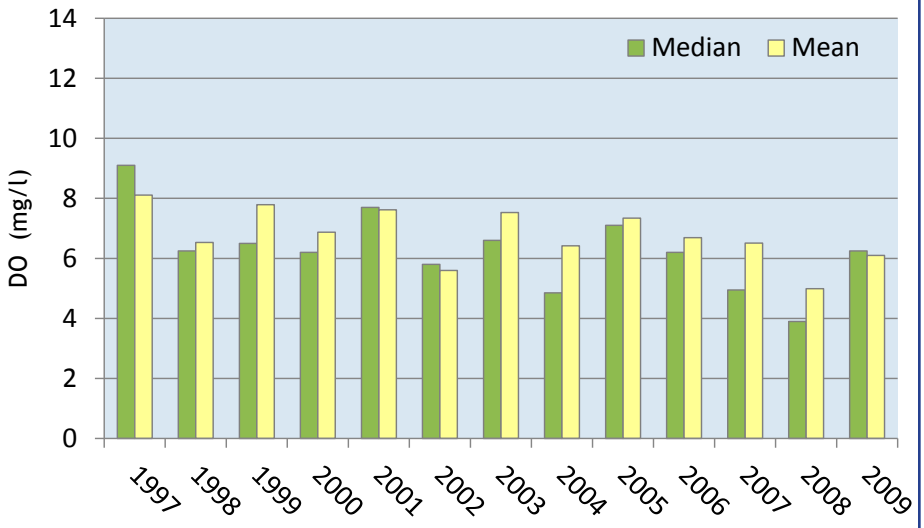


Figure 4-14: Summarized DO Values for All Data Collected at Ambient Sampling Stations in HUC 03010106

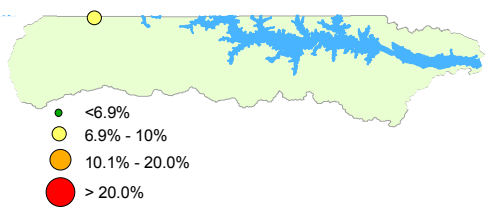


* NC DO Standard: Not < 5 mg/l daily avg. or not < 4 mg/l instantaneous

Fecal Coliform Bacteria

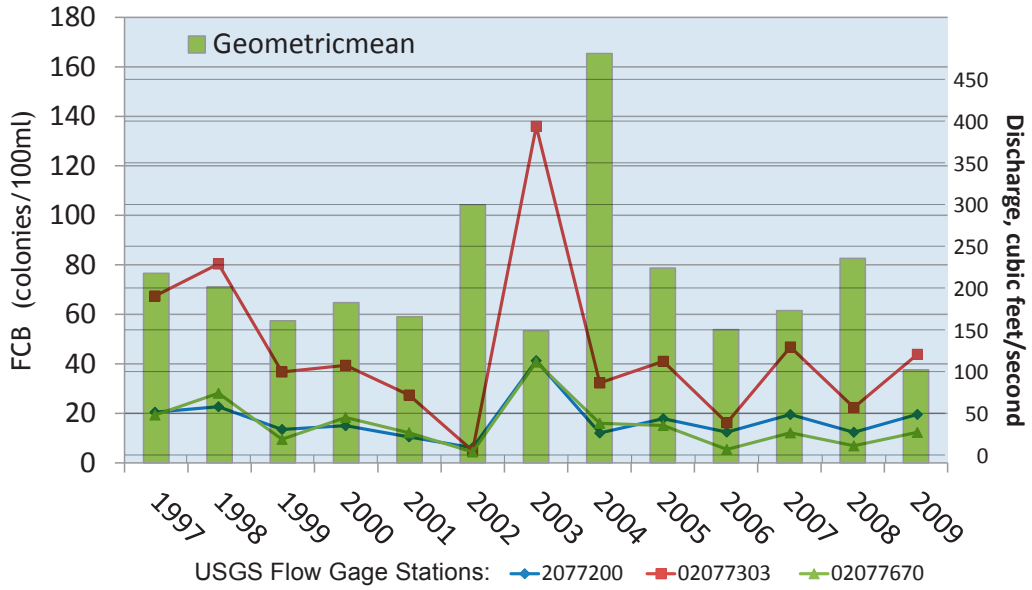
Fecal coliform bacteria (FCB) occurs in water as a result of nonpoint sources such as animal waste from wildlife, farm animals and/or pets, as well as from sanitary sewer overflows (SSOs). The FCB standard for freshwater streams is not to exceed the geometric mean of 200 colonies/100 ml, or 400 colonies/100 ml in 20% of the samples where five samples have been taken in a span of 30 days (5-in-30). Only results from a 5-in-30 study are used to indicate whether the stream is Impaired or Supporting. Waters with a use classification of B (primary recreational waters) receive priority for 5-in-30 studies. Other waters are studied as resources permit.

Figure 4-15: Percentage of Samples with Elevated FCB Levels (2005-2009)



As seen in Figure 4-15, the site had 9.6% of samples over 400 colonies/100 ml. Possible sources of elevated levels of FCB are discussed in the subwatershed sections. Figure 4-16 shows the yearly geometric mean (calculated average) for all samples taken over the course of 13 years in the Roanoke Rapids subbasin. The highest yearly geometric mean was recorded in 2001 (56 colonies/100 ml). The figure also includes the yearly average stream flow, as seen in Figure 4-2, to show how flow can be closely linked to FCB levels.

FIGURE 4-16: SUMMARIZED FECAL COLIFORM BACTERIA VALUES FOR ALL DATA COLLECTED AT AMBIENT SAMPLING STATIONS IN HUC 03010106 WITH OVERLAYING FLOW



* NC FCB Standard (5-in-30 data only): Geomean not > 200/100 ml or 400/100 ml in 20% of samples

Additional information about possible causes of parameters discussed above for particular stations, see the stream write ups below. For more information regarding any of the parameters listed above, see Section 3.3 of the **Supplemental Guide to North Carolina's Basinwide Planning**. For additional information about ambient monitoring data collected in this river basin, see the **Roanoke River Basin Ambient Monitoring System Report**.

Understanding the Data

Biological & Ambient Ratings Converted to Use Support Categories

Biological (benthic and fish community) samples are given a bioclassification/rating based on the data collected at the site by DWQs Environmental Sciences Section (ESS). These bioclassifications include Excellent, Good, Good-Fair, Not Impaired, Not Rated, Fair and Poor. For specific methodology defining how these rating are given see Benthic Standard Operating Procedures (SOP) or the Fish Community SOP. Once a rating is given, it is then translated into a Use Support Category (see Figure 4-17).

Figure 4-17: Use Support Categories for Biological Ratings

Biological Ratings	Aquatic Life Use Support
Excellent/ Natural	Supporting (Categories 1-2)
Good	
Good-Fair/ Moderate	
Not Impaired	
Not Rated	Not Rated (Category 3)
Fair	Impaired (Categories 4-5)
Poor/Severe	

Ambient monitoring data are analyzed based on the percent of samples exceeding the state standard for individual parameters for each site within a five year period. In general, if a standard is exceeded in greater than 10.0% of samples taken for a particular parameter, that stream segment is Impaired for that parameter. The fecal coliform bacteria parameter is exception to the rule. See the Fecal Coliform Bacteria section in the Ambient Data portion below.

