Appendix 2E

Additional Studies

Fishing Creek Subbasin
HUC 03020102

Long-term Analysis of Water Quality Trends in the Pamlico-Tar Watershed: Year Three Report

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ENVIRONMENTAL QUALITY INSTITUTE

THE UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE

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APPENDICES

Acknowledgments

Without volunteers this project and many other projects established to protect and improve water quality would not be possible. Thus, first and foremost we would like to thank those who have collected samples over the past year, including volunteers from Pitt County: Melanie Crawford, Tammy Edwards, David Emmerling, Clark Everett, Ellis Everett, Green, Leo LaFrance, Chris Mansfield, Ann McLung, Joy Moses-Hall, Blake Price, Scott Prichard, Sue Purser, Carolyn, Natalie, Lillie and Alice Reed, and Dave Schwartz. And recognizing our volunteers from Edgecombe County: Richard Anderson, Susan Bamann, Joel Bourne, Rebekah Eastep, Dennis Gosser, Shelton Harrell, Ken Lautzenheiser, Farrar Martin, Morene Oneill, Al Patezell and Donnie Whitehurst. And recognizing our volunteers from Nash County: Jon Burch, Terri Dula, Trevor and Tony Foote and Nate and Alex, Reba Fulghum, Bob Hudkins, Russell Jackson, Bobby Moss, Tommy Southerland, Marghi Sowerwine, Rachel Webb, and Sim Wilde

Special thanks also go to the Pamlico-Tar River Foundation for supporting this project and many others designed to preserve and protect the water quality of the Tar-Pamlico watershed. None of these projects would be possible were it not for the members and supporters of PTRF who have contributed time and money for the protection of this valuable resource. Thanks also to Pamlico-Tar Riverkeeper Heather Jacobs Deck for organizing this monitoring project, training the volunteers, and ensuring samples are collected and shipped, and to interns Joe Luchette, Tammy Hill and David Van Cura for doing much of the field work to identify the sample sites.

I. Introduction

VWIN's History

The Volunteer Water Information Network (VWIN) is a partnership of groups and individuals dedicated to preserving water quality in North Carolina. Organizations such as the the Pamlico-Tar River Foundation, the Pacolet Area Conservancy, the Environmental Conservation Organization, the Henderson County Board of Commissioners, Haywood Waterways Association, the Asheville Metropolitan Sewerage District, the Buncombe County Board of Commissioners, the Friends of Lake Glenville, the Town of Lake Lure, the Lake James Environmental Association, the Hiawassee River Watershed Coalition, the Madison County Soil and Water Conservation District, the Watershed Association of the Tuckasegee River, the Watauga River Conservation Partners, and others provide financial and administrative support. The UNC-Asheville Environmental Quality Institute (EQI) provides technical assistance through laboratory analysis of water samples, statistical analysis of water quality results, and written interpretation of the data. Volunteers venture out once per month to collect water samples from designated sites along streams and rivers in the state.

An accurate and on-going water quality database, as provided by VWIN, is essential for good environmental planning. The data gathered by the volunteers provides an increasingly accurate picture of water quality conditions and changes in these conditions over time. Communities can use this data to identify streams of high water quality, which need to be preserved, as well as streams that cannot support further development without significant water quality degradation. In addition, the information allows planners to assess the impacts of increased development and the success of pollution control measures. Thus, this program provides the water quality data for evaluation of current management efforts, and can help guide decisions affecting future management actions. The VWIN monitoring program also encourages involvement of citizens in the awareness, ownership and protection of their water resources.

In February of 1990, volunteers began monthly sampling 27 stream sites in Buncombe County, NC. The program expanded to 45 sites by November of 1990. Since that time the project has increased to over 200 monitored sites on local streams, rivers, and lakes throughout the state. Monthly sampling of these sites provides extensive water quality information for the Pamlico-Tar, French Broad, Broad, Catawba, Little Tennessee, Watauga, and Hiawassee River Watersheds in North Carolina.

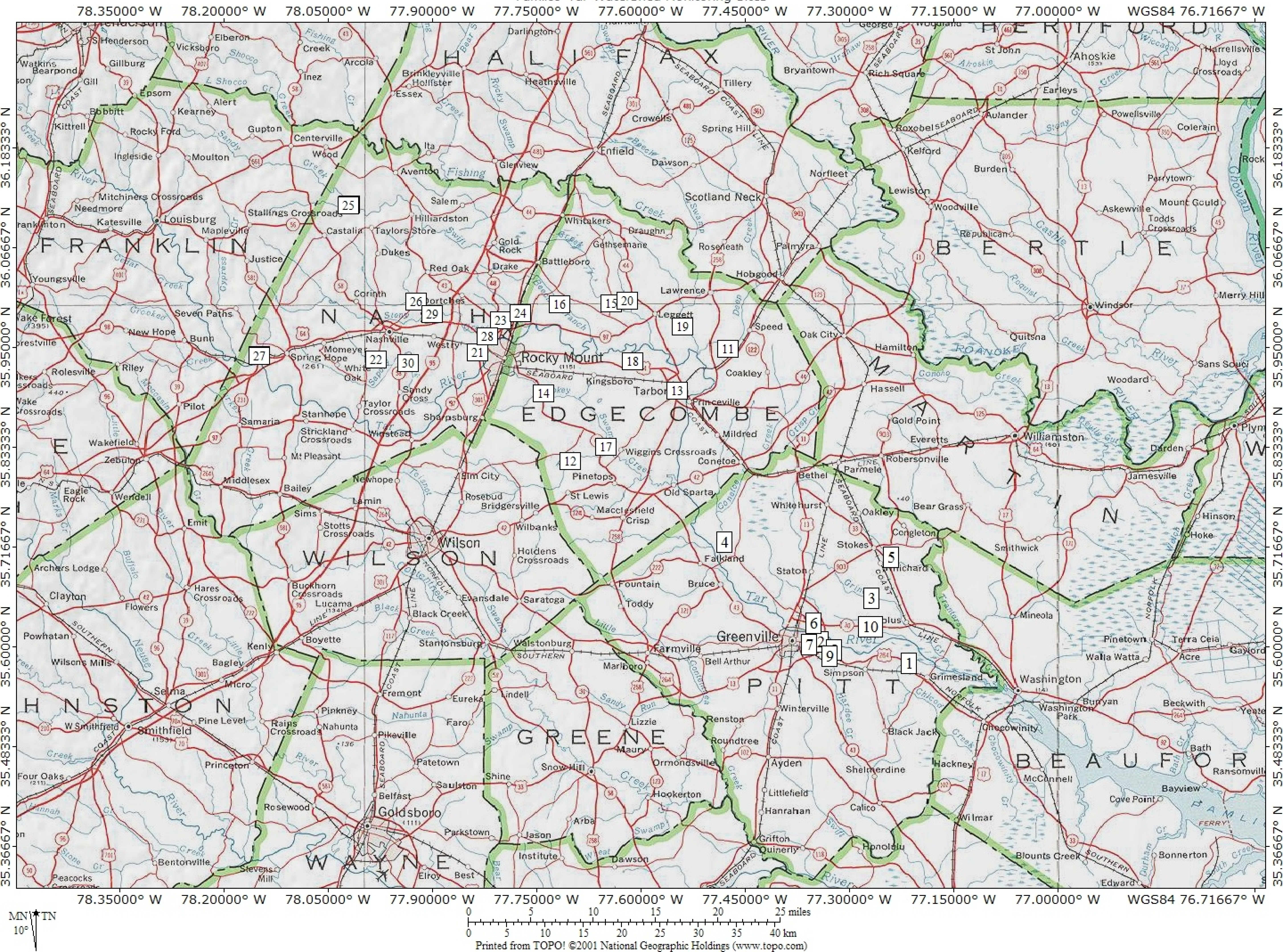
The Pamlico-Tar Watershed Monitoring Program

In August 2005, the Pamlico-Tar River Foundation initiated a monitoring program for ten selected stream sites in Pitt County. In August 2006 ten sites in Edgecombe County were added, and in August 2007 ten sites in Nash County were included. The approximate location of all the monitoring sites can be found in Figures 1. Table 1 is a list of the monitoring sites and their locations. This report represents statistical analyses and interpretation of data from samples gathered by volunteers from August 2005 through July 2008.

Table 1: Pamlico-Tar Watershed Monitoring Sites

1. Chicod Creek at Highway 33
2. Green Mill Run at Arlington Blvd
3. Grindle Creek at Whichard-Cherry Road
4. Conetoe Creek at Bud Parker Road
5. Briery Swamp at Briery Swamp Road
6. Parker Creek at Mumford Road
7. Green Mill Run at Green Springs Park
8. Hardee Creek at 10^{th} Street
9. Meetinghouse Branch at Oxford Road
10. Moye's Run at Old Pactolus Road
11. Deep Creek at Dickens Road
12. Town Creek at Baptist Church Road
13. Hendricks Creek
14. Cokey Swamp at Highway 43
15. Swift Creek at Speights Chapel Road
16. Beech Swamp at Cool Springs Road
17. Cokey Swamp at Davistown-Mercer Road
18. Penders Mill Run at Northwoods Country Road
19. Fishing Creek at Fishing Creek Road
20. White Oak Swamp at White Oak Swamp Road
21. Maple Creek at Old Mill Road
22. Little Sapony Creek at Old Bailey Highway
23. Hornbeam Branch at Jeffrey's Road
24. Compass Creek at Tanner Road
25. Red Bud Creek at Red Bud Road
26. Pig Basket Creek at Red Oak Road
27. Turkey Creek at Web Mill Road
28. Stony Creek at Bojangles
29. Stony Creek at Old Carriage Road
30. Sapony Creek at West Mount Drive

Pamlico-Tar Watershed Monitoring Sites



II. Methodology

A water monitoring coordinator provides hands-on instruction and experience in sample collection to all volunteers prior to their first day of sample collection. The Pamlico-Tar monitoring samples are collected on the second Saturday of each month. Water samples are collected in six 250 mL polyethylene bottles. In order to assure consistent sampling techniques, each bottle is labeled with the site number and the parameter for which the water from that particular bottle will be analyzed. Each set of samples includes a chain-of-custody form to be completed by the volunteer. This form includes site number and site location, the time and date of sample collection, the name of the person collecting the sample, and the weather conditions prior to sample collection. Appendix A is a copy of the chain-of-custody form used by the volunteers.

After collection, the volunteer takes the samples and data sheet to a designated drop point where the samples are refrigerated. It is the job of the volunteer coordinator to pick up the samples from the drop point and deliver them or ship them to the EQI laboratory for analysis within two days of collection. A description of the laboratory analysis methodology is contained in Appendix B. Following analysis of samples the empty bottles are cleaned in the laboratory and then packed together with blank chain-of-custody forms for use next month.

Various statistical analyses are performed on the data and are intended to:

1) Characterize the water quality of each stream site relative to accepted or established water quality standards;

2) Identify effects of precipitation, stream water level, seasonality, land use, and temporal trends on water quality, after sufficient data have been collected.

III. Results and Discussion

This discussion is based on three years of data gathered from August 2005 through July 2008 for sites 1-10 in Pitt County, two years of data gathered from August 2006 through July 2008 for sites 11-20 in Edgecombe County, and one year of data gathered from August 2007 through July 2008 for sites 21-30 in Nash County. Trends in water quality become more evident with each additional year of continuous stream monitoring, and a clearer picture of actual conditions existing in various streams and watersheds is available. Continuing water quality data collection over time provides updated information on changing conditions. With this information financial resources and policies can be focused on areas of greatest concern.

A discussion of the stream sites relative to specific water quality parameters follows. To better understand the parameters, explanations, standards and sources of contamination, some definitions of units and terms have been provided.

The amount of a substance in water is referred to in units of concentration. Parts per million (ppm) is equivalent to mg/L. This means that if a substance is reported to have a concentration of 1 ppm, then there is one milligram of the substance in each liter (1000 grams) of water. The parameter total suspended solids (TSS) illustrates the weight/volume concept of concentration. According to the statistical summary data for the Pamlico-Tar Watershed sites (Appendix C), site 1 had a median TSS concentration of 3.4 mg/L, which is equivalent to 3.4 ppm. Thus if you filter one liter of water from site 1 on average you will collect sediments that weigh 3.4 mg. The same conversion applies for parts per billion (ppb), which is equivalent to micrograms per liter (ug/L). Concentrations of parameters in water samples are compared to normal ambient levels. Ambient levels are estimates of the naturally occurring concentration ranges of a substance. For instance, the ambient level of copper in most streams is less than 1 ug/L (1 ppb). Concentrations of parameters are also compared with state water quality standards if they exist.

Appendix C contains summarized statistical data collected over the course of this study. It is a list of minimum, maximum, and median concentrations or values over the monitoring period. It should be noted that, although there are always some sites in each area that are relatively unaffected by human activities, most monitoring sites are generally chosen to measure the effects of human activities on stream water quality. For this reason, forest streams are under-represented and the averages in all areas are weighted somewhat toward streams that experience various degrees of pollution.

A. Acidity (pH) and Alkalinity: pH is used to measure acidity. The pH is a measure of the concentration of hydrogen ions in a solution. If the value of the measurement is less than 7.0, the solution is acidic. If the value is greater than 7.0, the solution is alkaline (more commonly referred to as basic). The ambient water quality standard is between 6.0 and 9.0. Natural pH in streams is generally in the range of 6.5 - 7.2. Values below 6.5 may indicate the effects of acid rain or other acidic inputs, and values above 7.5 may be indicative of an industrial discharge. It should also be noted that swamp waters are naturally more acidic and many streams in the lower Pamlico-Tar watershed flow through woody wetlands or formerly woody wetlands that have been drained for agriculture.

Because organisms in aquatic environments have adapted to the pH conditions of natural waters, even small pH fluctuations can interfere with the reproduction of those organisms or can even kill them outright. The pH is an important water quality parameter because it has the potential to seriously affect aquatic ecosystems. It can also be a useful indicator of specific types of discharges.

Alkalinity is the measure of the acid neutralizing capacity of a water or soil. Waters with high alkalinity are considered protected (well buffered) against acidic inputs. Streams that are supplied with a buffer are able to absorb and neutralize hydrogen ions introduced by acidic sources such as acid rain, decomposing organic matter and industrial effluent. For example, water can leach calcium carbonate (a natural buffer) from limestone soils or bedrock and then move into a stream, providing that stream with a buffer. As a result, pH levels in the stream are held constant despite acidic inputs. Unfortunately, natural buffering materials can become depleted due to excessive acidic precipitation over time. In that case, further acidic precipitation can cause severe decreases in stream pH. Potential future stream acidification problems can be anticipated by alkalinity measurement. There is no legal standard for alkalinity, but waters with an alkalinity below 30 mg/l are considered to have low alkalinity.

Figures 3 and 4 show median pH and alkalinity levels for each monitoring site.

Figure 3: Median pH levels at each monitoring site

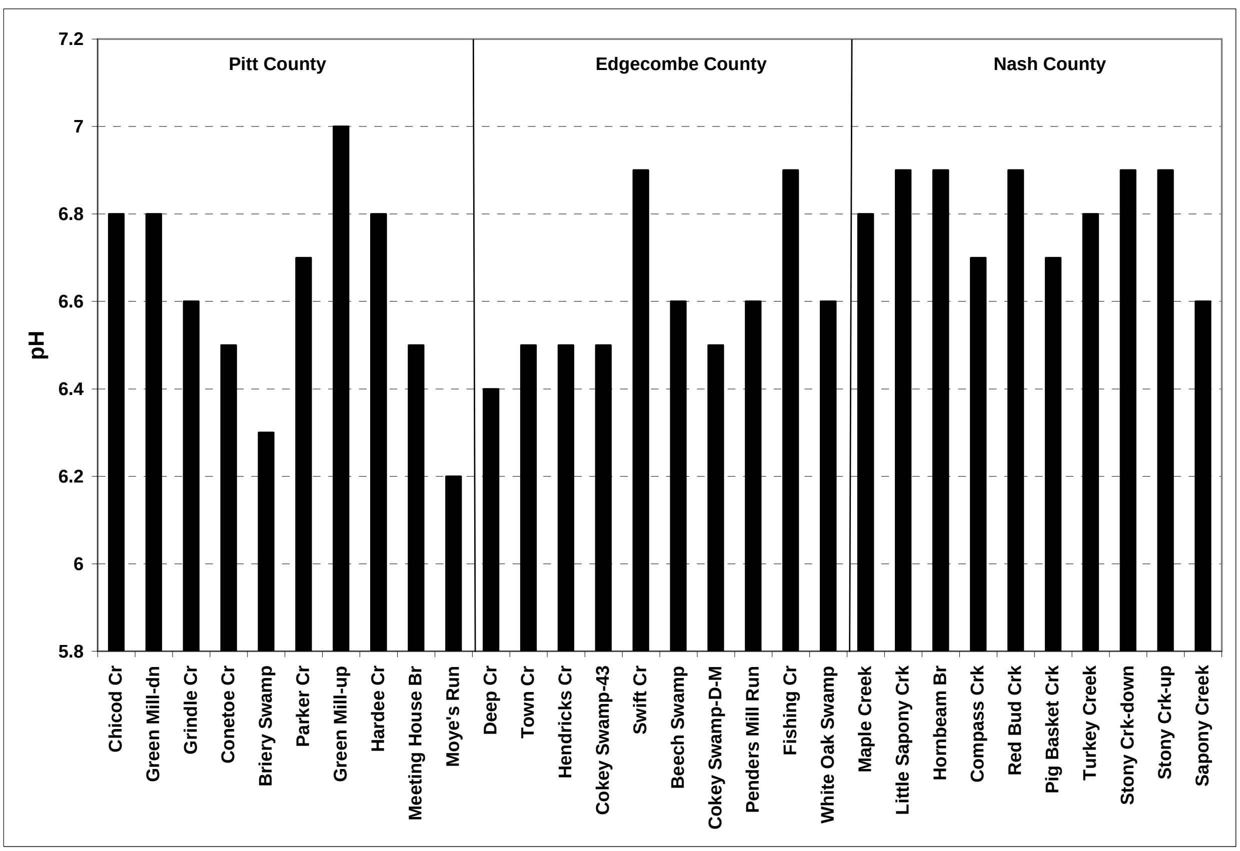
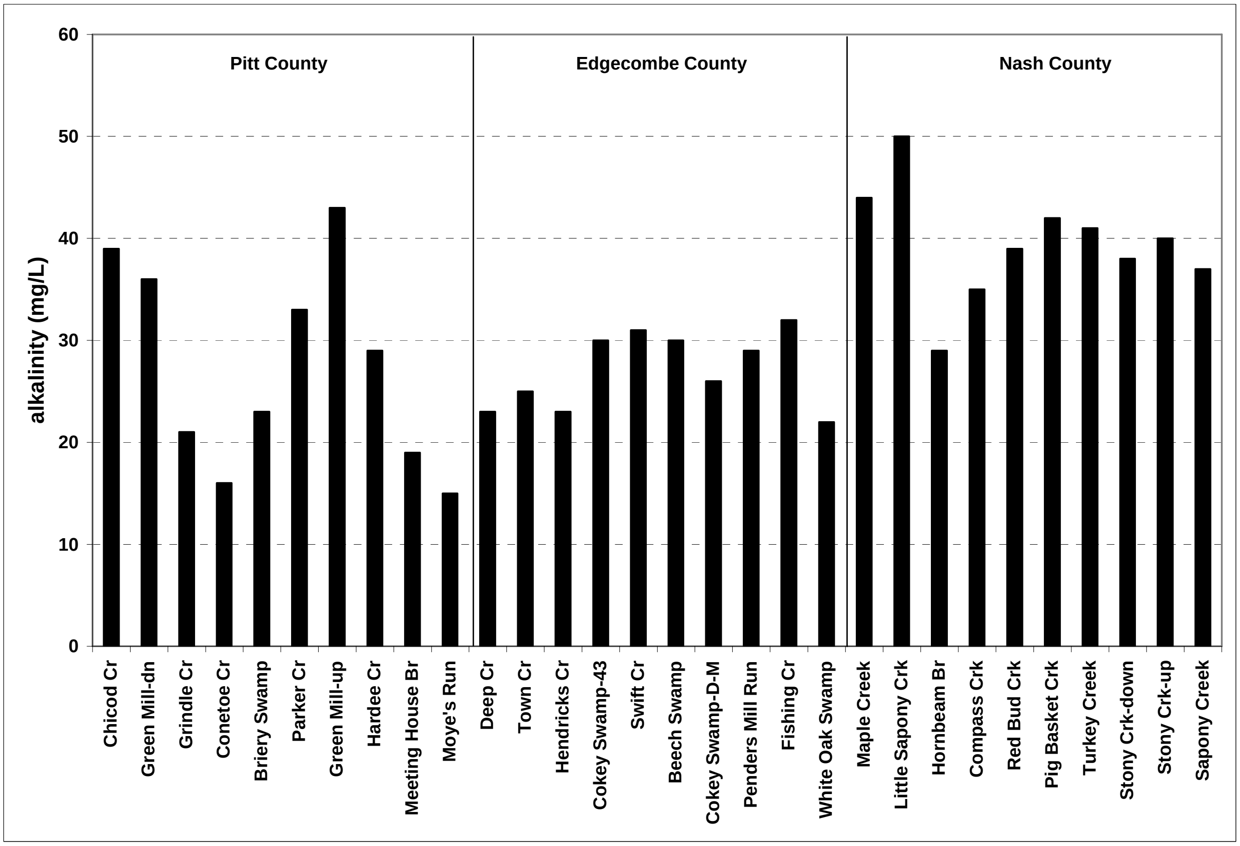


Figure 4: Median alkalinity levels at each monitoring site



B. Turbidity and Total Suspended Solids (TSS): Turbidity is a measurement of the visual clarity of a water sample and indicates the presence of fine suspended particulate matter. The unit used to measure turbidity is NTU (nephelometric turbidity units), which measures the absorption and reflection of light when it is passed through a sample of water. Because particles can have a wide variety of sizes, shapes and densities, there is only an approximate relationship between the turbidity of a sample and the concentration (i.e. weight) of the particulate matter present. This is why there are separate tests for NTU turbidity and suspended solids. The standard to protect aquatic life is 50 NTU.

Streams in undisturbed forested areas usually remain clear even after a moderately heavy rainfall event, but streams in areas with disturbed soil may become highly turbid after even a relatively light rainfall. Deposition of silt into a stream bottom can bury and destroy the complex bottom habitat. Consequently, the habitat for most species of aquatic insects, snails, and crustaceans is destroyed by stream siltation. The absence of these species reduces the diversity of the ecosystem. There is no legal standard for TSS, but values below 30.0 mg/l are generally considered low, and values above 100 mg/l are considered high. TSS quantifies solids by weight and is heavily influenced by the combination stream flow and land disturbing activities. A good measure of the upstream land use conditions is how much TSS rises after a heavy rainfall.

Figures 5 and 6 show median turbidity and total suspended solids at each monitoring site.

Figure 5: Median turbidity levels at each monitoring site

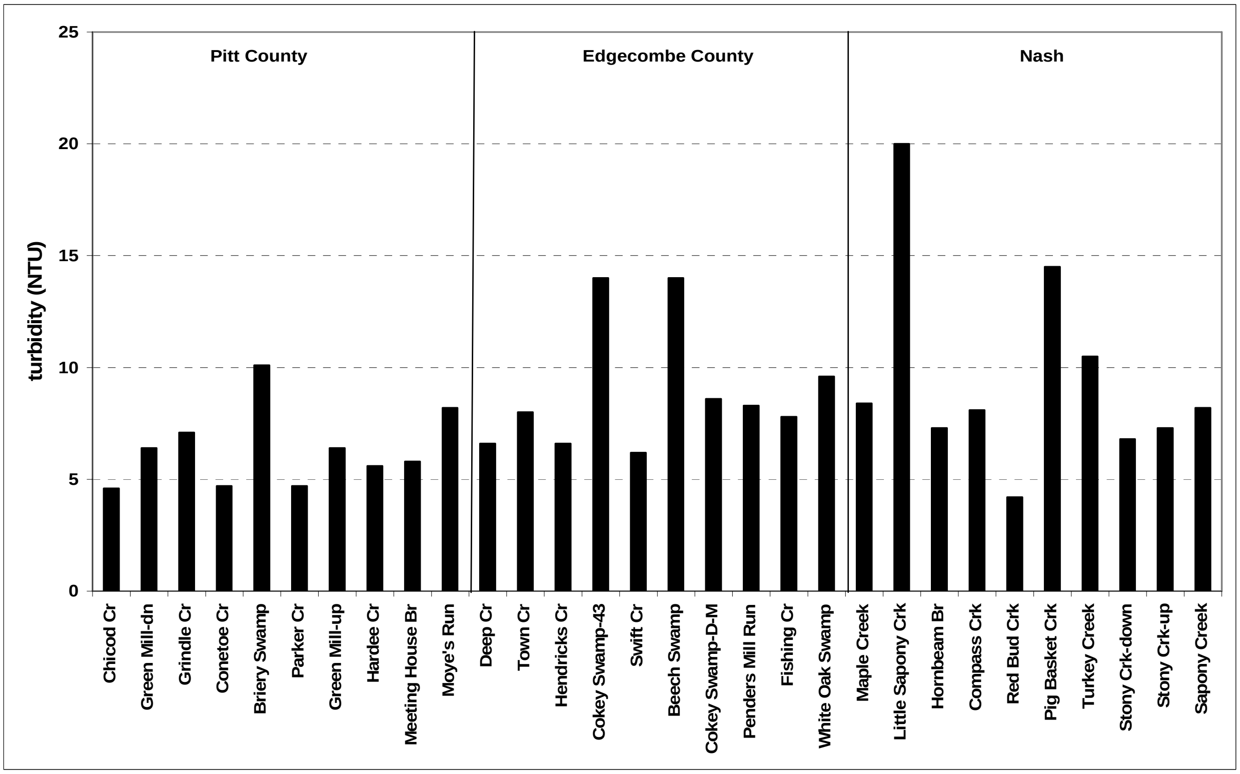
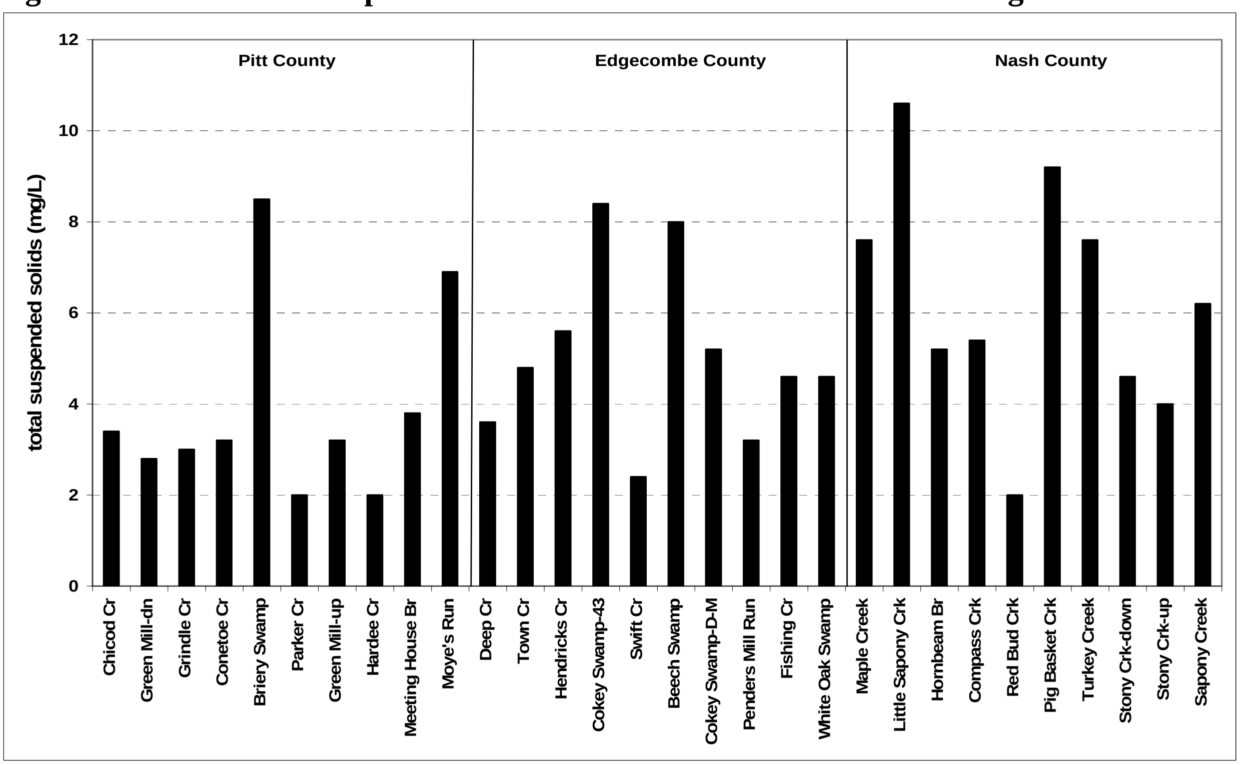


Figure 6: Median total suspended solids concentrations at each monitoring site



C. Conductivity and Heavy Metals (Copper, Lead, and Zinc):
Conductivity is measured in micromhos per centimeter (umho/cm) and is used to measure the ability of a water sample to conduct an electrical current. Pure water will not conduct an electrical current. However, samples containing dissolved solids and salts will form positively and negatively charged ions that will conduct an electrical current. The concentration of dissolved ions in a sample determines conductivity. Inorganic dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum affect conductivity levels. Geology of an area can affect conductivity levels. Streams that run through areas with granitic bedrock tend to have lower conductivity because granitic rock is composed of materials that do not ionize in water. Streams that receive large amounts of runoff containing clay particles generally have higher conductivity because of the presence of materials in clay that ionize more readily in water. Conductivity levels generally increase when water levels decline because salts become more concentrated. Rainwater also has very low concentrations of salts.

Metals are naturally occurring in surface waters in minute quantities as a result of chemical weathering and soil leaching. However, concentrations greater than those occurring naturally can be toxic to human and aquatic organisms. Elevated levels are often indicative of industrial pollution, wastewater discharge, and urban runoff, especially from areas with high concentrations of automobiles. Airborne contaminants from coal-fired power plants may also contribute metals to the atmosphere, which are then carried to land by precipitation and dry fallout. Because metals sorb readily to many sediment types, they may easily enter streams in areas with high sediment runoff. Another source of heavy metals can be runoff from agricultural fields using sewage sludge as fertilizer, which sometimes is permitted to contain up to 1500 mg metal/1 kg fertilizer.

Copper: The standard of 7.0 ug/l has been established to protect aquatic life. In most areas, ambient levels are usually below 1.0 ug/l. Wear of brake linings has been shown to contribute concentrations of copper, lead, and zinc. Copper has a relatively high content in brake linings. Copper is also present in leaded, unleaded, and diesel fuel emissions.

Lead: A standard of 25.0 ug/l has been established to protect aquatic life, while the normal ambient level is usually below 1.0 ug/l. Lead may be present in industrial wastewater and was once common in road runoff from the use of leaded gasoline. Roadside soils still generally contain high lead levels, resulting in elevated stream concentrations if these soils are subject to erosion.

Zinc: The surface water standard is 50.0 ug/l. Typical ambient levels of zinc are approximately 5.0 ug/l. Zinc is a major metal component of tire rubber, brake linings, and galvanized crash barriers. Studies have been conducted linking this to zinc contamination from urban runoff. Because zinc is a by-product of the auto tire vulcanization process as well as the galvanization of iron, its presence in water may also result from industrial or domestic wastewater.