Figure 4-18: Category Number to Use Support Rating

Category #	Use Support Rating
1	Supporting
2	
3	Not Rated
4	Impaired
5	

Each biological parameter (benthic and fish community) and each ambient parameter is assigned a Use Support Category based on its rating or percent exceedance. A detailed description of each category can be found on the first page of Appendix 4-A. Each monitored stream segment is given an overall category number which reflects the highest individual parameter category. Figure 4-18 shows how the category number is translated into the use support rating.

Example

Stream A had a benthic sample that rated Good-Fair and 12% of turbidity samples taken at the ambient station were exceeding the standard. The benthic sample would be given an individual category number of 1 (Figure 4-17) and the turbidity parameter would be given a category number of 5 since >10% of samples exceeded the standard. Therefore, stream A's overall category number would be a 5, indicating the stream has a use support rating of Impaired.

Recommendations & Action Plans at the Subbasin Scale

DWQ Priority Summary

Table 4-1 is a list of waters in the Middle Roanoke River Subbasin that DWQ has prioritized for restoration/ protection. The order of priority is not based solely on the severity of the steam's impairment or impacts but rather by the need for particular actions to be taken. A stream that is currently supporting its designated uses may be prioritized higher within this table than a stream that is currently impaired. This is based on a more holistic evaluation of the drainage area which includes monitoring results, current and needed restoration/ protection efforts, land use and other activities that could potentially impact water quality in the area. Some supporting streams may have a more urgent need for protections than an impaired stream with restoration needs already being implemented.

The table also lists potential stressors and sources that may be impacting a stream including in-field observations, monitoring data, historical evidence and permit or other violations. Additional study may be needed to determine exact source(s) of the impact. The last column includes a list of recommended actions.

Table 4-1: Notable Waters in the Roanoke Rapids Subbasin (Not Ranked)

Stream Name	AU#	Class.	Potential Stressor(s)	Potential Source(s)	Qualitative Status	Actions Needed
Lake Gaston	23-(12) & (20.2)	WS-V;B	Nutrients, Aquatic Weeds	--	Supporting	--
Roanoke Rapids Lake	23-(22.5)	WS-IV; B;CA	Nutrients, Aquatic Weeds	--	Supporting	--
Newmans Cr	23-10-2	C	Habitat Degradation, Erosion	High Volume/Velocity	Impaired	SC, SS, E, M
Smith Cr	23-10a, b & c	C	Low DO, Low Flow, Turbidity, Low pH	Runoff, Beaver Dams, Drought	Impaired	Ag, E

Class.: Classification (e.g., C, B, WS-I, WS-II, WS-III, WS-IV, WS-V, Tr, HQW, ORW, SW, UWL)

Stressor: Chemical parameters or physical conditions that at certain levels prevent waterbodies from meeting the standards for their designated use (e.g., low/high DO, nutrients, toxicity, habitat degradation, etc.). Fecal Coliform Bacteria (FCB),

Source: The cause of the stressor. (Volume & Velocity: when a stream receives stormwater runoff at a much higher volume and velocity than it would naturally receive due to ditching, impervious surfaces, etc.)

Status: Impaired, Impacted, Supporting, Improving (For current Use Support Assessment see the Integrated Report.)

Actions Needed: Agriculture BMPs (**Ag**), Best Management Practices (**BMPs**), Daylight Stream (**DS**), Education (**E**), Forestry BMPs (**F**), Local Ordinance (**LO**), Monitoring (**M**), Nutrient Mgnt Controls (**NMC**), Protection (**P**), Restoration (**R**), Riparian Buffer Restoration (**RBR**), Stormwater Controls (**SC**), Sediment and Erosion Control BMPs (**SEC BMPs**), Species Protection Plan (**SPP**), Stressor Study (**SS**), .

Status & Recommendations for Monitored Waters

Understanding this Section

In this Section, more detailed information about stream health, special studies, aquatic life stressors and sources and other additional information is provided by each 10-digit Hydrological Unit Code (HUC). Waterbodies discussed in this Chapter include all monitored streams, whether monitored by DWQ or local agencies with approved methods. Use Support information on all monitored streams within this watershed can be seen on the map in Figure 4-1, and a Use Support list of all monitored waters in this basin can be found in the Use Support Chapter.

Use Support & Monitoring Box:

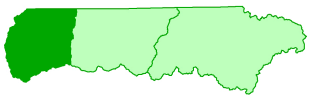
Each waterbody discussed in the Status & Recommendations for Monitored Waters within this Watershed section has a corresponding Use Support and Monitoring Box (Table 4-2). The top row indicates the 2010 Use Support and the length of that stream or stream segment. The next two rows indicate the overall Integrated Report category which further defines the Use Support for both the 2008 and the 2010 reports. These first three rows are consistent for all boxes in this Plan. The rows following are based on what type of monitoring stations are found on that stream or stream segment and may include benthic, fish community and/or ambient monitoring data. If one of these three types of monitoring sites is not shown, then that stream is not sampled for that type of data. The first column indicates the type of sampling in bold (e.g., **Benthos**) with the site ID below in parenthesis (e.g., CB79). The latest monitoring result/rating of that site is listed in the next column followed by the year that sample was taken. If there is more than one benthic site, for example, on that stream, the second site ID and site rating will be listed below the first. The last row in the sample box in Table 4-2 is the AMS data. The data window for all AMS sites listed in the boxes in this Plan is between 2004-2008. Only parameters exceeding the given standard are listed in the second column with the percent of exceedance listed beside each parameter.

Table 4-2: Example of a Use Support and Monitoring Box

Use Support: **Impaired** (14 mi)	
2008 IR Cat.	4a
2010 IR Cat.	4
Benthos (CB79) (CB80)	 Fair (2002) Fair (2002)
Fish Com (CF33)	 Good-Fair (2002)
AMS (C1750000)	Turbidity - 12% FCB - 48%

Please note any fecal coliform bacteria (FCB) listing in the last row (as seen in Table 4-2) only indicates elevated levels and a study of five samples in 30 days (5-in-30) must be conducted before a stream becomes Impaired for FCB.

Upper Lake Gaston-Roanoke River (0301010602)



Includes: Smith Creek [AU#: 23-10a, b & c] & Newmans Creek [AU#: 23-10-2]

This watershed contains a mix land use of agriculture, residential and some forested areas. There are three swine and one cattle permitted animal operations located with in the watershed. Two segments within this watershed (Newmans Creek & Smith Creek) are on the 2010 Impaired Waters List.

Newmans Creek [AU#: 23-10-2]

Newmans Creek is approximately six miles from source to Smith Creek [AU#: 23-10b]. Land cover for the majority of this drainage area is forest and agriculture. This creek was placed on the Impaired Waters list for the first time in 2008 as a result of a Fair benthic rating in 2004.