Elevated levels of conductivity and heavy metals are most often seen in streams receiving industrial or domestic wastewater or urban runoff. These substances also occur naturally in soils and may show higher levels in streams where severe erosion and runoff are occurring. Figure 7 shows median conductivity at each monitoring site. Figure 8 shows median zinc concentrations at each monitoring site.

Figure 7: Median conductivity levels at each monitoring site

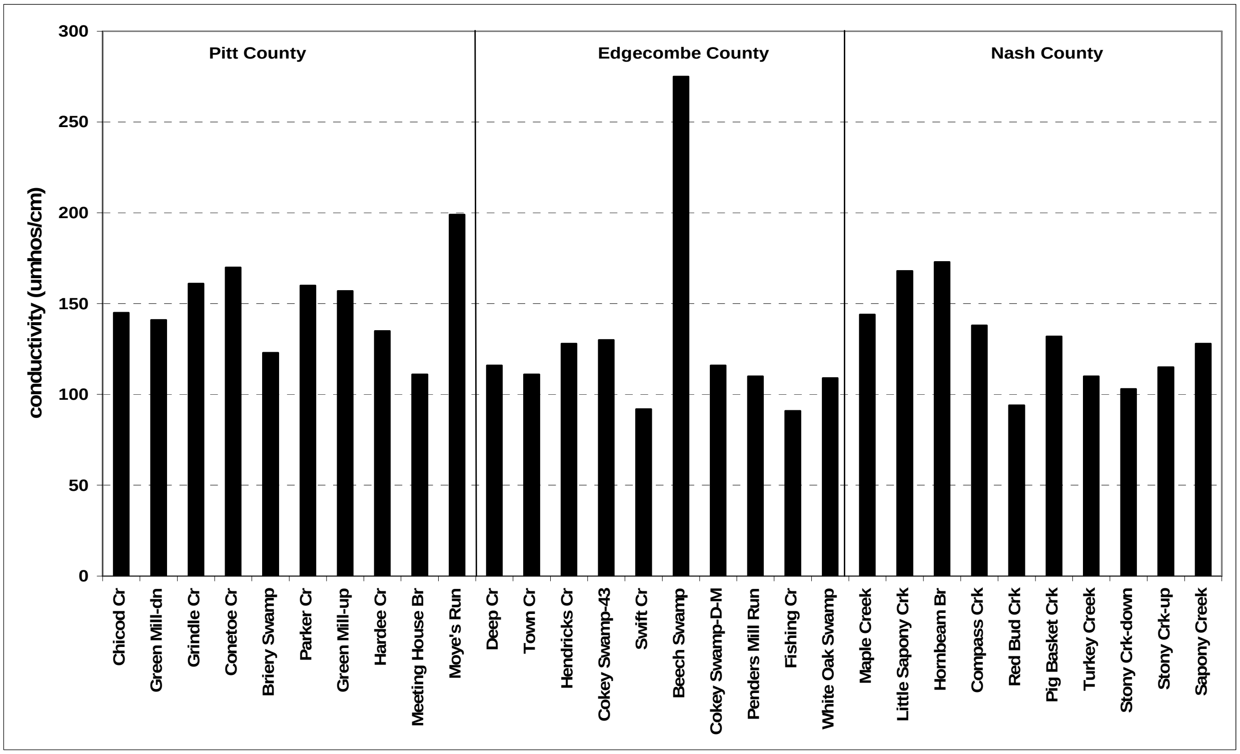
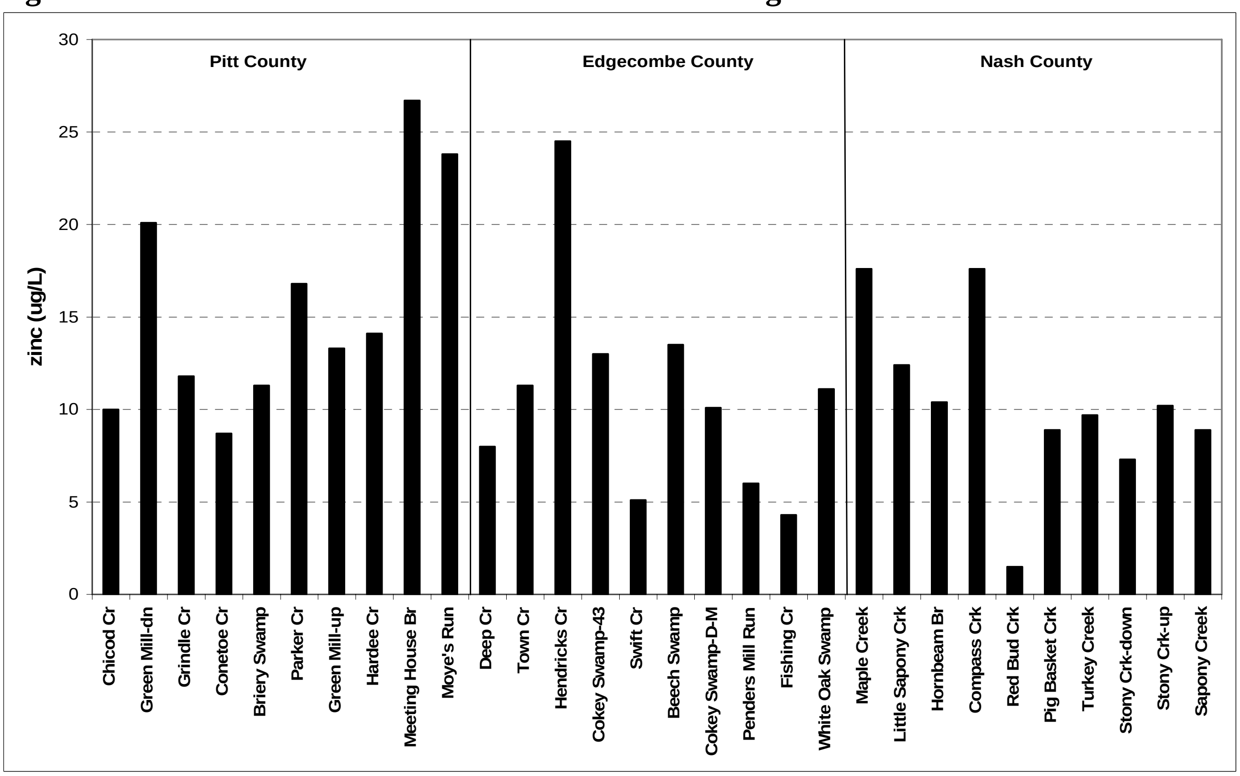


Figure 8: Median zinc concentrations at each monitoring site



D. Nutrients (Orthophosphate (PO_4^{3-}), Ammonia-Nitrogen (NH_4^+/NH_3), and Nitrate/Nitrite-Nitrogen (NO_3^-/NO_2^-): Phosphorus is an essential nutrient for aquatic plants and algae. It occurs naturally in water and is in fact, usually the limiting nutrient in most aquatic systems. In other words, plant growth is restricted by the availability of phosphorus in the system. Excessive phosphorus inputs stimulate the growth of algae and diatoms on rocks in a stream and cause periodic algal blooms in reservoirs downstream. Slippery green mats of algae in a stream, or blooms of algae in a lake are usually the result of an introduction of excessive phosphorus into
the system that has caused algae or aquatic plants to grow at abnormally high rates. Eutrophication is the term used to describe this growth of algae due to an over abundance of a limiting nutrient. Sources of phosphorus include soil, disturbed land, wastewater treatment plants, failing septic systems, runoff from fertilized crops and lawns, and livestock waste storage areas. Phosphates have an attraction for soil particles, and phosphorus concentrations can increase greatly during rains where surface runoff is a problem. **In this report orthophosphate is reported in the form of orthophosphate (PO_4^{3-}). To isolate phosphorus (P) from the measurement, divide the reported amount by 3.07.**

Orthophosphate: This is a measure of the dissolved phosphorus that is immediately available to plants or algae. Orthophosphate is also referred to as phosphorus in solution. There is no legal water quality standard, but generally levels should be below 0.05 mg/l to prevent downstream eutrophication.

Ammonia-Nitrogen (NH_4^+/NH_3) is contained in the remains of decaying wastes of plants and animals. Some species of bacteria and fungi decompose these wastes and NH_3 is formed. The normal ambient level is approximately 0.10 mg/l, and elevated levels of NH_3 can be toxic to fish. The most probable sources of ammonia nitrogen are agricultural runoff, livestock farming, septic drainage and sewage treatment plant discharges.

Like phosphorus, **nitrate/nitrite-nitrogen (NO_3^-/NO_2^-)** serves as an algal nutrient contributing to excessive stream and reservoir algal growth. In addition, nitrate is highly toxic to infants and the unborn causing inhibition of oxygen transfer in the blood stream at high doses. This condition is known as "blue-baby" disease. This is the basis for the 10 mg/L national drinking water standard. The ambient standard to protect aquatic ecosystems is 10 mg/L as well. The most probable sources are septic drainage and fertilizer runoff from agricultural land and domestic lawns. Nitrates from land sources end up in streams more quickly than other nutrients such as phosphorus because they dissolve in water more readily and can travel with ground water into streams. Consequently, nitrates are a good indicator of the possibility of sources of pollution from sewage or animal waste during dry weather.

The Pamlico-Tar basin is classified as nutrient sensitive because it is subject to excessive growth of vegetation, and this watershed is subject to management strategies that minimize nutrient loading. It is important to limit nutrient inputs to manage algae and plant growth. Figures 9, 10, and 11 show median orthophosphate, ammonia-nitrogen, and nitrate/nitrite-nitrogen concentrations at each monitoring site.

E. Dissolved Oxygen (DO) and temperature

Volunteers analyze dissolved oxygen on-site using the Winkler method each time monitoring