Use Support: **Impaired** (6.1 mi)	
2008 IR Cat.	5
2010 IR Cat.	5
Benthos (NB88)	 Fair (2004)

Water Quality Status

This creek was last monitored in 2004 as part of the Smith Creek TMDL study. At that time, the creek had poor habitat with deeply incised and vertical streambanks and severe bank erosion even though there were well established and intact riparian zones. The dominate nature of the pollution tolerant benthic species caused this site to receive a Fair rating and to be placed on the 2008 Impaired Waters List.

Smith Creek [AU#: 23-10a, b & c]

Smith Creek is approximately 11 miles from source to the Virginia/NC state line and is split into three segments. The majority of the drainage area is agriculture, forest and some residential area. There are two swine and two cattle operations permitted in Smith Creek's drainage area. Smith Creek has been on the Impaired Waters List since 1998 as a result of an unhealthy benthic community.

Use Support: Impaired (10.7 mi)	
2008 IR Cat.	5
2010 IR Cat.	5
Benthos	
(NB89)	Fair (2004)
(NB90)	Good-Fair (2004)
(NB52)	Fair (2004)
Fish Com	
(NF41)	Fair (2004)
AMS	
(N6400000)	DO - (23.4%)

Water Quality Status

The last biological samples taken in Smith Creek were part of a special study to determine stressors causing the Impairment within the creek and corresponding drainage area. Results of these samples are discussed in the **2006 Roanoke River Basinwide Water Quality Plan**. The study concluded that low or no flow conditions lead to both reduced edge habitat and low dissolved oxygen levels that likely caused the biological Impairment in the watershed. It indicates the low flows are likely due to beaver dams in the Blue Mud Creek tributary to Smith Creek that have been increasing over the past several years. There was also a steady increase in conductivity levels which suggests impacts from human activity as well. A connection was also made between the samples taken in the upper reaches of the watershed which had larger riparian zones and better biological scores and the lower reaches which had little riparian zones and lower biological scores.

An AMS site is located at US-1 near Paschall which is exceeding low dissolved oxygen (DO) levels in 23% of samples. This is an increase in exceedances of about 11% from the previous cycle. This increase could be contributed to the increase in beaver dams in the watershed as well as a decrease in rainfall since 2004. It should also be noted that average pH levels have been declining by about 0.3 su. Low pH exceedances (below 6.0) have increased from 3.6% last cycle to 8.3% this cycle, indicating the watershed is being impacted by low pH levels. Turbidity has also increased to 8.3% of samples exceeding the state standard. Specific conductivity levels increase during this cycle as well. Nutrient levels have, on average, remained the same, and fecal coliform bacteria has slightly declined.

Natural Conditions Assessment

In 2010, DWQ assessed Smith Creek to determine if the low DO levels were natural conditions or due to human impacts. The **December 2010 Draft Smith Creek Report** indicated that low DO levels were mainly originating from the Blue Mud tributary where multiple beaver dams were found. The beaver dams combined with natural low flows and decomposition of large inputs of vegetation from forested and agricultural areas which produce organic acids and increase oxygen demand, lower DO levels as the material decays and summer temperatures rise. Therefore, the report concluded that the low DO levels found in Smith Creek are natural.

Local Initiatives

In 2005, NC DSWC received $130,000 to complete the **Smith Creek Watershed Restoration Plan**, implement BMPs, and conduct education-outreach. The primary objective of the project was to address the severe sedimentation problems within the creek with the overall goal of removing Smith Creek from the Impaired Waters List. Below is a list of BMPs that were implemented as part of this grant.

- Grassed waterway
- Livestock exclusion fencing
- Water troughs

- Wells
- Heavy use protection areas
- Stream crossings
- Stock trails
- Crop conservation
- Agricultural road stabilization

Middle Lake Gaston-Roanoke River (0301010603)

Includes: Sixpound Creek [AU#: 23-13]**, Jordan Creek** [AU#: 23-14]**, Hawtree Creek** [AU#: 23-11-(1)] **& Lake Gaston** [AU#: 23-(12) & (20.2)]

This watershed contains a mix land use of agriculture, residential and forested areas. There are three permitted swine animal operations located within the watershed. No segments in this watershed are on the 2010 Impaired Waters List.

Lake Gaston [AU#: 23-(12) & (20.2)

Use Support: Supporting (11,939.2 ac)	
2008 IR Cat.	2
2010 IR Cat.	2
Lake Stations (ROA038A) (ROA039) (ROA039B)	No Exceedances

Lake Gaston is located on the North Carolina - Virginia border just downstream from the John H. Kerr Reservoir dam on the Roanoke River (~1,1939.2 ac). The drainage area for the lake is comprised of agricultural lands with some forested, residential and urbanized lands. The lake is classified as a Water Supply (WS-IV) and recreational waters (B) and currently Supporting its designated uses.

Water Quality Status

The lake is split into two segments that begin at the NC - Va. border and end a half mile upstream of the Lake Gaston Dam. There are three lake monitoring stations throughout the lake which were sampled five times each between May and September 2009. This data will be shown on the 2012 Integrated Report/Impaired Waters List. Assessment of parameters related to biological productivity indicated mesotrophic conditions and moderate biological productivity, as it did during the previous sampling cycle. However, average total nitrogen, TKN and chlorophyll *a* levels increased slightly. Total phosphorus levels remained the same.

As discussed in the previous *Roanoke River Basinwide Water Quality Plan*, the aquatic weed Hydrilla had become problematic. Since 2004, many steps have been taken to eradicate this noxious aquatic weed. In 2005, the Lake Gaston Stakeholder's Board developed and released *Managing Aquatic Plants in Lake Gaston: A Long-Term Action Plan*. The Lake Gaston Weed Control Council has been implementing this plan since that time. An update of the Council's actions can be found in the **Local Initiatives Chapter**.

Fish Consumption Advisory

A **fish consumption advisory** was put into place by the Division of Health and Human Services on November 18, 2009 for mercury found in walleye and largemouth bass.

Progress Energy Roxboro Steam Electric Power Plant (NC0003425)

CP&L DBA Progress Energy Carolinas, Inc. operates a steam electric power plant facility and holds an NPDES permit NC0003425 to discharge process control and industrial waste streams to Hyco Lake a Class WS-V;B water, in the Roanoke River Basin, in Person County.

Progress Energy Carolinas, Inc. installed wet limestone forced oxidation wet scrubbers on all operating units at the Roxboro Steam Electric Plant in response to requirements from the State of North Carolina under the Clean Smokestacks legislation. Accordingly, Progress Energy installed a Flue Gas Desulfurization (FGD) wastewater settling pond, a General Electric ABMet bioreactor (a new technology biological treatment system), and a FGD Flush Pond to treat wastewater generated by the recently added wet scrubbers.