Figure 9: Median orthophosphate concentrations at each monitoring site

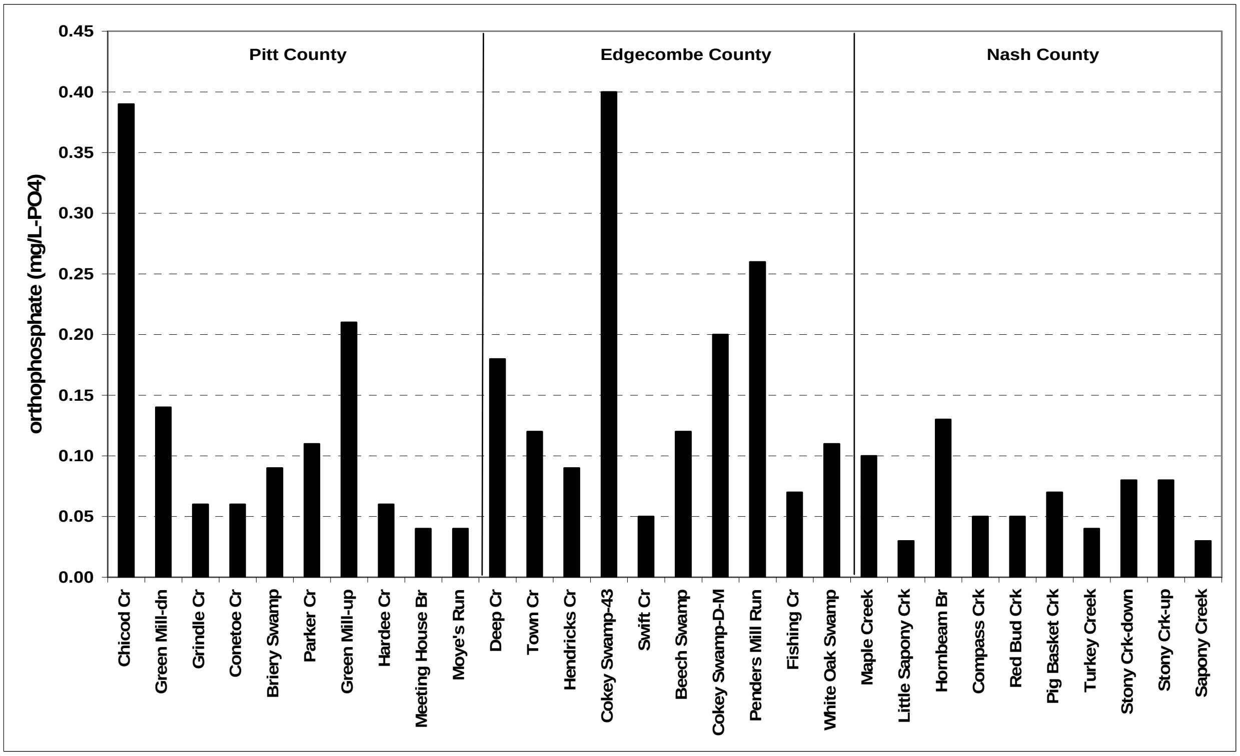


Figure 10: Median ammonia-nitrogen concentrations at each monitoring site

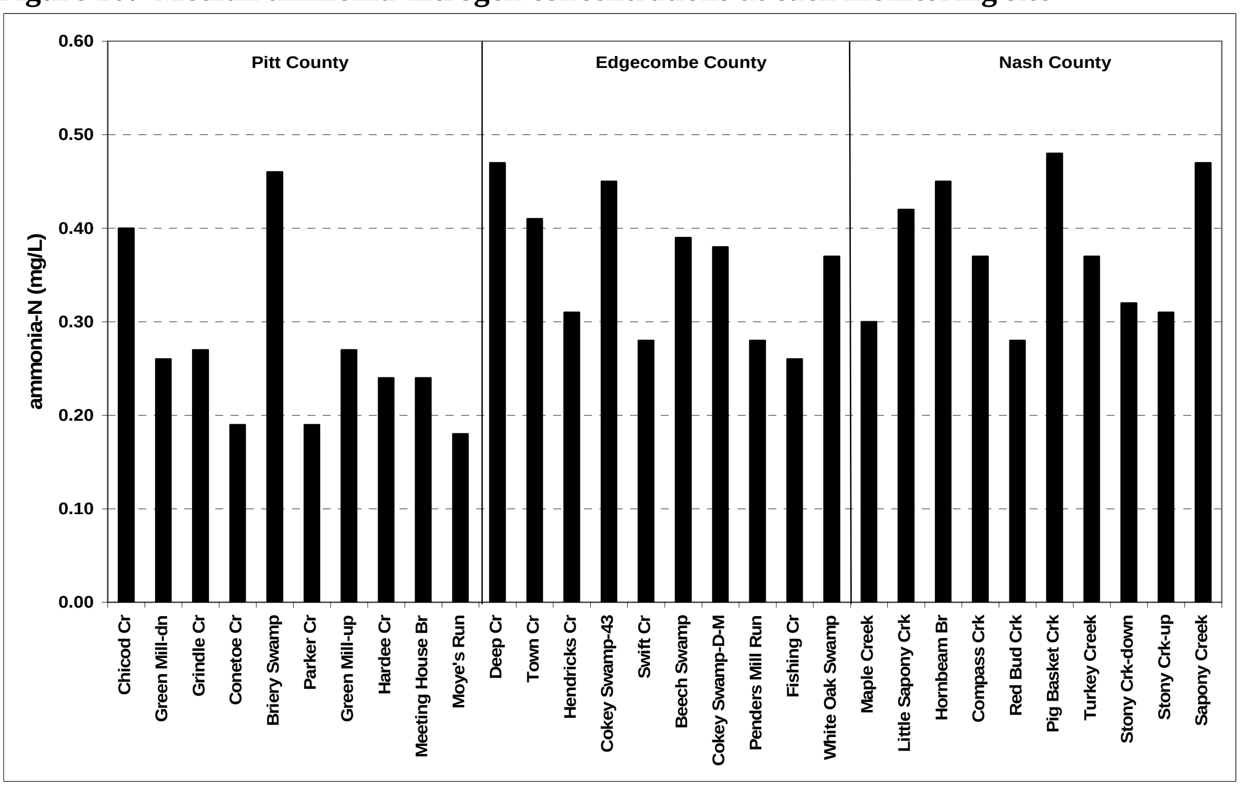
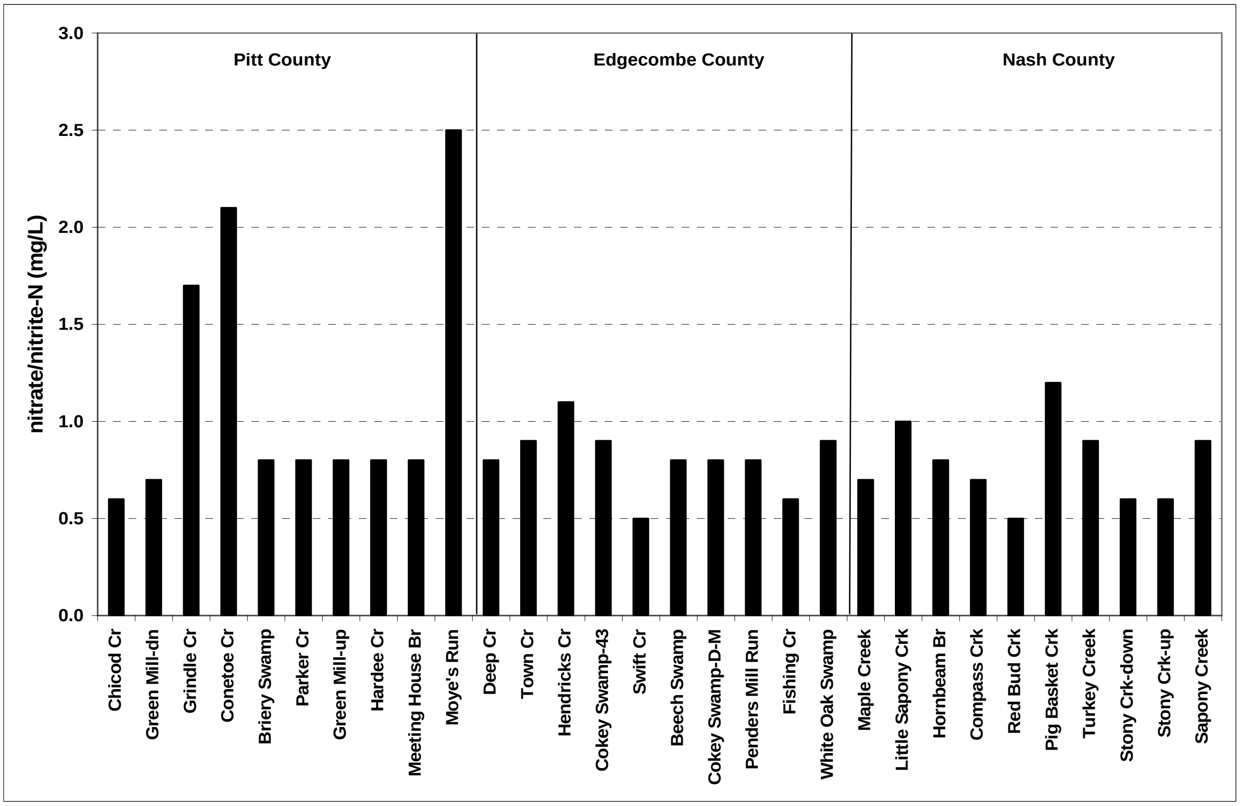


Figure 11: Median nitrate/nitrite-nitrogen concentrations at each monitoring site



samples are collected. All animal life requires oxygen to survive. Most oxygen in stream water comes from the atmosphere as the water tumbles over obstacles in the water and is exposed to air. Slow moving stream and river water has less opportunity for oxygenation. Plants also produce oxygen in the process of photosynthesis. Oxygen in water is consumed through respiration by aquatic organisms, decomposition of organic matter, and other chemical reactions. The amount of oxygen that can be dissolved in water is temperature and pressure dependent. The
higher the temperature, the less oxygen can be dissolved in the water, and the higher the pressure the more oxygen can be dissolved in the water. Percent saturation is the amount of oxygen (mg/L) in the water relative to the amount of oxygen that water could hold at a given temperature and pressure. Thus, while the concentration of dissolved oxygen may decline in summer, the percent saturation should remain the same assuming all other factors remain equal.

Figure 12 shows maximum, median, and minimum dissolved oxygen concentrations for each monitoring site, and Figure 13 shows maximum, median, and minimum oxygen saturation levels for each site.

Volunteers also record the air and water temperature while they are collecting samples. Water temperature is an important aspect of stream health not only because it determines the amount of oxygen the water can be dissolved, but because it also influences the rate of photosynthesis. The aquatic life in a stream is also partly determined by the temperature range in that stream because, like all organisms, aquatic species can only survive within a certain

Figure 12: Maximum, median, and minimum dissolved oxygen concentrations at each monitoring site

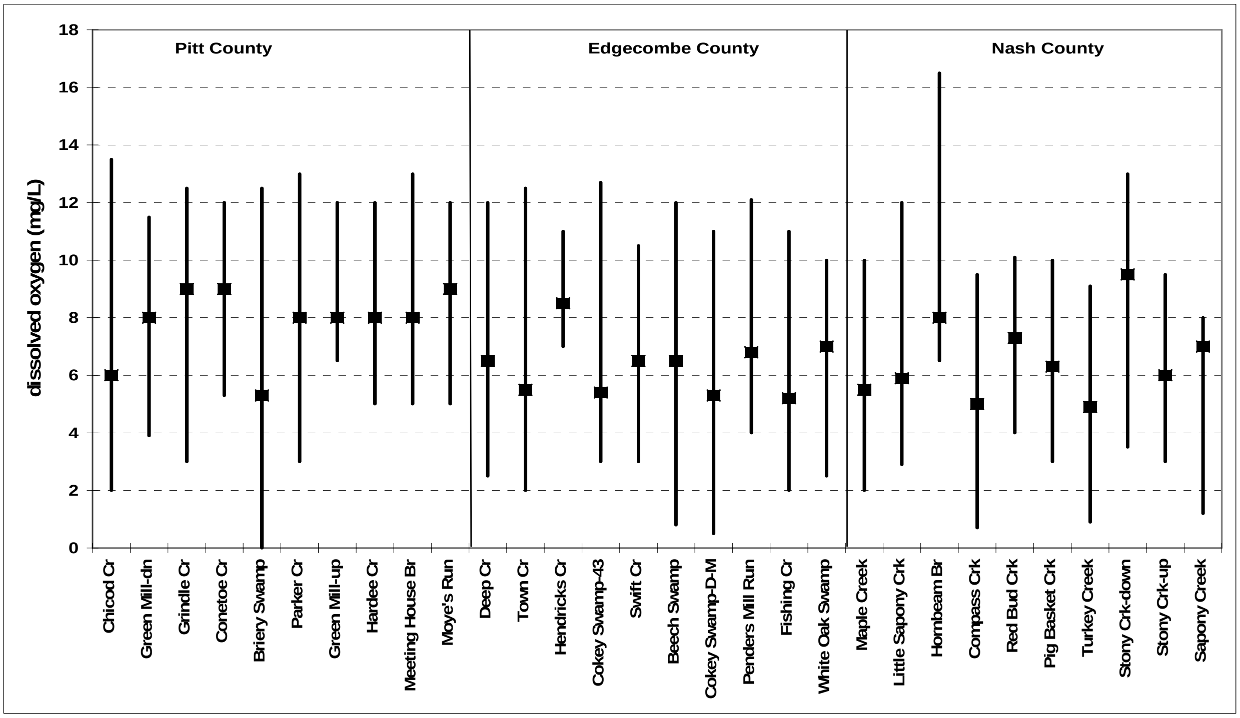
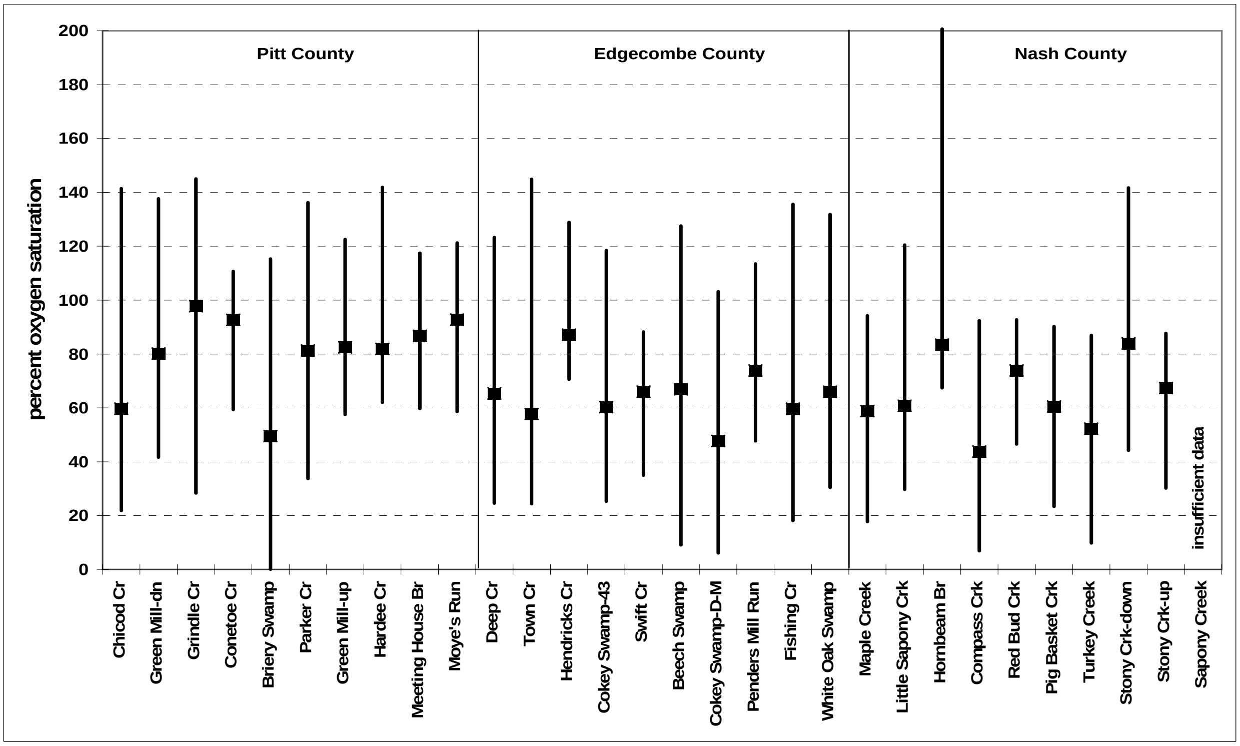
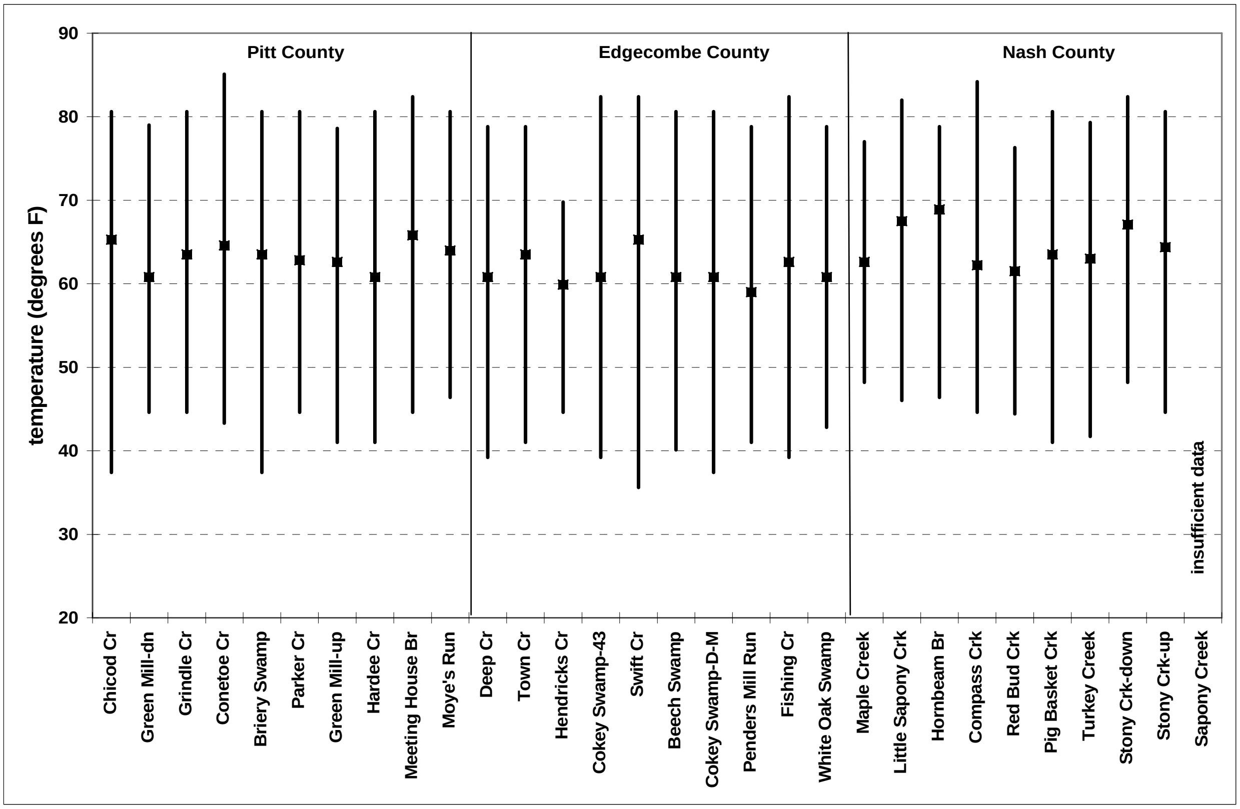


Figure 13: Maximum, median, and minimum percent oxygen saturation at each monitoring site



temperature range. Extremes that may occur outside that range, even only for a short time, could destroy a species or adversely affect reproduction. Historically North Carolina was a heavily forested state, but agriculture and development led to widespread clearing along streams. Unusually elevated water temperature is often an indication of insufficient shading along stream banks. Figure 14 minimum, median, and maximum stream temperature for each site.

Figure 14: Maximum, median, and minimum temperature at each monitoring site



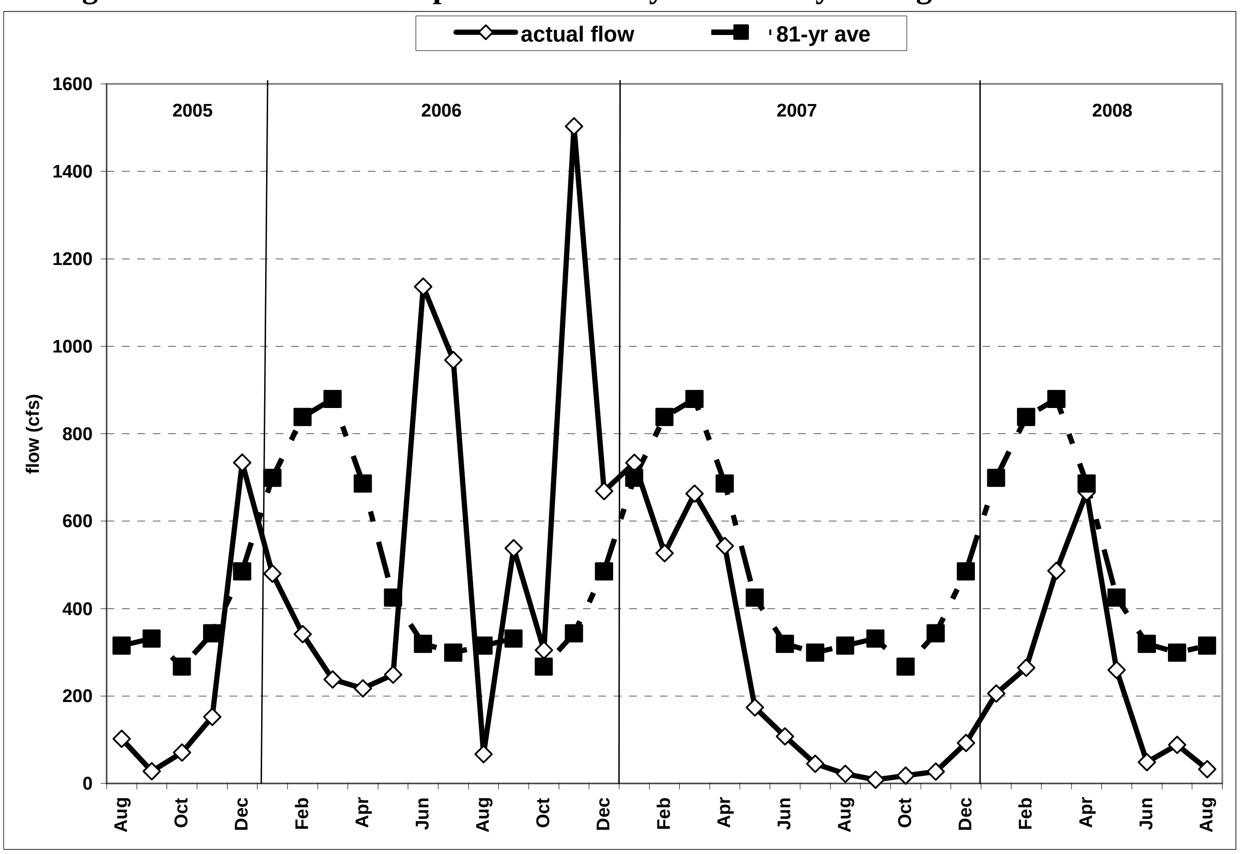
IV. Summary and Conclusions

Chemical analysis of samples collected at the Pamlico-Tar Watershed monitoring sites are intended to characterize the water quality relative to the parameters established by the Volunteer Water Information Network program. Concerned groups and individuals can use the information to help identify problems and evaluate solutions. Characterizing the water quality is a complex task, and interpretation of the data can be difficult due to many factors. With continued long term monitoring, however, various trends become more evident.

Weather patterns can have a significant effect on water quality. During years of low rainfall surface runoff decreases, and consequently there is less sediment flowing into the creeks. Sediment often carries many other pollutants with it, so lower sediment levels can also mean lower levels of certain other pollutants. On the other hand, when stream levels are low ambient concentrations of certain substances such as nutrients can increase because there is less dilution. If stream levels become very low even sediment concentrations can increase because the bottom silt mixes easily into the small amount of water flowing over it. When this situation occurs levels of other pollutants that are attached to bottom sediment can also increase. Water quality can also decline for the same reason when point-source pollution is a contributor. Higher concentrations of nutrients often result in greater organic activity, thus turbidity levels may remain elevated even though sediment concentrations decline. Changing levels of various parameters during periods of high and low rainfall can depend on such factors as whether the pollutant is largely from a point or non-point source and whether the stream still has a significant flow during the drought. Other parameters that can be affected by low stream flow include pH, alkalinity, conductivity, dissolved oxygen, and temperature.

Because sample collection and analysis from each of the three counties began in different years the results are affected by changing weather patterns. In 2006 half of the samples were collected at times when stream flow was higher than the 81-year average monthly flow (Figure 15). But since January 2007 stream flow during sample collection has never exceeded the average monthly flow. In fact it has only been equal to the average monthly flow once during that period, and during the summer months the flow has been well below average. Thus all of the samples from Nash County were collected during the prolonged drought, and that should be taken under consideration when viewing the data. It is important to analyze streams over longer periods of time to get a better view of average stream conditions.

Figure 15: Actual stream flow on the day samples were collected at the USGS gauge site on Fishing Creek near Enfield compared to the 81-year monthly average for that stream



Pitt County

The sites in Pitt County have been monitored the longest and samples have been collected under a much wider variety of conditions. Median pH and alkalinity levels exhibit a much greater variation in Pitt County than in Edgecombe and Nash Counties. Moye's Run, Briery Swamp, Conetoe Creek, and Meetinghouse Branch have four of the five lowest median pH levels of the 30 sites monitored, and Moye's Run, Conetoe Creek, Meetinghouse Branch, and

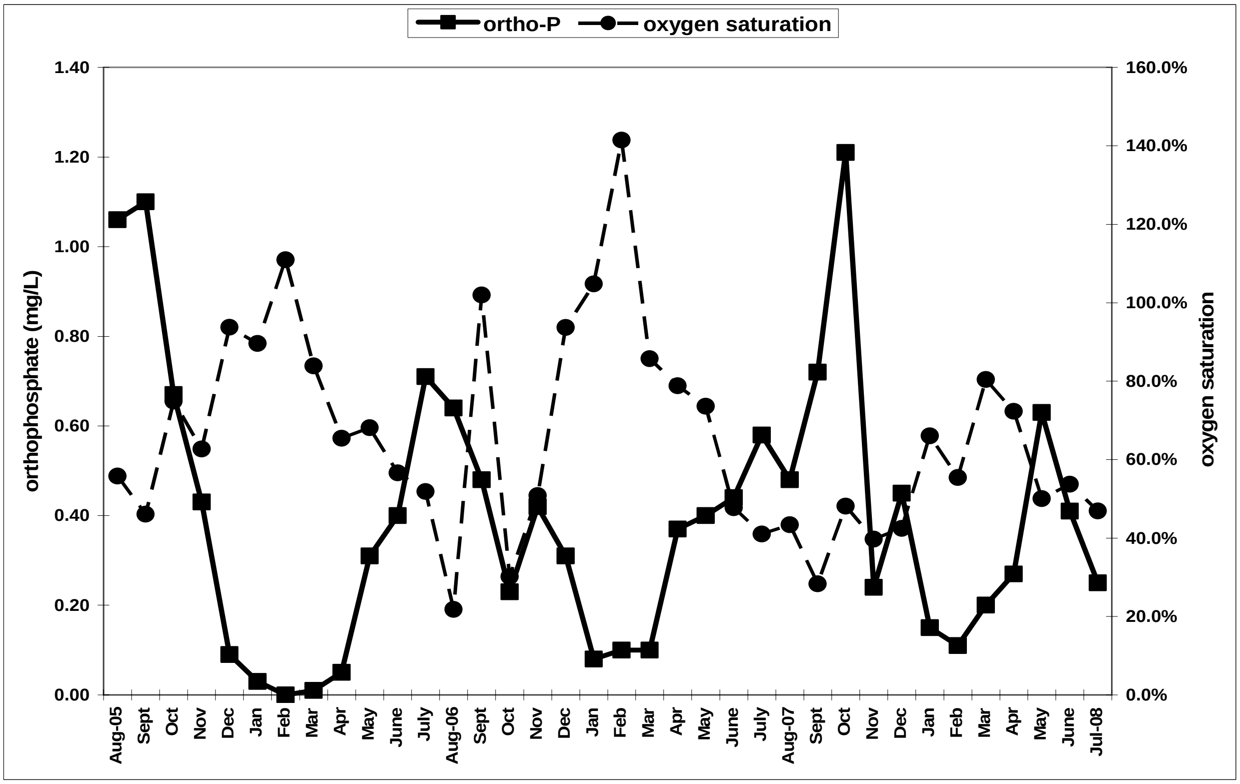
Grindle Creek have four of the five lowest median alkalinity levels of the 30 sites monitored. On the other hand, Green Mill Run has the highest median pH level of the 30 sites, and the third highest median alkalinity level.

Of the ten Pitt County sites, Briery Swamp exhibits the most consistently elevated turbidity and total suspended solids levels, and median levels at the Moye's Run site are also higher than average. These streams could have more sediment in the stream bed or less stable stream banks. Low water levels can actually result in more sediment in the water at some sites with heavy silt deposits because there is less water to dilute the water/silt mix. Moye's Run and the upstream site on Green Mill Run have exhibited excessive stream sedimentation during rain events, and Green Mill Run even occasionally during very dry weather. Green Mill Run is a very urban stream and might be more vulnerable to sedimentation from development. In general, however, median turbidity and total suspended solids levels are lower in Pitt County than in the other two counties. Seven of the ten sites with the lowest median turbidity and total suspended solids levels are in Pitt County even though sample collection has been occurring longer and during years with greater rainfall than in the other two counties.

Overall, median conductivity levels are higher at the Pitt County sites than the sites in the other two counties. Six of the ten sites with the highest median conductivity levels are in Pitt County. Six of the ten sites with the highest zinc concentrations are also in Pitt County. Elevated zinc concentrations are often caused by road runoff, and many of the sites in Pitt County are clustered in and around Greenville including Meetinghouse Branch, Green Mill Run, Parker Creek, and Hardee Creek. Sites with higher conductivity levels in Pitt County, such as Conetoe Creek, Grindle Creek, and Chicod Creek are located more in the rural areas. Moye's Run, Green Mill Run, and Parker Creek show both elevated conductivity levels and zinc concentrations. Many pollutants can affect conductivity levels, thus conductivity can be a general indication of pollutants entering a stream from either agricultural or urban sources.

Median orthophosphate and nitrate/nitrite-nitrogen levels are near average for the region at most of the Pitt County sites, but there are some exceptions. Median orthophosphate concentrations are well above average at the Green Mill Run site, and especially at the Chicod Creek site. Chicod Creek also has higher than average median ammonia-nitrogen concentrations and lower than average dissolved oxygen concentrations. The first three years of monitoring suggest an inverse relationship between orthophosphate concentrations and dissolved oxygen saturation levels at the Chicod Creek site (Figure 16), although both may be affected by season and stream flow. The Chicod Creek site also has a higher average water temperature than most of the other sites. Temperature and dissolved oxygen levels are probably affected by the high percentage of wetlands in the watershed.

The sites at Moye's Run, Grindle Creek, and Conetoe Creek all have much higher median nitrate/nitrite-nitrogen concentrations than any of the other Pamlico-Tar watershed monitoring **Figure 16: Orthophosphate concentrations and percent dissolved oxygen saturation each monitoring day at the Chicod Creek site**

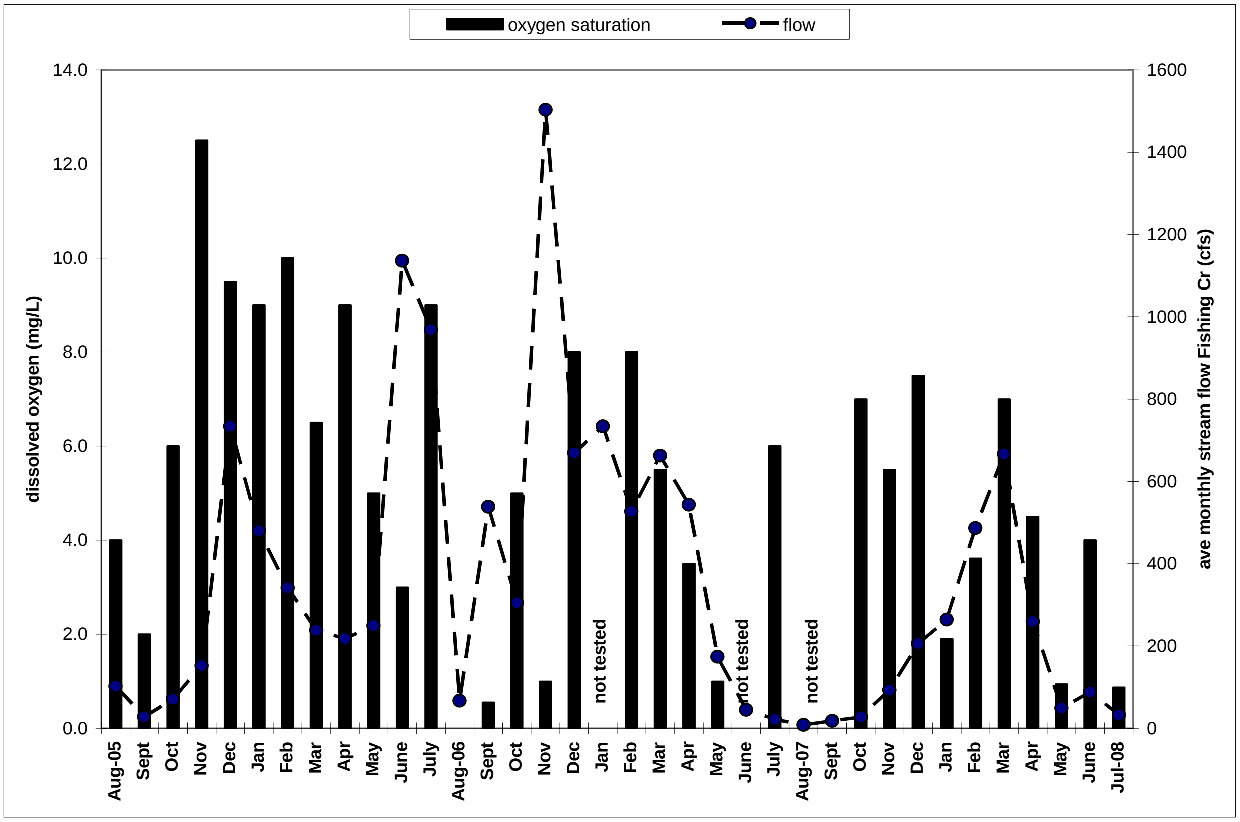


sites. These watersheds are all heavily agricultural and could be influenced by runoff from livestock waste or from fertilizer. With the exception of Chicod Creek and Briery Swamp, the Pitt County sites have higher dissolved oxygen concentrations than most of the other sites monitored in the Pamlico-Tar watershed, but the drought has affected some sites. During the first year of monitoring at Briery Swamp the median dissolved oxygen concentration was 7.8mg/L, but it has declined in the past two years to 5.0mg/L in the second year, and 4.0mg/L in the third year of monitoring. The drought could have influenced dissolved oxygen concentrations in the stream if the flow slowed considerably. There is no flow meter on Briery Swamp, but comparing the flow at the USGS site on Fishing Creek with dissolved oxygen concentrations each month at the Briery Swamp site provides some insight into the possible effects of prolonged drought conditions (Figure 17). Ammonia-nitrogen concentrations are also elevated at the Briery Creek site, and were significantly higher in the third year of monitoring. Increased breakdown of organic matter can elevate ammonia-N concentrations and cause dissolved oxygen concentrations to decline.

Edgecombe County

In general, the Edgecombe County sites have poorer water clarity and higher nutrient concentrations than the Pitt County sites. Median turbidity, total suspended solids, and orthophosphate levels are particularly elevated at the Cokey Swamp and Beech Swamp sites.

Figure 17: **Dissolved oxygen concentrations each month at the Briery Swamp site compared to average monthly stream flow at the USGS gauging station on Fishing Creek**



The upstream site on Cokey Swamp has the highest median orthophosphate concentration of the 30 sites monitored, and the downstream site ranks 26th out of 30. The Beech Swamp and upstream site on Cokey Swamp also rank in the bottom 5 of the 30 sites for turbidity and total suspended solids, and the Beech Swamp site with the highest median conductivity levels ranks 30th of the 30 sites for conductivity. Median heavy metals concentrations are also higher at these two sites than at most other sites. Both sites are on the outskirts of Rocky Mount and may be partially influenced by urban runoff, but agricultural runoff could also be a significant influence. Because the Beech Swamp site and upstream site on Cokey Swamp have elevated median levels of almost all parameters, as well as relatively low oxygen concentrations, they are the two of the lowest rated sites of the 30 analyzed. Although there is less oxygen in the water at the downstream site on Cokey Swamp compared to the upstream site, median levels of all chemical parameters are slightly lower, so the downstream site rates 24th of 30.