Since installation of FGD Settling Pond, FGD Flush Pond and GE ABMet bioreactor Progress Energy Carolinas, Inc. has:

- upgraded ash handling system to handle all fly ash at the plant as dry ash to reduce pollutant loading to the outfall.
- installed and uses the addition Sodium Hydroxide at the coal pile runoff pond.
- conducted pilot trial use of Met Clear treatment technology at the filter dam of the Ash Pond
- placed into service secondary hydrocyclones to reduce the amount of suspended solids in the blow down to the settling pond.
- experienced a structural failure of the FGD Flush pond and the FGD Settling Pond. These treatment units showed signs of structural stress that lead to a bypass of partially treated FGD wastewater to the ash pond.

Accordingly, additional monitoring, beyond the requirements of the NPDES permit was required by DWQ and sampling results from the FGD Treatment Units, NPDES Internal Outfall 002, and final NPDES Outfall 003 to Hyco Lake were reported by Progress Energy.

The repair and construction of the FGD Flush Pond, construction of new FGD Settling Pond (East Pond), and the refurbishment of the FGD Settling Pond (West Pond) are completed. Progress Energy has explained that any related or additional issues will be best addressed through the 2011 application for renewal of the Roxboro Plant's NPDES permit

Lower Lake Gaston-Roanoke River (0301010604)

Includes: Roanoke Rapids [AU#: 23-(22.5)]

This watershed contains a mix land use of agriculture, residential and forested areas. There are two minor NPDES permitted facilities along with three permitted cattle and two swine animal operations located within the watershed. No segments in this watershed are on the 2010 Impaired Waters List.

Roanoke Rapids Lake [AU#: 23-(22.5))

Roanoke Rapids Lake (~4,185 ac), located on the Roanoke River immediately downstream from Lake Gaston, is owned by the Virginia Electric and Power Company and used for hydropower generation as well as public recreation and as a water supply. The drainage area for the lake is comprised of mostly agricultural lands with some forested, residential and urbanized lands. There are four permitted animal operations and two minor NPDES permitted facilities. The lake was on the Impaired Waters list from 1998 to 2008 due to an infestation of aquatic weeds (Hydrilla). The development of a TMDL in 2006 has resulted in the lake being in the Supporting category.

Use Support: **Supporting** (4,185 ac)	
2008 IR Cat.	5
2010 IR Cat.	2
Lake Stations (ROA039C) (ROA039D) (ROA039E)	No Exceedances

Water Quality Status

The lake is one assessment unit spanning from the Lake Gaston Dam to the Roanoke Rapids Dam. Three lake monitoring stations were sampled five times each between May and September of 2009 throughout the lake. This data will be shown on the 2012 Integrated Report/Impaired Waters List. On average, nutrient levels increased from low to moderate levels. Chlorophyll *a* levels have also increased since the previous sampling cycle. This change indicates the lake has moderate biological productivity (mesotrophic). An Algal Growth Potential Test conducted at all three sites determined the lake to be nitrogen limited.

A sample taken in August 2009 at the most upstream station (ROA039C) showed the highest levels of DO, pH and chlorophyll *a* levels which are signs of elevated photosynthetic activity. A phytoplankton sample was taken at this site resulting in evidence of an algal bloom (*Aulacoseira sp.*). This bloom was not seen at the downstream monitoring station ROA039D. A significant amount of submerged aquatic plants were also present at the upstream station, which may have contributed to the elevated DO and pH readings at this site.

Aquatic Weed TMDL

A **TMDL for aquatic weeds** was developed and approved by EPA in 2006 for Roanoke Rapids Lake, along with a few other lakes within the state. For this lake, the TMDL addressed *Hydrilla verticillata, Myriphyllum spicatum* and *Egeria densa.* These species are all noxious, exotic weeds that will require extensive control. In 2003, the composition of aquatic weeds were dominated by Hydrilla (99%). This plant shades out native vegetation, provides poor habitat for fish and other wildlife, provides good breeding grounds for mosquitoes, and greatly interferes with recreational activities.

Management strategies to control these aquatic plants are discussed in detail within the TMDL. Two of these strategies include consecutive short-term draw downs of the lake levels during the summer months, when Hydrilla is most productive as well as the use of Grass Carp. If these strategies fail to control the plants, herbicides are suggested. However, improper application of the herbicides recommended can contaminate ground water and surface water.

References

References marked with (*) indicates a DWQ special study report. These reports are not currently available online. Contact the DWQ Environmental Science Section at (919) 743-8400 to receive a hardcopy.

North Carolina Department of Environment and Natural Resources (NCDENR). Division of Water Quality (DWQ). August 2004a. *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina*. North Carolina Administrative Code: 15A NCA 2B. Raleigh, NC. (http://h2o.enr.state.nc.us/csu/)

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Pate, Travis. 2009. *Watershed Assessment in North Carolina: Building a Watershed Database with Population, Land Cover, and Impervious Cover Information*. Master Theses, University of North Carolina at Chapel Hill.

Appendix 4-A

Use Support Ratings for All Monitored Waters in the Roanoke Rapids Subbasin

Draft 2010 IR Category	Integrated Reporting Categories for individual Assessment Unit/Use Support Category/ Parameter Assessments. A single AU can have multiple assessments depending on data available and classified uses.
1	All designated uses are monitored and supporting
1b	Designated use was impaired, other management strategy in place and no standards violations for the parameter of interest (POI)
1nc	DWQ have made field determination that parameter in exceedance is due to natural conditions
1r	Assessed as supporting watershed is in restoration effort status
1t	No criteria exceeded but approved TMDL for parameter of interest
2	Some designated uses are monitored and supporting none are impaired Overall only
2b	Designated use was impaired other management strategy in place and no standards violations Overall only
2r	Assessed as supporting watershed is in restoration effort status overall only
2t	No criteria exceeded but approved TMDL for POI Overall only
3a	Instream/monitoring data are inconclusive (DI)
3b	No Data available for assessment
3c	No data or information to make assessment
3n1	Chlorophyll a exceeds TL value and SAC is met-draft
3n2	Chlorophyll a exceeds EL value and SAC is not met first priority for further monitoring-draft
3n3	Chlorophyll a exceeds threshold value and SAC is not met first second priority for further monitoring-draft
3n4	Chlorophyll a not available determine need to collect-draft
3t	No Data available for assessment –AU is in a watershed with an approved TMDL
4b	Designated use impaired other management strategy expected to address impairment
4c	Designated use impaired by something other than pollutant
4cr	Recreation use impaired no instream monitoring data or screening criteria exceeded
4cs	Shellfish harvesting impaired no instream monitoring data- no longer used
4ct	Designated use impaired but water is subject to approved TMDL or under TMDL development
4s	Impaired Aquatic Life with approved TMDL for Aquatic Life POI or category 5 listing
4t	Designated use impaired approved TMDL
5	Designated use impaired because of biological or ambient water quality standards violations and needing a TMDL
5r	Assessed as impaired watershed is in restoration effort status

NC 2010 Integrated Report

All 13,123 Waters in NC are in Category 5-303(d) List for Mercury due to statewide fish consumption advice for several fish species

AU_Number	AU_Name	AU_Description	LengthArea	AU_Units	Classification
Category	Parameter	Reason for Rating	Use Category	Collection Year	303(d)year

Roanoke River Basin — **Upper Lake Gaston-Roanoke River Watershed** — **0301010602**

Roanoke River Basin — Lake Gaston-Roanoke River Subbasin — 03010106

Roanoke River Basin — **Upper Lake Gaston-Roanoke River Watershed** — **0301010602**

23-10-2	**Newmans Creek (Little Deep Creek)**	From source to Smith Creek	**6.1 FW Miles**	C	
5	**Ecological/biological Integrity Benthos**	Fair Bioclassification	Aquatic Life	2004	2008
23-10a	**Smith Creek**	From source to Cabin Branch	**6.1 FW Miles**	C	
4s	**Ecological/biological Integrity Benthos**	Fair Bioclassification	Aquatic Life	2004	2002
5	**Low Dissolved Oxygen**	Standard Violation	Aquatic Life	2008	1998
23-10b	**Smith Creek**	From Cabin Branch to SR1208	**1.6 FW Miles**	C	
1	**Ecological/biological Integrity Benthos**	Good-Fair Bioclassification	Aquatic Life	2004	
5	**Low Dissolved Oxygen**	Standard Violation	Aquatic Life	2008	1998
23-10c	**Smith Creek**	From SR1208 to North Carolina-Virginia State Line	**3.0 FW Miles**	C	
4s	**Ecological/biological Integrity Benthos**	Fair Bioclassification	Aquatic Life	2004	
4s	**Ecological/biological Integrity FishCom**	Fair Bioclassification	Aquatic Life	2004	
1	**Fecal Coliform (recreation)**	No Criteria Exceeded	Recreation	2008	
5	**Low Dissolved Oxygen**	Standard Violation	Aquatic Life	2008	1998
23-10-3-2	**Terrapin Creek**	From source to Blue Mud Creek	**5.0 FW Miles**	C	
3a	**Ecological/biological Integrity Benthos**	Not Rated Bioclassification	Aquatic Life	2007	

Roanoke River Basin — **Middle Lake Gaston-Roanoke River Watershed** — **0301010603**

23-14	**Jordan Creek**	From source to Lake Gaston, Roanoke River	**2.6 FW Miles**	C	
1	**Ecological/biological Integrity Benthos**	Not Impaired Bioclassification	Aquatic Life	2006	
23-13	**Sixpound Creek**	From source to Lake Gaston, Roanoke River	**6.3 FW Miles**	C	
1	**Ecological/biological Integrity Benthos**	Good-Fair Bioclassification	Aquatic Life	2004	

Roanoke River Basin — **Lower Lake Gaston-Roanoke River Watershed** — **0301010604**

23-24-(1)	**Deep Creek**	From source to a point 0.5 mile upstream of mouth	**11.6 FW Miles**	WS-IV	
1	**Ecological/biological Integrity Benthos**	Natural Bioclassification	Aquatic Life	2004	
1	**Ecological/biological Integrity FishCom**	Good Bioclassification	Aquatic Life	2004	
23-19	**Little Stonehouse Creek**	From source to Lake Gaston, Roanoke River	**2.8 FW Miles**	C	
1	**Ecological/biological Integrity Benthos**	Not Impaired Bioclassification	Aquatic Life	2006	

NC 2010 Integrated Report

All 13,123 Waters in NC are in Category 5-303(d) List for Mercury due to statewide fish consumption advice for several fish species

AU_Number	AU_Name	AU_Description	LengthArea	AU_Units	Classification
Category	Parameter	Reason for Rating	Use Category	Collection Year	303(d)year

Roanoke River Basin — **Lower Lake Gaston-Roanoke River Watershed** — **0301010604**

⊙ **23-(22.5)**	**ROANOKE RIVER (Lake Gaston below normal full power pool elevation 200 MSL and Roanoke Rapids Lake below normal full power pool elevation 132 feet MSL)**	From a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam to Roanoke Rapids Dam	**4,185.0 FW Acres**		WS-IV,B;CA

3t	**Aquatic Weeds**	Data Inconclusive	Aquatic Life	2000	2000
1	**Water Quality Standards Aquatic Life**	No Criteria Exceeded	Aquatic Life	2008	
1	**Water Quality Standards Water Supply**	No Criteria Exceeded	Water Supply	2008	

⊙ **23-(12)**	**ROANOKE RIVER (Lake Gaston below normal full power pool elevation 200 MSL)**	From North Carolina-Virginia State Line to a line across Lake Gaston following the Warren-Northampton County Line	**7,964.8 FW Acres**		WS-V,B

1	**Water Quality Standards Water Supply**	No Criteria Exceeded	Water Supply	2008	

⊙ **23-(20.2)**	**ROANOKE RIVER (Lake Gaston below normal full power pool elevation 200 MSL)**	From a line across Lake Gaston following the Warren-Northampton County Line to a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam	**3,974.4 FW Acres**		WS-IV,B

1	**Water Quality Standards Aquatic Life**	No Criteria Exceeded	Aquatic Life	2008	
1	**Water Quality Standards Water Supply**	No Criteria Exceeded	Water Supply	2008	

Appendix 4-B

Biological Sampling Site Data Sheets (Benthic Macroinvertebrate & Fish Community) for the Roanoke Rapids Subbasin

Biological Samples Taken During this Assessment Cycle

Station ID	Waterbody	County	Site Location	Sample Results
Benthic Sample Sites				
NB113	HUBQUARTER CR	WARREN	SR 1337	06 - Not Impaired
NB37	JORDAN CR	WARREN	SR 1306	06 - Not Impaired
NB37	JORDAN CR	WARREN	SR 1306	05 - Not Impaired
NB39	L STONEHOUSE CR	WARREN	SR 1358	06 - Not Impaired
NB51	SIXPOUND CR	WARREN	SR 1306	09 - Good-Fair
NB54	DEEP CR	HALIFAX	US 158	09 - Natural
Fish Community Sample Sites				
NF45	Deep Cr	Halifax	US 158	09 - Fair

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
SIXPOUND CR	SR 1306	NB51	08/13/09	Good-Fair

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WARREN	7	03010106	36.510000	-78.079444	23-13	Northern Outer Piedmont

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C	9.6	220	7	0.2

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	_	_

Water Quality Parameters

Temperature (°C)	23.8
Dissolved Oxygen (mg/L)	8.5
Specific Conductance (µS/cm)	62
pH (s.u.)	6.6
Water Clarity	slightly turbid

Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	18
Bottom Substrate (15)	5
Pool Variety (10)	8
Riffle Habitat (16)	7
Bank Erosion (7)	5
Bank Vegetation (7)	5
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	73

Site Photograph

Substrate Sand and silt was the dominant substrata.