Town Creek, a tributary of Cokey Swamp, generally falls in the middle range for most parameters relative to all of the other sites, but nutrient concentrations are higher than the overall average at the Town Creek site. Town Creek is a heavily agricultural subwatershed. Similar to the Cokey Swamp sites, oxygen concentrations are also low at the Town Creek site.

Hendricks Creek also rates relatively low compared with the other sites largely because of elevated heavy metals and nitrate-nitrogen concentrations. The monitoring site is in Tarboro and it is the most urban site of the ten sites monitored in Edgecombe County. Only one other site of the 30 monitored has median zinc concentrations greater than Hendricks Creek. Elevated zinc levels are one of the most common indications of urban runoff. Oxygen concentrations have remained good at all times at the Hendricks Creek site, and median levels are the best of the ten sites in Edgecombe County.

Swift Creek is one of the two highest rated sites of the 30 monitored based on the parameters analyzed, but its tributary, White Oak Swamp, rates much lower. Swift Creek is one of the largest watersheds of the 30 monitored, and White Oak Creek is a relatively small tributary in a largely agricultural area. The Swift Creek site has the lowest median levels of most parameters of all sites in Edgecombe County, and lower median levels than most of the sites in the other two counties as well. Median dissolved oxygen concentrations, however, are only average, and maximum oxygen concentrations have been lower than most other sites. The White Oak Creek water is more turbid than most other sites, and nutrient concentrations are somewhat higher than at most sites. Oxygen concentrations are about the same at both the Swift Creek and White Oak Creek sites.

Fishing Creek is a very large watershed, and Deep Creek is a fairly large tributary of that watershed. Fishing Creek rates well compared to the other monitored streams. Nutrient and heavy metals concentrations are low, and median conductivity levels are also low. Median turbidity is a little higher than at most sites, and sediment concentrations have been more elevated than most when samples were collected following a storm. The greatest problem, however, is unusually low oxygen concentrations. Oxygen saturation has been below 60% on half of all monitoring events. The dry weather and slower than normal flow could be part of the reason. Deep Creek rates lower than Fishing Creek largely because nutrient concentrations are much more elevated. In fact, Deep Creek has one of the highest median ammonia-nitrogen concentrations of the 30 sites monitored, and higher median orthophosphate concentrations than most sites. Maximum orthophosphate concentrations have also been higher at the Deep Creek site than at most other sites. Deep Creek is largely an agricultural watershed. Dissolved oxygen concentrations are higher at the Deep Creek site than at the Fishing Creek site, and are about average for the sites in Edgecombe County.

Pender’s Mill Run has shown overall average water quality results compared to the other sites analyzed, but median and maximum orthophosphate concentrations have been much greater compared to the other sites. Ammonia-nitrogen and nitrate/nitrite-nitrogen concentrations have remained in the average range, and conductivity and heavy metals levels have remained relatively low, so it is difficult to determine the source of the elevated phosphorus levels. Sometimes elevated phosphorus concentrations are caused by wastewater effluent entering a stream, and this could be investigated, but other sources are also possible. Oxygen concentrations are slightly better at the Pender’s Mill Run site than at most other sites in Edgecombe County, and minimum levels have not fallen as low as they have at most other sites.

Nash County

It is more difficult to come to conclusions about water quality with only one year of data, and it must be noted that samples from Nash County were collected during a prolonged drought, and that can affect the results. In general, although water quality has varied greatly at the Nash County sites, most sites rate in the bottom third overall of the 30 sites monitored in the Pamlico-Tar River watershed. However, two of the sites, Red Bud Creek and Stony Creek downstream, are in the top three overall best water quality based on median levels of the parameters analyzed (not including pH and alkalinity).

Red Bud Creek has exhibited the best overall water quality of the 30 sites monitored in the Pamlico-Tar River watershed. Median levels of all parameters are low, and maximum levels have never been extreme, although turbidity was elevated when samples were collected following a storm in March 2008. Oxygen concentrations are occasionally a little lower than desirable, but overall are good.

The Stony Creek sites have also generally exhibited good water quality with median levels of most parameters slightly lower at the downstream site than at the upstream site. Although the downstream site is in Rocky Mount, median zinc and copper concentrations are actually slightly higher at the upstream site. Median turbidity and total suspended solids levels are higher at the upstream site, but maximum levels are higher at the downstream site. Nutrient concentrations are almost identical at the two sites, but dissolved oxygen concentrations are generally much better at the downstream site.

All of the other sites in Nash County have exhibited poorer water quality overall than most other sites monitored in the Pamlico-Tar River watershed. Pig Basket Creek, a tributary of Stony Creek, is one of the most turbid streams of the 30 analyzed, and stream sedimentation is a consistent problem. However, maximum turbidity and total suspended solids levels have remained lower than most sites. Pig Basket Creek has the highest median ammonia-nitrogen concentrations of the 30 sites analyzed, and the highest nitrate/nitrite-nitrogen concentrations of the sites in Nash County, and maximum concentrations of both nitrogen parameters have also been quite elevated. Dissolved oxygen concentrations are average relative to the sites in Nash County.

Little Sapony Creek is the second lowest rated site of the 30 monitored sites. Median turbidity and total suspended solids levels far exceed most other sites, conductivity, nitrogen, and heavy metals levels exceed most other sites, and median dissolved oxygen concentrations are low. This would be a difficult environment for many aquatic organisms not adapted to poor water quality to survive. Although water quality at the Sapony Creek site is similar in some ways to Little Sapony Creek, median levels of most parameters are lower at the Sapony Creek site, and median dissolved oxygen concentrations are more acceptable. Similar to Little Sapony Creek, median ammonia-nitrogen and nitrate/nitrite-nitrogen concentrations are higher than almost all other sites, and median orthophosphate concentrations are quite low. The Sapony Creek site is downstream from the Little Sapony Creek site and the poor water quality from Little Sapony Creek could be affecting the water quality of Sapony Creek.

The site on Turkey Creek is on the western edge of Nash County. Median turbidity and total suspended solids levels are in the high range, and median dissolved oxygen concentrations are lower than any of the other sites in the three counties. Low dissolved oxygen concentrations create difficult living conditions for many aquatic organisms. As with many of the sites in Nash County, median orthophosphate concentrations are lower than at most sites in Pitt and Edgecombe Counties, but median ammonia-nitrogen concentrations are higher. Nitrate/nitrite-nitrogen concentrations are also higher at the Turkey Creek site that at most other sites in Nash County.

The remaining three sites, Maple Creek, Hornbeam Branch, and Compass Creek are in the vicinity of Rocky Mount. Maple and Compass Creeks exhibit the elevated zinc concentrations commonly found in streams that are affected by urban runoff. Maple Creek also has the highest median copper concentrations of the 30 sites monitored, and higher median lead concentrations than all but two sites. However, neither of these sites ever exceeded standards for lead or zinc concentrations in the first year of monitoring. Maple Creek has exceeded the copper standard twice. At the site on Maple Creek median turbidity and total suspended solids levels are also somewhat higher than average for the sites in the Pamlico-Tar watershed, but maximum levels have not been extremely high. Median dissolved oxygen concentrations are quite low at both the Maple Creek and Compass Creek sites. The sustained low oxygen concentrations are detrimental to many aquatic organisms.

Median heavy metals concentrations are not as elevated at the Hornbeam Branch site and dissolved oxygen concentrations are consistently excellent, but median conductivity levels and orthophosphate concentrations are well above typical levels for the Nash County sites.

Pitt, Edgecombe, and Nash County Overall Analysis

In general, water quality is slightly better at the sites in Pitt County compared to the sites in Edgecombe and Nash Counties. Median turbidity, total suspended solids, and ammonia-nitrogen levels are lower at most sites in Pitt County compared to the sites in Edgecombe and Nash Counties, and dissolved oxygen concentrations are better at most of the Pitt County sites. However, in general, conductivity levels and heavy metals concentrations are somewhat higher at the Pitt County sites. Zinc concentrations are particularly greater at the Greenville area sites. Better control of urban runoff from Greenville might be necessary to reduce pollution from heavy metals. Median pH and alkalinity levels are highest at the Nash County sites. These trends are true even when comparing only the most recent year of data when all 30 sites were being tested. Figures 18, 19, and 20 show median conductivity, total suspended solids, and dissolved oxygen levels at each site for the most recent monitoring year.

Appendix D is a general rating and ranking table for all 30 sites. The table is based on median values of each parameter analyzed excluding pH and alkalinity. Each site is ranked for each parameter with a rating of 1 to 30 with lowest median values receiving a rating of 1 and highest a rating of 30, except in the category of dissolved oxygen where high median levels indicate better water quality. Similar categories, such as turbidity and total suspended solids, the three nutrient parameters, and the three heavy metals parameters, are grouped and ranked together. Thus the five categories are turbidity/stream sedimentation, conductivity, nutrients, heavy metals, and dissolved oxygen. The sum of each category for each site is divided by five and the result is the overall rating. Thus, the higher the resultant value the poorer the overall water quality. Sites are listed in Appendix D based on their rating with best overall water quality ranking 1 and worst ranking 30. The table does not account for sites that may have relatively good water quality during base flow, but may experience extremes from surface runoff during storms.

Figure 18: Median conductivity levels at each site for the most recent monitoring year

(lines indicate averages of median levels for sites in each county)

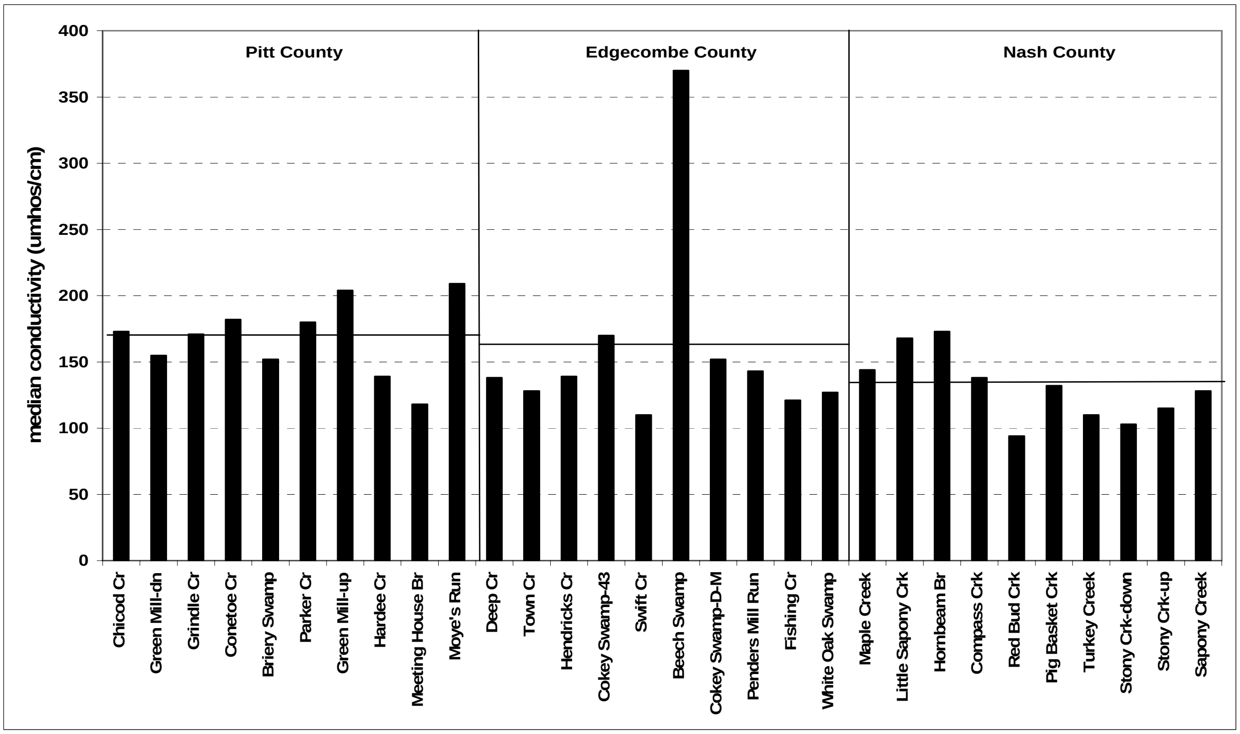


Figure 19: Median total suspended solids concentrations at each site for the most recent monitoring year (lines indicate averages of median levels for sites in each county)

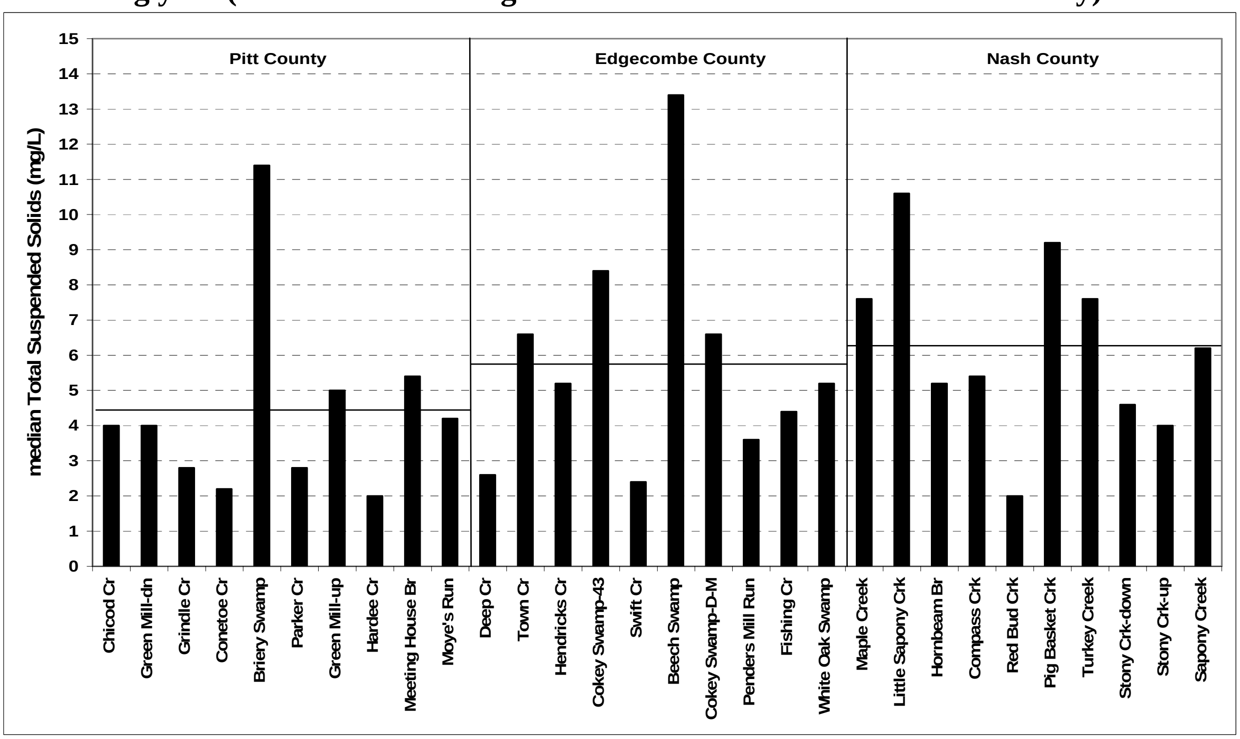
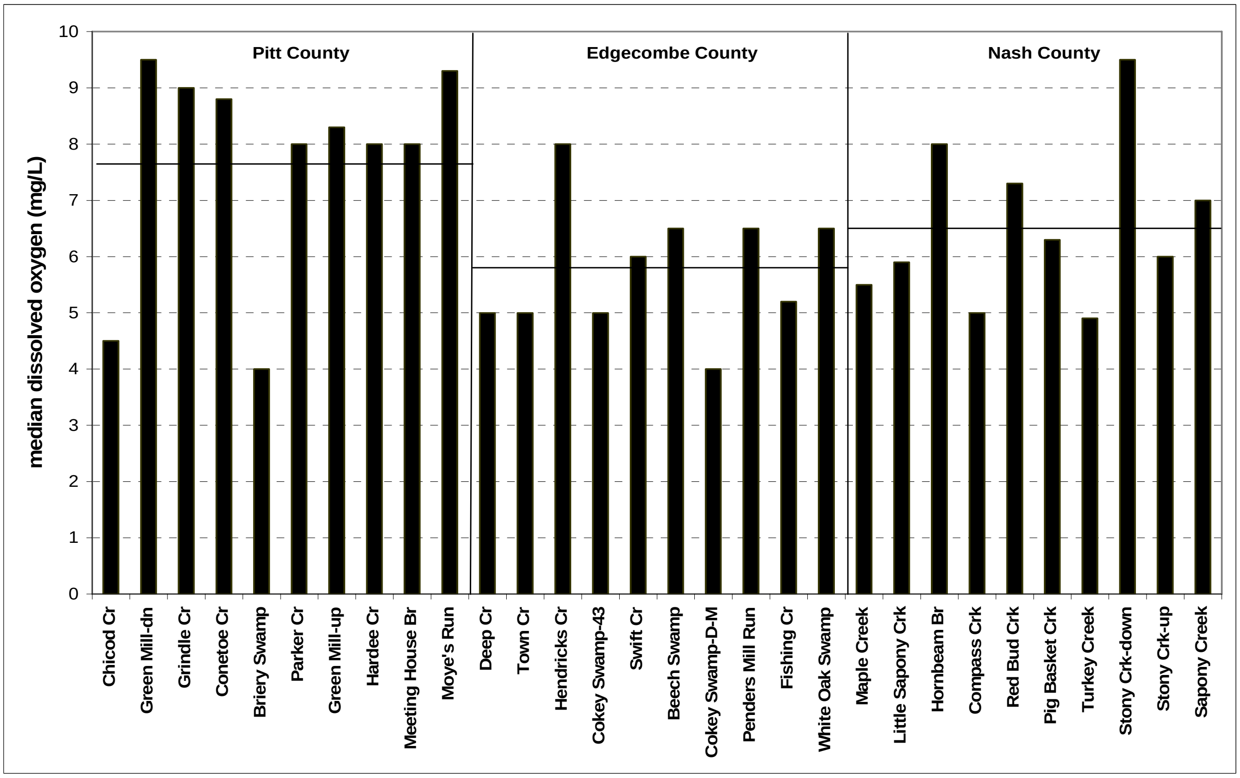