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
08/13/09	10812	58	13	5.75	4.69	Good-Fair
06/29/04	9418	62	15	6.43	5.44	Good-Fair
07/16/99	7923	54	14	5.50	5.03	Good-Fair
08/22/94	6643	12	12	5.51	5.51	Fair

Taxonomic Analysis

Only one stonefly larvae was collected at the sampling location. EPT taxa richness was low (13) and most are tolerant and common taxa found in North Carolina Peidmont streams. The intolerant caddisfly *Pycnopsyche spp* . was abundant at the site. Chironomid richness (12) and biomass was low with tolerant and slightly intolerant taxa present. No chironomid taxa were abundant at the site. Odonate richness (11) was high and several taxa were common or abundant at the site including *Argia spp.* , *Boyeria vinosa* , *Calopteryx spp.* , *Gomphus spp.* , and *Macromia spp.*

Data Analysis

No NPDES dischargers are located upstream from this location and land use is mostly rural with some agricultural portions. This site received a bioclassification of Good-Fair for the third year in a row. The NCBI and EPTBI dropped since 2004 potentially due to half as many chironomid taxa present in 2009. Also *Pycnopsyche spp.* were found rare at the site in 2004 and abundant in 2009. It was noted that water in the channel in certain sections did not reach the bottom of both banks, flows were low, and detritius was abundant similar to that found in swamp-like conditions. These observations and the presence of so many odonates suggests the site suffers from low flow conditions. Physical parameters such as infrequent embedded riffles and low flows may limit habitat necessary for colonization of some rheophilic macroinvertebrates such as long-lived stonefly taxa.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
DEEP CR	US 158	NB54	02/03/09	Natural

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HALIFAX	8	03010106	36.451389	-77.781944	23-24-(1)	Northern Outer Piedmont

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
WS-IV	23.3	145	7	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	90	0	0	10 (US 158)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	6.5
Dissolved Oxygen (mg/L)	11.4
Specific Conductance (µS/cm)	69
pH (s.u.)	5.9
Water Clarity	Clear

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	15
Pool Variety (10)	9
Riffle Habitat (16)	0
Bank Erosion (7)	7
Bank Vegetation (7)	7
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	90

Site Photograph

Substrate Rubble, gravel, sand, silt, and detritus.

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/03/09	10527	67	21	6.11	5.06	Natural
02/23/04	9339	63	23	5.54	4.42	Natural

Taxonomic Analysis

The primary reason for the jump in EPTBI in 2009 relative to previous samples was the first time collection of the pollution tolerant mayflies *Caenis spp.* and *Stenacron interpunctatum*. In addition, several intolerant stoneflies collected in 2004 were absent in 2009 (*Shipsa rotunda* and *Eccoptura xanthenes*) as was the intolerant caddisfly *Neophylax oligius*. The 2009 assessment produced a substantial increase in the diversity and abundance of pollution-tolerant chironmids relative to the the 2004 sample. Indeed the 2009 sample produced 23 chironomid taxa while the 2004 sample had 12. This shift in community composition was largely responsible for the increase in the BI from 2004 to 2009.

Data Analysis

Bioclassification and macroinvertebrate metrics have generally been stable at this location since sampling commenced in 2004 with both winter samples producing Natural bioclassifications. However, the slight increase in both the BI and EPTBI in 2009 relative to the 2004 sample correlates to the increasing trend in conductivity observed at this site as previous measurements in 1999 (21 µS/cm) and 2004 (47 µS/cm) were much lower than the 2009 measurement (69 µS/cm). These data combined may suggest a slight decrease in overall physical conditions at this site.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
DEEP CR	US 158	05/27/09	NF45	Fair

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HALIFAX	8	03010106	36.45138889	-77.7825	23-24-(1)	Northern Outer Piedmont

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-IV	23.5	145	8	0.4	No

	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
Visible Landuse (%)	75	25	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	20.4
Dissolved Oxygen (mg/L)	6.3
Specific Conductance (µS/cm)	89
pH (s.u.)	6.6
Water Clarity	Clear, slightly tannin stained

Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	16
Bottom Substrate (15)	4
Pool Variety (10)	10
Riffle Habitat (16)	5
Erosion (7)	6
Bank Vegetation (7)	7
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**73**

Site Photograph

Substrate Gravel, cobble, sand, silt

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/16/10	2010-50	22	48	Good
05/27/09	2009-48	18	38	Fair
05/26/04	2004-59	28	46	Good
09/21/94	94-39	21	50	Good

Most Abundant Species 2009 Spottail Shiner (37%)

Exotic Species 2009 Green Sunfish, Bluegill

Species Change Since Last Cycle (2009 vs. 2004)

Gains -- Eastern Silvery Minnow, Notchlip Redhorse, Flier. **Losses** -- Crescent Shiner, Rosefin Shiner, Satinfin Shiner, Creek Chubsucker, V-lip Redhorse, Flat Bullhead, Redfin Pickerel, Eastern Mudminnow, Eastern Mosquitofish, Pumpkinseed, Warmouth, Redear Sunfish, Largemouth Bass. All species gained or lost were represented by 1-9 fish/species, except for Eastern Mosquitofish, Flat Bullhead, and Satinfin Shiner (n= 11, 14, and 21, respectively).

Data Analysis

Watershed -- drains north-central Halifax County; no municipalities in the watershed; tributary to Roanoke Rapids Lake, site is ~ 1.4 miles upstream from the reservoir. **Habitats** -- straddles the Northern Outer Piedmont and the Rolling Coastal Plain Level IV ecoregions; good root mats, snags, undercuts, deadfalls, short and shallow riffles, high quality riparian zones. **2009** -- number of fish collected was not much lower than in 2004 (289 *vs* 316), but 10 fewer species were present; very low percentage of the species with multiple age classes (28%); high percentage of tolerant fish (primarily Redbreast Sunfish and Green Sunfish); skewed trophic structure due to the abundance of the omnivorous Spottail Shiner. **1994 - 2009** -- very diverse community, 31 species known from the site, including 8 species of sunfish, 5 species of catfish, but no intolerant species; in 1994 and 2004 the dominant species was the Redbreast Sunfish. **Note:** the site was re-sampled in 2010 following a wetter winter and spring flow period and the community was rated Good.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
DEEP CR	**US 158**	**NB54**	**02/03/09**	**Natural**

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HALIFAX	8	03010106	36.451389	-77.781944	23-24-(1)	Northern Outer Piedmont

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
WS-IV	23.3	145	7	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	90	0	0	10 (US 158)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (℃)	6.5
Dissolved Oxygen (mg/L)	11.4
Specific Conductance (µS/cm)	69
pH (s.u.)	5.9
Water Clarity	Clear

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	15
Pool Variety (10)	9
Riffle Habitat (16)	0
Bank Erosion (7)	7
Bank Vegetation (7)	7
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	90

Site Photograph

Substrate Rubble, gravel, sand, silt, and detritus.

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/03/09	10527	67	21	6.11	5.06	Natural
02/23/04	9339	63	23	5.54	4.42	Natural

Taxonomic Analysis

The primary reason for the jump in EPTBI in 2009 relative to previous samples was the first time collection of the pollution tolerant mayflies *Caenis spp.* and *Stenacron interpunctatum*. In addition, several intolerant stoneflies collected in 2004 were absent in 2009 (*Shipsa rotunda* and *Eccoptura xanthenes*) as was the intolerant caddisfly *Neophylax oligius*. The 2009 assessment produced a substantial increase in the diversity and abundance of pollution-tolerant chironmids relative to the the 2004 sample. Indeed the 2009 sample produced 23 chironomid taxa while the 2004 sample had 12. This shift in community composition was largely responsible for the increase in the BI from 2004 to 2009.