Figure 20: Median dissolved oxygen concentrations at each site for the most recent

monitoring year (lines indicate averages of median levels for sites in each county)



Appendix A: Chain-of-Custody

Volunteer Water Information Network

Pamlico-Tar Watershed

1) Sample Site Number ______________________________

2) Sample Site Name ______________________________

3) Collection Date ____________ Day ____ ____ __________

4) Time Collected ______________________________

5) Volunteer's Name ______________________________

6) Volunteer's Phone# &/or Email: ______________________________

7) Water Flow Rate (please circle one) Very High High Normal Low

8) Type of Rain in past 3 days (please circle one) Heavy Medium Light Dry

9) General Observations (turbidity, waste matter, dead animals upstream, anything out of the ordinary) ______________________________

____

____

10) Dissolved Oxygen - Test 1__________mg/L, Test 2_________mg/L

11) Air Temperature (Taken in shade)_____________°C

12) Water Temperature________________°C

13) Volunteer Signature_______________________Drop-off Time________pm/am

Parameter Results (For Lab Use Only)

Parameter and Result		Date of Analysis
NH3	mg/L	
NO3	mg/L	
Po	mg/L	
Turb	NTU	
TSS	mg/L	
Cond	umhos/cm	
Alk	mg/L	
Cu	ug/L	
Zn	ug/L	
Pb	ug/L	
pH		

Appendix B: Laboratory Analysis

Samples are kept refrigerated until they are delivered to the EQI laboratory on the Monday morning following Saturday collections. Methods follow EPA or Standard Methods for the Examination of Water and Wastewater-18TH – 20TH Edition techniques and the EQI laboratory is certified by the State of North Carolina for water and wastewater analysis of orthophosphate, total phosphorus, ammonia-nitrogen, turbidity, total suspended solids, pH, conductivity, copper, lead, and zinc. All samples are kept refrigerated until the time of analysis. Shipped samples are sent on ice. Analysis for nitrogen, phosphorus, pH, turbidity and conductivity are completed within 48 hours of the collection time. As pH cannot be tested on site, the holding time for pH is exceeded. When immediate analysis does not occur, such as for total phosphorus and heavy metals, the samples are preserved by acidification.

Explanations about the procedures and instruments used in the EQI lab are quite technical in nature and will be omitted from this report. Detailed information is available on request. The reporting limits for each parameter have been provided.

Approximate Analytical Reporting Limits for VWIN Water Quality Parameters.

PARAMETER	REPORTING LIMIT	UNITS
Ammonia Nitrogen	0.02	mg/L
Nitrate/nitrite Nitrogen	0.1	mg/L
Total Phosphorus (as PO_4^{3-})	0.02	mg/L
Orthophosphate (as PO_4^{3-})	0.02	mg/L
Alkalinity	1.0	mg/L
Total Suspended Solids	4.0	mg/L
Conductivity	10.0	umhos/cm
Turbidity	1.0	NTU
Copper	2.0	ug/L
Zinc	20.0	ug/L
Lead	2.0	ug/L
pH	n/a	n/a

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites

Site	the number assigned to the VWIN site
Sample #	the number of samples collected for each parameter
Low	minimum value of any sample(s)
Median	median value for each site for last 3 years and then for all years monitored
High	maximum value of any sample(s)

		pH			
site	site	sample #	low	median	high
1	Chicod Creek	36	6.3	6.8	7.0
2	Green Mill Run-down	35	6.5	6.8	7.1
3	Grindle Creek	36	5.9	6.6	6.9
4	Conetoe Creek	35	5.6	6.5	6.9
5	Briery Swamp	36	4.0	6.3	6.7
6	Parker Creek	34	6.3	6.7	7.0
7	Green Mill Run-up	35	6.6	7.0	7.5
8	Hardee Creek	35	6.5	6.8	7.2
9	Meeting House Branch	36	6.2	6.5	6.7
10	Moye's Run	34	4.8	6.2	7.2
11	Deep Creek	24	5.6	6.4	7.0
12	Town Creek	24	5.9	6.5	6.8
13	Hendricks	24	6.2	6.5	6.9
14	Cokey Swamp - up	21	6.0	6.5	6.9
15	Swift Creek	24	6.3	6.9	7.2
16	Beech Swamp	23	5.9	6.6	7.0
17	Cokey Swamp - down	23	4.1	6.5	6.7
18	Penders Mill Run	22	6.2	6.6	7.2
19	Fishing Creek	24	6.4	6.9	7.3
20	White Oak Swamp	20	5.8	6.6	7.2
21	Maple Creek	11	6.3	6.8	7.0
22	Little Sapony Creek	10	6.1	6.9	7.5
23	Hornbeam Branch	11	6.3	6.9	7.3
24	Compass Creek	12	6.3	6.7	6.9
25	Red Bud Creek	12	6.5	6.9	7.2
26	Pig Basket Creek	12	6.1	6.7	7.4
27	Turkey Creek	12	6.3	6.8	7.0
28	Stoney Creek - down	12	6.4	6.9	7.0
29	Stoney Creek - up	12	6.4	6.9	7.1
30	Sapony Creek	12	6.1	6.6	7.0

	Alkalinity (mg/L) - rep. limit 1 mg/L			
site	sample #	low	median	high
1	36	19	39	70
2	35	15	36	61
3	36	8	21	43
4	35	9	16	33
5	36	0	23	61
6	34	3	33	50
7	35	14	43	77
8	35	15	29	99
9	36	14	19	43
10	34	5	15	28
11	24	4	23	53
12	24	8	25	56
13	24	15	23	33
14	21	9	30	72
15	24	9	31	90
16	23	15	30	136
17	23	6	26	57
18	22	14	29	60
19	24	12	32	54
20	20	8	22	57
21	11	18	44	81
22	10	10	50	79
23	11	14	29	83
24	12	18	35	66
25	12	21	39	52
26	12	13	42	70
27	12	20	41	65
28	12	19	38	56
29	12	17	40	68
30	12	9	37	64

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Turbidity (NTU) - rep. limit 1 NTU			
site	site	sample #	low	median	high
1	Chicod Creek	36	2.2	4.6	29
2	Green Mill Run-down	35	2.0	6.4	50
3	Grindle Creek	36	1.7	7.1	95
4	Conetoe Creek	35	1.4	4.7	65
5	Briery Swamp	36	1.7	10.1	55
6	Parker Creek	34	2.5	4.7	70
7	Green Mill Run-up	35	2.4	6.4	280
8	Hardee Creek	35	1.9	5.6	30
9	Meeting House Branch	36	3.2	5.8	65
10	Moye's Run	34	2.1	8.2	130
11	Deep Creek	24	2.1	6.6	14
12	Town Creek	24	2.9	8.0	30
13	Hendricks	24	2.1	6.6	45
14	Cokey Swamp - up	21	5.0	14.0	70
15	Swift Creek	24	2.4	6.2	19
16	Beech Swamp	23	4.6	14.0	55
17	Cokey Swamp - down	23	2.9	8.6	38
18	Penders Mill Run	22	4.9	8.3	31
19	Fishing Creek	24	3.9	7.8	65
20	White Oak Swamp	20	3.0	9.6	37
21	Maple Creek	11	3.2	8.4	45
22	Little Sapony Creek	10	4.3	20.0	32
23	Hornbeam Branch	11	0.2	7.3	75
24	Compass Creek	12	3.0	8.1	27
25	Red Bud Creek	12	1.8	4.2	40
26	Pig Basket Creek	12	4.7	14.5	25
27	Turkey Creek	12	4.3	10.5	40
28	Stoney Creek - down	12	3.2	6.8	50
29	Stoney Creek - up	12	4.1	7.3	30
30	Sapony Creek	12	3.8	8.2	28

	TSS (mg/L) - rep. limit 4 mg/L			
site	sample #	low	median	high
1	36	0.0	3.4	24.8
2	35	0.0	2.8	26.4
3	36	0.0	3.0	62.4
4	35	0.0	3.2	50.4
5	36	0.6	8.5	44.8
6	34	0.0	2.0	96.8
7	35	0.0	3.2	137.2
8	35	0.8	2.0	14.4
9	36	2.0	3.8	44.0
10	34	0.0	6.9	137.6
11	24	1.2	3.6	17.2
12	24	1.6	4.8	18.8
13	24	1.6	5.6	70.0
14	21	2.0	8.4	41.2
15	24	1.2	2.4	12.8
16	23	2.4	8.0	189.2
17	23	1.6	5.2	40.4
18	22	0.8	3.2	22.0
19	24	1.2	4.6	74.8
20	20	0.8	4.6	35.6
21	11	2.4	7.6	27.2
22	10	1.2	10.6	16.4
23	11	2.4	5.2	70.4
24	12	1.2	5.4	25.2
25	12	0.0	2.0	27.6
26	12	0.8	9.2	16.5
27	12	2.8	7.6	20.8
28	12	1.6	4.6	36.4
29	12	0.8	4.0	14.8
30	12	1.6	6.2	18.4

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Conductivity - (umhos/cm)-rep. limit 10 umhos/cm			
site	site	sample #	low	median	high
1	Chicod Creek	36	100	145	357
2	Green Mill Run-down	35	38	141	199
3	Grindle Creek	36	47	161	227
4	Conetoe Creek	35	111	170	241
5	Briery Swamp	36	71	123	575
6	Parker Creek	34	49	160	235
7	Green Mill Run-up	35	32	157	229
8	Hardee Creek	35	84	135	167
9	Meeting House Branch	36	38	111	165
10	Moye's Run	34	65	199	272
11	Deep Creek	24	77	116	272
12	Town Creek	24	71	111	206
13	Hendricks	24	79	128	174
14	Cokey Swamp - up	21	70	130	303
15	Swift Creek	24	52	92	174
16	Beech Swamp	23	80	275	636
17	Cokey Swamp - down	23	85	116	406
18	Penders Mill Run	22	74	110	164
19	Fishing Creek	24	68	91	171
20	White Oak Swamp	20	89	109	252
21	Maple Creek	11	67	144	215
22	Little Sapony Creek	10	71	168	190
23	Hornbeam Branch	11	85	173	327
24	Compass Creek	12	88	138	298
25	Red Bud Creek	12	62	94	117
26	Pig Basket Creek	12	64	132	211
27	Turkey Creek	12	68	110	138
28	Stoney Creek - down	12	66	103	151
29	Stoney Creek - up	12	66	115	159
30	Sapony Creek	12	75	128	195

	Copper (ug/L) - rep. limit 2 ug/L			
site	sample #	low	median	high
1	36	<2	2.7	17.6
2	35	<2	1.2	23.5
3	36	<2	1.0	5.8
4	35	<2	0.9	3.5
5	36	<2	1.5	14.5
6	34	<2	1.3	7.1
7	35	<2	1.4	7.3
8	35	<2	1.5	4.3
9	36	<2	1.2	7.4
10	34	<2	0.5	6.0
11	24	<2	2.0	11.5
12	24	<2	1.5	8.8
13	24	<2	3.6	15.5
14	21	<2	2.2	4.3
15	24	<2	1.2	7.5
16	23	<2	3.2	7.8
17	23	<2	2.0	5.4
18	22	<2	0.9	5.1
19	24	<2	1.4	4.2
20	20	<2	1.5	4.4
21	11	<2	3.7	8.9
22	10	<2	2.5	7.8
23	11	<2	0.9	3.5
24	12	<2	1.4	5.1
25	12	<2	0.8	3.5
26	12	<2	2.4	4.2
27	12	<2	1.7	4.6
28	12	<2	1.2	3.9
29	12	<2	2.5	6.7
30	12	<2	2.2	5.0

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Lead (ug/L) - rep. limit 2 ug/L			
site	site	sample #	low	median	high
1	Chicod Creek	36	<2	0.6	2.8
2	Green Mill Run-down	35	<2	0.7	4.3
3	Grindle Creek	36	<2	0.7	3.1
4	Conetoe Creek	35	<2	0.6	4.4
5	Briery Swamp	36	<2	0.8	2.8
6	Parker Creek	34	<2	0.8	9.6
7	Green Mill Run-up	35	<2	0.7	21.8
8	Hardee Creek	35	<2	0.5	2.3
9	Meeting House Branch	36	<2	0.4	2.3
10	Moye's Run	34	<2	0.5	3.8
11	Deep Creek	24	<2	0.6	<2
12	Town Creek	24	<2	0.7	<2
13	Hendricks	24	<2	1.0	7.6
14	Cokey Swamp - up	21	<2	1.3	3.7
15	Swift Creek	24	<2	0.5	<2
16	Beech Swamp	23	<2	1.2	3.4
17	Cokey Swamp - down	23	<2	0.8	3.7
18	Penders Mill Run	22	<2	0.7	2.1
19	Fishing Creek	24	<2	0.6	3.6
20	White Oak Swamp	20	<2	0.5	2.9
21	Maple Creek	11	<2	1.2	3.1
22	Little Sapony Creek	10	<2	1.3	3.7
23	Hornbeam Branch	11	<2	0.9	3.0
24	Compass Creek	12	<2	0.7	2.0
25	Red Bud Creek	12	<2	0.3	2.0
26	Pig Basket Creek	12	<2	0.6	<2
27	Turkey Creek	12	<2	0.8	2.3
28	Stoney Creek - down	12	<2	0.7	2.5
29	Stoney Creek - up	12	<2	0.6	2.9
30	Sapony Creek	12	<2	0.9	<2