Data Analysis

Bioclassification and macroinvertebrate metrics have generally been stable at this location since sampling commenced in 2004 with both winter samples producing Natural bioclassifications. However, the slight increase in both the BI and EPTBI in 2009 relative to the 2004 sample correlates to the increasing trend in conductivity observed at this site as previous measurements in 1999 (21 µS/cm) and 2004 (47 µS/cm) were much lower than the 2009 measurement (69 µS/cm). These data combined may suggest a slight decrease in overall physical conditions at this site.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
DEEP CR	US 158	05/27/09	NF45	Fair

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
HALIFAX	8	03010106	36.45138889	-77.7825	23-24-(1)	Northern Outer Piedmont

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-IV	23.5	145	8	0.4	No

	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
Visible Landuse (%)	75	25	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	20.4
Dissolved Oxygen (mg/L)	6.3
Specific Conductance (µS/cm)	89
pH (s.u.)	6.6
Water Clarity	Clear, slightly tannin stained

Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	16
Bottom Substrate (15)	4
Pool Variety (10)	10
Riffle Habitat (16)	5
Erosion (7)	6
Bank Vegetation (7)	7
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**73**

Site Photograph

Substrate Gravel, cobble, sand, silt

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/16/10	2010-50	22	48	Good
05/27/09	2009-48	18	38	Fair
05/26/04	2004-59	28	46	Good
09/21/94	94-39	21	50	Good

Most Abundant Species 2009 Spottail Shiner (37%)

Exotic Species 2009 Green Sunfish, Bluegill

Species Change Since Last Cycle (2009 vs. 2004)

Gains -- Eastern Silvery Minnow, Notchlip Redhorse, Flier. **Losses** -- Crescent Shiner, Rosefin Shiner, Satinfin Shiner, Creek Chubsucker, V-lip Redhorse, Flat Bullhead, Redfin Pickerel, Eastern Mudminnow, Eastern Mosquitofish, Pumpkinseed, Warmouth, Redear Sunfish, Largemouth Bass. All species gained or lost were represented by 1-9 fish/species, except for Eastern Mosquitofish, Flat Bullhead, and Satinfin Shiner (n= 11, 14, and 21, respectively).

Data Analysis

Watershed -- drains north-central Halifax County; no municipalities in the watershed; tributary to Roanoke Rapids Lake, site is ~ 1.4 miles upstream from the reservoir. **Habitats** -- straddles the Northern Outer Piedmont and the Rolling Coastal Plain Level IV ecoregions; good root mats, snags, undercuts, deadfalls, short and shallow riffles, high quality riparian zones. **2009** -- number of fish collected was not much lower than in 2004 (289 *vs* 316), but 10 fewer species were present; very low percentage of the species with multiple age classes (28%); high percentage of tolerant fish (primarily Redbreast Sunfish and Green Sunfish); skewed trophic structure due to the abundance of the omnivorous Spottail Shiner. **1994 - 2009** -- very diverse community, 31 species known from the site, including 8 species of sunfish, 5 species of catfish, but no intolerant species; in 1994 and 2004 the dominant species was the Redbreast Sunfish. **Note:** the site was re-sampled in 2010 following a wetter winter and spring flow period and the community was rated Good.

APPENDIX 4-C

AMBIENT MONITORING SYSTEMS
STATION DATA SHEETS
FOR THE ROANOKE RAPIDS SUBBASIN

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: SMITH CRK AT US 1 NR PASCHALL
Station #: N6400000 **Hydrologic Unit Code:** 03010106
Latitude: 36.54087 **Longitude:** -78.19514 **Stream class:** C
Agency: NCAMBNT **NC stream index:** 23-10

Time period: 01/03/2005 to 11/18/2009

	# results	# ND	EL	Results not meeting EL #	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	<4	11	23.4	99.8	2.3	3.2	4.1	5.3	8.5	11.3	12.8
	47	0	<5	18	38.3	100	2.3	3.2	4.1	5.3	8.5	11.3	12.8
pH (SU)	48	0	<6	4	8.3		5.1	6	6.4	6.6	6.8	7.1	7.4
	48	0	>9	0	0		5.1	6	6.4	6.6	6.8	7.1	7.4
Salinity (ppt)	9	0	N/A				0	0	0	0	0.1	0.1	0.1
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				63	74	76	90	128	158	180
Water Temperature (°C)	48	0	>32	0	0		1.7	5.4	8.9	16.8	21.7	25	26.1
Other													
TSS (mg/L)	19	8	N/A				2.8	3	5	6.2	7	16	18
Turbidity (NTU)	48	0	>50	4	8.3		2.6	3.6	4.1	9.1	26.8	41.1	120
Nutrients (mg/L)													
NH3 as N	48	25	N/A				0.02	0.02	0.02	0.02	0.05	0.29	0.59
NO2 + NO3 as N	47	32	N/A				0.02	0.02	0.02	0.02	0.05	0.08	0.2
TKN as N	45	0	N/A				0.21	0.29	0.38	0.48	0.68	1.02	1.4
Total Phosphorus	46	0	N/A				0.03	0.04	0.05	0.07	0.08	0.15	0.92
Metals (ug/L)													
Aluminum, total (Al)	9	0	N/A				56	56	68	92	130	240	240
Arsenic, total (As)	9	9	>10	0	0		5	5	5	5	5	5	5
Cadmium, total (Cd)	9	9	>2	0	0		1	1	2	2	2	2	2
Chromium, total (Cr)	9	9	>50	0	0		10	10	25	25	25	25	25
Copper, total (Cu)	9	9	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	9	0	>1000	7	77.8		820	820	1405	2200	3600	8500	8500
Lead, total (Pb)	9	9	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	8	8	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	9	9	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	9	8	>50	0	0		10	10	10	10	10	11	11

Fecal Coliform Screening(#/100mL)