	Zinc - (ug/L) rep. limit 20 ug/L			
site	sample #	low	median	high
1	36	<20	10.0	185.9
2	35	<20	20.1	247.8
3	36	<20	11.8	189.3
4	35	<20	8.7	35.7
5	36	<20	11.3	399.8
6	34	<20	16.8	84.2
7	35	<20	13.3	49.0
8	35	<20	14.1	53.7
9	36	<20	26.7	723.6
10	34	<20	23.8	72.9
11	24	<20	8.0	43.6
12	24	<20	11.3	33.3
13	24	<20	24.5	66.2
14	21	<20	13.0	192.3
15	24	<20	5.1	50.8
16	23	<20	13.5	24.4
17	23	<20	10.1	203.0
18	22	<20	6.0	23.0
19	24	<20	4.3	<20
20	20	<20	11.1	82.3
21	11	<20	17.6	41.2
22	10	<20	12.4	56.8
23	11	<20	10.4	46.3
24	12	<20	17.6	25.3
25	12	<20	1.5	<20
26	12	<20	8.9	<20
27	12	<20	9.7	35.8
28	12	<20	7.3	<20
29	12	<20	10.2	<20
30	12	<20	8.9	<20

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Orthophosphate (mg/L as PO4)-rep. lim. 0.02 mg/L			
site	site	sample #	low	median	high
1	Chicod Creek	36	0.00	0.39	1.21
2	Green Mill Run-down	35	0.01	0.14	0.34
3	Grindle Creek	36	0.01	0.06	0.92
4	Conetoe Creek	35	0.01	0.06	0.21
5	Briery Swamp	36	0.00	0.09	0.98
6	Parker Creek	34	0.01	0.11	0.39
7	Green Mill Run-up	35	0.01	0.21	0.49
8	Hardee Creek	35	0.01	0.06	0.20
9	Meeting House Branch	36	0.00	0.04	0.44
10	Moye's Run	34	0.01	0.04	1.33
11	Deep Creek	24	0.01	0.18	0.64
12	Town Creek	24	0.02	0.12	0.34
13	Hendricks	24	0.02	0.09	0.23
14	Cokey Swamp - up	21	0.07	0.40	0.69
15	Swift Creek	24	0.01	0.05	0.18
16	Beech Swamp	23	0.03	0.12	1.42
17	Cokey Swamp - down	23	0.01	0.20	0.92
18	Penders Mill Run	22	0.04	0.26	0.82
19	Fishing Creek	24	0.01	0.07	0.21
20	White Oak Swamp	20	0.01	0.11	0.81
21	Maple Creek	11	0.01	0.10	0.43
22	Little Sapony Creek	10	0.00	0.03	0.11
23	Hornbeam Branch	11	0.04	0.13	0.18
24	Compass Creek	12	0.01	0.05	0.38
25	Red Bud Creek	12	0.02	0.05	0.10
26	Pig Basket Creek	12	0.01	0.07	0.17
27	Turkey Creek	12	0.01	0.04	0.10
28	Stoney Creek - down	12	0.03	0.08	0.24
29	Stoney Creek - up	12	0.02	0.08	0.19
30	Sapony Creek	12	0.00	0.03	0.16

	Orthophosphate (mg/L as P)-rep. lim. 0.01 mg/L			
site	sample #	low	median	high
1	36	0.00	0.13	0.39
2	35	0.00	0.05	0.11
3	36	0.00	0.02	0.30
4	35	0.00	0.02	0.07
5	36	0.00	0.03	0.32
6	34	0.00	0.04	0.13
7	35	0.00	0.07	0.16
8	35	0.00	0.02	0.07
9	36	0.00	0.01	0.14
10	34	0.00	0.01	0.43
11	24	0.00	0.06	0.21
12	24	0.01	0.04	0.11
13	24	0.01	0.03	0.07
14	21	0.02	0.13	0.22
15	24	0.00	0.02	0.06
16	23	0.01	0.04	0.46
17	23	0.00	0.07	0.30
18	22	0.01	0.08	0.27
19	24	0.00	0.02	0.07
20	20	0.00	0.04	0.26
21	11	0.00	0.03	0.14
22	10	0.00	0.01	0.04
23	11	0.01	0.04	0.06
24	12	0.00	0.02	0.12
25	12	0.01	0.02	0.03
26	12	0.00	0.02	0.06
27	12	0.00	0.01	0.03
28	12	0.01	0.03	0.08
29	12	0.01	0.03	0.06
30	12	0.00	0.01	0.05

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Ammonia-nitrogen (mg/L) - rep. lim. 0.02 mg/L			
site	site	sample #	low	median	high
1	Chicod Creek	36	0.21	0.40	0.63
2	Green Mill Run-down	35	0.15	0.26	0.41
3	Grindle Creek	36	0.11	0.27	0.82
4	Conetoe Creek	35	0.12	0.19	0.65
5	Briery Swamp	36	0.26	0.46	2.85
6	Parker Creek	34	0.04	0.19	0.45
7	Green Mill Run-up	35	0.13	0.27	3.55
8	Hardee Creek	35	0.12	0.24	0.41
9	Meeting House Branch	36	0.10	0.24	0.43
10	Moye's Run	34	0.07	0.18	0.42
11	Deep Creek	24	0.16	0.47	0.84
12	Town Creek	24	0.02	0.41	1.09
13	Hendricks	24	0.14	0.31	0.66
14	Cokey Swamp - up	21	0.22	0.45	0.76
15	Swift Creek	24	0.14	0.28	0.48
16	Beech Swamp	23	0.20	0.39	0.99
17	Cokey Swamp - down	23	0.19	0.38	0.69
18	Penders Mill Run	22	0.19	0.28	0.50
19	Fishing Creek	24	0.11	0.26	0.51
20	White Oak Swamp	20	0.23	0.37	0.63
21	Maple Creek	11	0.23	0.30	0.63
22	Little Sapony Creek	10	0.38	0.42	0.67
23	Hornbeam Branch	11	0.17	0.45	0.56
24	Compass Creek	12	0.26	0.37	0.87
25	Red Bud Creek	12	0.21	0.28	0.42
26	Pig Basket Creek	12	0.35	0.48	0.97
27	Turkey Creek	12	0.21	0.37	0.57
28	Stoney Creek - down	12	0.14	0.32	0.45
29	Stoney Creek - up	12	0.19	0.31	0.60
30	Sapony Creek	12	0.22	0.47	1.04

	Nitrate/nitrite-nitrogen (mg/L)- rep. limit 0.1 mg/L			
site	sample #	low	median	high
1	36	0.3	0.6	1.3
2	35	0.4	0.7	1.1
3	36	0.4	1.7	2.6
4	35	0.2	2.1	3.3
5	36	0.2	0.8	1.9
6	34	0.3	0.8	1.5
7	35	0.2	0.8	1.3
8	35	0.2	0.8	1.2
9	36	0.3	0.8	1.7
10	34	0.4	2.5	3.1
11	24	0.2	0.8	1.6
12	24	0.4	0.9	2.1
13	24	0.7	1.1	1.6
14	21	0.3	0.9	1.4
15	24	0.2	0.5	0.8
16	23	0.4	0.8	1.5
17	23	0.1	0.8	1.7
18	22	0.4	0.8	1.1
19	24	0.3	0.6	1.1
20	20	0.5	0.9	1.3
21	11	0.2	0.7	2.8
22	10	0.4	1.0	1.7
23	11	0.4	0.8	1.2
24	12	0.2	0.7	1.1
25	12	0.3	0.5	1.0
26	12	0.4	1.2	3.2
27	12	0.3	0.9	1.3
28	12	0.2	0.6	1.3
29	12	0.3	0.6	1.5
30	12	0.2	0.9	4.0

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Water Temperature (degrees C)			
site	site	sample #	low	median	high
1	Chicod Creek	36	3.0	18.5	27.0
2	Green Mill Run-down	35	7.0	16.0	26.1
3	Grindle Creek	36	7.0	17.5	27.0
4	Conetoe Creek	35	6.3	18.1	29.5
5	Briery Swamp	36	3.0	17.5	27.0
6	Parker Creek	34	7.0	17.1	27.0
7	Green Mill Run-up	34	5.0	17.0	26.0
8	Hardee Creek	35	5.0	16.0	27.0
9	Meeting House Branch	36	7.0	18.8	28.0
10	Moye's Run	34	8.0	17.8	27.0
11	Deep Creek	24	4.0	16.0	26.0
12	Town Creek	24	5.0	17.5	26.0
13	Hendricks	24	7.0	15.5	21.0
14	Cokey Swamp - up	21	4.0	16.0	28.0
15	Swift Creek	22	2.0	18.5	28.0
16	Beech Swamp	23	4.5	16.0	27.0
17	Cokey Swamp - down	23	3.0	16.0	27.0
18	Penders Mill Run	21	5.0	15.0	26.0
19	Fishing Creek	24	4.0	17.0	28.0
20	White Oak Swamp	19	6.0	16.0	26.0
21	Maple Creek	11	9.0	17.0	25.0
22	Little Sapony Creek	10	7.8	19.7	27.8
23	Hornbeam Branch	11	8.0	20.5	26.0
24	Compass Creek	10	7.0	16.8	29.0
25	Red Bud Creek	12	6.9	16.4	24.6
26	Pig Basket Creek	12	5.0	17.5	27.0
27	Turkey Creek	12	5.4	17.2	26.3
28	Stoney Creek - down	12	9.0	19.5	28.0
29	Stoney Creek - up	12	7.0	18.0	27.0
30	Sapony Creek	6	8.0	21.0	27.7

	Water Temperature (degrees F)			
site	sample #	low	median	high
1	24	37.4	65.3	80.6
2	24	44.6	60.8	79.0
3	24	44.6	63.5	80.6
4	23	43.3	64.6	85.1
5	24	37.4	63.5	80.6
6	23	44.6	62.8	80.6
7	23	41.0	62.6	78.8
8	23	41.0	60.8	80.6
9	24	44.6	65.8	82.4
10	24	46.4	64.0	80.6
11	12	39.2	60.8	78.8
12	12	41.0	63.5	78.8
13	12	44.6	59.9	69.8
14	12	39.2	60.8	82.4
15	11	35.6	65.3	82.4
16	11	40.1	60.8	80.6
17	11	37.4	60.8	80.6
18	11	41.0	59.0	78.8
19	12	39.2	62.6	82.4
20	12	42.8	60.8	78.8
21	11	48.2	62.6	77.0
22	10	46.0	67.5	82.0
23	11	46.4	68.9	78.8
24	10	44.6	62.2	84.2
25	12	44.4	61.5	76.3
26	12	41.0	63.5	80.6
27	12	41.7	63.0	79.3
28	12	48.2	67.1	82.4
29	12	44.6	64.4	80.6
30	6	46.4	69.8	81.9

Appendix C: Data Summary for Pamlico-Tar River Watershed Monitoring Sites - continued

		Dissolved Oxygen (mg/L)			
site	site	sample #	low	median	high
1	Chicod Creek	36	2.0	6.0	13.5
2	Green Mill Run-down	34	3.9	8.0	11.5
3	Grindle Creek	36	3.0	9.0	12.5
4	Conetoe Creek	33	5.3	9.0	12.0
5	Briery Swamp	32	0.0	5.3	12.5
6	Parker Creek	34	3.0	8.0	13.0
7	Green Mill Run-up	35	6.5	8.0	12.0
8	Hardee Creek	34	5.0	8.0	12.0
9	Meeting House Branch	36	5.0	8.0	13.0
10	Moye's Run	34	5.0	9.0	12.0
11	Deep Creek	23	2.5	6.5	12.0
12	Town Creek	23	2.0	5.5	12.5
13	Hendricks Creek	24	7.0	8.5	11.0
14	Cokey Swamp - up	21	3.0	5.4	12.7
15	Swift Creek	23	3.0	6.5	10.5
16	Beech Swamp	23	0.8	6.5	12.0
17	Cokey Swamp - down	22	0.5	5.3	11.0
18	Penders Mill Run	20	4.0	6.8	12.1
19	Fishing Creek	23	2.0	5.2	11.0
20	White Oak Swamp	17	2.5	7.0	10.0
21	Maple Creek	11	2.0	5.5	10.0
22	Little Sapony Creek	10	2.9	5.9	12.0
23	Hornbeam Branch	11	6.5	8.0	16.5
24	Compass Creek	11	0.7	5.0	9.5
25	Red Bud Creek	12	4.0	7.3	10.1
26	Pig Basket Creek	12	3.0	6.3	10.0
27	Turkey Creek	12	0.9	4.9	9.1
28	Stoney Creek - down	12	3.5	9.5	13.0
29	Stoney Creek - up	12	3.0	6.0	9.5
30	Sapony Creek	11	1.2	7.0	8.0

	Dissolved Oxygen Percent Saturation			
site	sample #	low	median	high
1	36	21.8%	59.7%	141.5%
2	34	41.6%	80.2%	137.7%
3	36	28.3%	97.8%	145.1%
4	33	59.4%	92.7%	110.8%
5	32	0.0%	49.6%	115.4%
6	34	33.7%	81.3%	136.3%
7	34	57.5%	82.5%	122.6%
8	34	62.0%	81.9%	141.9%
9	36	59.7%	86.8%	117.5%
10	34	58.6%	92.8%	121.3%
11	23	24.6%	65.4%	123.3%
12	23	24.3%	57.7%	145.0%
13	24	70.6%	87.2%	129.0%
14	21	25.3%	60.3%	118.5%
15	22	34.9%	66.0%	88.3%
16	23	9.1%	66.9%	127.6%
17	21	6.1%	47.7%	103.2%
18	19	47.7%	73.9%	113.5%
19	23	18.1%	59.7%	135.6%
20	17	30.4%	66.0%	131.9%
21	11	17.7%	58.8%	94.3%
22	10	29.7%	60.8%	120.5%
23	11	67.4%	83.5%	200.7%
24	10	6.9%	43.8%	92.4%
25	12	46.5%	73.9%	92.8%
26	12	23.4%	60.5%	90.3%
27	12	9.8%	52.3%	87.0%
28	12	44.2%	83.9%	141.8%
29	12	30.2%	67.4%	87.7%
30	5	15.2%	36.1%	86.4%

Appendix D: Site Rating and Ranking Table

site #	site name	overall rating #	rank
25	Red Bud Creek	5.1	1
15	Swift Creek	7.2	2
28	Stoney Creek - down	8.4	3
9	Meeting House Branch	9.5	4
8	Hardee Creek	10.8	5
4	Conetoe Creek	10.9	6
19	Fishing Creek	12.0	7
2	Green Mill Run-down	12.1	8
6	Parker Creek	12.6	9
18	Penders Mill Run	12.7	10
3	Grindle Creek	12.8	11
20	White Oak Swamp	14.0	12
7	Green Mill Run-up	14.3	13
11	Deep Creek	14.4	14
29	Stoney Creek - up	14.8	15
10	Moye's Run	15.3	16
1	Chicod Creek	16.2	17
13	Hendricks Creek	16.4	18
12	Town Creek	17.4	19
30	Sapony Creek	17.5	20
23	Hornbeam Branch	18.5	21
27	Turkey Creek	19.1	22
24	Compass Creek	19.5	23
17	Cokey Swamp - down	19.8	24
5	Briery Swamp	20.0	25
26	Pig Basket Creek	20.5	26
21	Maple Creek	21.7	27
14	Cokey Swamp - up	23.4	28
22	Little Sapony Creek	23.9	29
16	Beech Swamp	24.1	30