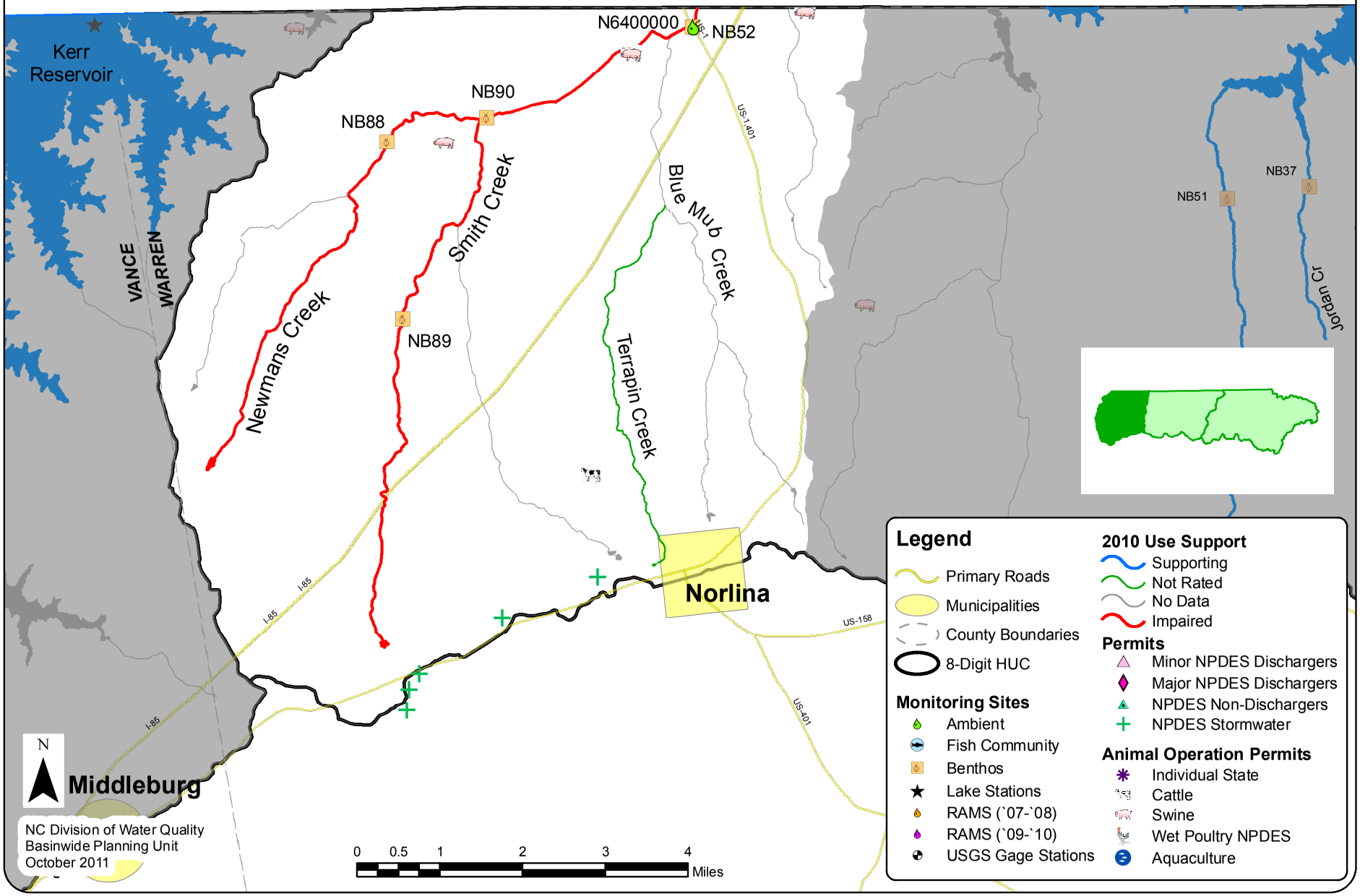
# results:	Geomean:	# > 400:	% > 400:	%Conf:
48	61.3	2	4.2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

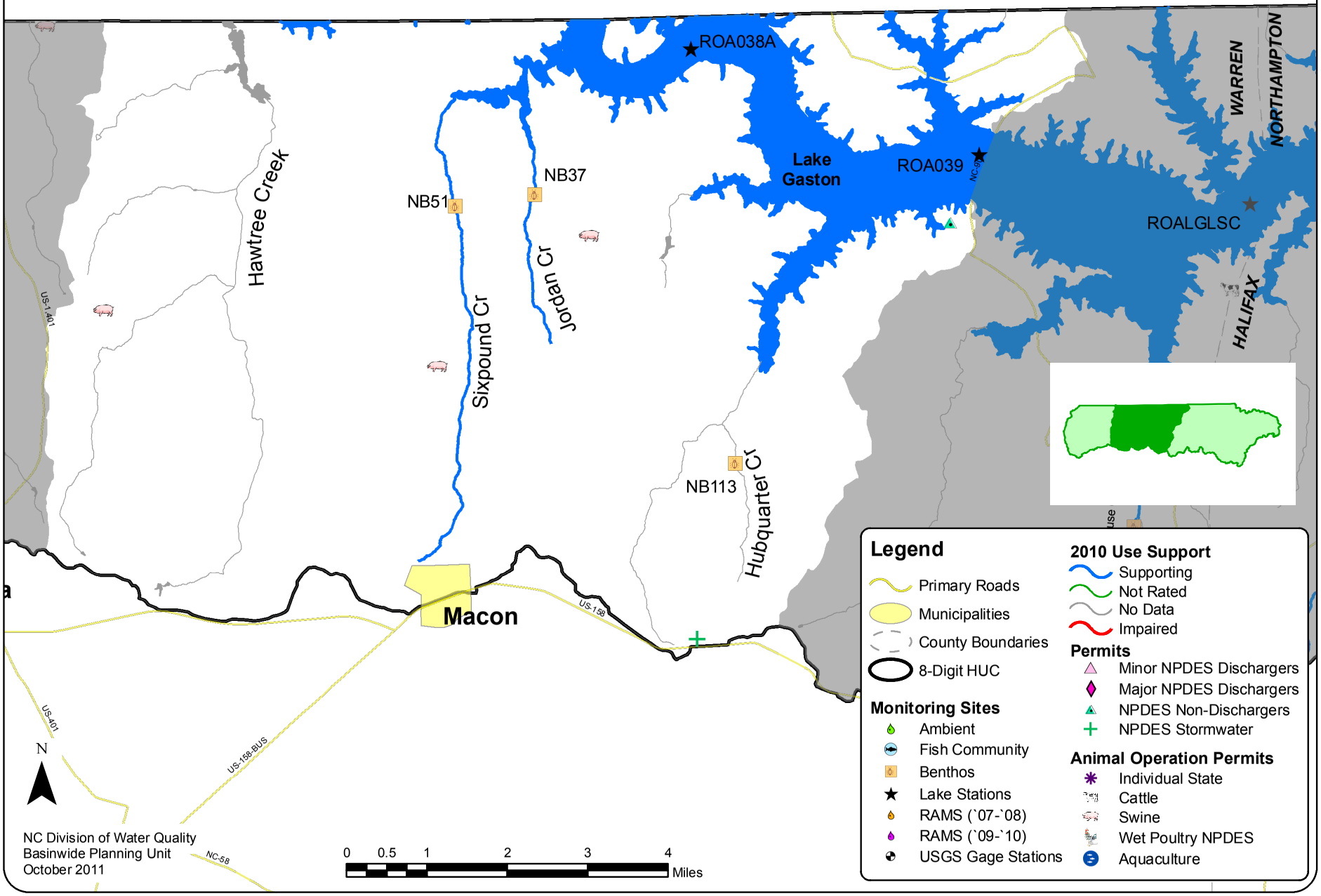
Appendix 4-D

10-Digit Watershed Maps for the Roanoke Rapids Subbasin

Upper Lake Gaston-Roanoke River (0301010602)



Middle Lake Gaston-Roanoke River (0301010603)



Lower Lake Gaston-Roanoke River (0301010604)